Operation and Maintenance Manual

Diesel engine-generator set

MTU 3R0096 DS30 (30 kW Standby) - DG03RJ096V1M00012
Built in North America

132693644E

Order No.	132693644
Serial No.	95090500548

WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information, go to www.P65warnings.ca.gov/diesel

ADVERTENCIA: Respirar los gases del escape de motores a diésel le expone a químicos conocidos por el Estado de California como causantes de cáncer y defectos de nacimiento u otros daños reproductivos.

- Siempre encienda y opere el motor en un área bien ventilada.
- Si es en un área cerrada, ventile el orificio del escape hacia el exterior.
- No modifique ni altere el sistema de escape.
- No encienda el motor, excepto cuando sea necesario.

Para mayor información visite www.P65warnings.ca.gov/diesel

AVERTISSEMENT: Respirer les gaz d'échappement de moteurs diesel peut vous exposer à des agents chimiques identifiés par l'État de Californie comme pouvant causer le cancer et des malformations congénitales ou autres effets nocifs sur la reproduction.

- Toujours démarrer et faire tourner le moteur dans une zone bien aérée.
- Si la zone est mal ventilée, évacuer les gaz d'échappement à l'extérieur.
- Ne pas modifier ou altérer le système d'échappement.
- Ne laisser le moteur tourner au ralenti que si cela est nécessaire.

Pour de plus amples informations, prière de consulter
www.P65warnings.ca.gov/diesel

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1 Safety

1.1 MTU System Safety Section

Important Safety Instructions

Save these Instructions!

This manual contains important instructions for MTU systems and MTU Onsite Energy engine-generator sets that should be followed during the installation and maintenance of the system.

System Safety Considerations

MTU systems or systems utilizing MTU equipment are integrated in a specific application to provide a capability to satisfy a stated need or objective.

In many cases, the system includes components from multiple product manufacturers, facility design considerations, and the use of outside contractors. Complete safety information for the system can include multiple sources in addition to information provided by MTU. It is recommended you obtain and review the latest product application manuals from each manufacturer before design, installation, or commissioning. It is the responsibility of the installation contractor and owner of the system installation site to ensure all local laws, ordinances, and regulations are followed.

Given variations in system requirements, facility design and equipment, incompatibilities may result in potential hazards. If a system design, procedure, or process that is not specifically recommended by MTU is used, you must take responsibility to ensure that it is safe for your application and facility.

UL 2200 Certified

MTU systems, particularly generator-set installations, use UL 2200 as a standard when writing detailed specifications. UL 2200 sets minimum requirements for health and safety of personnel when operating equipment.

As an accepted standard, UL 2200 certification is specified or used by the following:

- Qualified technicians and project planners
- Contractors and specifying engineers
- State and local inspectors
- Federal agencies

UL 2200 addresses the entire generator-set and is primarily concerned with reducing the risk of shock, fire, and machinery-related injuries. This standard also addresses matters such as the routing of fuel lines and safety measures for rotating parts. UL 2200 also requires manufacturers to load-test their generator sets to verify that they can produce nameplate-rated power levels.

System Installation and Commissioning

The safety guidelines and recommendations for the installation and commissioning of the MTU system are described in this manual and the Installation and Commissioning Validation Forms [for your application]. These materials contain specifications and procedures that must be considered by qualified technicians, project planners, and outside contractors when installing and commissioning an MTU system and supporting equipment. Categories include:

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- Transport, handling, and lifting
- System identification
- System room, enclosure, and open unit requirements
- Generator system
- Air inlet system
- Cooling system
- Mounting and foundation
- Fuel system
- Lube oil system
- Exhaust system
- Starting and battery charging system
- Electronic controls
- Electrical connections

TIM-ID: 0000035185 - 005

1.2 Use of MTU Technical Documentation

Access to MTU technical documentation is restricted, due to the highly technical nature of the information. Maintenance and workshop documentation is structured based on Qualification Levels (QLs). Personnel are to be qualified at the appropriate level to carry out specific tasks. The QLs are matched to MTU training courses and a demonstrated proficiency related to various tool kits.

QL1 - Operational monitoring and maintenance tasks that can be done during breaks in operation, and do not require disassembly of the system, engine or any components.

QL2 - Maintenance procedures requiring the exchange of assemblies.

QL3 - Maintenance procedures requiring overhaul of assemblies.

Do not use MTU Technical Documentation or attempt to perform the activities described in this manual if you have not been properly qualified by an MTU-authorized distributor for this QL level.

The information, specifications and illustrations in this manual are based upon information available at the time it was written. The information, specifications and illustrations can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before you start any work on the system, engine or any components.

If you did not receive this manual through MTU, stop all work and contact MTU to make sure you have the appropriate training and qualifications to follow the procedures within.

Keep this Manual near Engine for Personnel [QL1]

This publication must be provided to all MTU-certified personnel involved in any work being done on the engine and a copy must be located in the vicinity of the engine, accessible at all times.

General Responsibilities of Owners and Operators and MTU Technicians [QL1]

Owner and operator responsibilities

In preparation for service of an engine, owners and operators must:

- Keep unauthorized personnel clear of engine service areas.
- Provide a clear path for transport of the engine.
- Provide a service area for the engine.
- Provide proper equipment to transport the engine.
- Provide that lifting and handling of heavy objects are performed or supervised by personal knowledgeable with lifting procedures.
- Provide certified forklift and crane operators.
- Provide proper tools for working on an engine that are properly maintained and calibrated.
- Provide necessary add-on heat generating devices, such as a fuel heater.
- Make sure that servicing of batteries is performed or supervised by personnel knowledgeable with batteries and required battery service procedures.

TIM-ID: 0000035182 - 006

1.3 MTU Engine Safety Section

Preparing to Service Engine

Shut off equipment

You could be seriously injured or killed when working on running equipment. A release or spill of coolant, oil, fuel or hydraulic fluid while the engine is running can cause a fire or explosion. Do not fill coolant or fuel tanks while the engine is running. To reduce the risk of exposure to compressed air, fluids or moving parts, never carry out maintenance and repair work with the engine running and:

- Make sure that nobody is standing in the path of moving parts before barring over or starting the engine.
- Use care when working around moving belts and rotating parts.
- Remove safety guards only to complete service procedures that can only be completed with the guard removed and replace safety guards as soon as possible once the service is completed. Do not crank or start the engine with the safety guards removed unless specifically required in the procedure.

The engine may need to be running for some types of diagnostic activities.

Let engine and exhaust cool down

All exhaust components are hot when the engine is running and remain hot for an extended period after the engine is shut off. Other components and fluids are hot when the engine is running and remain hot for an extended period after the engine is shut off. Allow all components and fluids to cool before working on or near the unit, or use proper precautions to reduce the risk of being burned.

Engine placement [QL3]

When placing an engine in an area to be serviced, remember the following to reduce your risk of injury or death:

- Place the engine on a firm, flat and stable surface capable of supporting the units weight. Unless authorized by an MTU dealer or distributor, never set an engine down on the oil pan.
- Before servicing anything raised by hydraulics, make sure that it is mechanically supported by stands, blocks or a mechanical lock. Never rely on a hydraulic circuit alone when working underneath raised equipment.

Safe Engine Servicing

Following safe work practices can help reduce the risk of serious injury or death to yourself or bystanders when servicing an engine.

Use proper emergency shutdown procedures

If you have an emergency shutdown situation, use the hot shutdown procedure. You may damage the engine. Each emergency situation is unique. Follow the restart procedures in the manual.

Use lockout and tagout procedures

To reduce the risk of severe injury or death from electric shock or unintentional startup, disconnect all electrical power sources and batteries. Additionally, lockout and tagout the equipment before removing protective shields for service or maintenance. Do not remove a lockout tag unless proper authorization is obtained.

Provide proper ventilation

Do not operate this engine in an area where combustible chemicals or vapors may be present. Combustible vapors near the air intake system could be ingested into the engine, causing the engine to suddenly accelerate and overspeed or explode. This condition could cause an unexpected increase in engine rpm or fire. When changing the engine oil or working on the fuel system, make sure that the service area is properly ventilated.

Avoid carbon monoxide poisoning

All engine exhaust contains carbon monoxide, a deadly gas. Breathing carbon monoxide can cause headaches, dizziness, nausea, confusion and eventually death.

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Carbon monoxide is a colorless, odorless, tasteless gas that may be present even if you do not see or smell any engine exhaust. Deadly levels of carbon monoxide can collect rapidly and you can be quickly overcome and unable to save yourself. Also, deadly levels of carbon monoxide can linger for hours or days in enclosed or poorly ventilated areas. If you experience any symptoms of carbon monoxide poisoning, leave the area immediately, get fresh air and seek medical treatment.

To prevent serious injury or death from carbon monoxide:

- Never run engine in poorly ventilated or partially enclosed areas such as barns, garages, basements, carports, under dwellings, or in pits.
- Never run engine outdoors where engine exhaust can be drawn into a building through openings such as windows and doors.
- Make sure that the exhaust pipework is free of leaks and that the gases are discharged into the atmosphere.

Compressed gases and liquids hazards

Remember that you may be exposed to a variety of systems containing gases or fluids under pressure while working on an engine. Equipment does not necessarily have to be running to produce high fluid pressure-residual pressures in stationary circuits can represent a serious safety hazard.

Fluids in both liquid and gaseous states can be dangerous when proper safety precautions are not observed. Pressurized systems may cause fires, flying debris, or burns, and escaping fluid under high pressure, even a pin-hole sized leak, can penetrate body tissue, causing serious injury or death.

Electrical hazards

Hazardous voltages are present within this system. Contact with electrical components can result in electric shock. Disconnect all electrical power, and lockout and tagout the equipment before removing protective shields for service or maintenance.

Battery hazards

Refer to battery manufacturers warnings and instructions when interacting with batteries to reduce the risk of injury or death from electric shock, battery fire or explosion. Remember to:

- Use care when disconnecting battery cables. Always remove the negative side of the battery first.
- Charge batteries in a well-ventilated area and do not smoke in battery charging areas.

Using jumper cables

When starting the engine with an auxiliary or external power source, ground leads must be connected last and removed first. Improper jumper cable connections can cause an explosion that can result in injury. Connect the ground lead from the power source to the ground lead of the engine or to the ground terminal of the starter to avoid sparks in the vicinity of the battery.

Post-Service, Preparing to put Engine back in Service and to Start Engine

Complete all procedures when preparing to put an engine back into service to reduce the risk of serious injury or death to you and bystanders. Keep in mind the following steps to avoid incomplete procedures:

- Make sure all safety guards are in place and secured.
- Check that all protective devices have been reinstalled and all tools removed from the engine.
- Connect and secure all cables that may have become loose.
- Remove all loose components from the engine vicinity.
- Check battery polarity before connecting the cables to the battery.
- Ground the engine in accordance with the requirements in applicable national, state or local codes.
- Clear the area of bystanders before starting the engine.
- Start the engine from the operator station. Never short across the starting motor terminals or the batteries. This could bypass the engine neutral start system or damage the electrical system.
- Complete a successful commissioning inspection.

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1.4 MTU General Shop Safety Section

Personnel requirements

Work on the equipment must only be carried out by appropriately qualified and instructed personnel.

Observe the minimum legal age.

Responsibilities of the operating, maintenance and repair personnel must be specified by the operating company.

Personal Protective Equipment

Personal Protective Equipment (PPE) is required when performing all maintenance work. There are many hazards that you may encounter in the workplace, such as falling objects, flying debris, loud noises, chemical exposure and sharp edges. To reduce your risk of injury when servicing equipment, always consider your activity and remember to wear appropriate protective gear:

- Feet – approved safety shoes (not bare feet, sandals or sneakers)
- Face – approved face shield
- Eyes – protective glasses or goggles
- Ears – hearing protection
- Lungs – respiratory protection
- Head – safety helmet, tied back hair
- Hand – gloves (for example, sleeved heat protective gloves)
- Body – protective clothing – apron, cotton work clothing (no rings, watches, jewelry or loose clothing)

Use of Compressed Air

Follow general shop safety procedures when utilizing compressed air and follow these common rules to reduce your risk of injury:

- Always use a pressure reducing valve and a safety valve and do not exceed 376 kPa (40 psi) air pressure. Make sure that the connected devices and equipment are appropriate for this pressure.
- Make sure that the hose coupling and connections are securely attached together.
- Make sure that the snout of the air nozzle has a protective disc (for example, rubber disc) to prevent airborne particles from being deflected.
- Always shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tools are exchanged.
- Never use compressed air to force flammable liquids out of containers.
- Never force compressed air into thin-walled containers (for example, containers made of tin, plastic or glass) for drying purposes or to check for leaks as the container may shatter.
- Do not direct a compressed-air jet at someone and never use compressed air to clean contaminated clothing while it is worn.

Safe Use of Tools and Equipment

Make sure you understand how to use the tools before performing any service work. Always use tools that are in good conditions and follow manufacturers instructions. Improper use of tools or use of tools in poor condition can increase your risk of injury.

Working from Heights

When working from heights on the engine, always use proper procedures for working at height and follow equipment manufacturers instructions. To reduce your risk of injuries from falls while working on MTU engines, remember to:

- Use suitable ladders and work platforms.
- Make sure components are placed on stable surfaces.
- Never use pressurized lines for climbing or support.

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Welding

When welding, always use proper welding techniques and follow the manufacturers instructions and warning. To reduce your risk of injuries from welding, also keep in mind:

- If components (for example, exhaust manifold) are to be welded, they must be removed from the engine.
- Do not use the assembly or system as ground terminal.
- It is not necessary to remove the connector and the connections when carrying out welding operations on the manufacturers electronics if the master switch for power supply is switched from "ON" to "OFF" and the wire is disconnected from the negative and positive poles on the battery.

Safe Work Space

As with other industrial work, it is important to maintain an area surrounding the engine that is dry, well lit, ventilated and free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist. Make sure a First Aid Kit is available.

Fluids and lubricants must be kept in suitable, properly designated containers. Never put maintenance fluids into glass containers – glass containers can break.

Cleanup

After completion of maintenance and repair work, make sure that no loose objects are in or on the assembly or system. Try to organize parts in bins and on benches when you are disassembling components.

To reduce the risk of injury from slipping and falling, clean up spilled liquids with suitable cleaning agents or as defined by the manufacturers specifications. Clean up oil spills quickly. You can do this by applying absorbent grit: this not only absorbs oil but makes it less likely that a person may slip and fall on an oil slick.

Proper Disposal

Always dispose of all lubricants (motor oil, coolant, gear box oils, and so on.) and filters according to federal or local regulations. Used oil disposed of in nature or waterways contaminates drinking water and kills wildlife.

Fire Prevention

Ignition sources

As in other industrial contexts, there are various potential sources of fire or explosion hazards when working on an engine. To reduce the risk of injury from fire or explosion, be aware of potential ignition sources. Some examples of ignition sources include:

- Electrical sparks or arcs
- Cutting, welding or grinding sparks
- Open flame
- Hot surfaces
- Incandescent lights
- Smoking

Flammable materials and vapors

Avoid exposing potential ignition sources to flammable materials and vapors. Some examples of flammable materials and vapors include:

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- Paint
- Batteries or battery charging areas
- Oxygen and acetylene fuel cylinders
- Diesel fuel
- Fuel gases or vapors
- Engine oil
- Grease
- Textiles soaked in fuels and lubricants
- Most lubricants
- Some coolant mixtures
- Oil and fluid leaks

Clean up spills immediately. Substances spilled onto hot surfaces or electrical components can cause a fire.

To help reduce the severity of a fire, remember to keep appropriate fire extinguishers on hand. Know how to use them according to manufacturers instructions and inspect them regularly.

Noise

Recall that there is a risk of hearing damage, including permanent hearing loss, from exposure to high noise levels (above 85dB). Although this can be the result of a single exposure to a high level of noise, it often results from years of exposure to excessive and repetitive noise levels. Noise can also lead to an increased risk of accident if instructions or sounds indicating danger cannot be heard.

To reduce the risk of injury from hazardous noise levels, remember to wear hearing protection or protective devices for ears when the engine is in operation.

Chemical Safety

When working with fluids, lubricants and other chemical substances, remember to follow the instructions that are provided by other manufacturers or chemical producers and to review/have available material Safety Data Sheets for the products that you are using or coming into contact with.

To reduce the risk of injury from chemical contact, be cautious when handling acids, alkaline solutions, coolant, fuel, paint and preservatives. Follow the chemical manufacturers usage, handling, storage and disposal instructions. To reduce the risk of injury from chemicals, remember the following precautions:

- Make sure that the work area is well-ventilated and wear proper protective equipment (for example, gloves, respiratory protection, goggles) as necessary.
- Protect skin from contact with battery acid or alkaline electrolytes or caustic byproducts.
- Avoid contact with skin.
- Do not fill coolant or fuel tanks while the engine is running.

Dispose of used fluids, lubricants, materials and filters in accordance with local regulations. Used oil may contain combustion residues hazardous to health.

General precautions for chemical contact

If chemicals contact the skin with, wash skin immediately with water for at least 15 minutes.

Precautions for contact with battery acid or electrolyte

If you come in contact with battery acid, flush your skin with water, apply baking soda to help neutralize the acid and get medical attention immediately. Immediately seek medical attention after contact with electrolyte or byproduct.

Liquid nitrogen precautions

Liquid nitrogen is a clear, colorless liquid that is exceptionally cold, approximately -200 °C (-328 °F). Generally it is stored in containers at high pressure, and can cause rapid freezing on contact with living tissue, which may lead to frostbite. To reduce the risk of injury and damage to equipment when using liquid nitrogen, remember the following precautions:

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- Store liquid nitrogen only in small quantities in regulation containers without fixed covers, and make sure that all liquid nitrogen containers are handled properly.
- Use proper protective clothing, eye and hand protection, and a face shield.
- Make sure that the work area is well-ventilated. High concentrations of liquid nitrogen fumes may lead to suffocation.

Coolant precautions

Coolant is toxic and carries the risk of poisoning. Remember the following precautions, which can reduce your risk of severe illness or death, when working with coolants:

- Use proper hand protection when handling coolant.
- After coming into contact with any antifreeze or coolant solution, wash the affected skin areas.
- If coolant is accidentally ingested, contact a Poison Control Center immediately
- Keep coolant out of reach of children and animals.

Fluoroelastomer (for example, Viton®) precautions

Fluoroelastomer parts, such as O-rings and seals, are safe to handle under normal environmental conditions. However, they may present a potential hazard if raised to a temperature above 316 °C (600 °F). At this temperature, fluoroelastomers decompose (indicated by charring or the appearance of a black, sticky mass) and produce hydrofluoric acid. This acid is corrosive and may cause severe burns to bare skin if touched; however, the symptoms may not appear for several hours. To reduce your risk of injury or death, remember the following precautions when working with degraded fluoroelastomer parts:

- Wear eye protection (for example, goggles or face shield) and neoprene or PVC gloves.
- Discard protective clothing after handling degraded fluoroelastomer parts.

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1.5 General Service Safety

Contact Authorized Service for Additional Help

If you have any questions about a procedure or safety message related to servicing this engine, contact an authorized service outlet for assistance. Repair or engine overhaul must be carried out in an MTU authorized workshop.

Trained and Authorized Personnel Only

Maintenance and repair work is to be carried out by trained and authorized personnel only. Do not allow unauthorized personnel on or near the engine when the engine is serviced. Work on or around this engine must be performed by people who have the necessary training, skills, and tools to do the work. Improper maintenance or repair work can cause severe injury or death for yourself or bystanders.

Using this Manual

Read and understand this safety section before working on this product. This section contains general safety messages. Additional safety messages are included in the specific task procedures.

Signal Words Used in this Manual

Failure to follow the signal words and safety alert symbols contained in this manual can result in serious injury or death. Important safety information is distinguished in this manual by the following notations:

DANGER	In the event of immediate danger. **Consequences: Death or serious injury** • Remedial action
WARNING	In the event of potentially dangerous situations. **Consequences: Death or serious injury** • Remedial action
CAUTION	In the event of hazardous situations. **Consequences: Minor or moderate injuries** • Remedial action
NOTICE	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage!** • Remedial action. • Additional product information.

Consider the Safety of Procedures You Choose

The manufacturer cannot anticipate every possible circumstance that might involve a potential hazard. If a tool, procedure, work method, or operating technique that is not specifically recommended by the manufacturer is used, you must consider possible hazards and take responsibility to ensure that it is safe for you and for others. Ensure the product will not be damaged or made unsafe by the transport, installation, commissioning, operation, lubrication, maintenance, repair, or storage procedures that you choose.

TIM-ID: 0000033337 - 007

Hazardous Environment Operation

MTU equipment is not approved for hazardous environment operation. It is the responsibility of the operator to ensure the engine-system is not operated in a hazardous environment. A hazardous environment is defined as a mixture of volatile substances with air, in the form of gases, vapors, mist, or dust in which, ignition can occur.

ATEX in the EU and OSHA in the U.S., define and classifies hazardous environments.

Use Genuine Parts and Do Not Make Unauthorized Modifications

Unauthorized modifications, third-party add-on devices, and replacement parts may compromise the integrity of the equipment, and may present a safety risk. Only genuine MTU parts are allowed to be used to replace components or assemblies. Failure to heed this warning can lead to product damage, serious injury, or death and may cause non-compliance with environmental regulations.

Follow Applicable Standards and Regulations

MTU recommends owners, operators, and certified technicians become familiar with applicable national safety standards. To reduce the risk of severe injury or death, follow all codes, standards, regulations, and laws pertaining to the products installation and application.

Maintain Product Labels

Safety labels should be legible and not covered. If any safety labels are damaged, missing, or illegible, contact an MTU-authorized distributor or dealer to obtain replacement labels.

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1.6 Battery Safety Instructions

Battery

For proper unit operation, battery minus (-) terminal must always be connected to ground. Reverse connection of the battery will severely damage or destroy the battery charging alternator, regulator, and other polarity sensitive devices.

Wear protective safety eyeglasses and gloves when handling starting batteries and electrolyte. Battery acid can cause serious burns if it contacts eyes or skin.

Servicing of batteries is to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

Do not smoke or use an open flame when servicing batteries. Batteries generate an explosive gas during charging.

The replacement starting battery or batteries must be of equal size and cold cranking amps.

The generator controls must be in the off position when replacing the batteries.

Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

Do not open or mutilate the battery. Released electrolyte has been known to be harmful to the skin and eyes and to be toxic.

A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:

1. Remove watches, rings, or other metal objects
2. Use tools with insulated handles

Vented Batteries

The installation of the engine generator shall provide enough ventilation to ensure that gases generated by vented batteries during charging or caused by equipment malfunction are removed.

The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. It is electrically conductive and corrosive. The following procedures are to be observed:

1. Wear full eye protection and protective clothing
2. Where electrolyte contacts the skin, wash it off immediately with water
3. Where electrolyte contacts the eyes, flush thoroughly and immediately with water
4. Spilled electrolyte is to be washed down with an acid-neutralizing agent. A common practice is to use a solution of 500 g (1 lb) bicarbonate of soda solution to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.

Lead acid batteries present a risk of fire because they generate hydrogen gas. The following procedures are to be followed:

1. DO NOT SMOKE when near batteries
2. DO NOT cause flame or spark in battery area
3. Discharge static electricity from body before touching batteries by first touching a grounded metal surface

TIM-ID: 0000072836 - 001

1.7 Engine-Generator Set – Lockout/Tagout and Unlocking Procedures

1.7.1 Lockout/tagout procedure

Preconditions

☑ Engine is not running and controls are in "OFF" position.

☑ Engine starting circuit is disabled.

DANGER	
⚠	Not completely de-energized systems can contain parts under high voltage. Live components and connections. **Risk of burns or death from electric shock!** • Disconnect all electrical power. • Lockout and tagout the equipment before removing protective shields for service or maintenance.

DANGER	
⚠	Manipulation of interlocks on parts under high voltage. Live components and connections. **Risk of burns or death from electric shock!** • Do not tamper with any interlocks in the system.

DANGER	
⚠	High voltage. Live components and connections. **Risk of burns or death from electric shock!** • Disable the engine start contact leads from the engine-generator set control panel. • Do not disconnect the engine start contact leads from the transfer switch enclosure.

DANGER	
⚠	Circuit breakers are live components. **Risk of burns or death from electric shock!** • Ensure all circuit breakers are placed in the "OPEN" position prior to and while servicing the engine-generator set.

DANGER	
⚠	Battery charger is a live component. **Risk of burns or death from electric shock!** • Wait at least 30 seconds after removing power source from the battery charger prior to servicing the engine-generator set.

WARNING	
⚠	Rotating and moving parts and high level of engine noise in the event of unexpected engine-generator set start during service. **Risk of crushing, danger of parts of the body being caught or pulled in!** **Risk of damage to hearing!** • Ensure the engine-generator set has been stopped. • Ensure the control panel is in "OFF" position to disable starting during service. • Disconnect the battery charger prior to service.

WARNING	
⚠	Hot components/surfaces. **Risk of burns!** • Allow the engine to cool down to below 50 °C before beginning work. • Wear suitable protective equipment/thermal gloves. • Avoid unprotected contact with hot surfaces.

TIM-ID: 0000000257 - 016

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries are live parts.
Risk of electric shock!
- Take care when disconnecting battery cables.
- Remove the negative side of the battery first.

NOTICE

Surge when using insufficient fuses.
Damage to engine-generator set!
- Make notes from where each fuse is removed, and keep these notes until reinstallation.
- Ensure to install the correct fuses in each slot of the control panel and the battery charger.

Note: The instructions in this section are general and cannot reflect all possible control and electrical configurations (control panel, circuit breaker, etc.).

General recommendations

- MTU Onsite Energy strongly recommends documenting the particular starting procedure applicable to your system during commissioning.
- All commissioning personnel should attend the commissioning training for operators offered at the authorized training center for their specific region.

Facility battery charger

1. Remove AC power source from battery charger.
2. Remove the battery charger fuses.
3. Open the circuit breaker supplying AC power to the battery charger.

Battery

1. Disconnect the negative lead from battery terminal.
2. Tag "DO NOT OPERATE" or similar warning label, and secure lock.

Automatic transfer switch (if fitted)

1. Open the engine-generator set control panel door.
2. Remove the panel fuses.
3. Remove the generator start contact leads supplied from remote start.
4. Install protective cover to exposed lead ends.
5. Secure loose leads away from circuit boards and other electronic devices.
6. Close the engine-generator set control panel door.
7. Add lock and tag to panel door to indicate Lockout/Tagout condition.

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Engine-generator set controls

1. Push the EMERGENCY STOP button to lockout the engine-generator set.

Note: This causes the alarm to sound. There is another button which functions to silence the alarm. Depending on your panel configuration, this button is called ALARM SILENCE, ACK, etc.

2. Press this button to silence the alarm.
3. Add lock and tag to panel door to indicate Lockout/Tagout condition, if not in place.

Main circuit breaker(s)

1. Move circuit breaker handle into the "OPEN" position.
2. Tag "DO NOT OPERATE" or similar warning label.
3. For multiple breakers, repeat the two previous steps.

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2 Manufacturer's Documentation

2.1 Parts List - Shop Order DG03RJ096V1M00012 MIGO

ORDER SUMMARY

MATERIAL/SLU #:	DG03RJ096V1M00012 MIGO	MODEL #:	DG03RJ096V1M00012
APPLICATION:	☒ Standby ☐ Prime	kW:	30
DOC TYPE / QTY	With Unit: 1 HARDCOPY Separate: 0 HARDCOPY	0 CD 0 CD	0 USB 0 USB

Configuration Summary

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Model: DG03RJ096V1M00012
Genset Application:  60 Hz Standby Power
Engine Model:  John Deere 3029TFG80/9
EPA Certification Tier Level: Tier 4
Engine Voltage:  12 Volt
Engine Fuel Type:  Ultra Low Sulfur
Engine Fuel Consumption Rate (Liters Per Hour/Gallons Per Hour):
112/29.4
Operating RPM:  1800
Governor Type:  Mechanical
Cooling System: 50 Deg C Cooling System
Voltage:  240 Volt 1 Phase 60Hz
Temperature Rise:  105 Deg
Ambient Temperature:  40 Deg C
Specifications: UL2200

GENERATOR
Generator Rating: 285/1700 12W 30KW
Wire Configuration: Double Delta
PMG Specifications: No PMG

RATINGS
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ORDER SUMMARY

KW: 30
KVA: 30
P.F.: 1.0

ELECTRICAL DRAWINGS
XZG3000100075

MECHANICAL DRAWINGS
XZG3000100078

CONTROL PANEL
Control Model: MGC-1550
Control Panel Mounting: Mounted Rear Facing
Control Panel Accessories: Contact Expansion Module (CEM)

CIRCUIT BREAKER
Circuit Breaker: 125 Amp H Frame 2 Pole 80% Standard CB
Frame Size: H Frame
Circuit Breaker Model Number: HDL26125
Mounting Instructions: Factory Installed RH Side
Circuit Breaker Accessory: Shunt Trip 12V
Circuit Breaker Accessory: Auxiliary Switch

OTHER COMPONENTS
Jacket Water Heater: -20 Deg F Block Heater 120V 1PH - 1000W
Jacket Water Heater Accessories: Install Heater Shut-off Valves
Battery Configuration: Battery; Rack & Acid
Battery Charger: 12V 6A 120VAC
Air Filter: Standard Duty

TESTING
Unit Test Procedure: Standard Test

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PAINT
Paint Color Selected: ANSI 61 Gray (Standard)

HOUSING
Housing Option: Level 3 Enclosure
Wind Rating: 190 MPH
Housing Accessory: Exhaust Scoop
Housing Accessory: Sound Attenuation Kit
Exhaust Grade: Hospital Grade Silencer (Standard)

FUEL TANK/TRAILER
Fuel Tank/Trailer: Fuel Tank
Fuel Tank: Double Walled Sub-Base(UL and ULC-listed): 210 Gal
Tank Accessory: Emergency Pressure Relief Vent Cap (Standard)
Tank Accessory: Fuel Leak Detection Float Switch (Standard)
Tank Accessory: Electric Fuel Level Sender

MISC
Vibration Isolators: Pad Isolators (Standard)

SHIPPING INSTRUCTIONS
Ship Unit Wet (Fluids Installed)
Number of Manuals: 1 Manual

Raw Material Components

Material	Material Description	Quantity
XSG30300.00354	OIL DRAIN FOR GENSET	1
SUA43316	HOSE 4PLY 250 PSI GATES 4219G	4
SUA43320	CLAMP HOSE HEX HEAD WOR	1
XG3030100061	FITTING	1
XSG30120.00004	AIR FILTER FOR GENSET	1
SUA40198	AIR CLEANER ROUND 8.5" DIA W/ 2.5" OUTLE	1
SUA43333	CLAMP HOSE 2 5/16" - 3 1/16"OD HEX HEAD	2
SUA74856	ELBOW HOSE RUBBER 2 1/2" (SPL) USED ON A	1
SUA77336	INDICATOR AIR CLEANER 0-25"H2O RESTRICTI	1
SUA78225	SLEEVE HOSE RUBBER 2 1/2 OD USED W/ELBOW	1
SUA80487	TUBE 2 1/2" OD X 3" LONG (SPCL) ALUMINI	1
SUA43333	CLAMP HOSE 2 5/16" - 3 1/16"OD HEX HEAD	1
XSG30140.00008	EXHAUST SYSTEM	1
SUA107751	BRACKET MUFFLER UNIT MOUNTED JD 3029	1
SUA98895	BRACKET SUPPORT MUFFLER 10 INCH SPECIAL	1
SUA107810	BRACKET EXHAUST ELBOW SUPPORT JD 3029	1
SUA107750	MUFFLER 2 1/2" EM SPACE SAVER FULLY INSU	1
SUA107752	ELBOW TUBING FLARED 2 1/2" 90 DEG EXHAU	1
SUA96226	CLAMP V-BAND 2-1/2 INCH COLLAPSED FLARED	1
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	6
SUA95530	CAP SCREW HEX M8-1.25 X 45MM 8.8 DIN 933	1
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	5
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	4
SUA95901	CAP SCREW M12-1.75 X 25MM 8.8 DIN 933 FU	3
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	3
XSG30140.00010	EXHAUST SYSTEM	1
SUA107849	TUBE EXHAUST ELBOW HSD OUTLET 3029TF 30K	1
SUA77139	SHIELD RAIN 2 1/2"	1
SUA96226	CLAMP V-BAND 2-1/2 INCH COLLAPSED FLARED	1
SUA44318	CLAMP MUFFLER 2-1/2"	1
XG3014500002	PIPE	1
XG3030100439	PIPE SECTION	1
SUA44318	CLAMP MUFFLER 2-1/2"	1
XSG30170.00007	BATTERY TRAY	1

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ORDER SUMMARY

Material	Material Description	Quantity
SUA105488	BATTERY RACK - 30-60KW DIESEL	1
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	4
SUA97234	CABLE BATTERY 2/0 AWG X 24"L W/ AUX. WIR	1
SUA76018	CABLE BATTERY 2/0 AWG X 24"L W/ AUX WIRE	1
SUA96114	NUT FLANGE M10-1.5 DIN6923	4
XSG30170.00009	BATTERY TRAY	1
SUA80412	BRACKET BATTERY HOLD DOWN BAR USED WITH	1
SUA94350	BOLT BATTERY HOLD DOWN, 10MM ROD	2
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	2
SUA88935	HEX FULL NUT M10-1.5 DIN 934 Z CL8 COARS	4
XSG30230.00016	BASE FRAME	1
SUA107763	BASE HSD 280F GEN - 30KW JD3029	1
SUA96077	MOUNT VIBE UNIT TO BASE EBCO 4690-50-J -	4
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	8
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	8
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	8
SUA47719	WASHER FLAT1/2" ZINC PLATED USS	8
SUA47728	LOCK WASHER ZINC PLATED MEDIUM SPLI	4
SUA105137	BRACKET ENGINE SUPPORT JD4045 + JD3029 -	2
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	6
SUA89004	LOCK WASHER ZINC PLATED SPLI	6
SUA49473	CAP SCREW M12-1.75 X 30MM 8.8 DIN 933 FU	6
SUA93138	WIRE GROUNDING UL LISTED 12" 2/0 AWG GRE	1
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	1
SUA89195	WASHER M10 DIN 127 ZINC PLATED SPLIT LOC	1
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	1
SUA107768	HOLE SEAL 0.88" MAX DIA - ANSI 61 GRAY S	6
SUA107769	HOLE SEAL 3.0" MAX DIA - ANSI 61 GRAY ST	4
SUA105695	BRACKET LEAK SWITCH CONTAINMENT AREA - V	1
SUA79021	SWITCH FLOAT FULLY ASSEMBLED 5.50" W/ 1"	1
SUA88659	CAP SCREW GRADE 5 ZINC P	4
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	2
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	2
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	2
XSG30300.00007	COVER	1

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ORDER SUMMARY

Material	Material Description	Quantity
SUA105147	BREAKER COVER PANEL 360/280 FRAME OULET	1
XSG30300.00011	ACCESSORIES	1
XZG3150000006	FEMALE CONNECTOR	1
SUA99690	CABLE USB MINI B PANEL MOUNT	1
XG3030100106	CAP	1
XSG30300.00015	ASSEMBLY KIT	1
SUA63015	MOUNT VIBE PAD 3 X 8 X 1/4 SP NEOPRENE	6
XSG30300.00053	ENGINE OIL	1
SUA89619	OIL FOR WEIGHT CALCULATION ONLY	1
XSG30300.00054	COOLANT	1
SUA90763	COOLANT 50/50 FLEET CHARGE - EG	2
XSG30300.00352	CONNECTOR CABLE	1
SUA94312	CABLE USB 4 PIN MALE MINI B TO MALE TYPE	1
XSG30300.02081	PREHEATER	1
SUA43320	CLAMP HOSE HEX HEAD WOR	4
SUA105976	NUT FLANGE SERRATED M6 X 1.0 ZINC	2
SUA95568	CAP SCREW M6-1.0 X 20MM 8.8 DIN 933 FULL	2
SUA80452	HOSE 5/8" ID 2 PLY GREEN STRIPE (300' SP	4.5
SUA77805	ADAPTER 8 FEMALE 37 DEG FLARE TO 1/2" N	1
SUA94448	ADAPTER M16X1.5 (MALE) TO 8 (MALE) STRA	1
SUA57057	FITTING HOSE 5/8 HOSE BARB TO 1/2" NPT	2
SUA52057	BALL 1/2" NPT BRASS USE AS STANDARD	2
SUA47414	NIPPLE PIPE SCHED 40 BLK	1
SUA47425	ELBOW PIPE SCHED 40 BLK	1
SUA107850	BUSHING 1" M-NPT X 1/2" F-NPT 150 LB BLA	1
XG3030100059	PREHEATER	1
SUA47413	NIPPLE PIPE 1/2"NPT X 4" LG SCHED 40 BLK	1
XSG30300.02120	HOLDER	1
XG3030100015	HOLDER	1
XSG30300.02136	CURRENT TRANSFORMER	1
SUA41705	TRANSFORMER CURRENT 150:5 600V 5.0VA SEC	2
XSG30340.00012	GENERATOR	1
SUA105632	GENERATOR 285/1700 SAE 3 FLYWHEEL 11 1/2	1
XSG30340.00058	CIRCUIT BREAKER	1
SUA105543	SCREW SOCKET HEAD CAP M5-.8 X 70MM CL 12	2

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ORDER SUMMARY

Material	Material Description	Quantity
SUA85676	BREAKER 125A 600V 2P 80% H-FRAME SQUARE-	1
XSG30340.00085	BATTERY CHARGER	1
SUA79100	12V 6A 120VAC 2-STAGE (GUEST) ONSITE ENE	1
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	4
XZG3136000002	BATTERY CHARGER	1
XSG30340.00087	BATTERY	1
SUA120299	BATTERY 12V HP-31 ENGINE STARTING BATTER	1
XSG30360.00039	PIPE JOINT	1
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	12
SUA87301	WASHER FLAT (GOLD)	8
SUA87304	SCREW CAP SOCKET 3/8"-16 X 7/8" ASTM A5	8
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	12
XZG3134000001	COUPLING	1
XSG30360.00074	RADIATOR	1
SUA107761	RADIATOR - 30KW JD3029	1
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	2
SUA89004	LOCK WASHER ZINC PLATED SPLI	2
SUA49473	CAP SCREW M12-1.75 X 30MM 8.8 DIN 933 FU	2
SUA103046	SENSOR LOW WATER LEVEL "ROCHESTER GAUGE"	1
SUA107764	TUBE JW TOP - 30KW JD3029	1
XG3030100070	PIPE SECTION	1
SUA107765	TUBE JW BOTTOM - 30KW JD3029	1
XG3030100070	PIPE SECTION	1
SUA105718	HOSE 1.75"ID X 3"L SILICONE	3
SUA43329	CLAMP HOSE 1 9/16" - 2 1/2" OD HEX HEAD	8
XG3036700001	COOLANT ELBOW	1
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	6
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	6
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	2
SUA107778	SPACER FAN - 30KW JD3029	1
SUA107780	FAN WF FIXED 50/60HZ - 30KW JD3029	1
SUA107788	CAP SCREW HEX M8-1.25 X 75MM GR 10.9 YEL	4
XG3023300018	BRACE	1
XG3023300019	BRACE	1
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	2

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ORDER SUMMARY

Material	Material Description	Quantity
XSG30360.00077	RADIATOR	1
SUA107324	GASKET DUCT HSD IN ROLLS	7.1
XSG30380.00014	HOUSING	1
XG3039100006	ACOUSTIC ENCLOSURE	1
SUA93424	FLANGE BOLT PLATED	18
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	18
SUA89102	LOCK NUT M10-1.5 DIN 985 NYLON INSERT ZI	18
SUA82538	FOAM INSULATION 5/8" X 3/8" DOMED W.STRI	40
SUA82554	FOAM INSULATION 3/4" WIDE X 1/16" THICK	17
XZG3039100025	ACOUSTIC ENCLOSURE	1
XSG30500.00029	GENERATOR ACCESSOR.	1
SUA104961	HINGE PANEL DOOR 360/280 FRAME OUTLET BO	1
SUA105405	280 FRAME CONTROL PANEL LSFG OUTLET BOX	1
SUA105418	GASKET DOOR PANEL 280/360 FRAME OUTLET B	1
SUA105419	GASKET BREAKER 280-360 FRAME OUTLET BOX	1
SUA105822	GASKET REAR CONTROL PANEL 280 FRAME OUTL	1
SUA106094	SPACER PLASTIC .266" X .5" - 30-60KW	2
SUA34137	TRIM VINYL PROTECTIVE	1.5
SUA64014	CHANNEL RUBBER 1/16 "U" SHAPED USED ON A	3.6
SUA82554	FOAM INSULATION 3/4" WIDE X 1/16" THICK	3
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	8
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	12
SUA96031	BOLT ON (BLIND) POWDER BLACK STAINLESS P	2
XZG3134000007	HOLDER FOR SOCKET	1
SUA88859	FLANGE BOLT CASE HARDENED Z	4
SUA88881	FLAT 1/4"USS ZINC PLATED	4
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	10
XSG30500.00031	GENERATOR ACCESSOR.	1
SUA105142	PANEL COVER SE350 360 280 FRAME OUTLET B	1
XZG3134000010	COVER FOR SOCKET	1
XSG30500.00036	GENERATOR ACCESSOR.	1
SUA105410	PANEL TOP COVER 280 FRAME OUTLET BOX	1
XZG3134000007	HOLDER FOR SOCKET	1
XZG3134000008	HOLDER FOR SOCKET	1
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	5

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Material	Material Description	Quantity
XSG30500.00043	GENERATOR ACCESSOR.	1
SUA105153	PANEL BLANK DOOR 360/280 FRAME LSFG OUTL	1
XZG3134000003	HOLDER FOR SOCKET	1
XZG3134000005	HOLDER FOR SOCKET	1
XZG3134000007	HOLDER FOR SOCKET	1
XSG30500.00056	SWITCH	1
SUA95536	MACHINE SCREW, M5-0.8 X 25MM, DIN 7985 P	3
SUA97910	BLOCK NEUTRAL KIT 250-400A TNIA400UR GE	1
XZG3150000010	BLOCK WITH SWITCH	1
XSG30500.00064	ACCESSORIES FOR SWITCH CABINET	1
SUA105964	PLUG DOME 1/2" DIAMETER HOLE CONVEX MATT	2
SUA106794	GROUND LUG MECHANICAL - ALUM SINGLE COND	1
SUA49224	GROMMET RUBBER 4" OD X 2-5/8" ID X 13/32	1
SUA74221	CLAMP SUPPORT 1 1/4" ID PLASTIC COATED	2
SUA86539	COVER TERMINAL BLOCK D-STS 4 (USE WITH P	1
SUA86540	TERMINAL BLOCK D-STS 4 (USE WITH PN 8653	4
SUA90393	WASHER FLAT .25 .281ID X .875OD X .090 T	4
SUA93505	TERMINAL BLOCK, END BLOCK	2
SUA95528	K-LOCK NUT, M5-0.8 KEP ZINC PLATED	4
SUA95905	CAP SCREW M12-1.75 X 35MM 8.8 DIN 933 FU	2
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	2
SUA97421	WASHER FLAT M12 X 13MM ID X 24MM OD ZINC	2
SUA97425	WASHER FLAT M8 X 8.4MM ID X 17MM OD ZINC	2
SUAMF00049	SUB ASSEMBLY	1
SUA55021	RAIL MOUNTING DIN 35MM	4.25
SUA90460	TERMINAL BLOCK MARKER BLANK	4
XSG30500.00067	VOLTAGE REGULATOR	1
SUA70782	LABEL VOLTAGE REGULATOR ADJUST BLACK ON	1
SUA77199	REGULATOR VOLTAGE MAVC63-4D UL (SE350)	1
SUA95527	K-LOCK NUT, M4-0.7 KEP ZINC PLATED	2
XSG30500.00069	CONNECTION	1
SUA100595	BLOCK TERMINAL 4-QUATTRO PE 3031461	1
SUA39156	COVER DUPLEX RECEPTACLE STANDARD	1
SUA90460	TERMINAL BLOCK MARKER BLANK	5
SUA95537	MACHINE SCREW, M4-0.7 X 12MM, DIN 7985 P	2

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ORDER SUMMARY

Material	Material Description	Quantity
SUA95852	HARNESS WIRING DUPLEX RECEPTACLE SPECIAL	1
SUA96594	TERMINAL BLOCK DOUBLE DOUBLE 30A MAX ST	4
SUAMF96981	RECEPTACLE DUPLEX 120V 20A NEMA 5-20R 2P	1
SUA39185	RECEPTACLE 125V 20A DUPLEX NEMA 5-20R 2P	1
SUA93505	TERMINAL BLOCK, END BLOCK	2
SUA96738	TERMINAL BLOCK END CAP QUATTRO (USED WIT	1
XSG30500.00072	ACCESSORIES FOR ALTERNATOR	1
SUA49430	STUD GROUND LUG CSA TD COMPRESSION --SP-	1
XSG30500.00077	CONTROL PANEL	1
SUA42820	BLOCK FUSE	1
SUA42828	FUSE	2
SUA95527	K-LOCK NUT, M4-0.7 KEP ZINC PLATED	2
XZG3000100005	DIMENSIONAL DRAWING	1
XSG31300.00025	SOLENOID SWITCH FOR GENSET	1
SUA47700	LOCK NUT ZINC PLATED SERRATED FLA	2
SUA49516	HEX CAP SCREW M12-1.75 X 20MM 8.8 DIN 93	2
SUA80536	DIODE 6A 1/4" RING TO 10 RING (USED ON	1
SUA81734	SOLENOID STARTER 12VDC --NEW--	1
SUA88858	FLANGE BOLT CASE HARDENED Z	2
SUA88882	FLAT WASHER 12MM ID X 24MM OD DIN 125 ZI	2
SUA89004	LOCK WASHER ZINC PLATED SPLI	2
SUAMF00022	ASY SOLENOID GROUND WIRE (9 WIRE) RING L	1
SUA44103	CONNECTOR WIRE LUG RING 16-14AWG 1/4" ST	1
SUA44106	CONNECTOR WIRE RING LUG 10 INSULATED 14	1
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	0.5
XG3030100056	BRACKET	1
XSG31300.00027	TAG FOR GENSET	1
SUA72045	TAG CAUTION EXHAUST SYSTEM HAS BEEN SEAL	1
XSG31300.00028	ADHESIVE LABEL FOR GENSET	1
SUA100530	ADHESIVE LABEL	1
XSG31300.00030	ADHESIVE LABEL FOR GENSET	1
SUA92608	LABEL CONTROL PANEL MODEL 1.75L X 4.25W	1
XSG31300.00031	ADHESIVE LABEL FOR GENSET	1
SUA77906	LABEL NOTICE NOT RESPONSIBLE FOR LOOSE C	1
XSG31300.00040	TAG FOR GENSET	1

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Material	Material Description	Quantity
SUA100426	TAG TAG NFPA 37 EXHAUST	1
XSG31300.00042	ADHESIVE LABEL FOR GENSET	1
SUA79477	LABEL HEATER 120VAC CHARGER 120VAC WHITE	1
XSG31300.00046	TAG FOR GENSET	1
SUA96612	TAG-CONNECT BATTERIES BEFORE ENERGIZIING	1
XSG31300.00048	ADHESIVE LABEL FOR GENSET	1
SUA92623	LABEL CAUTION RISK OF ELECTRIC SHOCK REC	1
XSG31300.00050	ADHESIVE LABEL FOR GENSET	1
SUA39003	PLATE "PAC" W/ ADHESIVE BACKING BLK PRIN	1
SUA39015	PLATE "WARNING" (UL) (UNIT MAY	1
SUA39016	PLATE "DANGER" (UL)	1
SUA47938	PLATE "ISOLATED NEUTRAL N0T BONDED.."	1
SUA71558	PLATE - GROUND (UL)	1
SUA72036	TAG FUEL RETURN DO NOT BEND FLEX WHEN IN	1
SUA72037	TAG PRIME FUEL SYSTEM + BLEED LINE BEFOR	1
SUA72038	TAG FUEL INLET - DO NOT BEND FLEX WHEN I	1
SUA72039	TAG N0TICE: COOLING SYSTEM HAS BEEN FILL	1
SUA72044	TAG CAUTION CHECK OIL LEVEL BEFORE START	1
SUA72047	TAG DO NOT REMOVE TAG UNTIL WARRANTY REG	1
SUA72709	LABEL "CAUTION" FOR LOW WATER LEVEL SHUT	1
SUA73369	PLATE "NOTICE" DISCONNECT BATTERY CABLES	1
SUA73791	PLATE "CAUTION" RISK OF ELECTRICAL SHOCK	1
SUA73799	PLATE "NOTICE" SERVICE ACCESS DO N0T BLO	1
SUA73800	PLATE "NOTICE" AC+DC CIRCUITS MUST BE RU	1
SUA75985	TAG WARNING!!! BATTERY MUST BE FULLY CHA	1
SUA76197	PLATE "WARNING" 2" X 3" (UL) "UNIT STAR	2
SUA77823	DECAL "MADE IN THE USA"	1
SUA83389	TAG "IMPORTANT" REFER TO INSTALLTION GUI	1
XG3000400004	LABEL	1
XSG31300.00052	ADHESIVE LABEL FOR GENSET	1
SUA75981	PLATE RAINPROOF ENCLOSURE 1" X 2" BLACK	1
XSG31300.00059	ADHESIVE LABEL FOR GENSET	2
SUA88486	DECAL "MTU/ONSITE" (LARGE)	2
XSG31300.00060	ADHESIVE LABEL FOR GENSET	2
SUA88487	DECAL "MTU/ONSITE" (X-LARGE) .	2

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Material	Material Description	Quantity
XSG31300.00062	ADHESIVE LABEL FOR GENSET	1
SUA105982	LABEL LIFTING INSTRUCTION LIFTING HOLES	1
SUA97884	DECAL LIFT POINT 2L X 2W ISO STANDARD	4
XSG31300.00065	ENGINE OIL FOR GENSET	1
SUA101639	15W-40 DIESEL ENGINE	1
XSG31300.00068	FITTING FOR GENSET	1
SUA79048	ADAPTER 14MM X 1.5 TO 1/8" NPT FOR 4024/	1
SUA79049	SENDER TEMPERATURE 100-230 DEG F 1/8" NP	1
XG3030900031	OIL PRESSURE MONITOR	1
XSG31300.00071	WIRING HARNESS FOR GENSET	1
SUA103827	FERRULE UNINSULATED 4 AWG 25MM2	3
SUA47125	WIRE 4 AWG 150 DEG C BLACK TYPE EPDM LEA	6
SUA44118	CONNECTOR WIRE RING LUG 3/8" 0N-INSULATE	3
XSG31300.00076	NAMEPLATE FOR GENSET	1
SUA87005	NAMEPLATE - BLANK GEN-SET (ANODIZED)	1
XSG31300.00125	WIRING HARNESS	1
SUAMF140008	HARNESS VOLTAGE REGULATOR SE350/KAVC63-	1
SUA44146	CONNECTOR WIRE FEMALE PUSH-ON INSULATED	2
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	2
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	2
SUA96507	TAG IDENTIFICATION WIRING HARNESS (T+B T	1
SUA96726	CABLE TIE 3-9/16" (T+B TY23M)	2
SUA44105	CONNECTOR WIRE RING LUG 3/8" INSULATED	2
XSG31500.00011	CABLING	1
SUAMF140016	SUB ASSEMBLY	1
SUA41454	CONNECTOR WIRE MALE TAB INSULATED BLUE 1	1
SUA44146	CONNECTOR WIRE FEMALE PUSH-ON INSULATED	2
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	2
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	2
SUA47108	WIRE 16 AWG 105 DEG C WHITE UL1015 VINY	2
SUA96507	TAG IDENTIFICATION WIRING HARNESS (T+B T	1
SUA96726	CABLE TIE 3-9/16" (T+B TY23M)	2
SUA44105	CONNECTOR WIRE RING LUG 3/8" INSULATED	3
XSG31500.00015	CABLING	1
SUA106069	HARNESS MODULE WITH RESISTOR	1

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ORDER SUMMARY

Material	Material Description	Quantity
XSG25300.00423	WIRING HARNESS	1
XG3030900028	WIRING HARNESS FOR CONTROL PANEL	1
SUA102705	ALARM BUZZER 12-24VDC STD PANEL ALARM SO	1
SUA105976	NUT FLANGE SERRATED M6 X 1.0 ZINC	3
SUA106045	MGC-1550 (MICROPROCESSOR DGC-2020ES LEVE	1
SUA106826	SWITCHES SWITCH	1
SUA106831	HARNESS WIRE BREAKER ACCESSORY	1
SUA74221	CLAMP SUPPORT 1 1/4" ID PLASTIC COATED	3
SUA81176	WASHER LOCK FOR ROUND DEUTSCH CONNECTOR	1
SUA81177	NUT FOR ROUND DEUTSCH CONNECTOR FOR JDE	1
SUA88964	K-LOCK NUT (KEPS NUT) 10-24NC ZINC PLAT	4
SUA90088	SHUNT TRIP 12V DC D-H-J-LD-FRAME SQUARE-	1
SUA90090	1A 1B + ALARM SWITCH (BELL ALARM) SQ-D	1
SUA90393	WASHER FLAT .25 .281ID X .875OD X .090 T	3
SUA64005	LOOM WIRING 3/8" DIAMETER CONVOLUTED VIN	2
SUA43344	CLAMP SUPPORT 1" PLASTIC COATED	3
XSG30240.00003	ENGINE	1
XG3040800003	ENGINE	1
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	6
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	3
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	1
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	1
SUA73268	BUSHING PIPE BRASS HEX 1/2" X 1/4" NPT 1	1
SUA57040	PETCOCK 1/4" NPT MCMASTER-CARR 4921K16	1
SUA101370	UL2200 "CAUTION HOT SURFACES DO NOT TOUC	1
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	2
SUA89079	NUT HEX M8-1.25 DIN 934 CLASS 8 ZINC	2
XG3030900027	WIRING HARNESS FOR ENGINE	1
SUA44940	SENSOR SPEED MAGNETIC GAC 3/4-16 X 4" LO	1
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	1
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	1
SUA72679	CLAMP SUPPORT PLASTIC COATED	1
SUA43394	CLAMP SUPPORT 3/4" PLASTIC COATED	1
SUA101265	10X1.5X20MM FLANGE BOLT	2
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	1

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ORDER SUMMARY

Material	Material Description	Quantity
XG3030100058	GUARD	1
SUA79882	BRACKET HOT SIGN MOUNTING JOHN DEERE 402	1
XG3000400003	LABEL	1
XSG30300.02249	ADHESIVE LABELS	1
SUA78023	TAG FACTORY SET DO NOT ADJUST	1
SUA91508	DECAL MTU 24 HOUR SERVICE INFO	1
XG3030900015	ADHESIVE LABEL	1
XG3000400001	LABEL	1
XG3000400007	LABEL	1
XG3000400009	ADHESIVE LABEL	1
XSG30000.00021	DIMENSIONAL DRAWING	1
XZG3000100075	DRAWING SET	1
XSG30000.00024	DIMENSIONAL DRAWING	1
XZG3000100078	DIMENSIONAL DRAWING	1
XSG30300.02253	FUEL TANK	1
SUA78948	LABEL SYSTEM LEAK SWITCH UL	1
SUA46542	CONNECTOR WIRE FEMALE DISCONNECT FULLY-I	4
SUA46541	CONNECTOR WIRE PUSH-ON MALE INSULATED 18	4
XG3030100113	LABEL	1
SUA33107	TAPE FOAM INSULATION 3/8" X 1 1/2"W	21
SUA78028	HOSE 5/16" ID 50 PSI (FUEL) (UL) GATES 4	8
SUA106439	DECAL - NOT A LIFT POINT	4
SUA74460	PLATE FUEL LEVEL GAUGE	1
SUA74459	PLATE FUEL SUPPLY TO ENGINE	1
SUA74458	PLATE FUEL FILL DIESEL FUEL ONLY	1
SUA74457	PLATE FUEL RETURN TO TANK	1
SUA74456	PLATE FUEL TANK NORMAL VENT	1
SUA44640	PLATE FUEL LEAK SWITCH	1
SUA93422	1-PIECE ZINC 2-EAR CLAMP	2
SUA79117	FITTING HOSE 6 JIC FEMALE TO 5/16" ID H	2
SUA100962	ADAPTER 3/8" NPT (MALE) TO 6 JIC 37DEG	2
SUA47441	BUSHING PIPE 1/2" X 3/8" BLACK STEEL HEX	2
SUA105647	CHECK VALVE 1/2" FNPT NICKEL	1
SUA77788	VALVE FUSIBLE LINK 1/2" NPT 165 DEG (UL)	1
SUA47414	NIPPLE PIPE SCHED 40 BLK	2

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ORDER SUMMARY

Material	Material Description	Quantity
SUA89103	LOCK NUT M16 X 2.0 DIN 985 NYLON INSERT	6
SUA88802	CAP SCREW M16-2.0 X 50MM 8.8 DIN 933 FUL	6
SUA94436	WASHER, FLAT HARDENED, M16 X 17MM ID X 3	12
SUA86414	SWITCH FLOAT FULLY ASSEMBLED 31" W/ 1 1/	1
XG2188100013	LEVEL GAUGE FOR FUEL TANK	1
SUA89699	CAP VENT EMERGENCY 3" NPT UL LISTED FOR	2
SUA78989	VENT TANK 2" MUSHROOM STYLE USED AS N0RM	1
SUA82415	NIPPLE PIPE 2" NPT X 6" LG SCHED 40 THRE	1
SUA42239	CAP FUEL FILL 2" NPT FEMALE LOCKING STD	1
SUA48670	NIPPLE PIPE 2" NPT X 4" LG SCHED 40 THRE	1
XG3041200005	DIESEL FUEL TANK	1
SUA73698	CLAMP HOSE 2 EAR UL SP FOR 5/8" FUEL HO	2
XSG30500.00038	GENERATOR ACCESSOR.	1
XZG3134000007	HOLDER FOR SOCKET	1
XZG3134000008	HOLDER FOR SOCKET	1
XG3030100089	CONTROL PANEL	1
XSG32300.00282	WORK SCHEDULE	1
TXT00016703	DUMMY FOR IPAS PM GASSYSTEM DEVELOPMENT	1
XSG30230.00023	BRACKET	1
XG3023300010	BRACKET	1
XG3023300011	BRACKET	1
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	4
SUA89006	WASHER LOCK SPLIT M8 DIN 127 ZINC	4
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	4
SUA85836	FLANGE BOLT M6X20 DIN6921 CLASS 8.8 ZINC	6
SUA101348	NUT FLANGE LOCK HEX NYLON-INSERT M6-1.0	6
XSG30500.00085	MODULE	1
SUA47714	FLAT 1/4 ZINC PLATED SAE	4
SUA95540	LOCK NUT, M6-1.0 DIN 985, NYLON INSERT Z	4
SUA96299	CAP SCREW M6-1.0 X 35MM 8.8 DIN 933 FULL	4
SUA43394	CLAMP SUPPORT 3/4" PLASTIC COATED	1
SUA78974	CLAMP SUPPORT PLASTIC COATED (SP	2
SUA86608	BOARD 24 RELAY SINGLE POLE DO	1
XS00D000.06670	GENSET DOCUMENTATION ENGLISH	1

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2.2 Form A - Engine Generator Set Request for Start-Up OE-G-GEN-A-001

MTU ONSITE ENERGY

Form A - Engine Generator Set Request for Start-Up

Requested Date: ______________________

☐ First Visit ☐ Follow-Up Visit

Instructions

This form must be completed and signed by the customer/client to ensure proper installation of the generator set prior to scheduling a start-up date and to request start-up service from an authorized MTU Onsite Energy distributor or regional service center.

Applicant Contact Details

Company: ______________________

Name: ______________________

Telephone: ______________________

Email: ______________________

Project Details

Project Name: ______________________

Project Number: ______________________

Site Address: ______________________

____

Engine Generator Set Nameplate

Model Number: ______________________

Serial Number: ______________________

Rating: ______________________

Hz: __________ kW: __________

kVA: __________ Volts: __________

Phase: __________ Amps: __________

Engine

Model Number: ______________________

Serial Number: ______________________

Power: __________ RPM: __________

Fuel Type

☐ Diesel ☐ NG ☐ LP Vapor ☐ Liquid LP ☐ Other

ATS (☐ Yes ☐ No)

Manufacturer: ______________________

Model Number: ______________________

Serial Number: ______________________

Voltage: __________ Current: __________

Poles: __________

Utility Service

Volts: __________ Phase: __________

Phase Rotation: __________

Load Bank (☐ Yes ☐ No)

Capacity: ______________________

Pre-Start-Up Validation Checklist

	Yes	No	N/A
Unit set in final location	☐	☐	☐
Radiator ducted to air discharge louvers	☐	☐	☐
Intake and discharge air louvers installed and wired	☐	☐	☐
Unit filled with oil to proper level	☐	☐	☐
Unit filled with coolant to proper level	☐	☐	☐
Battery filled and fully charged	☐	☐	☐
Battery charger mounted with AC and DC wiring	☐	☐	☐
Block heater wired to correct AC power supply	☐	☐	☐
Switch gear/transfer switch connections made	☐	☐	☐
All other AC and DC electrical connections made	☐	☐	☐
Fuel inlet and return lines run between the unit and fuel storage system	☐	☐	☐
Fuel storage system filled with sufficient quantity for commissioning	☐	☐	☐
Exhaust system properly installed and supported	☐	☐	☐
Radiator and engine generator set room is free of debris	☐	☐	☐
Permission for use of site load or request load bank	☐	☐	☐
Other: ______________________	☐	☐	☐

NOTE: If the tasks on this checklist are not adequately completed upon arrival of the authorized MTU Onsite Energy technician or for reasons beyond MTU Onsite Energy's control, an additional start-up charge may be incurred. Please resubmit this form when items are addressed.

Additional Comments/Notes:

____

____

____

____

Completed by (signature): ______________________

Print Name: ______________________

Company: ______________________

Date: ______________________

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2.3 Form B - Engine Generator Set Installation and Commissioning OE-G-GEN-A-002

MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Instructions
This report must be completed and signed by an MTU Onsite Energy certified commissioning technician in order to accomplish all requirements of the MTU Onsite Energy Limited Warranty. This report includes the physical installation checkups and commissioning procedures for all control versions as well as open and enclosed generator sets.

After completion, a signed copy must be provided to each of the following:
1. Distributor/Dealer
2. Owner
3. MTU Onsite Energy Regional Warranty Department

Applicant Contact Details
Distributor/Company: ____________
Name: ____________
Telephone: ____________
Email: ____________

Project Details
Project Name: ____________
Project Number: ____________
Site Address: ____________
____
Start-Up and Commissioning Start Date: ____________
Start-Up and Commissioning Completion Date: ____________

Engine Generator Set Nameplate
Model Number: ____________
Serial Number: ____________
Rating: ____________
Hz: ________ kW: ________
kVA: ________ Volts: ________
Phase: ________ Amps: ________

Engine
Model Number: ____________
Serial Number: ____________
Power: ________ RPM: ________
Fuel Type:
☐ Diesel ☐ NG ☐ LP Vapor ☐ Liquid LP ☐ Other

Generator
Manufacturer: ____________
Model Number: ____________
Serial Number: ____________
AVR Type: ____________
kVA: ________ Hz: ________
Voltage: ________ Current: ________
Phase Rotation: ____________

Breaker (MTU Delivery ☐ Yes ☐ No)
Manufacturer: ____________
Model Number: ____________
Serial Number: ____________
Voltage: ________ Current: ________
Poles: ________

ATS (☐ Yes ☐ No)
Manufacturer: ____________
Model Number: ____________
Serial Number: ____________
Voltage: ________ Current: ________
Poles: ________

Controller
Manufacturer: ____________
Model Number: ____________
Serial Number: ____________
Firmware Version: ____________

General
Application: ☐ 3A Continuous ☐ 3B Prime ☐ 3D Standby ☐ 3F DCCP ☐ ________
Load test type on site: ☐ Building load ☐ Load bank ☐ Grid parallel ☐ None
Load test not possible because:
____
____

Engine Generator Set Application
☐ Installed in building
☐ Containerized
☐ Enclosed

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MTU ONSITE ENERGY

Form B - Engine Generator Set Installation and Commissioning

Prestart Safety Checks/Environmental Check

	Yes	No	N/A
Commissioning performed by an MTU Onsite Energy certified commissioning technician	☐	☐	☐
Personal protection equipment is available and functional	☐	☐	☐
Access only for authorized personnel	☐	☐	☐
Emergency escape routes are unobstructed (no loose materials, parts, or tools) and labeled	☐	☐	☐
Danger spots are indicated (e.g. trip hazards, beams, pipes)	☐	☐	☐
Control panel/engine area is unobstructed	☐	☐	☐
All warning plates and instruction labels are properly in place	☐	☐	☐
Genset room is free of debris, dirt, dust, loose materials, parts, and tools	☐	☐	☐
Air ducts are free and clean	☐	☐	☐
Engine generator set is leveled; mounting bolts secure	☐	☐	☐
Shipping blocks are removed	☐	☐	☐
For two-bearing generators, check for proper alignment	☐	☐	☐
Heat protection covers are installed	☐	☐	☐

Engine Generator Set Room (Equipment)

	Yes	No	N/A
Battery powered emergency light is installed	☐	☐	☐
Fire extinguishers are in place	☐	☐	☐
First aid kit is in place	☐	☐	☐
Oil resistant floor coating	☐	☐	☐
Spill containment system in place	☐	☐	☐

Fire extinguishing system

☐ Water ☐ CO_2 ☐ Chemical ☐ None

Engine Room Requirements (Open Power Units)

	Yes	No	N/A
Engine room is located as close as practical to the main consumer	☐	☐	☐
Space for maintenance is left around the engine generator set	☐	☐	☐
Battery powered back-up lights available	☐	☐	☐

Engine Generator Set Room Ventilation

	Yes	No	N/A
Intake and exhaust opening properly sized and louvers installed	☐	☐	☐
Flexible duct section installed	☐	☐	☐
Radiator duct properly sized to louver	☐	☐	☐
Proper air flow direction past alternator and then the engine	☐	☐	☐
Engine room inlet air filter in place	☐	☐	☐
Weather/animal guard is fitted to intake and outlet	☐	☐	☐

Self-Contained Engine Generator Set Ventilation

	Yes	No	N/A
Engine generator set intake positioned away from obstruction to airflow	☐	☐	☐
Radiator discharge positioned away from prevailing winds	☐	☐	☐
Sufficient clearance around self-contained engine generator set for airflow	☐	☐	☐

Air Inlet and Outlet

	Yes	No	N/A
Air ducts are clean and clear	☐	☐	☐
Ducts are installed properly	☐	☐	☐
Weather protection guards are installed	☐	☐	☐
Silencers are installed properly	☐	☐	☐
Louvers open and close automatically	☐	☐	☐
Manual operation of louvers is possible	☐	☐	☐
Structure air flows are correct (no thermal short circuit)	☐	☐	☐
Unrestricted airflow over the engine	☐	☐	☐

Cooling System

	Yes	No	N/A
Cooling system is free of leakages	☐	☐	☐
Pipelines and connections undamaged	☐	☐	☐
Radiator fan(s) are clear and clean	☐	☐	☐
Venting pipes have gradient toward expansion tank	☐	☐	☐
Overflow is free and spillage is avoided	☐	☐	☐
System is filled to proper level	☐	☐	☐
Filling cap is freely accessible	☐	☐	☐
Coolant-preheater is functional	☐	☐	☐
Coolant type and concentration as specified in MTU manual: ____________________	☐	☐	☐

Frame-Mounted Radiator

	Yes	No	N/A
Check belt tension and alignment	☐	☐	☐
Radiator clean and free from obstruction	☐	☐	☐
Radiator air outlet connected to outlet duct	☐	☐	☐
Check for possibility of hot air recirculation	☐	☐	☐
Engine generator set vent pipes routed upward toward radiator expansion tank	☐	☐	☐
Pipelines secure and undamaged	☐	☐	☐
Overflow clear and routed to avoid spillage	☐	☐	☐

Remote-Mounted Cooling System

	Yes	No	N/A
Pipelines cleaned and painted	☐	☐	☐
Device(s) aligned and fixed properly	☐	☐	☐
Pipelines fixed properly	☐	☐	☐
Expansion tank is of adequate size	☐	☐	☐
Pipelines isolated from generator set vibration	☐	☐	☐
Static head pressure is within system capability	☐	☐	☐
Auxiliary power supply is installed correctly	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
Fan rotational direction correct	☐	☐	☐
Overflow clear and routed to avoid spillage	☐	☐	☐
Engine generator set vent pipes routed upward toward radiator expansion tank	☐	☐	☐
Avoid air locks in pipelines – air bleed valves provided	☐	☐	☐
All proper electrical connections made	☐	☐	☐

Heat Exchanger and Cooling Tower

	Yes	No	N/A
Pipelines cleaned and painted	☐	☐	☐
Device(s) aligned and fixed properly	☐	☐	☐
Pipelines fixed properly	☐	☐	☐

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Form B - Engine Generator Set Installation and Commissioning

Heat Exchanger and Cooling Tower (continued)

	Yes	No	N/A
Expansion tank is of adequate size	☐	☐	☐
Pipelines isolated from generator set vibration	☐	☐	☐
Vent valves installed	☐	☐	☐
Static head pressure is within system capability	☐	☐	☐
Secondary circuit pump direction is accurate	☐	☐	☐
Secondary circuit pump is functional	☐	☐	☐
Potential equalization is functioning properly	☐	☐	☐
Overflow lines are clear and routed to avoid spillage	☐	☐	☐
Engine generator set vent pipes routed upward toward expansion tank	☐	☐	☐
Air bleed valves installed	☐	☐	☐
Cooling tower make up supply is complete	☐	☐	☐
Auxiliary power supply to fans is correctly installed	☐	☐	☐
All proper electrical connections made	☐	☐	☐

Mounting/Foundation

	Yes	No	N/A
Engine generator set is installed on proper mounts	☐	☐	☐
Static deflection area of mounts not blocked by components	☐	☐	☐
Surface is level	☐	☐	☐
Support structure is adequate to support engine generator set weight	☐	☐	☐
Engine generator set is supported at each mounting location	☐	☐	☐

Lube Oil System

	Yes	No	N/A
Engine is filled with oil to proper level	☐	☐	☐
No oil leaks present	☐	☐	☐
Flexible lines installed in make-up lube-oil system	☐	☐	☐
Oil type as specified in MTU manual (record type):	☐	☐	☐

____

Starting System

	Yes	No	N/A
Battery and cables are free from damage	☐	☐	☐
Battery and cables installed, mounted, and wired properly	☐	☐	☐
Batteries filled up to appropriate level	☐	☐	☐
Idle charging voltage min. 27.6 VDC for 24 V system or 13.7 VDC for 12 V system	☐	☐	☐
Battery charger properly installed and wired	☐	☐	☐
Battery is located near starter with shortest cable run as possible	☐	☐	☐

Diesel Fuel System

	Yes	No	N/A
Fuel system is free of leakages	☐	☐	☐
Flexible lines installed at engine	☐	☐	☐
Pipeline size adequate to system	☐	☐	☐
Pipelines and connections undamaged	☐	☐	☐
Flow and return lines connected correctly	☐	☐	☐
Fuel lines free of tension, scuffing, or kinks	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
Adequate room is left for fuel tank inspections	☐	☐	☐

Diesel Fuel System (continued)

	Yes	No	N/A
Tank is not overfilled	☐	☐	☐
Tank is not in the vicinity of exhaust or other heat sources	☐	☐	☐
For electric fan driven fuel coolers: Fuel cooler plumbed and wired correctly	☐	☐	☐
Fuel returns to fuel tank without restriction, proper sized pipe	☐	☐	☐
Fuel prefilter installed before engine inlet	☐	☐	☐
Electronic day tank pump used from main storage to day tank	☐	☐	☐
Day tank controls/pumps installed	☐	☐	☐
Fuel transfer pump connected to emergency power	☐	☐	☐
Level indicator used for checking tank contents	☐	☐	☐
Leak sensors are in place	☐	☐	☐
All proper control and sensor connections are made	☐	☐	☐
Spill containment procedure in place per code	☐	☐	☐

Diesel Fuel System (Main Storage Tank)

	Yes	No	N/A
Isolating valves correctly positioned	☐	☐	☐
Transfer pump and controls operational	☐	☐	☐
Pipeline/tank heating system operational	☐	☐	☐
Fuel level monitoring system operational	☐	☐	☐
Check for leaks	☐	☐	☐

Day Tank

	Yes	No	N/A
Tank is fixed properly and mounted to substructure	☐	☐	☐
Tank vent line is plumbed to safe area	☐	☐	☐
Tank filling line is of adequate size	☐	☐	☐
All unused fittings are plugged	☐	☐	☐
Mechanical fuel level indicator installed	☐	☐	☐
Electrical fuel level indicator installed and tested	☐	☐	☐
Fuel level switches installed and adjusted	☐	☐	☐
System pump(s) connected to emergency power	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
System pump(s) installed correctly (flow direction)	☐	☐	☐
Refill function checked	☐	☐	☐
Leakage sensor in place	☐	☐	☐
Adequate space available for inspections	☐	☐	☐
Isolating and solenoid valves checked	☐	☐	☐
Tank filled	☐	☐	☐
Check for leaks	☐	☐	☐
Fire valves present	☐	☐	☐

Gas Fuel System (Americas Only)

	Yes	No	N/A
Dedicated gas supply line of proper size and material	☐	☐	☐
Check for gas filter/screen	☐	☐	☐
Check gas solenoid valve operation	☐	☐	☐
Check supply lines for leaks	☐	☐	☐
Check manual shut-off valve operation	☐	☐	☐
Solenoid valves correctly positioned	☐	☐	☐
Regulator set to correct pressure	☐	☐	☐
Gas leak detection equipment operational	☐	☐	☐
Shut-off devices operational	☐	☐	☐
Specified gas pressure is available at fuel inlet	☐	☐	☐

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Exhaust System

	Yes	No	N/A
Piping is installed and secured properly	☐	☐	☐
Flexible connectors installed at engine exhaust outlet	☐	☐	☐
Flexible connectors installed correctly	☐	☐	☐
Exhaust line condensate trap with drain installed	☐	☐	☐
Silencer is installed and secure	☐	☐	☐
Exhaust thimble installed per local codes	☐	☐	☐
Exhaust system below back pressure limit	☐	☐	☐
Exhaust piping diameter properly sized for length of run	☐	☐	☐
No diameter reductions downstream on exhaust pipes	☐	☐	☐
All exhaust system weight is properly supported	☐	☐	☐
Proper pipe wall thickness is maintained	☐	☐	☐
Exhaust lines are properly insulated	☐	☐	☐
Exhaust installed with a downward pitch to outlet	☐	☐	☐
Exhaust line protected from natural elements (rain cap installed)	☐	☐	☐
Exhaust gas prevented from re-entry to building	☐	☐	☐
Hot parts safety decals/guards are present	☐	☐	☐

Fire Alarm/Suppression System

	Yes	No	N/A
Fire alarm/suppression system present	☐	☐	☐

Engine Management System (Engine Governor)

	Yes	No	N/A
Engine Control Unit box is free of damage	☐	☐	☐
Engine Control Unit box is securely mounted to engine	☐	☐	☐
Electrical connections securely fastened	☐	☐	☐

Grounding

	Yes	No	N/A
Engine and generator are properly grounded	☐	☐	☐

Electrical and Control System

	Yes	No	N/A
Remote wiring connected correctly	☐	☐	☐
Cables free of tension, scuffing, or kinks	☐	☐	☐
All connections clean and secure	☐	☐	☐
Bus bar phase sequence, voltage, and frequency checked	☐	☐	☐
Control cables routed in separate conduits from phase leads	☐	☐	☐
Engine generator set controls energized and functional	☐	☐	☐
Software version of engine generator set controller recorded	☐	☐	☐
All LEDs on panel illuminate when LED test is pressed	☐	☐	☐
Emergency stop control operational	☐	☐	☐
Test certificates available for all cables	☐	☐	☐
Utility service breaker capacity verified	☐	☐	☐
Small power and lighting circuits operational	☐	☐	☐

Switchgear/Transfer Switch

	Yes	No	N/A
Cables installed to correct torque specification	☐	☐	☐
Phase cables to switchgear/transfer switch are correctly sized and clearly identified	☐	☐	☐
Switchgear protection settings checked	☐	☐	☐
All other connections are clean and secure	☐	☐	☐

Generator Circuit Breaker

	Yes	No	N/A
ON/OFF function	☐	☐	☐
Auxiliary contact	☐	☐	☐
Adjust over-current protection	☐	☐	☐
Adjust the trip unit	☐	☐	☐
Phase rotation checked	☐	☐	☐

Preparation for Running Checks

☐ Follow appropriate lockout/tagout procedure

Running Checks

	Yes	No	N/A
Engine generator set engine control switch in the RUN position. Start engine and verify whether there is sufficient oil pressure	☐	☐	☐
Allow engine to run for five minutes	☐	☐	☐
Check coolant level, add as necessary, and reinstall cap	☐	☐	☐
Allow engine to run for at least 20 minutes and check engine operating temperature	☐	☐	☐
Check the battery charger for proper operation	☐	☐	☐
If the speed is unstable, adjust to specifications	☐	☐	☐
Adjust the AC output voltage to match the utility voltage using the voltage adjusting control	☐	☐	☐
Check for oil, coolant, and exhaust leaks/recirculation	☐	☐	☐
Check temperature on city water-cooled models and adjust the thermostatic valve as necessary	☐	☐	☐
Engine generator set engine control switch in the OFF position	☐	☐	☐
Permission must be obtained from the building authority before transfer switch test is performed	☐	☐	☐
Test transfer switch	☐	☐	☐

Record the current phase for the three phase systems

A ____________ B ____________ C ____________

	Yes	No	N/A
Set the engine generator set exerciser with load to the customer's required exercise period	☐	☐	☐
Verify that all options on the transfer switch are adjusted and functional to the customer's requirements	☐	☐	☐

Record transfer switch delay settings:

TDES (Time Delay to Engine Start)	________ sec.
TNE (Time Delay Normal to Emergency)	________ sec.
TDN (Time Delay to Normal)	________ min.
TDEC (Time Delay Engine Cooldown)	________ min.

Mains Failure Test

Number of start trials: ____________

Duration between mains failure and generator circuit breaker (GCB) closed (until emergency power source supplies load) ________ sec.

	Yes	No	N/A
Dyn. Frequency drift within limit of ISO 8528-5	☐	☐	☐
Static voltage drift during operation within limit of ISO 8528-5	☐	☐	☐
Static frequency drift during operation within limit of ISO 8528-5	☐	☐	☐

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MTU ONSITE ENERGY

Form B - Engine Generator Set Installation and Commissioning

Running Checks (record on chart)

Unless otherwise specified by local or state regulations, run the engine-generator set at full expected system load in excess of 30% of the nameplate rating). Record data at 15 minute intervals.

Time of Day	Generator Voltage, Volts	Generator Output A Phase, Amps	Generator Output B Phase, Amps	Generator Output C Phase, Amps	Generator Output Frequency, Hz	Ambient Room Temperature	Engine Oil Pressure	Battery Charger Volts (DC)	Coolant Temperature	Run Time, Minutes	Notes

Shutdowns

	Yes	No	N/A
Emergency stop (also external)	☐	☐	☐
Over-frequency/over speed	☐	☐	☐
Under-frequency	☐	☐	☐
Over-voltage	☐	☐	☐
Under-voltage	☐	☐	☐
Oil pressure Lo Lo	☐	☐	☐
Engine temperature Hi Hi	☐	☐	☐

Check and verify any additional protective devices and list:

____

____

____

Additional Comments/Notes:

____

____

____

____

____

____

____

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Customer Acknowledgement (Literature and Instructions)

☐ Verify that the customer has the appropriate engine/engine-generator set and transfer switch (if provided by MTU Onsite Energy) literature. Instruct the customer in the operation and maintenance of the power system.

I ______________________________ received instructions on ____________
Please print name of person receiving instructions. Date

______________________________ (signature)

To be filled out by the commissioning technician only.

Completed by (signature): ______________________________

Print Name: ______________________________

Company: ______________________________

Date: ______________________________

Note: Completion of this checklist does not relieve the installer of contract obligations.

To be filled out by the customer/client.

Witnessed by (signature): ______________________________

Print Name: ______________________________

Company: ______________________________

Location: ______________________________

Date: ______________________________

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2.4 Two (2) Year 3000 Hour Basic Standby/Prime/DCCP Limited Warranty_OE-M-GEN-S-026

MTU ONSITE ENERGY
TWO (2) YEAR / 3,000 HOUR BASIC
STANDBY (3D) / PRIME (3B) / DATA CENTER CONTINUOUS POWER (3F)
LIMITED WARRANTY

MTU America Inc. d/b/a MTU Onsite Energy ("MTU Onsite Energy") issues the following express Limited Warranty subject to the following terms, conditions, and limitations:

An original consumer ("Owner") who purchases an MTU Onsite Energy engine generator set ("Product") is entitled to coverage under this Limited Warranty. MTU Onsite Energy warrants to the Owner that the Product is free of defects in material and workmanship and will perform under normal use and service from valid start-up performed by MTU Onsite Energy. Any nonconformity to the foregoing is defined as a Warrantable Defect. This Limited Warranty applies to Product shipped by MTU Onsite Energy after January 1, 2014.

1. **Limited Warranty Periods**

   Limited Warranty Period. The Limited Warranty Period for a Warrantable Defect in the Product is twenty-four (24) months after the first commissioning of the Product. In all cases, the Limited Warranty period will expire not later than thirty-six (36) months from the date of shipment from MTU Onsite Energy's Mankato, MN facility or after 3,000 operation hours, whichever occurs first.

   Accessories Coverage Period. The Accessories Coverage Period for a Warrantable Defect in cords, receptacles, cord reels, gas flex pipes, housing lights, space heaters, and associated equipment ("Accessories") is twelve (12) months from the date of shipment from MTU Onsite Energy's Mankato, MN facility.

   MTU Onsite Energy's warranty obligations under this Limited Warranty are contingent upon distributor completing the following:

   (a) The MTU Onsite Energy warranty and the *Start-Up Validation and Pre-Inspection Form.* Return both to MTU Onsite Energy within sixty (60) days of the start-up date; and
   (b) The engine registration form (when applicable). Return to the manufacturer as stated in the engine registration form instructions.

2. **MTU Onsite Energy Responsibilities**

   If a Warrantable Defect is found during the Limited Warranty Period and/or the Accessories Coverage Period, and provided the Owner has complied with its obligations under Section 3, MTU Onsite Energy will, during normal working hours, through MTU Onsite Energy's authorized distributor, dealer, or service outlet, perform some or all of the following:

   (a) Repair or replace, at MTU Onsite Energy's sole election, the defective part with a new or remanufactured replacement part;
   (b) Provide reasonable or customary labor needed to correct the Warrantable Defect;
   (c) Provide technician travel time of 400 miles to and from the closest MTU Onsite Energy authorized distributor, dealer, or service outlet to the Product location;
   (d) Part removal and re-installation, if necessary and as solely determined by MTU Onsite Energy.

   MTU Onsite Energy's obligation to repair or replace defective parts does not include responsibility for reimbursement of incidental or consequential costs. If MTU Onsite Energy repairs or replaces an Accessory, part, or Product under this Limited Warranty, the repaired or replaced Accessory, part, or Product assumes the unexpired portion of the warranty period remaining from the original Accessory, part, or Product. Repair or replacement of an Accessory, part, or Product will not extend the term of the original Limited Warranty Period or Accessories Coverage Period. Parts or Product replaced shall become the property of MTU Onsite Energy.

   MTU Onsite Energy's failure to enforce any of the terms or conditions stated herein shall not be construed as a waiver of such provision or of any other terms and conditions of this Limited Warranty.

3. **Owner Responsibilities**

   During the Limited Warranty Period and Accessories Coverage Period, the Owner is responsible for, and MTU Onsite Energy will not reimburse for the following:

   (a) Battery;
   (b) Premium or overtime labor costs;
   (c) Labor and material costs for Product removal and reinstallation;
   (d) Any special access fees required to gain access to MTU Onsite Energy equipment, without limitation, training or safety policy requirement to gain access;
   (e) Transportation costs or travel expenses related to delivery of the Product to the designated distributor, dealer, or service outlet;
   (f) Incidental and consequential costs, damages, or administrative expenses of whatever nature;
   (g) Non-Product repairs, vehicle damage, "downtime" expenses, cargo damage, fines, lost income, any business costs of any kind, Owner's travel expenses, and other losses resulting from a Warrantable Defect;
   (h) Shipping charges for replacement parts/Products in excess of those which are usual and customary; or
   (i) Local taxes, if applicable.

   In addition, Owner must:

   (a) Operate, use, and maintain the Product in accordance with the applicable Owner's manual and/or any other manuals specified by MTU Onsite Energy, including without limitation handling, inspection, servicing, or operating instructions;
   (b) Promptly notify MTU Onsite Energy or its authorized representative of a Warrantable Defect and make the Product available for repair;
   (c) Comply with MTU Onsite Energy's or MTU Onsite Energy's authorized representative's reasonable directions regarding the timing, sequence, and location of warranty repairs and make the Product available for inspection;

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(d) Perform all required maintenance and maintain and provide proof that all required maintenance has been performed;
(e) Use MTU Onsite Energy specified parts, components, and consumables;
(f) Promptly return to MTU Onsite Energy all parts replaced under this Limited Warranty;
(g) Comply with MTU Onsite Energy's long term storage guidelines, if applicable, and maintain and provide proof of compliance;
(h) Routinely exercise the Product in accordance with operating instructions;
(i) Install the Product in accordance with the installation guide provided; and
(j) Reimburse MTU Onsite Energy for all costs incurred in providing warranty service where, following examination, the request or claim for warranty coverage proves to be unfounded or excluded, as well as all incidental costs including those incurred investigating the claim.

4. **Limitations**

MTU Onsite Energy is not responsible, and this Limited Warranty is not available under any circumstances, for any of the following:

(a) Failure of Owner to fulfill its obligations under Section 3;
(b) Failure of Owner to follow MTU Onsite Energy's instructions for Product stored by Owner longer than 180 days from date of shipment from MTU Onsite Energy's Mankato, MN facility;
(c) Defects caused by adjustments made by Owner to the fuel system or governor system;
(d) Defects which were obvious or capable of being identified by reasonable inspection and were not reported to MTU Onsite Energy within a reasonable time;
(e) Rental equipment used during warranty work;
(f) Defects caused or potentially caused by service work performed by non-MTU Onsite Energy authorized service providers and/or the use of non-genuine MTU Onsite Energy parts;
(g) Defects resulting from natural wear and tear, external action, negligence, natural disasters, accidents, incorrect use, improper handling or storage, inadequate corrosion-proofing, incorrect assembly or installation, or modification of the Product;
(h) Defects resulting from abuse or neglect, including unauthorized modifications to the Product;
(i) Repair or any use or installation which MTU Onsite Energy, in its sole discretion, determines to be improper;
(j) Defects caused by incorrect maintenance;
(k) Defects resulting from Owner's delay in making the Product available after being notified of a potential problem or Owner's failure to take immediate measures to avoid or mitigate damage;
(l) Damage caused by shipping;
(m) Repair of parts sold by MTU Onsite Energy that are warranted directly to the Owner by the respective part's manufacturer;
(n) Misapplication of the Product;
(o) Diesel engine "wet stacking" due to lightly loaded diesel engines;
(p) Acts of nature or acts of God;
(q) Any failure, other than those resulting from a defect in material or factory workmanship of the Product;
(r) Use of the Product for purposes other than those for which it was intended, including without limitation use of the Product under extraordinary operating conditions not made known to MTU Onsite Energy in writing at the time of the order; or
(s) Material provided by or a design specified by the Owner.

5. **Software Warranty.** Where software is included in the Product, MTU Onsite Energy warrants to the Owner that 1) the software will be substantially free from material program errors and material defects in material and workmanship and that 2) it shall function substantially in accordance with MTU Onsite Energy's specification at the time of dispatch from the MTU Onsite Energy manufacturing facility. MTU Onsite Energy does not warrant that the software is error-free or free from "bugs" as commonly categorized by the computer industry. MTU Onsite Energy shall, during the Limited Warranty Period, endeavor to remedy at its cost, in its sole discretion, by repair or replacement of any material program errors or material defects of which Owner has promptly notified MTU Onsite Energy. MTU Onsite Energy, at its option, may elect to provide the most current software at no cost, and in such case MTU Onsite Energy will not cover the cost to install the applicable updated software. MTU Onsite Energy shall have no obligation with respect to any nonconformities resulting from unauthorized modifications to the software or any Owner interfacing.

6. **Emissions Warranty.** The Product may be covered under an emissions warranty specified by the U.S. Environmental Protection Agency and/or the California Air Resources Board. The terms of the warranty, if applicable, may be accessed by following the link: http://www.mtuonsiteenergy.com/technical-info/emissions-warranty/. Any such Emissions Warranty is incorporated herein by reference in its entirety to the extent and with the same force as if fully set forth herein. The Product, if certified, may only be certified to comply with the required country or region specific emission regulations. Where applicable, the Product is only certified to those specific emission regulations/standards which are clearly stated in the respective RRPS/MTU Onsite Energy defined technical specifications. IT IS THE OWNER'S SOLE RESPONSIBILITY TO ENSURE THAT THE EXPORT/IMPORT, INSTALLATION, AND USE OF THE PRODUCT(S) COMPLIES WITH THE APPLICABLE EMISSION REGULATIONS IN THE COUNTRY OR REGION WHERE THE PRODUCT(S) WILL BE USED.

7. **Disclaimers**

LIMITATION OF WARRANTIES: THIS LIMITED WARRANTY IS GIVEN EXPRESSLY AND IN PLACE OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, FREEDOM FROM INFRINGEMENT OR THIRD PARTY INTELLECTUAL PROPERTY RIGHTS, OR ARISING FROM COURSE OF DEALING, COURSE OF PERFORMANCE OR USAGE OF TRADE. THERE ARE NO UNDERSTANDINGS, AGREEMENTS, REPRESENTATIONS, OR WARRANTIES NOT SPECIFIED HEREIN.

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THIS LIMITED WARRANTY, THE OBLIGATIONS OF MTU ONSITE ENERGY AND THE RIGHTS AND REMEDIES OF THE OWNER SET FORTH IN THIS LIMITED WARRANTY ARE EXCLUSIVE AND ARE EXPRESSLY IN LIEU OF, AND THE OWNER HEREBY WAIVES AND RELEASES ALL OTHER OBLIGATIONS, WARRANTIES (INCLUDING WARRANTY AGAINST REDHIBITORY DEFECTS), REPRESENTATIONS OR LIABILITIES, EXPRESS OR IMPLIED, ARISING BY LAW IN CONTRACT, TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHERWISE, INCLUDING BUT NOT LIMITED TO ANY CLAIMS ARISING OUT OF, CONNECTED WITH OR RESULTING FROM THE PERFORMANCE OF THIS LIMITED WARRANTY OR FROM THE DESIGN, MANUFACTURE, SALE, REPAIR, LEASE OR USE OF THE PRODUCT, ANY COMPONENT THEREOF AND SERVICES DELIVERED OR RENDERED HEREUNDER OR OTHERWISE.

IN NO EVENT, WHETHER AS A RESULT OF BREACH OF CONTRACT OR WARRANTY, ALLEGED NEGLIGENCE, OR OTHERWISE, SHALL MTU ONSITE ENERGY BE SUBJECT TO LIABILITY FOR INCIDENTAL, CONSEQUENTIAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING WITHOUT LIMITATION, DAMAGE TO THE PRODUCT, OR OTHER PROPERTY, COMMERCIAL LOSSES, LOST PROFITS, LOSS OF USE, INCONVENIENCE, LOSS OF TIME, COST OF CAPITAL, COST OF SUBSTITUTE EQUIPMENT, DOWNTIME, OR CLAIMS OF CUSTOMERS.

MTU ONSITE ENERGY SHALL NOT BE LIABLE FOR ANY CLAIM GREATER IN AMOUNT THAN THE PURCHASE PRICE OF THE PRODUCT.

8. The Owner is entitled to rectify the defect or to have it rectified by third parties only in urgent cases where operational safety is at risk or in order to prevent disproportionately extensive damage; provided that Owner has informed MTU Onsite Energy and obtained MTU Onsite Energy's prior written consent. In such cases, MTU Onsite Energy shall, in its sole discretion, reimburse the costs incurred by the Owner up to an amount equivalent to the costs MTU Onsite Energy would have incurred had it remedied the defect itself.

9. This Limited Warranty gives the Owner specific legal rights, and the Owner may also have other rights, which vary from state to state. Some states do not allow warranty duration limitations and/or certain exclusions or limitation of incidental or consequential damages. Therefore, the previously expressed exclusion(s) may not apply to Owner. If any one or more of the provisions contained in this Limited Warranty shall be invalid, illegal, or unenforceable in any respect, the validity, legality, or enforceability of the remaining provisions contained therein shall not in any way be affected or impaired thereby.

10. This Limited Warranty is governed by the laws of the State of Minnesota without regard to its conflicts of law principles and excluding the United Nations Convention for the International Sale of Goods.

11. In order to obtain performance of an MTU Onsite Energy warranty obligation, the Owner should contact the nearest MTU Onsite Energy authorized distributor, dealer, or service outlet for instructions. To find the location of the nearest MTU Onsite Energy authorized distributor, dealer, or service outlet call 800-325-5450 or write to: MTU Onsite Energy Warranty Department, 100 Power Drive, Mankato, MN 56001.

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2.5 Service Weekly Inspection Checklist

SERVICE
WEEKLY INSPECTION CHECKLIST

Please use the attached checklist to perform weekly service inspections on generator set equipment.

Before beginning any service, please conduct the following steps:

1. Perform lockout/tagout procedures before performing pre-start checks.
2. Refer to owner and operator manual for correct specifications.

DESCRIPTIONS:

Date	Record the date of the inspection.
Ambient Temp	Record air temperature around generator.
Oil Level	Record the level from the oil dipstick and the amount of oil added to the engine if it was needed.
Coolant Level	Record level of coolant in the radiator and add approved coolant, if needed.
Heaters	Check inlet and outlet hose temperature to verify operation.
Belts	Visually inspect belts for damage or fraying. Verify the **engine control** is in the **OFF** position.
Battery Charger	Visually inspect battery charger to verify operation. If equipped with a display, verify charge rate. If equipped with LEDs, verify correct LEDs are lit.
Battery Levels and Cables	Verify battery(s) are full of acid, cables are tight, and battery posts clean.
Leaks: Oil, Water, Fuel	Check all hoses and connections for dripping fluids. If needed, tighten hose clamps to contain leaks.
Amps	Record the amp reading when unit is running with load.
AC Volts	Record the AC volt reading when unit is running with load.
Frequency	Record the hertz reading when unit is running with load.
Oil Pressure	Record the oil pressure when unit is running with load.
Coolant Temp	When unit is running with load, record the coolant temperature reading once stabilized.
DC Volts	Record control panel DC voltage reading.
RTM	Record the Running Time Meter total before each test. Variances will show run time between inspection exercises.
ATS	Automatic Transfer Switch mark as **OK,** if test performed properly.
Maintenance Contact	Maintenance technician performing inspections should initial in this box.

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SERVICE: WEEKLY INSPECTION CHECKLIST

Date	Ambient Temp	Oil Level	Coolant Level	Heaters	Belts	Battery Charger	Battery Levels and Cables	Leaks: Oil, Water, Fuel	Amp	AC Volts	Frequency	Oil Pressure	Coolant Temp	DC Volts	RTM	ATS	Maintenance Contact	Comments

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2014-01

Installation and Basic Operation Manual

TIM-ID: 0000002924 - 025

MTU Onsite Energy Corporation
100 Power Drive, Mankato, MN 56001
Phone 800-325-5450 www.mtuonsiteenergy.com
2017-08

CALIFORNIA PROPOSITION 65

WARNING

ENGINE EXHAUST FROM THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS, AND OTHER REPRODUCTIVE HARM.

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Contents

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Product Identification Information

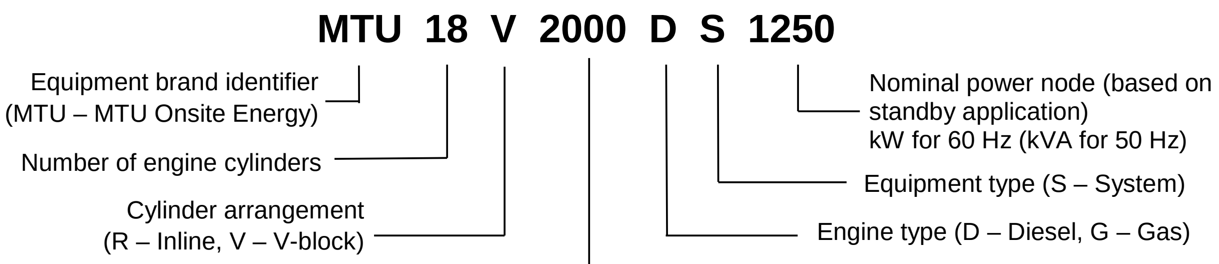
Locate and record numbers in the spaces below immediately after unpacking your generator set. This ensures that the numbers are readily available for future reference.

Model Designation: ______________________________

Serial Number: ______________________________

How to Read Model Numbers

MTU Onsite Energy's model numbering format is composed of 7 sections:



MTU Series or nominal displacement per cylinder
(4-digit identifier)

Example shown is for MTU Series units (Series 1600, Series 2000, Series 4000).
For Non-MTU Engine units, use nominal displacement per cylinder calculation:

(Engine Displacement ÷ Number of Cylinders) × 100 = Nominal Displacement per Cylinder

NOTE: Apply standard rounding rules after calculation. Add leading zero when calculations result in 3 digits. For example, the calculation for an engine with a 4.5L displacement and 4 cylinders is: (4.5 / 4) × 100 = 0113

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Forward

This Installation Guide provides general instructions for installing your MTU Onsite Energy generator set properly. It is essential that every person who works on or with the generator set be completely familiar with the contents of this manual, and that he/she carefully follows the instructions contained herein.

Each installation may require some modification of the suggested guidelines in this manual. Installations must be consistent with locally applicable standards and take into consideration safety guidelines and measures.

Following this guide will result in an efficient and reliable installation. Carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions section at the beginning of this manual.

IMPORTANT

Information in this publication represents data available at the time of print. MTU Onsite Energy reserves the right to change this publication and the products represented without notice and without any obligation or liability whatsoever.

All instructions and diagrams have been checked for accuracy and simplicity of application. However, the skills of the installer are most important. MTU Onsite Energy does not guarantee the result of any installation contained in this manual. Nor can MTU Onsite Energy assume responsibility for any injury or damage to property. Persons engaging in installation do so entirely at their own risk.

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Figures and Tables

The following is a list of all figures and tables contained in this manual.

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Safety Precautions

IMPORTANT SAFETY INSTRUCTIONS

Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained.

Dangers, Warnings and Cautions are used in this manual to alert the operator to special instructions concerning a particular procedure that may be hazardous if performed incorrectly. These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions and common sense operation are major accident prevention measures. Observe all warnings found on the equipment. Ensure that warning labels are legible and not obstructed by dirt, grease or other equipment. MTU Onsite Energy cannot anticipate every possible circumstance that might involve a hazard. The warnings in this manual and on tags and decals affixed to equipment are, therefore, not all inclusive.

DANGER

Danger indicates the presence of a hazard that will cause severe personal injury, death, or substantial property damage.

WARNING

Warning indicates the presence of a hazard that can cause severe personal injury, death, or substantial property damage.

CAUTION

Caution indicates the presence of a hazard that will or can cause minor personal injury or property damage.

This symbol signifies high voltage.

The following safety rules should be strictly complied with:

ACCIDENTAL STARTING

Be aware that the generator set could start at any time in the “AUTO” mode. Keep clear of all moving parts and be sure to turn switch to the “OFF” position before servicing and disconnect the negative battery cable after disconnecting the battery charger circuit.

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BATTERY

For proper unit operation, battery minus (-) terminal must always be connected to ground. Reverse connection of the battery will severely damage or destroy the battery charging alternator, regulator and other polarity sensitive devices.

Wear protective safety eyeglasses and gloves when handling starting batteries and electrolyte. Battery acid can cause serious burns if it contacts eyes or skin.

Servicing of batteries is to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

Do not smoke or use an open flame when servicing batteries. Batteries generate an explosive gas during charging.

The replacement starting battery or batteries must be of equal size and cold cranking amps.

The generator controls must be in the off position when replacing the batteries.

Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

Do not open or mutilate the battery. Released electrolyte has been known to be harmful to the skin and eyes and to be toxic.

A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:

1. Remove watches, rings, or other metal objects
2. Use tools with insulated handles

VENTED BATTERIES

The installation of the engine generator shall provide enough ventilation to ensure that gases generated by vented batteries during charging or caused by equipment malfunction are removed.

The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. It is electrically conductive and corrosive. The following procedures are to be observed:

1. Wear full eye protection and protective clothing
2. Where electrolyte contacts the skin, wash it off immediately with water
3. Where electrolyte contacts the eyes, flush thoroughly and immediately with water
4. Spilled electrolyte is to be washed down with an acid-neutralizing agent. A common practice is to use a solution of 500 g (1 lb) bicarbonate of soda solution to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.

Lead acid batteries present a risk of fire because they generate hydrogen gas. The following procedures are to be followed:

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1. DO NOT SMOKE when near batteries
2. DO NOT cause flame or spark in battery area
3. Discharge static electricity from body before touching batteries by first touching a grounded metal surface

Fire Hazard

Keep fire extinguishers in accessible locations. Use appropriate fire extinguishers as recommended by NFPA.

Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which present a potential fire hazard.

When an open bottom base is used, the stationary engine generator assembly is to be installed over noncombustible materials. It should be located such that it prevents combustible materials or loose debris from accumulating under or inside the generator set.

Do not service the engine when any ignition source such as an open flame is present. “DANGER” signs must be placed to warn of the fire hazard. No work may be performed on the engine involving an ignition source such as open flames, cutting, welding, or grinding.

A fire extinguisher (dry chemical or carbon dioxide, CO2) must be immediately available to the mechanics while working. When liquefied or natural gas leaks or escapes, it can result in dangerous accumulations of gas, which might cause a serious flash or explosion. Careful ventilation of the area is mandatory in the event of a fuel leak.

The total electric load on this equipment must not exceed the nameplate rating. Overloading can cause fires, damage the generator set, and damage any equipment that is connected to it.

Exhaust System

Engine exhaust gases contain DEADLY carbon monoxide gas, which is colorless and odorless. If breathed in sufficient concentrations, this gas can cause severe nausea, fainting, or death. Provide adequate ventilation to prevent buildup of exhaust gases. When the generator is installed inside a room or enclosure, exhaust gases must be piped outdoors. Install the exhaust system so exhaust gas does not leak at joints or piping connections. Make certain that the extended exhaust piping is plumbed properly and that the exhaust is not near an intake ventilator.

Increase the exhaust pipe diameter as necessary to reduce back pressure. Use a minimum number of fittings and elbows to prevent back pressure in the engine exhaust system. Be sure the enclosure has proper ventilation to accommodate the engine cooling system.

Fuel System

Gaseous, Natural Gas and Liquid Propane Gas are extremely flammable, and vapors are EXPLOSIVE. Comply with all laws regulating the storage and handling of these fuels. Check for leaks frequently and correct such leakage immediately.

Do not fill fuel tanks while the engine is running.

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Do not smoke or use open flame at any time when fuel is being handled. Fuel vapors are both toxic and flammable.

Liquid petroleum gas (LPG) systems operate at tank pressures around 690 kPa (100 psi) or above. The tank pressures are regulated down. Vaporized LPG systems operate at pressures near 2.7 kPa (11 in H_2O), as do most natural gas systems.

Safety precautions when handling liquefied petroleum gas cannot be over-emphasized. There are state, county and city codes, and fire regulations covering the handling and storage of liquefied petroleum gas or natural gas. In addition to the safety suggestions in this manual, all local codes and fire regulations on this subject must be followed explicitly. Where local codes are more stringent than the suggestions in this manual, the local codes must be given priority.

Before proceeding with any service, be certain that all switches are in the OFF position, disconnect battery ground cable, remove fuses in DC systems and turn off the battery charger. These safety suggestions apply to service of any engine using liquefied petroleum gas or natural gas fuel regardless of the work to be performed. When servicing the engine, ensure that there is adequate ventilation. This is to avoid the accumulation of gas/air mixtures in and about the engine caused by undetected leaks.

Any service performed on the fuel system requires that:

- All threaded connections are sealed with proper pipe thread compound. Replace defective fittings and reseal all connections.
- Fuel system is checked for leaks. Leaks are not permissible. Odorants, which are strong smelling components (an odor similar to spoiled cabbage), are added to liquefied petroleum gas as a warning agent to indicate the leakage of even small quantities of gas.
- A soap solution applied with a soft brush will bubble to indicate leaks. Never use an open flame to check for leaks. All leaks must be sealed.
- All flexible fuel connections are checked, metallic and neoprene, with the soap solution.

It is important to remember that all gas fuel systems are pressurized. Be certain that the fuel valves are tightly closed and all fuel has been vented before starting any repair work on the fuel system.

Hazardous Noise

Prolonged unprotected exposure to hazardous noise levels may cause loss of hearing. Never operate the generator set without a muffler or with a faulty exhaust system. Ear protection may be required.

Hazardous Voltage/Electrical Energy

Safe practices MUST be followed while performing work on electrical equipment to prevent death or injury from electric shock, electrocution, arc flash, and arc blast hazards. The Standard for Electrical Safety in the Workplace, NFPA 70E, requires that the owner of this electrical equipment provide a field-applied label which includes incident energy level,

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minimum Personal Protective Equipment (PPE) required, safe working distance, and arc flash boundary. This information is determined through an arc flash risk assessment performed by a licensed professional electrical engineer who is familiar with the electrical system design.

Dangerous voltages are present at power terminals of this equipment. Contact with such terminals will result in extremely dangerous and possibly lethal electric shock. Never allow any unqualified person to install, operate or service the equipment. The standby electric system must be installed, tested, and inspected per the manufacturer's recommendations. All codes, standards, regulations, and laws pertaining to the installation must be strictly complied with.

Accidental contact with electrical equipment can cause severe injury and death if the equipment is not properly grounded. The frame and external electrically conductive parts of this equipment must be properly connected to an approved earth ground, in accordance with applicable electrical codes. A grounding lug is provided on the generator and in other equipment for this purpose.

CAUTION: RISK OF ELECTRIC SHOCK!

The grounded conductor must be bonded to ground in accordance with the National Electrical Code, NFPA 70. The unit shall not be used in floating output applications.

Remove all electrical power before removing protective shields for service or maintenance. Exercise extreme caution when working on or around electrical components. Open or poorly insulated conductors are extremely dangerous during operation. Severe, possibly fatal, shock may result. Make certain that all conductors are properly insulated or guarded, all grounds are made and that the area is dry. Do not tamper with interlocks.

In the event of an accident from electrical shock, shut down the generator set immediately. If the set cannot be shut down, free the victim from contact with a dry nonconductor, avoiding direct contact with victim until free of the conductor. If the victim is unconscious, apply artificial respiration if qualified and get medical help immediately.

Verify that all power leads and control connections are properly insulated before starting the generator set. Neglecting this may result in extensive damage to equipment and personal injury. This problem arises if the unit is started before electrical installation is completed.

Make certain the area is well ventilated to dissipate any flammable vapors, which may collect from fuels. When servicing any part of the electrical system or making any connections, be sure the main switch is OFF and disconnect battery ground cable or remove fuse in DC system. Turn off the battery charger. Clean or service the generator set only when the engine is shut down. If the unit stops because of an engine safety device, do not attempt to restart until the cause for shutdown has been corrected.

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ELECTROMAGNETIC FIELD

When the generator is running, an electromagnetic field is present that can interfere with pacemakers or other active medical implants. Access to the generator area is prohibited for personnel wearing pacemakers or implanted defibrillators.

Hot Parts

The exhaust manifold, turbocharger(s), and extended exhaust piping are HOT when the engine is running. These can remain hot for long periods of time after the engine shuts off. Avoid contact with these parts. Consider insulating the exhaust system if installation is such that unintentional contact with the exhaust system components is likely.

Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.

Moving Parts

Moving parts can cause severe personal injury or death. Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.

Handling

Do not use lifting devices with marginal capacities when lifting or moving the unit. Observe the center of gravity of the equipment to be lifted and do not allow the generator set to swing if suspended. Make certain the supporting structure is adequate to support the unit. Failure to observe this warning may result in equipment damage and serious or fatal injury.

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1

General

When installed properly and according to applicable codes, your MTU Onsite Energy generator set will perform safely and reliably. Incorrect installation can cause continuing problems. Figure 1-1 illustrates a typical installation. Your authorized generator set distributor/dealer can provide advice about or assistance with your installation.

This manual references organizations and their codes that govern generator set selection and installation for US installations. Installers must comply with national and local codes when applicable.

NFPA 37…………Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54…………National Fuel Gas Code
NFPA 70…………National Electrical Code®
NFPA 99…………Health Care Facilities Code
NFPA 101………...Life Safety Code®
NFPA 110………...Emergency and Standby Power Systems
UL 2200…………..Stationary Engine Generator Assemblies

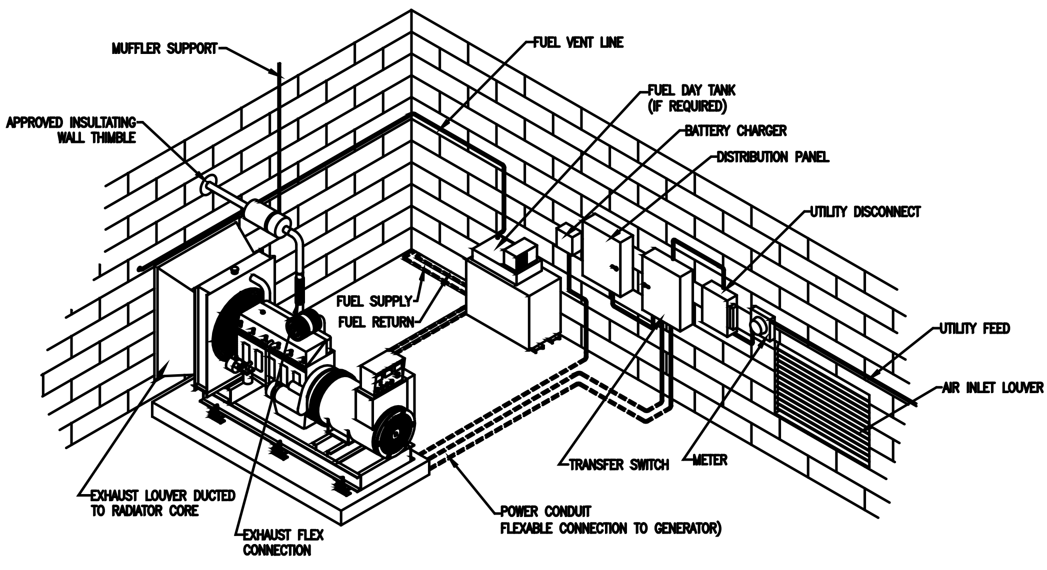

Figure 1-1: Typical generator set installation

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2

Lifting Provisions

To ensure personal safety and prevent damage to the product, we strongly recommend the guidelines in Figure 2-1 be observed when lifting MTU Onsite Energy generator sets. Due to the different designs, dimensions and weights of the generator sets, specific instructions for each model are not provided. It is the responsibility of the dealer/distributor to see that generator set lifting is performed within the framework of these guidelines.

DANGER

- **Never stand beneath a suspended load.**
- **Use appropriate lifting devices and appliances.**

CAUTION

Lifting brackets are for lifting purposes only. Do not use for any other purpose.

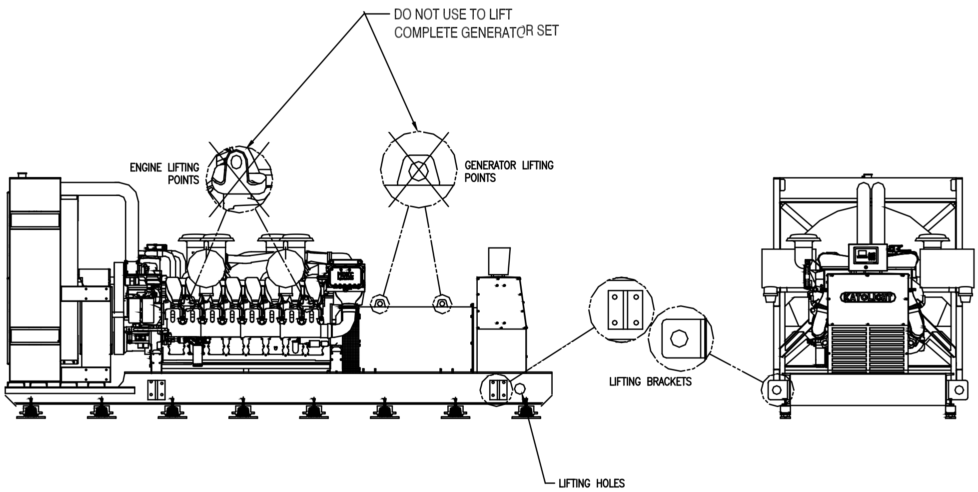

Figure 2-1: Lifting provisions

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3 Location

The location of the generator set is influenced by factors such as ventilation, exhaust piping, electrical service, fuel supply and accessibility for maintenance and service.

Before selecting the location for your generator set, consider the following:

- Supporting structure must be adequate for the generator set and accessories. For information on mounting on an inertia pad, see Section 4. For any other set-up, consult a structural engineer for an appropriate design.
- Area should be clean, dry and not subject to flooding.
- Ventilation should be available in the area with a minimum amount of duct work
- Exhaust gas must be piped away from the structure and any ventilation intakes. Piping must incorporate large radius, low restriction elbows.
- An adequate supply of fuel should be available at all times to sustain operation.
- The main diesel fuel supply should be as close as possible to the unit. If the main fuel tank is installed underground, an auxiliary pump and day tank are necessary to transfer fuel from the main tank to the day tank.
- Vibration should be effectively isolated and dampened to reduce transmission of vibration and prevent fatigue fractures of connected systems.
- Area should provide easy access for maintenance and repair. A minimum clearance of 0.91 m (3 ft) between an installed generator set and adjacent walls or other electrical equipment should be maintained on three sides of the generator set. Clearance of 1.52 m (5 ft) should be maintained at the rear of the generator set to facilitate removal, should it become necessary.
- Applicable fire rating codes and standards must be met.
- When an open bottom base is used, the stationary engine generator assembly is to be installed over noncombustible materials. It should be located such that it prevents combustible materials or loose debris from accumulating under or inside the generator set.

Local weather conditions will have a direct influence on location of the unit and the type of accessory equipment required to assure reliable operation. Extreme ambient temperature variations should be avoided. For ambient temperatures below 16 °C (60 °F), starting aids such as jacket water heaters and lubricating oil heaters will ensure dependable starting. Anti-condensation or strip heaters are available for control panels and generators to maintain a temperature above the dew point to prevent condensation of moisture.

Standard transfer switches located indoors in heated facilities are enclosed in NEMA 1 enclosures. Various other NEMA enclosures may be needed. If the generator set is located outside, heaters are needed below 0 °C (32 °F).

Consider preventive maintenance issues when selecting a generator set location. See Section 9 for a list of service points that should be accessible.

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4 Mounting

Your generator set should be installed in a location that is able to support the weight of the unit and accessories, resist dynamic loading, and does not transmit generator noise and vibration. See Section 3 for detailed information on selecting a location for your generator set.

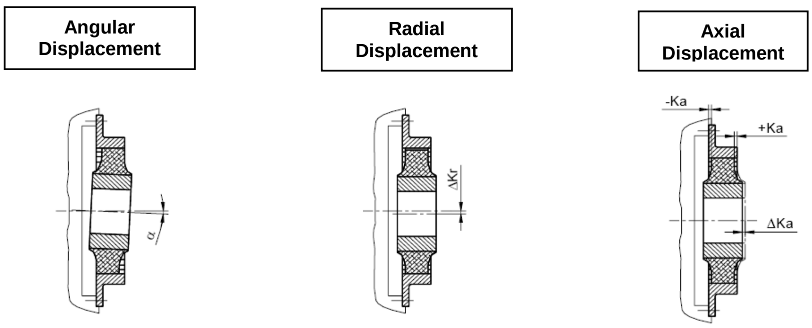
NOTE: Skid brackets are not to be used as mounting brackets. Make sure to follow proper installation instructions.

FIELD ALIGNMENT

Field alignment after the generator set is installed corrects any changes in the coupling alignment during transport and installation. This realignment ensures that the coupling will perform as needed and reduces the possibility of excess vibrations that decrease the useful life of the generator set.

After final installation, the following measurements must be checked to confirm proper alignment as noted in the table and illustration below:

Measurement	Specification
Angular Displacement	Less than or equal to 0.3°
Radial Displacement	Less than or equal to 1.49 mm (0.059 in)
Axial Displacement	Less than or equal to 3.99 mm (0.157 in)



Alignment can be validated by using dial indicators or a laser alignment tool.

NOTE: This applies only to models equipped with a two-bearing generator.

ENGINE LOCKS

All generator sets must be locked using the crankshaft locks provided with the engine by the engine manufacturer. If the generator sets are using vibration isolators, these must be blocked as well. Before installing the generator set, these engine locks and vibration isolator blocks must be removed.

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NOTE: This affects Series 4000 engine serial numbers beginning with 526, 527, and 528.

WEIGHT

The weight of the generator set and accessories will determine the type and design of the support structure. Generator set weight can be found in the specification sheet for your particular model. Be sure that the weight of accessory items and fuel (if a sub-base tank is used) are added to the total requirements.

INERTIA PAD/BASE

Your generator set must be mounted on a substantial inertia pad or base. The composition of the inertia pad should follow standard practice for the required loading. Common specifications call for 17 MPa (2,500 psi) concrete reinforced with 8-gauge wire mesh (4.06 mm or 0.16 in) or number 6 reinforcing bars on 30 cm (12 in) centers.

To determine the depth of the inertia pad, the following formula can be used:

$$\text{BASE DEPTH} = \frac{Wu}{d * w * l}$$

Where Wu = engine-generator set weight in kg (lb)
d = concrete density (usually 2,322.68 kg/m^3 or 145 lb/ft^3)
w = foundation width in m (ft)
l = foundation length in m (ft)

The inertia pad should be a minimum of 30.48 cm (12 in) wider and 30.48 cm (12 in) longer than the unit base. The inertia pad may be constructed higher than the floor level by 8 to 20 cm (3 to 8 in) for ease of maintenance.

To reduce the amount of unit vibration transmitted, you must isolate your inertia pad from the foundation. One method for isolating the inertia pad from the foundation is to use 20 to 25 cm (8 to 10 in) of wet gravel or sand as a bed in the inertia pad pit. For other methods, consult a qualified structural engineer.

To allow settlement of the inertia pad from the foundation, expansion joints should be incorporated between the inertia pad and the foundation.

VIBRATION ISOLATION

Vibration is a normal by-product of the operation of any generator set. Vibration transmitted to surrounding areas will increase the noise level and if severe, can cause structural damage. To minimize this risk, all generator sets should have vibration isolation between the generator base and inertia pad.

All fuel, coolant, exhaust and electrical connections must have flexible sections to isolate vibration. Leaks or fractures can develop rapidly without vibration isolation and there is a danger of eventual total failure.

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For generator sets enclosed within a building, where maximum vibration isolation is required, spring mounts provide vibration isolation between the generator base and the structure. Check state and local codes for such requirements.

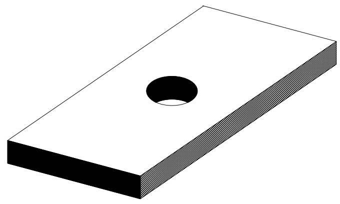

Figure 4-1: Typical pad type vibration

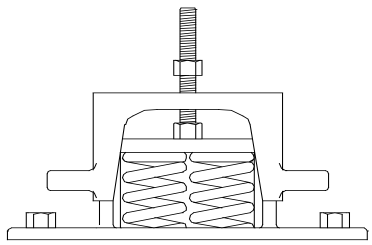

Figure 4-2: Spring mount vibration isolator

Anchor bolts should be loosened and double nutted after installation to avoid base distortion caused by unlevel inertia pads.

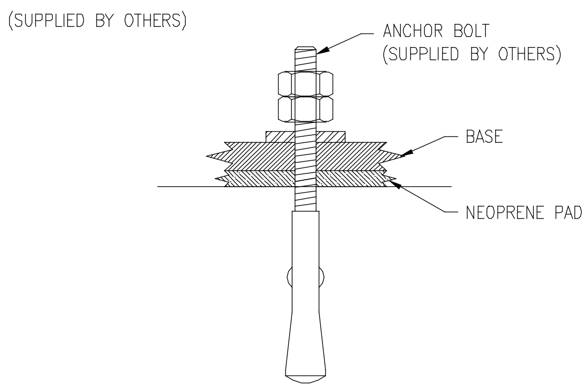

Figure 4-3: Recommended anchor bolt

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5

Air Requirements

General

When installing engine generator sets, great care must be taken to ensure adequate ventilation. Proper installations require enough ventilation to cool the engine generator set as well as supply adequate air for combustion.

When installing the ventilation system, the following factors should be considered:

- Location of intake and exhaust louvers
- Method of actuation of intake and exhaust louvers
- Ambient temperature
- Routing of exhaust air duct

The air intake and exhaust should be in line to provide engine room ventilation air flow which will parallel the generator set air flow over the engine, through the radiator and/or exhaust louver. The inlet and outlet openings must be large enough to provide the volume of air required by the engine generator.

NOTE

Exhaust louver effective opening should be at least 25% to 50% larger than engine radiator core. Intake louver should be 50% to 100% larger in effective opening than engine radiator core.

In most applications, intake and exhaust louvers should be used. Figure 5-1 indicates a typical louver.

Care should be taken to provide adequate open space outside the exhaust louver so as not to obstruct airflow.

Units with mounted radiators should be installed with ducting between the radiator and the exhaust louver to prevent recirculation of air.

CAUTION

Ensure that the exhaust ducting is installed so that no recirculation of radiator exhaust air occurs. Failure to prevent recirculation could cause the unit to overheat and shut down.

The exhaust louver should not be exposed to high prevailing winds, since wind pressure may reduce fan discharge and reduce cooling. The duct should be constructed with as few bends as possible. All units can be supplied with radiator duct flanges of the required size to meet the customer's application.

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WARNING

Prior to start-up, louver-securing hardware must be removed. For motorized louvers, louver blade assembly must be reattached.

If bends are required, they should be in the form of gradual sweeps to allow airflow with minimum restriction. Increase duct size one-fourth to one-half to compensate for bends.

Motorized and gravity louvers may be used to prevent entry of cold air which may cause difficulty in engine starting. (Refer to Chapter 8 for recommendations for wiring motorized louvers). Louvers also reduce the entry of rain, snow and insects into the building.

A gravity-operated louver can be used for the exhaust air. When the set operates, outlet airflow will open the louver and it will close automatically by gravity when the unit is shut down.

Generating sets with automatic start require the use of motor operated intake or fixed louvers or dampers. Motor operated louvers are held closed by spring tension and are driven to the open position by a motor operating through a mechanical linkage.

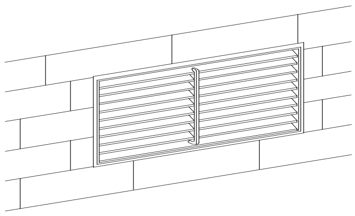

Figure 5-1: Typical center top pivoted louver

CAUTION

Care should be taken in wiring the system to ensure that the intake louver motor is supplied with power during all possible modes of unit operation, i.e. true power failure, simulated power failure due to incorporation of a system test switch, or automatic plant exercising. Incorrectly wired louver motors could result in the louvers closing prematurely during engine cool-down, which can cause overheating, engine shutdown, and possible damage to the unit.

In some extreme cold weather applications, the opening of intake louvers immediately upon starting may cause carburetor icing and vaporizing problems with engines utilizing gaseous fuels. Diesel engines may also be affected if lightly loaded. Thermostatically controlled louvers may be used to reduce the difficulties encountered with cold weather applications.

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Figure 5-2 illustrates a typical generator set installation for units with unit-mounted radiators, indicating ducting and preferred locations of the louvers.

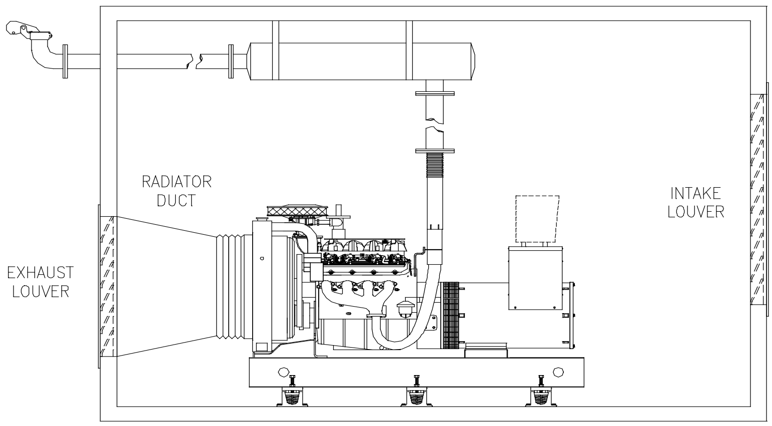

Figure 5-2: Typical installation with louvers

Engine-generator sets with remote cooling will not have an engine driven fan to move air through the generator room. As a result, a fan or some other means of moving air through the room must be considered. The fan must move the required amount of air against the allowable static friction.

The following formula may be used to estimate the amount of airflow required to remove engine and generator radiated heat and supply sufficient combustion air. The formula is based on air temperature of 38 °C (100 °F). Allowable room air temperature rise is 11 to 16 °C (20 to 30 °F).

$$V = \frac{Q}{F * \Delta T}$$

Where V = Air flow through the engine-generator room in m^3/min (ft^3/min)
Q = Engine-generator set radiated heat in kW (BTU/min)
F = 0.02 for metric units (0.018 for imperial units)
ΔT= Allowable room air temperature rise in °C (°F)

Higher elevation installations will require increased airflow. Add 10% for each increase of 762 m (2,500 ft). Also increase airflow for non-insulated exhaust silencer and other equipment that may add to the radiated heat in the room. Also keep in mind the required combustion airflow for the engine.

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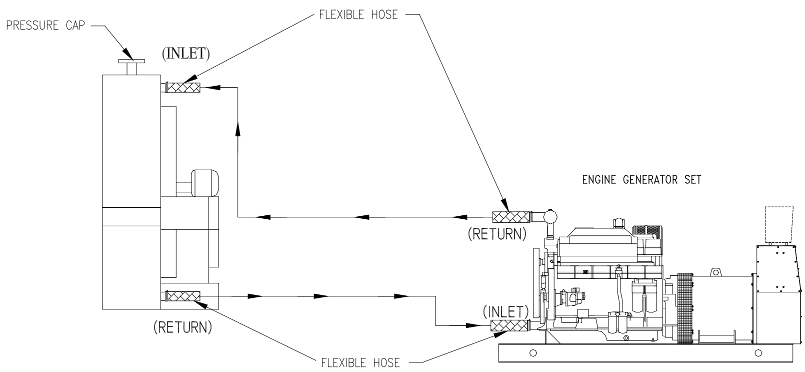

Figure 5-3: Typical remote radiator installation

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6 Exhaust System

Proper exhaust system installation is essential for maximum generator set engine efficiency. Because exhaust fumes are deadly, great care must be taken when installing the exhaust system. Consideration must be given to back pressure, piping, and placement. Figures 6-1 and 6-2 show the general arrangement of recommended exhaust systems.

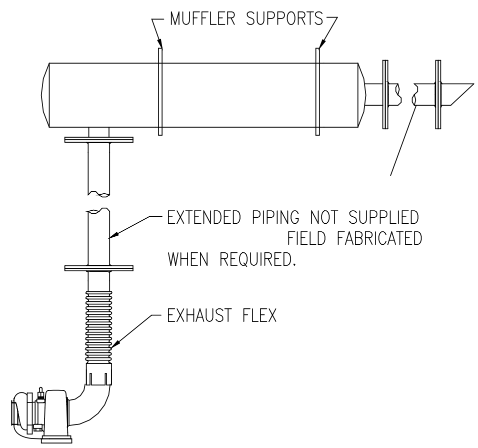

Figure 6-1: Typical side inlet exhaust

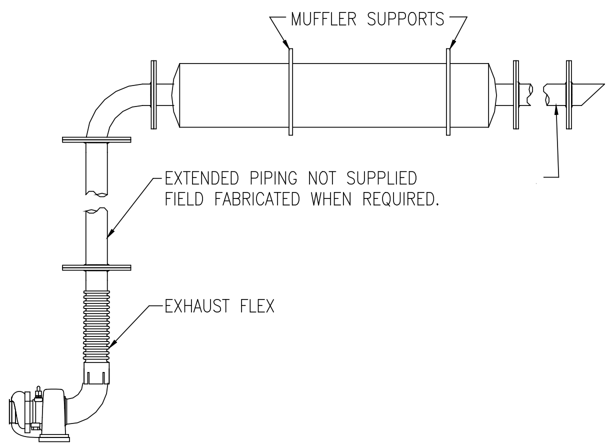

Figure 6-2: Typical end inlet exhaust

PLACEMENT

The exhaust pipe should terminate outdoors, away from doors, windows, or other building openings in an area where exhaust can dissipate. Placement of piping and exhaust silencer should take into account the location of combustible materials. If location cannot avoid these concerns, remove combustible materials on a regular basis. Keep dry grass, foliage, and combustible landscaping material a safe distance from the exhaust system.

WARNING

Inhalation of exhaust gases can cause death. Exhaust pipes must not terminate near fresh inlet vents of any type or near combustible materials. Avoid exhaust gas recirculation which could cause the engine-generator set to overheat. Generator sets installed outdoors inside enclosures should have their exhaust directed so that it will disperse away from buildings and building air intakes.

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BACK PRESSURE

The installed exhaust system must not exceed the engine manufacturer's maximum exhaust back pressure limit. Damage may result from excessive back pressure. Causes may include:

- Insufficient exhaust pipe diameter
- Exhaust run too long
- Exhaust silencer too small or designed improperly
- Too many bends and/or constrictions in piping
- Obstruction in exhaust piping

Your generator set has been sized so that exhaust system back pressure is kept within the acceptable limits. However, in situations when extended piping or a flex connector other than the one supplied must be used, contact MTU Onsite Energy to ensure that back pressure will not exceed the engine manufacturer's specification.

PIPING

Exhaust piping must conform to all applicable codes. Routing of exhaust piping should be as short and direct as possible. Exhaust piping should be of Schedule 40 black iron, steel or other suitable material having adequate strength and durability. The recommended material for exhaust piping is Schedule 40 black iron pipe. Where possible, sweep elbows with a radius of at least 3 times the pipe diameter should be used.

Exhaust pipes must be independently supported with no weight applied to the engine, turbocharger, exhaust manifold or flex connector. Where exhaust pipes attach to the engine, they must be connected with flexible connectors to minimize vibrations that can cause damage to the exhaust system.

CAUTION

Weight applied and vibration extended to the exhaust manifold or turbocharger could result in damage to these components. No exhaust piping weight may be carried by the engine, exhaust manifold or turbocharger.

The following applies to UL 2200 Listed engine-generator sets. When the complete exhaust system is not factory installed, exhaust piping and chimneys shall be designed, constructed, and installed in accordance with NFPA 37, Standard for the Installation and Use of Stationary combustion Engines and Gas Turbines.

FLEXIBLE SECTION

The supplied exhaust flex should be installed directly off the engine turbo elbow/manifold. This limits the stress on the engine exhaust manifold or turbocharger resulting from engine motion on its vibration mounts and temperature-induced changes in pipe dimensions. The flexible section should not be bent or used to make up for misalignment between the engine exhaust and the exhaust piping. Since typical exhaust temperatures range from 427 °C (800 °F) to over 649 °C (1,200 °F) for some engines, seamless stainless steel should be used for the flexible section.

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CAUTION

When installing a silencer, make certain flow direction is correct. Check inlet and outlet marking on the silencer nameplate.

Extended Piping

Engine exhaust piping can accumulate a considerable amount of condensed moisture after unit shutdown, particularly if the exhaust system is run through lengthy piping. To prevent condensed moisture from running back into the engine, exhaust piping should be sloped away from the engine and a condensate trap and drain should be incorporated at a low point ahead of engine manifolds. The trap should be drained periodically.

Horizontal extended exhaust pipe should terminate with a 45° tail pipe to prohibit rain from entering the system. A screen should be placed across the end of the tail pipe to keep birds and rodents from entering the system.

Where vertical exhaust stack is necessary, a rain cap should be fitted to exclude rain and snow from the exhaust pipe.

Where there is a danger of extending piping coming in contact with combustible material or personnel, the piping should be insulated or shielded.

Piping Insulation

The heat rejected by exhaust piping and the amount of ventilating air required can be substantially reduced by insulating exhaust piping with suitable high-temperature insulation. Exhaust temperatures are given on each generator model's specification sheet. DO NOT insulate piping for the turbocharger or manifold.

WALL OR ROOF THIMBLES

Exhaust piping passing through combustible walls or partitions must be guarded at the point of passage by an approved metal ventilated thimble to prevent exhaust pipe heat from being transmitted to the combustible material (Figure 6-3). Thimbles must be suitable for the application. Consider the type of exhaust system, construction materials used and local fire codes.

Roof Thimbles

Approved roof thimbles should be constructed so that they extend at least 23 cm (9 in) both ways from the surface of the roof. Ventilation holes are located on both ends for roof thimbles, therefore, a rain shield must be included above the thimble. Rain caps on the end of the exhaust pipe are recommended only in areas not subject to freezing temperatures. In an area where freezing is common, extend the exhaust piping well beyond the roof and use a gradual "U" bend at the end to direct the exhaust outlet downward which will keep rain, snow, etc., out of the pipe. The outlet of the pipe should be far enough away from the roof to prevent ignition of the roof material from hot exhaust.

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Wall Thimbles

Approved wall thimbles should be constructed so that they extend at least 15 cm (6 in) both ways from the surface of the wall. Wall thimbles have ventilation holes on one end which should be oriented to the inside of the building.

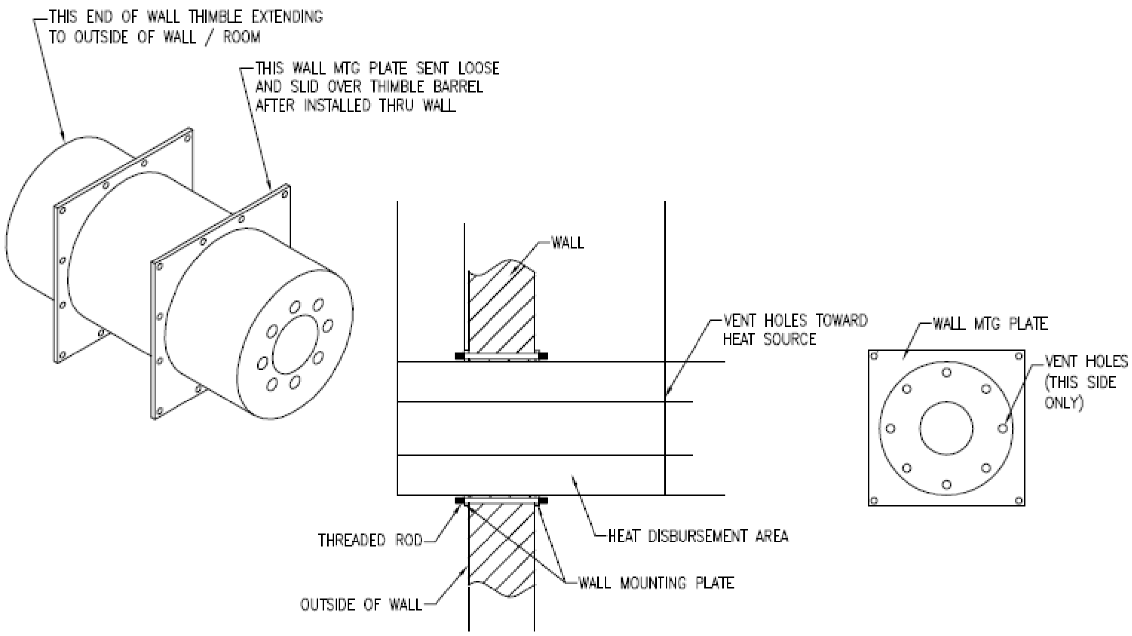

Figure 6-3: Wall thimble installation

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7

Fuel System

General

The fuel system must be installed properly to assure availability of fuel for starting and continuous running throughout the emergency. Before connecting the fuel lines to the engine, ensure that fuel connections are free from dirt, grease, water and other contaminants that could damage the engine.

The components comprising a fuel system will differ according to the generator set location, type of fuel and anticipated time of operation desired.

Diesel Applications

The following basic components comprise a representative diesel fuel system:

1. Main Fuel Tank Incorporating:
   a. Fill Line
   b. Vent Line
   c. Supply Line with Foot Valve
   d. Return Line

2. Day Tank (if required)
   a. Pump Control Switch

3. Electric Fuel Transfer Pump (if necessary)

Main Fuel Tank

The best location for the main fuel tank is as close to the engine as possible. If building codes and insurance regulations permit, the tank could be located in the same room as the generator set, or in an adjoining room. If this is not possible, the tank should be located in a convenient location compliant with local, regional and national codes.

The fuel level in the main tank should be level with the engine’s fuel transfer pump inlet. If located in the room, the tank should be on the same general level as the engine’s fuel injection pump but lower than the injectors. When the tank must be placed higher or lower than this, it often requires the usage of priming or float tanks. When the main tank can be located close to the set and where the vertical lift is 1.52 m (5 ft) or less, the fuel injection pump may be capable of supplying sufficient fuel. If the horizontal run is too great, or the vertical height exceeds 1.52 m (5 ft), a transfer pump is required. As a general rule, when static head and dynamic suction (horizontal head) exceed 20 kPA (6 inHg), an auxiliary pump and tank are required. A float tank or transfer tank is required with the auxiliary pump. The auxiliary pump should be of the positive displacement type, operated electrically from the load side of the transfer switch.

All tanks must be vented to a safe area in the event of an overflow and to allow air and other gases to escape to atmosphere. The vent must, however, prevent dust, dirt and moisture from entering the tank. Return lines are required. Keep the return space at least 30.48 cm (12 in)

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away from the pick-up or fuel supply in the day tank. If this is not done, air bubbles could be entrapped in the fuel and cause erratic operation. At least 5% of capacity should be allowed in a diesel main tank for expansion of the fuel. If the main tank is to be located overhead, an auxiliary fuel shut-off solenoid should be used.

The capacity of the fuel tank will be determined by the fuel consumption of the unit and the continuous operating time necessary. Minimum fuel supply must be sufficient to allow the set to operate for the prescribed number of hours. Before installing a fuel tank, review all local code requirements governing fuel tanks.

The number of lines connected to an underground fuel tank, whose depth of burial exceeds the below grade depth of the electric generating unit, will vary as a function of day tank positioning with regard to the engine and the number of ancillary devices utilized. However, all underground tanks must have the following:

- A vent line terminating above ground level in a screened or hooded type vent cap with unrestricted opening to atmosphere and a safe area, in the event of an overflow, that meets all necessary codes.
- A fuel fill line terminating above grade level, and fitted with an appropriate cap, and terminating in a fuel filler box with an appropriate cap plainly marked for the fuel utilized.
- A fuel supply line connected from the tank to an electric fuel transfer pump is needed when the fuel tank is located below the fuel lifting capacity of the set. The end of the fuel supply line within the tank must be fitted with a foot valve (permits flow in one direction only) to prevent loss of transfer pump prime when the transfer pump is not in operation.
- The day tank should be positioned so that the bottom of the day tank is above the level of the engine fuel filters in order to provide a positive head of pressure for the fuel injection pump. The mounting of the day tank in this manner will prevent loss of prime to the unit fuel injection pump and is recommended particularly in applications where the unit is utilized as a standby power source. In all applications, the return lines should returned to the main tank.

Local and national regulations governing fuel tank location must be checked before planning the installation. Fuel tanks must be adequately vented to prevent pressurization due to fuel expansion when heated.

CAUTION

The fuel system needs to be sized to handle the fuel flow required by the engine. Engine fuel flow is greater than engine fuel consumption and varies for different engine models. Engine fuel flow and consumption can be found on the model specification sheets located in the Operation and Maintenance manual.

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The fill, supply and return lines as well as all diesel fuel system piping must be constructed of black iron pipe. Do not use galvanized pipe for diesel fuel applications.

CAUTION

Galvanized tanks and piping must not be used since the diesel fuel and the galvanized coating react chemically to produce flaking which quickly clogs filters or causes failure of the fuel pump or injectors. Do not use Teflon tape on fuel fittings as it can clog the fuel injectors.

Cast iron and aluminum fittings and pipe should be avoided since they are porous and can leak fuel. Flexible fuel lines must be used to connect the unit to the fuel supply and return lines. Flexible lines must be of the type approved for diesel fuels.

WARNING!

Leaky fuel lines and fuel connections can introduce the possibility of explosion and fire, which can result in injury or death. Ensure fuel lines are properly connected and flexible lines are used between the engine and supply and return lines.

Fuel filters and drains must be located in easily accessible areas to promote regular and frequent service. Cleanliness of the fuel is critical for diesel engines that have easily damaged or clogged precision fuel injectors and pumps.

Day Tank

The day tank provides a ready supply of fuel at the injector pump. Day tanks are used when the engine pump does not have the necessary lift to draw fuel from the main tank. If the main tank is above the level of the injectors, the day tank is used to remove the fuel head pressure that would otherwise be placed on the engine fuel system components.

A slight head of fuel can cause leakage through the injectors and result in hydraulic lock problems such as filling of the engine cylinder with liquid fuel. The injector return line must always be at or below the level of the fitting on the engine. The line must drain toward the day tank.

Fuel Oil Transfer Pump

The fuel oil transfer pump (auxiliary pump) is used to supply fuel from the main tank to the day tank. The AC power supply for the transfer pump should be taken from the load side of the transfer switch. The pump will operate when its circuit is closed by the action of the level switch.

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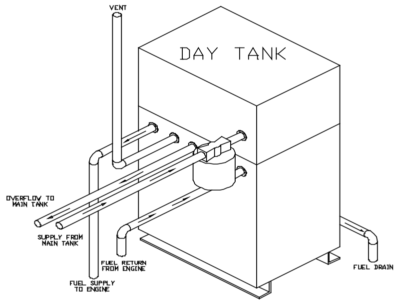

Figure 7-1: Fuel day tank

Fuel is then drawn from the main tank through a foot valve and is pumped into the day tank. Operation continues until the fuel level in the day tank rises causing the float to rise, opening the float switch and disconnecting the pump motor.

Gaseous Fuel Systems

System Variations: The gaseous fuel systems used can be grouped in four general classifications. The systems are covered in the following sequence:

1. Natural Gas (including manufactured gas)
2. LP Vapor
3. Liquefied Withdrawal
4. Dual Fuel Systems (natural gas and LP gas)

1. & 2. Natural Gas and Vapor Propane (Figure 7-2A):

Natural gas and most LP Vapor gas systems are vapor fuels as supplied by the utilities. These fuel system components are used in a similar manner. When the heating content of the fuel falls below 35,315 BTU/m^3 (1000 BTU/ft^3), as it does with some natural gas fuels, the generator set will have to be derated. Consult your MTU Onsite Energy distributor for application details. The gas distribution companies will provide piping from the main transmission line to the building. The primary regulator should be furnished by the utility company. It is the responsibility of the utility company to ensure that sufficient pressure is present at all times to operate the primary regulator. Installation, repair and alteration to gas piping should be undertaken only by the utility company or personnel authorized by them. Piping should be rigidly mounted but protected against damage from vibration. Only approved flexible connection should be used.

3. Liquid Withdrawal

Most LPG systems are operated from vapor. The main tank is sized to vaporize the fuel volume needed for ambient temperature of the installation. Sizing the LPG tank must be the responsibility of the fuel supplier. Give the fuel supplier the fuel volume required.

Vaporizers: Vaporizers are devices used exclusively with LPG systems. LPG in liquid form is introduced under tank pressure into the vaporizer which uses engine coolant heat to convert the liquid into a vapor state. Vaporizers may be referred to as converters; both names describe

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its function. There are several types of vaporizers. One type is strictly a vaporizer and must be used in conjunction with other pressure regulators. This type of vaporizer may be required if tank size is limited; low ambient temperatures or high fuel volume are conditions affecting the installation. The type classified as vaporizer-regulators provide vaporization plus primary and secondary regulation of gas pressure.

Fire regulations in most localities prohibit high gas pressures and liquid LP fuel lines inside a building or enclosure. This automatically precludes high-pressure equipment on or near an engine installed inside a building. Consult with the local authority having jurisdiction before installing a high pressure fuel system inside a building. Consult your MTU Onsite Energy distributor for other options.

4. Dual Fuel Systems (Natural or LP Vapor)

In many applications, natural gas is the main fuel and LPG is used as the emergency fuel when natural gas is not available. The dual fuel system (in common use) offers automatic changeover from one fuel to the other. Cutting off the natural gas operates a pressure switch in the line which automatically opens the LP Vapor solenoid and closes the natural gas solenoid.

Gas System Common Components

Gas piping: Piping must never be used to ground electrical apparatus. Piping must be rigidly mounted but protected against vibration. Where flexible connections are required, use only approved connections. A flexible section should be used between the point where the gas leaves the rigid fuel line and enters the engine. Refer to mechanical drawing for any locations of fuel inlet connections. Installation codes may require an automatic safety shutoff valve to be placed ahead of any flexible connector. This shutoff valve is not supplied by MTU Onsite Energy.

All gas lines and piping should be of black iron. All piping joints and connections must be leak free and tested for leaks in accordance with applicable local codes. The pipe should be of sufficient size to maintain the proper pressure and volume when operating at full load. The installer is responsible for determining pipe size for gaseous fuel systems based on fuel piping length, number of fittings, and pressure drop.

NOTE: The system nameplate shows the fuel consumption and pressures required for each system. In addition to the actual fuel consumption, the following factors must be considered:

- Pressure loss due to number of fittings
- Specific gravity of gas
- Pressure loss due to length of piping

Fuel shut-off solenoid: This device automatically shuts off the fuel supply when the engine stops. All MTU Onsite Energy automatic fuel shut-off valves are electrically activated solenoids that seal off the fuel the instant the ignition switch is turned off.

Primary regulator: This regulator is used to provide pressure regulation of the gas from the high-pressure supply line or with LPG with the supply tank.

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The primary regulator reduces line pressures to allowable inlet pressures for the secondary regulator. This regulator is supplied by the utility or fuel company.

Secondary regulator: The low-pressure type regulator admits fuel to the engine in response to engine demand. The secondary regulator is not supplied by MTU Onsite Energy and must be supplied by others. Natural gas and LPG vapor withdrawal inlet pressures must be from 1.74 to 2.74 kPa (7 to 11 in H_2O).

Electronic fuel control valve: The electronic fuel control valve regulates the volume of fuel to the mixer.

Mixer: The mixer combines the air and fuel and delivers it to the engine.

Throttle body: The throttle body controls the air/fuel mixture volume which is proportional to the load on the engine.

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8

Electrical Requirements

General

The electrical system consists of the AC power output of the generator set, AC power supplied to generator set accessories, and DC starting and control circuitry. These circuits must be enclosed in separate conduits.

Batteries

Batteries must be provided with enough capacity to deliver the cranking motor current specified on the unit specification sheet. Recommended batteries are lead-acid or nickel cadmium. Batteries should be located as close as possible to the generator set to eliminate line losses. Properly protect battery terminal connections to prevent corrosion.

Lead-acid batteries can be shipped wet or dry. If shipped dry, they can be stored indefinitely and when ready to use filled with electrolyte (acid) with a specific gravity of 1.250 to 1.265. It is recommended that batteries be placed on trickle charge for 12 hours after electrolyte is added. Check the electrolyte level periodically. Make certain all vent caps are in place and unobstructed.

Nickel cadmium batteries are shipped wet. It is advisable that batteries be placed on trickle charge for 12 hours when received.

Battery Racks and Cables

Where the battery installation requires remote battery location, the correct cross sectional area of battery cables is of importance in minimizing line drop. Battery racks or boxes can be supplied by MTU Onsite Energy for lead-acid batteries.

AC Power Output Wiring

All wiring must be in accordance with applicable electrical codes. Wires must be of adequate size, properly insulated and supported in an approved manner. Wires should not be placed where they may interfere with other equipment. Figures 8-1 through 8-8 illustrate the various generator connections for MTU Onsite Energy generators.

The following applies to UL 2200 Listed engine-generator sets where installed in accordance with NFPA 70, National Electric Code. For the generator output wiring, use listed stranded copper wire with 90 °C rated insulation. If wire terminals are not factory provided, use UL Listed wire terminals which are suitable for the application and ratings. When an output circuit breaker is not factory provided, install an approved overcurrent protection device rated equal to or greater than the generator voltage with a current rating no more than 125% of the output current of the unit, located within 7.6 m (25 ft) of the generator output terminals.

WARNING

Accidental contact with electrical equipment can cause severe injury and death if the equipment is not properly grounded. Ensure that all equipment is properly grounded.

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Automatic Transfer Switch

Installing an automatic transfer switch is primarily an electrical operation and, therefore, should be handled by a licensed electrician. Instructions and detailed wiring diagrams will accompany the switch.

The transfer switch is designed to be mounted on a wall or other vertical surface free from vibration. The switch should be at the electrical service entrance.

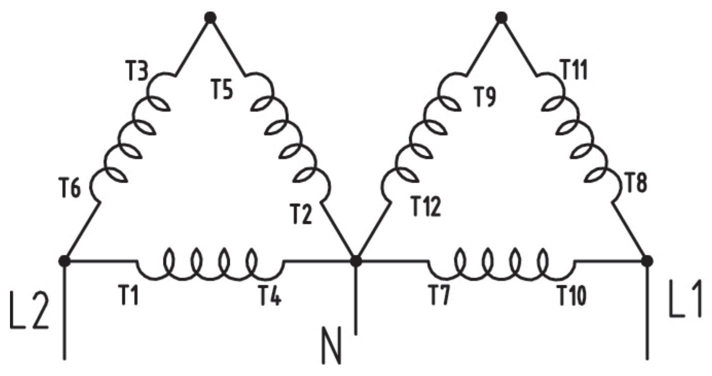
Remote Annunciator

The RDP-110 Remote Annunciator can be used in conjunction with the MGC Series generator set controllers for remote audible and visual annunciation of the generator set alarms and pre-alarms.

Accessory Wiring

When motor operated louvers are required for a generator set installation, the louver motors must be wired to operate whenever the engine generator set runs, during emergency conditions, normal periodic exercising, or for maintenance.

MTU Onsite Energy suggests the louver motors be wired to a distribution panel on the load side of the automatic transfer switch. The louver motor control circuit is wired to “energized to run” contacts in the generator set control panel.



	VOLTS	
HZ	L-L	L-N
60	240 277	120 139
50	200 220 240	100 110 120

Figure 8-1: 12 Lead Double Delta Single Phase

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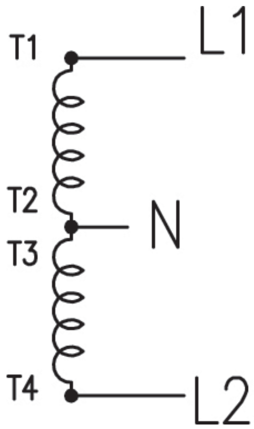
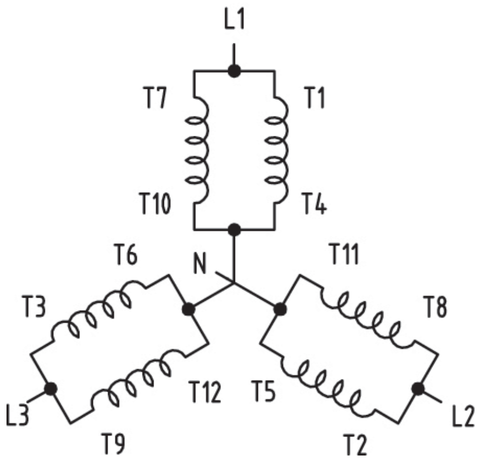


	VOLTS	
HZ	L-L	L-N
60	240 277	120 139
50	200 220 240	100 110 120

Figure 8-2: 4 Lead Dedicated Single Phase



	VOLTS	
HZ	L-L	L-N
60	190 208 220 230	110 120 127 133
50	190 200 208 220	110 115 120 127

Figure 8-3: 12 Lead Parallel WYE Three Phase

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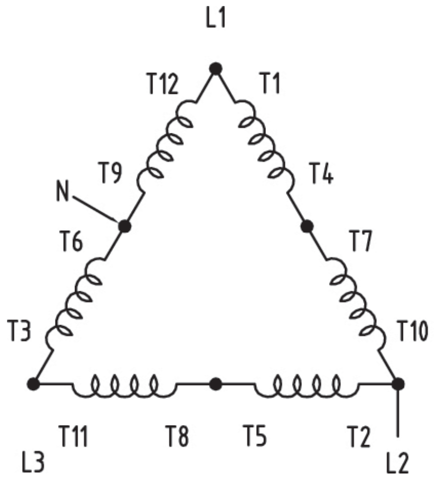
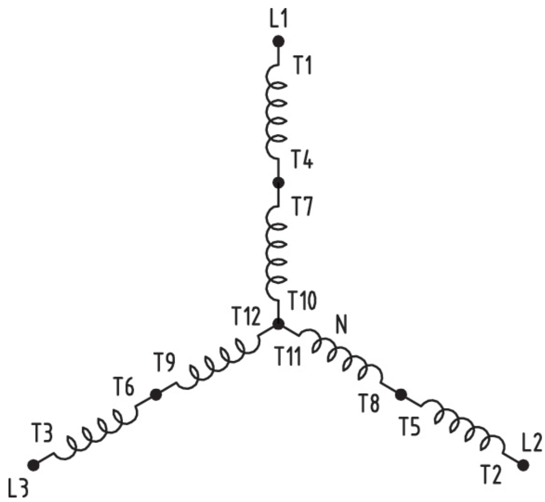


	VOLTS	
Hz	L-L	L-N
60	240 277	120 139
50	200 220 240	100 110 120

Figure 8-4: 12 Lead Series Delta Three Phase



	VOLTS	
HZ	L-L	L-N
60	380 416 440 460 480	219 240 254 266 277
50	380 400 415 440	219 231 240 254

Figure 8-5: 12 Lead Series WYE Three Phase

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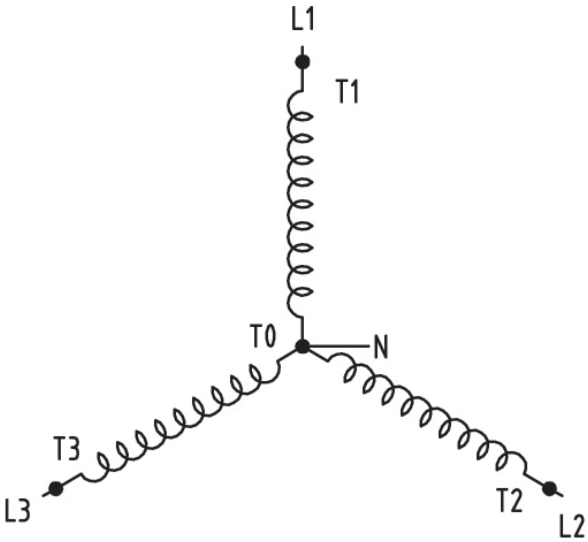
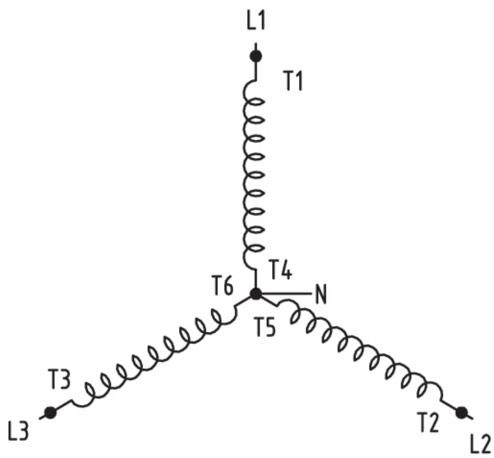


	VOLTS	
HZ	L-L	L-N
60	380	219
	480	277
	600	346
50	380	219
	400	231
	415	240

Figure 8-6: 4 Lead WYE Three Phase



	VOLTS	
HZ	L-L	L-N
60	380	219
	480	277
	600	346
	2400	1386
	3300	1905
	4160	2402
	6600	3811
	13200	7620
	13800	7967
50	380	219
	400	231
	415	240
	3300	1905
	6600	3811
	11000	6351

Figure 8-7: 6 Lead WYE Three Phase

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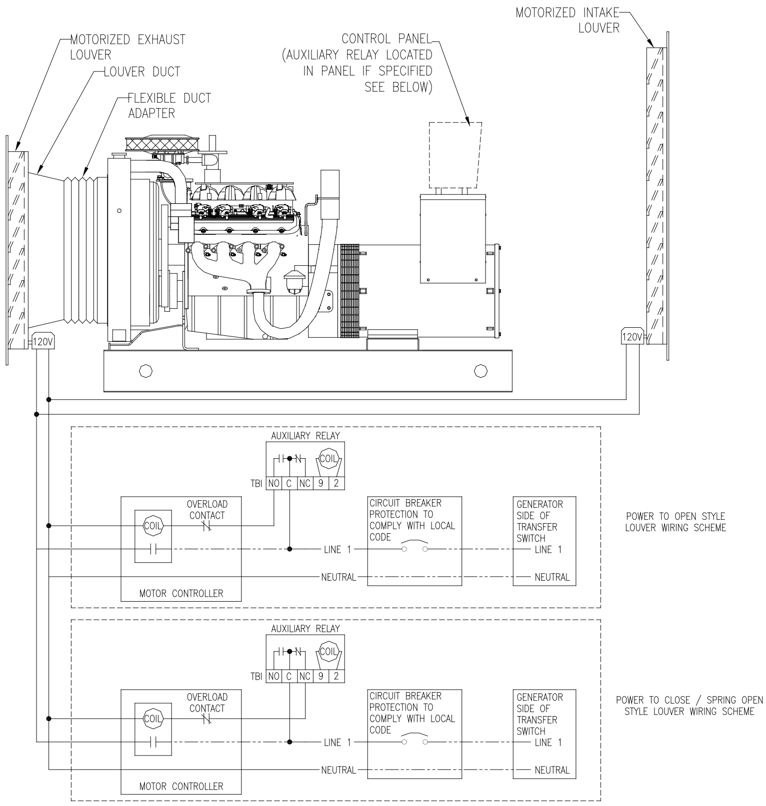

Figure 8-8: Suggested motorized louver wiring

As an alternate-wiring scheme, the louver motor may be wired directly to the generator output leads, prior to the mainline circuit breaker. The installation contractor must add any necessary wiring devices and circuit protection to comply with the local electrical code requirements.

There are many other wiring schemes which may be used to safely wire the louver motors and control circuits to ensure the louvers will open when the engine generator set runs. If there are any questions, consult your generator set supplier.

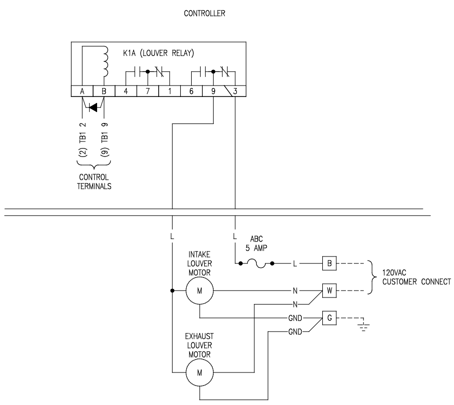

Figure 8-9: Optional motorized louver wiring

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9

Service

Install the generator set in an area that can be quickly reached for repair in case of malfunction. Service entrances should be large enough to permit service of components such as engine, radiator or generator in the event major overhaul or replacement is needed.

The location for items requiring service varies from model to model. All service items should be known and considered when planning the installation. An item requiring routine attention must, of course, be made more accessible.

In general, the following service points should be accessible:

- Air Cleaner
- Primary Fuel Filter
- Secondary Fuel Filter
- Lube Oil Dip Stick
- Oil Filter
- Starting Battery
- Starter
- Battery Charger & Voltage Regulator
- Generator & Control Systems

If your generator set requires service or repairs, simply contact an authorized MTU Onsite Energy dealer for assistance. Service technicians are factory-trained and are capable of handling all of your service needs.

When contacting a MTU Onsite Energy Authorized Dealer, always supply the complete model number and serial number of your unit, which are located on your generator set nameplate.

To locate the MTU Onsite Energy Authorized Dealer nearest you, call 800-325-5450.

NOTE

For standby units, it is important that servicing is performed on a calendar basis. Failure to do this may result in the generator set not starting or operating properly when the unit is most needed. Consult your Operation and Instruction Manual provided with the generator set for servicing information.

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10 Installation Checklist

Prior to initial start-up, refer to the following installation checklist to ensure that the generator set is installed properly.

CHECK	OK	CHECK	OK
1. Adequate clearance on all sides.		19. Exhaust nipple installed on manifold below flexible exhaust connection (condensate trap).	
2. Doors on unit must be in alignment.		20. Exhaust piping sloped away from engine.	
3. Remove engine locks and vibration isolator blocks.		21. Condensate trap or drain installed.	
4. Confirm proper alignment of angular displacement, radial displacement and axial displacement (applicable only to two-bearing generators only).		22. Muffler exhaust flow in right direction.	
5. Adequate incoming air flow.		23. Exhaust line free of excessive elbows and restrictions.	
6. Adequate outgoing air flow.		24. Exhaust line shielded/protected.	
7. Radiator duct flange connected.		25. Battery in cool location.	
8. Antifreeze required/installed.		26. Battery properly charged.	
9. Water heater properly connected and of proper voltage.		27. Battery of proper size and voltage.	
10. Proper size fuel line and connectors.		28. Battery cables correct size.	
11. Fuel lines protected.		29. Battery charger operating.	
12. Fuel pump lift adequate.		30. Generator properly connected.	
13. Flexible fuel connectors.		31. All controller contacts clean.	
14. Fuel return line.		32. Transfer switch operating correctly.	
15. Gas pressure acceptable.		33. Binding posts tight (all connections).	
16. Solenoid shut-off valve installed (gas).		34. Operator has instruction manual.	
17. Proper size exhaust line.		35. Maintenance schedule posted.	
18. Flexible exhaust connection installed.		36. No loose parts, belts, bolts, nuts, etc.	

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11 Start-Up Request Form

To provide an authorized factory start-up at the lowest possible prices, we must request that the following checklist and tasks be completed prior to an MTU Onsite Energy representative's arrival at the installation site to perform the start-up.

Unit Serial Number: ___________________________ Contact Name: ____________________________

Company Name: ______________________________ Title: ____________________________________

Please attach a map or directions to the site. Phone Number: (_______)_____________________

- ☐ Unit set in place on vibration pads with floor anchor/studs to prevent movement.
- ☐ Doors on unit in alignment.
- ☐ Radiator ducted to properly sized air discharge louvers.
- ☐ Unit full of oil and water/anti-freeze mix.
- ☐ Battery filled with acid and fully charged.
- ☐ Battery charger mounted with AC and DC wired, if not supplied mounted by the factory.
- ☐ All AC and DC electrical connections made.
- ☐ Engine heater wired to normal AC power supply.
- ☐ Fuel inlet and return lines run between the unit and fuel storage system, system filled and primed to the engine with proper fuel.
- ☐ Exhaust system in place and supported so that the exhaust manifold does not carry weight of exhaust system.
- ☐ Air inlet louver motor wired to an emergency generator source point to open upon the start of an engine generator set.
- ☐ Generator room cleaned of construction debris including excess nails, bolts, nuts, panel knockouts, etc. It is very important that the radiator fan area is checked for debris, as damage to the equipment and personal injury can occur if loose items come in contact with the fan when the unit is initially started.

Consult your Installation Guide on any questions.

If, upon arrival at the installation site, our representative cannot perform the start-up as a result of defective MTU Onsite Energy equipment, the problems will be resolved and we will reschedule another start-up date at the earliest possible date at no additional charge.

If the start-up cannot be performed due to an incomplete installation or for reasons beyond MTU Onsite Energy's control, you may incur an additional start-up charge at a later date.

Signature: ____ Date: ____________________

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12

Operating Procedures

CAUTION

Be aware that the generator set could start at any time in the "AUTO" mode. Keep clear of all moving parts and be sure to turn the switch to "OFF" position before servicing and disconnect the negative battery cable after disconnecting the battery charger circuit.

The high engine temperature shutdown system will not operate if the coolant level is too low. The high engine temperature sensor monitors coolant temperature. Loss of coolant will prevent sensor operation and allow the engine to overheat causing severe damage to the engine. Therefore, maintain adequate coolant level for proper operation of the high engine temperature shutdown system.

Low Coolant Level Shutdown: A submerged sensor in the top portion of the radiator shuts down the engine and lights the Hi Engine Temp fault lamp when the coolant level falls below the level of the sensor. Top off coolant frequently.

Prior to starting or testing the generator set, refer to the engine manual for maintenance checkpoints. Items such as oil level, coolant level, belt tension, battery electrolyte level, wire connections, and air filter are some of those that should be checked frequently.

CAUTION

Stop engine before filling fuel tank. Never fill tank when engine is hot.

STARTING PROCEDURE

The following sections cover the three systems used to start the generator set.

Starting at Control Panel (Manual Start)

1. Press the "RUN" button to activate the engine control system and the starting system.
2. The engine will begin cranking, and after a few seconds, will start.

If the engine does not start:

3. MTU Onsite Energy generator sets will automatically attempt two more crank cycles then will produce an overcrank alarm.
4. To clear an overcrank alarm, press the "OFF" button.
5. Wait two minutes for the starter motor to cool and then repeat the starting procedure.
6. If the engine does not run after a second attempt at starting, refer to the **Troubleshooting** section.

Automatic Operations

For automatic operation, the generator set will be controlled by the automatic transfer switch and the automatic engine control.

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For detailed operations of the transfer switch, refer to the Operations Manual supplied with the transfer switch.

For detailed operations of the automatic engine control, refer to the Operations Manual supplied with the generator set.

1. Leave the engine in the “AUTO” position.
2. Leave the generator set circuit breaker in the “ON/CLOSED” position.
3. Automatic starting and stopping is controlled by the transfer switch.
4. If issues for starting or stopping occur, refer to the **Troubleshooting** section.

EMERGENCY STOP PUSH BUTTON

In case of emergency the operator may shut down the generator set by pushing the red E-Stop button. This will stop and disable the generator set. The E-Stop button must be reset to resume generator set operation. Press the “OFF” button on the controller to reset the engine control before restarting the unit.

STOPPING PROCEDURE

Before Stopping

Run the generator set at no load for 3 to 5 minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

To Stop

If the set was started at the set control panel or at a remote control panel, move the RUN/OFF/AUTO switch or remote starting switch to the OFF position. If an automatic transfer switch started the set, the set will automatically stop after the normal power source returns and time delays have been satisfied.

BREAK-IN

Drain and replace the crankcase oil and oil filter(s) after the first 30 to 50 hours of operation on new generator sets. Refer to the **MAINTENANCE** section of the Engine manual for the recommended procedures. It is recommended to achieve the break in during the first 2 months after installation is completed. This will familiarize the operator with the system.

NO-LOAD OPERATION

Periods of no load operation should be held to minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a “dummy” electrical load. Such a load could consist of Load Banks.

EXERCISE PERIOD

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts. Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting.

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According to the NFPA 99-2005, NFPA 110-2010, and applicable national and local laws, ordinances, and regulations, exercise the generator set with load so the engine reaches normal operating exhaust gas temperatures. Generator sets must be tested 12 times a year, with testing intervals set at a minimum of 20 days and maximum of 40 days. For recommended minimum operating exhaust gas temperatures, refer to the engine manufacturer's documentation.

Testing the emergency power supply systems (EPSS) includes:

- using building load, as long as the load is in excess of 30% of the nameplate rating of the EPSS, or
- operating the engine maintaining a minimum exhaust gas temperature as recommended by the engine manufacturer to prevent "wet stacking" of the exhaust.

The Automatic Transfer switch has an optional exerciser that can be preset to provide regular exercise periods. Typically the exerciser can be set for time of start, length of run, and day of week. Consult your MTU Onsite Energy distributor for additional guidance as needed.

Low Operating Temperatures

Use a coolant heater if a separate source of power is available. The optional heater will help provide reliable starting under adverse weather conditions.

Be sure the voltage of the separate power source is correct for the heater element rating. The heater should be in use year round. A heater is required on all automatic systems to prevent engine damage due to short warm up cycles.

AUTOMATIC TRANSFER SWITCH

DANGER

HAZARDOUS VOLTAGE will cause severe injury or death. Turn OFF all power before installation, adjustment or removal of transfer switch or any of its components.

Equipment Inspection

Immediately inspect the transfer switch when received to detect any damage, which may have occurred during transit. If damage is found or suspected, file claims as soon as possible with the carrier and notify the nearest MTU Onsite Energy representative. The switch cabinet should be opened at inspection to check for internal freight damage, even if the box and cabinet enclosure appear undamaged.

Final Equipment Inspection

Prior to energizing the transfer switch:

- Remove any debris incurred due to shipment or installation. DO NOT use a blower since debris may become lodged in the electrical and mechanical components and cause damage. Use of a vacuum is recommended.
- Verify that all cabled connections are correct. Verify phase rotation and position of the high leg at both sources on the delta system.
- Check engine start connections and verify the correct connection of all control wires.

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- Check settings of all timers and adjust as necessary. Also adjust any optional accessories as required.
- Check the integrity of power connections by verifying actual lug torque values as specified in the ATS manual.
- Make sure that all covers and barriers are installed and properly fastened.

FUNCTIONAL TEST

Since there are various transfer switch designs available, please refer to the operator manual provided with the transfer switch for specific details.

The functional testing of the transfer switch consists of electrical tests described in this section. Before proceeding, refer to the information package supplied with the transfer switch. Read and understand all instructions and review the operation of all accessories provided.

Before starting the operation test, check the equipment-rating nameplate on the transfer switch to **verify the correct system voltage**.

To begin the test, close the Normal source circuit breaker. The micro-controller will illuminate the Normal Available LED if proper voltage is sensed. Verify the phase-to-phase voltages at the Normal line terminals.

Next, close the Emergency source breaker and start the engine generator. The Emergency Available LED indicator will illuminate when preset voltage and frequency levels are achieved. Check the phase-to-phase voltages at the Emergency line terminals. Also, verify that the phase rotation of the Emergency source is the same as the phase rotation of the Normal source.

After the sources have been verified, shut down the engine generator, and put the starting control in the automatic position. Complete the visual inspection of the transfer switch, and close and lock the cabinet door.

Initiate the electrical transfer test by activating the test switch. **Hold the test switch until transfer to Emergency is accomplished**. After the engine start time delay, the micro-controller will send an engine start signal and sensing will determine when the auxiliary source reaches preset levels. The switch will transfer to the Emergency source after the time delay of the transfer to the Emergency timer.

Deactivating the test switch will start retransfer to the Normal source. The switch will retransfer to the Normal source after the time delay of the retransfer to Normal timer. The engine over-run timer allows the engine generator to run unloaded for a preset cool-down period.

For complete details of timer and voltage sensing operations, please refer to the Automatic Transfer Switch Operation Manual.

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Maintenance and Testing
A preventive maintenance program will ensure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items.

Inspection and Cleaning

DANGER

HAZARDOUS VOLTAGE. De-energize all sources of power before doing any work on the transfer switch. Note: If approved disconnects are not in place contact your Local Electric Utility or a qualified Electrician before proceeding.

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. DO NOT use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (DO NOT USE EMERY CLOTH OR A FILE). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing
All worn or inoperative parts must be replaced using recommended replacement parts. Please contact your nearest Distributor for specific replacement part information and ordering procedures.

The operating mechanism of the transfer switch is lubricated. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional lubricant. (See Automatic Transfer Switch Manual for proper lubricant type).

Testing
A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. Both power sources MUST be disconnected before manual operation of the switch. Insert the handle and operate the transfer switch between the Normal and Emergency positions. The transfer switch should operate smoothly without binding. Return the switch to the Normal position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the test switch. Engine start timer will time out and the micro-controller will send an engine start signal. When the transfer to Emergency time has elapsed, the switch will complete its transfer by closing into the Emergency source.

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Deactivating the test switch will start retransfer to the Normal source. The switch will complete its retransfer to Normal after the time delay of the retransfer to Normal timer. The engine over-run timer allows the engine generator to run unloaded for a preset cool down period.

GOVERNORS

MECHANICAL GOVERNOR ADJUSTMENTS

All MTU Onsite Energy generator sets are tested at full load prior to shipment and the speed settings are adjusted. The typical settings will vary from 60 – 63 Hz at no load and are set to operate at 60 Hz when loaded to the nameplate rating. If the system load does not reach the nameplate rating the speed can be adjusted down to 60 Hz. Care must be taken to ensure that the MTU Onsite Energy generator set operates at no less than 60 Hz when the entire load to be on the unit is applied. See Figures 12-1 and 12-3 to find the typical speed adjust locations.

ELECTRONIC GOVERNOR DIESEL ADJUSTMENTS

Governor Speed Setting (Diesel)

The governed speed set point is increased by clockwise rotation of the Speed adjustment control. Remote speed adjustment can be obtained with an optional Speed Trim Control. See Figure 12-1.

Governor Performance (Diesel)

Once the engine is at operating speed and at no load, the following governor performance adjustments can be made: Rotate the Gain adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment 1/8 of a turn further counterclockwise to ensure stable performance.

Rotate the Stability adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment 1/8 of a turn further counterclockwise to ensure stable performance.

Gain and stability adjustment may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance. A strip chart recorder can be used to optimize the adjustments further. If instability cannot be corrected or further performance improvements are required, contact the nearest distributor or Service Center.

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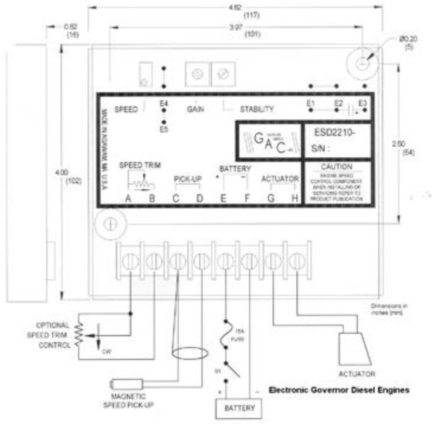

Figure 12-1: Standard GAC Governor Control

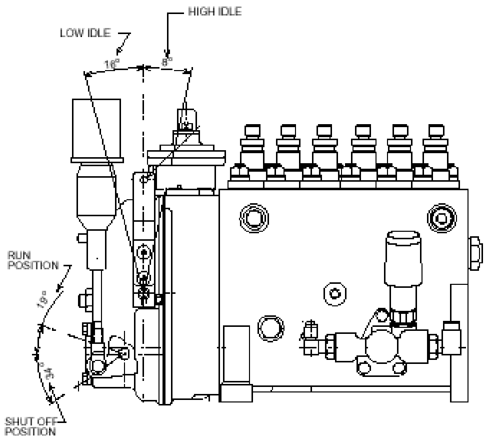

Figure 12-2: Standard Mechanical Governor for Diesel Engines

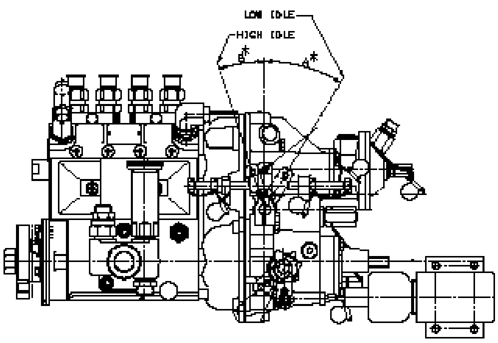

Figure 12-3: Standard Mechanical Governor for Diesel Engines

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Gas Engine Governor System

The gaseous engines utilize an electronic governor as standard. The governors are microprocessor controlled and have no operator accessible adjustments. The speed is factory set to operate at 60.1 hertz.

13 Troubleshooting

The generator set has a number of sensor units that continuously monitor the engine for abnormal conditions such as low oil pressure or high coolant temperature. If an abnormal condition does occur, the engine monitor will activate a fault lamp and may also stop the engine depending on the condition. If the generator set does shut down, the operator may be able to restart the set after making certain adjustments or corrections. This section describes the operation of the fault condition system and suggested troubleshooting procedures for the operator.

Depending on the model of the generator set, set points, pre-alarms and alarms may vary for oil pressure and coolant temperature. **Note:** These are generator control set points and **not** engine control set points.

Please consult your distributor for exact set point, pre-alarm and alarm values for your specific generator set.

SAFETY CONSIDERATIONS

High voltages are present within the control panel and generator outlet box when the generator is running.

WARNING

Contacting high voltage components can cause serious personal injury or death. Keep control and outlet box covers in place during troubleshooting.

Generator set installations are normally designed for automatic starting or remote starting. When troubleshooting a set that is shut down make certain the generator set cannot be accidentally restarted. Press the OFF button on the controller and remove the negative battery cable from the starting battery. Also, be sure to turn battery charger disconnect off before servicing battery circuits.

WARNING

Accidental starting of the generator set during troubleshooting can cause severe personal injury or death. Disable the generator set before troubleshooting.

When a fault comes on during operation the type of fault will be displayed on the LCD panel. The control panel will also illuminate an indicator light to correspond with the display. The red LED light will indicate fault (shutdown alarm) or the yellow LED pre-alarm (approaching shut down point).

DISPLAY MODE SWITCH

This switch allows the operator to lock the display by moving the switch upward when in the scroll lock mode, the display will not update. By moving the toggle downward the display will show total run time. When the mode switch is in the mid position (normal mode), the display

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will scroll through all parameters. Follow the trouble shooting procedures to locate and correct the problem. For any symptom not listed, contact your Distributor for service. Voltage and amperage may display 3 phases, when operated single phase. The unused positions will display “0”.

RESETTING THE CONTROL

Placing the RUN/OFF/AUTO switch in the OFF position and pressing the alarm silence switch can deactivate the external alarm and fault lamp. Locate the problem and make the necessary corrections before restarting the generator set.

MAIN LINE CIRCUIT BREAKER

The generator output mainline circuit breaker is mounted inside the generator outlet box. If the load exceeds the breaker current rating, the breaker will open to prevent the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as required. Manually reset the breaker to reconnect the load to the generator, by pushing the handle down to the open OFF position, then up to the closed ON position.

WARNING

Many troubleshooting procedures present hazards, which can result in severe personal injury or death, as well as severe damage to the unit. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review the Safety Precautions chapter and follow all local laws and regulations.

SYMPTOM As Indicated on Display Screen	CORRECTIVE ACTION
1. PRE HI ENGINE TEMP. Engine continues to operate.	Indicates engine temperature has risen above the normal operating range, and unit may shut down if corrective action is not taken. If generator is powering non-critical and critical loads and cannot be shut down, use the following: • Reduce load, if possible, by turning off non-critical loads. • Check air inlets and outlets and remove any obstructions to airflow. • Open doors or windows in generator area to increase ventilation. If engine can be stopped, follow procedure in Step 2.
2. HI ENGINE TEMP LED. Engine shuts down.	Indicates engine temperature has exceeded allowable limit or coolant level is low (on sets with coolant level sensor). Allow engine to cool down completely before proceeding with the following checks: • Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary. • Check for obstructions to cooling airflow and correct as necessary. • Check for a slipping fan belt and tighten if loose. • Reset control and restart after locating and correcting problem.
3. PRE LOW OIL PRESSURE. Engine continues to operate.	Indicates engine oil pressure has dropped below the normal operating range and unit may shut down if corrective action is not taken. If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow Step 4 procedure. If engine can be stopped, follow procedures in Step 4.
4. LOW OIL PRESSURE. Engine shuts down. NOTE: Also see Step 5.	Indicates engine oil pressure has dropped below an acceptable level, and the unit has stopped. Check oil level, lines and filters. If oil system is stable, but oil level is low, replenish. Reset control and restart.

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SYMPTOM As Indicated on Display Screen	CORRECTIVE ACTION
5. OVERCRANK. Engine stops cranking. Or Engine runs, shuts down, and LOW OIL PRESSURE.	Indicates possible fuel system problem. • Check for empty fuel tank, fuel leaks, or plugged fuel lines and correct as required. • Check for dirty fuel filter and replace if necessary (See Maintenance section of Engine Manual). • Check for dirty or plugged air filter and replace if necessary (See Maintenance section of Engine Manual). • Refer to Step 4. • Reset the control and restart after correcting the problem. Contact your Dealer or Distributor for service if none of the above.
6. OVERSPEED. Engine runs and then shuts down.	Indicates engine has exceeded normal operating speed. Refer to governor adjust procedure. Contact your Dealer or Distributor for service.
7. UNIT NOT IN AUTO.	Indicates AUTO/OFF/RUN switch is in the OFF position which will prevent automatic starting if an automatic transfer switch is used. Move the AUTO/OFF/RUN switch to the AUTO position for automatic starting.
8. LOW FUEL. Engine continues to run.	Indicates diesel fuel supply is running low. Check fuel supply and replenish as required.
9. LOW FUEL and LOW OIL.	Indicates engine has run out of fuel. Check fuel level and replenish as required. See Engine Manual for fuel system priming procedure.
10. LOW ENGINE TEMPERATURE. Set is in standby mode but not operating.	Indicates engine coolant heater is not operating or is not circulating coolant. Check for the following conditions: • Coolant heater not connected to power supply. Check for blown fuse, open circuit breaker or disconnected heater cord and correct as required. • Check for low coolant level and replenish if required. Look for possible coolant leakage points and repair as required.
11. Engine starts from generator control panel, but will not start automatically or from a remote panel. Note: The AUTO/OFF/RUN switch must be in the AUTO position. Automatic or remote starting.	Indicates possible fault with remote start circuit. Check the following: • Check wire to ATS. • See ATS section for further troubleshooting. • Contact your Dealer or Distributor for assistance.

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SYMPTOM As Indicated on Display Screen	CORRECTIVE ACTION
12. Engine will not crank.	Indicates possible fault with control or starting system. Check for the following conditions: • Fault lamp on. Correct fault and reset control. • Poor battery cable connections. Clean the battery cable terminals and tighten all connections. • Discharged or defective battery. Recharge or replace the battery. • Contact your Dealer or Distributor for assistance if none of the above.
13. No AC output voltage.	Indicates possible fault with voltage regulator. • Verify output with another meter. If OK, check meter. If OK, check meter fuses. • Regulator fuse is blown. Replace fuse. Contact your Dealer or Distributor if voltage build-up causes fuse to blow. • Check rotating rectifier for damaged diodes. Replace all diodes if any are failed.
14. No Engine Start.	Indicates Engine Start wires not terminated properly or Generator in OFF position. • Check Engine Start connections. • Investigate why Engine Control Switch was put in off. • Contact your Dealer or Distributor for assistance.
15. No Engine Stop.	Indicates Timing Cycle not complete, Engine Start wires not terminated correctly or Generator in RUN. • Check Engine Start Timer setting. • Check Engine Start Connections. • Investigate why the Engine Control Switch was put in Manual. • Contact your Dealer or Distributor for assistance.

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SYMPTOM As Indicated on Display Screen	CORRECTIVE ACTION
16. ATS will not transfer to Emergency.	Indicates Emergency voltage or frequency not within acceptable parameters, power supply harness unplugged, limit switch harness unplugged or timing cycle not complete. • Check Engine Start connections, generator output, and engine control switch. • Plug in power supply harness. • Plug in limit switch harness. • Check transfer to emergency timer setting. • Contact your Dealer or Distributor for assistance.
17. ATS will not transfer to Normal.	Indicates Normal voltage or frequency not within acceptable parameters, power supply harness unplugged, limit switch harness unplugged or retransfer to Normal timing cycle not complete. • Check utility and utility breakers. • Plug in power supply harness. • Plug in limit switch harness. • Check retransfer to Normal Timer setting. • Contact your Dealer or Distributor for assistance.

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13 Version History

Indicated below is a summary of the changes that have occurred in the Installation and Basic Operation Manual.

Version	Description of Change
2017-08	Updated **Gaseous Fuel System** section for current gas product. Updated **Electrical Requirements** with new generator wiring configuration diagrams. Tap switch content was removed per internal approvals as it is no longer offered. Removed **Diesel Fuel Recommendations** as it has been superseded by engine-specific documentation.
2016-06	Added safety information.
2016-04	Updated **Air Requirements** section to include: **WARNING** Prior to start-up, louver-securing hardware must be removed. For motorized louvers, louver blade assembly must be reattached.
2015-03	Updated **Product Identification Information** section with new nomenclature.
2014-10	Added direction to install overcurrent protection device when needed in **AC Power Output Wiring** section under **Electrical Requirements**.
2014-06	Added metric units to all measurements. Removed Table 6-1 and added Table 7-2 in **Determining Pipe Size for Gaseous Fuel Systems** section.
2014-04	Updated **Starting at Control Panel** section and added **Automatic Operations** section.
2014-02	Corrected table references in **Determining Pipe Size for Gaseous Fuel Systems** section. Previously, Table 6-1 was incorrectly referenced. References were corrected to refer to Table 7-1.
2013-12	Added arc flash safety information to **Hazardous Voltage/External Energy** section.
2013-09	Added tap switch information to **Voltage Selector Tap Switch (Optional)** section.
2013-07	Added statements for proper lifting and mounting to **Lifting Provisions** and **Mounting** sections.
2013-06	Added statements to **Piping** and **AC Power Output Wiring** sections based on UL feedback
2013-01v2	Updated **Exercise Period** section and references to website.
2013-01	Updated to include min./max. testing periods in **Exercise Period** section.
2012-08	Updated graphic by removing reference to Katolight

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DIESEL GENERATOR SET
MTU 3R0096 DS30

30 kWe / 60 Hz / Standby
208 - 600V

Reference MTU 3R0096 DS30 (27 kWe) for Prime Rating Technical Data

SYSTEM RATINGS

Standby

Voltage (L-L)	240V**	208V**	240V**	380V**	480V**	600V**
Phase	1	3	3	3	3	3
PF	1	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60
kW	30	30	30	30	30	30
kVA	30	37	37	37	37	37
Amps	125	104	90	57	45	36
skVA@30% Voltage Dip	65	142	142	187	187	142
Generator Model	285PSL1700	285PSL1700	285PSL1700	285PSL1700	285PSL1700	284PSL5252
Temp Rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	12 LEAD DOUBLE DELTA	12 LEAD WYE	12 LEAD DELTA	12 LEAD WYE	12 LEAD WYE	4 LEAD WYE

** UL 2200 Offered

CERTIFICATIONS AND STANDARDS

// **Emissions**
– EPA Tier 3 Certified

// **Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004**

// **Seismic Certification – Optional**
– IBC Certification

// **UL 2200 / CSA – Optional**
– UL 2200 Listed
– CSA Certified

// **Performance Assurance Certification (PAC)**
- Generator Set Tested to ISO 8528-5 for Transient Response
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

// **Power Rating**
- Accepts Rated Load in One Step Per NFPA 110

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STANDARD FEATURES*

- // MTU Onsite Energy is a single source supplier
- // Global Product Support
- // 2 Year Standard Warranty
- // 3029TFG89 Diesel Engine
  - 2.9 Liter Displacement
  - 4-Cycle
- // Engine-generator resilient mounted
- // Complete Range of Accessories
- // Generator
  - Brushless, Rotating Field Generator
  - 2/3 Pitch Windings
  - 300% Short Circuit Capability with Optional Permanent Magnet Generator (PMG)
- // Digital Control Panel(s)
  - UL Recognized, CSA Certified, NFPA 110
  - Complete System Metering
  - LCD Display
- // Cooling System
  - Integral Set-Mounted
  - Engine-Driven Fan

STANDARD EQUIPMENT*

// Engine

Air Cleaners
Oil Pump
Oil Drain Extension and S/O Valve
Full Flow Oil Filter
Fuel Filter with Water Separator
Jacket Water Pump
Thermostat
Blower Fan and Fan Drive
Radiator - Unit Mounted
Electric Starting Motor - 12V
Governor – Mechanical Droop
Base - Formed Steel
SAE Flywheel and Bell Housing
Charging Alternator - 12V
Battery Box and Cables
Flexible Fuel Connectors
Flexible Exhaust Connection
EPA Certified Engine

// Generator

NEMA MG1, IEEE and ANSI standards compliance for temperature rise and motor starting
Self-Ventilated and Drip-Proof
Superior Voltage Waveform
Solid State, Volts-per-Hertz Regulator
±1% Voltage Regulation No Load to Full Load
Brushless Alternator with Brushless Pilot Exciter
4 Pole, Rotating Field
130 °C Max. Standby Temperature Rise
1 Bearing, Sealed
Flexible Coupling
Full Amortisseur Windings
125% Rotor Balancing
3-Phase Voltage Sensing
100% of Rated Load - One Step
5% Max. Total Harmonic Distortion

// Digital Control Panel(s)

Digital Metering
Engine Parameters
Generator Protection Functions
Engine Protection
Windows®-Based Software
Multilingual Capability
Remote Communications to RDP-110 Remote Annunciator
Programmable Input and Output Contacts
UL Recognized, CSA Certified, CE Approved
Event Recording
IP 54 Front Panel Rating with Integrated Gasket
NFPA110 Compatible

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* Represents standard product only. Consult Factory/MTU Onsite Energy Distributor for additional configurations.

APPLICATION DATA

// Engine

Manufacturer	John Deere
Model	3029TFG89
Type	4-Cycle
Arrangement	3-Inline
Displacement: L (in^3)	2.9 (177)
Bore: cm (in)	10.6 (4.2)
Stroke: cm (in)	11 (4.3)
Compression Ratio	17.2:1
Rated RPM	1,800
Engine Governor	Mechanical Droop
Max. Power: kWm (bhp)	35 (47)
Speed Regulation	±1%
Air Cleaner	Dry

// Liquid Capacity (Lubrication)

Total Oil System: L (gal)	8 (2.1)
Engine Jacket Water Capacity: L (gal)	5.7 (1.5)
System Coolant Capacity: L (gal)	11.4 (3)

// Electrical

Electric Volts DC	12
Cold Cranking Amps Under -17.8 °C (0 °F)	925

// Fuel System

Fuel Supply Connection Size	5/16" ID/-6 JIC
Fuel Return Connection Size	5/16" ID/-6 JIC
Max. Fuel Lift: m (ft)	2 (6.6)
Recommended Fuel	Diesel #2
Total Fuel Flow: L/hr (gal/hr)	111.3 (29.4)

// Fuel Consumption

At 100% of Power Rating: L/hr (gal/hr)	9.9 (2.6)
At 75% of Power Rating: L/hr (gal/hr)	7.5 (2)
At 50% of Power Rating: L/hr (gal/hr)	5.2 (1.4)

// Cooling - Radiator System

Ambient Capacity of Radiator: °C (°F)	50 (122)*
Max. Restriction of Cooling Air: Intake and Discharge Side of Rad.: kPa (in. H_20)	0.12 (0.5)
Water Pump Capacity: L/min (gpm)	110 (29)
Heat Rejection to Coolant: kW (BTUM)	20.1 (1,144)
Heat Radiated to Ambient: kW (BTUM)	4.3 (245)
Fan Power: kW (hp)	0.7 (0.94)

*Installation of a gravity exhaust louver in a Level 3 enclosure will reduce the ambient capacity of the cooling system by 5 °C (9 °F).

// Air Requirements

Aspirating: *m^3/min (SCFM)	3.6 (127)
Air Flow Required for Rad. Cooled Unit: *m^3/min (SCFM)	46.7 (1,636)
Remote Cooled Applications; Air Flow Required for Dissipation of Radiated Generator Set Heat for a Max. of 25 °F Rise: *m^3/min (SCFM)	15.8 (553)

* Air density = 1.184 kg/m^3 (0.0739 lbm/ft^3)

// Exhaust System

Gas Temp. (Stack): °C (°F)	580 (1,076)
Gas Volume at Stack Temp: m^3/min (CFM)	8.3 (293)
Max. Allowable Back Pressure: kPa (in. H_20)	7.5 (30)

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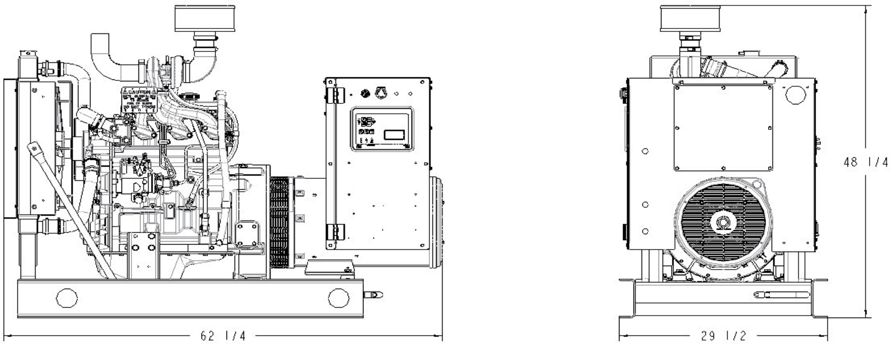
WEIGHTS AND DIMENSIONS



Drawing above for illustration purposes only, based on standard open power 480 volt generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (L x W x H)	Weight (dry/less tank)
Open Power Unit (OPU)	1,581 x 749 x 1,226 mm (62.25 x 29.5 x 48.25 in)	736-995 kg (1,623-2,194 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific generator set.

SOUND DATA

Unit Type	Standby Full Load
Level 0: Open Power Unit dB(A)	72.2

Sound data is provided at 7 m (23 ft). Generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

EMISSIONS DATA

NO_x + NMHC	CO	PM
4.41	0.44	0.11

All units are in g/hp-hr and shown at 100% load (not comparable to EPA weighted cycle values). Emission levels of the engine may vary with ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data was obtained in compliance with US EPA regulations. The weighted cycle value (not shown) from each engine is guaranteed to be within the US EPA Standards. 5-mode emission data per 40 CFR 89 or 40 CFR 1039 (as applicable) is available upon request.

RATING DEFINITIONS AND CONDITIONS

// Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 3046-1, BS 5514, and AS 2789. Average load factor: ≤ 85%.

// Deration Factor:
Altitude: Consult your local MTU Onsite Energy Power Generation Distributor for altitude derations.
Temperature: Consult your local MTU Onsite Energy Power Generation Distributor for temperature derations.

© MTU Onsite Energy. Subject to alteration due to technological advances. OE 23 827 (77 3E) 2017-09

C/F = Consult Factory/MTU Onsite Energy Distributor
N/A = Not Available

2.8 *** Please complete and return any warranty information:

DF2369BE (1 APR 00)

DEERE POWER SYSTEMS GROUP

Affix First-Class Postage

Return Address

Register your engine for warranty!! (See page 14)

JOHN DEERE ENGINE WARRANTY REGISTRATION

Purchaser's Name ____________________

MAILING Address ____________________

City ____________ **State/Province** ________ **Postal Code** ________ **Country** ________

Engine Serial Number from Engine Serial Number Plate _ _ _ _ _ _ _ _ _ _ _ _ _
(Required number is made up of two letters then four digits then one letter then six digits. All 13 characters required.)

Date Engine Delivered ____________ **Engine is** ___ **Original** ___ **Replacement**
(Day) (Month) (Year)

Equipment Manufacturer ____________
(The equipment, not the engine.)

Equipment Description & Model ____________
(What is it? What does the manufacturer call it?)

Does the engine provide the power to move the equipment from place to place? ___**Yes** ___**No**

How will the equipment be used? ____________________

Special Warranty Terms ____________________
("None", unless authorized in writing by John Deere. See *Engine Owner's Warranty* booklet.)

Operation and Maintenance Manual
Furnished with Engine # OMRG ____________
(John Deere stock number printed on cover)

The John Deere *Operation and Maintenance Manual* for the above engine was received. The warranty, safe operation, and proper servicing of the engine were explained to me. I have received and have read the Engine Owner's Warranty.

Telephone (______) ____________

E-mail Address ____________

Purchaser's Signature ____________ Date ________

Assistance needed in locating the nearest John Deere engine service dealer ☐ Yes ☐ No

Note: Mailing addresses and fax numbers are on page 14.

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DEERE POWER SYSTEMS GROUP

Return Address

Affix
First-
Class
Postage

Type or print in BLOCK letters

JOHN DEERE USED ENGINE WARRANTY TRANSFER

Original Purchaser's Name ______________________________

MAILING Address ______________________________

City __________ **State/Province** __________ **Postal Code** __________ **Country** __________

New Owner's Name ______________________________

MAILING Address ______________________________

City __________ **State/Province** __________ **Postal Code** __________ **Country** __________

Engine Serial Number from Engine Serial Number Plate _ _ _ _ _ _ _ _ _ _ _ _ _

(Required number is made up of two letters then four digits then one letter then six digits. All 13 characters required.)

Date of Change of Ownership ______________________________

Engine Hours of Use at Change of Ownership __________ **(Meter** __________ **Estimate** __________ **)**

I ____ did ____ did not receive the *Operation and Maintenance Manual* for the engine from the previous owner.

I received from the previous owner, and have read, the *Engine Owner's Warranty*.

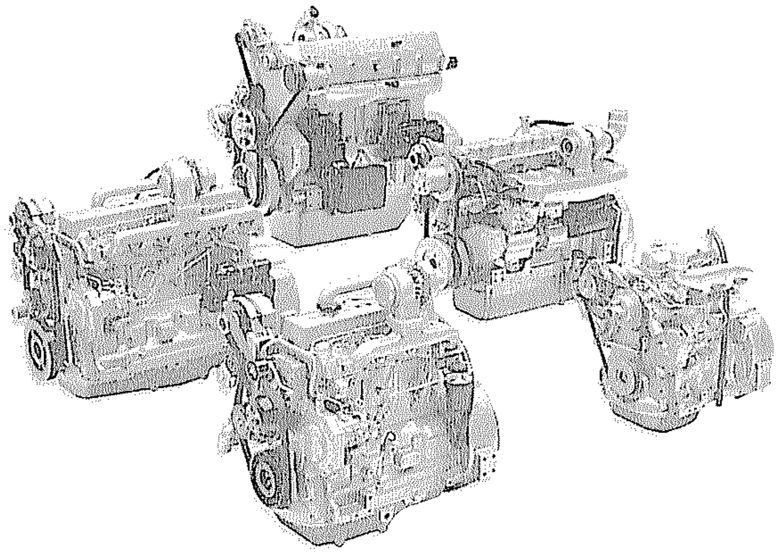
Telephone (________) ______________________

E-mail Address ______________________ ______________________ New Owner's Signature __________ Date

Note: This form may be faxed to John Deere. (See page 14 of *Engine Owner's Warranty*.)

Engine Owner's Warranty

Worldwide



New John Deere Off-Highway Engines

This booklet focuses on John Deere engines marketed in products manufactured by companies other than John Deere or its affiliates, and on John Deere repower engines in all applications.

Herein appears the original warranty applicable to the engine as delivered to the retail purchaser on or after 1 April 1998. Questions the purchaser might have about warranty and warranty service are addressed herein.

The tear-off Warranty Registration form should be completed promptly and mailed or faxed to John Deere.

But first:

1. **Record the engine's 13-character serial number below:**

   __ __ __ __ __ __ __ __ __ __ __ __ __

   (Take from the John Deere Serial Number plate on the side of the engine. It begins with two letters, and must be 13 characters in length; e.g., CD6068T123456.)

2. **Record the engine's Option Codes on page 13.**

   (Take these from the option code label on the engine rocker arm cover.)

3. **Read this booklet, and store it for handy reference.**

Note: "John Deere" means Deere Power Systems Group with respect to users in the United States, John Deere Limited with respect to users in Canada, and Deere & Company or its subsidiary responsible for marketing John Deere equipment in other countries where the user is located.

Visit John Deere at www.deere.com

1 April 00

CONTENTS

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WHEN WARRANTY SERVICE IS NEEDED

While most John Deere engines do not require the attention of an authorized John Deere service dealer during the engine warranty period, the nearest dealer stands ready with genuine parts and trained and equipped personnel should the need arise.

If following the operation and maintenance instructions delivered with the engine/machine are not adequate to correct an engine problem, contact the nearest John Deere service dealer for assistance. Authorized engine service dealers are listed in the *Parts and Service Directory for John Deere Engines*. In the U.S.A. and Canada, this information is also available by calling 1-800 JD ENGINE. In other countries, contact the machine importer, or Deere Power Systems Group in the U.S.A. at telephone number 1-319-292-5871, or fax number 1-319-292-5844; or in France (for Africa, Europe, and the Middle East) at telephone number 33.2.38.82.61.57 or fax number 33.2.38.84.62.66. Many off-highway engine service locations will also be found on the Internet at www.deere.com. (Click on "Dealer Locator".)

When requesting warranty service, the purchaser must be prepared to show proof that the engine is within the warranty period.

Should the efforts of the dealer contacted not yield satisfactory results, the purchaser should contact the Service Manager in that dealer's John Deere marketing unit. The units are indicated on pages 3-5 herein and in the *Parts and Service Directory.*

Regardless of the organization contacted, this information is always required: Engine serial number, date of delivery, engine owner, name and location of dealer and specific person contacted, date of contact, nature of engine problem, and outcome of the service dealer contact.

Given that normally it is the dealer contacted who in the end will provide the service required, maintaining a purchaser-dealer relationship of mutual respect from the beginning is always helpful.

John Deere Marketing Units/Contacts
(See page 6 for use of the numbers in parentheses.)

Argentina
(1) Industrias John Deere Argentina S.A.
Juan Orsetti 481
(2152) Granadero Baigorria
Santa Fe
Tel: 54-341-4718000 Fax: 54-341-4718001
diesel-arg@argentina.deere.com

Australia
(2) John Deere Limited
166-170 Magnesium Drive
Crestmead
Queensland 4132
Tel: 61-7-38023222 Fax: 61-7-38036555
jdlaust@deere.com

Brazil
(3) SLC - John Deere S.A.
Av. Jorge A.D. Logemann, 600
98920-000 - Horizontina - RS
Tel: 55-55-537-1322 Fax: 55-55-537-1035
diesel-br@brazil.deere.com

France
(4) John Deere France
10, Rue du Paradis, Ormes
B. P. 219
F-45144 St. Jean de la Ruelle CEDEX
Tel: 33-2-38-72-31-05 Fax: 33-2-38-74-86-65
jdfr-sav-oem@r2mannheim.deere.com

Germany
(5) John Deere Vertrieb Deutschland
John-Deere-Strasse 10
76646 Bruchsal
Tel: 49-7251-924860 Fax: 49-7251-924869
germanservice@r2mannheim.deere.com

Italy
(6) John Deere Italiana
Via G. di Vittorio, 1
I-20060 Vignate (Milano)
Tel: 39-2-95458210 Fax: 39-2-95364013
itservice@r2mannheim.deere.com

(continued on next page)

John Deere Marketing Units/Contacts (continued)
(See page 6 for use of the numbers in parentheses.)

Mexico
(7) Industrias John Deere S.A. de C.V.
Boulevard Díaz Ordaz N°. 500
Garza García, Nuevo León
Tel: 52-8-336-0828 Fax: 52-8-336-1237
mexicotechnicalservice@jdcorp.deere.com

South Africa
(8) John Deere (Pty) Ltd.
Johnson Road
Pretoriusstad
P.O. Box 198
Nigel 1490, Transvaal
Tel: 27-11-365-1000 Fax: 27-11-814-1447
rsa@deere.com

Spain
(9) John Deere Ibérica S.A.
Carretera de Toledo Km. 12.200
Apartado de Correos 10
Getafe 28900 (Madrid)
Tel: 34-91-4958353 Fax: 34-91-4958206
spainjohndeere@r2mannheim.deere.com

United Kingdom
(10) John Deere Ltd.
Harby Road
Langar
Nottingham NG13 9HT
Tel: 44-1-949-860491 Fax: 44-1-949-860490
ukservice@r2mannheim.deere.com

United States
(11) Deere Power Systems Group
P.O. Box 5100
Waterloo, IA 50704-5100
Tel: 1-319-292-5871 Fax: 1-319-292-5844
diesel-us@jdcorp.deere.com

Other countries:
(See page 6 to determine which organization below applies.)
(12) John Deere International, GmbH
Steubenstrasse 36-42
D-68163 Mannheim 1
Germany
Tel: 49-621-8298572 Fax: 49-621-8298202
48jdinproduct@r2mannheim.deere.com

(13) Deere Power Systems Group
B. P. 11013
F-45401 Fleury-les-Aubrais CEDEX
France
Tel: 33-2-38-82-61-57 Fax: 33-2-38-84-62-66
saranservice@r2mannheim.deere.com

(14) Deere Power Systems Group
P.O. Box 5100
Waterloo, IA 50704-5100, U.S.A.
Tel: 1-319-292-5871 Fax: 1-319-292-5844
diesel-us@jdcorp.deere.com

(15) Industrias John Deere S.A. de C.V.
Boulevard Díaz Ordaz N°. 500
Garza García, Nuevo León
66210 México
Tel: 52-8-336-1212 Fax: 52-8-336-1237
mexicotechnicalservice@jdcorp.deere.com

(16) John Deere Asia
166-170 Magnesium Drive
Crestmead
Queensland 4132, Australia
Tel: 61-7-38023219 Fax: 61-7-38023131
diesel-as@jdcorp.deere.com

(17) John Deere Latin America
c/o Industrias John Deere Argentina S.A.
Juan Orsetti 481
(2152) Granadero Baigorria
Santa Fe, Argentina
Tel: 54-341-4718000 Fax: 54-341-4718001
diesel-arg@argentina.deere.com

Note: Regarding John Deere Construction Equipment Dealers for all countries outside the U.S.A. and Canada, contact:

John Deere Construction Equipment Company - Overseas
P.O. Box 2000
Moline, IL 61265, U.S.A.
Tel: 1-309-765-3032 Fax: 1-309-765-3279
jdcecoverseas@jdcorp.deere.com

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The number following each country listed below indicates which of the John Deere marketing units appearing on pages 3-5 should be addressed with inquiries regarding service in that country.

Afghanistan - 13
Albania - 13
Algeria - 13
American Samoa - 16
Andorra - 4
Angola - 8
Anguilla - 17
Antigua - 17
Argentina - 1
Aruba - 17
Australia - 2
Austria - 12
Azerbaijan - 13
Azores - 9
Bahamas - 17
Bahrain - 13
Balearic Islands - 9
Bangladesh - 13
Barbados - 17
Barbuda - 17
Belarus - 13
Belgium - 12
Belize - 15
Benin - 13
Bermuda - 11
Bhutan - 13
Bolivia - 17
Bonaire - 17
Bophuthatswana - 8
Bosnia - 13
Botswana - 8
Brazil - 3
Brunei - 16
Bulgaria - 12
Burkina Faso - 13
Burundi - 13
Cambodia - 16
Cameroon - 13
Canada - 14
Canary Islands - 9
Cape Verde Islands - 13
Caroline Islands - 16
Cayman Islands - 17
Central African Rep. - 13
Chad - 13
Chile - 17
China - 16
Colombia - 17
Comoro Islands - 13
Congo, Dem Rep. of - 13
Congo, Rep. of - 13
Costa Rica - 15
Cote d'Ivoire - 13
Crete - 12
Croatia - 12
Cuba - 17
Curaçao - 17
Cyprus - 13
Czech Republic - 12
Denmark - 12
Djibouti - 13
Dominica - 17
Dominican Republic - 17
Ecuador - 17
Egypt - 12
El Salvador - 15
Equatorial Guinea - 13
Eritrea - 13
Estonia - 12
Ethiopia - 12
Faeroe Islands - 12
Falkland Islands - 17
Fernando Po - 13
Fiji - 16
Finland - 12
France - 4
French Guiana - 17
French Polynesia - 16
Gabon - 13
Gambia - 13
Georgia - 13
Germany - 5
Ghana - 13
Gibraltar - 9
Greece - 12
Greenland - 12
Grenada - 17
Grenadines - 17
Guadeloupe - 17
Guam - 16
Guatemala - 15
Guinea - 13
Guinea-Bissau - 13
Guyana - 17
Haiti - 17
Herzegovina - 13
Honduras - 15
Hungary - 12
Iceland - 12
India - 13
Indonesia - 16
Iran - 13
Iraq - 13
Ireland - 10
Israel - 12
Italy - 6
Jamaica - 17
Japan - 16
Jordan - 13
Kenya - 13
Kiribati - 16
Korea - 16
Kuwait - 13
Kyrgyzstan - 13
Kzakstan - 12
Laos - 16
Latvia - 12
Lebanon - 12
Lesotho - 8
Liberia - 13
Libya - 13
Liechtenstein - 13
Lithuania - 12
Luxembourg - 12
Macau - 16
Macedonia - 12
Madeira Islands - 9
Malagasy Republic - 12
Malawi - 8
Malaysia - 16
Maldives - 13
Mali - 13
Malta - 13
Mariana Islands - 16
Marshall Islands - 16
Martinique - 17
Mauritania - 13
Mauritius - 12
Mexico - 7
Micronesia - 16
Moldova - 13
Monaco - 4
Mongolia - 16
Montserrat - 17
Morocco - 12
Mozambique - 8
Myanmar - 16
Namibia - 8
Nauru - 16
Nepal - 13
Netherlands - 12
Nevis - 17
New Caledonia - 16
New Zealand - 2
Nicaragua - 15
Niger - 13
Nigeria - 13
Norway - 12
Oman - 12
Pakistan - 13
Palau - 16
Panama - 15
Papua New Guinea - 2
Paraguay - 17
Peru - 17
Philippines - 16
Poland - 12
Portugal - 9
Puerto Rico - 17
Qatar - 13
Reunion - 13
Romania - 12
Russia - 12
Rwanda - 13
Saba - 17
Sabah - 16
Saint Bart's - 17
Saint Croix - 17
Saint Eustatius - 17
Saint John - 17
Saint Kitts - 17
Saint Lucia - 17
Saint Martin - 17
Saint Thomas - 17
Saint Vincent - 17
San Marino - 6
Sao Tome & Principe - 13
Sarawak - 16
Saudi Arabia - 12
Senegal - 13
Seychelles - 13
Sierra Leone - 13
Singapore - 16
Slovakia - 12
Slovenia - 12
Solomon Islands - 16
Somalia - 13
South Africa - 8
Spain - 9
Spanish Guinea - 13
Sri Lanka - 16
Sudan - 13
Suriname - 17
Swaziland - 8
Sweden - 12
Switzerland - 12
Syria - 13
Tahiti - 16
Taiwan - 16
Tajikistan - 13
Tanzania - 13
Thailand - 16
Togo - 13
Tonga - 16
Transkei - 8
Trinidad-Tobago - 17
Tunesia - 12
Turkey -13
Turkmenistan - 12
Turks&Caicos Islands - 17
Tuvalu - 16
Uganda - 13
Ukraine - 12
United Arab Emirates - 12
United Kingdom - 10
United States - 11
Uruguay - 17
Uzbekistan - 13
Vanuatu - 16
Venezuela - 17
Viet Nam - 16
Virgin Islands - 17
Western Samoa - 16
Yemen - 13
Yugoslavia - 12
Zambia - 13
Zimbabwe - 8

JOHN DEERE NEW OFF-HIGHWAY ENGINE WARRANTY

Warranty Duration

Unless otherwise provided in writing by John Deere, John Deere makes the following warranty to the first retail purchaser and each subsequent purchaser (if purchase is made prior to expiration of applicable warranty) of each John Deere new off-highway engine marketed as part of a product manufactured by a company other than John Deere or its affiliates:

- 12 months, unlimited hours of use, or
- 24 months and prior to the accumulation of 2000 hours of use;

and on each John Deere engine used in an off-highway repower application:

- 12 months, unlimited hours of use.

Note: *In the absence of a functional hourmeter, hours of use will be determined on the basis of 12 hours of use per calendar day.*

Warranty Coverage

This warranty applies to the engine and to integral components and accessories sold by John Deere.

All John Deere-warranted parts and components of John Deere engines which, as delivered to the purchaser, are defective in materials and/or workmanship will be repaired or replaced, as John Deere elects, without charge for parts or engine repair labor, including reasonable costs of labor to remove and reinstall nonengine parts or components of the equipment in which the engine is installed, and, when required, reasonable costs of labor for engine removal and reinstallation, if such defect appears within the warranty period as measured from the date of delivery to the first retail purchaser, if the delivery is reported to John Deere within 30 days of the delivery.

Obtaining Warranty Service

Warranty service must be requested of the nearest authorized John Deere engine service outlet before the expiration of the warranty. An *authorized* service outlet is a John Deere engine distributor, a John Deere engine service dealer, or a John Deere equipment dealer selling and servicing equipment with an engine of the type covered by this warranty. (See "When Warranty Service is Needed" on page 2.)

Authorized service outlets will use only new or remanufactured parts or components furnished or approved by John Deere.

Authorized service locations and the name of the John Deere division or subsidiary making this warranty are listed in the *Parts and Service Directory*

for John Deere Engines (stock number DKD376) available through any John Deere Dealer or from Deere Power Systems Group (P.O. Box 5100, Waterloo, IA 50704-5100, U.S.A.; US$5.00, includes shipping and handling). Dealer information may also be obtained by calling (from the U.S. and Canada) 1-800 JD ENGINE, or from elsewhere by calling U.S.A. number 1-319-292-5871 or faxing 1-319-292-5844; or calling 33.2.38.82.61.57 or faxing 33.2.38.84.62.66 in France. Some off-highway engine service locations will also be found on the Internet at http://www.deere.com. (Click on "Dealer Locator".)

At the time of requesting warranty service, the purchaser must be prepared to present evidence of the date of delivery of the engine.

John Deere reimburses authorized service outlets for limited travel expenses incurred in making warranty service repairs in non-John Deere applications when travel is actually performed. The limit, as of the date of publication of this booklet, is US$300.00 or equivalent. If distances and travel times are greater than reimbursed by John Deere, the service outlet will charge the purchaser for the difference.

Warranty Exclusions

John Deere's obligations shall not apply to fuel injection pump and nozzles during the pump and nozzle manufacturer's warranty period on the pump and nozzles, components and accessories which are not furnished or installed by John Deere, nor to failures caused by such items. When the pump manufacturer's warranty is less than the engine warranty, John Deere will reimburse pump repair costs for warrantable-type failures during the remainder of the original engine warranty period, when so documented by the pump manufacturer's approved service outlet.

Purchaser's Responsibilities

The cost of normal maintenance and depreciation.

Consequences of negligence, misuse, or accident involving the engine, or improper application, installation, or storage of the engine.

Consequences of service performed by someone other than a party authorized to perform warranty service, if such service, in John Deere's judgment, has adversely affected the performance or reliability of the engine.

Consequences of any modification or alteration of the engine not approved by John Deere, including, but not limited to, tampering with fuel and air delivery systems.

The effects of cooling system neglect as manifested in cylinder liner or block cavitation ("pitting", "erosion", "electrolysis").

Any premium for overtime labor requested by the purchaser.

Costs of transporting the engine or the equipment in which it is installed to and from the location at which the warranty service is performed, if such costs are in excess of the maximum amount payable to the service location were the warranty service performed at the engine's location.

Costs incurred in gaining access to the engine; i.e., overcoming physical barriers such as walls, fences, floors, decks or similar structures impeding access to the engine, rental of cranes or similar, or construction of ramps or lifts or protective structures for engine removal and reinstallation.

Incidental travel costs including tolls, meals, lodging, and similar.

Service outlet costs incurred in solving or attempting to solve non-warrantable problems.

Services performed by a party other than an authorized John Deere engine service dealer, unless required by law.

Charges by dealers for initial engine start-up and inspection, deemed unnecessary by John Deere when operation and maintenance instructions supplied with the engine are followed.

Costs of interpreting or translating services.

No Representations or Implied Warranty

Where permitted by law, neither John Deere nor any company affiliated with it makes any guaranties, warranties, conditions, representations or promises, express or implied, oral or written, as to the nonoccurrence of any defect or the quality or performance of its engines other than those set forth in this booklet, and DOES NOT MAKE ANY IMPLIED WARRANTY OR CONDITIONS OF MERCHANTABILITY OR FITNESS otherwise provided for in the Uniform Commercial Code or required by any Sale of Goods Act or any other statute. This exclusion includes fundamental terms. In no event will a John Deere engine distributor or engine service dealer, John Deere equipment dealer, or John Deere or any company affiliated with John Deere be liable for incidental or consequential damages or injuries including, but not limited to, loss of profits, loss of crops, rental of substitute equipment or other commercial loss, damage to the equipment in which the engine is installed or for damage suffered by purchaser as a result of fundamental breaches of contract or breach of fundamental terms, unless such damages or injuries are caused by the gross negligence or intentional acts of the foregoing parties.

Remedy Limitation

The remedies set forth in this warranty are the purchaser's exclusive remedies in connection with the performance of, or any breach of guaranty, condition, or warranty in respect of new John Deere engines. In the event the above warranty fails to correct purchaser's performance problems caused by defects in workmanship and/or materials, purchaser's exclusive remedy shall

be limited to payment by John Deere of actual damages in an amount not to exceed the cost of the engine.

No Seller's Warranty

No person or entity, other than John Deere, who sells the engine or product in which the engine has been installed makes any guaranty or warranty of its own on any engine warranted by John Deere unless it delivers to the purchaser a separate written guaranty certificate specifically guaranteeing the engine, in which case John Deere shall have no obligation to the purchaser. Neither original equipment manufacturers, engine or equipment distributors, engine or equipment dealers, nor any other person or entity, has any authority to make any representation or promise on behalf of John Deere or to modify the terms or limitations of this warranty in any way.

Replacement Parts Warranty

New John Deere parts installed during engine warranty service are warranted for 90 days (Certain major parts may be warranted for longer periods.) or for the remaining warranty period of the engine, whichever is longer. A new engine replacing a failed engine under warranty is warranted for the remaining warranty period of the original engine.

Warranty Transfer

The remainder of the original engine warranty and the emissions control-related warranty may be transferred to a subsequent owner of the engine. The Engine Warranty Transfer card (the back cover of this booklet) should be used to report the transfer to John Deere.

Purchased Extended Warranty

Extended warranty may be purchased on most engines in many areas of the world. John Deere engine distributors and equipment dealers, and dealers of manufacturers using John Deere engines in their products, have details. John Deere may also be contacted at U.S.A. fax number 1-319-292-5844, or by fax in France at number 33.2.38.84.62.66.

Emissions Warranties

Emissions warranties appear in the operation and maintenance instructions furnished with the engine/machine. **(Warning: Statutes providing severe penalties for tampering with emissions controls may apply at the user's location.)** John Deere may also be contacted at U.S.A. fax number 1-319-292-5844; or by fax in France at number 33.2.38.84.62.66.

LOCAL WARRANTY REQUIREMENTS

Warranties required by local statutes will be furnished by the seller and noted below and on the following page.

LOCAL WARRANTY REQUIREMENTS (cont.)

OPTION CODES

(Engine manufacturing configuration)

When in need of engine replacement parts, your authorized John Deere service dealer will need to know the corresponding "Option Codes" for your engine. The option code label on the engine rocker arm cover may become damaged over time. By recording the four-digit codes below when the engine is new, and storing this booklet where it can be found when parts are needed, fast, accurate parts ordering and service will be assured.

Record below all of the four-digit code numbers as they appear on the option code label on the rocker arm cover of your engine. (Not all blanks below will be needed.)

Should there be a question about a code, note the engine serial number and call 1-800-JD ENGINE from the U.S.A. or Canada, or fax U.S.A. number 1-319-292-5844, or e-mail at diesel-us@jdcorp.deere.com, Attention: Warranty Administration; or fax number 33.2-38-84.62.66, or e-mail at saranservice@r2mannheim.deere.com, in France.

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REGISTERING THE ENGINE FOR WARRANTY

Completion and mailing of the John Deere Engine Warranty Registration form (the front ouside cover of this booklet) is very important. John Deere will not deny warranty service on an engine within its warranty period if the engine has not been registered.

However, prompt and accurate reporting before warranty service is required enables the authorized John Deere engine service dealer to determine quickly the warranty status of the engine. An engine shown on his computer screen to be in warranty assures the dealer providing the service that John Deere will reimburse him for the warranty service he provides.

Information provided on the form must be legible!

Typing is preferred, but legible handwritten reports are acceptable. "Block" numbers and Roman alphabet letters should be used; i.e.

1 2 3 4 5 6 7 8 9 0

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

All requested information should be given. Much of it contributes to reports, including reports required by governments.

Most engines do not have "Special Warranty Terms", so the appropriate entry on this line normally is "None". Any other entry must agree with information already on file with John Deere.

Every engine is to be delivered with operation and maintenance instructions. A manual not received should be requested of the engine/machine seller.

The purchaser's telephone number allows John Deere to make contact should there be questions concerning the registration. The purchaser should sign and date the form.

If the purchaser is located in Africa, Europe or the Middle East, return the card with first-class postage to:	Deere Power Systems Group B.P. 11013 F-45401 Fleury-les-Aubrais CEDEX FRANCE **or fax it to:** 33-2-38-84-62-66
If the purchaser is located in North America or any other location not mentioned above, return the card with first-class postage to:	Deere Power Systems Group P.O. Box 5100 Waterloo, IA 50704-5100 U.S.A. **or fax it to:** 1-319-292-5844

PowerTech™ 2.9 L OEM Diesel Engines

OPERATOR'S MANUAL

PowerTech 2.9 L OEM Diesel Engines

OMRG27897 ISSUE 02AUG17 (ENGLISH)

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

If this product contains a gasoline engine:

⚠ WARNING

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

The State of California requires the above two warnings.

Additional Proposition 65 Warnings can be found in this manual.

John Deere Power Systems
Worldwide Edition
PRINTED IN U.S.A.

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OEM Engine and Drivetrain Warranty Registration

RG24614 —UN—21OCT13

Scan this code to register your OEM engine online. You can also visit us directly at JohnDeere.com/warranty.

Why registering your OEM engine or drivetrain product is a really smart idea:

- **Get faster service.** Registering your engine or drivetrain product gives us the information we need to meet your service needs promptly and completely.
- **Protect your investment.** You'll be kept up-to-date on engine or drivetrain product updates.
- **Extend your warranty.** You'll be given the option to extend your coverage before your standard warranty term expires.
- **Stay informed.** Be the first to know about new products and money-saving offers from John Deere.

You're Covered

When you buy a John Deere engine or drivetrain product you aren't just buying pistons and crankshafts and gear drives. You're buying the ability to get work done. Without downtime, without worries, and without hassles. And you're buying the assurance that if you do need help, a strong support network will be there — ready to step in.

Confidence. That's what John Deere engines, John Deere drivetrains, and John Deere Warranties are all about.

Long durations. Warranties designed to give you confidence in your engine or drivetrain product.

Worldwide support. Get service when and where you need it. John Deere has 4,000+ service locations worldwide.

Genuine John Deere parts and service. Authorized service outlets will use only new or remanufactured parts or components furnished by John Deere.

Warranty Duration

Equipment operators can't afford downtime or unexpected repairs. That's why we offer a 2-year/2,000-hour warranty, with unlimited hours in the first year, on our OEM industrial and marine engines. This warranty takes effect the date that the engine is delivered to the first retail purchaser. In addition, extended warranties are available under certain conditions. John Deere offers a variety of purchased warranties to extend the warranty period for your engine. You'll be given the option to extend your coverage before your standard warranty term expires. Be sure to register your engine or drivetrain product and take full advantage of the John Deere service and support network.

Obtaining Warranty Service

Warranty service must be requested through an authorized John Deere service outlet before the expiration of the warranty. Evidence of the engine's or drivetrain product's delivery date to the first retail purchaser must be presented when requesting warranty service. Authorized service outlets include:

- John Deere distributor
- John Deere OEM service dealer
- John Deere equipment dealer
- John Deere marine dealer

Worldwide Support Network

Visit JohnDeere.com/dealer to find the authorized engine or drivetrain service location nearest you. For complete warranty details visit JohnDeere.com/warrantystatements to view, download, or print the warranty statement for your engine or drivetrain product.

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Foreword

THIS MANUAL CONTAINS INFORMATION to operate and service Tier III, Tier II, Tier I, and Non-Certified 2.9 L OEM emission-certifed engines.

NOTE: Most recent 3029 engines are now built with metric harware (screws, bolts, threads...).

READ THIS MANUAL carefully to learn how to operate and service your machine correctly. Failure to do so could result in personal injury or equipment damage.

THIS MANUAL SHOULD BE CONSIDERED a permanent part of your machine and should remain with the machine when you sell it.

MEASUREMENTS IN THIS MANUAL are given in both metric and customary U.S. unit equivalents. Use only correct replacement parts and fasteners. Metric and inch fasteners may require a specific metric or inch wrench.

WRITE ENGINE SERIAL NUMBERS and option codes in the spaces indicated in the Record Keeping Section. Accurately record all the numbers. Your dealer also needs these numbers when you order parts. File the identification numbers in a secure place off the engine.

SETTING FUEL DELIVERY beyond published factory specifications or otherwise overpowering will result in loss of warranty protection for this engine.

CERTAIN ENGINE ACCESSORIES such as radiator, air cleaner, and instruments are optional equipment on John Deere OEM Engines. These accessories may be provided by the equipment manufacturer instead of John Deere. This operator's manual applies only to the engine and those options available through the John Deere distribution network.

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Engine Owner

John Deere Engine Owner:

Don’t wait until you need warranty or other service to meet your local John Deere Engine Distributor or Service Dealer. To register your engine for warranty via the Internet, use the following URL: http://www.johndeere.com/enginewarranty

Learn who he is and where he is. At your first convenience, go meet him. He’ll want to get to know you and to learn what your needs might be.

Aux Utilisateurs De Moteurs John Deere:

N’attendez pas d’être obligé d’avoir recours à votre concessionnaire John Deere ou au point de service le plus proche pour vous adresser à lui. Pour enregistrer votre moteur pour la garantie via Internet, utilisez l'adresse suivante: http://www.johndeere.com/enginewarranty

Renseignez-vous dès que possible pour l’identifier et le localiser. A la première occasion, prenez contact avec lui et faites-vous connaître. Il sera lui aussi heureux de faire votre connaissance et de vous proposer ses services le moment venu.

An Den Besitzer Des John Deere Motors:

Warten Sie nicht auf einen evt. Reparaturfall, um den nächstgelegenen John Deere Händler kennen zu lernen. Zur Registrierung Ihres Motors für die Garantie dient folgende Internet-Adresse: http://www.johndeere.com/enginewarranty

Machen Sie sich bei ihm bekannt und nutzen Sie sein “Service Angebot”.

Proprietario del motore John Deere:

Non aspetti fino al momento di far valere la garanzia o di chiedere assistenza per fare la conoscenza del distributore dei motori John Deere o del concessionario che fornisce l'assistenza tecnica. Per registrare via Internet la garanzia del suo motore, si collegi al seguente sito URL: http://www.johndeere.com/enginewarranty

Lo identifichi e si informi sulla sua ubicazione. Alla prima occasione utile lo contatti. Egli desidera fare la sua conoscenza e capire quali potrebbero essere le sue necessità.

Propietario De Equipo John Deere:

No espere hasta necesitar servicio de garantía o de otro tipo para conocer a su Distribuidor de Motores John Deere o al Concesionario de Servicio. Registre su motor para la garantía en la siguiente dirección de internet: http://www.johndeere.com/enginewarranty

Aprenda quién es su distribuidor y donde él está situado. Cuando tenga un momento, vaya a visitarlo. A él le gustará conocerlo, y saber cuáles podrían ser sus necesidades.

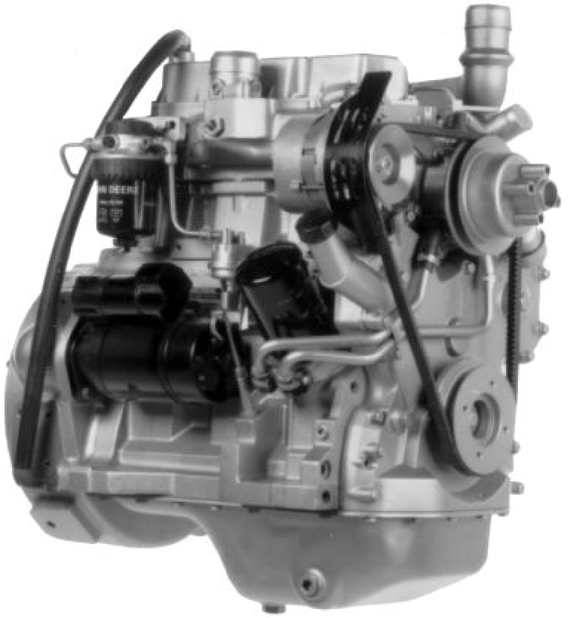
Till ägare av John Deere motorer:

Ta reda på vem din återförsäljare är och besök honom så snart tillfälle ges. Vänta inte tills det är dags för service eller eventuellt garantiarbete. Din motor garantiregistrerar Du via Internet på http://www.johndeere.com/enginewarranty

Din återförsäljare vill mycket gärna träffa dig för att lära känna dina behov och hur bäst han kan hjälpa dig.

OURGP11,0000251 -19-18SEP07-1/1

Identification Views—Tier I Emission Certified Engines



RG9173 —UN—29NOV00

3029D Right Front View

RG9172 —UN—29NOV00

3029D Left Front View

RG,RG34710,4501 -19-14FEB03-1/2

RG9175 —UN—29NOV00

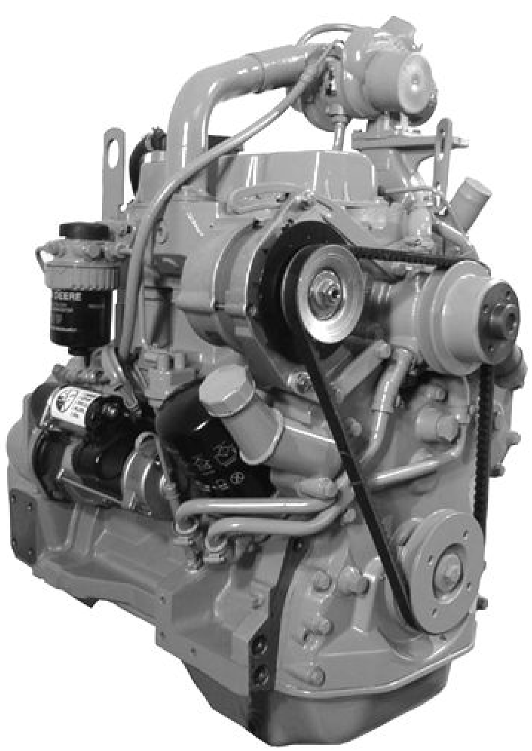
3029T Right Front View

RG9174 —UN—29NOV00

3029T Left Front View

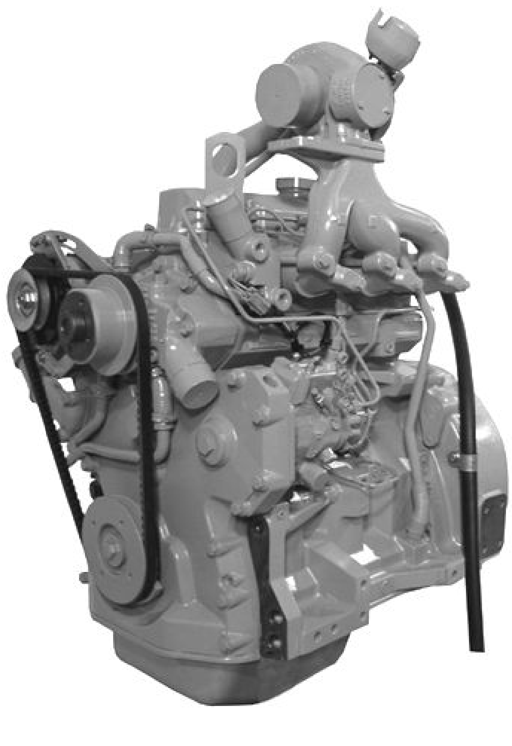
RG,RG34710,4501 -19-14FEB03-2/2

Identification Views—Tier II Emission Certified Engines



RG12834 —UN—05MAR03

3029TF270 Right Front View



RG12835 —UN—05MAR03

3029TF270 Left Front View

OUOD005,00001D6 -19-14FEB03-1/1

TIM-ID: 0000114010 - 001

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Continued on next page ZE59858,0000006 -19-09MAR16-1/2

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ZE59858,0000006 -19-09MAR16-2/2

TIM-ID: 0000114010 - 001

Contents

Continued on next page

TIM-ID: 0000114010 - 001

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TM-ID: 0000114010 - 001

Record Keeping

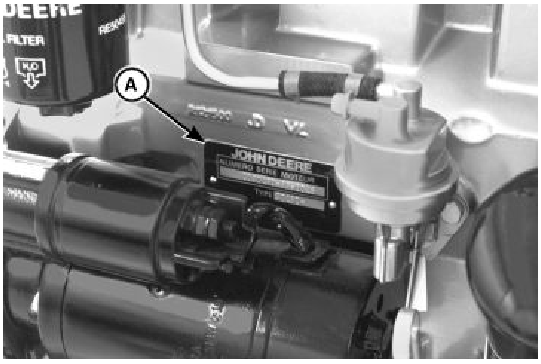
Engine Serial Number Plate

Each engine has a 13-digit John Deere engine serial number. The first two digits identify the factory that produced the engine:

- “CD” indicates the engine was built in Saran, France
- “PE” indicates the engine was built in Torreon, Mexico

Your engine's serial number plate (A) is located on the right-hand side of cylinder block near the starter motor.

A—Serial Number Plate



RG11522 —UN—01DEC00

Engine Serial Number Plate Location

RG,RG34710,5002 -19-30JAN98-1/1

Record Engine Serial Number

Record all of the numbers and letters found on your engine serial number plate in the spaces provided below.

This information is very important for repair parts or warranty information.

Engine Serial Number (A)

____

Engine Application Data (B)

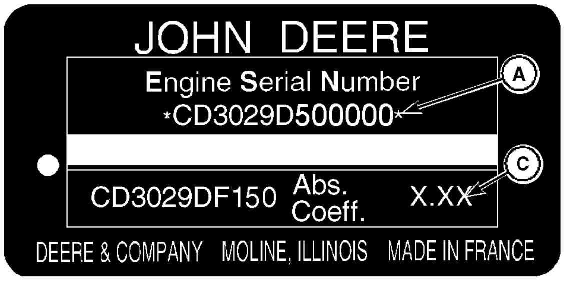
____

Coefficient of Absorption Value (For Smoke Emissions) (C) (Earlier Saran-Built Engines Only)

____

NOTE: Tier II emission-certified engines have application data (B) ending in “270s”, while Tier I emission certified engines have data ending in “150s” (as illustrated) or “180s”, and emission non-certified engines have application data ending in “120s” or “160s”.

A—Serial Number
B—Application Data
C—Coefficient of Absorption Value



RG11523 —UN—01DEC00

Saran Serial Number Plate

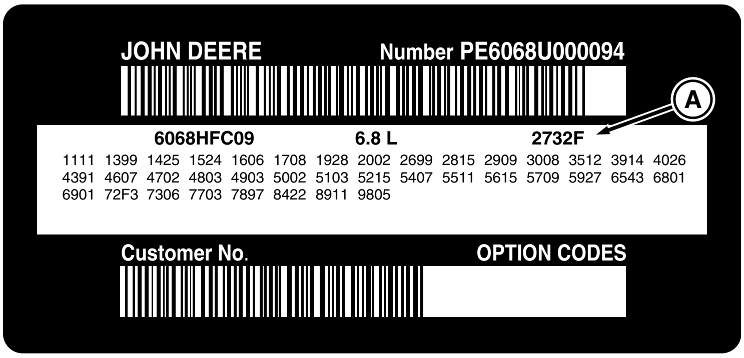
RG11524 —UN—01DEC00

Torreon Serial Number Plate

OURGP11,000000D -19-23MAY06-1/1

TIM-ID: 0000114010 - 001

Engine Option Codes



RG24026 —UN—05AUG13

Option Code Label Example

A—Engine Base Code (example)

OEM engines have an engine option code label affixed to the rocker arm cover. These codes indicate which of the engine options were installed on your engine at the factory. When in need of parts or service, furnish your authorized servicing dealer or engine distributor with these numbers.

The engine option code label includes an engine base code (A). This base code must also be recorded along with the option codes. At times it will be necessary to furnish this base code to differentiate two identical option codes for the same engine model.

The first two digits of each code identify a specific group, such as alternators. The last two digits of each code identify one specific option provided on your engine, such as a 24 volt, 120 amp alternator.

If an engine is ordered without a particular component, the last two digits of that functional group option code will be 99, 00, or XX. The following list shows only the first two digits of the code numbers. For future reference such as ordering repair parts, it is important to have these code numbers available. To ensure this availability, enter the third and fourth digits shown on your engine option code label in the spaces provided on the following page.

An additional option code label may also be delivered (in a plastic bag attached to the engine or inserted in the machine documentation). It is recommended to place this label either on this page of the operators manual or in the Engine Owner's Warranty booklet under Option Codes.

The machine manufacturer may have placed the label in a specific accessible area (inside the enclosure or close to a maintenance area).

Your engine option code label may not contain all option codes if an option has been added after the engine left the producing factory.

If option code label is lost or destroyed, consult your servicing dealer or engine distributor selling the engine for a replacement.

Record your engine Base Code (A) in the spaces provided below for easy reference.

Engine Base Code (A):

____

Option Codes	Description
10____________	Paint Protection
11____________	Rocker Arm Cover
12____________	Oil Filler
13____________	Crankshaft Pulley
14____________	Flywheel Housing
15____________	Flywheel
16____________	Fuel Injection System
17____________	Air Inlet
18____________	Air Cleaner
19____________	Oil Pan
20____________	Water Pump
21____________	Thermostat Cover
22____________	Thermostat
23____________	Fan Drive
24____________	Fan Belt

Option Codes	Description
56____________	Paint
57____________	Water Pump Inlet
58____________	Power Take Off
59____________	Oil Cooler/Oil Filter
60____________	Add-On Fan Drive Pulley
61____________	After Treatment Device/Muffler
62____________	Alternator Mounting
63____________	Low-Pressure Fuel Lines
64____________	Exhaust Elbow
65____________	Turbocharger
66____________	Temperature Switch
67____________	Engine Sensors
68____________	Damper
69____________	Engine Serial Number Plate
70____________	Decomposition Tube (OEM)

Continued on next page RG,RG34710,5004 -19-12JUN17-1/2

Option Codes	Description	Option Codes	Description
25	Fan	71	SCR (OEM)
26	Block Heater	72	Performance Software and Labels
27	Radiator/Heat Exchanger	7A	Performance Software and Labels
28	Exhaust Manifold	73	After Treatment Dosing System
29	Ventilator System	74	Air Conditioning
30	Starting Motor	75	Restriction Indicator
31	Alternator	76	Oil Pressure Switch
32	DEF Lines, Pressure (OEM)	77	Timing Gear Cover (S450/S650
33	DEF Lines, Supply/Return to Tank (OEM)	78	Air Compressor
34	DEF Tank and Header (OEM)	79	Certification
35	Final Fuel Filter	80	Sea Water Pump (Marine)
36	Front Plate and Idler Shafts	81	Primary Fuel Filter/Water Separator
37	Fuel Transfer Pump	82	Ignition System (Natural Gas)
38	Operator Manual	83	Vehicle Performance Software
39	Thermostat Housing	84	Wiring Harness
40	Dipstick and Tube	85	Fuel System (Natural Gas)
41	Belt Driven Auxiliary Drive (Add-On Crank Pulley)	86	Fan Pulley
42	DEF Line, Supply Module to Injector (OEM)	87	Belt Tensioner
43	Starting Aid	88	Oil Filter
44	Timing Gear Cover (S350)	89	EGR System
44	Tachometer Drive Sensors (S450/S650)	90	Trim Software (OEM)
45	Secondary Balancers	91	Engine Installation Kit (S350)
46	Cylinder Block with Camshaft	92	Engine Test Certificate/Engine Accessories (S350)
47	Crankshaft/Main Bearings	92	Engine Installation Kit (S450)
48	Connecting Rods/Pistons/Liners	93	Emission Label
49	Valve Actuating Mechanism	94	Custom Software
50	Oil Pump	95	Parts Installed at Factory
51	Cylinder Head with Valves	96	Engine Installation Kit/Ship With (S450/S650)
52	Gear Driven Auxiliary Drive	96	ECU Wiring Harness (6125/6135)
53	Fuel Heater	97	Field Installed Items
54	Turbo Air Intake	98	Engine Lift Strap
55	Shipping Stand	99	Service Only Parts

NOTE: This is a complete option code list based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice. Your engine will not contain all option codes listed.

RG,RG34710,5004 -19-12JUN17-2/2

Record Fuel Injection Pump Model Number

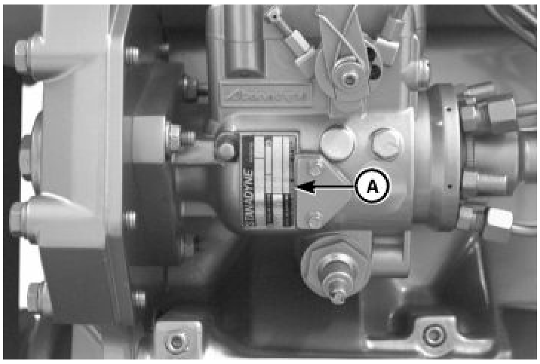
Record the fuel injection pump model and serial information found on the serial number plate (A).

Model No.________________________ RPM__________

Manufacturer's No.________________________

Serial No.________________________

A—Serial Number Plate



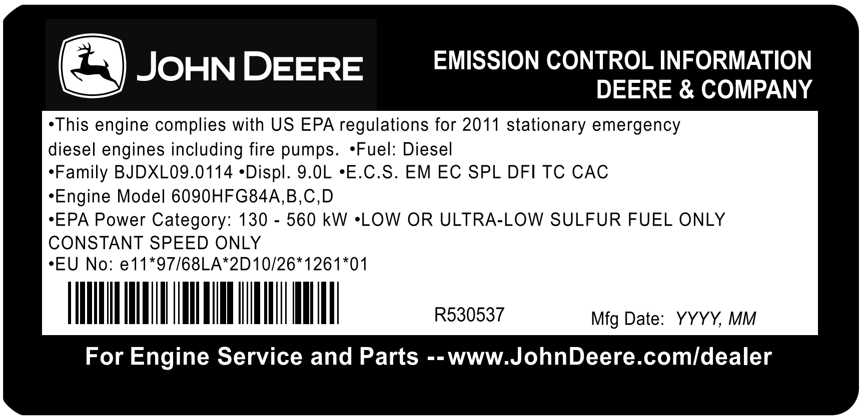
RG11526 —UN—01DEC00

Injection Pump Serial Number Plate

RG,RG34710,5005 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Emergency Stationary Engine Rule



RG19597 —UN—20OCT10

Emissions Label

Emissions Label

After Tier 4 standards take effect, engine manufacturers of emergency stationary engines that do not meet the standards for non-emergency engines must add to each such emergency engine a permanent label (such as the emission label as shown) which states that the engine is limited to stationary emergency use. On John Deere engines this is stated in the EPA emission label on each engine.

Fuel Requirements

Beginning 01 Oct 10, owners and operators of stationary engines that use diesel fuel must only use diesel fuel meeting the requirements of 40 CFR 80.510 (b), which requires that diesel fuel have a maximum sulfur content of 15 PPM and either a minimum cetane index of 40 or a maximum aromatic content of 35 volume percent.

Operation, Maintenance and Testing

The operation of emergency engines is limited to emergency operations and required maintenance and testing.

There is no time limit on the use of emergency stationary engines in emergency situations.

Maintenance and testing is limited to 100 hours per year. The EPA has also included a provision that allows anyone to petition the Administrator for additional hours, beyond the allowed 100 hours per year, if such additional hours should prove to be necessary for maintenance and testing reasons. The EPA will not require a petition for additional hours if the hours beyond 100 hours per year for maintenance and testing purposes are mandated by regulation such as State or Local requirements.

KW40574,0000003 -19-12MAY16-1/1

TIM-ID: 0000114010 - 001

Safety

Recognize Safety Information

This is a safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.

T81389 —UN—28JUN13

DX,ALERT -19-29SEP98-1/1

Understand Signal Words

TS187 —19—30SEP88

DANGER; The signal word DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

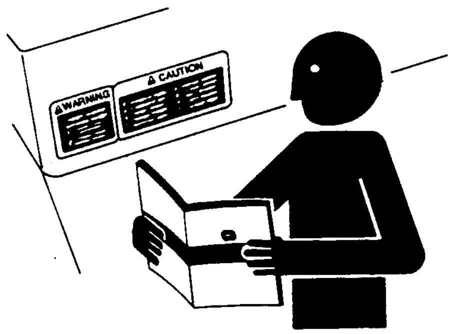
WARNING; The signal word WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION; The signal word CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. CAUTION may also be used to alert against unsafe practices associated with events which could lead to personal injury.

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards. DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

DX,SIGNAL -19-05OCT16-1/1

Follow Safety Instructions



TS201 —UN—15APR13

Carefully read all safety messages in this manual and on your machine safety signs. Keep safety signs in good condition. Replace missing or damaged safety signs. Be sure new equipment components and repair parts include the current safety signs. Replacement safety signs are available from your John Deere dealer.

There can be additional safety information contained on parts and components sourced from suppliers that is not reproduced in this operator's manual.

Learn how to operate the machine and how to use controls properly. Do not let anyone operate without instruction.

Keep your machine in proper working condition. Unauthorized modifications to the machine may impair the function and/or safety and affect machine life.

If you do not understand any part of this manual and need assistance, contact your John Deere dealer.

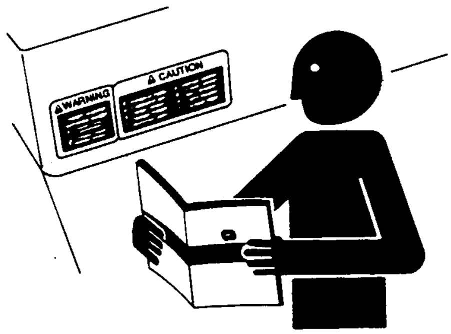
DX,READ -19-16JUN09-1/1

TIM-ID: 0000114010 - 001

Replace Safety Signs

Replace missing or damaged safety signs. Use this operator's manual for correct safety sign placement.

There can be additional safety information contained on parts and components sourced from suppliers that is not reproduced in this operator's manual.



TS201 —UN—15APR13

DX,SIGNS -19-18AUG09-1/1

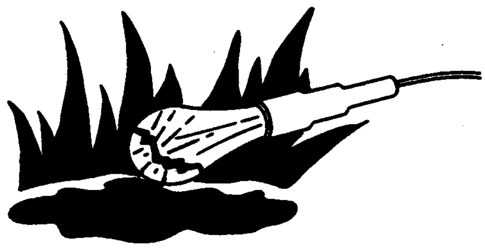
California Proposition 65 Warning

Diesel engine exhaust, some of its constituents, along with certain machine components contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. In addition, certain fluids contained in the machine and certain products of component wear contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

RG41061,000001F -19-12JAN10-1/1

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.



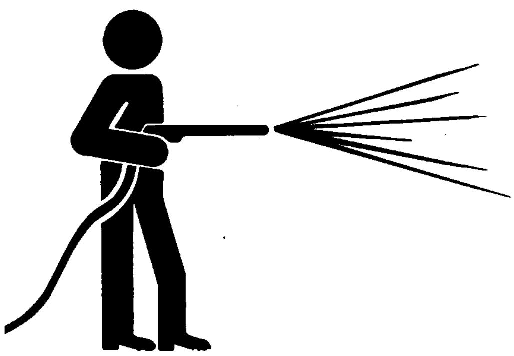
TS223 —UN—23AUG88

DX,LIGHT -19-04JUN90-1/1

Work in Clean Area

Before starting a job:

- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; do not attempt shortcuts.



T6642EJ —UN—18OCT88

DX,CLEAN -19-04JUN90-1/1

TIM-ID-0000114010-001

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards.

Use power tools only to loosen threaded parts and fasteners.

For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.

TS779 —UN—08NOV89

DX,REPAIR -19-17FEB99-1/1

Live With Safety

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

TS231 —19—07OCT88

DX,LIVE -19-25SEP92-1/1

Prevent Machine Runaway

Avoid possible injury or death from machinery runaway.

Do not start engine by shorting across starter terminals. Machine will start in gear if normal circuitry is bypassed.

NEVER start engine while standing on ground. Start engine only from operator's seat, with transmission in neutral or park.

TS177 —UN—11JAN89

DX,BYPAS1 -19-29SEP98-1/1

TIM-ID: 0000114010 - 001

Handle Fuel Safely—Avoid Fires

TS202 —UN—23AUG88

Handle fuel with care: it is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks.

Always stop engine before refueling machine. Fill fuel tank outdoors.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris. Always clean up spilled fuel.

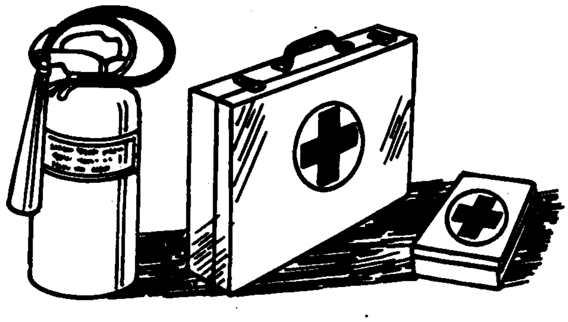
Use only an approved fuel container for transporting flammable liquids.

Never fill fuel container in pickup truck with plastic bed liner. Always place fuel container on ground before refueling. Touch fuel container with fuel dispenser nozzle before removing can lid. Keep fuel dispenser nozzle in contact with fuel container inlet when filling.

Do not store fuel container where there is an open flame, spark, or pilot light such as within a water heater or other appliance.

DX,FIRE1 -19-12OCT11-1/1

Prepare for Emergencies



TS291 —UN—15APR13

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

DX,FIRE2 -19-03MAR93-1/1

Handle Starting Fluid Safely

TS1356 —UN—18MAR92

Starting fluid is highly flammable.

Keep all sparks and flame away when using it. Keep starting fluid away from batteries and cables.

To prevent accidental discharge when storing the pressurized can, keep the cap on the container, and store in a cool, protected location.

Do not incinerate or puncture a starting fluid container.

Do not use starting fluid on an engine equipped with glow plugs or an air intake heater.

DX,FIRE3 -19-14MAR14-1/1

TIM-ID: 0000114010 - 001

In Case of Fire

CAUTION: Avoid personal injury.

Stop machine immediately at the first sign of fire. Fire may be identified by the smell of smoke or sight of flames. Because fire grows and spreads rapidly, get off the machine immediately and move safely away from the fire. Do not return to the machine! The number one priority is safety.

Call the fire department. A portable fire extinguisher can put out a small fire or contain it until the fire department arrives; but portable extinguishers have limitations. Always put the safety of the operator and bystanders first. If attempting to extinguish a fire, keep your back to the wind with an unobstructed escape path so you can move away quickly if the fire cannot be extinguished.

Read the fire extinguisher instructions and become familiar with their location, parts, and operation before a fire starts. Local fire departments or fire equipment distributors may offer fire extinguisher training and recommendations.

If your extinguisher does not have instructions, follow these general guidelines:

TS227 —UN—15APR13

1. Pull the pin. Hold the extinguisher with the nozzle pointing away from you, and release the locking mechanism.
2. Aim low. Point the extinguisher at the base of the fire.
3. Squeeze the lever slowly and evenly.
4. Sweep the nozzle from side-to-side.

DX,FIRE4 -19-22AUG13-1/1

Handle Fluids Safely—Avoid Fires

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

TS227 —UN—15APR13

DX,FLAME -19-29SEP98-1/1

TIM-ID: 0000114010 - 001

Avoid Static Electricity Risk When Refueling

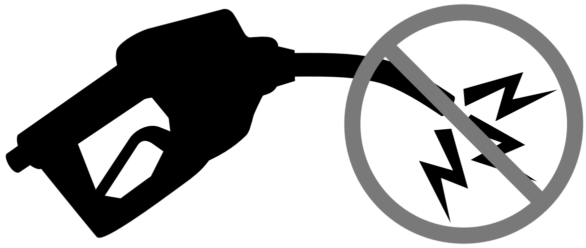
The removal of sulfur and other compounds in Ultra-Low Sulfur Diesel (ULSD) fuel decreases its conductivity and increases its ability to store a static charge.

Refineries may have treated the fuel with a static dissipating additive. However, there are many factors that can reduce the effectiveness of the additive over time.

Static charges can build up in ULSD fuel while it is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion.

Therefore, it is important to ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

RG22142 —UN—17MAR14



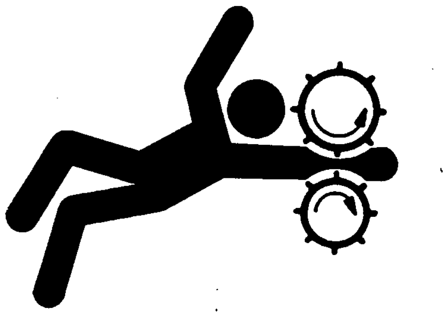
RG21992 —UN—21AUG13

DX,FUEL,STATIC,ELEC -19-12JUL13-1/1

Service Machines Safely

Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



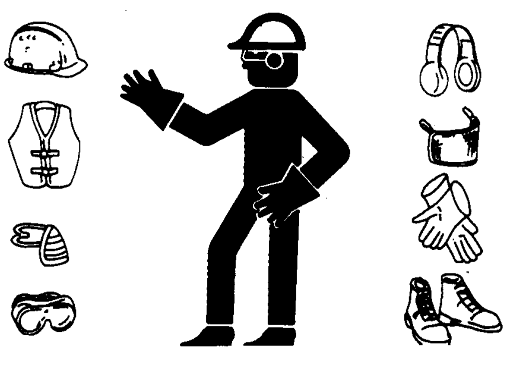
TS228 —UN—23AUG88

DX,LOOSE -19-04JUN90-1/1

Wear Protective Clothing

Wear close fitting clothing and safety equipment appropriate to the job.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



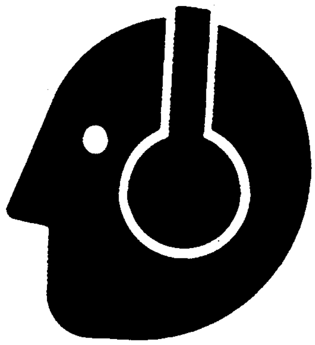
TS206 —UN—15APR13

DX,WEAR2 -19-03MAR93-1/1

Protect Against Noise

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



TS207 —UN—23AUG88

DX,NOISE -19-03MAR93-1/1

Handling Batteries Safely

Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace grounded clamp last.

Sulfuric acid in battery electrolyte is poisonous and strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid hazards by:

- Filling batteries in a well-ventilated area
- Wearing eye protection and rubber gloves
- Avoiding use of air pressure to clean batteries
- Avoiding breathing fumes when electrolyte is added
- Avoiding spilling or dripping electrolyte
- Using correct battery booster or charger procedure.

If acid is spilled on skin or in eyes:

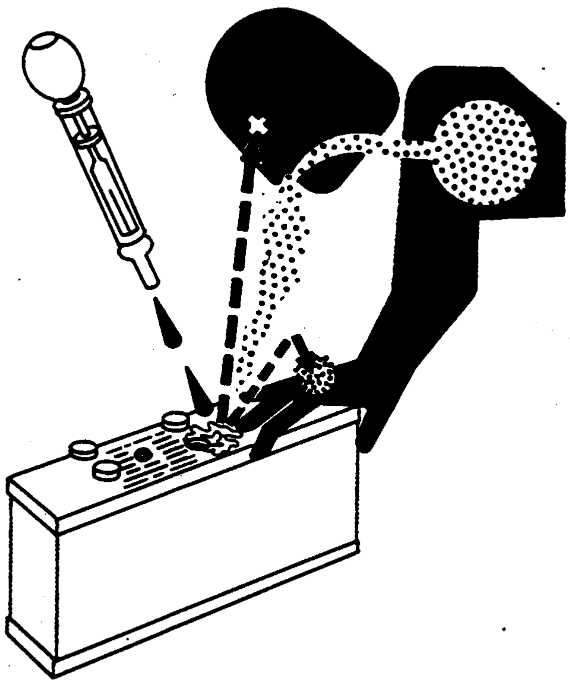
1. Flush skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 qt.).
3. Get medical attention immediately.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

TS204 —UN—15APR13



TS203 —UN—23AUG88

DX,WW,BATTERIES -19-02DEC10-1/1

TIM-ID: 0000114010 - 001

Prevent Acid Burns

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

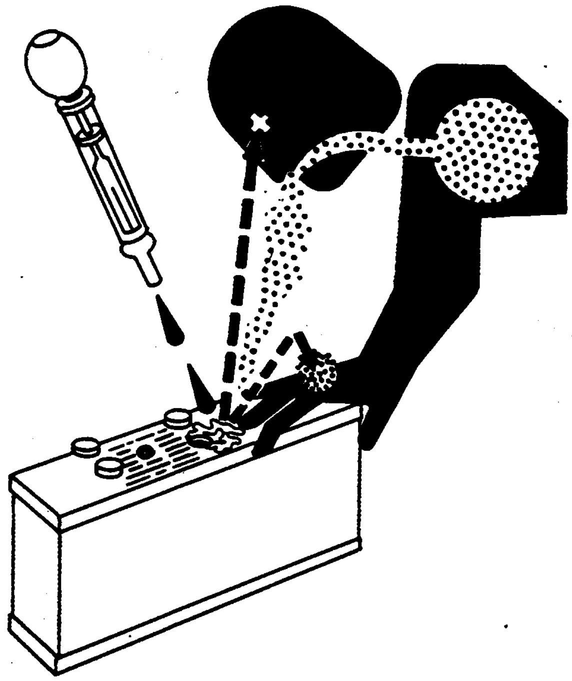
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 quarts).
3. Get medical attention immediately.



TS203 —UN—23AUG88

DX,POISON -19-21APR93-1/1

Stay Clear of Rotating Drivelines

Entanglement in rotating driveline can cause serious injury or death.

Keep all shields in place at all times. Make sure rotating shields turn freely.

Wear close-fitting clothing. Stop the engine and be sure that all rotating parts and drivelines are stopped before making adjustments, connections, or performing any type of service on engine or machine driven equipment.

TS1644 —UN—22AUG95

DX,ROTATING -19-18AUG09-1/1

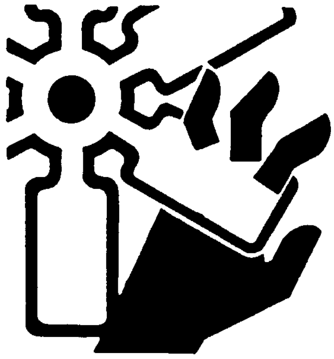
TIM-ID: 0000114010 - 001

Install All Guards

Rotating cooling system fans, belts, pulleys, and drives can cause serious injury.

Keep all guards in place at all times during engine operation.

Wear close-fitting clothes. Stop the engine and be sure fans, belts, pulleys, and drives are stopped before making adjustments, connections, or cleaning near fans and their drive components.



TS677 —UN—21SEP89

DX,GUARDS -19-18AUG09-1/1

Practice Safe Maintenance

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet, and clothing away from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.

On self-propelled equipment, disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

On towed implements, disconnect wiring harnesses from tractor before servicing electrical system components or welding on machine.

Falling while cleaning or working at height can cause serious injury. Use a ladder or platform to easily reach each location. Use sturdy and secure footholds and handholds.

TS218 —UN—23AUG88

DX,SERV -19-28FEB17-1/1

TIM-ID: 0000114010 - 001

Remove Paint Before Welding or Heating

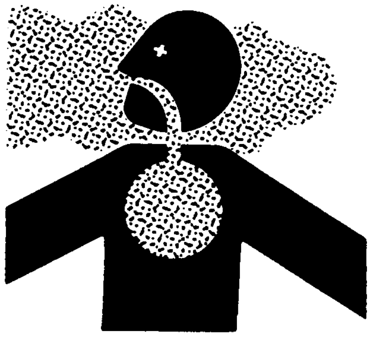
Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Remove paint before heating:

- Remove paint a minimum of 100 mm (4 in.) from area to be affected by heating. If paint cannot be removed, wear an approved respirator before heating or welding.
- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

Do not use a chlorinated solvent in areas where welding will take place.



TS220 —UN—15APR13

Do all work in an area that is well ventilated to carry toxic fumes and dust away.

Dispose of paint and solvent properly.

DX,PAINT -19-24JUL02-1/1

Avoid Heating Near Pressurized Fluid Lines

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can accidentally burst when heat goes beyond the immediate flame area.

TS953 —UN—15MAY90

DX,TORCH -19-10DEC04-1/1

Avoid High-Pressure Fluids

Inspect hydraulic hoses periodically – at least once per year – for leakage, kinking, cuts, cracks, abrasion, blisters, corrosion, exposed wire braid or any other signs of wear or damage.

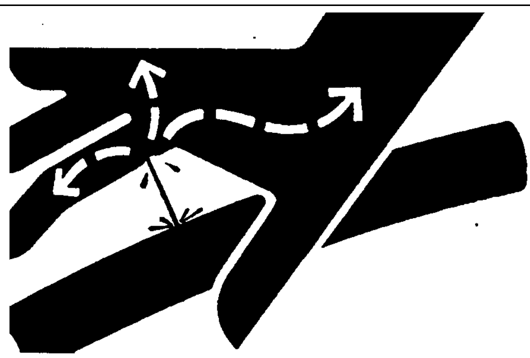
Replace worn or damaged hose assemblies immediately with John Deere approved replacement parts.

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within



X9811 —UN—23AUG88

a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available in English from Deere & Company Medical Department in Moline, Illinois, U.S.A., by calling 1-800-822-8262 or +1 309-748-5636.

DX,FLUID -19-12OCT11-1/1

Do Not Open High-Pressure Fuel System

High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt repair of fuel lines, sensors, or any other components between the high-pressure fuel pump and nozzles on engines with High Pressure Common Rail (HPCR) fuel system.

Only technicians familiar with this type of system can perform repairs. (See your John Deere dealer.)

TS1343 —UN—18MAR92

DX,WW,HPCR1 -19-07JAN03-1/1

Protect Against High Pressure Spray

Spray from high pressure nozzles can penetrate the skin and cause serious injury. Keep spray from contacting hands or body.

If an accident occurs, see a doctor immediately. Any high pressure spray injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

TS1343 —UN—18MAR92

DX,SPRAY -19-16APR92-1/1

Prevent Battery Explosions

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.

Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

TS204 —UN—15APR13

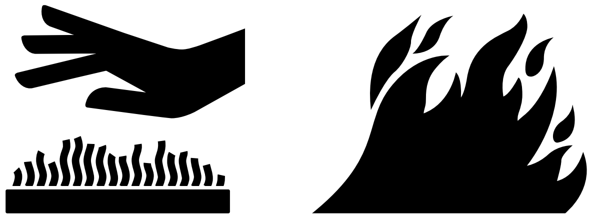
DX,SPARKS -19-03MAR93-1/1

TIM-ID: 0000114010 - 001

Avoid Hot Exhaust

Servicing machine or attachments with engine running can result in serious personal injury. Avoid exposure and skin contact with hot exhaust gases and components.

Exhaust parts and streams become very hot during operation. Exhaust gases and components reach temperatures hot enough to burn people, ignite, or melt common materials.



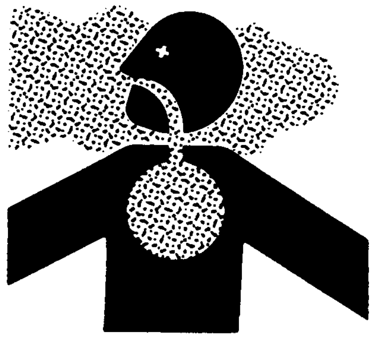
RG17488 —UN—21AUG09

DX,EXHAUST -19-20AUG09-1/1

Work In Ventilated Area

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.



TS220 —UN—15APR13

DX,AIR -19-17FEB99-1/1

Service Cooling System Safely

Explosive release of fluids from pressurized cooling system can cause serious burns.

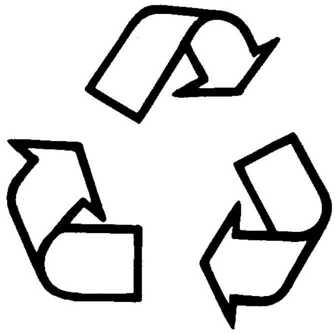
Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

TS281 —UN—15APR13

DX,WW,COOLING -19-19AUG09-1/1

TIM-ID: 0000114010 - 001

Decommissioning — Proper Recycling and Disposal of Fluids and Components



TS1133 —UN—15APR13

Safety and environmental stewardship measures must be taken into account when decommissioning a machine and/or component. These measures include the following:

- Use appropriate tools and personal protective equipment such as clothing, gloves, face shields or glasses, during the removal or handling of objects and materials.
- Follow instructions for specialized components.
- Release stored energy by lowering suspended machine elements, relaxing springs, disconnecting the battery or other electrical power, and releasing pressure in hydraulic components, accumulators, and other similar systems.
- Minimize exposure to components which may have residue from agricultural chemicals, such as fertilizers and pesticides. Handle and dispose of these components appropriately.
- Carefully drain engines, fuel tanks, radiators, hydraulic cylinders, reservoirs, and lines before recycling components. Use leak-proof containers when draining fluids. Do not use food or beverage containers.
- Do not pour waste fluids onto the ground, down a drain, or into any water source.
- Observe all national, state, and local laws, regulations, or ordinances governing the handling or disposal of waste fluids (example: oil, fuel, coolant, brake fluid); filters; batteries; and, other substances or parts. Burning of flammable fluids or components in other than specially designed incinerators may be prohibited by law and could result in exposure to harmful fumes or ashes.
- Service and dispose of air conditioning systems appropriately. Government regulations may require a certified service center to recover and recycle air conditioning refrigerants which could damage the atmosphere if allowed to escape.
- Evaluate recycling options for tires, metal, plastic, glass, rubber, and electronic components which may be recyclable, in part or completely.
- Contact your local environmental or recycling center, or your John Deere dealer for information on the proper way to recycle or dispose of waste.

DX,DRAIN -19-01JUN15-1/1

TIM-ID: 0000114010 - 001

Fuels, Lubricants, and Coolant

Diesel Fuel

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended. Renewable diesel fuel produced by hydrotreating animal fats and vegetable oils is basically identical to petroleum diesel fuel. Renewable diesel that meets EN 590, ASTM D975, or EN 15940 is acceptable for use at all percentage mixture levels.

Required Fuel Properties

In all cases, the fuel shall meet the following properties:

Cetane number of 40 minimum. Cetane number greater than 47 is preferred, especially for temperatures below –20 °C (–4 °F) or elevations above 1675 m (5500 ft.).

Cold Filter Plugging Point (CFPP) should be at least 5 °C (9 °F) below the expected lowest temperature or **Cloud Point** below the expected lowest ambient temperature.

Fuel lubricity should pass a maximum scar diameter of 0.52 mm as measured by ASTM D6079 or ISO 12156-1. A maximum scar diameter of 0.45 mm is preferred.

Diesel fuel quality and sulfur content must comply with all existing emissions regulations for the area in which the engine operates. DO NOT use diesel fuel with sulfur content greater than 10 000 mg/kg (10 000 ppm).

E-Diesel fuel

DO NOT use E-Diesel (Diesel fuel and ethanol blend). Use of E-Diesel fuel in any John Deere machine may void the machine warranty.

CAUTION: Avoid severe injury or death due to the fire and explosion risk from using E-Diesel fuel.

Sulfur content for Interim Tier 4, Final Tier 4, Stage III B, and Stage IV Engines

- Use ONLY ultra low sulfur diesel (ULSD) fuel with a maximum of 15 mg/kg (15 ppm) sulfur content.

Sulfur Content for Tier 3 and Stage III A Engines

- Use of diesel fuel with sulfur content less than 1000 mg/kg (1000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 1000—2000 mg/kg (1000—2000 ppm) REDUCES the oil and filter change interval.
- BEFORE using diesel fuel with sulfur content greater than 2000 mg/kg (2000 ppm), contact your John Deere dealer.

Sulfur Content for Tier 2 and Stage II Engines

- Use of diesel fuel with sulfur content less than 2000 mg/kg (2000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 2000—5000 mg/kg (2000—5000 ppm) REDUCES the oil and filter change interval.
- BEFORE using diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm), contact your John Deere dealer.

Sulfur Content for Other Engines

- Use of diesel fuel with sulfur content less than 5000 mg/kg (5000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content greater than 5000 mg/kg (5000 ppm) REDUCES the oil and filter change interval.

IMPORTANT: Do not mix used diesel engine oil or any other type of lubricating oil with diesel fuel.

Improper fuel additive usage may cause damage on fuel injection equipment of diesel engines.

DX,FUEL1 -19-13JAN16-1/1

Supplemental Diesel Fuel Additives

Diesel fuel can be the source of performance or other operational problems for many reasons. Some causes include poor lubricity, contaminants, low cetane number, and a variety of properties that cause fuel system deposits. These and others are referenced in other sections of this Operator's Manual.

To optimize engine performance and reliability, closely follow recommendations on fuel quality, storage, and handling, which are found elsewhere in this Operator's Manual.

To further aid in maintaining performance and reliability of the engine's fuel system, John Deere has developed a family of fuel additive products for most global markets. The primary products include Fuel-Protect Diesel Fuel Conditioner (full feature conditioner in winter and summer formulas) and Fuel-Protect Keep Clean (fuel injector deposit removal and prevention). Availability of these and other products varies by market. See your local John Deere dealer for availability and additional information about fuel additives that might be right for your needs.

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DX,FUEL13 -19-07FEB14-1/1

Lubricity of Diesel Fuel

Most diesel fuels manufactured in the United States, Canada, and the European Union have adequate lubricity to ensure proper operation and durability of fuel injection system components. However, diesel fuels manufactured in some areas of the world may lack the necessary lubricity.

IMPORTANT: Make sure the diesel fuel used in your machine demonstrates good lubricity characteristics.

Fuel lubricity should pass a maximum scar diameter of 0.52 mm as measured by ASTM D6079 or ISO 12156-1. A maximum scar diameter of 0.45 mm is preferred.

If fuel of low or unknown lubricity is used, add John Deere Fuel-Protect Diesel Fuel Conditioner (or equivalent) at the specified concentration.

Lubricity of BioDiesel Fuel

Fuel lubricity can improve significantly with BioDiesel blends up to B20 (20% BioDiesel). Further increase in lubricity is limited for BioDiesel blends greater than B20.

DX,FUEL5 -19-07FEB14-1/1

Handling and Storing Diesel Fuel

CAUTION: Reduce the risk of fire. Handle fuel carefully. DO NOT fill the fuel tank when engine is running. DO NOT smoke while you fill the fuel tank or service the fuel system.

Fill the fuel tank at the end of each day's operation to prevent water condensation and freezing during cold weather.

Keep all storage tanks as full as practical to minimize condensation.

Ensure that all fuel tank caps and covers are installed properly to prevent moisture from entering. Monitor water content of the fuel regularly.

When using biodiesel fuel, the fuel filter may require more frequent replacement due to premature plugging.

Check engine oil level daily prior to starting engine. A rising oil level may indicate fuel dilution of the engine oil.

IMPORTANT: The fuel tank is vented through the filler cap. If a new filler cap is required, always replace it with an original vented cap.

When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and prevent water condensation. Contact your fuel supplier or John Deere dealer for recommendations.

DX,FUEL4 -19-15FEB13-1/1

BioDiesel Fuel

BioDiesel fuel is comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. BioDiesel blends are BioDiesel mixed with petroleum diesel fuel on a volume basis.

Before using fuel containing BioDiesel, review the BioDiesel Use Requirements and Recommendations in this Operator’s Manual.

Environmental laws and regulations can encourage or prohibit the use of biofuels. Operators should consult with appropriate governmental authorities prior to using biofuels.

All John Deere Engines with Exhaust Filter (Released 2011 and After)

While 5% blends (B5) are preferred, BioDiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. BioDiesel blends up to B20 can be used ONLY if the BioDiesel (100% BioDiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

BioDiesel concentrations above B20 can harm the engine’s emission control systems and should not be used. Risks include, but are not limited to, more frequent stationary regeneration, soot accumulation, and increased intervals for ash removal.

John Deere approved fuel conditioners, which contain detergent and dispersant additives, are required when using BioDiesel blends from B10—B20, and are recommended when using lower BioDiesel blends.

All John Deere Engines Excluding Exhaust Filter (Primarily Released Prior to 2012)

While 5% blends (B5) are preferred, BioDiesel concentrations up to a 20% blend (B20) in petroleum diesel fuel can be used. BioDiesel blends up to B20 can be used ONLY if the BioDiesel (100% BioDiesel or B100) meets ASTM D6751, EN 14214, or equivalent specification. Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20.

These John Deere engines can operate on BioDiesel blends above B20 (up to 100% BioDiesel). Operate at levels above B20 ONLY if the BioDiesel is permitted by law and meets the EN 14214 specification (primarily available in Europe). Engines operating on BioDiesel blends above B20 might not fully comply with or be permitted by all applicable emissions regulations. Expect up to a 12% reduction in power and an 18% reduction in fuel economy when using 100% BioDiesel.

John Deere approved fuel conditioners, which contain detergent and dispersant additives, are required when using BioDiesel blends from B10—B20, and are recommended when using lower BioDiesel blends.

BioDiesel Use Requirements and Recommendations

The petroleum diesel portion of all BioDiesel blends must meet the requirements of ASTM D975 (US) or EN 590 (EU) commercial standard.

BioDiesel users in the U.S. are strongly encouraged to purchase BioDiesel blends from a BQ-9000 Certified Marketer and sourced from a BQ-9000 Accredited Producer (as certified by the National BioDiesel Board). Certified Marketers and Accredited Producers can be found at the following website: http://www.bq9000.org.

BioDiesel contains residual ash. Ash levels exceeding the maximums allowed in either ASTM D6751 or EN14214 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present).

The fuel filter can require more frequent replacement, when using BioDiesel fuel, particularly if switching from diesel. Check engine oil level daily prior to starting engine. A rising oil level can indicate fuel dilution of the engine oil. BioDiesel blends up to B20 must be used within 90 days of the date of BioDiesel manufacture. BioDiesel blends above B20 must be used within 45 days from the date of BioDiesel manufacture.

When using BioDiesel blends up to B20, the following must be considered:

- Cold-weather flow degradation
- Stability and storage issues (moisture absorption, microbial growth)
- Possible filter restriction and plugging (usually a problem when first switching to BioDiesel on used engines)
- Possible fuel leakage through seals and hoses (primarily an issue with older engines)
- Possible reduction of service life of engine components

Request a certificate of analysis from your fuel distributor to ensure that the fuel is compliant with the specifications provided in this Operator’s Manual.

Consult your John Deere dealer for approved fuel conditioners to improve storage and performance with BioDiesel fuels.

The following must also be considered if using BioDiesel blends above B20:

- Possible coking or blocked injector nozzles, resulting in power loss and engine misfire if John Deere approved fuel conditioners are not used
- Possible crankcase oil dilution (requiring more frequent oil changes)
- Possible lacquering or seizure of internal components
- Possible formation of sludge and sediments
- Possible thermal oxidation of fuel at elevated temperatures
- Possible compatibility issues with other materials (including copper, lead, zinc, tin, brass, and bronze) used in fuel handling equipment

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Continued on next page DX,FUEL7 -19-15MAY13-1/2

- Possible reduction in water separator efficiency
- Possible damage to paint if exposed to BioDiesel
- Possible corrosion of fuel injection equipment
- Possible elastomeric seal and gasket material degradation (primarily an issue with older engines)
- Possible high acid levels within fuel system
- Because BioDiesel blends above B20 contain more ash, using blends above B20 can result in more rapid ash loading and require more frequent cleaning of the Exhaust Filter (if present)

IMPORTANT: Raw pressed vegetable oils are NOT acceptable for use as fuel in any concentration in John Deere engines. Their use could cause engine failure.

DX,FUEL7 -19-15MAY13-2/2

Testing Diesel Fuel

A fuel analysis program can help to monitor the quality of diesel fuel. The fuel analysis can provide critical data such as cetane number, fuel type, sulfur content, water content, appearance, suitability for cold weather operations, bacteria, cloud point, acid number, particulate contamination, and whether the fuel meets specification.

Contact your John Deere dealer for more information on diesel fuel analysis.

DX,FUEL6 -19-14APR11-1/1

Aviation (Jet) Fuels

IMPORTANT: Not all fuels should be considered for regular use. Some fuels that can be used in this engine are for emergency only and can cause premature engine and component wear if used long term. Unless your engine has been specifically designed for prolonged use of aviation fuel, the following fuels should be used for an emergency only fuel alternative.

Aviation (jet) fuels may be used with the following restrictions.

Type	Comments
Jet A	**Not Recommended.**Lower viscosity and density than base No. 2-D diesel fuel. Power loss up to 10% can be expected.
Jet A-1	**Not Recommended.**Lower viscosity and density than base No. 2-D diesel fuel. Power loss up to 10% can be expected. May be used as an emergency fuel only, with the addition of John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.
Jet B	**Not Recommended.**Lower density and extremely low viscosity compared to base No. 2-D diesel fuel. Power loss up to 14% can be expected. May be used as an emergency fuel only, with the addition of John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.
JP-4	**Not Recommended.**Lower density and extremely low viscosity compared to base No. 2-D diesel fuel. Power loss up to 14% can be expected. May be used as an emergency fuel only, with the addition of John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.
JP-5	**Not Recommended.**Lower viscosity and density than base No. 2-D diesel fuel. Power loss up to 10% can be expected.
JP-7	**Not Recommended.**Lower viscosity and density than base No. 2-D diesel fuel. Power loss up to 10% can be expected.
JP-8	**Not Recommended.**Lower viscosity and density than base No. 2-D diesel fuel. Power loss up to 10% can be expected.

OURGP12,000003F -19-16AUG11-1/1

Burner Fuels

Burner fuels, like kerosene, may be used with the following restrictions.

Type	Comments
No.2	Higher density and specific gravity than base No. 2-D diesel fuel. Power increase up to 3% can be expected.
No.1	Lower viscosity than base No. 2-D diesel fuel. Power loss up to 2% can be expected.

OURGP12,0000040 -19-07JUL04-1/1

TIM-ID: 0000114010 - 001

Fuel Filters

The importance of fuel filtration cannot be overemphasized with modern fuel systems. The combination of increasingly restrictive emission regulations and more efficient engines requires fuel system to operate at much higher pressures. Higher pressures can only be achieved using fuel injection components with very close tolerances. These close manufacturing tolerances have significantly reduced capacities for debris and water.

John Deere brand fuel filters have been designed and produced specifically for John Deere engines.

To protect the engine from debris and water, always change engine fuel filters as specified in this manual.

DX,FILT2 -19-14APR11-1/1

TIM-ID: 0000114010 - 001

Minimizing the Effect of Cold Weather on Diesel Engines

John Deere diesel engines are designed to operate effectively in cold weather.

However, for effective starting and cold-weather operation, a little extra care is necessary. The following information outlines steps that can minimize the effect that cold weather may have on starting and operation of your engine. See your John Deere dealer for additional information and local availability of cold-weather aids.

Use Winter Grade Fuel

When temperatures fall below 0 °C (32 °F), winter grade fuel (No. 1-D in North America) is best suited for cold-weather operation. Winter grade fuel has a lower cloud point and a lower pour point.

Cloud point is the temperature at which wax begins to form in the fuel. This wax causes fuel filters to plug. **Pour point** is the lowest temperature at which movement of the fuel is observed.

NOTE: On average, winter grade diesel fuel has a lower Btu (heat content) rating. Using winter grade fuel may reduce power and fuel efficiency, but should not cause any other engine performance effects. Check the grade of fuel being used before troubleshooting for low-power complaints in cold-weather operation.

Air Intake Heater

An air intake heater is an available option for some engines to aid cold weather starting.

Ether

An ether port on the intake is available to aid cold weather starting.

CAUTION: Ether is highly flammable. Do not use ether when starting an engine equipped with glow plugs or an air intake heater.

Coolant Heater

An engine block heater (coolant heater) is an available option to aid cold weather starting.

Seasonal Viscosity Oil and Proper Coolant Concentration

Use seasonal grade viscosity engine oil based on the expected air temperature range between oil changes and a proper concentration of low silicate antifreeze as recommended. (See DIESEL ENGINE OIL and ENGINE COOLANT requirements in this section.)

Diesel Fuel Flow Additive

Use John Deere Fuel-Protect Diesel Fuel Conditioner (winter formula), which contains anti-gel chemistry, or equivalent fuel conditioner to treat non-winter grade fuel (No. 2-D in North America) during the cold-weather season. This generally extends operability to about 10 °C (18 °F) below the fuel cloud point. For operability at even lower temperatures, use winter grade fuel.

IMPORTANT: Treat fuel when outside temperature drops below 0 °C (32 °F). For best results, use with untreated fuel. Follow all recommended instructions on label.

BioDiesel

When operating with BioDiesel blends, wax formation can occur at warmer temperatures. Begin using John Deere Fuel-Protect Diesel Fuel Conditioner (winter formula) at 5 °C (41 °F) to treat BioDiesel fuels during the cold-weather season. Use B5 or lower blends at temperatures below 0 °C (32 °F). Use only winter grade petroleum diesel fuel at temperatures below -10 °C (14 °F).

Winterfronts

Use of fabric, cardboard, or solid winterfronts is not recommended with any John Deere engine. Their use can result in excessive engine coolant, oil, and charge air temperatures. This can lead to reduced engine life, loss of power and poor fuel economy. Winterfronts may also put abnormal stress on fan and fan drive components potentially causing premature failures.

If winterfronts are used, they should never totally close off the grill frontal area. Approximately 25% area in the center of the grill should remain open at all times. At no time should the air blockage device be applied directly to the radiator core.

Radiator Shutters

If equipped with a thermostatically controlled radiator shutter system, this system should be regulated in such a way that the shutters are completely open by the time the coolant reaches 93 °C (200 °F) to prevent excessive intake manifold temperatures. Manually controlled systems are not recommended.

If air-to-air aftercooling is used, the shutters must be completely open by the time the intake manifold air temperature reaches the maximum allowable temperature out of the charge air cooler.

For more information, see your John Deere dealer.

DX,FUEL10 -19-15MAY13-1/1

TIM-ID: 0000114010 - 001

Diesel Engine Break-In Oil — Non-Emissions Certified and Certified Tier 1, Tier 2, Tier 3, Stage I, Stage II, and Stage III

New engines are filled at the factory with either John Deere Break-In™ or John Deere Break-In Plus™ Engine Oil. During the break-in period, add John Deere Break-In™ or Break-In Plus™ Engine Oil, respectively, as needed to maintain the specified oil level.

Operate the engine under various conditions, particularly heavy loads with minimal idling, to help seat engine components properly.

If John Deere Break-In™ Engine Oil is used during the initial operation of a new or rebuilt engine, change the oil and filter at a maximum of 100 hours.

If John Deere Break-In Plus™ Engine Oil is used, change the oil and filter at a minimum of 100 hours and a maximum equal to the interval specified for John Deere Plus-50™ II or Plus-50™ oil.

After engine overhaul, fill the engine with either John Deere Break-In™ or Break-In Plus™ Engine Oil.

If John Deere Break-In™ or Break-In Plus™ Engine Oil is not available, use an SAE 10W-30 viscosity grade diesel engine oil meeting one of the following and change the oil and filter at a maximum of 100 hours of operation:

- API Service Classification CE
- API Service Classification CD
- API Service Classification CC
- ACEA Oil Sequence E2
- ACEA Oil Sequence E1

IMPORTANT: Do not use Plus-50™ II, Plus-50™, or engine oils meeting any of the following for the initial break-in of a new or rebuilt engine:

API CK-4	**ACEA E9**
API CJ-4	**ACEA E7**
API CI-4 PLUS	**ACEA E6**
API CI-4	**ACEA E5**
API CH-4	**ACEA E4**
API CG-4	**ACEA E3**
API CF-4	
API CF-2	
API CF	

These oils do not allow the engine to break in properly.

John Deere Break-In Plus™ Engine Oil can be used for all John Deere diesel engines at all emission certification levels.

After the break-in period, use John Deere Plus-50™ II, John Deere Plus-50™, or other diesel engine oil as recommended in this manual.

Break-In is a trademark of Deere & Company.
Break-In Plus is a trademark of Deere & Company
Plus-50 is a trademark of Deere & Company.

DX,ENOIL4 -19-02NOV16-1/1

TIM-ID: 0000114010 - 001

Diesel Engine Oil — Tier 3 and Stage III

Use oil viscosity based on the expected air temperature range during the period between oil changes.

John Deere Plus-50™ II oil is preferred.

John Deere Plus-50™ is also recommended.

Other oils may be used if they meet one or more of the following:

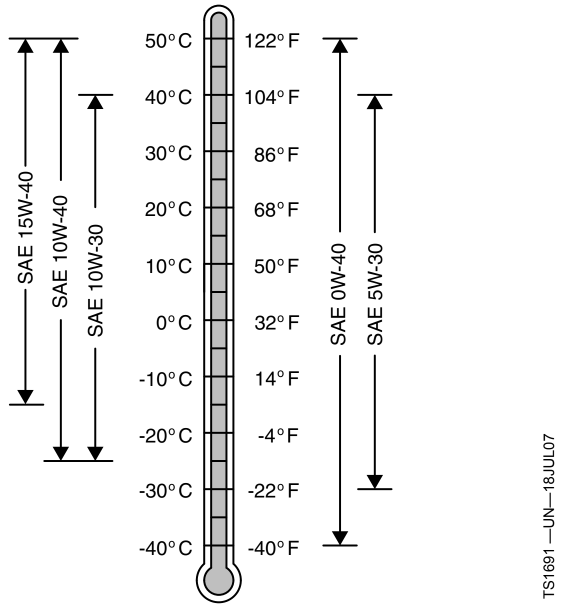
- John Deere Torq-Gard™
- API Service Category CK-4
- API Service Category CJ-4
- API Service Category CI-4 PLUS
- API Service Category CI-4
- ACEA Oil Sequence E9
- ACEA Oil Sequence E7
- ACEA Oil Sequence E6
- ACEA Oil Sequence E5
- ACEA Oil Sequence E4

Multi-viscosity diesel engine oils are preferred.

Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.

DO NOT use diesel fuel with sulfur content greater than 10000 mg/kg (10000 ppm).

Plus-50 is a trademark of Deere & Company
Torq-Gard is a trademark of Deere & Company



Oil Viscosities for Air Temperature Ranges

DX,ENOIL11 -19-02NOV16-1/1

TIM-ID: 0000114010 - 001

Engine Oil and Filter Service Intervals — Tier 3 and Stage IIIA — OEM Applications

Recommended oil and filter service intervals are based on a combination of oil pan capacity, type of engine oil and filter used, and sulfur content of the diesel fuel. Actual service intervals also depend on operation and maintenance practices.

Use oil analysis to evaluate the condition of the oil and to aid in selection of the proper oil and filter service interval. Contact your John Deere dealer for more information on engine oil analysis.

Change the oil and oil filter at least once every 12 months even if the hours of operation are fewer than the otherwise recommended service interval.

Diesel fuel sulfur content affects engine oil and filter service intervals.

- Use of diesel fuel with sulfur content less than 1000 mg/kg (1000 ppm) is RECOMMENDED.
- Use of diesel fuel with sulfur content 1000—2000 mg/kg (1000—2000 ppm) REDUCES the oil and filter service interval.
- BEFORE using diesel fuel with sulfur content greater than 2000 mg/kg (2000 ppm), contact your John Deere dealer.
- DO NOT use diesel fuel with sulfur content greater than 10000 mg/kg (10000 ppm).

IMPORTANT: To avoid engine damage:

- **Reduce oil and filter service intervals by 50% when using biodiesel blends greater than B20. Oil analysis may allow longer service intervals.**
- **Use only approved oil types.**

Approved Oil Types:

- “Plus-50 Oils” include John Deere Plus-50™ II and John Deere Plus-50™
- “Other Oils” include John Deere Torq-Gard™, API CK-4, API CJ-4, API CI-4 PLUS, API CI-4, ACEA E9, ACEA E7, ACEA E6, ACEA E5, and ACEA E4

NOTE: The 500 hour extended oil and filter change interval is only allowed if all of the following conditions are met:

- *Engine equipped with an extended drain interval oil pan*
- *Use of diesel fuel with sulfur content less than 2000 mg/kg (2000 ppm) for PowerTech™ Plus engines or 5000 mg/kg (5000 ppm) for PowerTech™ engine*
- *Use of John Deere Plus-50™ II or John Deere Plus-50™ oil*
- *Use of an approved John Deere oil filter*

	Tier 3 and Stage IIIA - PowerTech™ Plus				**Tier 3 and Stage IIIA - PowerTech™**		
	Oil Pan Size (L/kW)				Oil Pan Size (L/kW)		
Oil pan capacity	Greater than or equal to 0.10	Greater than or equal to 0.12	Greater than or equal to 0.14	Greater than or equal to 0.22	Greater than or equal to 0.10	Greater than or equal to 0.12	Greater than or equal to 0.14
Fuel Sulfur	Less than 1000 mg/kg (1000 ppm)				Less than 1000 mg/kg (1000 ppm)		
Plus-50 Oils	375 hours	500 hours	500 hours	500 hours	375 hours	500 hours	500 hours
Other Oils	250 hours	250 hours	250 hours	250 hours	250 hours	250 hours	250 hours
Fuel Sulfur	1000—2000 mg/kg (1000—2000 ppm)				1000—2000 mg/kg (1000—2000 ppm)		
Plus-50 Oils	300 hours	300 hours	500 hours	500 hours	300 hours	400 hours	500 hours
Other Oils	200 hours	200 hours	250 hours	250 hours	200 hours	200 hours	250 hours
Fuel Sulfur	2000—5000 mg/kg (2000—5000 ppm)				2000—5000 mg/kg (2000—5000 ppm)		
Plus-50 Oils	Not Recommended Contact John Deere dealer (dealer refers to DTAC solution)				275 hours	350 hours	500 hours
Other Oils	Not Recommended Contact John Deere dealer (dealer refers to DTAC solution)				150 hours	175 hours	250 hours
Fuel Sulfur	5000—10000 mg/kg (5000—10000 ppm)				5000—10000 mg/kg (5000—10000 ppm)		
Plus-50 Oils	Not Recommended Contact John Deere dealer (dealer refers to DTAC solution)				187 hours	250 hours	250 hours
Other Oils	Not Recommended Contact John Deere dealer (dealer refers to DTAC solution)				125 hours	125 hours	125 hours
Oil analysis may extend the service interval of “Other Oils”, to a maximum not to exceed the interval for Plus-50 Oils. Oil analysis means taking a series of oil samples at 50-hour increments beyond the normal service interval until either the data indicates the end of useful oil life or the maximum service interval of John Deere Plus-50 oils is reached.							

Plus-50 is a trademark of Deere & Company
Torq-Gard is a trademark of Deere & Company
PowerTech is a trademark of Deere & Company

DX,ENOIL13,T3,OEM -19-02NOV16-1/1

Mixing of Lubricants

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your John Deere dealer to obtain specific information and recommendations.

DX,LUBMIX -19-18MAR96-1/1

Alternative and Synthetic Lubricants

Conditions in certain geographical areas may require lubricant recommendations different from those printed in this manual.

Some John Deere brand coolants and lubricants may not be available in your location.

Consult your John Deere dealer to obtain information and recommendations.

Synthetic lubricants may be used if they meet the performance requirements as shown in this manual.

The temperature limits and service intervals shown in this manual apply to both conventional and synthetic lubricants.

Re-refined base stock products may be used if the finished lubricant meets the performance requirements.

DX,ALTER -19-11APR11-1/1

Lubricant Storage

Your equipment can operate at top efficiency only when clean lubricants are used.

Use clean containers to handle all lubricants.

Store lubricants and containers in an area protected from dust, moisture, and other contamination. Store containers on their side to avoid water and dirt accumulation.

Make certain that all containers are properly marked to identify their contents.

Properly dispose of all old containers and any residual lubricant they may contain.

DX,LUBST -19-11APR11-1/1

Oil Filters

Filtration of oils is critically important for proper operation and lubrication. John Deere brand oil filters have been designed and produced specifically for John Deere applications.

John Deere filters adhere to engineering specifications for quality of the filter media, filter efficiency rating, strength of the bond between the filter media and the element end cap, fatigue life of the canister (if applicable), and pressure capability of the filter seal. Non-John Deere branded oil filters might not meet these key John Deere specifications.

Always change oil filters regularly as specified in this manual.

DX,FILT1 -19-11APR11-1/1

TIM-ID: 0000114010 - 001

Diesel Engine Coolant (engine with wet sleeve cylinder liners)

Preferred Coolants

The following pre-mix engine coolants are preferred:

- **John Deere COOL-GARD™II**
- **John Deere COOL-GARD II PG**

COOL-GARD II pre-mix coolant is available in several concentrations with different freeze protection limits as shown in the following table.

COOL-GARD II pre-mix	Freeze Protection Limit
COOL-GARD II 20/80	-9 °C (16 °F)
COOL-GARD II 30/70	-16 °C (3 °F)
COOL-GARD II 50/50	-37 °C (-34 °F)
COOL-GARD II 55/45	-45 °C (-49 °F)
COOL-GARD II PG 60/40	-49 °C (-56 °F)
COOL-GARD II 60/40	-52 °C (-62 °F)

Not all COOL-GARD II pre-mix products are available in all countries.

Use COOL-GARD II PG when a non-toxic coolant formulation is required.

Additional Recommended Coolants

The following engine coolant is also recommended:

- John Deere COOL-GARD II Concentrate in a 40—60% mixture of concentrate with quality water.

IMPORTANT: When mixing coolant concentrate with water, do not use less than 40% or greater than 60% concentration of coolant. Less than 40% gives inadequate additives for corrosion protection. Greater than 60% can result in coolant gelation and cooling system problems.

Other Coolants

Other ethylene glycol or propylene glycol base coolants may be used if they meet the following specification:

- Pre-mix coolant meeting ASTM D6210 requirements
- Coolant concentrate meeting ASTM D6210 requirements in a 40—60% mixture of concentrate with quality water

If coolant meeting one of these specifications is unavailable, use a coolant concentrate or pre-mix coolant that has a minimum of the following chemical and physical properties:

- Provides cylinder liner cavitation protection according to either the John Deere Cavitation Test Method or a fleet study run at or above 60% load capacity
- Is formulated with a nitrite-free additive package
- Protects the cooling system metals (cast iron, aluminum alloys, and copper alloys such as brass) from corrosion

Water Quality

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

Coolant Drain Intervals

Drain and flush the cooling system and refill with fresh coolant at the indicated interval, which varies with the coolant used.

When COOL-GARD II or COOL-GARD II PG is used, the drain interval is 6 years or 6000 hours of operation.

If a coolant other than COOL-GARD II or COOL-GARD II PG is used, reduce the drain interval to 2 years or 2000 hours of operation.

IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.

Do not mix ethylene glycol and propylene glycol base coolants.

Do not use coolants that contain nitrites.

COOL-GARD is a trademark of Deere & Company

DX,COOL3 -19-15MAY13-1/1

TIM-ID: 0000114010 - 001

Water Quality for Mixing with Coolant Concentrate

Engine coolants are a combination of three chemical components: ethylene glycol (EG) or propylene glycol (PG) antifreeze, inhibiting coolant additives, and quality water.

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended for mixing with ethylene glycol and propylene glycol base engine coolant concentrate.

All water used in the cooling system should meet the following minimum specifications for quality:

Chlorides	<40 mg/L
Sulfates	<100 mg/L
Total solids	<340 mg/L
Total dissolved I hardness	<170 mg/L
pH	5.5—9.0

IMPORTANT: Do not use bottled drinking water because it often contains higher concentrations of total dissolved solids.

Freeze Protection

The relative concentrations of glycol and water in the engine coolant determine its freeze protection limit.

Ethylene Glycol	Freeze Protection Limit
40%	-24 °C (-12 °F)
50%	-37 °C (-34 °F)
60%	-52 °C (-62 °F)
Propylene Glycol	**Freeze Protection Limit**
40%	-21 °C (-6 °F)
50%	-33 °C (-27 °F)
60%	-49 °C (-56 °F)

DO NOT use a coolant-water mixture greater than 60% ethylene glycol or 60% propylene glycol.

DX,COOL19 -19-15MAY13-1/1

Operating in Warm Temperature Climates

John Deere engines are designed to operate using recommended engine coolants.

Always use a recommended engine coolant, even when operating in geographical areas where freeze protection is not required.

IMPORTANT: Water may be used as coolant *in emergency situations only.*

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended engine coolant as soon as possible.

DX,COOL6 -19-15MAY13-1/1

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Testing Coolant Freeze Point

The use of a handheld coolant refractometer is the quickest, easiest, and most accurate method to determine coolant freeze point. This method is more accurate than a test strip or a float-type hydrometer which can produce poor results.

A coolant refractometer is available through your John Deere dealer under the SERVICEGARD™ tool program. Part number 75240 provides an economical solution to accurate freeze point determination in the field.

To use this tool:

1. Allow cooling system to cool to ambient temperatures.
2. Open radiator cap to expose coolant.
3. With the included dropper, collect a small coolant sample.
4. Open the lid of the refractometer, place one drop of coolant on the window and close the lid.
5. Look through the eyepiece and focus as necessary.
6. Record the listed freeze point for the type of coolant (ethylene glycol coolant or propylene glycol) being tested.

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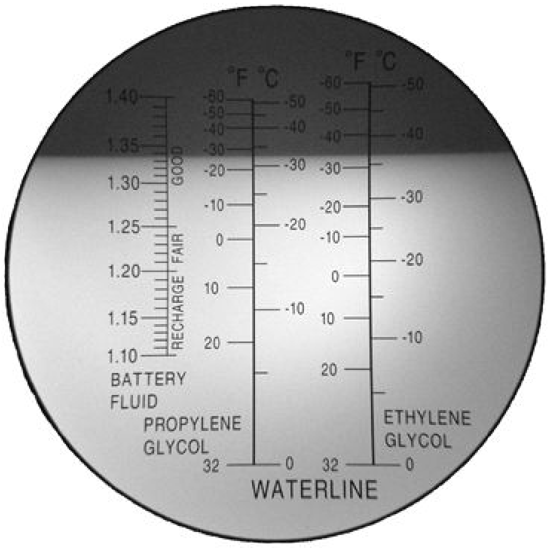
SERVICEGARD™ Part Number 75240



TS1733 —UN—04SEP13

Image with a Drop of 50/50 Coolant Placed on the Refractometer Window

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DX,COOL,TEST -19-13JUN13-1/1

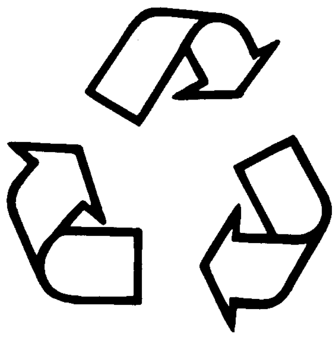
Disposing of Coolant

Improperly disposing of engine coolant can threaten the environment and ecology.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere engine distributor or servicing dealer.



TS1133 —UN—15APR13

Recycle Waste

RG,RG34710,7543 -19-09JAN07-1/1

Engine Operating Guidelines

Instrument (Gauge) Panels

IMPORTANT: Any time an electric gauge or meter does not register correctly, replace it with a new one. Do not attempt to repair it.

All controls and gauges covered in this manual are optional equipment for John Deere OEM Engines. They may be provided by the equipment manufacturer instead of John Deere. The following information applies only to those controls and gauges provided by John Deere.

Earlier Instrument (Gauge) Panel (North America)

Following is a brief description of the components on the John Deere instrument (gauge) panel:

A—Oil Pressure Gauge - Indicates engine oil pressure.

B—Coolant Temperature Gauge - Indicates the engine coolant temperature.

C—Key Switch - The four position key switch controls the electrical system.

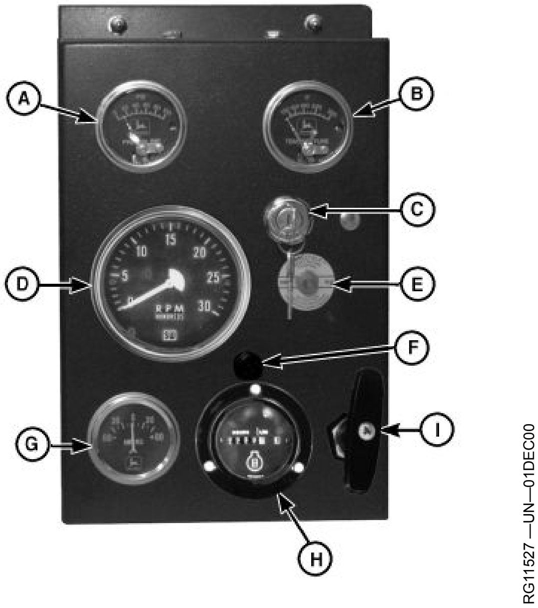
D—Tachometer (optional) - Indicates engine speed in revolutions per minute (rpm).

E—Reset (Safety) Switch - Overrides safety shutdown switch when depressed and held in during engine start-up. Hold button in until engine oil pressure is at a safe operating level.

F—Fuse Holder - Contains 14 amp fuse.

G—Ammeter - Indicates charging current within electrical system.

H—Hour Meter (optional) - Indicates the operating hours of the engine while key switch is in the "ON" position. The hour meter should be used as a guide for scheduling periodic service.



North American Instrument Panel (Earlier Engines)

A—Oil Pressure Gauge
B—Coolant Temperature Gauge
C—Key Switch
D—Tachometer
E—Reset (Safety) Switch
F—Fuse Holder
G—Ammeter
H—Hour Meter
I— Hand Throttle

I—Hand Throttle (optional) - Controls engine speed.

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Later Instrument (Gauge) Panel (North America)

IMPORTANT: Any time an electric gauge or meter does not register correctly, replace it with a new one. Do not attempt to repair it.

Following is a brief description of the components on instrument (gauge) panel:

A—Tachometer with Hourmeter (Optional) - The tachometer with hourmeter indicates engine speed in revolutions per minute (rpm) and shows the operating hours of the engine while key switch is in the "ON" position. The hour meter should be used as a guide for scheduling periodic service.

B—Oil Pressure Gauge - The oil pressure gauge indicates engine oil pressure. If the engine oil pressure falls below a safe operating pressure, the engine will shut down.

C—Voltmeter Gauge - The voltmeter indicates system battery voltage.

D—Coolant Temperature Gauge - The coolant temperature gauge indicates the engine coolant temperature. If coolant temperature rises above the preset, safe operating temperature, the engine will shut down.

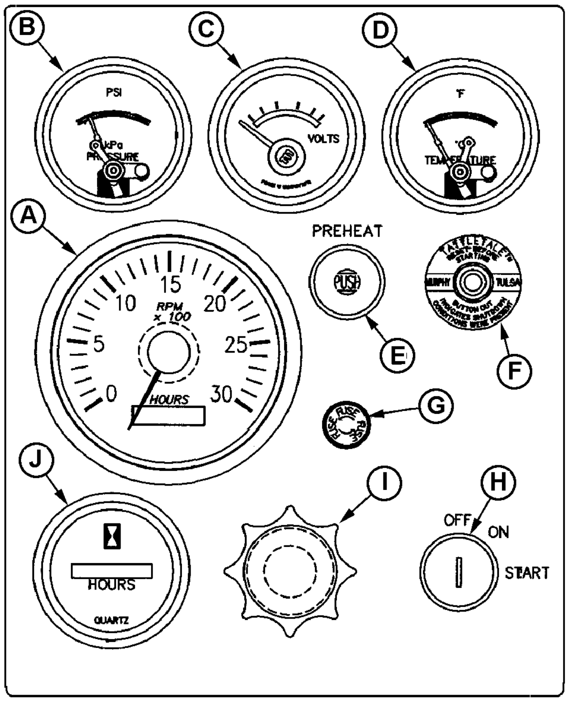
E—Pre-Heat Button - Press button to activate the preheater for cold weather starting.

F—Reset (Safety) Switch- Reset button will pop out and shut down the engine if the coolant temperature is too high or oil pressure is too low. Press in and hold while starting engine until oil pressure is at a safe operating level.

G—Fuse Holder - Contains 14 amp fuse.

H—Key Switch - The key switch controls the electrical system. Positions of key switch are marked as follows: OFF, ON, and START.

I—Throttle (Optional) - The throttle control is used to control engine speed.



RG13360 —UN—06FEB04

Instrument Panel and Gauges (Later Engines)

A—Tachometer with Hourmeter (Optional)
B—Oil Pressure Gauge
C—Voltmeter Gauge
D—Coolant Temperature Gauge
E—Preheat Button
F—Reset (Safety) Switch
G—Fuse Holder
H—Key Switch
I— Throttle (Optional)
J—Hourmeter (Optional)

J—Hourmeter (Optional) - The hourmeter indicates the operating hours of the engine while key switch is in the "ON" position. The hour meter should be used as a guide for scheduling periodic service.

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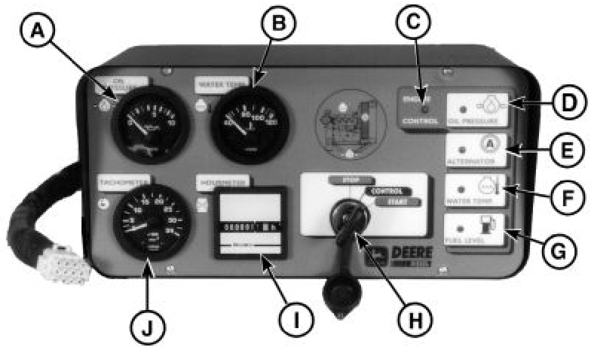
AEZ Instrument (Gauge) Panel (Except North America)



AEZ Instrument Panel

A—Oil Pressure Gauge
B—Coolant Temperature Gauge
C—Engine Control Light
D—Oil Pressure Light
E—Alternator Light
F—Coolant Temperature Light
G—Fuel Level Light
H—Key Switch
I—Hour Meter
J—Tachometer

A—Oil Pressure Gauge - The oil pressure gauge indicates engine oil pressure.

B—Coolant Temperature Gauge - The coolant temperature gauge indicates the engine coolant temperature.

C—Engine Control Light - The engine control light indicates that the engine protection is activated.

D—Oil Pressure Light - The oil pressure light illuminates when the key switch is turned to the CONTROL position. The light will remain on until the engine is started and the specified oil pressure is reached. If oil pressure is lost during engine operation, the light will illuminate and protection circuitry will stop the engine. The oil pressure light will remain on, indicating that the engine was stopped due to a low oil pressure condition.

E—Alternator Light - The alternator light illuminates when the key is turned to the CONTROL position. The light will remain on until the engine is started. After the engine is running, if the alternator stops charging, the light will illuminate and protection circuitry will stop the engine. The alternator light will remain on indicating the engine was stopped due to the alternator not charging.

F—Coolant Temperature Light - The coolant temperature light illuminates only if the engine has overheated. After the engine is running, if the engine overheats, the light will illuminate and protection circuitry will stop the engine. The coolant temperature light will remain on indicating the engine was stopped due to the engine overheating.

G—Fuel Level Light - The fuel level light illuminates only if the engine has stopped due to fuel tank being empty. After the engine is running, if the engine runs out of fuel, the light will illuminate. The fuel level light will remain on indicating the engine was stopped due to the fuel tank being empty.

H—Key Switch - The key switch controls the electrical system.

I—Hour Meter - Indicates the operating hours of the engine while key switch is in the "ON" position. The hour meter should be used as a guide for scheduling periodic service.

J—Tachometer - Indicates engine speed in revolutions per minute (rpm).

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VDO Instrument (Gauge) Panel (Except North America)

A—Oil Pressure Gauge - The oil pressure gauge indicates engine oil pressure.

B—Coolant Temperature Gauge - The coolant temperature gauge indicates coolant temperature.

C—Tachometer - The tachometer indicates engine speed in hundreds of revolutions per minute (rpm).

The engine control system consists of the following:

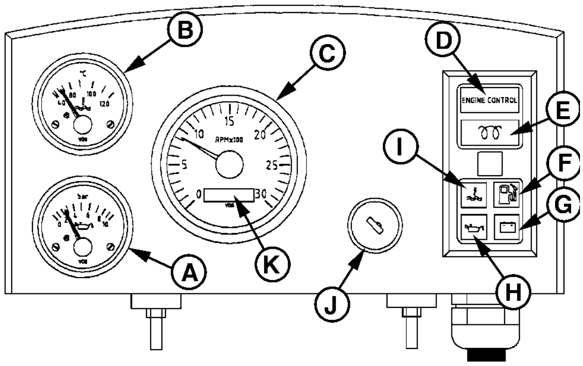
D—Engine Control Light - The engine control light illuminates after the engine has started and oil pressure is up to specification. The light indicates that the engine protection circuitry is activated.

E—Preheater Light - The preheater light illuminates when the key is turned to the bulb test position (position I). It should go off after approximately five seconds. When the key switch is held in position II, the engine preheater is energized and the preheater light illuminates.

F—Fuel Level Light - The fuel level light illuminates when the key is turned to the bulb test position (position I). It should go off after approximately five seconds. After the engine is running, if the engine runs out of fuel, the light will illuminate. The fuel level light will remain on indicating the engine was stopped due to the fuel tank being empty.

G—Battery Light - The battery light illuminates when the key is turned to the bulb test position (position I). It should go off after approximately five seconds. After the engine is running, if the alternator stops charging, the light will illuminate and protection circuitry will stop the engine. The battery light will remain on indicating the engine was stopped due to the alternator not charging.

H—Oil Pressure Light - The oil pressure light illuminates when the key switch is turned to the bulb test position (position I). The light will remain on until the engine is started and the specified oil pressure is reached. If oil pressure is lost during engine operation, the light will illuminate and protection circuitry will stop the engine. The oil pressure light will remain on, indicating that the engine was stopped due to a low oil pressure condition.



RG10606B —UN—20OCT99

A—Oil Pressure Gauge
B—Coolant Temperature Gauge
C—Tachometer
D—Engine Control Light
E—Preheater Light
F—Fuel Level Light
G—Battery Light
H—Oil Pressure Light
I— Coolant Temperature Light
J—Key/Start Switch
K—Hour Meter

I—Coolant Temperature Light - The coolant temperature light illuminates when the key is turned to the bulb test position (position I). It should go off after approximately five seconds. After the engine is running, if the engine overheats, the light will illuminate and protection circuitry will stop the engine. The coolant temperature light will remain on indicating the engine was stopped due to the engine overheating.

Other components on the instrument panel:

J—Key/Start Switch - The four-position key start switch controls the electrical system.

K—Hour Meter - The hour meter is an integral part of the tachometer. It shows the accumulated hours of engine service. The hour meter operates when the engine is running and accumulated hours are displayed in hours and tenths of hours.

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Auxiliary Gear Drive Limitations

IMPORTANT: When attaching an air compressor, hydraulic pump, or other accessory to be driven by the auxiliary gear drive (engine timing gear train at front of engine), power requirements of the accessory must be limited to values listed below:

Power Levels For Right-Hand Auxiliary Gear Drive:
- 16 kW (22 hp) Continuous Operation[1]
- 28 kW (37.5 hp) Intermittent Operation[1]

CD30354 —UN—03FEB93

Auxiliary Gear Drive

[1]*At 2400 engine rpm.*

RG,RG34710,5047 -19-30JAN98-1/1

Generator Set (Standby) Applications

To assure that your engine will deliver efficient standby operation when needed, start engine and run at rated speed (with 50%—70% load) for 30 minutes every 2 weeks. DO NOT allow engine to run extended period of time with no load.

RG,RG34710,5048 -19-30JAN98-1/1

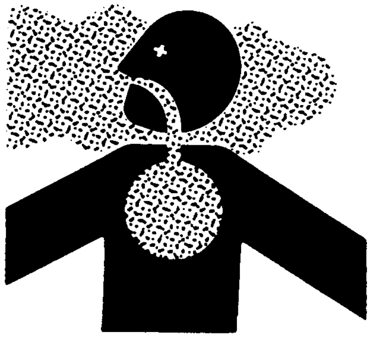
Starting The Engine

The following instructions apply to the optional controls and instruments available through the John Deere Parts Distribution Network. The controls and instruments for your engine may be different from those shown here; always follow manufacturer's instructions.

⚠ **CAUTION: Before starting engine in a confined building, install proper outlet exhaust ventilation equipment. Always use safety approved fuel storage and piping.**

NOTE: If temperature is below 0 °C (32 °F), it may be necessary to use cold weather starting aids (See COLD WEATHER OPERATION, later in this section).

1. Perform all prestarting checks outlined in Lubrication & Maintenance/Daily Section later in this manual.



TS220 —UN—15APR13

Avoid Toxic Fumes

2. Open the fuel supply shut-off valve, if equipped.

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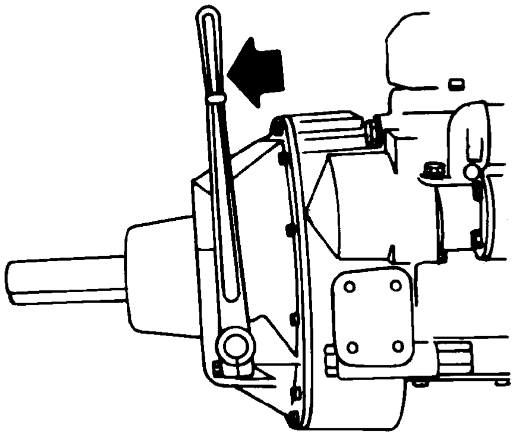
RG,RG34710,5049 -19-30JAN98-1/3

TIM-ID: 0000114010 - 001

3. If equipped with PTO clutch, pull lever (arrow) rearward (away from engine) to disengage PTO clutch.


RG5602 —UN—16JUN00

PTO Clutch Lever

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RG,RG34710,5049 -19-30JAN98-2/3

TIM-ID: 0000114010 - 001

4. Pull hand throttle (A) 1/3 of the way out. Turn the handle in either direction to lock it in place.
5. If equipped, depress and hold reset button (B) while starting.

IMPORTANT: Do not operate the starter for more than 30 seconds at a time. To do so may overheat the starter. If the engine does not start the first time, wait at least 2 minutes before trying again. If engine does not start after four attempts, see Troubleshooting Section.

6. Turn the key switch (C) clockwise to crank the engine. When the engine starts, release the key so that it returns to the "ON" position.

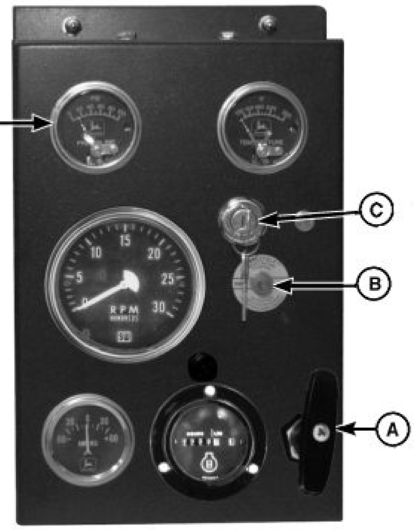
IMPORTANT: If the key switch is released before the engine starts, wait until the starter and the engine stop turning before trying again. This will prevent possible damage to the starter and/or flywheel.

7. After the engine starts, continue to hold the reset button in until the oil pressure gauge (D) reads at least 105 kPa (1.05 bar) (15 psi). The safety controls will not allow the engine to run at a lower oil pressure unless the reset button is held in.

IMPORTANT: Should the engine die while operating under load, immediately disengage PTO clutch and restart the engine. Overheating of turbocharger parts may occur when oil flow is stopped.

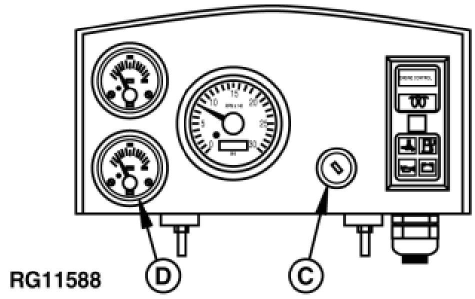
8. Check all gauges for normal engine operation. If operation is not normal, stop the engine and determine the cause.

A—Hand Throttle
B—Reset Button
C—Key Switch
D—Oil Pressure Gauge



North American Instrument Panel

AEZ Instrument Panel (Except North America)

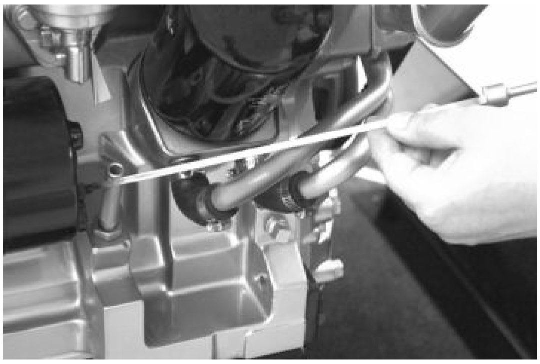


VDO Instrument Panel (Except North America)

RG,RG34710,5049 -19-30JAN98-3/3

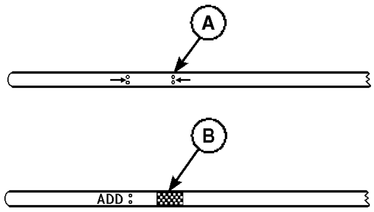
TIM-ID: 0000114010 - 001

Break-In Service



RG7314 —UN—29NOV00

Check Engine Oil Level



Dipstick Markings

RG11528 —UN—01DEC00

A—Full Mark **B—Crosshatch**

The engine is ready for normal operation. However, extra care during the first 100 hours of operation will result in more satisfactory long-term engine performance and life. DO NOT exceed 100 hours of operation with break-in oil.

1. This engine is factory-filled with a special break-in oil. Operate the engine at heavy loads with minimal idling during the break-in period.

IMPORTANT: Do not add makeup oil until the level is BELOW the ADD mark or lower arrow on dipstick. If make-up oil is required during the break-in period, an additional 100 hour break-in period is required. John Deere Engine Break-In Oil (TY22041) should be used to make up any oil consumed during the break-in period.

DO NOT fill above the top of the mark (A) or crosshatch pattern (B), whichever is present. Oil levels anywhere within arrows or crosshatch are considered in the acceptable operating range.

2. Check engine oil level more frequently. If oil must be added, John Deere Engine Break-In Oil is preferred. See ENGINE BREAK-IN OIL, in Fuels, Lubricants, and Coolant Section.

3. Check oil pressure and coolant temperature while engine is operating. See specification.

Specification

Engine [1]—Oil Pressure at
Full Load Rated Speed..... 345 ± 103 kPa (3.45 ± 1.03 bar) (50 ± 15 psi)
Minimum Oil Pressure at
Rated Speed..275 (2.75 bar) (40 psi)
Minimum Oil Pressure at
850 rpm .... 105 kPa (1.05 bar) (15 psi)
Coolant Temperature
Range .... 82°—94°C (180°—202°F)

4. During the first 20 hours, avoid prolonged periods of engine idling or sustained maximum load operation. Vary the engine speed throughout this period. If engine will idle longer than 5 minutes, stop engine.

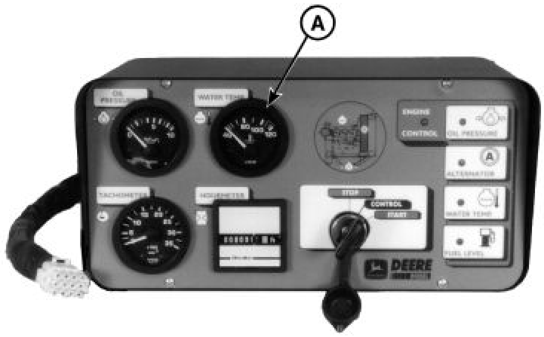
[1]*At normal operating temperature of 115 °C (240 °F) sump.*

Continued on next page

RG,RG34710,5046 -19-11FEB03-1/2

TIM-ID: 0000114010 - 001

North American Instrument Panel

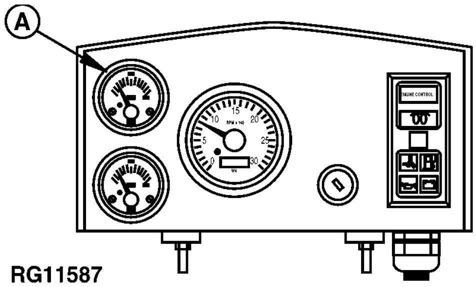


AEZ Instrument Panel (Except North America)

5. Watch coolant temperature gauge (A) closely. If coolant temperature rises above 112°C (234°F), reduce load on engine. Unless temperature drops quickly, stop the engine and determine the cause before resuming operation.

NOTE: When the coolant temperature gauge reads approximately 115°C (239°F), the engine will shutdown automatically, if equipped with safety controls.

6. The tension on newly installed belts should be checked daily for the first few days of operation because of the initial stretching. Also, check belts for proper seating in pulley grooves.



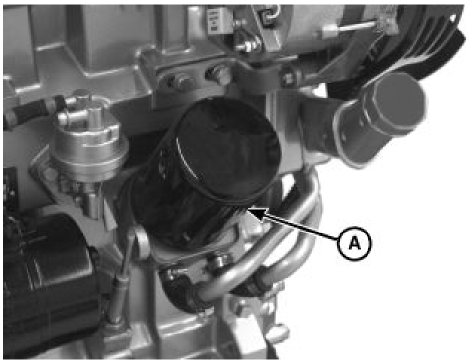
VDO Instrument Panel (Except North America)

A—Coolant Temperature Gauge

RG,RG34710,5046 -19-11FEB03-2/2

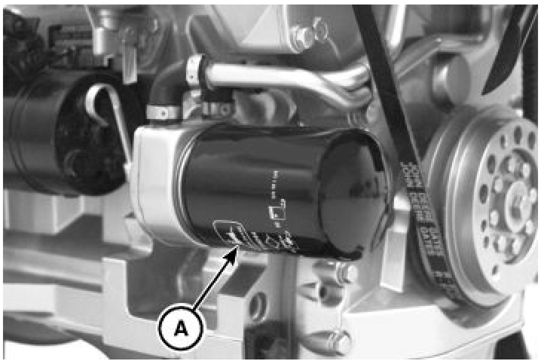
After Break-In Service

NOTE: If the engine has significant operating time at idle, constant speeds, and/or light load usage, or make-up oil is required in the first 100 hour period, a longer break-in period may be required. In these situations, an additional 100 hour break-in period is recommended using a new change of John Deere Engine Break-In Oil and new John Deere oil filter.



RG11529 —UN—01DEC00

Engine Mounted Oil Filter



RG11530 —UN—01DEC00

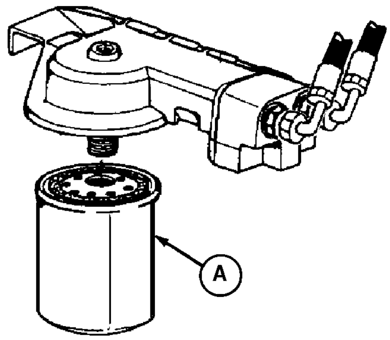
Engine Mounted Oil Filter

After break-in service, change engine oil and oil filter (A) according to maintenance interval indicated below.

All except 3029TF270 Engines: See CHANGING ENGINE OIL AND REPLACING OIL FILTER in Lubrication and Maintenance/250 Hour Section.

3029TF270 Engines: (See CHANGING ENGINE OIL AND REPLACING OIL FILTER in Lubrication and Maintenance/500 Hour Section.

Fill crankcase with seasonal viscosity grade oil. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section.)



RG11549 —UN—06DEC00

3029 Engines with Remote Oil Filter

A—Oil Filter

OURGP12,00001E3 -19-04MAR03-1/1

Normal Engine Operation

Observe engine coolant temperature and engine oil pressure. Temperatures and pressures will vary between engines and with changing operating conditions, temperatures, and loads.

Normal engine coolant operating temperature range is 82°–94°C (180°–202°F). If coolant temperature rises above 112°C (234°F), reduce load on engine. Unless temperature drops quickly, stop engine and determine cause before resuming operation.

Operate the engine under a lighter load and at slower than normal speed for first 15 minutes after start-up. DO NOT run engine at slow idle.

IMPORTANT: Should the engine die while operating under load, immediately remove load and restart the engine. Overheating of the turbocharger parts may occur when oil flow is stopped.

Stop engine immediately if there are any signs of part failure. Symptoms that may be early signs of engine problems are:

- Sudden drop in oil pressure
- Abnormal coolant temperatures
- Unusual noise or vibration
- Sudden loss of power
- Excessive black exhaust
- Excessive fuel consumption
- Excessive oil consumption
- Fluid leaks

RG,RG34710,5045 -19-30JAN98-1/1

Cold Weather Operation

CAUTION: Ether injector starting fluid is highly flammable. DO NOT use starting fluid on engines equipped with air intake heaters.

DO NOT use starting fluid near fire, sparks, or flames. DO NOT incinerate or puncture a starting fluid container.

TS1356 —UN—18MAR92

Handle Starting Fluid with Care

Engines may be equipped with intake air heaters, coolant heaters, or ether injectors as a cold weather starting aid.

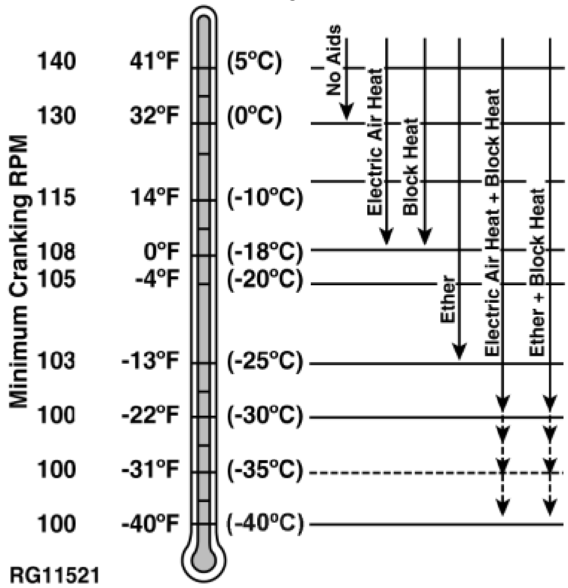
Starting aids are required below 0°C (32°F). They will enhance starting performance above these temperatures and may be needed to start applications that have high parasitic loads during cranking and/or start acceleration to idle.

Using correct grade of oil (per engine and machine operator's manual) is critical to achieving adequate cold weather cranking speed.

Other cold weather starting aids are required at temperatures below -30°C (-22°F) or at altitudes above 1500 m (5000 ft).

1. Follow steps 1—4 as listed under “STARTING THE ENGINE”, then proceed as follows according to the instrument (control) panel on your engine.
2. Switch on the air intake heater for 30 seconds or activate ether injector by following suppliers instructions.
3. Follow remaining steps 5—8 as listed under “STARTING THE ENGINE” earlier in this section.

   Additional information on cold weather operation is available from your authorized servicing dealer.



RG11521 —19—10JAN01

Cold Weather Starting Guidelines

RG,RG34710,5050 -19-11FEB03-1/1

TIM-ID: 0000114010 - 001

Warming Engine

IMPORTANT: To assure proper lubrication, operate engine at or below 1200 rpm with no load for 1–2 minutes. Extend this period 2–4 minutes when operating at temperatures below freezing.

Engines used in generator set applications where the governor is locked at a specified speed may not have a slow idle function. Operate these engines at high idle for 1 to 2 minutes before applying the load. This procedure does not apply to standby generator sets where the engine is loaded immediately upon reaching rated speed.

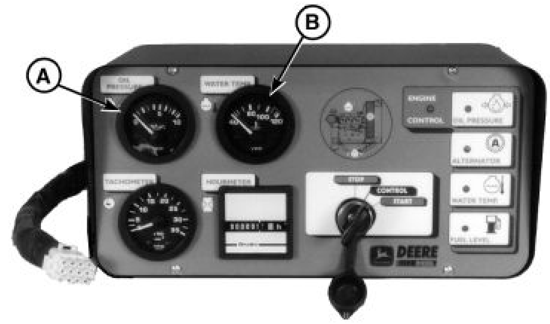
1. Check oil pressure gauge (A) as soon as engine starts. If gauge needle does not rise above minimum oil pressure specification of 105 kPa (1.05 bar) (15.0 psi) within 5 seconds, stop the engine and determine the cause. Normal engine oil pressure is 345 ±103 kPa (3.45 bar ± 1.03 bar) (50 ±15 psi) at rated full load speed (1800–2500 rpm) with oil at normal operating temperature of 105°C (221°F).
2. Watch coolant temperature gauge (B). Do not place engine under full load until it is properly warmed up. The normal engine coolant temperature range is 82°–94°C (180°–202°F).

NOTE: It is a good practice to operate the engine under a lighter load and at lower speeds than normal for the first few minutes after start-up.

A—Oil Pressure Gauge **B—Coolant Temperature Gauge**

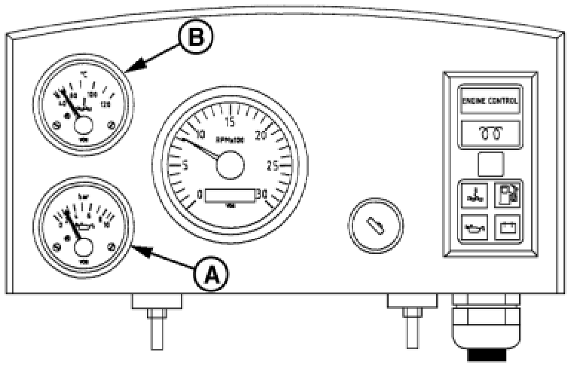
RG11533 —UN—01DEC00

North American Instrument Panel



RG11593 —UN—08DEC00

AEZ Instrument Panel (Except North America)



RG10613 —UN—21OCT99

VDO Instrument Panel (Except North America)

RG,RG34710,5051 -19-30JAN98-1/1

Changing Engine Speed-Standard (Mechanical) Governor

NOTE: Throttle levers are usually supplied by OEM manufacturer. Consult supplier literature to familiarize yourself with throttle lever used on your engine.

To increase engine speed, turn throttle handle (A) to the horizontal position and pull out until desired engine speed is obtained. Turn the handle in either direction to lock throttle position. The handle is pushed inward to decrease engine speed.

A—Throttle Handle

RG11534 —UN—01DEC00

Throttle Handle on North American Instrument Panel

RG,RG34710,5052 -19-30JAN98-1/1

Idling Engine

Avoid excessive engine idling. Prolonged idling may cause the engine coolant temperature to fall below its normal range. This, in turn, causes crankcase oil dilution, due to incomplete fuel combustion, and permits formation of gummy deposits on valves, pistons, and piston rings. It also promotes rapid accumulation of engine sludge and unburned fuel in the exhaust system.

Once an engine is warmed to normal operating temperatures, engine should be idled at slow idle speed.

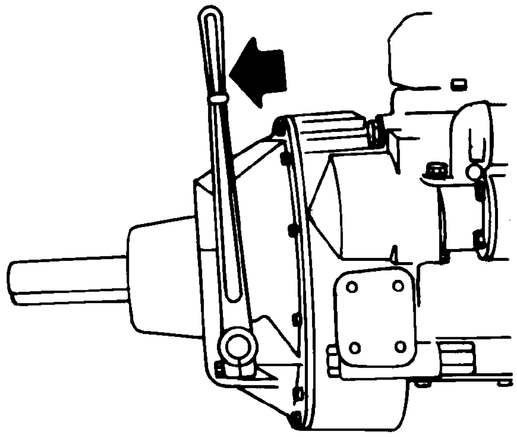
Slow idle speed for this engine is 850 rpm at factory. If an engine will be idling for more than 5 minutes, stop and restart later, or set engine speed at 1200 rpm.

NOTE: Generator set applications where the governor is locked at a specified speed may not have a slow idle function. These engines will idle at no load governed speed (high idle).

RG,RG34710,5053 -19-11FEB03-1/1

Stopping The Engine

1. Pull PTO clutch lever (arrow) rearward (away from engine) to disengage clutch, if equipped.



PTO Clutch Lever

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RG,RG34710,5054 -19-30JAN98-1/2

TIM-ID: 0000114010 - 001

2. Move the throttle handle (A) to slow idle on standard (mechanical) governor engines.

IMPORTANT: Before stopping an engine that has been operating at working load, idle engine at least 2 minutes at 1000–1200 rpm to cool hot engine parts.

Engines in generator set applications, where the governor is locked at a specified speed and no slow idle function is available, run engine for at least 2 minutes at fast idle and no load.

3. Turn key switch to “OFF” position. Remove ignition key.

IMPORTANT: Make sure that exhaust stack cap (rain cap) is installed when engine is not running. This will prevent water and dirt from entering engine.

A—Throttle Handle

Throttle Handle on North American Instrument Panel

Rain Cap

RG,RG34710,5054 -19-30JAN98-2/2

Using A Booster Battery Or Charger

CAUTION: Gas given off by battery is explosive. Keep sparks and flames away from battery. Before connecting or disconnecting a battery charger, turn charger off. Make last connection and first disconnection at a point away from battery. Always connect NEGATIVE (–) cable last and disconnect this cable first.

IMPORTANT: Be sure that polarity is correct before making connections. Reversed polarity will damage electrical system. Always connect positive to positive and negative to ground. Always use 12 volt booster battery for 12 volt electrical systems and 24 volt booster battery(ies) for 24 volt electrical systems.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

A 12 volt booster battery can be connected in parallel (B) with battery(ies) on the unit to aid in cold weather starting. ALWAYS use heavy-duty jumper cables.

Series:

- Amps = Same as single battery
- Volts = Twice as a single battery

Parallel:

- Amps = Twice as a single battery
- Volts = Same as a single battery

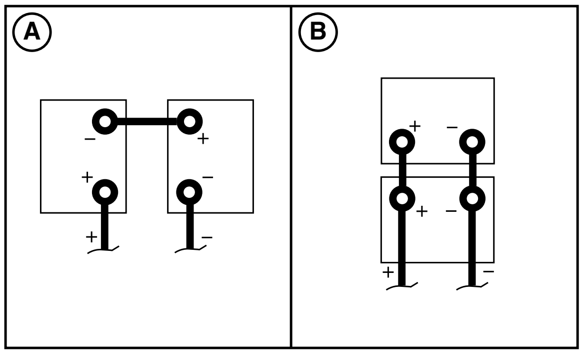
1. Connect booster battery or batteries to produce the required system voltage for your engine application.

NOTE: To avoid sparks, DO NOT allow the free ends of jumper cables to touch the engine.

2. Connect one end of jumper cable to the POSITIVE (+) post of the booster battery.
3. Connect the other end of the jumper cable to the POSITIVE (+) post of battery connected to starter.

TS204 —UN—15APR13

Exploding Battery



RG24885 —UN—17DEC13

A—Series **B—Parallel**

4. Connect one end of the other jumper cable to the NEGATIVE (–) post of the booster battery.
5. ALWAYS complete the hookup by making the last connection of the NEGATIVE (–) cable to a good ground on the engine frame and away from the battery(ies).
6. Start the engine. Disconnect jumper cables immediately after engine starts. Always disconnect NEGATIVE (–) cable first.

RG,RG34710,4060 -19-17DEC13-1/1

TIM-ID: 0000114010 - 001

Lubrication and Maintenance

Required Emission-Related Information

Service Provider

A qualified repair shop or person of the owner's choosing may maintain, replace, or repair emission control devices and systems with original or equivalent replacement parts. However, warranty, recall, and all other services paid for by John Deere must be performed at an authorized John Deere service center.

DX,EMISSIONS,REQINFO -19-12JUN15-1/1

Observe Service Intervals

RG11589 —UN—08DEC00

North American Instrument Panel Hour Meter

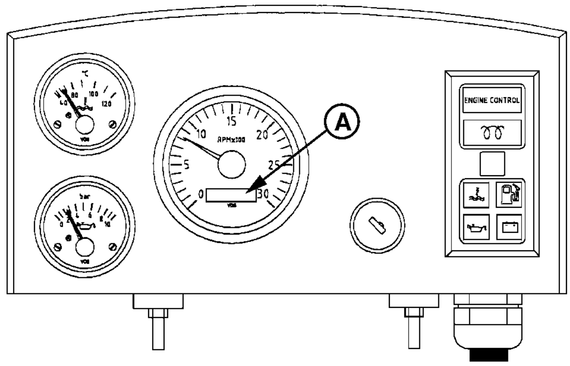
RG11594 —UN—08DEC00

AEZ Instrument Panel Hour Meter

Using hour meter (A) as a guide, perform all services at the hourly intervals indicated on following pages. At each scheduled maintenance interval, perform all previous maintenance operations in addition to the ones specified. Keep a record of hourly intervals and services performed using charts provided in Lubrication and Maintenance Records Section.

IMPORTANT: Recommended service intervals are for normal operating conditions. Service MORE OFTEN if engine is operated under adverse conditions. Neglecting maintenance can result in failures or permanent damage to the engine.

A—Hour Meter



RG10618 —UN—21OCT99

VDO Instrument Panel Hour Meter

RG,RG34710,5056 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Use Correct Fuels, Lubricants, And Coolant

IMPORTANT: Use only fuels, lubricants, and coolants meeting specifications outlined in Fuels, Lubricants, and Coolant Section when servicing your John Deere Engine.

Consult your John Deere Servicing Distributor or your nearest John Deere Parts Network for recommended fuels, lubricants, and coolant. Also available are necessary additives for use when operating engines in tropical, arctic, or any other adverse conditions.

TS100 —UN—23AUG88

John Deere Parts

RG,RG34710,5057 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Lubrication And Maintenance Service Interval Chart—Prime Power Engines

	Lubrication and Maintenance Service Intervals					
Item	Daily	250 Hour or 6 Month	500 Hour or 12 Month	600 Hours of Operation	2000 Hour or 24 Month	As Required
Check Engine Oil and Coolant Level	•					
Lubricate PTO Release Bearing	•					
Check Air Cleaner Dust Unloader Valve & Restriction Indicator[a]	•					
Visual Walk Around Inspection	•					
Check Fuel Filter	•					
Service Fire Extinguisher		•				
Lubricate PTO Clutch Shaft Bearing		•				
Service Battery		•				
Change Engine Oil and Filter- All except 3029TF270 & 3029HF270 Engines[b]		•				
Check Fan and Alternator Belt Tension		•				
Check PTO Clutch Adjustment		•				
Check Engine Mounts		•				
Change Engine Oil and Filter- 3029TF270 & 3029HF270 Engines[c]			•			
Check Engine Ground Connection			•			
Lubricate PTO Clutch Levers and Linkage (If Equipped)			•			
Clean Crankcase Vent Tube			•			
Check Air Intake Hoses, Connections, and System			•			
Replace Fuel Filter /Bleed System			•			
Coolant Solution Analysis-Add SCAs as needed			•			
Pressure Test Cooling System			•			
Check Engine Speeds			•			
Check Cooling System			•			
Test Thermostats					•	
Check and Adjust Valve Clearance				•		
Flush and Refill Cooling System[d]					•	
Add Coolant						•
Bleed Fuel System						•
Replace Air Cleaner Elements						•
Replace Belts						•
Inspect PTO Clutch (If Equipped)						•
Check Fuses						•

[a]Replace primary air cleaner element when restriction indicator shows a vacuum of 625 mm (25 in.) H2O.
[b]Change the oil and filter for the first time after 100 hours maximum of operation, then every 250 hours thereafter. If recommended oils are used along with the specified John Deere oil filter, the oil change interval may be extended by 50 percent to 375 hours. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant section.)
[c]Change the oil for the first time before 100 hours maximum of (break-in) operation, then every 500 hours thereafter. If PLUS-50 or ACEA E7/E6/E5/E4 oil is NOT used along with the specified John Deere oil filter, the oil change interval is reduced to 250 hours. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant section for oil pan and fuel sulfur content restrictions.)
[d]If John Deere COOL-GARD is used, the flushing and refilling interval may be extended to 3000 hours or 36 months. If John Deere COOL-GARD is used and the coolant is tested annually AND additives are replenished by adding supplemental coolant additives (SCAs), the flushing and refilling interval may be extended to 5000 hours or 60 months, whichever occurs first.

RG,RG34710,5058 -19-25JUL16-1/1

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Lubricant And Maintenance Service Interval Chart—Generator (Standby) Applications

NOTE: The service intervals in the Lubrication and Maintenance Sections that follow reflect standard engines. Use service intervals listed below for generator (standby) applications. Match service items below to titles in Lubrication and Maintenance Sections for procedures.

	Lubrication and Maintenance Service Intervals				
Item	**Every 2 Weeks**	**250 Hour or 6 Month**	**500 Hour or 12 Month**	**2000 Hour or 24 Month**	**As Required**
Operate Engine at Rated Speed and 50%-70% Load a Minimum of 30 Minutes	•				
Check Engine Oil and Coolant Level	•				
Check Fuel Filter	•				
Lubricate PTO Release Bearings	•				
Check Air Cleaner Dust Unloader Valve & Restriction Indicator Gauge[a]	•				
Visual Walkaround Inspection	•				
Service Fire Extinguisher		•			
Lubricate PTO Clutch Shaft Bearings		•			
Service Battery		•			
Change Engine Oil and Replace Oil Filter- All Except 3029TF270 & 3029HF270 Engines[b]		•			
Check Fan and Alternator Belt Tension		•			
Check PTO Clutch Adjustment		•			
Check Engine Mounts		•			
Change Engine Oil and Filter- 3029TF270 & 3029HF270 Engines[c]			•		
Check Engine Ground Connection			•		
Clean Crankcase Vent Tube			•		
Check Air Intake Hoses, Connections & System			•		
Replace Fuel Filter/Bleed System			•		
Coolant Solution Analysis-Add SCAs as required			•		
Pressure Test Cooling System			•		
Check Engine Speeds			•		
Check Cooling System			•		
Test Thermostats				•	
Adjust Variable Speed (Droop)				•	
Check and Adjust Valve Clearance				•	
Flush and Refill Cooling System[d]				•	
Add Coolant					•
Bleed Fuel System					•
Replace Air Cleaner Elements					•
Replace Belts					•
Check Fuses					•

[a]Replace primary air cleaner element when restriction indicator shows a vacuum of 625 mm (25 in.) H20.
[b]Change the oil and filter for the first time after 100 hours maximum of operation, then every 250 hours thereafter. If recommended oils are used along with the specified John Deere oil filter, the oil change interval may be extended by 50 percent to 375 hours. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant section.)
[c]Change the oil for the first time before 100 hours maximum of (break-in) operation, then every 500 hours thereafter. If PLUS-50 or ACEA E7/E6/E5/E4 oil is NOT used along with the specified John Deere oil filter, the oil change interval is reduced to 250 hours. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant section for oil pan and fuel sulfur content restrictions.)
[d]If John Deere COOL-GARD is used, the flushing and refilling interval may be extended to 3000 hours or 36 months. If John Deere COOL-GARD is used and the coolant is tested annually AND additives are replenished by adding supplemental coolant additives, the flushing and refilling interval may be extended to 5000 hours or 60 months, whichever occurs first.

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OUOD002,0000022 -19-31JUL15-1/1

Daily Prestarting Checks

Do the following BEFORE STARTING THE ENGINE for the first time each day:

Check Engine Oil Level

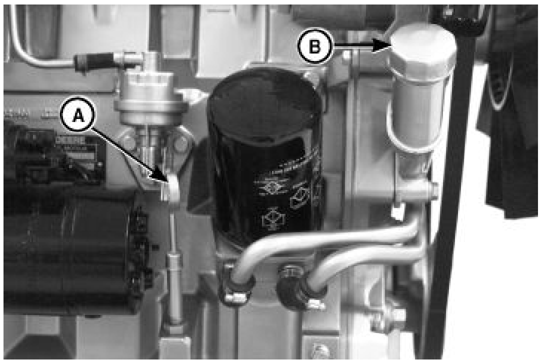
IMPORTANT: There is no need to add makeup oil until the oil level is BELOW the add mark.

DO NOT fill above the top mark on the dipstick. Oil levels anywhere within arrows (C) or crosshatch (D), whichever is present, are considered in the acceptable operating range.

1. Check engine oil level on dipstick (A). Oil level on dipstick should be within arrows (C) or crosshatch (D). Add oil at filler cap (B) as required, using seasonal viscosity grade oil. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section for oil specifications.)

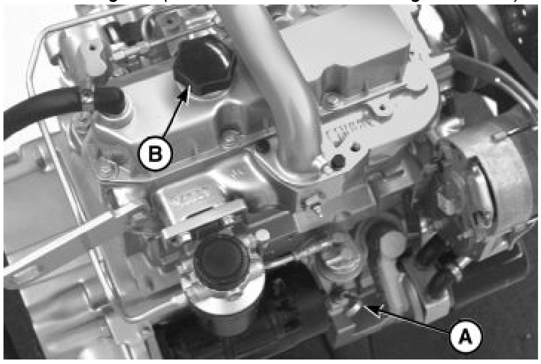
Some engines may have the oil filler cap on rocker arm cover, while others will have the filler cap on the timing gear cover.

A—Dipstick
B—Oil Filler Cap
C—Arrows
D—Crosshatch



RG11536 —UN—01DEC00

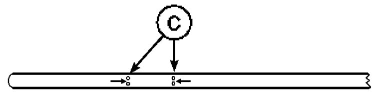
3029D Engines (Tier I Emission Certified Engine Shown)



RG11595 —UN—08DEC00

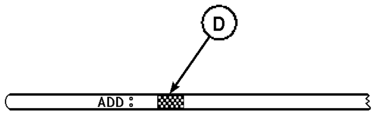
3029T Engines (Tier I Emission Certified Engine Shown)

RG11537 —UN—01DEC00



Correct Oil Level Within Arrows

RG11538 —UN—01DEC00



Correct Oil Level Within Crosshatch

Continued on next page

RG,RG34710,5059 -19-11FEB03-1/5

TIM-ID: 0000114010 - 001

Check Coolant Level

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Only remove filler cap when engine is cold or when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

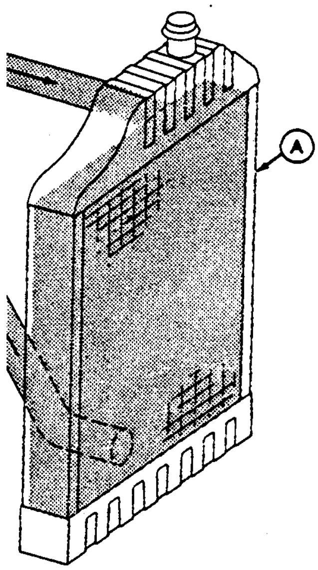
1. Check the coolant level when engine is cold. Coolant level should be at bottom of filler neck. Fill radiator (A) with proper coolant solution if level is low. (See <u>ADDING COOLANT</u> in Service As Required Section.) Check overall cooling system for leaks.

Refer to your vehicle's operator's manual for recommendations for non-John Deere supplied accessories.

A—Radiator

TS281 —UN—15APR13

Beware of Hot Fluids Under Pressure



RG4675 —UN—14DEC88

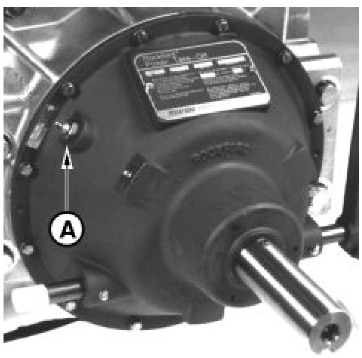
Coolant Level in Radiator

RG,RG34710,5059 -19-11FEB03-2/5

Lubricate PTO Bearing

1. Apply one shot of John Deere Multi-Purpose Lubricant or equivalent at PTO release bearing grease fitting (A). DO NOT over lubricate.

A—Grease Fitting



RG7331 —UN—20JUN00

PTO Release Bearing

Continued on next page

RG,RG34710,5059 -19-11FEB03-3/5

TIM-ID: 0000114010-001

Check Air Cleaner

IMPORTANT: Maximum air intake restriction is 3.5 kPa (0.03 bar) (0.5 psi) (14 in.) H_2O. A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine.

1. Squeeze dust unloader valve (A) on air cleaner assembly to remove dust deposits. If clogged, remove and clean the dust unloader valve. Replace if damaged.

IMPORTANT: Do not operate engine without the dust unloader valve.

If equipped with air intake restriction indicator gauge (B), check gauge. Service air cleaner when indicator is red.

Inspect Engine Compartment

1. Make a thorough inspection of the engine compartment. Look for oil or coolant leaks, worn fan and accessory drive belts, loose connections and trash build-up. Remove trash build-up and have repairs made as needed if leaks are found.

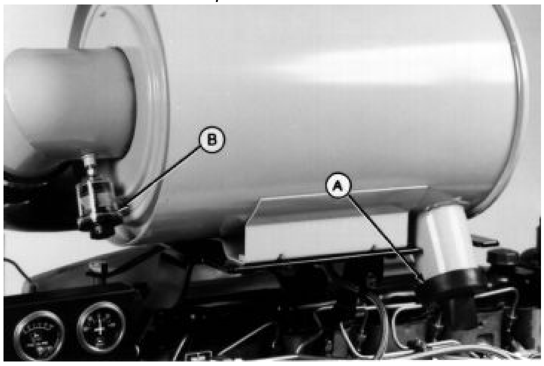
NOTE: Wipe all fittings, caps, and plugs before performing any maintenance to reduce the chance of system contamination.

Inspect:
- Radiator for leaks and trash build-up.
- Air intake system hoses and connections for cracks and loose clamps.
- Fan, alternator, and accessory drive belts for cracks, breaks or other damage.
- Water pump for coolant leaks.

NOTE: It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

RG11535 —UN—01DEC00

European Air Cleaner



RG7332 —UN—06JAN99

North American Air Cleaner

A—Dust Unloader Valve **B—Restriction Indicator Gauge**

Excessive coolant leakage may indicated the need to replace the water pump seal. Contact your engine distributor or servicing dealer for repairs.

Continued on next page

RG,RG34710,5059 -19-11FEB03-4/5

TIM-ID: 0000114010 - 001

Checking Fuel Filter

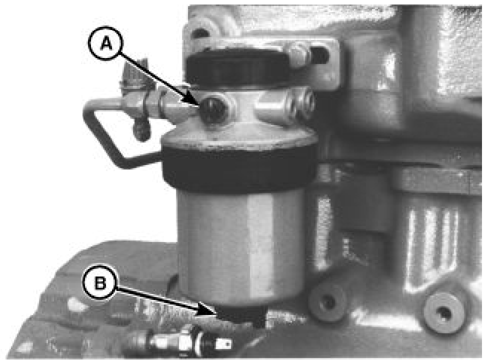
Check the fuel filter daily for water or debris and drain as necessary.

IMPORTANT: Drain water into a suitable container and dispose of properly.

1. Loosen drain plug (B) at bottom of fuel filter two or three turns.
2. Loosen air bleed plug (A) two full turns on fuel filter base and drain water from bottom until fuel starts to drain out.
3. When fuel starts to drain out, hand tighten drain plug.

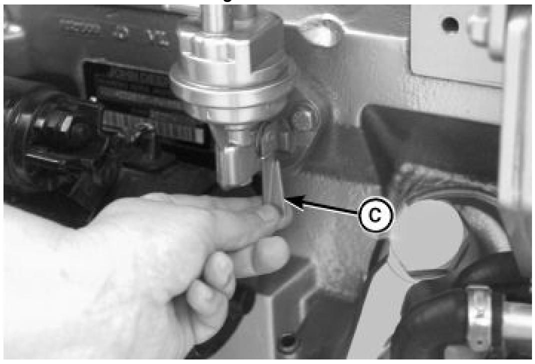
   After draining water from the fuel filter, the filter must be primed by bleeding all air from the fuel system.
4. Operate primer lever (C) of the fuel supply pump until fuel flow is free from air bubbles.
5. Tighten bleed plug (A) securely by hand. Continue operating hand primer until pumping action is not felt. When finished, pull hand primer outward (away from engine) as far as it will go.

   If the fuel system needs further bleeding of air, see BLEED FUEL SYSTEM in Service As Required Section, later in this manual.



RG11539 —UN—01DEC00

Draining the Fuel Filter



RG11540 —UN—01DEC00

Fuel Supply Pump Primer Lever

A—Bleed Plug
B—Drain Plug
C—Primer Lever

RG,RG34710,5059 -19-11FEB03-5/5

TIM-ID: 0000114010 - 001

Servicing Fire Extinguisher

A fire extinguisher (A) is available from your authorized servicing dealer or engine distributor.

Read and follow the instructions which are packaged with it. The extinguisher should be inspected at least every 250 hours of engine operation or once a month. Once extinguisher is operated, no matter how long, it must be recharged. Keep record of inspections on the tag which comes with the extinguisher instruction booklet.

A—Fire Extinguisher

RW4918 —UN—15DEC88

Service Fire Extinguisher

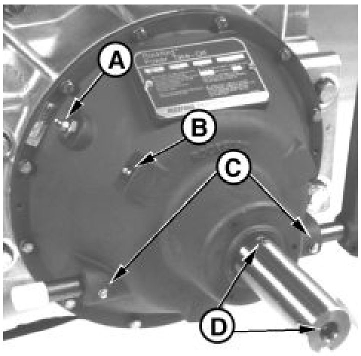
RG,RG34710,5062 -19-30JAN98-1/1

Lubricating PTO Clutch Shaft Bearings

Apply one or two shots of John Deere Multipurpose Lubricant or equivalent at clutch drive shaft bearing fitting (B) and pilot bearing fittings (D). DO NOT over-lubricate to avoid getting oil on clutch facings.

NOTE: Location of pilot bearing fitting will depend on application. Only one fitting will be used.

A—Release Bearing Grease Fitting
B—Drive Shaft Bearing Fitting
C—Lever Cross Shaft Fittings
D—Pilot Bearing Fitting



RG7331C —UN—26JUN00

Lubricate PTO Clutch

RG,RG34710,5061 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Servicing Battery

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded NEGATIVE (—) battery clamp first and replace it last.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. **Wash hands after handling.**

TS204 —UN—15APR13

Exploding Battery

1. On regular batteries, check electrolyte level. Fill each cell to bottom of filler neck with distilled water.

NOTE: Low-maintenance or maintenance-free batteries should require little additional service. However, electrolyte level can be checked by cutting the center section of decal on dash-line, and removing cell plugs. If necessary, add clean, soft water to bring level to bottom of filler neck.

2. Keep batteries clean by wiping them with a damp cloth. Keep all connections clean and tight. Remove any corrosion, and wash terminals with a solution of 1 part baking soda and 4 parts water. Tighten all connections securely.

NOTE: Coat battery terminals and connectors with a mixture of petroleum jelly and baking soda to retard corrosion.

3. Keep battery fully charged, especially during cold weather. If a battery charger is used, turn charger off before connecting charger to battery(ies). Attach POSITIVE (+) battery charger lead to POSITIVE (+) battery post. Then attach NEGATIVE (—) battery charger lead to a good ground.

Continued on next page

RG,RG34710,7563 -19-13FEB03-1/2

TIM-ID: 0000114010 - 001

CAUTION: Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

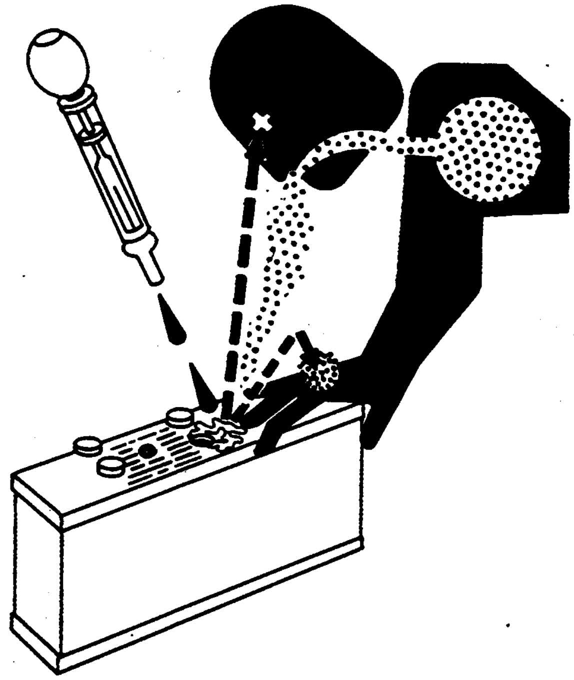
1. **Filling batteries in a well-ventilated area.**
2. **Wearing eye protection and rubber gloves.**
3. **Avoiding breathing fumes when electrolyte is added.**
4. **Avoiding spilling or dripping electrolyte.**
5. **Using proper jump start procedure.**

If you spill acid on yourself:

1. **Flush your skin with water.**
2. **Apply baking soda or lime to help neutralize the acid.**
3. **Flush your eyes with water for 10—15 minutes. Get medical attention immediately.**

If acid is swallowed:

1. **Drink large amounts of water or milk.**
2. **Then drink milk of magnesia, beaten eggs, or vegetable oil.**
3. **Get medical attention immediately.**


TS203 —UN—23AUG88

Sulfuric Acid

In freezing weather, run engine at least 30 minutes to ensure thorough mixing after adding water to battery.

Replacement battery(ies) must meet or exceed the following recommended capacities[1] at —18°C (0°F):

Specification	
12-Volt System—Minimum Battery Capacity—Cold Cranking Amps	640 Minimum
24-Volt System—Minimum Battery Capacity—Cold Cranking Amps	570 Minimum

[1] *Total recommended capacity based on batteries connected in series or parallel.*

RG,RG34710,7563 -19-13FEB03-2/2

TIM-ID: 0000114010 - 001

Changing Engine Oil And Replacing Oil Filter-All Except 3029TF270 Engines

NOTE: Change engine oil and filter for the first time after 100 hours maximum of operation, then every 250 hours thereafter.

If John Deere PLUS-50 engine oil **and** the specified John Deere oil filter are used, the oil and filter change interval may be increased by 50% to 375 hours.

OILSCAN is a John Deere sampling program to help you monitor machine performance and identify potential problems before they cause serious damage. OILSCAN kits are available from your John Deere dealer. Oil samples should be taken prior to the oil change. Refer to instructions provided with kit.

To change engine oil and filter:

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Remove oil pan drain plug (arrow).

RG4881 —UN—29NOV88

Oil Pan Drain Plug

NOTE: Drain plug location may vary, depending on the application.

3. Drain crankcase oil from engine while warm.

Continued on next page

RG,RG34710,5064 -19-13FEB03-1/3

TIM-ID: 0000114010 - 001

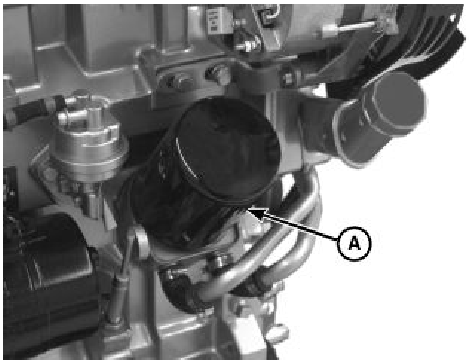
4. Remove and discard oil filter (A) using a suitable filter wrench.

NOTE: Depending on engine application, oil filter may be either vertical or horizontal on either engine model.

5. Remove oil filter packing and clean filter mounting pad.
6. Oil new packing and install new filter element. Hand tighten element according to values printed on filter element. If values are not provided, tighten element approximately 3/4—1-1/4 turn after packing contacts filter housing. DO NOT overtighten filter element.
7. Install oil pan drain plug with a new seal when equipped and tighten using the following specifications.

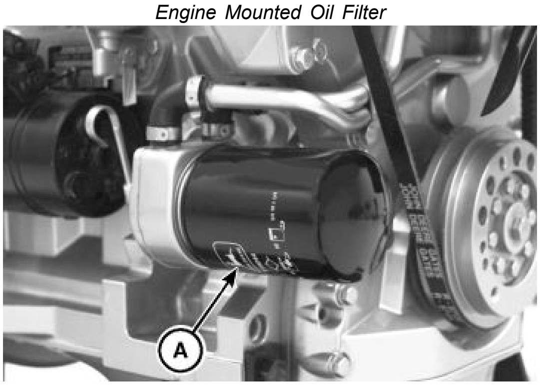
Conical Plug	55 N·m (41 lb-ft)
Cylindrical Plug W/Copper Washer	70 N·m (52 lb-ft)
Cylindrical Plug W/O-Ring	50 N·m (37 lb-ft)

A—Oil Filter



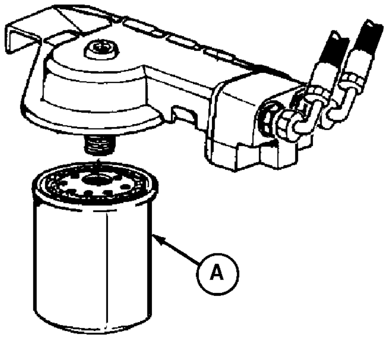
Engine Mounted Oil Filter

RG11529 —UN—01DEC00



Engine Mounted Oil Filter

RG11530 —UN—01DEC00



Engines W/Remote Oil Filter

RG11549 —UN—06DEC00

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RG,RG34710,5064 -19-13FEB03-2/3

TIM-ID: 0000114010 - 001

8. Fill engine crankcase with correct John Deere engine oil through timing gear cover opening (A) or rocker arm cover opening (B), depending on engine application. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section for determining correct engine oil.)

NOTE: Crankcase oil capacity may vary slightly. ALWAYS fill crankcase to top arrow or within crosshatch on dipstick, whichever is present. This should be checked after engine has run and oil has drained back into crankcase. DO NOT overfill.

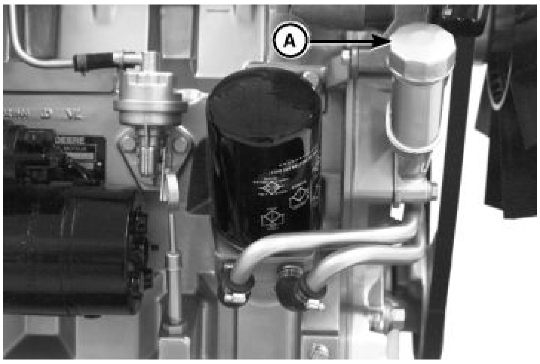
To determine the correct oil fill quantity for your engine, see ENGINE CRANKCASE OIL FILL QUANTITIES in the Specifications Section.

IMPORTANT: Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

9. Start engine and run to check for possible leaks.

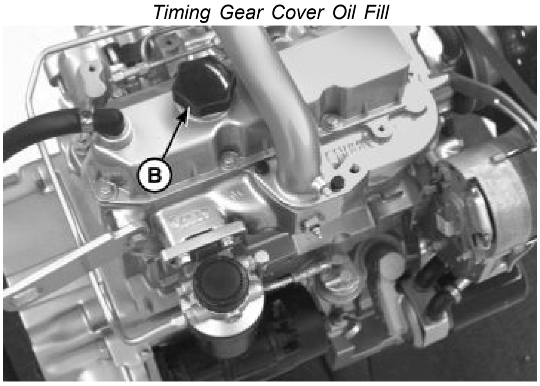
10. Stop engine and check oil level after 10 minutes. Oil level reading should be between arrows (C) or within crosshatch (D) of dipstick.

A—Timing Gear Cover Opening
B—Rocker Arm Cover Opening
C—Arrows
D—Crosshatch



RG11541 —UN—01DEC00

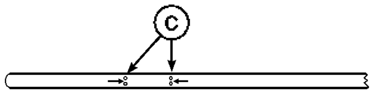
Timing Gear Cover Oil Fill



RG11596 —UN—08DEC00

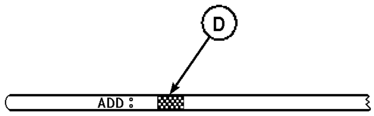
Rocker Arm Cover Oil Fill

RG11537 —UN—01DEC00



Correct Oil Level Within Arrows

RG11538 —UN—01DEC00



Correct Oil Level Within Crosshatch

RG,RG34710,5064 -19-13FEB03-3/3

TIM-ID: 0000114010 - 001

Checking Fan And Alternator V-Belt Tension

Low belt tension causes slippage resulting in excessive cover wear, burn spots, overheating, or "slip and grab", causing belt breakage.

High belt tension causes belt heating and excessive stretch, as well as damage to drive components such as pulleys and shafts. V-belts should ride on the sides of standard pulleys not on the bottom of the groove.

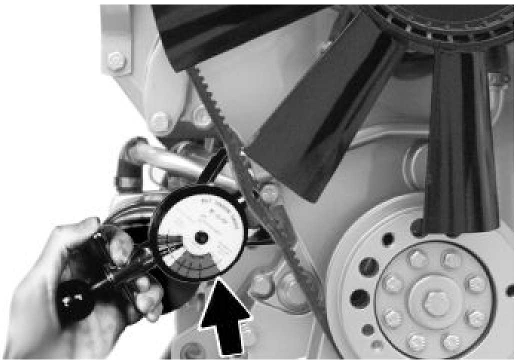
Standard V-belt tension can be checked with JDG529 Tension Gauge (bold arrow) or equivalent gauge. (Gauge is available from a John Deere Dealer or Distributor)

NOTE: On engines with dual belts, check tension of front belt only.

1. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.
2. Using JDG529 Belt Tension Gauge, or belt tension tester (A) and straightedge (B), check tension of warm belts:
   a. When using JDG529 Belt Tension Gauge, measure belt tension and compare with specifications on next page.
   b. Belt deflection when using belt tension tester (A) with straightedge (B), with force applied halfway between pulleys.

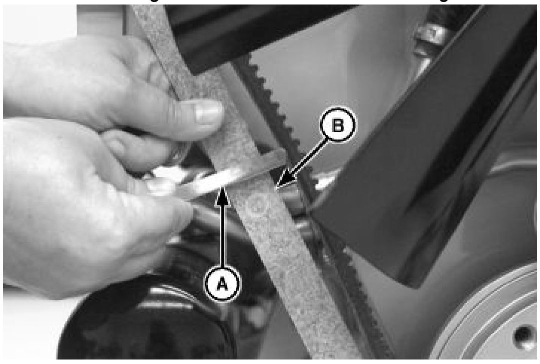
Specification

Standard V-Belt with 89 N (20 lb) force—Deflection .... 19 mm (3/4 in.)



RG7333 —UN—01DEC00

Checking Belt Tension with Tension Gauge



RG7334 —UN—01DEC00

Checking Belt Tension with Straightedge

A—Tension Tester **B—Straightedge**

RG,RG34710,5065 -19-30JAN98-1/2

3. If adjustment is necessary, loosen alternator bracket cap screw (C) and nut (D) on mounting bolt. Pull alternator frame outward until belts are correctly tensioned.

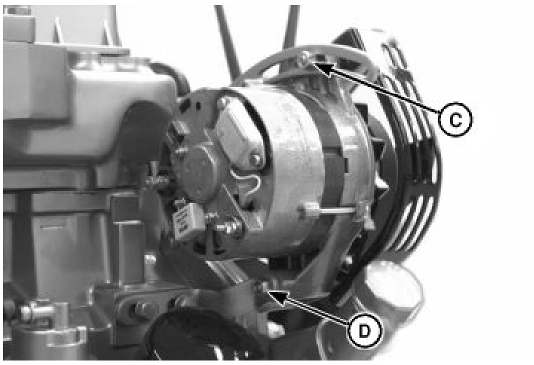
IMPORTANT: Do not pry against the alternator rear frame. Do not tighten or loosen belts while they are hot.

4. Tighten alternator bracket cap screw and nut firmly.
5. After a new or used belt has run for 10 minutes, recheck belt tension.

STANDARD V-BELTS

	New Belt Tension	Used Belt Tension[a]
Single Belt	578—623 N (130—140 lb force)	378—423 N (85—95 lb force)
Dual Belts	423—463 N (95—104 lb force)	378—423 N (85—95 lb force)

[a]Belts are considered used after 10 minutes of operation.



RG7329 —UN—01DEC00

Alternator Mounting Brackets

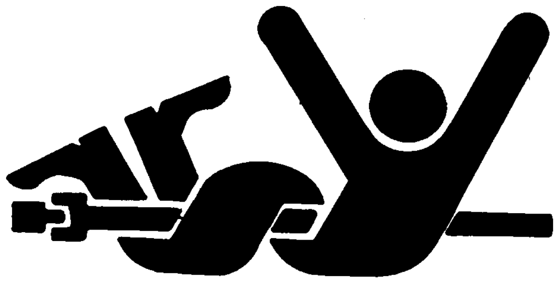
C—Cap Screw **D—Nut**

RG,RG34710,5065 -19-30JAN98-2/2

TIM-ID: 0000114010 - 001

Checking PTO Clutch Adjustment

CAUTION: Never attempt to service the PTO while it is in operation. Loose clothing could get caught in moving parts; keep clothing tight against body. Use extreme care when working around the PTO.



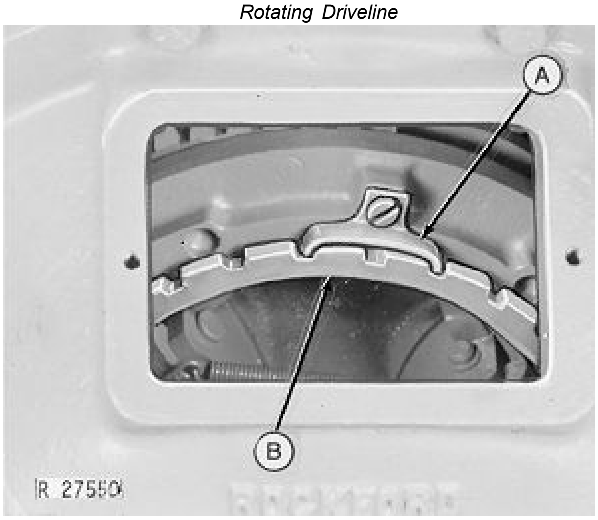
TS198 —UN—23AUG88

Rotating Driveline

1. Measure clutch engagement force at handle grip using a spring scale. The engagement force should be 267–311 N (60–70 lb force).

IMPORTANT: Improper adjustments of the PTO clutch may shorten clutch life. Make sure adjustments are made properly.

2. If adjustments are needed, disengage clutch and stop engine. Remove cover plate from clutch housing (shown removed).
3. Remove adjusting lock (A).
4. Turn adjusting ring (B) to adjust clutch engagement pressure.
5. Measure engagement force at clutch handle with spring scale.
6. Install lock screw and adjusting lock in clutch body splines when specified engagement pressure is achieved.
7. Tighten screw securely.
8. Recheck clutch engagement force with spring scale. Install cover plate. Disengage clutch.



R27550 —UN—14DEC88

PTO Clutch Adjustment

A—Adjusting Lock **B—Adjusting Ring**

RG,RG34710,4068 -19-01JAN96-1/1

Checking Engine Mounts

Engine mounting is the responsibility of the vehicle or generator manufacturer. Follow manufacturer's guidelines for mounting specifications.

IMPORTANT: Use only Grade SAE 8 or higher grade of hardware for engine mounting.

1. Check the engine mounting bracket, vibration isolators, and mounting bolts on support frame and engine block for tightness. Tighten as necessary.
2. Inspect overall condition of vibration isolators, if equipped. Replace isolators if rubber has deteriorated or mounts have collapsed, as necessary.

DPSG,RG34710,111 -19-07JAN02-1/1

TIM-ID: 0000114010 - 001

Changing Engine Oil And Replacing Oil Filter—3029TF270 Engines Only

Your engine is equipped with a special oil filter (A).

NOTE: During break-in, change engine oil and filter for the first time before 100 hours maximum of operation.

After break-in, if John Deere PLUS-50™ or ACEA-E7/E6/E5/E4 engine oil **and** a John Deere special oil filter are used, the oil and filter change interval is 500 hours or every 12 months, whichever comes first.

NOTE: If the above recommendations are not followed, the oil and filter change interval is every 250 hours/ or 6 months. If diesel fuel with a high sulfur content is used, the oil and filter change interval is also reduced. (See DIESEL ENGINE OIL in the "Fuels, Lubricants, and Coolant" Section.)

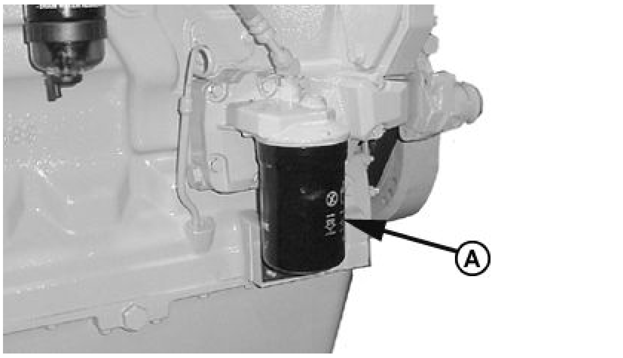
OILSCAN™ or OILSCAN PLUS™ is a John Deere sampling program to help you monitor machine performance and identify potential problems before they cause serious damage. OILSCAN™ and OILSCAN PLUS™ kits are available from your John Deere engine distributor or servicing dealer. Oil samples should be taken prior to the oil change. Refer to instructions provided with kit.

To change engine oil and oil filter:

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Remove oil pan drain plug (arrow).

NOTE: Drain plug location may vary, depending on the application.

PLUS-50 is a trademark of Deere & Company.
OILSCAN is a trademark of Deere & Company.
OILSCAN PLUS is a trademark of Deere & Company.



RG11616 —UN—24OCT01

Special Oil Filter

RG4881 —UN—29NOV88

Oil Pan Drain Plug

A—Oil Filter Element

3. Drain crankcase oil from engine while warm.

Continued on next page

OUOD005,00001D7 -19-30MAY06-1/3

TIM-ID: 0000114010 - 001

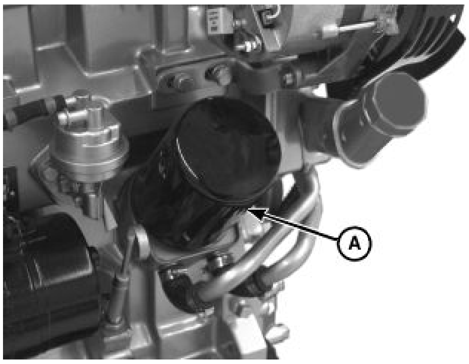
4. Remove and discard oil filter (A) using a suitable filter wrench.

NOTE: Depending on engine application, oil filter may be either vertical or horizontal on either engine model.

5. Remove oil filter packing and clean filter mounting pad.
6. Oil new packing and install new filter element. Hand tighten element according to values printed on filter element. If values are not provided, tighten element approximately 3/4—1-1/4 turn after packing contacts filter housing. DO NOT overtighten filter element.
7. Install oil pan drain plug with a new seal when equipped and tighten using the following specifications.

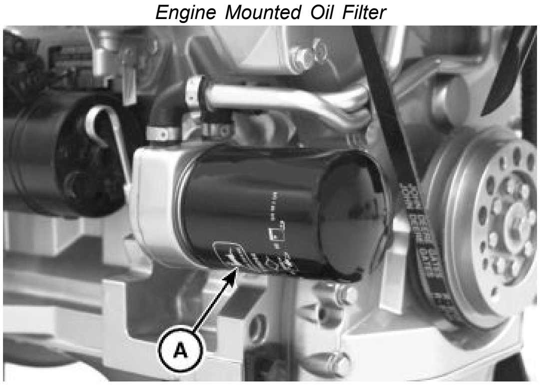
Conical Plug	55 N·m (41 lb-ft)
Cylindrical Plug W/Copper Washer	70 N·m (52 lb-ft)
Cylindrical Plug W/O-Ring	50 N·m (37 lb-ft)

A—Oil Filter



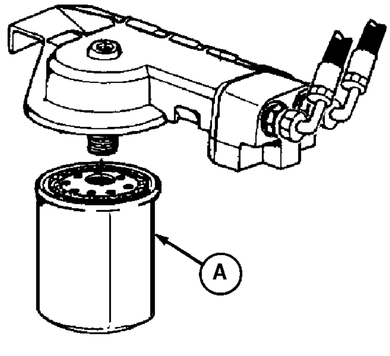
Engine Mounted Oil Filter

RG11529 —UN—01DEC00



Engine Mounted Oil Filter

RG11530 —UN—01DEC00



Engines W/Remote Oil Filter

RG11549 —UN—06DEC00

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OUOD005,00001D7 -19-30MAY06-2/3

TIM-ID: 0000114010 - 001

8. Fill engine crankcase with correct John Deere engine oil through timing gear cover opening (A) or rocker arm cover opening (B), depending on engine application. (See DIESEL ENGINE OIL in Fuels, Lubricants, and Coolant Section for determining correct engine oil.)

NOTE: Crankcase oil capacity may vary slightly. ALWAYS fill crankcase to top arrow or within crosshatch on dipstick, whichever is present. This should be checked after engine has run and oil has drained back into crankcase. DO NOT overfill.

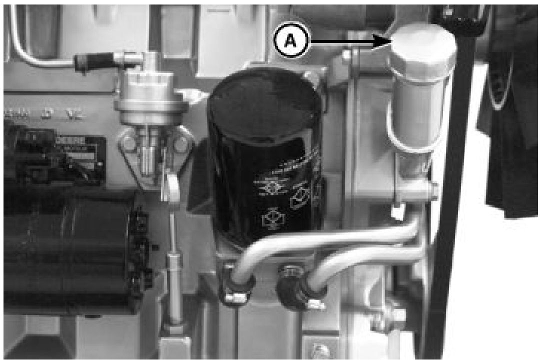
To determine the correct oil fill quantity for your engine, see ENGINE CRANKCASE OIL FILL QUANTITIES in the Specifications Section.

IMPORTANT: Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

9. Start engine and run to check for possible leaks.

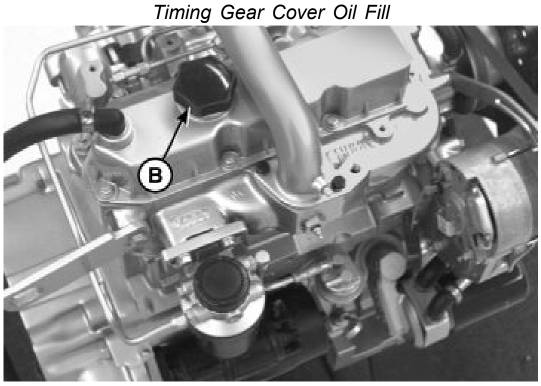
10. Stop engine and check oil level after 10 minutes. Oil level reading should be between arrows (C) or within crosshatch (D) of dipstick.

A—Timing Gear Cover Opening
B—Rocker Arm Cover Opening
C—Arrows
D—Crosshatch



RG11541 —UN—01DEC00

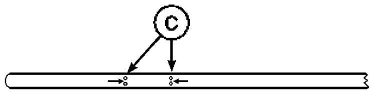
Timing Gear Cover Oil Fill



RG11596 —UN—08DEC00

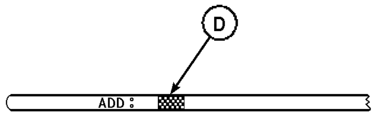
Rocker Arm Cover Oil Fill

RG11537 —UN—01DEC00



Correct Oil Level Within Arrows

RG11538 —UN—01DEC00



Correct Oil Level Within Crosshatch

OUOD005,00001D7 -19-30MAY06-3/3

TIM-ID: 0000114010 - 001

Lubricating PTO Clutch Internal Levers And Linkage

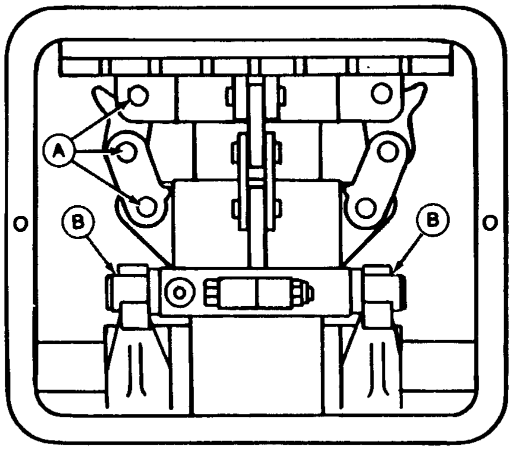
CAUTION: Never attempt to service the PTO while it is in operation. Loose clothing could get caught in moving parts; keep clothing tight against body. Use extreme care when working around the PTO.


TS198 —UN—23AUG88

Use Extreme Care When Working Around the PTO

1. Remove the PTO housing cover and apply one shot of John Deere Multipurpose Lubricant or equivalent (See FUELS, LUBRICANTS, and COOLANT Section) to the pivot points (A) of each clutch linkage.
2. Apply one shot of John Deere Multipurpose Lubricant or equivalent to the two PTO release lever shaft fittings (B).

A—Pivot Points **B—Fittings**



RG6641 —UN—18FEB93

Lubrication Internal Parts of PTO Clutch

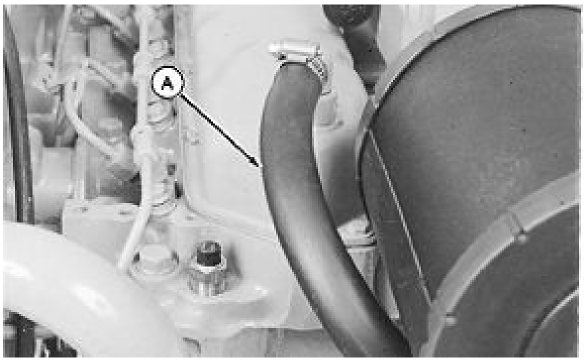
RG,RG34710,5068 -19-30JAN98-1/1

Cleaning Crankcase Vent Tube

If you operate the engine in dusty conditions, clean the tube at shorter intervals.

1. Remove and clean crankcase vent tube (A).
2. Install the vent tube. Be sure the tube is not pinched and O-ring fits correctly in the rocker arm cover for elbow adapter. Tighten hose clamp securely.

A—Vent Tube



RG6005 —UN—27JAN92

Crankcase Vent Tube

RG,RG34710,5069 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Checking Air Intake System

IMPORTANT: The air intake system must not leak. Any leak, no matter how small, may result in engine failure due to abrasive dirt and dust entering the intake system.

1. Inspect all intake hoses (piping) for cracks. Replace as necessary.
2. Check clamps (A) on piping which connect the air cleaner, engine, and, if present, turbocharger. Tighten clamps as necessary. This will help prevent dirt from entering the air intake system through loose connections causing internal engine damage.
3. If engine has a rubber dust unloader valve (B), inspect the valve on bottom of air cleaner for cracks or plugging. Replace as necessary.

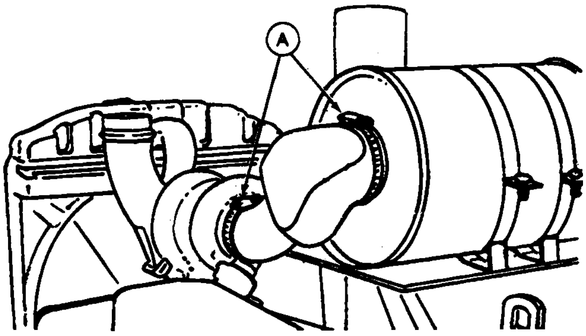
IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator is red or shows a vacuum of at least 3.5 kPa (14 in.) H_2O, is torn, or visibly dirty.

4. Test air restriction indicator (C) for proper operation. Replace indicator as necessary.

IMPORTANT: If not equipped with air restriction indicator, replace air cleaner elements at 500 Hours or 12 Months, whichever occurs first.

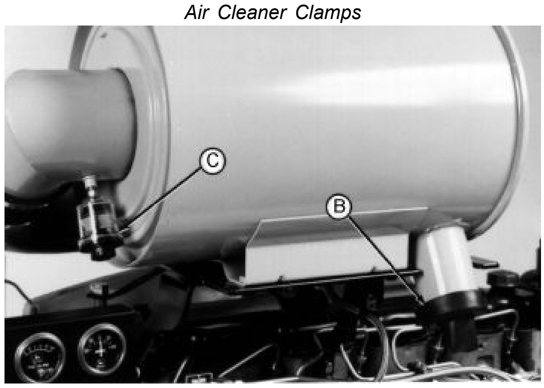
5. Remove and inspect primary air cleaner element. Service as necessary. (See INSPECTING PRIMARY FILTER ELEMENTand REPLACING AIR CLEANER ELEMENTS in Service As Required Section.)

A—Clamps
B—Unloader Valve
C—Restriction Indicator



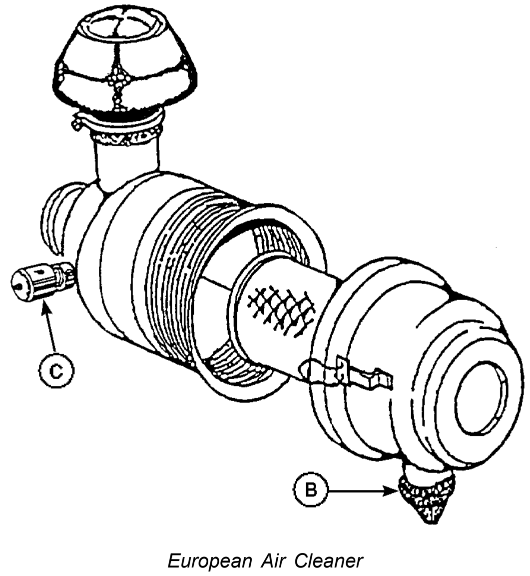
RG4689 —UN—20DEC88

Air Cleaner Clamps



RG11067 —UN—05JUN00

North American Air Cleaner



RG11542 —UN—01DEC00

European Air Cleaner

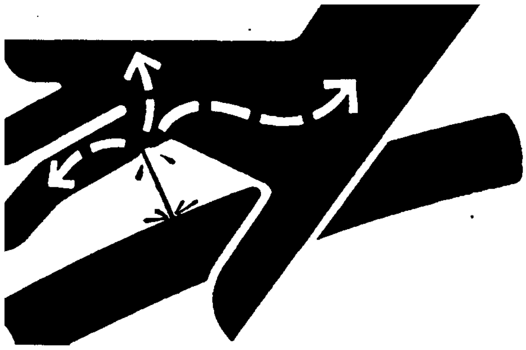
RG,RG34710,5070 -19-11FEB03-1/1

TIM-ID: 0000114010 - 001

Replacing Fuel Filter/Bleeding System

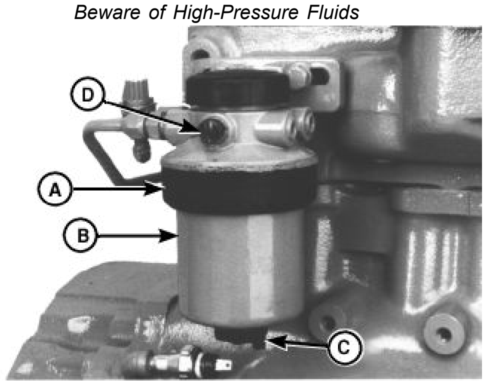
CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.



X9811 —UN—23AUG88

Beware of High-Pressure Fluids



RG11543 —UN—01DEC00

Fuel Filter

A—Retaining Ring
B—Filter Element
C—Filter Drain Plug
D—Air Bleed Plug

1. Close fuel shut-off valve at tank, if equipped.
2. Thoroughly clean fuel filter assembly and surrounding area.
3. Loosen filter drain plug (C) and air bleed plug (D). Drain fuel into a suitable container. Dispose of fuel in an environmentally safe manner.

NOTE: Lifting up on retaining ring as it is rotated helps to get it past raised locators.

4. Firmly grasp the retaining ring (A), lift up and rotate it clockwise 1/4 turn. Remove ring with filter element (B).
5. Save retaining ring and (if equipped) water separator bowl for reuse.
6. Remove red plug from new filter and install into removed filter to protect the environment from leaking fuel.
7. Inspect filter mounting base for cleanliness. Clean as required.

Continued on next page

RG,RG34710,5071 -19-13FEB03-1/2

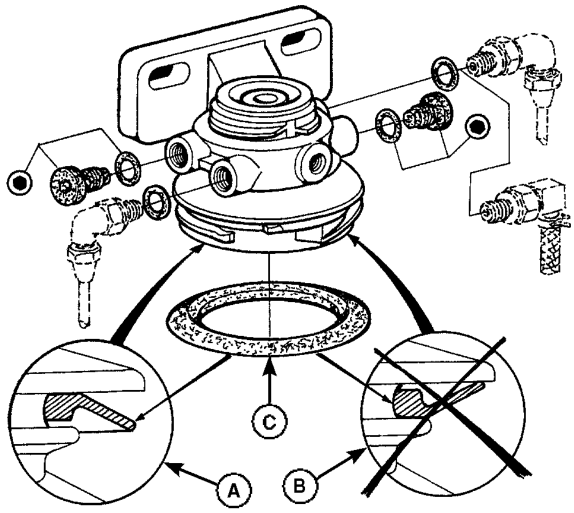
TIM-ID: 0000114010 - 001

8. Inspect condition of dust seal (C). Replace if necessary. Install dust seal as shown.

NOTE: Proper installation is indicated when a “click” is heard and a release of pressure on the ring is felt.

9. Align keys on filter element with slots in filter base, then tighten retaining ring counterclockwise 1/4 turn until it “snaps” into the detent. DO NOT overtighten.
10. If equipped with water separator, remove water separator bowl from removed filter element. Drain and clean separator bowl. Dry with compressed air. Install water separator bowl onto new element. Tighten securely.
11. Leave fuel shut-off valve open and bleed the fuel system. (See BLEED FUEL SYSTEM in Service As Required Section.) Tighten bleed plug.

A—Correct Installation
B—Incorrect Installation
C—Seal



Fuel Filter Dust Seal Installation

RG,RG34710,5071 -19-13FEB03-2/2

Checking Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head to allow air to escape when filling system. Retighten fitting when all the air has been expelled.

1. Check entire cooling system for leaks. Tighten all clamps securely.
2. Thoroughly inspect all cooling system hoses. Replace hoses when hardened, softened, or cracked.

Beware of Pressurized Fluids

3. If coolant must be added, use mixture as recommended in Fuels, Lubricants and Coolant section.

RG,RG34710,5073 -19-30JAN98-1/1

Testing Diesel Engine Coolant

Maintaining adequate concentrations of glycol and inhibiting additives in the coolant is critical to protect the engine and cooling system against freezing, corrosion, and cylinder liner erosion and pitting.

Test the coolant solution at intervals of 12 months or less and whenever excessive coolant is lost through leaks or overheating.

Coolant Test Strips

Coolant test strips are available from your John Deere dealer. These test strips provide a simple, effective method to check the freeze point and additive levels of your engine coolant.

When Using John Deere COOL-GARD II

John Deere COOL-GARD II Premix™ , COOL-GARD II PG Premix and COOL-GARD II Concentrate are maintenance free coolants for up to six years or 6000 hours of operation, provided that the cooling system is topped off using only John Deere COOL-GARD II Premix or COOL-GARD II PG premix. Test the coolant condition annually with coolant test strips designed for use with John Deere COOL-GARD II coolants. If the test strip chart indicates that additive is required, add John Deere COOL-GARD II Coolant Extender as directed.

Add only the recommended concentration of John Deere COOL-GARD II Coolant Extender. DO NOT add more than the recommended amount.

When Using Nitrite-Containing Coolants

Compare the test strip results to the supplemental coolant additive (SCA) chart to determine the amount of inhibiting additives in your coolant and whether more John Deere Liquid Coolant Conditioner should be added.

Add only the recommended concentration of John Deere Liquid Coolant Conditioner. DO NOT add more than the recommended amount.

Coolant Analysis

For a more thorough evaluation of your coolant, perform a coolant analysis. The coolant analysis can provide critical data such as freezing point, antifreeze level, pH, alkalinity, nitrite content (cavitation control additive), molybdate content (rust inhibitor additive), silicate content, corrosion metals, and visual assessment.

Contact your John Deere dealer for more information on coolant analysis.

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DX,COOL9 -19-11APR11-1/1

TIM-ID: 0000114010 - 001

Replenishing Supplemental Coolant Additives (SCAs) Between Coolant Changes

IMPORTANT: Do not add supplemental coolant additives when the cooling system is drained and refilled with John Deere ANTIFREEZE/SUMMER COOLANT or COOL-GARD™.

NOTE: If system is to be filled with coolant that does not contain SCAs, the coolant must be precharged. Determine the total system capacity and premix with 3% John Deere Coolant Conditioner.

Through time and use, the concentration of coolant additives is gradually depleted during engine operation. Periodic replenishment of inhibitors is required, even when John Deere ANTIFREEZE/SUMMER COOLANT is used. The cooling system must be recharged with additional supplemental coolant additives available in the form of liquid coolant conditioner.

Maintaining the correct coolant conditioner concentration (SCAs) and freeze point is essential in your cooling system to protect against rust, liner pitting and corrosion, and freeze-ups due to incorrect coolant dilution.

John Deere LIQUID COOLANT CONDITIONER is recommended as a supplemental coolant additive in John Deere engines.

DO NOT mix one brand of SCA with a different brand.

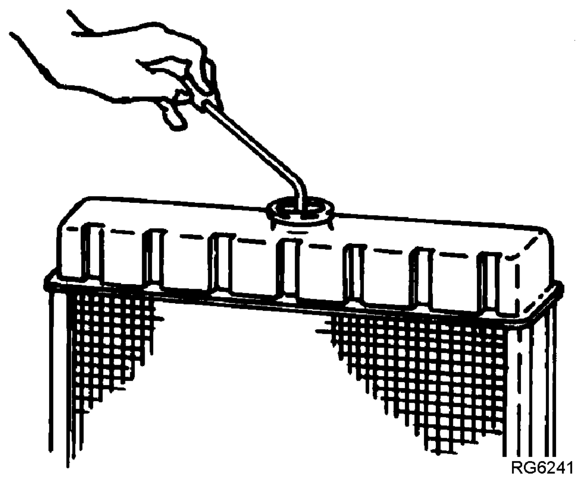
Test the coolant solution at 500 hours or 12 months of operation using either John Deere coolant test strips or a COOLSCAN™ analysis. If a COOLSCAN™ analysis is not available, recharge the system per instructions printed on label of John Deere Liquid Coolant Conditioner.

IMPORTANT: ALWAYS maintain coolant at correct level and concentration. DO NOT operate engine without coolant even for a few minutes.

If frequent coolant makeup is required, the glycol concentration should be checked with JTO7298 Coolant/Battery Tester to ensure that the desired freeze point is maintained. Follow manufacturer's instructions provided with Coolant/Battery Tester.

Add the manufacturer's recommended concentration of supplemental coolant additive. DO NOT add more than the recommended amount.

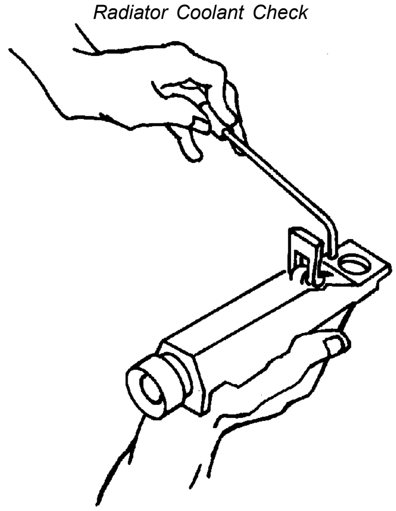
The use of non-recommended supplemental coolant additives may result in additive drop-out and gelation of the coolant.



RG6241

RG6261 —UN—08DEC97

Radiator Coolant Check



RG6262

RG6262 —UN—05DEC97

JTO7298 Coolant/Battery Tester

If other coolants are used, consult the coolant supplier and follow the manufacturer's recommendation for use of supplemental coolant additives.

See DIESEL ENGINE COOLANTS AND SUPPLEMENTAL ADDITIVE INFORMATION for proper mixing of coolant ingredients before adding to the cooling system.

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COOLSCAN is a trademark of Deere & Company

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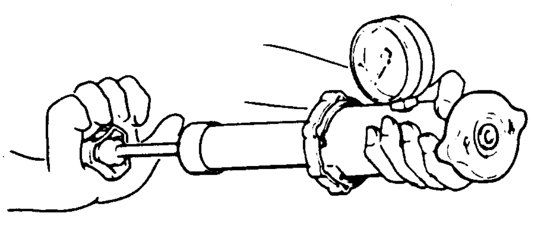
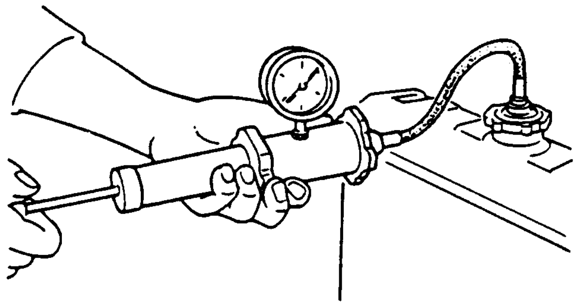
TIM-ID: 0000114010 - 001

Pressure Testing Cooling System


RG6557 —UN—20JAN93

Pressure Testing Radiator Cap


RG6558 —UN—20JAN93

Pressure Testing Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

Test Radiator Cap

1. Remove radiator cap and attach to D05104ST Tester as shown.
2. Pressurize cap to following specifications.[1] Gauge should hold pressure for 10 seconds within the normal range if cap is acceptable.

Specification	
Radiator Cap—Test Pressure	70 kPa (0.7 bar (10 psi)

If gauge does not hold pressure, replace radiator cap.

3. Remove the cap from gauge, turn it 180°, and retest cap. This will verify that the first measurement was accurate.

Test Cooling System

NOTE: Engine should be warmed up to test overall cooling system.

[1]*Test pressures recommended are for all Deere OEM cooling systems. On specific vehicle applications, test cooling system and pressure cap according to the recommended pressure for that vehicle.*

1. Allow engine to cool, then carefully remove radiator cap.
2. Fill radiator with coolant to the normal operating level.

IMPORTANT: DO NOT apply excessive pressure to cooling system, doing so may damage radiator and hoses.

3. Connect gauge and adapter to radiator filler neck. Pressurize cooling system to the following specifications[1].

Specification	
Cooling System—Test Pressure	70 kPa (0.7 bar (10 psi)

4. With pressure applied, check all cooling system hose connections, radiator, and overall engine for leaks.

   If leakage is detected, correct as necessary and pressure test system again.

   If no leakage is detected, but the gauge indicated a drop in pressure, coolant may be leaking internally within the system or at the block-to-head gasket. Have your servicing dealer or distributor correct this problem immediately.

RG,RG34710,5078 -19-20FEB03-1/1

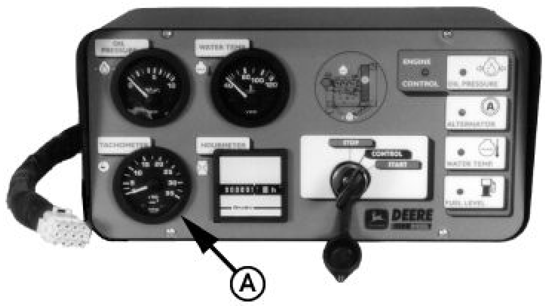
TIM-ID: 0000114010 - 001

Checking and Adjusting Engine Speeds

Observe tachometer reading (A) on the instrument panel to verify engine speeds. (Refer to ENGINE POWER AND SPEED SPECIFICATIONS in Specifications Section later in this manual for engine speed specifications.)

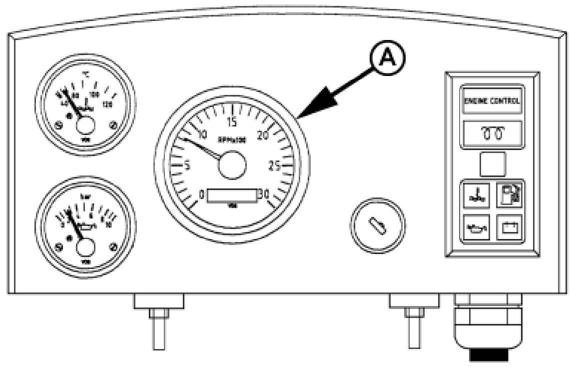
RG12831 —UN—13FEB03

North American Instrument Panel Tachometer



RG12832 —UN—13FEB03

AEZ Instrument Panel Tachometer



RG12830 —UN—13FEB03

VDO Instrument Panel Tachometer

OUOD005,00001D8 -19-20FEB03-1/1

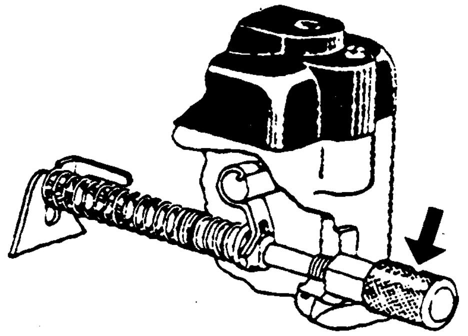
TIM-ID: 0000114010 - 001

Adjusting Variable Speed (Droop) On Generator Set Engines (Stanadyne Injection Pumps Only)

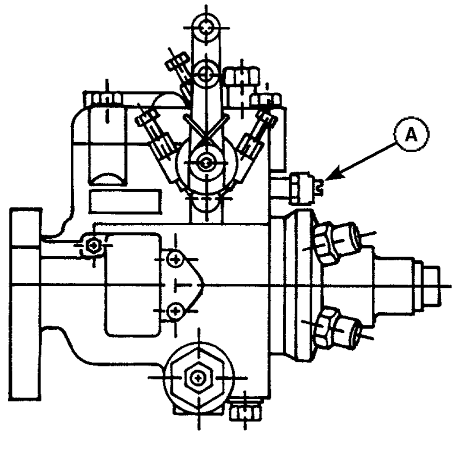
CAUTION: Statutes providing severe penalties for tampering with emissions controls may apply at the user's location.

1. Warm engine to normal operating temperature.
2. If necessary, disconnect throttle linkage or cable.
3. Run engine at fast idle. Check and adjust fast idle speed when necessary.
4. Apply full load.
5. Check power. Adjust with knob or screw (A) if needed.
6. Remove load.
7. Check and adjust fast idle if knob or screw (A) has been turned.
8. Repeat procedure until both the engine power and fast idle speed are correct.
9. Connect throttle linkage if previously removed.

A—Screw



Droop Adjusting Knob



Droop Adjusting Screw

RG,RG34710,5076 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Checking And Adjusting Engine Valve Clearance

CAUTION: To prevent accidental starting of engine while performing valve adjustments, always disconnect NEGATIVE (–) battery terminal.

IMPORTANT: Engine valve clearance MUST BE checked and adjusted with engine COLD.

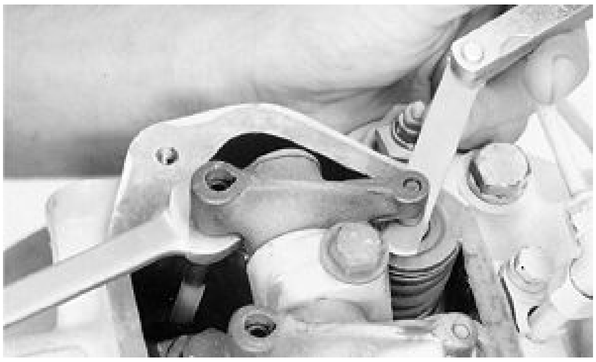
1. Remove rocker arm cover and crankcase ventilator tube.

IMPORTANT: Visually inspect contact surfaces of wear caps and rocker arm wear pads. Check all parts for excessive wear, breakage, or cracks. Replace parts that show visible damage.

Rocker arms with excessive valve clearance should be inspected more thoroughly to identify damaged parts.

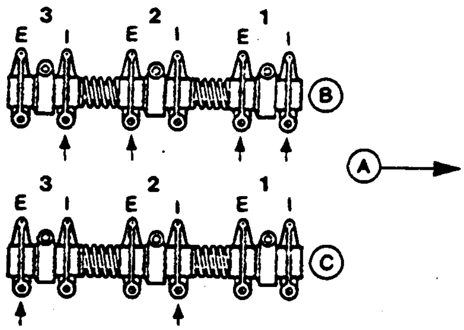
2. Using JDE83 or JDG820 Flywheel Turning Tool, rotate engine flywheel in running direction (clockwise viewed from front of engine) until JDG1571 (or JDE81-4) timing pin goes into flywheel hole. Check if Number 1 is at compression stroke (B). (No. 1 rocker arms should be loose.) If not, rotate engine one full revolution (360°) until timing pin goes into flywheel hole.

NOTE: Firing order is 1-2-3.



T81224 —UN—07NOV88

Checking Valve Clearance



RG4775 —UN—06DEC88

Valve Adjusting Order

A—Front of Engine
B—Number 1Piston at TDC Compression Stroke
C—Number 1 Piston at TDC Exhaust Stroke
E—Exhaust Valve
I— Intake Valve

Continued on next page

RG,RG34710,5067 -19-18FEB03-1/2

TIM-ID: 0000114010 - 001

3. Check and adjust valve clearance using a feeler gauge on No. 1 and 2 exhaust valves and No. 1 and 3 intake valves.

Specification

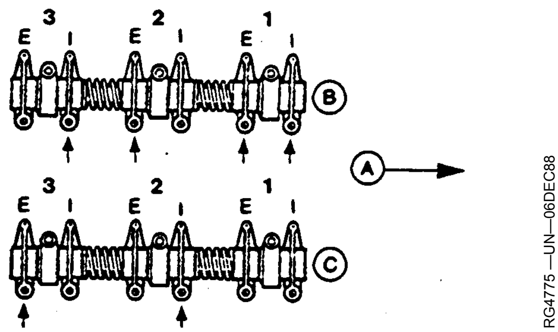
Valve Clearance (Engine Cold)—Specification—Intake	0.35 mm (0.014 in.)
Exhaust	0.45 mm (0.018 in.)

NOTE: If rocker arm is equipped with adjusting screw and lock nut, tighten lock nut to specification after adjusting valve clearance.

Specification

Rocker Arm Adjusting Screw Lock Nut—Specification—Torque	27 N·m (20 lb-ft)

4. Rotate flywheel 360° and lock No. 1 piston at "TDC" exhaust stroke (C).
5. Check and adjust valve clearance on No. 3 exhaust valve and No. 2 intake valve.
6. Reinstall rocker arm cover and crankcase vent tube.



Valve Adjusting Order

A—Front of Engine
B—Number 1Piston at TDC Compression Stroke
C—Number 1 Piston at TDC Exhaust Stroke
E—Exhaust Valve
I— Intake Valve

RG,RG34710,5067 -19-18FEB03-2/2

TIM-ID: 0000114010 - 001

Flushing And Refilling Cooling System

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

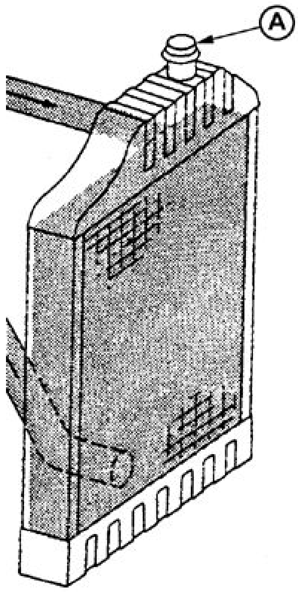
NOTE: Drain the initial factory fill engine coolant after the first 2000 hours or 24 months of operation. Subsequent drain intervals are determined by the coolant used for service.

When John Deere COOL-GARD™ is used, the drain interval is 3000 hours or 36 months. The drain interval may be extended to 5000 hours or 60 months of operation **provided that the coolant is tested annually AND additives are replenished as needed, by adding a supplemental cooling additive (SCA).**

If COOL-GARD™ is not used, the drain interval is reduced to 2000 hours or 24 months of operation.

TS281 —UN—15APR13

Beware of High Pressure Fluids



RG12833 —UN—13FEB03

Radiator Cap

Drain old coolant, remove thermostat, flush the entire cooling system, install thermostat, and fill with recommended clean coolant. For correct coolant mixture, refer to Fuels, Lubricants and Coolant section.

Perform these procedures as follows:

1. Pressure test entire cooling system and pressure cap if not previously done. (See PRESSURE TESTING COOLING SYSTEM, earlier in this section.)
2. Slowly open the engine cooling system filler cap or radiator cap (A) to relieve pressure and allow coolant to drain faster.

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RG,RG34710,5079 -19-11FEB03-1/3

TIM-ID: 0000114010 - 001

3. Open engine block drain valve or plug (A) on left side of engine. Drain all coolant from engine block.
4. Open radiator drain valve. Drain all coolant from radiator.
5. Remove thermostat at this time, if not previously done. Install cover (B) (without thermostat) and tighten cap screws to specification.

Specification

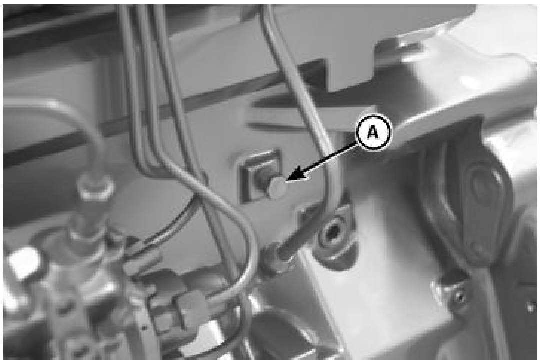
Capscrews—Torque... 47 N·m (35 lb ft)

6. Test thermostat opening temperature. (See TESTING THERMOSTAT OPENING TEMPERATURE following in this Section.)
7. Close all drain valves after coolant has drained.

CAUTION: Do not run engine longer than 5 minutes (at low idle) with water as coolant. Doing so may cause engine to overheat which may cause burns when water is draining.

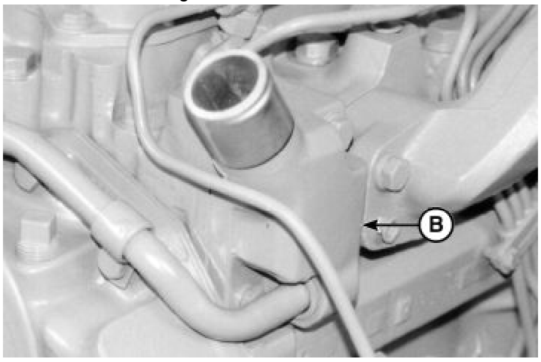
8. Fill the cooling system with clean water. Run the engine about 5 minutes at low idle to stir up possible rust or sediment.
9. Stop engine, pull off lower radiator hose and remove radiator cap to immediately drain the water from the system before rust and sediment settle.
10. After draining water, close drain valves. Install radiator cap, radiator hose and clamp. Fill the cooling system with clean water and a heavy duty cooling system cleaner such as FLEETGUARD® RESTORE™ or RESTORE PLUS™. Follow manufacturer's directions on label.

FLEETGUARD is a trademark of Cummins Engine Company, Inc.
RESTORE is a trademark of Fleetguard Inc.
RESTORE PLUS is a trademark of Fleetguard Inc.



RG7315 —UN—01DEC00

Engine Block Drain Valve



RG11597 —UN—08DEC00

Thermostat Housing

A—Plug **B—Cover**

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RG,RG34710,5079 -19-11FEB03-2/3

TIM-ID: 0000114010 - 001

11. After cleaning the cooling system, drain cleaner and fill with water to flush the system. Run the engine about 5 minutes, remove radiator cap and pull off lower radiator hose, immediately draining out flushing water.

IMPORTANT: Air must be expelled from cooling system when system is refilled. Loosen temperature sending unit fitting at rear of cylinder head to allow air to escape when filling system. Retighten fitting when all the air has been expelled.

12. Close all drain valves on engine and radiator. Install lower radiator hose and tighten clamp.

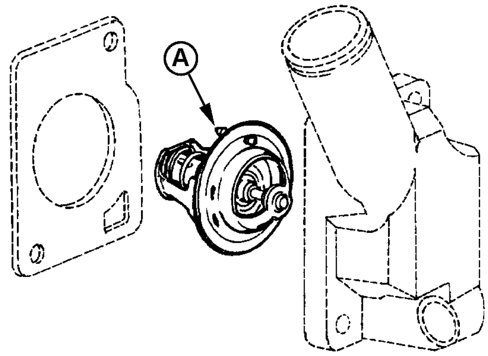
NOTE: Install thermostat with jiggle wire (A) at top position.

13. Install thermostat and cover using a new gasket. Tighten cap screws to specification.

Specification	
Capscrews—Torque	47 N·m (35 lb ft)

14. Refill system with fresh coolant at radiator until coolant touches bottom of filler neck[1]. (See ADDING COOLANT in Service As Required Section.)

[1] *Cooling system capacity for the Saran-sourced 3029 L engine factory generator set package is 12 L (11.5 qt). Refer to OEM manufacturer for capacities of cooling systems not supplied by John Deere.*



Jiggle Wire

A—Jiggle Wire

15. Run engine until it reaches operating temperature. This mixes the solution uniformly and circulates it through the entire system. The normal engine coolant temperature range is 82°–94°C (180°–202°F).

16. After running engine, check coolant level and entire cooling system for leaks.

RG,RG34710,5079 -19-11FEB03-3/3

Testing Thermostat Opening Temperature

1. Remove thermostat.
2. Visually inspect thermostat for corrosion or damage.

CAUTION: DO NOT allow thermostat or thermometer to rest against the side or bottom of container when heating water. Either may rupture if overheated.

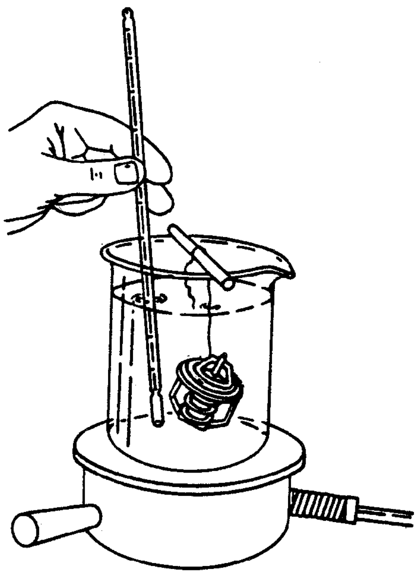
3. Suspend thermostat and a thermometer in a container of water.
4. Stir the water as it heats. Observe opening action of thermostat and compare temperatures with specification given in chart below.

NOTE: Due to varying tolerances of different suppliers, initial opening and full open temperatures may vary slightly from specified temperatures.

THERMOSTAT TEST SPECIFICATIONS

Rating	Initial Opening (Range)	Full Open (Nominal)
82°C (180°F)	80-84°C (175-182°F)	94°C (202°F)

5. Remove thermostat and observe its closing action as it cools. In ambient air the thermostat should close completely. Closing action should be smooth and slow.



Testing Thermostats

6. Replace thermostat if opening temperature is not within specification.

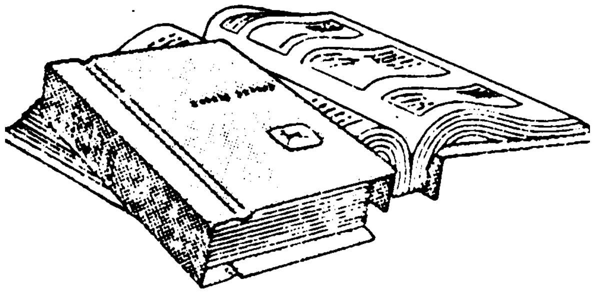
RG,RG34710,5083 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Service As Required

Additional Service Information

This is not a detailed service manual. If you want more detailed service information, see John Deere Service Literature Available later in this manual to order the Component Technical Manuals for "Repair" and "Operation and Diagnosis".



RG4624 —UN—15DEC88

John Deere Service Manuals

RG,RG34710,5080 -19-30JAN98-1/1

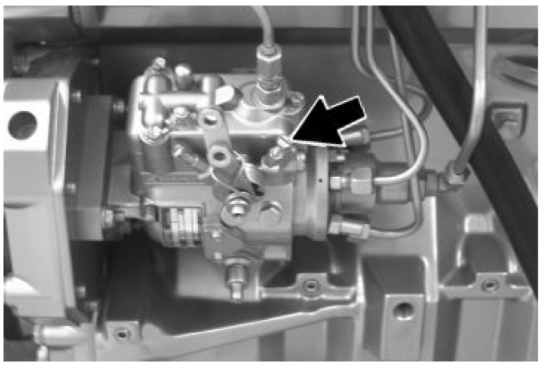
Do Not Modify Fuel System

IMPORTANT: Modification or alteration of the injection pump, the injection pump timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.

In addition, tampering with fuel system which alters emission-related equipment on engines may result in fines or other penalties, per EPA regulations or other local emission laws.

Do not attempt to service injection pump or fuel injectors yourself. Special training and special tools are required. (See your authorized servicing dealer or engine distributor.)

T81389 —UN—28JUN13



RG11546 —UN—01DEC00

Fuel Injection Pump

RG,RG34710,5081 -19-28AUG13-1/1

TIM-ID: 0000114010 - 001

Adding Coolant

CAUTION: Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

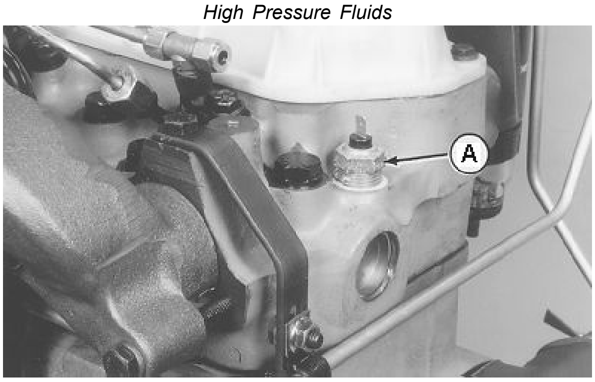
TS281 —UN—15APR13

High Pressure Fluids

IMPORTANT: Never pour cold liquid into a hot engine, as it may crack cylinder head or block. NEVER operate engine without coolant.

John Deere TY15161 Cooling System Sealer may be added to the radiator to stop leaks on a temporary or emergency basis only. DO NOT use any other stop-leak additives in the cooling system. Leaks should be permanently repaired as quickly as possible.

Air must be expelled from cooling system when coolant is added.



RG11607 —UN—25JAN01

Coolant Temperature Sending Unit Fitting

A—Sending Unit Fitting

1. Loosen temperature sending unit fitting (A) at rear of cylinder head to allow air to escape when filling system.

IMPORTANT: When adding coolant to the system, use the appropriate coolant solution. (See ENGINE COOLANT SPECIFICATIONS in Fuels, Lubricants, and Coolant Section for mixing of coolant ingredients before adding to cooling system.)

Do not overfill cooling system. A pressurized system needs space for heat expansion without overflowing at top of radiator.

2. Fill until coolant level touches bottom of radiator filler neck.
3. Tighten fitting when air has been expelled from system.

RG,RG34710,3593 -19-11FEB03-1/1

TIM-ID: 0000114010 - 001

Pre-Start Cleaning Guide

IMPORTANT: Before cleaning machine, allow ample time for hot surfaces to cool.

IMPORTANT: Do not direct high-pressure spray from hose output directly at or close to electrical connections and sensors.

Rigorous cleaning as needed is recommended. Clean more frequently during heavy machine use, and when weather conditions are dry.

- Check enclosed areas daily. Clean the engine and other enclosed areas of equipment to remove debris and any buildup of oil and grease. Keep the engine and engine compartment free of combustible material.
- Check for debris buildup daily on and around intake systems, exhaust systems, and intercooler piping systems. Verify that there are no holes or leaks in intake or exhaust systems. Do not allow debris to build up near hot exhaust components. Verify that hot exhaust components are cleaned as often as environmental conditions require.
- Inspect cooling system daily to determine whether cooling system needs cleaning. Visible buildup of residue that blocks airflow may degrade machine performance and requires more frequent cleaning depending on environmental conditions.
- Inspect difficult to observe areas daily as conditions may require additional cleaning care to remove debris.
- Check for oil and fuel leaks daily. Replace or repair any sources of leaks, including gaskets, seals, breather tubes, fittings, and fluid lines.

Maintenance and Service Reminders

- Keep surfaces free of grease and oil.
- Clean up after hydraulic and other fluid leaks.
- Fuel Lines — Check for leaks, cracks, and kinks that require service before use.
- Fuel Pumps — Check fittings, especially compression ring couplings, for cracks and leaks.
- Fuel Injectors — Check pressure and return lines for signs of leaks.
- When servicing fuel filter or draining water separator, avoid fuel spills. Immediately clean up any fuel spill.
- Handle transmission and power steering fluids with care. Immediately clean up any spills, especially around fill points.
- Check for transmission case venting system seepage, transmission case leakage, power steering cylinder leakage, or power steering line leakage.
- Check for loose electrical connectors, damaged wiring, corrosion, and poor connections.

ZE59858,0000009 -19-20MAY13-1/1

TIM-ID: 0000114010 - 001

Bleeding The Fuel System

CAUTION: Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

IMPORTANT: Do not operate the engine at high speeds or full loads just before bleeding the fuel system as this may cause fuel injection pump failure.

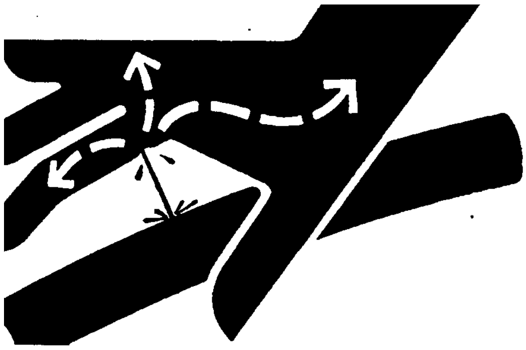
Bleed the fuel system anytime the fuel system has been opened up. This includes:

- After fuel filter changes.
- After pump or nozzle replacement.
- Anytime fuel lines have been disconnected.
- After engine has runout of fuel.

Bleed the fuel system using the following procedure:

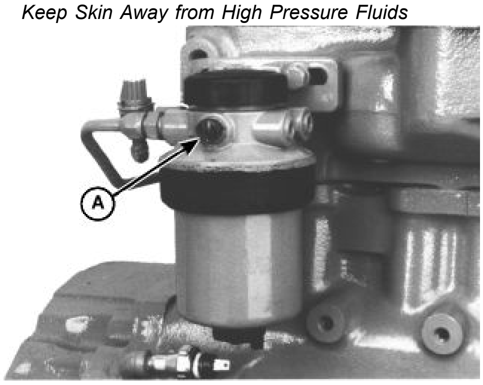
1. Loosen the air bleed vent screw (A) two full turns.
2. On mechanical supply pumps, operate supply pump primer lever (B) until fuel flow is free from air bubbles.
3. On electric supply pumps, turn key switch to “ON” position until fuel flow is free from air bubbles.
4. Tighten bleed plug securely by hand. Continue operating hand primer until pumping action is not felt. When finished, pull hand primer outward (away from engine) as far as it will go.
5. Start engine and check for leaks.

   If engine will not start, it may be necessary to bleed air from fuel system at fuel injection pump or injection nozzles as explained next.



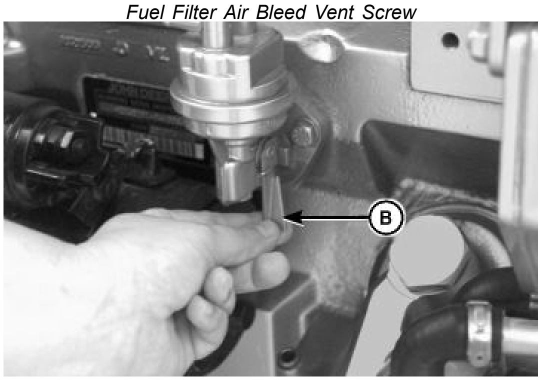
X9811 —UN—23AUG88

Keep Skin Away from High Pressure Fluids



RG11544 —UN—01DEC00

Fuel Filter Air Bleed Vent Screw



RG11545 —UN—01DEC00

Fuel Supply Pump Primer Lever

A—Vent Screw **B—Primer Lever**

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RG,RG34710,5084 -19-28AUG13-1/3

TIM-ID: 0000114010 - 001

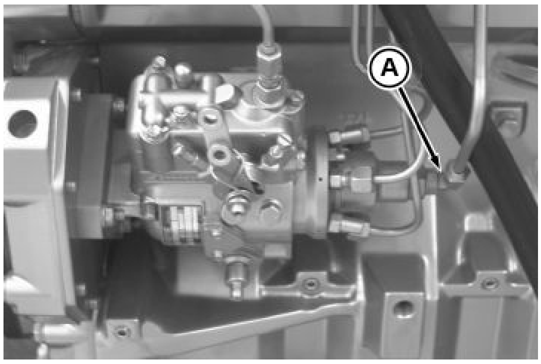
At Fuel Injection Pump

1. Slightly loosen fuel supply line connector (A) at injection pump.
2. On mechanical supply pumps, operate fuel supply pump primer lever until fuel, without air bubbles, flows from fuel line connection.
3. On electric supply pumps, turn key switch to “ON” position until fuel, without air bubbles, flows from fuel line connection.
4. Tighten fuel supply line connector to specification.

Specification

Connector—Torque.. 16 N·m (12 lb.-ft.)

5. Leave hand primer in the outward position away from cylinder block.



RG24247 —UN—28AUG13

Fuel Supply Line Connector at Injection Pump

A—Connector

RG,RG34710,5084 -19-28AUG13-2/3

At Fuel Injection Nozzles

1. Move the speed control lever to half throttle position. On engines equipped with electronic fuel shutoff solenoid, energize solenoid.
2. Using two open-end wrenches, loosen fuel line connection at injection nozzle.
3. Crank engine over with starting motor, (but do not start engine), until fuel free from air bubbles flows out of loosened connection. Tighten connection to specification.

Specification

Connection—Torque.. 27 N·m (20 lb.-ft.)

4. Repeat procedure for remaining injection nozzles (if necessary) until all air has been removed from fuel system.


T92924 —UN—01NOV88

Bleeding Fuel System at Injection Nozzle

If engine still will not start, see your authorized servicing dealer or engine distributor.

RG,RG34710,5084 -19-28AUG13-3/3

TIM-ID: 0000114010 - 001

Replacing Air Cleaner Filter Elements

IMPORTANT: ALWAYS REPLACE primary air cleaner element when air restriction indicator shows a vacuum of at least 3.5 kPa (14 in.) of H_2O, is torn, or visibly dirty.

NOTE: This procedure applies to John Deere air cleaner kits. Refer to manufacturers' instructions for servicing air cleaners not supplied by John Deere.

North American Air Cleaners

1. Remove wing nut and remove canister cover shown in small illustration inset.

2. Remove wing nut (A) and remove primary element (B) from canister.

3. Thoroughly clean all dirt from inside canister.

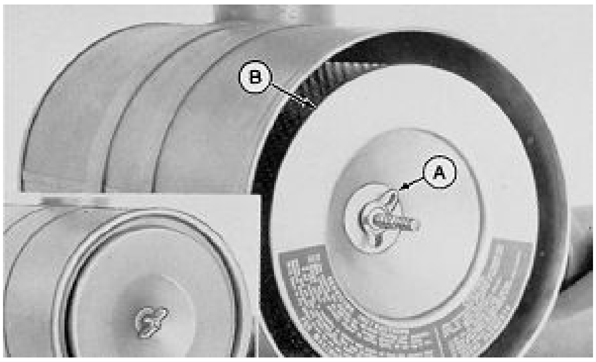
NOTE: Some engines may have a dust unloader valve (C) on the air cleaner. If equipped, squeeze valve tip to release any trapped dirt particles.

IMPORTANT: Remove secondary (safety) element (E) ONLY for replacement. DO NOT attempt to clean, wash, or reuse secondary element. Replacement of secondary element is usually necessary ONLY when primary element has a hole in it.

4. To replace secondary element, remove retaining nut (D) and secondary element (E). Immediately replace secondary element with new element to prevent dust from entering air intake system.

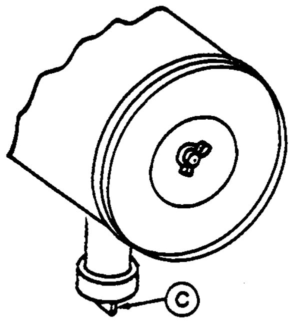
5. Install new primary element and tighten wing nut securely. Install cover assembly and tighten retaining wing nut securely.

A—Wing Nut
B—Primary Element
C—Unloader Valve
D—Retaining Nut
E—Secondary Element



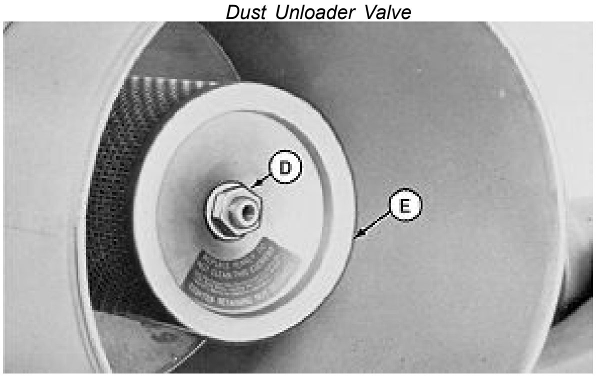
RG4686 —UN—20DEC88

Air Cleaner Primary Element (North American)



RG4687 —UN—20DEC88

Dust Unloader Valve



RG11068 —UN—26JUN00

Air Cleaner Secondary Element

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DPSG,OUOD002,1580 -19-30MAY06-1/2

TIM-ID: 0000114010 - 001

IMPORTANT: Whenever the air cleaner has been serviced or had cover removed, ALWAYS fully depress the air restriction indicator reset button (if equipped) to assure accurate readings.

6. If equipped, fully depress air restriction indicator reset button and release to reset indicator.

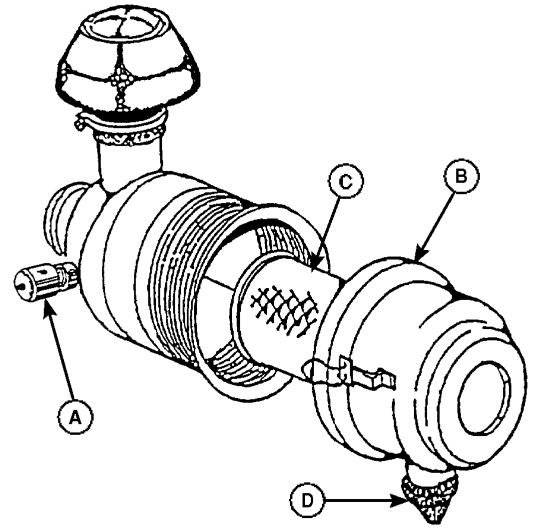
On European Sourced Air Cleaner Kits:

Clean filter element when air restriction indicator (A) or (G) is red. Replace filter element every 6 cleanings or once every 12 months.

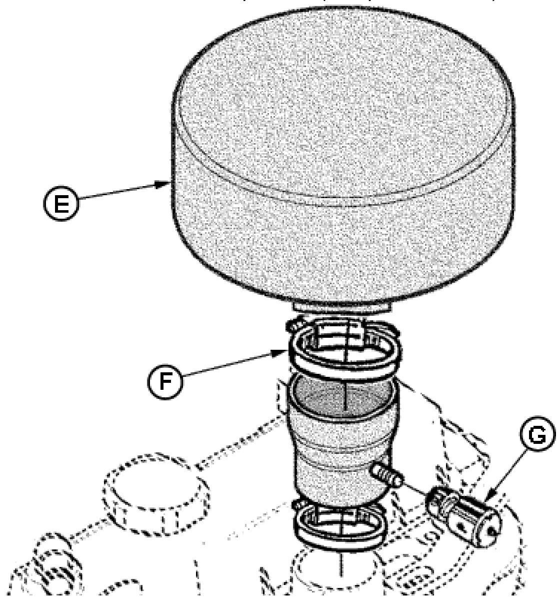
NOTE: On light-duty air cleaner, loosen clamp (F) and remove light-duty filter element (E).

1. Remove cover (B).
2. Remove filter element (C).
3. Thoroughly clean all dirt from inside filter housing.
4. Squeeze dust unloader valve (D) to remove dust deposits. If clogged, remove and clean the dust unloader valve. Replace if damaged.
5. Clean filter element using compressed air.
6. Reinstall the filter element and cover.
7. Depress air restriction indicator (A) button and release to reset indicator.

A—Restriction Indicator
B—Cover
C—Filter Element
D—Dust Unloader Valve
E—Light-Duty Filter Element
F—Clamp
G—Restriction Indicator



Air Cleaner Components (European Sourced)



Light-Duty Air Cleaner

DPSG,OUOD002,1580 -19-30MAY06-2/2

TIM-ID: 0000114010 - 001

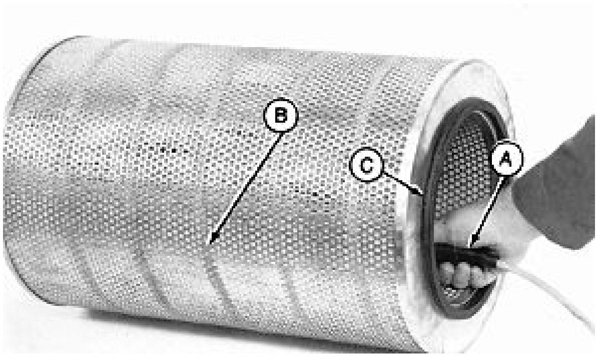
Inspecting Primary Filter Element

Inspect filter to determine if it is practical to clean or for damage after cleaning filter.

1. Hold a bright light (A) inside element and check carefully for holes. Discard any element which shows the smallest hole or rupture.
2. Be sure outer screen (B) is not dented. Vibration would quickly wear a hole in filter.
3. Be sure filter gasket (C) is in good condition. If gasket is damaged or missing, replace element.

IMPORTANT: Air cleaner MUST BE DRY before storing in plastic bag.

If the filter is to be stored for later use, place it in a plastic bag to protect it from dust and damage.



RW4768 —UN—15DEC88

Inspecting Primary Air Filter Element

A—Light
B—Outer Screen
C—Gasket

RG,RG34710,3598 -19-30AUG96-1/1

Cleaning Primary Filter Element

IMPORTANT: Always replace secondary (safety) filter elements. DO NOT attempt to clean them.

Do not blow air from outside portion of filter with air nozzle. Wear safety glasses and remove bystanders.

1. Gently pat sides of element with palm of hand to loosen dirt. DO NOT tap element against a hard surface.

CAUTION: Only a special air cleaning gun (A) should be used. Concentrated air pressure from an ordinary air nozzle may severely damage filter element. Do not exceed 210 kPa (2.1 bar) (30 psi) when cleaning filter element.

2. Insert the cleaning gun into element, hold air nozzle about 25.4 mm (1.0 in.) from perforated metal retainer. Force air through filter from inside to outside and move air gun up and down pleats to remove as much dirt as possible.

RG11065 —UN—26JUN00

Cleaning Primary Element

A—Air Cleaning Gun

3. Repeat steps 1 and 2 to remove additional dirt.
4. Inspect element for damage after cleaning. Replace element if any damage is found.

RG,RG34710,3599 -19-30AUG96-1/1

Element Storage

IMPORTANT: Air cleaner element MUST BE DRY before storing in plastic bag.

Seal element in a plastic bag and store in shipping container to protect against dust and damage.

RG,RG34710,3601 -19-30AUG96-1/1

Replace Fan And Alternator Belts

Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary. (See CHECKING FAN AND ALTERNATOR V-BELT TENSION in Lubrication and Maintenance/250 Hour Section.)

RG,RG34710,5086 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

Inspecting Power Take-Off (PTO) Clutch

CAUTION: Entanglement in rotating driveline can cause serious injury or death. Keep shield on PTO drive shaft (A) between the clutch housing and the engine driven equipment at all times during engine operation. Wear close fitting clothing. Stop the engine and be sure PTO driveline is stopped before making adjustments.

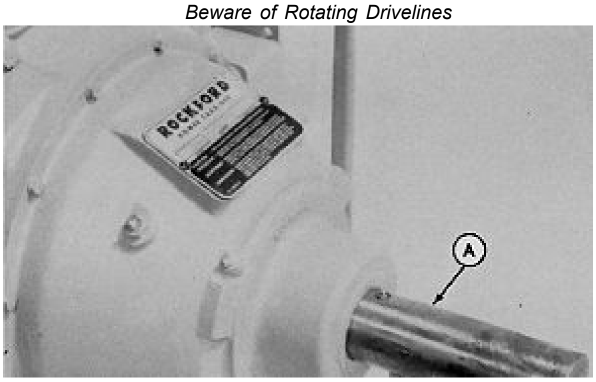
TS198 —UN—23AUG88

Beware of Rotating Drivelines

Proper performance of the power take-off unit will be related to the care it is given. Lubricate it periodically and keep the clutch properly adjusted. (See LUBRICATION AND MAINTENANCE/250 HOUR Section.)

NOTE: For standard 500 rpm PTO operation, run engine at 2400 rpm.

If the power take-off does not work properly after adjustment and lubrication, contact your authorized servicing dealer or engine distributor.



RG4693 —UN—14DEC88

PTO Drive Shaft

A—PTO Driveshaft

RG,RG34710,5087 -19-11FEB03-1/1

Checking Fuses

The following instructions apply to engines equipped with a John Deere instrument panel.

On North American Instrument Panels:

1. Check the fuse (A) and replace as necessary with an equivalent 14-amp fuse.

RG11548 —UN—01DEC00

North American Instrument Panel

Continued on next page

OUOD013,0000003 -19-28NOV00-1/3

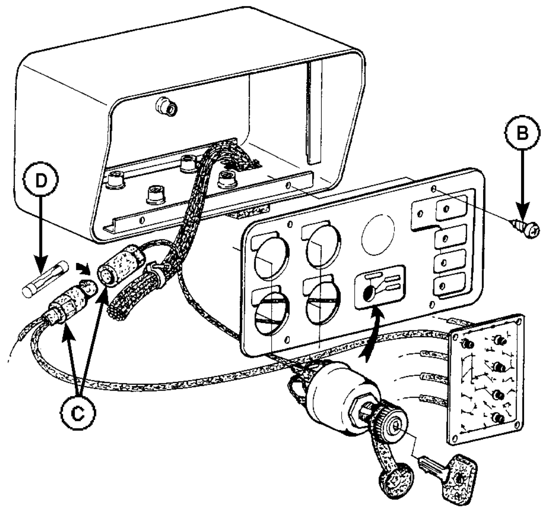
On AEZ Instrument Panels (Except North America):

1. Remove the four cap screws (B) holding the instrument panel board.
2. Open fuse holder (C).
3. Replace as necessary with an equivalent 16-amp fuse (D).

IMPORTANT: Always replace a blown fuse with a fuse of the same amperage.

4. Reinstall the instrument panel board.

B—Cap Screws
C—Fuse Holder
D—16-Amp Fuse



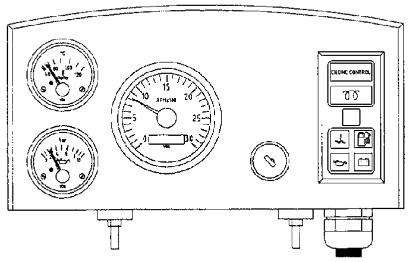
RG8149 —UN—01DEC00

AEZ Instrument Panel (Except North America)

OUOD013,0000003 -19-28NOV00-2/3

On VDO Instrument Panels (Except North America):

5. The fuse is located on the electronic control card inside the panel's rear access cover. Remove cover and check fuse. If defective, replace with a 10 amp fuse. There is a spare fuse available on the card in the “SPARE” terminal.



RG10606A —UN—19JUN00

VDO Instrument Panel (Except North America)

OUOD013,0000003 -19-28NOV00-3/3

TIM-ID: 0000114010 - 001

Troubleshooting

General Troubleshooting Information

Troubleshooting engine problems can be difficult. An engine wiring diagram is provided in this section to help isolate electrical problems on power units using John Deere wiring harness and instrument (gauge) panel.

Later in this section is a list of possible engine problems that may be encountered accompanied by possible causes and corrections. The illustrated diagrams and troubleshooting information are of a general nature, final design of the overall system for your engine application may be different. See your engine distributor or servicing dealer if you are in doubt.

A reliable program for troubleshooting engine problems should include the following basic diagnostic thought process:

- Know the engine and all related systems.
- Study the problem thoroughly.
- Relate the symptoms to your knowledge of engine and systems.
- Diagnose the problem starting with the easiest things first.
- Double-check before beginning the disassembly.
- Determine cause and make a thorough repair.
- After making repairs, operate the engine under normal conditions to verify that the problem and cause were corrected.

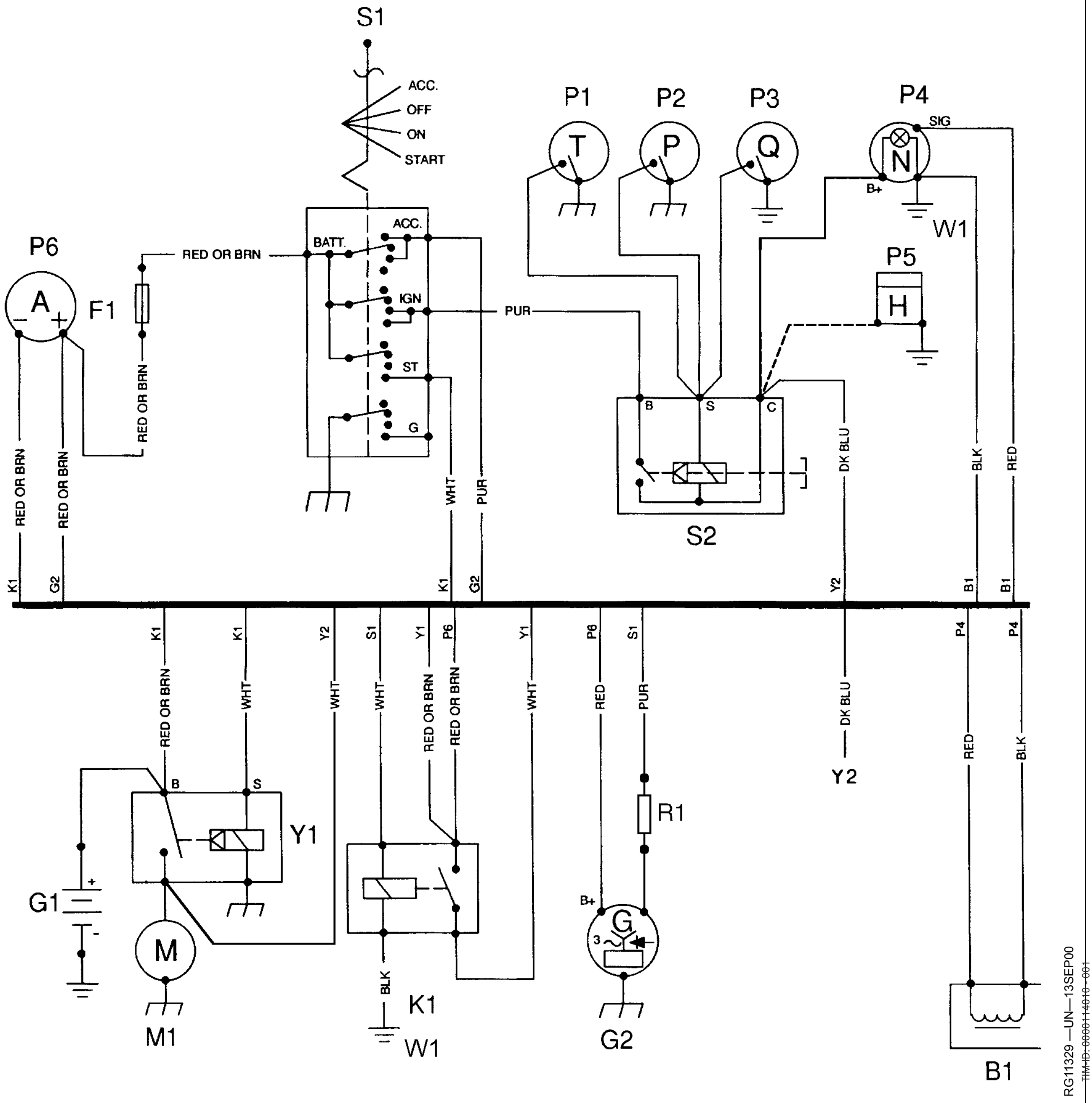
RG,RG34710,5089 -19-30JAN98-1/1

TIM-ID: 0000114010 - 001

TIM-ID: 0000114010 - 001

North American Wiring Diagram

S1 KEY SWITCH	B	G	ACC.	ON	ST.
OFF					
ACC.	•		•		
ON	•		•	•	
START	•	•		•	•



North American Wiring Diagram

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RG,RG34710,5091 -19-30JAN98-1/2

A1—Speed Control Unit
B1—Magnetic Speed Sensor
B2—Coolant Temperature Sensor
B3—Oil Pressure Sensor
F1—Starting Circuit Fuse (14 Amp)
F3—Fuse (Early Models)[1]
G1—Battery
G2—Alternator
H1—Coolant Temperature Indicator Light
H2—Oil Pressure Indicator Lamp
K1—Starter Relay
M1—Starter Motor
P1—Coolant Temperature Gauge
P2—Oil Pressure Gauge
P3—Crankcase Oil Level Switch/Gauge
P4—Tachometer[1]
P5—Hourmeter[2]
P6—Ammeter
R1—Resistor (48 ohm)
S1—Key Switch
S2—Magnetic Safety Switch—North American , Auto Override Module—European (Saran)
W1—Ground on K1 Starter Relay Mounting Stud
Y1—Starter Solenoid
Y2—Fuel Shut-Off Solenoid
BLK—Black
BLU—Blue
BRN—Brown
DK BLU—Dark Blue
GRN—Green
ORG—Orange
PUR—Purple
RED—Red
YEL—Yellow

[1]P4 tachometer has a built-in hourmeter. On some earlier engines, a separate hourmeter (P5) and fuse (F3) are used.
[2]P4 tachometer has a built-in hourmeter. On some engines, a separate hourmeter (P5) and fuse (F3) are used.

RG,RG34710,5091 -19-30JAN98-2/2

Engine Troubleshooting

Symptom	Problem	Solution
Engine Will Not Crank	Weak battery	Replace battery.
	Corroded or loose battery connections	Clean battery terminals and connections.
	Defective main switch or start safety switch	Repair switch as required.
	Starter solenoid defective	Replace solenoid.
	Starter defective	Replace starter.
Engine cranks but will not start	Incorrect starting procedure.	Verify correct starting procedure.
	No fuel.	Check fuel in tank and manual shut-off valve.
	Exhaust restricted.	Check and correct exhaust restriction.
	Fuel filter plugged or full of water.	Replace fuel filter or drain water from filter.
	Injection pump not getting fuel or air in fuel system.	Check fuel flow at supply pump or bleed fuel system.
	Faulty injection pump or nozzles.	Consult authorized diesel repair station for repair or replacement.
Engine hard to start or will not start	Engine starting under load.	Disengage PTO.
	Improper starting procedure.	Review starting procedure.
	No fuel.	Check fuel tank.
	Air in fuel line.	Bleed fuel line.
	Cold weather.	Use cold weather starting aids.
	Slow starter speed.	See “Starter Cranks Slowly”.
	Crankcase oil too heavy.	Use oil of proper viscosity.
	Improper type of fuel.	Consult fuel supplier; use proper type fuel for operating conditions.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Clogged fuel filter.	Replace filter element.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.

TM-ID: 0000114010 -001

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RG,RG34710,5092 -19-30JAN98-1/6

Symptom	Problem	Solution
	Injection pump shut-off not reset.	Turn key switch to “OFF” then to “ON”.
	Poor fuel quality	Drain fuel and replace with quality fuel of the proper grade.
	Slow cranking speed	Check for problem in the charging/starting system.
Engine knocks	Low engine oil level.	Add oil to engine crankcase.
	Injection pump out of time.	See your authorized servicing dealer or engine distributor.
	Low coolant temperature.	Remove and check thermostat.
	Engine overheating.	See “Engine Overheats”.
Engine runs irregularly or stalls frequently	Low coolant temperature.	Remove and check thermostat.
	Clogged fuel filter.	Replace fuel filter element.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
Below normal engine temperature	Defective thermostat.	Remove and check thermostat.
	Defective temperature gauge or sender.	Check gauge, sender, and connections.
Lack of power	Engine overloaded.	Reduce load.
	Intake air restriction.	Service air cleaner.
	Clogged fuel filter.	Replace filter elements.
	Improper type of fuel.	Use proper fuel.
	Poor fuel quality	Drain fuel and replace with quality fuel of the proper grade.
	Overheated engine.	See “Engine Overheats”.
	Below normal engine temperature.	Remove and check thermostat.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.

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RG,RG34710,5092 -19-30JAN98-2/6

TIM-ID: 0000114010 - 001

Symptom	Problem	Solution
	Injection pump out of time.	See your authorized servicing dealer or engine distributor.
	Turbocharger not functioning. (Turbocharged engines only.)	See your authorized servicing dealer or engine distributor.
	Leaking exhaust manifold gasket.	See your authorized servicing dealer or engine distributor.
	Defective aneroid control line.	See your authorized servicing dealer or engine distributor.
	Restricted fuel hose.	Clean or replace fuel hose.
	Low fast idle speed.	See your authorized servicing dealer or engine distributor.
Engine idles poorly	Poor fuel quality	Drain fuel and replace with quality fuel of the proper grade.
	Engine out of time	See your authorized servicing dealer or engine distributor.
	Air leak on suction side of air intake system.	Check hose and pipe connections for tightness; repair as required.
Low oil pressure	Low oil level.	Add oil.
	Improper type of oil.	Drain, fill crankcase with oil of proper viscosity and quality.
High oil consumption	Crankcase oil too light.	Use proper viscosity oil.
	Oil leaks.	Check for leaks in lines, gaskets, and drain plug.
	Restricted crankcase vent tube.	Clean vent tube.
	Defective turbocharger.	See your authorized servicing dealer or engine distributor.
Engine emits white exhaust smoke	Improper type of fuel.	Use proper fuel.
	Low engine temperature.	Warm up engine to normal operating temperature.
	Defective thermostat.	Remove and check thermostat.
	Defective injection nozzles.	See your authorized servicing dealer or engine distributor.
	Engine out of time (retarded).	See your authorized servicing dealer or engine distributor.

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RG,RG34710,5092 -19-30JAN98-3/6

Symptom	Problem	Solution
	Coolant entering combustion chamber (failed cylinder head gasket or cracked cylinder head)	Repair or replace as required. See your John Deere engine distributor or servicing dealer.
	Engine compression too low	Determine cause of low compression and repair as required. See your John Deere engine distributor or servicing dealer.
Engine emits black or gray exhaust smoke	Improper type of fuel.	Use proper fuel.
	Clogged or dirty air cleaner.	Service air cleaner.
	Engine overloaded.	Reduce load.
	Injection nozzles dirty.	See your authorized servicing dealer or engine distributor.
	Engine out of time.	See your authorized servicing dealer or engine distributor.
	Turbocharger not functioning.	See your authorized servicing dealer or engine distributor.
	Engine burning oil	See LUBRICATION SYSTEM TROUBLESHOOTING, later in this section.
	Defective muffler/exhaust piping (causing back-pressure)	Replace muffler or defective piping.
Engine Overheats	Engine overloaded.	Reduce load.
	Low coolant level.	Fill radiator to proper level, check radiator and hoses for loose connections or leaks.
	Faulty radiator cap.	Have technician check.
	Loose or defective fan belts.	Adjust belt tension. Replace as required.
	Low engine oil level.	Check oil level. Add oil as required.
	Cooling system needs flushing.	Flush cooling system.
	Defective thermostat.	Remove and check thermostat.
	Defective temperature gauge or sender.	Check coolant temperature with thermometer and replace, if necessary.
	Incorrect grade of fuel.	Use correct grade of fuel.

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RG,RG34710,5092 -19-30JAN98-4/6

Symptom	Problem	Solution
High fuel consumption	Improper type of fuel.	Use proper type of fuel.
	Clogged or dirty air cleaner.	Service air cleaner.
	Engine overloaded.	Reduce load.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
	Injection nozzles dirty.	See your authorized servicing dealer or engine distributor.
	Engine out of time.	See your authorized servicing dealer or engine distributor.
	Defective turbocharger.	See your authorized servicing dealer or engine distributor.
	Low engine temperature.	Check thermostat.
	Compression too low.	Determine cause of low compression and repair as needed.
Fuel in Oil	Cracked cylinder head	Locate crack, repair/replace components as required. See your John Deere engine distributor or servicing dealer.
Abnormal Engine Noise	Worn main or connecting rod bearings	Determine bearing clearance. See your John Deere engine distributor or servicing dealer.
	Excessive crankshaft end play	Check crankshaft end play. See your John Deere engine distributor or servicing dealer.
	Loose main bearing caps	Check bearing clearance; replace bearings and bearing cap screws as required. See your John Deere engine distributor or servicing dealer.
	Worn connecting rod bushings and piston pins	Inspect piston pins and bushings. See your John Deere engine distributor or servicing dealer.
	Scored pistons	Inspect pistons. See your John Deere engine distributor or servicing dealer.
	Worn timing gears or excess backlash	Check timing gear back lash. See your John Deere engine distributor or servicing dealer.

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RG,RG34710,5092 -19-30JAN98-5/6

Symptom	Problem	Solution
	Excessive valve clearance	Check and adjust valve clearance. See your John Deere engine distributor or servicing dealer.
	Worn camshaft lobes	Inspect camshaft. See your John Deere engine distributor or servicing dealer.
	Worn rocker arm shaft(s)	Inspect rocker arm shafts. See your John Deere engine distributor or servicing dealer.
	Insufficient engine lubrication	See LUBRICATION SYSTEM TROUBLESHOOTING, later in this section.
	Turbocharger noise	See AIR INTAKE SYSTEM TROUBLESHOOTING, later in this section.

RG,RG34710,5092 -19-30JAN98-6/6

Electrical Troubleshooting

Symptom	Problem	Solution
Undercharged system	Excessive electrical load from added accessories.	Remove accessories or install higher output alternator.
	Excessive engine idling.	Increase engine rpm when heavy electrical load is used.
	Poor electrical connections on battery, ground strap, starter, or alternator.	Inspect, clean and tighten as necessary.
	Defective battery.	Test battery.
	Defective alternator.	Test charging system.
Battery used too much water	Cracked battery case.	Check for moisture and replace as necessary.
	Defective battery.	Test battery.
	Battery charging rate too high.	Test charging system.
Batteries will not charge	Loose or corroded connections.	Clean and tighten connections.
	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Loose or defective alternator belt.	Adjust belt tension or replace belts.
Starter will not crank	PTO engaged.	Disengage PTO.
	Loose or corroded connections.	Clean and tighten loose connections.
	Low battery output voltage.	See your authorized servicing dealer or engine distributor.
	Faulty start circuit relay.	See your authorized servicing dealer or engine distributor.
	Blown fuse.	Replace fuse.
Starter cranks slowly	Low battery output.	See your authorized servicing dealer or engine distributor.
	Crankcase oil too heavy.	Use proper viscosity oil.
	Loose or corroded connections.	Clean and tighten loose connections.
Entire electrical system does not function	Faulty battery connection.	Clean and tighten connections.

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Continued on next page RG,RG34710,5093 -19-30JAN98-1/2

Symptom	Problem	Solution
	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Blown fuse.	Replace fuse.

RG,RG34710,5093 -19-30JAN98-2/2

Lubrication System Troubleshooting

Symptom	Problem	Solution
Low Oil Pressure	Low crankcase oil level	Fill crankcase to proper oil level.
	Clogged oil cooler or filter	Remove and inspect oil cooler. See your John Deere engine distributor or servicing dealer.
	Excessive oil temperature	Remove and inspect oil cooler. See your John Deere engine distributor or servicing dealer.
	Defective oil pump	Remove and inspect oil pump. See your John Deere engine distributor or servicing dealer.
	Incorrect oil	Drain crankcase and refill with correct oil.
	Oil pressure regulating valve failure	Remove and inspect oil pressure regulating valve. See your John Deere engine distributor or servicing dealer.
	Clogged oil pump screen or cracked pick-up tube	Remove oil pan and clean screen/replace pick-up tube.
	Excessive main or connecting rod bearing clearance	Determine bearing clearance. See your John Deere engine distributor or servicing dealer.
High Oil Pressure	Improper oil classification	Drain crankcase and refill with correct oil.
	Oil pressure regulating valve failure	Remove and inspect oil pressure regulating valve. See your John Deere engine distributor or servicing dealer.
	Stuck or damaged filter bypass valve	Remove and inspect filter bypass valve. See your John Deere engine distributor or servicing dealer.
	Stuck or damaged oil cooler bypass valve	Remove and inspect oil cooler bypass valve. See your John Deere engine distributor or servicing dealer.
Excessive Oil Consumption	Too low viscosity crankcase oil	Drain crankcase and refill with correct viscosity oil.
	Crankcase oil level too high	Drain oil until oil level is correct.
	External oil leak(s)	Determine source of oil leak(s) and repair as required.

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RG,RG34710,7600 -19-30JUN97-1/2

Symptom	Problem	Solution
	Oil control rings worn or broken	Replace piston rings. See your John Deere engine distributor or servicing dealer.
	Scored cylinder liners or pistons	Remove and inspect cylinders and liners; replace as required. See your John Deere engine distributor or servicing dealer.
	Worn valve guides or stems	Inspect and measure valve stems and valve guides; repair as required. See your John Deere engine distributor or servicing dealer.
	Excessive oil pressure	See High Oil Pressure.
	Piston ring grooves excessively worn	Remove and inspect pistons. See your John Deere engine distributor or servicing dealer.
	Piston rings sticking in ring grooves	Remove and inspect pistons. See your John Deere engine distributor or servicing dealer.
	Insufficient piston ring tension	Remove and inspect pistons. See your John Deere engine distributor or servicing dealer.
	Piston ring gaps not staggered	Remove and inspect pistons. See your John Deere engine distributor or servicing dealer.
	Front and/or rear crankshaft oil seal faulty	Replace oil seals. See your John Deere engine distributor or servicing dealer.
		See LOW PRESSURE SYSTEM-FUEL PRESSURE LOW TROUBLESHOOTING earlier in this section.
Fuel in Oil		See FUEL IN OIL TROUBLESHOOTING earlier in this section.
Coolant in Oil		See COOLING SYSTEM TROUBLESHOOTING later in this section.

RG,RG34710,7600 -19-30JUN97-2/2

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Cooling System Troubleshooting

Symptom	Problem	Solution
Engine Overheats	Lack of coolant in cooling system	Fill cooling system to proper level.
	Radiator core dirty	Clean radiator as required.
	Engine overloaded	Reduce engine load.
	Too low crankcase oil level	Fill crankcase to proper oil level.
	Loose or defective fan belt	Replace fan belt as required. Check belt tensioner. (See Lubrication and Maintenance 500 Hour/12 Month Section.)
	Defective thermostat	Test thermostat opening temperature; replace thermostat as required.
	Damaged cylinder head gasket	Replace cylinder head gasket. See your John Deere engine distributor or servicing dealer.
	Defective coolant pump	Replace coolant pump. See your John Deere engine distributor or servicing dealer.
	Defective radiator cap	Replace radiator cap as required.
Coolant in Oil	Cylinder head gasket defective	Replace cylinder head gasket. See your John Deere engine distributor or servicing dealer.
	Cylinder head or block cracked	Locate crack, repair/replace components as required.
	Cylinder liner seals leaking	Remove and inspect cylinder liners. See your John Deere engine distributor or servicing dealer.
	Leaking oil cooler	Pressure test oil cooler; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Defective oil cooler O-rings	Remove and inspect oil cooler O-rings; replace as required. See your John Deere engine distributor or servicing dealer.
	Faulty coolant pump seal; weep hole plugged; coolant leaking through bearing	Replace coolant pump seals. See your John Deere engine distributor or servicing dealer.
Coolant Temperature Below Normal	Defective thermostat(s)	Test thermostats; replace thermostats as required.

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RG,RG34710,7601 -19-11FEB03-1/1

Air Intake System Troubleshooting

If turbocharger requires replacement, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit.

NOTE: Turbochargers are equipped on 3029T engines only.

Symptom	Problem	Solution
Hard to Start or Will Not Start		See ENGINE TROUBLESHOOTING earlier in this section.
Engine Misfiring or Runs Irregularly		See ENGINE TROUBLESHOOTING earlier in this section.
Black or Grey Exhaust Smoke		See ENGINE TROUBLESHOOTING earlier in this section.
Lack of Engine Power		See ENGINE TROUBLESHOOTING earlier in this section.
Turbocharger "Screams"	Air leak in intake manifold.	Check intake manifold gasket and manifold; repair as required. See your John Deere engine distributor or servicing dealer.
Turbocharger Noise or Vibration *NOTE: Do not confuse the whine heard during run down with noise which indicates a bearing failure.*	Bearings not lubricated (insufficient oil pressure)	Determine cause of lack of lubrication; repair as required. See your John Deere engine distributor or servicing dealer.
	Air leak in engine intake or exhaust manifold	Check intake and exhaust manifold gaskets and manifolds; repair as required. See your John Deere engine distributor or servicing dealer.
	Improper clearance between turbine wheel and turbine housing	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Broken blades (or other wheel failures)	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
Oil on Turbocharger Compressor Wheel or in Compressor Housing (Oil Being Pushed or Pulled Through Center Housing)	Excessive crankcase pressure.	Determine cause of excessive crankcase pressure; repair as required. See your John Deere engine distributor or servicing dealer.
	Air intake restriction	Determine cause of intake restriction; repair as required. See your John Deere engine distributor or servicing dealer.
	Drain tube restriction	Determine cause of drain tube restriction; repair as required. See your John Deere engine distributor or servicing dealer.

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RG,RG34710,7602 -19-13MAR03-1/3

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Symptom	Problem	Solution
Oil in Intake Manifold or Dripping from Turbocharger Housing	Excessive crankcase pressure	Determine cause of excessive crankcase pressure; repair as required. See your John Deere engine distributor or servicing dealer.
	Air intake restriction	Determine cause of intake restriction; repair as required. See your John Deere engine distributor or servicing dealer.
	Drain tube restriction	Determine cause of drain tube restriction; repair as required. See your John Deere engine distributor or servicing dealer.
	Damaged or worn housing bearings	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Imbalance of rotating assembly	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Damage to turbine or compressor wheel or blade	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Dirt or carbon build-up on wheel or blade	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Bearing wear	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Oil starvation or insufficient lubrication	Determine cause of lack of lubrication; repair as required. See your John Deere engine distributor or servicing dealer.
	Shaft seals worn	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
Turbocharger Turbine Wheel Drag	Carbon build-up behind turbine wheel caused by coked oil or combustion deposits	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
	Dirt build-up behind compressor wheel caused by air intake leaks.	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.

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Symptom	Problem	Solution
	Bearing seizure or dirty, worn bearings	Inspect turbocharger; repair/replace as required. See your John Deere engine distributor or servicing dealer.
Turbocharger Wastegate Mechanism (If Equipped) Does Not Operate	Pivot shaft or rod linkage seized	Inspect wastegate mechanism. If required, see your John Deere engine distributor or servicing dealer.

RG,RG34710,7602 -19-13MAR03-3/3

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Engine Storage Guidelines

IMPORTANT: Special considerations should be taken prior to storage when using BioDiesel. See BioDiesel Fuel in the Fuels, Lubricants, and Coolant Section.

1. John Deere engines can be stored outside for up to three months with no long-term preparation if covered by a waterproof covering. No outside storage is recommended without a waterproof covering.
2. John Deere engines can be stored in a standard overseas shipping container for up to three months with no long-term preparation.
3. John Deere engines can be stored inside for up to six months with no long-term preparation.
4. John Deere engines expected to be stored more than six months **must** have long-term storage preparation. See Preparing Engine for Long-Term Storage in the Storage Section.

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Preparing Engine for Long Term Storage

IMPORTANT: Any time your engine will not be used for over six months, the following recommendations for storing it and removing it from storage will help to minimize corrosion and deterioration.

IMPORTANT: Long-term storage is not advised when using BioDiesel. For storage longer than one year, use straight hydrocarbon fuel.

If BioDiesel must be used it is recommended the blend not exceed B7 and a high-quality fuel stabilizer be used. Storage should not exceed one year.

For more information see BioDiesel Fuel in the Fuels, Lubricants, and Coolants Section.

NOTE: The following storage preparations are used for long-term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

1. Change engine oil and replace filter. (For all except 3029TF270 engines, see CHANGE ENGINE OIL AND FILTER in Lubrication and Maintenance/250 Hour/6 Month Section. For 3029TF270 engines, see the 500 Hour/12 Month section.) Used oil will not give adequate protection. Add one ounce of rust preventive oil to the engine crankcase for every quart of oil. This rust preventive oil should be an SAE 10W oil with 1-4 percent morpholine or equivalent vapor corrosion inhibitor, such as NOX RUST VCI-10 OIL from Daubert Chemical Company, Inc.
2. Service air cleaner. See Replacing Air Cleaner Filter Elements in the Service As Required Section.
3. Draining and flushing of cooling system is not necessary if engine is to be stored only for several months. However, for extended storage periods of a year or longer, it is recommended that the cooling system be drained, flushed, and refilled. Refill with appropriate coolant. See Adding Coolant in the Service As Required Section.
4. Pour three ounces of rust preventive oil into the turbocharger intake. (It may be necessary to temporarily install a short intake elbow on the turbocharger inlet to receive the oil.)
5. Prepare a tank with a solution of diesel fuel and rust preventive oil, at ten ounces of rust preventive oil per gallon of diesel fuel.
6. Remove existing lines/plugs as required, and run a temporary line from the tank to the engine fuel intake, and another temporary line from the fuel return manifold to the tank, so rust preventive oil solution is circulated through the injection system during cranking.
7. Crank the engine several revolutions with starter (do not allow the engine to start). This will allow rust preventive oil solution to circulate.
8. Remove temporary lines installed in Step 6 above, and replace any lines/plugs previously removed.

NOTE: One gallon of fuel/oil solution can be used to treat 100 engines; two gallons to treat 200 engines, etc. The oil could then be replenished by adding an additional five ounces of rust preventive oil per gallon of solution. However, starting over with a new solution is recommended to dispose of any water or other impurities.

9. Loosen, or remove and store, fan/alternator poly-vee belt.
10. Remove and clean batteries. Store them in a cool, dry place and keep them fully charged.
11. Disengage the clutch for any driveline.
12. Clean the exterior of the engine with salt-free water and touch up any scratched or chipped painted surfaces with a good quality paint.
13. Coat all exposed (machined) metal surfaces with grease or corrosion inhibitor if not feasible to paint.
14. Seal all openings on engine with plastic bags and tape.
15. Store the engine in a dry protected place. If engine must be stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

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Removing Engine from Long Term Storage

Refer to the appropriate section for detailed services listed below or have your authorized servicing dealer or engine distributor perform services that you may not be familiar with.

1. Remove all protective coverings from engine. Unseal all openings in engine and remove covering from electrical systems.
2. Remove the batteries from storage. Install batteries (fully charged) and connect the terminals.
3. Install fan/alternator poly-vee belt if removed.
4. Fill fuel tank.
5. Perform all appropriate prestarting checks. (See DAILY PRESTARTING CHECKS in Lubrication and Maintenance/Daily Section.)

IMPORTANT: DO NOT operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.

6. Crank engine for 20 seconds with starter (do not allow the engine to start). Wait 2 minutes and crank engine an additional 20 seconds to assure bearing surfaces are adequately lubricated.
7. Start engine and run at low idle and no load for several minutes. Warm up carefully and check all gauges before placing engine under load.
8. On the first day of operation after storage, check overall engine for leaks and check all gauges for correct operation.

NOTE: If using BIODIESEL blends after long term storage, frequency of fuel filter plugging may increase initially.

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Specifications

General OEM Engine Specifications

ITEM	3029 (2.9 L) (Naturally Aspirated)	3029 (2.9 L) (Turbocharged)
Number of Cylinders	3	3
Bore	106 mm (4.19 in)	106 mm (4.19 in)
Stroke	110 mm (4.33 in)	110 mm (4.33 in)
Displacement	2.9 L (179 in³)	2.9 L (179 in³)
Compression Ratio	17.8:1	17.8:1 / 17.2:1
Aspiration	Naturally Aspirated	Turbocharged
Engine Firing Order	1-2-3	1-2-3
Valves Per Cylinder	1 Intake 1 Exhaust	1 Intake 1 Exhaust
Valve Clearance (Cold) Intake Valves Exhaust Valves	 0.35 mm (0.014 in) 0.45 mm (0.018 in)	 0.35 mm (0.014 in) 0.45 mm (0.018 in)
Battery Capacities (CCA) 12 - Volt System 24 - Volt System	 640 570	 640 570
Thermostat Start To Open Temperature	82°C (180°F)	82°C (180°F)
Thermostat Fully Open Temperature	94°C (202°F)	94°C (202°F)
Coolant Capacity[a]	5.7 L (6 qt)	5.7 L (6 qt)
Recommended Radiator Pressure Cap	69 kPa (10 psi)	69 kPa (10 psi)
Crankcase Oil Fill Capacity	See “Engine Crankcase Oil Fill Quantities” later in this section.	
Oil Pressure At Rated Speed, Full Load With Oil Warmed to 115°C (240°F)	345 kPa (50 psi)	345 kPa (50 psi)
Oil Pressure At Low Idle (Minimum)	105 kPa (15 psi)	105 kPa (15 psi)
Length[b]	716 mm (28.2 in)	716 mm (28.2 in)
Width[b]	528 mm (20.8 in)	528 mm (20.8 in)
Height[b]	819 mm (32.2 in)	928 mm (36.5 in)
Weight[b]	317 kg (698 lb)	329 kg (724 lb)

[a] *Coolant capacity may vary with different engine applications.*
[b] *Measurement may vary depending on installed options*

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Engine Power and Speed Specifications — 3029

OPTION CODES	FUEL INJECTION PUMP PART NUMBER	POWER RATING @RATED SPEED[a] kW (hp)	RATED SPEED[b] (rpm)	SLOW IDLE [c] (rpm)	FAST IDLE[d] (rpm)
1602	RE53783	59 (79)	2500	800	2700
1602	RE53785	43 (58)	2500	850	2700
1602	RE55766				
1603	RE53786	35 (47)	1800	—	1890
1603	RE55764				
1632	RE51940	37 (50)	2200	850	2400
1632	RE58903	59 (79)	2500	850	2700
1633	RE51979	46 (62)	2200	800	2400
1634	RE53783	59 (79)	2500	800	2700
1640	RE53958	59 (79)	2500	850	2700
1641	RE53787	31 (41)	1500	—	1560
1641	RE55765				
1641	RE64241	31 (41)	1500	—	1560
1641	RE64241	43 (58)	2500	850	2700
1642	RE67269				
1642	RE67271	43 (58)	2500	850	2700
1643	RE67271	43 (58)	2500	850	2700
1644	RE41939	35 (47)	1800	—	1890
1644	RE58928				
1648	RE58929				
1648	RE64242	30 (40)	1500	—	1560
1648	RE64272	30 (40)	1500	—	1560
1650	RE58930				
164D	RE518991	48 (64)	2500	850	2700
164D	RE519011	48 (64)	2500	850	2700
164E	RE518992	48 (64)	2500	850	2700
164E	RE518993	48 (64)	2500	850	2700
164E	RE519012	48 (64)	2500	850	2700
164F	RE519013	53 (71)	2500	850	2700
164G	RE518997	48 (64)	2500	850	2700
164G	RE519014	53 (71)	2500	850	2700
164H	RE518995	48 (64)	1800	—	1890
164H	RE519015	48 (64)	1800	—	1890
164I	RE518998	48 (64)	1800	—	1890
164I	RE519016	48 (64)	1800	—	1890
1650	RE41938	43 (58)	2500	850	2700
1654	RE63523	41 (55)	2400	800	2600
1655	RE53785	43 (58)	2500	850	2700
168W	RE22670	53 (71)	2500	850	2700
168X	RE522671	53 (71)	2500	850	2700
169T	RE523969				
169U	RE523970				
16BJ	RE570228	31 (42)	1500	—	1560
16BR	RE547817	31 (42)	1500	—	1560
16BS	RE53785	43 (58)	2500	800	2700
16BT	RE53783	59 (79)	2500	800	2700
16DE	RE502218	59 (79)	2500	850	2700
16DF	RE502238	52 (70)	2500	850	2700

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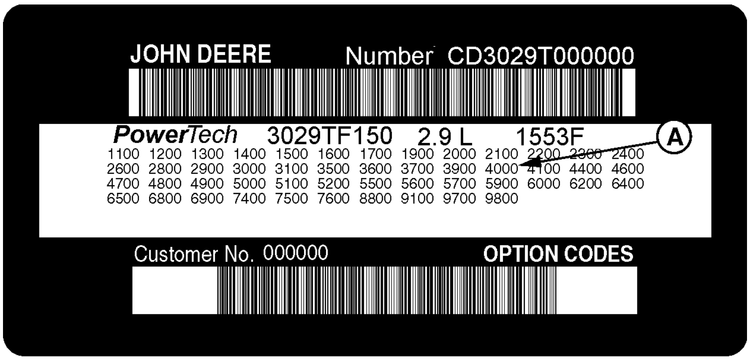
16DG	RE502218	59 (79)	2500	850	2700
16DH	RE502238	52 (70)	2500	850	2700
16DR	RE502217	43 (58)	2500	850	2700
16DP	RE502217	43 (58)	2500	850	2700
16DV	RE53785	43 (58)	2500	850	2700
16DZ	RE501258	43 (58)	2500	850	2700
16EA	RE501218	59 (79)	2500	850	2700
16EG	RE501983	43 (58)	2500	850	2700
16EH	RE501983	43 (58)	2500	850	2700
16EJ	RE501985	59 (79)	2500	850	2700
16EK	RE502986	52 (70)	2500	850	2700
16EL	RE501985	59 (79)	2500	850	2700
16EM	RE501986	52 (70)	2500	850	2700
16EV	RE53958	59 (79)	2500	800	2700
16EQ	RE502182	43 (58)	2500	850	2700
16EQ	RE502509	43 (58)	2500	1700	2700
16HW	RE501259	36 (49)	2500	850	2700
16K5	RE532980	32 (43)	1500	—	1560
16K6	RE532981	32 (43)	1500	—	1560
16K7	RE532982	43 (58)	1500	—	1560
16K8	RE532983	43 (58)	1500	—	1560
16KZ	RE502217	43 (58)	2500	850	2700
16NP	RE502217	43 (58)	2500	850	2700
16PH	RE501259	36 (49)	2500	850	2700
16PN	RE502217	43 (58)	2500	850	2700
16QN	RE547815	31 (42)	1500	—	1560
16QP	RE547816	31 (42)	1500	—	1560
16RF	RE570228	41 (55)	1500	—	1560
16RG	RE570327	41 (55)	1500	—	1560
16RH	RE570328	46 (62)	1800	—	1890
16RM	RE570329	46 (62)	1800	—	1890
16SV	RE547816	35 (47)	1800	—	1890
16SW	RE547815	35 (47)	1800	—	1890
16TH	RE53785	43 (58)	2500	850	2700
16TR	RE506877	48 (64)	1800	—	1890
16TR	RE506899	48 (64)	1800	—	1890
16TS	RE506878	48 (64)	1800	—	1890
16TS	RE506901	48 (64)	1800	—	1890
16TT	RE506879	42 (57)	1500	—	1560
16TT	RE506900	42 (57)	1500	—	1560
16TU	RE506880	42 (57)	1500	—	1560
16TU	RE506902	42 (57)	1500	—	1560
16YG	RE51940	37 (50)	2200	800	2400
16ZB	RE502238	52 (70)	2500	850	2700
16ZE	RE523773	53 (71)	2500	850	2700

[a] Power ratings are for a bare engine without the drag effect of accessories like fans, transmission, and auxiliary drives.
[b]Generator set engines (3-5% governor) usually run at 1500 rpm (50 Hz) or 1800 (60 Hz) when operating under load depending on cycles of AC current.
[c]Engine speeds listed are preset to factory specification. Slow idle speed may be reset depending upon specific vehicle application requirements. Refer to your machine operator's manual for engine speeds that are different from those preset at the factory.
[d]For engines with standard governor, fast idle is 7-10% above rated speed. For engines with generator set governors, fast idle is 3-5% above rated speed.

BL90236,0000054 -19-19AUG15-2/2

TIM-ID: 0000114010 - 001

Engine Crankcase Oil Fill Quantities



RG11604 —UN—24JAN01

Option Code Label

A—Dipstick Tube Option (used to determine crankcase oil fill quantity)

To determine the option code for the oil fill quantity of your engine, refer to the engine option code label affixed to the rocker arm cover (shown above). The first two digits of the code (40) (see A) identify the dipstick tube group. The last two digits of the code identify the specific dipstick and tube assembly on your engine.

The following table lists engine crankcase oil fill quantities:

Engine Model	Dipstick Tube Option Code(s)	Crankcase Oil Capacity L (qt)
3029 (2.9 L)	4004	6.0 (6.3)
	4005	6.0 (6.3)
	4006	8.0 (8.5)
	4022	7.0 (7.4)
	4023	9.0 (9.5)
	4024	6.0 (6.3)
	4025	8.0 (8.5)
	4026	8.5 (9.0)
	4033	8.0 (8.5)
	40AA	6.0 (6.3)

NOTE: Crankcase oil capacity may vary slightly from amount shown. ALWAYS fill crankcase to within crosshatch on dipstick. DO NOT overfill.

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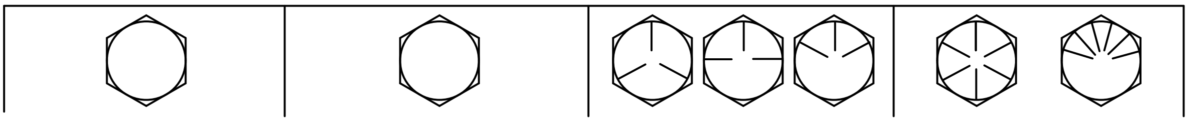
TIM-ID: 0000114010 - 001

Unified Inch Bolt and Screw Torque Values

TS1671 —UN—01MAY03



Bolt or Screw Size	SAE Grade 1				SAE Grade 2[a]				SAE Grade 5, 5.1 or 5.2				SAE Grade 8 or 8.2			
	Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]		Lubricated[b]		Dry[c]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
1/4	3.7	33	4.7	42	6	53	7.5	66	9.5	84	12	106	13.5	120	17	150
													N·m	lb.-ft.	N·m	lb.-ft.
5/16	7.7	68	9.8	86	12	106	15.5	137	19.5	172	25	221	28	20.5	35	26
									N·m	lb.-ft.	N·m	lb.-ft.				
3/8	13.5	120	17.5	155	22	194	27	240	35	26	44	32.5	49	36	63	46
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
7/16	22	194	28	20.5	35	26	44	32.5	56	41	70	52	80	59	100	74
	N·m	lb.-ft.														
1/2	34	25	42	31	53	39	67	49	85	63	110	80	120	88	155	115
9/16	48	35.5	60	45	76	56	95	70	125	92	155	115	175	130	220	165
5/8	67	49	85	63	105	77	135	100	170	125	215	160	240	175	305	225
3/4	120	88	150	110	190	140	240	175	300	220	380	280	425	315	540	400
7/8	190	140	240	175	190	140	240	175	490	360	615	455	690	510	870	640
1	285	210	360	265	285	210	360	265	730	540	920	680	1030	760	1300	960
1-1/8	400	300	510	375	400	300	510	375	910	670	1150	850	1450	1075	1850	1350
1-1/4	570	420	725	535	570	420	725	535	1280	945	1630	1200	2050	1500	2600	1920
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2140	1580	2700	2000	3400	2500
1-1/2	990	730	1250	930	990	730	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For plastic insert or crimped steel type lock nuts, for stainless steel fasteners, or for nuts on U-bolts, see the tightening instructions for the specific application. Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Replace fasteners with the same or higher grade. If higher grade fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a] *Grade 2 applies for hex cap screws (not hex bolts) up to 6 in. (152 mm) long. Grade 1 applies for hex cap screws over 6 in. (152 mm) long, and for all other types of bolts and screws of any length.*

[b] *"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or 7/8 in. and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.*

[c] *"Dry" means plain or zinc plated without any lubrication, or 1/4 to 3/4 in. fasteners with JDM F13B, F13E or F13H zinc flake coating.*

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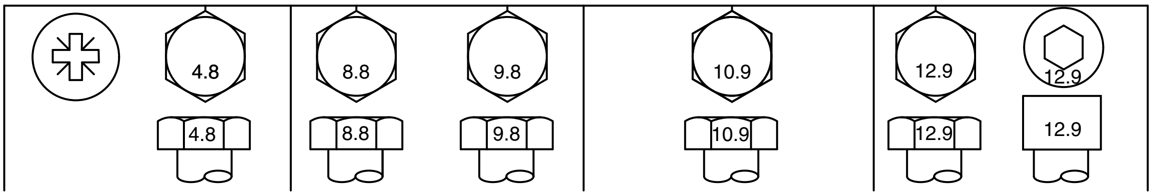
TIM-ID: 0000114010 - 001

Metric Bolt and Screw Torque Values

TS1670 —UN—01MAY03



Bolt or Screw Size	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]		Lubricated[a]		Dry[b]	
	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.	N·m	lb.-in.
M6	4.7	42	6	53	8.9	79	11.3	100	13	115	16.5	146	15.5	137	19.5	172
									N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.
M8	11.5	102	14.5	128	22	194	27.5	243	32	23.5	40	29.5	37	27.5	47	35
			N·m	lb.-ft.	N·m	lb.-ft.	N·m	lb.-ft.								
M10	23	204	29	21	43	32	55	40	63	46	80	59	75	55	95	70
	N·m	lb.-ft.														
M12	40	29.5	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	46	80	59	120	88	150	110	175	130	220	165	205	150	260	190
M16	100	74	125	92	190	140	240	175	275	200	350	255	320	235	400	300
M18	135	100	170	125	265	195	330	245	375	275	475	350	440	325	560	410
M20	190	140	245	180	375	275	475	350	530	390	675	500	625	460	790	580
M22	265	195	330	245	510	375	650	480	725	535	920	680	850	625	1080	800
M24	330	245	425	315	650	480	820	600	920	680	1150	850	1080	800	1350	1000
M27	490	360	625	460	950	700	1200	885	1350	1000	1700	1250	1580	1160	2000	1475
M30	660	490	850	625	1290	950	1630	1200	1850	1350	2300	1700	2140	1580	2700	2000
M33	900	665	1150	850	1750	1300	2200	1625	2500	1850	3150	2325	2900	2150	3700	2730
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2770	4750	3500

Torque values listed are for general use only, based on the strength of the bolt or screw. DO NOT use these values if a different torque value or tightening procedure is given for a specific application. For stainless steel fasteners or for nuts on U-bolts, see the tightening instructions for the specific application. Tighten plastic insert or crimped steel type lock nuts by turning the nut to the dry torque shown in the chart, unless different instructions are given for the specific application.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class. Replace fasteners with the same or higher property class. If higher property class fasteners are used, tighten these to the strength of the original. Make sure fastener threads are clean and that you properly start thread engagement. When possible, lubricate plain or zinc plated fasteners other than lock nuts, wheel bolts or wheel nuts, unless different instructions are given for the specific application.

[a] *"Lubricated" means coated with a lubricant such as engine oil, fasteners with phosphate and oil coatings, or M20 and larger fasteners with JDM F13C, F13F or F13J zinc flake coating.*
[b] *"Dry" means plain or zinc plated without any lubrication, or M6 to M18 fasteners with JDM F13B, F13E or F13H zinc flake coating.*

DX,TORQ2 -19-12JAN11-1/1

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Lubrication and Maintenance Records

Using Lubrication And Maintenance Records

Refer to specific Lubrication and Maintenance Section for detailed service procedures.

1. Keep a record of the number of hours you operate your engine by regular observation of hour meter.
2. Check your record regularly to learn when your engine needs service.
3. DO ALL the services within an interval section. Write the number of hours (from your service records) and the date in the spaces provided. For a complete listing of all items to be performed and the service intervals required, refer to the quick-reference chart near the front of the Lubrication and Maintenance Section.

IMPORTANT: The service recommendations covered in this manual are for the accessories that are provided by John Deere. Follow manufacturer's service recommendations for servicing engine driven equipment not supplied by Deere.

RG,RG34710,5103 -19-30JAN98-1/1

Daily (Prestarting) Service

Check engine oil level.

Check coolant level.

Lubricate PTO release bearing.

Check air cleaner dust unloader valve and air restriction indicator, if equipped.

Visual walkaround inspection.

Check fuel filter.

RG,RG34710,5104 -19-30JAN98-1/1

250 Hour/6 Month Service

Service fire extinguisher.

Lubricate PTO clutch shaft bearings.

Service battery.

All except 3029TF270 engines: Change engine oil and filter.[1]

Check fan and alternator belt tension.

Check PTO clutch adjustment.

Check engine mounts.

Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									

[1] *If John Deere PLUS-50 or E7/E6/E5/E4 oil is used along with the specified John Deere oil filter, the oil change interval may be extended by 50 percent to 375 hours.*

RG,RG34710,5105 -19-30MAY06-1/1

TIM-ID: 0000114010 - 001

500 Hour/12 Month Service

3029TF270 engines only: Change engine oil and filter.[1]

Check engine ground connection.

Lubricate PTO clutch internal levers and linkage.

Clean crankcase vent tube.

Check air intake hoses, connections, and system.

Replace fuel filter/bleed system.

Check cooling system.

Coolant solution analysis - add SCAs as needed.

Pressure test cooling system.

Check and adjust engine speeds.

Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									

[1]If John Deere PLUS-50 or ACEA-E7/E6/E5/E4 oil and the specified John Deere oil filter are NOT used, the oil change interval is reduced to 250 hours.

RG,RG34710,5108 -19-30MAY06-1/1

2000 Hour/24 Month Service

Adjust variable speed (droop) on generator set engines.

Check and adjust engine valve clearance.

Flush and refill cooling system.[1]

Test thermostat opening temperature.

Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									

[1]If John Deere COOL-GARD is used, the flushing interval may be extended to 3000 hours or 36 months. If John Deere COOL-GARD is used, and the coolant is tested annually AND additives are replenished by adding supplemental coolant additives (SCA's), the flushing interval may be extended to 5000 hours or 60 months, whichever occurs first.

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Service As Required

Add coolant.

Bleed fuel system.

Replace air cleaner elements.

Replace belts.

Check fuses.

Inspect PTO clutch. (If equipped.)

Hours									
Date									
Hours									
Date									
Hours									
Date									
Hours									
Date									

RG,RG34710,5110 -19-13FEB03-1/1

John Deere Warranty in OEM Applications

Overview

This section focuses on John Deere engines marketed in products manufactured by companies other than John Deere or its affiliates, and on John Deere repower engines in all applications. Herein appears the original warranty applicable to the engine as delivered to the retail purchaser on or after 1 May 2010. The following is information about the warranty and warranty service.

NOTE: "John Deere" means John Deere Power Systems with respect to users in the United States, John Deere Limited with respect to users in Canada, and Deere & Company or its subsidiary responsible for making John Deere equipment in other countries where the user is located.

Promptly register your engine online at https://www.johndeere.com/enginewarranty

When Warranty Service Is Needed

The nearest dealer stands ready with genuine parts and trained and equipped personnel should the need arise. If following the Operator's Manual delivered with the engine/machine are not adequate to correct an engine problem, contact the nearest John Deere service dealer for assistance. Authorized engine service dealers can be found at: https://www.johndeere.com/ (click on "Dealer Locator").

NOTE: When requesting warranty service, the purchaser must be prepared to provide proof that the engine is within the warranty period.

The following information is always required: Engine serial number, date of delivery, engine owner, name and location of dealer and specific person contacted, date of contact, nature of engine problem, and outcome of the service dealer contact.

Given that normally it is the dealer contacted who in the end will provide the service required, maintaining a purchaser-dealer relationship of mutual respect from the beginning is always helpful.

Privacy Notice

At John Deere your privacy is important to us. We collect, use, and disclose your personal information in accordance with the John Deere privacy statement. For instance, we collect, use, and disclose your personal information to provide you with the products and services that you request; to communicate with you as our customer (examples include warranty and product improvement programs) and to meet safety and legal requirements; and for marketing and promotional purposes. Sometimes, we may ask our John Deere affiliates, dealers, or business partners to do work for us which involves your information. For complete details on your privacy rights and to obtain a copy of the John Deere Privacy Statement, please visit our website at https://www.johndeere.com/.

Warranty Duration

Unless otherwise provided in writing by John Deere, John Deere makes the following warranty to the first retail purchaser and each subsequent purchaser (if purchase is made prior to the expiration of applicable warranty) of each John Deere new off-highway engine marketed as part of a product manufactured by a company other than John Deere or its affiliates and on each John Deere engine used in an off-highway repower application:

- 12 months, unlimited hours of use, or
- 24 months and before the accumulation of 2000 hours of use.

NOTE: In the absence of a functional hourmeter, hours of use will be determined on the basis of 12 hours of use per calendar day.

Warranty Coverage

This warranty applies to the engine and to integral components and accessories sold by John Deere, and delivered to the first retail purchaser on or after 1 May 2010.

All John Deere-warranted parts and components of John Deere engines which, as delivered to the purchaser, are defective in materials and/or workmanship will be repaired or replaced, as John Deere elects. Warrantable repairs will be made without charge for parts or engine repair labor, including reasonable labor costs to remove and reinstall non-engine parts or components of the equipment in which the engine is installed. If required, reasonable labor costs for engine removal and reinstallation will also be included. All coverage is based on the defect appearing within the warranty period as measured from the date of delivery to the first retail purchaser.

Obtaining Warranty Service

Warranty service must be requested of the nearest authorized John Deere engine service outlet before the expiration of the warranty. An *authorized* service outlet is a John Deere engine distributor, a John Deere engine service dealer, or a John Deere equipment dealer selling and servicing equipment with an engine of the type covered by this warranty. (See When Warranty Service is Needed above.)

Authorized service outlets will use only new or remanufactured parts or components furnished or approved by John Deere.

NOTE: Authorized engine service locations are listed on the Internet at https://www.johndeere.com/ (Click on "Dealer Locator".)

At the time of requesting warranty service, the purchaser must be prepared to present evidence of the date of delivery of the engine.

TM-ID: 0000114010 -001

Continued on next page JR74534,0000462 -19-05JUL16-1/3

John Deere reimburses authorized service outlets for limited travel expenses incurred in making warranty service repairs in non-John Deere applications when travel is actually performed. The limit, as of the date of publication of this booklet, is US$400.00 (US$500.00 if engine is marine) or equivalent. **If distances and travel times are greater than reimbursed by John Deere, the service outlet will charge the purchaser for the difference.**

Warranty Exclusions

John Deere's obligations will not apply to components and accessories which are not furnished or installed by John Deere, nor to failures caused by such items, except as required by law.

Purchaser's Responsibilities

The cost of normal maintenance and depreciation.

Periodic cleaning of the diesel particulate filter (DPF).

Consequences of negligence, misuse, or accident involving the product, or improper application, installation, or storage.

Consequences of service performed by someone other than an authorized John Deere engine service outlet.

Consequences of any product modification or alteration not approved by John Deere, including, but not limited to, tampering with engine fuel and air delivery systems.

Consequences of failure of non-product components.

Consequences of fuels, lubricants, or coolants that fail to meet the specifications and requirements listed in the Operator's Manual.

The effects of cooling system neglect as manifested in cylinder liner or cylinder block cavitation ("pitting, "erosion", "electrolysis").

Any premium for overtime labor requested by the purchaser.

Costs of transporting the product or the equipment in which it is installed to and from the location at which the warranty service is performed, if such costs are in excess of the travel reimbursement payable to the dealer had the warranty service been performed at the product's location.

Costs incurred in gaining access; for example, overcoming physical barriers such as walls, fences, floors, decks, or similar structures impeding access to the product, rental of cranes or similar, or construction of ramps or lifts or protective structures for product removal and reinstallation.

Incidental travel costs including meals, lodging, and similar, and any travel time or mileage costs in excess of the maximum allowance.

Service outlet costs incurred in solving or attempting to solve non-warrantable problems.

Services performed by a party other than an authorized John Deere service dealer.

Charges by dealers for initial start-up and inspection deemed unnecessary by John Deere when an Operator's Manual is supplied with the product are followed.

Costs related to interpretation or translation services.

No Representations or Implied Warranty

Where permitted by law, neither John Deere nor any company affiliated with it makes any guaranties, warranties, conditions, representations or promises, express or implied, oral or written, as to the nonoccurrence of any defect or the quality of performance of its engines other than those set forth in this booklet, and DOES NOT MAKE ANY IMPLIED WARRANTY OR CONDITIONS OF MERCHANTABILITY OR FITNESS otherwise provided for in the Uniform Commercial Code or required by any Sale of Goods Act or any other statute. This exclusion includes fundamental terms. In no event will a John Deere engine distributor or engine service dealer, John Deere equipment dealer, or John Deere or any company affiliated with John Deere be liable for incidental or consequential damages or injuries including, but not limited to, loss of profits, loss of crops, rental of substitute equipment or other commercial loss, damage to the equipment in which the engine is installed or for damage suffered by purchaser as a result of fundamental breaches of contract or breach of fundamental terms, unless such damages or injuries are caused by the gross negligence or intentional acts of the foregoing parties.

Remedy Limitation

The remedies set forth in this warranty are the purchaser's exclusive remedies in connection with the performance of, or any breach of guaranty, condition, or warranty in respect of new John Deere engines. In the event the above warranty fails to correct purchaser's performance problems caused by defects in workmanship and/or materials, purchaser's exclusive remedy shall be limited to payment by John Deere of actual damages in an amount not to exceed the cost of the engine.

No Seller's Warranty

No person or entity, other than John Deere, who sells the engine or product in which the engine has been installed makes any guaranty or warranty of its own on any engine warranted by John Deere unless it delivers to the purchaser a separate written guaranty certificate specifically guaranteeing the engine, in which case John Deere shall have no obligation to the purchaser. Neither original equipment manufacturers, engine or equipment distributors, engine or equipment dealers, nor any other person or entity, has any authority to make any representation or promise on behalf of John Deere or to modify the terms or limitations of this warranty in any way.

TIM-ID: 0000114010 - 001

Continued on next page JR74534,0000462 -19-05JUL16-2/3

Replacement Parts Warranty

John Deere and John Deere Reman parts and components (excluding replacement engines) installed during engine warranty service are warranted for the remaining warranty period of the engine or the applicable warranty term for the installed service part, whichever is greater. A new or remanufactured engine replacing a failed engine under warranty is warranted for 90 days or the remaining warranty period of the original engine, whichever is greater.

Warranty Transfer

The remainder of the original engine warranty and the emissions control-related warranty may be transferred to a subsequent owner of the engine. The Engine Warranty Transfer card should be used to report the transfer to John Deere. If a card is not available, contact your Dealer or simply send the following Information to JDPS Warranty Administration at Diesel-US@JohnDeere.com.

1. The complete 13-character engine serial number.
2. The name and mailing address of the original purchaser.
3. Delivery date to the original purchaser.
4. Hours at the time of transfer.
5. Date of transfer to the new owner.
6. Name and mailing address of the new owner.
7. How the engine/drivetrain being used, i.e., what equipment it powers, by manufacturer and model.
8. Equipment it powers, by manufacturer and model.

Purchased Extended Warranty

Extended warranty may be purchased on most engines in many areas of the world. John Deere engine distributors and equipment dealers, and dealers of manufacturers using John Deere engines in their products, have details. John Deere may also be contacted at U.S.A. fax number 1-309-749-0816, or in Europe fax number 33.2.38.84.62.66.

Emissions Warranties

Emissions warranties appear in the Operator's Manual furnished with the engine/machine. **(Warning: Statutes providing severe penalties for tampering with emissions controls may apply at the user's location.)** John Deere may also be contacted at U.S.A. fax number 1-309-749-0816; or in Europe fax number 33.2.38.84.62.66.

Local Warranty Requirements

Warranties required by local statutes will be furnished by the seller.

Option Codes (Engine Manufacturing Configuration)

When in need of engine replacement parts, your authorized John Deere service dealer will need to know the corresponding "Option Codes" for your engine. The option code label on the engine rocker arm cover may become damaged over time. By recording the four-digit codes when the engine is new, and storing this manual where it can be found when parts are needed, fast, accurate parts ordering and service will be assured. (See Engine Option Codes in the Record Keeping Section).

Should there be a question about an engine option code, note the engine serial number and call 1-800-JDENGINE from the U.S.A. or Canada, or fax U.S.A. number 1-309-749-0816; or E-mail at diesel-us@johndeere.com, Attention: Warranty Administration; or in Europe fax number 33.2.38.84.62.66, or E-mail at saranservice@johndeere.com.

Registering The Engine For Warranty

Completion and submission of the John Deere Engine Warranty Registration form (cut out sheet found in this manual) is very important. John Deere will not deny warranty service on an engine within its warranty period if the engine has not been registered. However, registering your engine will assure your servicing dealer that the engine is within the warranty period.

The easiest way to register your engine is via the Internet. Go to website https://www.johndeere.com/enginewarranty You can use the sheet in this manual to gather the information needed to register the warranty.

NOTE: Information provided on the form must be legible!

Typing is preferred, but legible handwritten reports are acceptable. "Block" numbers and Roman alphabet letters should be used. For example: 1,2,3,4 and A, B, C, D.

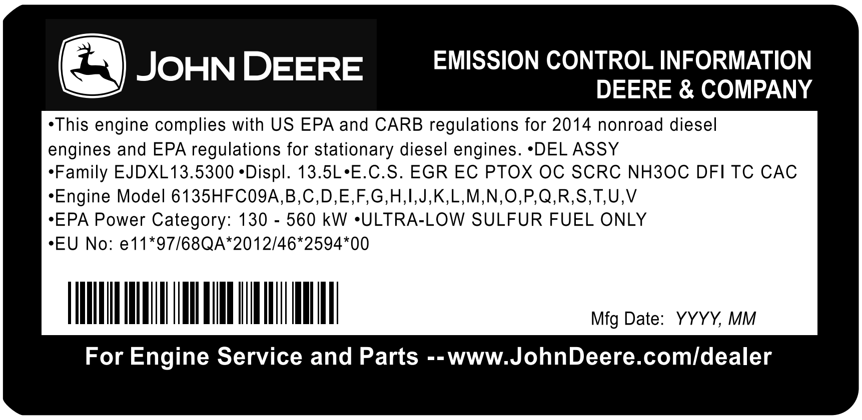
All requested information should be given. Much of it contributes to reports, including those required by governments.

The purchaser's telephone number or E-mail address allows John Deere to make contact should there be questions concerning the registration. The purchaser should sign and date the form.

JR74534,0000462 -19-05JUL16-3/3

TIM-ID: 0000114010 - 001

Emissions Control System Certification Label



RG24291 —UN—18SEP13

Engine Emissions Label

CAUTION: Statutes providing severe penalties for tampering with emissions controls may apply to the user or dealer.

The emissions warranty applies to those engines marketed by John Deere that have been certified by the United States Environmental Protection Agency (EPA) and/or California Air Resources Board (CARB); and used in the United States and Canada in Non-road equipment. The presence of an emissions label like the one shown signifies that the engine has been certified with the EPA and/or CARB. The EPA and CARB warranties only apply to new engines having the certification label affixed to the engine and sold as stated above in the geographic areas. The presence of an EU number signifies that the engine has been certified with the European Union countries per Directive 97/68/EC. The EPA and/or CARB emissions warranties do not apply to the EU countries.

The emissions label has applicable US EPA and/or CARB regulatory year. The regulatory year determines which warranty statement is applicable to engine. See “EPA Non-road Emissions Control Warranty Statement—Compression Ignition” and “CARB Non-road Emissions Control Warranty Statement—Compression Ignition”. For additional regulatory year warranty statements, see www.JohnDeere.com or contact the nearest John Deere service dealer for assistance.

Emission Control System(s) Laws

The U.S. EPA and California ARB prohibit the removal or rendering inoperative of any device or element of design installed on or in engines/equipment in compliance with applicable emission regulations prior to or after the sale and delivery of the engines/equipment to the ultimate purchaser.

DX,EMISSIONS,LABEL -19-01AUG14-1/1

TIM-ID: 0000114010 - 001

EPA Non-road Emissions Control Warranty Statement—Compression Ignition

DXLOGOV1 —UN—28APR09

JOHN DEERE

U.S. AND CANADA EMISSION CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the "Emissions Control Information" label located on the engine. If the engine is operated in the United States or Canada and the Emissions Control information label states: "This engine complies with US EPA regulations for nonroad and stationary diesel engines", or "This engine conforms to US EPA nonroad compression-ignition regulations", refer to the "U.S. and Canada Emission Control Warranty Statement." If the engine is operated in California, and the label states: "This engine complies with US EPA and CARB regulations for nonroad diesel engines", or "This engine conforms to US EPA and California nonroad compression-ignition emission regulations", also refer to the "California Emission Control Warranty Statement."

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emissions-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

JOHN DEERE'S WARRANTY RESPONSIBILITY

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine including all parts of its emission-control system was designed, built and equipped so as to conform at the time of the sale with Section 213 of the Clean Air Act and is free from defects in materials and workmanship which would cause the engine to fail to conform with applicable US EPA regulations for a period of five years from the date the engine is placed into service or 3,000 hours of operation, whichever first occurs.

Where a warrantable condition exists, John Deere will repair or replace, as it elects, any part or component with a defect in materials or workmanship that would increase the engine's emissions of any regulated pollutant within the stated warranty period at no cost to you, including expenses related to diagnosing and repairing or replacing emission-related parts. Warranty coverage is subject to the limitations and exclusions set forth herein. Emission- related components include engine parts developed to control emissions related to the following:

Air-Induction System	Aftertreatment Devices
Fuel System	Crankcase Ventilation Valves
Ignition System	Sensors
Exhaust Gas Recirculation Systems	Engine Electronic Control Units

EMISSION WARRANTY EXCLUSIONS

John Deere may deny warranty claims for malfunctions or failures caused by:

- Non-performance of maintenance requirements listed in the Operator's Manual
- The use of the engine/equipment in a manner for which it was not designed
- Abuse, neglect, improper maintenance or unapproved modifications or alterations
- Accidents for which it does not have responsibility or by acts of God

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel can harm the emissions control system of the engine/equipment and is not approved for use.

To the extent permitted by law John Deere is not liable for damage to other engine components caused by a failure of an emission-related part, unless otherwise covered by standard warranty.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISIONS OF MATERIAL AND SERVICES AS SPECIFIED HEREIN. WHERE PERMITTED BY LAW, NEITHER JOHN DEERE NOR ANY AUTHORIZED JOHN DEERE ENGINE DISTRIBUTOR, DEALER, OR REPAIR FACILITY OR ANY COMPANY AFFILIATED WITH JOHN DEERE WILL BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Emission_CI_EPA (18Dec09)

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DX,EMISSIONS,EPA -19-12DEC12-1/2

TIM-ID: 0000114010 - 001

JOHN DEERE

U.S. AND CANADA EMISSION CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the "Emissions Control Information" label located on the engine. If the engine is operated in the United States or Canada and the Emissions Control information label states: "This engine complies with US EPA regulations for nonroad and stationary diesel engines", or "This engine conforms to US EPA nonroad compression-ignition regulations", refer to the "U.S. and Canada Emission Control Warranty Statement." If the engine is operated in California, and the label states: "This engine complies with US EPA and CARB regulations for nonroad diesel engines", or "This engine conforms to US EPA and California nonroad compression-ignition emission regulations", also refer to the "California Emission Control Warranty Statement."

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emissions-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

JOHN DEERE'S WARRANTY RESPONSIBILITY

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine including all parts of its emission-control system was designed, built and equipped so as to conform at the time of the sale with Section 213 of the Clean Air Act and is free from defects in materials and workmanship which would cause the engine to fail to conform with applicable US EPA regulations for a period of five years from the date the engine is placed into service or 3,000 hours of operation, whichever first occurs.

Where a warrantable condition exists, John Deere will repair or replace, as it elects, any part or component with a defect in materials or workmanship that would increase the engine's emissions of any regulated pollutant within the stated warranty period at no cost to you, including expenses related to diagnosing and repairing or replacing emission-related parts. Warranty coverage is subject to the limitations and exclusions set forth herein. Emission- related components include engine parts developed to control emissions related to the following:

Air-Induction System
Fuel System
Ignition System
Exhaust Gas Recirculation Systems
Aftertreatment Devices
Crankcase Ventilation Valves
Sensors
Engine Electronic Control Units

EMISSION WARRANTY EXCLUSIONS

John Deere may deny warranty claims for malfunctions or failures caused by:

- Non-performance of maintenance requirements listed in the Operator's Manual
- The use of the engine/equipment in a manner for which it was not designed
- Abuse, neglect, improper maintenance or unapproved modifications or alterations
- Accidents for which it does not have responsibility or by acts of God

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel can harm the emissions control system of the engine/equipment and is not approved for use.

To the extent permitted by law John Deere is not liable for damage to other engine components caused by a failure of an emission-related part, unless otherwise covered by standard warranty.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISIONS OF MATERIAL AND SERVICES AS SPECIFIED HEREIN. WHERE PERMITTED BY LAW, NEITHER JOHN DEERE NOR ANY AUTHORIZED JOHN DEERE ENGINE DISTRIBUTOR, DEALER, OR REPAIR FACILITY OR ANY COMPANY AFFILIATED WITH JOHN DEERE WILL BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Emission_CI_EPA (18Dec09)

TS1721 —UN—15JUL13

DX,EMISSIONS,EPA -19-12DEC12-2/2

TIM-ID: 0000114010 - 001

CARB Non-road Emissions Control Warranty Statement—Compression Ignition

Emissions Control Warranty Statement 2016 through 2018

DXLOGOV1 —UN—28APR09

JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2016 through 2018 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

TIM-ID: 0000114010 - 001

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JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first.
The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator’s Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner’s failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (13Jun14)

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DX,EMISSIONS,CARB -19-03FEB17-2/8

TIM-ID: 0000114010 - 001

Emissions Control Warranty Statement 2016 through 2018

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JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2016 through 2018 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

RG26035 —UN—24JUN14

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TIM-ID: 0000114010 - 001

JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator’s Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner’s failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (13Jun14)

RG26036 —UN—24JUN14

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DX,EMISSIONS,CARB -19-03FEB17-4/8

TIM-ID: 0000114010 - 001

Emissions Control Warranty Statement 2019 through 2021

DXLOGOV1 —UN—28APR09

JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the “Emission Control Information” label located on the engine. If the engine is operated in the United States or Canada and the engine label states: “This engine complies with US EPA regulations for nonroad and stationary diesel engines”, or “This engine complies with US EPA regulations for stationary emergency diesel engines”, refer to the “U.S. and Canada Emission Control Warranty Statement.” If the engine is operated in California, and the engine label states: “This engine complies with US EPA and CARB regulations for nonroad diesel engines” also refer to the “California Emissions Control Warranty Statement.”

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2019 through 2021 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State’s stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

TIM-ID: 0000114010 - 001

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JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (01Feb17)

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DX,EMISSIONS,CARB -19-03FEB17-6/8

TIM-ID: 0000114010 - 001

Emissions Control Warranty Statement 2019 through 2021

DXLOGOV1 —UN—28APR09

JOHN DEERE

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

To determine if the John Deere engine qualifies for the additional warranties set forth below, look for the "Emission Control Information" label located on the engine. If the engine is operated in the United States or Canada and the engine label states: "This engine complies with US EPA regulations for nonroad and stationary diesel engines", or "This engine complies with US EPA regulations for stationary emergency diesel engines", refer to the "U.S. and Canada Emission Control Warranty Statement." If the engine is operated in California, and the engine label states: "This engine complies with US EPA and CARB regulations for nonroad diesel engines" also refer to the "California Emissions Control Warranty Statement."

Warranties stated on this certificate refer only to emissions-related parts and components of your engine. The complete engine warranty, less emission-related parts and components, is provided separately. If you have any questions about your warranty rights and responsibilities, you should contact John Deere at 1-319-292-5400.

CALIFORNIA EMISSIONS CONTROL WARRANTY STATEMENT:

The California Air Resources Board (CARB) is pleased to explain the emission-control system warranty on 2019 through 2021 off-road diesel engines. In California, new off-road engines must be designed, built and equipped to meet the State's stringent anti-smog standards. John Deere must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

John Deere warrants to the ultimate purchaser and each subsequent purchaser that this off-road diesel engine was designed, built, and equipped so as to conform at the time of sale with all applicable regulations adopted by CARB and is free from defects in materials and workmanship which would cause the failure of a warranted part to be identical in all material respects to the part as described in John Deere's application for certification for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first for all engines rated at 19 kW and greater. In the absence of a device to measure hours of use, the engine shall be warranted for a period of five years.

EMISSIONS WARRANTY EXCLUSIONS:

John Deere may deny warranty claims for failures caused by the use of an add-on or modified part which has not been exempted by the CARB. A modified part is an aftermarket part intended to replace an original emission-related part which is not functionally identical in all respects and which in any way affects emissions. An add-on part is any aftermarket part which is not a modified part or a replacement part.

In no event will John Deere, any authorized engine distributor, dealer, or repair facility, or any company affiliated with John Deere be liable for incidental or consequential damage.

RG29280 —UN—02FEB17

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TIM-ID: 0000114010 - 001

JOHN DEERE'S WARRANTY RESPONSIBILITY:

Where a warrantable condition exists, John Deere will repair or replace, as it elects, your off-road diesel engine at no cost to you, including diagnosis, parts or labor. Warranty coverage is subject to the limitations and exclusions set forth herein. The off-road diesel engine is warranted for a period of five years from the date the engine is delivered to an ultimate purchaser or 3,000 hours of operation, whichever occurs first. The following are emissions-related parts:

Air Induction System

- Intake manifold
- Turbocharger
- Charge air cooler

Fuel Metering system

- Fuel injection system

Exhaust Gas Recirculation

- EGR valve

Catalyst or Thermal Reactor Systems

- Catalytic converter
- Exhaust manifold

Emission control labels

Particulate Controls

- Any device used to capture particulate emissions
- Any device used in the regeneration of the capturing system
- Enclosures and manifolding
- Smoke Puff Limiters

Positive Crankcase Ventilation (PCV) System

- PCV valve
- Oil filler cap

Advanced Oxides of Nitrogen (NOx) Controls

- NOx absorbers and catalysts

SCR systems and urea containers/dispensing systems

Miscellaneous Items used in Above Systems

- Electronic control units, sensors, actuators, wiring harnesses, hoses, connectors, clamps, fittings, gasket, mounting hardware

Any warranted emissions-related part scheduled for replacement as required maintenance is warranted by John Deere for the period of time prior to the first scheduled replacement point for the part. Any warranted emissions-related part not scheduled for replacement as required maintenance or scheduled only for regular inspection is warranted by John Deere for the stated warranty period.

OWNER'S WARRANTY RESPONSIBILITIES:

As the off-road diesel engine owner you are responsible for the performance of the required maintenance listed in your Operator's Manual. John Deere recommends that the owner retain all receipts covering maintenance on the off-road diesel engine, but John Deere cannot deny warranty solely for the lack of receipts or for the owner's failure to ensure the performance of all scheduled maintenance. However, as the off-road diesel engine owner, you should be aware that John Deere may deny you warranty coverage if your off-road diesel engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

The off-road diesel engine is designed to operate on diesel fuel as specified in the Fuels, Lubricants and Coolants section in the Operators Manual. Use of any other fuel may result in the engine no longer operating in compliance with applicable emissions requirements.

The owner is responsible for initiating the warranty process, and should present the machine to the nearest authorized John Deere dealer as soon as a problem is suspected. The warranty repairs should be completed by the authorized John Deere dealer as quickly as possible.

Emissions regulations require the customer to bring the unit to an authorized servicing dealer when warranty service is required. As a result, John Deere is NOT liable for travel or mileage on emissions warranty service calls.

Emission_CI_CARB (01Feb17)

RG29281 —UN—27FEB17

DX,EMISSIONS,CARB -19-03FEB17-8/8

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John Deere Service Literature Available

Technical Information

Technical information can be purchased from John Deere. Publications are available in print or CD-ROM format.

Orders can be made using one of the following:

- John Deere Technical Information Store: **www.JohnDeere.com/TechInfoStore**
- Call 1-800-522-7448
- Contact your John Deere dealer

Available information includes:

PARTS CATALOGS list service parts available for your machine with exploded view illustrations to help you identify the correct parts. It is also useful in assembling and disassembling.

TS189 —UN—17JAN89

DX,SERVLIT -19-07DEC16-1/4

OPERATOR'S MANUALS providing safety, operating, maintenance, and service information.

TS191 —UN—02DEC88

DX,SERVLIT -19-07DEC16-2/4

TECHNICAL MANUALS outlining service information for your machine. Included are specifications, illustrated assembly and disassembly procedures, hydraulic oil flow diagrams, and wiring diagrams. Some products have separate manuals for repair and diagnostic information. Some components, such as engines, are available in a separate component technical manual.

TS224 —UN—17JAN89

Continued on next page

DX,SERVLIT -19-07DEC16-3/4

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EDUCATIONAL CURRICULUM including five comprehensive series of books detailing basic information regardless of manufacturer:

- Agricultural Primer series covers technology in farming and ranching.
- Farm Business Management series examines “real-world” problems and offers practical solutions in the areas of marketing, financing, equipment selection, and compliance.
- Fundamentals of Services manuals show you how to repair and maintain off-road equipment.
- Fundamentals of Machine Operation manuals explain machine capacities and adjustments, how to improve machine performance, and how to eliminate unnecessary field operations.
- Fundamentals of Compact Equipment manuals provide instruction in servicing and maintaining equipment up to 40 PTO horsepower.

TS1663 —UN—10OCT97

DX,SERVLIT -19-07DEC16-4/4

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INSTRUCTION MANUAL

FOR

MGC-1550

DIGITAL GENSET CONTROLLER

TIM-ID: 0000097284 - 001

Publication: 9469200991
Revision: B Nov-14

Preface

This instruction manual provides information about the installation and operation of the MGC-1550 Digital Genset Controller. To accomplish this, the following information is provided:

- Controls and indicators
- Inputs and outputs
- Protection and control functions
- Reporting and alarms information
- Mounting and connection diagrams
- BESTCOMS*Plus*® software
- Communication and security
- Maintenance and troubleshooting procedures
- Specifications
- CEM-2020
- MTU Fault Codes
- Exhaust Treatment
- Diagnostic Trouble Codes
- Modbus™ Communications

Conventions Used in this Manual

Important safety and procedural information is emphasized and presented in this manual through Warning, Caution, and Note boxes. Each type is illustrated and defined as follows.

Warning!
Warning boxes call attention to conditions or actions that may cause personal injury or death.

Caution
Caution boxes call attention to operating conditions that may lead to equipment or property damage.

Note
Note boxes emphasize important information pertaining to Digital Genset Controller installation or operation.

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Warning!
READ THIS MANUAL. Read this manual before installing, operating, or maintaining the MGC-1550. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

Basler Electric does not assume any responsibility to compliance or noncompliance with national code, local code, or any other applicable code. This manual serves as reference material that must be well understood prior to installation, operation, or maintenance.
For terms of service relating to this product and software, contact MTU Onsite Energy
It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact MTU Onsite Energy for the latest revision of this manual.
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Introduction

An MGC-1550 Enhanced Digital Genset Controller accommodates both analog senders and J1939 CAN bus communication and provides Modbus™ communication via an RS-485 port. In this publication, the MGC-1550 Enhanced controller is hereby referred to as simply MGC-1550.

The MGC-1550 Digital Genset Controller provides integrated engine-genset control, protection, and metering in a rugged and economic package. Its features set make the MGC-1550 ideal for standalone genset applications where paralleling or load sharing is not required. Microprocessor based technology allows for exact measurement, setpoint adjustment, and timing functions. Front panel controls and indicators enable quick and simple MGC-1550 operation. The BESTCOMS*Plus*® software allows units to be easily customized for each application. Because of the low sensing burden in the MGC-1550, dedicated potential transformers (PTs) are not required. A liquid crystal display (LCD) with backlighting can be viewed under a wide range of ambient light and temperature conditions.

Features and Functions

The MGC-1550 Digital Genset Controller has the following features:

- Generator Control
- Engine and Generator Protection
- Automatic Transfer Switch Control (Mains Failure)
- Automatic Generator Configuration Detection
- Programmable Analog Engine Senders
- Seven Programmable Contact Inputs
- Programmable Logic
- Exercise Timer
- ECU Communications via SAE J1939
- Modbus Communications via RS-485
- Additional contact input/output module available to expand the capabilities of the MGC-1550

MGC-1550 Digital Genset Controllers perform the following functions:

Generator Protection and Metering

Multifunction generator protection guards against generator overvoltage, undervoltage, reverse power, loss of excitation, underfrequency, overfrequency, and overcurrent. Each generator protection function has an adjustable pickup and time delay setting.

Metered generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor (PF).

Engine Protection and Metering

Engine protection features include oil pressure and coolant temperature monitoring, overcrank protection, ECU specific protection elements, and diagnostic reporting.

Metered engine parameters include oil pressure, coolant temperature, battery voltage, speed, fuel level, engine load, coolant level (from ECU), ECU specific parameters, and run-time statistics.

Event Recording

An event log retains a history of system events in nonvolatile memory. Up to 30 event types are retained and each record contains a time stamp of the first and last occurrence, and the number of occurrences for each event. For more information, see the *Event Recording* chapter.

Contact Inputs and Outputs

MGC-1550 controllers have seven programmable contact inputs. All contact inputs recognize dry contacts. The programmable inputs can be configured to initiate a pre-alarm or alarm. An input can be programmed to receive an input from an automatic transfer switch. Inputs can also be programmed to

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override MGC-1550 alarms and protection functions. Each input can be assigned a user-defined name for easy identification at the front panel display and in fault records.

Output contacts include three dedicated relays for energizing an engine's glow plugs, fuel solenoid, and starter solenoid. Four additional user-programmable output contacts are provided.

Additional contact inputs and output contact requirements can be accommodated with an optional CEM-2020 (Contact Expansion Module). Contact MTU Onsite Energy for ordering information.

Automatic Transfer Switch Control (Mains Failure)

The MGC-1550 can detect a mains failure via a single- or three-phase bus input. A mains failure is established when any one of the following conditions are met:

- Any phase of bus voltage falls below dead the bus threshold
- Any phase of bus voltage is unstable due to overvoltage or undervoltage
- Any phase of bus voltage is unstable due to overfrequency or underfrequency

At this time, the MGC-1550 will start the genset and when ready, apply power to the load via the genset. The MGC-1550 implements open transitions to and from the mains. When the mains returns and is considered stable, the MGC-1550 will transfer the load back to the mains.

Communication

MGC-1550 communication features include a standard USB port for local (and temporary) communication, SAE J1939 interface for remote communication, and RS-485 interface for communication with an optional Remote Display Panel.

USB Port

The USB communication port can be used with BESTCOMS*Plus* software to quickly configure an MGC-1550 with the desired settings or retrieve metering values and event log records.

CAN Interface

The CAN interface provides high-speed communication between the MGC-1550 and the engine control unit (ECU) on an electronically controlled engine. This interface provides access to oil pressure, coolant temperature, and engine speed data by reading these parameters directly from the ECU. When available, engine diagnostic data can also be accessed. The CAN interface supports the following protocols:

- SAE J1939 Protocol - Oil pressure, coolant temperature, and engine speed data are received from the ECU. In addition, DTCs (Diagnostic Trouble Codes) help diagnose any engine or related failures. The engine DTCs are displayed on the front panel of the MGC-1550 and may be obtained using BESTCOMS*Plus*® software.
- MTU Protocol - An MGC-1550 connected to a genset equipped with an MTU ECU receives oil pressure, coolant temperature, and engine speed data from the engine controller, along with various alarms and pre-alarms that are MTU specific. In addition, the MGC-1550 tracks and displays the active fault codes issued by the MTU engine ECU.

RS-485

An RS-485 communication port uses the Modbus™ communication protocol and enables remote control and monitoring of the MGC-1550 over a polled network. The RS-485 port may be used for either Modbus communication or communication with an optional Remote Display Panel. The type of communication used by the RS-485 port is based on style number and is decided during the ordering process. See Style Number below for details.

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Style Number

Standard-order MGC-1550 controllers are identified by a style number which consists of a combination of letters and numbers that define the controller's electrical characteristics and operational features. The model number, together with the style number, describes the options included in a specific controller. Figure 1 illustrates the MGC-1550 style number identification chart.

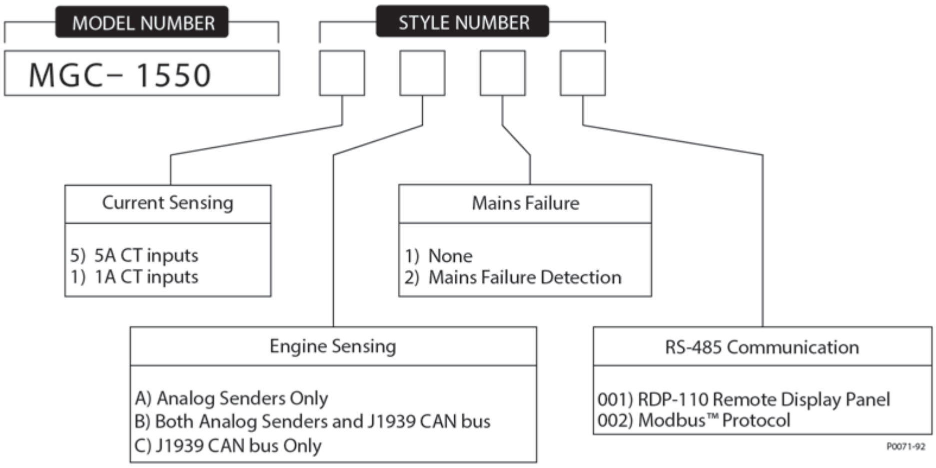

Figure 1. MGC-1550 Style Chart

For example, an MGC-1550 with style number **5A2002**, has the following characteristics and features.

5 5 Aac Current Sensing Inputs
A Analog Senders Only
2 Mains Failure Detection
002 Modbus™ Protocol

Optional Features and Capabilities

CEM-2020 (Contact Expansion Module)

The optional CEM-2020 provides 10 additional contact inputs and 24 additional output contacts to the MGC-1550. The CEM-2020 communicates with the MGC-1550 through a CAN interface. Refer to the *CEM-2020* chapter for more information.

Remote Display Panel

The optional Remote Display Panel provides remote indication of many pre-alarm and alarm conditions. The MGC-1550 communicates with the Remote Display Panel through an RS-485 interface. Refer to the *Controls and Indicators* chapter for more information.

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Controls and Indicators

MGC-1550 controls and indicators are located on the front panel and are intended for local control and monitoring of MGC-1550 operation. Front panel controls consist of pushbuttons. Front panel indicators consist of LED (light emitting diode) indicators and a backlit LCD (liquid crystal display).

MGC-1550 controls and indicators are illustrated in Figure 2. Lettered locators in Figure 2 correspond to the control and indicator descriptions of Table 1.

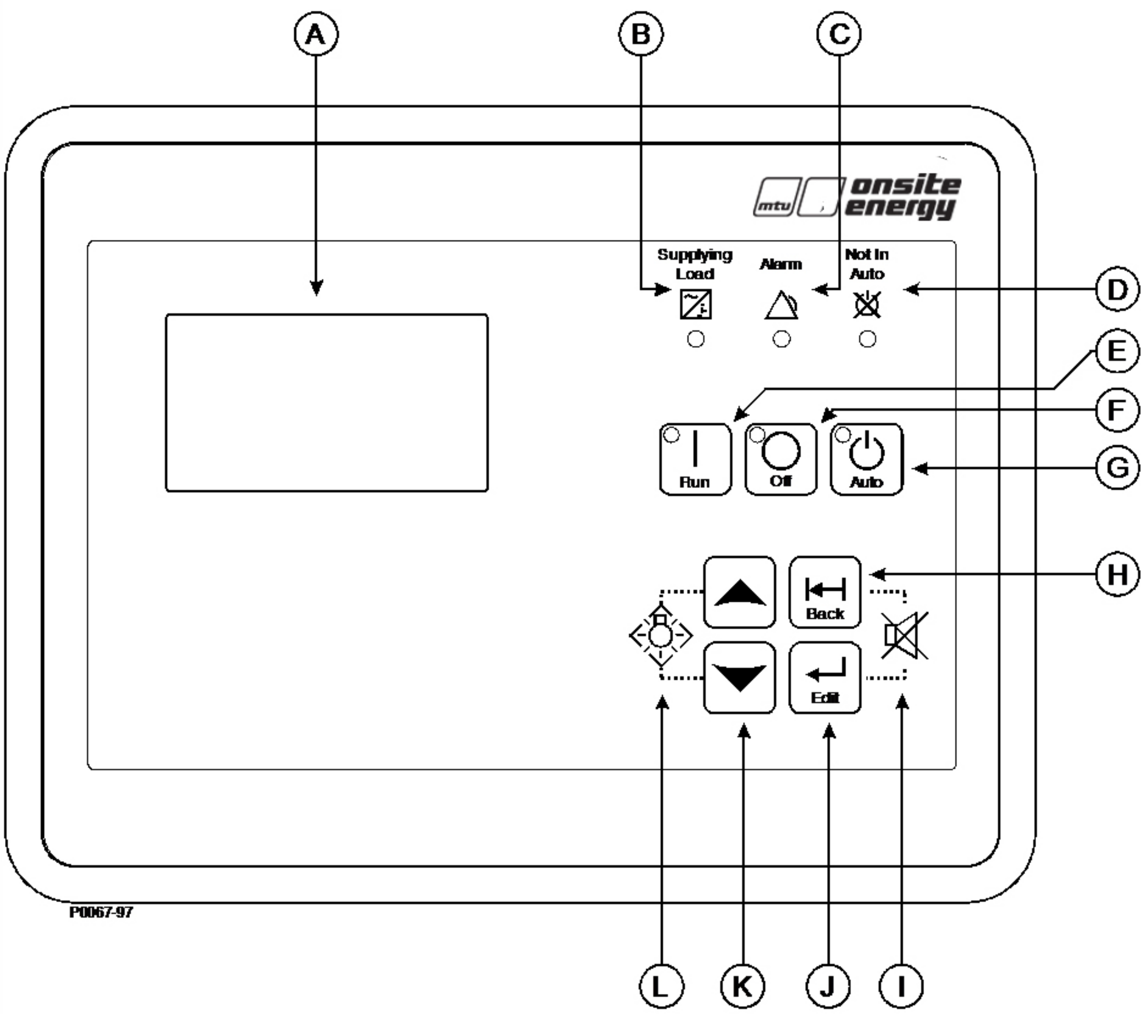

Figure 2. Front Panel

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Table 1. Front Panel HMI Descriptions

Locator	Description
A	*Liquid Crystal Display.* The backlit, 64 by 128 pixel LCD serves as the local information source for metering, alarms, pre-alarms, and protective functions. Display operation is maintained at –40°C.
B	*Supplying Load Indicator.* This green LED lights when the generator current is greater than Emergency Power Supply (EPS) threshold current.
C	*Alarm Indicator.* This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
D	*Not in Auto Indicator.* This red LED lights when the MGC-1550 is not operating in Auto mode. When the MGC-1550 is operating in Run or Off mode, this LED is on.
E	*Run Pushbutton and Mode Indicator.* Pressing this button places the MGC-1550 in Run mode. The green Run mode LED lights when Run mode is active.
F	*Off Pushbutton and Mode Indicator.* Pressing this button places the MGC-1550 in Off mode. The red Off mode LED lights when the MGC-1550 is in Off mode. This button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms.
G	*Auto Pushbutton and Mode Indicator.* Pressing the Auto button places the MGC-1550 in Auto mode. The green Auto mode LED lights when Auto mode is active.
H	*Back Pushbutton.* This button is pressed to cancel a settings editing session and discard any settings changes. When navigating through menus, pressing this button moves upward a level. When pressed momentarily, this button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms. This button is also used to reset the Maintenance Interval when pressed for 10 seconds while viewing Hours Until Maintenance or Maintenance Due Pre-Alarm.
I	*Alarm Silence Pushbutton Combination*. Simultaneously pressing both the *Back* and *Edit* buttons opens the relay output programmed as the horn output.
J	*Edit Pushbutton.* Pressing this button starts an editing session and enables changes to MGC-1550 settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes. When navigating through menus, pressing this button moves downward one level. When entering a string, such as a password, this button locks the selected character and moves to the next position. When finished, press Edit twice to submit the string.
K	*Arrow Pushbuttons.* These two buttons are used to navigate through the front panel display menus and modify settings. Within a level, the up- and down-arrow buttons are used to move among items within the menu level. Pressing the down-arrow button moves to items lower in the list. Pressing the up-arrow button moves to items higher in the list. During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.
L	*Lamp Test Pushbutton Combination*. Simultaneously pressing both the Up- and Down-arrow buttons tests the MGC-1550 indicators by exercising all LCD pixels and lighting all LEDs for as long as both buttons are held.

Display Operation and Navigation

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The front panel display is used to make settings changes and display metering values. Refer to locators H, J, and K in Table 1 for information on changing settings through the front panel and navigating through the Metering screens.

Login and Permissions

To login, navigate to the SETTINGS > ENTER PASSWORD screen and press the *Edit* key. Use the *Up/Down* arrow keys to scroll through the characters. Use the *Edit* key to accept a character and move to the next space. Once the password has been entered, press the *Edit* key again to login. A LOGOUT selection now appears in the list of SETTINGS. To logout, navigate to SETTINGS > LOGOUT and press the *Edit* key. The LOGOUT selection is removed from the SETTINGS list.

If communication access is active through the USB port, the front panel will display REMOTE COMMS, FRONT PANEL IS READ ONLY and the summary screen. This informs the user that the front panel can only be used for viewing metering data and settings information. USB port access must be ended before modifying settings through the front panel.

If a front-panel key is not pressed for more than 15 minutes, the user is automatically logged out.

Summary Screen and Configurable Metering

The summary screen can be set to standard or scrolling. When set to standard, only the following parameters are displayed:

- VOLT∗
- AMP∗
- PH∗
- Hz
- OIL
- FUEL
- TEMP
- BATT

∗ When set to standard, individual phase information can be automatically toggled at a rate set by the Phase Toggle Delay setting. Navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit PH TOG DELAY. When the Phase Toggle Delay is set to zero, information for each phase is obtained by pressing the *Up* or *Down* arrow keys on the front panel HMI. When it is set to a number other than zero, the display will toggle through the phases automatically at the rate specified by the Phase Toggle Delay Setting.

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values will scroll at a delay time specified by the user. To select a standard or scrolling summary, navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit the SUMMARY VIEW. The SCROLL DELAY setting is also found on this screen.

To select the scrolling values, navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit the CONFIGURABLE METERING. The following parameters may be placed in the scrolling summary:

- BATT V
- BLANK (Shows nothing on this line)
- BOOST PRESS
- BUS Hz
- BUS VAB
- BUS VBC
- BUS VCA
- CHRG AIR TMP
- COOLANT PRESS
- DEF1 %
- DEF2 %
- ENGINE % LOAD
- ENG INTCLR TEMP
- ENG OIL TEMP
- FUEL
- FUEL DELV P
- FUEL RATE
- FUEL TEMP
- GEN Hz
- GEN IA
- GEN VBN
- GEN VCA
- GEN VCN
- INJ RAIL PRS
- INTAK MNFLD TMP
- kVA A
- kVA B
- kVA C
- kVA TOT
- kvar A
- kvar B
- kvar C
- kW LD %
- kvar TOTAL
- kW A
- kW B
- kW C
- kWh
- kW TOT
- NONE (Removes a line from the scrolling list)

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- GEN IB
- GEN IC
- GEN PF
- GEN VAB
- GEN VAN
- GEN VBC
- OIL P
- RPM
- RPM SRC
- RUN HRS
- TEMP
- TOTAL FUEL USED

Sleep Mode

Sleep mode de-energizes the LCD backlight and heater when no pushbutton activity is detected for 15 minutes and the MGC-1550 is operating in OFF mode or Auto mode with the engine not running. Normal display operation resumes when any pushbutton is pressed or the genset is started remotely via the ATS input. Sleep mode will not be entered while an alarm is active. Sleep mode can be permanently disabled through BESTCOMS*Plus*® or the front panel.

Changing a Setting

To change a setting, navigate to the setting you want to change and press the *Edit* key. If you are not already logged in, you will be prompted for your password. Use the *Up/Down* arrow key to raise or lower the value. Press the *Edit* key again when finished.

Front Panel Display Structure

The front panel display structure begins with the SUMMARY SCREEN. Pressing the *Edit* key opens the MAIN MENU screen. The MAIN MENU screen consists of METERING, SETTINGS and, when enabled, the ONE-LINE DIAGRAM, indicated by this symbol: . The METERING screen branches are shown in Figure 3. Details of the METERING screen branches follow Figure 3. The SETTINGS screen branches are shown in Figure 4. Details of the SETTINGS screen branches follow Figure 4. The ONE-LINE DIAGRAM screen options are shown in Figure 5.

METERING

ENGINE
GENERATOR
POWER
RUN STATISTICS
ALARMS-STATUS
DIAGNOSTICS

P0067-82

Figure 3. Metering Screen Branches

ENGINE

- **OIL PRESSURE**
- **COOLANT TMP**
- **BATTERY VOLT**
- **RPM**
- **SPEED SRC**
- **FUEL LEVEL**
- **ENGINE LOAD**
- **COOLANT LEVL** (Visible when CAN Bus is enabled.)
- **TOTAL RUN TM**
- **HRS TO MAINT**
- **DEF TANK 1 LVL %** (Visible when CAN Bus is enabled.)
- **DEF TANK 2 LVL %** (Visible when CAN Bus is enabled.)

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GENERATOR

- **GEN CONNECT**
- **GEN VAB**
- **GEN VBC**
- **GEN VCA**
- **GEN VAN**
- **GEN VBN**
- **GEN VCN**
- **GEN FREQ**
- **GEN AMPS A**
- **GEN AMPS B**
- **GEN AMPS C**
- **BUS CONNECT**
- **BUS VAB**
- **BUS FREQ**

POWER

- **kW A**
- **kW B**
- **kW C**
- **kW TOTAL**
- **kVA A**
- **kVA B**
- **kVA C**
- **kVA TOTAL**
- **kvar A**
- **kvar B**
- **kvar C**
- **kvar TOTAL**
- **PF**

RUN STATISTICS

- **CUMULATIVE**
  - CUMULATIVE
    - START
    - # STARTS
    - HRS TO MAINT
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
  - LOADED RUN TIME
    - HOURS
    - MINUTES
  - UNLOADED RUN TIME
    - HOURS
    - MINUTES
- **SESSION**
  - SESSION
    - START
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
  - LOADED RUN TIME
    - HOURS
    - MINUTES
  - UNLOADED RUN TIME
    - HOURS
    - MINUTES

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ALARMS-STATUS

- **ACTIVE ALARMS**
- **ACTIVE PRE-ALARMS**
- **MTU FAULT CODES** (Visible when ECU is configured for MTU MDEC, MTU ADEC, MTU ECU7/ECU8 or MTU Smart Connect.)
- **MTU STATUS** (Visible when ECU is configured for MTU MDEC, MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - NMT-ALIVE STATUS (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - SPS_NODE
    - SW_TYP
    - SW_VAR
    - SW_ED1
    - SW_ED2
    - REV
    - SW_MOD
  - TRIP FUEL (Visible when ECU is configured for MTU ECU7/ECU8.)
    - TRIP HRS
    - TRIP IDLE HRS
    - FUEL RATE
    - TRIP FL RATE
    - TOTAL RUN TM
    - DAILY FUEL
    - TOTAL FUEL
  - FUEL (Visible when ECU is configured for MTU ADEC.)
    - DAY TANK LVL
    - STORE TANK LVL
  - ENGINE STATUS (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - MTU FAULT CODES
    - ENG RUNNING
    - CYL CUTOUT
    - ENG OPTIMIZED (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - PREHT NT RCHD (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPEC TORQUE (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPD DMD FL MD (Visible when ECU is configured for MTU ADEC.)
    - CURR P DEGREE (Visible when ECU is configured for MTU ADEC.)
    - LOAD GEN ON (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - PRIME PUMP ON (Visible when ECU is configured for MTU ADEC.)
    - RUNUP SPD LO (Visible when ECU is configured for MTU ADEC.)
    - IDLE SPD LO (Visible when ECU is configured for MTU ADEC.)
    - CYL CUTOUT CD (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - DROOP % (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
    - ENG COOL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CHRG AIR TMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INTRCOOLR TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ENG OIL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FUEL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - OIL PRESSURE (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CHG AIR P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FUEL DELV P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FL RAIL P (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU SHUTDOWN (Visible when ECU is configured for MTU ECU7/ECU8.)
    - TOTAL RUN TM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU SUPP VOLTS (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INJCT DBR % (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INJCT QTY (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RATED KW (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RESRV PWR % (Visible when ECU is configured for MTU ECU7/ECU8.)

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        - START SEQ (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
        - ECU OVRD FDBK (Visible when ECU is configured for MTU Smart Connect.)
        - COOLNT PRHT DONE (Visible when ECU is configured for MTU Smart Connect.)
        - REQ TORQUE (Visible when ECU is configured for MTU Smart Connect.)
        - EXT STOP (Visible when ECU is configured for MTU Smart Connect.)
        - OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)
    - SPEED (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
        - SPD DMD SRC
        - CAN SPD DMD
        - ANLG SPD DMD
        - SPEED DEMAND (Visible when ECU is configured for MTU Smart Connect.)
        - SEL SPD DMD (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
        - EFF SET SPEED (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
        - SPD DMD FL MD (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
        - RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
        - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
        - CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
        - IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
        - FREQ RPM DMD (Visible when ECU is configured for MTU ECU7/ECU8.)
    - SIGNL FEEDBK (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
        - ECU_OVRD_FDBK
        - EXT STOP
        - SPD UP IN
        - SPD DN IN
        - CAN MODE FDBK (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
        - CYL CUTOUT (Visible when ECU is configured for MTU ECU7/ECU8.)
    - DIAGNOSTICS (Visible when ECU is configured for MTU ECU7/ECU8.)
        - AL PWR AMP 1
        - AL PWR AMP 2
        - XSTR OUT AL
        - XSTR OUT STS
        - ECU SHUTDOWN
    - CAN BUS (Visible when ECU is configured for MTU ECU7/ECU8.)
        - CAN MODE FDBK
        - CAN NODES
        - LOST NODES
    - LIMITS (Visible when ECU is configured for MTU ECU7/ECU8.)
        - OIL PRESSURE
        - LO LIM OILP
        - LOLOLIM OILP
        - ENG COOL TEMP
        - CLNT LMT HI
        - CLNT LMT HIHI
        - CHRG AIR TMP
        - CHG AIR LMT HI
        - ECU SUPP VOLTS
        - L1L ECU VOLTS
        - L2L ECU VOLTS
        - U1L ECU VOLTS
        - U2l ECU VOLTS
        - INTRCOOLR TMP
        - INTCLR LMT HI
- **STATUS**
    - AUTO XFER SWITCH (Visible when the Auto Transfer Switch programmable function is configured to be driven by an input.)
    - EPS SUPP. LOAD
    - GEN BREAKER
    - MAINS BREAKER
    - BATTLE OVERRIDE (Visible when the Battle Override programmable function is configured to be driven by an input.)
    - LOW LINE OVERRIDE (Visible when the Low Line Override programmable function is configured to be driven by an input.)

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    - LOW COOL LEVEL (Visible when the Low Coolant Level programmable function is configured to be driven by an input.)
    - LOW FUEL LEVEL (Visible when the Low Coolant Level programmable function is configured to be driven by an input.)
    - BATT CHRG FAIL (Visible when the Battery Charger Fail programmable function is configured to be driven by an input.)
    - FUEL LEAK DETECT (Visible when the Fuel Leak Detect programmable function is configured to be driven by an input.)
    - GRND DELTA O-RIDE (Visible when Generator Connection is configured for Delta and the Grounded Delta Override programmable function is configured to be driven by an input.)
    - 1 PHASE O-RIDE (Visible when the 1-Phase Override programmable function is configured to be driven by an input.)
    - BUS DEAD
    - BUS STABLE
    - BUS FAILED
    - GEN DEAD
    - GEN STABLE
    - GEN FAILED
    - ENG RUNNING
    - CLDN TMR ACTVE
    - OFF MODE COOLDN
    - COOLDN REQ
    - COOL & STOP REQ
    - EXT START DEL
    - START DEL BYPASS
    - ALT FRQ O-RIDE
    - RESET
    - ALARM SILENCE
    - LAMP TEST
    - IDLE REQUEST
    - MAINS FAIL TEST
    - CEM CONNECTED
- **INPUTS**
    - INPUT X (X = 1 to 7 (8 to 17 optional))
- **OUTPUTS**
    - START
    - RUN
    - PRESTART
    - OUTPUT X (X = 1 to 4 (5 to 28 optional))
- **LOGIC CTL RELAYS**
    - LCR X (X = 1 to 16)
- **CONF ELEMENTS**
    - CONFIG ELEMENT X (X = 1 to 8)
- **EVENT LOG**
    - [EVENT NAME]
        - ACTIVE
        - OCCURRENCE COUNT
        - FIRST DATE
        - FIRST TIME
        - LAST DATE
        - LAST TIME
        - FIRST ENG HRS
        - LAST ENG HRS
        - DETAILS
            - OCCURRENCE (Use the *Edit/Up/Down* keys to change the occurrence.)
            - DATE
            - TIME
            - ENG HRS
        - CLEAR EVENT (Visible when logged in through the front panel.)
- **J1939 DATA** (Visible when CAN bus is enabled and ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, MTU Smart Connect, Scania, or John Deere.)
    - THROTTLE POSITN
    - LOAD @ CRNT RPM
    - ACTUAL ENG TORQ
    - ENGINE SPEED

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- DESIRED SPEED
- INJ CNTRL PRESS
- INJ RAIL PRS
- ENGINE HOURS
- TRIP FUEL
- TRIP AVE FL RT
- TOTAL FUEL USED
- ENG COOLANT TEMP
- COOLNT PRHT DONE
- FUEL TEMP
- ENG OIL TEMP
- ENG INTCLR TEMP
- INTRCR CLNT LVL
- FUEL DELV P
- ENG OIL LEVEL
- ENG OIL PRESS
- COOLANT PRESS
- COOLANT LEVEL
- FUEL RATE
- BAROMETRIC PRESS
- AMB AIR TEMP
- AIR INLET TEMP
- BOOST PRESS
- INTAK MNFLD TEMP
- INTAK MNFLD1 ABS PRESS
- AIR FLTR DIF PRS
- EXHAUST GAS TEMP
- BATTERY VOLTAGE
- ECU INPUT VOLTS
- TRANS OIL PRESS
- TRANS OIL TEMP
- WINDG 1 TEMP
- WINDG 2 TEMP
- WINDG 3 TEMP
- ECU TEMP
- AUX PRESSURE1
- AUX PRESSURE2
- RATED KW
- RATED RPM
- EXHAUST TMP A
- EXHAUST TMP B
- CHRG AIR TMP
- FUEL 1 LEAK
- FUEL 2 LEAK
- ALARM RST FDBK
- ECU SHUTDOWN
- DEF TANK 1 LVL %
- DEF TANK 2 LVL %

- **J1939 ENGINE CONFIG** (Visible when CAN bus is enabled and ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
  - SPD @ IDLE PNT 1
  - TRQ @ IDLE PNT 1
  - SPD @ PNT 2
  - TRQ @ PNT 2
  - SPD @ PNT 3
  - TRQ @ PNT 3
  - SPD @ PNT 4
  - TRQ @ PNT 4
  - SPD @ PNT 5
  - TRQ @ PNT 5
  - SPD @ PNT 6
  - ENDSPEED GOV KP
  - REF ENG TORQUE
  - O-RIDE SPD PNT 7
  - O-RIDE TIME LMT

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  - SPEED LOWER LMT
  - SPEED UPPER LMT
  - TORQUE LOWER LMT
  - TORQUE UPPER LMT

- **MAINS FAIL TRANSFER** (Visible when MGC-1550 style number is xx2 and Mains Fail Transfer is enabled.)
  - **MAINSFAIL XFER STATE**
    - **DISABLED** (The possible mains fail transfer states are as follows: Power From Mains, Transfer Timer Active, Transferring to Gens, Power From Gens, Return Timer Active, Transferring to Mains, Disabled (when MGC is in OFF or RUN modes, or in the alarm state))
  - **TRANSFER DELAY** (Visible when actively counting and relevant to mains fail transfer.)
  - **RETURN DELAY** (Visible when actively counting and relevant to mains fail transfer.)
  - **MAX TRANSFER TIME** (Visible when actively counting and relevant to mains fail transfer.)

DIAGNOSTICS

- **FLASH WR**

SETTINGS

GENERAL SETTINGS
COMMUNICATIONS
SYSTEM PARAMS
PROGRAMMABLE INPUTS
PROGRAMMABLE OUTPUTS
ALARM CONFIGURATION
GENERATOR PROTECTION
BREAKER MANAGEMENT
LOGIC TIMERS
ENTER PASSWORD

P0067-83

Figure 4. Settings Screen Branches

GENERAL SETTINGS

- **FRONT PANEL HMI**
  - SUMMARY VIEW
  - SCROLL DELAY
  - PH TOG DELAY
  - LCD CONTRAST
  - SLEEP MODE
  - LANGUAGE
  - CONFIGURABLE METERING
    - ITEM X (X = 1 to 20)
  - ONE-LINE DIAGRAM
- **CONFIGURE DATE/TIME**
  - YEAR
  - MONTH
  - DAY
  - HOURS
  - MINUTES
  - SECONDS
  - UTC OFFSET
  - DST ENABLED
  - CLK NOT SET WRN
- **VIEW DATE/TIME**
- **VERSION INFO**
  - MGC-1550
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - LANGUAGE VERSION
    - LANGUAGE PART NUM

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    - STYLE CODE
  - CEM-2020 (Visible when CEM-2020 is enabled.)
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - BUILD DATE

COMMUNICATIONS∗

∗(Visible when the optional J1939 CAN bus is enabled, style code xCx.)

- **CAN BUS SETUP**
  - CAN BUS SETUP
    - CAN BUS ENABLE
    - DTC ENABLE (Visible when CAN BUS is enabled.)
    - SPN CONV METHOD (Visible when CAN BUS is enabled.)
    - CAN BUS ADDR (Visible when CAN BUS is enabled.)
    - ECU OPT SLCT (Visible when CAN BUS is enabled.)
    - ECU PULSING (Visible when CAN BUS is enabled.)
    - ENG SHTDN TM (Visible when CAN BUS is enabled.)
    - PLS CYCL TM (Visible when CAN BUS is enabled.)
    - ECU SET TM (Visible when CAN BUS is enabled.)
    - RESP TIMEOUT (Visible when CAN BUS is enabled.)
  - ECU SETUP (Visible when CAN BUS is enabled.)
    - ECU CONF
    - GEN DATA TRANSMIT
    - ENGINE PARAM XMT
    - TRIP RESET (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
    - DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
      - DPF MANUAL REGEN
      - DPF REGEN DISABLE
    - SPEED SELECT (Visible when ECU is configured for Volvo Penta.)
    - ACCEL POSITION (Visible when ECU is configured for Volvo Penta.)
    - MODULE TYPE (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - ALIVE MSG (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - SPEED SETUP
      - J1939 RPM ENABLE (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
      - ENGINE RPM
      - RPM BAND WIDTH
      - IDLE RPM
      - SPEED UP (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - SPEED DN (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - TEST OVRSPEED (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - SPD DMAND SRC (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - IDLE REQUEST (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - INCREASE IDLE (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
    - ECU SETUP (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
      - TRIP RESET (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
      - INT OIL PRIME
      - GOV PRM SW (Visible when ECU is configured for MTU ADEC or MTU Smart Connect.)
      - ENG STRT PRIME (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)

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- FAN OVERRIDE (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
- MODE SWITCH (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
- GOV PARAM SET (Visible when ECU is configured for MTU ECU7/ECU8.)
- CAN RATING SW 1 (Visible when ECU is configured for MTU ECU7/ECU8.)
- CAN RATING SW 2 (Visible when ECU is configured for MTU ECU7/ECU8.)
- DIS CYL CUT 1 (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
- DIS CYL CUT 2 (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8 or MTU Smart Connect.)
- OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)

SYSTEM PARAMS

- **SYSTEM SETTINGS**
  - GEN CONNECT
  - BUS CONNECT
  - RATED kW
  - RATED VOLTS
  - RATED FREQ
  - ALTRNATE FRQ
  - RATED RPM
  - RATED PF
  - ROTATION
  - EPS
    - EPS THRESHLD
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - FUEL LVL TYP
  - SYSTEM UNITS
  - PRESSURE UNITS (Visible when Metric is selected for System Units.)
  - BATTERY VOLT
  - FLYWHL TEETH
  - SPEED SOURCE
  - MAINT RESET
  - NFPA LEVEL
  - POWER UP DELAY
- **REMOTE MODULE SETUP**
  - CEM SETUP
    - ENABLE
    - OUTPUTS (Visible when CEM-2020 is enabled.)
    - CAN BUS ADDR (Visible when CEM-2020 is enabled.)
    - VERSION INFO (Visible when CEM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
      - SERIAL NUMBER
      - PART NUMBER
      - MODEL NUMBER
      - BUILD DATE
    - CEM DEBUG MENU (Visible when CEM-2020 is enabled.)
      - DGC TO CEM BP
      - CEM TO DGC BP
- **CRANK SETTINGS**
  - DISCNCT LMIT
  - PRECRNK DELY
  - PRESTRT CNTCT
  - STYLE
  - # CYCLES (Visible when Cycle is selected for Cranking Style.)
  - CONT TIME (Visible when Continuous is selected for Cranking Style.)
  - CYCLE TIME
  - COOLDWN TIME
  - OFF MODE COOLDN
  - PRESTART REST CONFIG
    - CONF

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- OIL PRS CRANK DISC
  - ENABLE
  - CRANK DISC PRS
- **AUTOMATIC RESTART**
  - ENABLE
  - ATTEMPTS
  - INTERVAL
- **EXERCISE TIMER**
  - MODE
  - RUN WITH LOAD
  - START HOUR
  - START MINUTE
  - RUN HOURS
  - RUN MINUTES
- **SENSING TRANS**
  - GEN PT PRI V
  - GEN PT SEC V
  - GEN CT PRI A
  - CT LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - BUS PT PRI V
  - BUS PT SEC V
- **RELAY CONTROL**
  - START
  - RUN
  - PRESTART
- **AUTO CONFIG DETECT**
  - ENABLE
  - LOW LINE THRESH
  - 1-PH THRESH
- **ENGINE STATISTICS**
  - START YEAR
  - START MONTH
  - START DAY
  - # STARTS
  - HRS TO MAINT
  - kW-HRS
  - TOTAL HRS
  - LOADED HRS
  - UNLOADED HRS

PROGRAMMABLE INPUTS

- **CONFIGURABLE INPUTS**
  - INPUT X (X = 1 to 7)
    - ALARM CONFIG
    - ACTIVATN DLY
    - RECOGNITION
- **PROG FUNCTIONS**
  - EMERGENCY STOP
    - INPUT
  - AUTO XFER SWITCH
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - GRND DELTA O-RIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - BATTLE OVERRIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - LOW LINE OVERRIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - 1 PHASE O-RIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)

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- BATT CHRG FAIL
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
  - RECOGNITION (Visible when an INPUT is selected.)
- LOW COOL LEVEL
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
  - RECOGNITION (Visible when an INPUT is selected.)
- LOW FUEL LEVEL
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
  - RECOGNITION (Visible when an INPUT is selected.)
- FUEL LEAK DETECT
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
  - RECOGNITION (Visible when an INPUT is selected.)

PROGRAMMABLE OUTPUTS

- **CONFIG ELEMENTS**
  - CONFIG ELEMENT X (X = 1 to 8)
    - ALARM CONFIG
    - ACTIVATN DLY
    - RECOGNITION

ALARM CONFIGURATION

- **HORN CONFIGURATION**
  - HORN
  - NOT IN AUTO HORN
- **PRE-ALARMS**
  - HIGH COOLANT TEMP
    - ENABLE
    - THRESHOLD
  - LOW COOLANT TEMP
    - ENABLE
    - THRESHOLD
  - LOW OIL PRESSURE
    - ENABLE
    - THRESHOLD
  - LOW FUEL LEVEL
    - ENABLE
    - THRESHOLD
  - MAINTENANCE INTERVAL
    - ENABLE
    - THRESHOLD
  - BATTERY OVERVOLTAGE
    - ENABLE
    - THRESHOLD
  - LOW BATTERY VOLTAGE
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY
  - WEAK BATTERY VOLTAGE
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY
  - HIGH FUEL LEVEL
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY

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- ACTIVE DTC (Visible when DTC is enabled.)
    - ENABLE
- ECU COMMS FAIL (Visible when CAN BUS is enabled.)
    - ENABLE
- COOLANT LEVEL (Visible when CAN BUS is enabled.)
    - ENABLE
    - THRESHOLD
- CEM COMM FAIL (Visible when CEM-2020 is enabled.)
    - ENABLE
- CHECKSUM FAIL
    - ENABLE
- BRK CLOSE FAIL PALM
    - ENABLE
- BRK OPEN FAIL PALM
    - ENABLE

- **ALARMS**
    - HIGH COOLANT TEMP
        - ENABLE
        - THRESHOLD
        - ARMING DELAY
    - LOW OIL PRESSURE
        - ENABLE
        - THRESHOLD
        - ARMING DELAY
    - LOW FUEL LEVEL
        - ENABLE
        - THRESHOLD
        - ACTIVATN DLY
    - OVERSPEED
        - ENABLE
        - THRESHOLD
        - ACTIVATN DLY
    - COOLANT LEVEL (Visible when CAN bus is enabled.)
        - ENABLE
        - THRESHOLD

NOTE

The HIGH COOLANT TEMP and LOW OIL PRESSURE alarms have an ARMING DLY setting that disables the alarm for the specified time after engine startup.

- **SENDER FAIL**
    - COOL TEMP SENDR FAIL
        - CONFIG TYPE
        - ACTIVATN DLY
    - OIL PRESS SENDR FAIL
        - CONFIG TYPE
        - ACTIVATN DLY
    - FUEL LEVL SENDR FAIL
        - CONFIG TYPE
        - ACTIVATN DLY
    - VOLTAGE SENSE FAIL
        - CONFIG TYPE
        - ACTIVATN DLY
    - SPEED SENDR FAIL
        - TIME DELAY

GENERATOR PROTECTION

- **27 UNDERVOLTAGE**
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
        - PICKUP
        - HYSTERESIS

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        - TIME DELAY
        - FREQ INHIBIT
        - ALARM CONFIG
- **59 OVERVOLTAGE**
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
        - PICKUP
        - HYSTERESIS
        - TIME DELAY
        - ALARM CONFIG
- **47 PHASE IMBALANCE**
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
- **81 O/U FREQUENCY**
    - UNDERFREQUENCY
        - INHIBIT VOLTS
        - PICKUP
        - HYSTERESIS
        - TIME DELAY
        - ALARM CONFIG
    - OVERFREQUENCY
        - PICKUP
        - HYSTERESIS
        - TIME DELAY
        - ALARM CONFIG
    - ALTRNT FRQ SCALE FCTR
        - ALT FREQ SF
- **50 OVERCURRENT**
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
        - PICKUP
        - TIME DELAY
        - ALARM CONFIG

BREAKER MANAGEMENT

- **BREAKER HARDWARE**
    - MAINS FAIL TRANSFER
        - ENABLE
        - RETURN DELAY
        - TRANSFER DELAY
        - MAX TRANSFER TIME
    - CLOSE WAIT TIME
        - TIME
    - GEN BREAKER
        - CONTINUOUS
        - CLOSING TIME
        - OPEN CMD
        - CLOSE CMD
    - MAINS BREAKER
        - CONFIGURED
        - CONTINUOUS (Visible when configured.)
        - CLOSING TIME (Visible when configured.)
        - OPEN CMD (Visible when configured.)
        - CLOSE CMD (Visible when configured.)
    - BRK CLOSE FAIL PALM
    - BRK OPEN FAIL PALM
- **BUS CONDITION DETECT**
    - GEN DEAD
        - THRESHOLD
        - TIME DELAY
    - GEN STABLE

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        - OV PICKUP
        - OV DROPOUT
        - UV PICKUP
        - UV DROPOUT
        - OF PICKUP
        - OF DROPOUT
        - UF PICKUP
        - UF DROPOUT
        - TIME DELAY
        - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
        - ALT FREQ SF
    - GEN FAILED
        - TIME DELAY
    - BUS DEAD
        - THRESHOLD
        - TIME DELAY
    - BUS STABLE
        - OV PICKUP
        - OV DROPOUT
        - UV PICKUP
        - UV DROPOUT
        - OF PICKUP
        - OF DROPOUT
        - UF PICKUP
        - UF DROPOUT
        - TIME DELAY
        - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
        - ALT FREQ SF
    - BUS FAILED
        - TIME DELAY

LOGIC TIMERS

- **TIMER X (X = 1 to 10)**
    - HOURS
    - MINUTES
    - SECONDS

ENTER PASSWORD

LOGOUT (Visible when logged in through the front panel.)

One-Line Diagram

A one-line diagram of the breaker hardware configuration can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. The one-line diagram is disabled by default. To display the one-line diagram using front panel controls, navigate to Settings > General Settings > Front Panel HMI > One-Line Diagram and enable the setting. If using BESTCOMS*Plus,* navigate to Settings Explorer, General Settings, Front Panel HMI and select Enable on the One-Line Diagram setting.

Once enabled, the one-line diagram appears on both the front panel Summary and Main Menu screens. The One-Line Diagram Menu screen provides metering for mains fail transfer, generator and bus parameters as well as breaker controls. To access the One-Line Diagram Menu screen, go to the Main Menu and select the one-line diagram as you would a normal menu option and press the *Edit* pushbutton. The one-line diagram, mains fail transfer state (if enabled), generator and bus parameters, and breaker controls are displayed respectively from the top of the menu.

Further mains fail transfer state metering is available by selecting the “MAINSFAIL XFER STATE” and pressing the *Edit* pushbutton. Mains fail transfer state, transfer delay, return delay, and max transfer time are displayed.

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To issue a breaker open or breaker close command, select the appropriate menu option, press *Edit* and select ON.

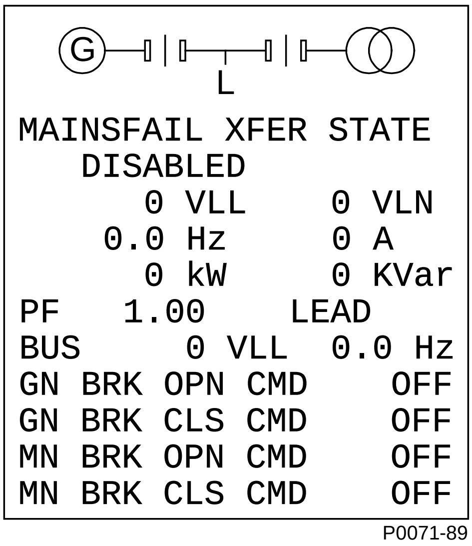
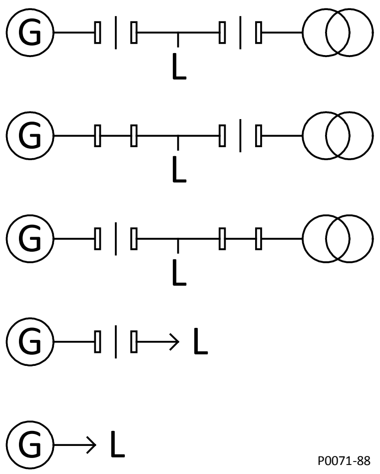


Figure 5. One-Line Diagram Menu Options (Available when One-Line Diagram is Enabled)



Generator and mains breakers are configured and both breakers are open.

Generator and mains breakers are configured. The generator breaker is closed and the mains breaker is open.

Generator and mains breakers are configured. The generator breaker is open and the mains breaker is closed.

Generator breaker is configured and open.

No breakers are configured.

Figure 6. One-Line Diagram: Breaker Hardware Status Indication

Mains Fail Transfer Status Display

Mains Fail Transfer Status can be viewed from three locations; however, the MGC-1550 must be equipped with Mains Fail Transfer (style number xx2) and Mains Fail Transfer must be enabled.

To enable Mains Fail Transfer, navigate to Settings > Breaker Management > Breaker Hardware > Mains Fail Transfer using the front panel controls or Settings Explorer, Breaker Management, Mains Fail using BESTCOMS*Plus*.

Mains Fail Transfer Status is displayed on the front panel in Metering > Alarms-Status > Mains Fail Transfer and also on the Breaker Hardware One-Line Diagram screen. It is displayed in BESTCOMS*Plus* on the Metering Explorer, Mains Fail Transfer Status screen.

These screens display the Mains Fail Transfer State and any timers relevant to the mains fail transfer process. These parameters are listed below.

Mains Fail Transfer State: The different mains fail transfer states are described below.

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Power From Mains: Power is being supplied to the load from the mains bus.

Transfer Timer Active: Transfer Delay timer is actively counting.

Transferring to Gens: Load is being transferred to the generator bus.

Power From Gens: Power is being supplied to the load from the generator bus.

Return Timer Active: Return Delay timer is actively counting.

Transferring to Mains: Load is being transferred to the mains bus.

Disabled: MGC-1550 is in the OFF or RUN operating mode or in the alarm state.

Transfer Delay: Displays the current timer value in seconds.

Return Delay: Displays the current timer value in seconds.

Max Transfer Time: Displays the current timer value in seconds.

Note
The Mains Fail Transfer screen found at Metering > Alarms-Status > Mains Fail Transfer shows only timers that are actively counting and are relevant to mains fail transfer. They are not otherwise visible.

Display Setup

The MGC-1550 LCD can be customized to fit the needs of your specific application. The options can be adjusted using the front panel controls and through BESTCOMS*Plus*®. The display options are described below.

The *Front Panel HMI* screen is found in the BESTCOMS*Plus*® *Settings Explorer* under the *General Settings* category. If using the front panel, navigate to Settings > General Settings > Front Panel HMI.

Figure 7 shows the BESTCOMS*Plus*® Front Panel HMI settings screen.

1. LCD Contrast - Adjust this setting to reach the desired level of LCD contrast.
2. Front Panel Sleep Mode - Select *Enable* to send the MGC-1550 into sleep mode. In sleep mode, the LEDs and LCD backlight turn off after 15 minutes of inactivity on the front panel to minimize battery drain.
3. One Line Diagram Display Enable- Select *Enable* to display the one-line diagram.
4. Language Selection - Select from English, French, German, or Spanish.
5. Scrolling Screens - Specify the parameters which are to appear on the front panel LCD display.
    a. Configure the *Configurable HMI Summary Settings.*
    b. Set the *Scrolling Screen Enable* to *Enable*.
    c. Set the *Scrolling Screen Scroll Delay* parameter to the desired value.
6. Phase Toggle Delay - Set the phase toggle delay to a nonzero value if automatic scrolling through the phase information in the standard overview screen on the front panel is desired. If it is left at zero, scrolling through phase information is accomplished using the up and down arrow buttons.
7. Initializing Message 1 - This parameter defines the first line of text that appears on the front panel of the MGC-1550 as it is going through its power up and initializing sequence.
8. Initializing Message 2 - This parameter defines the second line of text that appears on the front panel of the MGC-1550 as it is going through its power up and initializing sequence.

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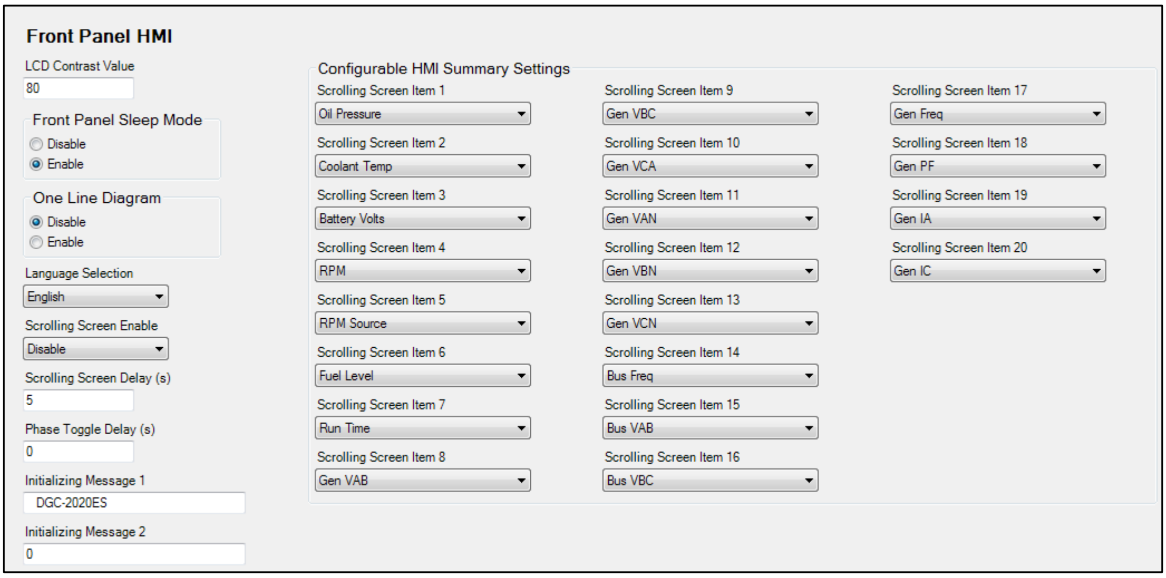

Figure 7. Settings Explorer, General Settings, Front Panel HMI Screen

Remote Display Panel (optional)

Applications that require remote annunciation can use Basler Electric's Remote Display Panel. This device provides remote indication of many pre-alarm and alarm conditions.

The following pre-alarm conditions are indicated by LEDs on the Remote Display Panel:

- High coolant temperature
- Low coolant temperature
- Low oil pressure
- Low fuel level∗
- Weak battery
- Battery overvoltage†
- Battery charger failure∗†

The following alarm conditions are indicated by LEDs and an audible alarm on the Remote Display Panel:

- Low coolant level∗
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop activated
- Fuel leak/Sender failure∗†
- Sender failure†

∗ This can be configured in the MGC-1550 as *None*, *Alarm*, or *Pre-alarm*. See the *Contact Inputs* chapter for more information. The LED on the Remote Display Panel illuminates when the input that is assigned to the programmable function is closed, whether the function is configured as *None*, *Alarm*, or *Pre-alarm*.

† This LED can be reprogrammed in the MGC-1550 to suit the needs of a particular application. The condition listed above is annunciated by default.

Additionally, the Remote Display Panel indicates when the MGC-1550 is not operating in Auto mode and when the generator is supplying load or when the MGC-1550 is in an alarm state not listed above.

Refer to Basler Publication 9318100990 for more information on the Remote Display Panel.

See the *Terminals and Connectors* chapter for more information on connecting the Remote Display Panel to the MGC-1550.

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Note
The RS-485 port may be used for either Modbus communication or communication with an RDP-110, but not simultaneously.

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Power Input

Operating power for the MGC-1550 is typically supplied by the genset starter battery. Power from the battery is supplied to an internal power supply that provides power for MGC-1550 logic, protection, and control functions.

Nominal Voltage Input and Acceptable Range of Input Voltage

A nominal voltage of 12 or 24 Vdc within a range of 6 to 32 Vdc is accepted. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the MGC-1550 will not operate.

Terminal Assignments

Input power is applied to terminals 18 (BATT+), 17 (BATT–), and 16 (CHASSIS).

Power Consumption

The amount of power consumed by the MGC-1550 varies based on the selected mode. The power saving Sleep mode consumes 4.5 W with all relays de-energized. The Normal Operational Mode consumes 6.5 watts in Run mode with the LCD heater off and 3 relays energized. The Maximum Operational Mode consumes 14 watts in Run mode with the LCD heater on and 7 relays energized.

Battery Ride-Through Capability

Starting at 10 Vdc, withstands cranking ride-through down to 0 Vdc for 50 milliseconds.

Fuse Protection

To follow UL guidelines, a 5 A maximum, 32 Vdc supplementary fuse must be implemented in the battery input circuit to the MGC-1550.

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Voltage and Current Sensing

The MGC-1550 senses generator voltage, generator current, and bus voltage through dedicated, isolated inputs.

Generator Voltage

The MGC-1550 accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 12 to 576 volts, rms line-to-line. Single-phase generator voltage is sensed across phases A and B. Generator voltage sensing terminals are listed in Table 2.

Table 2. Generator Voltage Sensing Terminals

Terminal	Description
40 (GEN VN)	Neutral generator voltage sensing input
41 (GEN VC)	C-phase generator voltage sensing input
43 (GEN VB)	B-phase generator voltage sensing input
45 (GEN VA)	A-phase generator voltage sensing input

Bus Voltage

Bus sensing over the range of 12 to 576 volts rms line-to-line is accepted by the MGC-1550. Sensing of bus voltage enables the MGC-1550 to detect failures of the mains (utility). Controllers with style number xx2 measure bus voltage sensing to perform automatic mains failure transfers. Single-phase bus voltage is sensed across phases A and B. Bus voltage sensing terminals are listed in Table 3.

Table 3. Bus Voltage Sensing Terminals

Terminal	Description
46 (BUS VA)	A-phase bus voltage sensing input
48 (BUS VB)	B-phase bus voltage sensing input
50 (BUS VC)	C-phase bus voltage sensing input

Generator Current

The MGC-1550 has sensing inputs for A-phase, B-phase, and C-phase generator current. Depending on the style number, an MGC-1550 has a nominal sensing current rating of 1 Aac or 5 Aac. A style number of 1xx indicates 1 Aac nominal current sensing and a style number of 5xx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 4.

Table 4. Generator Current Sensing Terminals

Terminal	Description
38 (IA+)	A-phase generator current sensing input
37 (IA–)	
36 (IB+)	B-phase generator current sensing input
35 (IB–)	
34 (IC+)	C-phase generator current sensing input
33 (IC–)	

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Note

Unused current sensing inputs should be shorted to minimize noise pickup.

Caution

Generator current sensing terminals 37 (IA–), 35 (IB–), and 33 (IC–) must be terminated to ground for proper operation.

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Engine Sender Inputs

The MGC-1550 has sender inputs dedicated to monitoring the engine fuel level, oil pressure, and coolant temperature. These inputs are programmable to give the user flexibility in selecting the sender to be used in an application. Information about programming sender inputs is provided later in this chapter.

Connections

Oil pressure sender connections are made at terminals 52 and 2 (sender common). Fuel level sender connections are made at terminals 1 and 2. Coolant temperature sender connections are made at terminals 53 and 2.

Compatible Senders

Oil pressure senders that are compatible with the MGC-1550 include Datcon model 02505-00, Isspro model R8919, Stewart-Warner models 279BF, 279C, 411K and 411M, and VDO models 360025 and 360811. Compatible Fuel Level senders include the Isspro model R8925. Compatible Coolant Temperature senders include Datcon model 02019-00, Faria model TS4042, Isspro model, R8959, and Stewart-Warner model 334P. Other senders may also be used.

Operation

A current is provided to each sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the sender terminals will cause the MGC-1550 to indicate a failed sender.

Sender Programmability

BESTCOMS*Plus*® software allows for the programming of sender characteristics. See *Sender Characteristic Curves*, below, for more information.

Sender Characteristic Curves

The sender inputs of the MGC-1550 can be customized to obtain maximum accuracy from the coolant temperature, oil pressure, and fuel level senders.

The characteristic curve of each sender input can be configured with up to 11 points. Each point can be assigned a resistance input value and a corresponding temperature (coolant temperature sender), pressure (oil pressure sender), or percentage (fuel level sender) value. A sender slope setting automatically orders the values in the resistance column according to whether the sender requires a negative or positive slope. Sender curve points are automatically plotted on a curve in BESTCOMS*Plus*, which can be printed.

Sender curve points configured in BESTCOMS*Plus* can be saved in the configuration file. The data for all three senders is automatically saved with the MGC-1550 configuration file.

Any changes made in BESTCOMS*Plus* to the sender points, can be reverted to the factory-default values. A new settings file can also be created.

Curve Configuration

If the MGC-1550 receives engine information from an ECU, the programmable sender parameters for coolant temperature and oil pressure do not require configuration because they have no effect. Configuration of sender parameters is appropriate for resistive senders only.

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Fuel Level

Figure 8 illustrates the *Fuel Level* screen found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Senders* category. To program the fuel level sender, perform the following procedure:

1. The percent fuel level sender is configured by selecting one of the sender types that come as a part of the BESTCOMS*Plus* sender library. Click on *Load Fuel Settings File* and select the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to fuel level may be modified by setting numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Fuel Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Fuel Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the MGC-1550.

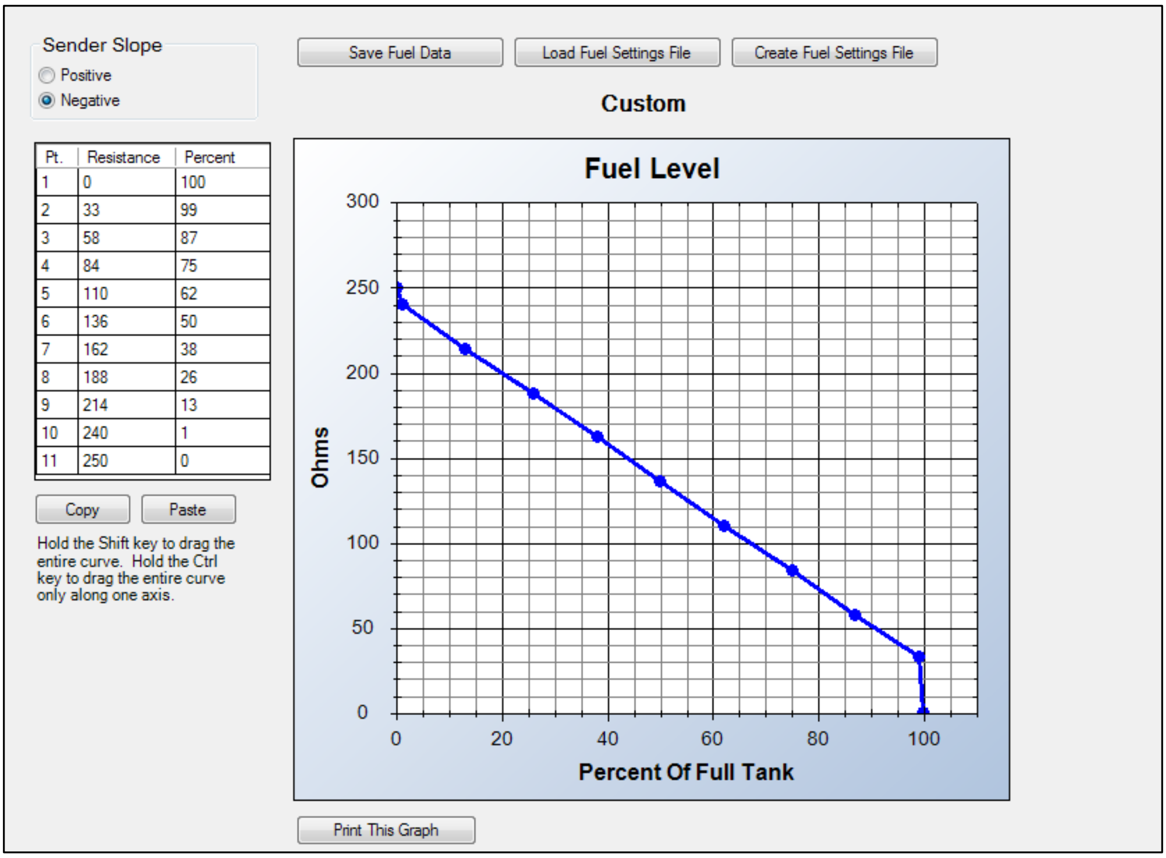

Figure 8. Settings Explorer, Programmable Senders, Fuel Level Screen

Oil Pressure

Figure 9 illustrates the *Oil Pressure* screen found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Senders* category. To program the oil pressure sender, perform the following procedure:

1. The oil pressure sender can be configured by selecting one of the sender types that come as a part of the BESTCOMS*Plus* sender library. Click on *Load Oil Settings File* and select the appropriate sender.

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2. If no sender file matches the sender being used, the individual points that map resistance points to oil pressure may be modified by setting numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Oil Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Oil Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the MGC-1550.

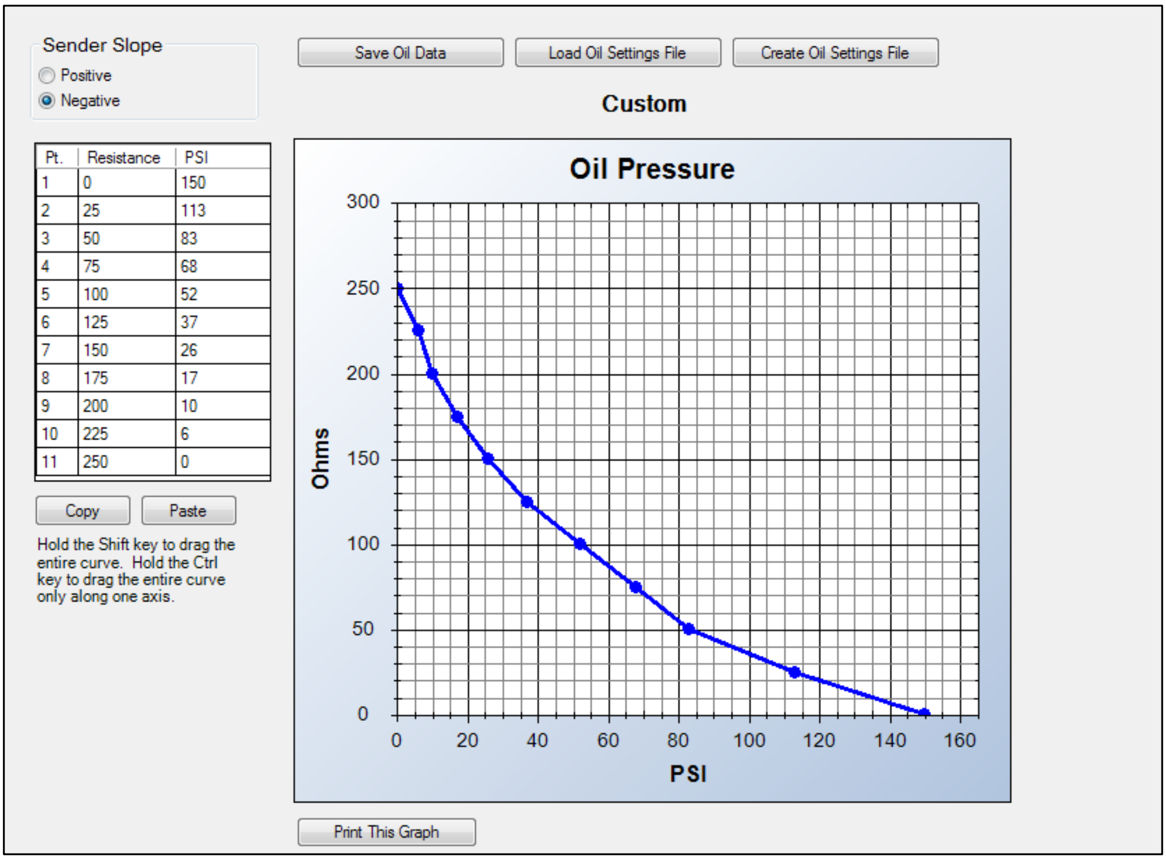

Figure 9. Settings Explorer, Programmable Senders, Oil Pressure Screen

Coolant Temperature

Figure 10 illustrates the *Coolant Temperature* screen found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Senders* category. To program the fuel level sender, perform the following procedure:

1. The coolant temperature sender can be configured by selecting one of the sender types that come as a part of the BESTCOMS*Plus* sender library. Click on *Load Cool Settings File* and select the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to coolant temperature may be modified by setting numeric values in the table, or by dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.

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4. Click *Save Cool Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Cool Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the MGC-1550.

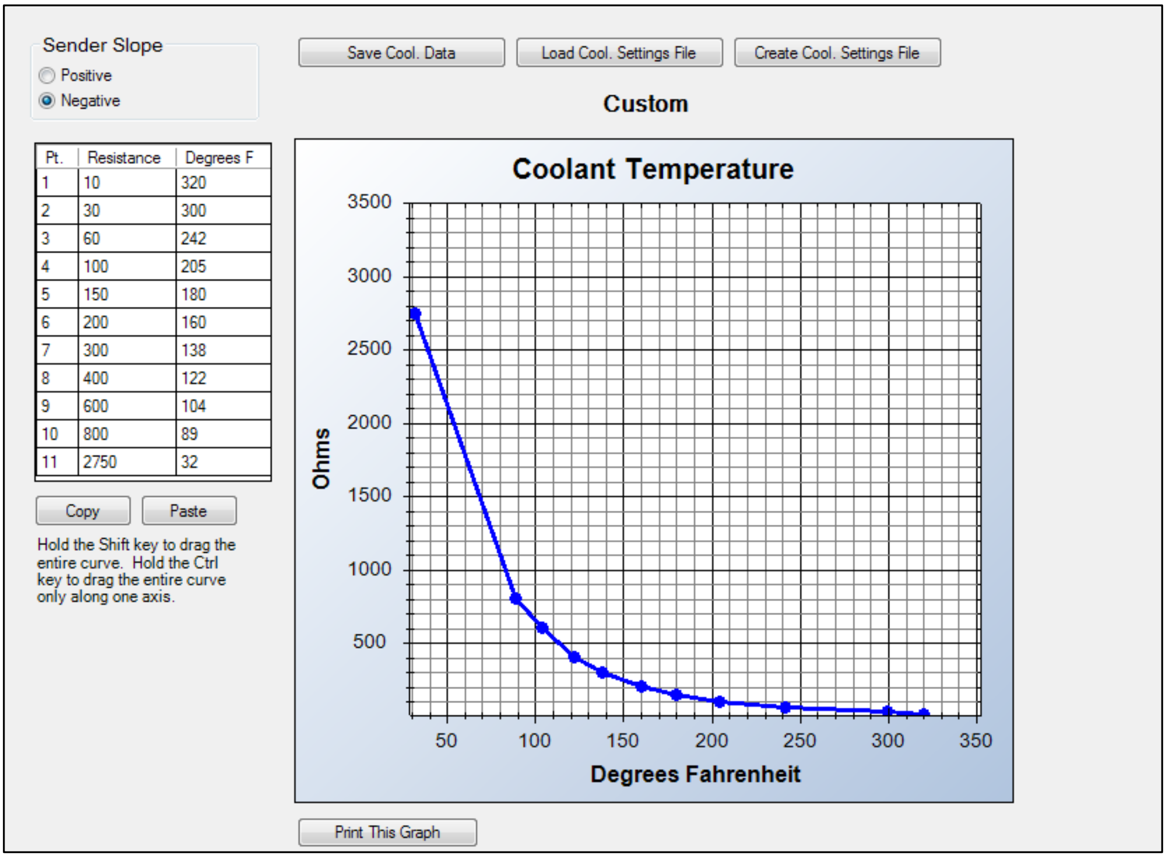

Figure 10. Settings Explorer, Programmable Senders, Coolant Temperature Screen

Sender Failure Detection

The MGC-1550 can be configured to annunciate a pre-alarm or alarm when a loss of signal is detected at the coolant temperature, oil pressure, or fuel level sender input. The speed sender fail alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

Alarm and pre-alarm annunciations for loss of engine speed signals are not user-programmable and operate as follows. If the MPU (magnetic pickup) or generator frequency is programmed as the sole engine speed source and that signal source fails, an alarm (and shutdown) is triggered. If the engine speed source is configured as MPU and generator frequency and a loss of one of the signal sources occurs, a pre-alarm is annunciated. An alarm (and shutdown) is triggered if both speed signals are lost.

The BESTCOMS*Plus* Sender Fail screen is illustrated in Figure 11 and is found in the *Settings Explorer* under *Alarm Configuration*. If using the front panel, navigate to Settings > Alarm Configuration > Sender Fail.

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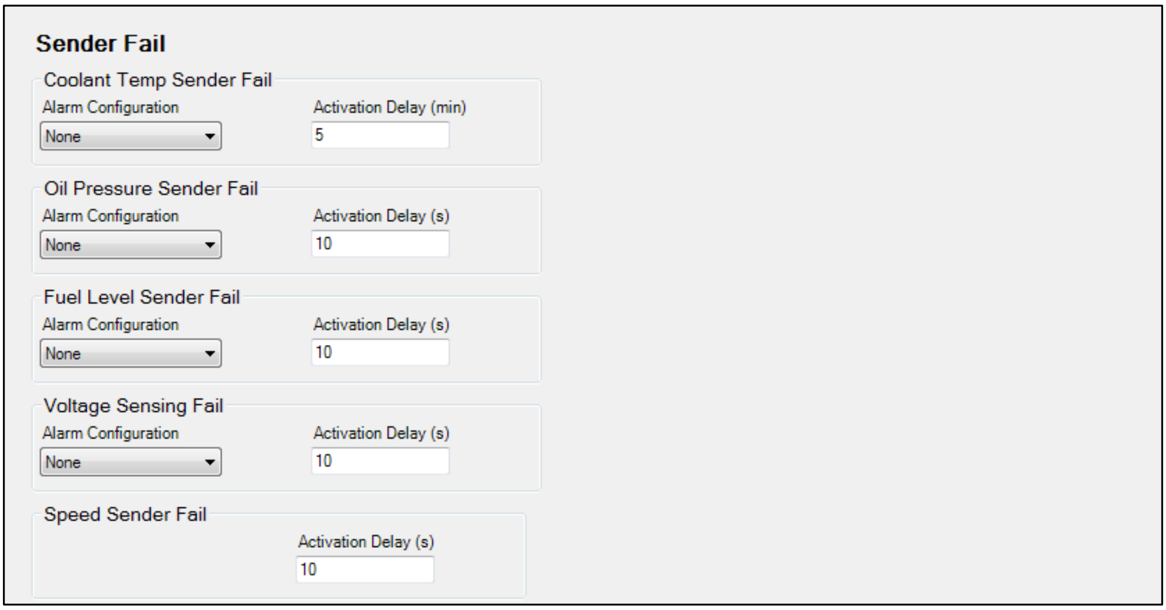

Figure 11. Settings Explorer, Alarm Configuration, Sender Fail Screen

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Speed Signal Inputs

The MGC-1550 uses signals from the generator voltage sensing inputs and magnetic pickup (MPU) input to detect machine speed.

Magnetic Pickup

Voltage supplied by a magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source. The MPU input accepts a signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz.

Terminals

Magnetic pickup connections are provided at terminals 31 (+) and 32 (–).

Generator Sensing Voltage

The generator voltage sensed by the MGC-1550 is used to measure frequency and can be used to measure machine speed.

Terminals

Sensing voltage is applied to terminals 45 (A-phase), 43 (B-phase).

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Contact Inputs

Contact inputs are available to initiate MGC-1550 actions. The MGC-1550 has seven programmable contact sensing inputs. Additional contact inputs can be accommodated with an optional CEM-2020 (Contact Expansion Module). Contact MTU Onsite Energy for availability and ordering information.

Programmable

Each programmable input (Input 1 through Input 7) can be independently configured to perform the following functions. By default, each programmable input is disabled.

- Auto Transfer Switch
- Battery Charger Fail
- Battle Override
- Emergency Stop
- Fuel Leak Detect
- Grounded Delta Override
- Low Coolant Level
- Low Fuel Level
- Low Line Override
- Single-Phase Override

The programmable inputs accept dry contacts. A contact is connected between a programmable input and the negative side of the battery. Through BESTCOMS*Plus*®, each programmable contact input can be assigned a name (16 alphanumeric characters, maximum) and configured as an alarm input, a pre-alarm input, or none. The default names for the inputs are INPUT_x (where x = 1 to 7). When a programmable contact input is closed, the front panel display shows the name of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the pre-alarm metering screen of the front panel. If neither alarm nor pre-alarm is programmed, no indication is given. Programming an input as *None* is useful when a programmable input is used as an input to programmable logic.

Connections for the programmable inputs are provided at terminals 3 (Input 1) through 9 (Input 7). The negative side of the battery voltage (terminal 17) serves as the return connection for the programmable inputs.

Contact Input Configuration

Figure 12 illustrates the *Contact Inputs* screen found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Inputs* category. If using the front panel, navigate to Settings > Programmable Inputs > Configurable Inputs.

For each contact input, configure the following parameters:

1. Alarm Configuration - Select *None, Alarm,* or *Pre-Alarm*. When an alarm occurs, the horn output closes and the engine shuts down. When a pre-alarm occurs, the horn output toggles between open and closed while the engine remains running. If *None* is selected, the input is status only. The status is available to BESTlogic™*Plus* Programmable Logic regardless of *Alarm Configuration* setting.

2. Activation Delay - This parameter defines the duration that the input remains on before any annunciation occurs.

3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogic™*Plus* Programmable Logic and in the event log if the input is configured as an alarm or pre-alarm.

4. Contact Recognition - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when oil pressure is low. Such a switch would be closed when the engine is not running but a low oil pressure alarm or pre-alarm should not be annunciated unless the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

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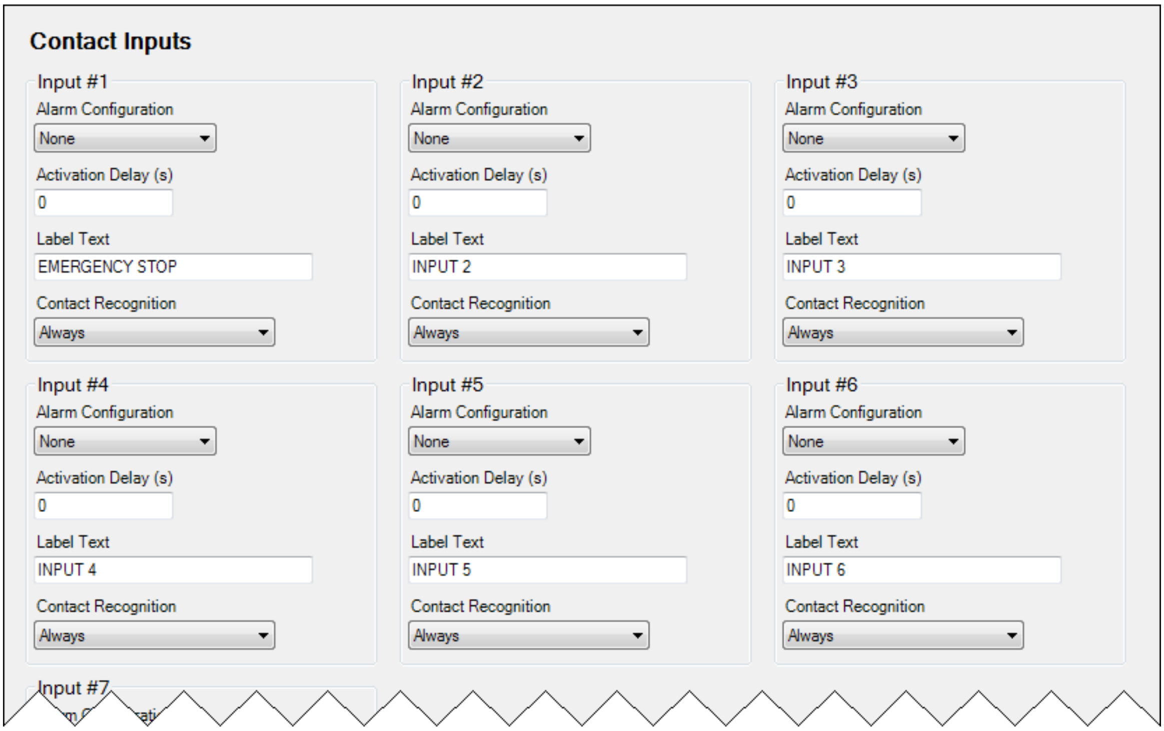

Figure 12. Settings Explorer, Programmable Inputs, Contact Inputs Screen

Programmable Functions

Any of the seven contact inputs can be programmed to recognize any one of 10 function types:

- Automatic Transfer Switch (ATS) - Start and run the generator while the ATS input is true and the MGC-1550 is in Auto mode.
- Grounded Delta Override - Uses Grounded Delta sensing if the generator connection is set for Delta.
- Battle Override - The alarms programmed to shut down the unit will be overridden and ignored.
- Low-Line Override - The 51, 27, and 59 settings are scaled by the low-line scale factor setting.
- Single-Phase Override - The unit switches to single-phase sensing configuration and uses the 1 Phase Override Sensing setting (A-B or A-C).
- Emergency Stop - Opens the Start, Run, and Fuel output relays and an ESTOP alarm is annunciated.
- Battery Charger Fail - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Low Coolant Level - When the selected input is invoked, a Low Coolant Level pre-alarm or alarm is annunciated after the activation delay.
- Low Fuel Level - When the selected input is invoked, a Low Fuel Level pre-alarm or alarm is annunciated after the activation delay.
- Fuel Leak Detect - When the selected input is invoked, a Fuel Leak pre-alarm or alarm is annunciated after the activation delay.

An Alarm Configuration setting of "None" prevents a function from being triggered by a contact input. Programmable function status is available in BESTlogic™*Plus* Programmable Logic when the "None" alarm configuration setting is selected.

The *Programmable Functions* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Inputs* category. If using the front panel, navigate to Settings > Programmable Inputs > Programmable Functions.

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The BESTCOMS*Plus* Programmable Functions screen is illustrated in Figure 13.

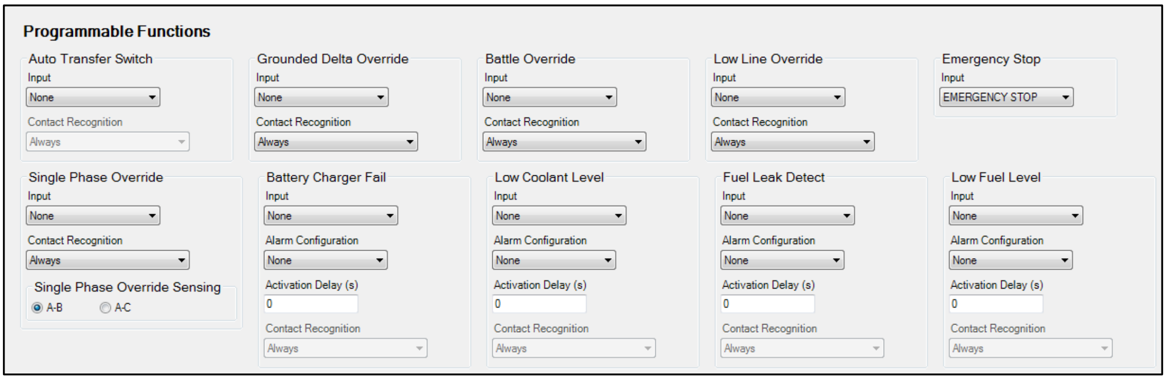

Figure 13. Settings Explorer, Programmable Inputs, Programmable Functions

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Contact Outputs

Output contact operation is controlled by the operating mode of the MGC-1550. The state of the Emergency Stop contact input also affects output contact operation. When the Emergency Stop contact input is open (emergency stop condition), the PRESTART, START, and RUN outputs open and an emergency stop alarm is annunciated. When the Emergency Stop input is closed, all output contacts operate normally.

MGC-1550 output contacts include PRESTART, START, RUN, and four programmable outputs. Additional output contacts can be accommodated with an optional CEM-2020 (Contact Expansion Module).

Prestart

This output closes to energize the engine glow plugs or run pre-lubrication pumps. The PRESTART output can be programmed to close up to 30 seconds prior to engine cranking. The PRESTART output can also be programmed to open upon engine startup or remain closed as long as the engine is operating.

During the resting state, the PRESTART output can be set to Off, On, or Preheat Before Crank. If Preheat Before Crank is selected, the PRESTART output will be closed for a time equal to the Pre-crank delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the PRESTART output will be closed for the entire rest time.

PRESTART output connections are made through terminals located on the PRESTART relay.

Start

This output closes when engine cranking is initiated by the MGC-1550 and opens when the magnetic pickup (MPU) or generator frequency indicates that the engine has started. Prior to engine starting, the duration of cranking is determined by the cranking style (cycle or continuous) selected. Cycle cranking permits up to seven crank cycles with crank cycle duration of 5 to 15 seconds. The continuous crank time is adjustable from 5 to 60 seconds.

START output connections are made through terminals located on the START relay.

Run

This output closes when engine cranking is initiated by the MGC-1550. The RUN output remains closed until it receives a command to stop the engine.

RUN output connections are made through terminals located on the RUN relay.

Relay Control

In some applications, it may be beneficial to modify the standard operation of the MGC-1550 Run, Pre-Start, or Start relays. If desired, these relays can be configured to operate outside their predefined functionality. For example, if your genset does not require starting assistance from glow plugs, the Pre-Start relay may be assigned for another purpose. Configuring these relays as programmable makes them available in BESTlogic™*Plus* programmable logic to be used in the same manner as the other programmable relay outputs. Predefined or programmable operation of the Run, Pre-Start, and Start relays is selected on the Relay Control screen (Figure 14). See the BESTlogic*Plus* chapter for more information about MGC-1550 programmable logic.
The Relay Control screen is found in the BESTCOMS*Plus*® Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Relay Control.

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Figure 14. Settings Explorer, System Parameters, Relay Control Screen

For each relay (Start, Run, and Pre-Start), select whether it should use its predefined functionality or be made programmable.

When *Programmable* is selected for a relay, it becomes available to BESTlogic*Plus* Programmable Logic as a logic element. The elements are titled *Start Output, Prestart Out,* and *Run Output*. The predefined functionality is available as an input to the logic. If *Programmable* is selected as the relay control mode, connecting the corresponding predefined input function to the relay causes it to function as if *Predefined* were selected as its relay control type. However, other logic can be combined with it to create operation that is more versatile. If *Programmable* is selected for a relay, but it is not used in the logic, that relay will never close.

An example logic scheme connecting the predefined inputs directly to the “programmable” relay outputs for all three relays is shown in Figure 15.

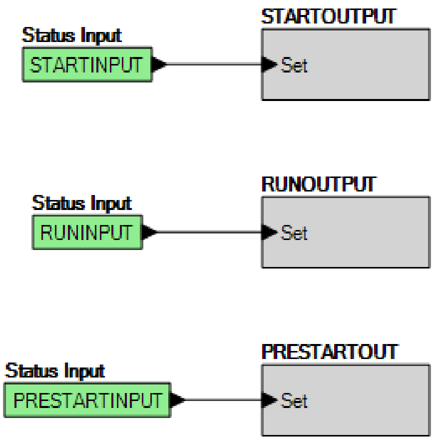

Figure 15. Example Logic Scheme of Programmable Relays

Programmable

MGC-1550 controllers have four programmable output contacts (OUT 1 through 4). An additional 24 contact outputs are provided with an optional CEM-2020 (Contact Expansion Module).

Programmable Output Configuration

Figure 16 illustrates the *Contact Outputs* screen found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Outputs* category. If using the front panel, navigate to Settings > Programmable Outputs > Contact Outputs.

Each output can be programmed with a text label describing its use. This label appears in BESTlogic*Plus* Programmable Logic where the output is used to aid in program clarity and ease of programming.

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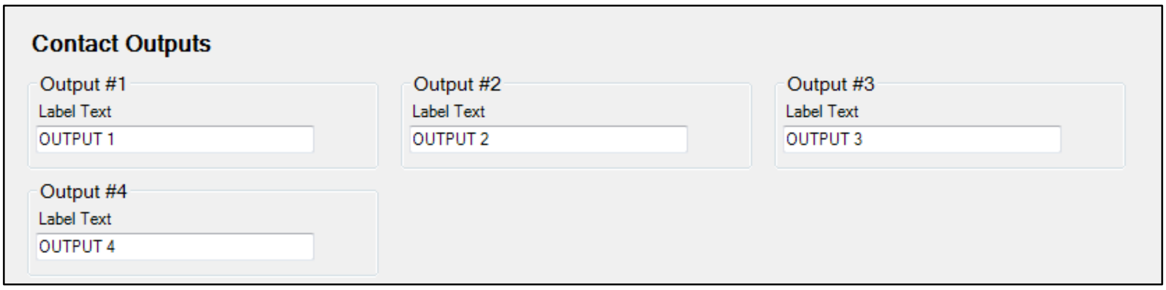

Figure 16. Settings Explorer, Programmable Outputs, Contact Outputs

Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *Elements* group in BESTlogic*Plus*. For more details, refer to the BESTlogic*Plus* chapter. Each of the eight elements can be independently configured to annunciate an alarm or pre-alarm. A user-adjustable time delay can be set to delay recognition of an element. By default, all elements are configured so that they do not trigger an alarm or pre-alarm. To make identifying an element easier, each of the elements can be given a user-assigned name. If used for an alarm or pre-alarm, the user-assigned name appears in the alarm or pre-alarm annunciation and in the MGC-1550 event log. Elements can be recognized always or only while the engine is running. Configurable element status is available in BESTlogic*Plus* Programmable Logic when “None” is selected for Alarm Configuration. Configurable element status can be used as logic inputs to drive other logic in the program, similar to logic control relays.

The BESTCOMS*Plus Configurable Elements* screen is illustrated in Figure 17 and found in the *Settings Explorer* under the *Programmable Outputs* category. If using the front panel, navigate to Settings > Programmable Outputs > Configurable Elements.

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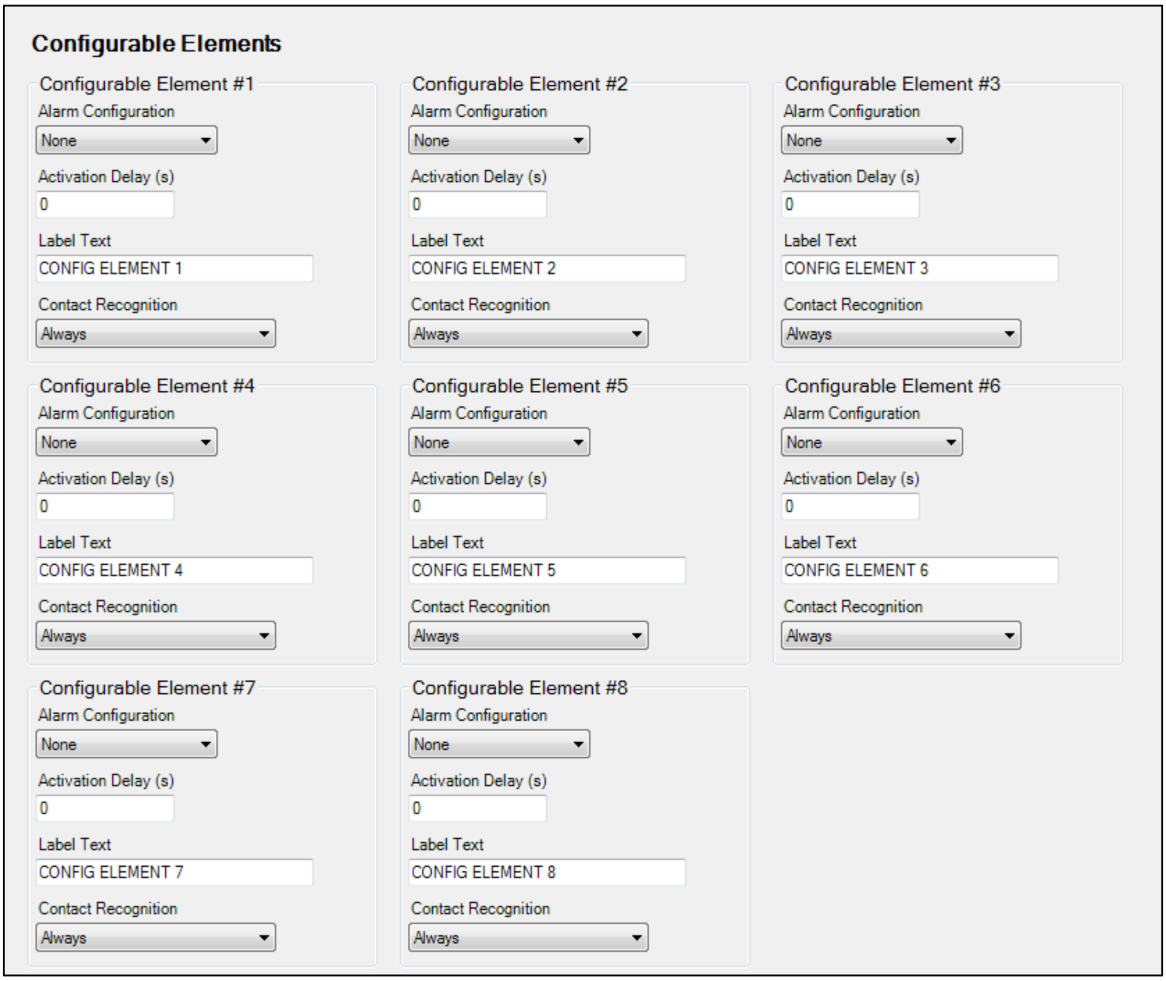

Figure 17. Settings Explorer, Programmable Outputs, Configurable Elements

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Operating Modes

Three operating modes provide the versatility to meet the application's needs. The MGC-1550 operates in Off, Run, or Auto mode. These operating modes are described in the following paragraphs.

Off

In OFF mode, the MGC-1550 will not start under any circumstance. It cannot be started automatically. Programmable logic functions normally in this mode.

Run

In RUN (manual) mode, the MGC-1550 runs and cannot be shut off automatically. The breaker can be opened or closed through programmable logic inputs. Programmable logic functions normally in this mode.

Auto

In AUTO mode, the MGC-1550 may be started automatically or "self-start" from an automatic starting feature described in the following paragraphs. If the MGC-1550 is not in AUTO mode, the self-starting modes will have no effect. The self-starting modes are independent, meaning that if any self-starting mode indicates that the unit should run, it will run. It will not shut down unless all self-starting modes indicate that the unit should not be running.

ATS Contact Input

The ATS (automatic transfer switch) programmable function has an input mapped to it through BESTCOMS*Plus*®. The unit will start and run when this contact is closed, and will stop when the contact is open.

Generator Exerciser

The unit starts at the designated time and runs for the specified duration. The breaker will be closed if "Run with Load" is checked in the generator exerciser settings.

Mains Fail Transfer Functionality

If mains fail transfer is enabled, the unit runs when any phase of the utility is dead or unstable, and will not stop until all phases of the utility are stable and the load has been transitioned to the utility.

Run-with-Load Logic Element

When the run-with-load logic element start input is energized, the unit starts and closes its breaker. When the run-with-load logic element stop input is energized, the unit opens its breaker and stops.

Engine Run Logic Element

When the engine run logic element start input is energized, the unit starts. When the engine run logic element stop input is energized, the unit opens its breaker if needed, cools down, and then stops.

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Operating Mode Control

Controls for selecting operating mode are located on the front panel and within BESTCOMS*Plus*.

Refer to the *Controls and Indicators* chapter for more information.

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Breaker Management

The MGC-1550 is capable of controlling the generator breaker and the mains breaker. Once it is determined that a valid breaker request is available, the MGC-1550 will attempt to operate the breaker if possible. The user can choose to control only the generator breaker, the generator and mains breakers, or none. BESTCOMS*Plus*® is used to configure breaker management. Refer to the BESTCOMS*Plus* chapter for setting information.

Breaker Status

The status of the breakers is determined by using BESTlogic™*Plus* programmable logic and sent to the GENBRK and MAINSBRK logic blocks. These logic blocks have outputs that can be configured to energize an output contact and control a breaker as well as inputs for breaker control and status. See *Breaker Configuration*, below, for details on configuring the logic.

Breaker Operation

The MGC-1550 will attempt to close a breaker only after verifying that it can be closed. If the breaker cannot be closed, the close request will be ignored. Only one breaker can be closed at a time. Closure to a dead bus can be performed after meeting dead bus threshold and timing requirements set by the user.

Breaker Operation Requests

Types of breaker operation requests include:

- Local Request - initiated by internal functions and based on operating modes.
- Com Request - initiated through a communication port using BESTCOMS*Plus* or the front panel.
- Logic Request - initiated from BESTlogic*Plus*.

The type of response given for a local request depends on the operating mode of the MGC-1550.

RUN Mode

When in RUN mode, the generator and mains breakers can be closed manually using contact inputs or the breaker operation settings on the BESTCOMS*Plus Control* screen.

OFF or AUTO Mode (Not Running)

If operating in the OFF mode or AUTO and not running, the generator breaker can be closed if the bus is determined to be dead.

AUTO Mode (Running)

When in AUTO mode and running, the mains fail transfer feature will automatically control the mains breaker and the generator breaker. Or, the external ATS (automatic transfer switch) will start the generator and control the breakers itself. In addition, the generator breaker can be automatically controlled by the exercise timer function or a RUNWLOAD (run with load) start through BESTlogic*Plus*. The generator breaker can be manually controlled using contact inputs and outputs or the breaker operation settings on the BESTCOMS*Plus Control* screen.

Breaker Closure Conditions

The conditions under which the MGC-1550 will close a breaker are described in the following paragraphs.

Breaker Status and Voltage Stability

Before the generator breaker can be closed, it must be configured in BESTCOMS*Plus*. If only the generator breaker is configured (mains breaker not configured) the MGC-1550 reads user settings to determine if the generator side of the breaker is stable or dead and the bus side is dead. If both the generator breaker and the mains breaker are configured and open, the MGC-1550 closes the generator

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breaker if the generator side of the breaker is stable or dead. If both breakers are configured and the mains breaker is closed, the MGC-1550 will not close the generator breaker.

Before the mains breaker can be closed, it must be configured in BESTCOMS*Plus*. If both the mains and the generator breakers are configured and open, the MGC-1550 will close the mains breaker if the mains side of the breaker is stable. If both breakers are configured and the generator breaker is closed, the MGC-1550 will not close the mains breaker.

Command Agreement

A breaker will not change state if it receives conflicting commands. In other words, if an input is indicating an open command at the same time another input is indicating a close command, the breaker will not change state.

Breaker Configuration

The following paragraphs describe how to properly configure an MGC-1550 for generator breaker control.

Initial System Setup

Connect the MGC-1550 according to the appropriate figure in the *Typical Connections* chapter for the type of generator connection desired (wye, delta, etc.).

Set up the basic system parameters that will govern engine operation and alarm and pre-alarm annunciation. Details can be found in the *Configuration* chapter.

Breaker Hardware

Configure the generator breaker parameters on the BESTCOMS*Plus Settings Explorer, Breaker Management, Breaker Hardware* screen. If using the front panel, navigate to Settings > Breaker Management > Breaker Hardware. Figure 18 illustrates the BESTCOMS*Plus* Breaker Hardware screen.

1. *Mains Fail*: When two breakers are configured (enabled), the MGC-1550 can be enabled to automatically transfer load power from the mains to the genset during a mains failure. This feature also enables the MGC-1550 to transfer the load back to the mains once mains power is restored. Settings include a transfer delay, return delay, max transfer time, and max return time.
    a. When enabled, Reverse Rotation Inhibit prevents automatic load transfer due to a mains failure when the machine is determined to have reverse phase rotation.
    b. If the in-phase monitor is enabled and the Mains Fail Return Delay time has expired, the generator waits until it detects that the phases are aligned between the generator and the mains before performing the open transition from the generator back to the utility.
2. *Breaker Close Wait Time*: This is a time interval in which it is expected that the breaker will transition from open to closed or closed to open. If the generator breaker does not change state within that time, either a Gen Breaker Close Fail alarm or Gen Breaker Open Fail alarm is annunciated. If the mains breaker does not change state within that time, either a Mains Breaker Close Fail alarm or Mains Breaker Open Fail alarm is annunciated.
3. *Generator Breaker*
    a. Set the *Contact Type* and *Open/Close Pulse Times* if pulsed contacts are used.
    b. Set the *Breaker Closing Time*.
4. *Mains Breaker*
    a. Set the Mains Breaker as Configured if it is used, otherwise do not configure these settings.
    b. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
    c. If the mains breaker is configured, set the breaker close time.

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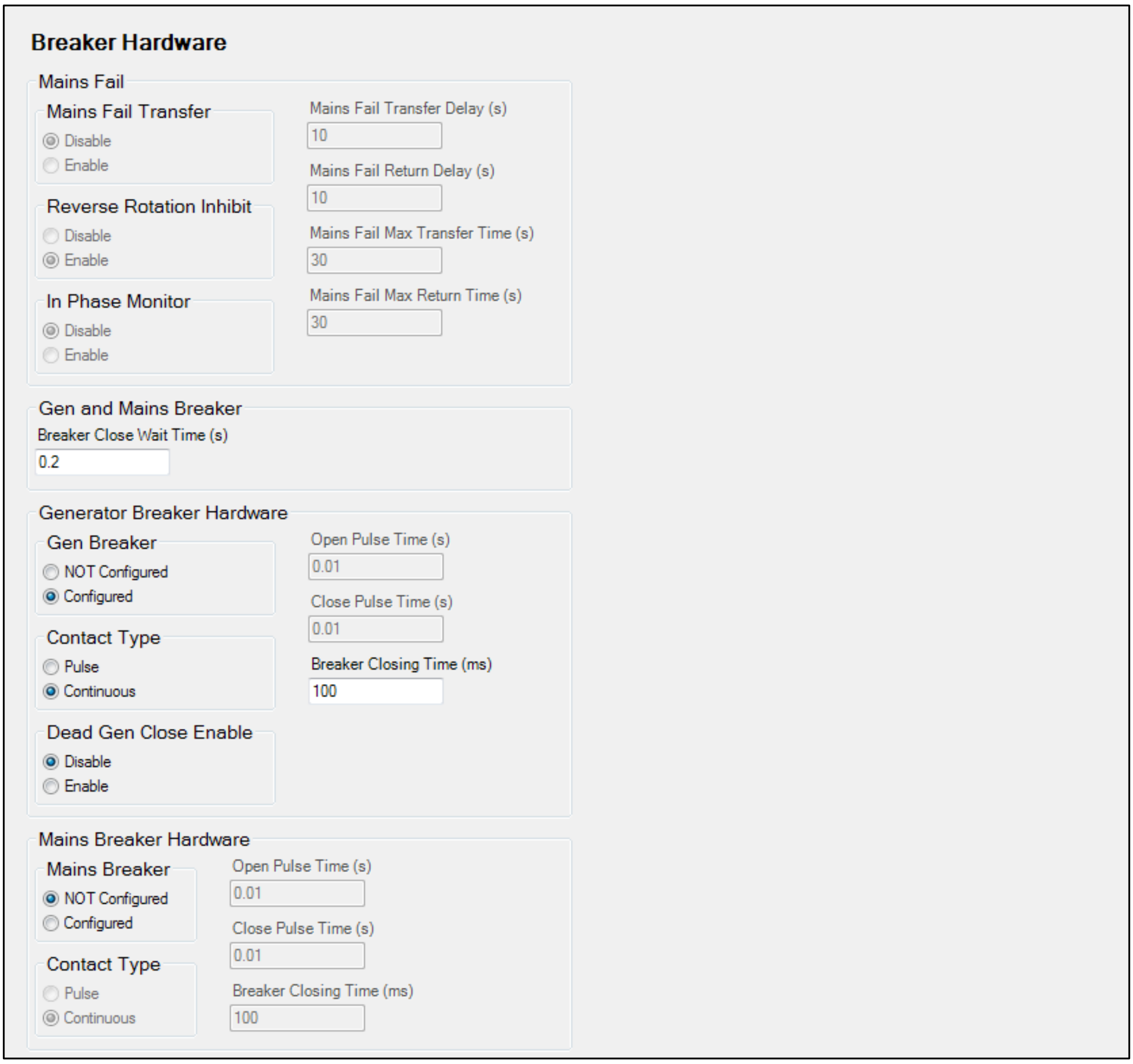

Figure 18. Settings Explorer, Breaker Management, Breaker Hardware Screen

Breaker Setup in BESTlogic™*Plus*

Set up the Gen Breaker in BESTlogic*Plus* Programmable Logic under the BESTCOMS*Plus Settings Explorer,* BESTlogic*Plus Programmable Logic* screen*.* BESTlogic*Plus* is not available through the front panel interface. Figure 19 illustrates the Gen breaker logic scheme in BESTlogic*Plus*.

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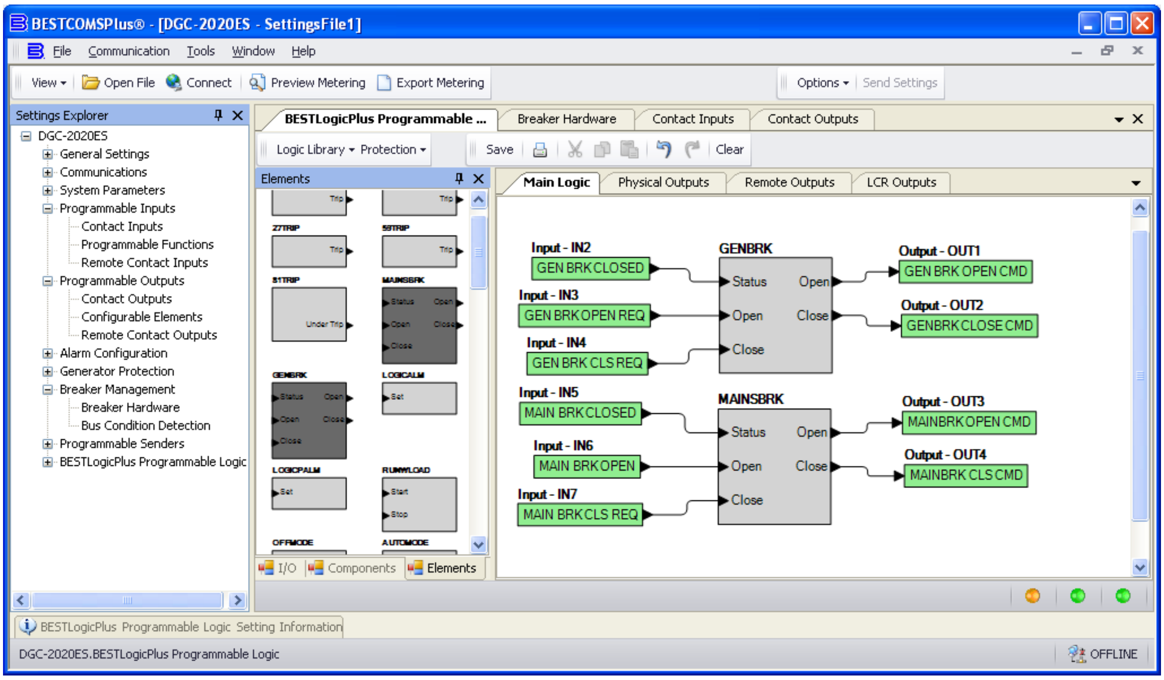

Figure 19. Settings Explorer, BESTlogic*Plus* Programmable Logic Screen

1. Generator Breaker
    a. Drag the Gen Breaker element into the logic diagram.
    b. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    c. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when the breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the MGC-1550.
    d. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If both inputs close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
2. Mains Breaker (if configured)
    a. Drag the Mains Breaker element into the logic diagram.
    b. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    c. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open if the breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the MGC-1550.
    d. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If both inputs close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
3. Click the *Save* button when the logic setup is complete.
4. From the Communication pull-down menu, select *Upload Logic to Device* to load the logic into the MGC-1550 if connected, or save the settings file if working off line.

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Bus Condition Detection

(These thresholds determine when the generator and bus are considered to be stable or dead.)

Set the parameters for detecting stable and failed bus and generator under the BESTCOMS*Plus Settings Explorer, Breaker Management, Bus Condition Detection*. If using the front panel, navigate to Settings > Breaker Management > Bus Condition Detection.

Figure 20 illustrates the BESTCOMS*Plus Bus Condition Detection* screen.

1. Generator Sensing
    a. Dead Bus Voltage Threshold and Activation Delay. When the generator voltage is below this threshold for the duration of the activation delay, the generator is deemed “Dead”.
    b. Gen Stable Overvoltage and Undervoltage thresholds and Overfrequency and Underfrequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the generator voltage frequency is within the specified range for the duration of the Bus Stable Activation Delay, the generator is deemed “Stable”. Otherwise, it is deemed “Failed”.
2. Bus Sensing
    a. Dead Bus Voltage Threshold and Activation Delay. When the voltage of the bus is below this threshold for the duration of the activation delay, the bus is deemed “Dead”.
    b. Bus Stable Overvoltage and Undervoltage thresholds and Overfrequency and Underfrequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the bus voltage and frequencies are within the specified ranges for the duration of the Bus Stable Activation Delay, the bus is deemed “Stable”. Otherwise, it is deemed “Failed”.

Caution

The bus condition parameters are critical because they determine when a breaker can be closed. The generator breaker can be closed when any one of the following is true:

- The generator is stable, the bus is dead, and both breakers are open.
- The generator is dead, the bus is dead, and both breakers are open.

The mains breaker can be closed only when the bus is stable and both breakers are open.

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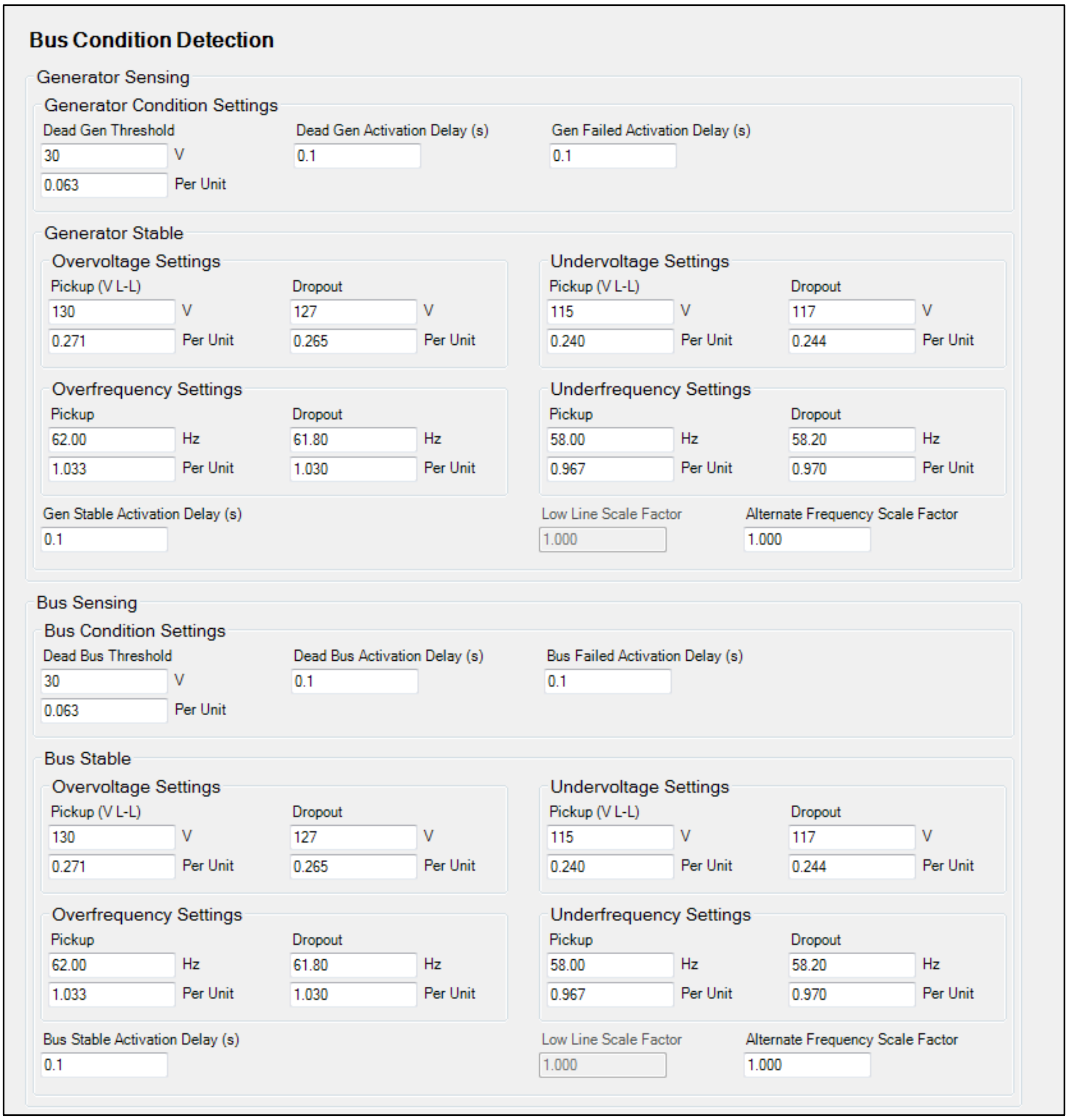

Figure 20. Settings Explorer, Breaker Management, Bus Condition Detection

Place the unit in AUTO. The unit is now configured for generator breaker control. It can be tested by driving the RUN WITH LOAD logic element true, setting up the exercise timer for a loaded test, or by starting the unit in RUN or AUTO mode and giving it CLOSE and OPEN commands from the physical inputs if they are available for breaker control.

Refer to the *Maintenance and Troubleshooting* chapter if the breaker does not seem to operate properly.

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Generator Protection

MGC-1550 controllers offer standard protection consisting of undervoltage (27), overvoltage (59), overcurrent (50), overfrequency (81O), underfrequency (81U), and phase-imbalance voltage (47) elements.

The description of generator protection is organized as follows:

- Voltage (27, 59, 47)
- Frequency (81)
- Overcurrent (50)

Voltage

Voltage protection consists of an undervoltage element, an overvoltage element, and a phase-sequence voltage element.

Undervoltage (27)

Two sets of undervoltage settings are provided for this element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the PT secondary side. When a single-phase override contact input is received, the MGC-1550 automatically switches from the three-phase undervoltage settings to the single-phase undervoltage settings.

An undervoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) decreases below the corresponding 27 pickup setting for the duration of the corresponding 27 activation delay. An undervoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An undervoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A frequency-based inhibit setting prevents a 27 trip from occurring during an undervoltage condition associated with system startup.

A low-line scale factor setting is used to automatically adjust the undervoltage pickup settings in applications that may utilize more than one type of genset connection. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate low-line override. This triggers scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 × PU).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic™*Plus* Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMS*Plus*® automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Undervoltage 27 Three-Phase Pickup
- Undervoltage 27 Single-Phase Pickup

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The *Undervoltage* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Generator Protection, Voltage* category. If using the front panel, navigate to Settings > Generator Protection > 27 Undervoltage. The BESTCOMS*Plus* Undervoltage screen is illustrated in Figure 21.

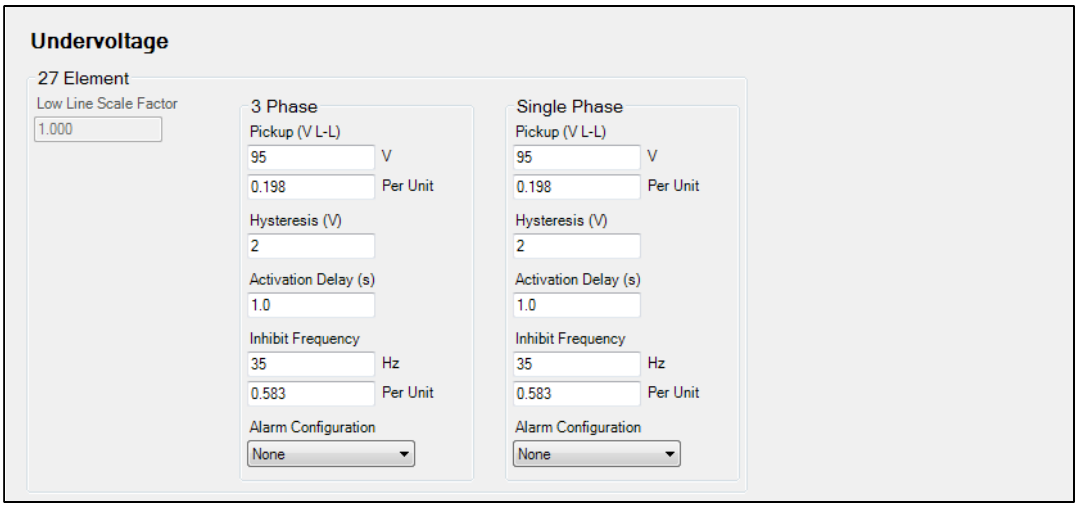

Figure 21. Settings Explorer, Generator Protection, Voltage, Undervoltage (27) Screen

Overvoltage (59)

Two sets of overvoltage settings are provided for this element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the PT secondary side (MGC-1550). When a single-phase override contact input is received, the MGC-1550 automatically switches from the three-phase overvoltage settings to the single-phase overvoltage settings.

An overvoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) increases above the corresponding 59 pickup setting for the duration of the corresponding 59 activation delay. An overvoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overvoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting is used to automatically adjust the overvoltage pickup settings in applications that may utilize more than one type of genset connection. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate low-line override. This triggers scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 × PU).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Overvoltage 59 Three-Phase Pickup

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- Overvoltage 59 Single-Phase Pickup

The *Overvoltage* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Generator Protection, Voltage* category. If using the front panel, navigate to Settings > Generator Protection > 59 Overvoltage. The BESTCOMS*Plus* Overvoltage screen is illustrated in Figure 22.

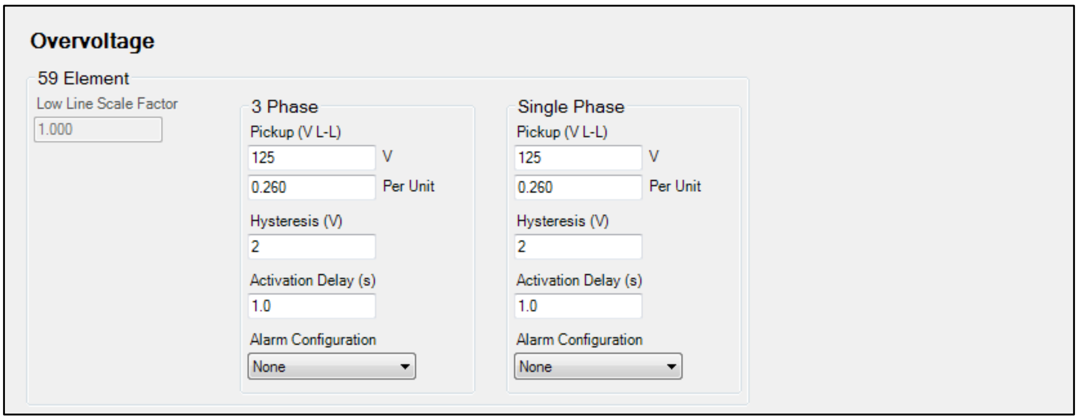

Figure 22. Settings Explorer, Generator Protection, Voltage, Overvoltage (59) Screen

Phase Imbalance (47)

MGC-1550 controllers are capable of protecting against voltage imbalances between any of the three phases. The pickup setting entered is based on the PT secondary side. A phase imbalance condition is annunciated when the difference between any of the three phases of generator voltage increases above the 47 pickup setting for the duration of the 47 activation delay setting. A phase imbalance annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A phase imbalance annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as a phase imbalance dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting is used to automatically adjust the phase imbalance pickup setting in applications that may utilize more than one type of genset connection. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate the low-line override. This triggers scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup setting. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 × PU).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Phase Imbalance 47 Pickup

The *Phase Imbalance* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Generator Protection, Voltage* category. If using the front panel, navigate to Settings > Generator Protection > 47 Phase Imbalance. The BESTCOMS*Plus* Phase Imbalance screen is illustrated in Figure 23.

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Figure 23. Settings Explorer, Generator Protection, Voltage, Phase Imbalance (47) Screen

Frequency

Two sets of frequency protection settings are provided: one for underfrequency (81U) and one for overfrequency (81O).

Underfrequency (81U)

An underfrequency condition is annunciated when the generator frequency decreases below the 81U pickup setting for the duration of the 81U activation delay setting. An underfrequency annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An underfrequency annunciation can also be user-configured to close a programmable output.

A voltage-based inhibit setting prevents an 81U trip from occurring during an underfrequency condition associated with system startup.

The hysteresis setting functions as an underfrequency dropout by preventing rapid switching of the pickup output.

Overfrequency (81O)

When the generator frequency increases above the 81O pickup setting for the duration of the 81O activation delay setting, an overfrequency condition is annunciated. An overfrequency annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overfrequency condition can also be user configured to close a programmable output.

The hysteresis setting functions as an overfrequency dropout by preventing rapid switching of the pickup output.

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

Alternate Frequency Scale Factor

An alternate frequency scale factor setting is used for automatic adjustment of the frequency pickup settings in applications that may utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogic*Plus* Programmable Logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if an alternate frequency scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the pickup setting is doubled (2.000 x PU).

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Per Unit

Settings which are related to machine ratings can be set in either actual units of hertz or in per unit values. Per unit settings are available for Pickup (81O/81U) and Inhibit Volts (81U). When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- 81 U Pickup
- 81 O Pickup

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- 81 U Inhibit Voltage

The *Frequency* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Generator Protection, Frequency* category. If using the front panel, navigate to Settings > Generator Protection > 81 O/U Frequency. The BESTCOMS*Plus* Frequency screen is illustrated in Figure 24.

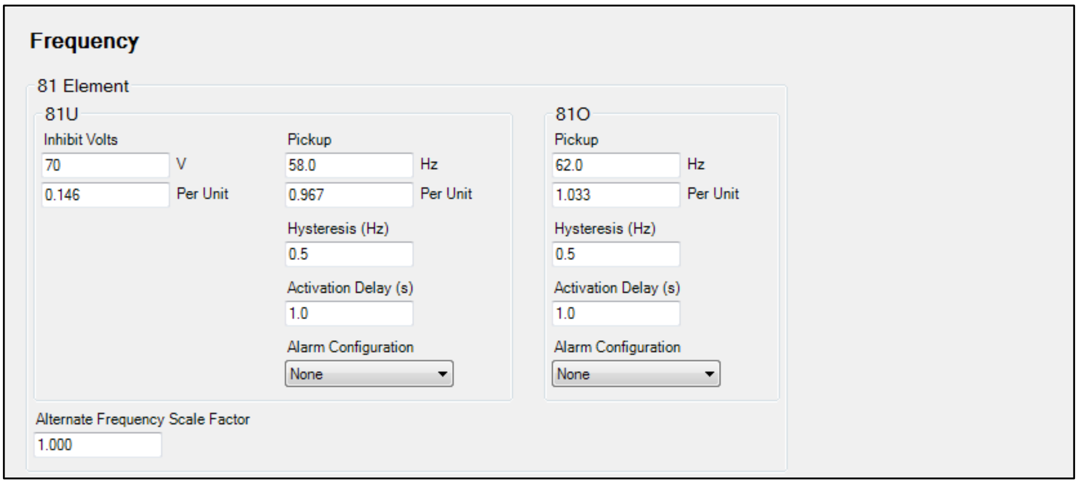

Figure 24. Settings Explorer, Generator Protection, Frequency, Frequency (81) Screen

Overcurrent

Two sets of overcurrent settings are provided for this element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the CT secondary side. When a single-phase override contact input is received by the MGC-1550, the overcurrent protection settings automatically switch from the three-phase settings to the single-phase overcurrent protection settings.

When any of the phase currents increase above the pickup setting for the duration of the overcurrent time delay, an overcurrent condition is annunciated. An overcurrent annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overcurrent annunciation can also be user-configured to close a programmable output.

A low-line scale factor setting is used for automatic adjustment of the overcurrent pickup settings in applications that may utilize more than one type of genset connection. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate low-line override. This triggers scaling of the protection settings. The value of the scale factor setting

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serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 × PU).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of current or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Amps*, and the rated data associated with them is *Rated Secondary Phase Amps* (on the *System Parameters, Rated Data* screen).

- Overcurrent 50 Three-Phase Pickup
- Overcurrent 50 Single-Phase Pickup

The *Overcurrent* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Generator Protection, Current* category. If using the front panel, navigate to Settings > Generator Protection > 50 Overcurrent. The BESTCOMS*Plus* Overcurrent screen is illustrated in Figure 25.

Figure 25. Settings Explorer, Generator Protection, Current, Overcurrent

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Metering

The MGC-1550 provides comprehensive metering of internal and system conditions. These capabilities include extensive parameter metering, status indication and reporting.

Metering Explorer

MGC-1550 metering is accessed through the metering explorer menu on the front panel display or the BESTCOMS*Plus*® metering explorer.

Front Panel

On the front panel, the metering explorer is accessed through the Metering branch of the menu. Refer to the *Controls and Indicators* chapter for more information.

BESTCOMS*Plus*®

In BESTCOMS*Plus,* the metering explorer is located in the upper left portion of the application window.

Metering Screen Docking

A docking feature within the metering explorer allows arrangement and docking of multiple metering screens. Clicking and dragging a metering screen tab displays a blue, transparent square, several arrow boxes, and a tab box. These docking elements are illustrated in Figure 26 and described in Table 5.

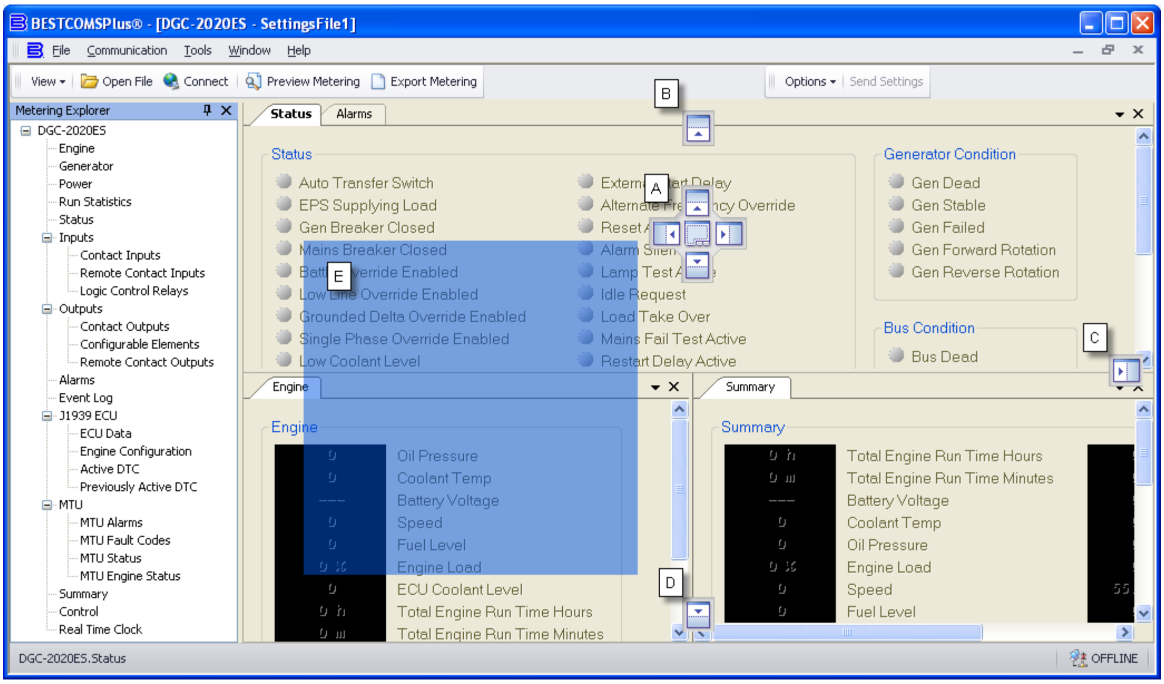

Figure 26. Metering Screen Docking Options

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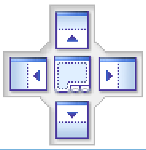
Table 5. Descriptions of Call-outs in Figure 26.

Call-Out	Symbol	Description
A		Holding the left mouse button down on a metering tab and dragging it to one of the four arrow boxes will place the metering tab inside the selected window on the location selected. To place the metering tab as a tab inside the selected window, drop it on the tabs button in the center of the arrow buttons.
B		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the top of the screen. Click on the (thumbtack) to dock it on the top bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the top bar.
C		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the side of the screen. Click on the (thumbtack) to dock it on the side bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the side bar.
D		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the bottom of the screen. Click on the (thumbtack) to dock it on the bottom bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the bottom bar.
E		Holding the left mouse button down on a metering tab and dragging it anywhere other than an arrow box will place it as a floating metering screen. This floating screen can later be closed by clicking on the in the upper right corner. It can also be dragged to one of the arrow boxes used for docking.

BESTspace™

BESTspace provides the ability to manage customized workspaces. Refer to the *BESTCOMSPlus* chapter for more information on BESTspace.

Engine

The *Engine* metering screen (Figure 27) provides information and metering of engine components. Parameters that do not apply to your engine are marked as either NS (not sent) or NA (not applicable).

The *Engine* screen is found in the BESTCOMS*Plus Metering Explorer*. If using the front panel, navigate to Metering > Engine.

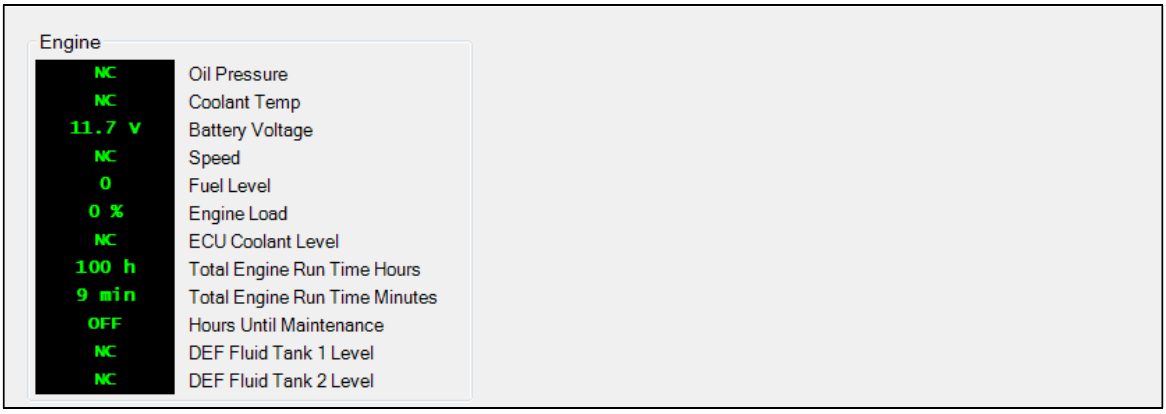


Figure 27. Metering Explorer, Engine Screen

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Generator

This screen provides metering of generator voltages and currents. See Figure 28.

The *Generator* screen is found in the BESTCOMS*Plus Metering Explorer*. If using the front panel, navigate to Metering > Generator.

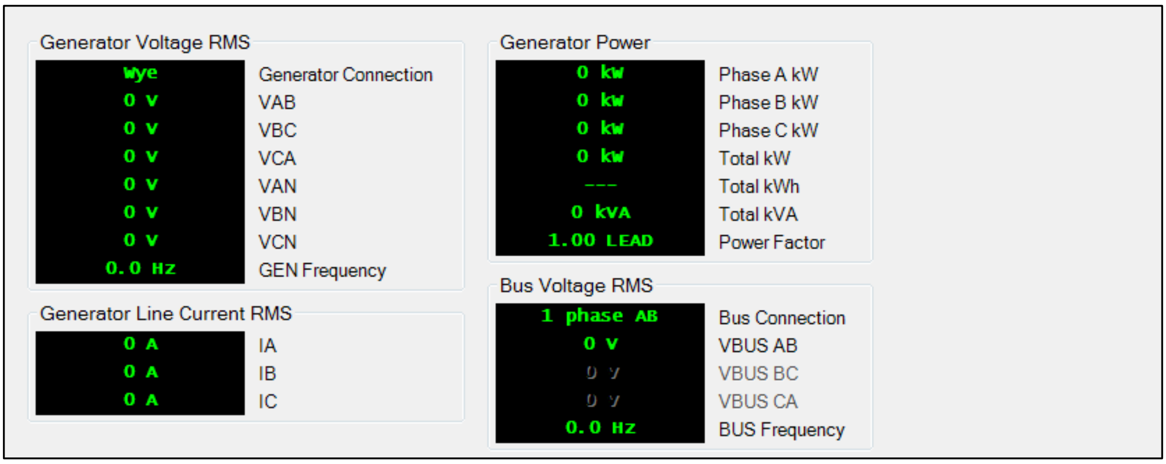

Figure 28. Metering Explorer, Generator Screen

Power

This screen provides metering of generator power and power factor. See Figure 29.

The *Power* screen is found in the BESTCOMS*Plus Metering Explorer*. If using the front panel, navigate to Metering > Power.

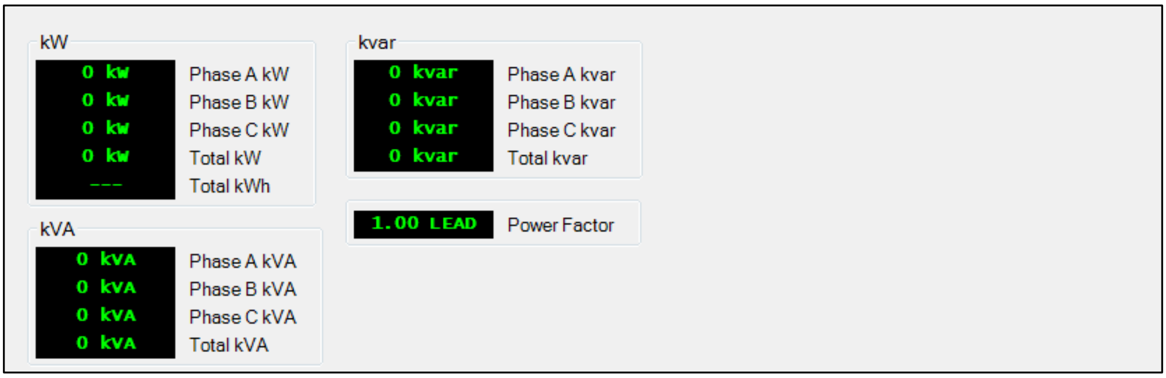

Figure 29. Metering Explorer, Power Screen

Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. See Figure 30.

The Cumulative Run Statistics are tracked from the first time the genset was started. The Session Run Statistics are tracked from the last time the genset was started until the following shutdown.

The Number of Starts, Hours Until Maintenance, Total kWh, Total Engine Run Time, Loaded Run Time, and Unloaded Run time can be changed by clicking the *Edit Cumulative Run Statistics* button. This is helpful when installing the MGC-1550 into a pre-existing system. This allows the current statistics of the genset to be transferred into the MGC-1550 for uninterrupted tracking.

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The Hours Until Maintenance pre-alarm is configured on the Pre-Alarms screen in the Settings Explorer. The Hours Until Maintenance field displays “OFF” when the Maintenance Interval pre-alarm is disabled. Clicking *Reset Maintenance Interval* resets the Hours Until Maintenance to the value set for the Maintenance Interval pre-alarm on the Pre-Alarms screen in the Settings Explorer.

To change the commission date, click *Edit DGC Commission Date.* The DGC Commission Date dialog box appears. Enter the new commission date and click *Upload Data to Device.* Click *Close*. Note that the Commission Date field on the BESTCOMS*Plus* screen updates after the *Close* button is clicked.

The *Run Statistics* screen is found in the BESTCOMS*Plus Metering Explorer*. If using the front panel, navigate to Metering > Run Statistics.

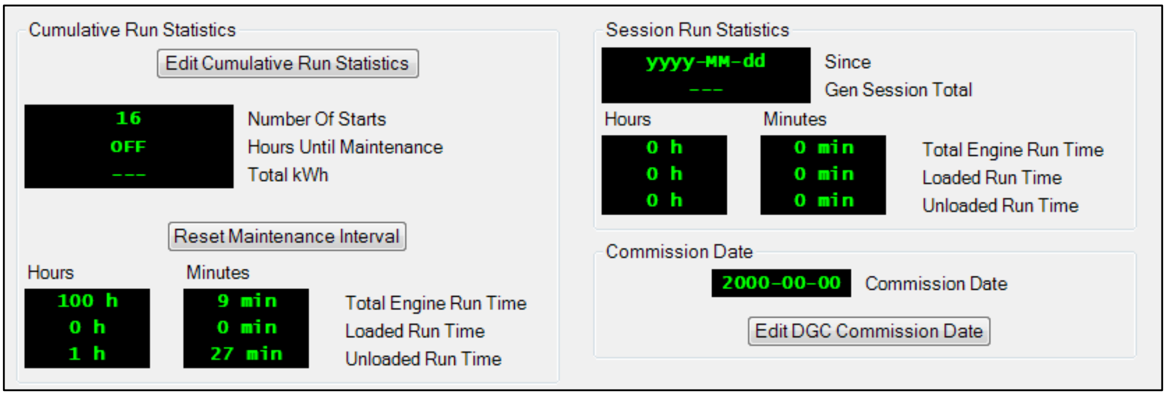

Figure 30. Metering Explorer, Run Statistics Screen

Status Indication

This screen indicates status of breakers, modes, switches, and I/O connection status. The status is TRUE when the corresponding indicator is red. See Figure 31.

The *Status* screen is found in the BESTCOMS*Plus Metering Explorer*. If using the front panel, navigate to Metering > Alarms-Status > Status.

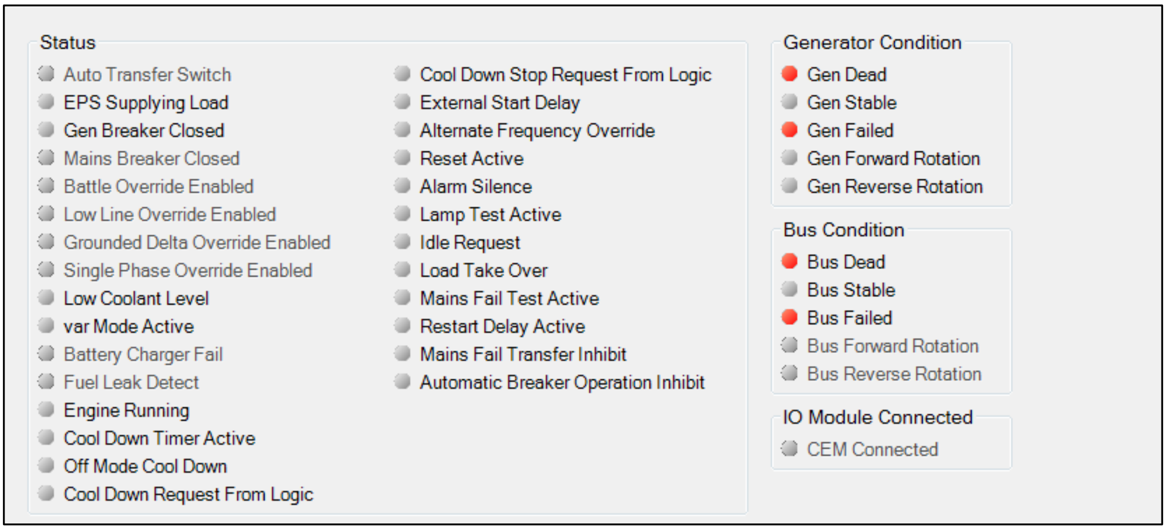

Figure 31. Metering Explorer, Status Screen

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Inputs

Contact Inputs

This screen indicates the status of contact inputs, contact input alarms, and contact input pre-alarms. The status is TRUE when the corresponding indicator is red. See Figure 32.

The *Contact Inputs* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Inputs* category. If using the front panel, navigate to Metering > Alarms-Status > Inputs.

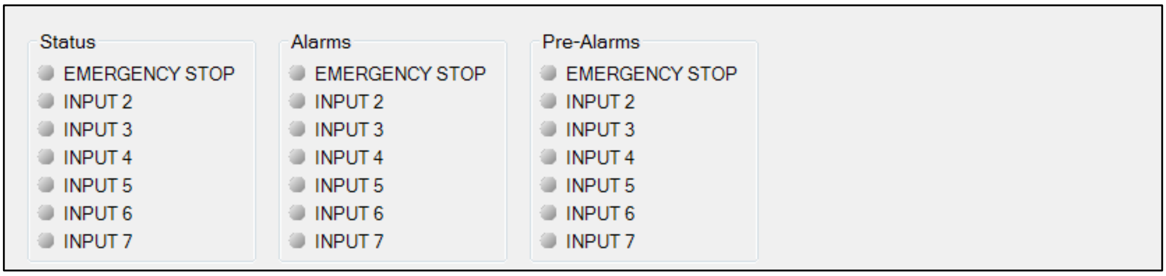

Figure 32. Metering Explorer, Inputs, Contact Inputs Screen

Remote Contact Inputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact inputs, configurable remote contact input alarms, and remote contact input pre-alarms are shown on this screen. The status is TRUE when the corresponding indicator is red. See Figure 33.

The *Remote Contact Inputs* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Inputs* category. If using the front panel, navigate to Metering > Alarms-Status > Inputs.

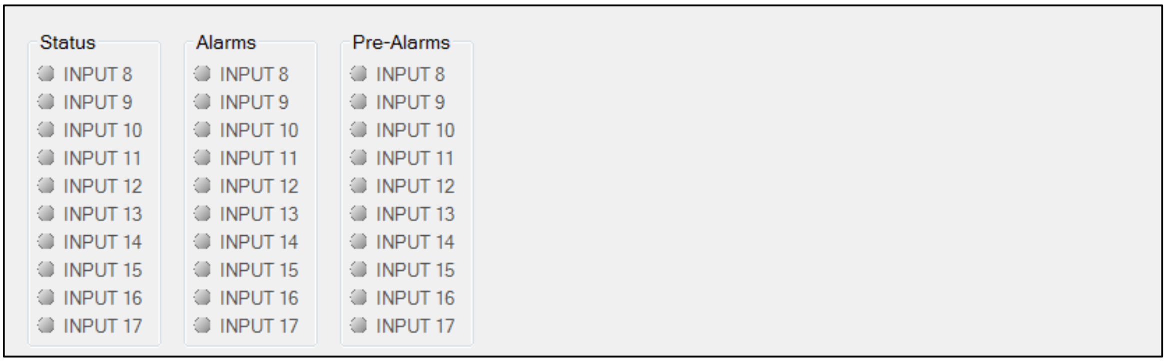

Figure 33. Metering Explorer, Inputs, Remote Contact Inputs Screen

Logic Control Relays

This screen indicates the status of logic control relays. The status is TRUE when the corresponding indicator is green. See Figure 34.

The *Logic Control Relays* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Inputs* category. If using the front panel, navigate to Metering > Alarms-Status > Logic Control Relays.

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Figure 34. Metering Explorer, Inputs, Logic Control Relays Screen

Outputs

Contact Outputs

This screen indicates the status of contact outputs. The status is TRUE when the corresponding indicator is green. See Figure 35.

The *Contact Outputs* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Outputs* category. If using the front panel, navigate to Metering > Alarms-Status > Outputs.

Figure 35. Metering Explorer, Outputs, Contact Outputs Screen

Remote Contact Outputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact outputs is shown on this screen. The status is TRUE when the corresponding indicator is green. See Figure 36.

The *Remote Contact Outputs* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Outputs* category. If using the front panel, navigate to Metering > Alarms-Status > Outputs.

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Figure 36. Metering Explorer, Outputs, Remote Contact Outputs Screen

Configurable Elements

This screen indicates the status of configurable elements. It also indicates alarms and pre-alarms of configurable elements. The status is TRUE when the corresponding indicator is green. See Figure 37.

The *Configurable Elements* screen is found in the BESTCOMS*Plus Metering Explorer* under the *Outputs* category. If using the front panel, navigate to Metering > Alarms-Status > Configurable Elements.

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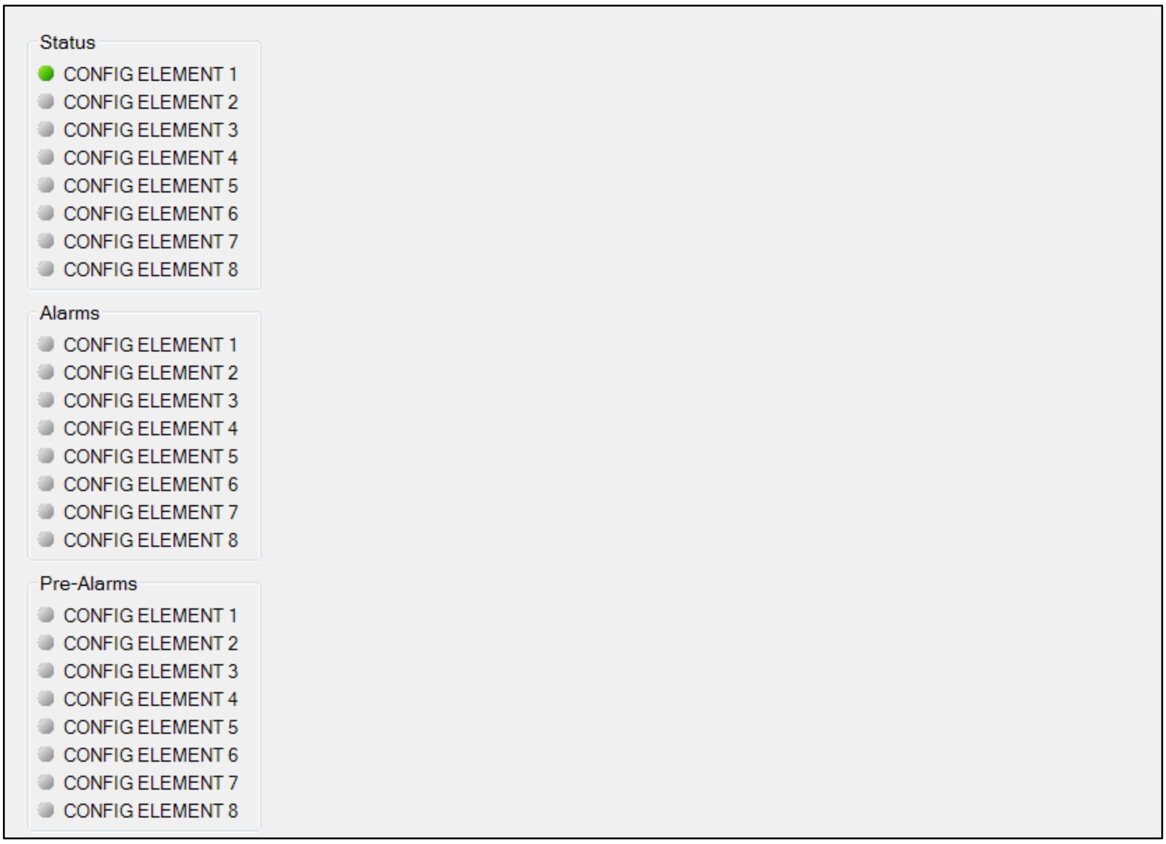

Figure 37. Metering Explorer, Outputs, Configurable Elements Screen

Control

Controls for stopping/starting the engine, opening/closing breakers, and opening/closing switches are accessed using BESTCOMS*Plus* through the *Metering Explorer*, *Control* screen. This set of controls is especially useful when commissioning the MGC-1550. The PC or laptop running BESTCOMS*Plus* must be connected to the MGC-1550 via the USB port (see the *Communication* chapter for details). When running BESTCOMS*Plus* in *Live* mode, these buttons interact with the MGC-1550 in real time.

Otherwise, you will be prompted before the settings are sent.

Using the Metering Explorer in BESTCOMS*Plus,* open the *Control* branch. Refer to Figure 38.

Emergency Stop

The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button.

Engine Control

The engine can be started and stopped by clicking on the *Start* and *Stop* buttons. This function requires a connection to a properly configured ECU via J1939 (CANBus).

Run, Auto, Off

The operating mode can be set to Run, Auto, or Off.

Generator and Mains Breakers

There are controls for opening and closing the generator breaker and mains breaker. The breaker is open when the corresponding indicator is green and closed when red. This function requires that the Generator and Mains breakers be configured.

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Switches 1 through 4

Each of these switches can be opened or closed by clicking on the *Open* or *Close* buttons. The switch is closed when the corresponding indicator is red. These buttons control the virtual inputs found in BESTlogic™*Plus* Programmable Logic. The number of the switch corresponds to the number of the virtual input it controls. See the *BESTlogicPlus* chapter for more information.

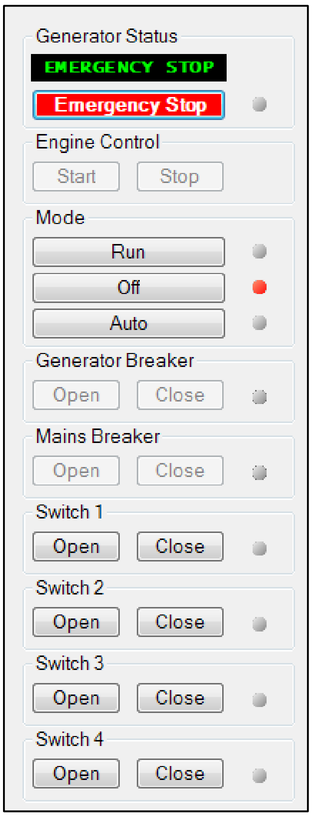

Figure 38. Metering Explorer, Control Screen

Mains Fail Transfer Status

The Mains Fail Transfer Status screen (Figure 39) displays the Mains Fail Transfer State and any timers relevant to the mains fail transfer process. These parameters are listed below.

Mains Fail Transfer State: The different mains fail transfer states are described below.

Power From Mains: Power is being supplied to the load from the mains bus.

Transfer Timer Active: Transfer Delay timer is actively counting.

Transferring to Gens: Load is being transferred to the generator bus.

Power From Gens: Power is being supplied to the load from the generator bus.

Return Timer Active: Return Delay timer is actively counting.

Transferring to Mains: Load is being transferred to the mains bus.

Disabled: MGC-1550 is in the OFF or RUN operating mode or in the alarm state.

Remaining Transfer Delay: Displays the current timer value in seconds.

Remaining Return Delay: Displays the current timer value in seconds.

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Figure 39. Metering, Mains Fail Transfer Status

Auto Export Metering

This function automatically exports metering data over a user-defined period when an MGC-1550 connection is active. To display the Auto Export Metering screen, click the *Tools* pull-down menu from the upper menu bar and click *Auto Export Metering*. Specify the *Number of Exports* and the *Interval* between each export. Enter a filename for the metering data and a folder in which to save. The file is saved in .CSV (comma separated values) format. The first export is performed immediately after clicking the *Start* button. Click the *Filter* button to select specific metering screens.

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Reporting and Alarms

The MGC-1550 monitors ECU data, generator protection functions, and engine senders. An alarm or pre-alarm is annunciated when the monitored parameter exceeds its threshold settings.

When an alarm condition exists, the engine is stopped by opening the Fuel output contact. An existing pre-alarm condition is annunciated only.

When alarms are active, the front panel *Overview* screen is replaced by the *Active Alarms* screen. When only pre-alarms are active, the front panel *Overview* screen is alternated with the *Active Pre-Alarms* screen in one-second intervals. Active alarms and pre-alarms can be viewed through BESTCOMS*Plus*®.

The front panel Alarm LED is illuminated when alarms are active. When pre-alarms are active, the Alarm LED flashes in one-second intervals.

If programmed and enabled, the horn output is closed when alarms are active. When pre-alarms are active, the horn output toggles in one-second intervals.

Each alarm provides a logic output that can be connected to a physical output or other logic input using BESTlogic™*Plus* Programmable Logic.

A detailed list of alarms is provided in Table 6.

Table 6. Available Alarms

Name	Description
Alarms	
AUTO RESTART FAIL	Automatic Restart Failure
BATT CHRG FAIL	Battery Charger Fail
ECU SHUTDOWN	ECU Shutdown
EMERGENCY STOP	Emergency Shutdown
FUEL LEAK DETECT	Fuel Leak Detected
GEN TRANSFER FL	Transfer Fail
GLBL ALARM	Global Alarm
GLBL SNDR FAIL	Global Sender Fail
HI COOLANT TMP	High Coolant Temp
LOST ECU COMM	Loss of ECU Communication
LOW COOL LEVEL	Low Coolant Level
LOW FUEL LEVEL	Low Fuel Level
LOW OIL PRES	Low Oil Pressure
OVERCRANK	Overcrank
OVERSPEED	Overspeed
UNEXPECTED SHUTDN	Unexpected Shutdown
Pre-alarms	
BATT CHRG FAIL	Battery Charger Fail
BATT OVERVOLT	Battery Overvoltage
BUS REV ROT	Reverse Bus Rotation
CEM COMM FAIL	CEM Communication Failure
CEM HW MISMATCH	CEM Hardware Mismatch
CHECKSUM FAIL	Checksum Failure

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Name	Description
DEF ENGINE DERATE	DEF Engine Derate
DEF FLUID EMPTY	DEF Fluid Empty
DEF FLUID LOW	DEF Fluid Low
DEF INDUCMT O-RIDE	DEF Inducement Override
DEF PRESVR INDUCMT	DEF Pre-Severe Inducement
DEF SEVERE INDUCMT	DEF Severe Inducement
DIAG TRBL CODE	Active DTC
DPF REGEN INHBTD	DPF Regenerate Disabled
DPF REGEN REQD	DPF Regenerate Required
DPF SOOT HIGH	DPF Soot Level High
DPF SOOT LVL EXT HI	DPF Soot Level Severely High
DPF SOOT LVL MOD HI	DPF Soot Level Moderately High
FUEL 1 LEAK	Fuel Filter 1 Leak
FUEL 2 LEAK	Fuel Filter 2 Leak
FUEL LEAK DETECT	Fuel Leak Detect
GEN REV ROT	Reverse Generator Rotation
GN BRK CL FL	Breaker Close Failure
GN BRK OP FL	Breaker Open Failure
HI COOLANT TMP	High Coolant Temp
HIGH EXHAUST TEMP	High Exhaust Temperature
HIGH FUEL LEVEL	High Fuel Level
LOST ECU COMM	Loss of ECU Communication
LOW BATT VOLT	Low Battery Voltage
LOW COOL LEVEL	Low Coolant Level
LOW COOL TMP	Low Coolant Temp
LOW FUEL LEVEL	Low Fuel Level
LOW OIL PRES	Low Oil Pressure
MAINT INTERVAL	Maintenance Interval
MPU FAIL	MPU Failure
MULTIPLE CEM	Duplicate CEM
SERFLASH RD FAIL	Serial Flash Read Failure
WEAK BATTERY	Weak Battery Voltage
Sender Fail	
COOL SNDR FAIL	Coolant Temp Sender Fail
FUEL LEVEL SNDR	Fuel Level Sender Fail
LOSS OF VOLT	Voltage Sensing Fail
OIL SNDR FAIL	Oil Pressure Sender Fail
SPD SNDR FAIL	Speed Sender Fail

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Name	Description
Generator Protection	
27 UNDVOLT TRP	Undervoltage (27)
47 PHS IMBAL TRP	Phase Imbalance (47)
50 OVRCURR TRP	Overcurrent (50)
59 OVRVOLT TRP	Overvoltage (59)
81O OVRFREQ TRP	Frequency (81O)
81U UNDFREQ TRP	Frequency (81U)

Alarm Configuration

Alarms, pre-alarms, sender failure alarms, and the audible horn can be configured through BESTCOMS*Plus* or the front panel.

Alarms

To configure alarms using BESTCOMS*Plus*, open the *Alarm* screen (Figure 40). This screen is found in the *Settings Explorer* under the *Alarm Configuration* category. If using the front panel, navigate to Settings > Alarm Configuration > Alarms.

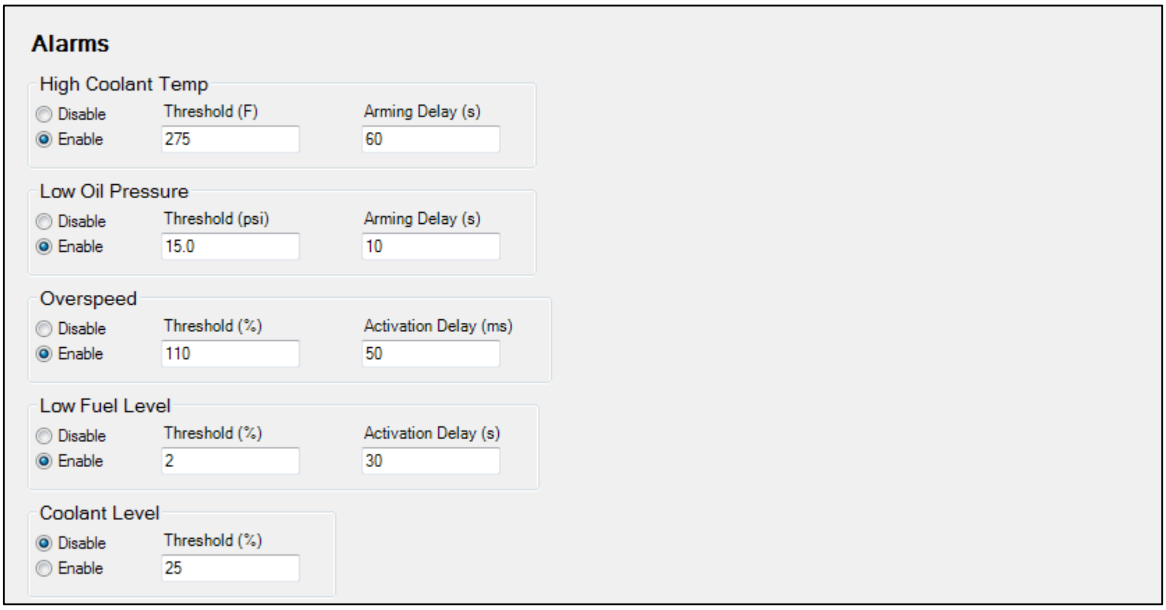

Figure 40. Settings Explorer, Alarm Configuration, Alarms Screen

The alarm settings are described below.

High Coolant Temp

High coolant temperature alarm settings consist of an enable/disable setting, a threshold setting, and an arming delay. If enabled, a high coolant temperature alarm is triggered after a four second delay when the engine coolant temperature exceeds the threshold setting. The arming delay disables the high coolant temperature alarm function for a user-adjustable period after engine startup. System units are configured on the System Settings screen.

Low Oil Pressure

Low oil pressure alarm settings consist of an enable/disable setting, a threshold setting, and an arming delay. If enabled, a low oil pressure alarm is triggered after a two second delay when the engine oil

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pressure decreases below the threshold setting. The arming delay disables the low oil pressure alarm function for a user-adjustable period after engine startup. System units and metric pressure units are configured on the System Settings screen.

Overspeed

Overspeed alarm settings include an enable/disable setting, a threshold setting, and an activation delay. If enabled, an overspeed alarm occurs when the engine speed (in rpm) exceeds the threshold setting for the duration of the activation time delay.

Low Fuel Level

Low fuel level alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay setting. If enabled, a low fuel level alarm is triggered when the metered fuel level drops below the threshold setting for the duration of the activation time delay.

Low Coolant Level

Low coolant level alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant level drops below the threshold setting. ECU Support must be enabled on the *Communications, CAN Bus, CAN Bus Setup* screen before this alarm can be configured.

Pre-alarms

To configure pre-alarms using BESTCOMS*Plus*, open the *Pre-Alarms* screen (Figure 41). This screen is found in the *Settings Explorer* under the *Alarm Configuration* category. If using the front panel, navigate to Settings > Alarm Configuration > Pre-alarms.

The pre-alarm settings are described below.

High Fuel Level

High fuel level pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a high fuel level pre-alarm is triggered when the metered fuel level increases above the threshold setting for the duration of the activation delay.

Low Fuel Level

Low fuel level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low fuel level pre-alarm is triggered when the metered fuel level decreases below the threshold setting.

Low Battery Voltage

Low battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a low battery voltage pre-alarm is triggered when the battery voltage decreases below the threshold setting for the duration of the activation time delay. The threshold can be entered in actual volts or a per-unit value. The per-unit threshold value is based on the nominal battery voltage setting found on the *System Parameters, Rated Data* screen.

High Coolant Temp

High coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature pre-alarm is annunciated when the engine coolant temperature exceeds the threshold setting for a fixed duration of four seconds. The arming delay disables the High Coolant Temp pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the High Coolant Temp Alarm Arming Delay setting. System units are configured on the System Settings screen.

Weak Battery Voltage

Weak battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation time delay. If enabled, a weak battery voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. The

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threshold can be entered in actual volts or a per-unit value. The per-unit threshold value is based on the nominal battery voltage setting found on the *System Parameters, Rated Data* screen.

Low Coolant Temp

Low coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting. System units are configured on the System Settings screen.

Battery Overvoltage

Battery overvoltage pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting. The threshold can be entered in actual volts or a per-unit value. The per-unit threshold value is based on the nominal battery voltage setting found on the *System Parameters, Rated Data* screen.

ECU Coms Fail

ECU communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, this pre-alarm is triggered when the MGC-1550 detects a problem in its J1939 CAN connection to the ECU.

Coolant Level

Low coolant level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level pre-alarm is triggered when the metered coolant level decreases below the threshold setting.

Maintenance Interval

Maintenance interval pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a maintenance interval pre-alarm is annunciated when the MGC-1550 maintenance timer counts down to zero from the threshold time setting.

Active DTC

Active DTC (diagnostic trouble code) pre-alarm settings consist of a single enable/disable setting. If J1939 CAN and DTC support are both enabled, an “active DTC” pre-alarm can be enabled. This pre-alarm is triggered when a DTC is sent from the ECU to the MGC-1550.

Low Oil Pressure

Low oil pressure pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is triggered after a two second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the Low Oil Pressure Alarm Arming Delay setting. System units and metric pressure units are configured on the *System Settings* screen.

CEM Comm Failure

CEM-2020 communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, this pre-alarm is triggered when communication between the optional CEM-2020 and MGC-1550 is lost.

Checksum Failure

When one of the internal checksum calculations, used for data integrity purposes, has failed, the checksum failure pre-alarm is triggered. This indicates that some of the user settings or firmware code has been corrupted.

After upgrading firmware through BESTCOMS*Plus*, the checksum failure pre-alarm may trigger. This pre-alarm is not indicative of an error in this case. It can be cleared by cycling power to the MGC-1550. If the pre-alarm reoccurs, then it is indicative of an error and corrective action should be taken. See *Resetting Alarms, Checksum Failure*, below, for more information.

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Breaker Close Failure

If enabled, this pre-alarm is triggered when the MGC-1550 has issued a "breaker close" output and has not received "breaker closed" feedback from the breaker within the allowed closing time. The Monitor setting determines whether this condition is monitored only during transitions or always.

Breaker Open Failure

If enabled, this pre-alarm is triggered when the MGC-1550 has issued a "breaker open" output and has not received "breaker opened" feedback from the breaker within the allowed closing time. The Monitor setting determines whether this condition is monitored only during transitions or always.

Reverse Rotation

If enabled, this pre-alarm is triggered when the Generator or Bus rotation is opposite of the Phase Rotation setting defined on the Rated Data screen.

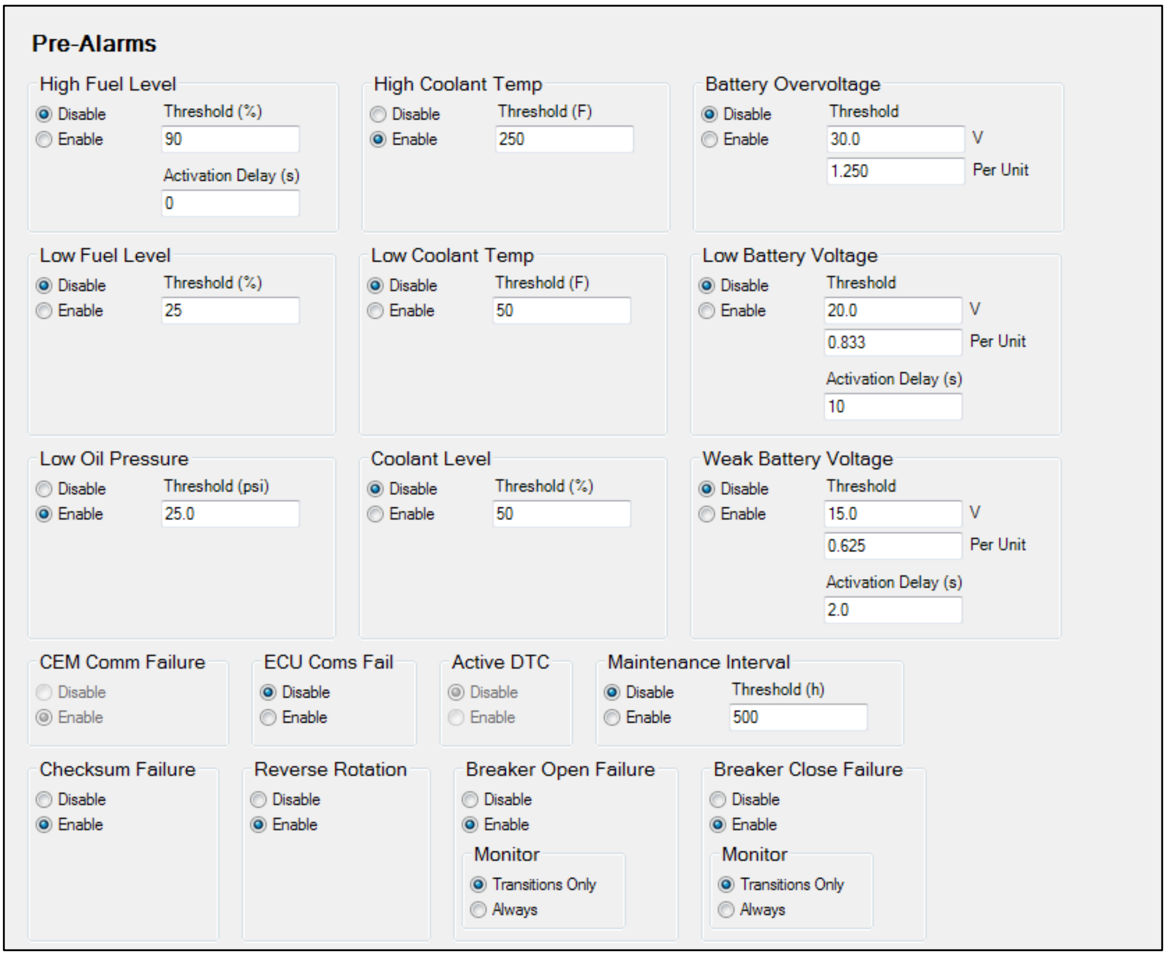

Figure 41. Settings Explorer, Alarm Configuration, Pre-Alarms Screen

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Horn Configuration

To configure the audible horn using BESTCOMS*Plus*, open the *Horn Configuration* screen (Figure 42). This screen is found in the *Settings Explorer* under the *Alarm Configuration* category. If using the front panel, navigate to Settings > Alarm Configuration > Horn Configuration.

An output contact is configured through programmable logic to energize an audible horn when an alarm or pre-alarm condition exists. The horn settings consist of an enable/disable setting and a Not in Auto enable/disable setting. If enabled, the contact output is closed when an alarm condition exists. The contact output is toggled between open and closed when a pre-alarm condition exists. If the Not in Auto setting is enabled, the horn is disabled when the MGC-1550 is not operating in Auto mode.

Figure 42. Settings Explorer, Alarm Configuration, Horn Configuration Screen

Sender Failure

To configure sender failure alarms using BESTCOMS*Plus*, open the *Sender Fail* screen (Figure 43). This screen is found in the *Settings Explorer* under the *Alarm Configuration* category. If using the front panel, navigate to Settings > Alarm Configuration > Sender Fail.

Coolant temperature, oil pressure, fuel level, and voltage sensing sender failure settings consist of an alarm configuration setting and an activation delay. The alarm configuration setting allows selection of the type of alarm to be annunciated when a sender fail condition exists. None, Alarm, and Pre-alarm can be selected. The selected alarm type is triggered when a sender failure exists for the duration of the activation time delay.

Speed sender failure settings consist of a single activation delay. An alarm is triggered when a speed sender failure exists for the duration of the activation time delay.

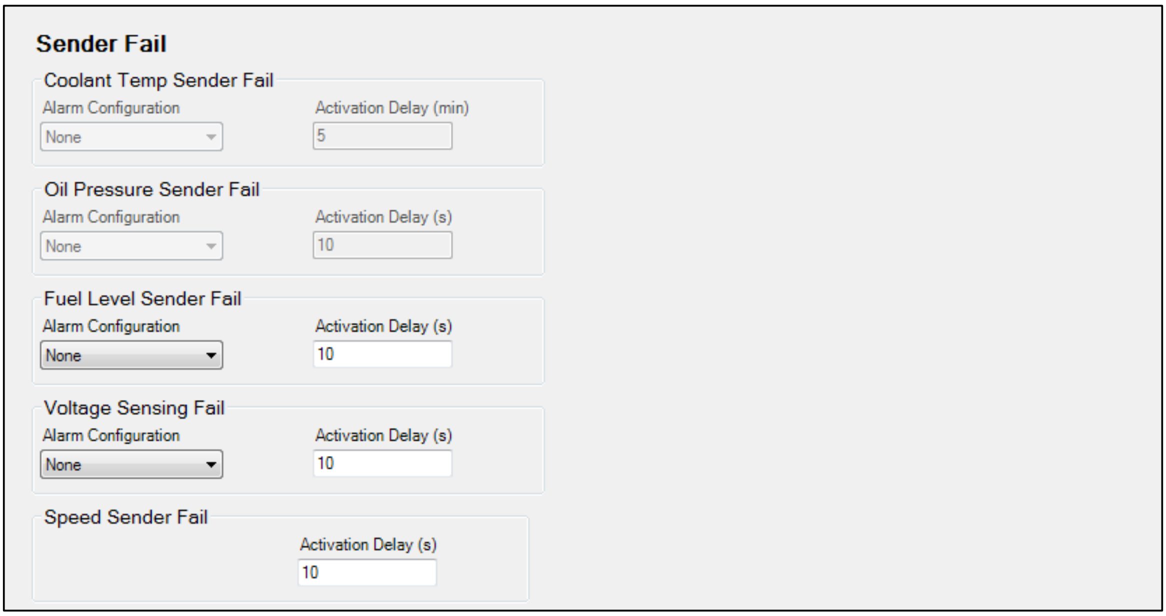

Figure 43. Settings Explorer, Alarm Configuration, Sender Fail Screen

Retrieving Alarm Information

Alarms can be viewed on the front panel display and through BESTCOMS*Plus*.

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Front Panel Display

The lists of active alarms and pre-alarms can be viewed by navigating to Metering > Alarms-Status > Active Alarms *or* Active Pre-alarms. These lists are scrollable by using the *Up* and *Down* pushbuttons.

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The status of each alarm and pre-alarm is displayed on the *Alarms* screen (Figure 44). This screen is found in the *Metering Explorer*. Alarms with a red indicator are active.

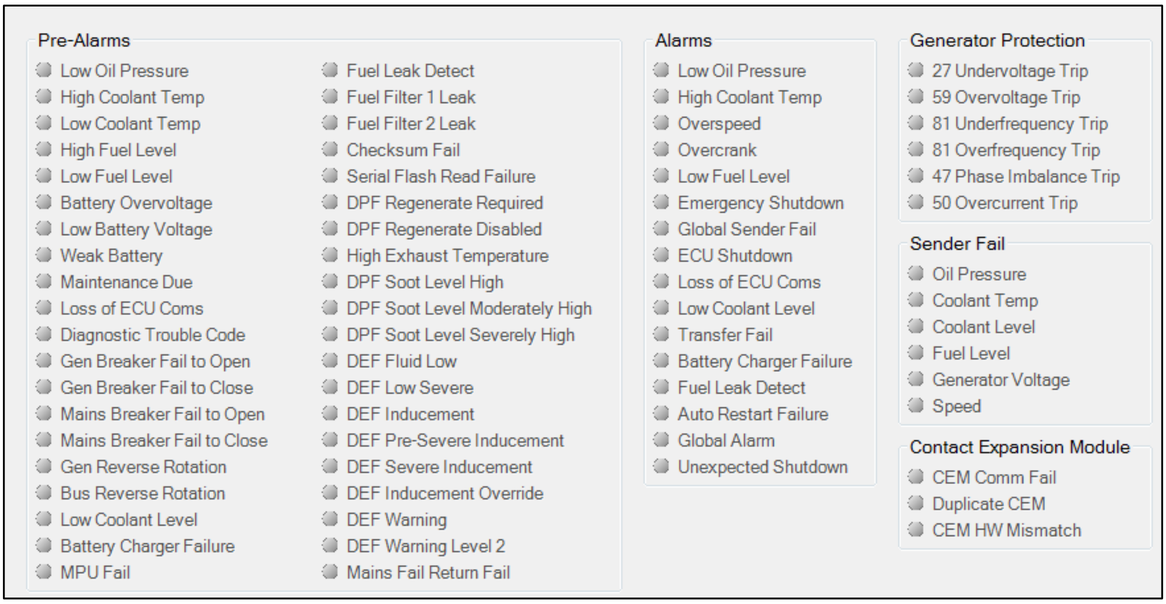

Figure 44. Metering Explorer, Alarms Screen

Resetting Alarms and Pre-Alarms

Most pre-alarms automatically reset when the alarm condition no longer exists. Pre-alarms that do not automatically reset are listed below:

- Weak Battery
- Breaker Fail to Open
- Breaker Fail to Close

These pre-alarms are reset by navigating to the Overview screen on the front panel display and holding the *Back* pushbutton for two seconds.

Alarms do not automatically reset. Manually reset alarms by pressing the *Off* pushbutton.

Horn

The audible horn can be silenced by simultaneously pressing the *Back* and *Edit* pushbuttons. This does not reset the alarm or pre-alarm causing the horn to annunciate.

Maintenance Interval

To reset the maintenance interval pre-alarm through the front panel, navigate to the Settings > System Params > System Settings > Maint Reset screen. Operator, Settings, or OEM access level is required to reset the maintenance interval pre-alarm. If the maintenance interval pre-alarm is not enabled, the *Maint Reset* parameter is not visible on the front panel.

To reset the maintenance interval pre-alarm by using BESTCOMS*Plus*, use the *Metering Explorer* to open the *Run Statistics* screen and click on the *Reset Maintenance Interval* button.

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To reset the maintenance interval pre-alarm from the front panel, navigate to the *Overview* screen and hold the *Back* pushbutton for 12 seconds.

Checksum Failure

The checksum failure pre-alarm can be cleared by holding the *Back* pushbutton for two seconds while displaying the *Overview* screen. However, the pre-alarm will reoccur the next time the checksum is verified if the data is still corrupted. Some checksum calculations are done only on power-up, so this may not occur until the next time operating power is cycled.

If there are consistent checksum failure pre-alarms, attempt the following actions to correct the problem:

1. Load default settings by holding the *Up* and *Down* pushbuttons on the front panel while cycling power. After loading defaults, upload the settings file through BESTCOMS*Plus* if necessary.

Caution
Loading default settings will erase all custom settings. All reports and events will be cleared. It is recommended that all settings are downloaded and saved through BESTCOMS*Plus* before attempting to load defaults. Once defaults are loaded, the saved settings can then be uploaded.

2. If the problem persists, reload the firmware file through BESTCOMS*Plus*. See the *BESTCOMSPlus* chapter for more information.
3. Contact MTU Onsite Energy Technical Support.
4. The checksum failure pre-alarm can be disabled. This disables only the annunciation of the pre-alarm and does not correct any error conditions.

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Event Recording

An event log retains history of system events in nonvolatile memory. Fifty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 50 records in memory, the record that has the oldest “last” event occurrence is removed from the log, and the new category takes its place. Since 50 event records with up to 99 occurrences each are retained in memory, a history of nearly 5,000 specific events are retained by the MGC-1550. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 50 event records. Thus the time, date, and engine hours details for up to 1,500 specific event occurrences are retained in the event log.

Event Log

An event log can be downloaded into BESTCOMS*Plus*® for viewing and storage. The *Options* button is used to save the entire event log to a file, or to save the list to the computer clipboard making it available for insertion into other software applications. It is possible to copy a portion of the log to the computer clipboard by selecting the desired portion with the mouse then using the Options->Copy Selection feature. The *Download* button refreshes the event log list by performing a fresh download of the list from the MGC-1550. The *Clear* button gives the user the option of clearing selected or all event logs. Refer to Figure 45.

Options ▾ | Refresh | Clear ▾ | Toggle Sorting | Sorting: Enabled

Event ID	Description	Occurrence	Date	Eng Hrs (H:m)
3	OFF MODE	29	2014-09-22 11:15:04	100:09
3	OFF MODE	28	2014-09-22 11:12:48	100:09
3	OFF MODE	27	2014-09-22 11:12:09	100:09
3	OFF MODE	26	2014-09-22 11:11:51	100:09
3	OFF MODE	25	2014-09-22 11:11:25	100:09
3	OFF MODE	24	2014-09-22 11:06:21	100:09
3	OFF MODE	23	2014-09-22 11:06:06	100:09
3	OFF MODE	22	2014-09-22 10:53:03	100:09
3	OFF MODE	21	2014-04-25 17:31:47	100:09
3	OFF MODE	20	2014-04-25 17:31:26	100:09
3	OFF MODE	19	2014-04-25 17:27:19	100:09
3	OFF MODE	18	2014-04-25 17:21:29	100:09
3	OFF MODE	1	2014-04-15 11:50:54	100:09
4	AUTO MODE	8	2014-09-22 11:24:26	100:09
4	AUTO MODE	7	2014-09-22 11:24:19	100:09
4	AUTO MODE	6	2014-09-22 10:48:39	100:09
4	AUTO MODE	5	2014-04-25 17:31:48	100:09
4	AUTO MODE	4	2014-04-25 17:31:28	100:09
4	AUTO MODE	3	2014-04-25 17:31:08	100:09
4	AUTO MODE	2	2014-04-17 16:57:18	100:09
4	AUTO MODE	1	2014-04-17 16:57:15	100:09
5	RUN MODE	2	2014-09-22 11:24:22	100:09
5	RUN MODE	1	2014-04-17 16:57:16	100:09

Figure 45. Metering Explorer, Event Log Screen (Sorted by Event ID)

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The event log may also be viewed on the front panel display by navigating to *Metering, Alarms-Status, Event Log.* Use the Up/Down keys to highlight an event and press the *Right* key to view the summary of that event record. The summary contains the description of the event, date, time, and engine hours of the first occurrence of the event, along with date, time, and engine hours of the most recent occurrence of the event. To view details of specific event occurrences, press the *Down* key until DETAILS is highlighted, and then, press the *Right* key. The occurrence number can be changed by pressing the *Edit* key, *Up/Down* keys to select #, and pressing the *Edit* key again to exit. Table 7 lists all possible event strings (as shown in the event log).

Table 7. Event List

Event String	Event Description	Event Type
27 UNDVOLT TRP A	27 Undervoltage Trip	Alarm
27 UNDVOLT TRP P	27 Undervoltage Trip	Pre-Alarm
47 PHS IMBAL TRP A	47 Phase Imbalance Trip	Alarm
47 PHS IMBAL TRP P	47 Phase Imbalance Trip	Pre-Alarm
50 OVRCURR TRP A	50 Overcurrent Trip	Alarm
50 OVRCURR TRP P	50 Overcurrent Trip	Pre-Alarm
59 OVRVOLT TRP A	59 Overvoltage Trip	Alarm
59 OVRVOLT TRP P	59 Overvoltage Trip	Pre-Alarm
81O OVRFREQ TRP A	81 Overfrequency Trip	Alarm
81O OVRFREQ TRP P	81 Overfrequency Trip	Pre-Alarm
81U UNDFREQ TRP A	81 Underfrequency Trip	Alarm
81U UNDFREQ TRP P	81 Underfrequency Trip	Pre-Alarm
ATS INPUT CLOSED	ATS Input	Status
AUTO RESTART	Automatic Restart in Progress	Status
AUTO RESTART FAIL A	Automatic Restart Fail	Alarm
BATT CHRG FAIL A	Battery Charger Fail	Alarm
BATT CHRG FAIL P	Battery Charger Fail	Pre-Alarm
BATT OVERVOLT P	Battery Overvoltage	Pre-Alarm
BATTLE OVERRIDE	Battle Override	Status
CAN BUS OFF	CAN Bus entered Bus Off state	Status
CAN ERROR PASSIVE	CAN Bus entered Error Passive state	Status
CEM COMM FAIL P	CEM-2020 Communications Failure	Pre-Alarm
CEM HW MISMATCH P	Connected CEM-2020 is wrong type	Pre-Alarm
CHECKSUM FAIL P	Corrupt user settings or firmware code	Pre-Alarm
COMBINED RED A	Combined Red	Alarm
COMBINED YELLOW P	Combined Yellow	Pre-Alarm
CONFIG ELEMENT X A (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Alarm
CONFIG ELEMENT X P (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Pre-Alarm
COOL LVL SNDR FL A	Coolant Level Sender Fail	Alarm
COOL SNDR FAIL	Coolant Temperature Sender Fail	Status
COOL SNDR FAIL A	Coolant Temperature Sender Fail	Alarm
COOL SNDR FAIL P	Coolant Temperature Sender Fail	Pre-Alarm
DEF ENGINE DERATE P	Diesel Exhaust Fluid Engine Derate	Pre-Alarm
DEF FLUID EMPTY P	Diesel Exhaust Fluid Empty	Pre-Alarm
DEF FLUID LOW P	Diesel Exhaust Fluid Low	Pre-Alarm
DEF INDUCMT O-RIDE P	Diesel Exhaust Fluid Inducement Override	Pre-Alarm

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Event String	Event Description	Event Type
DEF PRESVR INDUCMT P	Diesel Exhaust Fluid Pre-Severe Inducement	Pre-Alarm
DEF SEVERE INDUCMT P	Diesel Exhaust Fluid Severe inducement	Pre-Alarm
DGC HEARTBEAT FAIL P	DGC Heartbeat Fail	Pre-Alarm
DIAG TRBL CODE P	Diagnostic Trouble Code	Pre-Alarm
DPF REGNRATE DISABLD P	Diesel Particulate Filter Regeneration Disabled	Pre-Alarm
DPF REGEN REQD P	Diesel Particulate Filter Regeneration Required	Pre-Alarm
DPF SOOT LVL EXT HI P	Diesel Particulate Filter Soot Level Extremely High	Pre-Alarm
DPF SOOT LVL MOD HI P	Diesel Particulate Filter Soot Level Moderately High	Pre-Alarm
ECU SHUTDOWN A	ECU Shutdown	Alarm
EMERGENCY STOP A	Emergency Stop	Alarm
ENGINE RUNNING	Engine Running	Status
FUEL FLT PRS HI P	Fuel Filter Differential Pressure High	Pre-Alarm
FUEL LEAK 1 P	Fuel Filter 1 Leak	Pre-Alarm
FUEL LEAK 2 P	Fuel Filter 2 Leak	Pre-Alarm
FUEL LEAK DETECT A	Fuel Leak Detect	Alarm
FUEL LEAK DETECT P	Fuel Leak Detect	Pre-Alarm
FUEL LEVL SENDR A	Fuel Level Sender Fail	Alarm
FUEL LEVL SENDR FAIL	Fuel Level Sender Fail	Status
FUEL LEVL SENDR P	Fuel Level Sender Fail	Pre-Alarm
GEN TEST LOADED	Generator Exerciser Test with Load	Status
GEN TEST UNLOADED	Generator Exerciser Test without Load	Status
GLBL SNDR FAIL A	Global Sender Fail	Alarm
GN BKR CL FL P	Generator Breaker Fail to Close	Pre-Alarm
GN BKR OP FL P	Generator Breaker Fail to Open	Pre-Alarm
GN BKR SYN FL P	Generator Breaker Synchronization Fail	Pre-Alarm
HI COOLANT TMP A	High Coolant Temp	Alarm
HI COOLANT TMP P	High Coolant Temp	Pre-Alarm
HI DAY TANK LEVEL P	High Day Tank Level	Pre-Alarm
HI ECU VOLTS A	High ECU Supply Voltage	Alarm
HI EXHAUSE B T P	High Exhaust Temp B	Pre-Alarm
HI EXHAUST A T P	High Exhaust Temp A	Pre-Alarm
HI PRESSURE IN 1 P	High Pressure Input 1	Pre-Alarm
HI PRESSURE IN 2 P	High Pressure Input 2	Pre-Alarm
HI SUPPLY VOLTS P	High Voltage Supply	Pre-Alarm
HI T FUEL P	High Fuel Temp	Pre-Alarm
HIGH AMB TEMP P	High Ambient Temp	Pre-Alarm
HIGH CHARGE AIR TEMP A	High Charge Air Temp	Alarm
HIGH CHARGE AIR TEMP P	High Charge Air Temp	Pre-Alarm
HIGH COIL TEMP 1 P	High Temp Coil 1	Pre-Alarm
HIGH COIL TEMP 2 P	High Temp Coil 2	Pre-Alarm
HIGH COIL TEMP 3 P	High Temp Coil 3	Pre-Alarm
HIGH COOLANT TEMP A	High Coolant Temp	Alarm
HIGH COOLANT TEMP P	High Coolant Temp	Pre-Alarm

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Event String	Event Description	Event Type
HIGH ECU TEMPERATURE P	High ECU Temp	Pre-Alarm
HIGH EXHAUST TEMP P	High Exhaust Temp	Pre-Alarm
HIGH FUEL LEVEL P	High Fuel Level	Pre-Alarm
HIGH FUEL RAIL PRESS P	High Fuel Rail Pressure	Pre-Alarm
HIGH INTRCOOLER TEMP P	High Intercooler Temp	Pre-Alarm
HIGH OIL TEMPERATURE P	High Oil Temp	Pre-Alarm
HIGH OIL TERMPERATURE A	High Oil Temp	Alarm
HIGH STRG TANK LEVEL P	High Storage Tank Level	Pre-Alarm
IDLE SPD LO P	Idle Speed Low	Pre-Alarm
INPUT X A (X = 1 to 17)	User Configurable Input X (X = 1 to 17)	Alarm
INPUT X P (X = 1 to 17)	User Configurable Input X (X = 1 to 17)	Pre-Alarm
LO AFTERCLR COOL LVL A	Low After Cooler Cool Level	Alarm
LO CHG AIR CLNT LVL P	Low Charge Air Coolant Level	Pre-Alarm
LO DAY TANK LEVEL P	Low Day Tank Level	Pre-Alarm
LO ECU VOLTS P	Low ECU Supply Voltage	Pre-Alarm
LO FUEL DLV PRESSURE A	Low Fuel Delivery Pressure	Alarm
LO SUPPLY VOLTS P	Low Voltage Supply	Pre-Alarm
LOAD TAKEOVER	Load Takeover	Status
LOGIC OUPUT A	Logic Output	Alarm
LOGIC OUPUT P	Logic Output	Pre-Alarm
LOSS OF VOLT	Voltage Sensing Fail	Status
LOSS OF VOLT A	Voltage Sensing Fail	Alarm
LOSS OF VOLT P	Voltage Sensing Fail	Pre-Alarm
LOSS REM COMS P	Loss of Remote Module Communication	Pre-Alarm
LOST ECU COMM A	Loss of ECU Communication	Alarm
LOST ECU COMM P	Loss of ECU Communication	Pre-Alarm
LOW BATT VOLT P	Low Battery Voltage	Pre-Alarm
LOW CHARGE AIR PRESS P	Low Charge Air Pressure	Pre-Alarm
LOW COOL LEVEL A	Low Coolant Level	Alarm
LOW COOL LEVEL P	Low Coolant Level	Pre-Alarm
LOW COOL TMP A	Low Coolant Temperature	Alarm
LOW COOL TMP P	Low Coolant Temperature	Pre-Alarm
LOW COOLANT LEVEL P	Low Coolant Level	Pre-Alarm
LOW FUEL DELIV PRESS P	Low Fuel Delivery Pressure	Pre-Alarm
LOW FUEL LEVEL A	Low Fuel Level	Alarm
LOW FUEL LEVEL P	Low Fuel Level	Pre-Alarm
LOW FUEL RAIL PRESS P	Low Fuel Rail Pressure	Pre-Alarm
LOW OIL PRES A	Low Oil Pressure	Alarm
LOW OIL PRES P	Low Oil Pressure	Pre-Alarm
LOW OIL PRESSURE A	Low Oil Pressure	Alarm
LOW OIL PRESSURE P	Low Oil Pressure	Pre-Alarm
LOW STRG TANK LEVEL P	Low Storage Tank Level	Pre-Alarm
MAINS FAIL TEST	Mains Fail Test	Status

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Event String	Event Description	Event Type
MAINT INTERVAL P	Maintenance Interval	Pre-Alarm
MF TRANSFER	Mains Fail Transfer Complete	Status
MF TRANSFER FAIL	Mains Fail Transfer Fail	Status
MN BKR CL FL P	Mains Breaker Fail to Close	Pre-Alarm
MN BKR OP FL P	Mains Breaker Fail to Open	Pre-Alarm
MPU FAIL P	Magnetic Pickup Fail	Pre-Alarm
MULTIPLE CEM P	Multiple CEM-2020's	Pre-Alarm
NORM SHUTDOWN	Normal Shutdown	Status
OIL SNDR FAIL	Oil Pressure Sender Fail	Status
OIL SNDR FAIL A	Oil Pressure Sender Fail	Alarm
OIL SNDR FAIL P	Oil Pressure Sender Fail	Pre-Alarm
OVERCRANK A	Overcrank	Alarm
OVERSPD TEST ON P	Overspeed Test On	Pre-Alarm
OVERSPEED A	Overspeed	Alarm
PRIMING FAULT P	Priming Fault	Pre-Alarm
PROT SHUTDOWN	Protective Shutdown	Status
REV BUS ROT P	Reverse Bus Rotation	Pre-Alarm
REV GEN ROT P	Reverse Generator Rotation	Pre-Alarm
RUNUP SPD LO P	Run Up Speed Low	Pre-Alarm
SERFLASH RD FAIL	Serial Flash Read Fail	Pre-Alarm
SPD SNDR FAIL	Speed Sender Fail	Status
SPD SNDR FAIL A	Speed Sender Fail	Alarm
SPEED DMD FL P	Speed Demand Fail	Pre-Alarm
SPEED TOO LOW P	Engine Speed Too Low	Pre-Alarm
SS OVERRIDE ON P	Shutdown Override	Pre-Alarm
START SPEED LOW P	Start Speed Low	Pre-Alarm
VOLTAGE SENSE FAIL	Voltage Sensing Fail	Status
VOLTAGE SENSE FAIL A	Voltage Sensing Fail	Alarm
VOLTAGE SENSE FAIL P	Voltage Sensing Fail	Pre-Alarm
WEAK BATTERY P	Weak Battery	Pre-Alarm

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Mounting

MGC-1550 controllers are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a unit, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify MTU Onsite Energy.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Hardware

The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. MGC-1550 controllers are mounted using the four permanently attached 10-24 studs. The torque applied to the mounting hardware should not exceed 20 inch-pounds (2.2 newton meters).

Dimensions

Panel cutting and drilling dimensions are shown in Figure 46. Overall dimensions are shown in Figure 47. All dimensions are shown in inches with millimeters in parenthesis.

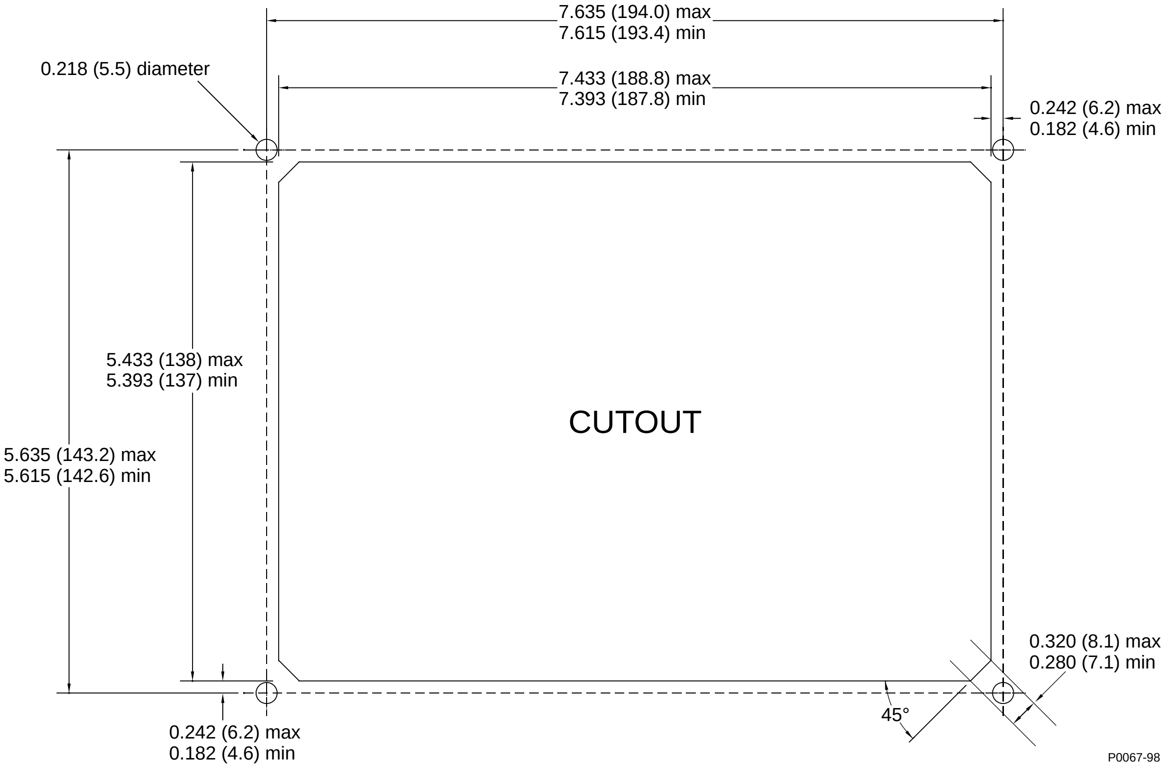

Figure 46. Panel Cutting and Drilling Dimensions

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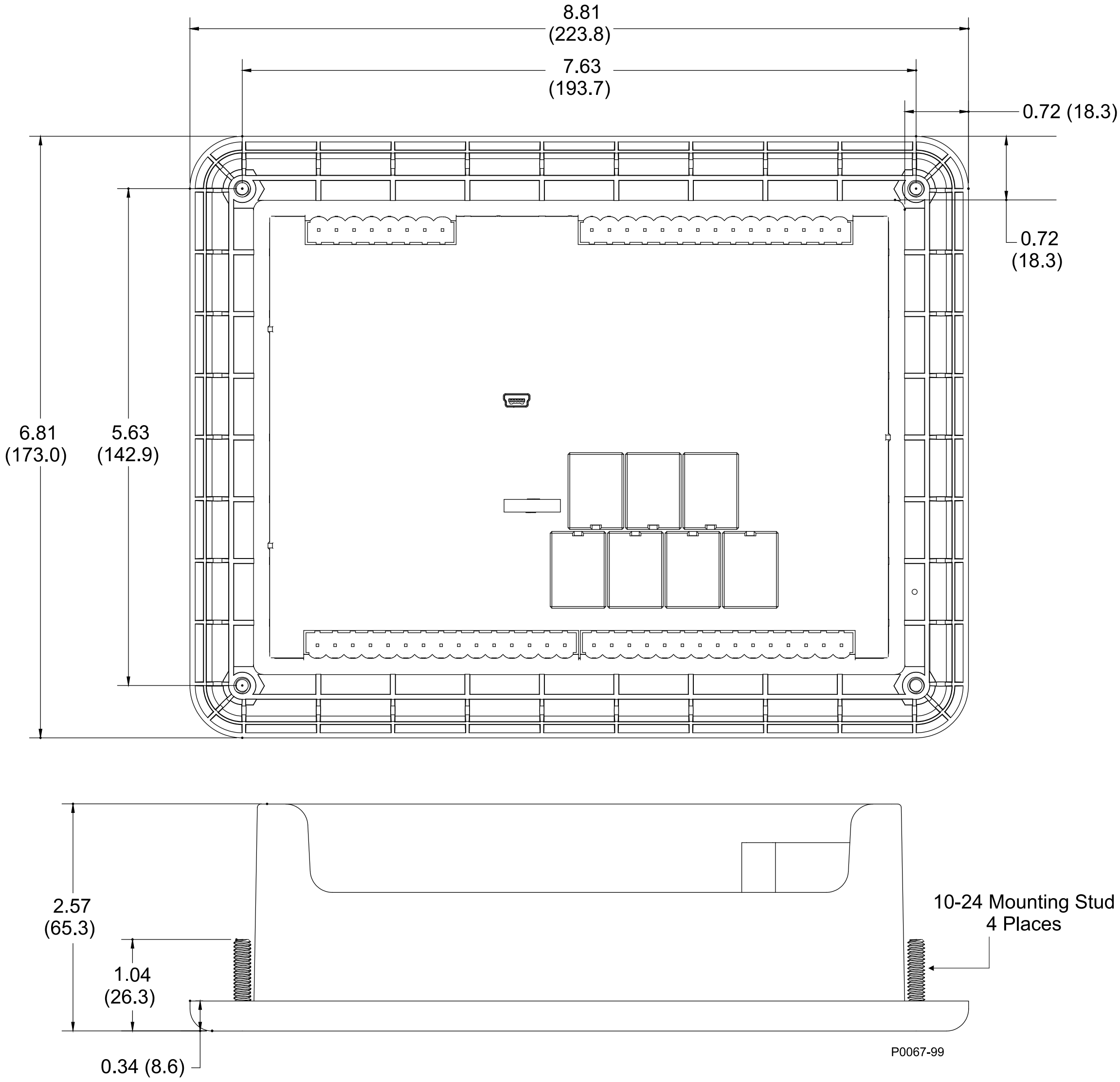

Figure 47. Overall Dimensions

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Terminals and Connectors

All MGC-1550 terminals and connectors are located on the rear panel. MGC-1550 terminals consist of a mini-B USB socket and plug-in connectors with spring clamp terminals.

Figure 48 illustrates the rear panel terminals. Locator letters in the illustration correspond to the terminal block and connector descriptions in Table 8.

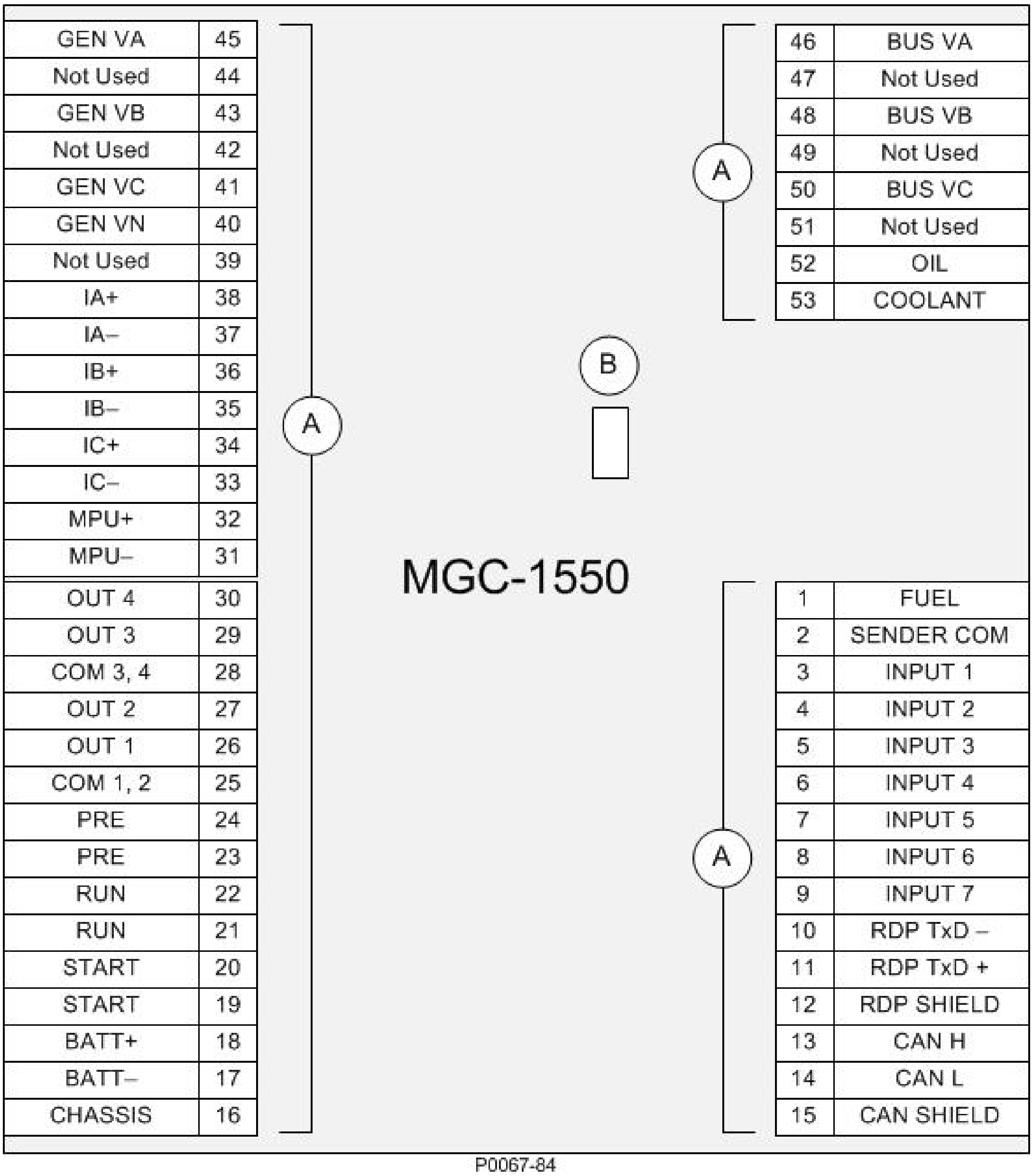

Figure 48. Rear Panel

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Table 8. Rear Panel Terminal and Connector Descriptions

Locator	Description
A	The majority of external, **MGC-1550** wiring is terminated at 8- or 15-position connectors with spring clamp terminals. These connectors plug into headers on the **MGC-1550**. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Spring clamp terminals accept a maximum wire size of 12 AWG.
B	The mini-B USB socket mates with a standard USB cable and is used with a PC running BESTCOMS*Plus*® software for local communication with the **MGC-1550**.

Connections

MGC-1550 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

Note
Be sure that the MGC-1550 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (terminal 1) on the rear of the controller. Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the MGC-1550 will not operate. For the MGC-1550 to correctly meter power factor, the generator must be rotating clockwise (A-B-C).

The MGC-1550 terminals are grouped by function and include operating power, generator current sensing, generator voltage sensing, bus voltage sensing, analog engine sender inputs, magnetic pickup input, contact sensing inputs, output contacts, USB interface, CAN interface, and Remote Display Panel connections.

MGC-1550 terminal groups are described in the following paragraphs.

Operating Power

The MGC-1550 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the MGC-1550 will not operate. Operating power terminals are listed in Table 9.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the MGC-1550. A fuse helps prevent wire damage and nuisance trips due to initial power supply inrush current. To follow UL guidelines, a 5 A maximum, 32 Vdc supplementary fuse must be implemented in the battery input circuit to the MGC-1550

Table 9. Operating Power Terminals

Terminal	Description
16 (CHASSIS)	Chassis ground connection
17 (BATT–)	Negative side of operating power input
18 (BATT+)	Positive side of operating power input

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Generator Current Sensing

The MGC-1550 has sensing inputs for A-phase, B-phase, and C-phase generator current. An MGC-1550 with a style number of 1xx has a 1 Aac nominal current sensing and an MGC-1550 with a style number of 5xx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 10.

Table 10. Generator Current Sensing Terminals

Terminals	Description
37 (IA–)	A-phase current sensing input
38 (IA+)	
35 (IB–)	B-phase current sensing input
36 (IB+)	
33 (IC–)	C-phase current sensing input
34 (IC+)	

Note

Unused current sensing inputs should be shorted to minimize noise pickup.

Caution

Generator current sensing terminals 37 (IA–), 35 (IB–), and 33 (IC–) must be terminated to ground for proper operation.

Generator Voltage Sensing

The MGC-1550 accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 12 to 576 volts, rms line-to-line. Generator voltage sensing terminals are listed in Table 11.

Table 11. Generator Voltage Sensing Terminals

Terminal	Description
40 (GEN VN)	Neutral generator voltage sensing input
41 (GEN VC)	C-phase generator voltage sensing input
43 (GEN VB)	B-phase generator voltage sensing input
45 (GEN VA)	A-phase generator voltage sensing input

Bus Voltage Sensing

Sensing of bus voltage enables the MGC-1550 to detect failures of the mains (utility). The MGC-1550 senses A-phase, B-phase, and C-phase bus voltage. Bus voltage sensing terminals are listed in Table 12.

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Table 12. Bus Voltage Sensing Terminals

Terminal	Description
46 (BUS VA)	A-phase bus voltage sensing input
48 (BUS VB)	B-phase bus voltage sensing input
50 (BUS VC)	C-phase bus voltage sensing input

Analog Engine Sender Inputs

Inputs are provided for oil pressure, fuel level, and coolant temperature senders. For a listing of oil pressure, fuel level, and coolant temperature senders that are compatible with the MGC-1550, refer to the *Engine Sender Inputs* chapter. Analog engine sender input terminals are listed in Table 13.

Table 13. Sender Input Terminals

Terminal	Description
1 (FUEL)	Fuel level sender input
2 (SENDER COM)	Sender return terminal
52 (OIL)	Oil pressure sender input
53 (COOLANT)	Coolant temperature sender input

Magnetic Pickup Input

The magnetic pickup input accepts a speed signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz. Magnetic pickup input terminals are listed in Table 14.

Table 14. Magnetic Pickup Input Terminals

Terminals	Description
31 (MPU–)	Magnetic pickup return input
32 (MPU+)	Magnetic pickup positive input

Contact Sensing Inputs

Contact sensing inputs consist of seven programmable inputs. The programmable inputs accept normally open, dry contacts. Terminal 17 (BATT–) serves as the common return line for the programmable inputs. While input 1 is programmed to recognize an emergency stop input by default, it can be programmed for any function. Information about configuring the programmable inputs is provided in the *Contact Inputs* chapter. Contact sensing input terminals are listed in Table 15.

Table 15. Contact Sensing Inputs

Terminal	Description
17 (BATT–)	Common return line for programmable contact inputs
3 (INPUT 1)	Programmable contact input 1 (ESTOP by default)
4 (INPUT 2)	Programmable contact input 2
5 (INPUT 3)	Programmable contact input 3
6 (INPUT 4)	Programmable contact input 4
7 (INPUT 5)	Programmable contact input 5
8 (INPUT 6)	Programmable contact input 6
9 (INPUT 7)	Programmable contact input 7

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Output Contacts

The MGC-1550 has three sets of fixed-function output contacts: Pre, Start, and Run. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the starter solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the three sets of contacts are made at terminals 19 through 24. The Pre, Start, and Run relay terminals are listed in Table 16.

Table 16. Fixed-Function Output Contact Terminals

Terminal	Description
19 (START)	Start output contact (Start solenoid)
20 (START)	
21 (RUN)	Run output contact (Fuel solenoid)
22 (RUN)	
23 (PRE)	Pre-start output contact (Glow plugs)
24 (PRE)	

Four programmable output contacts are provided in two sets. Each set of two output contacts share a common terminal. Programmable output contact terminals are listed in Table 17.

Table 17. Programmable Output Contact Terminals

Terminal	Description
25 (COM 1, 2)	Common connection for outputs 1 and 2
26 (OUT 1)	Programmable output 1
27 (OUT 2)	Programmable output 2
28 (COM 3, 4)	Common connection for outputs 3 and 4
29 (OUT 3)	Programmable output 3
30 (OUT 4)	Programmable output 4

USB Interface

A mini-B USB socket enables local communication with a PC running BESTCOMS*Plus* software. The MGC-1550 is connected to a PC using a standard USB cable equipped with a type A plug on one end (PC termination) and a mini-B plug on the other end (MGC-1550 termination).

CAN Interface

These terminals provide communication using the SAE J1939 protocol or the MTU protocol and provide high-speed communication between the MGC-1550 and an ECU on an electronically controlled engine. Connections between the ECU and MGC-1550 should be made with twisted-pair, shielded cable. CAN interface terminals are listed in Table 18. For typical CAN connections, refer to the *Typical Connections* chapter.

Table 18. CAN Interface Terminals

Terminals	Description
13 (CAN H)	CAN high connection
14 (CAN L)	CAN low connection
15 (SHIELD)	CAN drain connection

Note

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1. If the MGC-1550 is providing one end of the J1939 bus, a 120 Ω, ½ watt terminating resistor should be installed across terminals 14 (CANL) and 13 (CANH).
2. If the MGC-1550 is not providing one end of the J1939 bus, the stub connecting the MGC-1550 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the MGC-1550

Optional Remote Display Panel Connections

Terminals are provided for connection with the optional Remote Display Panel. These terminals provide dc operating power to the Remote Display Panel and enable communication between the MGC-1550 and Remote Display Panel. Twisted-pair conductors are recommended for connecting the communication terminals of the MGC-1550 and Remote Display Panel. Communication may become unreliable if the connection wires exceed 1,219 m (4,000 ft). Table 19 lists the MGC-1550 terminals that connect to the Remote Display Panel.

Table 19. Remote Display Panel Interface Terminals

Terminal	Description
10 (RDP TxD–)	Remote Display Panel terminal (TxD–)
11 (RDP TxD+)	Remote Display Panel terminal (TxD+)
17 (BATT–)	Remote Display Panel terminal DC COM (–)
18 (BATT+)	Remote Display Panel terminal 12/24 (+)

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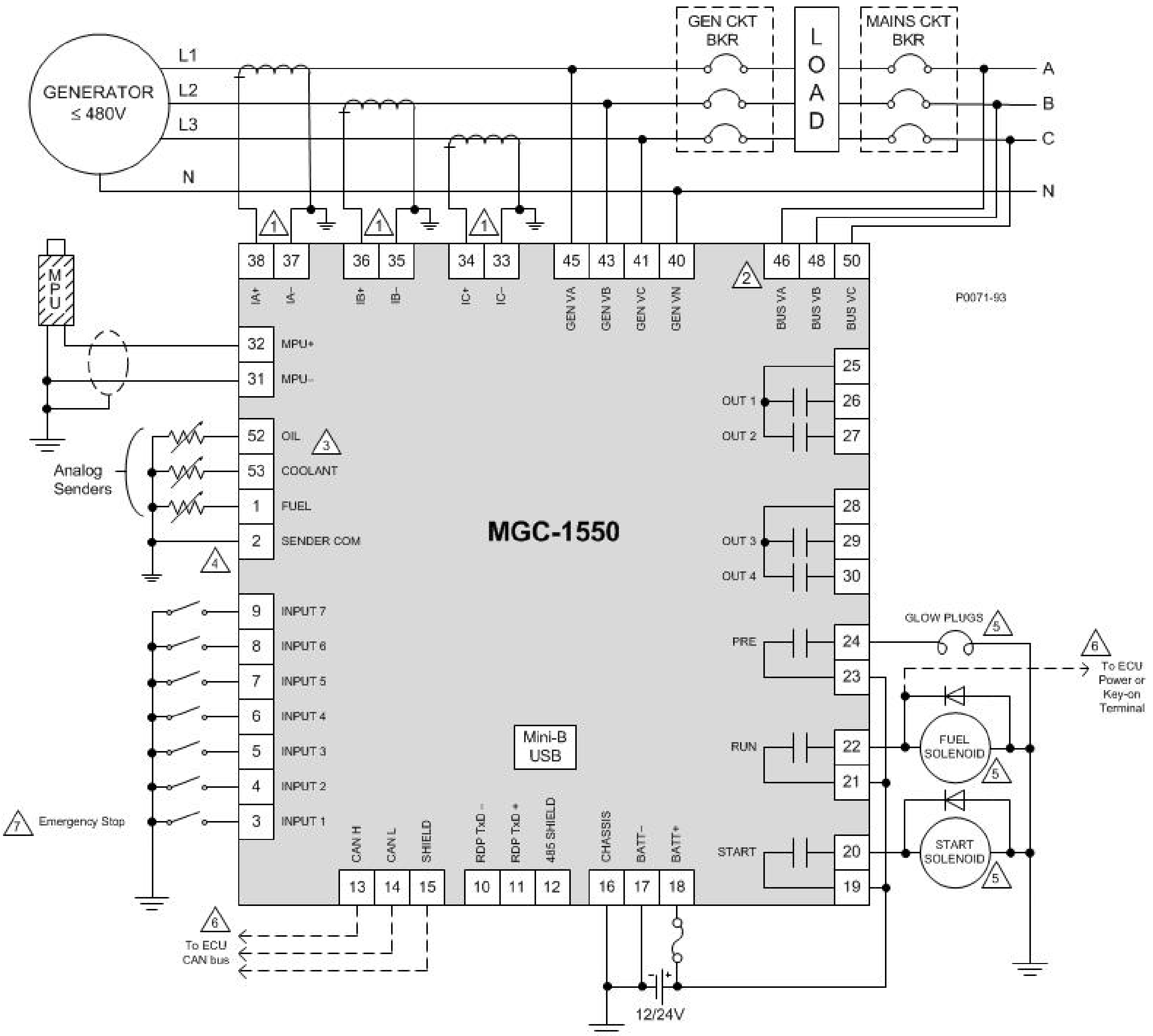
Typical Connections

Typical connection diagrams are provided in this chapter as a guide when wiring the MGC-1550 for communication, mechanical senders, contact inputs and outputs, sensing, and operating power.

Connections for Typical Applications

Typical connections for applications using three-phase wye, three-phase delta, single-phase AB, and single-phase AC generator voltage sensing are shown on the following pages.

Figure 49 illustrates typical three-phase wye generator voltage sensing connections.



1 Current inputs are 1A or 5A, depending on style.

2 Bus sensing inputs are optional, depending on style.

3 Oil pressure and coolant temperature senders are *not* available when the MGC-1550 has the J1939 CAN interface option (style xCx). However, the fuel sender is always available.

4 Connect near engine block (negative battery terminal) side of senders.

5 If component is under ECU control, do not connect to MGC-1550.

6 Connect to the ECU on an electronically controlled engine when the MGC-1550 has the J1939 CAN interface option (style xCx).

7 Labels indicate the functions assigned by the default programmable logic to the contact inputs.

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Figure 49. 3-Phase Wye Connections for Typical Applications

Figure 50 illustrates typical three-phase delta generator voltage sensing connections.

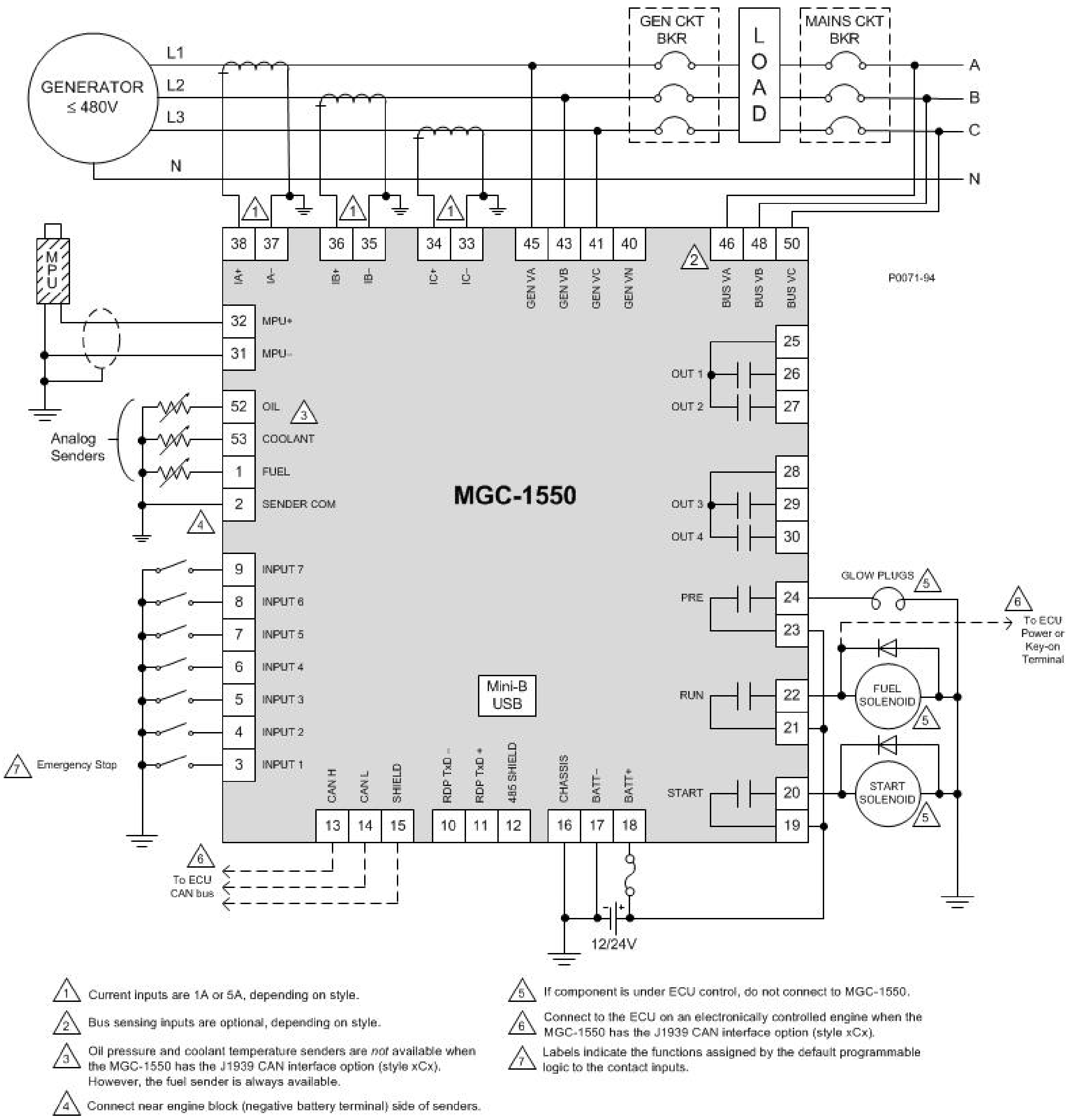

Figure 50. 3-Phase Delta Connections for Typical Applications

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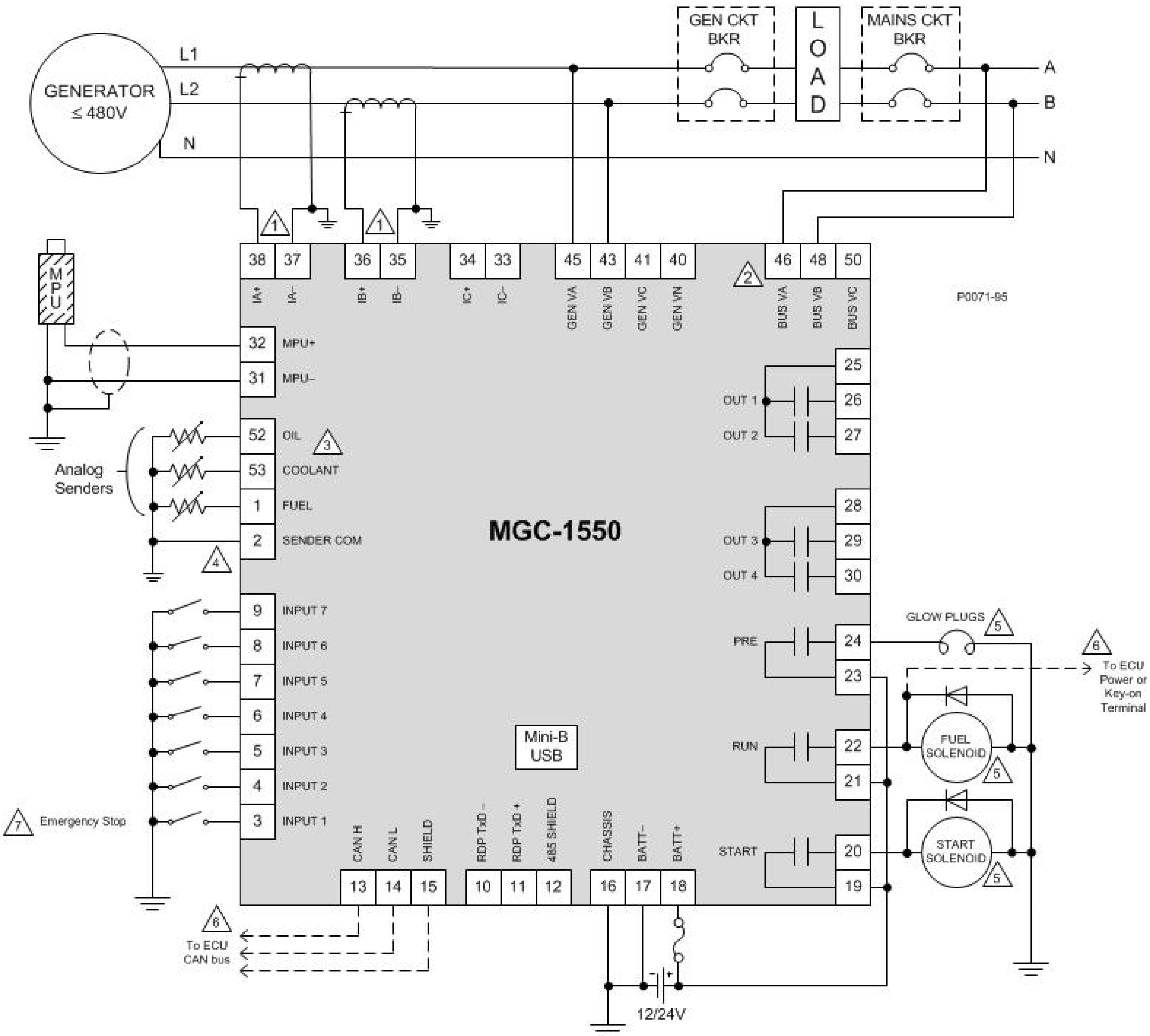
Figure 51 illustrates typical single-phase A-B generator voltage sensing connections.



1 Current inputs are 1A or 5A, depending on style.

2 Bus sensing inputs are optional, depending on style.

3 Oil pressure and coolant temperature senders are *not* available when the MGC-1550 has the J1939 CAN interface option (style xCx). However, the fuel sender is always available.

4 Connect near engine block (negative battery terminal) side of senders.

5 If component is under ECU control, do not connect to MGC-1550.

6 Connect to the ECU on an electronically controlled engine when the MGC-1550 has the J1939 CAN interface option (style xCx).

7 Labels indicate the functions assigned by the default programmable logic to the contact inputs.

Figure 51. Single-Phase A-B Connections for Typical Applications

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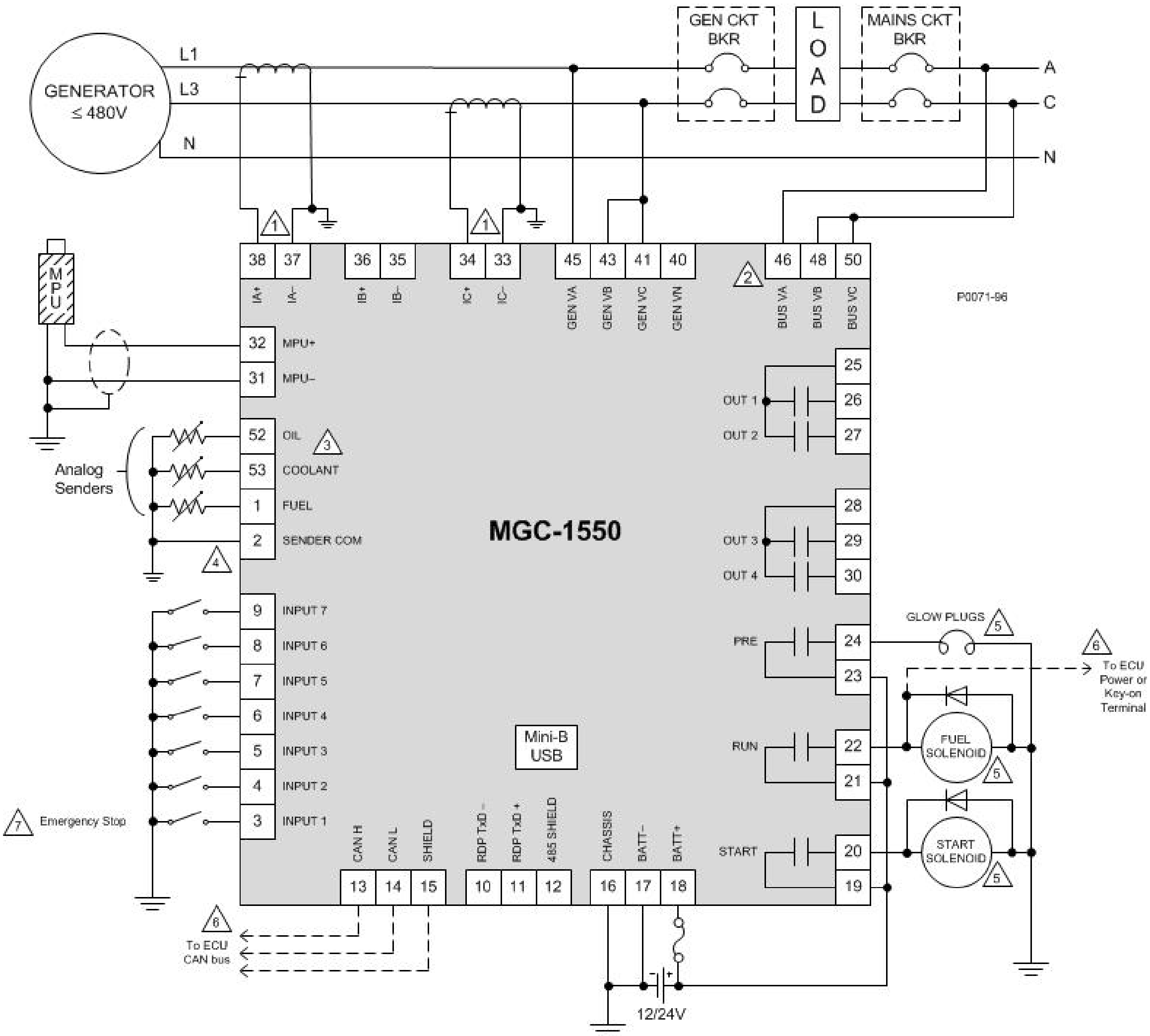
Figure 52 illustrates typical single-phase A-C generator voltage sensing connections.



1. Current inputs are 1A or 5A, depending on style.
2. Bus sensing inputs are optional, depending on style.
3. Oil pressure and coolant temperature senders are *not* available when the MGC-1550 has the J1939 CAN interface option (style xCx). However, the fuel sender is always available.
4. Connect near engine block (negative battery terminal) side of senders.
5. If component is under ECU control, do not connect to MGC-1550.
6. Connect to the ECU on an electronically controlled engine when the MGC-1550 has the J1939 CAN interface option (style xCx).
7. Labels indicate the functions assigned by the default programmable logic to the contact inputs.

Figure 52. Single-Phase A-C Connections for Typical Applications

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CAN Connections

Typical CAN connections are shown in Figure 53 and Figure 54.

Note
1. If the MGC-1550 is providing one end of the J1939 bus, a 120 Ω, ½ watt terminating resistor should be installed across terminals 14 (CANL) and 13 (CANH).
2. If the MGC-1550 is not providing one end of the J1939 bus, the stub connecting the MGC-1550 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the MGC-1550.

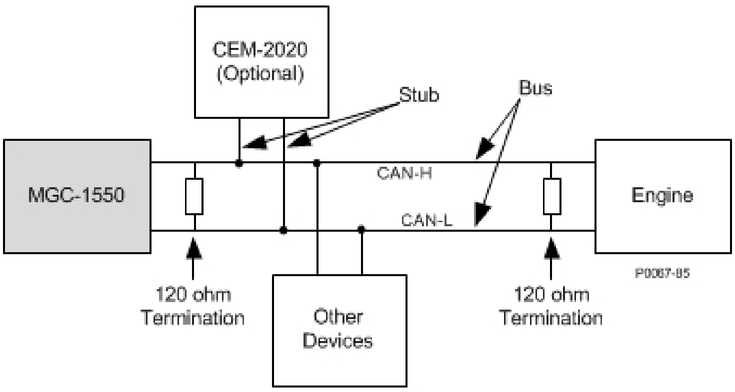

Figure 53. CAN Interface with MGC-1550 Providing One End of the Bus

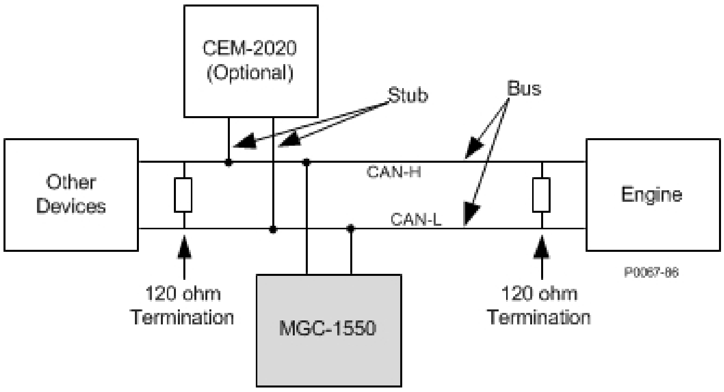

Figure 54. CAN Interface with Other Devices

CEM-2020 Connections

The CEM-2020 (Contact Expansion Module) is an optional module that may be installed with the MGC-1550. It is a remote auxiliary device that provides additional contact inputs and outputs for the MGC-1550. This module interfaces to the MGC-1550 via CAN, thus the CAN terminals are the only common connections (Figure 55) between the MGC-1550 and CEM-2020. Refer to the *CEM-2020* chapter for more information.

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Refer to *Terminals and Connectors* for details on MGC-1550 CAN connections.

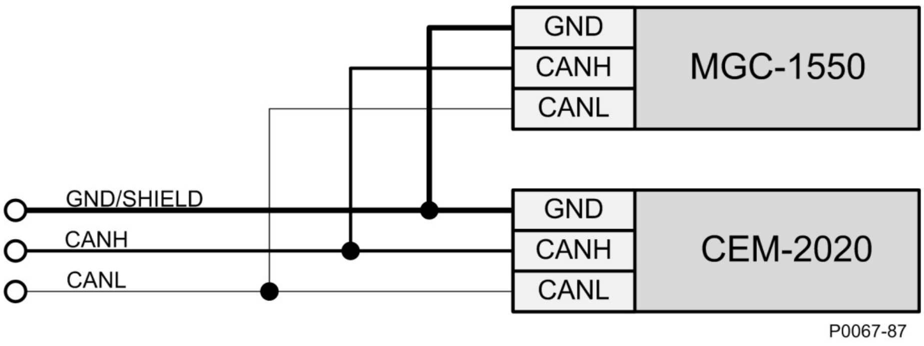

Figure 55. MGC-1550 and CEM-2020 CAN Connections

Installation for CE Systems

For CE compliant systems, it may be required to route ac voltage and current sensing wires separately from other wires.

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BESTCOMS*Plus*®

BESTCOMS*Plus*® is a Windows®-based, PC application that provides a user-friendly, graphical user interface (GUI) for use with Basler Electric communicating products. The name BESTCOMS*Plus* is an acronym that stands for Basler Electric Software Tool for Communications, Operations, Maintenance, and Settings.

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the MGC-1550. The capabilities of BESTCOMS*Plus* make the configuration of one or several MGC-1550 controllers fast and efficient. A primary advantage of BESTCOMS*Plus* is that a settings scheme can be created, saved as a file, and then uploaded to the MGC-1550 at the user's convenience.

BESTCOMS*Plus* uses plugins, allowing the user to manage several different Basler Electric products. The MGC-1550 plugin must be activated before use. The plugin can be activated automatically by connecting to an MGC-1550, or manually by requesting an activation key from Basler Electric.

The MGC-1550 plugin opens inside the BESTCOMS*Plus* main shell. The same default logic scheme that is shipped with the MGC-1550 is brought into BESTCOMS*Plus* by downloading settings and logic from the MGC-1550. This gives the user the option of developing a custom setting file by modifying the default logic scheme or by building a unique scheme from scratch.

BESTlogic™*Plus* Programmable Logic is used to program MGC-1550 logic for protection elements, inputs, outputs, alarms, etc. This is accomplished by drag-and-drop method. The user can drag elements, components, inputs, and outputs onto the program grid and make connections between them to create the desired logic scheme.

Figure 56 illustrates the typical user interface components of the MGC-1550 plugin with BESTCOMS*Plus*.

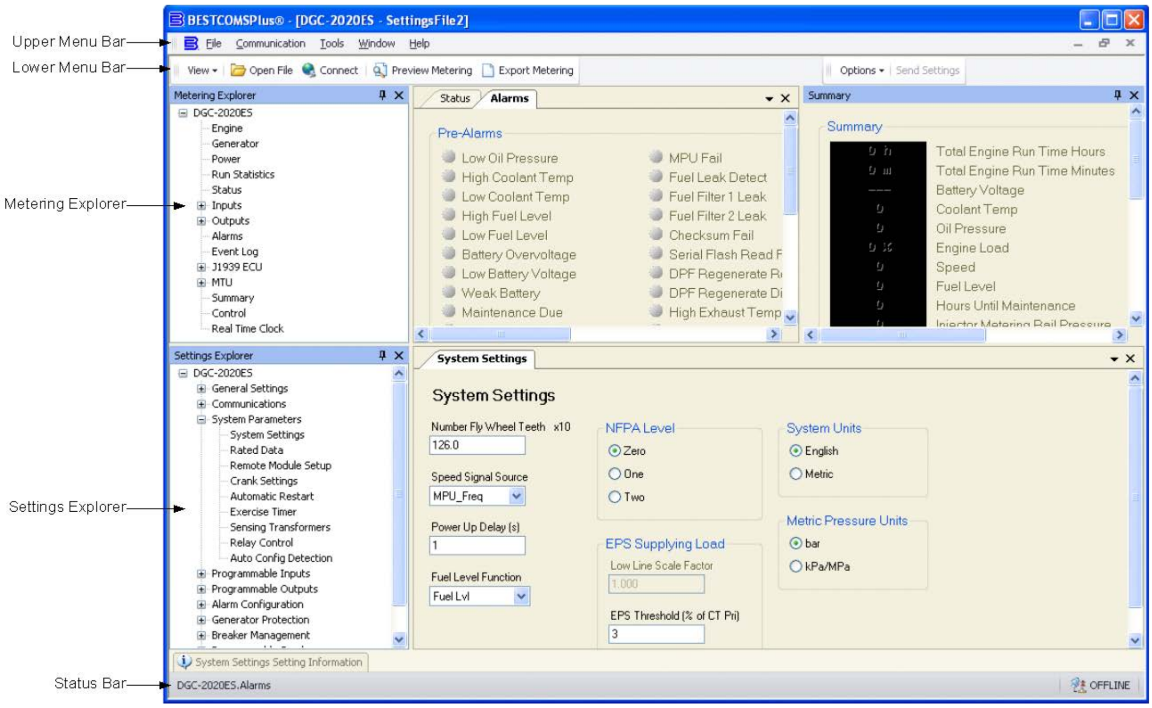

Figure 56. Typical User Interface Components

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System Recommendations

BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the BE1-11 plugin and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® XP 32-bit SP3, Windows Vista 32-bit SP1 (all editions), Windows 7 32-bit (all editions), Windows 7 64-bit (all editions), and Windows 8. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 20.

Table 20. System Recommendations for BESTCOMS*Plus* and the .NET Framework

System Type	Component	Recommendation
32/64 bit	Processor	2.0 GHz
32/64 bit	RAM	1 GB (minimum), 2 GB (recommended)
32 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC)
		950 MB (if .NET Framework is not already installed on PC)
64 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC)
		2.1 GB (if .NET Framework is not already installed on PC)

To install and run BESTCOMS*Plus*, a Windows user must have Administrator rights. A Windows user with limited rights might not be permitted to save files in certain folders.

Installation

Note

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete may result in errors.

1. Insert the BESTCOMS*Plus* CD-ROM into the PC CD-ROM drive.
2. When the BESTCOMS*Plus* Setup and Documentation CD menu appears, click the *Install* button for the BESTCOMS*Plus* application. The setup utility installs BESTCOMS*Plus*, the .NET Framework (if not already installed), the USB driver, and the MGC-1550 plugin for BESTCOMS*Plus* on your PC.

When BESTCOMS*Plus* installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows *Start* button and then accessing the Basler Electric folder in the *Programs* menu. The Basler Electric folder contains an icon that starts BESTCOMS*Plus* when clicked.

Activation of the MGC-1550 Plugin

The MGC-1550 plugin is a module that runs inside the BESTCOMS*Plus* shell. The MGC-1550 plugin contains specific operational and logic settings for only the MGC-1550. Uploading settings to the MGC-1550 is possible only after activating the MGC-1550 plugin.

The MGC-1550 plugin can be activated automatically or manually. Automatic activation is achieved by using a USB cable to establish communication between the MGC-1550 and BESTCOMS*Plus*. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMS*Plus*. Manual activation is useful if you want to create a settings file prior to receiving your MGC-1550. Refer to *Manual Activation of MGC-1550 Plugin.*

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Connect a USB Cable

The USB driver was copied to your PC during BESTCOMS*Plus* installation and is installed automatically after powering the MGC-1550. USB driver installation progress is shown in the Windows taskbar area. Windows will notify you when installation is complete.

Connect a USB cable between the PC and your MGC-1550. Apply operating power to the MGC-1550. Wait until the boot sequence is complete.

Start BESTCOMS*Plus*® and Activate the MGC-1550 Plugin Automatically

To start BESTCOMS*Plus*, click the Windows *Start* button, point to *Programs*, *Basler Electric*, and then click the *BESTCOMSPlus* icon. During initial startup, the *BESTCOMSPlus Select Language* screen is displayed (Figure 57). You can choose to have this screen displayed each time BESTCOMS*Plus* is started, or you can select a preferred language and this screen will be bypassed in the future. Click *OK* to continue. This screen can be accessed later by selecting *Tools* and *Select Language* from the menu bar.

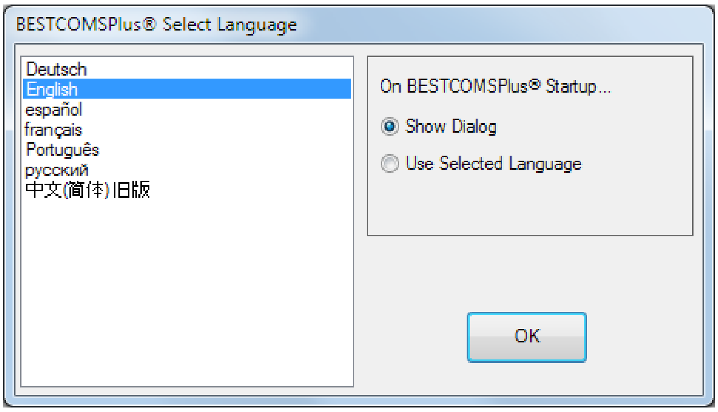

Figure 57. BESTCOMS*Plus* Language Selection Dialog

The BESTCOMS*Plus* platform window opens. Select *New Connection* from the *Communication* pull-down menu and select DGC-2020ES. See Figure 58. The MGC-1550 plugin is activated automatically after connecting to an MGC-1550.

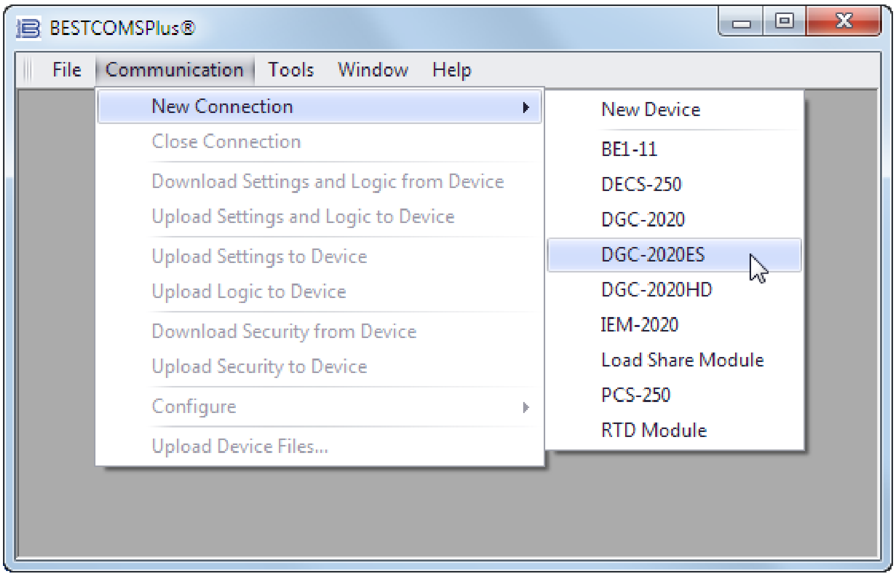

Figure 58. Communication Pull-Down Menu

The *MGC-1550 Connection* screen, shown in Figure 59, appears.

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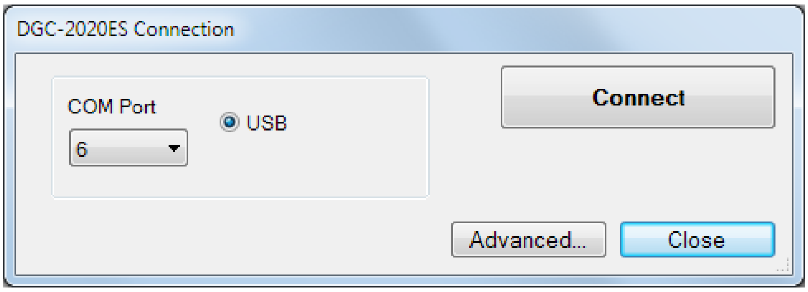

Figure 59. MGC-1550 Connection Dialog

Select *COM Port.* The USB drivers are installed automatically during the BESTCOMS*Plus* installation process. To select the correct *COM Port,* open the Windows Device Manager and expand the *Ports (COM & LPT)* branch. Locate the device named *CP2101 USB to UART Bridge Controller (COMx).* The *COM Port* number will be displayed in parenthesis *(COMx).* Be sure operating power is applied to the MGC-1550 and the USB cable is connected before opening the Device Manager. See Figure 60.

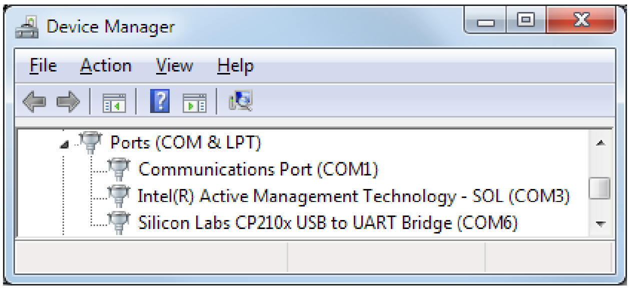

Figure 60. Device Manager

The MGC-1550 plugin opens indicating that activation was successful. You can now configure the MGC-1550 communication ports and other settings.

Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the MGC-1550:

1. Apply operating power to the MGC-1550 and wait for the boot sequence to complete.
2. Connect a USB cable between the PC and MGC-1550.
3. The *Found New Hardware Wizard* dialog box appears.
4. Select "**No, not this time**" and select *Next* to continue.
5. Choose to "**Install from a list or specific location (Advanced)**" and select *Next* to continue.
6. Insert the CD-ROM labeled BESTCOMS*Plus* into the PC CD-ROM drive.
7. Navigate to C:\Program Files\Basler Electric\BESTCOMS*Plus*\USBDeviceDrivers\ and select *Next* to continue.

When installation of the driver is complete, you may be asked to restart your computer.

Manual Activation of the MGC-1550 Plugin

Manual activation of the MGC-1550 plugin is required only if your initial use of BESTCOMS*Plus* will be on a PC that is not connected to an MGC-1550. Manual activation is described in the following paragraphs.

Requesting an Activation Key

When initially running the MGC-1550 plugin, the *Activate Device Plugin* pop-up appears. You must contact Basler Electric for an activation key before you can activate the MGC-1550 plugin. You can request an activation key through email or the Basler Electric website. Click either the *Website* or *Email* button. Click the *Activate* button when you are ready to enter the activation key you received from Basler Electric. The *Activate Device Plugin* pop-up appears. Refer to Figure 61.

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Entering an Activation Key

Select DGC-2020ES from the *Device* pull-down menu. Enter your *Email Address* and *Activation Key* provided by Basler Electric. If you received an email containing the *Activation Key*, you can select all of the text in the email and copy it to the Windows clipboard using normal Windows techniques. The *Get Data* button will extract the *Device, Email Address,* and *Activation Key* from the Windows clipboard and paste it into the appropriate fields. Click the *Activate* button to continue. The *Activate Device Plugin* screen is also found by selecting *Activate Device* from the *Tools* pull-down menu of the BESTCOMS*Plus* main screen.

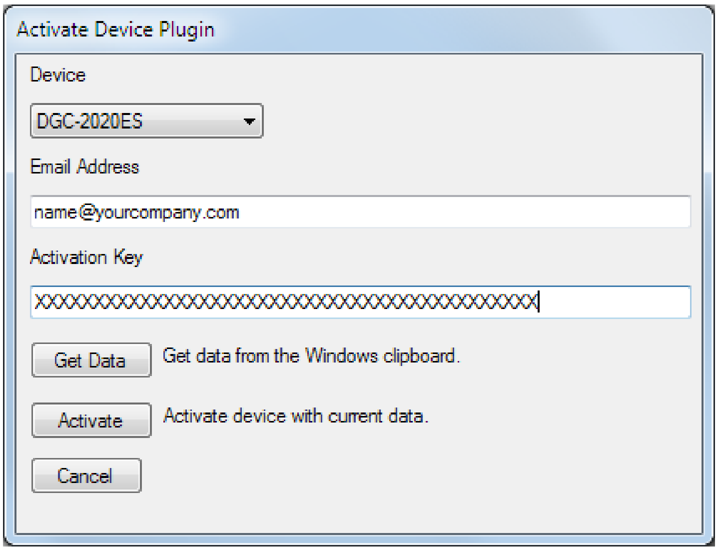

Figure 61. Activate Device Plugin

Menu Bars

The menu bars are located near the top of the BESTCOMS*Plus* window (see Figure 56). The upper menu bar has five pull-down menus. With the upper menu bar, it is possible to manage settings files, configure communication settings, upload and download settings/security files, and compare settings files. The lower menu bar consists of clickable icons. The lower menu bar is used to change BESTCOMS*Plus* views, save or load a BESTspace™ workspace, open a settings file, connect/disconnect, preview metering printout, export metering, switch to live mode, and send settings to the MGC-1550.

Upper Menu Bar (BESTCOMS*Plus*® Shell)

Upper menu bar functions are listed and described in Table 21.

Table 21. Upper Menu Bar (BESTCOMS*Plus* Shell)

Menu Item	Description
File	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *,txt, etc. files
Close	Close settings file
Save	Save settings file
Save As	Save settings file with a different name
Export To File	Save settings as a *.csv file
Print	Print, export, or send a settings file

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Menu Item	Description
Properties	View properties of a settings file
History	View history of a settings file
Recent Files	Open a previously opened file
Exit	Close BESTCOMS*Plus* program
Communication	
New Connection	Choose new device or MGC-1550
Close Connection	Close communication between BESTCOMS*Plus* and MGC-1550
Download Settings and Logic from Device	Download operational and logic settings from the device
Upload Settings and Logic to Device	Upload operational and logic settings to the device
Upload Settings to Device	Upload operational settings to the device
Upload Logic to Device	Upload logic settings to the device
Download Security from Device	Download security settings from the device
Upload Security to Device	Upload security settings to the device
Upload Device Files	Upload firmware to the device
Tools	
Select Language	Select BESTCOMS*Plus* language
Activate Device	Activate the MGC-1550 plugin
Set File Password	Password protect a settings file
Compare Settings Files	Compare two settings files
Auto Export Metering	Exports metering data on a user-defined interval
Event Log - View	View the BESTCOMS*Plus* event log
Event Log - Clear	Clear the BESTCOMS*Plus* event log
Event Log - Set New File Name	Set a new file name for event log
Window	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
Help	
Check for Updates	Check for BESTCOMS*Plus* updates via the internet
Check for Update Settings	Enable or change automatic checking for updates
About	View general, detailed build, and system information

Lower Menu Bar (MGC-1550 Plugin)

The lower menu bar functions are listed and described in Table 22.

Table 22. Lower Menu Bar (MGC-1550 Plugin)

Menu Button	Description
	Enables you to show/hide the Metering Panel, Settings Panel, or Settings Info Panel. Opens and saves BESTspace™ workspaces. Customized workspaces make switching between tasks easier and more efficient.
	Opens a saved settings file.

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Menu Button	Description
Connect	Connect: Opens the DGC-2020ES *Connection* screen which enables you to connect to the MGC-1550 via USB or a modem. This button only appears when an MGC-1550 is not connected.
Disconnect	Disconnect: Used to disconnect a connected MGC-1550. This button only appears when an MGC-1550 is connected.
Preview Metering	Displays the *Print Preview* screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.
Export Metering	Enables all metering values to be exported into a *.csv file.
Options ▾	Displays a drop-down list entitled *Live Mode Settings* which enables *Live* mode where settings are automatically sent to the device in real time as they are changed.
Send Settings	Sends settings to the MGC-1550 when BESTCOMS*Plus* is not operating in Live Mode. Click this button after making a setting change to send the modified setting to the MGC-1550.

Settings Explorer

The Settings Explorer is a convenient tool within BESTCOMS*Plus* used to navigate through the various settings screens of the MGC-1550 plugin.

These screens allow the user to edit general settings, communications, system parameters, programmable inputs, programmable outputs, alarm configuration, generator protection, breaker management, programmable senders, and BESTlogic*Plus* programmable logic.

Logic setup will be necessary after making certain setting changes. For more information, refer to the BESTlogic*Plus* chapter.

Metering Explorer

The Metering Explorer is a convenient tool within BESTCOMS*Plus* used to navigate through the various metering screens of the MGC-1550 plugin.

These screens allow the user to view real-time system data including generator voltages and currents, input/output status, alarms, reports, and other parameters. Refer to the Metering chapter for more information on the Metering Explorer.

BESTspace™

BESTspace provides the ability to manage customized workspaces. A workspace consists of the position and size of all open screens within BESTCOMS*Plus*. Pre-saved workspaces can be quickly loaded to fit the specific task at hand. Any number of different workspaces can be saved including a default workspace which loads when the MGC-1550 plug-in is started. The Metering Explorer screens and the Settings Explorer screens can be saved independently into the workspace file. A *Comments* box is provided for writing a description or leaving notes for each saved workspace. To access BESTspace, click *View* (on the lower menu bar) and hover over *BESTspace*. Figure 62 illustrates the BESTspace options found under the *View* pull-down menu. Figure 63 illustrates the options included in the Load/Save Workspace File screen.

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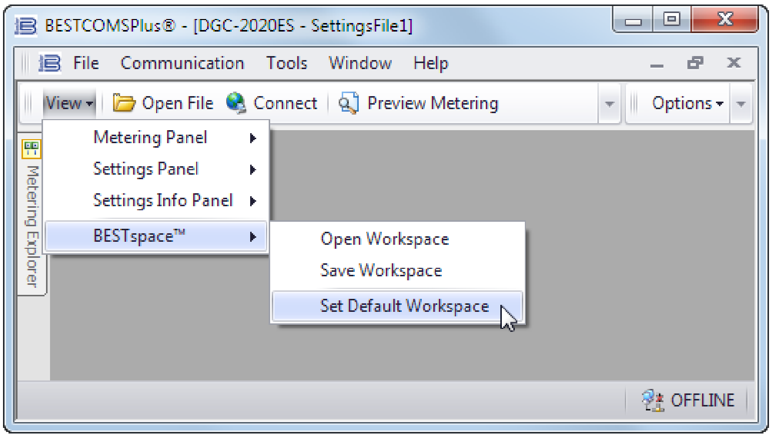

Figure 62. View Menu, BESTspace™ Options

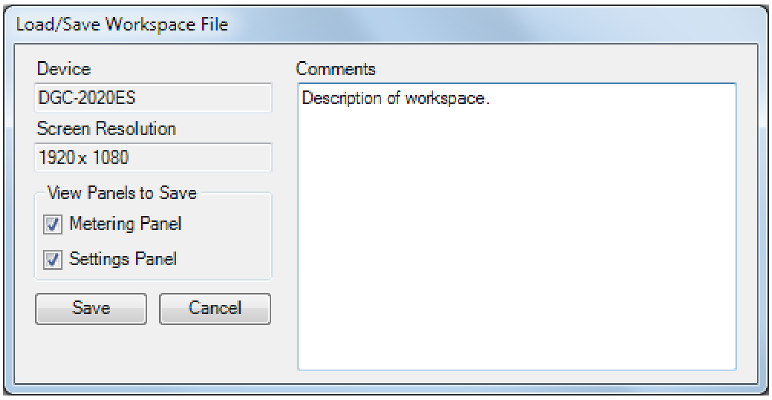

Figure 63. View Menu, BESTspace™, Save Workspace Screen

Settings File Management

A settings file contains all MGC-1550 settings, including logic. A settings file assumes a file extension of "∗.bstx". It is possible to save the logic only as a separate logic library file on the BESTlogic*Plus* Programmable Logic screen. This function is helpful when similar logic is required for several devices. A logic library file assumes a file extension of "∗.bslx". It is important to note that settings and logic can be uploaded to the device together or separately, but are always downloaded together. For more information on logic files, refer to the *BESTlogicPlus* chapter.

Opening a Settings File

To open an MGC-1550 settings file with BESTCOMS*Plus*, pull down the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose *Open*. You can also open a file by clicking on the *Open File* button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose *Yes*, the settings displayed in BESTCOMS*Plus* will be overwritten with the settings of the opened file.

Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box appears allowing you to enter a filename and location to save the file. Select the *Save* button to complete the save.

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Upload Settings and/or Logic to Device

To upload a settings file to the MGC-1550, open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the *Communication* menu and select *Upload Settings and Logic to Device.* If you want to upload operational settings without logic, select *Upload Settings to Device*. If you want to upload logic without operational settings, select *Upload Logic to Device*. You are prompted to enter the password. The default password is "OEM". If the password is correct, the upload begins and the progress bar is shown.

Download Settings and Logic from Device

To download settings and logic from the MGC-1550, pull down the *Communication* menu and select *Download Settings and Logic from Device*. If the settings in BESTCOMS*Plus* have changed, a dialog box will open asking if you want to save the current settings changes. You can choose *Yes* or *No*. After you have taken the required action to save or discard the current settings, downloading begins. BESTCOMS*Plus* will read all settings and logic from the MGC-1550 and load them into BESTCOMS*Plus* memory.

Print a Settings File

To view a preview of the settings printout, select *Print Preview* from the *File* pull-down menu. To print the settings, select the printer icon in the upper left corner of the *Print Preview* screen.

You can skip the print preview and go directly to print by pulling down the *File* menu and selecting *Print*. A dialog box opens containing the typical Windows options for setting the properties of the printer. Configure these settings as necessary and then select *Print*.

Compare Settings Files

BESTCOMS*Plus* has the ability to compare two settings files. To compare files, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPlus Settings Compare Setup* dialog box appears (Figure 64). Select the location of the first file under *Left Settings Source* and select the location of the second file under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.

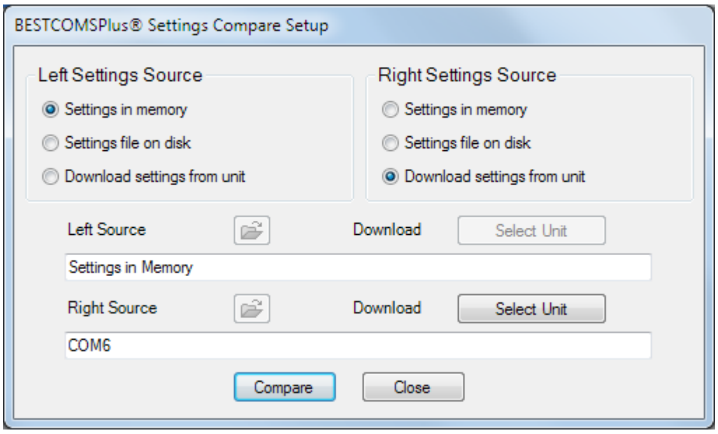

Figure 64. Tools, Compare Settings Files Screen

A dialog box appears, displaying the results of the comparison. The *BESTCOMSPlus Settings Compare* dialog box (Figure 65) is displayed where you can view all settings (*Show All Settings*), view only the differences (*Show Settings Differences*), view all logic *(Show All Logic Paths),* or view only logic differences *(Show Logic Path Differences).* Select *Close* when finished.

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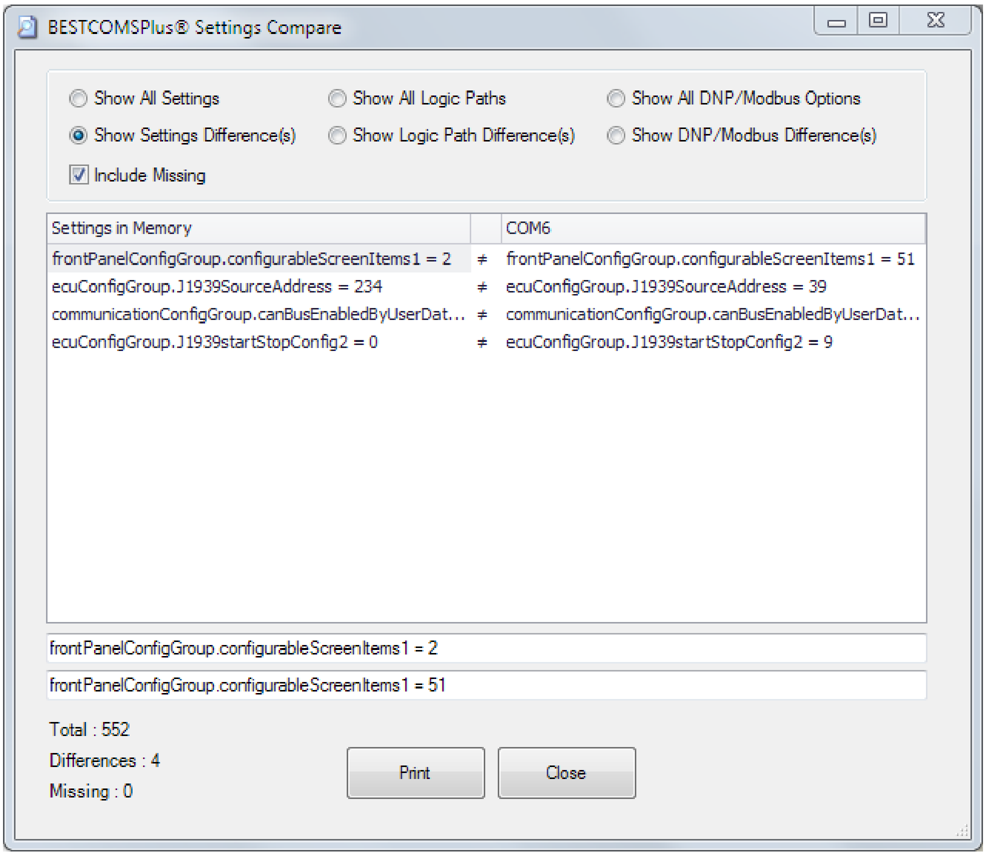

Figure 65. Settings Comparison Results Screen

Firmware Updates

Future enhancements to the MGC-1550 functionality will make a firmware update desirable. Because default settings are loaded when DGC-2020 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

Note
The latest version of BESTCOMS*Plus* software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware and a language module. Embedded firmware is the operating program that controls the actions of the MGC-1550. The MGC-1550 stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

The language of the front panel LCD can be changed by uploading a different language module into the MGC-1550. The MGC-1550 stores the language module in nonvolatile flash memory; the language module contains all language translations for the MGC-1550. The language module can be reprogrammed through the communications port. In general, any time a firmware upgrade is made to the MGC-1550, the language module should be uploaded as well.

The MGC-1550 can be used in conjunction with the Contact Expansion Module (CEM-2020) which expands the MGC-1550 capabilities. When upgrading the firmware in any component of this system, the

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firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the components.

Caution

The order in which the components are upgraded is critical. Assuming a system of an MGC-1550 and expansion module is in a state where the MGC-1550 is communicating with the system expansion module, **the expansion module must be upgraded before the MGC-1550.** This is necessary because the MGC-1550 must be able to communicate with the expansion module before the MGC-1550 can send firmware to it. If the MGC-1550 were upgraded first, and the new firmware included a change to the expansion module communication protocol, it is possible that the expansion module could no longer communicate with the upgraded MGC-1550. Without communications between the MGC-1550 and the expansion module, upgrading the expansion module is not possible.

Note

If power is lost or communication is interrupted during file transfer to the MGC-1550, it will cease to operate and will not recover automatically. If this occurs or if the front panel HMI becomes blank and all LEDs are flashing at a two-second rate, the MGC-1550 will not have valid firmware installed and the firmware must be uploaded again. To accomplish this, cycle power to the MGC-1550 and activate the MGC-1550 plugin in BESTCOMS*Plus*. Select *Upload Device Files* from the *Communication* pull-down menu and proceed normally.

Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in the MGC-1550 expansion module. This must be completed before upgrading firmware in the MGC-1550. If no expansion module is present, proceed to *Upgrading Firmware in the MGC-1550.*

1. Place the MGC-1550 in OFF mode. This can be accomplished by clicking the *Off* button on the *Control* screen inside the Metering Explorer or by pressing the *Off* button on the MGC-1550 front panel.
2. Enable the expansion module that is present in the system. If it has not already been enabled, enable the expansion module on the SETTINGS > SYSTEM PARAMETERS > REMOTE MODULE SETUP screen.
3. Verify that the MGC-1550 and the associated expansion module are communicating. This can be verified by examining the pre-alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to METERING > ALARMS-STATUS > PRE-ALARMS. There should be no *Loss of Comms* pre-alarms in the pre-alarm status when communications are functioning properly.
4. Connect to the MGC-1550 through the USB port if not already connected.
5. Select *Upload Device Files* from the Communication pull-down menu.
6. You will be asked to save the current settings file. Select *Yes* or *No*.
7. When the *Basler Electric Device Package Uploader* screen (Figure 66) appears, click on the *Open* button to browse for the device package you have received from Basler Electric. The *Package Files* along with *File Details* are listed. Place a check in the boxes next to the individual files you want to upload.

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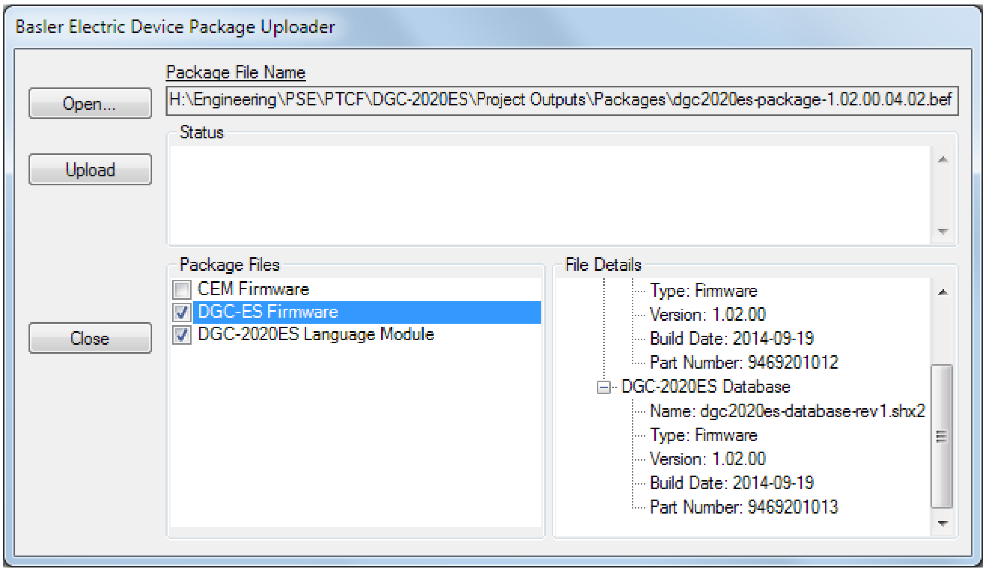

Figure 66. Basler Electric Device Package Uploader

8. Click on the *Upload* button and the *Proceed with Device Upload* screen will appear. Select *Yes* or *No*.
9. After selecting *Yes*, the *MGC-1550 Selection* screen will appear. Select the communication port to begin upload. Refer to Figure 67.
10. After file(s) have been uploaded, click the *Close* button on the *Basler Electric Device Package Uploader* screen and disconnect communication to the MGC-1550.

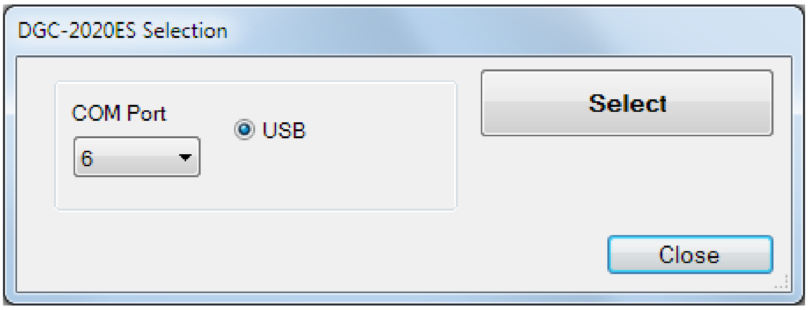

Figure 67. MGC-1550 Selection

Upgrading Firmware in the MGC-1550

Upgrade DGC-2020 firmware and then load a saved settings file.

1. Upgrade the MGC-1550 firmware and language module.
    a. Connect to the MGC-1550 with BESTCOMS*Plus*. Check the firmware Application Version on the GENERAL SETTINGS-> VERSION INFO->MGC-1550 screen.
    b. Select *Upload Device Files* from the *Communication* pull-down menu. You do not have to be connected to the MGC-1550 at this time. Save settings when prompted, if desired.
    c. Open the desired device package file (****DGC-2020-*****_xxyyzz.bef, where **** may be additional descriptive text of varying length, and xx.yy.zz is the version number of the device package file.)
    d. Check the boxes for DGC-2020 *Firmware* and DGC-2020 *Language Module.* Note the version number of the DGC-2020 firmware; this is the version that will be used to set the Application Version in the settings file in a later step. This is NOT the same as the version of the package file that is contained in the fields xx.yy.zz in the package file name.

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   e. Click the *Upload* button and follow the instructions that appear to begin the upgrade process.
   f. After the upload is complete, disconnect communication to the MGC-1550.
2. Load the saved settings file into the MGC-1550.
   a. Close all settings files.
   b. From the *File* pull-down menu, select *New*, DGC-2020.
   c. Connect to the MGC-1550.
   d. Once all settings have been read from the MGC-1550, open the saved settings file by selecting the file with *File, Open File* in the BESTCOMS*Plus* menu.
   e. When BESTCOMS*Plus* asks if you wish to upload settings and logic to the device, click *Yes*.
   f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the MGC-1550 style number in the saved file matches that of the MGC-1550 into which the file is being uploaded. The style number in the settings file is found under GENERAL SETTINGS > STYLE NUMBER in BESTCOMS*Plus*.
   g. If the style number of the settings file does not match that of the MGC-1550 into which it is to be loaded, disconnect from the MGC-1550, then modify the style number in the settings file. Then repeat the steps titled *Load the Settings File into the DGC-2020.*

BESTCOMSPlus® Updates

Ongoing MGC-1550 functionality enhancements may make future DGC-2020 firmware updates desirable. Enhancements to DGC-2020 firmware typically coincide with enhancements to the MGC-1550 plugin for BESTCOMS*Plus*. When an MGC-1550 is updated with the latest version of firmware, the latest version of BESTCOMS*Plus* should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMS*Plus* software.
- You can check for BESTCOMS*Plus* updates by visiting www.basler.com.
- You can use the manual “check for updates” function in BESTCOMS*Plus* to ensure that the latest version is installed by selecting Check for Updates in the Help drop-down menu. (An internet connection is required.)

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BESTlogic™*Plus*

BESTlogic*Plus* Programmable Logic is a programming method used for managing the input, output, protection, control, monitoring, and reporting capabilities of MTU Onsite Energy's MGC-1550 Digital Genset Controller. Each MGC-1550 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in equation form with BESTlogic*Plus*. BESTlogic*Plus* equations entered and saved in the MGC-1550 system's nonvolatile memory integrate (electronically wire) the selected or enabled protection and control blocks with control inputs and hardware outputs. A group of logic equations defining the logic of the MGC-1550 is called a logic scheme.

One default active logic scheme is preloaded into the MGC-1550. This scheme is configured for a typical protection and control application and virtually eliminates the need for "start-from-scratch" programming. BESTCOMS*Plus*® can be used to open a logic scheme that was previously saved as a file and upload it to the MGC-1550. The default logic scheme can also be customized to suit your application. Detailed information about logic schemes is provided later in this section.

BESTlogic*Plus* is not used to define the operating settings (modes, pickup thresholds, and time delays) of the individual protection and control functions. Operating settings and logic settings are interdependent but separately programmed functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the pickup thresholds and time delays of an MGC-1550. Detailed information about operating settings is provided in the *BESTCOMSPlus* chapter.

Overview of BESTlogic™Plus

Use BESTCOMS*Plus* to change BESTlogic*Plus* settings. Use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 68.

The *BESTlogicPlus Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

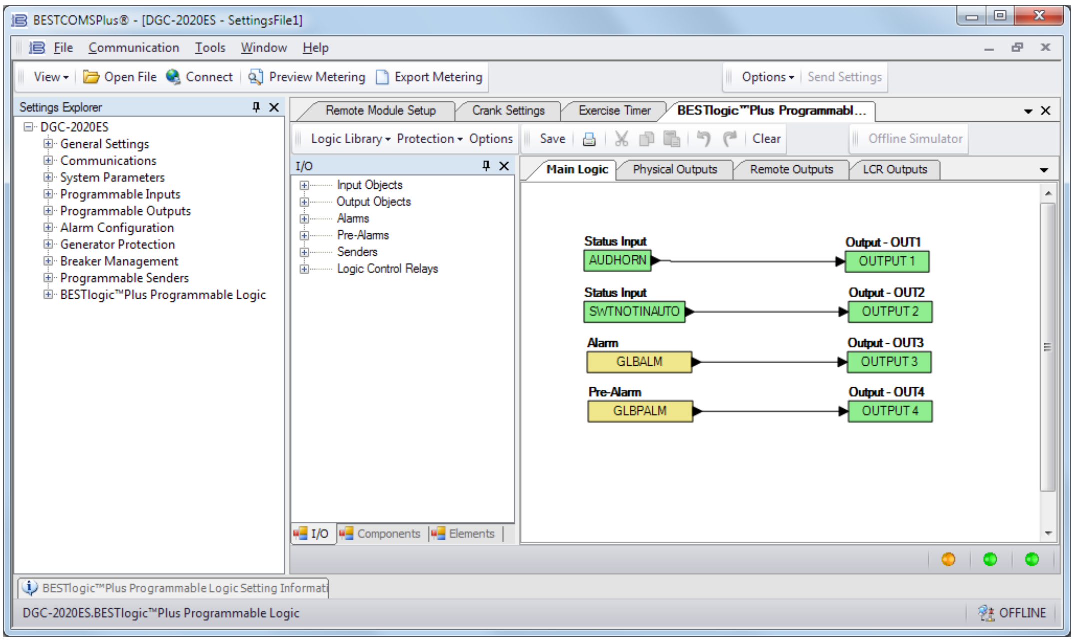

Figure 68. Settings Explorer, BESTlogic*Plus* Programmable Logic Screen

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BESTlogic™Plus Composition

There are three main groups of objects used for programming BESTlogic*Plus*. These groups are *I/O, Components,* and *Elements.* For details on how these objects are used to program BESTlogic*Plus*, see the paragraphs on *Programming BESTlogicPlus,* later in this chapter.

I/O

This group contains Input Objects, Output Objects, Alarms, Pre-Alarms, Senders, and Logic Control Relays. Table 23 lists the names and descriptions of the objects in the *I/O* group.

Table 23. I/O Group, Names and Descriptions

Name	Description	Symbol
Input Objects		
Logic 0	Always false (Low).	Fixed 0
Logic 1	Always true (High).	Fixed 1
Physical Inputs IN1 – IN7	True when Physical Input x is active.	Input - IN1 INPUT 1
Remote Inputs IN8 – IN17	True when Remote Input x is active. (Available when an optional CEM-2020 is connected.)	Input - IN8 INPUT 8
Virtual Inputs VIN1 – VIN4	True when Virtual Input x is active.	Input - VIN1 VIN1
Status Input Alarm Silence	True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	Status Input ALARMSILENCEIN
Status Input Alternate Frequency Override	True when the Alternate Frequency Override logic element is true.	Status Input ALTFREQOVERIN
Status Input ATS Input	True when the ATS (Auto Transfer Switch) input is true or the ATS logic element is true.	Status Input ATSINSTATUS
Status Input Audible Horn	True when the Audible Horn is active.	Status Input AUDHORN
Status Input Auto Mode	True when the MGC-1550 is in Auto Mode or the Auto Mode logic element is true.	Status Input AUTOMODE
Status Input Auto Restart	True when the Automatic Restart function is active.	Status Input AUTORESTART
Status Input Battery Charger Fail	True when the Battery Charger Fail input is true.	Status Input BATTCHRGFAIL
Status Input Battle Override	True when the Battle Override input is true.	Status Input BATTLORIDE
Status Input Bus Dead	True when the Bus Dead condition settings have been exceeded.	Status Input BUSDEAD

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Name	Description	Symbol
Status Input Bus Fail	True when the Bus Fail condition settings have been exceeded.	Status Input BUSFAIL
Status Input Bus Forward Rotation	True when the bus rotation matches the Phase Rotation setting.	Status Input BUSFORWARDROTATION
Status Input Bus Reverse Rotation	True when the bus rotation is opposite of the Phase Rotation setting.	Status Input BUSREVERSEROTATION
Status Input Bus Stable	True when the Bus Stable condition settings have been exceeded.	Status Input BUSSTABLE
Status Input CAN Bus - Bus Off	True when the CAN Bus - bus is off.	Status Input CANBUSBUSOFF
Status Input CAN Bus Error Passive	True when a passive error is annunciated by the CAN Bus.	Status Input CANBUSERRORPASSIVE
Status Input Configurable Elements 1-8	True when the Configurable Element x logic element is true.	Status Input CONFIGELEMENT1
Status Input Contact Expansion Module	Contact Expansion Module Connected. True when an optional CEM-2020 is connected to the MGC-1550.	Status Input CEMCONNECTED
Status Input Cool Down Timer Active	True when the Cool Down Timer is timing out. The Cool Down Timer is true under two circumstances: 1. The unit is in auto and ATS is removed, causing the MGC-1550 to go into a cooldown state. 2. The engine is running (in RUN or AUTO mode with ATS applied) and the load has been removed (i.e. the EPSSUPLOAD status input is false due to small load). If the load is reapplied, the Cool Down Timer stops and resets, and it will restart when the load is removed the next time.	Status Input CDOWNTMRACT
Status Input DPF Lamp Command	True when DPF lamp is lit. This status input mimics the state of the DPF lamp. It remains true when the DPF lamp is constantly lit and toggles true and false at a rate of 1 Hz when DPF lamp is blinking.	Status Input DPFLAMPCOMMAND
Status Input Emergency Stop	True when the Emergency Stop button has been pressed.	Status Input EMERGSTOP
Status Input Engine Running	True while the Engine is Running.	Status Input ENGRUNNING
Status Input EPS Supplying Load	True while the EPS is supplying load.	Status Input EPSSUPLOAD
Status Input Front Panel Buttons	True while the *Auto* front panel button is pressed.	Status Input AUTOBUTTON
Status Input Front Panel Buttons	True while the *Down* front panel button is pressed.	Status Input DOWNBUTTON

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Name	Description	Symbol
Status Input Front Panel Buttons	True while the *Edit* front panel button is pressed.	Status Input EDITBUTTON
Status Input Front Panel Buttons	True while the *Up and Down* front panel buttons are simultaneously pressed.	Status Input LAMPBUTTON
Status Input Front Panel Buttons	True while the *Off* front panel button is pressed.	Status Input OFFBUTTON
Status Input Front Panel Buttons	True while the *Back* front panel button is pressed.	Status Input RESETBUTTON
Status Input Restart Delay Active	True when the restart delay is currently active.	Status Input RESTARTDELAYACTIVE
Status Input Front Panel Buttons	True while the *Run* front panel button is pressed.	Status Input RUNBUTTON
Status Input Front Panel Buttons	True while the *Back and Edit* front panel buttons are simultaneously pressed.	Status Input SILENCEBUTTON
Status Input Front Panel Buttons	True while the *Up* front panel button is pressed.	Status Input UPBUTTON
Status Input Fuel Leak	True when the Fuel Leak Detect input is true.	Status Input FUELLEAK
Status Input Generator Dead	True when the Gen Dead condition settings have been exceeded.	Status Input GENDEAD
Status Input Generator Fail	True when the Gen Fail condition settings have been exceeded.	Status Input GENFAIL
Status Input Generator Forward Rotation	True when the generator rotation matches the Phase Rotation setting.	Status Input GENFORWARDROTATION
Status Input Generator Protection	True when the 27 element is tripped.	Status Input 27UNDRVLTTRIPSTATUS
Status Input Generator Protection	True when the 59 element is tripped.	Status Input 59OVOLTTRIPSTATUS
Status Input Generator Protection	True when the 47 element is tripped.	Status Input 47PH_IMBTRIPSTATUS
Status Input Generator Protection	True when the 50 element is tripped.	Status Input 50OCURRTRIPSTATUS
Status Input Generator Protection	True when the 81 Over element is tripped.	Status Input 81OFRQTRIPSTATUS
Status Input Generator Protection	True when the 81 Under element is tripped.	Status Input 81UFRQTRIPSTATUS

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Name	Description	Symbol
Status Input Generator Reverse Rotation	True when the generator rotation is opposite of the Phase Rotation setting.	Status Input GENREVERSEROTATION
Status Input Generator Stable	True when the Gen Stable condition settings have been exceeded.	Status Input GENSTABLE
Status Input Generator Test Loaded	True when the Exercise Timer has started the generator and run with load is selected.	Status Input GENTESTLOADED
Status Input Generator Test	True when the Exercise Timer has started the generator.	Status Input GENTEST
Status Input Global Low Coolant Level	True when the Low Coolant Level input is true.	Status Input GLBLOWCOOLLVL
Status Input Ground Delta Override	True when the Grounded Delta Override input is true.	Status Input GNDDLTAORIDE
Status Input Idle Request	True when the Idle Request logic element is true.	Status Input IDLEREQUESTIN
Status Input In Alarm State	True when the MGC-1550 is in the alarm state.	Status Input INALARMSTATE
Status Input In Connecting State	True when the MGC-1550 is in the connecting state.	Status Input INCONNECTINGSTATE
Status Input In Cooling State	True when the MGC-1550 is in the cooling state.	Status Input INCOOLINGSTATE
Status Input In Cranking State	True when the MGC-1550 is in the cranking state.	Status Input INCRANKINGSTATE
Status Input In Disconnect State	True when the MGC-1550 is in the disconnect state.	Status Input INDISCONNECTSTATE
Status Input In Prestart State	True when the MGC-1550 is in the pre-start state.	Status Input INPRESTARTSTATE
Status Input In Pulsing State	True when the MGC-1550 is in the pulsing state.	Status Input INPULSINGSTATE
Status Input In Ready State	True when the MGC-1550 is in the ready state.	Status Input INREADYSTATE
Status Input In Resting State	True when the MGC-1550 is in the resting state.	Status Input INRESTINGSTATE
Status Input In Running State	True when the MGC-1550 is in the running state.	Status Input INRUNNINGSTATE
Status Input Lamp Test	True when the Lamp Test logic element is true or the Lamp Test button is pressed on the front panel.	Status Input LAMPTESTIN

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Name	Description	Symbol
Status Input Load Take Over	True when the Load Take Over logic element is true.	Status Input LOADTAKEOVERIN
Status Input Low Line Override	True when the Low Line Override input is true.	Status Input LOWLINEORIDE
Status Input Mains Fail Test	True when the Mains Fail Test logic element is true.	Status Input MAINSFAILIN
Status Input Mains Fail Transfer Complete	True when the MGC-1550 is configured for mains fail transfers and has successfully transferred to the generator from the utility. It remains true until the utility power is deemed good and the MGC-1550 transfers the load back to utility power.	Status Input MAINSFLTRCOMPLETE
Status Input Off Mode	True when the MGC-1550 is in Off Mode or the Off Mode logic element is true.	Status Input OFFMODE
Status Input Off Mode Cooldown	True when the MGC-1550 is in Off Mode and cooling down.	Status Input OFFMODECOOL
Status Input Pre Start Condition in Effect	True while in the Pre Start state.	Status Input PRESTCONDINEFFECT
Status Input Pre Start Input	True when the MGC-1550 is indicating that the Pre Start relay should be closed.	Status Input PRESTARTINPUT
Status Input Reset Active	True when the Reset logic element is true or when the Reset key on the front panel is pressed.	Status Input RESETACTIVE
Status Input Restart Delay Active	True when the Restart Delay timer is timing out.	Status Input RESTARTDELAYACTIVE
Status Input Run Input	True when the MGC-1550 is indicating that the Run relay should be closed.	Status Input RUNINPUT
Status Input Run Mode	True when the MGC-1550 is in Run Mode or the Run Mode logic element is true.	Status Input RUNMODE
Status Input Single Phase Connection Override	True when the Single Phase Override input is true.	Status Input SPORIDE
Status Input Switch not in Auto	True when the MGC-1550 is not in Auto Mode.	Status Input SWTNOTINAUTO
Status Input Start Input	True when the MGC-1550 is indicating that the Start relay should be closed to start the engine.	Status Input STARTINPUT
Output Objects		
Physical Outputs OUT1 – OUT4	Physical Outputs 1 through 4.	Output - OUT1 OUTPUT 1
Remote Outputs OUT5 – OUT28	Remote Outputs 5 through 28. (Available when an optional CEM-2020 is connected.)	Output - OUT5 OUTPUT 5

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Name	Description	Symbol
Alarms		
Auto Restart Fail	True after the Automatic Restart function fails to restart the generator.	Alarm AUTORSTRTFAILALM
Battery Charger Fail	True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	Alarm BATTCHRGFAILALM
Coolant Level Sender Fail	True when a low coolant level error status code is received from the ECU. CAN Bus must be enabled.	Alarm COOLLVLSENDFAILALM
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	Alarm COOLTEMPSENDFAILALM
ECU Comm Loss	True when communication to ECU has been lost.	Alarm LOSSECUCOMMALM
ECU Shutdown	True when ECU has shut down the engine.	Alarm ECUSHUTDOWNALM
Emergency Stop	True when the Emergency Stop button has been pressed.	Alarm EMERGSTOPALM
Fuel Leak	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	Alarm FUELLEAKALM
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	Alarm FUELLSENDFAILALM
Generator Protection 27	True when the 27 element is configured as an alarm and has tripped.	Alarm 27UNDRVLTALM
Generator Protection 59	True when the 59 element is configured as an alarm and has tripped.	Alarm 59OVOLTALM
Generator Protection 47	True when the 47 element is configured as an alarm and has tripped.	Alarm 47PH_IMBLALM
Generator Protection 50	True when the 50 element is configured as an alarm and has tripped.	Alarm 50OCURRALM
Generator Protection 81 Over	True when the 81 Over element is configured as an alarm and has tripped.	Alarm 81OFRQALM
Generator Protection 81 Under	True when the 81 Under element is configured as an alarm and has tripped.	Alarm 81UFRQALM
Global Alarm	True when one or more alarms are set.	Alarm GLBALM
Global Sender Fail	True when one or more of the Sender Fails are configured as alarms and are true.	Sender Fail GLBSENDFALM

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Name	Description	Symbol
Hi Coolant Temp	True when the High Coolant Temp Alarm settings have been exceeded.	Alarm HITEMPALM
Low Coolant Level	True when the Low Coolant Level function is configured as an alarm and the activation delay has expired. In addition, true when CAN Bus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Alarm LOWCOOLLVLALM
Low Fuel Level	True when the Low Fuel Level Alarm settings have been exceeded.	Alarm LOWFUELLALM
Low Oil Pressure	True when the Low Oil Pressure Alarm settings have been exceeded.	Alarm LOWOILPRALM
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	Alarm OILPRESSENDFAILALM
Overcrank	True when an Overcrank condition exists.	Alarm OCRANKALM
Overspeed	True when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPDALM
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Alarm SPDSENDFAILALM
Unexpected Shutdown Alarm	True when the metered engine speed (RPM) unexpectedly drops to 0 while the engine is running.	Alarm UNEXPECTEDSHUTDNALM
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.	Alarm VOLTSENSFAILALM
Pre-Alarms		
Battery Charger Fail	True when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm BATTCHRGFAILPALM
Battery Overvoltage	True when the Battery Overvoltage pre-alarm threshold has been exceeded.	Pre-Alarm BATOVOLTPALM
Checksum Failure	True when some of the user settings or firmware code has been corrupted. Refer to the *Reporting and Alarms* chapter for more details.	Pre-Alarm CHECKSUMFAILPALM
Contact Expansion Module Multiple Contact Expansion Modules Connected	True when more than one CEM-2020 is connected.	Pre-Alarm DUPCEMPALM
Contact Expansion Module Contact Expansion Module Comm Fail	True when communication from the CEM-2020 to the MGC-1550 has been lost.	Pre-Alarm CEMCOMMFPALM

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Name	Description	Symbol
Contact Expansion Module Contact Expansion Modules Hardware Mismatch	True when the connected CEM-2020 does not have the same number of outputs as defined on the *System Parameters, Remote Module Setup* screen in BESTCOMS*Plus*.	Pre-Alarm CEMHWMISMATCHPALM
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm COOLTEMPSENDFAILPALM
DEF Inducement	This is the lowest level of inducement not to operate the engine when Diesel Exhaust Fluid (DEF) is low or of poor quality or there is a problem with the Exhaust After Treatment System (EATS). The engine is operating in a reduced power mode. Eventually the level of inducement will be increased unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFENGINEDERATEPALM
DEF Low Severe	True when the engine ECU reports via CAN Bus that Diesel Exhaust Fluid (DEF) is at a level below 8%.	Pre-Alarm DEFEMPTYPALM
DEF Fluid Low	True when the engine ECU reports via CAN Bus that the Diesel Exhaust Fluid (DEF) is at a level between 8 and 23%.	Pre-Alarm DEFLOWPALM
DEF Inducement Override	This pre-alarm indicates a temporary override of inducement not to operate the engine. This is set by the ECU and is not a user setting.	Pre-Alarm DEFINDUCEOVERRIDEPALM
DEF Pre-severe Inducement	This pre-alarm indicates a high level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, after which it will enter a state of severe inducement unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFPRESEVEREINDUCEPALM
DEF Severe Inducement	This pre-alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine.	Pre-Alarm DEFSEVEREINDUCEPALM
Diag Trouble Code	True when a Diagnostic Trouble Code exists.	Pre-Alarm DIAGTRBCODEPALM
DPF Regenerate Disabled	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is inhibited.	Pre-Alarm DPFREGENDISABLDPALM
DPF Regenerate Required	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is required.	Pre-Alarm DPFREGENREQPALM
DPF Soot Level High	True when the engine ECU reports via CAN Bus that Diesel Particulate Filter (DPF) soot level is high.	Pre-Alarm DPFSOOTHIPALM

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Name	Description	Symbol
DPF Soot Level Moderately High	True when Diesel Particulate Filter (DPF) lamp status (yellow warning) broadcast over CAN Bus indicates that the soot level is moderately high.	Pre-Alarm DPFSOOTMODHIPALM
DPF Soot Level Severely High	True when Diesel Particulate Filter (DPF) lamp status (red warning) broadcast over CAN Bus indicates that the soot level is severely high.	Pre-Alarm DPFSOOTEXTHIPALM
ECU Comm Loss	True when communication to ECU has been lost.	Pre-Alarm LOSSECUCOMMPALM
Fuel Leak	True when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLEAKPALM
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLSENDFAILPALM
Generator Breaker Close Fail	True when a generator breaker close fail pre-alarm occurs. The pre-alarm occurs when the MGC-1550 has issued a generator breaker close output but does not receive a generator breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	Pre-Alarm GENBRKCLOSEFAIL
Generator Breaker Open Fail	True when a generator breaker open fail pre-alarm occurs. The pre-alarm occurs when the MGC-1550 has issued a generator breaker open output but does not receive a generator breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	Pre-Alarm GENBRKOPENFAIL
Generator Protection 27	True when the 27 element is configured as a pre-alarm and has tripped.	Pre-Alarm 27UNDRVLTPALM
Generator Protection 59	True when the 59 element is configured as a pre-alarm and has tripped.	Pre-Alarm 59OVOLTPALM
Generator Protection 47	True when the 47 element is configured as a pre-alarm and has tripped.	Pre-Alarm 47PH_IMBPALM
Generator Protection 50	True when the 50 element is configured as a pre-alarm and has tripped.	Pre-Alarm 50OCURRPALM
Generator Protection 81 Over	True when the 81 Over element is configured as a pre-alarm and has tripped.	Pre-Alarm 81OFRQPALM
Generator Protection 81 Under	True when the 81 Under element is configured as a pre-alarm and has tripped.	Pre-Alarm 81UFRQPALM
Global Pre-Alarm	True when one or more pre-alarms are set.	Pre-Alarm GLBPALM
Hi Coolant Temp	True when the High Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm HITEMPPALM
High Exhaust Temperature	True when Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates high exhaust temperature.	Pre-Alarm HIGHEXHTEMPPALM

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Name	Description	Symbol
High Fuel Level	True when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm HIFUELLPALM
Low Battery Voltage	True when the Low Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm LOWBATVPALM
Low Coolant Level	True when the Low Coolant Level function is configured as a pre-alarm and the activation delay has expired. In addition, true when CAN Bus is enabled and the Low Coolant Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWCOOLLVLPALM
Low Coolant Temp	True when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWTEMPPALM
Low Fuel Level	True when the Low Fuel Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWFUELLPALM
Low Oil Pressure	True when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWOILPRPALM
Mains Breaker Close Fail	True when a mains breaker close fail pre-alarm occurs. The pre-alarm occurs when the MGC-1550 has issued a mains breaker close output but does not receive a mains breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	Pre-Alarm MAINBRKCLOSEFAIL
Mains Breaker Open Fail	True when a mains breaker open fail pre-alarm occurs. The pre-alarm occurs when the MGC-1550 has issued a mains breaker open output but does not receive a mains breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	Pre-Alarm MAINBRKOPENFAIL
Mains Fail Return Failed	True when a mains fail return fail pre-alarm has occurred. The pre-alarm occurs when the MGC-1550 is attempting to transfer from generator power to mains power after mains returns, but has not returned to the mains from the generator before the Mains Fail Return Delay has expired.	Pre-Alarm MAINSFAILRETURNFAIL
Mains Fail Transfer Failed	True when a mains fail transfer fail pre-alarm occurs. The pre-alarm occurs when the MGC-1550 is configured for mains fail transfers, but has not transferred to the generator from the utility before the Mains Fail Max Transfer Time has expired. It remains true until the pre-alarm is cleared by pressing the *Reset* button on the front panel.	Pre-Alarm MAINSFLTRFAIL
Maintenance Interval	True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm MAINTINTPALM
MPU Fail	True when the MPU has failed.	Pre-Alarm MPUFAILPALM
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm OILPRESSENDFAILPALM

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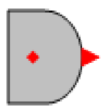
Name	Description	Symbol
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm VOLTSENSFAILPALM
Weak Battery	True when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm WEAKBATPALM
Senders		
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail COOLTEMPSENDFAIL
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail FUELLSENDFAIL
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail OILPRESSENDFAIL
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Sender Fail SPDSENDFAIL
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail VOLTSENSFAIL
Logic Control Relays		
The logic control relays (LCR) consist of LCR outputs and LCR inputs. The output can be used to terminate the "output" end of a logic network, and then use the corresponding input as an input to logic elsewhere in the logic scheme. When a given LCR output is true the corresponding LCR input is true. In other words, when LCR Output N (N being a number from 1 to 16) becomes true, then LCR Input N is true also. If you get a "too many logic levels" error while building a logic network, LCR outputs and inputs can be used as a solution to this problem. Place an LCR output on the end of the partial logic network and then use the corresponding LCR input to build more logic than was previously possible.		
Inputs Input 1-16	See description above.	LCR Input LCRINPUT1
Outputs Output 1-16	See description above.	LCR Output LCROUTPUT1

Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 24 lists the names and descriptions of the objects in the *Components* group.

Table 24. Components Group, Names and Descriptions

Name	Description	Symbol
Logic Gates		
AND	Input / Output: 0 0 → 0 0 1 → 0 1 0 → 0 1 1 → 1	

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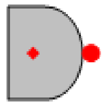
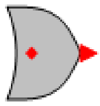
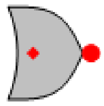
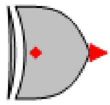
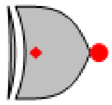
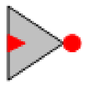
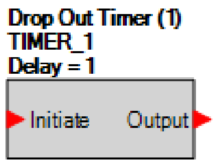
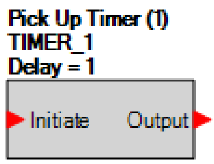
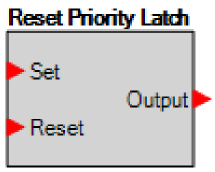
<table>
<tr><th>Name</th><th>Description</th><th>Symbol</th></tr>
<tr><td>NAND</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td></tr>
<tr><td>OR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td><td></td></tr>
<tr><td>NOR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td></tr>
<tr><td>XOR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td></tr>
<tr><td>XNOR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td><td></td></tr>
<tr><td>NOT (INVERTER)</td><td><table><tr><th>Input</th><th>Output</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table></td><td></td></tr>
<tr><td colspan="3">Pickup and Dropout Timers</td></tr>
<tr><td>Drop Out Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td>
</td></tr>
<tr><td>Pickup Up Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td>
</td></tr>
<tr><td colspan="3">Latches</td></tr>
<tr><td>Reset Priority Latch</td><td>When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state.</td><td>
</td></tr>
</table>

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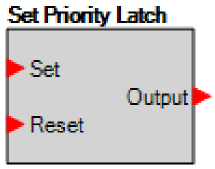
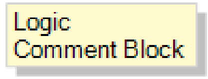
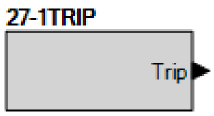
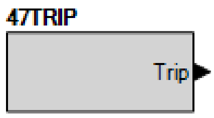
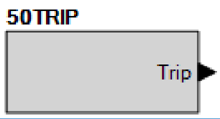
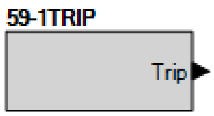
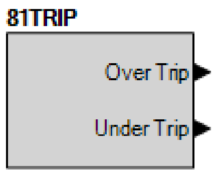
Name	Description	Symbol
Set Priority Latch	When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a set priority latch will go to the SET (ON) state.	
Other		
Comment Block	Enter user comments.	

Elements

This group contains elements for the 27, 47, 50, 59, and 81. It also contains elements for Generator Breaker, Mains Breaker, Logic Alarm, Logic Pre-Alarm, Configurable Elements, AUTO Mode, OFF Mode, RUN Mode, Run with Load, Engine Run, ATS, Run Inhibit, Test Inhibit, Pre-Start Output, Start Output, Run Output, Cool Stop Request, Cool Down Request, External Start Delay, Start Delay Bypass, Alternate Frequency Override, Mains Fail Test, Load Take Over, EPS Supplying Load, MTU Speed Demand Switch, Reset, Alarm Silence, Lamp Test, Idle Request, Low Fuel Pre-Alarm, Diesel Particulate Filter Manual Regeneration, Diesel Particulate Filter Regeneration Inhibit, Emergency Stop, Speed Raise, Speed Lower, MTU Cylinder Cutout Disable, and Automatic Breaker Operation Inhibit from PLC.

Table 25 lists the names and descriptions of the elements in the *Elements* group.

Table 25. Elements Group, Names and Descriptions

Name	Description	Symbol
Protection		
27TRIP	True when the 27-1 undervoltage is in a TRIP condition. Connect to another logic block input.	
47TRIP	True when the 47 phase imbalance is in a TRIP condition. Connect to another logic block input.	
50TRIP	True when the 50 overcurrent is in a TRIP condition. Connect to another logic block input.	
59TRIP	True when the 59-1 overvoltage is in a TRIP condition. Connect to another logic block input.	
81TRIP	True when the 81 frequency is in a TRIP condition. Connect to another logic block input.	

Other		

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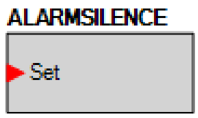
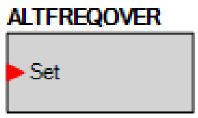
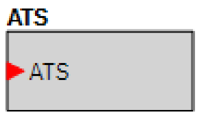
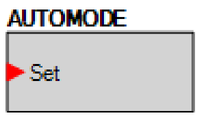
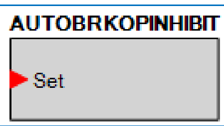
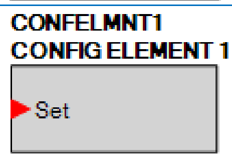
Name	Description	Symbol
ALARMSILENCE	The alarm will be silenced when this element is true. The alarm can also be silenced by pressing the Alarm Silence button on the front panel of the MGC-1550.	
ALTFREQOVER	When this logic element is true, protection and bus condition detection is forced to operate at the Alternate Frequency instead of the Rated Frequency.	
ATS	When this logic element is true, and the MGC-1550 is in AUTO mode, the generator will run. This can be used in place of the ATS programmable function if it is desired to generate the ATS signal as a combination of programmable logic rather than a simple contact input. If either the ATS logic element is true or the contact mapped to the ATS programmable function is true, and the MGC-1550 is in AUTO mode, the generator will run. If both the ATS logic element and the ATS programmable function are false, and the MGC-1550 is in AUTO mode, the generator will cool down and stop.	
AUTOMODE	When this input is true, and the MGC-1550 is in OFF mode, the MGC-1550 will switch to AUTO mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
AUTOBRKOP-INHIBIT	Automatic breaker operation is inhibited when the Set input is true.	
CONFELMNTX (X = 1 to 8)	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under *Programmable Outputs, Configurable Elements.* The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the MGC-1550 event log.	

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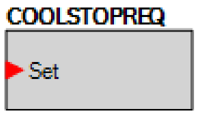
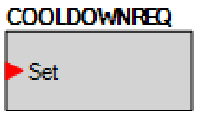
Name	Description	Symbol
COOLSTOPREQ	<u>RUN Mode</u> If the unit is in RUN mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. <u>AUTO Mode</u> If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	
COOLDOWNREQ	<u>RUN Mode</u> If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in RUN mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process, the unit will remain running in RUN mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. <u>AUTO Mode</u> If the unit is in AUTO mode and the Cool Down Request is received, the unit is forced to unload and open its breaker and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in AUTO mode, unless there are no conditions that cause the unit to run in AUTO mode, in which case it will shut down and remain in AUTO mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running in AUTO mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	

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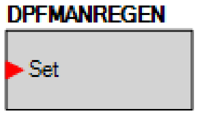
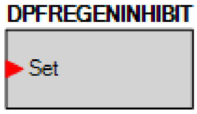
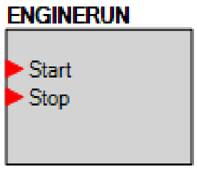
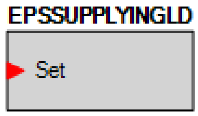
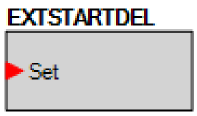
Name	Description	Symbol
DPFMANREGEN	Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	
DPFREGENINHIBIT	Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	
ENGINERUN	The Start input starts the generator. No load is applied. The breaker remains open. The Stop input stops the generator. The MGC-1550 only responds to this logic element when in AUTO mode.	
EPSSUPPLYINGLD	When this element is true and the generator is deemed stable, the EPS Supplying Load LED, on the front panel, is illuminated. Under normal operation, the MGC-1550 indicates that it is supplying load when the generator is deemed stable and the generator current is above a percentage of CT primary current (typically 3%). The generator current requirement for supplying load indication may be bypassed by setting this element true. This is useful for testing purposes or in cases where the generator supplies load at a current level which falls below the requirement. A cool-down cycle is performed when the MGC-1550 is in auto mode, is indicating that it is supplying load (whether driven by logic or generator current), and the ATS input is removed.	
ESTOP	When this element is true, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.	
EXTSTARTDEL	If the Set input is true while the MGC-1550 is in the Pre Start state, the MGC-1550 will remain in the Pre Start state until the Set input is false.	

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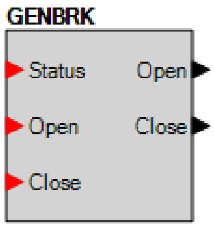
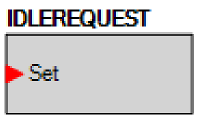
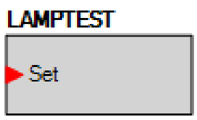
Name	Description	Symbol
GENBRK	This element is used to connect the breaker open and close output signals from the MGC-1550 to physical output contacts to open and close the generator breaker, and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests. Inputs *Status:* This input allows a contact input to be mapped that will provide breaker status feedback to the MGC-1550. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open. *Open:* This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the MGC-1550 is in RUN or AUTO mode, the breaker will open. *Close:* This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the MGC-1550 is in AUTO or RUN mode, and the generator is stable, a close request will be initiated. If bus is dead, the breaker will close; if the bus is not dead the generator breaker will not be closed. Outputs The outputs must be mapped to the contact outputs of the MGC-1550 that will be used to drive the breaker. *Open:* This output is pulsed true (closes the output contact it is mapped to) when the MGC-1550 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. *Close:* This output is pulsed true (closes the output contact it is mapped to) when the MGC-1550 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.	
IDLEREQUEST	When this element is true, the MGC-1550 sends an idle request to the ECU on J1939 engines that are equipped to receive such a request. The request consists of an enable bit command and an idle RPM setting. At this time, only Volvo and Cummins are implemented. ECUs that accept the idle RPM setting set the engine to the requested RPM. ECUs that accept only the enable bit command, set the engine to their internal idle speed setting, ignoring the requested idle RPM from the MGC-1550.	
LAMPTEST	The lamp test will be performed when this element is true. The lamp test can also be accomplished by simultaneously pressing the *Up* and *Down* buttons on the front panel of the MGC-1550.	

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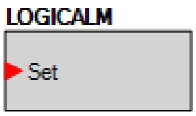
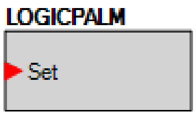
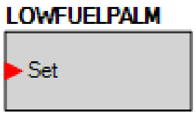
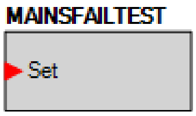
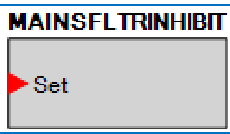
Name	Description	Symbol
LOADTAKEOVER	When this logic element is true, the generator is forced to start, assume load, and disconnect from the mains, in an open transition.	
LOGICALM	When this input is true, the MGC-1550 goes into an alarm condition.	
LOGICPALM	When this input is true, the MGC-1550 goes into a Pre-alarm condition.	
LOWFUELPALM	When this element is true, a Low Fuel Pre-Alarm is annunciated and the Low Fuel Level LED on the RDP-110 is illuminated.	
MAINSFAILTEST	When this element is true, the MGC-1550 will exercise its mains fail transfer function exactly as it would if the mains were to fail on a mains fail machine. This can be used as a test of the mains fail transfer capability of the unit without having to cause a true mains failure.	
MAINSFLTRINHIBIT	The mains fail transfer function is inhibited when the Set input is true.	

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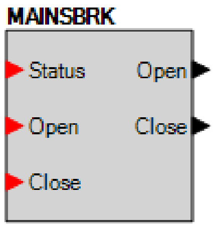
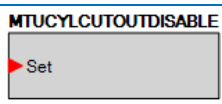
Name	Description	Symbol
MAINSBRK	This element is used to connect the breaker open and close output signals from the MGC-1550 to physical output contacts to open and close the mains breaker and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests. This element is only available when the Mains Breaker Hardware in configured on the *Breaker Hardware* screen via the *Breaker Management* tree branch. <u>Inputs</u> *Status:* This input allows a contact input to be mapped that will provide breaker status feedback to the MGC-1550. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open. *Open:* This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the MGC-1550 is in RUN or AUTO mode, the breaker will open. *Close:* This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed, the mains is stable, and both breakers are open, a close request will be initiated. <u>Outputs</u> The outputs must be mapped to the contact outputs of the MGC-1550 that will be used to drive the breaker. *Open:* This output is pulsed true (closes the output contact it is mapped to) when the MGC-1550 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. *Close:* This output is pulsed true (closes the output contact it is mapped to) when the MGC-1550 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.	
MTUCYLCUTOUT-DISABLE (MTU Cylinder Cutout Disable)	When this logic element is true, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are both sent to the engine ECU with true status. When this logic element is false, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are sent to the engine ECU with states set by the values programmed for the Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 MGC-1550 settings which are configured on the ECU Setup screen in BESTCOMS*Plus*.	

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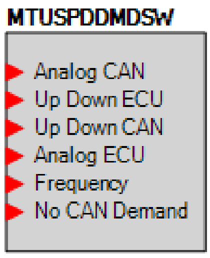
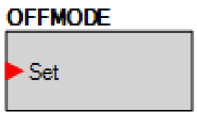
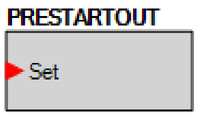
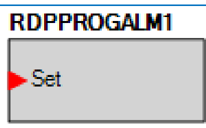
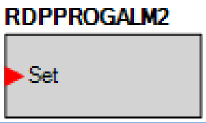
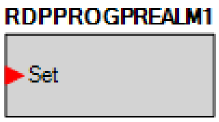
Name	Description	Symbol
MTUSPDDMDSW	This logic element can be used to specify the Speed Demand Source parameter value that is sent to an MTU Engine ECU. When no input is true, the value sent to the engine ECU is the value specified in the Speed Demand Source setting in the ECU configuration setting. If an input on this logic element is true, the selected Speed Demand Source will be sent rather than the value specified by the Speed Demand Source setting. If multiple inputs are true at the same time, the input that is closest to the top of the logic element symbol will specify the Speed Demand Source parameter value that is sent to the ECU. Analog CAN: This input configures the MTU ECU to accept speed bias requests over J1939 CAN Bus from the MGC-1550. Up Down ECU: This input configures the MTU ECU to accept speed raise/lower commands via contact inputs on the ECU. Up Down CAN: This input configures the MTU ECU to accept speed raise/lower commands via communications over J1939 CAN Bus. Analog ECU: This input configures the MTU ECU to accept speed bias via bias voltage input connections on the ECU. Frequency: This configures the MTU ECU to accept speed commands via a frequency signal input on the ECU. The mapping of input signal frequency to machine speed is configured in a curve within the engine ECU. No CAN Demand: This input configures the MTU ECU to disregard all speed requests or speed raise/lower requests from J1939 CAN Bus.	
OFFMODE	When this input is true, the MGC-1550 will switch to OFF mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
PRESTARTOUT	This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to “Programmable”. When the Prestart Output Relay configuration is set to “Programmable”, the prestart relay will not close unless logic is used to drive this element. When the Prestart Output Relay configuration is set to “Predefined”, the prestart relay is closed according to the predefined prestart functionality of the MGC-1550. When the “Predefined” functionality is selected, the relay will not respond to this element.	
RDPPROGALM1	When true, this element illuminates the *Fuel Leak/Sender Failure* LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	
RDPPROGALM2	When true, this element illuminates the *Sender Failure* LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	
RDPPROGPREALM1	When true, this element illuminates the *Battery Overvoltage* LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	

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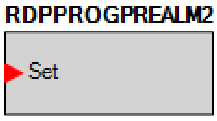
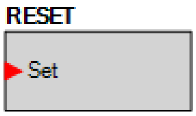
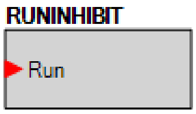
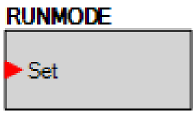
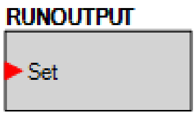
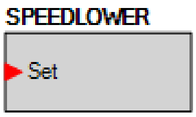
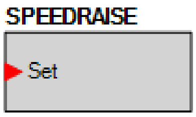
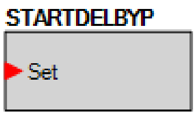
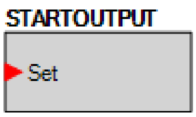
Name	Description	Symbol
RDPPROGPREALM2	When true, this element illuminates the *Battery Charger Failure* LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	
RESET	Reset will be active when this element is true. Reset can also be accomplished by pressing the Reset button on the front panel of the MGC-1550.	
RUNINHIBIT	When this logic element is true, the MGC-1550 is prevented from starting and running the generator, regardless of any condition that would normally cause the generator to run. If this element is false and there is <u>any</u> condition in effect which will cause the generator to run, the MGC-1550 will start and run the generator.	
RUNMODE	When this input is true, and the MGC-1550 is in OFF mode, the MGC-1550 will switch to RUN mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	
RUNOUTPUT	This element is used to drive the run output relay from logic when the Run Output Relay configuration is set to “Programmable”. When the Run Output Relay configuration is set to “Programmable”, the run relay will not close unless logic is used to drive this element. When the Run Output Relay configuration is set to “Predefined”, the run relay is closed according to the predefined run functionality of the MGC-1550. When the “Predefined” functionality is selected, the relay will not respond to this element.	
RUNWLOAD	The Start input starts the generator and closes the Gen breaker. The Stop input stops the generator and opens the Gen breaker. The MGC-1550 only responds to this logic element when in AUTO mode.	
SPEEDLOWER	This element lowers the speed setting of the MGC-1550 by up to 2 rpm per second. After the speed has not been lowered for 30 seconds, the modified speed is saved to nonvolatile memory.	
SPEEDRAISE	This element raises the speed setting of the MGC-1550 by up to 2 rpm per second. After the speed has not been raised for 30 seconds, the modified speed is saved to nonvolatile memory.	
STARTDELBYP	This element allows the Pre Start state to be skipped based on logic. For example, a start delay may not be necessary when the engine is warm. This also allows an external device, such as an ECU, to control the pre start interval.	
STARTOUTPUT	This element is used to drive the start output relay from logic when the Start Output Relay configuration is set to “Programmable”. When the Start Output Relay configuration is set to “Programmable”, the start relay will not close unless logic is used to drive this element. When the Start Output Relay configuration is set to “Predefined”, the start relay is closed according to the predefined start functionality of the MGC-1550. When the “Predefined” functionality is selected, the relay will not respond to this element.	

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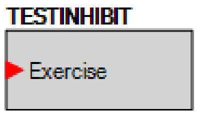
Name	Description	Symbol
TESTINHIBIT	When this logic element is true, the generator exercise timer cannot start the generator. If the TESTINHIBIT logic function is false during an exercise period, or transitions from true to false at any time during an exercise period, the MGC-1550 will start and run the generator for the duration of the exercise period.	

Logic Schemes

A logic scheme is a group of logic variables written in equation form that defines the operation of an MGC-1550 Digital Genset Controller. Each logic scheme is given a unique name. This gives you the ability to select a specific scheme and be confident that the selected scheme is in operation. One logic scheme is configured for typical control applications and is the default active logic scheme. Only one logic scheme can be active at a given time. In most applications, preprogrammed logic schemes eliminate the need for custom programming. Preprogrammed logic schemes may provide more inputs, outputs, or features than are needed for a particular application. This is because a preprogrammed scheme is designed for a large number of applications with no special programming required. Unneeded logic block outputs may be left open to disable a function or a function block can be disabled through operating settings.

When a custom logic scheme is required, programming time is reduced by modifying the default logic scheme.

The Active Logic Scheme

Digital Genset Controllers must have an active logic scheme in order to function. All MTU Onsite Energy MGC-1550 units are delivered with a default, active logic scheme pre-loaded in memory. If the function block configuration and output logic of the default logic scheme meets the requirements of your application, then only the operating settings (power system parameters and threshold settings) need to be adjusted before placing the MGC-1550 in service.

Copying and Renaming Preprogrammed Logic Schemes

Copying a saved logic scheme to the active logic and assigning a unique name is accomplished by loading the saved logic scheme into BESTCOMS*Plus* and then typing over the logic scheme's name. Changes are not activated until the new settings have been saved and uploaded to the device.

Sending and Retrieving Logic Schemes

To retrieve settings from the MGC-1550, it must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the MGC-1550 by selecting *Download Settings and Logic* on the *Communication* pull-down menu.

To send settings to the MGC-1550, it must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the MGC-1550 by selecting *Upload Settings and Logic* on the *Communication* pull-down menu.

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Caution

Always remove the MGC-1550 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the MGC-1550 is in service could generate unexpected or unwanted outputs.

Modifying a logic scheme in BESTCOMS*Plus* does not automatically make that scheme active in the MGC-1550. The modified scheme must be uploaded into the MGC-1550.

Programming BESTlogic™Plus

Use BESTCOMS*Plus* to program BESTlogic*Plus*. Using BESTCOMS*Plus* is analogous to physically attaching wire between discrete MGC-1550 terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMS*Plus* to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 68.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the MGC-1550.

The view of the Main Logic, Physical Outputs, Remote Outputs, and LCR Outputs can be automatically arranged by clicking the right mouse button on the window and selecting *Auto-Layout.*

The following must be met before BESTCOMS*Plus* will allow logic to be uploaded to the MGC-1550:

- A minimum of two inputs and a maximum of four inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of five logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- Only 20 gates per logic level. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed. A maximum of 50 gates allowed per diagram.
- At all levels there can only be 64 used link/wired or endpoints. Endpoints being inputs, outputs, both sides of element blocks.

Three status LEDs are located in the lower right corner of the BESTlogic*Plus* window. These LEDs show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 26 defines the colors for each LED.

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Table 26. Status LEDs

LED	Color	Definition
Logic Save Status (Left LED)	Orange	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (Right LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.

Pickup and Dropout Timers

A pickup timer produces a true output when the elapsed time is greater than or equal to the Pickup Time setting after a false to true transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to false, the output transitions to false immediately.

A drop out timer produces a true output when the elapsed time is greater than or equal to the Dropout Time setting after a true to false transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to true, the output transitions to false immediately. Refer to Figure 69.

To program logic timer settings, use the Settings Explorer within BESTCOMS*Plus* to open the *BESTlogicPlus Programmable Logic/Logic Timers* tree branch. Enter a *Name* label that you want to appear on the timer logic block. The *Time Delay* value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the *Components* tab inside the BESTlogic*Plus* window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the *Logic Timers* tree branch. The *Logic Timer Properties Dialog Box* will appear. Select the timer you want to use.

Timing accuracy is ±15 milliseconds.

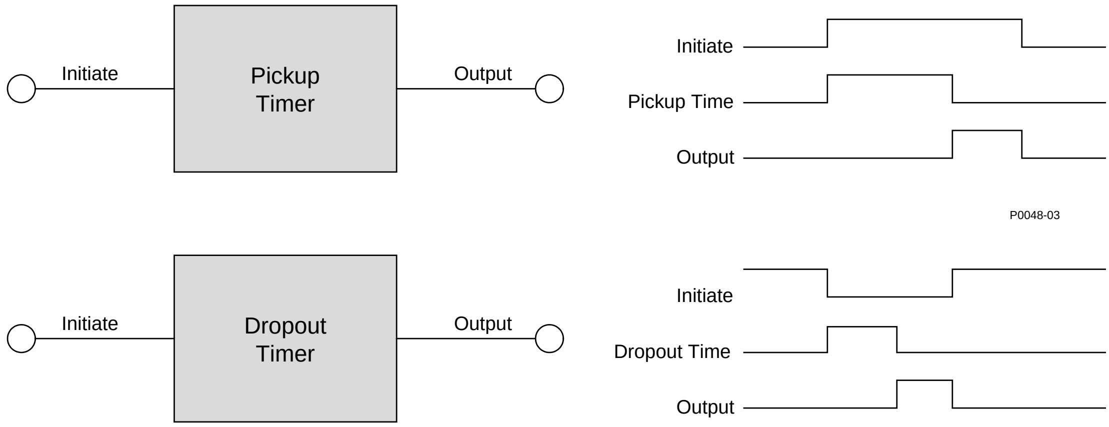

Figure 69. Pickup and Dropout Timer Logic Blocks

Offline Logic Simulator

The offline logic simulator allows you to change the state of various logic elements to illustrate how that state travels through the system. Before running the logic simulator, you must click the Save button on the BESTlogic*Plus* toolbar to save the logic to memory. Changes to the logic (other than changing the state) are disabled when the simulator is enabled. Colors are selected by clicking the Options button on the BESTlogic*Plus* toolbar. By default, Logic 0 is red and Logic 1 is green. Using your mouse, double-click on a logic element to change its state.

An example of the offline logic simulator is shown in Figure 70. Output 1 is Logic 0 (red) when Virtual Switch 1 is Logic 0 (red) and Fixed 1 is Logic 1 (green).

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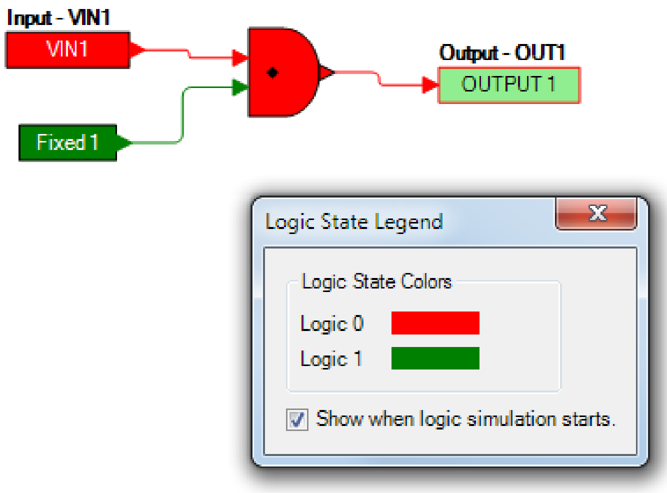

Figure 70. Offline Logic Simulator Example

BESTlogic™Plus File Management

To manage BESTlogic*Plus* files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogic*Plus* Programmable Logic toolbar to manage BESTlogic*Plus* files. Refer to Figure 71. For information on Settings Files management, refer to the *BESTCOMSPlus* chapter.

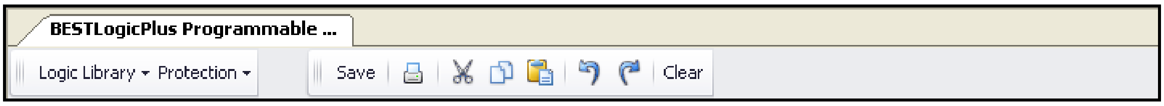

Figure 71. BESTlogic*Plus* Programmable Logic Toolbar

Saving a BESTlogic*Plus* File

After programming BESTlogic*Plus* settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogic*Plus* settings can be uploaded to the MGC-1550, you must select *Save* from the *File* pull-down menu located at the top of the BESTCOMS*Plus* main shell. This step will save both the BESTlogic*Plus* settings and the operating settings to a file.

The user also has the option to save the BESTlogic*Plus* settings to a unique file that contains only BESTlogic*Plus* settings. Click on the *Logic Library* drop-down button and select *Save Logic Library File.* Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename.

Opening a BESTlogic*Plus* File

To open a saved BESTlogic*Plus* file, click on the *Logic Library* drop-down button on the BESTlogic*Plus* Programmable Logic toolbar and select *Open Logic Library File.* Use normal Windows techniques to browse to the folder where the file is located.

Protecting a BESTlogic*Plus* File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select *Show Lock Status* from the *Protection* drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select *Lock Object(s).* The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select *Protect Logic Document* from the *Protection* drop-down button. A password is optional.

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Uploading a BESTlogic*Plus* File

To upload a BESTlogic*Plus* file to the MGC-1550, you must first open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the *Communication* menu and select *Upload Logic.*

Downloading a BESTlogic*Plus* File

To download a BESTlogic*Plus* file from the MGC-1550, you must pull down the *Communication* menu and select *Download Logic*. If the logic in your BESTCOMS*Plus* has changed, a dialog box will open asking you if want to save the current logic changes. You may choose *Yes* or *No*. After you have taken the required action to save or not save the current logic, the downloading is executed.

Printing a BESTlogic*Plus* File

To view a preview of the printout, click on the *Print Preview* icon located on the BESTlogic*Plus* Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by clicking on the *Printer* icon on the BESTlogic*Plus* Programmable Logic toolbar. A dialog box, *Select Views to Print* opens allowing you to check which views you would like to print. Next, the *Print* dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

A *Page Setup* icon is also provided on the BESTlogic*Plus* Programmable Logic toolbar allowing you to select *Paper Size, Paper Source, Orientation,* and *Margins.*

Clearing the On-Screen Logic Diagram

Click on the *Clear* button to clear the on-screen logic diagram and start over.

BESTlogic™Plus Examples

Example 1 - GENBRK Logic Block Connections

Figure 72 illustrates the GENBRK logic block, three input logic blocks, and two output logic blocks. Output 3 is active while the GENBRK is sending an “open breaker” command and Output 4 is active while the GENBRK is sending the “close breaker” command.

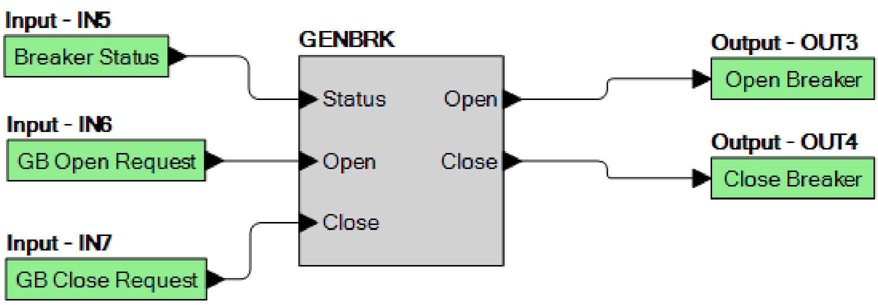

Figure 72. Example 1 – GENBRK Logic Block Connections

Example 2 - AND Gate Connections

Figure 73 illustrates a typical AND gate connection. In this example, Output 11 will become active when the Low Fuel alarm AND the Low Oil Pressure alarm are true.

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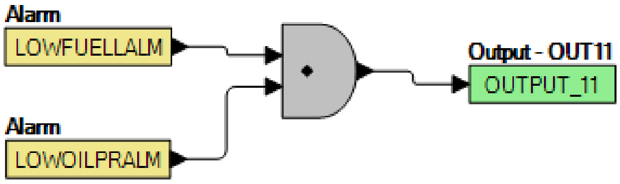

Figure 73. Example 2 – AND Gate Connections

Example 3 - Multiple Logic Connections

In this example, there are two comment boxes, which may be placed on the logic diagram. Double-click a comment box to modify the inside text. Output 3 becomes true when the 27TRIP is true. Output 1 becomes true when the High Coolant Temp is true. Output 2 becomes true when the MGC-1550 is in RUN mode (RUN Mode true). Refer to Figure 74.

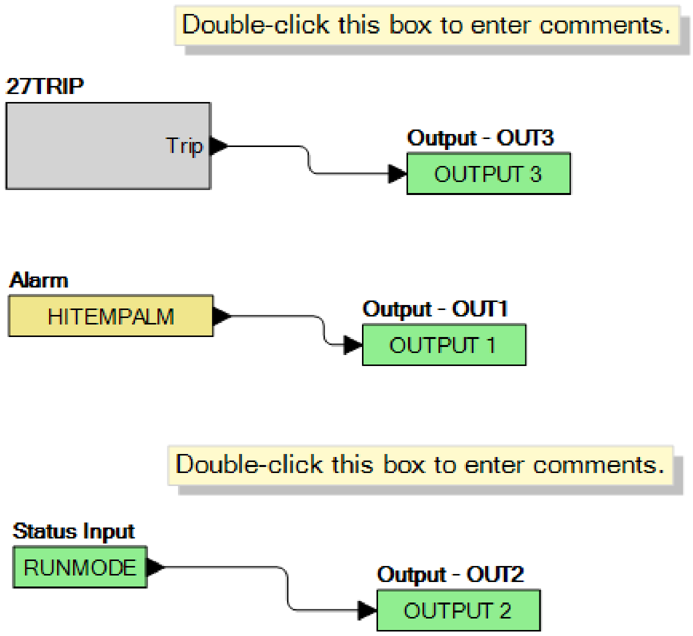

Figure 74. Example 3 – Multiple Logic Connections

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Communication

MGC-1550 communication ports include a mini-B USB port, CAN terminals, and provisions for an optional Remote Display Panel. The following paragraphs describe the MGC-1550 communication ports in detail.

USB

The rear-panel, mini-B USB port enables local communication with a PC running BESTCOMS*Plus*® software. The MGC-1550 is connected to a PC using a standard USB cable. BESTCOMS*Plus* is a Windows®-based communication software package that is supplied with the MGC-1550. A detailed description of BESTCOMS*Plus* is provided in the BESTCOMS*Plus* chapter.

CAN

A Controller Area Network (CAN) is a standard interface that enables communication between multiple controllers on a common network using a standard message protocol. MGC-1550 controllers have a CAN interface that supports the SAE J1939 protocol and the MTU protocol.

Applications using an engine-driven generator set controlled by an MGC-1550 may also have an Engine Control Unit (ECU). The CAN interface allows the ECU and MGC-1550 to communicate. The ECU reports operating information to the MGC-1550 through the CAN interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed for monitoring.

The primary use of the CAN interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. Table 27 lists the ECU parameters and Table 28 lists the engine configuration parameters supported by the MGC-1550 CAN interface. These parameters are transmitted via the CAN interface at preset intervals. See the column labeled Update Rate in Table 27 for transmission rates.

CAN interface connections are made at 13 (CAN H), 14 (CAN L), and 15 (SHIELD).

Table 27. ECU Parameters Obtained from CAN Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
Aftertreatment 1 Diesel Particulate Filter Outlet Temperature	°C	°F	500 ms	3246
Air Filter Differential Pressure	kPa	psi	500 ms	107
Air Inlet Temperature	kPa	°F	1 s	172
Alarm Reset Feedback	Binary (0 or 1)		1 s	2815
Ambient Air Temperature	°C	°F	1 s	171
Auxiliary Pressure 1	kPa	psi	On Request	1387
Auxiliary Pressure 2	kPa	psi	On Request	1388
Barometric Pressure	kPa	psi	1 s	108
Battery Voltage	Vdc	Vdc	1 s	168
Boost Pressure	kPa	psi	500 ms	102
Charge Air Temperature	°C	°F	1 s	2629
Coolant Level	%	%	500 ms	111
Coolant Pressure	kPa	psi	500 ms	109
DEF Inducement Level - Level of Inducement Not to Run the Engine	%	%	1 s	5246

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ECU Parameter	Metric Units	English Units	Update Rate	* SPN
DEF Severity Level - Severity of Tank Low Level	%	%	1 s	5245
DEF Tank 1 Level	%	%	1 s	1761
DEF Tank 2 Level	%	%	1 s	4367
ECU Temperature	°C	°F	1 s	1136
Engine Coolant Preheated State	Binary (0 or 1)		500 ms	3552
Engine Coolant Temperature	°C	°F	1 s	110
Engine Desired Operating Speed	rpm	rpm	250 ms	515
Engine Intake Manifold #1 Absolute Pressure	kPa	psi	500 ms	3563
Engine Intercooler Coolant Level	%	%	500 ms	3668
Engine Intercooler Temperature	°C	°F	1 s	52
Engine Oil Level	%	%	500 ms	98
Engine Oil Pressure	kPa	psi	500 ms	100
Engine Oil Temperature	°C	°F	1 s	175
Engine Speed	rpm	rpm	Engine Speed Dependent	190
Exhaust Gas Temperature	°C	°F	500 ms	173
Exhaust Temperature A	°C	°F	500 ms	2433
Exhaust Temperature B	°C	°F	500 ms	2434
Fuel Delivery Pressure	kPa	psi	500 ms	94
Fuel Leak Filter 1	Binary (0 or 1)		1 s	1239
Fuel Leak Filter 2	Binary (0 or 1)		1 s	1240
Fuel Rate	liter/hr	gal/hr	100 ms	183
Fuel Temperature	°C	°F	1 s	174
High Exhaust System Temp (HEST) Lamp/Indicator	—	—	500 ms	3698
Injection Control Pressure	MPa	psi	500 ms	164
Injector Metering Rail Pressure	MPa	psi	500 ms	157
Intake Manifold Temperature	°C	°F	500 ms	105
Particulate Filter (DPF) Lamp/Indicator	—	—	500 ms	3697
Percent Load at Current rpm	%	%	50 ms	92
Rated Power	watts	watts	On Request	166
Rated rpm	rpm	rpm	On Request	189
Regeneration Disabled (Inhibit) Lamp/Indicator	—	—	500 ms	3703
Shutdown from ECU	Binary (0 or 1)		1 s	1110
Switched Battery Voltage (at ECU)	Vdc	Vdc	1 s	158
Throttle (Accelerator Pedal) Position	%	%	50 ms	91
Total Engine Hours	hours	hours	Requested 1.5 s	247
Total Fuel Used	liters	gallons	Requested 1.5 s	250
Transmission Oil Pressure	kPa	psi	1 s	127
Transmission Oil Temperature	°C	°F	1 s	177
Trip Average Fuel Rate	liters	gallons	500 ms	1029
Trip Fuel	liters	gallons	Requested 1.5 s	182
Winding 1 Temperature	°C	°F	1 s	1124

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ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Winding 2 Temperature	°C	°F	1 s	1125
Winding 3 Temperature	°C	°F	1 s	1126

* SPN is suspect parameter number.

Table 28. Engine Configuration Parameters Obtained from CAN Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Engine Speed at High Idle Point 6	rpm	rpm	5 s	532
Engine Speed at Idle Point 1	rpm	rpm	5 s	188
Engine Speed at Point 2	rpm	rpm	5 s	528
Engine Speed at Point 3	rpm	rpm	5 s	529
Engine Speed at Point 4	rpm	rpm	5 s	530
Engine Speed at Point 5	rpm	rpm	5 s	531
Gain (Kp) of End Speed Governor	%/rpm	%/rpm	5 s	545
Maximum Momentary Engine Override Speed Point 7	rpm	rpm	5 s	533
Maximum Momentary Engine Override Time Limit	seconds	seconds	5 s	534
Percent Torque at Idle Point 1	%	%	5 s	539
Percent Torque at Point 2	%	%	5 s	540
Percent Torque at Point 3	%	%	5 s	541
Percent Torque at Point 4	%	%	5 s	542
Percent Torque at Point 5	%	%	5 s	543
Reference Engine Torque	N•m	ft-lb	5 s	544
Requested Speed Control Range Lower Limit	rpm	rpm	5 s	535
Requested Speed Control Range Upper Limit	rpm	rpm	5 s	536
Requested Torque Control Range Lower Limit	%	%	5 s	537
Requested Torque Control Range Upper Limit	%	%	5 s	538

* SPN is suspect parameter number.

Caution

When the CAN is enabled, the MGC-1550 ignores the following sender inputs: oil pressure, coolant temperature, and magnetic pickup.

Under certain circumstances, the following strings may be displayed on the front panel HMI and in the Metering Explorer of BESTCOMS*Plus*:

- *NC (Not Connected)* - String displayed for a J1939 parameter when the engine ECU is not connected to the MGC-1550.
- *SF (Sender Fail)* - String displayed for a J1939 parameter when the engine ECU sends a special code indicating a measurement failure for the parameter. For example, if oil sender is determined to be bad by the ECU, it sends a special code in place of the J1939 oil pressure data indicating a sender fail condition.
- *NS (Not Sent)* - String displayed for a J1939 parameter when the J1939 parameter has not been sent to the MGC-1550 by the engine ECU.
- *NA (Not Applicable)* - String displayed for a J1939 parameter when the engine ECU sends a special code for the parameter indicating that the parameter is not implemented or not applicable in the ECU.

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- *UF (Unknown Failure)* - String displayed when the J1939 parameter data received by the ECU is not within the valid J1939 data range for the parameter but is not one of the special codes above.

Table 29 lists the J1939 data transmitted from the MGC-1550.

Table 29. J1939 Data Transmitted from the MGC-1550

ECU Parameter	Update Rate	* SPN
Battle Override Switch	100 ms	1237
Speed Request	10 ms	518
Note: Requests from the MGC-1550 to the Engine ECU for various parameters are made by issuing the request.		
Address Claim Request	Once on power up, and any time a Global Request for Address Claim (GRAC) PGN is received.	NA
Currently Active Diagnostic Trouble Codes Request	Whenever a refresh of Currently Active Diagnostic Trouble Code Requests is received.	NA
Previously Active Diagnostic Trouble Codes Request	2 s	NA
Clear Currently Active Diagnostic Trouble Codes Request	Whenever a request to reset Currently Active Diagnostic Trouble Code Request is made.	NA
Clear Previously Active Diagnostic Trouble Codes Request	Whenever a request to reset Previously Active Diagnostic Trouble Code Request is made.	NA
Engine Hours/Revolutions Request	2 s	NA
Fuel Consumption Request	2 s	NA
Electronic Engine Controller #4 (Rated Speed and Power) Request	2 s	NA
Auxiliary Analog Information	2 s	N/A

CAN Setup

The following paragraphs describe the settings found on the CAN Setup screen. This screen is found in the BESTCOMS*Plus Settings Explorer*, under the *Communications, CAN Bus* category. If using the front panel, navigate to Settings > Communications > CAN Bus Setup > CAN Bus Setup. Figure 75 illustrates the BESTCOMS*Plus* CAN Bus Setup screen.

Enable ECU Support

Set to Enabled for the MGC-1550 to communicate with the ECU.

Enable DTC (Diagnostic Trouble Code) Support

If the ECU is a J1939 ECU, enable DTC support. If the ECU does not support it, no diagnostic trouble codes will be logged by the MGC-1550.

SPN Conversion Method

The most common SPN conversion method is 4 and is the default for the MGC-1550. Refer to ECU manufacturer documentation to determine the correct SPN conversion method of the ECU and set the SPN Conversion Method setting in the MGC-1550 accordingly.

CAN bus Address

This parameter sets a unique address number for the MGC-1550 operating on a CAN. The CAN Address is set internally by the MGC-1550 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply.

ECU Contact Control - Output Select

Select whether the RUN output relay or the PRE (Prestart) output relay closes to give the ECU its “energize to run” signal. In some implementations, this relay may actually be providing ECU power.

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ECU Contact Control - Pulsing Enable

Select if the ECU is not to be on line at all times. Often ECUs are allowed to go “off line” to conserve battery drain when the engine is not running. The MGC-1550 will “pulse” it periodically to force it to be active to allow the MGC-1550 to read data such as coolant temperature and coolant level. This is required if the MGC-1550 is to report low coolant temperature conditions (which may indicate a failure of a block heater), or low coolant level conditions (if a leak occurs while the machine is not running). Pulsing is also used to check the integrity of CAN communications when the machine is not running.

ECU Related Time Values - Engine Shut Down

Set this parameter for a value longer than the duration required to stop the engine after being shut down. The ECU is pulsed after this time expires. If the time is too short, the pulse may occur while the engine is still turning which could cause a brief re-start and possibly damage the flywheel and starter system.

ECU Related Time Values - Pulse Cycle Time

Set this parameter for the desired time between ECU pulse cycles.

ECU Related Time Values - Settling Time

This parameter is the duration of the “on line” time of the pulse cycle during which the MGC-1550 reads data from the ECU. The settling time should be set long enough so that any ECU parameters that require time to “settle down” after the ECU is on line can do so. Since the MGC-1550 may use some of the ECU data for alarm or pre-alarm annunciation, it is important that the data have time to settle.

ECU Related Time Values - Response Timeout

This setting defines the amount of time that the MGC-1550 will wait to receive data from the ECU during a pulse cycle or start attempt. If no data is received during this time in a pulse cycle, a LOSS OF ECU COMMS pre-alarm is annunciated. If no data is received in this time during an engine starting attempt, a LOSS OF ECU COMMS alarm is annunciated.

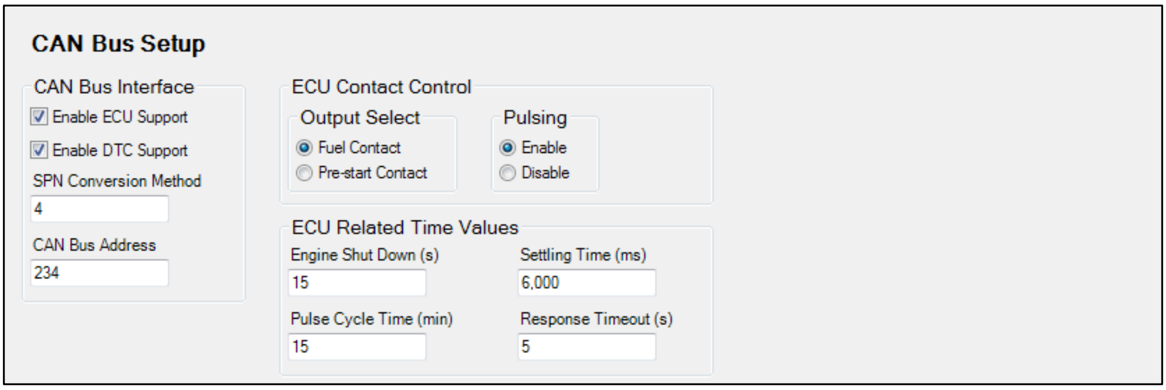

Figure 75. Settings Explorer, Communications, CAN Bus, CAN Bus Setup

ECU Setup

The following paragraphs describe the settings on the ECU Setup screen. This screen is found in the BESTCOMS*Plus Settings Explorer*, under the *Communications, CAN Bus* category. If using the front panel, navigate to Settings > Communications > CAN Bus Setup > ECU Setup. Refer to Figure 76.

ECU Type

The MGC-1550 can be configured for Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, MTU Smart Connect, Scania, or John Deere.

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Generator Parameter Transmit

When the Generator Parameter Transmit setting is enabled, the MGC-1550 broadcasts generator metered parameters over CAN as listed in Table 30. The Generator Parameter Transmit setting is not used when ECU Type is set for MTU MDEC, MTU ECU7/ECU8, or MTU Smart Connect.

Engine Parameter Transmit

When the Engine Parameter Transmit setting is enabled, the MGC-1550 broadcasts engine metered parameters over CAN. When the Engine Parameter Transmit setting is disabled, transmission of J1939 commands from the MGC-1550 to the engine are disabled, but commands from the engine to the MGC-1550 are allowed.

Table 30. Generator Parameter Transmit

PGN Name	PGN	Hex	SPN	Parameter	Bytes Within PGN Data
Generator Total AC Energy	65018	FDFA	2468	Generator Total kW Hours Export	1 to 4
			2469	Generator Total kW Hours Import	5 to 8
Generator Total AC Reactive Power	65028	FE04	2456	Generator Total Reactive Power	1 to 4
			2464	Generator Overall Power Factor	5 to 6
			2518	Generator Overall Power Factor Lagging	7, bits 1 & 2
Generator Total AC Power	65029	FE05	2452	Generator Total Real Power	1 to 4
			2460	Generator Total Apparent Power	5 to 8
Generator Average Basic AC Quantities	65030	FE06	2440	Generator Average L-L AC RMS Voltage	1 to 2
			2444	Generator Average L-N AC RMS Voltage	3 to 4
			2436	Generator Average AC Frequency	5 to 6
			2448	Generator Average AC RMS Current	7 to 8
Engine Temperature	65262	FEEE	110	Engine Coolant Temperature (Not sent when CAN is enabled.)	1
Engine Fluid Level/Pressure	65263	FEEF	100	Engine Oil Pressure (Not sent when CAN is enabled.	4
Dash Display	65276	FEFC	96	Fuel Level	2

Diesel Particulate Filter (DPF)

The diesel particulate filter settings are used when the ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect. The MGC-1550 supports the CAN parameters that are related to the diesel particulate filter implemented on certain engines to meet Tier 4 emission requirements.

Two parameters are provided to initiate or disable DPF regeneration. The first, *Manual Regeneration*, is transmitted to the engine via CAN to initiate DPF regeneration. The second, *Disable Regeneration*, is transmitted to the engine via CAN to disable DPF regeneration. Extended operation with regeneration disabled is not recommended.

Speed Setup

Speed control over J1939 and ECU7/ECU8 is implemented over CAN when the CAN bus RPM Request setting is enabled. This is implemented for all ECUs. The Engine RPM setting defines the nominal requested engine rpm. The Idle RPM setting is the requested rpm when the IDLE REQUEST logic element is true.

Volvo Penta

Configuring the MGC-1550 for Volvo Penta* necessitates the configuration of two additional settings: Speed Select and Accelerator Position. The Speed Select setting configures the Volvo Penta ECU to operate the engine at the primary or secondary base speed. If the engine is configured by Volvo for 60 Hz

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applications, the primary base speed is 1,800 rpm and the secondary base speed is 1,500 rpm. If the engine is configured by Volvo for 50 Hz applications, the primary base speed is 1,500 rpm and the secondary base speed is 1,800 rpm. The Accelerator Position setting is expressed as a percentage and tells the Volvo Penta ECU where to set the engine speed (trim) relative to the base speed. The range of the setting is the base speed ±120 rpm. A setting of 0% will cause the engine to run at 120 rpm below the base speed, a setting of 50% will cause the engine to run at the base speed, and a setting of 100% will cause the engine to run at 120 rpm above the base speed. The Accelerator Position setting is linear with a gain of 2.4 rpm/percentage. This setting is not saved in nonvolatile memory and defaults back to 50% after MGC-1550 operating power is cycled.

The MGC-1550 sends the following parameters to a Volvo Penta ECU through Volvo Proprietary J1939 communications:

- Start Request - sent when starting the engine.
- Stop Request - sent when shutting down the engine.
- Idle Request - sent when the Idle Request logic element is true in BESTlogic*Plus.*
- Preheat Request - sent anytime the MGC-1550 would normally have its PRE relay closed for engines requiring a preheat contact.
- Accelerator Pedal Position - sent based on the Accelerator Position setting. If the Accelerator Pedal Position setting is left at the default 50%, this is calculated and sent based on the programmable Engine RPM setting to achieve the desired engine RPM.
- Primary/Secondary Engine Speed - sent based on the Speed Select setting and the state of the Alternate Frequency Override element in BESTlogic*Plus*. Primary speed is sent when the Speed Select setting is set for Primary and Secondary speed is sent when the Speed Select setting is set for Secondary. However, these are reversed if the Alternate Frequency Override is true. A setting of Primary results in Secondary being sent and a setting of Secondary results in Primary being sent when the Alternate Frequency Override is true.

∗ The Volvo Penta ECU configuration is applicable only to the EDC3 and EMS2 models of Volvo Penta engine controllers.

Cummins

When Cummins is selected as the ECU type, the following parameters are sent to the engine via Cummins Proprietary J1939 communications:

- Start Request - sent when starting or running the engine.
- Stop Request - sent when stopping the engine.
- Idle Request - sent when the Idle Request logic element is true in BESTlogic*Plus.*
- Rated Speed (50 or 60 Hz) - sent based on the Rated Speed setting of the MGC-1550. However, these are reversed if the Alternate Frequency Override is true. A setting of 60 Hz Rated Speed results in 50 Hz being sent and a setting of 50 Hz Rated Speed results in 60 Hz being sent when the Alternate Frequency Override is true.

MTU

If the engine is configured as MTU MDEC, the configuration of the following settings is necessary:

- MDEC Module Type - Specifies the type of MDEC module.
- Speed Demand Switch - Specifies speed demand source for the MTU engine ECU.
- NMT Alive Transmit Rate - Specifies the rate at which messages are transmitted to the MTU engine.

If the engine is configured as MTU ADEC, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Governor Param Switch Over - Specifies which governor parameters an MTU ECU should use.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an MTU ECU engine to perform an internal lubrication cycle.

If the engine is configured as MTU ECU7/ECU8, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test - Temporarily drives an MTU ECU into overspeed for testing overspeed.

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- Speed Up - Increases speed of the MTU ECU.
- Speed Down - Decreases speed of the MTU ECU.
- Idle Request - Turns the idle request on or off.
- Increased Idle - Sets the MTU ECU idle.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an MTU ECU engine to perform an internal lubrication cycle.
- MTU 50 Hz 60 Hz Switch Setting - Set automatically based on rated frequency of the MGC-1550 and the state of the alternate frequency override.
- Engine Start Prime - Turns the engine start prime on or off.
- Fan Override - Turns the fan override on or off.
- Mode Switch - Turns the mode switch on or off.
- Governor Param Set Select - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2 - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2 - Turns the cylinder cutout disable 1 & 2 on or off.
- MTU ECU7/ECU8 Module Type - Specifies ECU7/ECU8 Module type.
- NMT Alive Transmit Rate - Specifies the rate at which messages are transmitted to the MTU engine.

If the engine is configured as MTU Smart Connect, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up - Increases speed of the MTU ECU.
- Speed Down - Decreases speed of the MTU ECU.
- Idle Request - Turns the idle request on or off.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an MTU ECU engine to perform an internal lubrication cycle.
- Governor Param Switch Over - Specifies which governor parameters an MTU ECU should use.
- Cylinder Cutout Disable 2 - Turns the cylinder cutout disable 2 on or off.
- Engine Operating Mode - Selects engine operating mode 1 or 2.

Scania

The majority of CAN Bus parameters are sent from Scania Engine ECUs via standard J1939 communications. However, some additional proprietary parameters are sent via Scania proprietary J1939 communications. Proprietary Start, Stop, and Emergency Stop commands are sent from the MGC-1550 to the Scania ECU. The ECU communicates Diesel Exhaust Fluid (DEF) Levels, as well as DEF Fluid Low, DEF Low Severe, DEF Inducement, and DEF Severe Inducement Pre-Alarms to the MGC-1550 through Proprietary Scania parameters. Additional information on DEF related parameters can be found in the *Exhaust Treatment* chapter.

John Deere

The Regeneration Interlock setting enables John Deere proprietary parameters to be broadcast over the J1939 CAN Bus.

The Regeneration Interlock parameter is sent via the Stationary Regeneration/Cleaning CAN Lockout Message PGN, which is PGN 61194. When the DGC Regeneration Interlock value is set to Enabled, the MGC-1550 sends a value of 01 (binary) for the two bit “Allowed” configuration which allows regeneration to occur. When the MGC-1550 Regeneration Interlock value is set to Disabled, the MGC-1550 sends a value of 00 (binary) for the two bit “Not Allowed” configuration which inhibits regeneration.

The MGC-1550 sends starter engagement requests to the ECU via the SAE J1939 Engine Start Control PGN. When the MGC-1550 requests the starter to be engaged it sends a value of 01 (binary) for the two bit starter engagement parameter. Otherwise the MGC-1550 sends a value of 00 (binary) for the two bit starter engagement parameter.

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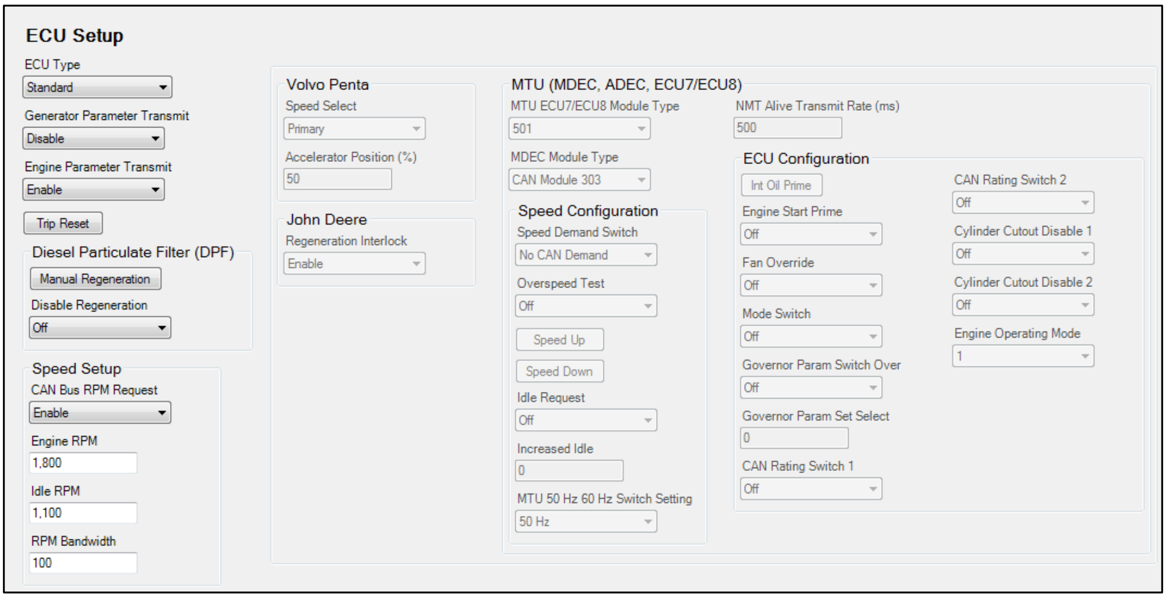

Figure 76. Settings Explorer, CAN Bus, ECU Setup

Modbus Communication

MGC-1550 controllers can be monitored and controlled via a polled network using the Modbus protocol. Adjustable RS-485 port settings include the baud rate, parity, and Modbus address. Fixed RS-485 port settings include the number of data bits (8) and stop bits (1).

Modbus register values for the MGC-1550 are listed and defined in the *Modbus Communication* chapter.

The BESTCOMS*Plus* RS485 Setup screen is illustrated in Figure 77.

Figure 77. Settings Explorer, Communications, RS485 Setup

Offline Access to RS485 Setup Screen

Upon establishing a connection with an MGC-1550 via BESTCOMS*Plus*, the normally hidden *RS485 Setup* screen is revealed. When changing settings offline, a special key sequence must be entered in order to reveal the *RS485 Setup* screen. To achieve this, perform the following steps:

1. Open the BESTCOMS*Plus, Settings Explorer, General Settings, Style Number* screen. Be sure to make the screen active by clicking somewhere inside it.
2. Press and hold the *Shift* key.
3. Press the following sequence of keys "+MTU+" (do not include the quotation marks).
4. Release the *Shift* key.
5. Press *Enter*.

If done successfully, the *Customer Code* setting appears on the *Style Number* screen. Selecting option *002* reveals the *RS485 Setup* screen. Figure 78 shows the *Style Number* screen before and after entering the key sequence.

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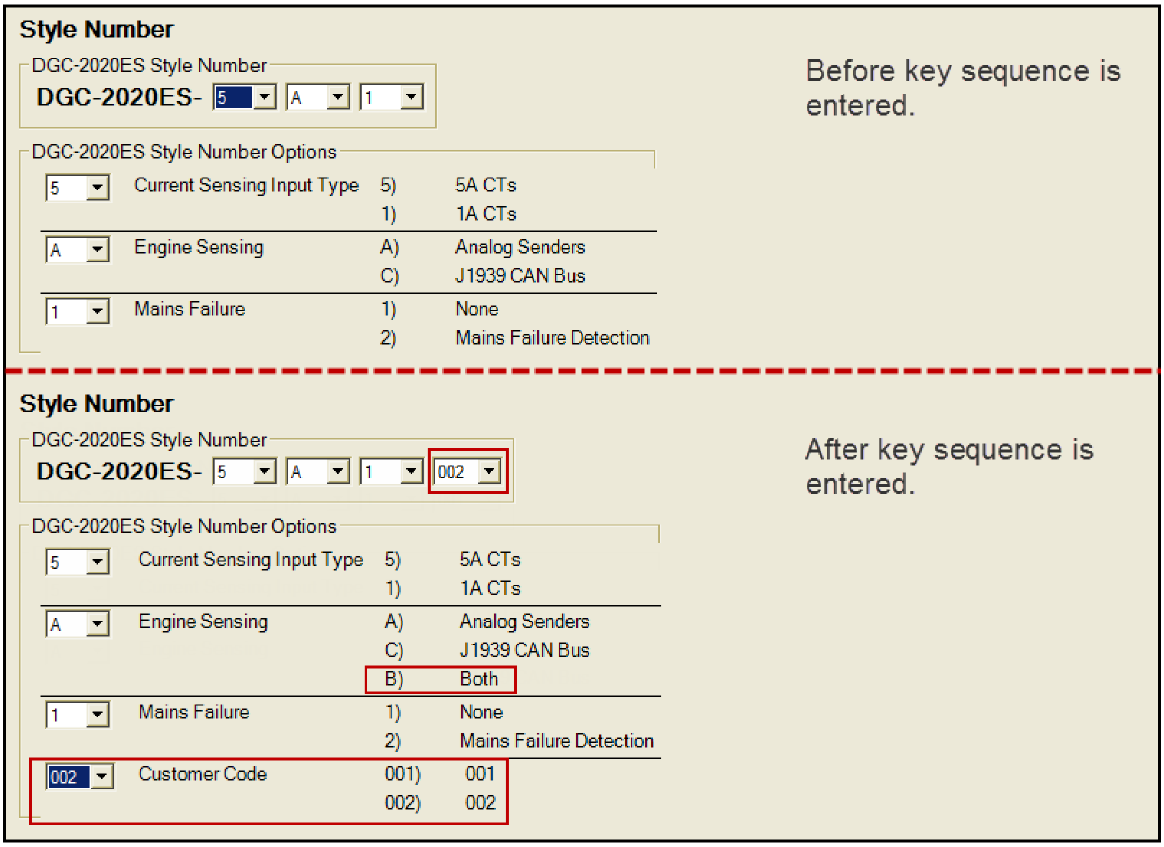

Figure 78. Settings Explorer, General Settings, Style Number

Remote Display Panel (optional)

Applications that require remote annunciation can use Basler Electric’s Remote Display Panel. This device provides remote indication of many pre-alarm and alarm conditions.

Remote Display Panel connections are made at 10 (RDP TxD–), 11 (RDP TxD+), 17 (BATT–), and 18 (BATT+).

The following pre-alarm conditions are indicated by LEDs on the Remote Display Panel:

- High coolant temperature
- Low coolant temperature
- Low oil pressure
- Low fuel level∗
- Weak battery
- Battery overvoltage†
- Battery charger failure∗†

The following alarm conditions are indicated by LEDs and an audible alarm on the Remote Display Panel:

- Low coolant level∗
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop activated
- Fuel leak/Sender failure∗†
- Sender failure†

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⁎ This can be configured in the MGC-1550 as *None*, *Alarm*, or *Pre-alarm*. See the *Contact Inputs* chapter for more information. The LED on the Remote Display Panel illuminates when the input that is assigned to the programmable function is closed, whether the function is configured as *None*, *Alarm*, or *Pre-alarm*.

† This LED can be reprogrammed in the MGC-1550 to suit the needs of a particular application. The condition listed above is annunciated by default.

Additionally, the Remote Display Panel indicates when the MGC-1550 is not operating in Auto mode and when the generator is supplying load or when the MGC-1550 is in an alarm state not listed above.

Refer to Basler Publication 9318100990 for more information on the Remote Display Panel.

See the *Terminals and Connectors* chapter for more information on connecting the Remote Display Panel to the MGC-1550.

Note
The RS-485 port may be used for either Modbus communication or communication with an RDP-110, but not simultaneously.

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Configuration

System parameters configure the MGC-1550 for operation with a specific application. This chapter lists items to consider when configuring the MGC-1550. These items consist of style number, system settings and rated data, remote module setup, crank settings, automatic restart settings, exercise timer settings, sensing transformer ratings, relay control settings, and system configuration detection settings.

Style Number

The model number, together with the style number, describes the options included in a specific device. The style number of the MGC-1550 is displayed on the BESTCOMS*Plus*® Style Number screen after downloading settings from the device. When configuring MGC-1550 settings offline, the style number for the unit to be configured can be entered into BESTCOMS*Plus* to enable configuration of the required settings. The BESTCOMS*Plus* Style Number screen is illustrated in Figure 79.

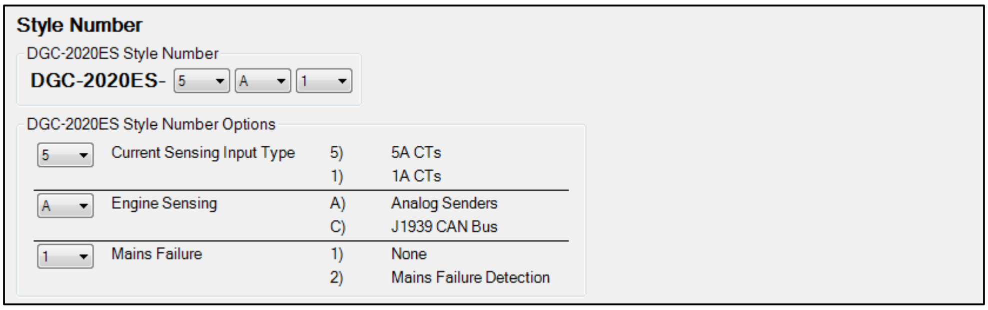

Figure 79. Settings Explorer, General Settings, Style Number

When changing settings offline, a special key sequence must be entered in order to reveal the extra features of the Enhanced MGC-1550. To achieve this, perform the following steps:

1. Open the BESTCOMS*Plus, Settings Explorer, General Settings, Style Number* screen. Be sure to make the screen active by clicking somewhere inside it.
2. Press and hold the *Shift* key.
3. Press the following sequence of keys "+MTU+" (do not include the quotation marks).
4. Release the *Shift* key.
5. Press *Enter*.

If done successfully, the *Customer Code* setting appears on the *Style Number* screen. Selecting option *002* reveals Engine Sensing style option B and the *RS485 Setup* screen. Figure 80 shows the *Style Number* screen after entering the key sequence.

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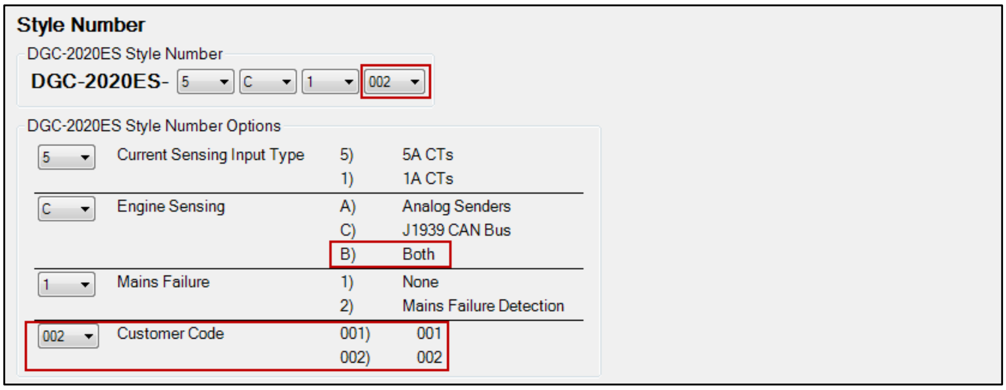

Figure 80. Settings Explorer, General Settings, Style Number (Extra Options)

System Settings

The System Settings parameters consist of number of fly wheel teeth, speed signal source, power-up delay, fuel level function, NFPA compliance level, EPS supplying load, system units, and metric pressure units. The System Settings screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > System Settings.

Number Flywheel Teeth

The Number Fly Wheel Teeth setting accepts a value from 1 to 500, in increments of 0.1. This value is used when calculating engine rpm.

Speed Signal Source

The MGC-1550 can be configured to detect engine speed from a magnetic pickup (MPU), the genset frequency, or both the MPU and genset frequency. On engines with CAN ECUs, if MPU or MPU Freq is selected as the Speed Signal Source, the MGC-1550 uses CAN as the speed source when CAN is enabled. If Gen Freq is set as the Speed Signal Source, the MGC-1550 uses the generator frequency.

When engine speed is obtained from the genset frequency, the MGC-1550 uses the rated (nominal) genset frequency and nominal rpm rating when calculating engine rpm.

When engine speed is obtained from an MPU, the MGC-1550 uses the nominal rpm rating and the number of flywheel teeth when calculating engine rpm.

The speed signal from the MPU takes priority when both the genset frequency and MPU are selected as the engine speed source. If both MPU and genset frequency are selected and the MPU fails, the MGC-1550 automatically switches to the genset frequency as the engine speed source.

Power Up Delay

In some cases, the ECU takes longer than the MGC-1550 to power up. The power up delay setting is used to delay the initial pulsing of the ECU for data on MGC-1550 power up. This setting ranges from 0 to 60 seconds in 1 second increments.

Fuel Level Function

This setting determines whether the fuel level indications and the related alarm and pre-alarm are enabled or disabled. Setting selections include, Fuel Lvl (Fuel Level), Natural Gas, Liquid Propane, or

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Disabled. Selecting a fuel type other than Fuel Lvl disables any fuel level indication, alarm, or pre-alarm. This includes the Fuel Level value on the *Metering Explorer, Engine* screen in BESTCOMS*Plus*.

NFPA Compliance Level

The MGC-1550 can be used in an application requiring compliance with NFPA Standard 110. Levels 1 and 2 of Standard 110 are supported. Selecting level 1 or 2 affects MGC-1550 operation in the following ways:

- The number of crank cycles is fixed at 3
- Crank cycle time is fixed at 15 seconds
- Continuous crank time is fixed at 45 seconds
- The low coolant temperature pre-alarm setting is fixed at 70°F

EPS Supplying Load

EPS Supplying Load settings consist of Low Line Scale Factor and EPS Threshold. These settings are described in the following paragraphs.

Low Line Scale Factor

Low Line Scale Factor automatically adjusts the EPS threshold setting in applications utilizing more than one type of genset connection. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate scaling of the settings. The value of the scale factor setting serves as a multiplier for the threshold setting. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the threshold setting is doubled (2.000 x Threshold setting).

EPS Threshold

Indication that the emergency power system is supplying load is determined by a user-adjustable threshold setting. This setting is expressed as a percentage of the genset CT (nominal) primary rating.

This setting accepts values from 3 to 10, in increments of 1%.

System Units

Engine oil pressure and coolant temperature can be displayed in English or metric units of measure.

Metric Pressure Units

This setting allows engine oil pressure to be displayed in bar or kPa/MPa.

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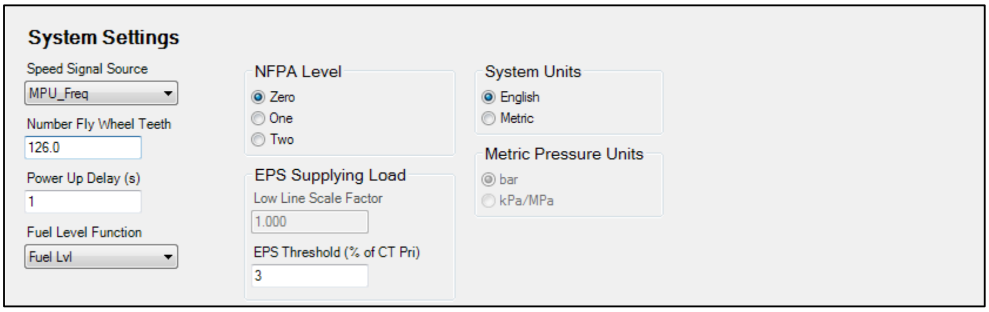

Figure 81. Settings Explorer, System Parameters, System Settings Screen

Rated Data

Rated Data parameters consist of sensing transformer ratings, voltage, power factor, kW, engine RPM, frequency, battery volts, generator and bus connection types, and phase rotation. The Rated Data screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > System Settings.

Click the Edit button on the BESTCOMS*Plus* Rated Data settings screen to adjust values. Click OK to accept the changes, and Cancel to discard them.

Sensing Transformers

For information on sensing transformers settings, see *Sensing Transformers*, below.

Rated Data

Genset nameplate data used by the MGC-1550 includes the rated voltage, power factor, kW, and engine RPM.

Rated Volts (V L-L)

This setting accepts values from 1 to 99,999, in increments of 1.

Rated Power Factor (PF)

This setting accepts values from -1 to 1, in increments of 0.001.

Genset kW Rating

This setting accepts values from 5 to 9,999, in increments of 1.

Rated Engine RPM

This setting accepts values from 750 to 3,600, in increments of 1.

Calculated Rated Data

Rated Secondary Volts, Rated Phase Amps, Rated Secondary Phase Amps, Rated kVA, and Rated kvar are calculated automatically. The equations used for these calculations are listed below.

$$\text{Rated Secondary Volts} = \text{Rated Volts}\left(\frac{\text{Gen PT Secondary Volts}}{\text{Gen PT Primary Volts}}\right)$$

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Error! Bookmark not defined. $\text{Rated Phase Amps}(3-\text{phase machine}) = \dfrac{\text{Rated kVA}}{\text{Rated L}-\text{L Volts}\sqrt{3}}$

$$\text{Rated Phase Amps}(1-\text{phase machine}) = \frac{\text{Rated kVA}}{\text{Rated L}-\text{L Volts}}$$

$$\text{Rated Secondary Phase Amps} = \text{Rated Phase Amps}\left(\frac{\text{CT Secondary Amps}}{\text{CT Primary Amps}}\right)$$

$$\text{Rated kVA} = \frac{\text{Rated kW}}{\text{Rated PF}}$$

$$\text{Rated kvar} = \text{Rated kVA}\sqrt{1-\text{Rated PF}^2}$$

Frequency

The frequency settings allow selection of the rated frequency of the generator and an alternate frequency.

Rated Frequency of the Unit

Rated frequency settings consist of 50 and 60 Hz.

Alternate Frequency

This setting accepts values from 10 to 450, in increments of 0.01.

Battery Volts

The nominal voltage of the starter battery is used by the MGC-1550 to detect and annunciate battery overvoltage and low or weak battery voltage. The Battery Volts settings consist of 12 V and 24 V.

Generator Connection

Genset connection types accommodated by the MGC-1550 include three, three-phase connections (delta, wye, and grounded delta) and a single-phase configuration (sensing across phases A and B.)

Bus Connection

Bus connection types consist of single- and three-phase. Single-phase bus voltage is sensed across phases A and B.

Phase Rotation

The Phase Rotation setting allows selection of ABC or CBA rotation according to the phase rotation connection of the machine. The MGC-1550 calculates the power angle as the angle between the Phase AB voltage and phase B current. An angle compensation factor, determined by the phase rotation setting, is then applied. If the actual phase rotation connection of the machine does not match the phase rotation setting, calculation of the power angle will be incorrect, which may result in a miscalculation of kW, kvar, and power factor.

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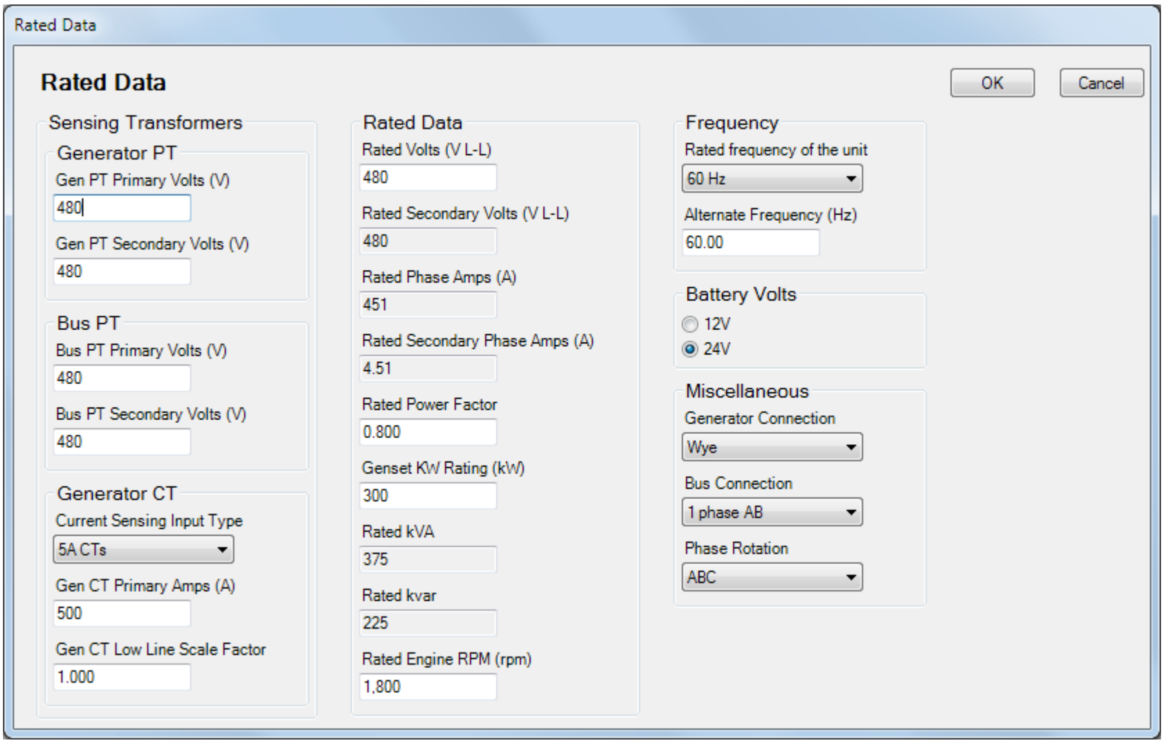

Figure 82. Settings Explorer, System Parameters, Rated Data Screen

Remote Module Setup

When the optional CEM-2020 is enabled, a J1939 address must be entered. Select the appropriate number of outputs available on the CEM-2020. The CEM-2020 provides 24 contact outputs.

The Remote Module Setup screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Remote Module Setup.

The BESTCOMS*Plus* Remote Module Setup screen is illustrated in Figure 83.

Figure 83. Settings Explorer, System Parameters, Remote Module Setup Screen

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Crank Settings

The Crank Settings consist of pre-start, restart, cranking, crank disconnect, and cooldown. These settings are described in the paragraphs below.

The Crank Settings screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Crank Settings.

The BESTCOMS*Plus* Crank Settings screen is illustrated in Figure 84.

Pre-Start

If desired, cycle or continuous cranking can be delayed after initiating engine startup. During this delay, the Pre-Start output closes to energize glow plugs or pre-start the lubrication pump. The Pre-crank Delay setting accepts values from 0 to 30, in increments of 1 second.

The Pre-Start output can be configured to open upon the conclusion of engine cranking or remain closed as long as the engine is running.

The Pre-Start output can be configured during the resting state. If Preheat Before Crank is selected, the Pre-Start output is closed for the duration of the Pre-crank Delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the Pre-Start output is closed for the entire duration of the rest time.

Restart

Attempting to start an engine after a normal shutdown but before the engine RPM has settled to zero can stress an engine in certain situations. The Restart Delay inhibits attempts to start the engine immediately after a normal shutdown for the duration of the Restart Delay timer. This delay should allow an engine to properly spin down before attempting to restart. This setting accepts values from 0 to 120, in increments of 1 second.

Cranking

The MGC-1550 can be programmed for either cycle or continuous cranking.

Cycle cranking provides multiple engine starting attempts. Each starting attempt consists of a fixed interval of engine cranking followed by a rest interval. The Number of Crank Cycles setting accepts values from 1 to 7, in increments of 1. The Cycle Crank Time setting accepts values from 5 to 15, in increments of 1 second.

Continuous cranking provides a single, extended engine-starting attempt. The Continuous Crank Time setting accepts values from 5 to 60, in increments of 1 second.

Crank Disconnect

Under normal operation, engine rpm is used to determine crank disconnect. The Crank Disconnect Limit setting establishes the engine rpm percentage at which the starter is disconnected. This setting accepts values from 10 to 100, in increments of 1 percent.

The Oil Pressure Crank Disconnect provides a secondary indication that the engine is running. This ensures that the starter is disconnected, even if no engine rpm sources are functioning. When enabled, oil pressure is used to determine if the engine is running. If the engine oil pressure is above the threshold, the starter is disconnected from the engine. The Crank Disconnect Pressure threshold setting accepts values from 2.9 to 150 psi, 0.2 to 10.3 bar, and 20 to 1,034.5 kPa, in increments of 0.1.

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Cool Down

After the load is removed from a genset, the MGC-1550 implements a smart cooldown function. This function ensures that the engine and turbocharger properly cool down by maintaining engine operation for a user-defined duration. The No Load Cool Down Time setting accepts values from 0 to 60, in increments of 1 minute.

This cooldown function is initiated for any one of the following conditions:

- Genset load is removed and engine shutdown is permitted while in AUTO mode
- Auto Transfer switch (ATS) opens while operating in AUTO mode
- Remote shutdown is initiated while in AUTO mode
- Off Mode Cooldown is initiated
- The Cooldown Request logic element is initiated
- The Cool and Stop Request logic element is initiated

Smart Cooldown Function

The smart cooldown function reduces unnecessary fuel expenditure by considering overall cooldown time through multiple requests. For example, a new cooldown request is initiated after a previous cooldown sequence has already started. The cooldown timer is not simply reset with each new request. Instead, the amount of time that the engine has spent cooling down is factored into the new request. This saves time and fuel by running the engine no longer than necessary to achieve proper cooldown.

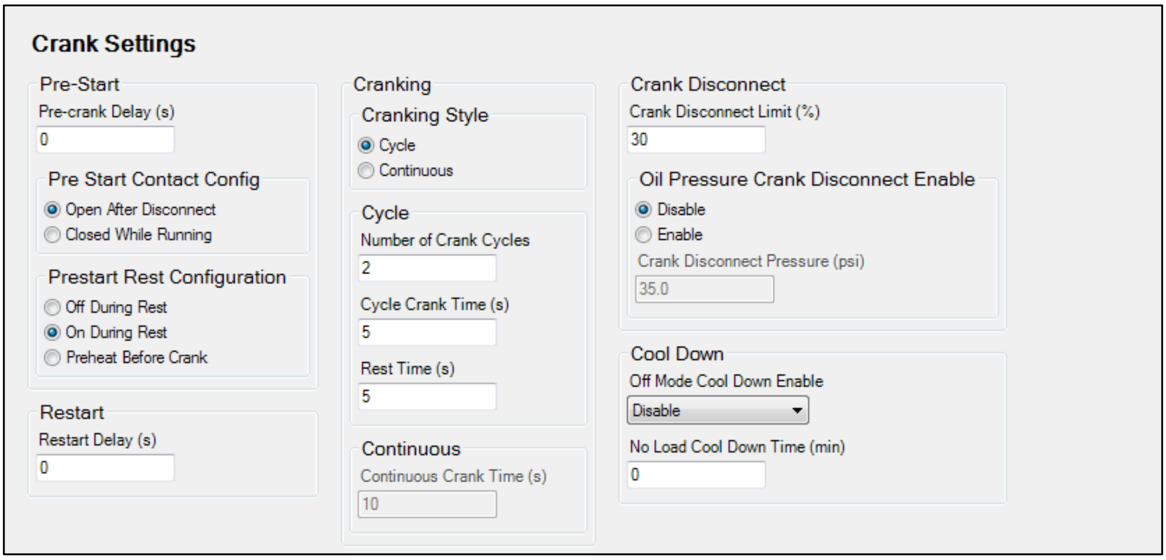

Figure 84. Settings Explorer, System Parameters, Crank Settings Screen

Automatic Restart

When enabled, the Automatic Restart clears all alarms automatically if the MGC-1550 shuts down due to an alarm condition. An attempt to restart the engine is made, after a predetermined time delay, if the ATS contact input is closed. If an ATS contact is not present, the unit remains in the READY state with alarms cleared. A restart is not attempted if a low fuel alarm or emergency stop is present. The number of restart attempts is programmable. Automatic restart attempts are recorded in the event log.

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The Auto Restart Interval setting accepts values from 0.5 to 30, in increments of 0.5 minutes. The Auto Restart Attempts setting accepts values from 1 to 10, in increments of 1.

The Automatic Restart screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Automatic Restart.

The BESTCOMS*Plus* Automatic Restart screen is illustrated in Figure 85.

Figure 85. Settings Explorer, System Parameters, Automatic Restart Screen

Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for a user-defined period. The mode defines how often the genset will run. If monthly is selected, the day of the month to start must also be selected. If weekly is selected, the day of the week to start must also be selected. Settings for Start Hour and Start Minute can also be defined. The Run Period Hours and Minutes define how long the genset will run each session. The Start Hour and Run Period Hours settings accept values from 0 to 23, in increments of 1 hour. The Start Minute and Run Period Minutes settings accept values from 0 to 59, in increments of 1. If Run with Load is enabled, the MGC-1550 closes the generator breaker during the run time.

Contact inputs and outputs can be assigned to this function. Refer to the *BESTlogicPlus* chapter for more information.

The Exercise Timer screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Exercise Timer.

The BESTCOMS*Plus* Exercise Timer screen is illustrated in Figure 86.

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Figure 86. Settings Explorer, System Parameters, Exercise Timer Screen

Sensing Transformers

Three sets of transformer settings configure the MGC-1550 for operation with a specific system. These settings, along with the generator voltage, generator current, and bus voltage detected by the MGC-1550, enable it to accurately meter system values and offer generator protection.

The Sensing Transformers screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Sensing Transformers.

When adjusting these settings using BESTCOMS*Plus*, click the *Rated Data* button. See *Rated Data,* above, for more information.

Generator PT

The generator PT settings establish the nominal primary (generator side) and secondary (MGC-1550 side) voltage levels at the generator voltage-sensing transformer. The Generator PT Primary setting accepts values from 1 to 99,999, in increments of 1. The Generator PT Secondary setting accepts values from 1 to 480, in increments of 1.

Bus PT

Primary and secondary bus transformer ratings are used by the optional automatic transfer switch function. This function monitors a three-phase bus input to detect mains failure. The primary setting establishes the nominal voltage present at phases A, B, and, C of the bus. This setting accepts values from 1 to 99,999, in increments of 1. The secondary setting establishes the nominal voltage detected at the bus voltage input of the MGC-1550. This setting accepts values from 1 to 480, in increments of 1.

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Generator CT

The generator CT setting establishes the nominal, primary (generator side) current level at the generator current sensing transformer. This setting accepts values from 1 to 9,999, in increments of 1. The secondary value of the generator CT is dictated by the style number of the controller. An MGC-1550 with a style number of 1xx uses a nominal CT secondary rating of 1 Aac. An MGC-1550 with a style number of 5xx uses a nominal CT secondary rating of 5 Aac.

The Gen CT Low Line Scale Factor setting is used to automatically adjust the Gen CT Primary Amps setting in applications that may utilize more than one type of genset connection. This setting accepts a value from 0.001 to 3, in increments of 0.001. The scale factor setting is implemented when the MGC-1550 senses a contact closure at a contact input programmed to activate scaling of the settings. The value of the scale factor setting serves as a multiplier for the Gen CT Primary Amps setting. For example, if a scale factor contact input is received by the MGC-1550 and the scale factor setting is 2.000, the Gen CT Primary Amps setting is doubled (2.000 x Gen CT Primary Amps).

Relay Control

The default operational setting for the Start, Run, and Pre-start relays is *Predefined* or standard. Any of these relays can be logic driven by selecting the *Programmable* setting. Logic driven (programmable relays must be set up using BESTlogic*Plus*.

The Relay Control screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Relay Control.

The BESTCOMS*Plus* Relay Control screen is illustrated in Figure 87.

Figure 87. Settings Explorer, System Parameters, Relay Control Screen

System Configuration Detection

When enabled, this feature allows the MGC-1550 to automatically detect its sensing configuration in relation to the generator. Upon starting the genset, the configuration of the generator is automatically detected. The Single Phase Override and Low Line Override programmable function settings are then adjusted accordingly.

There is a one-second delay in the detection to prevent the MGC-1550 from alternating between detected configurations. When the MGC-1550 is in the *Off* mode or the engine is not running, the Automatic Configuration Detection function is disabled. The MGC-1550 is assumed to be in the last valid automatically detected configuration.

It is recommended that the Single Phase Override and Low Line Override programmable functions are not assigned to contact inputs when Automatic Configuration Detection is enabled.

Single Phase Detect Threshold

If the difference between the maximum and minimum line-to-line voltage exceeds this threshold, the unit is determined to be in single-phase configuration. If determined to be in single-phase configuration, the Single Phase Override programmable function forces the MGC-1550 into single-phase mode. The single-phase mode connection is determined by the *Single Phase Detect Generator Connection*, below.

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If the Single Phase Override function is assigned to a contact output, the state of the contact output and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for single phase.

Low Line Detect Threshold

If the average of the valid line-to-line voltages for the detected configuration is above this threshold, the unit is determined to be in a high-line configuration. If the average is below this threshold, it is determined to be in a low-line configuration. If determined to be in low-line configuration, the Low-Line Override function forces the MGC-1550 into the low-line configuration.

If the Low-Line Override function is assigned to a contact output, the state of the contact output and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line.

Single Phase Detect Generator Connection

This setting specifies which single-phase connection to use when the system is determined to be single-phase. Single-phase AB or Single-phase AC can be selected.

The *Auto Config Detection* screen is found in the BESTCOMS*Plus* Settings Explorer under the System Parameters category. If using the front panel, navigate to Settings > System Parameters > Auto Config Detect. The BESTCOMS*Plus* Auto Config Detection screen is illustrated in Figure 88.

Figure 88. Settings Explorer, System Parameters, Auto Config Detection Screen

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Security

Password protection guards against unauthorized changing of MGC-1550 settings. Three levels of password protection are available. Each level is described in the following paragraphs.

- *OEM Access.* This password level allows access to all settings. The default, OEM-access password is **OEM**.
- *Settings Access.* This password level allows all except uploading of firmware and clearing of device event log. The default, settings-access password is **SET**.
- *Operator Access.* The default, operator-access password is **OP**. This password level allows all settings to be read and allows changes to be made to the following:
    - LCD Contrast
    - Sleep Mode
    - Date/Time
    - All Sender Fail Time Delays
    - Metric Conversion
    - Low Fuel Pre-Alarm Level
    - Low Fuel Alarm Level
    - Pre-Start Contact after Cranking
    - Cooldown Time
    - Pre-Crank Time Delay
    - Reset of Maintenance Interval
    - All controls on the Control screen available via the Metering Explorer in BESTCOMS*Plus*®

Changing Passwords

Passwords can be changed only after communication between the PC and MGC-1550 is established. Changes to passwords are made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMS*Plus* to open the *General Settings, Device Security Setup* screen.

The content of the *Device Security Setup* screen depends on the password level used when accessing the screen. For example, someone logged in with a settings-access password will be able to change only the settings-access and operator-access passwords - not the OEM-access password.

The BESTCOMS*Plus* Device Security Setup screen is illustrated in Figure 89. All three access levels are shown.

A password is changed by clicking on the access level, entering the new password, and then clicking on the *Save Password* button. MGC-1550 passwords are case sensitive.

Saving Passwords in an MGC-1550 Settings File

The passwords can be modified while BESTCOMS*Plus* is connected to an MGC-1550. The settings from the BESTCOMS*Plus* session can then be saved into a settings file. The settings file will contain the new passwords. Also, the passwords in a settings file can be modified off line, saved with the file, and then later loaded into an MGC-1550.

Saving Passwords to a Settings File when On Line.

The following procedure describes how to save passwords to a settings file when BESTCOMS*Plus* is connected to an MGC-1550 (on line):

1. When connected to an MGC-1550 with BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
2. You will be prompted to enter a password.

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3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMS*Plus* will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the “Password” setting that became active when the password to modify was clicked.
5. Click the “Save” button to save the new password into BESTCOMS*Plus* memory (it’s not in the MGC-1550 yet).
6. Repeat steps 4 and 5 for all password levels you with to modify.
7. Once all password modifications are complete, in the main menu of BESTCOMS*Plus*, select *Upload Security* from the *Communications* pull-down menu. This is the step where passwords are sent to the MGC-1550. Failure to perform this step might cause all password modifications to be lost.
8. Close the *Device Security* tab in BESTCOMS*Plus*.
9. Re-open the *Device Security* tab in BESTCOMS*Plus*. This will read the passwords back out of the MGC-1550.
10. Verify the passwords obtained from the MGC-1550 are correct.
11. Once all desired settings have been loaded into the MGC-1550, save the settings file. The resulting settings file has the passwords saved as part of the saved settings.
12. At this point, the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

Saving Passwords to a Settings File when Off Line

The following procedure describes how to save passwords to a settings file when working off line:

1. When the settings file is open in BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
2. You will be prompted to enter a password.
3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMS*Plus* will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the “Password” setting that became active when the password to modify was clicked.
5. Click the “Save” button to save the new password into BESTCOMS*Plus* memory.
6. Repeat steps 4 and 5 for all password levels you wish to modify.
7. Close the *Device Security* tab in BESTCOMS*Plus*.
8. Save the settings file.
9. Close the settings file by clicking on the X in the upper right-hand corner of the settings file, or close BESTCOMS*Plus*.
10. Restart BESTCOMS*Plus* if you have shut it down.
11. Re-open the settings file that you have saved with the password information.
12. When the settings file is open in BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
13. You will be prompted to enter a password.
14. Enter the password for the highest level of password modified; it should be the new modified password.
15. When passwords are shown, verify they are correct.

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16. At this point the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

Loading Passwords from a Settings File into the MGC-1550

1. Connect to the MGC-1550 with BESTCOMS*Plus*.
2. Once connected, click the “Open File” button that is used to load a settings file into the MGC-1550.
3. You will be prompted asking if you wish to load settings and logic into the MGC-1550. Select *Yes* if you need to upload settings logic. Select *No* if all you need to do is update security. If you select *No*, the settings file opens into BESTCOMS*Plus* memory.
4. Whether you have loaded settings and logic to the MGC-1550 or not, the next step is to select *Upload Security* from the *Communications* pull-down menu.
5. DO NOT try to view the passwords before performing step 4. This would download the existing passwords from the MGC-1550 and they will overwrite the new passwords that were loaded into BESTCOMS*Plus* memory from opening the settings file.
6. If you are prompted for a password, enter a password of a level equal to that of the highest level password you wish to modify.
7. The passwords are uploaded to the MGC-1550.
8. After you have uploaded the new passwords, select GENERAL SETTINGS > DEVICE SECURITY SETUP in the settings explorer of BESTCOMS*Plus.* Verify the passwords are correct.
9. This concludes loading passwords from a settings file into the MGC-1550.

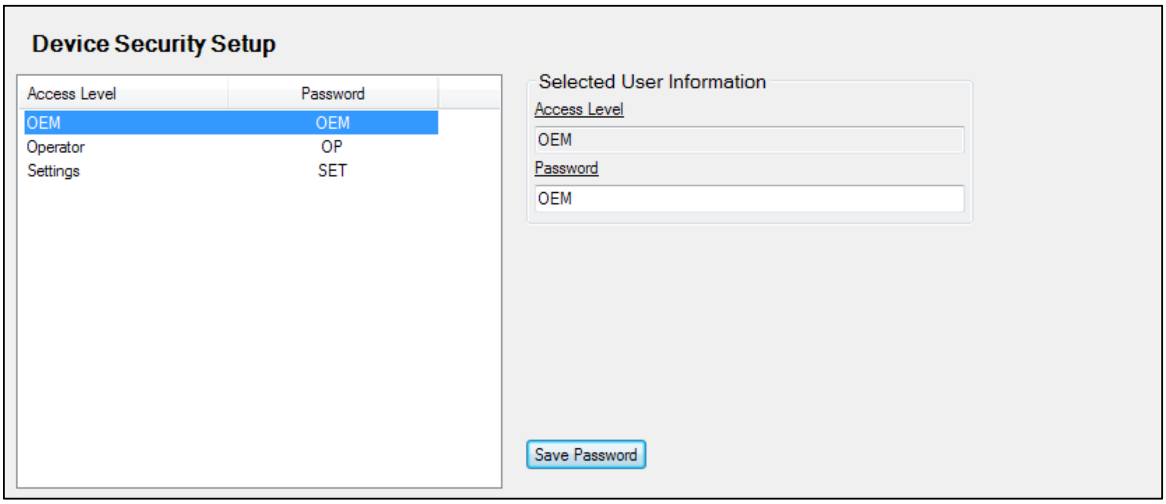

Figure 89. Settings Explorer, General Settings, Device Security Setup Screen

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Timekeeping

The MGC-1550 provides a real-time clock with capacitor backup that is capable of operating the clock for up to 24 hours after power is removed from the controller. As the capacitor nears depletion, an internal backup battery takes over and maintains timekeeping. The battery will maintain the clock for approximately ten years depending on conditions. The battery is not replaceable.

The clock is used by the events recorder function to time-stamp events and the exercise timer to start and stop the genset when the exercise feature is utilized.

Clock Setup

Clock settings are made through the communication ports using BESTCOMS*Plus*® or through the front-panel interface. Write access to ports is required to program the clock. An alarm is provided to detect when the MGC-1550 has powered up and the clock has not been set.

The clock settings are made through BESTCOMS*Plus* by selecting *Clock Setup* under *General Settings.* If using the front panel, navigate to Settings > General Settings > Configure Date/Time.

The BESTCOMS*Plus Clock Setup* screen is illustrated in Figure 90. Settings are listed in Table 31.

The local time zone is configured on this screen. The Time Zone Offset is the local offset to UTC (Coordinated Universal Time). The Time Zone Offset is required when the Start/End Time Reference is set to UTC (Coordinated Universal Time). The Start/End Time Reference is set to UTC time if required by local daylight savings time rules. The Start/End Hour/Minute settings determine the time when the DST will go into effect. The Bias setting is the amount of time that the clock moves forward or backward. The user is notified when the clock is not set when the Clock Not Set Warning is enabled.

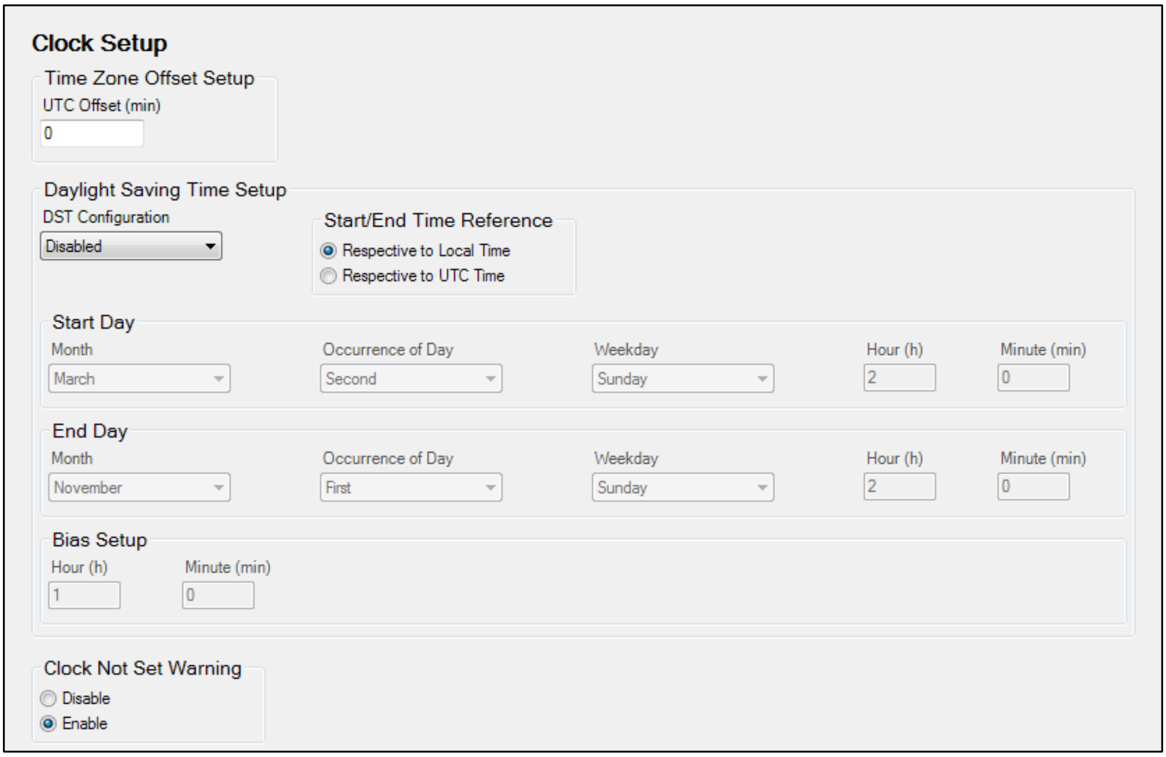

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Figure 90. Settings Explorer, General Settings, Clock Setup Screen

Table 31. Settings for Clock

Setting	Range	Increment	Unit	Default
UTC Offset	–1,440 to 1,440	1	minutes	–6
DST Configuration	Floating Dates or Fixed Dates	n/a	n/a	Disabled
Start/End Time Reference	Respective to Local Time or Respective to UTC Time	n/a	n/a	Respective to Local Time
Bias Setup (Hour)	–12 to 12	1	hours	Disabled
Bias Setup (Minute)	–59 to 59	1	minutes	0
Clock Not Set Warning	Disable or Enable	n/a	n/a	Disable

Setting the Time and Date

Time and date settings are made through BESTCOMS*Plus* on the Real Time Clock screen (Figure 91) of the Metering Explorer. Settings can also be made through the front panel.

Figure 91. Metering Explorer, Real Time Clock Screen

Real-Time Clock Specifications

Resolution .... 1 s
Accuracy.. ±1.73 s/d at 25°C

Clock Holdup

Capacitor Holdup Time .... Up to 24 hours depending on conditions
Battery Holdup Time .... Approximately ten years depending on conditions

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Maintenance and Troubleshooting

Maintenance

Preventive maintenance consists of periodically checking that the connections between the MGC-1550 and the system are clean and tight. Periodically check that the mounting hardware is clean and fastened with the proper amount of torque. MGC-1550 units are manufactured using state-of-the-art, surface-mount technology. These components are encased in potting material. As such, MTU Onsite Energy recommends that no repair procedures be attempted by anyone other than MTU Onsite Energy personnel.

Storage

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

Troubleshooting

If you do not get the results that you expect from the MGC-1550, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

Communications

USB Port Does Not Operate Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to the *Communication* chapter.

CAN Communication Does Not Operate Properly

Step 1: Verify that there is a 120-ohm termination resistor on each end of the bus section of the wiring, and that there are not any termination resistors at any node connections that are on stubs from the main bus.

Step 2: Check all CAN wiring for loose connections and verify that the CAN H and CAN L wires have not gotten switched somewhere on the network.

Step 3: Verify that the cable length of the bus section of the wiring does not exceed 40 meters (131 feet), and verify that any stubs from the main bus do not exceed 3 meters (9.8 feet) in length.

Step 4: If the engine is equipped with a Volvo or MTU ECU, verify that the ECU Configuration setting is set to match the actual ECU configuration.

Inputs and Outputs

Programmable Inputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Confirm that the inputs are programmed properly.

Step 3. Ensure that the input at the MGC-1550 is actually connected to the BATT– terminal (17).

Programmable Outputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Confirm that the outputs are programmed properly.

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Metering/Display

Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Confirm that the SENDER COM terminal (2) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.

Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (18) and the SENDER COM terminal (2).

Step 4. Verify that the correct senders are being used.

Step 5. Use a voltmeter connected between the BATT– terminal (17) and the SENDER COM terminal (2) on the MGC-1550 to verify that there is no voltage difference at any time. Any voltage differences may manifest themselves as erratic sender readings. Wiring should be corrected so that no differences exist.

Step 6: Check the sender wiring and isolate sender wiring from any of the ac wiring in the system. The sender wiring should be located away from any power ac wiring from the generator and any ignition wiring. Separate conduits should be used for sender wiring and any ac wiring.

Incorrect Display of Generator Voltage

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Ensure that the proper voltage is present at the MGC-1550 voltage sensing inputs (40, 41, 43, and 45).

Step 3. Verify that the voltage transformer ratio and sensing configuration is correct.

Step 4. Confirm that the voltage sensing transformers are correct and properly installed.

Incorrect Measurement or Display of Generator Current

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Ensure that the proper current is present at the MGC-1550 current sensing inputs 33, 34, 35, 36, 37, and 38.

Step 3. Verify that the current sensing transformer ratios are correct.

Step 4. Confirm that the current sensing transformers are correct and properly installed.

Incorrect Display of Engine RPM

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Connections* chapter.

Step 2. Verify that the flywheel teeth setting is correct.

Step 3. Verify that the prime mover governor is operating properly.

Step 4. Verify that the measured frequency of the voltage at the MPU input (31 and 32) is correct.

Step 5. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the MGC-1550.

MGC-1550 Indicates Incorrect Power Factor

Check the rotation of the machine and the labeling of the A-B-C terminals. The machine must be rotating in the same phase sequence as dictated by the generator phase rotation setting for correct power factor metering. A power factor indication of 0.5 with resistive load present is a symptom of incorrect phase rotation.

LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals

This indicates that the MGC-1550 does not detect that valid application firmware is installed. The unit is running its boot loader program, waiting to accept a firmware upload.

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Step 1. Start BESTCOMS*Plus*®*.* Use the top pull-down menu and select FILE > NEW >DGC-2020ES.

Step 2. Select COMMUNICATIONS > UPLOAD DEVICE FILES and select the device package file that contains the firmware and language you want to upload.

Step 3. Check the boxes for DGC-2020 Firmware and DGC-2020 Language Module. Click the UPLOAD button to start the upload process.

Generator Breaker and Mains Breaker

Generator Breaker Will Not Close to a Dead Bus

Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in the BESTlogic™*Plus* chapter*.*

Step 2: Review the section on breaker close requests in the *Breaker Management* chapter*.*

Step 3: Navigate to the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER screen and set DEAD BUS CL ENBL to ENABLE.

Step 4: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status by using the Metering Explorer in BESTCOMS*Plus* and verify that when the generator is running, the GEN STABLE status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.

Step 5: Verify the bus status is DEAD. Check status by using the Metering Explorer in BESTCOMS*Plus* and verify that when the generator is running, the BUS DEAD status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.

Step 6: Verify the connections in BESTlogic*Plus* Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an "A" or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

Step 7: Verify the breaker is receiving a close command. Breaker close command sources are:

- The MGC itself when the automatic mains fail transfer (ATS) feature is enabled.
- The MGC itself when the RUN WITH LOAD logic element receives a *Start* pulse in the programmable logic.
- The MGC itself when started from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
- Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Step 8: Verify the wiring to the breaker from the MGC-1550. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

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Generator Breaker Does Not Open When It Should

Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in the *BESTlogicPlus* chapter.

Step 2: Review the section on breaker operation requests in the *Breaker Management* chapter.

Step 3: Verify the connections in BESTlogic*Plus* Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an "A" or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

Step 4: Verify the breaker is receiving an open command. Breaker open command sources are:

- The MGC-1550 itself when the automatic transfer (ATS) feature is enabled.
- The MGC-1550 itself when the RUN WITH LOAD logic element receives a *Stop* pulse in the programmable logic.
- The MGC-1550 itself when shutting down the engine due to an active alarm.
- The MGC-1550 itself when ending a run session from the Exercise Timer and the *Run with Load* box is checked in the Generator Exerciser settings.
- Manual Breaker Open Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Step 5: Verify the wiring to the breaker from the MGC. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Mains Breaker Does Not Open When Mains Fails

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 4: Verify that a failure of the mains is detected by the MGC. Check status using the Metering Explorer in BESTCOMS*Plus* and verify that the MAINS FAIL status LED is lit when the power on the MGC bus voltage input is either out of voltage or frequency range. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen to achieve correct detection.

Step 5: Verify the wiring to the breaker from the MGC. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the

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breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Mains Breaker Does Not Close After Mains Returns

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 4: Verify that stable mains power is detected by the MGC. Check status using the Metering Explorer in BESTCOMS*Plus* and verify that the MAINS STABLE status LED is lit when the power on the MGC bus voltage input is good. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen to achieve correct detection.

Step 5: Verify the wiring to the breaker from the MGC. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

MGC Front Panel Debug Screen

There is one debug screen in the MGC that can be useful for debugging I/O module related issues. The following debug screen is available: CEM DEBUG

CEM DEBUG

This screen shows the binary data that is being sent between the CEM-2020 (Contact Expansion Module) and the MGC.

The CEM DEBUG screen is located on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > CEM SETUP > CEM DEBUG MENU.

The following parameters are visible on the CEM DEBUG screen:

- DGC TO CEM BP: MGC to CEM-2020 Binary Points. This is the status of the CEM-2020 output relays being transmitted from the MGC to the CEM-2020. This is a 32-bit, bit packed number representing the desired states of the CEM-2020 outputs. The left most bit is the first output, etc.
- CEM TO DGC BP: CEM-2020 to MGC Binary Points. This is the status of the CEM-2020 inputs being transmitted from the CEM-2020 to the MGC. This is a 32-bit, bit packed number representing the metered states of the CEM-2020 inputs. The left most bit is the first input, etc.

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Specifications

MGC-1550 electrical and physical characteristics are listed in the following paragraphs.

Operating Power

Nominal .... 12 or 24 Vdc
Range... 6 to 32 Vdc
Terminals... 18 (+), 17 (–), 16 (chassis ground)

Power Consumption

Sleep Mode .... 4.5 W - LCD heater off, all relays de-energized
Normal Operational Mode .... 6.5 W - Run mode, LCD heater off, 3 relays energized
Maximum Operational Mode .... 14 W - Run mode, LCD heater on, 7 relays energized

Battery Ride Through

Starting at 10 Vdc, withstands cranking ride-through down to 0 Vdc for 50 ms

Current Sensing

Burden... 1 VA
Terminals... 38, 37 (A-phase)
36, 35 (B-phase)
34, 33 (C-phase)

1 Aac Current Sensing

Continuous Rating............................ 0.02 to 1.0 Aac
1 Second Rating............................... 5 Aac
0.050 Second Rating........................ 10 Aac

5 Aac Current Sensing

Continuous Rating............................ 0.1 to 5.0 Aac
1 Second Rating............................... 25 Aac
0.050 Second Rating........................ 50 Aac

Voltage Sensing

Range... 12 to 576 V rms, line-to-line
Frequency .... 50/60 Hz
Frequency Range............................ 10 to 72 Hz
Burden... 1 VA
1 Second Rating............................... 720 V rms

Generator Sensing

Configuration .... Line-to-line or line-to-neutral
Generator Sensing Terminals .... 45 (A-phase)
43 (B-phase)
41 (C-phase)
40 (Neutral)

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Bus Sensing

Configuration.................................... Line-to-line
Bus Sensing Terminals .... 46 (A-phase)
(Optional with style number xx2) 48 (B-phase)
50 (C-phase)

Contact Sensing

Contact sensing inputs include seven programmable inputs. All inputs accept dry contacts.

Time from an MGC-1550 input application to:

- Shutdown the generator via an alarm = 490 ms max
- Close a relay on board the MGC-1550 = 215 ms max
- Close a relay on board the CEM-2020 = 400 ms max

Notes
A contact input is true (on) if the input is connected to battery ground with a resistance of less than 240 ohms. The maximum length of wire that can be accommodated depends on the resistance of the wire, and the resistance of the contacts of the device driving the input at the far end of the wire. The maximum wire length can be calculated as follows: $L_{max} = (240 - R_{device})$/(Resistance per Foot of Desired Wire)

Terminals

Input 1 .... 3, 17
Input 2 .... 4, 17
Input 3 .... 5, 17
Input 4 .... 6, 17
Input 5 .... 7, 17
Input 6 .... 8, 17
Input 7 .... 9, 17

Engine System Inputs

Stated accuracies are subject to the accuracy of the senders used. Values within these ranges are deemed “good” and the MGC-1550 will use them for the appropriate calculation and protection. Values outside these ranges are deemed “bad” and the MGC-1550 will begin timing towards a sender failure condition.

Fuel Level Sensing

Resistance Range............................ 5 to 250 Ω nominal
Terminals.. 1, 2 (sender common)

Coolant Temperature Sensing

Resistance Range............................ 5 to 2,750 Ω nominal
Terminals.. 53, 2 (sender common)

Oil Pressure Sensing

Resistance Range............................ 5 to 250 Ω nominal
Terminals.. 52, 2 (sender common)

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Engine Speed Sensing

Magnetic Pickup

Voltage Range .... 3 to 35 V peak (6 to 70 V peak-peak)
Frequency Range............................ 32 to 10,000 Hz
Terminals.. 32 (+), 31 (–)

Generator Voltage

Range... 12 to 576 V rms
Terminals.. 45 (A-phase)
43 (B-phase)
41 (C-phase)

Output Contacts

Start, Run, and Prestart Relays

Rating .... 5 A, 28 Vdc—general purpose, 1.2 A pilot duty, the load must be in parallel with a diode rated at least 3 times the coil current and 3 times the coil voltage.

Terminals

START... 19, 20
RUN... 21, 22
PRE 23, 24

Programmable Relays (4)

Rating .... 2 A, 28 Vdc—general purpose, 1.2 A pilot duty, the load must be in parallel with a diode rated at least 3 times the coil current and 3 times the coil voltage.

Terminals

Output 1... 26, 25 (common)
Output 2... 27, 25 (common)
Output 3... 29, 28 (common)
Output 4... 30, 28 (common)

The programmable relays share common terminals: terminal 25 is used for outputs 1 and 2, terminal 28 is used for outputs 3 and 4.

Metering

Generator and Bus Voltage (rms)

Metering Range............................... 0 to 576 Vac (direct measurement)
577 to 9,999 Vac (through VT using VT ratio setting)
VT Ratio Range............................... 1:1 to 125:1 in primary increments of 1
Accuracy*.. ±2.0% of programmed rated voltage or ±3 Vac
Display Resolution .... 1 Vac

* Voltage metering indicates 0 V when generator voltage is below 2% of the full-scale rating.

Generator Current (rms)

Generator current is measured at the secondary windings of user-supplied 1 A or 5 A CTs.

Metering Range............................... 0 to 5,000 Aac
CT Primary Range .... 1 to 5,000 Aac in primary increments of 1 Aac

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Accuracy* .... ±3.0% of programmed rated current or ±3 Aac
Display Resolution .... 1 Aac

* Current metering indicates 0 A when generator current is below 2% of the full-scale rating.

Generator and Bus Frequency

Frequency is sensed through the generator and bus voltage inputs (phases A and B).

Metering Range............................... 10 to 72 Hz
Accuracy.. ±0.25% or 0.05 Hz
Display Resolution .... 0.1 Hz

Apparent Power

Indicates total kVA and individual line kVA (4-wire, line-to-neutral or 3-wire, line-to-line).

Measurement/Calculation Methods

Total .... kVA = ($V_{L-L} \times I_L \times \sqrt{3}$) ÷ 1000
4-Wire, Line-to-Neutral..................... kVA calculated with respect to neutral
3-Wire, Line-to-Line.......................... A-phase kVA = $V_{AB} \times I_A \div 1000 \div \sqrt{3}$
B-phase kVA = $V_{BC} \times I_B \div 1000 \div \sqrt{3}$
C-phase kVA = $V_{CA} \times I_C \div 1000 \div \sqrt{3}$
Accuracy.. ±5% of the full-scale indication or ±4 kVA ∗†

∗ kVA metering indicates 0 kVA when the generator kVA is below 2% of the full-scale rating.

† Applies when temperature is between −40°C to +70°C.

Power Factor

Metering Range............................... 0.2 leading to 0.2 lagging
Calculation Method .... PF = cosine of the angle between phase AB voltage (Vab) and phase A current (Ia) *
Accuracy.. ±0.02 †

* In single-phase AC-connected machines, it is the cosine of the angle between phase CA voltage (Vca) and phase C current (Ic).

† Applies when temperature is between –40°C to +70°C (–40°F to +158°F).

Note
For the MGC-1550 to correctly meter power factor, the generator must be rotating in the same phase sequence as dictated by the generator phase rotation setting.

Real Power

Indicates total kW and individual line kW (4-wire, line-to-neutral or 3-wire line-to-line)

Measurement/Calculation Methods

Total .... PF × Total kVA
4-Wire, Line-to-Neutral..................... kW calculated with respect to neutral
3-Wire, Line-to-Line.......................... A-phase kW = $V_{AB} \times I_A \times PF \div 1000 \div \sqrt{3}$
B-phase kW = $V_{BC} \times I_B \times PF \div 1000 \div \sqrt{3}$
C-phase kW = $V_{CA} \times I_C \times PF \div 1000 \div \sqrt{3}$
Accuracy.. ±5% of the full-scale indication or ±4 kW ∗†

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∗ kW metering indicates 0 kW when the generator kW is below 2% of the full-scale rating.

† Applies when temperature is between –40°C to +70°C.

Oil Pressure

Metering Range............................... 0 to 150 psi, 0 to 10.3 bar, or 0 to 1,034 kPa
Accuracy... ±3% of actual indication or ±2 psi, ±0.12 bar, or ±12 kPa (subject to accuracy of sender)
Display Resolution .... 1 psi, 0.1 bar, or 1 kPa

Coolant Temperature

Metering Range............................... 32 to 410°F or 0 to 204°C
Accuracy... ±3% of actual indication or ±2° (subject to accuracy of sender)

Battery Voltage

Metering Range............................... 6 to 32 Vdc
Accuracy... ±3% of actual indication or ±0.2 Vdc
Display Resolution .... 0.1 Vdc

Engine RPM

Metering Range............................... 0 to 4,500 rpm
Accuracy*....................................... ±2% of actual indication or ±2 rpm
Display Resolution .... 2 rpm

* When engine speed is below 2% of full-scale, reported rpm is 0.

Engine Run Time

Engine run time is retained in nonvolatile memory.

Metering Range............................... 0 to 99,999 hours
Update Interval............................... 6 min
Accuracy... ±1% of actual indication or ±12 min
Display Resolution .... 1 minute

Maintenance Timer

Maintenance timer indicates the time remaining until genset service is due. Value is retained in nonvolatile memory.

Metering Range............................... 0 to 5,000 hours
Update Interval............................... 6 min
Accuracy... ±1% or actual indication or ±12 min
Display Resolution .... 1 minute

Fuel Level

Metering Range............................... 0 to 100%
Accuracy... ±3% (subject to accuracy of sender)
Display Resolution 1.0%

Generator Protection Functions

Overvoltage (59) and Undervoltage (27)

Pickup Range.................................. 70 to 1,000 Vac
Pickup Increment .... 1 Vac
Inhibit Frequency Range.................. 20 to 66 Hz (27 function only)

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Activation Delay Range.................... 0 to 30 s
Activation Delay Increment .... 0.1 s

Note
The maximum voltage that can be safely applied to the MGC-1550 is 576 V. The pickup range is higher so that when the low-line override is used, and the scale factor is 0.5 or less, effective protection levels of 500 V can be reached with a scale factor of 0.5.

Underfrequency (81U) and Overfrequency (81O)

Pickup Range.................................. 45 to 66 Hz
Pickup Increment .... 0.1 Hz
Activation Delay Range.................... 0 to 30 s
Activation Delay Increment .... 0.1 s
Inhibit Voltage Range....................... 70 to 576 Vac (81U function only)

Overcurrent (50)

Pickup Range.................................. 0.18 to 1.18 Aac (1 A current sensing)
0.9 to 7.75 Aac (5 A current sensing)
Time Dial Range .... 0 to 7,200 s (fixed time curve)
Time Dial Increment......................... 0.1

Phase Imbalance (47)

Pickup Range.................................. 5 to 100 Vac
Pickup Increment .... 1 Vac
Activation Delay Range.................... 0 to 30 s
Activation Delay Increment .... 0.1 s

Logic Timers

Hours Setting Range........................ 0 to 250
Hours Setting Increment 1
Minutes Setting Range..................... 0 to 250
Minutes Setting Increment 1
Seconds Setting Range .... 0 to 1,800
Seconds Setting Increment.............. 0.1
Accuracy.. ±15 ms

Communication Interface

USB

Specification Compatibility .... USB 2.0
Data Transfer Speed........................ 115,200 baud
Connector Type............................... Mini-B jack

RDP-110

Minimum Wire Size .... 20 AWG
Maximum Wire Length .... 4,000 feet (1,219 meters)
Terminals... 11 (RDP TxD+), 10 (RDP TxD–)

CAN

Differential Bus Voltage.................... 1.5 to 3 Vdc
Maximum Voltage .... –32 to +32 Vdc with respect to negative battery terminal

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Communication Rate....................... 250 kb/s
Terminals.. 14 (low), 13 (high), and 15 (shield)

Notes

1. If the MGC-1550 is providing one end of the J1939 bus, a 120 Ω, ½ watt terminating resistor should be installed across terminals 14 (CANL) and 13 (CANH).
2. If the MGC-1550 is not part of the J1939 bus, the stub connecting the MGC-1550 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the MGC-1550.

Real-Time Clock

Clock has leap year and selectable daylight saving time correction. Backup capacitor and backup battery sustain timekeeping during losses of MGC-1550 operating power.

Resolution .... 1 s
Accuracy... ±1.73 s/d at 25°C

Clock Holdup

Battery Holdup Time .... Approximately 10 yrs

Liquid Crystal Display (LCD)

Display .... 128 by 64 dot pixels LCD with LED Backlight
Operating Temperature................... –40 to +70°C (–40 to +158°F)
Storage Temperature...................... –40 to +80°C (–40 to +176°F)

LCD Heater

The ambient temperature is monitored by a temperature sensor located near the LCD inside the MGC-1550. The LCD heater turns on when the ambient temperature falls below 0°C (32°F). The heater turns off when the ambient temperature rises above 5°C (41°F). This range of operation implements 5°C (9°F) of hysteresis between heater turn-on and turn-off.

Type Tests

Shock and Vibration EN60068-2-6
Dielectric Strength........................... IEC 255-5
Impulse EN60664-1
Transients....................................... EN61000-4-4
Static Discharge EN61000-4-2

Shock

Withstands 15 G in three perpendicular planes.

Vibration

Tested in three mutually perpendicular planes for 8 hours over the following ranges:

3 to 25 Hz at 1.6 mm (0.063 inches), peak amplitude
25 to 2,000 Hz at 5G

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Radio Interference

Type tested using a 5 W, hand-held transceiver operating at random frequencies centered around 144 and 440 MHz with the antenna located within 150 mm (6”) of the device in both vertical and horizontal planes.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the MGC-1550 was subjected to temperature tests (tested over a temperature range of –100°C to +130°C), vibration tests (of 5 to 50 G at +20°C), and temperature/vibration tests (tested at 50 G over a temperature range of –95°C to +125°C). Combined temperature and vibration testing at these extremes proves that the MGC-1550 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels.

Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 Ignition System.

Environment

Operating Temperature.................... –40 to +70°C (–40 to +158°F)
Storage Temperature....................... –40 to +85°C (–40 to +185°F)
Humidity .... IEC 68-2-38
Salt Spray... IEC 68-2-52
Ingress Protection .... IEC IP56 for front panel

UL Approval

“cURus” recognized to UL Standard 6200 & CSA Standard C22.2 No. 14.

CSA Certification

CSA certified to Standard C22.2 No. 14.

NFPA Compliance

Complies with NFPA Standard 110, Standard for Emergency and Standby Power.

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - Electronic Equipment for use in Power Installations
- EN 61000-6-4:2001 - Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments
- EN 61000-6-2:2001 - Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments

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Physical

Weight .... 1.9 lb (0.86 kg)
Dimensions...................................... See the *Mounting* chapter.

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CEM-2020

General Information

The optional CEM-2020 is a remote auxiliary device that provides additional MGC-1550 contact inputs and outputs.

Features

CEM-2020s have the following features:

- 10 Contact Inputs
- 24 Contact Outputs (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTlogic™*Plus* Programmable Logic
- Communications via CAN

Specifications

Operating Power

Nominal ....12 or 24 Vdc
Range ....8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms)

Maximum Power Dissipation

CEM-2020 ....14 W

Contact Inputs

The CEM-2020 contains 10 programmable inputs that accept dry contacts.

Time from a CEM-2020 input application to:

- Shut down the generator via an alarm = 700 ms max
- Close a relay on board the MGC-1550 = 300 ms max
- Close a relay on board the CEM-2020 = 550 ms max

Notes
A CEM-2020 contact input is true (on) if the input is connected to battery ground with a resistance of less than 200 ohms. The maximum length of wire that can be accommodated depends on the resistance of the wire, and the resistance of the contacts of the device driving the input at the far end of the wire. The maximum wire length can be calculated as follows: $L_{max} = (200 - R_{device})$/(Resistance per Foot of Desired Wire)

Contact Outputs

Ratings

CEM-2020
Outputs 5 through 16 ....1 Adc at 30 Vdc, Form C, gold contacts
Outputs 17 through 28 ....4 Adc at 30 Vdc, Form C

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Communications Interface

CAN
Differential Bus Voltage..........................1.5 to 3 Vdc
Maximum Voltage ....–32 to +32 Vdc with respect to negative battery terminal
Communication Rate..............................250 kb/s

Type Tests

Shock

Withstands 15 G in three perpendicular planes.

Vibration

Swept over the following ranges for12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:
5 to 29 to 5 Hz.......................................1.5 G peak for 5 min.
29 to 52 to 29 Hz....................................0.036” Double Amplitude for 2.5 min.
52 to 500 to 52 Hz.................................5 G peak for 7.5 min.

Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Lift Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the CEM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Humidity ....Complies with IEC 68-2-38

Temperature
Operating...–40 to +70°C (–40 to +158°F)
Storage ....–40 to +85°C (–40 to +185°F)

UL Approval (CEM-2020 Only)

“cURus” recognized to UL Standard 508 & CSA Standard C22.2 No. 14.

UL Approval (CEM-2020H Only)

UL recognized to UL Standard 508.

CSA Certification

CSA certified to Standard C22.2 No.14.

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

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CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

Physical

Dimensions..See *Installation* later in this chapter.

Weight

CEM-2020 ....2.25 lb (1.02 kg)

Functional Description

Contact Inputs

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the MGC-1550. The label text of each contact input is customizable.

Contact Outputs

CEM-2020

The CEM-2020 provides 24 programmable contact outputs with the same functionality as the contact outputs on the MGC-1550. Outputs 5 through 16 can carry 1 A. Outputs 17 through 28 can carry 4 A. The label text of each contact output is customizable.

Communications

CAN

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the MGC-1550.

BESTCOMSPlus® Software

BESTCOMS*Plus* provides the user with a point-and-click means to set and monitor the Contact Expansion Module. Installation and operation of BESTCOMS*Plus* is described in the BESTCOMS*Plus* chapter.

Installation

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

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Mounting

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 92 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in brackets.

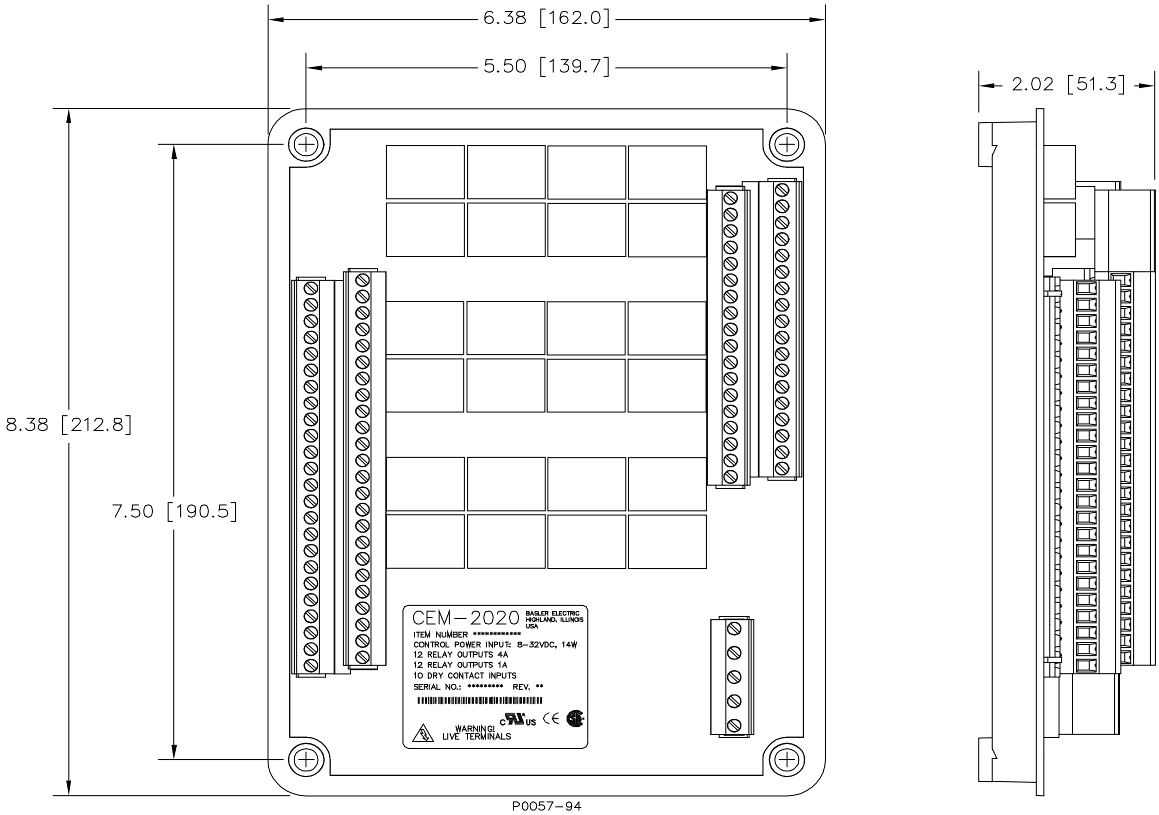

Figure 92. CEM-2020 Overall Dimensions

Connections

Contact Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

> **Note**
>
> Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.
>
> Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

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Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. The connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. Connector screw terminals accept a maximum wire size of 12 AWG (3.31 mm^2). Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Contact Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Operating power terminals are listed in Table 32.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 32. Operating Power Terminals

Terminal	Description
P1- ⏚ (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1 + (BATT+)	Positive side of operating power input

Contact Inputs and Contact Outputs

The CEM-2020 (Figure 93) has 10 contact inputs and 24 contact outputs.

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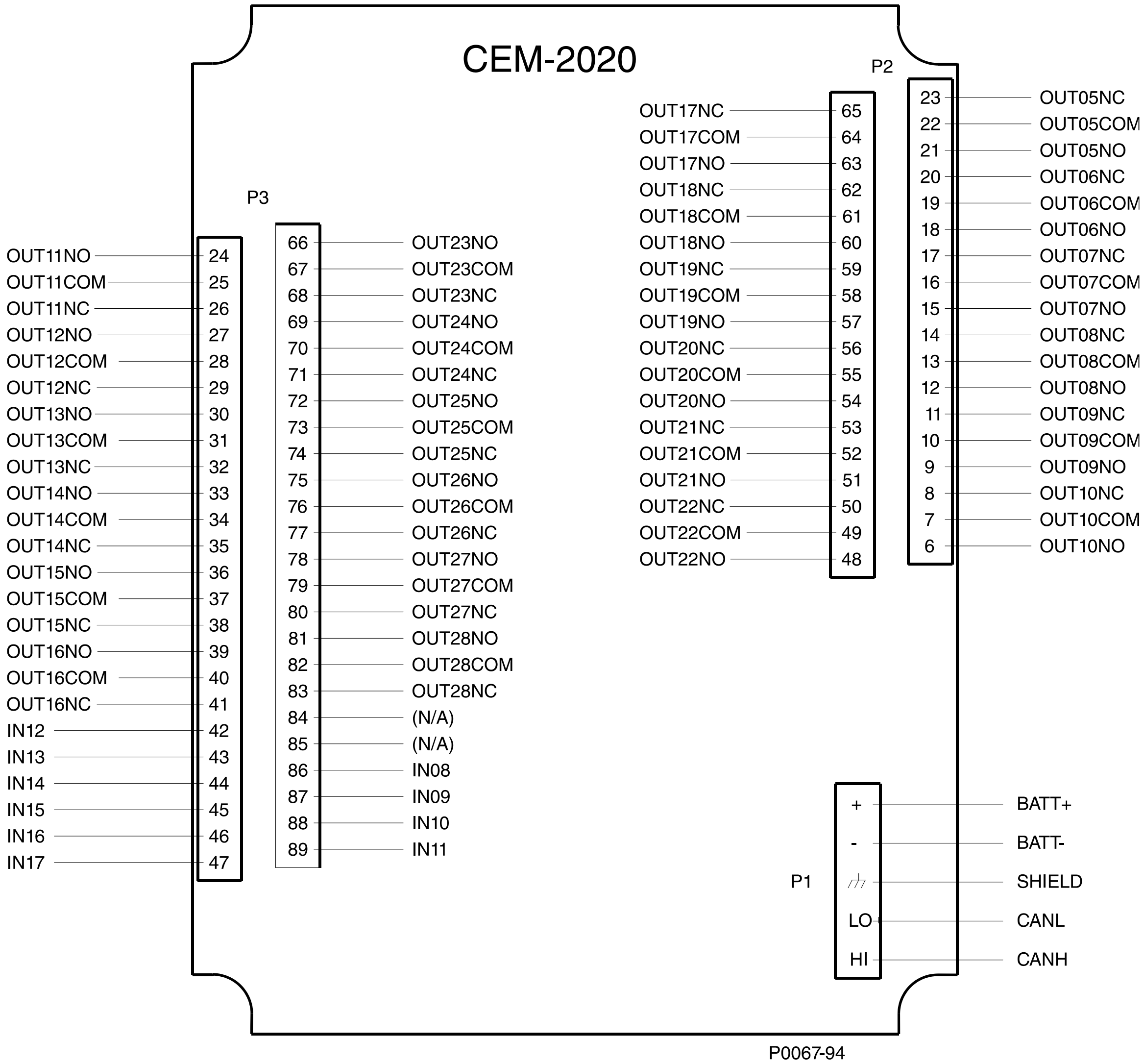

Figure 93. CEM-2020 Contact Input and Contact Output Terminals

CAN Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the MGC-1550. Connections between the CEM-2020 and MGC-1550 should be made with twisted-pair, shielded cable. CAN interface terminals are listed in Table 33. Refer to Figure 96 and Figure 97.

Table 33. CAN Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- (SHIELD)	CAN drain connection

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Notes
1. If the CEM-2020 is providing one end of the J1939 bus, a 120 Ω, ½ watt terminating resistor should be installed across terminals P1-LO (CANL) and P1- HI (CANH).
2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

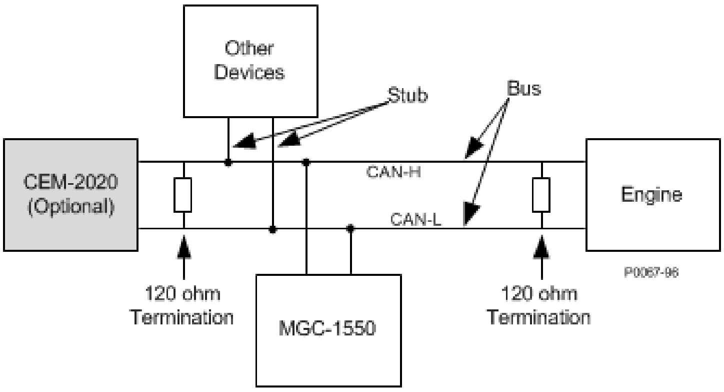

Figure 94. CAN Interface with CEM-2020 providing One End of the Bus

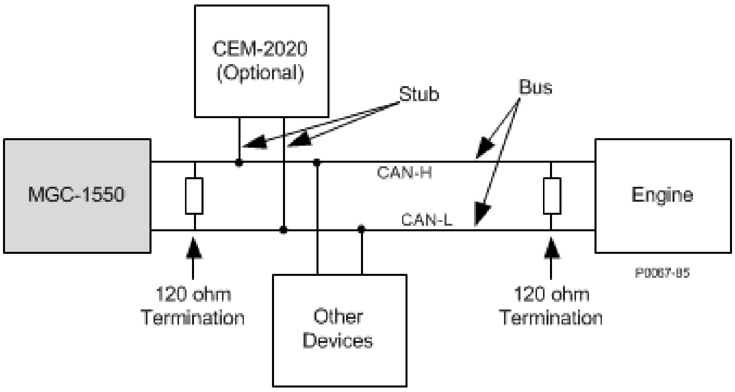

Figure 95. CAN Interface with MGC-1550 providing One End of the Bus

Remote Contact Input Configuration

The CEM-2020 provides 10 contact inputs. Each of the 10 contact inputs can be independently configured to annunciate an alarm or pre-alarm when the input senses a contact closure. A user-adjustable time delay can be set to delay recognition of a contact input. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the contact inputs easier, a user-assigned name can be given to each input.

Contacts can be recognized always or only while the engine is running.

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The remote contact inputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to the BESTlogic*Plus* chapter.

Remote contact input status is available in BESTlogic*Plus* Programmable Logic when “None” is selected for Alarm Configuration.

The *Remote Contact Inputs* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Inputs* category. If using the front panel, navigate to Settings > Programmable Inputs > Configurable Inputs. The BESTCOMS*Plus* Remote Contact Inputs screen is illustrated in Figure 98.

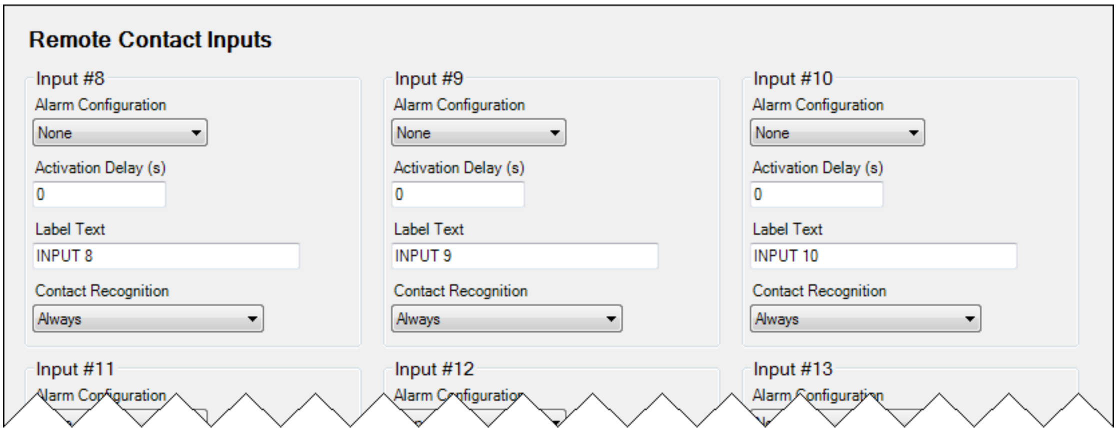

Figure 96. Settings Explorer, Programmable Inputs, Remote Contact Inputs Screen

Remote Contact Output Configuration

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name.

The contact outputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *I/O* group in BESTlogic*Plus*. For more details, refer to the BESTlogic*Plus* chapter.

The *Remote Contact Outputs* screen is found in the BESTCOMS*Plus Settings Explorer* under the *Programmable Inputs* category. If using the front panel, navigate to Settings > Programmable Outputs > Configurable Outputs. The BESTCOMS*Plus* Contact Outputs screen is illustrated in Figure 99.

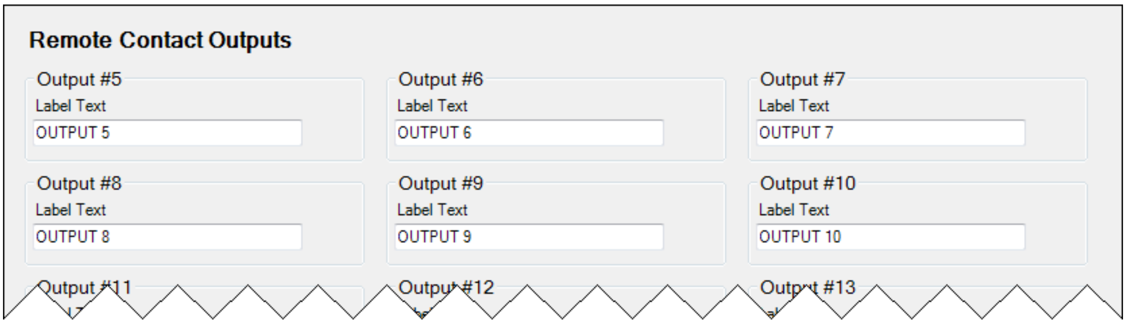

Figure 97. Settings Explorer, Programmable Outputs, Remote Contact Outputs Screen

Maintenance

Preventive maintenance consists of periodically checking that the connections between the CEM-2020 and the system are clean and tight. Contact Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, MTU Onsite Energy recommends that no repair procedures be attempted by anyone other than MTU Onsite Energy personnel.

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MTU Fault Codes

MTU Fault Codes

An MGC-1550 connected to a genset equipped with an MTU engine ECU tracks and displays the active fault codes issued by the MTU engine ECU. Active MTU fault codes can be viewed through BESTCOMS*Plus*® by using the Metering Explorer to expand the MTU tree or through the front panel display by navigating to METERING > ALARMS-STATUS > MTU FAULT CODES.

Each fault code is displayed with a fault description and the fault number. If the MGC-1550 does not have descriptive information about a fault number that was received, the fault description will display as “NO TEXT AVAILABLE”. Fault codes displayed by the MGC-1550 are listed in Table 34.

Table 34. MTU Fault Codes

Fault Code Number	String	Description
3	HI T FUEL	Fuel temperature too high (limit 1).
4	SS T FUEL	Fuel temperature too high (limit 2).
5	HI T CHRG AIR	Charge air temperature too high (limit 1).
6	SS T CHRG AIR	Air temperature too high (limit 2).
9	HI T INTERCOOLER	Coolant temperature of InterCooler too high (limit 1).
10	SS T INTERCOOLER	Coolant temperature of InterCooler too high (limit 2)
15	LO P LUBE OIL	Pressure of lube oil too low (limit 1).
16	SS P LUBE OIL	Pressure of lube oil too low (limit 2).
19	HI T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 1).
20	SS T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 2).
21	HIT T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 1).
22	SS T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 2).
23	LO COOLANT LEVEL	Coolant level too low (limit 1).
24	SS COOLANT LEVEL	Coolant level too low (limit 2).
25	HI P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 1).
26	SS P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 2).
27	HI LEVEL LEAKAGE FUEL	Level of leakage fuel too high (limit 1).
29	HI ETC IDLE SPD TOO HI	Idle speed of one of the switchable chargers too high.
30	SS ENGINE OVERSPEED	Engine overspeed (limit 2).
31	HI ETC1 OVERSPEED	Speed of basic charger too high (limit 1).
32	SS ETC1 OVERSPEED	Speed of basic charger too high (limit 2).
33	L1 P FUELFLT DIF	Differential pressure of fuel filter too high (limit 1).
36	HI ETC2 OVERSPEED	Speed of 1st switchable charger too high (limit 1).
37	SS ETC2 OVERSPEED	Speed of 1st switchable charger too high (limit 2).
38	AL ETC SPEED DEVIATION	Speed deviation between basic turbo charger and one of the switchable chargers.
39	AL ETC2 CUTIN FAIL	Switching of charger ETC2 failed.
44	LO LEVEL INTRCLR	Coolant level of intercooler too low (limit 1).
45	FAULT L2 LEVEL INTRCLR	Coolant level of intercooler too low (limit 2).
51	HI T LUBE OIL	Lube oil temperature too high (limit 1).
52	SS T LUBE OIL	Lube oil temperature too high (limit 2).
53	HI T INTAKE AIR	Air intake temperature high (Limit 1).
54	HIHI T INTAKE AIR	Air intake temperature high (Limit 2).
57	LO P COOLANT	Coolant pressure too low (limit 1).

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Fault Code Number	String	Description
58	SS P COOLANT	Coolant pressure too low (limit 2).
59	SS T COOLANT L3	Coolant temperature too high/too low (limit 3).
60	SS T COOLANT L4	Coolant temperature too high/too low (limit 4).
61	HI P ADCRANK CS L1	AdCrankCase pressure too high (Limit 1).
62	HI P ADCRANK CS L2	AdCrankCase pressure too high (Limit 2).
63	HI P CRANKCASE	Crankcase pressure too high (limit 1).
64	SS P CRANK CASE	Crankcase pressure too high (limit 2).
65	LO P FUEL	Fuel supply pressure too low (limit 1).
66	SS P FUEL	Fuel supply pressure too low (limit 2).
67	HI T COOLANT	Coolant temperature too high (limit 1).
68	SS T COOLANT	Coolant temperature too high (limit 2).
69	L1 T EXTERN 1	Limit 1, out of range.
70	L2 T EXTERN 1	Limit 2, out of range.
71	L1 T EXTERN 2	Limit 1, out of range.
72	L2 T EXTERN 2	Limit 2, out of range.
73	L1 P EXTERN 1	Limit 1, out of range.
74	L2 P EXTERN 1	Limit 2, out of range.
75	L1 P EXTERN 2	Limit 1, out of range.
76	L2 P EXTERN 2	Limit 2, out of range.
77	LIM EXT CLNT LEV	Binary signal 1 Plant active.
78	LIM INTERCLR LEV	Binary signal 2 Plant active.
79	L BIN EXTERN 3	Binary signal 3 Plant active.
80	L BIN EXTERN 4	Binary signal 4 Plant active.
81	AL RAIL LEAKAGE	Rail pressure gradient too low for Start or too high for Stop.
82	HI P FUEL COMON RAIL	Rail pressure > setpoint value.
83	LO P FUEL COMMON RAIL	Rail pressure < setpoint value.
85	HI T UMBLASSEN	‘Umblasen’ temperature too high (limit 1).
86	SS T UMBLASSEN	‘Umblasen’ temperature too high (limit 2).
89	SS SPEED TOO LOW	Engine is being stalled. The engine speed of the normally operating engine dropped below the limit from parameter 2.2500.027 Limit Engine Speed Low without any stop request. For safety reason the engine is stopped when this event occurs.
90	SS IDLE SPEED LOW	Idle speed not reached.
91	SS RELEASE SPEED LO	Acceleration speed not reached.
92	SS STARTER SPEED LO	Starter speed not reached.
93	SS PREHT TMP	Preheat temperature too low (limit 2).
94	LO PREHT TMP	Preheat temperature too low (limit 1).
95	AL PRELUBE FAULT	Prelubrication fault.
99	DUMMY FAULT	Dummy fault - this is not a real fault, but is used on some ECU’s to test the fault reporting mechanism.
100	EDM NOT VALID	Checksum fault EDM.
101	IDM NOT VALID	Checksum fault IDM.
102	INVLD FUEL CNS 1	Fuel consumption counter detect.
103	INVLD FUEL CNS 2	Consumption monitoring 2 not valid.
104	ENG HRS INVALID 1	Engine Hours Counter defect.
105	ENG HRS INVALID 2	Checksum fault.
106	ERR REC1 INVALID	Checksum fault.
107	ERR REC2 INVALID	Checksum fault.

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Fault Code Number	String	Description
118	LO ECU SUPPLY VOLTS	Power supply voltage too low (limit 1).
119	LOLO ECU SUPPLY VOLTS	Power supply voltage too low (limit 2).
120	HI ECU SUPPLY VOLTS	Power supply voltage too high (limit 1).
121	HIHI ECU SUPPLY VOLTS	Power supply voltage too high (limit 2).
122	HI T ECU	Temperature of electronic too high (limit 1).
134	15v POSECU DEFCT	Internal electronic fault.
136	15V NEGECU DEFCT	Internal electronic fault.
137	L1 5V BUFFR TEST	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
138	SENSOR PWR DEFCT	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
139	L1 TE BUFFR TEST	Internal electronic fault.
140	TE BUF ECU DEFCT	Internal electronic fault.
141	AL POWER TOO HIGH	AL power too high.
142	MCR EXCEEDED 1 HR STR	AL MCR exceeded 1 hour.
143	BANK1 ECU DEFECT	Internal electronic fault.
144	BANK2 ECU DEFECT	Internal electronic fault.
145	15V GOODECU DFCT	Internal electronic fault.
147	AD TST1ECU DEFCT	Internal electronic fault.
149	AD TST2ECU DEFCT	Internal electronic fault.
151	AD TST3ECU DEFCT	Internal electronic fault.
170	MI MODULE FAIL	Module in maintenance indicator defect.
171	MI NOT ACTIVE	WI not active anymore.
172	TBO EXPIRED	TBO expired.
173	MODL WRITE LIMIT	EEPROM write limit reached.
176	AL LIFE DATA NA	No (fitting) LifeData-Backup-System is available within a delay time after ECU Reset.
177	AL LIFE DATA INCPLT	If the ADEC has to restore the LifeData from the backup-system and at least one checksum is wrong after the upload or the upload is incomplete, then this failure is set.
180	AL CAN1 NODE LOST	Connection to a node on CAN 1 lost.
181	AL CAN2 NODE LOST	Connection to a node on CAN 2 lost.
182	AL CAN WRONG PARAMS	Incorrect CAN parameter values have been entered.
183	AL CAN NO PU DATA	A CAN mode is selected which the communication is initialized aided of the PU data module. However, required PU data module is not present or is not valid.
184	AL CAN PUDATA ERR	During attempt to copy a received PU data module to Flash module, a program error occurred.
185	CAN LESS MAILBXS	CAN less mailboxes.
186	AL CAN1 BUS OFF	CAN controller 1 is in “Bus Off” state.
187	AL CAN1 ERR PASSV	CAN controller 1 has signaled a warning.
188	AL CAN2 BUS OFF	CAN controller 2 is in “Bus Off” state.
189	AL CAN2 ERROR PASSV	CAN controller 2 has signaled a warning.
190	AL EMU PARAM NO SUPPORT	EMU parameters are not supported.
198	AL COMB ALM YEL	Combined Yellow Alarm - a yellow alarm is a warning and does generally not result in engine shutdown.
201	SD T COOLANT	Coolant temperature-sensor defect.
202	SD T FUEL	Fuel temperature-sensor defect.
203	SD T CHARGE AIR	Charge air temperature-sensor defect.
205	SD T CLNT INTERC	Intercooler coolant temperature-sensor defect.
206	SD T EXHAUST A	Exhaust gas temperature-sensor on A-side defect.

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Fault Code Number	String	Description
207	SD T EXHAUST B	Exhaust gas temperature-sensor on B-side defect.
208	SD P CHARGE AIR	Charge air pressure-sensor defect.
211	SD P LUBE OIL	Lube oil pressure-sensor defect.
212	SD P COOLANT	Coolant pressure-sensor defect.
213	SD P COOLANT INTRCOOLR	Intercooler coolant pressure-sensor defect.
214	SD P CRANKCASE	Crankcase pressure-sensor defect.
215	SD P HD	Rail pressure-sensor defect.
216	SD T LUBE OIL	Lube oil temperature-sensor defect.
219	SD T INTAKE AIR	Intake air temperature-sensor defect.
220	SD COOLANT LEVEL	Sensor for coolant level defect.
221	SD P DIFF LUBE OIL	Sensor for differential pressure of lube oil defect.
222	SL LVL LKG FUEL	Sensor for leakage level of fuel defect.
223	SD LVL INTERCLR	Sensor for coolant level of intercooler defect.
227	SD PRE FILT P LUBE OIL	Pressure sensor for lube oil before filter defect.
228	SD P FL PRE FILTR	Sensor defect on the fuel pre-filter pressure sensor.
229	AL SD CAM STOP	Sensor of Camshaft defect and sensor of crankshaft defect before.
230	SD CRANKSHFT SPD	Sensor defect on crankshaft.
231	SD CAMSHAFT SPD	Sensor defect on camshaft.
232	SD CHARGER1 SPEED	Speed-sensor of basic charger defect.
233	SD CHARGER2 SPEED	Speed-sensor of switching charger defect.
239	SD P DIFF FUEL	Sensor defect in the fuel filter differential pressure sensor.
240	SD P FUEL	Fuel pressure-sensor defect.
241	SD T UMBLASSEN	Temperature-sensor of recirculated charge air defect.
242	SD T COOLANT R	Redundant coolant temperature-sensor defect.
244	SD P LUBE OIL R	Redundant pressure sensor for lube oil defect.
245	SD POWER SUPPLY	Internal ECU error.
246	SD T ELECTRONIC	Internal ECU fault.
249	SD CAN STOP	Missing data CAN.
250	SD CAN SPD DEMND	Missing data CAN.
251	SD CAN UP DOWN	Missing data CAN.
252	SD CAN NOTCH POS	Missing data CAN.
253	SD CAN OVERRIDE	Missing data CAN.
254	SD CAN TST OVRSP	Missing data CAN.
255	SD CAN ENGAGE SIG	Missing data CAN.
256	SD CAN CYL CUTOUT	Missing data CAN.
257	SD CAN LOCAL	Missing data CAN.
258	SD CAN RCS ENGAGE	Missing data CAN.
259	SD CAN RCS CYL CT	Missing data CAN.
260	SD 15V POS SPPLY	Internal ECU fault.
261	15V POS SPPLY	Internal ECU fault.
262	SD 5V BUFFR TEST	Internal ECU fault.
263	SD TE BUFFR TEST	Internal ECU fault.
264	SD BANK 1 TEST	Internal ECU fault.
265	SD BANK 2 TEST	Internal ECU fault.
266	SD SPD DEMAND AN	Analog speed demand defect.
267	SD SPDMTEST BNCH	Short circuit, cable breakage.

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Fault Code Number	String	Description
268	SD SPINUT	Analog spinning value defect.
269	SD LOAD ANLG FLT	Filtered analog load pulse signal not available.
270	SD FREQUENCY INPUT	Frequency input defect.
271	SD T EXTERN 1	Missing data CAN.
272	SD T EXTERN 2	Missing data CAN.
273	SD P EXTERN 1	Missing data CAN.
274	SD P EXTERN 2	Missing data CAN.
275	SD EXT CLNT LVL	Missing data CAN.
276	SD INTERCLER LVL	Missing data CAN.
277	SD BIN EXT3	Missing data CAN.
278	SD BIN EXT4	Missing data CAN.
279	SD CANRES TRIPFL	Missing data CAN.
280	SD CAN ALRM RST	Missing data CAN.
281	SD ADTEST1 SPPLY	Internal ECU fault.
282	SD ADTEST 2 SPPLY	Internal ECU fault.
283	SD ADTEST3 SPPLY	Internal ECU fault.
284	SD CAN LAMP TEST	Missing data CAN.
285	SD CAN IDLE RQ SR	Missing data CAN.
286	SD CAN IDLE REQ	Missing data CAN.
287	SD CAN IDLE REQ	Missing data CAN.
288	SD CAN TRBOSW LCK	Missing data CAN.
301	TIMING CYLNDR A1	Error in timing of injector cylinder A1: timing value too low/high.
302	TIMING CYLNDR A2	Error in timing of injector cylinder A2: timing value too low/high.
303	TIMING CYLNDR A3	Error in timing of injector cylinder A3: timing value too low/high.
304	TIMING CYLNDR A4	Error in timing of injector cylinder A4: timing value too low/high.
305	TIMING CYLNDR A5	Error in timing of injector cylinder A5: timing value too low/high.
306	TIMING CYLNDR A6	Error in timing of injector cylinder A6: timing value too low/high.
307	TIMING CYLNDR A7	Error in timing of injector cylinder A7: timing value too low/high.
308	TIMING CYLNDR A8	Error in timing of injector cylinder A8: timing value too low/high.
309	TIMING CYLNDR A9	Error in timing of injector cylinder A9: timing value too low/high.
310	TIMING CYLNDR A10	Error in timing of injector cylinder A10: timing value too low/high.
311	TIMING CYLNDR B1	Error in timing of injector cylinder B1: timing value too low/high.
312	TIMING CYLNDR B2	Error in timing of injector cylinder B2: timing value too low/high.
313	TIMING CYLNDR B3	Error in timing of injector cylinder B3: timing value too low/high.
314	TIMING CYLNDR B4	Error in timing of injector cylinder B4: timing value too low/high.
315	TIMING CYLNDR B5	Error in timing of injector cylinder B5: timing value too low/high.
316	TIMING CYLNDR B6	Error in timing of injector cylinder B6: timing value too low/high.
317	TIMING CYLNDR B7	Error in timing of injector cylinder B7: timing value too low/high.
318	TIMING CYLNDR B8	Error in timing of injector cylinder B8: timing value too low/high.
319	TIMING CYLNDR B9	Error in timing of injector cylinder B9: timing value too low/high.
320	TIMING CYLNDR B10	Error in timing of injector cylinder B10: timing value too low/high.
321	WIRING CYLNDR A1	Short circuit in injector cable of cylinder A1.
322	WIRING CYLNDR A2	Short circuit in injector cable of cylinder A2.
323	WIRING CYLNDR A3	Short circuit in injector cable of cylinder A3.
324	WIRING CYLNDR A4	Short circuit in injector cable of cylinder A4.
325	WIRING CYLNDR A5	Short circuit in injector cable of cylinder A5.
326	WIRING CYLNDR A6	Short circuit in injector cable of cylinder A6.

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Fault Code Number	String	Description
327	WIRING CYLNDR A7	Short circuit in injector cable of cylinder A7.
328	WIRING CYLNDR A8	Short circuit in injector cable of cylinder A8.
329	WIRING CYLNDR A9	Short circuit in injector cable of cylinder A9.
330	WIRING CYLNDR A10	Short circuit in injector cable of cylinder A10.
331	WIRING CYLNDR B1	Short circuit in injector cable of cylinder B1.
332	WIRING CYLNDR B2	Short circuit in injector cable of cylinder B2.
333	WIRING CYLNDR B3	Short circuit in injector cable of cylinder B3.
334	WIRING CYLNDR B4	Short circuit in injector cable of cylinder B4.
335	WIRING CYLNDR B5	Short circuit in injector cable of cylinder B5.
336	WIRING CYLNDR B6	Short circuit in injector cable of cylinder B6.
337	WIRING CYLNDR B7	Short circuit in injector cable of cylinder B7.
338	WIRING CYLNDR B8	Short circuit in injector cable of cylinder B8.
339	WIRING CYLNDR B9	Short circuit in injector cable of cylinder B9.
340	WIRING CYLNDR B10	Short circuit in injector cable of cylinder B10.
341	OPN LD CYLNDR A1	Open load in injector cable of cylinder A1.
342	OPN LD CYLNDR A2	Open load in injector cable of cylinder A2.
343	OPN LD CYLNDR A3	Open load in injector cable of cylinder A3.
344	OPN LD CYLNDR A4	Open load in injector cable of cylinder A4.
345	OPN LD CYLNDR A5	Open load in injector cable of cylinder A5.
346	OPN LD CYLNDR A6	Open load in injector cable of cylinder A6.
347	OPN LD CYLNDR A7	Open load in injector cable of cylinder A7.
348	OPN LD CYLNDR A8	Open load in injector cable of cylinder A8.
349	OPN LD CYLNDR A9	Open load in injector cable of cylinder A9.
350	OPN LD CYLNDR A10	Open load in injector cable of cylinder A10.
351	OPN LD CYLNDR B1	Open load in injector cable of cylinder B1.
352	OPN LD CYLNDR B2	Open load in injector cable of cylinder B2.
353	OPN LD CYLNDR B3	Open load in injector cable of cylinder B3.
354	OPN LD CYLNDR B4	Open load in injector cable of cylinder B4.
355	OPN LD CYLNDR B5	Open load in injector cable of cylinder B5.
356	OPN LD CYLNDR B6	Open load in injector cable of cylinder B6.
357	OPN LD CYLNDR B7	Open load in injector cable of cylinder B7.
358	OPN LD CYLNDR B8	Open load in injector cable of cylinder B8.
359	OPN LD CYLNDR B9	Open load in injector cable of cylinder B9.
360	OPN LD CYLNDR B10	Open load in injector cable of cylinder B10.
361	AL POWER STAGE LOW	Internal error of electronic.
362	AL POWER STAGE HIGH	Internal error of electronic.
363	AL STOP POWER STAGE	Internal error of electronic.
364	AL STOP POWER STAGE 2	Internal error of electronic.
365	AL MV WIRING GND	Cable line error.
371	AL WIRING TO 1	Short circuit or open load on transistor output 1 (TO 1).
372	AL WIRING TO 2	Short circuit or open load on transistor output 2 (TO 2).
373	AL WIRING TO 3	Short circuit or open load on transistor output 3 (TO 3).
374	AL WIRING TO 4	Short circuit or open load on transistor output 4 (TO 4).
381	AL WIRING TOP 1	Short circuit or open load on transistor output plant 1 (TOP 1).
382	AL WIRING TOP 2	Short circuit or open load on transistor output plant 2 (TOP 2).
383	AL WIRING TOP 3	Short circuit or open load on transistor output plant 3 (TOP 3).
384	AL WIRING TOP 4	Short circuit or open load on transistor output plant 4 (TOP 4).

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Fault Code Number	String	Description
385	AL WIRING TOP 5	Short circuit or open load on transistor output plant 5 (TOP 5).
386	AL WIRING TOP 6	Short circuit or open load on transistor output plant 6 (TOP 6).
390	AL MCR EXCEEDED	DBR/MCR Function: MCR (Maximum Continuous Rating) in exceeded.
392	HI T COOLNT R	Redundant coolant temperature too high (limit 1).
393	SS T COOLNT R	Redundant coolant temperature too high (limit 2).
394	LO P LUBE OIL R	Redundant pressure of lube oil too low (limit 1).
395	SS P LUBE OIL R	Redundant pressure of lube oil too low (limit 2).
396	TD T COOLANT	Maximum deviation of T-Coolant sensors.
397	TD P LUBE OIL	Maximum deviation of P-Oil sensors.
399	AL INTERFACE ECU	Interface ECU.
400	AL OPN LD DIGIN 1	Open load on digital input 1.
401	AL OPN LD DIGIN 2	Open load on digital input 2.
402	AL OPN LD DIGIN 3	Open load on digital input 3.
403	AL OPN LD DIGIN 4	Open load on digital input 4.
404	AL OPN LD DIGIN 5	Open load on digital input 5.
405	AL OPN LD DIGIN 6	Open load on digital input 6.
406	AL OPN LD DIGIN 7	Open load on digital input 7.
407	AL OPN LD DIGIN 8	Open load on digital input 8.
408	AL OPN LD E STOP	Open load on input for emergency stop.
410	LO U PDU	Power driver voltage (injectors) too low (limit 1).
411	LOLO U PDU	Power driver voltage (injectors) too low (limit 2).
412	HI U PDU	Power driver voltage (injectors) too high (limit 1).
413	HIHI U PDU	Power driver voltage (injectors) too high (limit 2).
414	HI L WATER FUEL PREFILT	Water level of fuel prefilter too high (limit 1).
415	LO P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 1).
416	SS P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 2).
417	SD L WATER FUEL PREFILT	Water level-sensor of fuel prefilter defect.
418	SD INTAKE AIR B	Sensor defect of the Intake Air B temperature sensor.
419	SD PRE_ENG T COOL	Sensor defect in the Coolant Temperature Sensor before engine coolant intake.
420	AL L1 AUX 1	Input of Aux 1 injured limit 1.
421	AL L2 AUX 1	Input of Aux 1 injured limit 2.
422	SD T CHRG AIR B	Sensor defect in the Charge Air B Temperature Sensor.
423	LO P COOLANT DIFF	Low Coolant Differential Pressure.
424	AL L1 AUX 2	Auxiliary 2 Alarm Level 1 Alarm.
425	AL L2 AUX 2	Auxiliary 2 Alarm Level 2 Alarm.
426	SD AIR MASS A	Sensor defect in Air Mass Sensor A.
427	SD AIR MASS B	Sensor defect in Air Mass Sensor B.
428	AL L1 T AUX 1	Temperature input of Aux 1 injured limit 1.
429	HI P COOLANT	High Coolant Pressure.
430	LO PRE ENG P COOLNT	Low Pre-Engine Coolant Pressure (Limit 1).
431	SS PRE ENG P COOLNT	Low Pre-Engine Coolant Pressure (Limit 2).
432	AL L1 T AUX2	Auxiliary Temperature 2 Level 1 Alarm.
433	AL L2 T AUX2	Auxiliary Temperature 2 Level 2 Alarm.
434	HI PRE ENG T COOLNT	High Pre-Engine Coolant Temperature (Limit 1).
435	SS PRE ENG T COOLNT	High Pre-Engine Coolant Temperature (Limit 2).

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Fault Code Number	String	Description
436	AL L1 P AUX 2	Auxiliary Pressure 2 Level 1 Alarm.
437	AL L2 P AUX 2	Auxiliary Pressure 2 Level 2 Alarm.
438	LO P FUEL RAIL 2 STR	Low pressure on fuel rail 2.
439	HI P FUEL RAIL 2 STR	Hi pressure on fuel rail 2.
440	AL L1 P AUX 1	Pressure input of Aux 1 injured limit 1.
441	AL RAIL 2 LEAKAGE STR	Alarm fuel rail 2 leak detected.
442	AL L2 P AUX 1	Pressure input of Aux 1 injured limit 2.
443	HI P CHG MIX DIFF	High Charge Mix Differential Pressure.
444	SD U PDU	Sensor defect of Injector Power driver unit.
445	SD P AMBIENT AIR	Ambient air pressure-sensor defect.
446	SD P HD2	Sensor Defect In HD 2 Pressure Sensor.
447	HIHI P CHG MIX DIFF	Charge Mixture Differential Pressure High (Limit 2).
448	HI P CHARGE AIR	Pressure of charge air too high (limit 1).
449	SS P CHARGE AIR	Pressure of charge air too high (limit 2).
450	SD IDLE END TRQ IN	Input of Idle/End-Torque defect
451	HI T CHARGE MIX	High Charge Mixture Temperature (Limit 1).
452	HI HI T CHARGE MIX	High Charge Mixture Temperature (Limit 2).
453	LO T CHARGE MIX	Low Charge Mixture Temperature.
454	SS PWR RED ACT	Power Reduction is activated.
455	AL L1 AUX1 PLANT	Input of Aux 1 (plant) injured limit 1.
456	AL L2 AUX1 PLANT	Input of Aux 1 (plant) injured limit 2.
457	LO T INTAKE AIR	Low Intake Air Temperature (Limit 1).
458	LO LO T INTAKE AIR	Low Intake Air Temperature (Limit 2).
459	SD P CLNT B ENG	Sensor Defect In the Coolant Before Engine Pressure Sensor.
460	HI T EXHAUST EMU	Exhaust gas temperature of EMU too high (limit 1).
461	LO T EXHAUST EMU	Exhaust gas temperature of EMU too low (limit 1).
462	HI T COOLANT EMU	Coolant temperature of EMU injured limit 1.
463	SD AUX 2	Sensor defect on Aux 2.
464	SD P AUX 1	Analog input for pressure Aux 1 defect.
465	SD P AUX 2	Sensor Defect in the Auxiliary 2 Pressure Sensor.
466	SD T AUX 2	Sensor Defect in the Auxiliary 2 Temperature Sensor.
467	AL L2 T AUX 1	Temperature input of Aux 1 injured limit 2.
468	SD T AUX 1	Analog input for Temperature Aux 1 defect.
469	SD AUX 1	Analog input for Aux 1 defect.
470	SD T ECU	ECU temperature-sensor defect.
471	SD COIL CURRENT	Coil Current sensor defect.
472	AL STOP SD	Engine stop, because critical channel has sensor defect.
473	AL WIRING PWM CM2	Open load or short circuit on channel PWM CM2.
474	AL WIRING FREQ OUT	Open load or short circuit on frequency output (FO) channel.
475	AL CR TRIG ENG ST	Released in case of an engine stop in order to trigger the crash recorder.
476	AL CRASH REC ERR	Initial error of crash recorder.
477	WRT MISTK BIN VAL	Binary Data Write Error.
478	AL COMB ALM YEL	Combined Alarm YELLOW (Plant).
479	AL COMB ALM RED	Combined Alarm RED (Plant).
480	AL EXT ENG PROT	External Engine Protection function active.
481	SD COIL CURRENT 2	Sensor Defect In Coil Current 2 Sensor.
482	SD T EXHAUST C	Sensor Defect In Exhaust System C Temperature Sensor.

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Fault Code Number	String	Description
483	SD T EXHAUST D	Sensor Defect In Exhaust System D Temperature Sensor.
484	HI T EXHAUST C	High Exhaust C Temperature (Limit 1).
485	SS T EXHAUST C	High Exhaust C Temperature (Limit 2).
486	HI T EXHAUST D	High Exhaust D Temperature.
487	SS T EXHAUST D	Shutdown due to High Exhaust D Temperature.
488	HI ETC 3 OVERSPD	High Turbo Charger ETC 3 Overspeed (Limit 1).
489	SS ETC 3 OVERSPD	High Turbo Charger ETC 3 Overspeed (Limit 2).
490	HI ETC 4 OVERSPD	High Turbo Charger ETC 4 Overspeed (Limit 1).
491	SS ETC 4 OVERSPD	High Turbo Charger ETC 4 Overspeed (Limit 2).
492	HI ETC 4 CUTIN FAIL	High Turbo Charger ETC 4 Cut In Failure (Limit 1).
493	HI ETC 3 CUTIN FAIL	High Turbo Charger ETC 3 Cut In Failure (Limit 2).
494	SD THROTL A FDBK	Sensor Defect In Throttle A Feedback Sensor.
495	SD THROTL B FDBK	Sensor Defect In Throttle B Feedback Sensor.
496	SD P CHARGE MIX A	Sensor Defect In Charge Mix A Pressure Sensor.
497	SD P CHARGE MIX B	Sensor Defect In Charge Mix B Pressure Sensor.
498	SD P CHRG MIX DIFF	Sensor Defect In Charge Mix Differential Pressure Sensor.
499	SD P CHARGE MIX	Sensor Defect In Charge Mix Pressure Sensor.
500	AL WIRING POM STARTER 1	A wiring fault has been detected in the connection of starter 1 of POM.
501	AL WIRING POM STARTER 2	A wiring fault has been detected in the connection of starter 2 of POM.
502	AL OPEN LD POM ALTRNATR	An open load on POM's alternator output has been detected.
503	AL BATT NOT CHARGING	Battery is not being charged by alternator.
504	AL CAN POM NODE LOST	POM is missing on CAN bus.
505	AL NEW POM FOUND	New POM found.
506	AL LOW STARTER VOLTS	Battery voltage is too low for starting.
507	AL POM ERROR	A general POM error has been detected.
508	AL WRONG POM ID	POM sends a different identification number (ID) than expected.
509	AL CHECK POM FUSE	Check POM fuse.
510	AL OVERRIDE APPLIED	Override applied.
511	HIHI P CHG MIX A	Hi Charge Air Mix A Pressure (Limit 2).
512	HIHI P CHG MIX B	Hi Charge Air Mix B Pressure (Limit 2).
513	SD P COOLNT DIFF	Sensor Defect In Coolant Differential Pressure Sensor.
514	WRITE ERR FLASH	Write Error Occurred when writing data to Flash Memory.
515	STARTER NOT ENGAGED	Starter of POM could not be engaged.
516	OILNIVEAU CAL ERR	Remote Oil Level Watchman Calibration Error.
517	SD CHG MX PR THRT	Sensor Defect In Charge Pre-Throttle Mix Pressure Sensor.
518	SD THROT BYPASS FDBK	Sensor Defect In Throttle Feedback Bypass Sensor.
519	OIL LVL CAL ERROR	Oil Level Calibration Error.
520	SD P IN AIR AFT FLT A	Sensor Defect In Intake Air After Filter A Pressure Sensor.
521	SD P OIL MID VAL	Lube Oil Pressure Middle Value (Limit 2).
522	SD P IN AIR AFT FLT B	Sensor Defect In Intake Air After Filter B Pressure Sensor.
523	SD T COOL RED MIDVL	Coolant Temperature Mid value (Limit 2).
524	SS ENG OVRSPD MIDVL	Engine Speed Middle Value too high (Limit 2).
525	SD P LUBE OIL R2	Sensor Defect In Lube Oil Pressure (R2) Sensor.
526	SD T COOL OIL R2	Sensor Defect In Oil Coolant Temperature (R2) Sensor.
527	TD ENG SPD SNS DEV	Engine Speed Sensor Deviation.

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Fault Code Number	String	Description
528	SD ENG SPD SENSR 3	Sensor Defect in Engine Speed Third Sensor.
529	SS T COOL RED 2	Coolant Temperature Red 2 Alarm (Limit 2).
530	SS P LUBE OIL RED 2	Lube Oil Pressure Red 2 Alarm (Limit 2).
531	AL WIRING PWM CM1	PWM CM1 Wiring Issue.
532	AL WIRING PWM1	PWM 1 Wiring Issue.
533	AL WIRING PWM2	PWM 2 Wiring Issue.
534	HIHI POWER DIFF	Power Difference High (Limit 2).
535	LOLO POWER DIFF	Power Difference Low (Limit 2).
536	AL WIRING PWM1 CM1	PWM CM1 Wiring Issue.
537	SD P VNTRI DLTA SD A	Sensor Defect In Venture Side A Delta Pressure Sensor.
538	SD P VNTRI DLTA SD B	Sensor Defect In Venture Side B Delta Pressure Sensor.
539	SD P EGR VNTRI STATIC	Sensor Defect In EGR Venture Static Pressure Sensor.
540	SD T EGR	Sensor Defect In EGR Temperature Sensor.
541	AL L1 T EGR	EGR Temperature (Limit 1) Alarm.
542	AL L2 T EGR	EGR Temperature (Limit 2) Alarm.
543	MULTIPLE FDH SLAVES	There is more than one device which is configured as Backup for FDH-Functionality.
544	CONFIGURATION CHANGED	Gets active in case of changing system configuration e.g. by changing ECU- or SAM-Device. Remains until undo procedure or data is transferred by a valid maintenance case. Is cancelled automatically.
545	AL L1 P EXT PLNT1	External Plant 1 Pressure Alarm (Limit 1).
546	AL L1 P EXT PLNT2	External Plant 2 Pressure Alarm (Limit 1).
547	AL L1 T EXT PLNT1	External Plant 1 Temperature Alarm (Limit 1).
548	AL L1 T EXT PLNT2	External Plant 2 Temperature Alarm (Limit 1).
549	AL PWR CUTOFF DET	Power Cutoff Detected.
550	SS ENG OVRSP RED2	Engine Overspeed Red2 (Limit 1) Alarm.
551	SS ENG OVRSPD CAMSFT	Engine Overspeed Camshaft (Limit 1) Alarm.
552	AL GAS CTRL CHK FLT	Gas Control Check Fault Alarm.
553	AL AUX DEVICES FLT	Auxiliary Devices Alarm.
554	AL IGNITION FAULT	Ignition Fault Alarm.
555	AL CALL FIELD SERVICE	Gets active in case of completing a maintenance-case which manipulates Engine-Parameters. Remains also after switching on-off ECU until a valid release code is entered via Display- and Button-Control of SAM-Device. Release Code is available via Internet by a special procedure.
556	AL GAS VALVE FLT	Gas Valve Fault Alarm.
557	AL ENG SPD COLL. FLT	Engine Speed Collapse Fault Alarm.
558	AL WIRING PWM CM2	PWM CM2 Wiring Issue.
559	AL MIX THRT A FLT	Throttle A Mixture Fault Alarm.
560	AL MIX THRT B FLT	Throttle B Mixture Fault Alarm.
561	AL LIM EXT PLNT BIN1	External Plant Bin 1 Limit Alarm.
562	AL LIM EXT PLNT BIN2	External Plant Bin 2 Limit Alarm.
563	AL LIM EXT PLNT BIN3	External Plant Bin 3 Limit Alarm.
564	AL LIM EXT PLNT BIN4	External Plant Bin 4 Limit Alarm.
565	L1 P AFTER AIR FLT A	Intake A Air Pressure After Filter (Limit 1).
566	L2 P AFTER AIR FLT A	Intake A Air Pressure After Filter (Limit 2).
567	L1 P AFTER AIR FLT B	Intake B Air Pressure After Filter (Limit 1).
568	L2 P AFTER AIR FLT B	Intake B Air Pressure After Filter (Limit 2).
569	AL SAM MSG DATA FLT	SAM Module Missing Data Fault.
570	L1 CAN MAX TIMG RETRD	Maximum Timing Retard from CAN (Limit 1).

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Fault Code Number	String	Description
571	L2 CAN MAX TIMG RETRD	Maximum Timing Retard from CAN (Limit 2).
572	L3 CAN MAX TIMG RETRD	Maximum Timing Retard from CAN (Limit 3).
573	SD P DIFF STR VS VRD	Sensor Defect in Pressure Differential Sensor Pitot Tube vs. Pressure.
574	SD M AIR EGR BEF CLR	Sensor Defect In Air Mass Sensor before EGR Cooler.
575	SD M INTAKE AIR	Sensor Defect In Intake Air Mass Sensor.
576	AL ESCM OVERRIDE STR	Exceeding of the corrected current MCR - odr DBR/MCR value.
577	SD T LUBE OIL PAN	Sensor Defect In Oil Pan Lube Oil Temperature Sensor.
578	AL L1 T LUBOIL PAN	Lube Oil Pan Temperature (Limit 1).
579	AL MD CANRQ IDLE SPD	MD Idle Speed Request over Can Bus.
580	AL CAN SPD LIMIT	MD Speed Limitation From Can Bus.
581	AL PWM CM3	PWM CM3 Alarm.
582	AL EMERG STOP FL	Emergency Stop Failed Alarm.
583	AL BRKR CLOSED	Circuit Breaker Closed Alarm.
584	AL CAN STRTCLR FL	Start Clearance from Can Bus Fail Alarm.
585	AS MOTORSTRT BL	Engine Start Blocked Alarm.
586	LO P OIL REFILL PMP	Refill Pump Lower Oil Pressure.
587	AL WIRING PWM CM4	PWM CM4 Wiring Issue.
588	SD P OIL REFILL PUMP	Sensor Defect In Refill Pump Oil Pressure Sensor.
589	SD T EGR SIDE B	Side B EGR Temperature Alarm.
590	SD P DLTA EXHAUST A	Sensor Defect In Exhaust A Pressure Delta Sensor.
591	SD P EGRB VNTRI STATC	Sensor Defect In Side B EGR Venture Static Pressure Sensor.
592	AS P DLTA EXH B	Sensor Defect In Exhaust B Pressure Delta Sensor.
593	SD OIL T J1939	Sensor Defect in Lube Oil Pan Temperature Sensor.
594	AL L1 PRV 1 DEFECT STR	Yellow alarm pressure relief valve first rail.
595	AL L2 PRV 1 DEFECT STR	Red alarm pressure relief valve first rail.
596	DEVELOP PR SET	Develop PR Set Alarm.
597	AL WIRING PWM CM5	PWM CM5 Wiring Issue.
598	AL L1 PRV 2 DEFECT STR	Yellow alarm pressure relief valve second rail.
599	AL L2 PRV 2 DEFECT STR	Red alarm pressure relief valve second rail.
600	SD T EXG A+B	Sensor Defect In Exhaust A Plus B Temperature Sensor.
601	SD ETC1 + EC2	Turbo Charger Speed Sensors 1 and 2 Faulty.
602	AK CAB ENG STRT LOCK	Engine Start Lock from Can Alarm.
603	SD AIR HUMIDITY	Sensor Defect In Air Humidity Sensor.
604	AL HUT CHGSPD MAX	HUT Speed Change Maximum Limit Alarm.
605	AL HUT DEV TOO HI	HUT DEV too high limit alarm.
606	AL DBL NODES LOST 1+2	Nodes Lost on Can1 and Can2 Alarm.
607	AL MD CAN STOP	MD Can Stop Alarm.
608	AL WIRING PWM CM6	PWM CM6 Wiring Issue.
609	AL WIRING PWM CM7	PWM CM7 Wiring Issue.
610	AL WIRING SUCK RESTRCT 1 STR	Open load or short circuit on PWM HP fuel control block channel.
611	AL WIRING SUCK RESTRCT 2 STR	Open load or short circuit on PWM HP fuel control block channel 2.
612	AL WIRING PRESS CTRL VLV 1 STR	Open load or short circuit on PWM pressure regulating valve channel.
613	AL WIRING PRESS CTRL VLV 2 STR	Open load or short circuit on PWM pressure regulating valve channel 2.
614	L1 P FUEL SEC FLTDIFF	Secondary Filter Fuel Pressure Limit 1 Alarm.

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Fault Code Number	String	Description
615	AL EIL PROTECTION STR	Alarm for Protection Module in response to faulty or manipulated EIL.
616	AL EIL ERROR STR	EIL Error.
617	LO ACTUAL HU VAL	HU Actual Value Low (Limit 1).
618	LOLO ACTUAL HU VAL	HU Actual Value Low (Limit 2).
619	HI ACTUAL HU VAL	HU Actual Value High (Limit 1).
620	HIHI ACTUAL HU VAL	HU Actual Value High (Limit 2).
621	LO NOX VALUE	NO_X Value Low (Limit 1).
622	LOLO NOX VALUE	NO_X Value Low (Limit 2).
623	HI NOX VALUE	NO_X Value High (Limit 1).
624	HIHI NOX VALUE	NO_X Value High (Limit 2).
625	SD P FUEL ADD SEC FLT	Sensor Defect in Pressure Sensor that meters Fuel Pressure Before supplemental Filter.
626	AL WIRING PWM CM8	PWM CM8 Wiring Issue.
627	AL WIRING PWM CM9	PWM CM9 Wiring Issue.
628	AL WIRING PWM CM10	PWM CM10 Wiring Issue.
629	EGR THOTTLE A DFCT	EGR Throttle EGR Defect.
630	EGR THOTTLE B DFCT	EGR Throttle EGR Defect.
631	AL BYPASS THROT DFCT	Bypass Throttle Defect.
632	AL DISPNS THRTL DFCT	Dispenser Throttle Defect.
633	SD P AMBAIR HDT2800	Sensor Defect in Ambient HD2800 Air Pressure Sensor.
634	SD T AMBAIR HDT2800	Sensor Defect in Ambient HD2800 Air Temperature Sensor.
635	SD H AMBAIR HDT2800	Sensor Defect in Ambient HD2800 Air Humidity Sensor.
636	SD OIL LVL J1939	Sensor Defect in J1939 Lube Oil Level Sensor.
637	SD OIL T J1939	Sensor Defect in J1939 Lube Oil Temperature Sensor.
638	AL WIRING PWM SIG1	PWM SIG1 Wiring Issue.
639	AL WIRING PWM SIG2	PWM SIG2 Wiring Issue.
640	SD SM NOX O2 FACTR	Sensor Defect In Smart NOX Oxidation Factor Sensor.
641	AS SYS WATCHDG RST	System Restart by Watchdog Detected.
642	SD ELCT ENG PWR AI2	Sensor Defect In Engine Power AI2 Electronic Sensor.
643	SP P FUEL BOF	Sensor Defect in BOF Fuel Pressure Sensor.
644	AL L1 P FUEL BOF	BOF Fuel Pressure Limit 1.
645	AL L2 P FUEL BOF	BOF Fuel Pressure Limit 2.
646	AL KNOCK INTNSTY	Knock Intensity Too High.
647	SD P EXH LAMBDA	Sensor Defect in Exhaust Lambda Pressure Sensor.
648	SD P CHRG AIR B	Sensor Defect In Charge Air B Pressure Sensor.
649	AL REQ ANGL THRT A	Throttle A Angle Alarm.
650	AL REQ ANGL THRT B	Throttle B Angle Alarm.
651	AL PREHT ERROR	Preheating Error Alarm.
652	AL GET COM LOST	GET Communications Lost.
653	AL IX92X COMM LOST	IC92X Communications Lost.
654	AL FSERIES COMM LOST	F Series Communications Lost.
655	AL TECJET COMM LOST	TECJET Communications Lost.
656	AL PROACT A COMM LST	PROACT A Communications Lost.
657	AL PROACT B COMM LST	PROACT B Communications Lost.
658	AL NOXA COMM LOST	NO_X A Communications Lost.
659	AL NOXB COMM LOST	NO_X B Communications Lost.
660	AL PHYTRNA COM LST	PHYTRON A Communications Lost.

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Fault Code Number	String	Description
661	AL PHYTRNB COM LST	PHYTRON B Communications Lost.
662	SD SMRT NOX HTR	Sensor Defect in Smart NOX Heater Element Sensor.
663	SD SMRT NOX CONC.	Sensor Defect in Smart NOX Concentration Sensor.
664	AL OIL REFILL ERR	Oil Refill Error.
665	AL GET YELLOW	GET Yellow Alarm.
666	AL IC92X YELLOW	IC92X Yellow Alarm.
667	AL FSERIES YELLOW	F Series Yellow Alarm.
668	AL TECJET YELLOW	TECJET Yellow Alarm.
669	AL PROACTA YELLOW	PROACT A Yellow Alarm.
670	AL PROACTB YELLOW	PROACT B Yellow Alarm.
671	AL NOXA YELLOW	NOX A Yellow Alarm.
672	AL NOXB YELLOW	NOX B Yellow Alarm.
673	AL PHYA YELLOW	PHYTRON A Yellow Alarm.
674	AL PHYB YELLOW	PHYTRON B Yellow Alarm.
675	AL GET RED	GET Red Alarm.
676	AL IC92X RED	IC92X Red Alarm.
677	AL FSERIES RED	F Series Red Alarm.
678	AL TECJET RED	TECJET Red Alarm.
679	AL PROACTA RED	PROACT A Red Alarm.
680	AL PROACTB RED	PROACT B Red Alarm.
681	AL NOXA RED	NOX A Red Alarm.
682	AL NOXB RED	NOX B Red Alarm.
683	AL PHYA RED	PHYTRON A Red Alarm.
684	AL PHYB RED	PHYTRON B Red Alarm.
685	AL LUBE OIL MIN	Lube Oil Minimum.
686	AL LUBE OIL MAX	Lube Oil Maximum.
687	AL LUBEOIL LVL SW	Lube Oil Level Switch is Faulty.
688	LO OIL REFILL	Low Oil Refill.
689	HI OIL REFILL	High Oil Refill.
690	AL LUBEOIL LVL LO	Lube Oil Level Low.
691	HI LUBEOIL LVL REFILL	Lube Oil Refill Level High.
692	AL ECU PWR OFF ON REQ STR	ECU configuration changed, switch power off/on.
693	AL MB VALVE ERR	MB Valve Error.
694	SD T GAS	Sensor Defect in Gas Temperature Sensor.
695	AL EGR FAILURE	EGR Failure Alarm.
696	AL SMARTCONCT USB ERR STR	Alarm configuration parameter.
697	AL SMARTCONCT RS485 ERR STR	Alarm configuration parameter.
698	AL SD STOP BUTTON STR	Channel signals open load or internal error.
700	AL SD START BUTTON STR	Channel signals open load.
701	AL SD UP BUTTON STR	Channel signals open load.
702	AL SD DN BUTTON STR	Channel signals open load or internal error.
703	AL SD EXT SPEED DMD SW STR	Channel signals open load.
704	AL SD SPEED DMD INCREASE STR	Channel signals open load or internal error.

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Fault Code Number	String	Description
705	AL SD BINARY SPD DMD LMT STR	Channel signals open load or internal error.
706	AL SD DROOP 2 SWITCH STR	Channel signals open load or internal error.
707	AL SD FREQUENCY SWITCH STR	Channel signals open load or internal error.
709	AL SD OVERRIDE BUTTON STR	Channel signals open load or internal error.
710	AL SD ALARM RESET STR	Channel signals open load or internal error.
711	AL SD CYLINDER CUTOUT STR	Channel signals open load or internal error.
712	AL SD RQST BIN OUT TST STR	Channel signals open load or internal error.
713	AL SD EXT ENGINE PROTECTN STR	Channel signals open load or internal error.
714	AL SD PRELUBE SIGNAL STR	Channel signals open load.
715	AL SD EXT INC IDLE BIN STR	Channel signals open load.
716	AL SD EXT INC IDLE BIN BRK STR	Channel signals open load.
717	AL SD RQST PLANT DBR STR	Channel signals open load.
718	INTK AIR THRTL DFCT	Intake Air Throttle Defect.
719	AL T GAS L1	Gas Temperature Limit Alarm (Limit 1).
720	AL T GAS L2	Gas Temperature Limit Alarm (Limit 2).
721	AL T GAS L3	Gas Temperature Limit Alarm (Limit 3).
722	AL T GAS L4	Gas Temperature Limit Alarm (Limit 4).
723	SD T EXH BEF DOC A	Sensor Defect Exhaust Temperature Sensor before DOC.
724	SD T EXH BEF DPF A	Sensor Defect Exhaust Temperature Sensor before DPF.
725	SD T EXH AFTR DPF A	Sensor Defect Exhaust Temperature Sensor after DPF
726	SD P DELTA EXH DPF A	Sensor Defect in DPF Exhaust Pressure Delta Sensor.
727	L1 DELTA T_NT INTRCLR	NT Intercooler NT Temperature (Limit 1) Alarm.
728	L2 DELTA T_NT INTRCLR	NT Intercooler NT Temperature (Limit 2) Alarm.
729	L1 T EXH BEF DOC	Exhaust Temperature Before DOC (Limit 1) Alarm.
730	L2 T EXH BEF DOC	Exhaust Temperature Before DOC (Limit 2) Alarm.
731	L2 T EXH BEF DPF	Exhaust Temperature Before DPF (Limit 1) Alarm.
732	L2 T EXH BEF DPF	Exhaust Temperature Before DPF (Limit 2) Alarm.
733	L1 T EXH AFTR DPF	Exhaust Temperature After DPF (Limit 1) Alarm.
734	L2 T EXH AFTR DPF	Exhaust Temperature After DPF (Limit 2) Alarm.
735	L1 P_DPF DIFF	DPF Exhaust Pressure Difference Alarm (Limit 1) Alarm.
736	L2 P_DPF DIFF	DPF Exhaust Pressure Difference Alarm (Limit 2) Alarm.
737	L1 P_DPF NORM DIFF	DPF Normal Difference Pressure (Limit 1) Alarm.
738	L2 P_DPF NORM DIFF	DPF Normal Difference Pressure (Limit 2) Alarm.
739	L3 P_DPF NORM DIFF	DPF Normal Difference Pressure (Limit 3) Alarm.
740	L4 P_DPF NORM DIFF	DPF Normal Difference Pressure (Limit 4) Alarm.
741	DPF RIGOROUS TM ABORT	DPF Rigorous TM Aborted Alarm.
742	DPF PER RIGOROUS TM	DPF Periodic Rigorous TM Alarm.
743	DPF RIG TM SUPPR	DPF Rigorous TM Suppressed Alarm.
744	DPF FLASH READ ERR	DPF Flash Memory Read Error Alarm.

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Fault Code Number	String	Description
745	AL EMISSN FLT	Emission Fault Alarm.
746	AL EMISSN FLT2	Emission Fault 2 Alarm.
747	SD P INTK AIRFLT DIFF	Sensor Defect in the Intake Air Filter Differential Pressure Sensor.
748	SD T EXH BEF SCR F1	Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 1.
749	SD T EXH BEF SCR F2	Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 2.
750	SD T EXH AFTR SCR F1	Sensor Defect in Exhaust Temperature Sensor After SCR Filter 1.
751	SD T EXH AFTR SCR F2	Sensor Defect in Exhaust Temperature Sensor After SCR Filter 2.
752	SD DEF TANK LVL	Sensor Defect in DEF Tank Level Sensor.
753	SD T RM TANK	Sensor Defect in RM Tank Temperature Sensor.
754	SD BOSCH LSU LMBDA SNS	Sensor Defect In Bosch LSU Lambda Sensor.
755	SELCTD MODE NOT VLD	Selected Mode Not Valid Alarm.
756	NO VLD MODE SW SGNL	No Valid Mode Switch Alarm.
757	AL LIM T COOL LT FAN	Coolant LT Fan Limit (Limit 1) Alarm.
758	DEF NOZZLE DAMG	DEF Nozzle Damage Alarm.
759	L1 T FUEL B ENGINE	Fuel Temperature Before Engine too high (Limit 1) Alarm.
760	L2 T FUEL B ENGINE	Fuel Temperature Before Engine too high (Limit 2) Alarm.
761	SD T FUEL B ENGINE	Sensor Defect In Sensor metering Fuel Temperature Before Engine Alarm.
762	AL SMRT CNCT LOST	Smart Connect Lost Alarm.
763	AL OL ASO FLP FDBK B	OL ASO Flap B Feedback Alarm.
764	ASO FLP B CLSD A FL	ASO Flap B Closed A Failed Alarm.
765	AL OL ASO FLP FDBK A	OL ASO Flap A Feedback Alarm.
766	ASO FLP A CLSD B FL	ASO Flap A Closed B Failed Alarm.
767	ASP FLAPS CLOSED	ASO Flaps Closed Alarm.
768	ST T EXH V HPTURBN A1	Sensor Defect In Exhaust V HP Turbine A1 Temperature Sensor.
769	SD T EXH AFTR ENG	Sensor Defect In Exhaust Temperature After Engine Sensor.
770	SD T SEA WATER PUMP	Sensor Defect In Sea Water After Pump Temperature Sensor.
771	SD T FUEL B	Sensor Defect In Fuel Temperature B Sensor.
772	SD LVL OIL REFILL TNK	Sensor Defect In Refill Tank Oil Level Sensor.
773	SD P FUEL RTN PATH	Sensor Defect In Return Path Fuel Pressure Sensor.
774	SD P FUEL BEFR ENG	Sensor Defect In Fuel Pressure Before Engine Sensor.
775	SD P SCHM AFT LVL PMP	Sensor Defect In After Level Pump Oil Pressure Sensor.
776	SD P SCHM AT HPPUMP A	Sensor Defect In Oil Pressure at HP Pump A Sensor.
777	SD P SCHM AT HPPUMP B	Sensor Defect In Oil Pressure at HP Pump B Sensor.
778	ASO FLPS OPN FL TO CLS	ASO Flaps Open, Failed to Close Alarm.
779	WRONG NOX SNSR E1	NO_X Sensor E1 Wrong Position Alarm.
780	WRONG NOX SNSR E2	NO_X Sensor E2 Wrong Position Alarm.
781	WRONG NOX SNSR E3	NO_X Sensor E3 Wrong Position Alarm.
782	SD P LUBOIL ETC A	Turbo Charger A Lube Oil Pressure Too High.
783	SD T EXH BEFR SCR F3	Sensor Defect In Before SCR Exhaust Temperature Sensor.
784	SD T EXH AFTR SCR F3	Sensor Defect In After SCR Exhaust Temperature Sensor.
785	L1 P OIL BEF HD PMP A	Oil Pressure Before HD PUMP A (Limit 1) Alarm.
786	L1 P OIL BEF HD PMP B	Oil Pressure Before HD PUMP B (Limit 1) Alarm.
787	L1 P OILNIV PUMP	Oil Pressure in Oil Niveaux Pump (Limit 1) Alarm.
788	ETC SPD FL DETECT	Turbo Charger Speed Failure Detected.
789	WRONG POS TMP SNS E1	Temperature Sensor E1 Wrong Position Alarm.
790	WRONG POS TMP SNS E2	Temperature Sensor E2 Wrong Position Alarm.
791	WRONG POS TMP SNS E3	Temperature Sensor E3 Wrong Position Alarm.

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Fault Code Number	String	Description
792	L1 P CHARGE AIR B	Charge Air B Pressure (Limit 1) Alarm.
793	L2 P CHARGE AIR B	Charge Air B Pressure (Limit 2) Alarm.
794	L1 P FL BEFR ENGN	Fuel Pressure Before Engine (Level 1) Alarm.
795	L1 P FUEL RTN	Fuel Pressure in Return Path (Limit 1) Alarm.
796	HI T CHARGE AIR B	High Charge Air B Temperature (Limit 1) Alarm.
797	HIHI T CHRG AIR B	High Charge Air B Temperature (Limit 2) Alarm.
798	L1T EXH BEF HPTRBN A1	Exhaust Temperature Before HP Turbine A1 (Limit 1) Alarm.
799	L2T EXH BEF HPTRBN A1	Exhaust Temperature Before HP Turbine A1 (Limit 2) Alarm.
800	L1 T EXH AFTR ENGINE	Exhaust Temperature After Engine (Limit 1) Alarm.
801	L1T RAW WATR AFTR PMP	Raw Water After Pump Temperature (Limit 1) Alarm.
802	L1T FUEL BEFR ENGINE	Fuel Temperature Before Engine (Limit 1) Alarm.
803	HI T FUEL B	High Fuel B Temperature (Limit 1) Alarm.
804	SS T FUEL B	High Fuel B Temperature (Limit 2) Alarm.
805	LO OIL LVL REFILL	Refill Oil Level Low Alarm.
806	SD CHARGR 3 SPD	Sensor Defect In Turbo Charger 3 Speed Sensor.
807	SD CHARGR 4 SPD	Sensor Defect In Turbo Charger 4 Speed Sensor.
808	SD CHARGR 5 SPD	Sensor Defect In Turbo Charger 5 Speed Sensor.
809	SD F1 NOX BEFOR SCR	Sensor Defect In F1 NO_X Before SCR sensor.
810	NO COMS F1NOX BF SCR	Communications Lost with F1 NO_X Before SCR sensor.
811	SD F1 NOX AFTR SCR	Sensor Defect In F1 NO_X After SCR sensor.
812	NO COMS F1NOX AF SCR	F1 NO_X After SCR Communications lost alarm.
813	SD F2 NOX BEFOR SCR	Sensor Defect In F2 NO_X Before SCR sensor.
814	NO COMS F2NOX BF SCR	F2 NO_X Before SCR Communications lost alarm.
815	SD F2 NOX AFTR SCR	Sensor Defect In F2 NO_X After SCR sensor.
816	NO COMS F2NOX AF SCR	F2 NO_X After SCR Communications lost alarm.
817	SD F3 NOX BEFOR SCR	Sensor Defect In F3 NO_X Before SCR sensor.
818	NO COMS F3NOX BF SCR	F3 NO_X Before SCR Communications lost alarm.
819	SD F3 NOX AFTR SCR	Sensor Defect In F3 NO_X After SCR sensor.
820	NO COMS F3NOX AF SCR	F3 NO_X After SCR Communications lost alarm.
821	HI ETC1 IDLE SPEED	Turbo Charger 1 Speed at Idle Too High.
822	HI ETC2 IDLE SPEED	Turbo Charger 2 Speed at Idle Too High.
823	HI ETC3 IDLE SPEED	Turbo Charger 3 Speed at Idle Too High.
824	HI ETC4 IDLE SPEED	Turbo Charger 4 Speed at Idle Too High.
825	HI ETC5 IDLE SPEED	Turbo Charger 5 Speed at Idle Too High.
826	AL ETC1 SPD DEVTN	Turbo Charger 1 Speed Deviation.
827	AL ETC2 SPD DEVTN	Turbo Charger 2 Speed Deviation.
828	AL ETC3 SPD DEVTN	Turbo Charger 3 Speed Deviation.
829	AL ETC4 SPD DEVTN	Turbo Charger 4 Speed Deviation.
830	AL ETC5 SPD DEVTN	Turbo Charger 5 Speed Deviation.
831	AL ETC JOB ROTATN	Turbo Charger Job Rotation Alarm.
832	EIL DIFF ENG NUMBR	EIL Different Engine Number Alarm.
833	AL EMISSION WRN	Emission Warning Alarm.
834	AL GAS PATH WRN	Gas Path Warning Alarm.
835	AL GAST PATH FLT	Gas Path Fault Alarm.
836	AL SPEED DMD FAIL	Speed Demand Failure Alarm.
837	BYPASS VLV DEFCT	Bypass Valve Defect Alarm.
838	AL ASH VOLUME	Ash Volume Alarm.

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Fault Code Number	String	Description
839	ECU NT CLS ECO FLAP A	ASO Flap A not closed by ECU Alarm.
840	ECU NT CLS ECO FLAP B	ASO Flap B not closed by ECU Alarm.
841	SD P GASLN COM RL	Sensor Defect in Gasoline Common Rail Pressure Sensor.
842	AL ACT FL VLV POS L1	ACT Fuel Valve Position (Limit 1) Alarm.
843	SD T CHRG AIR BEF EGR	Sensor Defect in Charge Air Before EGR Temperature Sensor.
844	HI T CHRG AIR BEF EGR	Charge Air Before EGR High Temperature (Limit 1) Alarm.
845	HIHI T CHRGAIR BF EGR	Charge Air Before EGR High Temperature (Limit 2) Alarm.
846	HI T CHRG AIR DIFF AB	Charge Air Differential AB High Temperature (Limit 1) Alarm.
847	HIHI T CHRG AIR DF AB	Charge Air Differential AB High Temperature (Limit 2) Alarm.
848	AL REL HUMIDTY L1	Relative Humidity (Limit 1) Alarm.
849	AL IBT FUNCT ACTV	IBT Function Active Alarm.
850	SD ALIVE FIP	Sensor Defect in ALIVE FIP sensor.
851	AL EXT STRT HD HI	External Start and HD Too High Alarm.
852	MAX BLNK SH TM EXP	Max Blank Shot Time Expired Alarm.
853	HSB1 COMMS LOST	HSB1 Communications Lost Alarm.
854	HSB1 ACUTATR DEFCT	HSB1 Actuator Defect Alarm.
855	BYPASS THR2 DEFCT	Bypass Throttle 2 Defect Alarm.
856	SD P LUBOIL ETC B	Sensor Defect In Turbo Charger Oil Pressure Sensor.
857	NOX ATO1 SENSR DEFCT	NOX ATO 1 Sensor Defect Alarm.
858	L1 P LUBOIL ETC B	Turbo Charger B Oil Pressure Low (Limit 1).
859	HSB2 COMMS LOST	HSB2 Communications Lost Alarm.
860	HSB2 ACUTATR DEFCT	HSB2 Actuator Defect Alarm.
861	DEF IN PIPE S_ACT SYS	DEF in DEF Pipe in ACT system Alarm.
862	DEF TNK HT SNS_ACT SD	DEF Tank ACT Sensor Defect.
863	HSB3 COMMS LOST	HSB3 Communications Lost Alarm.
864	HSB3 ACUTATR DEFCT	HSB3 Actuator Defect Alarm.
865	HSB4 COMMS LOST	HSB4 Communications Lost Alarm.
866	HSB4 ACUTATR DEFCT	HSB4 Actuator Defect Alarm.
867	L1 P LUBOIL ETC A	Turbo Charger A Oil Pressure Low (Limit 1).
868	L2 P LUBOIL ETC A	Turbo Charger A Oil Pressure Low (Limit 2).
869	L2 P LUBOIL ETC B	Turbo Charger B Oil Pressure Low (Limit 2).
870	AL MB VLV DEFCT 2	MB Valve Defect 2 Alarm.
871	NOX ATO1 COMS LOST	NO_X ATO 1 Communications Lost Alarm.
872	EGR A REF LEARN FAIL	EGR Reference Learning Algorithm Failure Alarm.
873	DEF TNK LVL EMPTY	DEF Tank Level Empty Alarm.
874	SCR FAIL	SCR Failure Alarm.
875	ADBLUE TANK LOW	ADBLUE (DEF) Tank Level Low Alarm.
876	EGR B REF LEARN FAIL	EGR B Reference Learning Algorithm Failure Alarm.
877	BYP A REF LEARN FAIL	Bypass A Reference Learning Algorithm Failure Alarm.
878	BYPASS B FAST LRN FL	Bypass B Fast Learn Algorithm Failure Alarm.
879	DISPNSR REF LRN FL	Dispenser Reference Learn Algorithm Failure Alarm.
880	INTAKEAIR REF LRN FL	Intake Air Reference Learn Algorithm Failure Alarm.
881	AL UREA QLTY RELEASE	Urea Quality Release Alarm.
882	SCR F1 SU REVLTN RNG	SCR F1 SU Revolution Range Alarm.
883	SCR F2 SU REVLTN RNG	SCR F2 SU Revolution Range Alarm.
884	SCR F1 SU ADBLUE QNTY	SCR F1 SU ADBLUE Quantity.
885	SCR F2 SU ADBLUE QNTY	SCR F2 SU ADBLUE Quantity.

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Fault Code Number	String	Description
886	SCR ADBLUE PRESSR	SCR ADBLUE Pressure Alarm.
887	SCR SU PRIME REQUEST	SCR SU Priming Request Alarm.
888	SCR SU ADBLUE PRESSR	SCR SU ADBLUE Pressure Alarm.
889	SD T LUBEOIL ETC	Sensor Defect In Turbo Charger Oil Temperature Sensor.
890	L2 T LUBEOIL ETC	Lube Oil Temperature Too High (Limit 2).
891	AL TURNING ACTIVATED	Turning Activation Alarm.
892	FLO1 SPPLYUNT1 COM LS	Lost Communications with Air Flow 1 Supply Unit 1.
893	FLO1 SPPLYUNT2 COM LS	Lost Communications with Air Flow 1 Supply Unit 2.
894	FLO2 SPPLYUNT1 COM LS	Lost Communications with Air Flow 2 Supply Unit 1.
895	FLO2 SPPLYUNT2 COM LS	Lost Communications with Air Flow 2 Supply Unit 2.
896	FLO3 SPPLYUNT1 COM LS	Lost Communications with Air Flow 3 Supply Unit 1.
897	FLO3 SPPLYUNT2 COM LS	Lost Communications with Air Flow 3 Supply Unit 2.
898	TRICAN COMMS LOST	Communications Lost on TRICAN network.
899	OLT COMMS LOST	Communications to OLT Lost.
900	SCRF3 SU REV RNG	SCR F3 SU Revolution Range Alarm.
901	SCRF3 SU ADBLUE QTY	SCR F3 SU Adblue Quantity Low.
902	HI TCOOL CYL HEAD	High Cylinder Head Coolant Temperature (Limit 1).
903	SD TCOOL CYL HEAD	Sensor Defect in Cylinder Head Coolant Temperature Sensor.
904	SS TCOOL CYL HEAD	High Cylinder Head Coolant Temperature (Limit 2).
905	ADBLUE EXP CNS FL	ADBLUE Expected Consumption Failure Alarm.
906	ADBLUE BALANCE FL	ADBLUE Balance Failed Alarm.
907	NOX RAW EMISSN FL	NO_X Raw Gas Emission Failed Alarm.
908	APPRCH NOX DOS STP FL	Approach NO_X Dosing Stop Failed Alarm.
909	SCR TEXH BTW FLOWS FL	Exhaust Temperature Between SCR Flows Failed Alarm.
910	EXP TEXH BFR SCR FL	Expected Exhaust Temperature Before SCR Failure Alarm.
911	EXP TEXH AFT SCR FL	Expected Exhaust Temperature After SCR Failure Alarm.
912	SCR F1 TEXH BFR GRDNT	SCR F1 Exhaust Temperature Before Gradient Alarm.
913	SCR F2 TEXH BFR GRDNT	SCR F2 Exhaust Temperature Before Gradient Alarm.
914	SCR F3 TEXH BFR GRDNT	SCR F3 Exhaust Temperature Before Gradient Alarm.
915	SCR F1 TEXH AFT GRDNT	SCR F1 Exhaust Temperature After Gradient Alarm.
916	SCR F2 TEXH AFT GRDNT	SCR F2 Exhaust Temperature After Gradient Alarm.
917	SCR F3 TEXH AFT GRDNT	SCR F3 Exhaust Temperature After Gradient Alarm.
918	L1 T LUBEOIL ETC	Turbo Charger Lube Oil Temperature High (Limit 1).
919	ENERGY CNTR DEFCT	Energy Counter Defect Alarm.
920	L1 TEXH BFR SCRF1	Exhaust Temperature Before SCR F1 (Limit 1) Alarm.
921	L2 TEXH BFR SCRF1	Exhaust Temperature Before SCR F1 (Limit 2) Alarm.
922	L1 TEXH AFT SCRF1	Exhaust Temperature After SCR F1 (Limit 1) Alarm.
923	L2 TEXH AFT SCRF1	Exhaust Temperature After SCR F1 (Limit 2) Alarm.
924	L1 TEXH BFR SCRF2	Exhaust Temperature Before SCR F2 (Limit 1) Alarm.
925	L2 TEXH BFR SCRF2	Exhaust Temperature Before SCR F2 (Limit 2) Alarm.
926	L1 TEXH AFT SCRF2	Exhaust Temperature After SCR F2 (Limit 1) Alarm.
927	L2 TEXH AFT SCRF2	Exhaust Temperature After SCR F2 (Limit 2) Alarm.
928	L1 TEXH BFR SCRF3	Exhaust Temperature Before SCR F3 (Limit 1) Alarm.
929	L2 TEXH BFR SCRF3	Exhaust Temperature Before SCR F3 (Limit 2) Alarm.
930	L1 TEXH AFT SCRF3	Exhaust Temperature After SCR F3 (Limit 1) Alarm.
931	L2 TEXH AFT SCRF3	Exhaust Temperature After SCR F3 (Limit 2) Alarm.
932	AL MIC5 YELLOW	MIC 5 Yellow Alarm.

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Fault Code Number	String	Description
933	AL MIC5 RED	MIC 5 Red Alarm.
934	AL MIC5 COMM LOST	MIC 5 Comms Lost Alarm.
935	LO F1 TEXH BFR SCR	F1 Exhaust Temperature before SCR Too Low Alarm.
936	LO F2 TEXH BFR SCR	F2 Exhaust Temperature before SCR Too Low Alarm.
937	LO F3 TEXH BFR SCR	F3 Exhaust Temperature before SCR Too Low Alarm.
938	LO F1 TEXH AFT SCR	F1 Exhaust Temperature after SCR Too Low Alarm.
939	LO F2 TEXH AFT SCR	F2 Exhaust Temperature after SCR Too Low Alarm.
940	LO F3 TEXH AFT SCR	F3 Exhaust Temperature after SCR Too Low Alarm.
941	LO SCR OPRATING T	SCR Operating Temperature Too Low Alarm.
942	CATLY CONV LO F1	Catalytic Conversion Too Low F1 Alarm.
943	CATLY CONV LO F2	Catalytic Conversion Too Low F2 Alarm.
944	CATLY CONV LO F3	Catalytic Conversion Too Low F3 Alarm.
945	L1 L VOLTAGE ASO	Low ASO Voltage (Limit 1) Alarm.
946	L2 L VOLTAGE ASO	Low ASO Voltage (Limit 2) Alarm.
947	INVALD LSI CHANL CFG	Invalid LSI Channel Configuration Alarm.
948	AL ESI ACTIVATED	ESI Activated Alarm.
949	SD VOLTAGE ASO	Sensor Defect in ASO Voltage Sensor.
950	SCR SU FLT S EXST F1	SCR SU Fault S F1 Exists alarm.
951	ETC0 CUTIN FAIL	Turbo Charger 0 Cut In Failure.
952	ETC1 CUTIN FAIL	Turbo Charger 1 Cut In Failure.
953	LAMBDA VALUE INVALID	Lambda Value Invalid Alarm.
954	NOX VALUE INVALID	NO_X Value Invalid Alarm.
955	THRML MANGMT ACTV	Thermal Management Active Alarm.
956	P5 CNTVAR LIM MN ACTV	P5 Control Variable Minimum Limit Active Alarm.
957	P5 CV MAX BOI MN ACT	P5 Control Variable Max BOI Minimum Active Alarm.
958	LMDA CTLVR LMT MN ACT	Lambda Control Variable Minimum Limit Active Alarm.
959	LMDA CV MX BOI MN ACT	Lambda Control Variable Max BOI Minimum Active Alarm.
960	NOXP5 MN BOI MX ACTV	NO_X P5 Minimum BOI Maximum Active.
961	NOXP5 MX BOI MN ACTV	NO_X P5 Maximum BOI Minimum Active.
962	GPS LMDA CV MAX ACTV	GPS Lambda Control Variable Maximum Active Alarm.
963	GPS P5 CV MAX ACTV	GPS P5 Control Variable Maximum Active Alarm.
964	GPS P5 CV MIN ACTV	GPS P5 Control Variable Minimum Active Alarm.
965	SCR SU FLT S EXIST F2	SCR SU Fault S F2 Exists Alarm.
966	SCR SU FLT S EXIST F3	SCR SU Fault S F3 Exists Alarm.
967	SCR SU PRIM REQ F1	SCR SU Priming Request F1 Alarm.
968	SCR SU PRIM REQ F2	SCR SU Priming Request F2 Alarm.
969	SCR SU PRIM REQ F3	SCR SU Priming Request F3 Alarm.
970	SD P EXHAUST	Sensor Defect in Exhaust Pressure Sensor.
971	COLD ENGINE ALARM	Cold Engine Alarm.
972	MIC5 SINGATURE DIFF	MIC5 Signature Difference Alarm.
973	AL CHECKSUM IIG	IIG Check Sum Alarm.
974	AL CAN3 BUS OFF	Can3 Bus Off Alarm.
975	CAN3 ERR PASSIVE	Can3 Error Passive Alarm.
976	AL CAN4 BUS OFF	Can4 Bus Off Alarm.
977	CAN4 ERR PASSIVE	Can4 Error Passive Alarm.
978	HI ETC5 OVERSPEED	Turbo Charger 5 Overspeed (Limit 1).
979	SS ETC5 OVERSPEED	Turbo Charger 5 Overspeed (Limit 2).

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Fault Code Number	String	Description
980	ADBLUE TEMP HI F1	ADBLUE (DEF) Temperature Too High F1 Alarm.
981	ADBLUE TEMP HI F2	ADBLUE (DEF) Temperature Too High F2 Alarm.
982	ADBLUE TEMP HI F3	ADBLUE (DEF) Temperature Too High F3 Alarm.
983	STOP ON TRIG CRSHRECR	Stop on Crash Recorder Trigger Alarm.
984	NOX ATO2 SNSR DEFCT	NOX ATO2 Sensor Defect Alarm.
985	NOX ATO2 SNS COM LOST	NOX ATO 2 Communications Lost Alarm.
1000	SD LVL DEF TNK B	Sensor Defect In DEF Tank B Level Sensor.
1001	SD LVL COOL WTR	Sensor Defect In Coolant Water Level Sensor.
1002	SD LVL HYD OIL	Sensor Defect In Hydraulic Oil Level Sensor.
1003	L1 LVL COOL WTR	Coolant Water Level (Limit 1) Alarm.
1004	L2 LVL COOL WTR	Coolant Water Level (Limit 2) Alarm.
1005	L1 LVL HYD OIL	Hydraulic Oil Level (Limit 1) Alarm.
1006	L2 LVL HYD OIL	Hydraulic Oil Level (Limit 2) Alarm.
1007	L1 LVL LUBEOIL J1939	J1939 Lube Oil Level (Limit 1) Alarm.
1008	L2 LVL LUBEOIL J1939	J1939 Lube Oil Level (Limit 2) Alarm.
1009	SD P FLTR MONITR	Sensor Defect In Fuel Filter Pressure Sensor.
1010	L1 P FLTR MONITR	Fuel Filter Pressure (Limit 1) Alarm.
1011	DEF TANK LVL LO	DEF Tank Level Low Alarm.
1012	MIC5 PARM DNLOAD ACTV	MIC5 Parameter Download Active Alarm.
1013	HI DELTA NOX AB	HI Delta NO_X A-B (Limit 1) Alarm.
1014	HIHI DLTA NOX AB	HI Delta NO_X A-B (Limit 2) Alarm.
1015	TTL BKDN NOX SNRS	NO_X Sensors Total Breakdown alarm.
1016	REDUND LOSS NOX SNRS	NO_X Sensors Redundancy Loss Alarm.
1017	HI DELTA P5 FOR NOX	High Delta P5 for NO_X Alarm.
1018	F1 DEF CONSUMPT ERROR	F1 DEF Consumption Error Alarm.
1019	F1 DEF BALANCE ERROR	F1 DEF Balance Error Alarm.
1020	F1 RAW GAS EMSN ERROR	F1 Raw Gas Emission Error Alarm.
1021	F1 NOX ANNHRG ERROR	F1 NO_X Approaching Error Condition Alarm.
1022	TEX BEF SCR BET F1&F2	Exhaust Temperature Before SCR Between F1 and F2 Alarm.
1023	TEX AFT SCR BET F1&F2	Exhaust Temperature After SCR Between F1 and F2 Alarm.
1024	LOLO P FUEL COMM RL A	Fuel Common Rail A Low Fuel Pressure (Limit 2) Alarm.
1025	LOLO P FUEL COMM RL B	Fuel Common Rail B Low Fuel Pressure (Limit 2) Alarm.
1026	IAP COMMS LOST	IAP Communications Lost Alarm.
1027	ENGN COLD ACTIV	Engine Cold Active Alarm.
1028	F1EXP TEX BFR SCR ERR	F1 Expected Exhaust Temperature Before SCR Error Alarm.
1029	IAP MISSNG ENERG DATA	IAP Missing Energization Data Error.
1030	LO P CRANK CASE	Low Crankcase Pressure (Limit 1) Alarm.
1031	LOLO P CRK CASE	Low Crankcase Pressure (Limit 2) Alarm.
1032	INJ DRIFT LMT1 CYL A1	Cylinder A1 Injector Drift Limit 1 Alarm.
1033	INJ DRIFT LMT1 CYL A2	Cylinder A2 Injector Drift Limit 1 Alarm.
1034	INJ DRIFT LMT1 CYL A3	Cylinder A3 Injector Drift Limit 1 Alarm.
1035	INJ DRIFT LMT1 CYL A4	Cylinder A4 Injector Drift Limit 1 Alarm.
1036	INJ DRIFT LMT1 CYL A5	Cylinder A5 Injector Drift Limit 1 Alarm.
1037	INJ DRIFT LMT1 CYL A6	Cylinder A6 Injector Drift Limit 1 Alarm.
1038	INJ DRIFT LMT1 CYL A7	Cylinder A7 Injector Drift Limit 1 Alarm.
1039	INJ DRIFT LMT1 CYL A8	Cylinder A8 Injector Drift Limit 1 Alarm.
1040	INJ DRIFT LMT1 CYL A9	Cylinder A9 Injector Drift Limit 1 Alarm.

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Fault Code Number	String	Description
1041	INJ DRFT LMT1 CYL A10	Cylinder A10 Injector Drift Limit 1 Alarm.
1042	INJ DRIFT LMT1 CYL B1	Cylinder B1 Injector Drift Limit 1 Alarm.
1043	INJ DRIFT LMT1 CYL B2	Cylinder B2 Injector Drift Limit 1 Alarm.
1044	INJ DRIFT LMT1 CYL B3	Cylinder B3 Injector Drift Limit 1 Alarm.
1045	INJ DRIFT LMT1 CYL B4	Cylinder B4 Injector Drift Limit 1 Alarm.
1046	INJ DRIFT LMT1 CYL B5	Cylinder B5 Injector Drift Limit 1 Alarm.
1047	INJ DRIFT LMT1 CYL B6	Cylinder B6 Injector Drift Limit 1 Alarm.
1048	INJ DRIFT LMT1 CYL B7	Cylinder B7 Injector Drift Limit 1 Alarm.
1049	INJ DRIFT LMT1 CYL B8	Cylinder B8 Injector Drift Limit 1 Alarm.
1050	INJ DRIFT LMT1 CYL B9	Cylinder B9 Injector Drift Limit 1 Alarm.
1051	INJ DRFT LMT1 CYL B10	Cylinder B10 Injector Drift Limit 1 Alarm.
1052	INJ DRIFT LMT2 CYL A1	Cylinder A1 Injector Drift Limit 2 Alarm.
1053	INJ DRIFT LMT2 CYL A2	Cylinder A2 Injector Drift Limit 2 Alarm.
1054	INJ DRIFT LMT2 CYL A3	Cylinder A3 Injector Drift Limit 2 Alarm.
1055	INJ DRIFT LMT2 CYL A4	Cylinder A4 Injector Drift Limit 2 Alarm.
1056	INJ DRIFT LMT2 CYL A5	Cylinder A5 Injector Drift Limit 2 Alarm.
1057	INJ DRIFT LMT2 CYL A6	Cylinder A6 Injector Drift Limit 2 Alarm.
1058	INJ DRIFT LMT2 CYL A7	Cylinder A7 Injector Drift Limit 2 Alarm.
1059	INJ DRIFT LMT2 CYL A8	Cylinder A8 Injector Drift Limit 2 Alarm.
1060	INJ DRIFT LMT2 CYL A9	Cylinder A9 Injector Drift Limit 2 Alarm.
1061	INJ DRFT LMT2 CYL A10	Cylinder A10 Injector Drift Limit 2 Alarm.
1062	INJ DRIFT LMT2 CYL B1	Cylinder B1 Injector Drift Limit 2 Alarm
1063	INJ DRIFT LMT2 CYL B2	Cylinder B2 Injector Drift Limit 2 Alarm.
1064	INJ DRIFT LMT2 CYL B3	Cylinder B3 Injector Drift Limit 2 Alarm.
1065	INJ DRIFT LMT2 CYL B4	Cylinder B4 Injector Drift Limit 2 Alarm.
1066	INJ DRIFT LMT2 CYL B5	Cylinder B5 Injector Drift Limit 2 Alarm.
1067	INJ DRIFT LMT2 CYL B6	Cylinder B6 Injector Drift Limit 2 Alarm.
1068	INJ DRIFT LMT2 CYL B7	Cylinder B7 Injector Drift Limit 2 Alarm.
1069	INJ DRIFT LMT2 CYL B8	Cylinder B8 Injector Drift Limit 2 Alarm.
1070	INJ DRIFT LMT2 CYL B9	Cylinder B9 Injector Drift Limit 2 Alarm.
1071	INJ DRFT LMT2 CYL B10	Cylinder B10 Injector Drift Limit 2 Alarm.
1072	F1EXP TEX AFT SCR ERR	F1 Expected Exhaust Temperature After SCR Error Alarm.
1073	F1GRD TEX BFR SCR ERR	F1 Exhaust Temperature Gradient Before SCR Error Alarm.
1074	F1GRD TEX AFT SCR ERR	F1 Exhaust Temperature Gradient After SCR Error Alarm.
1075	F1 T DEF TOO HI	F1 DEF Temperature Too High Alarm.
1076	LO F1 TEXH BFR SCR	F1 Exhaust Temperature before SCR Too Low Alarm.
1077	LO F1 TEXH AFT SCR	F1 Exhaust Temperature after SCR Too Low Alarm.
1078	F2 DEF CONSMPT ERR	F2 DEF Consumption Error Alarm.
1079	F2 DEF BALNC ERR	F2 DEF Balance Error Alarm.
1080	F2 RAW GAS EMISN ERR	F2 Raw Gas Emission Error Alarm.
1081	F2 NOX ANNHRG ERROR	F2 NO_X Approaching Error Condition Alarm.
1082	F2EXP TEX BFR SCR ERR	F2 Expected Exhaust Temperature Before SCR Error Alarm.
1083	F2EXP TEX AFT SCR ERR	F2 Expected Exhaust Temperature After SCR Error Alarm.
1084	F2GRD TEX BFR SCR ERR	F2 Exhaust Temperature Gradient Before SCR Error Alarm.
1085	F2GRD TEX AFT SCR ERR	F2 Exhaust Temperature Gradient After SCR Error Alarm.
1086	F2 T DEF TOO HI	F2 DEF Temperature Too High Alarm.
1087	LO F2 TEXH BFR SCR	F2 Exhaust Temperature before SCR Too Low Alarm.

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Fault Code Number	String	Description
1088	LO F2 TEXH AFT SCR	F2 Exhaust Temperature after SCR Too Low Alarm.

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Exhaust Treatment

Diesel Particulate Filter (DPF)

In order to meet Tier 4 emission requirements, some engine manufacturers are applying Diesel Particulate Filters (DPF) to the exhaust system of the engine. A Diesel Particulate Filter traps particulate matter contained in diesel exhaust and prevents it from distributing into the air. The particulate matter is later burned off during a regeneration process.

The MGC-1550 communicates DPF control and status information to and from the engine ECU via J1939 communications in the form of various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). These are summarized in the following paragraphs.

Regeneration

Regeneration is accomplished by operating the engine at elevated exhaust temperatures where the accumulated particulate is burned off. If, in normal operation, the engine can be loaded to a high enough level to achieve the elevated exhaust temperature, then regeneration can occur as a part of normal operation. This is known as *passive regeneration*.

High exhaust temperatures can also be accomplished by methods such as providing dampers in the exhaust stream or heating the exhaust through the burning of fuel. This is known as *active regeneration* since it is outside of normal engine operation.

Heavily loaded engines will seldom require active regeneration. A lightly loaded engine will likely undergo active regeneration when regeneration is required.

DPF Control

DPF control information is sent from the MGC-1550 to the Engine ECU through PGN Number 57244 (0xE000). A manual regeneration request is sent using SPN 3695, Diesel Particulate Filter Regeneration Force Switch. Regeneration can be inhibited by SPN 3695, Diesel Particulate Filter Regeneration Inhibit Switch.

Manual Regeneration

The operator can force a regeneration cycle by turning on the Manual Regeneration setting found on the front panel under Settings > Communication > CANBus Setup > ECU Setup > DPF Regenerate Setup. The parameter will remain on for a few seconds then go off. The ECU will respond to the momentary setting by logging the request to force a manual regeneration. A continuous request is not used because this can be problematic for some engine ECUs.

Manual regeneration can also be initiated by clicking the *Manual Regeneration* button on the ECU Setup screen in BESTCOMS*Plus*®. BESTlogic™*Plus* programmable logic can also be used to initiate manual regeneration by setting the DPF Manual Regeneration (DPFMANREGEN) logic element true.

Regeneration Inhibit

The operator can inhibit regeneration by turning on the DPF Regeneration Disable setting found on the ECU Setup screen in BESTCOMS*Plus*.

Regeneration can also be disabled by turning on the Disable Regeneration setting on the ECU Setup screen in BESTCOMS*Plus*.

BESTlogic*Plus* programmable logic can also be used to inhibit regeneration by setting the DPF Regeneration Inhibit (DPFREGENINHIBIT) logic element true.

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DPF Status and Pre-Alarms

The MGC-1550 receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). The MGC-1550 displays this information on the front panel, and in BESTCOMS*Plus*, via DPF related pre-alarms. The J1939 parameters and the resulting MGC-1550 pre-alarms are summarized in the following paragraphs.

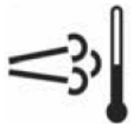
- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1
    - *SPN 3697, Diesel Particulate Filter Lamp Command*

      DPF REGEN REQUIRED Pre-Alarm: When SPN 3697 has a value of 1 or 4 indicating the DPF lamp is on, the MGC-1550 will annunciate a pre-alarm with text of DPF REGEN REQUIRED. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel.

    - *SPN 3698, Exhaust System High Temperature Lamp Command*

      HIGH EXHAUST TEMP Pre-Alarm: When SPN 3698 has a value of 1 indicating the high exhaust temperature lamp is on, the MGC-1550 will annunciate a pre-alarm with text of HIGH EXHAUST TEMP. The high exhaust temperature symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel.

    - *SPN 3703 Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch*

      DPF REGEN INHIBITED Pre-Alarm: When SPN 3703 has a value of 1 indicating the DPF Regeneration is inhibited due to the inhibit switch being set, the MGC-1550 will annunciate a pre-alarm with text of DPF REGEN INHBTD. The DPF regeneration inhibited symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel.

- DPF Soot Level Annunciation via Diagnostic Trouble Code (DTC) SPN 3719 Diesel Particulate Filter Soot Load Percent

  In addition to the standard diagnostic trouble code annunciation, the MGC-1550 will annunciate a pre-alarm under circumstances described below.

    - *FMI = 15: Data Valid But Above Normal Operating Range Least Severe Level*

      DPF SOOT LEVEL HIGH Pre-Alarm: When the FMI is equal to 15, the MGC-1550 will annunciate a pre-alarm with text of DPF SOOT LVL HI. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel.

    - *FMI = 16: Data Valid But Above Normal Operating Range Moderately Severe Level*

      DPF SOOT LEVEL MODERATELY HIGH Pre-Alarm: When the FMI is equal to 16, the MGC-1550 will annunciate a pre-alarm with text of DPF SOOT LVL MOD HI. The DPF warning symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel.

    - *FMI = 0: Data Valid But Above Normal Operating Range Most Severe Level*

      DPF SOOT LEVEL EXTREMELY HIGH Pre-Alarm: When the FMI is equal to 0, the MGC-1550 will annunciate a pre-alarm with text of DPF SOOT LVL EXT HI. The DPF stop symbol, shown to the right, will accompany the text when the pre-alarm appears on the MGC-1550 front panel. If the DPF soot level reaches the most severe level, the engine ECU may shut the engine down and prevent it from running or it may allow it to run, but at a reduced power level. The MGC-1550 only indicates a pre-alarm. It does

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not prevent the engine from running or cause operation at a reduced power level, but the operator should be aware that the engine ECU or after treatment system may cause such behavior.

Exhaust After-Treatment Systems (EATS)

In order to meet Tier 4 emission requirements, some engine manufacturers are adding Exhaust After Treatment Systems (EATS) which treat the engine exhaust within the exhaust system to reduce particulate matter and harmful contaminants prior to releasing the exhaust into the atmosphere. One such system uses urea-based Diesel Exhaust Fluid (DEF) catalyst which is combined with the exhaust gasses in the EATS to bring the emissions to acceptable levels.

The MGC-1550 meters EATS information from the engine ECU via J1939 CANBus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.

Most systems will contain one DEF tank, while some may contain two tanks. The MGC-1550 front panel displays the level of DEF in each tank under Metering > Alarms-Status > J1939 Status > DEF Tank1 LVL% and Metering > Alarms-Status > J1939 Status > DEF Tank2 LVL%. The tank 1 level is sent from the ECU via SPN 1761 in J1939 PGN 65110 - After Treatment 1 Reagent Tank 1 Information. The tank 2 level is sent from the ECU via SPN 4367 in J1939 PGN 64829 - After Treatment 1 Reagent Tank 2 Information. The tank levels are expressed in units of percent.

Pre-Alarms

The ECU sends DEF level diagnostics to the MGC as SPNs 5245 and 5246 in PGN 65110 (the AT1TI PGN). SPN 5245 communicated DEF level diagnostics, whereas SPN 5246 communicates DEF inducement level status.

There are several pre-alarms related to the EATS which annunciate DEF level diagnostics and DEF inducement level status. They are always enabled and will annunciate when received from the engine ECU. Each of them contains the symbol for DEF functions when annunciated on the front panel; however it will not be displayed in BESTCOMS*Plus*. The pre-alarms are summarized in the following paragraphs.

- DEF FLUID LOW: This pre-alarm displays when SPN 5245 has a value of 1, indicating that the DEF tank level is low. A DEF level of 8% to 23% causes this annunciation.
- DEF FLUID EMPTY: This pre-alarm displays when SPN 5245 has a value of 4, indicating that the DEF tank level is low. The low condition is announced when the tank level is below 8%. When this occurs and is not remedied, the engine ECU may enter a mode of inducement not to operate the engine where some of the conditions in the pre-alarms descriptions below may occur.
- DEF ENGINE DERATE: This pre-alarm displays when SPN 5246 has a value of 3, indicating the Engine Derate level of inducement. This indicates that the engine is going into a reduced power mode indicating the lowest level of inducement not to operate the engine when the EATS is not functioning properly or out of DEF.
- DEF PRESEVERE INDUCEMENT: This pre-alarm displays when SPN 5246 has a value of 4, indicating the Pre-Severe Inducement level of inducement. This indicates that the engine has entered the second highest level of inducement not to operate the engine when the EATS is not functioning properly or the DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.
- DEF SEVERE INDUCEMENT: This pre-alarm displays when SPN 5246 has a value of 5, indicating the Severe Inducement level of inducement. This indicates that the engine has entered the highest level of inducement not to operate the engine when the EATS is not functioning properly or DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.

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- DEF INDUCEMENT OVERRIDE: This pre-alarm displays when SPN 5246 has a value of 6, indicating the Temporary Override of inducement. This indicates DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT state.

Exit Conditions for DEF Severe Inducement

- First Restart: Return to 0% torque reduction in exit condition, until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart. After the second restart, a service tool is required to exit the severe inducement.
- With Service Tool Clearing: Invoke 0% torque reduction with service tool clearing until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart.

Diagnostic Trouble Codes

Diagnostic engine information is obtained from a compatible engine control unit (ECU). The MGC-1550 will receive an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table 35 lists the diagnostic information that the MGC-1550 obtains over the CAN interface.

Table 35. Diagnostic Information Obtained Over the CAN Interface

Parameter	Transmission Repetition Rate
Active diagnostic trouble code	1 s
Lamp status	1 s
Previously active diagnostic trouble code	On request
Request to clear active DTCs	On request
Request to clear previously active DTCs	On request

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

For certain DTCs, if the MGC-1550 recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table 36. If the MGC-1550 recognizes an SPN in Table 36, but the FMI does not match the FMI in Table 36, then it displays the string from Table 36 corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table 37. For example, if the MGC-1550 receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the MGC-1550 does not have descriptive information about an SPN and FMI that was received, the description will display as “NO TEXT AVAILABLE”.

Table 36. DTCs Displayed by the MGC-1550

SPN	FMI	String Displayed	Description
27	#	EGR1 VALVE POSITN	Caption Indicating EGR1 Valve Position
28	3	Throttle Volt HI	Throttle Voltage High
28	4	Throttle Volt LO	Throttle Voltage Low
28	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	3	Throttle Volt HI	Throttle Voltage High
29	4	Throttle Volt LO	Throttle Voltage Low
29	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	#	ACCEL PEDAL 2 POSITN	Caption string for accelerator pedal 2 position
51	#	ENG THROTTLE POSITN	Caption Indicating Engine Throttle Position
52	15	INTERCOOLER TEMP HI	Engine Intercooler Temperature is above the HIGH threshold
69	#	2 SPEED AXLE SWITCH	Caption Indicating Two Speed Axle Switch
70	#	PARKING BRAKE SWITCH	Caption Indicating Parking Brake Switch
84	#	VEHICLE SPEED	Caption string for vehicle speed signal
91	#	ACCEL POSITION	Caption string for Accelerator Position
91	3	Thr Pos Sns Volt HI	Throttle Position Sensor Input Voltage (High)
91	4	Thr Pos Sns Volt LO	Throttle Position Sensor Input Voltage (Low)

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SPN	FMI	String Displayed	Description
91	14	Thr Pos Sns Volt OOR	Throttle Voltage (Out of Range)
94	1	FUEL DELIV PRS LO LO	Engine Fuel Delivery Pressure is below the LOW LOW threshold
94	3	Fuel Pmp Prs Volt HI	Fuel Pump Pressure Input Voltage (High)
94	4	Fuel Pmp Prs Volt LO	Fuel Pump Pressure Input Voltage (Low)
94	17	Fuel Pressure LO	Fuel Supply Pressure (Low Least Severe)
96	#	FUEL LEVEL	Caption string for Fuel Level
97	3	Water In Fl Volt HI	Water In Fuel Signal Voltage High
97	4	Water In Fl Volt LO	Water In Fuel Signal Voltage Low
97	16	Water in Fuel	Water In Fuel Detected
98	#	ENG OIL LEVEL	Caption used on front panel for Display of J1939 Parameter
99	#	OIL FILTER DIFF PRESS	Caption string for oil filter differential pressure parameter
100	1	ENG OIL PRESS LO LO	Engine Oil Pressure is below the LOW LOW threshold
100	3	Oil Prs Snsr Volt HI	Oil Pressure Sensor Input Voltage (High)
100	4	Oil Prs Snsr Volt LO	Oil Pressure Sensor Input Voltage (Low)
100	17	ENG OIL PRESS LO	Engine Oil Pressure is below the LOW threshold
100	18	Oil Prs Snsr Volt MLO	Oil Pressure Sensor Input Voltage (Moderately Low)
100	31	Oil Pressure INVLD	Oil Pressure (Invalid)
101	#	CRANKCASE PRESSURE	Caption string for crankcase pressure
102	#	INTK MNFLD1 PRESSURE	Caption string for intake manifold 1 pressure
102	2	Manifld Air Prs INVD	Manifold Air Pressure Invalid
102	3	Mnfld AirP SnsVlt HI	Manifold Air Pressure Sensor Input Voltage High
102	4	Mnfld AirP SnsVlt LO	Manifold Air Pressure Sensor Input Voltage Low
103	0	Trbo Overspd Severe	Turbo Overspeed (Most Severe)
103	2	Trbo Speed MisMatch	Turbo Speed (Mismatch)
103	5	Trbo Spd Sns Curr LO	Turbo Speed Sensor Current (Low)
103	6	Trbo Spd Sns Curr HI	Turbo Speed Sensor Current (High)
103	8	Trbo Speed INVLD	Turbo Speed (Invalid)
103	31	Trbo Speed MISSING	Turbo Speed (Missing)
105	0	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	3	EGR Air Temp Vlt HI	Exhaust Gas Recirculation Mixed Air Temp Voltage (High)
105	4	EGR Air Temp Vlt LO	Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)
105	15	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	16	EGR MxdAir Tmp MHI	Exhaust Gas Recirculation Mixed Air Temp (Moderately High)
106	#	INTAKE AIR PRESSR	Caption Indicating Intake Air Pressure
107	0	Air Filt Restricted	Air Filter Restriction (High)
108	2	Barometrc Prs INVLD	Barometric Pressure (Invalid)
108	31	Barometrc Prs ERR	Barometric Pressure (Error)
109	1	ENG COOLNT PRS LO LO	Engine Coolant Pressure is below the LOW LOW threshold
109	17	ENG COOLANT PRS LO	Engine Coolant Pressure is below the LOW threshold
110	0	ENG COOLNT TMP HI HI	Engine Coolant Temperature is above the HIGH HIGH threshold
110	3	Cool Tmp Sns Volt HI	Coolant Temp Sensor Input Voltage (High)

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SPN	FMI	String Displayed	Description
110	4	Cool Tmp Sns Volt LO	Coolant Temp Sensor Input Voltage (Low)
110	15	ENG COOLANT TEMP HI	Engine Coolant Temperature is above the HIGH threshold
110	16	Cool Temp MHI	Coolant Temp Sensor Input (Moderately High)
110	17	Cool Temp LO	Coolant Temp Sensor Input (Low Least Severe)
111	1	Coolnt Lvl LO	Coolant Level (Low)
111	17	ENG COOLANT LVL LO	Engine Coolant Level is below the LOW threshold
111	#	LOW COOL LEVEL	Low Coolant Level string used in event log and/or Alarm and Pre-alarm annunciation
157	3	Fuel Rail Prs Vlt HI	Fuel Rail Pressure Input Voltage (High)
157	4	Fuel Rail Prs Vlt LO	Fuel Rail Pressure Input Voltage (Low)
157	10	Fuel Rail Prs LOSS	Fuel Rail Pressure Loss Detected
157	17	Fuel Rl Prs NOT DEV	Fuel Rail Pressure Not Developed
158	#	BATTERY VOLTAGE	Caption Indicating Battery Voltage
158	#	KEY SW BATT VOLTAGE	Caption string for key switch battery potential
158	0	KSW BATT VOLTS HI HI	Key Switch Battery Potential is above the HIGH HIGH threshold
158	1	KSW BATT VOLTS LO LO	Key Switch Battery Potential is below the LOW LOW threshold
158	15	KSW BATT VOLTS HI	Key Switch Battery Potential is above the HIGH threshold
158	17	KSW BATT VOLTS LO	Key Switch Battery Potential is below the LOW threshold
161	#	TR INPUT SHAFT SPD	Caption Indicating Transmission Input Shaft Speed
168	#	LOW BATT VOLT	Low Battery Voltage string used in event log and/or Alarm and Prealarm annunciation
174	0	Fuel Temp EXT HI	Fuel Temp (Extremely High)
174	3	Fuel Tmp Sns Volt HI	Fuel Temp Sensor Input Voltage (High)
174	4	Fuel Tmp Sns Volt LO	Fuel Temp Sensor Input Voltage (Low)
174	16	Fuel Temp MHI	Fuel Temp (Moderately High)
175	#	ENG OIL TEMP	Caption used on front panel for Display of J1939 Parameter
188	17	SPEED AT IDLE LO	Metering string for ECU trouble code metering indicates Engine Idle speed is below the LOW threshold
189	0	Engine Spd DERATE	Engine Speed Derate
190	0	Engine OvrSpd EXTRM	Engine Overspeed (Extreme)
190	1	ENGINE SPEED LOW	Engine speed is below the LOW threshold
190	16	Engine OvrSpd MODRT	Engine Overspeed (Moderate)
190	17	SPEED AT IDLE LO	Engine Idle speed is below the LOW threshold
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
191	#	TR OUTPUT SHAFT SPD	Caption Indicating Transmission Output Shaft Speed
237	2	VIN Data MisMatch	VIN Data Mismatch with other controllers
354	#	RELATIVE HUMIDITY	Caption Indicating Relative Humidity
412	0	EGR Temp EXT HI	Exhaust Gas Recirculation Temp (Extremely High)
412	3	EGR Temp In Vlt HI	Exhaust Gas Recirculation Temp Input Voltage (High)
412	4	EGR Temp In Vlt LO	Exhaust Gas Recirculation Temp Input Voltage (Low)
412	16	EGR Temp MHI	Exhaust Gas Recirculation Temp (Moderately High)
442	#	AUX TEMP 2	Caption Indicating Aux Temperature 2

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SPN	FMI	String Displayed	Description
443	#	BATTERY VOLT 2	Caption Indicating Battery Voltage 2
444	#	AUX PRESSURE2	Caption Indicating Auxiliary Pressure 2
515	#	DESIRED SPEED	Caption string for parameter that indicates speed demand desired from the engine.
520	#	RETARDER % TORQUE	Caption string for retarder % torque
523	#	TRANS CURRNT GEAR	Caption Indicating Transmission Current Gear
524	#	TRANS SELECTD GEAR	Caption Indicating Transmission Selected Gear
558	#	ACCEL PEDAL IDLE SW	Caption Indicating Accelerator Pedal Idle Switch
559	#	ACCEL PEDAL KICKDN SW	Caption Indicating Accelerator Pedal Kickdown Switch
563	#	ABS ACTIVE	Caption String for Antilock Brake System (ABS) active
573	#	TRQCNV LOCKUP ENGAGD	Caption Indicating Transmission Torque Converter Lockup Engaged
574	#	TR SHIFT IN PROGRESS	Caption Indicating Transmission Shift in Process
596	#	CRUISE CNTL ENABLE SW	Caption Indicating Cruise Control Enable Switch
597	#	BRAKE SWITCH	Caption Indicating Brake Switch
598	#	CLUTCH SWITCH	Caption Indicating Clutch Switch
599	#	CRUISE CNTL SET SW	Caption Indicating Cruise Control Set Switch
600	#	CRUISE CNTL COAST SW	Caption Indicating Cruise Control Coast (Decelerate) Switch
601	#	CRUISE CNTL RESUME SW	Caption Indicating Cruise Control Resume Switch
602	#	CRUISE CNTL ACCEL SW	Caption Indicating Cruise Control Accelerate Switch
609	#	CONTROLLER #2	Caption Indicating Controller Number 2
611	#	SYS DIAGNST CODE 1	Caption Indicating System Diagnostic Code 1
611	3	Inj Short to PWR	Injector Wiring Shorted to Power
611	4	Inj Short to GND	Injector Wiring Shorted to Ground
620	#	5 VOLT SUPPLY	Caption Indicating 5 Volt Supply
623	#	RED STOP LAMP	Caption Indicating Red Stop Lamp
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
624	#	COMBINED YELLOW	Caption Indicating a Yellow Alarm from the Engine ECU
625	#	PROP COMM NETWK 1	Caption Indicating Proprietary Communications Network 1
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
627	1	Inj Spply Vlt Problm	Injector Supply Voltage Problem
627	16	ECU Power Volt HI	ECU Power High Voltage
627	18	ECU Power Volt LO	ECU Power Low Voltage
627	13	ECU ERROR	ECU Error
628	#	PROGRAM MEMORY	Caption Indicating Program Memory
629	#	CONTROLLER #1	Caption Indicating Controller 1
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
636	#	ENG POSITION SENSOR	Caption Indicating Engine Position Sensor
636	2	Pump Pos Sns Noisy	Pump Position Sensor Input Noise
636	5	Pump Pos Sns Curr LO	Pump Position Sensor Current (Low)
636	6	Pump Pos Sns Curr HI	Pump Position Sensor Current (High)

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SPN	FMI	String Displayed	Description
636	8	Pump Pos Sns In MSNG	Pump Position Sensor Input Missing
636	10	Pump Pos Sns In ERR	Pump Position Sensor Input Pattern Error
637	2	Crank Pos Sns Noisy	Crank Position Input Noise
637	5	Crank Pos Sns Curr LO	Crank Position Sensor Current (Low)
637	6	Crank Pos Sns Curr HI	Crank Position Sensor Current (High)
637	7	Crnk/Pmp Pos Tmg OOS	Crank/Pump Position Timing Moderately Out of Sync
637	8	Crank Pos Sns MSNG	Crank Position Missing
637	10	Crank Pos Sns In ERR	Crank Position Input Pattern Error
639	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
641	4	Trbo Actuator ERR	Turbo Actuator Error
641	12	ECU/Trbo Comm ERR	ECU/Turbo Communication Error
641	13	TrboAct Lrnd Val ERR	Turbo Actuator Learned Value Error
641	16	Trbo Act Temp MHI	Turbo Actuator Temp (Moderately High)
645	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
651	2	Cyl 1 EUI PN INVLD	Cylinder #1 EUI Part Number (Invalid)
651	5	Cyl 1 EUI Ckt OPEN	Cylinder #1 EUI Circuit (Open)
651	6	Cyl 1 EUI Ckt SHORT	Cylinder #1 EUI Circuit (Shorted)
651	7	Cyl 1 EUI Ckt MECH FL	Cylinder #1 EUI Circuit (Mechanical Failure)
651	13	Cyl 1 EUI QR INVLD	Cylinder #1 EUI Circuit QR Code (Invalid)
651	#	CYLINDER 1 INJECTOR	Caption String for Cylinder 1 Injector
652	2	Cyl 2 EUI PN INVLD	Cylinder #2 EUI Part Number (Invalid)
652	5	Cyl 2 EUI Ckt OPEN	Cylinder #2 EUI Circuit (Open)
652	6	Cyl 2 EUI Ckt SHORT	Cylinder #2 EUI Circuit (Shorted)
652	7	Cyl 2 EUI Ckt MECH FL	Cylinder #2 EUI Circuit (Mechanical Failure)
652	13	Cyl 2 EUI QR INVLD	Cylinder #2 EUI Circuit QR Code (Invalid)
652	#	CYLINDER 2 INJECTOR	Caption String for Cylinder 2 Injector
653	2	Cyl 3 EUI PN INVLD	Cylinder #3 EUI Part Number (Invalid)
653	5	Cyl 3 EUI Ckt OPEN	Cylinder #3 EUI Circuit (Open)
653	6	Cyl 3 EUI Ckt SHORT	Cylinder #3 EUI Circuit (Shorted)
653	7	Cyl 3 EUI Ckt MECH FL	Cylinder #3 EUI Circuit (Mechanical Failure)
653	13	Cyl 3 EUI QR INVLD	Cylinder #3 EUI Circuit QR Code (Invalid)
653	#	CYLINDER 3 INJECTOR	Caption String for Cylinder 3 Injector
654	2	Cyl 4 EUI PN INVLD	Cylinder #4 EUI Part Number (Invalid)
654	5	Cyl 4 EUI Ckt OPEN	Cylinder #4 EUI Circuit (Open)
654	6	Cyl 4 EUI Ckt SHORT	Cylinder #4 EUI Circuit (Shorted)
654	7	Cyl 4 EUI Ckt MECH FL	Cylinder #4 EUI Circuit (Mechanical Failure)
654	13	Cyl 4 EUI QR INVLD	Cylinder #4 EUI Circuit QR Code (Invalid)
654	#	CYLINDER 4 INJECTOR	Caption String for Cylinder 4 Injector
655	2	Cyl 5 EUI PN INVLD	Cylinder #5 EUI Part Number (Invalid)
655	5	Cyl 5 EUI Ckt OPEN	Cylinder #5 EUI Circuit (Open)
655	6	Cyl 5 EUI Ckt SHORT	Cylinder #5 EUI Circuit (Shorted)
655	7	Cyl 5 EUI Ckt MECH FL	Cylinder #5 EUI Circuit (Mechanical Failure)
655	13	Cyl 5 EUI QR INVLD	Cylinder #5 EUI Circuit QR Code (Invalid)

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SPN	FMI	String Displayed	Description
655	#	CYLINDER 5 INJECTOR	Caption String for Cylinder 5 Injector
656	2	Cyl 6 EUI PN INVLD	Cylinder #6 EUI Part Number (Invalid)
656	5	Cyl 6 EUI Ckt OPEN	Cylinder #6 EUI Circuit (Open)
656	6	Cyl 6 EUI Ckt SHORT	Cylinder #6 EUI Circuit (Shorted)
656	7	Cyl 6 EUI Ckt MECH FL	Cylinder #6 EUI Circuit (Mechanical Failure)
656	13	Cyl 6 EUI QR INVLD	Cylinder #6 EUI Circuit QR Code (Invalid)
656	#	CYLINDER 6 INJECTOR	Caption String for Cylinder 6 Injector
657	#	CYLINDER 7 INJECTOR	Caption String for Cylinder 7 Injector
658	#	CYLINDER 8 INJECTOR	Caption String for Cylinder 8 Injector
659	#	CYLINDER 9 INJECTOR	Caption String for Cylinder 9 Injector
660	#	CYLINDER 10 INJECTOR	Caption String for Cylinder 10 Injector
661	#	CYLINDER 11 INJECTOR	Caption String for Cylinder 11 Injector
662	#	CYLINDER 12 INJECTOR	Caption String for Cylinder 12 Injector
663	#	CYLINDER 13 INJECTOR	Caption String for Cylinder 13 Injector
664	#	CYLINDER 14 INJECTOR	Caption String for Cylinder 14 Injector
665	#	CYLINDER 15 INJECTOR	Caption String for Cylinder 15 Injector
666	#	CYLINDER 16 INJECTOR	Caption String for Cylinder 16 Injector
667	#	CYLINDER 17 INJECTOR	Caption String for Cylinder 17Injector
668	#	CYLINDER 18 INJECTOR	Caption String for Cylinder 18 Injector
669	#	CYLINDER 19 INJECTOR	Caption String for Cylinder 19 Injector
670	#	CYLINDER 20 INJECTOR	Caption String for Cylinder 20 Injector
671	#	CYLINDER 21 INJECTOR	Caption String for Cylinder 21 Injector
672	#	CYLINDER 22 INJECTOR	Caption String for Cylinder 22 Injector
673	#	CYLINDER 23 INJECTOR	Caption String for Cylinder 23 Injector
674	#	CYLINDER 24 INJECTOR	Caption String for Cylinder 24 Injector
675	#	ENG GLOW PLUG LAMP	Caption Indicating Glow Plug Lamp
676	#	ENG GLOW PLUG RELAY	Caption String for Engine Glow Plug Relay
677	#	ENGINE START RELAY	Caption String for Engine Start Relay
697	#	AUX PWM DRIVER 1	Caption Indicating Auxiliary PWM Driver 1
698	#	AUX PWM DRIVER 2	Caption Indicating Auxiliary PWM Driver 2
699	#	AUX PWM DRIVER 3	Caption Indicating Auxiliary PWM Driver 3
700	#	AUX PWM DRIVER 4	Caption Indicating Auxiliary PWM Driver 4
701	#	AUX I/O 1	Caption String for Auxiliary I/O 1
702	#	AUX I/O 2	Caption String for Auxiliary I/O 2
703	#	AUX I/O 3	Caption String for Auxiliary I/O 3
704	#	AUX I/O 4	Caption String for Auxiliary I/O 4
705	#	AUX I/O 5	Caption String for Auxiliary I/O 5
706	#	AUX I/O 6	Caption String for Auxiliary I/O 6
707	#	AUX I/O 7	Caption String for Auxiliary I/O 7
708	#	AUX I/O 8	Caption String for Auxiliary I/O 8
709	#	AUX I/O 9	Caption String for Auxiliary I/O 9
710	#	AUX I/O 10	Caption String for Auxiliary I/O 10
711	#	AUX I/O 11	Caption String for Auxiliary I/O 11

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SPN	FMI	String Displayed	Description
712	#	AUX I/O 12	Caption String for Auxiliary I/O 12
713	#	AUX I/O 13	Caption String for Auxiliary I/O 13
714	#	AUX I/O 14	Caption String for Auxiliary I/O 14
715	#	AUX I/O 15	Caption String for Auxiliary I/O 15
716	#	AUX I/O 16	Caption String for Auxiliary I/O 16
723	#	SPEED SENSOR #2	Caption Indicating Engine Speed Sensor #2
724	#	O2 SENSOR	Caption Indicating O2 Sensor
729	#	INTAKE HEATER #1	Caption Indicating Intake Air Heater #1
730	#	INTAKE HEATER #2	Caption Indicating Intake Air Heater #2
731	#	KNOCK SENSOR #1	Caption Indicating Knock Sensor 1
870	#	HEATER REGEN SYSTM	Caption Indicating Heater Regeneration System
898	2	REQ SPD DATA ERRATIC	Speed Demand Data is erratic
898	9	Spd/Trq Msg INVLD	Vehicle Speed/Torque Message Invalid
898	#	ENGINE REQSTED SPEED	Caption String for Engine Requested Speed
904	#	FRONT AXLE SPEED	Caption Indicating Front Axle Speed
920	#	AUDIBLE ALARM	Caption Indicating Audible Alarm
923	#	PWM OUTPUT	Caption String for Engine PWM Output
924	#	AUX OUT #1	Caption Indicating Auxiliary Output 1
925	#	AUX OUT #2	Caption Indicating Auxiliary Output 2
926	#	AUX OUT #3	Caption Indicating Auxiliary Output 3
970	2	Aux Eng SD SW INVLD	Auxiliary Engine Shutdown Switch (Invalid)
970	31	Aux Eng SD SW ACTV	Auxiliary Engine Shutdown Switch Active
971	31	Eng Derate SW ACTV	External Engine Derate Switch Active
973	#	ENG RETARDR SELECTN	Caption Indicating Engine Retarder Selection
974	#	REMOTE ACCEL PEDAL	Caption Indicating Remote Accelerator Pedal
975	#	FAN SPEED	Caption String for Engine Fan Speed
986	#	REQSTD FAN SPEED	Caption Indicating Requested Fan Speed
1004	#	TRIP VEH IDLE FL USED	Caption Indicating Trip Vehicle Idle Fuel Used
1005	#	TRIP CRUISE FL USED	Caption Indicating Trip Cruise Fuel Used
1015	#	TRIP AVG LOAD FACTOR	Caption Indicating Trip Average Load Factor
1072	#	ENG BRAKE OUTPUT 1	Caption String for Engine Brake Output 1
1072	#	ENG COMPR BRK OUTPUT1	Caption Indicating Engine (Compression) Brake Output 1
1073	#	ENG COMPR BRK OUTPUT2	Caption Indicating Engine (Compression) Brake Output 2
1074	#	ENG EXHAUST BRAKE OUT	Caption String for Engine Exhaust Brake Output
1075	5	Fuel TR Pump Curr LO	Fuel Transfer Pump Current (Low)
1075	6	Fuel TR Pump Curr HI	Fuel Transfer Pump Current (High)
1075	12	Fuel TR Pump ERR	Fuel Transfer Pump (Error)
1079	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
1080	3	Snsr Supp 1 Volt LO	Sensor Supply 1 Voltage (Low)
1080	4	Snsr Supp 1 Volt HI	Sensor Supply 1 Voltage (High)
1080	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
1081	#	ENG WAIT TO START LMP	Caption String for Engine Wait to Start Lamp
1109	31	Eng Shutdown WARNING	Engine Shutdown Warning

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SPN	FMI	String Displayed	Description
1109	#	EPS SHUTDN APPROACHG	Caption String for indication that Engine Protective System Shutdown Is Approaching
1110	31	Eng Prot Shutdown	Engine Protection Shutdown
1127	#	TURBOCHG1 BOOST PRS	Caption Indicating Turbo Charger 1 Boost Pressure
1128	#	TURBOCHG2 BOOST PRS	Caption Indicating Turbo Charger 2 Boost Pressure
1129	#	TURBOCHG3 BOOST PRS	Caption Indicating Turbo Charger 3 Boost Pressure
1130	#	TURBOCHG4 BOOST PRS	Caption Indicating Turbo Charger 4 Boost Pressure
1132	#	INTK MNFLD3 TEMP	Caption Indicating Intake Manifold 3 Temperature
1133	#	INTK MNFLD4 TEMP	Caption Indicating Intake Manifold 4 Temperature
1136	0	ECU Temp EXT HI	ECU Temperature (Extremely High)
1136	15	ENG ECU TEMP HI	ECU Temperature has exceeded the HIGH level
1136	16	ECU Temp MHI	ECU Temperature (Moderately High)
1172	3	Trbo Cmp Tmp Volt HI	Turbo Compressor Inlet Temp Input Voltage (High)
1172	4	Trbo Cmp Tmp Volt LO	Turbo Compressor Inlet Temp Input Voltage (Low)
1172	16	Trbo Cmp In Tmp MHI	Turbo Compressor Inlet Temp (Moderately High)
1180	0	Trbo Trbn Tmp EXT HI	Turbo Turbine Inlet Temp (Extremely High)
1180	16	Trbo Trbn In Tmp MHI	Turbo Turbine Inlet Temp (Moderately High)
1184	#	TURBOCHG1 OUTLET TEMP	Caption Indicating Turbo Charger 1 Outlet Temperature
1185	#	TURBOCHG2 OUTLET TEMP	Caption Indicating Turbo Charger 2 Outlet Temperature
1186	#	TURBOCHG3 OUTLET TEMP	Caption Indicating Turbo Charger 3 Outlet Temperature
1187	#	TURBOCHG4 OUTLET TEMP	Caption Indicating Turbo Charger 4 Outlet Temperature
1188	#	TRBO WST GT ACT1 POS	Caption Indicating Turbo Waste Gate Actuator 1 Position
1189	#	TRBO WST GT ACT2 POS	Caption Indicating Turbo Waste Gate Actuator 2 Position
1192	#	TRBO WSTGT ACT AIR PR	Caption Indicating Engine Turbocharger Waste gate Actuator Control Air Pressure
1213	#	MALFUNC LAMP	Caption string for the malfunction indicator lamp status that is broadcast by ECU as part of diagnostic trouble code information
1227	#	TEST LIMIT MAX	Caption Indicating Test Limit Maximum
1231	#	J1939 NETWORK 2	Caption String for J1939 Network number 2
1235	#	J1939 NETWORK 3	Caption String for J1939 Network number 3
1237	#	ENG SHUTDN ORIDE SW	Caption String for Engine Shutdown Override Switch
1240	#	FUEL LEAKAGE2	Caption Indicating Fuel Leakage 2 Parameter
1268	#	IGNITION COIL 1	Caption Indicating Engine Ignition Coil 1
1269	#	IGNITION COIL 2	Caption Indicating Engine Ignition Coil 2
1270	#	IGNITION COIL 3	Caption Indicating Engine Ignition Coil 3
1271	#	IGNITION COIL 4	Caption Indicating Engine Ignition Coil 4
1272	#	IGNITION COIL 5	Caption Indicating Engine Ignition Coil 5
1273	#	IGNITION COIL 6	Caption Indicating Engine Ignition Coil 6
1274	#	IGNITION COIL 7	Caption Indicating Engine Ignition Coil 7
1275	#	IGNITION COIL 8	Caption Indicating Engine Ignition Coil 8
1276	#	IGNITION COIL 9	Caption Indicating Engine Ignition Coil 9

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SPN	FMI	String Displayed	Description
1277	#	IGNITION COIL 10	Caption Indicating Engine Ignition Coil 10
1278	#	IGNITION COIL 11	Caption Indicating Engine Ignition Coil 11
1279	#	IGNITION COIL 12	Caption Indicating Engine Ignition Coil 12
1280	#	IGNITION COIL 13	Caption Indicating Engine Ignition Coil 13
1281	#	IGNITION COIL 14	Caption Indicating Engine Ignition Coil 14
1282	#	IGNITION COIL 15	Caption Indicating Engine Ignition Coil 15
1283	#	IGNITION COIL 16	Caption Indicating Engine Ignition Coil 16
1284	#	IGNITION COIL 17	Caption Indicating Engine Ignition Coil 17
1285	#	IGNITION COIL 18	Caption Indicating Engine Ignition Coil 18
1286	#	IGNITION COIL 19	Caption Indicating Engine Ignition Coil 19
1287	#	IGNITION COIL 20	Caption Indicating Engine Ignition Coil 20
1288	#	IGNITION COIL 21	Caption Indicating Engine Ignition Coil 21
1289	#	IGNITION COIL 22	Caption Indicating Engine Ignition Coil 22
1290	#	IGNITION COIL 23	Caption Indicating Engine Ignition Coil 23
1291	#	IGNITION COIL 24	Caption Indicating Engine Ignition Coil 24
1321	#	STARTER LKOUT RLY DRV	Caption Indicating Engine Starter Solenoid Lockout Relay Driver Circuit
1322	#	MULTI CYL MISFIRE	Caption String for Misfire detected on multiple engine cylinders
1323	#	MISFIRE CYLINDER 1	Caption String for Misfire detected on a single engine cylinder
1324	#	MISFIRE CYLINDER 2	Caption String for Misfire detected on a single engine cylinder
1325	#	MISFIRE CYLINDER 3	Caption String for Misfire detected on a single engine cylinder
1326	#	MISFIRE CYLINDER 4	Caption String for Misfire detected on a single engine cylinder
1327	#	MISFIRE CYLINDER 5	Caption String for Misfire detected on a single engine cylinder
1328	#	MISFIRE CYLINDER 6	Caption String for Misfire detected on a single engine cylinder
1329	#	MISFIRE CYLINDER 7	Caption String for Misfire detected on a single engine cylinder
1330	#	MISFIRE CYLINDER 8	Caption String for Misfire detected on a single engine cylinder
1331	#	MISFIRE CYLINDER 9	Caption String for Misfire detected on a single engine cylinder
1332	#	MISFIRE CYLINDER 10	Caption String for Misfire detected on a single engine cylinder
1333	#	MISFIRE CYLINDER 11	Caption String for Misfire detected on a single engine cylinder
1334	#	MISFIRE CYLINDER 12	Caption String for Misfire detected on a single engine cylinder
1335	#	MISFIRE CYLINDER 13	Caption String for Misfire detected on a single engine cylinder
1336	#	MISFIRE CYLINDER 14	Caption String for Misfire detected on a single engine cylinder
1337	#	MISFIRE CYLINDER 15	Caption String for Misfire detected on a single engine cylinder
1338	#	MISFIRE CYLINDER 16	Caption String for Misfire detected on a single engine cylinder
1339	#	MISFIRE CYLINDER 17	Caption String for Misfire detected on a single engine cylinder
1340	#	MISFIRE CYLINDER 18	Caption String for Misfire detected on a single engine cylinder
1341	#	MISFIRE CYLINDER 19	Caption String for Misfire detected on a single engine cylinder
1342	#	MISFIRE CYLINDER 20	Caption String for Misfire detected on a single engine cylinder
1343	#	MISFIRE CYLINDER 21	Caption String for Misfire detected on a single engine cylinder
1344	#	MISFIRE CYLINDER 22	Caption String for Misfire detected on a single engine cylinder
1345	#	MISFIRE CYLINDER 23	Caption String for Misfire detected on a single engine cylinder
1346	#	MISFIRE CYLINDER 24	Caption String for Misfire detected on a single engine cylinder
1347	#	FUEL PUMP ASSY #1	Caption Indicating Fuel Pump Pressurizing Assembly #1

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SPN	FMI	String Displayed	Description
1347	3	Pump Ctrl Vlv Curr HI	Pump Control Valve Current (High)
1347	5	Pmp Ctrl Vlv C MSMCH	Pump Control Valve Current (Mismatch)
1347	7	Fuel Rl Prs Ctrl ERR	Fuel Rail Pressure Control (Error)
1348	#	FUEL PUMP ASSY #2	Caption Indicating Fuel Pump Pressurizing Assembly #2
1350	#	TIME SINCE LST SERVC	Caption Indicating Time Since Last Service
1384	#	J1939 COMANDED SHUTDN	Caption Indicating J1939 Commanded Shutdown
1385	#	AUX TEMP 1	Caption Indicating Aux Temperature 1
1386	#	AUX TEMP 2	Caption Indicating Aux Temperature 2
1387	#	AUX PRESSURE1	Caption Indicating Auxiliary Pressure 1
1388	#	AUX PRESSURE2	Caption Indicating Auxiliary Pressure 2
1390	#	FUEL VALVE1 INLET PRS	Caption Indicating Fuel Valve 1 Inlet Pressure
1485	#	ECU MAIN RELAY	Caption Indicating ECM Main Relay
1569	31	Fuel Derate	Fuel Derate
1623	#	TACOGRPH OUT SHFT SPD	Caption Indicating Tachograph Output Shaft Speed
1624	#	TACOGRPH VEHICLE SPD	Caption Indicating Tachograph Vehicle Speed
1633	#	CRUISE CNTL PAUSE SW	Caption Indicating Cruise Control Pause Switch
1634	#	CALIB VERIFICATN NMBR	Caption Indicating Calibration Verification Number
1636	#	INTK MNFD1 TMP HI RES	Caption Indicating Intake Manifold 1 Air Temperature (High Resolution)
1638	#	HYDRAULIC TEMP	Caption String for Hydraulic Temperature
1639	1	Fan Speed Zero	Fan Speed Detected (Zero)
1639	16	Fan Speed HI	Fan Speed Detected (High)
1639	18	Fan Speed LO	Fan Speed Detected (Low)
1692	#	INTKMNFLD1 DESIRD PR	Caption Indicating Engine Intake Manifold Desired Absolute Pressure
1695	#	EGO SNSR FUEL CORRCTN	Caption Indicating Exhaust Gas Oxygen Sensor Fueling Correction
1716	#	RETRDR SEL NON ENGINE	Caption Indicating Retarder Selection non-engine
1761	#	DEF 1 TANK LEVEL	Diesel Exhaust Fluid 1 Tank Level
1908	#	AUX VLV0 STATE CMD	Caption Indicating Aux Valve 0 State Command
2000	13	Security Violation	Security Violation
2005	9	TSC CAN Msg NT RCV	TSC CAN Message Not Received
2030	9	AC Clutch Msg NT RCV	A/C Clutch Status CAN Message Not Received
2071	9	Tr Oil Can Msg NT RCV	Trans. Oil, Tier Size, Vehicle Speed CAN Message Not Received
2436	#	GEN AVG FREQUENCY	Caption Indicating Generator Average AC Frequency
2629	0	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2629	15	TURBO 1 OUT TMP HI	Turbocharger 1 outlet pressure is above the HIGH threshold
2630	0	EGR FrAir Tmp EXT HI	Exhaust Gas Recirculation Fresh Air Temp (Extremely High)
2630	3	EGR FrAir Tmp Vlt HI	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)
2630	4	EGR FrAir Tmp Vlt LO	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)
2630	15	EGR FrAir Tmp HI	Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)

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SPN	FMI	String Displayed	Description
2630	16	EGR FrAir Tmp MHI	Exhaust Gas Recirculation Fresh Air Temp (Moderately High)
2634	#	POWER RELAY	Caption String for main Power Relay
2646	#	AUX OUT #4	Caption Indicating Auxiliary Output 4
2647	#	AUX OUT #5	Caption Indicating Auxiliary Output 5
2659	2	EGR Flo/Tmp MISMATCH	Exhaust Gas Recirculation Flow/Temp Mismatch
2659	15	EGR Flo Rt High	Exhaust Gas Recirculation Flow Rate (High Least Severe)
2659	17	EGR Flo Rt LO	Exhaust Gas Recirculation Flow Rate (Low Least Severe)
2790	16	Trbo Cmp Out Tmp HI	Turbo Compressor Outlet Temp (Moderately High)
2791	2	EGR Vlv Pos Invld	Exhaust Gas Recirculation Valve Position Invalid
2791	3	EGRVlv Pos In Vlt HI	Exhaust Gas Recirculation Valve Position Input Voltage (High)
2791	4	EGRVlv Pos In Vlt LO	Exhaust Gas Recirculation Valve Position Input Voltage (Low)
2791	13	EGR Vlv Control ERR	Exhaust Gas Recirculation Valve Control Error
2791	31	EGR Valve Cal ERR	Exhaust Gas Recirculation Valve Calibration Error
2791	#	EGR VALVE CONTROL	Caption String for EGR Valve Control
2795	7	Trbo Act Pos MSMATCH	Turbo Actuator Position Mismatch
2797	#	INJECTOR GROUP 1	Caption Indicating Engine Injector Group 1
2798	#	INJECTOR GROUP 2	Caption Indicating Engine Injector Group 2
2899	#	START ENABL DEV 1 CFG	Caption Indicating Engine Start Enable Device 1 Configuration
3050	#	CATALYST SYSTM MONITR	Caption Indicating Catalyst 1 System Monitor
3056	#	EGO SENSOR MONITOR 1	Caption Indicating Exhaust Gas Oxygen Sensor 1 Monitor
3057	#	EGO SENSOR MONITOR 2	Caption Indicating Exhaust Gas Oxygen Sensor 2 Monitor
3217	#	AFTR TRT 1 INTK O2	Caption Indicating Aftertreatment 1 Intake O_2
3218	#	AFT1 INTK SNSPWR IN RG	Caption Indicating Aftertreatment 1 Intake Gas Sensor Power In Range
3219	#	AFT1 INTK SNSR AT TMP	Caption Indicating Aftertreatment 1 Intake Gas Sensor at Temperature
3220	#	AFT1 INTK NOX STBL	Caption Indicating Aftertreatment 1 Intake NO_X Reading Stable
3221	#	AFT1 INTK WR O2 STBL	Caption Indicating Aftertreatment 1 Intake Wide-Range Percent O_2 Reading Stable
3222	#	AFT1 INTK SNS HTR FMI	Caption Indicating Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI
3224	#	AFT1 INTK NOXSNSR FMI	Caption Indicating Aftertreatment 1 Intake NO_X Sensor Preliminary FMI
3225	#	AFT1 INTK O2 SNSR FMI	Caption Indicating Aftertreatment 1 Intake O_2 Sensor Preliminary FMI
3232	#	AFT1 OUT SNS HTR FMI	Caption Indicating Aftertreatment 1 Outlet Gas Sensor Heater Preliminary FMI
3234	#	AFT1 OUT NOX SNSR FMI	Caption Indicating Aftertreatment 1 Outlet NO_X Sensor Preliminary FMI
3250	#	DPF INTRMED GAS TEMP	Caption Indicating Aftertreatment 1 Diesel Particulate Filter Intermediate Gas Temperature
3256	#	AFTR TRT 2 INTK O2	Caption Indicating Aftertreatment 2 Intake Percent O_2
3257	#	AFT2 INTK SNSPWR IN RG	Caption Indicating Aftertreatment 2 Intake Gas Sensor Power In Range
3260	#	AFT2 INTK WR O2 STBL	Caption Indicating Aftertreatment 2 Intake Wide-Range Percent O2 Reading Stable

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SPN	FMI	String Displayed	Description
3261	#	AFT2 INTK SNS HTR FMI	Caption Indicating Aftertreatment 2 Intake Gas Sensor Heater Preliminary FMI
3264	#	AFT2 INTK O2 SNSR FMI	Caption Indicating Aftertreatment 2 Intake O2 Sensor Preliminary FMI
3271	#	AFT2 OUT SNS HTR FMI	Caption Indicating Aftertreatment 2 Outlet Gas Sensor Heater Preliminary FMI
3361	#	AFT1 CTLYST DOSE UNIT	Caption Indicating Aftertreatment 1 SCR Catalyst Dosing Unit
3363	#	AFT1 SCR TANK HTR	Caption Indicating Aftertreatment 1 SCR Tank Heater
3464	#	THROTTLE ACT 1 CNTL	Caption Indicating Throttle Actuator 1 Control
3465	#	THROTTLE ACT 2 CNTL	Caption Indicating Throttle Actuator 2 Control
3485	#	AFT1 SUPPLY AIR PRESS	Caption Indicating Aftertreatment 1 Supply Air Pressure
3509	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
3510	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
3511	#	SNSR SUPPLY VOLT 3	Caption Indicating Sensor Supply Voltage 3
3512	#	SNSR SUPPLY VOLT 4	Caption Indicating Sensor Supply Voltage 4
3513	#	SNSR SUPPLY VOLT 5	Caption Indicating Sensor Supply Voltage 5
3514	#	SNSR SUPPLY VOLT 6	Caption Indicating Sensor Supply Voltage 6
3515	#	DEF TEMP	String for Diagnostic Trouble Code Indicating DEF Temperature
3516	#	DEF CONCENTRATION	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Concentration
3520	#	DEF QUALITY	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Properties Preliminary FMI
3597	#	ECU SUPPLY VOLTAGE 1	Caption Indicating ECU Power Supply Voltage 1
3598	#	ECU SUPPLY VOLTAGE 2	Caption Indicating ECU Power Supply Voltage 2
3599	#	ECU SUPPLY VOLTAGE 3	Caption Indicating ECU Power Supply Voltage 3
3601	#	FUEL VLV LK TEST CTL	Caption Indicating Engine Fuel Shutoff Valve Leak Test Control
3605	#	COOLANT PUMP CTL	Caption Indicating Coolant Pump Control
3609	#	DPF INTAKE PRESSR 1	Caption Indicating DPF Intake Pressure 1
3610	#	DPF OUTLET PRESSR 1	Caption Indicating DPF Outlet Pressure 1
3611	#	DPF INTAKE PRESSR 2	Caption Indicating DPF Intake Pressure 2
3612	#	DPF OUTLET PRESSR 2	Caption Indicating DPF Outlet Pressure 2
3673	#	THROTTLE POSITION 2	Caption Indicating Engine Throttle 2 Position
3719	0	DPF SOOT LVL EXT HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Most Severe Level
3719	15	DPF SOOT LVL HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level
3719	16	DPF SOOT LVL MOD HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Moderately Severe Level
3822	#	EGR1 VLV 2 POSITION	Caption Indicating Engine Exhaust Gas Recirculation 1 Valve 2 Position
3826	#	DEF AVG CONSUMPTION	Caption Indicating DEF Average Consumption
3828	#	DEF CURRNT CONSUMPTN	Caption Indicating DEF Current Consumption
4096	#	NOx HI DEF EMPTY	NOx Limits Exceeded Due to Diesel Exhaust Fluid Empty
4213	#	ENG CRNK WITHOUT_FUEL	Caption Indicating Engine Crank Without Fuel
4332	#	DEF SYSTEM STATE	Caption Indicating DEF System State

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SPN	FMI	String Displayed	Description
4334	#	DEF ABSOLUTE PRESSR	Caption Indicating DEF Absolute Pressure
4335	#	DEF DOSING AIR ABS PR	Caption Indicating DEF Dosing Air Assist Absolute Pressure
4336	#	AFT1 DOSE AIR ASSTVLV	Caption Indicating Aftertreatment 1 SCR Dosing Air Assist Valve
4354	#	AFT1 DEF LINE HTR	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Line Heater 1
4364	#	SCR CNVRSN EFFICIENCY	Caption Indicating SCR Conversion Efficiency
4755	#	AFT1 CTLYST DIFF PRS	Caption Indicating Aftertreatment 1 Gas Oxidation Catalyst Differential Pressure
4794	#	AFT1 CTLYST SYS MSSNG	Caption Indicating Aftertreatment 1 SCR Catalyst System Missing
4809	#	AFT1 DEF WARM IN TMP	Caption Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Inlet Temperature
4810	#	AFT1 DEF WARM OUT TMP	Caption Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Outlet Temperature
5246	#	SCR INDUCMT SEVERITY	Selective Catalytic Reduction Inducement Severity Level
5264	#	EGR2 VALVE 1 CONTROL	Caption Indicating Engine Exhaust Gas Recirculation 2 Valve 1 Control
520837	1	STARTER SPEED LO LO	Starter Speed is below the LOW LOW threshold
520838	1	RUN UP SPEED LO LO	Run Up Speed is below the LOW LOW threshold
522192	12	MTU ENGINE BAD	Component failure of the MTU engine control ECU
523212	#	ENGPRT CAN MSG	Caption String for CAN Message
523216	#	PREHTENCMD CAN MSG	Caption String for CAN Message
523218	#	RxCCVS CAN MSG	Caption String for CAN Message
523222	#	TC01 CAN MSG	Caption String for CAN Message
523238	#	SWTOUT CAN MSG	Caption String for CAN Message
523239	#	DECV1 CAN MSG	Caption String for CAN Message
523240	#	FUNMODCTL CAN MSG	Caption String for CAN Message
523350	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523351	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523352	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523353	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523354	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523355	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523370	#	RAIL PRESSURE	Caption String for Rail Pressure
523420	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523450	#	MULTI STATE SWITCH 1	Caption String for Multi State Switch 1
523451	#	MULTI STATE SWITCH 2	Caption String for Multi State Switch 2
523452	#	MULTI STATE SWITCH 3	Caption String for Multi State Switch 3
523470	#	RAIL PRESSURE LMT VLV	Caption String for Rail Pressure Limit Valve
523490	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523500	#	CAN MSG TIMEOUT	Caption String indicating Can Message Timeout has occurred
523550	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523561	#	INJECTN PERIOD CYL 1	Caption String for Single Cylinder Injection Period
523562	#	INJECTN PERIOD CYL 2	Caption String for Single Cylinder Injection Period

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SPN	FMI	String Displayed	Description
523563	#	INJECTN PERIOD CYL 3	Caption String for Single Cylinder Injection Period
523564	#	INJECTN PERIOD CYL 4	Caption String for Single Cylinder Injection Period
523565	#	INJECTN PERIOD CYL 5	Caption String for Single Cylinder Injection Period
523566	#	INJECTN PERIOD CYL 6	Caption String for Single Cylinder Injection Period
523567	#	INJECTN PERIOD CYL 7	Caption String for Single Cylinder Injection Period
523568	#	INJECTN PERIOD CYL 8	Caption String for Single Cylinder Injection Period
523600	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523601	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523602	#	FAN SPEED	Caption String for Engine Fan Speed
523604	#	RXENGTMP CAN MSG	Caption String for CAN Message
523605	#	TSC1-AE MSG MISSING	Caption String for CAN Message
523606	#	TSC1-AR MSG MISSING	Caption String for CAN Message
523607	#	TSC1-DE MSG MISSING	Caption String for CAN Message
523608	#	TSC1-DR MSG MISSING	Caption String for CAN Message
523609	#	TSC1-PE MSG MISSING	Caption String for CAN Message
523610	#	TSC1-VE MSG MISSING	Caption String for CAN Message
523611	#	TSC1-VR MSG MISSING	Caption String for CAN Message
523612	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523613	#	RAIL PRESSURE	Caption String for Rail Pressure
523615	#	METERING UNIT VALVE	Caption String for Metering Unit Valve
523617	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error

Table 37. DTCs Displayed by the MGC-1550 (FMI Strings)

FMI	String Displayed	Description
0	DATA HI MOST SEVERE	Data is higher than expected at the most severe level
1	DATA LO MOST SEVERE	Data is lower than expected at the most severe level
2	DATA ERRATIC OR BAD	Data is erratic, intermittent, or incorrect
3	VOLTS HI OR SHORTED	Measured voltage is higher than expected or shorted to a high source
4	VOLTS LO OR SHORTED	Measured voltage is lower than expected or shorted to a low source
5	CURRENT LO OR OPEN	Measured current is lower than expected or the circuit is open
6	CURRENT HI OR SHORTED	Measured current is higher than expected or shorted
7	MECHANICAL SYSTM ERR	Mechanical system error
8	FREQ OR PWM ERROR	Error in frequency, pulse width or period of any frequency or PWM signal is outside its predetermined limits
9	ABNORMAL UPDATE RATE	Update rate of parameter is abnormal
10	DATA RT OF CHG ERR	Rate of change of data is abnormal
11	FAILURE CAUSE UNKNOWN	String indicating failure cause is unknown
12	BAD INTELLIGENT DEVICE	Engine ECU is reporting that an intelligent device or component failure has been detected
13	OUT OF CALIBRATION	Device or parameter is out of calibration
14	CONSULT ENG MFG DATA	User should consult engine manufacturer's data
15	DATA HI LST SEVERE	Data is higher than expected at the least severe level
16	DATA HI MODERATE SVR	Data is higher than expected at a moderately severe level
17	DATA LO LST SEVERE	Data is lower than expected at the least severe level

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FMI	String Displayed	Description
18	DATA LO MODERATE SVR	Data is lower than expected at a moderately severe level
19	NETWORK DATA ERR	String Indicating Network Data contained an error indication
20	DATA DRIFTED HI	Data has drifted to a value higher than the maximum valid value.
21	DATA DRIFTED LO	Data has drifted to a value lower than the minimum valid value.
22	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
23	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
24	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
25	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
26	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
27	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
28	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
29	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
30	FMI RESERVED BY SAE	This FMI is reserved by the Society of Automotive Engineers.
31	CONDTN EXST OR FMI NA	If the SPN refers to a parameter with status of ON or OFF, an FMI of 31 indicates ON. If the SPN refers to a parameter with a numeric value, an FMI of 31 indicates that there is no FMI to describe the parameter’s condition.

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Modbus™ Communication

Introduction

General Overview

An optional feature of the MGC-1550 performs Modbus™ communications by emulating a subset of the Modicon 984 Programmable Controller. This document describes the Modbus communications protocol employed by theMGC-1550 and how to exchange information with the MGC-1550 over a Modbus network.

The MGC-1550 maps all parameters into the Modicon 984 Holding Register address space (4XXXX). Refer to *MAPPING – MGC-1550 Parameters into MODICON ADDRESS SPACE* in this section.

Note
The 40XXX registers are identical to the data that was present in the MGC-1550 product. This allows the MGC-1550 to work seamlessly in Modbus applications where it is replacing an MGC-1550. The 42XXX registers contain all information included in the MGC-1550 and should be used for any new Modbus applications.`

Intended Use of the Communications Protocol

This document provides the necessary information for 3rd party OEMs to develop in-house software to communicate with the MGC-1550 via Modbus protocol. This will allow the exchange of setup information and measured data between a Modbus Master Station and the MGC-1550.

The MGC-1550 data supported for remote access is listed in *MAPPING – MGC-1550 Parameters into MODICON ADDRESS SPACE* in this section.

Detailed Description of MGC-1550 Modbus™ Protocol

Modbus™ Protocol Overview

Modbus communications use a master-slave technique in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications on the Modbus, and will always generate a response to the query unless certain error conditions occur. The MGC-1550 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query.

If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected.

Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field. Subsequent sections in this document detail each message field and the corresponding functionality supported by the MGC-1550.

Query / Response Message Structure:

- Device Address
- Function Code
- Eight-Bit Data Bytes
- Error Check

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Device Address Field

The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

Function Code Field

The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

Data Block Field

The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

Error Check Field

The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

Serial Transmission Details

A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The MGC-1550 supports only the RTU (Remote Terminal Unit) mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. A ninth data bit is added when parity is selected. Parity checking is user-configurable to even, odd or none. The transmission baud rate is also user-configurable, and both parity and baud rate can be altered during real-time operation. If altered, the new baud rate and / or parity will not be enforced until the response message to the current query has completed. The MGC-1550 supported baud rates are 9600, 4800, 2400, and 1200.

Message Framing / Timing Considerations

When receiving a message, the MGC-1550 will allow maximum inter-byte latency up to 3.5 - 4.0 character times before considering the message complete.

Once a valid query is received, the MGC-1550 waits 10 msec. before responding.

Error Handling and Exception Responses

Any query received that contains a non-existent device address, a framing error or CRC error will be ignored - no response will be transmitted. Queries addressed to an MGC-1550 with an unsupported function code, unsupported register references, or illegal values in the data block will result in an error response message with an Exception Response Code. The Exception Response codes supported by the MGC-1550 are listed in Table 38.

Table 38. Exception Response Codes

Code	Name	Meaning
01	Illegal Function	The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group.
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

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Detailed MGC-1550 Message Definition

Device Address

The MGC-1550 Device Address can be any value in the Modbus protocol Device Address range (1 - 247). A query with a Device Address of 0 signifies a Broadcast message to all slaves - the connected MGC-1550s will not respond to the broadcast query.

Function Code and Data Block

The MGC-1550 maps all parameters into the Modicon 984 Holding Register address space (4XXXX) and supports the following Function Codes:

- Function 03 - Read Holding Registers
- Function 6 - Preset Single Register, Non-Broadcast & Broadcast
- Function 08, Subfunction 00 - Diagnostics: Return Query Data
- Function 16 - Preset Multiple Registers, Non-Broadcast & Broadcast

The only Broadcast query supported by the MGC-1550 is the Preset Multiple Registers query.

Read Holding Registers

Read Holding Registers - General

QUERY:

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read Holding Register N+1.

Device Address	
Function Code	03 (hex)
Starting Address Hi	
Starting Address Lo	
No. of Registers Hi	
No. of Registers Lo	
CRC Error Check	

The number of registers cannot exceed 125 without causing an error response with Exception Code "Illegal Function".

Queries to read Write Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.

RESPONSE:

The response message contains the data queried, respectively. The data block contains the block length in bytes followed by the data for each requested register. Attempting to read an unused register or a register which does not support read results in an error response with Exception Code of "Illegal Data Address".

Device Address	
Function Code	03 (hex)
Byte Count	
Data Hi	
Data Lo	
.	
.	
.	
Data Hi	
Data Lo	
CRC Error Check	

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Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address	
Function Code	08 (hex)
Subfunction Hi	00 (hex)
Subfunction Lo	00 (hex)
Data Hi	
Data Lo	
CRC Error Check	

Preset Multiple Registers, Non-Broadcast & Broadcast

Preset Multiple Registers - General

QUERY:

This query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.
- Queries attempting to write more than 100 registers cause an error response with Exception Code “Illegal Function”.
- An incorrect Byte Count will result in an error response with Exception Code of “Illegal Data Value”.
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) MGC-1550 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address	
Function Code	10 (hex)
Starting Address Hi	
Starting Address Lo	
No. of Registers Hi	
No. of Registers Lo	
Byte Count	
Data Hi	
Data Lo	
.	
.	
.	
Data Hi	
Data Lo	
CRC Error Check	

RESPONSE:

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

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Device Address	
Function Code	10 (hex)
Starting Address Hi	
Starting Address Lo	
No. of Registers Hi	
No. of Registers Lo	
CRC Error Check	

Preset Single Register, Non-Broadcast & Broadcast

QUERY:

This query message requests a register to be written. A device address is 0 for a broadcast query.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) MGC-1550 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code "Illegal Data Address".
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of "Illegal Data Value".

Device Address	
Function Code	06 (hex)
Address Hi	
Address Lo	
Data Hi	
Data Lo	
CRC Error Check	

RESPONSE:

The response message echoes the address and the value written. There is no response message when the query is broadcast.

Device Address	
Function Code	06 (hex)
Address Hi	
Address Lo	
Data Hi	
Data Lo	
CRC Error Check	

Data Formats

Short Integer Data Format (INT8)

The Modbus short integer data format uses a single holding register to represent an 8 bit data value. The holding register high byte will always be zero.

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Example: The value 132 represented in short integer format is hexadecimal 0x84. This number will read from a holding register as follows:

Holding Register	Value
K (Hi Byte)	hex 00

K (Lo Byte) hex 84

The same byte alignments are required to write.

Integer Data Format (INT16)

The Modbus integer data format uses a single holding register to represent a 16-bit data value.

Example: The value 4660 represented in integer format is hexadecimal 0x1234. This number will read from a holding register as follows:

Holding Register	Value
K (Hi Byte)	hex 12
K (Lo Byte)	hex 34

The same byte alignments are required to write.

Long Integer Data Format (INT32)

The Modbus long integer data format uses two consecutive holding registers to represent a 32-bit data value. The first register contains the low-order 16 bits and the second register contains the high-order 16 bits.

Example: The value 95,800 represented in long integer format is hexadecimal 0x00017638. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 76
K (Lo Byte)	hex 38
K+1 (Hi Byte)	hex 00
K+1 (Lo Byte)	hex 01

The same byte alignments are required to write.

32-bit Bit-Mapped Parameter Mapping

The register arrangement for 32-bit bit-mapped parameters is illustrated in Figure 100. The Alarm Metering registers (44812/44813) are shown as an example. In this example, Bit 25 is set indicating an Overcrank condition and Bit 17 is set indicating a Global Alarm.

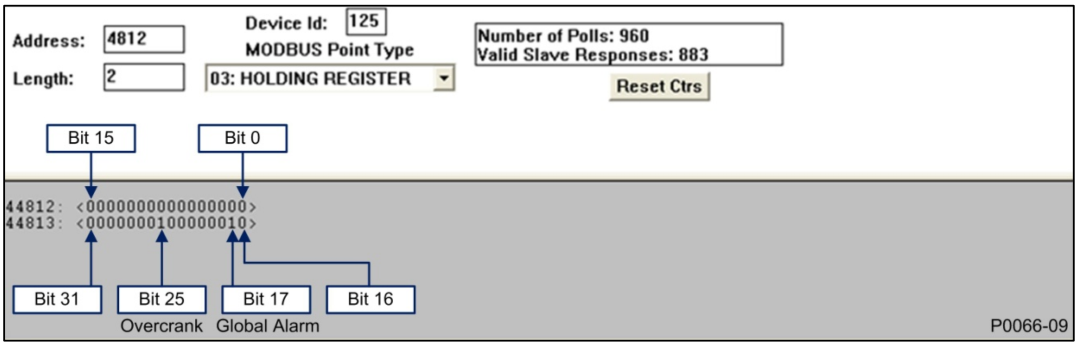

Figure 100. 32-Bit Bit-Mapped Parameter Mapping

The Alarm Metering register bits are defined as follows:

- Bit 0 through Bit 16 = Not Used
- Bit 24 = Emergency Shutdown

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- Bit 17 = Global Alarm
- Bit 18 = Auto Restart Failure
- Bit 19 = Fuel Leak Detect
- Bit 20 = Battery Charger Failure
- Bit 21 = Transfer Fail
- Bit 22 = Low Coolant Level
- Bit 23 = ECU Shutdown
- Bit 25 = Overcrank
- Bit 26 = Loss of ECU Comms
- Bit 27 = Global Sender Fail
- Bit 28 = Low Fuel Level
- Bit 29 = Low Oil Pressure
- Bit 30 = Hi Coolant Temp
- Bit 31 = Overspeed

Floating Point Data Format

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table 39 shows the floating-point format.

Table 39. Floating Point Format

Sign	Exponent + 127	Mantissa
1 bit	8 bits	23 bits

The floating-point format allows for values ranging from approximately $8.43X10^{-37}$ to $3.38X10^{38}$. A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

Example: The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 1C
K (Lo Byte)	hex 00
K+1 (Hi Byte)	hex 47
K+1 (Lo Byte)	hex BB

The same byte alignments are required to write.

Double Precision Data Format (DP)

The Modbus Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

Triple Precision Data Format (TP)

The Modbus Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

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Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The MGC-1550 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (40023-40055) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

Mapping – MGC-1550 Parameters into Modicon Address Space

Current Parameter Table

The MGC-1550 maps all non-legacy parameters into the Holding Register address space (42000 and above). Query address N will access the Holding Register N+1.

Bus Condition Detection

Register	Description	Type	Units	Scaling Factor	R/W	Range
42000-804	RESERVED					
42806	Gen Dead Status	Int32	N/A	N/A	R	0 - 1
42808	Gen Stable Status	Int32	N/A	N/A	R	0 - 1
42810	Gen Fail Status	Int32	N/A	N/A	R	0 - 1
42812	Bus Dead Status	Int32	N/A	N/A	R	0 - 1
42814	Bus Stable Status	Int32	N/A	N/A	R	0 - 1
42816	Bus Fail Status	Int32	N/A	N/A	R	0 - 1
42818-3506	RESERVED					

System Configuration and Status

Register	Description	Type	Units	Scaling Factor	R/W	Range
43508	Off Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43510	Run Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43512	Auto Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43514	Virtual Input 1 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43516	Virtual Input 2 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable

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Register	Description	Type	Units	Scaling Factor	R/W	Range
43518	Virtual Input 3 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43520	Virtual Input 4 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43522	RTC Clock Hour	Int32	Hour	N/A	RW	0 - 23
43524	RTC Minute	Int32	Minute	N/A	RW	0 - 59
43526	RTC Second	Int32	Second	N/A	RW	0 - 59
43528	RTC Month	Int32	N/A	N/A	RW	1 - 12
43530	RTC Day	Int32	N/A	N/A	RW	1 - 31
43532	RTC Year	Int32	N/A	N/A	RW	0 - 99
43534-748	RESERVED					

Control

Register	Description	Type	Units	Scaling Factor	R/W	Range
43750	Emergency Stop: Writing a 1 will toggle emergency stop from off to on. Writing a 1 again will toggle emergency stop from on to off	Int32	N/A	N/A	RW	1 = Toggle On/Off
43752	Remote Start	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43754	Remote Stop	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43756	Run Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43758	Off Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43760	Auto Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43762	Alarm Reset	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43764	Gen Breaker Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43766	Gen Breaker Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43768	Mains Breaker Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43770	Mains Breaker Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43772	RESERVED					
43774	Virtual Input 1 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43776	Virtual Input 1 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43778	Virtual Input 2 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43780	Virtual Input 2 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43782	Virtual Input 3 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43784	Virtual Input 3 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43786	Virtual Input 4 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43788	Virtual Input 4 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43790	ESTOP Latch Status	Int32	N/A	N/A	R	0 = Disabled 1 = Enabled
43792-4749	RESERVED					

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Metering

Register	Description	Type	Units	Scaling Factor	R/W	Range
44750	Gen VAB Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44752	Gen VBC Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44754	Gen VCA Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44756	Gen VAN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44758	Gen VBN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44760	Gen VCN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44762	Bus Voltage Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44764	Gen IA Metering	Int32	Amp	N/A	R	(-32768) - 32767
44766	Gen IB Metering	Int32	Amp	N/A	R	(-32768) - 32767
44768	Gen IC Metering	Int32	Amp	N/A	R	(-32768) - 32767
44770	Gen kVA A Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44772	Gen kVA B Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44774	Gen kVA C Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44776	Gen kVA Total Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44778	Gen kW A Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44780	Gen kW B Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44782	Gen kW C Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44784	Gen kW Total Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44786	Power Factor Metering	Float	N/A	N/A	R	(-1) - 1
44788	Gen PF Lagging	Int32	N/A	N/A	R	(-128) - 127
44790	Gen Frequency Metering	Float	Hertz	N/A	R	45 - 440
44792	Bus Frequency Metering	Float	Hertz	N/A	R	45 - 440
44794	Active Speed Source	Uint32	N/A	N/A	R	0 - 255
44796	Engine Speed Metering	Uint32	RPM	N/A	R	0 - 65535
44798	Engine Load Metering	Int32	Percent	N/A	R	(-32768) - 32767
44800	Coolant Temp. Metering	Int32	Deg F	N/A	R	(-32768) - 32767
44802	Oil Pressure Metering	Int32	PSI	N/A	R	(-32768) - 32767
44804	Battery Voltage Metering	Int32	DeciVolt	N/A	R	(-32768) - 32767
44806	Fuel Level Metering	Int32	N/A	N/A	R	(-32768) - 32767
44808	ECU Coolant Level Metering	Uint32	N/A	N/A	R	0 - 255
44810	Cool Down Time Remaining	Int32	Minute	N/A	R	(-128) - 127

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44812-13	Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Unexpected Shutdown Bit 17 = Global Alarm Bit 18 = Auto Restart Failure Bit 19 = Fuel Leak Detect Bit 20 = Battery Charger Failure Bit 21 = Transfer Fail Bit 22 = Low Coolant Level Bit 23 = ECU Shutdown Bit 24 = Emergency Shutdown Bit 25 = Overcrank Bit 26 = Loss of ECU Comms Bit 27 = Global Sender Fail Bit 28 = Low Fuel Level Bit 29 = Low Oil Pressure Bit 30 = Hi Coolant Temp Bit 31 = Overspeed

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44814-15	Pre-Alarm Metering 1	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Serial Flash Read Failure Bit 3 = Checksum Fail Bit 4 = Global Pre-Alarm Bit 5 = Fuel Filter 2 Leak Bit 6 = Fuel Filter 1 Leak Bit 7 = Engine kW Overload 3 Bit 8 = Engine kW Overload 2 Bit 9 = MPU Fail Bit 10 = Fuel Leak Detect Bit 11 = Battery Charger Failure Bit 12 = Low Coolant Level Bit 13 = Mains Brkr Fail to Open Bit 14 = Mains Brkr Fail to Close Bit 15 = Sync Fail at Mains Brkr Bit 16 = Gen Brkr Fail to Open Bit 17 = Gen Brkr Fail to Close Bit 18 = Sync Fail at Gen Brkr Bit 19 = High Fuel Level Bit 20 = Loss of Rem. Mod. Com Bit 21 = Engine kW Overload Bit 22 = Diagnostic Trouble Code Bit 23 = Loss of ECU Comms Bit 24 = Maintenance Due Bit 25 = Battery Overvoltage Bit 26 = Weak Battery Bit 27 = Low Battery Voltage Bit 28 = Low Coolant Temp Bit 29 = Low Fuel Level Bit 30 = Low Oil Pressure Bit 31 = Hi Coolant Temp

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44816-17	MTU Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = High ECU Supply Bit 24 = Combined Red Bit 25 = Overspeed Bit 26 = Low Oil Pressure Bit 27 = Low Fuel Delivery Press. Bit 28 = Low Aftercooler Coolant Level Bit 29 = High Coolant Temp Bit 30 = High Oil Temp Bit 31 = High Charge Air Temp

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44818-19	MTU Pre-Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Low Storage Tank Bit 1 = High Storage Tank Bit 2 = Low Day Tank Bit 3 = High Day Tank Bit 4 = Alternator Winding Temp Bit 5 = Idle Speed Low Bit 6 = Run Up Speed Low Bit 7 = Start Speed Low Bit 8 = Priming Fault Bit 9 = Low Charge Air Coolant Level Bit 10 = High Fuel Temp. Bit 11 = High Exhaust Temp. B Bit 12 = High Exhaust Temp. A Bit 13 = Low ECU Supply Voltage Bit 14 = Engine Speed Too Low Bit 15 = High Voltage Supply Bit 16 = Low Voltage Supply Bit 17 = Speed Demand Fail Bit 18 = ECU Faulty Bit 19 = Combined Yellow Bit 20 = Low Oil Press. Bit 21 = Low Fuel Delivery Press. Bit 22 = Low Charge Air Press. Bit 23 = Low Coolant Level Bit 24 = Low Fuel Rail Press. Bit 25 = High Fuel Rail Press. Bit 26 = Shutdown Override Bit 27 = High Coolant Temp. Bit 28 = High Charge Air Temp. Bit 29 = High Intercooler Temp. Bit 30 = High Oil Temp. Bit 31 = High ECU Temp.

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44820-21	Sender Fail Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Generator Voltage Bit 28 = Fuel Level Bit 29 = Coolant Temp Bit 30 = Oil Pressure Bit 31 = Speed

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44822	Generator Protection Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Bit 21 = 40Q Loss of Excitation Bit 22 = 32 Reverse Power Bit 23 = 59-2 Overvoltage Bit 24 = 27-2 Undervoltage Bit 25 = 51-2 Overcurrent Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59-1 Overvoltage Bit 29 = 27-1 Undervoltage Bit 30 = 47 Phase Imbalance Bit 31 = 51-1 Overcurrent

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44824	Generator Protection Pre-Alarms	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Gen Phase Imbalance Bit 27 = Gen Overcurrent Bit 28 = Gen Underfrequency Bit 29 = Gen Overfrequency Bit 30 = Gen Undervoltage Bit 31 = Gen Overvoltage

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44826	Generator Protection Alarms	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Gen Phase Imbalance Bit 27 = Gen Overcurrent Bit 28 = Gen Underfrequency Bit 29 = Gen Overfrequency Bit 30 = Gen Undervoltage Bit 31 = Gen Overvoltage

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44828-29	Local Input Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44830-31	Local Output Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Pre Start Output Bit 18 = Run Output Bit 19 = Start Output Bit 20 = Output 12 Bit 21 = Output 11 Bit 22 = Output 10 Bit 23 = Output 9 Bit 24 = Output 8 Bit 25 = Output 7 Bit 26 = Output 6 Bit 27 = Output 5 Bit 28 = Output 4 Bit 29 = Output 3 Bit 30 = Output 2 Bit 31 = Output 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44832-33	Status Metering 1	Int32	N/A	N/A	R	Bit 0 = Idle Request Bit 1 = Lamp Test Bit 2 = Alarm Silence Bit 3 = Reset Bit 4 = Alternate Frequency Override Bit 5 = Start Delay Bypass Bit 6 = Cooldown and Stop Request from Logic Bit 7 = Cooldown Request from Logic Bit 8 = External Start Delay Bit 9 = Off Mode Cooldown Bit 10 = PF Mode Active Bit 11 = Var Mode Active Bit 12 = Cooldown Timer Active Bit 13 = Engine Running Bit 14 = Fuel Leak Detect Bit 15 = Battery Charger Failure Bit 16 = Low Coolant Level Bit 17 = Gen Failed Bit 18 = Gen Stable Bit 19 = Gen Dead Bit 20 = Bus Failed Bit 21 = Bus Stable Bit 22 = Bus Dead Bit 23 = Gen Breaker Closed Bit 24 = Mains Breaker Closed Bit 25 = Grounded Delta Override Bit 26 = Battle Override Bit 27 = Auto Transfer Switch Bit 28 = Low Line Override Bit 29 = Single Phase AC Override Bit 30 = Single Phase Override Bit 31 = EPS Supplying Load
44834	Hours Until Maintenance	Int32	N/A	N/A	RW	0 - 5000
44836	Cum. Total Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44838	Cum. Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44840	Cum. Loaded Engine Run Hrs.	Int32	N/A	N/A	R	0 - 99999
44842	Cum. Loaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44844	Cum. Unloaded Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44846	Cum. Unloaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44848	Cum. Total kW-Hrs	Uint32	KiloWattHour	N/A	R	0 - 999999999
44850	Cum. Total kW-Mins	Uint32	KiloWattMinute	N/A	R	0 - 4294967295
44852	Commission Date Month	Uint32	N/A	N/A	RW	1 - 12
44854	Commission Date Day	Uint32	N/A	N/A	RW	1 - 31
44856	Commission Date Year	Uint32	N/A	N/A	RW	0 - 99
44858	Session Total Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44860	Session Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44862	Session Loaded Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44864	Session Loaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44866	Session Unloaded Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44868	Session Unloaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44870	Session kW-Hrs	Int32	KiloWattHour	N/A	R	0 - 999999999
44872	Cumulative Number of Engine Starts	Uint32	N/A	N/A	RW	0 - 65535
44874	Session Start Date Month	Uint32	N/A	N/A	RW	1 - 12
44876	Session Start Date Day	Uint32	N/A	N/A	RW	1 - 31
44878	Session Start Date Year	Uint32	N/A	N/A	RW	0 - 99
44880	Generator Status	Uint32	N/A	N/A	R	0 = RESET State 1 = READY State 2 = CRANKING State 3 = RESTING State 4 = RUNNING State 5 = ALARM State 6 = PRESTART State 7 = COOLING State 8 = CONNECTING State 9 = DISCONNECT State 10 = PULSING State

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44882	Contact Input Status	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Input 7 Bit 22 = Input 6 Bit 23 = Input 5 Bit 24 = Input 4 Bit 25 = Input 3 Bit 26 = Input 2 Bit 27 = Input 1 Bit 28 = Reserved Bit 29 = Estop Bit 30 = Not Used Bit 31 = Not Used
44884	Main and Auxiliary Relay Image	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Output 4 Bit 25 = Output 3 Bit 26 = Output 2 Bit 27 = Output 1 Bit 28 = Reserved Bit 29 = Prestart Bit 30 = Run Bit 31 = Start

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44886-918	RESERVED					
44920-32	FUTURE USE					
44934-35	Protection Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59 Overvoltage Bit 29 = 27 Undervoltage Bit 30 = 47 Phase Imbalance Bit 31 = 51 Overcurrent
44936	Cumulative Stats - Total Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44938	Cumulative Stats - Loaded Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44940	Cumulative Stats - Unloaded Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44942	Run Stats - Total Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44944	Run Stats - Loaded Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44946	Run Stats - Unloaded Run Minutes	Uint32	Hour	N/A	RW	0 - 5999940
44948-49	RESERVED					
44950	Global Alarm	Uint32	N/A	N/A	R	Bit 0 = No system alarms in effect Bit 1 = System alarm(s) in effect
44952	Global Pre-Alarm	Uint32	N/A	N/A	R	Bit 0 = No system pre-alarms in effect Bit 1 = System pre-alarm(s) in effect

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44954-55	Local Configurable Inputs Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44956-57	Local Configurable Inputs Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44958-59	Configurable Elements Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44960-61	Configurable Elements Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44962-63	Configurable Elements Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44964-65	Remote Inputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 17 Bit 23 = Remote Input 16 Bit 24 = Remote Input 15 Bit 25 = Remote Input 14 Bit 26 = Remote Input 13 Bit 27 = Remote Input 12 Bit 28 = Remote Input 11 Bit 29 = Remote Input 10 Bit 30 = Remote Input 9 Bit 31 = Remote Input 8

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44966-67	Remote Outputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Remote Output 28 Bit 9 = Remote Output 27 Bit 10 = Remote Output 26 Bit 11 = Remote Output 25 Bit 12 = Remote Output 24 Bit 13 = Remote Output 23 Bit 14 = Remote Output 22 Bit 15 = Remote Output 21 Bit 16 = Remote Output 20 Bit 17 = Remote Output 19 Bit 18 = Remote Output 18 Bit 19 = Remote Output 17 Bit 20 = Remote Output 16 Bit 21 = Remote Output 15 Bit 22 = Remote Output 14 Bit 23 = Remote Output 13 Bit 24 = Remote Output 12 Bit 25 = Remote Output 11 Bit 26 = Remote Output 10 Bit 27 = Remote Output 9 Bit 28 = Remote Output 8 Bit 29 = Remote Output 7 Bit 30 = Remote Output 6 Bit 31 = Remote Output 5

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44968-69	CEM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = CEM Hardware Mismatch Bit 30 = Duplicate CEM Bit 31 = CEM Comm Fail

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44970-71	Remote Configurable Inputs Pre-Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 17 Bit 23 = Remote Input 16 Bit 24 = Remote Input 15 Bit 25 = Remote Input 14 Bit 26 = Remote Input 13 Bit 27 = Remote Input 12 Bit 28 = Remote Input 11 Bit 29 = Remote Input 10 Bit 30 = Remote Input 9 Bit 31 = Remote Input 8

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44972-73	Remote Configurable Inputs Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 17 Bit 23 = Remote Input 16 Bit 24 = Remote Input 15 Bit 25 = Remote Input 14 Bit 26 = Remote Input 13 Bit 27 = Remote Input 12 Bit 28 = Remote Input 11 Bit 29 = Remote Input 10 Bit 30 = Remote Input 9 Bit 31 = Remote Input 8
44974-75	RESERVED					
44976	Slip Frequency	Int32	Hertz	Centi	R	(-32768) - 32767
44978	Slip Angle	Int32	DeciUnit	Deci	R	(-32768) - 32767
44980	Voltage Difference	Int32	Volt	N/A	R	(-2147483648) - 2147483647

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44982-83	MDEC Pre-Alarms	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = High Fuel Filter Diff Pressure Bit 25 = Overspeed Test On Bit 26 = Ambient Temp Bit 27 = High Temp Coil 3 Bit 28 = High Temp Coil 2 Bit 29 = High Temp Coil 1 Bit 30 = High Pressure Input 2 Bit 31 = High Pressure Input 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
44984-85	MTU Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = ECU Shutdown Bit 21 = Priming Pump ON Bit 22 = CAN Mode Feedback Bit 23 = Preheat Temp Not Reached Bit 24 = Load Gen On Bit 25 = Cylinder Cutout Bit 26 = Engine Running Bit 27 = Speed Decrease Bit 28 = Speed Increase Bit 29 = Speed Demand Fail Mode Bit 30 = External Stop Active Bit 31 = ECU Override
44986	Generator Frequency	Int32	Hertz	Deci	R	0 - 4400
44988	Bus Frequency	Int32	Hertz	Deci	R	0 - 4400
44990	Power Factor	Int32	N/A	Centi	R	(-100) - 100
44992	Slip Frequency	Int32	Hertz	Milli	R	(-450000) -450000
44994	Bus VAB	Int32	Volt	N/A	R	(-2147483648) – 2147483647
44996	Bus VBC	Int32	Volt	N/A	R	(-2147483648) – 2147483647
44998	Bus VCA	Int32	Volt	N/A	R	(-2147483648) – 2147483647

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45000-01	ECU Lamp Status	Int32	N/A	N/A	R	Bit 0 = Protect Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Warning Bit 4 = Stop Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Malfunction Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used Bit 31 = Not Used
45002-11	Reserved					
45012	Raw ECU accelerator pedal position	Uint32	0.4%/bit gain, 0% offset	N/A	R	0 to 100%
45014	Raw ECU percent load at current speed	Uint32	1%/bit gain, 0% offset	N/A	R	0 to 125%
45016	Raw ECU actual engine percent torque	Uint32	1%/bit gain, -125% offset	N/A	R	0 to 125%
45018	Raw ECU engine speed	Uint32	RPM (0.125rpm/bit gain)	N/A	R	0 to 8031.875 rpm
45020	Raw ECU injection control pressure 2	Uint32	1/256 MPa/bit, 0 Offset	N/A	R	0 to +251 MPa
45022	Raw ECU injector metering rail pressure 2	Uint32	1/256 MPa/bit, 0 Offset	N/A	R	0 to +251 MPa
45024	Raw ECU engine run time	Uint32	0.05 h/bit gain, 0 h offset	N/A	R	0 to +210,554, 060.75 h
45026	Raw ECU trip fuel	Uint32	0.5 L per bit gain, 0 L offset	N/A	R	0 to +2,105,540, 608 L
45028	Raw ECU total fuel used	Uint32	0.5 L per bit gain, 0 L offset	N/A	R	0 to +2,105,540, 608 L
45030	Raw ECU coolant temperature	Uint32	1 °C/bit gain, -40 °C offset	N/A	R	-40 to +210 °C
45032	Raw ECU fuel temperature	Uint32	1 °C/bit gain, -40 °C offset	N/A	R	-40 to +210 °C
45034	Raw ECU engine oil temperature	Uint32	0.03125 °C/bit gain, -273 °C offset	N/A	R	-273 to +1735.0 °C

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45036	Raw ECU engine intercooler temperature	Uint32	1 °C/bit gain, -40 °C offset	N/A	R	-40 to +210 °C
45038	Raw ECU fuel delivery pressure	Uint32	4 kPa/bit gain, 0 kPa offset	N/A	R	0 to +1000 kPa
45040	Raw ECU engine oil level	Uint32	0.4 %/bit gain, 0 % offset	N/A	R	0 to +100 %
45042	Raw ECU oil pressure	Uint32	4 kPa/bit gain, 0 kPa offset	N/A	R	0 to +1000 kPa
45044	Raw ECU coolant pressure	Uint32	2 kPa/bit gain, 0 kPa offset	N/A	R	0 to +500 kPa
45046	Raw ECU coolant level	Uint32	0.4 %/bit gain, 0 % offset	N/A	R	0 to +100 %
45048	Raw ECU fuel rate	Uint32	0.05 L/h per bit , 0 offset	N/A	R	0 to +3212.75 L/h
45050	Raw ECU barometric pressure	Uint32	0.5 kPa/bit gain, 0 kPa offset	N/A	R	0 to +125 kPa
45052	Raw ECU ambient air temperature	Uint32	0.03125 °C/bit gain, -273 °C offset	N/A	R	-273 to +1735.0 °C
45054	Raw ECU air inlet temperature	Uint32	1 °C/bit gain, -40 °C offset	N/A	R	-40 to +210 °C
45056	Raw ECU boost pressure	Uint32	2 kPa/bit gain, 0 kPa offset	N/A	R	0 to +500 kPa
45058	Raw ECU intake manifold temperature	Uint32	1 °C/bit gain, -40 °C offset	N/A	R	-40 to +210 °C
45060	Raw ECU air filter differential pressure	Uint32	0.05 kPa/bit gain, 0 kPa offset	N/A	R	0 to +12.5 kPa
45062	Raw ECU exhaust gas temperature	Uint32	0.03125 °C/bit gain, -273 °C offset	N/A	R	-273 to +1735.0 °C
45064	Raw ECU electrical potential voltage	Uint32	0.05 V/bit gain, 0 V offset	N/A	R	0 to +3212.75 V
45066	Raw ECU battery potential voltage switched	Uint32	0.05 V/bit gain, 0 V offset	N/A	R	0 to +3212.75 V
45068	Raw ECU speed at idle point 1	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45070	Raw ECU torque at idle point 1	Uint32	1%/bit gain, -125% offset	N/A	R	0 to +125 %
45072	Raw ECU speed at idle point 2	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45074	Raw ECU torque at idle point 2	Uint32	1%/bit gain, -125% offset	N/A	R	0 to +125 %
45076	Raw ECU speed at idle point 3	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45078	Raw ECU torque at idle point 3	Uint32	1%/bit gain, -125% offset	N/A	R	0 to +125 %
45080	Raw ECU speed at idle point 4	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45082	Raw ECU torque at idle point 4	Uint32	1%/bit gain, -125% offset	N/A	R	0 to +125 %
45084	Raw ECU speed at idle point 5	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45086	Raw ECU torque at idle point 5	Uint32	1%/bit gain, -125% offset	N/A	R	0 to +125 %
45088	Raw ECU speed at high idle point 6	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45090	Raw ECU gain of end speed governor	Uint32	0.0007813%ref trq/rpm per bit gain, 0 Offset	N/A	R	0 to 50.2 %/rpm
45092	Raw ECU reference engine torque	Uint32	1 Nm/bit gain, 0 Nm offset	N/A	R	0 to 64 255 Nm
45094	Raw ECU override speed point 7	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 to 8031.875 rpm
45096	Raw ECU override time limit	Uint32	0.1 s/bit gain, 0 s offset	N/A	R	0 s to 25 s
45098	Raw ECU speed lower limit	Uint32	10 rpm/bit gain, 0 rpm offset	N/A	R	0 to 2500 rpm
45100	Raw ECU speed upper limit	Uint32	10 rpm/bit gain, 0 rpm offset	N/A	R	0 to 2500 rpm
45102	Raw ECU torque lower limit	Uint32	1%/bit gain, -125% offset	N/A	R	0 to 125%
45104	Raw ECU torque upper limit	Uint32	1%/bit gain, -125% offset	N/A	R	0 to 125%
45106	Active DTC 1	Uint32	N/A	N/A	R	0 – 65535
45108	Active DTC 2	Uint32	N/A	N/A	R	0 – 65535
45110	Active DTC 3	Uint32	N/A	N/A	R	0 – 65535
45112	Active DTC 4	Uint32	N/A	N/A	R	0 – 65535
45114	Active DTC 5	Uint32	N/A	N/A	R	0 – 65535
45116	Active DTC 6	Uint32	N/A	N/A	R	0 – 65535
45118	Active DTC 7	Uint32	N/A	N/A	R	0 – 65535
45120	Active DTC 8	Uint32	N/A	N/A	R	0 – 65535
45122	Active DTC 9	Uint32	N/A	N/A	R	0 – 65535
45124	Active DTC 10	Uint32	N/A	N/A	R	0 – 65535
45126	Active DTC 11	Uint32	N/A	N/A	R	0 – 65535
45128	Active DTC 12	Uint32	N/A	N/A	R	0 – 65535
45130	Active DTC 13	Uint32	N/A	N/A	R	0 – 65535
45132	Active DTC 14	Uint32	N/A	N/A	R	0 – 65535
45134	Active DTC 15	Uint32	N/A	N/A	R	0 – 65535
45136	Active DTC 16	Uint32	N/A	N/A	R	0 – 65535
45138	Previously Active DTC 1	Uint32	N/A	N/A	R	0 – 65535
45140	Previously Active DTC 2	Uint32	N/A	N/A	R	0 – 65535
45142	Previously Active DTC 3	Uint32	N/A	N/A	R	0 – 65535
45144	Previously Active DTC 4	Uint32	N/A	N/A	R	0 – 65535
45146	Previously Active DTC 5	Uint32	N/A	N/A	R	0 – 65535
45148	Previously Active DTC 6	Uint32	N/A	N/A	R	0 – 65535
45150	Previously Active DTC 7	Uint32	N/A	N/A	R	0 – 65535
45152	Previously Active DTC 8	Uint32	N/A	N/A	R	0 – 65535
45154	Previously Active DTC 9	Uint32	N/A	N/A	R	0 – 65535
45156	Previously Active DTC 10	Uint32	N/A	N/A	R	0 – 65535
45158	Previously Active DTC 11	Uint32	N/A	N/A	R	0 – 65535
45160	Previously Active DTC 12	Uint32	N/A	N/A	R	0 – 65535

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45162	Previously Active DTC 13	Uint32	N/A	N/A	R	0 – 65535
45164	Previously Active DTC 14	Uint32	N/A	N/A	R	0 – 65535
45166	Previously Active DTC 15	Uint32	N/A	N/A	R	0 – 65535
45168	Previously Active DTC 16	Uint32	N/A	N/A	R	0 – 65535
45170	Active DTC Count	Uint32	N/A	N/A		0-16
45172	Previously Active DTC Count	Uint32	N/A	N/A		0-16
45174	MTU Fault Code Count	Uint32	N/A	N/A		0-20
45176-261	RESERVED					
45262	MDEC speed demand source 2	Uint32	N/A	N/A	RW	0 = Analog CAN 1 = Up Down ECU 2 = Up Down CAN 3 = Analog ECU 4 = Frequency 5 = No CAN Demand
45264	RESERVED					
45266	Volvo accelerator pedal position 2	Int32	Percent	N/A	RW	0 – 100
45268	Volvo RPM select 2	Uint32	N/A	N/A	RW	0 = Primary 1 = Secondary
45270-79	RESERVED					
45280	MTU request test overspeed	Uint32	N/A	N/A	RW	0 = Off 1 = On
45282	MTU governor switch-over parameters	Uint32	N/A	N/A	RW	0 = Off 1 = On
45284	MTU intermittent oil prime request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45286	MTU trip info reset request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45288	MTU speed increase	Uint32	N/A	N/A	RW	0 = Off 1 = On
45290	MTU speed decrease	Uint32	N/A	N/A	RW	0 = Off 1 = On
45292	MTU speed demand limit Boolean	Uint32	N/A	N/A	RW	0 = Off 1 = On
45294	MTU mode switch	Uint32	N/A	N/A	RW	0 = Off 1 = On
45296	MTU increase idle	Uint32	N/A	N/A	RW	0 – 1000
45298	MTU governor parameter set select	Uint32	N/A	N/A	RW	0 – 1000
45300	MTU fan override	Uint32	N/A	N/A	RW	0 = Off 1 = On
45302	MTU prime on engine start	Uint32	N/A	N/A	RW	0 = Off 1 = On
45304	MTU CAN rating switch 1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45306	MTU CAN rating switch 2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45308	MTU disable cylinder cutout 1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45310	MTU disable cylinder cutout 2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45312	RESERVED					

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45314	MTU 50/60 Hz switch data	Int32	N/A	N/A	RW	0 = 50 Hz 1 = 60 Hz
45316-19	RESERVED					
45320	DPF manual regenerate data	Int32	N/A	N/A	RW	0 = Off 1 = On
45322	DPF regeneration disable data	Int32	N/A	N/A	RW	0 = Off 1 = On
45324-29	RESERVED					
45330	Requested MTU SMC ENG Operating Mode	Int32	N/A	N/A	RW	1 - 2
45332-573	RESERVED					
45574	Gen Kvar A	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45576	Gen Kvar B	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45578	Gen Kvar C	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45580	Gen Kvar Total	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45582	FUTURE USE					

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45584-85	Logic Control Relay Status	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Logic Control Relay 16 Bit 17 = Logic Control Relay 15 Bit 18 = Logic Control Relay 14 Bit 19 = Logic Control Relay 13 Bit 20 = Logic Control Relay 12 Bit 21 = Logic Control Relay 11 Bit 22 = Logic Control Relay 10 Bit 23 = Logic Control Relay 9 Bit 24 = Logic Control Relay 8 Bit 25 = Logic Control Relay 7 Bit 26 = Logic Control Relay 6 Bit 27 = Logic Control Relay 5 Bit 28 = Logic Control Relay 4 Bit 29 = Logic Control Relay 3 Bit 30 = Logic Control Relay 2 Bit 31 = Logic Control Relay 1

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45586-87	I/O Modules Connected	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = CEM Connected Bit 31 = Not Used
45588-92	RESERVED					

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45594-95	Status Metering 2	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Bus Reverse Rotation Bit 17 = Bus Forward Rotation Bit 18 = Gen Reverse Rotation Bit 19 = Gen Forward Rotation Bit 20 = Not Used Bit 21 = Auto Breaker Operation Inhibit Bit 22 = Mains Fail Transfer Inhibit Bit 23 = Restart Delay Active Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Mains Fail Test Bit 31 = Take Over Load

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45596-97	Gen Protect Pre-Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59 Overvoltage Bit 29 = 27 Undervoltage Bit 30 = 47 Phase Imbalance Bit 31 = 51 Overcurrent

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45598-99	Gen Protect Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59 Overvoltage Bit 29 = 27 Undervoltage Bit 30 = 47 Phase Imbalance Bit 31 = 51 Overcurrent

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Register	Description	Type	Units	Scaling Factor	R/W	Range
45600-01	Pre-Alarm Metering 2	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Bus Reverse Rotation Bit 19 = Gen Reverse Rotation Bit 20 = DEF Inducement Override Bit 21 = DEF Severe Inducement Bit 22 = DEF Presevere Inducement Bit 23 = DEF Engine Derate Bit 24 = DEF Fluid Level Empty Bit 25 = DEF Fluid Level Low Bit 26 = DPF Soot Level Severely High Bit 27 = DPF Soot Level Moderately High Bit 28 = DPF Soot Level High Bit 29 = High Exhaust Temperature Bit 30 = DPF Regenerate Disabled Bit 31 = DPF Regenerate Required
45602	Operating Units Config Data	Int32	N/A	N/A	R	0 – 3
45604-643	RESERVED					
45644	Generator Connection	Int32	N/A	N/A	R	0-4
45646	Bus Connection	Int32	N/A	N/A	R	0 – 4
45648	Generator Average Line to Line Voltage	Int32	N/A	N/A	R	-2147483648 – 2147483647
45650	Generator Average Line to Neutral Voltage	Int32	N/A	N/A	R	-2147483648 – 2147483647
45652	Generator Average Current	Int32	N/A	N/A	R	-2147483648 – 2147483647
45654-662	RESERVED	Int32	N/A	N/A	R	0 – 32767

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Register	Description	Type		Units	Scaling Factor	R/W	Range
45664-748	FUTURE USE						
45750-761	RESERVED						
45762	Embedded Code Version Number	Uint32	N/A	N/A	R	0 – 4294967295	
45764	Boot Code Version Number	Int32	N/A	N/A	R	-2147483648 – 2147483647	
45766	Model Number	Uint32	N/A	N/A	R	0 – 4294967295	
45768	Embedded Code Part Number	Uint32	N/A	N/A	R	0 – 4294967295	
45770-977	RESERVED						
45978-999	FUTURE USE						
46000	Raw J1939 transmission oil pressure	Uint32	16 kPa/bit, 0 offset	N/A	R	0 to +4000 kPa (0 to 580 psi)	
46002	Raw J1939 transmission oil temperature	Uint32	.03125 Deg C/bit Offset -273 Deg C	N/A	R	−273 to +1735.0 °C (−459.4 to 3155.0 °F)	
46004	Raw J1939 winding 1 temperature	Uint32	1 Deg C Per Bit Offset -40 Deg C	N/A	R	−40 to +210 °C (−40 to 410 °F)	
46006	Raw J1939 winding 2 temperature	Uint32	1 Deg C Per Bit Offset -40 Deg C	N/A	R	−40 to +210 °C (−40 to 410 °F)	
46008	Raw J1939 winding 3 temperature	Uint32	1 Deg C Per Bit Offset -40 Deg C	N/A	R	−40 to +210 °C (−40 to 410 °F)	
46010	Raw J1939 ECU temperature	Uint32	.03125 Deg C/bit Offset -273 Deg C	N/A	R	-273 to 1734.96875 degC	
46012	Raw J1939 auxiliary pressure 1	Uint32	16 kPa/bit 0 Offset	N/A	R	0 to 4000 kPa	
46014	Raw J1939 auxiliary pressure 2	Uint32	16 kPa/bit 0 Offset	N/A	R	0 to 4000 kPa	
46016	Raw J1939 rated power	Uint32	0.5 kW/bit 0 Offset	N/A	R	0 to 32,127.5 kW	
46018	Raw J1939 rated RPM	Uint32	0.125 rpm/bit 0 Offset	N/A	R	0 to 8,031.875 rpm	
46020	Raw J1939 exhaust temperature A	Uint32	.03125 Deg C/bit Offset -273 Deg C	N/A	R	-273 to 1734.96875 degC	
46022	Raw J1939 exhaust temperature B	Uint32	.03125 Deg C/bit Offset -273 Deg C	N/A	R	-273 to 1734.96875 degC	
46024	Raw J1939 charge air temperature	Uint32	.03125 Deg C/bit Offset -273 Deg C	N/A	R	-273 to 1734.96875 degC	
46026	Raw J1939 ADEC ECU error code	Uint32	No Scale or Offset	N/A	R	0 - 65535	
46028	Raw J1939 ADEC selected speed demand	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 - 8031.875	
46030	Raw J1939 ADEC effective set speed	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 - 8031.875	
46032	Raw J1939 ADEC CAN bus speed demand feedback	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 - 8031.875	

Register	Description	Type		Units	Scaling Factor	R/W	Range
46034	Raw J1939 ADEC analog speed demand feedback	Uint32	0.125 rpm/bit, 0 rpm offset	N/A	R	0 - 8031.875	
46036	Raw J1939 ADEC speed demand source	Uint32	0 = ANALOG_CAN, 1 = UP_DN_ECU, 2 = UP_DN_CAN, 3 = ANALOG_ECU, 5 = FREQUENCY, 7 = NO_CAN_DEMAND	N/A	R	0 - 7	
46038	Raw J1939 ADEC specified torque	Uint32	1 Nm/Bit, 0 Offset	N/A	R	0 to 64255 Nm	
46040	Raw J1939 ADEC engine optimized	Uint32	No Scale or Offset	N/A	R	0 - 64255	
46042	Raw J1939 ADEC current P degree	Uint32	0.0025%/Bit, 0 offset	N/A	R	0 to 160.7375%	
46044	Raw J1939 ADEC day tank fill percent	Uint32	0.4%/Bit, 0 offset	N/A	R	0 to 100%	
46046	Raw J1939 ADEC storage tank fill percent	Uint32	0.4%/Bit, 0 offset	N/A	R	0 - 4294967295	
46048	Raw J1939 ADEC injection quantity	Uint32	0.1 mm2 per bit	N/A	R	0 - 429496729.5	
46050	Raw J1939 ADEC engine power reserve	Uint32	0.001% per bit	N/A	R	0 - 4294967.295	
46052	Raw J1939 ADEC cylinder cutout code	Uint32	No Scale or Offset	N/A	R	0 - 4294967295	
46054	Raw J1939 ADEC start sequence bit field	Uint32	Bit Packed Data	N/A	R	0 - 4294967295	
46056	Raw J1939 ADEC P lube oil limit lo	Uint32	binary on or off	N/A	R	0 - 1	
46058	Raw J1939 ADEC P lube oil limit lo-lo	Uint32	binary on or off	N/A	R	0 - 1	
46060	Raw J1939 ADEC P charge air pressure	Uint32	.01 mbar/bit, 0 offset	N/A	R	0 - 42949672.5 mbar	
46062	Raw J1939 ADEC AL power amp 1 fail bit field	Uint32	Bit Packed Data	N/A	R	0 - 4294967295	
46064	Raw J1939 ADEC AL power amp 2 fail bit field	Uint32	Bit Packed Data	N/A	R	0 - 4294967295	
46066	Raw J1939 ADEC AL transistor out bit field	Uint32	Bit Packed Data	N/A	R	0 - 4294967295	
46068	Raw J1939 ADEC camshaft RPM	Uint32	0.1 rpm/bit, 0 offset	N/A	R	0 - 429496729.5 rpm	
46070	Raw J1939 ADEC daily fuel consumption	Uint32	.0001 m3 per bit, 0 offset	N/A	R	0 - 429496.7295 m3	
46072	Raw J1939 ADEC frequency speed demand	Uint32	0.1 rpm/bit, 0 offset	N/A	R	0 - 429496729.5 rpm	
46074	Raw J1939 ADEC average trip fuel consumption	Uint32	0.001 L/h/bit, 0 offset	N/A	R	0 - 4294967.295 L/h	
46076	Raw J1939 ADEC injection quantity DBRPct	Uint32	0,01% /bit, 0 offset	N/A	R	0 - 42949672.95 %	

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Register	Description	Type		Units	Scaling Factor	R/W	Range
46078	Raw J1939 ADEC actual droop	Uint32	0.001%/bit, 0 offset	N/A	R		0 - 4294967.295 %
46080	Raw J1939 ADEC nodes on CAN bus	Uint32	No Scale or Offset	N/A	R		0 - 4294967295
46082	Raw J1939 ADEC lost nodes on CAN bus	Uint32	No Scale or Offset	N/A	R		0 - 4294967295
46084	Raw J1939 ADEC trip operating time	Uint32	No Scale or Offset	N/A	R		0 - 4294967295 h
46086	Raw J1939 ADEC transistor out bit field	Uint32	Bit Packed Data	N/A	R		0 - 4294967295
46088	Raw J1939 ADEC L1L ECU power supply volts	Uint32	0.001 V/bit	N/A	R		0 - 4294967.295
46090	Raw J1939 ADEC L2L ECU power supply volts	Uint32	0.001 V/bit	N/A	R		0 - 4294967.295
46092	Raw J1939 ADEC U1L power supply volts	Uint32	0.001 V/bit	N/A	R		0 - 4294967.295
46094	Raw J1939 ADEC U2L power supply volts	Uint32	0.001 V/bit	N/A	R		0 - 4294967295
46096	Raw J1939 ADEC trip idle time	Uint32	1 sec per bit, 0 offset	N/A	R		0 - 4294967295 sec
46098	Raw J1939 ADEC T coolant limit hi	Uint32	0.01 Deg C/Bit, 0 offset	N/A	R		0 - 42949672.95
46100	Raw J1939 ADEC T coolant limit hi-hi	Uint32	0.01 Deg C/Bit, 0 offset	N/A	R		0 - 42949672.95
46102	Raw J1939 ADEC T charge air limit hi	Uint32	0.01 Deg C/Bit, 0 offset	N/A	R		0 - 42949672.95
46104	Raw J1939 ADEC T intercooler limit hi	Uint32	0.01 Deg C/Bit, 0 offset	N/A	R		0 - 42949672.95
46106	Raw J1939 MTU SPS node byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46108	Raw J1939 MTU SW type byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46110	Raw J1939 MTU SW var byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46112	Raw J1939 MTU SW ED 1 byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46114	Raw J1939 MTU SW ED 2 byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46116	Raw J1939 MTU SW rev byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46118	Raw J1939 MTU SW mod byte	Uint32	No Scale or Offset	N/A	R		0 - 255
46120	J1939 ECU protection lamp status data	Uint32	Raw ECU Parameter Data	N/A	R		0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash
46122	J1939 ECU warning lamp status data	Uint32	Raw ECU Parameter Data	N/A	R		0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash

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Register	Description	Type		Units	Scaling Factor	R/W	Range
46124	J1939 ECU red stop lamp status data	Uint32	Raw ECU Parameter Data	N/A	R	0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash	
46126	J1939 ECU malfunction status data	Uint32	Raw ECU Parameter Data	N/A	R	0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash	
46128-964	RESERVED						

Legacy Parameter Table

The MGC-1550 maps all legacy parameters previously associated with the DGC-2020 into the Holding Register address space (40000 to 41999). Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40001-18	RESERVED				
PARAMETER SETTINGS					
40019	Emergency Stop	0-1	R W	0 =Off 1 =Stop	
40020	Remote Start / Stop: Runs when in Auto mode	0-1	R W	0 =Stop 1 =Start	
40021-79	RESERVED				
SYSTEM MONITOR					
40080	Active Speed Signal Sources	1-4	R	1 = MPU 2 = ALT 3 = GEN 4 = NONE	
40081	Sender Failure Alarm Code	individual bits are 0 or 1	R	b0 = High Coolant Temperature b1 = Oil Pressure b2 = Fuel Level b3 = Magnetic Pick-up b4 = Generator Voltage Sensing b5 = Battery Charger Fail b6 = Coolant Level Sender Fail b7 not used	
40082	Alarm Codes	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Low Coolant Level b2=Low Fuel Level b3=Emergency Stop b4=Sender Failure b5=Over Crank b6=Over Speed b7=Low Oil Pressure Rev. 3.04 Added: b8 = CAN Fail	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40083	Pre-Alarm Codes	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Low Coolant Temperature b2=Weak Battery b3=Low Battery b4=Battery Overvoltage b5=Battery Charger Fail b6=Maintenance Interval b7=Engine Overload Rev. 3.04 Added: b8 = DTC b9 = CAN Fail	
40084	Pre-Alarm Codes, Group 2	individual bits are 0 or 1	R	b0=Low Oil Pressure b1=Low Fuel Level b2=Magnetic Pick-up Fail b3=Fuel Level Sender Fail b4=Aux Input 1 b5=Aux Input 2 b6=Aux Input 3 b7=Aux Input 4	
40085	Engine Coolant Temperature		R		DegF
40086	Engine Oil Pressure		R		PSI
40087	Battery Voltage		R		0.1 VoltsDC
40088	Fuel Level		R		% Full Tank
40089	Time Remaining until Maintenance		R		Hours
40090	Accumulated Engine Runtime(a)		R W	DP	Minutes x 10000
40091-93	RESERVED				
40094	Engine Speed(a)		R	DP	RPM x10000
40095	Engine Speed(b)		R	DP	RPM
40096	Engine Load(a)		R	DP	
40097	Engine Load(b)		R	DP	% of Rated Load
GENERATOR MONITOR					
40098	Phase a-b RMS Voltage(a)		R	DP	RMS Volt x 10000
40099	Phase a-b RMS Voltage(b)		R	DP	RMS Volt
40100	Phase b-c RMS Voltage(a)		R	DP	RMS Volt x 10000
40101	Phase b-c RMS Voltage(b)		R	DP	RMS Volt
40102	Phase c-a RMS Voltage(a)		R	DP	RMS Volt x 10000
40103	Phase c-a RMS Voltage(b)		R	DP	RMS Volt
40104	Phase a-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40105	Phase a-n RMS Voltage(b)		R	DP	RMS Volt
40106	Phase b-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40107	Phase b-n RMS Voltage(b)		R	DP	RMS Volt
40108	Phase c-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40109	Phase c-n RMS Voltage(b)		R	DP	RMS Volt
40110	Phase a RMS Current		R		RMS Amps
40111	Phase b RMS Current		R		RMS Amps
40112	Phase c RMS Current		R		RMS Amps
40113	Phase a Apparent Power(a)		R	DP	KVA x 10000
40114	Phase a Apparent Power(b)		R	DP	KVA
40115	Phase b Apparent Power(a)		R	DP	KVA x 10000
40116	Phase b Apparent Power(b)		R	DP	KVA
40117	Phase c Apparent Power(a)		R	DP	KVA x 10000
40118	Phase c Apparent Power(b)		R	DP	KVA
40119	3 Phase Apparent Power(a)		R	DP	KVA x 10000

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40120	3 Phase Apparent Power(b)		R	DP	KVA
40121	Phase a Power(a)		R	DP	KWatt x 10000
40122	Phase a Power(b)		R	DP	KWatt
40123	Phase b Power(a)		R	DP	KWatt x 10000
40124	Phase b Power(b)		R	DP	KWatt
40125	Phase c Power(a)		R	DP	KWatt x 10000
40126	Phase c Power(b)		R	DP	KWatt
40127	3 Phase power(a)		R	DP	KWatt x 10000
40128	3 Phase power(b)		R	DP	KWatt
40129	3 Phase Total kW-Hours(a)		R W	TP	KWH x 10000 x 10000
40130	3 Phase Total kW-Hours(b)		R W	TP	KWH x 10000
40131	3 Phase Total kW-Hours(x)		R W	TP	KWH
40132	Power Factor	0-100	R		0.01
40133	Frequency		R		0.1 Hertz
40134-36	RESERVED				
40137	Generator Speed Mode	individual bits are 0 or 1	R W	<u>active spd signals:</u> b0 =mag. pick-up or CAN's ECU engine's speed. b1 =generator	
40138-39	RESERVED				
40140	Power Factor State	0-3	R	0= +LAG 1= -LEAD 2= -LAG 3= +LEAD	
40141-272	RESERVED				
40273	Input Contacts States	individual bits are 0 or 1	R	b0 = coolant level, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4.	
40274	BESTCOMS*Plus*® Test Buttons States	individual bits are 0 or 1	R W	b0 = button #1, b1 = button #2, b2 = button #3, b3 = button #4, b4-b7 are not used.	
40275-80	RESERVED				
40281	Embedded Code Version Number (a)	0-99	R		
40282-97	RESERVED				

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40298	Read Relay Image of both Main and Aux Output	individual bits are 0 or 1	R	Main is in lower byte and Aux is in upper byte. b0 = Aux Output 1, b1 = Aux Output 2, b2 = Aux Output 3, b3 = Aux Output 4, b4 = Aux Output 5, b5 = Aux Output 6, b6 = Aux Output 7, b7 = Aux Output 8. b8 = Master Start Relay, b9 = Fuel Solenoid Relay, b10 = PreHeat PreLube Relay, b11 = Alarm Relay, b12 = UNASSIGNED, b13 = Buzzer On, b14 = EPS Loaded Relay, b15 = PreAlarm Relay,	
40299	RESERVED				
J1939 DIAGNOSTIC TROUBLE CODES					
40300	Active DTC Number 16 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40301	Active DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40302	Active DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40303	Active DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40304	Active DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40305	Active DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40306	Active DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40307	Active DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40308	Active DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40309	Active DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40310	Active DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40311	Active DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40312	Active DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40313	Active DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40314	Active DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40315	Active DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40316	Active DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40317	Active DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40318	Active DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40319	Active DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40320	Active DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40321	Active DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40322	Active DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40323	Active DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40324	Active DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40325	Active DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40326	Active DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40327	Active DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40328	Active DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40329	Active DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40330	Active DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40331	Active DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40332	Previous DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40333	Previous DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40334	Previous DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40335	Previous DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40336	Previous DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40337	Previous DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40338	Previous DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40339	Previous DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40340	Previous DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40341	Previous DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40342	Previous DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40343	Previous DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40344	Previous DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40345	Previous DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40346	Previous DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40347	Previous DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40348	Previous DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40349	Previous DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40350	Previous DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40351	Previous DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40352	Previous DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40353	Previous DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40354	Previous DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40355	Previous DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40356	Previous DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40357	Previous DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40358	Previous DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40359	Previous DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40360	Previous DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40361	Previous DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40362	Previous DTC Number 16 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40363	Previous DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40364-67	RESERVED				
40368	DTC Lamp Status NOTE: Even bits are Always a Zero Value.	individual bits are 0 or 1	R	Active stored in upper byte – Previous stored in lower byte. b0 = 0, b1 = Protect Lamp, b2 = 0, b3 = Amber Warning Lamp, b4 = 0, b5 = Red Stop Lamp, b6 = 0, b7 = Malfunction Indicator Lamp, b8 = 0, b9 = Protect Lamp, b10 = 0, b11 = Amber Warning Lamp, b12 = 0, b13 = Red Stop Lamp, b14 = 0, b15 = Malfunction Indicator Lamp	
40369	Number of DTC's	0-65535	R	Active stored in upper byte – Previous stored in lower byte.	
40370	RESERVED				
40371	CAN Related Parameter: Percent Coolant Level	0-100	R		Percent
40372	RESERVED				
40373	System Config	individual bits are 0 or 1	R W	Bit 0 – RUN Bit 1 – OFF Bit 2 – AUTO_RUN Bit 3 – AUTO_OFF Bit 4 – AUTO_ANY	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40374	System Status	0 - 10	R	0 = RESET 1 = READY 2 = CRANKING 3 = RESTING 4 = RUNNING 5 = ALARM 6 = PRESTART 7 = COOLING 8 = CONNECTING 9 = DISCONNECT 10 = PULSING	
40375-82	RESERVED				
40383	MTU speed demand switch	0-7	R W	0 = ANALOG_CAN 1 = UP_DN_ECU 2 = UP_DN_CAN 3 = ANALOG_ECU 5 = FREQUENCY 7 = NO_CAN_DEMAND	
40384	RESERVED				
40385	Volvo Accelerator Pedal Position (Trim)	0-100	R W	0 = Rated speed – 120rpm; 50 = Rated speed; 100 = Rated speed + 120rpm.	
40386	Volvo Engine RPM Select	0-1	R W	0 = Primary, 1 = Secondary.	
40387-420	RESERVED				
J1939 DATA					
40421	Accelerator Pedal Position	0 to 100%	R	0.4%/bit gain, 0% offset	
40422	Percent Load At Current Speed	0 to 125%	R	1%/bit gain, 0% offset	
40423	Actual Engine Percent Torque	0 to 125%	R	1%/bit gain, -125% offset	
40424	Engine Speed	0 to 8031.875	R	RPM (0.125rpm/bit gain)	
40425	Injection Control Pressure2		R		
40426	Injector Metering Rail Pressure2	0 to +251 MPa (0 to 36 404 psi)	R	1/256 MPa/bit gain, 0 MPa offset	
40427	Engine Run Time	0 to +210,554, 060.75 h	R	0.05 h/bit gain, 0 h offset	
40428-29	RESERVED		R		
40430	Trip Fuel	Data Range: 0 to +2,105,540, 608 L	R	0.5 L per bit gain, 0 L offset	
40431-32	RESERVED				
40433	Total Fuel Used	Data Range: 0 to +2,105,540, 608 L	R	0.5 L per bit gain, 0 L offset	
40434-35	RESERVED				
40436	Coolant Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain	
40437	Fuel Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40438	Engine Oil Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40439	Engine Intercooler Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40440	Fuel Delivery Pressure	0 to +1000 kPa (0 to 145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40441	Engine Oil Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40442	Oil Pressure	0 to +1000 kPa (0 to 145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40443	Coolant Pressure	0 to +500 kPa (0 to 72.5 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40444	Coolant Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40445	Fuel Rate	0 to +3212.75 L/h	R	Raw ECU Parameter Data 0.05 L/h per bit gain, 0 L/h offset (13.9 x 10-6 L/s per bit)	
40446	Barometric Pressure	0 to +125 kPa (0 to +18.1 psi)	R	Raw ECU Parameter Data 0.5 kPa/bit gain, 0 kPa offset	
40447	Ambient Air Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40448	Air Inlet Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40449	Boost Pressure	0 to +500 kPa (0 to 72.5 psi)	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 kPa offset	
40450	Intake Manifold Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40451	Air Filter Differential Pressure	0 to +12.5 kPa (0 to +1.8 psi)	R	Raw ECU Parameter Data 0.05 kPa/bit gain, 0 kPa offset	
40452	Exhaust Gas Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40453	Electrical Potential Voltage	0 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40454	Battery Potential Voltage Switched	Data Range: 0 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40455	Speed At Idle Point1	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40456	Torque At Idle Point1	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40457	Speed At Idle Point2	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40458	Torque At Idle Point2	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40459	Speed At Idle Point3	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40460	Torque At Idle Point3	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40461	Speed At Idle Point4	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40462	Torque At Idle Point4	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40463	Speed At Idle Point5	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40464	Torque At Idle Point5	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40465	Speed At High Idle Point6	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40466	Gain Of End speed governor	0 to 50.2 %/rpm	R	Raw ECU Parameter Data 0.0007813 % engine reference torque/rpm per bit gain (normalized), 0 %/rpm per bit offset	
40467	Reference Engine Torque	0 to 64 255 Nm	R	Raw ECU Parameter Data 1 Nm/bit gain, 0 Nm offset	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40468	Override Speed Point7	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40469	Override Time Limit	0 s to 25 s	R	Raw ECU Parameter Data 0.1 s/bit gain, 0 s offset	
40470	Speed Lower Limit	0 to 2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40471	Speed Upper Limit	0 to 2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40472	Torque Lower Limit	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40473	Torque Upper Limit	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40474-499	RESERVED				
40500	DGC-2020ES product series identifier	2020	R		
40501-03	RESERVED				
40504	LED Status	individual bits are 0 or 1	R	Bits indicate status of LED's: b0 = RUN b1 = OFF b2 = AUTO b3 = ALARM b4 = LOAD b5 = NOT IN AUTO	
40507	Read Relay Image of both Main and Aux Output (Duplicate of 40298)	individual bits are 0 or 1	R	Main is in lower byte and Aux is in upper byte. b0 = Aux Output 1, b1 = Aux Output 2, b2 = Aux Output 3, b3 = Aux Output 4, b4 = Aux Output 5, b5 = Aux Output 6, b6 = Aux Output 7, b7 = Aux Output 8. b8 = Master Start Relay, b9 = Fuel Solenoid Relay, b10 = PreHeat PreLube Relay, b11 = Alarm Relay, b12 = UNASSIGNED, b13 = Buzzer On, b14 = EPS Loaded Relay, b15 = PreAlarm Relay,	
40508	Input Contacts States (Duplicate of 40273)	individual bits are 0 or 1	R	b0 = coolant level, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4.	
40509-636	RESERVED				
GENERATOR PROTECTION STATUS					
40637	Gen Protection Status (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	
40638	Gen Protection Status (lower 16 bits)	0-65535	R	b0 = overvoltage trip, b1 = undervoltage trip, b2 = overfrequency trip, b3 = underfrequency trip, b4 = overcurrent trip, b5 = phase imbalance trip, b6-b15 UNASSIGNED	
40639	Gen Protection Pre-Alarms (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40640	Gen Protection Pre-Alarms (lower 16 bits)	0-65535	R	b0 = overvoltage pre-alarm, b1 = undervoltage pre-alarm, b2 = overfrequency pre-alarm, b3 = underfrequency pre-alarm, b4 = overcurrent pre-alarm, b5 = phase imbalance pre-alarm, b6-b15 UNASSIGNED	
40641	Gen Protection Alarms (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	
40642	Gen Protection Alarms (lower 16 bits)	0-65535	R	b0 = overvoltage alarm, b1 = undervoltage alarm, b2 = overfrequency alarm, b3 = underfrequency alarm, b4 = overcurrent alarm, b5 = phase imbalance alarm, b6-b15 UNASSIGNED	
40643-99	RESERVED				
REAL TIME CLOCK					
40700	Hours	0-23	R W		
40701	Minutes	0-59	R W		
40702	Seconds	0-59	R W		
40703	Month	1-12	R W		
40704	Day	1-31	R W		
40705	Year		R W		
40706-33	RESERVED				
RUN STATISTICS					
40734	RESERVED				
40735	Hours Until Maintenance	0-5000	R W		hours
40737	Commission Start Month	1-12	R W		month
40738	Commission Start Day	1-31	R W		day
40739	Commission Start Year	0-99	R W		year
40740-41	Cumulative Run Hours x 60	0-4294967295	R W	DP	hours
40742-43	Cumulative Loaded Run Hours x 60	0-4294967295	R W	DP	hours
40744-45	Cumulative Unloaded Run Hours x 60	0-4294967295	R W	DP	hours
40746	Start Count	0-65535	R W		
40747	Session Start Month	1-12	R W		month
40748	Session Start Day	1-31	R W		day
40749	Session Start Year	0-99	R W		year
40750-51	Session Run Hours x 60	0-4294967295	R W	DP	hours
40752-53	Session Loaded Run Hours x 60	0-4294967295	R W	DP	hours
40754-55	Session Unloaded Run Hours x 60	0-4294967295	R W	DP	hours
40756-59	RESERVED				
CANbus ECU					
40760	MDEC Alarms	0-65535	R	b0 = High Charge Air Temp, b1 = High Oil Temp, b2 = High Coolant Temp, b3 = Low Aftercooler Level, b4 = Low Fuel Delivery Press, b5 = Low Oil Press, b6 = Overspeed, b7 = Combined Red, b8-b15 UNASSIGNED	

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Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40761	MTU Pre-alarms	0-65535	R	b0 = High ECU Temp, b1 = High Oil Temp, b2 = High Intercooler Temp, b3 = High Charge Air Temp, b4 = High Coolant Temp, b5 = Shutdown Override, b6 = High Fuel Rail Press, b7 = Low Fuel Rail Press, b8 = Low Coolant Level, b9 = Low Charge Air Pressure, b10 = Low Fuel Deliv Pressure, b11 = Low Oil Pressure, b12 = Combined Yellow, b13-b15 UNASSIGNED	

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Revision History

Table 40 provides a historical summary of the changes made to the MGC-1550 hardware. Firmware changes are listed in Table 41 and software changes are listed in Table 42. The corresponding revisions made to this instruction manual are summarized in Table 43. Revisions are listed in chronological order.

Table 40. Hardware Revision History

Hardware Version and Date	Change
A, Dec-13	• Initial release
B, Apr-14 (9469200108, -111)	• Released firmware version 1.01.00
Rev C, May-14 (9469200108, -111)	• Released firmware version 1.01.01 and BESTCOMS*Plus* 3.06.00
Rev B May-14 (94692001112)	• Released firmware version 1.01.01 and BESTCOMS*Plus* 3.06.00
Rev D, Nov-14 (9469200108, -111)	• Released firmware version 1.02.00 and BESTCOMS*Plus* 3.07.00
Rev C, Nov-14 (94692001112)	• Released firmware version 1.02.00 and BESTCOMS*Plus* 3.07.00

Table 41. Firmware Revision History

Firmware Version and Date	Change
1.01.00, Jan-14	• Initial release
1.01.01, Apr-14	• Made the J1939 data menu available through the HMI when the unit is configured for Scania ECU type
1.02.00, Oct-14	• Added MTU Speed Demand Switch setting from logic capability • Added a rest timer for cyclic cranking • Added Mains Fail Return Fail pre-alarm and Mains Fail Max Return Time setting • Added System kW Generation in Per Unit to Gen Status screen and configurable protection • Added Total Off Line Capacity on Generator Network Status screen • Added DPF Outlet Gas Temperature to J1939 metering and configurable protection • Added John Deere to list of ECU configurations • Changed DEF EMPTY pre-alarm to DEF LOW SEVERE • Changed DEF ENGINE DERATE pre-alarm to DEF INDUCEMENT • Added descriptive text for Diagnostic Trouble Codes (DTC's) broadcast by Mercedes, PSI, and MTU-ECU9 engine ECU's • Added ECU9 Fault Code list for MTU • Added Modbus registers

Table 42. Software Revision History

Software Version and Date	Change
3.05.02, Dec-13	• Initial Release
3.05.03, Mar-14	• Maintenance release (DECS-250N changes)
3.06.00, Apr-14	• Maintenance release (BE1-11 changes)

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Software Version and Date	Change
3.07.00, Oct-14	• Updated to support firmware version 1.02.00 (see firmware revision history) • Removed duplicate results in the device discovery list • Improvements to device directory on Connection screen • Changed to allow a comma in the Device ID • Changed to prevent current settings from being lost after cancelling save when entering live mode • Changed to annunciate a connection failure message when a device is not present on a selected port • Improved prompts to save settings when choosing to close all open views • Changed to allow the middle mouse button to close the security view • Improved display of raw analog input currents • Changed to make BESTlogic*Plus* status LEDs report all logic errors

Table 43. Instruction Manual Revision History

Manual Revision and Date	Change
A, Dec-13	• Initial release
B, Nov-14	• Revised to support firmware version 1.02.00 (see firmware revision history) and BESTCOMS*Plus* version 3.07.00 (see software revision history) • Added Mains Fail Transfer settings • Added Offline Logic Simulator in the BESTlogic*Plus* chapter • Added DPF Lamp Command status input and EPSSUPPLYINGLD logic element to the BESTlogic*Plus* chapter • Updated system recommendations for BESTCOMS*Plus* • Replaced several BESTCOMS*Plus* screenshots where the layout changed throughout the manual • Minor text edits throughout manual

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2.11 Circuit Breaker Enclosure Data Diesel 27-30 kW/30-34 kVA (0096)

CIRCUIT BREAKER ENCLOSURE - DIESEL
27-30 kW / 30-34 kVA Data Sheet

DESCRIPTION

This circuit breaker enclosure data sheet is used in conjunction with dimensional drawings to assist with submittal documentation, specification requirements, and installation. This document summarizes the enclosure dimensions and mounting positions for the MTU 3R0096 DS30 and MTU 3R0096 DS34 circuit breakers. The dimensional drawings will govern and should be referenced for installation.

280 FRAME ENCLOSURE

- Supplied with all 280 frame alternator applications.
- Right side breakers shown. Left side breakers optional.
- Reference Figure 2 for breaker mounting positions.

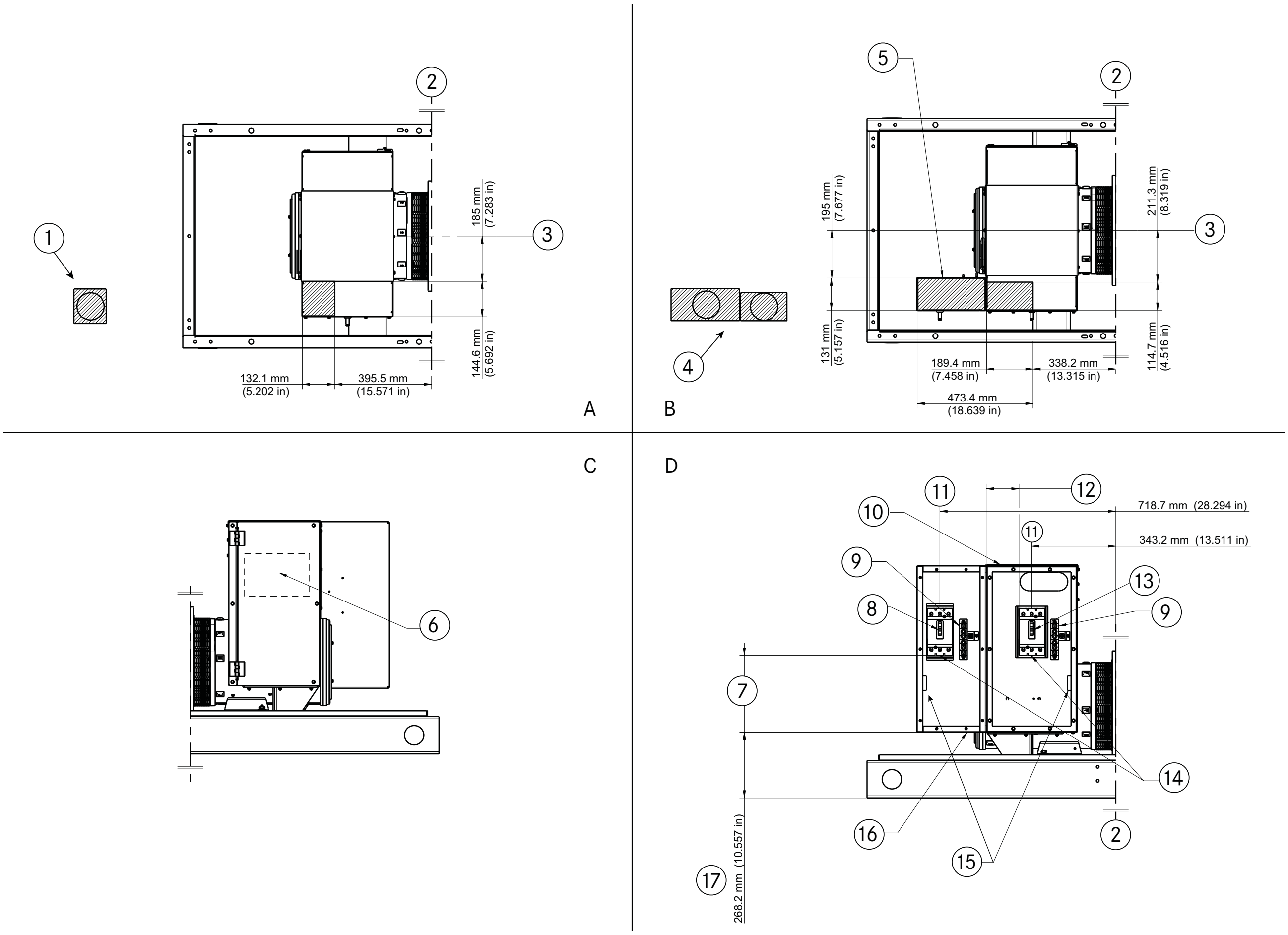

Figure 1: 280 Frame Enclosure

A. Top view, top entry conduit area
B. Top view, bottom entry conduit area
C. Left view, breaker enclosure detail
D. Right view, breaker enclosure detail (enclosure cover not shown)

1. Possible top entry conduit locations
2. Rear face of flywheel housing
3. Generator centerline
4. Possible bottom entry conduit locations
5. Optional secondary breaker enclosure
6. Optional control panel location
7. Dimension A
8. Optional second breaker
9. Neutral ASM (torque to 275 in/lbs)
10. Top entry conduit area
11. Breaker center line
12. Dimension B
13. Primary breaker
14. Customer connect end (recommended torque on label)
15. Equipment ground terminal (torque to 275 in/lbs)
16. Bottom entry conduit area
17. See note 4

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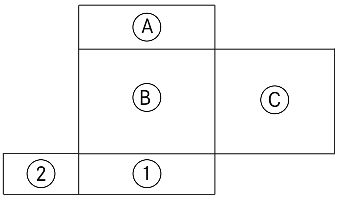
CIRCUIT BREAKER ENCLOSURE - DIESEL
27-30 kW / 30-34 kVA Data Sheet

Available Circuit Breakers		Enclosure Data				
Breaker Frame	Amperage	Output Wire Range 90 °C Cu (wires per lug)	Wire Bending Space(1) Dimension A mm (in)	Wire Gutter Space(1,2) Dimension B mm (in)	Conduit Quantity	Conduit Size(3) in
H-Frame	20-150	(1) 8-3/0	329 (12.95)	134 (5.27)	1	2.5
J-Frame	175	(1) 4-4/0	314 (12.36)	134 (5.27)	1	2.5
J-Frame	200-250	(1) 3/0-350	314 (12.36)	134 (5.27)	1	3

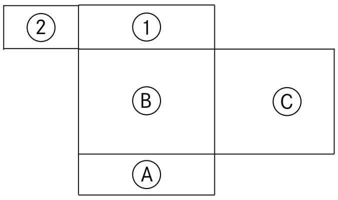
(1) Meets or exceeds NFPA 70, NEC 312.6(A), and NEC 312.6(B)
(2) Top entry only available for single breaker applications
(3) Based on flexible metal conduit at 40% fill using THHN wire
(4) Add 177.8 mm (7 in) for bases with integrated single wall fuel tank (see Figure 1)

NOTE: Equipment grounding terminal wire range: 6 AWG - 3/0 AWG

Table 1: 280 Frame Enclosure Data



Top View - Right Side Breaker



Top View - Left Side Breaker

Figure 2: 280 Frame Enclosure Breaker Mounting Positions

A. Controls
B. Outlet box
C. 280 frame alternator

1. Position 1 (Primary)
2. Position 2

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PowerPact H-, J-, and L-Frame Circuit Breakers

Catalog
0611CT1001 R02/16

2015

Class 0611

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Description . . . . Page

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SQUARE D™
by Schneider Electric

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PowerPact™ H-, J-, and L-Frame Circuit Breakers

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Section 1—Catalog Numbering

PowerPact™ with Micrologic™ Circuit Breakers

The PowerPact H-, J-, and L-frame circuit breakers are designed to protect electrical systems from damage caused by overloads and short circuits. H- and J-frame circuit breakers are available with either thermal-magnetic or Micrologic electronic trip units. L-frame circuit breakers are available with Micrologic electronic trip units only.

Direct Access to Energy Management

The new generation PowerPact with Micrologic circuit breakers set the standard with direct access to energy management. Integrated metering enhances their protective functions. For the first time, Schneider Electric™ users can monitor energy from 15 to 3000 A, offering new performance in a remarkably compact device.

- Smart – A meter in every breaker
- Safe – Combines safety and performance in one compact device
- Simple – To select, install, and use

Increased energy availability
Safety and Protection
Energy measurement and control

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Catalog Numbering

Table 1: Circuit Breaker Catalog Numbers

Segment	Character	Description	—	J	L	L	3	6	250	W	T	—	— — — —
Brand	—	Square D											
	N	Schneider Electric											
Frame	H	H-Frame											
	J	J-Frame											
	L	L-Frame											
Performance Level (kA) See Table 2													
Terminations	L	Lugs Line/Load Side											
	M	Lugs Line Side											
	P	Lugs Load Side											
	F	Bus Bar											
	A	A-Line											
	S	Rear Connected											
	N	Plug-in											
	D	Drawout											
	K	Reverse I-Line											
Poles	2	Two Pole											
	3	Three Pole											
	4	Four Pole											
Voltage	6	600 V											
	4	480 V											
Amperage	060	60 A											
	100	100 A											
	150	150 A											
	250	250 A											
	400	400 A											
	600	600 A											
	000	Switch or Frame Only											
Mission Critical	W	(J- and L-frame with D, G, J and L-interrupting ratings											
Trip Unit	See Table 3												
I-Line Phasing													
Accessory Suffix Code	See Table 4												

Table 2: Interrupting Rating

	UL® / CSA® / NOM®					IEC 647-2 Icu/Ics					
	240 Vac	480 Vac	600 Vac	250 Vdc[1]	500 Vdc[2]	220/240 Vac	380/440/415 Vac	500/525 Vac	690 Vac	250 Vdc[1]	500 Vdc[3]
D	25 kA	18 kA	14 kA	20 kA	—	25/25 kA	18/18 kA	14/14 kA	—	20 kA	20 kA
G	65 kA	35 kA	18 kA	20 kA	20 kA	65/65 kA	35/35 kA	18/18 kA	—	20 kA	20 kA
J	100 kA	65 kA	25 kA	20 kA	—	100/100 kA	65/65 kA	25/25 kA	—	20 kA	20 kA
L	125 kA	100 kA	50 kA	20 kA	50 kA	125/125 kA	100/100 kA	50/50 kA	—	20 kA	20 kA
R	200 kA	200 kA	100 kA	—	—	150 kA	125 kA	75 kA	20 kA	—	—

1 250 Vdc ratings only available with PowerPact H or J circuit breakers with thermal-magnetic trip units (not including MCP).
2 UL 500 Vdc ratings only available with PowerPact H-, J-, and L-frame circuit breakers with thermal-magnetic trip units (not including MCP).
3 IEC 500 Vdc rating only available on PowerPact J-frame circuit beakers.

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Table 3: Trip Unit Numbering

Trip Unit Type	Character	Description
Micrologic Trip Units	U31 X	LI Standard Protection
	U33X	LSI Standard Protection
	U43X	LSI plus Ammeter
	U44X	LSIG plus Ammeter
	U53X	LSI plus Energy Management
	U54X	LSIG plus Energy Management
	M37X	Magnetic Only (L-Frame Only)
	M38X	Motor Protector Circuit Breaker
	S40X	400 A Molded Case Switch (L-Frame Automatic Switch)
	S60X	600 A Molded Case Switch (L-Frame Automatic Switch)
	F40	400 A L-Frame Only (No Trip Unit)
	F60	600 A L-Frame Only (No Trip Unit)
Thermal-Magnetic Trip Units	—	Standard Fixed Trip Unit (Suitable for reverse connection)
	F06	60 A H-Frame Only (No trip unit)
	F15	150 A H-Frame Only (No trip unit)
	F25	250 A J-Frame Only (No trip unit)
	T	Complete Circuit Breaker (Frame + removable trip unit)
	S15	150 A Molded Case Switch (H-Frame automatic switch)
	S17	175 A Molded Case Switch (J-Frame automatic switch)
	S25	250 A Molded Case Switch (J-Frame automatic switch)
	C	100% Rated Continuous Current Rating[1]
	M71	30 A H-Frame Motor Circuit Protector (MCP)
	M72	50 A H-Frame Motor Circuit Protector (MCP)
	M73	100 A H-Frame Motor Circuit Protector (MCP)
	M74	150 A H-Frame Motor Circuit Protector (MCP)
	M75	250 A J-Frame Motor Circuit Protector (MCP)
	D81	500 Vdc 150–175 A J-Frame Molded Case Circuit Breaker
	D82	500 Vdc 200–250 A J-Frame Molded Case Circuit Breaker
	D87	500 Vdc 30–70 A H-Frame Molded Case Circuit Breaker
	Dxx	500 Vdc 300A–1200A L-Frame Molded Case Circuit Breaker (Refer to Table 9 for details)
	R	100% Rated Continuous Current Rating Complete Circuit Breaker (frame + removable trip unit)

[1] 100% ratings valid for:
Three-pole H/J frame unit mount and busbar connection
Three-pole/four-pole L-frame 250 A and 400 A unit mount
Three-pole L-frame 250 A and 400 A I-Line

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PowerPact H-, J-, and L-Frame Circuit Breakers
Catalog Numbering

Table 4: Factory Installed Accessory Suffix Codes (Building Sequence as Listed) and Field-Installable Kit Number

(1) Communication Networks[1]

Suffix	Description	Kit No.
EA	NSX Cord 1.3 m, V ≤ 480 V	S434201
EB	NSX Cord 3 m, V ≤ 480 V	S434202
ED	NSX Cord 1.3 m, V > 480 V	S434204
EE	NSX Cord 3 m, V > 480 V	S434303
EG[4]	BSCM + NSX Cord 1.3 m, V ≤ 480 V	S434201BS
EH[4]	BSCM + NSX Cord 3 m, V ≤ 480 V	S434202BS
EK[4]	BSCM + NSX Cord 1.3 m, V > 480 V	S434204BS
EL[4]	BSCM + NSX Cord 3 m, V > 480 V	S434303BS
EN	24 Vdc Power Supply Terminal Block	S434210

(2) Indication Contacts

Suffix	Description	Kit No.
V	SDX	S429532
	SDTAM (motor only trip units)	S429424

(3) Auxiliary Switch

Suffix	Contacts	Kit No.	Kit Qty.
AA	1A/1B Standard	S29450	1
AB	2A/2B Standard	S29450	2
AC	3A/3B Standard (L-frame only)	S29450	3
AE	1A/1B Low-Level	S29452	1
AF	2A/2B Low-Level	S29452	2
AG	3A/3B Low Level (L-frame only)	S29452	3

(4) Alarm/Overcurrent Trip Switch

Suffix	Switch	Kit No.	Kit Qty.
PowerPact L-Frame and PowerPact H/J-Frame with Micrologic 5/6 trip units			
BC	Alarm Switch	S29450	1
BH	Alarm Switch Low-Level	S29452	1
BD	Overcurrent Trip Switch, Standard SDE Actuator	S29450 S29451	1 1
BJ	Overcurrent Trip Switch, Low-Level SDE Actuator	S29452 S29451	1 1
BE	Alarm Switch and Overcurrent Trip Switch, Standard	S29450	2
BK	Alarm Switch and Overcurrent Trip Switch, Low-Level	S29452	2
PowerPact H/J-Frame with Thermal-Magnetic or Micrologic 1/2/3 trip units			
BC	Alarm Switch	S29450	1
BH	Alarm Switch Low-Level	S29452	1
BD	Overcurrent Trip Switch, Standard SDE Actuator	S29450 S29451	1 1
BJ	Overcurrent Trip Switch, Low-Level SDE Actuator	S29452 S29451	1 1
BE	Alarm Switch and Overcurrent Trip Switch, Standard SDE Actuator	S29450 S29451	2 1
BK	Alarm Switch and Overcurrent Trip Switch, Low-Level SDE Actuator	S29452 S29451	2 1

1 Except for 24 Vdc Power Supply Terminal Block, installation requires IFM (STRV00210) for Modbus communication and/or FDM (STRV00121) for external display.
2 YH1 = all installed accessories but ZSI and ENCT.
YH2 = ENCT and all installed accessories.
YH3 = ZSI and all installed accessories.
YH4 = ZSI, ENCT and all installed accessories.
3 I-Line wire harness included for communication network accessories.
Optional wire harness for unit mount requires YH1 suffix.
4 If using with a motor operator, requires Communicating Motor Operator (suffix NC).
5 Requires Micrologic trip unit U43, U44, U53, or U54 and communication accessories EG, EH, EK, or EL.

(5) Shunt Trip		(6) Undervoltage Release UVR		Voltage
Suffix	Kit No.	Suffix	Kit No.	
SK	S29384	UK	S29404	24 Vac
SL	S29385	UL	S29405	48 Vac
SA	S29386	UA	S29406	120 Vac
SD	S29387	UD	S29407	208/277 Vac
SH	S29388	UH	S29408	380/480 Vac
SJ	S29389	UJ	S29409	525/600 Vac
SN	S29382	UN	S29402	12 Vdc
SO	S29390	UO	S29410	24 Vdc
SU	S29391	UU	S29411	30 Vdc
SP	S29392	UP	S29412	48 Vdc
SV	S29383	UV	S29403	60 Vdc
SR	S29393	UR	S29413	125 Vdc
SS	S29394	US	S29414	250 Vdc

(6) Communicating Motor Operator[5]

Suffix	Voltage	H-Frame	J-Frame	L-Frame
NC	220/240 Vac	S429441	S431549	S432652

(7) Motor Operator

Suffix	Voltage	H-Frame	J-Frame	L-Frame
ML	48/60 Vac	S29440	S31548	S432639
MA	120 Vac	S29433	S31540	S432640
MD	277 Vac	S29434	S31541	S432641
MF	380/415 Vac	—	—	S432642
MH	440/480 Vac	S29435	S31542	S432647
MO	24/30 Vdc	S29436	S31543	S432643
MV	48/60 Vdc	S29437	S31544	S432644
MR	110/130 Vdc	S29438	S31545	S432645
MS	250 Vdc	S29439	S31546	S432646

(8) Rotary Handle

Suffix	Handle Type (color)	H/J-Frame	L-Frame
RD10	Direct Mount (black)	S29337	S32597
RD20	Direct Mount (red)	S29339	S32599
RE10	Extended Door Mount (black)	S29338	S32598
RT10	Telescoping (black)	S29343	S32603
RE20	Extended Door Mount (red)	S29340	S32600

(9) Wire Harnesses[2]

Suffix	Harness[2]	Kit No.
YH3	ZSI Wire Harness, H/J Frame	S434300
YH3	ZSI Wire Harness, L-Frame	S434301
YH2	ENCT Wire Harness	S434302
YH1	OF Wire Harness	S434500
YH1	SD/SDE Wire Harness	S434501
YH1	SDx/SDTAM Wire Harness	S434502
YH1	MN Wire Harness	S434503
YH1	MX Wire Harness	S434504
YH1	Motor Operator Wire Harness	S434506
YH1	Communicating Motor Operator Wire Harness	S434507
YH1[3]	NSX Wire Harness	S434508
YH4	ENCT and ZSI Wire Harnesses	—
YH1[3]	24 Vdc Power Supply Wire Harness	S434505

(10) Handle Padlocks

Suffix	Padlock Type	H/J-Frame	L-Frame
YP	Handle Padlock, ON or OFF	S29371	S32631
YQ	Handle Padlock, OFF Only	S37422	NJPAF
YQ	Handle Padlock, OFF Only 2P	H2PHLA	—

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Section 2—General Information

The PowerPact™ H-, J-, and L-frame circuit breakers are designed to protect electrical systems from damage caused by overloads and short circuits. H- and J-frame circuit breakers are available with either thermal-magnetic or Micrologic™ electronic trip units. L-frame circuit breakers are available with Micrologic electronic trip units only.

H- and J-frame circuit breakers with thermal-magnetic trip units contain individual thermal (overload) and instantaneous (short circuit) sensing elements in each pole. The amperage ratings of the thermal trip elements are calibrated at 104°F (40°C) free air ambient temperature. Per the National Electric Code® (NEC®) and the Canadian Electrical Code, standard circuit breakers may only be applied continuously at up to 80% of their rating. Circuit breakers rated for 100% operation are available but require specially-designed enclosures and 194°F (90°C) rated wire.

Devices with the Micrologic electronic trip unit provide adjustable protection settings for greater system flexibility. In addition to electronic protection, Micrologic trip units allow users to monitor both energy and power. Through direct access to in-depth information and networking using open protocols, PowerPact circuit breakers with Micrologic trip units let operators optimize the management of their electrical installations. Far more than just a circuit breaker, these devices are a measurement and communication tool ready to meet energy-efficiency needs through optimized power requirements, increased energy availability, and improved installation management.

Applications

PowerPact H-, J-, and L-frame circuit breakers offer high performance and a wide range of interchangeable trip units to protect most applications.

Electronic trip units provide highly accurate protection with wide setting ranges and can integrate measurement, metering and communication functions. They can be combined with the front display module (FDM121) to provide functions similar to a power meter.

Table 5: Applications

	Power Meter	PowerPact H-, J-, and L-frame circuit breakers equipped with Micrologic 5/6 trip units offer type A (ammeter) or E (energy) metering functions as well as communication capability. Using Micrologic trip unit sensors and intelligence, PowerPact H-, J-, and L-frame circuit breakers provide access to measurements of all the main electrical parameters on the built-in screen, on a dedicated front display module (FDM121) or through the communication network.
	Operating assistance	Integration of measurement functions provides operators with operating assistance functions including alarms tripped by user-selected measurement values, time-stamped event tables and histories, and maintenance indicators.
	Front display module	The main measurements can be read on the built-in screen of Micrologic 5/6 trip units. They can also be displayed on the equipment FDM121 along with pop-up windows signalling the main alarms.
	Communication Network	PowerPact H-, J-, and L-frame circuit breakers equipped with Micrologic 5/6 trip units provide communication capabilities. Simple RJ45 cables connect to a Modbus communication interface module.

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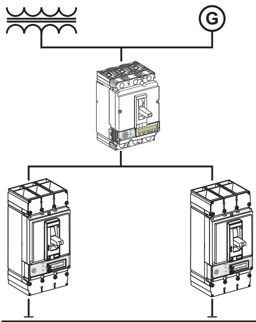
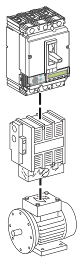
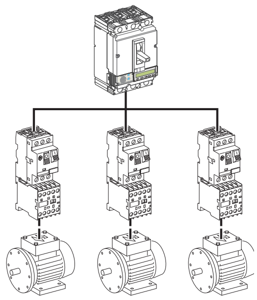
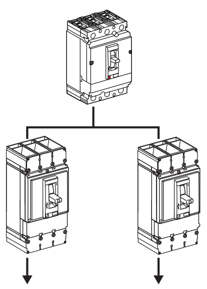
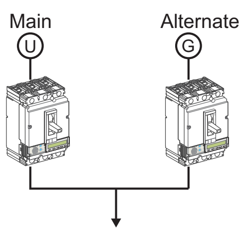
PowerPact H-, J-, and L-Frame Circuit Breakers
General Information

Table 5: Applications

	Protection of distribution systems Mission critical applications	The PowerPact H-, J-, and L-frame circuit breakers provide protection against short circuits and overloads for: • distribution systems supplied by transformers • distribution systems supplied by engine generator sets They are easily installed at all levels in distribution systems, from the main LV switchboard to the subdistribution boards and enclosures. All PowerPact circuit breakers can protect against insulation faults by adding an external Vigirex relay. The PowerPact H-, J-, and L-frame mission critical circuit breakers provide high levels of selective coordination with QO and ED/EG/EJ circuit breakers.
	Protection of motors	The PowerPact H-, J-, and L-frame circuit breakers include a number of versions to protect motor applications: • basic short-circuit protection with electronic instantaneous only MCP or the electronic Micrologic 1.3 M trip units, combined with a special overload relay to provide thermal protection • protection against overloads, short circuit and phase unbalance or loss with Micrologic 2 M trip units The exceptional limiting capacity of the PowerPact circuit breakers automatically provides coordination with the motor starter.
	Protection of special applications	The PowerPact H-, J-, and L-frame circuit breakers offer a number of version for special protection applications: • industrial control panels with: — compliance with international standards IEC 60947-2 and UL 508/CSA 22.2 N°14 — compliance with UL 489 — installation in universal and functional enclosures • 400 Hz systems
	Control using automatic switches	An automatic switch version of PowerPact H-, J-, and L-frame circuit breakers is available for circuit control. All add-on functions for the circuit breakers may be combined with the basic automatic switch function, including motor operators. For information on other automatic switches, contact Schneider Electric.
	Manual transfer systems	To ensure a continuous supply of power, some electrical installations are connected to two power systems: • the normal source, usually the utility (U) • a replacement source to supply the installation when the normal source is not available, generally from a generator (G) A mechanical and/or electrical interlocking system between two circuit breakers or automatic switches avoids all risk of parallel connection of the sources during switching. A system can be manual transfer mechanical device interlocking.

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Mission Critical Circuit Breakers

The PowerPact™ J- and L-Frame Mission Critical circuit breakers deliver high levels of selective coordination in a flexible design that can be easily configured for a variety of applications. Tested to be selectively coordinated with the QO™ family of miniature circuit breakers and the ED, EG, and EJ circuit breakers, this solution provides peace of mind when power availability is critical.

An electronic trip unit provides adjustable long-time settings in three sensor sizes, allowing coverage from 70 through 600 A on 120-240, 208Y/120, 240, and 480Y/277 V systems.

Ratings	Available Configurations
UL 489 Listed CSA Certified Voltage: 480Y/277 V	• I-Line mounting • Main circuit breaker in NQ and NF panelboards • Unit mount for OEM users • Plug-in base for OEM users • Drawout base for OEM users

In addition to unique design attributes, the PowerPact Mission Critical circuit breakers have also undergone rigorous testing procedures to certify the coordination with downstream circuit breakers—combining innovative engineering with validated test results.

Apply Schneider Electric Mission Critical circuit breakers in emergency power distribution systems, data centers, hospitals, or anywhere continuity of service is desired.

Theory of Operation

There are several dynamic forces between the PowerPact Mission Critical circuit breakers and downstream circuit breakers when a fault occurs downstream of the branch circuit breaker. Many of these events cannot be shown on the trip curve.

The PowerPact Mission Critical circuit breakers analyze the fault current to make decisions which maximize selectivity with downstream circuit breakers. The trip units deploy a special selectivity delay to allow downstream circuit breakers to clear. However, on very high faults or if the downstream circuit breaker does not trip, the circuit breaker trips the mechanism instantaneously.

The combination of the PowerPact Mission Critical circuit breaker and downstream circuit breakers shown in the selectivity charts in the instruction bulletin are selective due to the fact that the series impedance and the let-through from the downstream circuit breaker does not produce enough energy to trip the PowerPact Mission Circuit circuit breaker.

This system maximizes the interaction of the circuit breakers in series to allow selectivity.

Trip Units and Trip Curves

The PowerPact J- and L-Frame Mission Critical circuit breakers deliver high levels of selective coordination with the QO™ family of miniature circuit breakers and the ED, EG, and EJ circuit breakers in a flexible design that can be easily configured for a variety of applications. These circuit breaker can be equipped with 3.2-W, 3.2S-W, 5.2A-W, 5.2E-W, 6.2A-W, 3.3S-W, 5.3A-W, 6.3A-2, and 6.3E-2 Micrologic trip units. See the catalog numbers and references beginning in Table 21.

The mission critical trip units have the same settings and trip curves as the standard trip units described in this document.

For more information see the trip unit user guides 48940-310-01 and 48940-312-01 on the Schneider Electric website.

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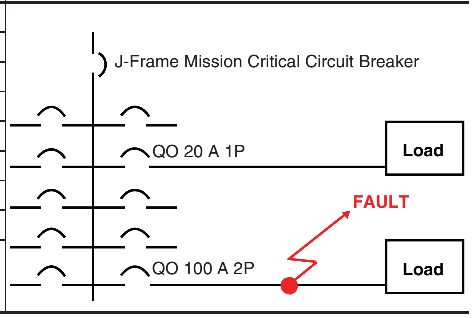
J-frame mission critical circuit breakers are selective with QO or E-frame circuit breakers per Table 6 when the amperage of the main circuit breaker is at least two times the amperage of the branch circuit breaker.

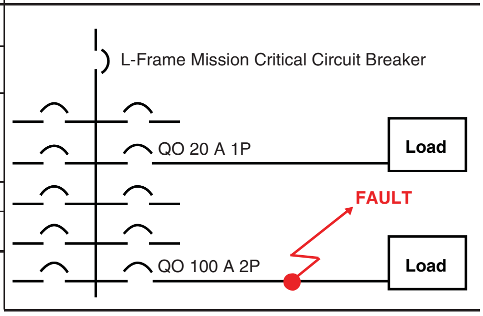
Table 6: J-Frame Selectivity with QO and E-Frame Circuit Breakers[1]

Circuit Breaker				Voltage	Current	One-Line Diagram
Main	**Branch**					
J–W, 250 A	QO(B) QO(B)-H QO(B)-VH QH	1P, 2P	10–30 A	240/120 V 120 V	18 kA	
			35–60 A		15 kA	
			70–125 A		12 kA	
		3P	10–30 A	240 V 208 V	15 kA	
			35–60 A		13 kA	
			70–125 A		10 kA	
J–W, 250 A	E-Frame	1P, 2P, 3P	15–125 A	240 V	18 kA	
			15–60 A	480Y/277 V	10 kA	
			70–125 A		7 kA	

[1] Including AFI, CAFI, EPD and GFI circuit breakers.

L-frame mission critical circuit breakers are selective with QO-style and E-frame circuit breakers per Table 7 when the amperage of the main circuit breaker is at least two times greater than the amperage of the branch circuit breaker.

Table 7: L-Frame Selectivity with QO and E-Frame Circuit Breakers[1]

Circuit Breaker			Voltage	Current	One-Line Diagram
Main	**Branch**				
L–W, 250 A	QO(B) QO(B)-H QO(B)-VH QH	10–60 A	240 V	18 kA	
		70–125 A		10 kA	
L–W, 400 A L–W, 600 A	QO(B) QO(B)-H QO(B)-VH QH	15–150 A	240 V	30 kA	
L–W, 250 A L–W, 400 A L–W, 600 A	E-Frame	15–125 A	240 V	30 kA	
			480Y/277	30 kA	

[1] Including AFI, CAFI, EPD and GFI circuit breakers.

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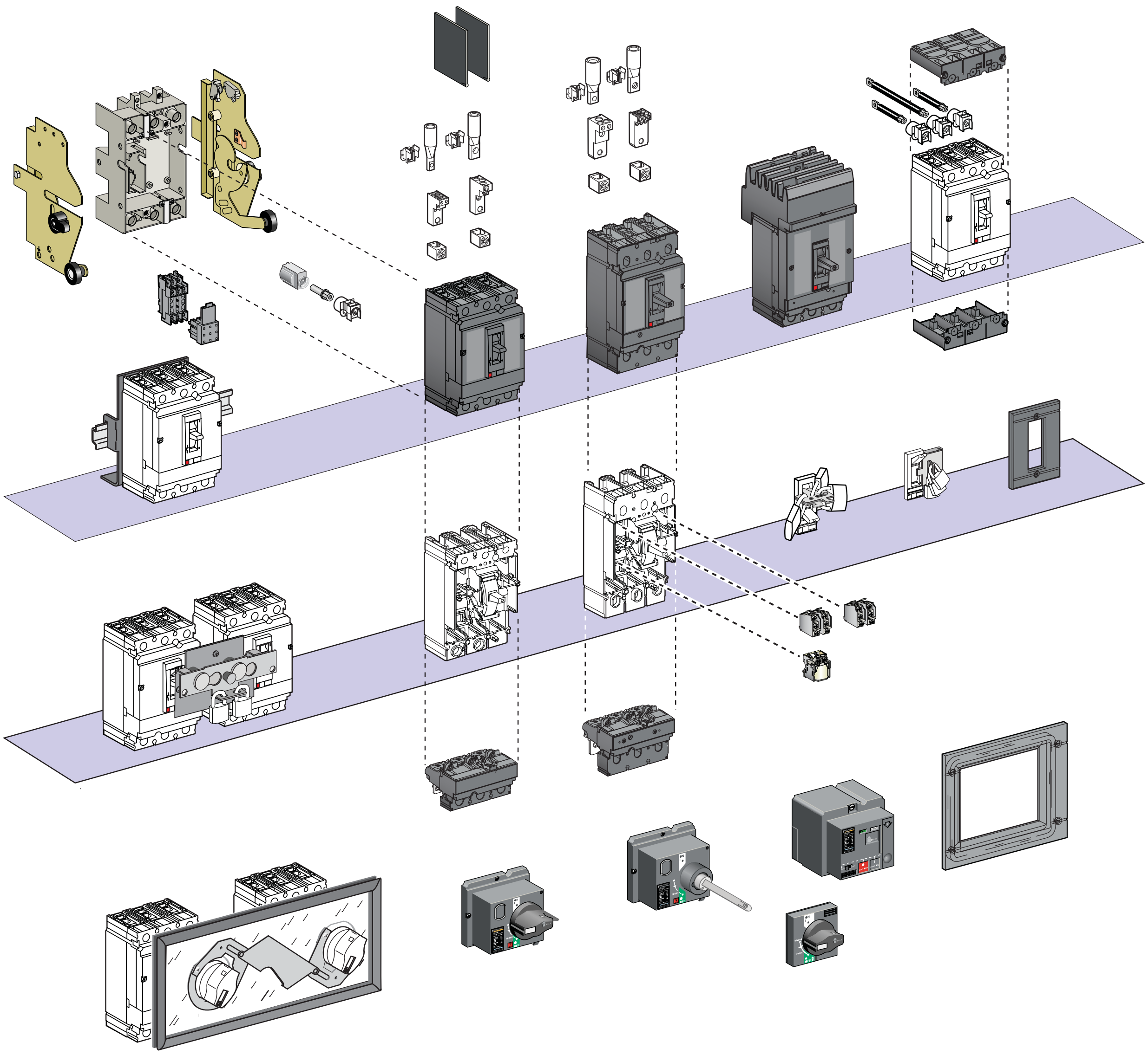
Flexible Configurations

The PowerPact H-, J- and L-frame circuit breakers may be configured with lugs, bus bar connections, rear connections, I-Line™, drawout cradle, or plug-in base.

Field Installable Accessories and Trip Units

Figure 1: Field Installable Accessories and Trip Units



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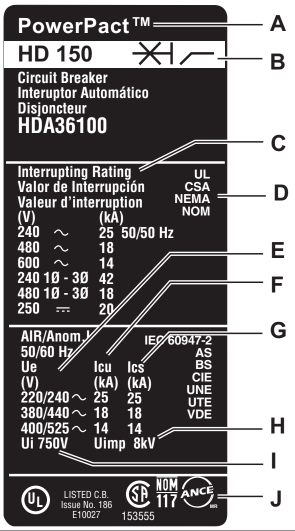
General Characteristics

Faceplate Label



Characteristics indicated on the faceplate label:

A. Circuit breaker type
B. Circuit breaker disconnector symbol
C. Performance levels
D. Standards
E. Ue: Operating voltage per IEC
F. Icu: Ultimate breaking capacity per IEC
G. Ics: Service breaking capacity per IEC
H. Uimp: Rated impulse withstand voltage per IEC
I. Ui: Insulation voltage per IEC
J. Certification marks

NOTE: When the circuit breaker is equipped with an extended rotary handle, the door must be opened to view the faceplate.

Codes and Standards

H-, J-, and L-frame circuit breakers, automatic switches and electronic motor circuit protectors are manufactured and tested in accordance with the following standards.

NOTE: Apply circuit breakers according to guidelines detailed in the National Electric Code (NEC) and other local wiring codes.

Table 8: Codes and Standards (Domestic)

PowerPact H-, J-, and L-Frame Circuit Breakers	H-, J-, and L-Frame Switches	PowerPact H-, J-, and L-Frame Motor Circuit Protectors
UL 489[1]	UL 489[3]	UL 508
IEC 60947-2	IEC 60947-3	IEC 60947-2
CSA C22.2 No. 5[2]	CSA C22.2 No. 5[4]	CSA C22.2 No. 14
Federal Specification W-C-375B/GEN	Federal Specification W-C-375B/GEN	NEMA AB1
NEMA AB1	NEMA AB1	CCC
NMX J-266	NMX J-266	CE Marking
CCC	CE Marking	
CE Marking		

1 PowerPact H- and J-frame circuit breakers are in UL File E10027. PowerPact L-frame circuit breakers are in UL File E63335.
2 PowerPact H- and J-frame circuit breakers are in CSA File LR40970. PowerPact L-frame circuit breakers are in CSA File 69561.
3 PowerPact H- and J-frame switches are in UL File E87159.
4 PowerPact H- and J-frame switches are in CSA File LR32390.

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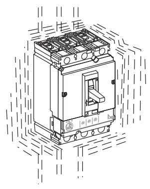
Vibration



PowerPact H-, J-, and L-frame devices resist mechanical vibration.

Tests are carried out in compliance with standard UL 489 SA and SB for the levels required by merchant-marine inspection organizations (Veritas®, Lloyd's®, etc.):

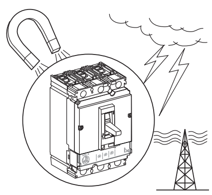
PowerPact H-, J-, and L-frame circuit breaker meet IEC 60068-2-6 for vibration:

— 2.0 to 25.0 Hz and amplitude +/- 1.6 mm

— 25.0 to 100 Hz acceleration +/- 4.0 g

Excessive vibration may cause tripping, breaks in connections or damage to mechanical parts.

Electromagnetic Disturbances



PowerPact H-, J-, and L-frame devices are protected against:

- overvoltages caused by circuit switching
- overvoltages caused by an atmospheric disturbances or by a distribution-system outage (such as from failure due to lightning)
- devices emitting radio waves (radios, walkie-talkies, radar, etc.)
- electrostatic discharges produced directly by users

PowerPact H-, J-, and L-frame devices have successfully passed the electromagnetic-compatibility tests (EMC) defined by the following international standards:

- IEC/EN 60947-2: Low-voltage switchgear and controlgear, part 2: Circuit breakers:
  - — Annex F: Immunity tests for circuit breakers with electronic protection
  - — Annex B: Immunity tests for residual current protection
- IEC/EN 61000-4-2: Electrostatic-discharge immunity tests
- IEC/EN 61000-4-3: Radiated, radio-frequency, electromagnetic-field immunity tests
- IEC/EN 61000-4-4: Electrical fast transient/burst immunity tests
- IEC/EN 61000-4-5: Surge immunity tests
- IEC/EN 61000-4-6: Immunity tests for conducted disturbances induced by radio frequency fields
- CISPR 11: Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

These tests ensure that:

- no nuisance tripping occurs due to electromagnetic disturbances
- tripping times are respected

Tropicalization

The materials used in PowerPact circuit breakers will not support the growth of fungus and mold.

PowerPact circuit breakers have passed the test defined below for extreme atmospheric conditions.

Dry cold and dry heat:

— IEC 68-2-1–dry cold at -55°C

— IEC 68-2-2–dry heat at +85°C

Damp heat (tropicalization)

— IEC 68-2-30–damp heat (temperature + 55°C and relative humidity of 95%)

— IEC 68-2-52 level 2–salt mist

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Special Ratings

The H-frame and J-frame circuit breakers also comply with the following special ratings:

- HACR rating
- SWD switch duty rating (applies only to 15 and 20 A / 277 Vac or less, two- and three-pole)
- HID high intensity discharge lighting rating (15–50 A)

The L-frame circuit breakers complies with the following special rating:

- HACR rating

Marine Ratings

UL Marine Listed/CSA Certified Circuit Breakers (UL 489 Supplement SA)

The PowerPact H- and J-frame circuit breakers with thermal-magnetic trip units with D, G, J and L interruption levels meet the UL 489 Supplement SA requirements for use on vessels of any length under or over 65 ft. (19.8 m). The PowerPact H-, J-, and L-frame circuit breakers with Micrologic electronic trip units meet the UL 489 Supplement SA for use on vessels over 65 ft. (19.8 m) in length. Marine circuit breakers must not use aluminum or aluminum alloys for terminal connections and must be calibrated at an ambient temperature of 104°F (40°C). Standard circuit breakers should not be specified or used in the place of marine rated circuit breakers.

Circuit breakers can be ordered with the Marine SA listing by adding the suffix “YA” (marine) to the catalog number.

UL Naval Listed/CSA Certified Circuit Breakers (UL 489 Supplement SB)

The PowerPact H-, J-, and L-frame circuit breakers with Micrologic trip units with D, G, J and L interruption levels meet the UL 489 Supplement SB requirements for use on naval vessels. These circuit breakers are subject to various vibration tests as described in UL 489 Supplement SB. Naval circuit breakers must not use aluminum or aluminum alloys for terminal connections and must be calibrated at an ambient temperature of 122°F (50°C). Standard circuit breakers should not be specified or used in the place of navel rated circuit breakers.

Circuit breakers can be ordered with the Naval SB listing by adding the suffix “YA1” (naval) to the catalog number.

American Bureau of Shipping (ABS)

The PowerPact H-, J-, and L-Frame circuit breakers are certified to ABS-NVR (American Bureau of Shipping - Naval Vessel Rules), for use on Naval vessels.

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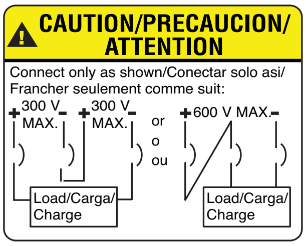
UL 489 SC Listed 500 Vdc Circuit Breakers

The UL Listed/CSA Certified thermal-magnetic H-, J-, and L-frame molded case circuit breakers are specifically designed for use on ungrounded dc systems having a maximum short-circuit voltage of 500 Vdc or a maximum floating (unloaded) voltage of 600 Vdc. The circuit breakers are suitable for use only with UPS (uninterruptable power supplies) and ungrounded systems. This two-level voltage rating allows these circuit breakers to be applied to battery sources having a short-circuit availability of 20,000 or 50,000 amperes at 500 Vdc.

These circuit breakers are UL Listed/CSA Certified for the interrupting ratings shown only if applied with three poles connected in series (series connection is external to circuit breaker). See diagram below.

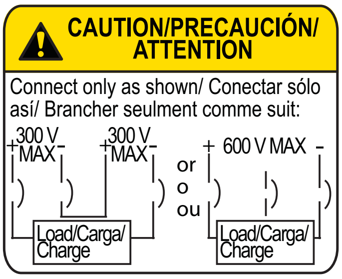
NOTE: Due to external series connection, I-Line circuit breakers are not available for this application.

Figure 2: DC Circuit Breaker Caution Labels

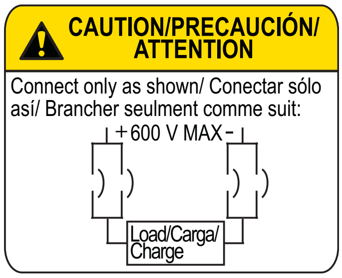


Source = 600 Vdc max. (floating)
500 Vdc max. (loaded)

H- and J-Frame Circuit Breakers



L-Frame Three-Pole Circuit Breakers



L-Frame Four-Pole Circuit Breakers

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Table 9: DC Molded Case Circuit Breakers–Adjustable Magnetic Trip

Ampere Rating	Circuit Breaker Cat. No.	Adjustable Magnetic Trip Range—DC Amperes		Performance Level at 500 Vdc
		Low	High	
100 A	**JGL37100D81**	350	600	20 k AIR
125 A	**JGL37125D81**	350	600	
150 A	**JGL37150D81**	350	600	
175 A	**JGL37175D81**	350	600	
200 A	**JGL37200D82**	500	850	
225 A	**JGL37225D82**	500	850	
250 A	**JGL37250D82**	500	850	
300 A	**LGL37030D27**	750	1500	
350 A	**LGL37035D29**	875	1750	
400 A	**LGL37040D30**	1000	2000	
450 A	**LGL37045D31**	1125	2250	
500 A	**LGL37050D32**	1250	2500	
600 A	**LGL37060D33**	1500	3000	
700 A	**LGL47070D35**	1750	3500	
800 A	**LGL47080D36**	2000	4000	
900 A	**LGL47090D86**	2250	4500	
1000 A	**LGL47100D40**	2500	5000	
1200 A	**LGL47120D42**	3000	6000	
100 A	**JLL37100D81**	350	600	50 k AIR
125 A	**JLL37125D81**	350	600	
150 A	**JLL37150D81**	350	600	
175 A	**JLL37175D81**	350	600	
200 A	**JLL37200D82**	500	850	
225 A	**JLL37225D82**	500	850	
250 A	**JLL37250D82**	500	850	
300 A	**LLL37030D27**	750	1500	
350 A	**LLL37035D29**	875	1750	
400 A	**LLL37040D30**	1000	2000	
450 A	**LLL37045D31**	1125	2250	
500 A	**LLL37050D32**	1250	2500	
600 A	**LLL37060D33**	1500	3000	
700 A	**LLL47070D35**	1750	3500	
800 A	**LLL47080D36**	2000	4000	
900 A	**LLL47090D86**	2250	4500	
1000 A	**LLL47100D40**	2500	5000	
1200 A	**LLL47120D42**	3000	6000	

Table 10: DC Molded Case Circuit Breakers–Fixed Magnetic Trip

Ampere Rating	Circuit Breaker Cat. No.	Adjustable Magnetic Trip Range—DC Amperes		Performance Level at 500 Vdc
		Low	High	
30 A	**HGL37030D87**	300	600	20 k AIR
50 A	**HGL37050D87**	300	600	
70 A	**HGL37070D87**	300	600	
30 A	**HLL37030D87**	300	600	50 k AIR
50 A	**HLL37050D87**	300	600	
70 A	**HLL37070D87**	300	600	

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Table 11: Circuit Breakers

Circuit Breaker		150 A H-Frame					250 A J-Frame					400 A L-Frame					600 A L-Frame					1200 A L-Frame	
Circuit Breaker Type		HD	HG	HJ	HL	HR	JD	JG	JJ	JL	JR	LD	LG	LJ	LL	LR	LD	LG	LJ	LL	LR	LG	LL
Number of poles[1]		2, 3				3	2, 3				3	3, 4					3, 4					4	
Amperage Range (A)		15-150					70-250					70-400					200-600					700-1200	
UL 489 Circuit Breaker Ratings																							
Breaking Capacity (AIR) UL/CSA/NOM (kA rms)	240 Vac	25	65	100	125	200	25	65	100	125	200	25	65	100	125	200	25	65	100	125	200	—	—
	480 Vac	18	35	65	100	200	18	35	65	100	200	18	35	65	100	200	18	35	65	100	200	—	—
	600 Vac	14	18	25	50	100	14	18	25	50	100	14	18	25	50	100	14	18	25	50	100	—	—
	250 Vdc[2]	20	20	20	20	—	20	20	20	20	—	—	—	—	—	—	—	—	—	—	—	—	—
	500 Vdc[2, 3]	—	20	—	50	—	—	20	—	—	50	—	20	—	—	50	—	20	—	20	—	20	50
IEC 947-2 Circuit Breaker Ratings																							
Ultimate breaking capacity (Icu) (kA rms)	220/240 Vac	25	65	100	125	150	25	65	100	125	150	25	65	100	125	150	25	65	100	125	150	—	—
	380/415 Vac	18	35	65	100	125	18	35	65	100	125	18	35	65	100	125	18	35	65	100	125	—	—
	440/480 Vac	18	35	65	100	125	18	35	65	100	125	18	35	65	100	125	18	35	65	100	125	—	—
	500/525 Vac	14	18	25	50	75	14	18	25	50	75	14	18	25	50	75	14	18	25	50	75[4]	—	—
	690 Vac	—	—	—	—	20	—	—	—	—	20	—	—	—	—	20	—	—	—	—	20	—	—
	250 Vdc[2]	—	—	—	—	—	20	20	20	20	—	—	—	—	—	—	—	—	—	—	—	—	—
	500 Vdc[2, 3]	—	—	—	—	—	20	20	20	20	—	—	—	—	—	—	—	—	—	—	—	—	—
Service breaking capacity (Ics)	% Icu	100%					100%					100%					100%					—	—
Insulation Voltage	V_i	750 Vac					750 Vac					750 Vac					750 Vac					—	—
Impulse Withstand Voltage	V_{imp}	8 kVac					8 kVac					8 kVac					8 kVac					—	—
Operational Voltage	V_e	690 Vac					690 Vac					690 Vac					690 Vac					—	—
Sensor Rating	I_n	150 A					250 A					400 A					600 A					—	—
Utilization Category	—	A					A					A					A					—	—
Operations (Open-Close Cycles)																							
Without Current		4000					5000					5000					5000					—	
With Current		4000					1000					1000					1000					—	
Protection and Measurements																							
Short-circuit protection	Magnetic only	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
Overload/short-circuit protection	Thermal-magnetic	X	X	X	X	X	X	X	X	X	X	—	—	—	—	—	—	—	—	—	—	X	X
	Electronic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	with neutral protection (Off-0.5-1-OSN)[5]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	with ground fault protection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	with zone selective interlocking (ZSI)[6]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
Display / I, V, f, P, E, THD measurements / interrupted-current measurement		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
Options	Front display module (FDM121)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	Operating assistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	Counters	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	Histories and alarms	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	Metering Com	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
	Device status/control com	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—
Dimensions / Weight / Connections																							
Dimensions (Three-Pole Unit Mount) in. (mm)	Height	6.4 (163)					7.5 (191)					13.38 (340)					13.38 (340)					13.38 (340)	
	Width	4.1 (104)					4.1 (104)					5.51 (140)					5.51 (140)					5.51 (140)	
	Depth	3.4 (86)					3.4 (86)					4.33 (110)					4.33 (110)					4.33 (110)	
Weight - lb. (Kg)		4.8 (2.2)					5.3 (2.4)					13.2 (6.0)					13.7 (6.2)					13.7 (6.2)	
Connections / Terminations	Unit Mount	X					X					X					X					X	
	I-Line	X					X					X					X					—	
	Rear Connection	X					X					X					X					X[7]	
	Plug-In	X					X					X					X					—	
	Drawout	X					X					X					X					—	
	Optional Lugs	X					X					X					X					—	

1 H and J-frame breakers with Micrologic trip units available only with three poles. The HJ, HL and the J-Frame two pole circuit breakers are three pole modules.

2 DC not available with PowerPact H, J or L-frame circuit breakers with Micrologic trip units.

3 500 Vdc specific catalog numbers, ungrounded UPS systems only.

4 I_{cs} for 600 A L-frame circuit breaker at 525 V is 19 kA.

5 OSN: Over Sized Neutral protection for neutrals carrying high currents (e.g. 3rd harmonics).

6 ZSI using restraint wires.

7 Rear connection is not available for 700–1200 A four pole L-frame circuit breakers.

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PowerPact H-, J-, and L-frame Circuit Breaker Trip Units

Table 12: Micrologic Trip Unit Features

Features	Micrologic Trip Unit (X = Standard Feature, O = Available Option					
	Standard		Ammeter		Energy	
	3.2/3.3	3.2S/3.3S	5.2A/5.3A	6.2A/6.3A	5.2E/5.3E	6.2E/6.3E
LI	X					
LSI[1]		X	X		X	
LSIG/Ground Fault Trip[2]				X		X
Ground-Fault Alarm Trip				X		X
Current Settings Directly in Amperes	X	X	X	X	X	X
True RMS Sensing	X	X	X	X	X	X
UL Listed	X	X	X	X	X	X
Thermal Imaging	X	X	X	X	X	X
LED for Long-Time Pickup	X	X	X	X	X	X
LED for Long-Time Alarm	X	X	X	X	X	X
LED Green "Ready" Indicator	X	X	X	X	X	X
Up to 12 Alarms Used Together			X	X	X	X
Digital Ammeter			X	X	X	X
Zone-Selective Interlocking[3]			X	X	X	X
Communications	O	O	O	O	O	O
LCD Display			X	X	X	X
Front Display Module FDM121			O	O	O	O
Advanced User Interface			X	X	X	X
Neutral Protection			X	X	X	X
Contact Wear Indication[4]			X	X	X	X
Incremental Fine Tuning of Settings			X	X	X	X
Load Profile[4, 5]			X	X	X	X
Power Measurement					X	X
Power Quality Measurements					X	X

1 The LSI with 3.2S/3.3S trip units have fixed short time and long time delays.
2 Requires neutral current transformer on three-phase four-wire loads.
3 ZSI for H/J-frame devices is only OUT. ZSI for L-frame devices is IN and OUT.
4 Indication available using the communication system only.
5 % of hours in 4 current ranges: 0–49%, 50–79%, 80–89%, and >90% I_n.

Thermal-Magnetic or Electronic Trip Unit?

Thermal-magnetic trip units (available on H- and J-frame circuit breakers only) protect against overcurrents and short-circuits using tried and true techniques. For applications requiring installation optimization and energy efficiency, electronic trip units offering more advanced protection functions combined with measurements.

Trip units using digital electronics are faster as well as more accurate. Wide setting ranges make installation upgrades easier. Designed with processing capabilities, Micrologic trip units can provide measurement information and device operating assistance. With this information, users can avoid or deal more effectively with disturbances and can play a more active role in system operation. They can manage the installation, anticipate events and plan any necessary servicing.

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Accurate Measurements for Complete Protection

PowerPact H-, J-, and L-frame circuit breakers devices offer excellent measurement accuracy from 15 amperes on up to the short-circuit currents. This is made possible by a new generation of current transformers combining “iron-core” sensors for self-powered electronics and “air core” sensors (Rogowski coils) for measurements. The protection functions are managed by an ASIC (Application Specific Integrated Circuit) component that is independent of the measurement functions. This independence ensures immunity to conducted and radiated disturbances and increases reliability.

Numerous Security Functions

Torque-limiting screws	The screws secure the trip unit to the circuit breaker. When the correct tightening torque is reached, the screw heads break off. Optimum tightening avoids any risk of temperature rise. A torque wrench is no longer required.
Easy and sure changing of trip units	All trip units are interchangeable, without wiring. A mechanical mismatch-protection system makes it impossible to mount a trip unit on a circuit breaker with a lower rating.
“Ready” LED for a continuous self-test	The LED on the front of the electronic trip units indicates the result of the self-test running continuously on the measurement system and the tripping release. As long as the green LED is flashing, the links between the CTs, the processing electronics and the tripping mechanism are operational. The circuit breaker is ready to protect. A minimum current of 15 to 50 A, depending on the device, is required for this indication function.
A patented dual adjustment system for protection functions.	Available on Micrologic 5/6 trip units, the system consists of: • an adjustment using rotary switches sets the maximum value • an adjustment using the keypad or made remotely, fine-tunes the setting. This setting may not exceed the first one. It can be read directly on the Micrologic trip unit screen, to within one ampere and a fraction of a second.

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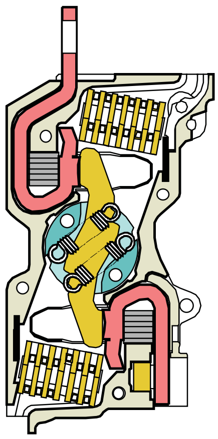
Section 3—Circuit Breakers



Dual-Break Rotating Contacts

All PowerPact™ H-, J-, and L-frame circuit breakers are equipped with dual-break rotating contacts that reduce the amount of peak current during a short circuit fault. This reduces the let-through currents and enhances equipment protection.

Reduced Let-Through Currents

The moving contact has the shape of an elongated "S" and rotates around a floating axis. The shape of the fixed and moving contacts are such that the repelling forces appear as soon as the circuit reaches approximately 15 times I_n.

Due to the rotating movement, repulsion is rapid and the device greatly limits short-circuit currents, whatever the interrupting level of the unit (D, G, J or L). The fault current is extinguished before it can fully develop. Lower let-through currents provide less peak energy, reducing the required bus bar bracing, lowering enclosure pressure, and delivering improved series or combination ratings. See page 25 for UL Current-Limiting labels.

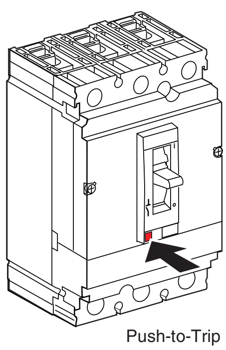
High Ampere Interrupting Ratings (AIR)

Circuit breakers are available with interrupting ratings up to:

- 200 kA at 240 Vac delta
- 200 kA at 480 Vac delta
- 100 kA at 600 Vac delta.

See Table 2 for additional performance levels.

Internal Operating Mechanism



PowerPact H-, J-, and L-frame circuit breakers have an over-center toggle mechanism providing quick-make, quick-break operation. The operating mechanism is also trip-free, which allows tripping even when the circuit breaker handle is held in the "ON" position.

Internal cross-bars provide common opening and closing of all poles with a single operating handle.

All PowerPact circuit breakers have an integral push-to-trip button in the cover to manually trip the circuit breaker. This should be used as part of a regular preventive maintenance program.

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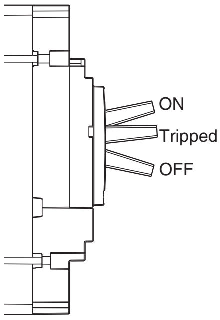
Handle Position Indication



The circuit breaker handle can assume any of three positions, ON, tripped or OFF as shown. The center tripped position provides positive visual indication that the circuit breaker has tripped.

The circuit breaker can be reset by first pushing the handle to the extreme “OFF” position. Power can then be restored to the load by pushing the handle to the “ON” position.

Circuit Breaker Ratings

The interrupting rating is the highest current at rated voltage the circuit breaker is designed to safely interrupt under standard test conditions. Circuit breakers must be selected with interrupting ratings equal to or greater than the available short-circuit current at the point where the circuit breaker is applied to the system (unless it is a branch device in a series rated combination). Interrupting ratings are shown on Table 11: Circuit Breakers on page 21 and on the faceplate label on the front of the circuit breaker.

Reverse Feeding of Circuit Breakers

The standard unit-mount H-, J-, and L-frame circuit breakers have sealed trip units and may be reverse fed. See Tables 18, 19, and 32 through 40 for catalog numbers.

Circuit breakers with field-interchangeable trip units (designated by the suffix T and labeled “LINE” and “LOAD”) cannot be reverse fed. Neither can circuit breaker frames without terminations or trip units.

Current-Limiting

The current-limiting attributes of PowerPact H-, J-, and L-frame circuit breakers provide greater protection for downstream devices by limiting the let-through current in the event of a fault. The current-limiting capabilities of HJ/HL/HR, JJ/JL/JR, and LJ/LL/LR frame circuit breakers are documented with Underwriters Laboratories and Canadian Standards Association. These current-limiting circuit breakers ship with a label that identifies them as UL/CSA Current-Limiting Circuit Breakers. (The HD/HG, JD/JG, and LD/LG circuit breakers do not carry the UL Current-Limiting label).

The trip curves with let-through data are available in the trip curve section in this catalog.

Please note that as let-through curves for UL Listed/CSA Certified Current-Limiting Circuit Breakers, these curves are maximum let-through values.

100% Rated

Some models of the H-, J-, and L-frame circuit breakers are UL Listed/CSA Certified to be applied at up to 100% of their current rating. Because of the additional heat generated, the use of specially-designed enclosures on H- and J-frame circuit breakers and 194°F (90°C) rated wire is required when applying circuit breakers at 100% of continuous current rating. (H-, J-, and L-frame circuit breakers can use aluminum or copper lugs.) Markings on the circuit breaker indicate the minimum enclosure size and ventilation required. The 194°F (90°C) wire must be sized according to the ampacities of the 167°F (75°C) wire column in the NEC. Circuit breakers with 100% rating can also be used in applications requiring only standard (80%) continuous loading.

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PowerPact H-, J-, and L-Frame Circuit Breakers
Circuit Breakers

100% ratings valid for:

- three-pole H/J-frame unit mount construction only.
- three- and four-pole L-frame 250 A and 400 A unit mount construction.
- three-pole L-frame 250 A and 400 A I-Line™ construction.

Corner Grounded Delta Ratings (1Ø-3Ø)

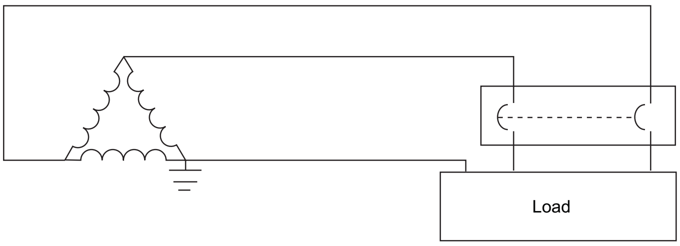
Circuit breakers suitable for corner-grounded circuits are marked 1Ø-3Ø. For additional information, refer to data bulletin 2700DB0202.

Table 13: Corner Grounded Delta Ratings (1Ø-3Ø)

	Two-Pole H-Frame					Two-Pole J-Frame				
	HD	HG	HJ[1]	HL[1]	HR[1]	JD[1]	JG[1]	JJ[1]	JL[1]	JR[1]
Ampere Rating (A)	15–150					150–250				
Voltage Rating (Vac)	240					240				
UL Interrupting Rating (kA)	42	42	65	100	200	42	42	65	100	200

[1] Built using three-pole module.

Figure 3: Three-Phase 240 Vac Corner-Grounded Delta System



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Special Applications

Protection of Industrial Control Panels

PowerPact H-, J-, and L-frame circuit breakers are also used in industrial control panels. They serve as an incoming devices or can be combined with contactors to protect motor feeders:

- compliance with worldwide standards including IEC 60947-2 and UL 508 / CSA C22.2 N°14
- overload and short-circuit protection
- installation in universal and functional type

PowerPact H-, J-, and L-frame circuit breakers equipped for motor protection functions as described in the following pages can be used in industrial control panels. The accessories for the PowerPact H-, J-, and L-frame circuit breakers are suitable for the special needs of these applications.

400 Hz Applications

Impact on Protective Devices

The current in 400 Hz systems have higher losses caused by eddy currents and an increase in the skin effect (reduction in the useful cross-sectional area of conductors). The higher losses cause additional temperature rise in circuit breakers subjected to the higher frequency current. To remain within the rated temperature-rise limits of devices, current derating is required. For circuit breakers equipped with Micrologic electronic trip units, only the current rating (Ir) must be derated. See Table 14. On circuit breakers equipped with thermal-magnetic trip units, the current rating (In) must be derated and the magnetic trip setting Im must be increased. See Table 15.

Breaking Capacity in 400 Hz, 480 V Systems

The power levels of 400 Hz applications rarely exceed a few hundred kW with relatively low short-circuit currents, generally not exceeding four times the rated current.

Circuit Breaker	Max. Breaking Capacity AIR at 400 Hz
H-frame	10 kA
J-frame	10 kA
L-frame	10 kA

Micrologic Electronic Trip Units

Micrologic™ 3.2/3, 5.2/3 A or E and 6.2/3 with A or E measurement functions are suitable for 400 Hz. The use of electronics offers the advantage of greater operating stability when the frequency varies. However the units are still subject to temperature rise caused by the frequency.

The practical consequences are:

- limit settings: see the I_r derating table below
- the long-time, short-time and instantaneous pick-ups are not modified (see pages 87 or 89)
- the accuracy of the displayed measurements is 2% (Class II)

Table 14: Current Derating Maximum I_r Setting

Circuit Breaker	Maximum Setting Coefficient	Max I_r Setting at 400 Hz
H-Frame, 150 A	0.9	135
J-Frame, 250 A	0.9	225
L-Frame, 400 A	0.8	320
L-Frame, 600 A	0.65	390

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Thermal-Magnetic Trip Units

Thermal-magnetic trip units require the current rating (I_n) to be derated and the magnetic trip setting (I_m) to be increased.

Table 15: Current Rating (In) and Magnetic Trip Setting (Im) Rerating

Circuit Breaker	Maximum Setting Coefficient	Max I_r Setting at 400 Hz	Magnetic I_m Coefficient at 400 Hz
H-Frame, 150 A	0.9	135	1.6
J-Frame, 250 A	0.9	225	1.6
L-Frame, 400 A	0.8	320	1.6
L-Frame, 600 A	0.65	390	1.6

Auxiliary Switch (OF) in 400 Hz Networks

Table 16: Electrical Characteristics of Auxiliary Switches

Contact		Standard		Low Level	
Utilization cat. (IEC 60947-5-1)		AC12	AC15	AC12	AC15
Operational current	24 V	6 A	6 A	5 A	3 A
	40 V	6 A	6 A	5 A	3 A
	110 V	6 A	5 A	5 A	2.5 A
	200/240 V	6 A	4 A	5 A	2 A
	380/415 V	6 A	2 A	5 A	1.5 A

Shunt Trip (MX) or Undervoltage Trip (MN) Voltage Release at 400 Hz and 440 V

For circuit breakers on 400 Hz systems, only 125 Vdc undervoltage trip (MN) or shunt trip (MX) releases may be used. The release must be supplied by the 400 Hz system through a rectifier bridge (to be selected from the table below) and an additional resistor with characteristics depending on the system voltage.

Table 17: Rectifier Bridges for MN or MX Releases

Voltage	Rectifier	Additional Resistor
220/240 V	Thomson 110 BHz or General Instrument W06 or Semikron SKB at 1.2/1.3	4.2 kΩ-5 W
380/240 V	Semikron SKB at 1.2/1.3	10.7 kΩ-10 W

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H- and J-Frame Catalog Numbers

Unit-Mount Circuit Breaker Catalog Numbers

Table 18: PowerPact H-Frame 150 A Unit-Mount[1] Thermal-Magnetic Circuit Breakers (600 Vac, 250 Vdc) with Factory Sealed Trip Unit (Suitable for Reverse Connection)

Current Rating at 104°F (40°C)	Fixed AC Magnetic Trip		Interrupting Rating							
			D		G		J[2]		L[2]	
	Hold	Trip	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated
H-Frame, 150 A, Two-Pole, 600 Vac 50/60 Hz, 250 Vdc[3]										
15 A	350 A	750 A	**HDL26015**	**HDL26015C**	**HGL26015**	**HGL26015C**	**HJL26015**	**HJL26015C**	**HLL26015**	**HLL26015C**
20 A	350 A	750 A	**HDL26020**	**HDL26020C**	**HGL26020**	**HGL26020C**	**HJL26020**	**HJL26020C**	**HLL26020**	**HLL26020C**
25 A	350 A	750 A	**HDL26025**	**HDL26025C**	**HGL26025**	**HGL26025C**	**HJL26025**	**HJL26025C**	**HLL26025**	**HLL26025C**
30 A	350 A	750 A	**HDL26030**	**HDL26030C**	**HGL26030**	**HGL26030C**	**HJL26030**	**HJL26030C**	**HLL26030**	**HLL26030C**
35 A	400 A	850 A	**HDL26035**	**HDL26035C**	**HGL26035**	**HGL26035C**	**HJL26035**	**HJL26035C**	**HLL26035**	**HLL26035C**
40 A	400 A	850 A	**HDL26040**	**HDL26040C**	**HGL26040**	**HGL26040C**	**HJL26040**	**HJL26040C**	**HLL26040**	**HLL26040C**
45 A	400 A	850 A	**HDL26045**	**HDL26045C**	**HGL26045**	**HGL26045C**	**HJL26045**	**HJL26045C**	**HLL26045**	**HLL26045C**
50 A	400 A	850 A	**HDL26050**	**HDL26050C**	**HGL26050**	**HGL26050C**	**HJL26050**	**HJL26050C**	**HLL26050**	**HLL26050C**
60 A	800 A	1450 A	**HDL26060**	**HDL26060C**	**HGL26060**	**HGL26060C**	**HJL26060**	**HJL26060C**	**HLL26060**	**HLL26060C**
70 A	800 A	1450 A	**HDL26070**	**HDL26070C**	**HGL26070**	**HGL26070C**	**HJL26070**	**HJL26070C**	**HLL26070**	**HLL26070C**
80 A	800 A	1450 A	**HDL26080**	**HDL26080C**	**HGL26080**	**HGL26080C**	**HJL26080**	**HJL26080C**	**HLL26080**	**HLL26080C**
90 A	800 A	1450 A	**HDL26090**	**HDL26090C**	**HGL26090**	**HGL26090C**	**HJL26090**	**HJL26090C**	**HLL26090**	**HLL26090C**
100 A	900 A	1700 A	**HDL26100**	**HDL26100C**	**HGL26100**	**HGL26100C**	**HJL26100**	**HJL26100C**	**HLL26100**	**HLL26100C**
110 A	900 A	1700 A	**HDL26110**	**HDL26110C**	**HGL26110**	**HGL26110C**	**HJL26110**	**HJL26110C**	**HLL26110**	**HLL26110C**
125 A	900 A	1700 A	**HDL26125**	**HDL26125C**	**HGL26125**	**HGL26125C**	**HJL26125**	**HJL26125C**	**HLL26125**	**HLL26125C**
150 A	900 A	1700 A	**HDL26150**	**HDL26150C**	**HGL26150**	**HGL26150C**	**HJL26150**	**HJL26150C**	**HLL26150**	**HLL26150C**
H-Frame, 150 A, Three-Pole, 600 Vac 50/60 Hz, 250 Vdc										
15 A	350 A	750 A	**HDL36015**	**HDL36015C**	**HGL36015**	**HGL36015C**	**HJL36015**	**HJL36015C**	**HLL36015**	**HLL36015C**
20 A	350 A	750 A	**HDL36020**	**HDL36020C**	**HGL36020**	**HGL36020C**	**HJL36020**	**HJL36020C**	**HLL36020**	**HLL36020C**
25 A	350 A	750 A	**HDL36025**	**HDL36025C**	**HGL36025**	**HGL36025C**	**HJL36025**	**HJL36025C**	**HLL36025**	**HLL36025C**
30 A	350 A	750 A	**HDL36030**	**HDL36030C**	**HGL36030**	**HGL36030C**	**HJL36030**	**HJL36030C**	**HLL36030**	**HLL36030C**
35 A	400 A	850 A	**HDL36035**	**HDL36035C**	**HGL36035**	**HGL36035C**	**HJL36035**	**HJL36035C**	**HLL36035**	**HLL36035C**
40 A	400 A	850 A	**HDL36040**	**HDL36040C**	**HGL36040**	**HGL36040C**	**HJL36040**	**HJL36040C**	**HLL36040**	**HLL36040C**
45 A	400 A	850 A	**HDL36045**	**HDL36045C**	**HGL36045**	**HGL36045C**	**HJL36045**	**HJL36045C**	**HLL36045**	**HLL36045C**
50 A	400 A	850 A	**HDL36050**	**HDL36050C**	**HGL36050**	**HGL36050C**	**HJL36050**	**HJL36050C**	**HLL36050**	**HLL36050C**
60 A	800 A	1450 A	**HDL36060**	**HDL36060C**	**HGL36060**	**HGL36060C**	**HJL36060**	**HJL36060C**	**HLL36060**	**HLL36060C**
70 A	800 A	1450 A	**HDL36070**	**HDL36070C**	**HGL36070**	**HGL36070C**	**HJL36070**	**HJL36070C**	**HLL36070**	**HLL36070C**
80 A	800 A	1450 A	**HDL36080**	**HDL36080C**	**HGL36080**	**HGL36080C**	**HJL36080**	**HJL36080C**	**HLL36080**	**HLL36080C**
90 A	800 A	1450 A	**HDL36090**	**HDL36090C**	**HGL36090**	**HGL36090C**	**HJL36090**	**HJL36090C**	**HLL36090**	**HLL36090C**
100 A	900 A	1700 A	**HDL36100**	**HDL36100C**	**HGL36100**	**HGL36100C**	**HJL36100**	**HJL36100C**	**HLL36100**	**HLL36100C**
110 A	900 A	1700 A	**HDL36110**	**HDL36110C**	**HGL36110**	**HGL36110C**	**HJL36110**	**HJL36110C**	**HLL36110**	**HLL36110C**
125 A	900 A	1700 A	**HDL36125**	**HDL36125C**	**HGL36125**	**HGL36125C**	**HJL36125**	**HJL36125C**	**HLL36125**	**HLL36125C**
150 A	900 A	1700 A	**HDL36150**	**HDL36150C**	**HGL36150**	**HGL36150C**	**HJL36150**	**HJL36150C**	**HLL36150**	**HLL36150C**

1 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.

2 UL Listed/CSA Certified as current-limiting circuit breakers.

3 HD and HG circuit breakers are true two-pole construction.

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Table 19: PowerPact J-Frame 250 A Unit-Mount Thermal-Magnetic Circuit Breakers with Factory Sealed Trip Unit (Suitable for Reverse Connection)

Current Rating at 104°F (40°C)	Adjustable AC Magnetic Trip		Interrupting Rating									
			D		G		J[1]		L[1]		R[1]	
	Hold	Trip	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated	Standard (80%) Rated	100% Rated
J-Frame, 250 A, Two-Pole, 600 Vac 50/60 Hz, 250 Vdc												
150 A[2]	750 A	1500 A	**JDL26150**	**JDL26150C**	**JGL26150**	**JGL26150C**	**JJL26150**	**JJL26150C**	**JLL26150**	**JLL26150C**	—	—
175 A[2]	875 A	1750 A	**JDL26175**	**JDL26175C**	**JGL26175**	**JGL26175C**	**JJL26175**	**JJL26175C**	**JLL26175**	**JLL26175C**	—	—
200 A[3]	1000 A	2000 A	**JDL26200**	**JDL26200C**	**JGL26200**	**JGL26200C**	**JJL26200**	**JJL26200C**	**JLL26200**	**JLL26200C**	—	—
225 A[3]	1125 A	2250 A	**JDL26225**	**JDL26225C**	**JGL26225**	**JGL26225C**	**JJL26225**	**JJL26225C**	**JLL26225**	**JLL26225C**	—	—
250 A[3]	1250 A	2500 A	**JDL26250**	**JDL26250C**	**JGL26250**	**JGL26250C**	**JJL26250**	**JJL26250C**	**JLL26250**	**JLL26250C**	—	—
J-Frame, 250 A, Three-Pole, 600 Vac 50/60 Hz, 250 Vdc												
150 A[2]	750 A	1500 A	**JDL36150**	**JDL36150C**	**JGL36150**	**JGL36150C**	**JJL36150**	**JJL36150C**	**JLL36150**	**JLL36150C**	**JRL36150**	**JRL36150C**
175 A[2]	875 A	1750 A	**JDL36175**	**JDL36175C**	**JGL36175**	**JGL36175C**	**JJL36175**	**JJL36175C**	**JLL36175**	**JLL36175C**	**JRL36175**	**JRL36175C**
200 A[3]	1000 A	2000 A	**JDL36200**	**JDL36200C**	**JGL36200**	**JGL36200C**	**JJL36200**	**JJL36200C**	**JLL36200**	**JLL36200C**	**JRL36200**	**JRL36200C**
225 A[3]	1125 A	2250 A	**JDL36225**	**JDL36225C**	**JGL36225**	**JGL36225C**	**JJL36225**	**JJL36225C**	**JLL36225**	**JLL36225C**	**JRL36225**	**JRL36225C**
250 A[3]	1250 A	2500 A	**JDL36250**	**JDL36250C**	**JGL36250**	**JGL36250C**	**JJL36250**	**JJL36250C**	**JLL36250**	**JLL36250C**	**JRL36250**	**JRL36250C**

1 UL Listed/CSA Certified as current-limiting circuit breakers.
2 Standard lug kit: AL175JD. Terminal wire range: 4–4/0 AWG Al or Cu.
3 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.

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Table 20: H-Frame 150 A and J-Frame 250 A Electronic Trip UL Rated Circuit Breakers (600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating				
Type	Function	Trip Unit		D	G	J[1]	L[2]	R[2]
Standard (80%) Rated Circuit Breakers, Three-Pole								
Standard	LI	3.2[2]	60 A[3]	HDL36060U31X	HGL36060U31X	HJL36060U31X	HLL36060U31X	HRL36060U31X
			100 A[3]	HDL36100U31X	HGL36100U31X	HJL36100U31X	HLL36100U31X	HRL36100U31X
			150 A[3]	HDL36150U31X	HGL36150U31X	HJL36150U31X	HLL36150U31X	HRL36150U31X
			250 A[4]	JDL36250U31X	JGL36250U31X	JJL36250U31X	JLL36250U31X	JRL36250U31X
Standard	LSI	3.2S[2]	60 A[3]	HDL36060U33X	HGL36060U33X	HJL36060U33X	HLL36060U33X	HRL36060U33X
			100 A[3]	HDL36100U33X	HGL36100U33X	HJL36100U33X	HLL36100U33X	HRL36100U33X
			150 A[3]	HDL36150U33X	HGL36150U33X	HJL36150U33X	HLL36150U33X	HRL36150U33X
			250 A[4]	JDL36250U33X	JGL36250U33X	JJL36250U33X	JLL36250U33X	JRL36250U33X
Ammeter	LSI	5.2A	60 A[3]	HDL36060U43X	HGL36060U43X	HJL36060U43X	HLL36060U43X	HRL36060U43X
			100 A[3]	HDL36100U43X	HGL36100U43X	HJL36100U43X	HLL36100U43X	HRL36100U43X
			150 A[3]	HDL36150U43X	HGL36150U43X	HJL36150U43X	HLL36150U43X	HRL36150U43X
			250 A[4]	JDL36250U43X	JGL36250U43X	JJL36250U43X	JLL36250U43X	JRL36250U43X
Energy	LSI	5.2E	60 A[3]	HDL36060U53X	HGL36060U53X	HJL36060U53X	HLL36060U53X	HRL36060U53X
			100 A[3]	HDL36100U53X	HGL36100U53X	HJL36100U53X	HLL36100U53X	HRL36100U53X
			150 A[3]	HDL36150U53X	HGL36150U53X	HJL36150U53X	HLL36150U53X	HRL36150U53X
			250 A[4]	JDL36250U53X	JGL36250U53X	JJL36250U53X	JLL36250U53X	JRL36250U53X
Ammeter	LSIG	6.2A	60 A[3]	HDL36060U44X	HGL36060U44X	HJL36060U44X	HLL36060U44X	HRL36060U44X
			100 A[3]	HDL36100U44X	HGL36100U44X	HJL36100U44X	HLL36100U44X	HRL36100U44X
			150 A[3]	HDL36150U44X	HGL36150U44X	HJL36150U44X	HLL36150U44X	HRL36150U44X
			250 A[4]	JDL36250U44X	JGL36250U44X	JJL36250U44X	JLL36250U44X	JRL36250U44X
Energy	LSIG	6.2E	60 A[3]	HDL36060U54X	HGL36060U54X	HJL36060U54X	HLL36060U54X	HRL36060U54X
			100 A[3]	HDL36100U54X	HGL36100U54X	HJL36100U54X	HLL36100U54X	HRL36100U54X
			150 A[3]	HDL36150U54X	HGL36150U54X	HJL36150U54X	HLL36150U54X	HRL36150U54X
			250 A[4]	JDL36250U54X	JGL36250U54X	JJL36250U54X	JLL36250U54X	JRL36250U54X
100% Rated Circuit Breakers, Three-Pole								
Standard	LI	3.2[2]	60 A[3]	HDL36060CU31X	HGL36060CU31X	HJL36060CU31X	HLL36060CU31X	HRL36060CU31X
			100 A[3]	HDL36100CU31X	HGL36100CU31X	HJL36100CU31X	HLL36100CU31X	HRL36100CU31X
			150 A[3]	HDL36150CU31X	HGL36150CU31X	HJL36150CU31X	HLL36150CU31X	HRL36150CU31X
			250 A[4]	JDL36250CU31X	JGL36250CU31X	JJL36250CU31X	JLL36250CU31X	JRL36250CU31X
Standard	LSI	3.2S[2]	60 A[3]	HDL36060CU33X	HGL36060CU33X	HJL36060CU33X	HLL36060CU33X	HRL36060CU33X
			100 A[3]	HDL36100CU33X	HGL36100CU33X	HJL36100CU33X	HLL36100CU33X	HRL36100CU33X
			150 A[3]	HDL36150CU33X	HGL36150CU33X	HJL36150CU33X	HLL36150CU33X	HRL36150CU33X
			250 A[4]	JDL36250CU33X	JGL36250CU33X	JJL36250CU33X	JLL36250CU33X	JRL36250CU33X
Ammeter	LSI	5.2A	60 A[3]	HDL36060CU43X	HGL36060CU43X	HJL36060CU43X	HLL36060CU43X	HRL36060CU43X
			100 A[3]	HDL36100CU43X	HGL36100CU43X	HJL36100CU43X	HLL36100CU43X	HRL36100CU43X
			150 A[3]	HDL36150CU43X	HGL36150CU43X	HJL36150CU43X	HLL36150CU43X	HRL36150CU43X
			250 A[4]	JDL36250CU43X	JGL36250CU43X	JJL36250CU43X	JLL36250CU43X	JRL36250CU43X
Energy	LSI	5.2E	60 A[3]	HDL36060CU53X	HGL36060CU53X	HJL36060CU53X	HLL36060CU53X	HRL36060CU53X
			100 A[3]	HDL36100CU53X	HGL36100CU53X	HJL36100CU53X	HLL36100CU53X	HRL36100CU53X
			150 A[3]	HDL36150CU53X	HGL36150CU53X	HJL36150CU53X	HLL36150CU53X	HRL36150CU53X
			250 A[4]	JDL36250CU53X	JGL36250CU53X	JJL36250CU53X	JLL36250CU53X	JRL36250CU53X

1 UL Listed/CSA Certified as current-limiting circuit breakers.

2 Three-pole circuit breakers with this trip unit can be used for two-pole applications.

3 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.

4 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.
For smaller wire range (4–4/0 AWG Al or Cu), replace the lug's wire binding screws with the larger binding screws provided.

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Table 21: J-Frame 250 A Mission Critical Electronic Trip UL Rated Circuit Breakers (Three-Pole, 480Y/277 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating[1]			
Type	Function	Trip Unit		D	G	J	L
Standard (80%) Rated Circuit Breakers, Three-Pole							
Standard	LI	3.2-W	250 A	**JDL34250WU31X**	**JGL34250WU31X**	**JJL34250WU31X**	**JLL34250WU31X**
Standard	LSI	3.2S-W	250 A	**JDL34250WU33X**	**JGL34250WU33X**	**JJL34250WU33X**	**JLL34250WU33X**
Ammeter	LSI	5.2A-W	250 A	**JDL34250WU43X**	**JGL34250WU43X**	**JJL34250WU43X**	**JLL34250WU43X**
Energy	LSI	5.2E-W	250 A	**JDL34250WU53X**	**JGL34250WU53X**	**JJL34250WU53X**	**JLL34250WU53X**
Ammeter	LSIG	6.2A-W	250 A	**JDL34250WU44X**	**JGL34250WU44X**	**JJL34250WU44X**	**JLL34250WU44X**
Energy	LSIG	6.2E-W	250 A	**JDL34250WU54X**	**JGL34250WU54X**	**JJL34250WU54X**	**JLL34250WU54X**

1 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.
For smaller wire range (4–4/0 AWG Al or Cu), replace the lug's wire binding screws with the larger binding screws provided.

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I-Line Circuit Breaker Catalog Numbers

Table 22: PowerPact H-Frame 150 A I-Line Thermal-Magnetic Circuit Breakers[1] with Factory Sealed Trip Unit (Suitable for Reverse Connection)[2]

Current Rating at 104°F (40°C)	Fixed AC Magnetic Trip		Interrupting Rating[3] Standard (80%) Rated			
	Hold	Trip	D	G	J[4]	L[4]
H-Frame, 150 A, Two-Pole, 600 Vac 50/60Hz, 250 Vdc						
15 A	350 A	750 A	**HDA26015( )**	**HGA26015( )**	**HJA26015( )**	**HLA26015( )**
20 A	350 A	750 A	**HDA26020( )**	**HGA26020( )**	**HJA26020( )**	**HLA26020( )**
25 A	350 A	750 A	**HDA26025( )**	**HGA26025( )**	**HJA26025( )**	**HLA26025( )**
30 A	350 A	750 A	**HDA26030( )**	**HGA26030( )**	**HJA26030( )**	**HLA26030( )**
35 A	400 A	850 A	**HDA26035( )**	**HGA26035( )**	**HJA26035( )**	**HLA26035( )**
40 A	400 A	850 A	**HDA26040( )**	**HGA26040( )**	**HJA26040( )**	**HLA26040( )**
45 A	400 A	850 A	**HDA26045( )**	**HGA26045( )**	**HJA26045( )**	**HLA26045( )**
50 A	400 A	850 A	**HDA26050( )**	**HGA26050( )**	**HJA26050( )**	**HLA26050( )**
60 A	800 A	1450 A	**HDA26060( )**	**HGA26060( )**	**HJA26060( )**	**HLA26060( )**
70 A	800 A	1450 A	**HDA26070( )**	**HGA26070( )**	**HJA26070( )**	**HLA26070( )**
80 A	800 A	1450 A	**HDA26080( )**	**HGA26080( )**	**HJA26080( )**	**HLA26080( )**
90 A	800 A	1450 A	**HDA26090( )**	**HGA26090( )**	**HJA26090( )**	**HLA26090( )**
100 A	900 A	1700 A	**HDA26100( )**	**HGA26100( )**	**HJA26100( )**	**HLA26100( )**
110 A	900 A	1700 A	**HDA26110( )**	**HGA26110( )**	**HJA26110( )**	**HLA26110( )**
125 A	900 A	1700 A	**HDA26125( )**	**HGA26125( )**	**HJA26125( )**	**HLA26125( )**
150 A	900 A	1700 A	**HDA26150( )**	**HGA26150( )**	**HJA26150( )**	**HLA26150( )**
H-Frame, 150 A, Three-Pole, 600 Vac 50/60Hz, 250 Vdc						
15 A	350 A	750 A	**HDA36015**	**HGA36015**	**HJA36015**	**HLA36015**
20 A	350 A	750 A	**HDA36020**	**HGA36020**	**HJA36020**	**HLA36020**
25 A	350 A	750 A	**HDA36025**	**HGA36025**	**HJA36025**	**HLA36025**
30 A	350 A	750 A	**HDA36030**	**HGA36030**	**HJA36030**	**HLA36030**
35 A	400 A	850 A	**HDA36035**	**HGA36035**	**HJA36035**	**HLA36035**
40 A	400 A	850 A	**HDA36040**	**HGA36040**	**HJA36040**	**HLA36040**
45 A	400 A	850 A	**HDA36045**	**HGA36045**	**HJA36045**	**HLA36045**
50 A	400 A	850 A	**HDA36050**	**HGA36050**	**HJA36050**	**HLA36050**
60 A	800 A	1450 A	**HDA36060**	**HGA36060**	**HJA36060**	**HLA36060**
70 A	800 A	1450 A	**HDA36070**	**HGA36070**	**HJA36070**	**HLA36070**
80 A	800 A	1450 A	**HDA36080**	**HGA36080**	**HJA36080**	**HLA36080**
90 A	800 A	1450 A	**HDA36090**	**HGA36090**	**HJA36090**	**HLA36090**
100 A	900 A	1700 A	**HDA36100**	**HGA36100**	**HJA36100**	**HLA36100**
110 A	900 A	1700 A	**HDA36110**	**HGA36110**	**HJA36110**	**HLA36110**
125 A	900 A	1700 A	**HDA36125**	**HGA36125**	**HJA36125**	**HLA36125**
150 A	900 A	1700 A	**HDA36150**	**HGA36150**	**HJA36150**	**HLA36150**

1 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.
2 No 100% I-Line available.
3 () Indicates phasing. See “Catalog Numbering” on page 8.
4 UL Listed/CSA Certified as current-limiting circuit breakers.

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Table 23: PowerPact J-Frame 250A I-Line Thermal-Magnetic Circuit Breakers with Factory Sealed Trip Unit (Suitable for Reverse Connection)[1]

Current Rating a 104°F (40°C)	Adjustable AC Magnetic Trip		Interrupting Rating[2] Standard (80%) Rated				
	Hold	Trip	D	G	J[3]	L[3]	R[3]
J-Frame, 250 A, Two-Pole, 600 Vac 50/60Hz, 250 Vdc							
150 A[4]	750 A	1500 A	**JDA26150( )**	**JGA26150( )**	**JJA26150( )**	—	—
175 A[4]	875 A	1750 A	**JDA26175( )**	**JGA26175( )**	**JJA26175( )**	—	—
200 A[5]	1000 A	2000 A	**JDA26200( )**	**JGA26200( )**	**JJA26200( )**	—	—
225 A[5]	1125 A	2250 A	**JDA26225( )**	**JGA26225( )**	**JJA26225( )**	—	—
250 A[5]	1250 A	2500 A	**JDA26250( )**	**JGA26250( )**	**JJA26250( )**	—	—
J-Frame, 250 A, Three-Pole, 600 Vac 50/60Hz, 250 Vdc							
150 A[4]	750 A	1500 A	**JDA36150**	**JGA36150**	**JJA36150**	**JLA36150**	**JRA36150**
175 A[4]	875 A	1750 A	**JDA36175**	**JGA36175**	**JJA36175**	**JLA36175**	**JRA36175**
200 A[5]	1000 A	2000 A	**JDA36200**	**JGA36200**	**JJA36200**	**JLA36200**	**JRA36200**
225 A[5]	1125 A	2250 A	**JDA36225**	**JGA36225**	**JJA36225**	**JLA36225**	**JRA36225**
250 A[5]	1250 A	2500 A	**JDA36250**	**JGA36250**	**JJA36250**	**JLA36250**	**JRA36250**

1 No 100% I-Line available.
2 () Indicates phasing. See “Catalog Numbering” on page 8.
3 UL Listed/CSA Certified as current-limiting.
4 Standard lug kit: AL175JD. Terminal wire range: 4–4/0 AWG Al or Cu.
5 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.

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Table 24: H-Frame 150 A and J-Frame 250 A I-Line Standard (80%) Rated Electronic Trip UL Rated Circuit Breakers (Three-Pole, 600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection [1]

Electronic Trip Unit			Sensor Rating	Interrupting Rating				
Type	Function	Trip Unit		D	G	J[2]	L[2]	R[2]
Standard	LI	3.2[3]	60 A[4]	HDA36060U31X	HGA36060U31X	HJA36060U31X	HLA36060U31X	HRA36060U31X
			100 A[4]	HDA36100U31X	HGA36100U31X	HJA36100U31X	HLA36100U31X	HRA36100U31X
			150 A[4]	HDA36150U31X	HGA36150U31X	HJA36150U31X	HLA36150U31	HRA36150U31X
			250 A[3, 5]	JDA36250U31X	JGA36250U31X	JJA36250U31X	JLA36250U31X	JRA36250U31X
Standard	LSI	3.2S[3]	60 A[4]	HDA36060U33X	HGA36060U33X	HJA36060U33X	HLA36060U33X	HRA36060U33X
			100 A[4]	HDA36100U33X	HGA36100U33X	HJA36100U33X	HLA36100U33X	HRA36100U33X
			150 A[4]	HDA36150U33X	HGA36150U33X	HJA36150U33X	HLA36150U33X	HRA36150U33X
			250 A[3, 5]	JDA36250U33X	JGA36250U33X	JJA36250U33X	JLA36250U33X	JRA36250U33X
Ammeter	LSI	5.2A	60 A[4]	HDA36060U43X	HGA36060U43X	HJA36060U43X	HLA36060U43X	HRA36060U43X
			100 A[4]	HDA36100U43X	HGA36100U43X	HJA36100U43X	HLA36100U43X	HRA36100U43X
			150 A[4]	HDA36150U43X	HGA36150U43X	HJA36150U43X	HLA36150U43X	HRA36150U43X
			250 A[3, 5]	JDA36250U43X	JGA36250U43X	JJA36250U43X	JLA36250U43X	JRA36250U43X
Energy	LSI	5.2E	60 A[4]	HDA36060U53X	HGA36060U53X	HJA36060U53X	HLA36060U53X	HRA36060U53X
			100 A[4]	HDA36100U53X	HGA36100U53X	HJA36100U53X	HLA36100U53X	HRA36100U53X
			150 A[4]	HDA36150U53X	HGA36150U53X	HJA36150U53X	HLA36150U53X	HRA36150U53X
			250 A[3, 5]	JDA36250U53X	JGA36250U53X	JJA36250U53X	JLA36250U53X	JRA36250U53X
Ammeter	LSIG	6.2A[6]	60 A[4]	HDA36060U44X	HGA36060U44X	HJA36060U44X	HLA36060U44X	HRA36060U44X
			100 A[4]	HDA36100U44X	HGA36100U44X	HJA36100U44X	HLA36100U44X	HRA36100U44X
			150 A[4]	HDA36150U44X	HGA36150U44X	HJA36150U44X	HLA36150U44X	HRA36150U44X
			250 A[3, 5]	JDA36250U44X	JGA36250U44X	JJA36250U44X	JLA36250U44X	JRA36250U44X
Energy	LSIG	6.2E	60 A[4]	HDA36060U54X	HGA36060U54X	HJA36060U54X	HLA36060U54X	HRA36060U54X
			100 A[4]	HDA36100U54X	HGA36100U54X	HJA36100U54X	HLA36100U54X	HRA36100U54X
			150 A[4]	HDA36150U54X	HGA36150U54X	HJA36150U54X(	HLA36150U54X	HRA36150U54X
			250 A[3, 5]	JDA36250U54X	JGA36250U54X	JJA36250U54X	JLA36250U54X	JRA36250U54X

1 No 100% I-Line available.

2 UL Listed/CSA Certified as current-limiting circuit breakers.

3 Three-pole circuit breakers with this trip unit can be used for two-pole applications.

4 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.

5 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.
For smaller wire range (4–4/0 AWG Al or Cu), replace the lug's wire binding screws with the larger binding screws provided.

6 Three-pole circuit breakers with this trip unit can be used for two-pole applications in order to have ground fault protection. Additional metering capabilities will not work properly on the unconnected phase.

Table 25: J-Frame 250 A Mission Critical I-Line Standard (80%) Rated Electronic Trip UL Rated Circuit Breakers (Three-Pole, 480Y/277 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating[1].			
Type	Function	Trip Unit		D	G	J	L
Standard	LI	3.2-W	250 A	JDA34250WU31X	JGA34250WU31X	JJA34250WU31X	JLA34250WU31X
Standard	LSI	3.2S-W	250 A	JDA34250WU33X	JGA34250WU33X	JJA34250WU33X	JLA34250WU33X
Ammeter	LSI	5.2A-W	250 A	JDA34250WU43X	JGA34250WU43X	JJA34250WU43X	JLA34250WU43X
Energy	LSI	5.2E-W	250 A	JDA34250WU53X	JGA34250WU53X	JJA34250WU53X	JLA34250WU53X
Ammeter	LSIG	6.2A-W	250 A	JDA34250WU44X	JGA34250WU44X	JJA34250WU44X	JLA34250WU44X
Energy	LSIG	6.2E-W	250 A	JDA34250WU54X	JGA34250WU54X	JJA34250WU54X	JLA34250WU54X

1 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.
For smaller wire range (4–4/0 AWG Al or Cu), replace the lug's wire binding screws with the larger binding screws provided.

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Circuit Breakers with Field-Interchangeable Trip Units Catalog Numbers

Table 26: H-Frame 150 A Circuit Breaker Frame[1] with Field-Interchangeable Thermal-Magnetic Trip Units[2] (Three-Pole, 600 Vac, 250 Vdc)

Ampere Rating	Fixed AC Magnetic Trip		Interrupting Rating			
			D	G	J[3]	L[3]
	Hold	Trip	Cat. No.	Cat. No.	Cat. No.	Cat. No.
15 A	350 A	750 A	**HDL36015T[4]**	**HGL36015T**	**HJL36015T**	**HLL36015T**
20 A	350 A	750 A	**HDL36020T**	**HGL36020T**	**HJL36020T**	**HLL36020T**
25 A	350 A	750 A	**HDL36025T**	**HGL36025T**	**HJL36025T**	**HLL36025T**
30 A	350 A	750 A	**HDL36030T**	**HGL36030T**	**HJL36030T**	**HLL36030T**
35 A	400 A	850 A	**HDL36035T**	**HGL36035T**	**HJL36035T**	**HLL36035T**
40 A	400 A	850 A	**HDL36040T**	**HGL36040T**	**HJL36040T**	**HLL36040T**
45 A	400 A	850 A	**HDL36045T**	**HGL36045T**	**HJL36045T**	**HLL36045T**
50 A	400 A	850 A	**HDL36050T**	**HGL36050T**	**HJL36050T**	**HLL36050T**
60 A	800 A	1450 A	**HDL36060T**	**HGL36060T**	**HJL36060T**	**HLL36060T**
70 A	800 A	1450 A	**HDL36070T**	**HGL36070T**	**HJL36070T**	**HLL36070T**
80 A	800 A	1450 A	**HDL36080T**	**HGL36080T**	**HJL36080T**	**HLL36080T**
90 A	800 A	1450 A	**HDL36090T**	**HGL36090T**	**HJL36090T**	**HLL36090T**
100 A	900 A	1700 A	**HDL36100T**	**HGL36100T**	**HJL36100T**	**HLL36100T**
110 A	900 A	1700 A	**HDL36110T**	**HGL36110T**	**HJL36110T**	**HLL36110T**
125 A	900 A	1700 A	**HDL36125T**	**HGL36125T**	**HJL36125T**	**HLL36125T**
150 A	900 A	1700 A	**HDL36150T**	**HGL36150T**	**HJL36150T**	**HLL36150T**

1 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.
2 Circuit breakers will be labeled with Line and Load markings and are not suitable for reverse connections. Available on three-pole circuit breakers. Not allowed in I-Line, plug-in, or drawout devices. Not available in R interrupting rating.
3 UL Listed/CSA Certified as current-limiting circuit breakers.
4 For 100% rated circuit breakers replace the “T” suffix with “R.” Not available in I-Line, plug-in, or drawout constructions. Not available in R interrupting rating.

Table 27: J-Frame 250 A Circuit Breaker Frame with Field-Interchangeable Thermal-Magnetic Trip Units[1] (Three-Pole, 600 Vac, 250 Vdc)

Ampere Rating	Adjustable AC Magnetic Trip		Interrupting Rating			
			D	G	J[2]	L[3]
	Low	High	Cat. No.	Cat. No.	Cat. No.	Cat. No.
150 A[3]	750 A	1500 A	**JDL36150T[4]**	**JGL36150T**	**JJL36150T**	**JLL36150T**
175 A[3]	875 A	1750 A	**JDL36175T**	**JGL36175T**	**JJL36175T**	**JLL36175T**
200 A[5]	1000 A	2000 A	**JDL36200T**	**JGL36200T**	**JJL36200T**	**JLL36200T**
225 A[5]	1125 A	2250 A	**JDL36225T**	**JGL36225T**	**JJL36225T**	**JLL36225T**
250 A[5]	1250 A	2500 A	**JDL36250T**	**JGL36250T**	**JJL36250T**	**JLL36250T**

1 Circuit breakers will be labeled with Line and Load markings and are not suitable for reverse connections. Available on three-pole circuit breakers. Not allowed in I-Line, plug-in, or drawout devices. Not available in R interrupting rating.
2 UL Listed/CSA Certified as current-limiting circuit breakers.
3 Standard lug kit: AL175JD. Terminal wire range: 4–4/0 AWG Al or Cu.
4 For 100% rated circuit breakers replace the “T” suffix with “R.” Not available in I-Line, plug-in, or drawout constructions. Not available in R interrupting rating.
5 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.

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Table 28: H-Frame 150 A and J-Frame 250 A Three-Pole Circuit Breakers with Lugs and Field-Interchangeable Electronic Trip Units[1], [2] (Standard (80%) Rated, 600 Vac, 50/60 Hz)

Electronic Trip Unit			Sensor Size	Interrupting Rating			
Type	Function	Trip Unit		D	G	J[3]	L[3]
Standard	LI	3.2	60 A[4]	HDL36060TU31X[5]	HGL36060TU31X	HJL36060TU31X	HLL36060TU31X
			100 A[4]	HDL36100TU31X	HGL36100TU31X	HJL36100TU31X	HLL36100TU31X
			150 A[4]	HDL36150TU31X	HGL36150TU31X	HJL36150TU31X	HLL36150TU31X
			250 A[6]	JDL36250TU31X	JGL36250TU31X	JJL36250TU31X	JLL36250TU31X
Standard	LSI	3.2S	60 A[4]	HDL36060TU33X	HGL36060TU33X	HJL36060TU33X	HLL36060TU33X
			100 A[4]	HDL36100TU33X	HGL36100TU33X	HJL36100TU33X	HLL36100TU33X
			150 A[4]	HDL36150TU33X	HGL36150TU33X	HJL36150TU33X	HLL36150TU33X
			250 A[6]	JDL36250TU33X	JGL36250TU33X	JJL36250TU33X	JLL36250TU33X
Ammeter	LSI	5.2A	60 A[4]	HDL36060TU43X	HGL36060TU43X	HJL36060TU43X	HLL36060TU43X
			100 A[4]	HDL36100TU43X	HGL36100TU43X	HJL36100TU43X	HLL36100TU43X
			150 A[4]	HDL36150TU43X	HGL36150TU43X	HJL36150TU43X	HLL36150TU43X
			250 A[6]	JDL36250TU43X	JGL36250TU43X	JJL36250TU43X	JLL36250TU43X
Energy	LSI	5.2E	60 A[4]	HDL36060TU53X	HGL36060TU53X	HJL36060TU53X	HLL36060TU53X
			100 A[4]	HDL36100TU53X	HGL36100TU53X	HJL36100TU53X	HLL36100TU53X
			150 A[4]	HDL36150TU53X	HGL36150TU53X	HJL36150TU53X	HLL36150TU53X
			250 A[6]	JDL36250TU53X	JGL36250TU53X	JJL36250TU53X	JLL36250TU53X
Ammeter	LSIG	6.2A	60 A[4]	HDL36060TU44X	HGL36060TU44X	HJL36060TU44X	HLL36060TU44X
			100 A[4]	HDL36100TU44X	HGL36100TU44X	HJL36100TU44X	HLL36100TU44X
			150 A[4]	HDL36150TU44X	HGL36150TU44X	HJL36150TU44X	HLL36150TU44X
			250 A[6]	JDL36250TU44X	JGL36250TU44X	JJL36250TU44X	JLL36250TU44X
Energy	LSIG	6.2E	60 A[4]	HDL36060TU54X	HGL36060TU54X	HJL36060TU54X	HLL36060TU54X
			100 A[4]	HDL36100TU54X	HGL36100TU54X	HJL36100TU54X	HLL36100TU54X
			150 A[4]	HDL36150TU54X	HGL36150TU54X	HJL36150TU54X	HLL36150TU54X
			250 A[6]	JDL36250TU54X	JGL36250TU54X	JJL36250TU54X	JLL36250TU54X

1 Circuit breakers will be labeled with Line and Load markings and are not suitable for reverse connections.
2 Available on three-pole circuit breakers. Not allowed in I-Line devices. Not available in R interrupting ratings.
3 UL Listed/CSA Certified as current-limiting circuit breakers.
4 Standard lug kit: AL150HD. Terminal wire range: 14–3/0 AWG Al or Cu.
5 For 100% rated circuit breakers replace the "T" suffix with "R." Not available in I-Line, plug-in, or drawout constructions. Not available in R interrupting rating.
6 Standard lug kit: AL250JD. Terminal wire range: 3/0 AWG–350 kcmil Al or Cu.
For smaller wire range (4–4/0 AWG Al or Cu), replace the lug's wire binding screws with the larger binding screws provided.

H-Frame Trip Unit

Table 29: H-Frame and J-Frame Three-Pole Field-Installable Thermal-Magnetic Trip Units

15–60 A H-Frame		70–150 A H-Frame		150–250 A J-Frame	
Amperage	Cat. No.	Amperage	Cat. No.	Amperage	Cat. No.
15 A	HT3015	70 A	HT3070	150 A	JT3150
20 A	HT3020	80 A	HT3080	175 A	JT3175
25 A	HT3025	90 A	HT3090	200 A	JT3200
30 A	HT3030	100 A	HT3100	225 A	JT3225
35 A	HT3035	110 A	HT3110	250 A	JT3250
40 A	HT3040	125 A	HT3125	—	—
45 A	HT3045	150 A	HT3150	—	—
50 A	HT3050	—	—	—	—
60 A	HT3060	—	—	—	—

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Table 30: H-Frame and J-Frame Three-Pole Field-Installable Micrologic Electronic Trip Units[1]

Electronic Trip Unit			Ampere Settings	Trip Unit Cat. No.
Type	Function	Trip Unit		
Standard	LI	3.2	15-20-25-30-35-40-45-50-60	HE3060U31X
			35-40-45-50-60-70-80-90-100	HE3100U31X
			50-60-70-80-90-100-110-125-150	HE3150U31X
			70-80-100-125-150-175-200-225-250	JE3250U31X
	LSI	3.2S	15-20-25-30-35-40-45-50-60	HE3060U33X
			35-40-45-50-60-70-80-90-100	HE3100U33X
			50-60-70-80-90-100-110-125-150	HE3150U33X
			70-80-100-125-150-175-200-225-250	JE3250U33X
Ammeter	LSI	5.2A	15–60	HE3060U43X
			35–100	HE3100U43X
			50–150	HE3150U43X
			70–250	JE3250U43X
	LSIG	6.2A	15–60	HE3060U44X
			35–100	HE3100U44X
			50–150	HE3150U44X
			70–250	JE3250U44X
Energy	LSI	5.2E	15–60	HE3060U53X
			35–100	HE3100U53X
			50–150	HE3150U53X
			70–250	JE3250U53X
	LSIG	6.2E	15–60	HE3060U54X
			35–100	HE3100U54X
			50–150	HE3150U54X
			70–250	JE3250U54X

1 Electronic trip units cannot be used for DC applications.

Table 31: H-Frame 150A and J-Frame 250 A Three-Pole Basic Circuit Breaker Frame Without Terminations or Trip Unit (600 Vac, 250 Vdc[1])

Circuit Breaker Frame	Ampere Rating	Interrupting Rating			
		D	G	J[2]	L[2]
		Cat. No.	Cat. No.	Cat. No.	Cat. No.
H-Frame[3]	15–60 A	HDF36000F06	HGF36000F06	HJF36000F06	HLF36000F06
	70–150 A	HDF36000F15	HGF36000F15	HJF36000F15	HLF36000F15
J-Frame	150–250 A	JDF36000F25	JGF36000F25	JJF36000F25	JLF36000F25

1 Not suitable for reverse connection.
2 UL Listed/CSA Certified as current-limiting circuit breakers.
3 Field-installed trip units must match frame ampere rating.

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L-Frame Circuit Breaker Catalog Numbers

Unit-Mount Circuit Breaker Catalog Numbers

Table 32: L-Frame 600 A Electronic Trip UL Rated Three-Pole Circuit Breakers (600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating (2nd Letter of Catalog Number)				
Type	Function	Trip Unit		D	G	J[1]	L[1]	R[1]
Standard (80%) Rated, 600 Vac, 50/60 Hz								
Standard	LI	3.3[2]	250 A[3]	LDL36250U31X	LGL36250U31X	LJL36250U31X	LLL36250U31X	LRL36250U31X
			400 A[4]	LDL36400U31X	LGL36400U31X	LJL36400U31X	LLL36400U31X	LRL36400U31X
			600 A[4]	LDL36600U31X	LGL36600U31X	LJL36600U31X	LLL36600U31X	LRL36600U31X
Standard	LSI	3.3S[2]	250 A[3]	LDL36250U33X	LGL36250U33X	LJL36250U33X	LLL36250U33X	LRL36250U33X
			400 A[4]	LDL36400U33X	LGL36400U33X	LJL36400U33X	LLL36400U33X	LRL36400U33X
			600 A[4]	LDL36600U33X	LGL36600U33X	LJL36600U33X	LLL36600U33X	LRL36600U33X
Ammeter	LSI	5.3A	400 A[4]	LDL36400U43X	LGL36400U43X	LJL36400U43X	LLL36400U43X	LRL36400U43X
			600 A[4]	LDL36600U43X	LGL36600U43X	LJL36600U43X	LLL36600U43X	LRL36600U43X
Energy	LSI	5.3E	400 A[4]	LDL36400U53X	LGL36400U53X	LJL36400U53X	LLL36400U53X	LRL36400U53X
			600 A[4]	LDL36600U53X	LGL36600U53X	LJL36600U53X	LLL36600U53X	LRL36600U53X
Ammeter	LSIG	6.3A[5]	400 A[4]	LDL36400U44X	LGL36400U44X	LJL36400U44X	LLL36400U44X	LRL36400U44X
			600 A[4]	LDL36600U44X	LGL36600U44X	LJL36600U44X	LLL36600U44X	LRL36600U44X
Energy	LSIG	6.3E	400 A[4]	LDL36400U54X	LGL36400U54X	LJL36400U54X	LLL36400U54X	LRL36400U54X
			600 A[4]	LDL36600U54X	LGL36600U54X	LJL36600U54X	LLL36600U54X	LRL36600U54X
100% Rated, 600 Vac, 50/60 Hz								
Standard	LI	3.3[2]	250 A[3]	LDL36250CU31X	LGL36250CU31X	LJL36250CU31X	LLL36250CU31X	LRL36250CU31X
			400 A[4]	LDL36400CU31X	LGL36400CU31X	LJL36400CU31X	LLL36400CU31X	LRL36400CU31X
Standard	LSI	3.3S[2]	250 A[3]	LDL36250CU33X	LGL36250CU33X	LJL36250CU33X	LLL36250CU33X	LRL36250CU33X
			400 A[4]	LDL36400CU33X	LGL36400CU33X	LJL3640C0U33X	LLL36400CU33X	LRL36400CU33X
Ammeter	LSI	5.3A	400 A[4]	LDL36400CU43X	LGL36400CU43X	LJL36400CU43X	LLL36400CU43X	LRL36400CU43X
Energy	LSI	5.3E	400 A[4]	LDL36400CU53X	LGL36400CU53X	LJL36400CU53X	LLL36400CU53X	LRL36400CU53X
Ammeter	LSIG	6.3A[5]	400 A[4]	LDL36400CU44X	LGL36400CU44X	LJL36400CU44X	LLL36400CU44X	LRL36400CU44X
Energy	LSIG	6.3E	400 A[4]	LDL36400CU54X	LGL36400CU54X	LJL36400CU54X	LLL36400CU54X	LRL36400CU54X

1 UL Listed/CSA Certified as current-limiting circuit breakers.

2 Three-pole circuit breakers with this trip unit can be used for two-pole applications.

3 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.

4 Standard lug kit: AL600LS52K3. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.

5 Three-pole circuit breakers with this trip unit can be used for two-pole applications in order to have ground fault protection. Additional metering capabilities will not work properly on the unconnected phase.

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Table 33: L-Frame 600 A Mission Critical Standard (100%[1]) Rated Electronic Trip UL Rated Three-Pole Circuit Breakers (480Y/277 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating (2nd Letter of Catalog Number)			
Type	Function	Trip Unit		D	G	J	L
Standard	LI	3.3-W	250 A[2]	LDL34250WU31X	LGL34250WU31X	LJL34250WU31X	LLL34250WU31X
			400 A[3]	LDL34400WU31X	LGL34400WU31X	LJL34400WU31X	LLL34400WU31X
			600 A[3]	LDL34600WU31X	LGL34600WU31X	LJL34600WU31X	LLL34600WU31X
Standard	LSI	3.3S-W	250 A[2]	LDL34250WU33X	LGL34250WU33X	LJL34250WU33X	LLL34250WU33X
			400 A[3]	LDL34400WU33X	LGL34400WU33X	LJL34400WU33X	LLL34400WU33X
			600 A[3]	LDL34600WU33X	LGL34600WU33X	LJL34600WU33X	LLL34600WU33X
Ammeter	LSI	5.3A-W	400 A[3]	LDL34400WU43X	LGL34400WU43X	LJL34400WU43X	LLL34400WU43X
			600 A[3]	LDL34600WU43X	LGL34600WU43X	LJL34600WU43X	LLL34600WU43X
Energy	LSI	5.3E-W	400 A[3]	LDL34400WU53X	LGL34400WU53X	LJL34400WU53X	LLL34400WU53X
			600 A[3]	LDL34600WU53X	LGL34600WU53X	LJL34600WU53X	LLL34600WU53X
Ammeter	LSIG	6.3A-W	400 A[3]	LDL34400WU44X	LGL34400WU44X	LJL34400WU44X	LLL34400WU44X
			600 A[3]	LDL34600WU44X	LGL34600WU44X	LJL34600WU44X	LLL34600WU44X
Energy	LSIG	6.3E-W	400 A[3]	LDL34400WU54X	LGL34400WU54X	LJL34400WU54X	LLL34400WU54X
			600 A[3]	LDL34600WU54X	LGL34600WU54X	LJL34600WU54X	LLL34600WU54X

1 Standard rating is 100% for 250 and 400 A only. Standard rating is 80% for 600 A.
2 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
3 Standard lug kit: AL600LS52K3. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.

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Table 34: L-Frame 600 A Electronic Trip UL Rated Four-Pole Circuit Breakers (600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating (2nd Letter of Catalog Number)				
Type	Function	Trip Unit		D	G	J[1]	L[1]	R[1]
Standard (80%) Rated, 600 Vac, 50/60 Hz								
Standard	LI	3.3	250 A[2]	LDL46250U31X	LGL46250U31X	LJL46250U31X	LLL46250U31X	LRL46250U31X
			400 A[3]	LDL46400U31X	LGL46400U31X	LJL46400U31X	LLL46400U31X	LRL46400U31X
			600 A[3]	LDL46600U31X	LGL46600U31X	LJL46600U31X	LLL46600U31X	LRL46600U31X
Standard	LSI	3.3S	250 A[2]	LDL46250U33X	LGL46250U33X	LJL46250U33X	LLL46250U33X	LRL46250U33X
			400 A[3]	LDL46400U33X	LGL46400U33X	LJL46400U33X	LLL46400U33X	LRL46400U33X
			600 A[3]	LDL46600U33X	LGL46600U33X	LJL46600U33X	LLL46600U33X	LRL46600U33X
Ammeter	LSI	5.3A	400 A[3]	LDL46400U43X	LGL46400U43X	LJL46400U43X	LLL46400U43X	LRL46400U43X
			600 A[3]	LDL46600U43X	LGL46600U43X	LJL46600U43X	LLL46600U43X	LRL46600U43X
Energy	LSI	5.3E	400 A[3]	LDL46400U53X	LGL46400U53X	LJL46400U53X	LLL46400U53X	LRL46400U53X
			600 A[3]	LDL46600U53X	LGL46600U53X	LJL46600U53X	LLL46600U53X	LRL46600U53X
Ammeter	LSIG	6.3A	400 A[3]	LDL46400U44X	LGL46400U44X	LJL46400U44X	LLL46400U44X	LRL46400U44X
			600 A[3]	LDL46600U44X	LGL46600U44X	LJL46600U44X	LLL46600U44X	LRL46600U44X
Energy	LSIG	6.3E	400 A[3]	LDL46400U54X	LGL46400U54X	LJL46400U54X	LLL46400U54X	LRL46400U54X
			600 A[3]	LDL46600U54X	LGL46600U54X	LJL46600U54X	LLL46600U54X	LRL46600U54X
100% Rated, 600 Vac, 50/60 Hz								
Standard	LI	3.3	250 A[2]	LDL46250CU31X	LGL46250CU31X	LJL46250CU31X	LLL46250CU31X	LRL46250CU31X
			400 A[3]	LDL46400CU31X	LGL46400CU31X	LJL46400CU31X	LLL46400CU31X	LRL46400CU31X
Standard	LSI	3.3S	250 A[2]	LDL46250CU33X	LGL46250CU33X	LJL46250CU33X	LLL46250CU33X	LRL46250CU33X
			400 A[3]	LDL46400CU33X	LGL46400CU33X	LJL46400CU33X	LLL46400CU33X	LRL46400CU33X
Ammeter	LSI	5.3A	400 A[3]	LDL46400CU43X	LGL46400CU43X	LJL46400CU43X	LLL46400CU43X	LRL46400CU43X
Energy	LSI	5.3E	400 A[3]	LDL46400CU53X	LGL46400CU53X	LJL46400CU53X	LLL46400CU53X	LRL46400CU53X
Ammeter	LSIG	6.3A	400 A[3]	LDL46400CU44X	LGL46400CU44X	LJL46400CU44X	LLL46400CU44X	LRL46400CU44X
Energy	LSIG	6.3E	400 A[3]	LDL46400CU54X	LGL46400CU54X	LJL46400CU54X	LLL46400CU54X	LRL46400CU54X

1 UL Listed/CSA Certified as current-limiting circuit breakers.
2 Standard lug kit: AL400L61K4. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
3 Standard lug kit: AL600LS52K4. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.

Table 35: L-Frame 600 A Mission Critical Standard (80%) Rated Electronic Trip UL Rated Four-Pole Circuit Breakers (480Y/277 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating (2nd Letter of Catalog Number)			
Type	Function	Trip Unit		D	G	J	L
Standard	LI	3.3-W	250 A[1]	LDL44250WU31X	LGL44250WU31X	LJL44250WU31X	LLL44250WU31X
			400 A[2]	LDL44400WU31X	LGL44400WU31X	LJL44400WU31X	LLL44400WU31X
			600 A[2]	LDL44600WU31X	LGL44600WU31X	LJL44600WU31X	LLL44600WU31X
Standard	LSI	3.3S-W	250 A[1]	LDL44250WU33X	LGL44250WU33X	LJL44250WU33X	LLL44250WU33X
			400 A[2]	LDL44400WU33X	LGL44400WU33X	LJL44400WU33X	LLL44400WU33X
			600 A[2]	LDL44600WU33X	LGL44600WU33X	LJL44600WU33X	LLL44600WU33X
Ammeter	LSI	5.3A-W	400 A[2]	LDL44400WU43X	LGL44400WU43X	LJL44400WU43X	LLL44400WU43X
			600 A[2]	LDL44600WU43X	LGL44600WU43X	LJL44600WU43X	LLL44600WU43X
Energy	LSI	5.3E-W	400 A[2]	LDL44400WU53X	LGL44400WU53X	LJL44400WU53X	LLL44400WU53X
			600 A[2]	LDL44600WU53X	LGL44600WU53X	LJL44600WU53X	LLL44600WU53X
Ammeter	LSIG	6.3A-W	400 A[2]	LDL44400WU44X	LGL44400WU44X	LJL44400WU44X	LLL44400WU44X
			600 A[2]	LDL44600WU44X	LGL44600WU44X	LJL44600WU44X	LLL44600WU44X
Energy	LSIG	6.3E-W	400 A[2]	LDL44400WU54X	LGL44400WU54X	LJL44400WU54X	LLL44400WU54X
			600 A[2]	LDL44600WU54X	LGL44600WU54X	LJL44600WU54X	LLL44600WU54X

1 Standard lug kit: AL400L61K4. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
2 Standard lug kit: AL600LS52K4. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.

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I-Line Circuit Breaker Catalog Numbers

Table 36: L-Frame 600 A I-Line Standard (80%) Rated Electronic Trip UL Rated Circuit Breakers (600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating				
Type	Function	Trip Unit		D	G	J [1]	L[3]	R[3]
Standard	LI	3.3[2]	250 A[3]	LDA36250U31X	LGA36250U31X	LJA36250U31X	LLA36250U31X	LRA36250U31X
			400 A[4]	LDA36400U31X	LGA36400U31X	LJA36400U31X	LLA36400U31X	LRA36400U31X
			600 A[4]	LDA36600U31X	LGA36600U31X	LJA36600U31X	LLA36600U31X	LRA36600U31X
Standard	LSI	3.3S[2]	250 A[3]	LDA36250U33X	LGA36250U33X	LJA36250U33X	LLA36250U33X	LRA36250U33X
			400 A[4]	LDA36400U33X	LGA36400U33X	LJA36400U33X	LLA36400U33X	LRA36400U33X
			600 A[4]	LDA36600U33X	LGA36600U33X	LJA36600U33X	LLA36600U33X	LRA36600U33X
Ammeter	LSI	5.3A	400 A[44]	LDA36400U43X	LGA36400U43X	LJA36400U43X	LLA36400U43X	LRA36400U43X
			600 A[4]	LDA36600U43X	LGA36600U43X	LJA36600U43X	LLA36600U43X	LRA36600U43X
Energy	LSI	5.3E	400 A[4]	LDA36400U53X	LGA36400U53X	LJA36400U53X	LLA36400U53X	LRA36400U53X
			600 A[4]	LDA36600U53X	LGA36600U53X	LJA36600U53X	LLA36600U53X	LRA36600U53X
Ammeter	LSIG	6.3A[5]	400 A[4]	LDA36400U44X	LGA36400U44X	LJA36400U44X	LLA36400U44X	LRA36400U44X
			600 A[4]	LDA36600U44X	LGA36600U44X	LJA36600U44X	LLA36600U44X	LRA36600U44X
Energy	LSIG	6.3E	400 A[4]	LDA36400U54X	LGA36400U54X	LJA36400U54X	LLA36400U54X	LRA36400U54X
			600 A[4]	LDA36600U54X	LGA36600U54X	LJA36600U54X	LLA36600U54X	LRA36600U54X

1 UL Listed/CSA Certified as current-limiting circuit breakers.
2 Three-pole circuit breakers with this trip unit can be used for two-pole applications.
3 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
4 Standard lug kit: AL600LF52K3. Terminal wire range: (2) 3/0 AWG–500 kcmil Al/Cu. Type of terminal shield: short.
5 Three-pole circuit breakers with this trip unit can be used for two-pole applications in order to have ground fault protection. Additional metering capabilities will not work properly on the unconnected phase.

Table 37: L-Frame 600 A Mission Critical I-Line Standard (80%) Rated Electronic Trip UL Rated Circuit Breakers (480/277 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating			
Type	Function	Trip Unit		D	G	J	L
Standard	LI	3.3-W	250 A[1]	LDA34250WU31X	LGA34250WU31X	LJA34250WU31X	LLA34250WU31X
			400 A[2]	LDA34400WU31X	LGA34400WU31X	LJA34400WU31X	LLA34400WU31X
			600 A[2]	LDA34600WU31X	LGA34600WU31X	LJA34600WU31X	LLA34600WU31X
Standard	LSI	3.3S-W	250 A[1]	LDA34250WU33X	LGA34250WU33X	LJA34250WU33X	LLA34250WU33X
			400 A[2]	LDA34400WU33X	LGA34400WU33X	LJA34400WU33X	LLA34400WU33X
			600 A[2]	LDA34600WU33X	LGA34600WU33X	LJA34600WU33X	LLA34600WU33X
Ammeter	LSI	5.3A-W	400 A[2]	LDA34400WU43X	LGA34400WU43X	LJA34400WU43X	LLA34400WU43X
			600 A[2]	LDA34600WU43X	LGA34600WU43X	LJA34600WU43X	LLA34600WU43X
Energy	LSI	5.3E-W	400 A[2]	LDA34400WU53X	LGA34400WU53X	LJA34400WU53X	LLA34400WU53X
			600 A[2]	LDA34600WU53X	LGA34600WU53X	LJA34600WU53X	LLA34600WU53X
Ammeter	LSIG	6.3A-W	400 A[2]	LDA34400WU44X	LGA34400WU44X	LJA34400WU44X	LLA34400WU44X
			600 A[2]	LDA34600WU44X	LGA34600WU44X	LJA34600WU44X	LLA34600WU44X
Energy	LSIG	6.3E-W	400 A[2]	LDA34400WU54X	LGA34400WU54X	LJA34400WU54X	LLA34400WU54X
			600 A[2]	LDA34600WU54X	LGA34600WU54X	LJA34600WU54X	LLA34600WU54X

1 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
2 Standard lug kit: AL600LS52K3. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.

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Table 38: L-Frame 250 A and 400 A I-Line 100% Rated Electronic Trip UL Rated Circuit Breakers (600 Vac, 50/60 Hz) With Factory Sealed Trip Unit Suitable for Reverse Connection

Electronic Trip Unit			Sensor Rating	Interrupting Rating				
Type	Function	Trip Unit		D	G	J [1]	L[3]	R[3]
Standard	LI	3.3[2]	250 A[3]	LDA36250CU31X	LGA36250CU31X	LJA36250CU31X	LLA36250CU31X	LRA36250CU31X
			400 A[4]	LDA36400CU31X	LGA36400CU31X	LJA36400CU31X	LLA36400CU31X	LRA36400CU31X
Standard	LSI	3.3S[2]	250 A[3]	LDA36250CU33X	LGA36250CU33X	LJA36250CU33X	LLA36250CU33X	LRA36250CU33X
			400 A[4]	LDA36400CU33X	LGA36400CU33X	LJA36400CU33X	LLA36400CU33X	LRA36400CU33X
Ammeter	LSI	5.3A	400 A[4]	LDA36400CU43X	LGA36400CU43X	LJA36400CU43X	LLA36400CU43X	LRA36400CU43X
Energy	LSI	5.3E	400 A[4]	LDA36400CU53X	LGA36400CU53X	LJA36400CU53X	LLA36400CU53X	LRA36400CU53X
Ammeter	LSIG	6.3A[5]	400 A[4]	LDA36400CU44X	LGA36400CU44X	LJA36400CU44X	LLA36400CU44X	LRA36400CU44X
Energy	LSIG	6.3E	400 A[4]	LDA36400CU54X	LGA36400CU54X	LJA36400CU54X	LLA36400CU54X	LRA36400CU54X

1 UL Listed/CSA Certified as current-limiting circuit breakers.
2 Three-pole circuit breakers with this trip unit can be used for two-pole applications.
3 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
4 Standard lug kit: AL600LS52K3. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.
5 Three-pole circuit breakers with this trip unit can be used for two-pole applications in order to have ground fault protection. Additional metering capabilities will not work properly on the unconnected phase.

Circuit Breakers with Field-Interchangeable Trip Units Catalog Numbers

Table 39: L-Frame 3 Pole, 600 A Circuit Breakers with Lugs and Field-Interchangeable Electronic Trip Units (600 Vac, 50/60 Hz)[1, 2]

Electronic Trip Unit			Sensor Rating	Interrupting Rating			
Type	Function	Trip Unit		D	G	J [3]	L[3]
Standard (80% Rated), 600 Vac, 50/60 Hz							
Standard	LI	3.3	250 A[4]	LDL36250TU31X	LGL36250TU31X	LJL36250TU31X	LLL36250TU31X
			400 A[5] 600 A[5]	LDL36400TU31X LDL36600TU31X	LGL36400TU31X LGL36600TU31X	LJL36400TU31X LJL36600TU31X	LLL36400TU31X LLL36600TU31X
Standard	LSI	3.3S	250 A[4]	LDL36250TU33X	LGL36250TU33X	LJL36250TU33X	LLL36250TU33X
			400 A[5] 600 A[5]	LDL36400TU33X LDL36600TU33X	LGL36400TU33X LGL36600TU33X	LJL36400TU33X LJL36600TU33X	LLL36400TU33X LLL36600TU33X
Ammeter	LSI	5.3A	400 A[5] 600 A[5]	LDL36400TU43X LDL36600TU43X	LGL36400TU43X LGL36600TU43X	LJL36400TU43X LJL36600TU43X	LLL36400TU43X LLL36600TU43X
Energy	LSI	5.3E	400 A[5] 600 A[5]	LDL36400TU53X LDL36600TU53X	LGL36400TU53X LGL36600TU53X	LJL36400TU53X LJL36600TU53X	LLL36400TU53X LLL36600TU53X
Ammeter	LSIG	6.3A	400 A[5] 600 A[5]	LDL36400TU44X LDL36600TU44X	LGL36400TU44X LGL36600TU44X	LJL36400TU44X LJL36600TU44X	LLL36400TU44X LLL36600TU44X
Energy	LSIG	6.3E	400 A[5] 600 A[5]	LDL36400TU54X LDL36600TU54X	LGL36400TU54X LGL36600TU54X	LJL36400TU54X LJL36600TU54X	LLL36400TU54X LLL36600TU54X
100% Rated, 600 Vac, 50/60 Hz[6]							
Standard	LI	3.3	250 A[4]	LDL36250RU31X	LGL36250RU31X	LJL36250RU31X	LLL36250RU31X
			400 A[5]	LDL36400RU31X	LGL36400RU31X	LJL36400RU31X	LLL36400RU31X
Standard	LSI	3.3S	250 A[4]	LDL36250RU33X	LGL36250RU33X	LJL36250RU33X	LLL36250RU33X
			400 A[5]	LDL36400RU33X	LGL36400RU33X	LJL36400RU33X	LLL36400RU33X
Ammeter	LSI	5.3A	400 A[5]	LDL36400RU43X	LGL36400RU43X	LJL36400RU43X	LLL36400RU43X
Energy	LSI	5.3E	400 A[5]	LDL36400RU53X	LGL36400RU53X	LJL36400RU53X	LLL36400RU53X
Ammeter	LSIG	6.3A	400 A[5]	LDL36400RU44X	LGL36400RU44X	LJL36400RU44X	LLL36400RU44X
Energy	LSIG	6.3E	400 A[5]	LDL36400RU54X	LGL36400RU54X	LJL36400RU54X	LLL36400RU54X

1 Circuit breakers will be labeled with Line and Load markings and are not suitable for reverse connections.
2 Only available on three-pole unit-mount circuit breakers. Not available in R interrupting rating. Not available with I-Line.
3 UL Listed/CSA Certified as current-limiting circuit breakers.
4 Standard lug kit: AL400L61K3. Terminal wire range: (1) 2 AWG–600 kcmil Cu or (1) 2 AWG–500 kcmil Al. Type of terminal shield: short.
5 Standard lug kit: AL600LS52K3. Terminal wire range: (2) 2/0 AWG–500 kcmil Al/Cu. Type of terminal shield: medium.
6 Not available in I-Line, plug-in, or drawout constructions. Not available in R interrupting rating.

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Table 40: L-Frame 600 A, 3 Pole, Basic Circuit Breaker Frame Without Terminations or Trip Units (600 Vac, 50/60 Hz)[1]

Ampere Rating	Interrupting Rating			
	D	G	J [2]	L[2]
250 A (70–250 A)	**LDF36000F25**	**LGF36000F25**	**LJF36000F25**	**LLF36000F25**
400 A (125–400 A)	**LDF36000F40**	**LGF36000F40**	**LJF36000F40**	**LLF36000F40**
600 A (200–600 A)	**LDF36000F60**	**LGF36000F60**	**LJF36000F60**	**LLF36000F60**

1 Not suitable for reverse connection.

2 UL Listed/CSA Certified as current-limiting

Table 41: L-Frame Three-Pole Field-Installable Micrologic Electronic Trip Units

Electronic Trip Unit			Ampere Setting	Trip Unit Cat. No.
Type	Function	Trip Unit		
Standard	LI	3.3	70-80-100-125-150-175-200-225-250	**LE3250U31X**
			125-150-175-200-225-250-300-350-400	**LE3400U31X**
			200-225-250-300-350-400-450-500-600	**LE3600U31X**
	LSI	3.3S	70-80-100-125-150-175-200-225-250	**LE3250U33X**
			125-150-175-200-225-250-300-350-400	**LE3400U33X**
			200-225-250-300-350-400-450-500-600	**LE3600U33X**
Ammeter	LSI	5.3A	125–400	**LE3400U43X**
			200–600	**LE3600U43X**
	LSIG	6.3A	125–400	**LE3400U44X**
			200–600	**LE3600U44X**
Energy	LSI	5.3E	125–400	**LE3400U53X**
			200–600	**LE3600U53X**
	LSIG	6.3E	125–400	**LE3400U54X**
			200–600	**LE3600U54X**

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Section 4—Automatic Switches

Automatic Switch Functions

An automatic switch can be used to open and close a circuit under normal operating conditions. They are similar in construction to circuit breakers, except that the switches open instantaneously at a factory-set, non-adjustable trip point calibrated to protect only the molded case switch.

Molded case switches are intended for use as disconnect devices only. UL489 requires molded case switches to be protected by a circuit breaker or fuse of equivalent rating. Molded case switches are labeled with their appropriate withstand ratings. The withstand rating of a switch is defined as the maximum current at rated voltage that the molded case switch will withstand without damage when protected by a circuit breaker with an equal continuous current rating.

PowerPact™ H-, J-, and L-frame automatic switches are available in unit mount, I-Line™, plug-in and drawout versions. They use the same accessories and offer the same connection possibilities as the circuit-breaker versions. They may be interlocked with another switch or circuit breaker to form a source-changeover system.

Switches are Listed under UL file E103740 and Certified under CSA file LR88980.

Motor Operator

PowerPact H-, J-, and L-frame switches equipped with a motor operator module allow remote closing and opening.

Ground Fault Protection (H- and J-Frame Circuit Breakers Only)

An ELM or GFM module may be added to an automatic switch to monitor all leakage currents in the outgoing circuits of the equipment on which the automatic switch is installed. When the ELM or GFM module detects an earth-leakage current, the automatic switch interrupts the load current.

Automatic Switch Protection

The automatic switch can make and break its rated current. For an overload or a short-circuit, it must be protected by an upstream device, in compliance with installation standards. Due to their high-set instantaneous release PowerPact H-, J- and L-frame automatic switches are self-protected.

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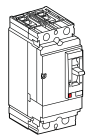
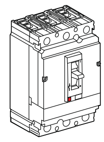
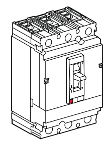
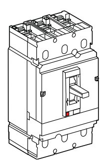
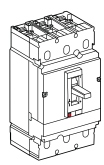
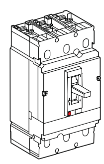
Specifications

Table 42: H-Frame Automatic Molded Case Switch Specifications

Frame			H-Frame			
Withstand Rating			“G”		“L”	
						
UL 489	Poles		Two-Pole	Three-Pole	Two-Pole[1]	Three-Pole
	Catalog Number	150 A	HGL26000S15	HGL3600S15	HLL26000S15	HLL36000S15
		175 A	—	—	—	—
		250 A	—	—	—	—
	Withstand Ratings	240 Vac	65 kA	65 kA	125 kA	125 kA
		480 Vac	35 kA	35 kA	100 kA	100 kA
		600 Vac	18 kA	18 kA	50 kA	50 kA
		250 Vdc	20 kA	20 kA	20 kA	20 kA
	AC Trip Point		2250 A	2250 A	2250 A	2250 A
IEC 60947-3	Rated Insulation Voltage		750 Vac	750 Vac	750 Vac	750 Vac
	Rated Impulse Withstand Voltage		8 kV	8 kV	8 kV	8 kV
	Rated Operational Voltage	ac	525 Vac	525 Vac	525 Vac	690 Vac
		dc	—	—	—	—

[1] Two-pole devices use a three-pole switch frame with the center pole inoperative.

Table 43: J-Frame Automatic Molded Case Switch Specifications

Frame			J-Frame				
Withstand Rating			“G”		“L”		“R”
							
UL 489	Poles		Two-Pole[1]	Three-Pole	Two-Pole[1]	Three-Pole	Three-Pole
	Catalog Number	150 A	—	—	—	—	—
		175 A	JGL26000S17	JGL36000S17	JLL26000S17	JLL36000S17	JRL36000S17
		250 A	JGL26000S25	JGL36000S25	JLL26000S25	JLL36000S25	JRL36000S25
	Withstand Ratings	240 Vac	65 kA	65 kA	125 kA	125 kA	200 kA
		480 Vac	35 kA	35 kA	100 kA	100 kA	200 kA
		600 Vac	18 kA	18 kA	50 kA	50 kA	100 kA
		250 Vdc	20 kA	20 kA	20 kA	20 kA	20 kA
	AC Trip Point		3125 A	3125 A	3125 A	3125 A	3125 A
IEC 60947-3	Rated Insulation Voltage		750 Vac	750 Vac	750 Vac	750 Vac	750 Vac
	Rated Impulse Withstand Voltage		8 kV	8 kV	8 kV	8 kV	8 kV
	Rated Operational Voltage	ac	525 Vac	525 Vac	525 Vac	525 Vac	690 Vac
		dc	500 Vdc	500 Vdc	500 Vdc	500 Vdc	500 Vdc

[1] Two-pole devices use a three-pole switch frame with the center pole inoperative.

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Catalog Numbers

Table 44: PowerPact H-Frame and J-Frame 250 A Unit-Mount Automatic Molded Case Switches, 600 Vac with Factory Sealed Trip Unit (Suitable for Reverse Connection)

Ampere Rating	2-pole Cat. No.	3-pole Cat. No.	Withstand Rating [1] 240 Vac	480 Vac	600 Vac	Trip Point	Standard Lug Kit Terminal Wire Range
G Withstand							
150 A	**HGL26000S15** [2]	**HGL36000S15**	65	35	18	2250 A	AL150HD #14–#3/0 AWG Al or Cu
175 A	**JGL26000S17**	**JGL36000S17**	65	35	18	3125 A	AL175JD #4–#4/0 AWG Al or Cu
250 A	**JGL26000S25**	**JGL36000S25**	65	35	18	3125 A	AL250JD #3/0–350 kcmil Al or Cu
L Withstand							
150 A	**HLL26000S15**	**HLL36000S15**	125	100	50	2250 A	AL150HD #14–#3/0 AWG Al or Cu
175 A	**JLL26000S17**	**JLL36000S17**	125	100	50	3125 A	AL175JD #4–#4/0 AWG Al or Cu
250 A	**JLL26000S25**	**JLL36000S25**	125	100	50	3125 A	AL250JD #3/0–350 kcmil Al or Cu
R Withstand							
175 A	—	**JRL36000S17**	200	200	100	3125 A	AL175JD #4–#4/0 AWG Al or Cu
250 A	—	**JRL36000S25**	200	200	100	3125 A	AL250JD #3/0–350 kcmil Al or Cu

1 The withstand rating is the fault current, at rated voltage, that the molded case switch will withstand without damage when protected by a circuit breaker or fuse with an equal continuous current rating.

2 Two-pole device with 3 in. (76 mm) mounting height, all other two-pole circuit breakers use three-pole switch 4.5 in. (114 mm) mounting height.

Table 45: PowerPact H-Frame and J-Frame I-Line Automatic Molded Case Switches, 600 Vac with Factory Sealed Trip Unit (Suitable for Reverse Connection)

Ampere Rating	2-pole Cat. No.	3-pole Cat. No.	Withstand Rating [1] 240 Vac	480 Vac	600 Vac	Trip Point	Standard Lug Kit Terminal Wire Range
G Withstand							
150 A	HGA26000S15( )[2]	**HGA36000S15**	65	35	18	2250A	AL150HD #14–#3/0 AWG Al or Cu
175 A	JGA26000S17( )	**JGA36000S17**	65	35	18	3125 A	AL175JD #4–#4/0 AWG Al or Cu
250 A	JGA26000S25( )	**JGA36000S25**	65	35	18	3125 A	AL250JD #3/0–350 kcmil Al or Cu
L Withstand							
150 A	HLA26000S15( )	**HLA36000S15**	125	100	50	2250 A	AL150HD #14–#3/0 AWG Al or Cu
175 A	JLA26000S17( )	**JLA36000S17**	125	100	50	3125 A	AL175JD #4–#4/0 AWG Al or Cu
250 A	JLA26000S25( )	**JLA36000S25**	125	100	50	3125 A	AL250JD #3/0–350 kcmil Al or Cu
R Withstand							
175 A	JRA26000S17( )	**JRA36000S17**	200	200	100	3125A	AL175JD #4–#4/0 AWG Al or Cu
250 A	JRA26000S25( )	**JRA36000S25**	200	200	100	3125A	AL250JD #3/0–350 kcmil Al or Cu

1 The withstand rating is the fault current, at rated voltage, that the molded case switch will withstand without damage when protected by a circuit breaker or fuse with an equal continuous current rating.

2 Two-pole device with 3 in. (76 mm) mounting height, all other two-pole circuit breakers use three-pole 4.5 in. (114 mm) mounting height.

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Table 46: PowerPact L-Frame 600 A Unit-Mount Automatic Molded Case Switches, 600 Vac

Ampere Rating	Poles[1]	Cat. No.	Withstand Rating [2] 240 Vac	480 Vac	600 Vac	Trip Point	Standard Lug Terminal Wire Range
Unit-Mount Automatic Molded Case Switches							
G Withstand							
400 A	3	**LGL36000S40X**	65 kA	35 kA	18 kA	4800 A	AL600LS52K3 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LGL36000S60X**	65 kA	35 kA	18 kA	6600 A	
400 A	4	**LGL46000S40X**	65 kA	35 kA	18 kA	4800 A	AL600LS52K4 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LGL46000S60X**	65 kA	35 kA	18 kA	6600 A	
L Withstand							
400 A	3	**LLL36000S40X**	125 kA	100 kA	50 kA	4800 A	AL600LS52K3 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LLL36000S60X**	125 kA	100 kA	50 kA	6600 A	
400 A	4	**LLL46000S40X**	125 kA	100 kA	50 kA	4800 A	AL600LS52K4 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LLL46000S60X**	125 kA	100 kA	50 kA	6600 A	
R Withstand							
400 A	3	**LRL36000S40X**	200 kA	200 kA	100 kA	4800 A	AL600LS52K3 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LRL36000S60X**	200 kA	200 kA	100 kA	6600 A	
400 A	4	**LRL46000S40X**	200 kA	200 kA	100 kA	4800 A	AL600LS52K4 (2) 2 AWG–500 kcmil Al/Cu
600 A		**LRL46000S60X**	200 kA	200 kA	100 kA	6600 A	
I-Line Circuit Breakers Automatic Molded Case Switches							
G Withstand							
400 A	3	**LGA36000S40X**	65 kA	35 kA	18 kA	4800 A	AL600LF52K3 (2) 3/0 AWG–500 kcmil Al/Cu
600 A		**LGA36000S60X**	65 kA	35 kA	18 kA	6600 A	
L Withstand							
400 A	3	**LLA36000S40X**	125 kA	100 kA	50 kA	4800 A	AL600LF52K3 (2) 3/0 AWG–500 kcmil Al/Cu
600 A		**LLA36000S60X**	125 kA	100 kA	50 kA	6600 A	
R Withstand							
400 A	3	**LRA36000S40X**	200 kA	200 kA	100 kA	4800 A	AL600LF52K3 (2) 3/0 AWG–500 kcmil Al/Cu
600 A		**LRA36000S60X**	200 kA	200 kA	100 kA	6600 A	

1 Four-pole circuit breaker available as bus connected, with lug configurations, and in plug-in, draw-out and rear-connected configurations.

2 The withstand rating is the fault current, at rated voltage, that the molded case switch will withstand without damage when protected by a circuit breaker or fuse with an equal continuous current rating.

Table 47: L-Frame Ratings and Withstand Ratings

Circuit Breaker			400 A	600 A
Number of Poles			3, 4	3, 4
Ampere Rating (A)			400	600
UL 489 Ratings				
Rated Voltage (V)			600	600
IEC 60947-3 ratings				
Rated Insulation Voltage (V)			750	750
Rated Impulse Withstand Voltage (kV)			8	8
Rated Operational Voltage	Ue	AC 50/60 Hz	690	690
Rated Operational Current	Ie	AC 525 V	400	600
Making Capacity (kA peak)			7.1	8.5
Short-Time Withstand Current (kA rms)	Icw	Icw (kA ms)	5	6
		Duration (s)	1	1

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Section 5—Motor Circuit Protection

General Information

The parameters to be considered for motor-feeder protection depend on:

- the application (type of machine driven, operating safety, frequency of operation, etc.)
- the level of continuity of service required by the load or the application
- the applicable standards for the protection of equipment.

The required electrical functions are:

- isolation
- switching, generally at high endurance levels
- protection against overloads and short-circuits, adapted to the motor
- additional special protection.

A motor branch circuit must comply with the requirements of standard UL 508 concerning contactors and their protection:

- coordination of feeder components
- overload relay trip classes.

Motor Branch Circuit Protection Function

A motor branch circuit comprises a set of devices for motor protection and control, as well as for protection of the branch circuit itself.

Switching

The purpose is to control the motor (ON / OFF), either manually, automatically or remotely, taking into account overloads upon start-up and the long service life required. This function is provided by a contactor. When the coil of the contactor's electromagnet is energized, the contactor closes and establishes, through the poles, the circuit between the upstream supply and the motor, through the circuit breaker.

Basic Protection

- Short-circuit protection
  Detection and breaking, as quickly as possible, of high short-circuit currents to avoid damage to the installation. This function is provided by a circuit breaker.
- Overload protection
  Detection of overload currents and motor shutdown before temperature rise in the motor and conductors damages insulation. This function is provided by a circuit breaker or a separate motor overload relay.
- Phase unbalance or phase loss protection
  Phase unbalance or phase loss can cause temperature rise and braking torques that can lead to premature aging of the motor. These effects are even greater during starting, therefore protection must be virtually immediate.

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Additional Electronic Protection

- Locked rotor
- Under-load
- Long starts and stalled rotor
- Insulation faults

Trip Class of a Overload Relay Device

The motor branch circuit includes thermal protection that may be built into the circuit breaker. The protection must have a trip class suited to motor starting. Depending on the application, the motor starting time varies from a few seconds (no-load start) to a few dozen seconds (high-inertia load).

Table 48: Trip Class of Overload Relays as a Function of Their FLA Setting

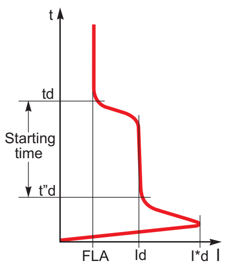
Class	1.05 FLA[1]	1.2 FLA[1]	1.5 FLA[2]	6.0 FLA[1]
5	t > 2 h	t < 2h	t < 2 mn	2 s < t ≤ 5 s
10	t > 2 h	t < 2h	t < 4 mn	4 s < t ≤ 10 s
20	t > 2 h	t < 2h	t < 8 mn	6 s < t ≤ 20 s

1 Time for a cold start (motor off and cold).

2 Time for warm start (motor running under normal conditions).

Example: In class 20, the motor must have finished starting within 20 seconds (6 to 20 s) for a starting current of 6 x FLA.

Asynchronous-Motor Starting Parameters



Typical motor-starting curve

The main parameters of direct on-line starting of three-phase asynchronous motors (90% of all applications) are listed below.

- FLA: full load amperes
  This is the current drawn by the motor at full rated load.
- Id: locked rotor current
  This is the current drawn by the motor during starting, on average 6.0 x I_n for a duration of 5 to 30 seconds depending on the application. These values determine the trip class and any additional "long-start" protection devices that may be needed.
- Id: peak starting current
  This is the subtransient current during the first two half-waves when the system is energized, on the average 14 I_n for 10 to 15 ms (e.g. 1840 A peak).

The protection settings must effectively protect the motor, notably through a suitable overload relay trip class, but let the peak starting current through.

Motor-Feeder Solutions

PowerPact™ H-, J-, and L-frame circuit breakers motor circuit breakers are designed for motor-feeder solutions using:

- three devices, including an electronic MCP or 1.3 M instantaneous-only trip unit
- two devices including a 2 M electronic trip unit.

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PowerPact H-, J-, and L-Frame with Micrologic™ Trip Units Motor-Protection Range

PowerPact H-, J-, and L-frame circuit breakers with Micrologic trip units can be used to create motor-feeder solutions comprising two or three devices. The protection devices are designed for continuous duty at 104°F (40°C).

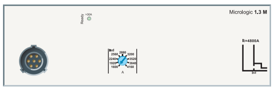
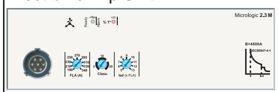
Three-device solutions

- 1 PowerPact circuit breaker with Micrologic 1.3 M trip unit
- 1 contactor
- overload relay

Two-device solutions

- 1 PowerPact circuit breaker with a Micrologic 2 M electronic trip unit.
- 1 contactor

Table 49: Motor Protection Specifications

Type of Motor Protection			**3 Devices (Circuit Breaker + Contactor + Overload Relay)**	**2 Devices (Circuit Breaker + Contactor)**
PowerPact H-, J-, or L-frame circuit breaker			PowerPact L-frame 400/600 A	PowerPact H-, J-, and L-Frame 100–600 A
	Type 2 coordination with		Contactor + overload relay	Contactor
Trip Unit	Type		Micrologic 1.3 M Electronic Trip Unit 	Micrologic 2 M Electronic Trip Unit 
Overload Relay	Separate		X	
	Built-in, Class	5		X
		10		X
		20		X
Protection functions of PowerPact H-, J-, and L-frame circuit breaker				
Short-circuits			X	X
Overloads				X
Special motor functions	Phase unbalance			X

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Electronic Motor Circuit Protectors (AC Only)

PowerPact H- and J-frame Electronic Motor Circuit Protectors (MCP) are instantaneous-trip circuit breakers. They are designed to offer short circuit protection and are National Electrical Code® (NEC®) compliant when installed as part of a combination controller having motor overload protection. MCP circuit breakers accept the same accessories and terminals as the equivalent thermal-magnetic circuit breakers. (See Section 3 for Accessories.)

The unique design of the PowerPact MCPs includes two rotary switches to allow quick setting adjustments based on the characteristics of the motor.

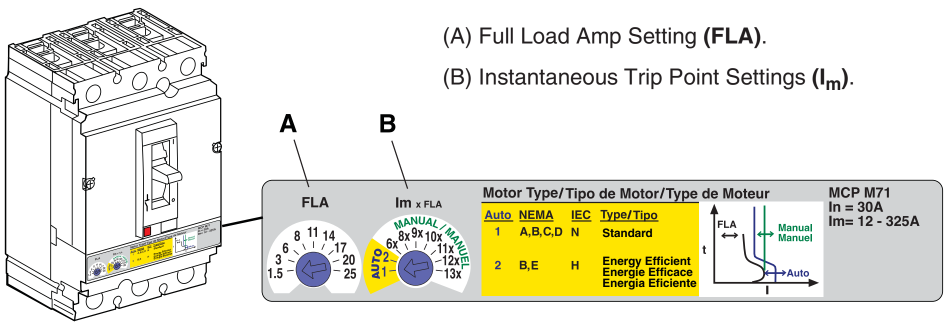
The first rotary switch allows for Full Load Amperes (FLA) adjustment across the range of the frame size.

The second rotary switch selects the type of motor protection based on Automatic 1 for Standard Efficiency or Automatic 2 for High Energy Efficient. When using the automatic settings the MCP microprocessor automatically adjusts the trip settings for both current and time to align with the start-up characteristic for the motor type, whether it is a standard or energy-efficient motor. This includes a dampening means to accommodate a transient motor in-rush current without nuisance tripping of the circuit breaker. Rotary switch 2 also allows for traditional motor protection from 8 to 13 times the selected FLA.

The MCP rotary switches are detented and allow the device to be set to specific trip values within a typical accuracy range of +/-5%.

(A) Full Load Amp Setting **(FLA)**.

(B) Instantaneous Trip Point Settings **(I_m)**.



Full Load Amp Settings

1. Determine the motor's full-load current by referring to the nameplate on the motor.
2. Set the trip range by turning the FLA rotary switch to the setting closest to the motor's full load current.

Automatic Protection Settings

The MCP microprocessor automatically adjusts the trip settings for both current and time to align with the start-up characteristics for the motor type selected. This includes a dampening means to accommodate a transient motor in-rush current without nuisance tripping of the circuit breaker.

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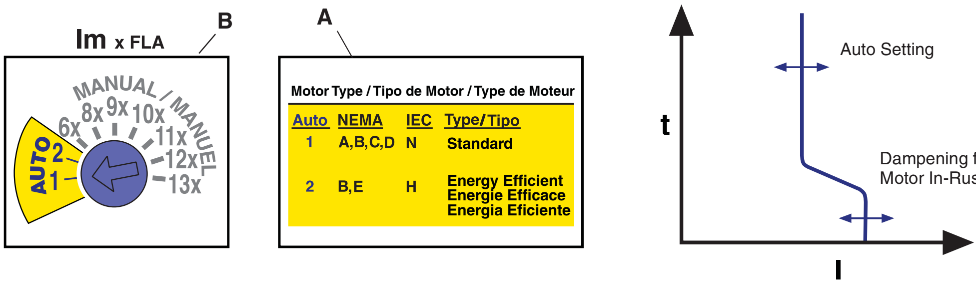
Figure 4: Automatic Protection Settings

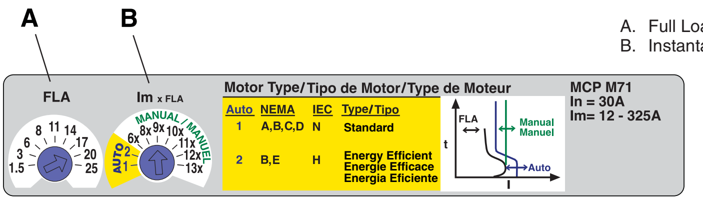


Manual Protection Settings

The manual settings may be adjusted to multiples of current based on the rotary switch setting for motor Full Load Amps (FLA).

$$\text{Instantaneous Trip Point} = (\text{FLA}) \times (I_m)$$

For example, if FLA rotary switch is set to 20 and I_m rotary switch is set to 9x, then the instantaneous trip point will be 180 A.



A. Full Load Amp Setting **(FLA)**.
B. Instantaneous Trip Point Settings **(I_m)**.

See Tables 55 thru 57 for more information.

Table 50: H- and J-Frame Electronic Motor Circuit Protectors (MCP)

Frame	Current	Full Load Amperes Range	Adjustable Instantaneous Trip Range	Suffix	J Interrupting (See SCCR Table Below)	L Interrupting (See SCCR Table Below)	R Interrupting
					Cat. No.	Cat. No.	Cat. No.
H-Frame	30 A	1.5–25 A	9–325 A	M71	HJL36030M71	HLL36030M71	HRL36030M71
	50 A	14–42 A	84–546 A	M72	HJL36050M72	HLL36050M72	HRL36050M72
	100 A	30–80 A	180–1040 A	M73	HJL36100M73	HLL36100M73	HRL36100M73
	150 A	58–130 A	348–1690 A	M74	HJL36150M74	HLL36150M74	HRL36150M74
J-Frame	250 A	114–217 A	684–2500 A	M75	JJL36250M75	JLL36250M75	JRL36250M75

- High Short Circuit Current Ratings (SCCR)

  The PowerPact MCP helps achieve the high UL508A Short Circuit Current Rating (SCCR) needed to meet NEC Article 409 requirements for industrial control panels. They deliver up to 100 kA at 480 Vac SCCR when used in combination with approved Square D™ NEMA or Schneider Electric™ IEC motor starters.

Table 51: Short Circuit Current Ratings (SCCR)

Contactor/Starter	J Interrupting			L Interrupting			R Interrupting		
	200–240 Vac	480 Vac	600 Vac	200–240 Vac	480 Vac	600 Vac	200–240 Vac	480 Vac	600 Vac
Tesys D-line and F-line	100 kA	65 kA	25 kA	100 kA	100 kA	50 kA	200 kA	200 kA	100 kA
NEMA Type S	100 kA	65 kA	25 kA	100 kA	100 kA	50 kA	200 kA	200 kA	100 kA

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PowerPact H-, J-, and L-Frame Circuit Breakers
Motor Circuit Protection

Table 52: MCP Selection by HP Ratings of Induction-Type Squirrel-Cage and Wound-Rotor Motors

Horsepower Rating of Induction-Type Squirrel-Cage and Wound-Rotor Motors 3Ø 60 Hz					NEC Full Load Amperes	PowerPact H-Frame and J-Frame Electronic MCP	
Starter Size	200 Vac	230 Vac	480 Vac	575 Vac			
				1/2	0.9 A		
			1/2		1.1 A		
				3/4	1.3 A		
			3/4	1	1.7 A		
			1		2.1 A		
		1/2			2.2 A		
				1-1/2	2.4 A		
	1/2				2.5 A		
				2	2.7 A		
			1-1/2		3 A		
00		3/4			3.2 A		
			2		3.4 A		
	3/4				3.7 A		
				3	3.9 A	HJL36030M71 and HLL36030M71 1/2–10 hp	
		1			4.2 A		
	1				4.8 A		
			3		4.8 A		
		1-1/2			6 A		
				5	6.1 A		
		2			6.8 A		
	1-1/2				6.9 A		
			5		7.6 A		
	2				7.8 A		
0				7-1/2	9 A		
		3			9.6 A		
	3		7-1/2	10	11 A		
			10		14 A		
		5			15.2 A		
				15	17 A		
1	5				17.5 A		
			15		21 A		HJL36050M72 and HLL36050M72 10–25 hp
		7-1/2		20	22 A		
	7-1/2				25.3 A		
			20	25	27 A		
2		10			28 A		
				30	32 A		
	10				32.2 A		
			25		34 A		
			30		40 A		
				40	41 A	HJL36100M73 and HLL36100M73 15–50 hp	
		15			42 A		
	15				48.3 A		
3			40	50	52 A		
		20			54 A		
	20			60	62 A		
			50		65 A		
		25			68 A		
			60	75	77 A		HJL36150M74 and HLL36150M74 30–100 hp
	25				78.2 A		
		30			80 A		
	30				92 A		
4			75		96 A		
				100	99 A		
		40			104 A		
	40				120 A		
			100		124 A		
				125	125 A	JJL36250M75 and JLL36250M75 50–150 hp	
		50			130 A		
				150	144 A		
	50				150 A		
5		60			154 A		
			125		156 A		
	60				177.1 A		
			150		180 A		
		75		200	192 A		
	75				221 A		
			200		240 A		
		100			248 A		

Shaded area is not covered by J-frame electronic motor circuit protector.

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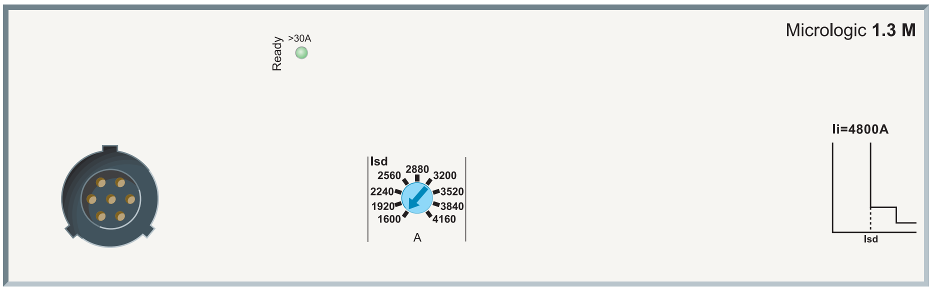
Micrologic 1.3 M Electronic Trip Units for Instantaneous Protection Only (L-Frame Circuit Breakers Only)

Micrologic 1.3 M trip units are used in 3-device motor-feeder solutions on PowerPact L-frame circuit breakers with performance levels G/J/L. They provide short-circuit protection for motors up to 250 kW at 400 V.



Micrologic 1.3 M trip units provide instantaneous protection only, using electronic technology. They are dedicated to 600 A three-pole (3P 3D) circuit breakers or four-pole circuit breakers with detection on three poles (4P, 3D). They are especially used in three-pole versions for motor protection.

Circuit breakers equipped with Micrologic 1.3 M trip units, without thermal protection, are used in certain applications to replace automatic switches. Micrologic 1.3 M trip units are available on PowerPact L-frame circuit breakers only.

NOTE: All Micrologic trip units have a transparent, sealable cover that protects access to the adjustment rotary switches.

They also provide the benefits of electronic technology:

- accurate settings
- tests
- “Ready” LED.

Circuit breakers with a Micrologic 1.3 M trip unit are combined with a overload relay and a contactor.

Protection settings are made using a rotary switch.

Protection Version

Three pole (3P): three-pole frame circuit breakers equipped with detection on all three poles.

Indications

The green “Ready” LED blinks slowly when the electronic trip unit is ready to provide protection. It indicates the trip unit is operating correctly.

NOTE: All the trip units have a transparent sealable cover that protects access to the adjustment rotary switches.

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Table 53: Micrologic 1.3 M Electronic Trip Unit

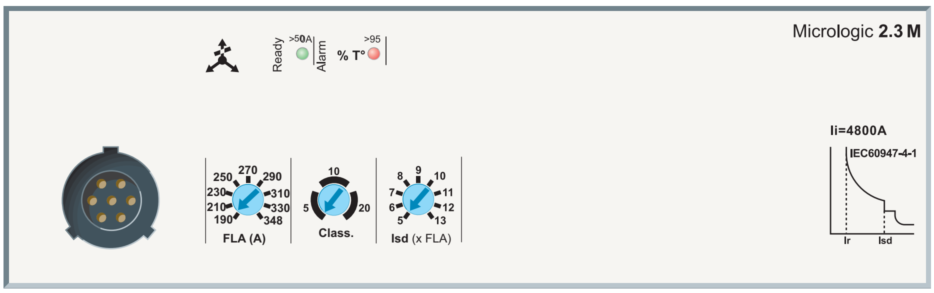
Rating: I_n at 104°F (40°C)[1]		400 A	600 A
Circuit Breaker	PowerPact L-frame	X	X
Short-time protection			
Pick-up (A) accuracy ±15%	I_{sd}	Adjustable directly in amps	
	There is a very short delay to let through motor starting currents	9 settings: 2000-2400-2800-3200-3600-4000-4800 A	9 settings: 3000-3600-4200-4800-5400-6000-6600-7200 A
Time delay (ms)	t_{sd}	Non-adjustable	
	Non-tripping time Maximum break time	20 60	
Instantaneous protection			
Pick-up (A) accuracy ±15%	I_i non-adjustable	4800	7200
	Non-tripping time Maximum break time	0 30 ms	

[1] Motor standards require operation at 104°F (40°C). Circuit-breaker ratings are derated to take this requirement into account.

Micrologic 2.2 M and 2.3 M Electronic Trip Units

Micrologic 2.2 M and 2.3 M trip units provide built-in thermal and instantaneous protection. They are used in 2-device motor-feeder solutions on PowerPact H-, J-, and L-frame circuit breakers with performance levels J/L. They provide protection for motors up to 315 kW at 400 V against:

- short-circuits
- overloads with selection of a trip class (5, 10 or 20)
- phase unbalance.



Circuit breakers with a Micrologic 2.2 M/ 2.3 M trip unit include protection similar to an inverse-time overload relay. They are combined with a contactor.

Protection settings are made using a rotary switch.

Overloads (or Thermal Protection)

Long-time protection and trip class (FLA)

- Inverse-time thermal protection against overloads with adjustable pick-up FLA.
- Settings are made in amperes. The tripping curve for the long-time protection, which indicates the time delay tr before tripping, is defined by the selected trip class.

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Trip Class

- The class is selected as a function of the normal motor starting time.
  - Class 5: starting time less than 5 s
  - Class 10: starting time less than 10 s
  - Class 20: starting time less than 20 s
- For a given class, it is necessary to check that all motor-feeder components are sized to carry the 6 x FLA starting current without excessive temperature rise during the time corresponding to the class.

Short-Circuits

Short-time protection (I_{sd})

- Provides protection with an adjustable pick-up I_{sd}.
- There is a very short delay to let through motor starting currents.

Non-adjustable instantaneous protection (I_i)

- Instantaneous protection with non-adjustable pick-up I_i.

Phase Unbalance or Phase Loss (I_{unbal})

- This function opens the circuit breaker if a phase unbalance occurs:
  - that is greater than the 30% fixed pick-up I_{unbal}
  - following the non-adjustable time delay t_{unbal} equal to:
    • 0.7 s during starting
    • 4 s during normal operation
- Phase loss is an extreme case of phase unbalance and leads to tripping under the same conditions.

Indications

Front indications

- The green “Ready” LED blinks slowly when the electronic trip unit is ready to provide protection. It indicates the trip unit is operating correctly.
- Red alarm LED for motor operation goes ON when the thermal image of the rotor and stator is greater than 95% of the permissible temperature rise.

Remote indications using SDTAM module

- PowerPact H-, J-, and L-frame devices with a Micrologic 2 M trip unit can be equipped with an SDTAM module dedicated to motor applications for:
  - A contact to indicate circuit-breaker overload.
  - A contact to open the contactor. In the event of a phase unbalance or overload, this output is activated 400 ms before circuit-breaker tripping to open the contactor and avoid circuit breaker tripping
- This module takes the place of the shunt trip (MN)/undervoltage trip (MX) coils and an auxiliary switch (OF) contact

SDTAM remote indication relay module with its terminal block.

Note: All the trip units have a transparent sealable cover that protects access to the adjustment rotary switches.

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Table 54: Micrologic 2.2 M and 2.3 M Electronic Trip Unit

Rating: I_n at 104°F (40°C)[1]		30 A	50 A	100 A	150 A	250 A	400 A	600 A
Circuit Breaker	PowerPact H-frame	X	X	X	X	—	—	—
	PowerPact J-frame	—	—	—	—	X	—	—
	PowerPact L-frame	—	—	—	—	—	X	X

Overloads (or Thermal Protection): Long-Time Protection and Trip Class

	FLA		Value depending on trip unit rating (I_n) and setting on rotary switch								
Pick-Up (A) Tripping between 1.05 and 1.20 FLA	I_n = 30 A	FLA =	14	16	18	20	21	22	23	24	25
	I_n = 50 A	FLA =	14	17	21	24	27	29	32	36	42
	I_n = 100 A	FLA =	30	35	41	45	51	56	63	71	80
	I_n = 150 A	FLA =	58	71	78	86	91	97	110	119	130
	I_n = 250 A	FLA =	114	137	145	155	163	172	181	210	217
	I_n = 400 A	FLA =	190	210	230	250	270	290	310	330	348
	I_n = 600 A	FLA =	312	338	364	390	416	442	468	484	520

Time Delay

Trip Class			5	10	20	
Time Delay (s) Depending on selected trip class	t_r	1.5 x FLA	120	240	480	For warm start
		6 x FLA	6.5	13.5	26	For cold start
		7.2 x FLA	5	10	20	For cold start

S Short Circuits: Short-time protection with fixed time delay

Pick-up (A) accuracy ±15%	I_{sd} = FLA x	5	6	7	8	9	10	11	12	13
Time delay (ms)	t_{sd}	Non-adjustable								
	Non-tripping time	20								
	Maximum break time	60								

I Short Circuit: Non-adjustable instantaneous protection

Pick-up (A) accuracy ±15%	I_i non-adjustable	450	750	1500	2250	3750	4800	7200
Time delay (ms)	Non-tripping time	0						
	Maximum break time	30 ms						

Phase unbalance or phase loss

Pick-up (A) accuracy ±20%	I_{unbal} in % average current[2]	30%
Time delay (ms)	Non-adjustable	0.7 s during starting 4 s during normal operation

1 Motor standards require operation at 104°F (40°C). Circuit-breaker ratings are derated to take this requirement into account.

2 The unbalance measurement takes into account the most unbalanced phase with respect to the average current.

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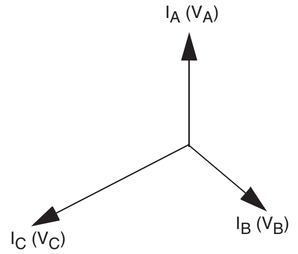
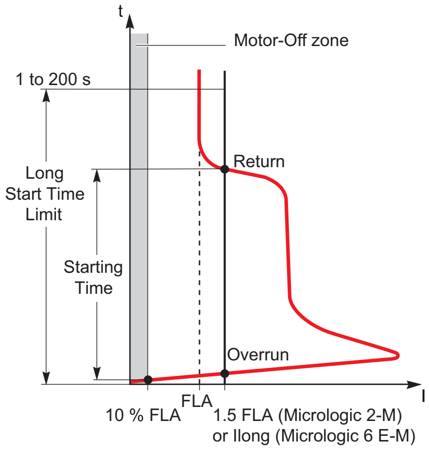
Additional Technical Characteristics

Table 55: Additional Technical Characteristics



Unbalance of Phase Currents and Voltages



Motor Starting and Long Starts

Phase unbalance	An unbalance in three-phase systems occurs when the three voltages are not equal in amplitude and/or not displaced 120° with respect to each other. It is generally due to single-phase loads that are incorrectly distributed throughout the system and unbalance the voltages between the phases. These unbalances create negative current components that cause braking torques and temperature rise in asynchronous machines, thus leading to premature aging.
Phase loss	Phase loss is a special case of phase unbalance. • During normal operation, it produces the effects mentioned above and tripping must occur after four seconds. • During starting, the absence of a phase may cause motor reversing, i.e. it is the load that determines the direction of rotation. This requires virtually immediate tripping (0.7 seconds). Starting time in compliance with the class (Micrologic 2 M) For normal motor starting, Micrologic 2 M checks the conditions below with respect to the thermal-protection (long-time) pick-up FLA: • current > 10% x FLA (motor-off limit) • overrun of 1.5 x FLA threshold, then return below this threshold before the end of a 10 s time delay. If either of these conditions is not met, the thermal protection trips the device after a maximum time equal to that of the selected class. Pick-up FLA must have been set to the current indicated on the motor rating plate.
Starting time in compliance with the class (Micrologic 2 M)	For normal motor starting, Micrologic 2 M checks the conditions below with respect to the thermal-protection (long-time) pick-up FLA: • current > 10% x FLA (motor-off limit) • overrun of 1.5 x FLA threshold, then return below this threshold before the end of a 10 s time delay If either of these conditions is not met, the thermal protection trips the device after a maximum time equal to that of the selected class. Pick-up FLA must have been set to the current indicated on the motor rating plate.

Table 56: L-Frame Electronic Trip Unit Magnetic Only 3 Pole, 600 Vac, 50/60 Hz—Three Device Solutions[1]

Sensor Rating		Trip Unit	Adjustable[2] Trip Range (A)	G-Interrupting Cat. No.	J-Interrupting Cat. No.	L-Interrupting Cat. No.	R-Interrupting Cat. No.
PowerPact L-Frame	400	1.3 M	500–1200%	LGL36400M37X	LJL36400M37X	LLL36400M37X	LRL36400M37X
	600		500–1200%	LGL36600M37X	LJL36600M37X	LLL36600M37X	LRL36600M37X

[1] Three-device solutions are the traditional solutions: motor circuit protector plus motor starter plus overload relay.
[2] UL magnetic trip tolerances are -20%/+30% from the nominal values shown.

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Table 57: H-Frame (150 A), J-Frame (250 A) and L-Frame (600 A) Electronic Motor Protector Circuit Breakers (UL Ratings)—Two Device Solutions[1]

Electronic Trip Unit Type	Frame	Sensor Rating	Trip Unit	Full Load Amperes Range (FLA)	I_{sd} (x FLA)	G Interrupting Cat. No.	J Interrupting Cat. No.	L Interrupting Cat. No.	R Interrupting Cat. No.
Standard[2]	H-Frame	30	2.2 M	14–25	5-13 x FLA	HGL36030M38X	HJL36030M38X	HLL36030M38X	HRL36030M38X
		50		14–42	5-13 x FLA	HGL36050M38X	HJL36050M38X	HLL36050M38X	HRL36050M38X
		100		30–80	5-13 x FLA	HGL36100M38X	HJL36100M38X	HLL36100M38X	HRL36100M38X
		150		58–130	5-13 x FLA	HGL36150M38X	HJL36150M38X	HLL36150M38X	HRL36150M38X
	J-Frame	250		114–217	5-13 x FLA	JGL36250M38X	JJL36250M38X	JLL36250M38X	JRL36250M38X
	L-Frame	400	2.3 M	190–348	5-13 x FLA	LGL36400M38X	LJL36400M38X	LLL36400M38X	LRL36400M38X
		600		312–520	5-13 x FLA	LGL36600M38X	LJL36600M38X	LLL36600M38X	LRL36600M38X

1 Two-device solutions (these electronic motor protector circuit breakers include short circuit and overload protection)
—1 electronic motor circuit protector with a Micrologic 2.2 M electronic trip unit, plus
—1 contactor

2 The standard trip unit offers Class 5, 10 and 20 and phase unbalance or phase loss protection.

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Section 6—Energy Management

Energy Management Using the Smart System

Use the Smart System to connect your building to real savings in three steps:

A. Measure

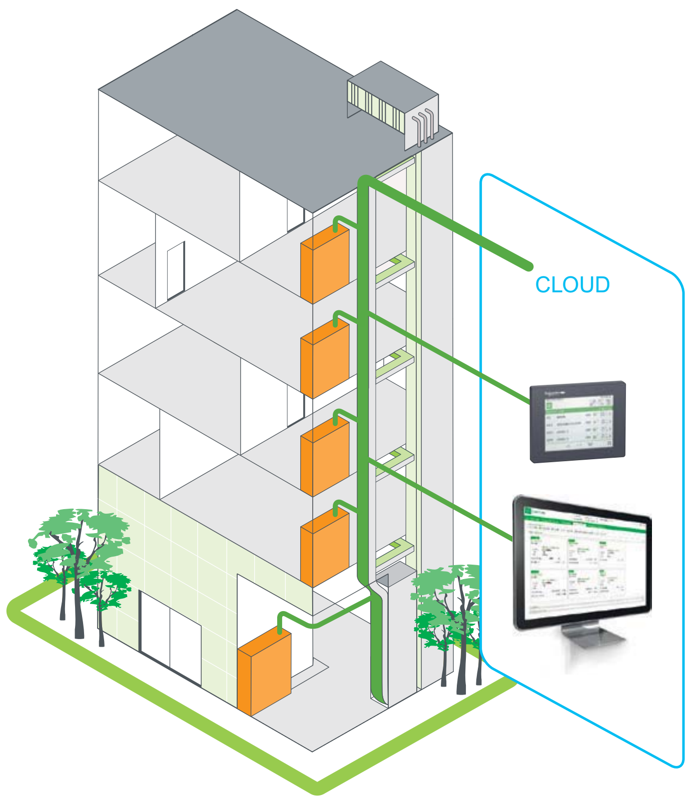
   Embedded and stand-alone metering and control

B. Connect

   — Integrated communication interfaces
   — Ready to connect to energy management platforms

C. Save

   — Data-driven energy efficiency actions
   — Real-time monitoring and control
   — Access to energy and site information through on-line services



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Measure

Smart System communications mean visible information.

Grouping most of the electrical protection, command and metering components, the switchboards are now significant sources of data locally displayed and sent via communication networks.

Connect

Smart Systems use reliable, simple-to-install-and-use displays, and Ethernet and Modbus interfaces.

Information is safely transmitted through the most efficient networks:

— Modbus SL inside switchboards, between components,

— Ethernet, on cable or WiFi, inside the building and connecting switchboards and computers,

— Ethernet or GPRS, for access to on-line services by Schneider Electric.

— Energy experts, no matter where they are located, can now provide advise based on the updated data of the building.

Save

On-Site Real-Time Monitoring and Control

The FDM128 touch screen display connected to the Ethernet:

- shows essential electrical information and alarms concerning the electrical network,
- allows control (open, close, reset…) of various equipment.

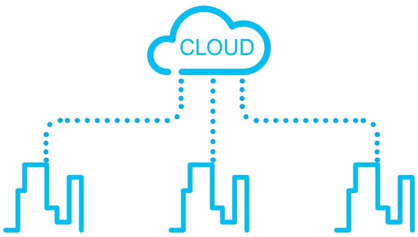
The FDM128 touch screen provides real-time value checking and control, directly on the front panel of the main switchboard.

On a PC display with common browser:

- shows monitoring web pages hosted into the local Ethernet interface,
- alarm events generate automatic email notifications,
- allows control (open, close, reset…) of various equipment.

The data is displayed graphically or recorded into files for optimizing the use of energy in the building.

As an example, the data can help validate the change of temperature settings, time scheduling in a Building Management System or other automated devices.



On-Line Energy Management Services

StruXureWare Energy Operation automates data collection using an open, scalable, and secure energy management information system.

With the help of the Schneider Electric energy management services team, data is turned into information to enable customers to understand their facilities' performance on an ongoing basis.

Energy Operation leverages companies' current investments in their existing systems, and can be used to communicate advanced results and performance to a broad audience for a shared understanding throughout an organization.

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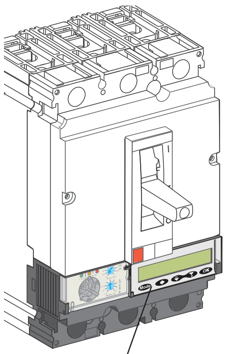
Smart System Communication Components

PowerPact Circuit Breakers with Micrologic Trip Units


Trip Unit LCD

Ammeter A

- Micrologic 5 A selective protection
- Micrologic 6 A selective + ground-fault protection

Energy E

- Micrologic 5 E selective protection
- Micrologic 6 E selective + ground-fault protection

Displays

Power Meter

FDM121

- One-to-one front display module
- See page 64 for more information


Operating Assistance Functions

FDM128

- One-to-eight front display module
- See page 65 for more information


Communication

Communication

- PowerPact and Compact circuit breakers in a communication network
- I/O application module
- IFE: Ethernet interface module
- IFM: Modbus interface module
- Com'X: Energy server


I/O Module


IFE Module


IFM Module


Com'X 200

See page 95 for more information.

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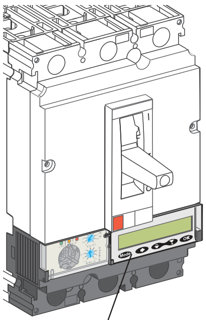
Power Meter Functions

In addition to protection functions, Micrologic A/E trip units offer all the functions of Power Meter products as well as operating assistance for the circuit breaker.

Micrologic A/E trip unit measurement functions are made possible by the Micrologic trip unit's intelligence and the accuracy of the sensors. They are handled by a microprocessor that operates independent of protection functions.

Display Functions

Micrologic Trip Unit LCD


Trip Unit LCD

The user can display all the protection settings and the main measurements on the LCD screen of the trip unit.

- Micrologic A trip unit: instantaneous rms current measurements
- Micrologic E trip unit: voltage, frequency and power measurements and energy metering, in addition to the measurements offered by Micrologic A

To make the display available under all conditions and increase operating comfort, an external power supply is recommended for Micrologic A trip unit. It is required to:

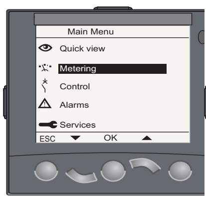
- display faults and interrupted current measurements
- use all the functions of Micrologic E trip unit (such as metering of low power and energy values)
- ensure operation of the communication network

The external power supply can be shared by several devices. For description, see page 109.

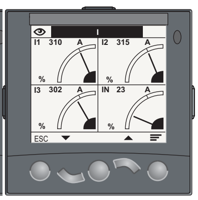
FDM121 Display Unit (One to One)

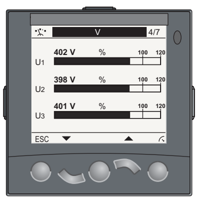

Display Function

The FDM121 switchboard display unit can be connected to a communication (COM) option (Breaker Communication Module [BSCM]) using a circuit breaker ULP cord to display all measurements on a screen. The LCD screen is 3.78 x 3.78 in. (96 x 96 mm). The FMD121 display unit requires a 24 Vdc power supply. The COM option (BSCM) unit is supplied by the same power supply via the circuit breaker ULP cord connecting it to the FDM121. See page 72 for more information.

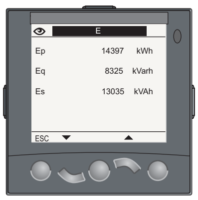


FDM121 Display Navigation


FDM121 Display Current


FDM121 Display: Voltage

FDM121 Display: Power



FDM121 Display: Consumption

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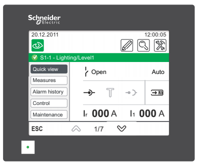
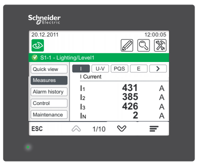
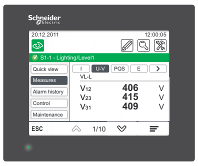
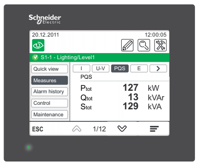
FDM128 Display Unit (One to Eight)

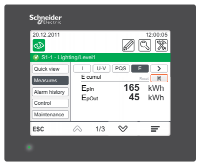
The FDM128 display unit uses an IFE Ethernet interface for low-voltage circuit breakers.


FDM128 Display Navigation


FDM128 Display Current


FDM128 Display: Voltage


FDM128 Display: Power


FDM128 Display: Consumption

For all FDM, in addition to the information displayed on the Micrologic trip unit LCD, the FDM screen shows demand, power quality, and maximum/minimum ammeter values along with histories and maintenance indicators.

Measurement Function


Measurement Function

Instantaneous RMS Measurements

The Micrologic trip unit continuously displays the RMS value of the highest current of the three phases and neutral (Imax). The navigation buttons can be used to scroll through the main measurements.

In the event of a fault trip, the trip cause is displayed.

The Micrologic A trip unit measures phase, neutral, and ground fault currents.

Micrologic E trip units offer voltage, power, frequency, and energy metering in addition to the measurements provided by Micrologic A trip units.

Maximum / Minimum Ammeter

Every instantaneous measurement provided by Micrologic A/E trip units can be associated with a maximum/minimum ammeter. The maximum for the highest current of the three phases, neutral, and demand current can be reset using the Micrologic trip unit keypad, FDM display unit, or the communication system.

Energy Metering

The Micrologic E trip units also measures the energy consumed since the last reset of the meter. The active energy meter can be reset using the Micrologic trip unit keypad, the FDM display unit, or the communication system.

Demand and Maximum Demand Values

Micrologic E trip units also calculate demand current and power values. These calculations can be made using a block or sliding interval that can be set from five to sixty minutes in steps of one minute. The window can be synchronised with a signal sent through the communication system. Whatever the calculation method, the calculated values can be recovered on a PC through the communication network.

Ordinary spreadsheet software can be used to provide trend curves and forecasts based on this data. They provide a basis for load shedding and reconnection operations used to adjust consumption to the subscribed power.

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Power Quality

The Micrologic E trip unit calculates power quality indicators taking into account the presence of harmonics up to the fifteenth harmonic, including the total harmonic distortion (THD) of current and voltage.

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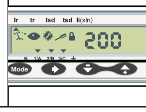
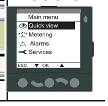
Table 58: Micrologic 5/6 Trip Units Integrated Power Meter Functions

			Type		Display	
			A	E	**Trip Unit LCD** 	**Front Display Module** 
Display of Protection Settings						
Pick-ups (A) and delays	All settings can be displayed	I_r, t_r, I_{sd}, t_{sd}, I_i, I_g, t_g	X	X	X	
Measurements						
Instantaneous rms measurements						
Currents (A)	Phase and neutral	I_A, I_B, I_C, I_N	X	X	X	X
	Average of phases	Iavg = (I_A + I_B + I_C) / 3	X	X	—	X
	Highest current of the 3 phases and neutral	Imax of I_A, I_B, I_C, I_N	X	X	X	X
	Ground fault (Micrologic 6 trip unit)	% Ig (pick-up setting)	X	X	X	X
	Current unbalance between phases	% Iavg	—	X	—	X
Voltage (V)	Phase-to-phase	V_{AB}, V_{BC}, V_{CA}	—	X	X	X
	Phase-to-neutral	U_{AN}, U_BN, U_{CN}	—	X	X	X
	Average of phase-to-phase voltages	Vavg = (V_{AB} + V_{AC} + V_{BC}) / 3	—	X	—	X
	Average of phase-to-neutral voltages	Uavg = (U_{AN} + U_{BN} + U_{CN}) / 3	—	X	—	X
	Ph-Ph and Ph-N voltage unbalance	% Vavg and% Uavg	—	X	—	X
	Phase sequence	1-2-3, 1-3-2	—	X	X	X
Frequency (Hz)	Power System	f	—	X	X	X
Power	Active (kW)	P, total/per phase	—	X	X	X
	Reactive (kVAR)	Q, total/per phase	—	X	X	X
	Apparent (kVA)	S, total/per phase	—	X	X	X
	Power factor and cos φ (fundamental)	PF and cos φ, total and per phase	—	X	—	X
Maximum, minimum (MAX/MIN)						
	Associated with instantaneous rms measurements	Reset with Micrologic trip unit or front display module	X	X	—	X
Energy metering						
Energy	Active (kWh), reactive (kVAR), apparent (kVA)	Total since last reset Absolute or signed mode[1]	—	X	X	X
Demand and maximum demand values						
Demand current (A)	Phases and neutral	Present value on the selected window	—	X	—	X
		Maximum demand since last reset	—	X	—	X
Demand power	Active (kWh), reactive (kVAR), apparent (kVA)	Present value on the selected window	—	X	—	X
		Maximum demand since last reset	—	X	—	X
Calculation window		Adjustable from 5 to 60 minutes in 1 minute steps	—	X	—	[2]
Power quality						
Total harmonic distortion THD (%)	Of voltage with respect to rms value	THDU, THDV of the Ph-Ph and Ph-N voltage	—	X	—	X
	Of current with respect to rms value	THDI of the phase current	—	X	—	X

1 Absolute mode: E absolute = E out + E in; Signed mode: E signed = E out - E in.

2 Available through the communication network only.

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Additional Technical Characteristics

Measurement accuracy of the entire measurement system, including the sensors:

- Current: +/- 1%
- Voltage: +/- 0.5%
- Power and energy: +/- 2%
- Frequency: +/- 0.1%

Operating-Assistance Functions Characteristics

Micrologic Trip Unit Alarms with Time-Stamping

Alarm Types

The user can assign an alarm to all Micrologic A or E trip unit measurements or events:

- up to 12 alarms can be used together:
  - — two alarms are predefined and activated automatically:
    Micrologic 5 trip unit: overload (I_r)
    Micrologic 6 trip unit: overload (I_r) and ground fault (I_g)
  - — thresholds, priorities and time delays can be set for ten other alarms.
- the same measurement can be used for different alarms to precisely monitor certain values, e.g. the frequency or the voltage
- alarms can also be assigned to various states: phase lead/lag, four quadrants, phase sequence selection of display priorities, with screen displaying a window showing high priority alarm
- alarm time-stamping.

Alarm Settings

Alarms cannot be set using the keypad or the front display module. They are set through the communication network with the PC. Set-up includes the threshold, priority, activation delay before display and deactivation delay. It is also possible to reprogram the standard assignment for the two SDx relay outputs to user-selected alarms.

Alarm Reading

Remote alarm indicators:

- reading on the front display module or on a PC through the communication network
- system remote indicators using SDx relay with two output contacts for alarms
- Micrologic trip unit built-in LCD display

Histories and Event Tables

Micrologic A and E trip unit have histories and event tables that are always active.

Three types of time-stamped histories

- Tripping due to overruns of I_r, I_{sd}, I_i, I_g: last 17 trips
- Alarms: last 10 alarms
- Operating events: last 10 events

Each history record is stored with:

- indicators in clear text in a number of user-selectable languages
- time-stamping: date and time of event
- status: pick-up / drop-out

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Two types of time-stamped event tables

- Protection settings
- Minimums / maximums

Display of alarms and tables

The time-stamped history and event tables may be displayed on a PC through the communication network.

Embedded memory

Micrologic A and E trip units have a non-volatile memory that saves all data on alarms, histories, event tables, counters and maintenance indicators even if power is lost.

Maintenance Indicators

Micrologic A and E trip units have indicators for, among others, the number of operating cycles, contact wear and operating times (operating hours counter) of the PowerPact H-, J-, and L-frame circuit breakers.

It is possible to assign an alarm to the operating cycle counter to plan maintenance. The various indicators can be used together with the trip histories to analyze the level of stresses the device has been subjected to. The information provided by the indicators cannot be displayed on the Micrologic trip unit LCD. It is displayed on the PC through the communication network.

Management of Installed Devices

Each circuit breaker equipped with a Micrologic 5 or 6 trip unit can be identified using the communication network:

- serial number
- firmware version
- hardware version
- device name assigned by the user

This information together with that previously described provides a clear view of the state of the installed devices.

NOTE: Please refer to page 64 for more details on display formats.

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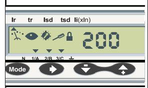
Table 59: Micrologic 5/6 Trip Units Operating Assistance Functions

			Type A	Type E	Display: Trip Unit LCD 	Display: Front Display Module 
Operating Assistance						
Personalized Alarms						
Settings	Up to 10 alarms assigned to all A and E measurements		X	X	—	[1]
	Phase lead/lag, four quadrants, phase sequence, display priority selection		—	X	—	[1]
Display	Alarms and tripping		X	X	—	[1]
Remote Indicators	Activation of two dedicated contacts on SDx module		X	X	—	[1]
Time-Stamped Histories						
Trips (last 17)	Cause of tripping (time-stamping with ms)	I_r, I_{sd}, I_i (Micrologic 5, 6 Trip Unit)	X	X	—	[1]
		I_g (Micrologic 6 Trip Unit)	X	X	—	[1]
Alarms (last 10)			X	X	—	[1]
Operating events (last 10)	Event types	Modification of protection setting by rotary switch	—	X	—	[1]
		Opening of keypad lock	—	X	—	[1]
		Test using keypad	—	X	—	[1]
		Test using external tool	—	X	—	[1]
		Time setting (date and time)	—	X	—	[1]
		Reset for maximum, minimum and energy meter	X	X	X	X
Time Stamping	Presentation	Date and time, text, status	X	X	—	[1]
Time-Stamped Event Tables						
Protection settings	Setting modified (value displayed)	I_r, t_r, I_{sd}, t_{sd}, I_i, I_g, t_g	X	X	—	[1]
	Time-stamping	Date and time of modification	X	X	—	[1]
	Previous value	Value before modification	X	X	—	[1]
Min/Max	Values monitored	I_A, I_B, I_C, I_N, I_i	X	X	—	[1]
	Time-stamping Previous value	Date and time of min/max record Min/max value	X	X	—	[1]
Maintenance Indicators						
Counter	Mechanical cycles[2] Electrical cycles[2] Trips Alarms Hours	Assignable to an alarm Assignable to an alarm One per type of trip One for each type of alarm Total operating time (hours)	X	X	—	[1]
Indicator	Contact wear	%	X X	X X	—	[1]
Load profile	Hours at different load levels	% of hours in four current ranges: 0–49% I_n, 50–79% I_n, 80–89% I_n and ≥ 90% I_n	X X	X X	—	[1]

1 Available through the communication network only.
2 The BSCM (page 108) is required for these functions.

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Additional Technical Characteristics:

- Contact wear
  Each time PowerPact H-, J-, and L-frame circuit breakers open, the Micrologic 5/6 trip unit measures the interrupted current and increments the contact-wear indicator as a function of the interrupted current, according to test results stored in memory. Breaking under normal load conditions results in a very slight increment. The indicator value may be read on the front display module. It provides an estimation of contact wear calculated on the basis of the cumulative forces affecting the circuit breaker. When the indicator reaches 80%, it is advised to replace the circuit breaker to ensure the availability of the protected equipment.
- Circuit breaker load profile
  Micrologic 5/6 trip units calculate the load profile of the circuit breaker protecting a load circuit. The profile indicates the percentage of the total operating time at four current levels (% of I_n):
  - 0 to 49% I_n
  - 50 to 79% I_n
  - 80 to 89% I_n
  - ≥ 90% I_n

  This information can be used to optimize use of the protected devices or to plan ahead for expansion.

Motor Circuit Protectors (AC Only)

See Section 5 for information about PowerPact H-, J- and L-frame electronic motor circuit protectors (MCP) with trip units:

- Micrologic 1.3 M
- Micrologic 2 M

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FDM121 Display

Micrologic trip unit measurement capabilities come into full play with the FDM121 display. It connects with a circuit breaker ULP cord and displays the Micrologic trip unit information. The result is a true integrated unit combining a circuit breaker and a power meter. Additional operating assistance functions can also be displayed.

An FDM121 display unit can be connected to ULP communication devices using a prefabricated cord to display all measurements, alarms, histories and event tables, maintenance indicators, and management of installed devices on a screen.

The FMD121 display unit requires a 24 Vdc power supply.

The FDM121 is a display that can be integrated with the PowerPact H/J/L/P/R or Masterpact NW/NT circuit breaker systems. It uses the sensors and processing capacity of the Micrologic trip unit. It is easy to use and requires no special software or settings. It is immediately operational when connected to the circuit breaker by a ULP cord.

It also provides monitoring and control with the use of the I/O application module, the motor mechanism module, or the circuit breaker communication module.

The FDM121 has a large display, but requires very little depth. The anti-glare graphic screen is backlit for very easy reading even under poor ambient lighting and at sharp angles.

Display of Micrologic Trip Unit Measurements and Alarms

The FDM121 is intended to display Micrologic trip unit measurements, alarms and operating information. It cannot be used to modify the protection settings.

Measurements can be easily accessed using a menu. All user-defined alarms are automatically displayed. The display mode depends on the priority level selected during alarm set-up:

- high priority: a pop-up window displays the time-stamped description of the alarm and the orange Alarm LED flashes;
- medium priority: the orange Alarm LED goes continuously on;
- low priority: no display on the screen.

All faults resulting in a trip automatically produce a high-priority alarm, without any special settings required. In all cases, the alarm history is updated. The Micrologic trip unit saves the information in its non-volatile memory in the event of an FDM121 power loss.

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Status Indications and Remote Control

FDM121 Display


Surface Mount Accessory


Connection with FDM121 Display Unit

When the circuit breaker is equipped with the Breaker Communications Module (BSCM), the FDM121 display can also be used to view circuit breaker status conditions:

- O/F: ON/OFF
- SD: trip indication
- SDE: fault-trip indication (overload, short-circuit, or ground fault).

When the circuit breaker system is equipped with the I/O application module, the FDM121 can monitor and control:

- cradle management
- circuit breaker operation
- light and load control
- custom applications.

When the circuit breaker is equipped with the communication motor operator etc., the FDM121 display can also be used to control (open/close) the circuit breaker.

Two operating mode are available:

- local mode: open/close commands are enabled from the FDM121 while disabled from the communication network;
- remote mode: open/close commands are disabled from the FDM121 while enabled from the communication network.

Main Characteristics

- A 3.78 x 3.78 x 1.18 in. (96 x 96 x 30 mm) screen requiring 0.39 in. (10 mm) behind the door (or 0.79 in. [20 mm] when the 24 V power supply connector is used).
- White backlighting.
- Wide viewing angle: vertical ±60°, horizontal ±30°.
- High resolution: excellent reading of graphic symbols.
- Alarm LED: flashing orange for alarm pick-up, steady orange after operator reset if the alarm condition persists.
- Operating temperature range: +14°F (-10°C) to +131°F (+55°C).
- CE / UL / CSA marking.
- 24 Vdc power supply, with tolerances 24 V -20% (19.2 V) to 24 V +10% (26.4 V).

When the FDM121 is connected to the communication network, the 24 Vdc can be supplied by the communication system wiring system. Consumption is 40 mA.

Mounting

The FDM121 is easily installed in a switchboard.

- Standard door cut-out is 3.6 x 3.6 in. (92 x 92 mm).
- Attached using clips.

To avoid a cut-out in the door, an accessory is available for surface mounting by drilling only two 0.87 in. (22 mm) diameter holes.

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Connection

The FDM121 is equipped with a 24 Vdc terminal block:

- A plug-in type terminal block with two wire inputs per point for easy daisy-chaining.
- A power supply range of 24 Vdc -20% (19.2 V) to 24 Vdc +10% (26.4 V).
  A 24 Vdc type auxiliary power supply must be connected to a single point on the ULP system. The FDM121 display has a two-point screw connector on the rear panel of the module for this purpose. The ULP module to which the auxiliary power supply is connected distributes the supply via the ULP cable to all the ULP modules connected to the system and therefore also to Micrologic trip unit. See wiring diagram later in this section.
- Two RJ45 jacks.

The Micrologic trip unit connects to the internal communication terminal block on the PowerPact or Compact circuit breaker with the circuit breaker ULP cord. Connection to one of the RJ45 connectors on the FDM121 automatically establishes communication between the Micrologic trip unit and the FDM121 and supplies power to the Micrologic trip unit measurement functions.

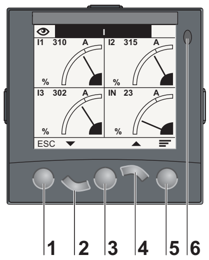
When the second connector is not used, it must be fitted with a line terminator.

Navigation

Five buttons are used for intuitive and fast navigation.

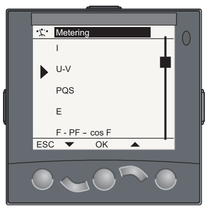
The “Context” button may be used to select the type of display (digital, bargraph, analogue).

The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.).

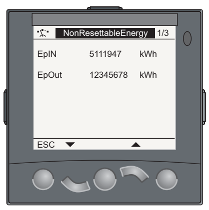


1 Escape
2 Down
3 OK
4 Up
5 Context
6 Alarm LED

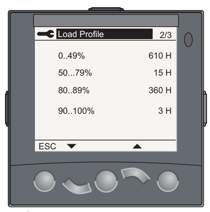
Product Identification



Metering: Submenu



Metering: Meter



Services

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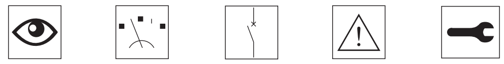
Screens

Main Menu

When powered up, the FDM121 screen automatically displays the ON/OFF status of the device.



When not in use, the screen is not backlit. Backlighting can be activated by pressing one of the buttons. It goes off after three minutes.

Fast Access to Essential Information

- “Quick view” provides access to five screens that display a summary of essential operating information (I, U-V, f, P, E, THD, circuit breaker ON/OFF).

Access to Detailed Information

- “Metering” can be used to display the measurement data (I, U-V, f, P, Q, S, E, THD, PF) with the corresponding min/max values.
- “Alarms” displays active alarms and the alarm history.
- “Services” provides access to the operation counters, energy and maximum ammeter reset function, maintenance indicators, identification of modules connected to the internal bus, and FDM121 internal settings (language, contrast, etc.).

Communication Components and FDM121 Connections

The FDM121 degree of protection is IP54 in front. IP54 is maintained after switchboard mounting by using the supplied gasket during installation.

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Figure 5: FDM121 Connections

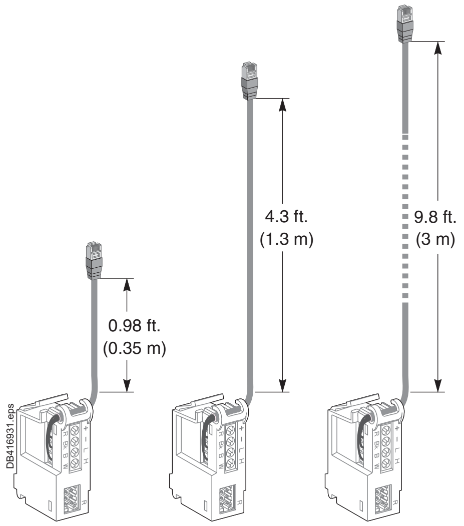
Connections

PowerPact circuit breaker is connected to the I/O module or FDM121 display unit via the internal terminal block for the NSX cord equipped with an RJ45 connector:

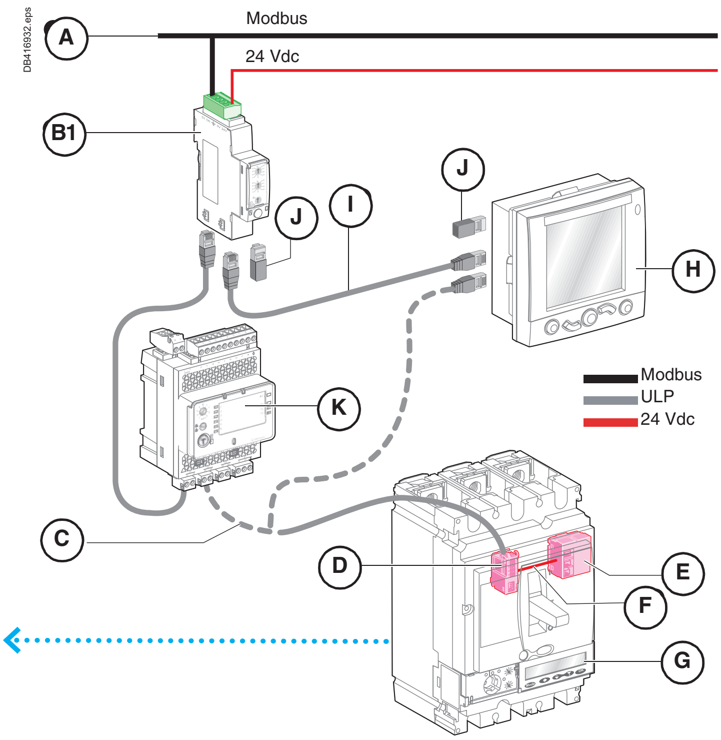
- Cord is available in three lengths: 0.98 ft. (0.35 m), 4.3 ft. (1.3 m) and 9.8 ft. (3 m).
- Lengths up to 32.9 ft. (10 m) are possible using extensions.

The FDM121 display unit and the I/O module are connected to:

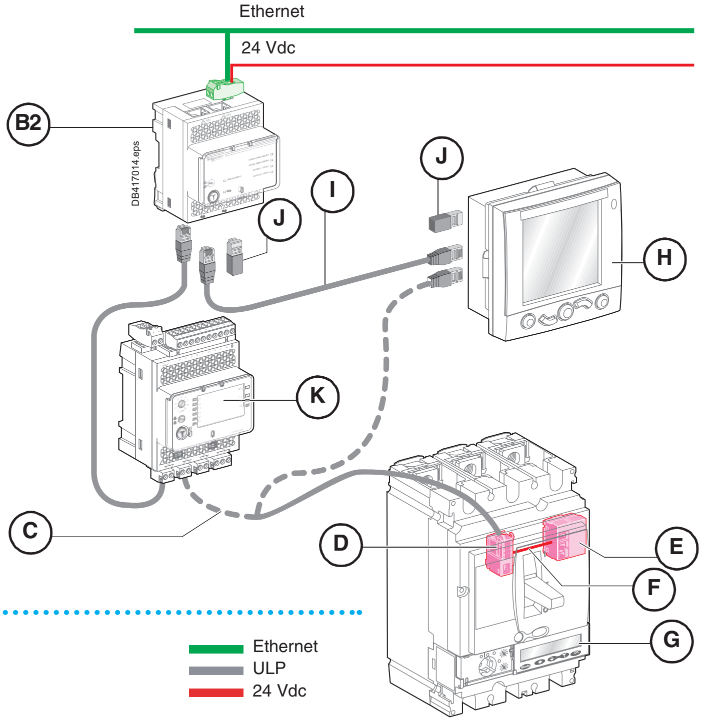
- the IFM Modbus interface by a communication cable with RJ45 connectors on both ends
  or
- the IFE Ethernet interface module by a communication cable with RJ45 connectors on both ends.



Communication Components and Connections, IFM



Communication Components and Connections, IFE



A. Modbus Network
B. Modbus Interface
   B1: IFM Modbus Interface
   B2: IFE Modbus Interface
C. NSX Cord
D. Internal Terminal Block for Communication via NSX Cord
E. BSCM Module
F. Prefabricated wiring
G. Micrologic Trip Unit
H. FDM121 Display
I. RJ45 Cable
J. Line Terminator (on unused connector if applicable)
K. I/O Module

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FDM128 Display

The Micrologic trip unit measurement capabilities are fully utilized with the FDM128 display. The FDM128 display connects to Ethernet communication using the RJ45 port and displays Micrologic trip unit information. The result is an integrated unit combining a circuit breaker with a power meter. Additional operating assistance functions can also be displayed.

The FDM128 display unit can be connected to a Micrologic COM option (BSCM). It uses the sensors and processing capacity of the Micrologic trip unit and requires no special software or settings. The FDM128 is a large display, but requires very little depth. The anti-glare graphic screen is backlit for easy reading even under poor ambient lighting and at sharp angles.

The FDM128 display is designed to manage up to eight devices (PowerPact H/J/L/P/R or Masterpact NW/NT circuit breakers).

Display of Micrologic Trip Unit Measurements and Trips

The FDM128 is intended to display Micrologic 5/6 trip unit measurements, trips, and operating information. It cannot be used to modify the protection settings.

- Measurements may be easily accessed using a menu.
- Trips are automatically displayed.
- A pop-up window displays the time-stamped description of the trip.

Status Indications

When the circuit breaker is equipped with the COM option (BSCM) (including its set of sensors) the FDM128 display can also be used to view circuit breaker status conditions:

- O/F: ON/OFF
- SDE: Fault-trip indication (overload, short-circuit, ground fault)
- CE, CD, CT cradle management with I/O application module.

Remote Control

When the circuit breaker is equipped with the COM option (BSCM) (including connection to a communicating motor operator), the FDM128 display can also be used to operate (open/close) the circuit breaker.

Two operating mode are available:

- Local mode: open/close commands are enabled from the FDM128 while disabled from the communication network.
- Remote mode: open/close commands are disabled from the FDM128 while enabled from the communication network.

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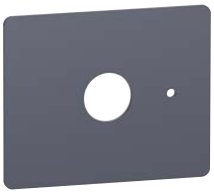
FDM128 Display


Surface Mount Accessory


Connection with Display Unit

Main Characteristics

- 4.54 x 3.40 in. (115.2 x 86.4 mm) with 5.7 in. (145 mm) QVGA display 320 x 240 pixels.
- Color TFT LCD, with LED backlight.
- Wide viewing angle: vertical ±80°, horizontal ±70°.
- High resolution: excellent reading of graphic symbols.
- Operating temperature range: +14°F (-10°C) to +131°F (+55°C).
- CE / UL / CSA marking.
- 24 Vdc power supply, -10%/+20% (limit 20.4 - 28.8 Vdc).
- Consumption 6.8 W.

Mounting

The FDM128 is easily installed in a switchboard.

- Standard door hole Ø 0.87 in. (22 mm).
- The FDM128 degree of protection is IP65 at the touch screen cover. IP54 is maintained after installation by using the supplied gasket.

Connection

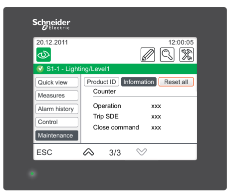
The FDM128 is equipped with:

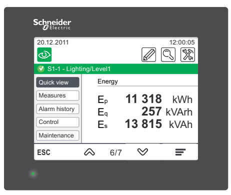
- a 24 Vdc terminal block:
  — with a power supply range of 24 Vdc (limit 20.4 - 28.8 Vdc).
  — secures to the FDM128 display unit using a 2-point screw connector on the rear panel of the module.
- one RJ45 Ethernet jack.

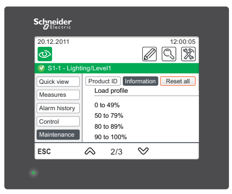
The Micrologic trip unit connects to the internal communication terminal block on the PowerPact circuit breakers through the circuit breaker ULP cord and Ethernet connection through the IFE.

Navigation

- A touch screen is used for intuitive and fast navigation.
- The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.).


Product Identification


Metering: Meter


Services

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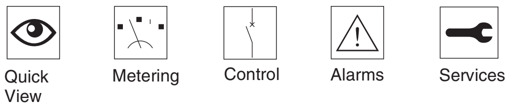
Screens

Main Menu



When not in use, the screen is automatically shifted to low back-lighting.

Fast Access to Essential Information

- “Quick view” provides access to five screens that display a summary of essential operating information (I, U-V, f, P, E, THD, circuit breaker On / Off).

Access to Detailed Information

- "Metering" can be used to display the measurement data (I, U-V, f, P, Q, S, E, THD, PF) with the corresponding min/max values.
- “Alarms” displays the trip history.
- “Services” provides access to the operation counters, energy and maximum ammeter reset function, maintenance indicators, identification of modules connected to the internal bus and FDM128 internal settings (language, contrast, etc.).

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Communication Components and FDM128 Connections

The FDM128 degree of protection is IP65 at the touch screen cover. IP54 is maintained after installation by using the supplied gasket.

Figure 6: FDM128 Connections

Communication Components and Connections

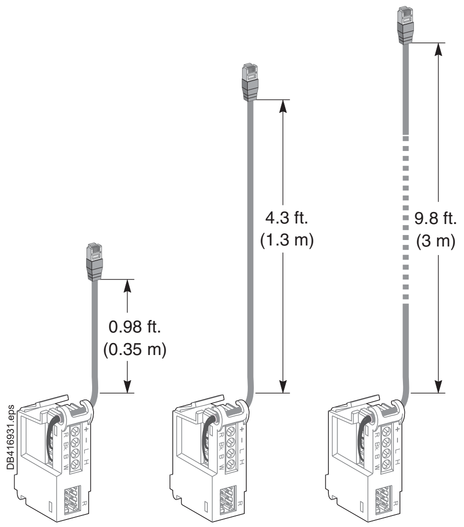
Connections

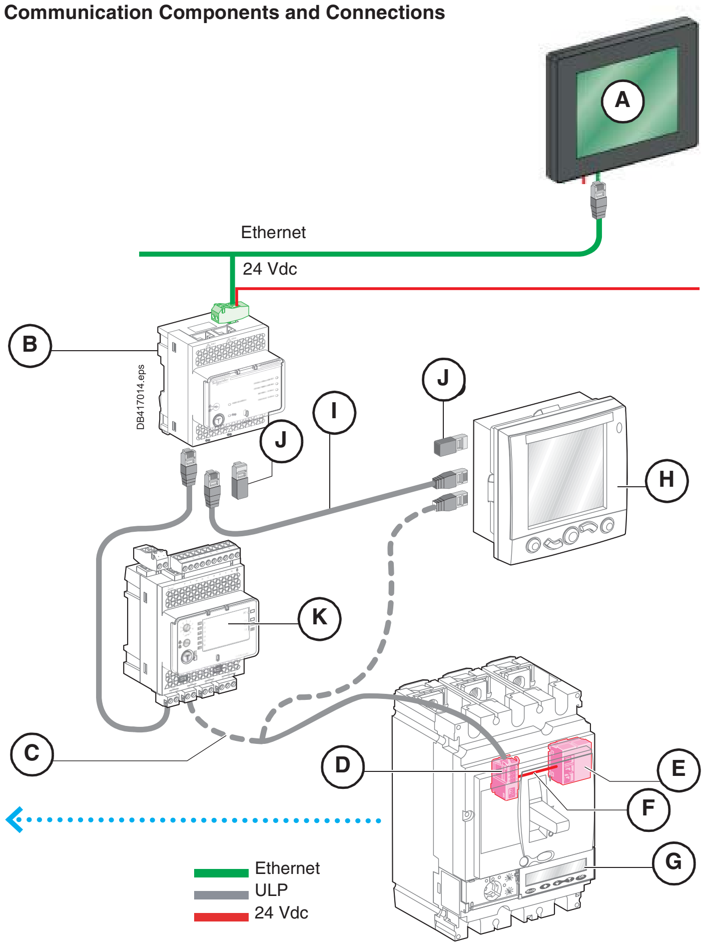
PowerPact circuit breaker is connected to the I/O module or FDM121 display unit via the internal terminal block for the NSX cord equipped with an RJ45 connector:

- Cord is available in three lengths: 0.98 ft. (0.35 m), 4.3 ft. (1.3 m) and 9.8 ft. (3 m).
- Lengths up to 32.9 ft. (10 m) are possible using extensions.

The FDM121 display unit and the I/O module are connected to:

- the IFM Modbus interface by a communication cable with RJ45 connectors on both ends
  or
- the IFE Ethernet interface module by a communication cable with RJ45 connectors on both ends.





A. FDM128
B. IFE Modbus Interface
C. NSX Cord
D. Internal Terminal Block for Communication via NSX Cord
E. BSCM Module
F. Prefabricated wiring
G. Micrologic Trip Unit
H. FDM121 Display
I. RJ45 Cable
J. Line Terminator (on unused connector if applicable)
K. I/O Module

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Figure 7: Panelboard and Switchboard Connections

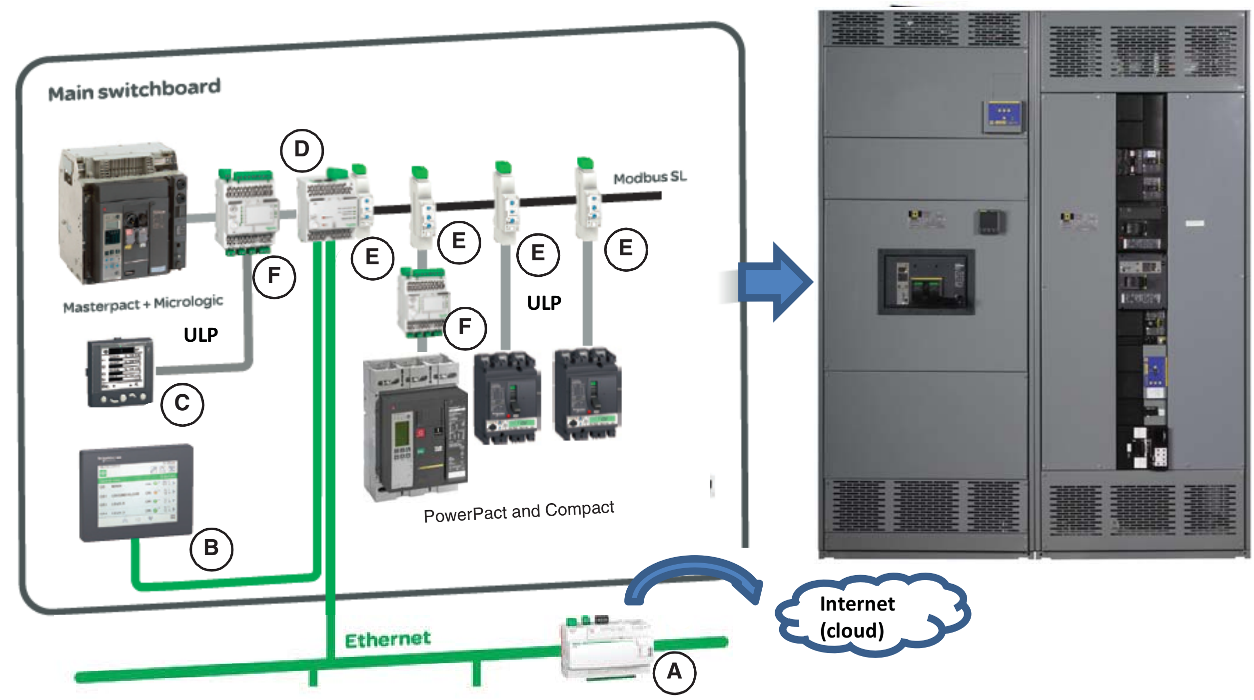

Table 60: Smart System Communication Devices and Displays

		Name	Function	Port		Bin. Input	Analog. Input	Bin. Output
				To Device	To Server			
A		Com'X 200	Energy Server with Ethernet Gateway® Function	Modbus Master	Ethernet Cable + WiFI	6	2	—
B		FDM128	Ethernet LCD Color Touch Screen	—	Ethernet	—	—	—
C		FDM121	LCD Display for Circuit Breaker	ULP	—	—	—	—

Continued on next page

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Table 60: Smart System Communication Devices and Displays *(continued)*

		Name	Function	Port To Device	 To Server	Bin. Input	Analog. Input	Bin. Output
D		IFE Interface + Gateway	Ethernet Interface & Gateway	Modbus Master & ULP	Ethernet	—	—	—
		IFE Interface	Ethernet Interface for Circuit Breakers	ULP	Ethernet	—	—	—
E		IFM	Modbus Interface for Circuit Breakers	ULP	Modbus Slave	—	—	—
F		I/O	Input/Output Application Module for Circuit Breakers	ULP	ULP	6	1	1

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Section 7—Trip Units

Available Trip Units

- PowerPact™ H-, J-, and L-Frame circuit breakers offer a range of thermal-magnetic and Micrologic™ electronic trip units in interchangeable cases. Thermal-magnetic trip units are designed to open automatically under overload or short circuit. H-frame and J-frame thermal-magnetic circuit breakers contain individual thermal (overload) and instantaneous (short circuit) sensing elements in each pole.
- Micrologic electronic trip units provide intelligent operation, with wide setting ranges make installation upgrades easier. Designed with processing capabilities, Micrologic trip units can provide measurement information and device operating assistance to supply all of the information required to manage the electrical installation and optimize energy use.

  Micrologic trip units offer excellent measurement accuracy, using a new generation of current transformers combining “iron-core” sensors for self-powered electronics and “air-core” sensors (Rogowski coils) for measurements. The protection functions are managed by an ASIC component that is independent of the measurement functions. This independence ensures immunity to conducted and radiated disturbances and a high level of reliability.

  An LED on the front of the electronic trip units indicates the result of the self-test running continuously on the measurement system and the tripping release. When the green LED is flashing, the links between the CTs, the processing electronics and the Mitop release are operational. The circuit breaker is ready to protect. A minimum current of 15 to 50 A, depending on the device, is required for this function.

  The dual adjustment for protection functions on Micrologic 5/6 consists of:

  — an adjustment using rotary switches sets the maximum value

  — an adjustment, made using the keypad or remotely, fine-tunes the setting. This setting may not exceed the first one. It can be read directly on the Micrologic screen, to within one ampere and a fraction of a second.

NOTE: All the trip units have a transparent sealable cover that protects access to the adjustment rotary switches.

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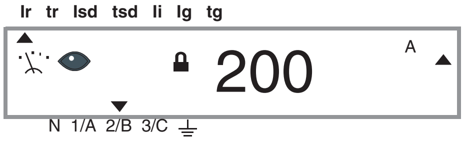
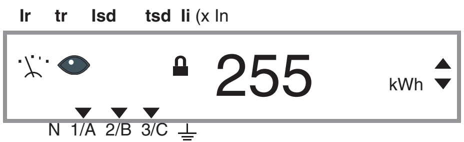
PowerPact H-, J-, and L-Frame Circuit Breakers
Trip Units

Table 61: Understanding the Names of Micrologic Electronic Trip Units

<table>
<tr><th></th><th>Protection</th><th>Frame</th><th>Measurements</th><th>Applications</th></tr>
<tr><td></td><td>1: I
3: LI or LSI
5: LSI
6: LSIG</td><td>H- and J-frame
</td><td>A: Ammeter
</td><td>DIstribution
or
M: Motors</td></tr>
<tr><td></td><td>L: Long time
S: Short time
I: Instantaneous
G: Ground fault</td><td>L-frame
</td><td>E: Energy
</td><td></td></tr>
<tr><td colspan="5">Examples</td></tr>
<tr><td>Micrologic 1.3 M Trip Unit</td><td>Instantaneous only</td><td colspan="2">400 or 600 A</td><td>Motor</td></tr>
<tr><td>Micrologic 3.3 Trip Unit</td><td>LI</td><td colspan="2">250, 400, or 600 A</td><td>Distribution</td></tr>
<tr><td>Micrologic 3.2S Trip Unit</td><td>LSI</td><td colspan="2">60, 100, 150, or 250 A</td><td>Distribution</td></tr>
<tr><td>Micrologic 5.2A Trip Unit</td><td>LSI—Ammeter</td><td colspan="2">60, 100, 150, or 250 A</td><td>Distribution</td></tr>
</table>

For Micrologic trip unit features, see table 12 on page 22.

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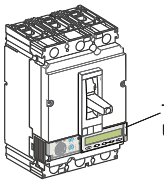
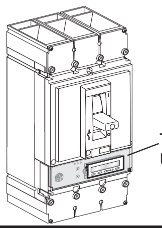
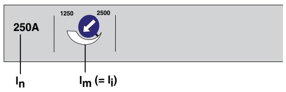
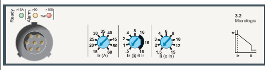
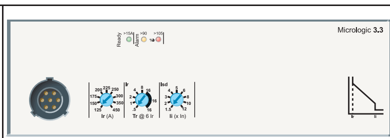
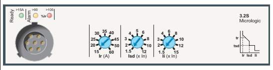
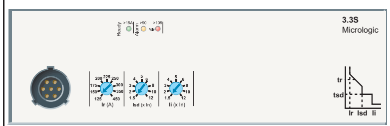
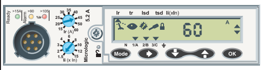
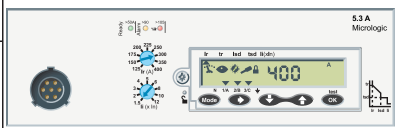
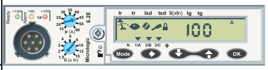
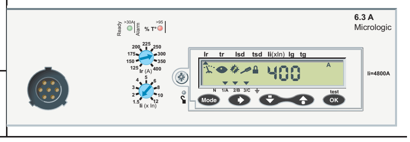
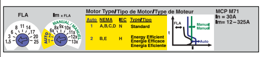
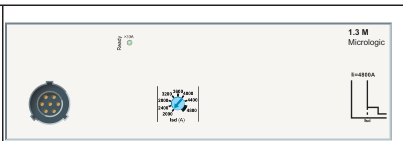
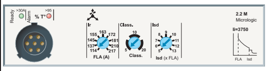
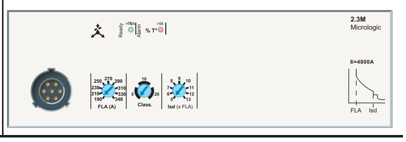
Table 62: Trip Unit Availability

Trip Unit Type	Trip Unit	H-, J-Frame	Trip Unit	L-Frame
				
Distribution Protection Thermal-Magnetic	T-M		N/A	
Distribution Protection LI	Micrologic 3.2 and 3.2-W		Micrologic 3.3 and 3.3-W	
Distribution Protection LSI Fixed ST and LT delays	Micrologic 3.2S and 3.2S-W		Micrologic 3.3S and 3.3S-W	
Distribution Protection LSI + Ammeter	Micrologic 5.2 A and 5.2 A-W		Micrologic 5.3 A and 5.3 A-W	
Distribution Protection LSI + Energy Monitoring	Micrologic 5.2 E and 5.2 E-W		Micrologic 5.3 E and 5.3 E-W	
Distribution Protection LSIG + Ammeter	Micrologic 6.2 A and 6.2 A-W		Micrologic 6.3 A and 6.3 A-W	
Distribution Protection LSIG + Energy Monitoring	Micrologic 6.2 E and 6.2 E-W		Micrologic 6.3 E and 6.3 E-W	
Motor Circuit Protection Magnetic Only	M		N/A	
Motor Protection Micrologic 1 M	N/A		Micrologic 1.3M	
Motor Protection Micrologic 2 M	Micrologic 2.2 M		Micrologic 2.3 M	

NOTE: W = mission critical trip unit.

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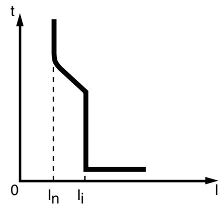
Protection of Distribution Systems

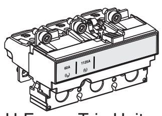
Thermal-Magnetic Trip Units



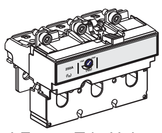
H-Frame Trip Curve

(I_n) Fixed threshold thermal protection against overload
(I_i) **Fixed** threshold instantaneous protection against short circuits

TM thermal-magnetic trip units can be used on PowerPact H and J-frame circuit breakers with interrupting levels D/G/J/L. Thermal-magnetic trip units are available in factory sealed or field-interchangeable constructions.



H-Frame Trip Unit



J-Frame Trip Unit

Table 63: H-Frame and J-Frame Three-Pole Field-Installable Thermal-Magnetic Trip Unit

15–60 A H-Frame		70–150 A H-Frame		150–250 A J-Frame	
Amperage	**Cat. No.**	**Amperage**	**Cat. No.**	**Amperage**	**Cat. No.**
15 A	**HT3015**	70 A	**HT3070**	150 A	**JT3150**
20 A	**HT3020**	80 A	**HT3080**	175 A	**JT3175**
25 A	**HT3025**	90 A	**HT3090**	200 A	**JT3200**
30 A	**HT3030**	100 A	**HT3100**	225 A	**JT3225**
35 A	**HT3035**	110 A	**HT3110**	250 A	**JT3250**
40 A	**HT3040**	125 A	**HT3125**	—	—
45 A	**HT3045**	150 A	**HT3150**	—	—
50 A	**HT3050**	—	—	—	—
60 A	**HT3060**	—	—	—	—

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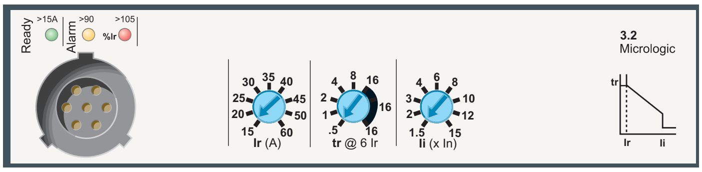
Micrologic 3 Trip Units

Micrologic 3 trip units can be used on PowerPact H-, J-, and L-Frame circuit breakers with performance levels D/G/J/L.



They provide:

- standard protection of distribution cables
- indication of:
  - — overloads (using LEDs)
  - — overload tripping (using the SDx relay module)

Circuit breakers equipped with Micrologic 3 trip units can be used to protect distribution systems supplied by transformers.

Protection

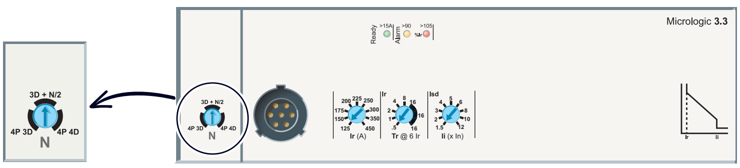
Settings are made using the adjustment rotary switches.

Overloads: Long time protection (I_r)

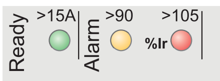
Inverse time protection against overloads with an adjustable current pick-up I_r set using a rotary switch and an adjustable time delay t_r.

Neutral protection

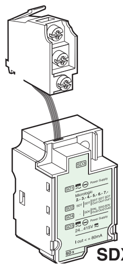
- On three-pole L-frame circuit breakers, neutral protection is not possible.
- On four-pole L-frame circuit breakers, neutral protection may be set using a three-position switch:
  - — switch position 4P 3D: neutral unprotected
  - — switch position 4P 3D + N/2: neutral protection at half the value of the phase pick-up, (0.5 x I_r)
  - — switch position 4P 4D: neutral fully protected at I_r



Indicators



Front Indicators



SDX Module

Front indicators

- The green “Ready” LED blinks slowly when the electronic trip unit is ready to provide protection. It indicates the trip unit is operating correctly.
- Orange overload pre-alarm LED: steady on when I > 90% I_r
- Red overload LED: steady on when I > 105% I_r

Remote indicators

An overload trip signal can be remotely checked by installing an SDx relay module inside the circuit breaker. This module receives the signal from the Micrologic electronic trip unit through an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is reclosed. See page 120.

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Table 64: Micrologic 3 Trip Unit

Ratings	I_n at 104°F (40°C)[1]		60 A	100 A	150 A	250 A	400 A	600 A			
Circuit Breaker	H-frame		X	X	X						
	J-frame					X					
	L-frame					X	X	X			
Micrologic 3.2 / 3.3 trip units[2]											
L Long-time protection											
Pick-Up (A) Tripping between 1.05 and 1.20 I_r	**I_r**		**Value depending on sensor rating (I_n) and setting on rotary switch**								
	I_n =60 A	I_r =	15	20	25	30	35	40	45	50	60
	I_n = 100 A	I_r =	35	40	45	50	60	70	80	90	100
	I_n = 150 A	I_r =	50	60	70	80	90	100	110	125	150
	I_n = 250 A	I_r =	70	80	100	125	150	175	200	225	250
	I_n = 400 A	I_r =	125	150	175	200	225	250	300	350	400
	I_n = 600 A	I_r =	200	225	250	300	350	400	450	500	600
Time Delay (s) Accuracy 0 to -20%	t_r		0.5	1	2	4	8	16			
		1.5 x I_r	15	25	50	100	200	400			
		6 x I_r	0.5	1	2	4	8	16			
		7.2 x I_r	0.35	0.7	1.4	2.8	5.5	11			
Thermal memory			20 minutes before and after tripping								
I Instantaneous											
Pick-up (A) accuracy ± 15%	I_i x	60 A, 100 A	1.5	2	3	4	6	8	10	12	15
		150 A	1.5	2	3	4	6	8	10	12	15
		250 A	1.5	2	3	4	5	6	8	10	12
		400 A	1.5	2	3	4	5	6	8	10	12
		600 A	1.5	2	3	4	5	6	8	10	11
	Non-tripping time Maximum break time		10 ms 50 ms for I > 1.5 li								
Micrologic 3.2S / 3.3S trip units[2]											
L Long-time protection											
Pick-Up (A) Tripping between 1.05 and 1.20 I_r	**I_r**		**Value depending on sensor rating (I_n) and setting on rotary switch**								
	I_n =60 A	I_r =	15	20	25	30	35	40	45	50	60
	I_n = 100 A	I_r =	35	40	45	50	60	70	80	90	100
	I_n = 150 A	I_r =	50	60	70	80	90	100	110	125	150
	I_n = 250 A	I_r =	70	80	100	125	150	175	200	225	250
	I_n = 400 A	I_r =	125	150	175	200	225	250	300	350	400
	I_n = 600 A	I_r =	200	225	250	300	350	400	450	500	600
Time Delay (s) Accuracy 0 to -20%	t_r		non-adjustable								
		1.5 x I_r	400								
		6 x I_r	16								
		7.2 x I_r	11								
Thermal memory			20 minutes before and after tripping								
S Short-time protection											
Pick-up (A) accuracy ± 10%	I_{sd} - I_r x...		1.5	2	3	4	5	6	7	8	10
Time delay (ms)	t_{sd}		non-adjustable								
	Non-tripping time Maximum break time		20 80								
I Instantaneous											
Pick-up (A) accuracy ± 15%	I_i x	60 A, 100 A	1.5	2	3	4	6	8	10	12	15
		150 A	1.5	2	3	4	6	8	10	12	15
		250 A	1.5	2	3	4	5	6	8	10	12
		400 A	1.5	2	3	4	5	6	8	10	12
		600 A	1.5	2	3	4	5	6	8	10	11
	Non-tripping time Maximum break time		10 ms 50 ms for I > 1.5 li								

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1 If the trip units are used in high-temperature environments, the Micrologic trip unit setting must take into account the thermal limitations of the circuit breaker. See the temperature derating information on page 150.

2 Mission Critical trip units have a “-W” at the end of the number (for example 3.2-W). All other protections are the same and have the same trip curves.

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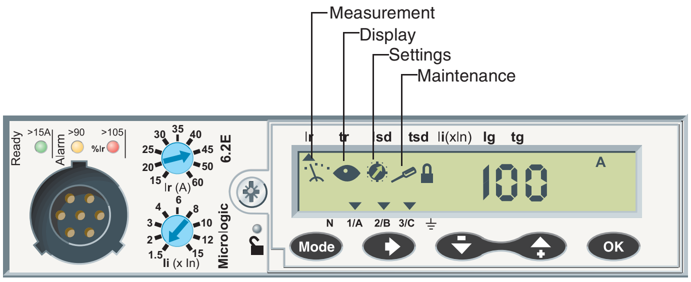
Micrologic 5/6 A or E Trip Units

Micrologic 5/6 A (Ammeter) or E (Energy) trip units can be used on PowerPact H-, J-, and L-frame circuit breakers with performance levels D, G, J, or L. They all have a front display module. They offer basic LSI protection (Micrologic 5 trip unit) or LSI and ground-fault protection G (Micrologic 6 trip unit). They also offer measurement, alarm and energy values.



The capabilities of Micrologic 5/6 A and E trip units come into full play with the front display module. When the two are connected using a simple cable with RJ45 connectors, the combination offers full Power Meter capabilities and all the measurements required to monitor the electrical installation.

	Measurements	**Operating and Maintenance Assistance**	**Communication Network**
Ammeter (Micrologic A Trip Unit)	Current measurements • Phase and neutral currents I_A, I_B, I_C, I_N • Average current of the 3 phases I_{avg} • Highest current of the three phases I_{max} • Ground-fault current Ig (Micrologic 6.2 / 6.3 A) trip units • Maximum and minimum current measured	Indicators, alarms and histories • Fault types • Alarms for high/low alarm thresholds linked to I measurements • Trip, alarm and operating histories • Time-stamped tables for settings and maximum current Maintenance indicators • Operation, trip and alarm counters • Operating hours counter • Contact wear • Load profile and thermal image	Modbus with add-on module
Energy (Micrologic E Trip Unit)	Current measurements • Phase and neutral currents I_A, I_B, I_C, I_N • Average current of the 3 phases I_{avg} • Highest current of the three phases I_{max} • Ground-fault current I_g (Micrologic 6.2 / 6.3 A trip units) • Maximum and minimum current measured • Current unbalance between phases Voltage measurements • Phase-to-phase (V) and phase-to-neutral (U) voltages • Average voltages V_{avg}, U_{avg} • Ph-Ph (V) and Ph-N (U) voltage unbalance Frequency measurements • Frequency (f) Power-quality indicators • Total harmonic distortion (THD) for current and voltage Power measurements • Active, reactive and apparent power, total and per phase • Power factor and cos φ Maximum and minimum • For all I, V, f, P, E measurements Demand current and power measurements • Demand values, total and per phase • Maximum demand Energy metering • Active, reactive and apparent energy, total and per phase	Indicators, alarms and histories • Fault types • Alarms for high/low thresholds linked to I, V, f, P, E measurements • Trip, alarm and operating histories • Time-stamped tables for settings and I, V, f, P, E maximum values Maintenance indicators • Operation, trip and alarm counters • Operating hours counter • Contact wear • Load profile and thermal image	Modbus with add-on module

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Power Requirements

The amount of current needed to power the trip unit is printed in the upper left hand corner of the trip unit by the Ready LED.

Table 65: Trip Unit Power Requirements

Frame		Power-Up Requirement
H-Frame, 60 A	60 A	> 15 A
	100 A	> 15 A
	150 A	> 30 A
J-Frame, 250A	250A	> 30 A
L-Frame, 600 A	400 A	> 50 A
	600 A	> 50 A

Protection

Settings can be adjusted in two ways, using the rotary switches and/or the keypad.

- The keypad can be used to make fine adjustments in 1 A steps below the maximum value defined by the setting on the rotary switch.
- Access to setting modifications using the keypad is protected by a locking function displayed on the screen and controlled by a microswitch.
- The lock is activated automatically if the keypad is not used for 5 minutes.
- Access to the microswitch is protected by a transparent, sealable cover.
- With the cover closed, it is still possible to display the various settings and measurements using the keypad.

Overloads: Long-Time Protection (I_r)

Inverse time protection against overloads with an adjustable current pick-up I_r is set using a rotary switch or the keypad for fine adjustments. The time delay t_r is set using the keypad.

Short-Circuits: Short-Time Protection (I_{sd})

Short-circuit protection with an adjustable pick-up I_{sd} and adjustable time delay t_{sd}, with the possibility of including a portion of an inverse time curve (I^2t On).

Short-Circuits: Instantaneous Protection (I_i)

Instantaneous protection with adjustable pick-up I_i.

Additional Ground Fault Protection (I_g) on Micrologic 6 Trip Units

Residual type ground-fault protection with an adjustable pick-up I_g and adjustable time delay t_g. Possibility of including a portion of an inverse time curve (I^2t On).

Neutral Protection

- On four-pole circuit breakers, this protection can be set using the keypad:
  - Off: neutral unprotected
  - 0.5: neutral protection at half the value of the phase pick-up (0.5 x I_r)
  - 1.0: neutral fully protected at I_r
  - OSN: Oversized neutral protection at 1.6 times the value of the phase pick-up.
    Used when there is a high level of 3rd order harmonics (or orders that are multiples of 3) that accumulate in the neutral and create a high current. In this case, the device must be limited to I_r = 0.63 x I_n for the maximum neutral protection setting of 1.6 x I_r.
- With three-pole circuit breakers, the neutral can be protected by installing an external neutral sensor with the output (T1, T2) connected to the trip unit.

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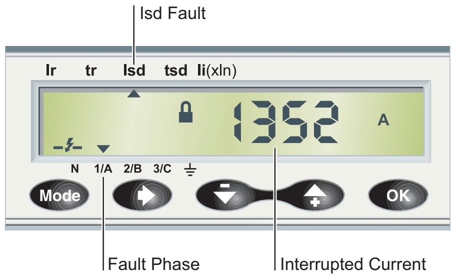
Zone Selective Interlocking (ZSI)

A ZSI terminal block may be used to interconnect a number of Micrologic trip units to provide zone selective interlocking for short-time (I_{sd}) and ground-fault (I_g) protection, without a time delay. For PowerPact H- and J-frame circuit breakers, the ZSI function is available only in relation to the upstream circuit breaker (ZSI out). For PowerPact L-frame circuit breakers, the ZSI function is available in relation to the upstream circuit breaker (ZSI out) and downstream circuit breakers (ZSI in).

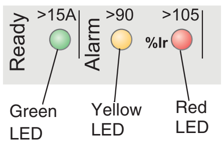
Display of Type of Fault.



Display of Interrupted Current.

On a fault trip, the type of fault (I_r, I_{sd}, I_i, I_g), the phase concerned and the interrupted current are displayed. An external power supply is required.

Indicators



Front Indicators

- The green "Ready" LED blinks slowly when the electronic trip unit is ready to provide protection. It indicates the trip unit is operating correctly.
- Orange overload pre-alarm LED stays on when I > 90% I_r
- Red overload LED stays on when I > 105% I_r

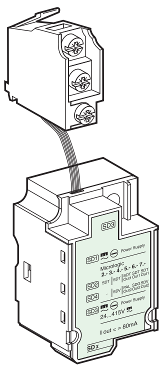
Remote Indicators

An SDx relay module installed inside the circuit breaker can be used to remote the following information:

- overload trip
- overload prealarm (Micrologic 5 trip units) or ground fault trip (Micrologic 6 trip units)

This module receives the signal from the Micrologic electronic trip unit through an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed. Note: all the trip units have a transparent sealable cover.

These outputs can be reprogrammed to be assigned to other types of tripping or that protects access to the adjustment rotary switch. The module is described in detail in the section dealing with accessories.



SDx Module

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Table 66: Micrologic 5/6 Trip Unit[1]

Ratings	I_n at 104°F (40°C)[2]	60 A	100 A	150 A	250 A	400 A	600 A
Circuit Breaker	H-frame	X	X	X			
	J-frame				X		
	L-frame					X	X

L Long-time protection

Pick-up (A) tripping between 1.05 and 1.20 I_r	I_r	rotary switch	Value depending on the trip unit rating (I_n) and setting on rotary switch								
	I_n = 60 A	I_r =	15	20	25	30	35	40	45	50	60
	I_n = 100 A	I_r =	35	40	45	50	60	70	80	90	100
	I_n = 150 A	I_r =	50	60	70	80	90	100	110	125	150
	I_n = 250 A	Ir =	70	80	100	125	150	175	200	225	250
	I_n = 400 A	Ir =	125	150	175	200	225	250	300	350	400
	I_n = 600 A	Ir =	200	225	250	300	350	400	450	500	600
		keypad setting	Fine adjustment in 1 A steps below maximum value set on rotary switch								
Time Delay (s) Accuracy 0 to -20%	tr =	keypad setting	0.5	1	2	4	8	16			
		1.5 x Ir	15	25	50	100	200	400			
		6 x Ir	0.5	1	2	4	8	16			
		7.2 x Ir	0.35	0.7	1.4	2.8	5.5	11			
Thermal memory			20 minutes before and after tripping								

S Short-time protection

Pick-up (A) accuracy ± 10%	I_{sd}	keypad setting		1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
				Fine adjustment in 0.5 x I_r steps using the keypad																	

Time delay	t_{sd} =	Keypad setting	I^2t Off	0	0.1 s	0.2 s	0.3 s	0.4 s
			I^2t On	—	0.1 s	0.2 s	0.3 s	0.4 s
	Non-tripping time			20 ms	80 ms	140 ms	230 ms	350 ms
	Maximum break time			80 ms	140 ms	200 ms	320 ms	500 ms

I Instantaneous

Pick-up (A) accuracy ± 15%	I_i = I_n x	Rotary Switch	60 A	1.5	2	.3	4	6	8	10	12	15
			100 A	1.5	2	.3	4	6	8	10	12	15
			150 A	1.5	2	.3	4	6	8	10	12	15
			250 A	1.5	2	.3	4	5	6	8	10	12
			400 A	1.5	2	.3	4	5	6	8	10	12
			600 A	1.5	2	.3	4	5	6	8	10	11
	Non-tripping time Maximum break time			10 ms 50 ms for I > Ii								

G Ground-fault protection - for Micrologic 6 A or E Trip Units

Pick-up (A) accuracy ± 10%	I_g	Keypad Setting																	
	I_n= 60 A	I_g =	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1		
	I_n= 100–600 A	I_g =	0.2	2.5	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1

Time delay (s)	t_g =	Keypad setting	I^2t Off	0	0.1	0.2	0.3	0.4
			I^2t On	—	0.1	0.2	0.3	0.4
	Non-tripping time			20	80	140	230	350
	Maximum break time			80	140	200	320	500
Test	I_g function			Built in				

1 Mission Critical trip units have a "-W" at the end of the number (for example 3.2-W). All other protections are the same and have the same trip curves.

2 If the trip units are used in high-temperature environments, the Micrologic trip unit setting must take into account the thermal limitations of the circuit breaker. See the temperature derating information on page 150.

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Table 67: Micrologic 3 Field-Installable Trip Units[1]

Circuit Breaker				Trip Unit Type	Catalog No.
Frame	**Standard**	**Poles**	**Rating**		
H-frame	UL/CSA/NOM	3	60 A	Micrologic 3.2	**HE3060U31X**
		3	60 A	Micrologic 3.2S	**HE3060U33X**
		3	100 A	Micrologic 3.2	**HE3100U31X**
		3	100 A	Micrologic 3.2S	**HE3100U33X**
		3	150 A	Micrologic 3.2	**HE3150U31X**
		3	150 A	Micrologic 3.2S	**HE3150U33X**
J-Frame	UL/CSA/NOM	3	250 A	Micrologic 3.2	**JE3250U31X**
		3	250 A	Micrologic 3.2S	**JE3250U33X**
L-Frame	UL/CSA/NOM	3	250 A	Micrologic 3.3	**LE3250U31X**
				Micrologic 3.3S	**LE3250U33X**
			400 A	Micrologic 3.3	**LE3400U31X**
				Micrologic 3.3S	**LE3400U33X**
			600 A	Micrologic 3.3	**LE3600U31X**
				Micrologic 3.3S	**LE3600U33X**
		4	250 A	Micrologic 3.3	**LE4250U31X**
				Micrologic 3.3S	**LE4250U33X**
			400 A	Micrologic 3.3	**LE4400U31X**
				Micrologic 3.3S	**LE4400U33X**
			600 A	Micrologic 3.3	**LE4600U31X**
				Micrologic 3.3S	**LE4600U33X**

1 Mission Critical trip units that end in “W” are factory sealed and are not available as field installable units.

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Table 68: Micrologic 5 and 6 Field-Installable Trip Units[1]

Circuit Breaker				Trip Unit Type	Catalog No.
Frame	Standard	Poles	Rating		
H-frame	UL/CSA/NOM	3	60 A	Micrologic 5.2 A	**HE3060U43X**
				Micrologic 6.2 A	**HE3060U44X**
				Micrologic 5.2 E	**HE3060U53X**
				Micrologic 6.2 E	**HE3060U54X**
			100 A	Micrologic 5.2 A	**HE3060U43X**
				Micrologic 6.2 A	**HE3100U44X**
				Micrologic 5.2 E	**HE3100U53X**
				Micrologic 6.2 E	**HE3100U54X**
			150 A	Micrologic 5.2 A	**HE3150U43X**
				Micrologic 6.2 A	**HE3150U44X**
				Micrologic 5.2 E	**HE3150U53X**
				Micrologic 6.2 E	**HE3150U54X**
J-Frame	UL/CSA/NOM	3	250 A	Micrologic 5.2 A	**JE3250U43X**
				Micrologic 6.2 A	**JE3250U44X**
				Micrologic 5.2 E	**JE3250U53X**
				Micrologic 6.2 E	**JE3250U54X**
L-Frame	UL/CSA/NOM	3	400 A	Micrologic 5.3 A	**LE3400U43X**
				Micrologic 6.3 A	**LE3400U44X**
				Micrologic 5.3 E	**LE3400U53X**
				Micrologic 6.3 E	**LE3400U54X**
			600 A	Micrologic 5.3 A	**LE3600U43X**
				Micrologic 6.3 A	**LE3600U44X**
				Micrologic 5.3 E	**LE3600U53X**
				Micrologic 6.3 E	**LE3600U54X**
	UL/CSA/NOM	4	400 A	Micrologic 5.3 A	**LE4400U43X**
				Micrologic 6.3 A	**LE4400U44X**
				Micrologic 5.3 E	**LE4400U53X**
				Micrologic 6.3 E	**LE4400U54X**
			600 A	Micrologic 5.3 A	**LE4600U43X**
				Micrologic 6.3 A	**LE4600U44X**
				Micrologic 5.3 E	**LE4600U53X**
				Micrologic 6.3 E	**LE4600U54X**

1 Mission Critical trip units that end in “W” are factory sealed and are not available as field installable units.

Table 69: Micrologic Spare Parts

Description	Frame	Trip Unit	Catalog No.
LCD Display	H/J/L	Micrologic 5	**S429483**
		Micrologic 6	**S429484**
Trip Unit Cover-Transparent	H/J	Micrologic 3	**S429481**
	L		**S432461**
	H/J	Micrologic 5/6	**S429478**
	L		**S432459**
Trip Unit Wire Seal	H	Micrologic 3/5/6	**MICROTUSEAL**

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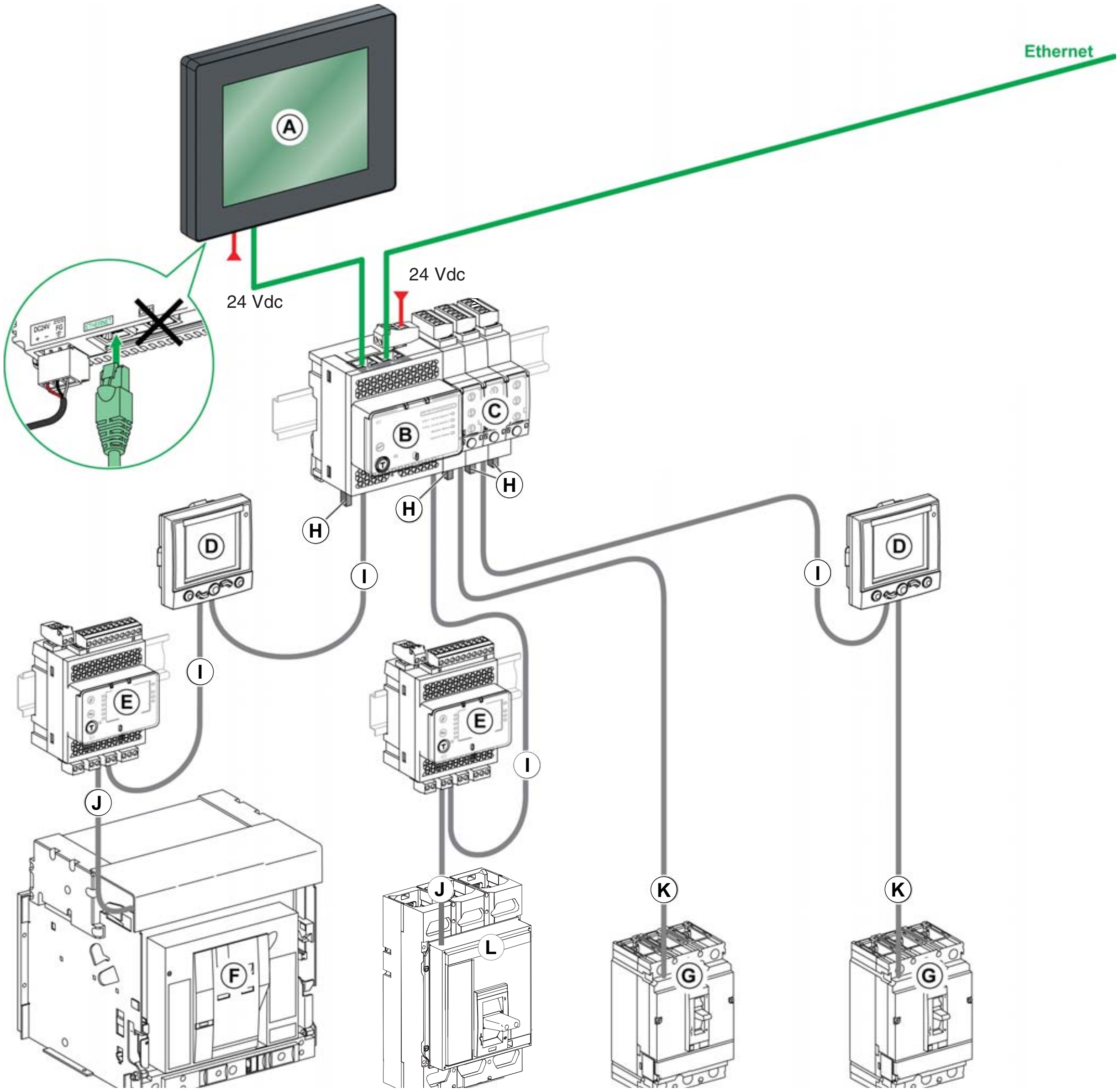
Smart System Communication Wiring System

Wiring System ULP

The wiring system is designed for low-voltage power switchboards. Installation does not require special tools or training. The prefabricated wiring ensures both data transmission (Modbus protocol) and 24 Vdc power distribution for the communications modules on the Micrologic trip units.



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A. FDM128 display for 8 LV devices
B. IFE Ethernet interface for LV circuit breaker and gateway
C. IFM Modbus-SL interface for LV circuit breaker
D. FDM121 display for LV circuit breaker
E. IO input/output interface module for LV circuit breaker
F. Masterpact NT/NW circuit breaker
G. PowerPact H-, J-, or L-frame circuit breaker
H. ULP line terminator
I. ULP cable
J. Breaker ULP cord
K. NSX cord
L. PowerPact P/R or Compact NS

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Four Functional Levels

All PowerPact H-, J-, and L-frame circuit breakers devices can be equipped with the communication function using a pre-wired connection system and a Modbus™ communication interface module. The interface module can be connected directly or through the front display module (FDM121).

The PowerPact H-, J-, and L-frame circuit breakers can be integrated in a Modbus communication network. Four functional levels can be used separately or combined to adapt to all supervision requirements.

Level	Function
Communication of status indications	Compatible with PowerPact H-, J- and L-frame circuit breakers and automatic switches. Use the BSCM module to access the following information: • ON/OFF position • trip indication • fault-trip indication
Communication of commands	Available on all circuit breakers and automatic switches with communicating motor operators, the remote control can be used to: • open • closed • reset
Communication of measurements with Micrologic 5/6 A or E trip unit	This level provides access to: • instantaneous and demand values • maximums/minimums • energy metering • demand current and power • power quality
Communication of operating assistance with Micrologic 5/6 A or E trip unit	This level also provides access to: • protection and alarm settings • time-stamped histories and event tables • maintenance indicators

Modbus Principle

The Modbus RS 485 (RTU protocol) system is an open bus on which communicating Modbus devices (PowerPact and Masterpact circuit breakers, Power Meter PM700, PM800, etc.) are installed. All types of PLCs and microcomputers may be connected to the bus.

Number of Devices

The maximum number of devices that may be connected to the Modbus bus depends on the type of device (PowerPact circuit breaker with Modbus COM, PM700, PM800, Masterpact circuit breaker, etc.), the baud rate (19200 is recommended), the volume of data exchanged and the desired response time. The RS 485 physical layer offers up to thirty-two connection points on the bus (one master, thirty-one slaves).

Length of Bus

The maximum recommended length for the Modbus bus is 3940 feet (1200 meters).

Bus Power Source

A 24 Vdc power supply is required (less than 20% ripple, insulation class II).

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Ethernet Principle

Ethernet is a data link and physical layer protocol defined by IEEE 802 10 and 100 Mbps specifications that connects computer or other Ethernet devices. Ethernet is an asynchronous Carrier Sense Multiple Access with Collision detection (referred as CSMA/CD) protocol. Carrier Sense means that the hosts can detect whether the medium (coaxial cable) is idle or busy.

Multiple Access means that multiple hosts can be connected to the common medium. Collision Detection means a host detects whether its transmission has collided with the transmission of another host (or hosts).

IFE Ethernet interface can be connected to a PC or a laptop over Ethernet. The maximum length of Ethernet cable is 325 feet (100 meters). IFE Ethernet interface + gateway provides a Modbus TCP/IP gateway over Ethernet to enable Modbus TCP communication from a Modbus TCP master to any Modbus slave devices connected to it. The maximum active Modbus TCP client connection is twelve.

IFE Ethernet interface has an embedded web server (web page).

IFE Ethernet Interface

IFE Interface, IFE Interface + Gateway Description

IFE Interface

Introduction

The IFE interface and IFE interface + gateway enable low-voltage circuit breakers such as Masterpact and PowerPact to be connected to an Ethernet network.

IFE Interface

Provides Ethernet access to a single low-voltage circuit breaker.

Function: Interface - one circuit breaker is connected to the IFE interface using its ULP port.

IFE Interface + Gateway

IFE Interface + Gateway

Provides Ethernet access to one or several low-voltage circuit breakers.

Functions:

- Interface - one circuit breaker is connected to the IFE interface using its ULP port.
- Gateway: several circuit breakers on a Modbus network are connected using the IFE interface + gateway master Modbus port.

IFE Interface, IFE Interface + Gateway Features

- Dual 10/100 Mbps Ethernet port for simple daisy chain connection.
- Device profile web service for discovery of the IFE interface, IFE interface + gateway on the LAN.
- Ethernet interface for Masterpact and PowerPact circuit breakers.
- Gateway for Modbus-SL connected devices (IFE interface + gateway only).
- Embedded set-up web pages.
- Embedded monitoring web pages.
- Embedded control web pages.
- Built-in e-mail alarm notification.

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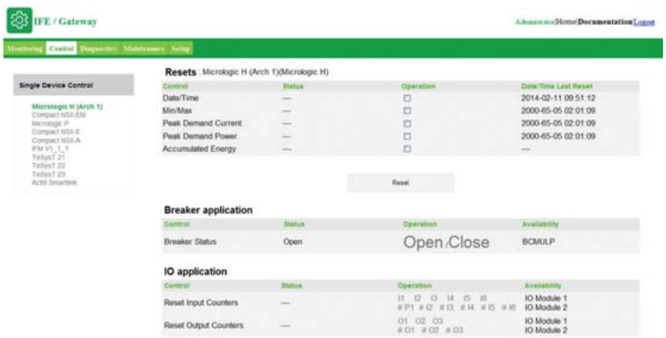
Figure 8: IFE Interface, IFE Interface + Gateway Screen



Mounting

The IFE interface and IFE interface + gateway are DIN rail mounting devices. A stacking accessory enables the user to connect several IFMs (ULP to Modbus interfaces) to an IFE interface + gateway without additional wiring.

24 Vdc Power Supply

The IFE interface and the IFE interface + gateway must always be supplied with 24 Vdc.

The IFMs stacked to an IFE interface + gateway have power supplied by the IFE interface + gateway, thus it is not necessary to supply them separately. It is recommended to use a UL listed and recognized limited voltage/limited current or a class 2 power supply with a 24 Vdc, 3 A maximum.

Required Circuit Breaker Communication Modules

The connection to an IFE interface or IFE interface + gateway requires a communication module embedded into the circuit breaker:

- PowerPact and Compact (fixed or drawout) circuit breakers: BSCM communication module
- Drawout PowerPact and Compact circuit breakers: BSCM and its respective I/O (Input/Output) application module.

All connection configurations for PowerPact and Compact circuit breakers require the circuit breaker ULP cord. The insulated NSX cord is mandatory for system voltages greater than 480 Vac. When the second ULP RJ45 connector is not used, it must be closed with a ULP terminator (TRV00880).

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Table 70: Network Communication Interface

Characteristic		Value
Type of interface module		Modbus RTU, RS485 serial connection Modbus TCP/IP Ethernet
Transmission	Modbus RS485	• Transfer rate: 9,600–19,200 Baud • Medium Double shielded twisted pair • Impedance 120 Ω
	Ethernet	Transfer rate: 10/100 Mbps Medium STP, Cat5e, straight cable
Structure	Type	Modbus, Ethernet
	Method	Master/Slave
Device type	Modbus	Master
	Ethernet	Server
Turnaround time	Modbus	10 ms
	Ethernet	1 ms
Maximum length of cable	Modbus	1000 m
	Ethernet	100 m
Type of bus connector	Modbus	4-pin connector
	Ethernet	RJ45 (Shielded)

Table 71: IFE Ethernet Interface Characteristics

General Characteristics	
Environmental Characteristics	
Conforming to standards	UL 508, UL 60950, IEC 60950, 60947-6-2
Certification	cUIUs, FCC, CE
Ambient temperature	Storage: -40 to +185°F (-40 to +85°C) Operation: -13 to +158°F (-25 to +70°C)
Protective Treatment	ULVO, conforming to IEC 60068-2-30
Pollution	Level 3
Mechanical Characteristics	
Shock resistance	Conforming to IEC 60068-2-27 15g/11ms, 1/2 sinusoidal
Resistance to sinusoidal vibrations	Conforming to IEC 60068-2-6
Electrical Characteristics	
Power Supply	24 Vdc, -20%/+10% (19.2 to 26.4 Vdc)
Consumption	Typical: 4 Vdc, 120 mA at 68°F (20°C) Maximum with gateway: 26.4 Vdc, 3 A at 140°F (60°C)
Physical Characteristics	
Dimensions	2.83 x 4.13 x 2.79 in. (72 x 105 x 71 mm)
Mounting	Mounting DIN rail
Weight	182.5 g (0.41 lb)
Degree of protection of the installed module	On the front panel (wall mounted enclosure): IP4x Connectors: IP2x Other parts: IP3x
Connections	Screw type terminal blocks
Technical Characteristics - 24 Vdc Power Supply	
Power supply type	Regulated switch type
Rated power	72 W
Input voltage	100–120 Vac for single phase 200–500 Vac phase-to-phase
PFC filter	With IEC 61000-3-2
Output voltage	24 Vdc
Power supply out current	3 A

IFE Web Page Description	
Monitoring Web Page	
Real time data	X
Device logging	X
Control Web Page	
Single device control	X
Diagnostics Web Page	
Statistics	X
Device information	X
IMU (circuit breaker) information	X
Read device registers	X
Communication check	X
Maintenance Web Page	
Maintenance log	X
Maintenance counters	X
Setup Web Page	
Device localization/name	X
Ethernet configuration (dual port)	X
IP configuration	X
Modbus TCP/IP filtering	X
Serial port	X
Date and time	X
E-mail server configuration	X
Alarms to be e-mailed	X
Device list	X
Device logging	X
Device log export	X
SNMP parameters	X
Documentation links	X
Preferences	X
Advanced services control	X
User accounts	X

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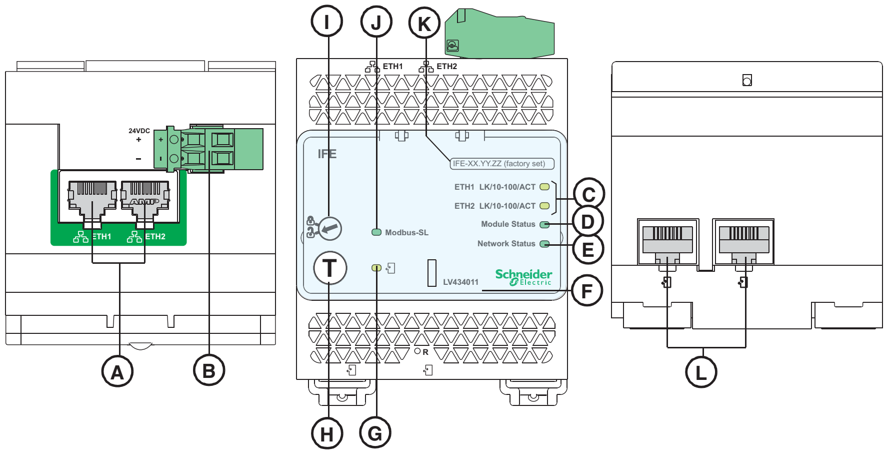
Table 71: IFE Ethernet Interface Characteristics

NOTE: Use a UL Listed/UL Recognized limited voltage/limited current or a Class 2 power supply with a 24 Vdc, 3 A maximum.



A. Ethernet 1 and Ethernet 2 communication port.
B. 24 Vdc power supply terminal block.
C. Ethernet communication LEDs:
   - yellow: 10 Mb
   - green: 100 Mb.
D. Module status LED:
   - steady off: no power
   - steady green: device operational
   - steady red: major fault
   - flashing green: standby
   - flashing red: minor fault
   - flashing green/red: self-test.
E. Network status LED:
   - steady off: no power/no valid IP address
   - steady green: connected, valid IP address
   - steady orange: default IP address
   - steady red: duplicated IP address
   - flashing green/red: Self-test.
F. Sealable transparent cover.
G. ULP status LED.
H. Test button (accessible closed cover).
I. Locking pad.
J. Modbus traffic status LED (IFE Interface + Gateway only).
K. Device name label.
L. ULP ports.

IFM Modbus Communication Interface

Function

IFM Modbus Communication Interface. Ref.: TRV00210

An IFM Modbus communication interface is required for connection of a Masterpact or PowerPact circuit breaker to a Modbus network as long as this circuit breaker is provided with a ULP (Universal Logic Plug) port. The port is available on the BSCM.

Once connected, the circuit breaker is considered as a slave by the Modbus master. Its electrical values, alarm status, open/close signals can be monitored or controlled by a Programmable Logic Controller or any other system.

Characteristics

ULP Port

Two RJ45 sockets, internal parallel wiring.

- Connection of a single circuit breaker.
- A ULP line terminator or an FDM121 display unit must be connected to the second RJ45 ULP socket.
- The RJ45 sockets deliver a 24 Vdc supply fed from the Modbus socket.
- Built-in test function, for checking the correct connection to the circuit breaker and FDM121 display unit.

Modbus Slave Port

- Top socket for screw-clamp connector, providing terminals for:
  — 24 Vdc input supply (0 V, +24 V)
  — Modbus line (D1, D2, Gnd) 2-wire Modbus system.

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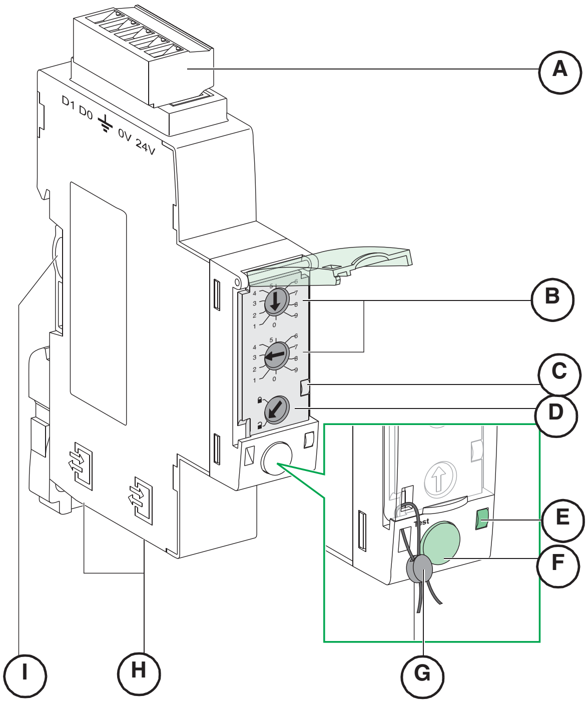
- Lateral socket, for DIN-rail stackable connector. Both top and lateral sockets are internally parallel wired.
- Multiple IFMs can be stacked, thus sharing a common power supply and Modbus line without individual wiring.
- On the front face:
  - — Modbus address setting (1 to 99): 2 coded rotary switches
  - — Modbus locking pad: enables or disable the circuit breaker remote control and modification of IFM parameters.
- Self-adjusting communication format (Baud rate, parity).



A. Modbus Screw Clamp Connector
B. Modbus Address Switches
C. Modbus Traffic LED
D. Modbus Locking Pad
E. ULP Activity LED
F. Test Button
G. Mechanical Lock
H. ULP RJ45 Connectors
I. Stacking Accessory Connection

Technical Characteristics

Table 72: IFM Modbus Communication Interface

Dimensions		0.71 x 2.83 x 3.78 in. (18 x 72 x 96 mm)
Maximum number of stacked IFM		12
Degree of protection of the installed module	Part projecting beyond the escutcheon	IP4x
	Other module parts	IP3x
	Connectors	IP2x
Operating temperature		-13 to 158°F (-25 to +70°C)
Power supply voltage		24 Vdc -20%/+10% (19.2–26.4 Vdc)
Consumption	Typical	21 mA/24 Vdc at 68°F (20°C)
	Maximum	30 mA/19.2 Vdc at 140°F (60°C)
Certification	CE	IEC/EN 60947-1
	UL	UL 508 - Industrial Control Equipment
	CSA	No. 142-M1987 - Process Control Equipment • CAN/CSA C22.2 No. 0-M91 - General requirements - Canadian Electrical Code Part • CAN/CSA C22.2 No. 14-05 - Industrial Control Equipment

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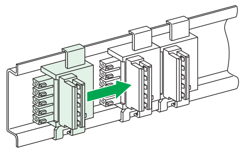
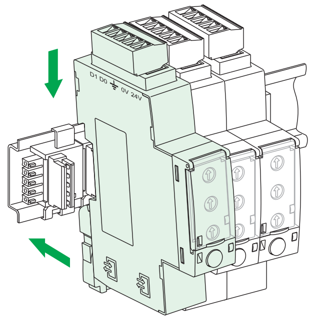
Simplified IFM Installation

Stacking an IFM

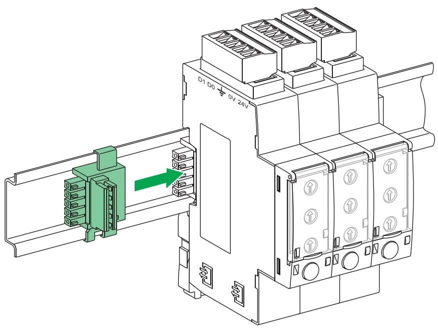


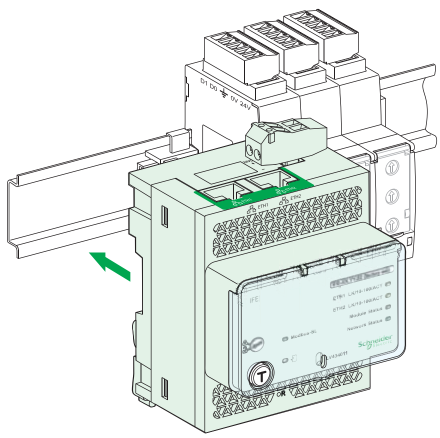
Stacking Accessories



Up to Twelve Stacked IFM

Stacking an IFE Interface + Gateway with IFMs





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I/O Application Module

Description

I/O Application Module

The I/O (Input/Output) application module for a low-voltage circuit breaker is part of an ULP system with built-in functions and applications to enhance the application needs. The ULP system architecture can be built without any restrictions using the wide range of circuit breakers.

The I/O application module is compliant with the ULP system specifications.

Two I/O application modules can be connected in the same ULP network.

The ranges of low-voltage circuit breakers enhanced by the I/O application module are:

- Masterpact NW
- Masterpact NT
- PowerPact R-Frame
- PowerPact P-Frame
- PowerPact H-Frame
- PowerPact J-Frame
- PowerPact L-Frame

I/O (Input/Output) Application Module for Low-Voltage Circuit Breaker Resources

The I/O application module resources are:

- Six digital inputs that are self powered for either NO and NC dry contact or pulse counter.
- Three digital outputs that are a bistable relay (5 A maximum).
- One analog input for PT100 temperature sensor.

Pre-Defined Application

The pre-defined application adds new functions to the I/O application module by:

- Selection by the application rotary switch on the I/O application module, defining the application with pre-defined input/output assignment and wiring diagram.
- No additional setting with the customer engineering tool required.

The resources not assigned to the pre-defined application are free for additional user-defined applications:

- cradle management
- circuit breaker operation
- cradle management + ERMS (Energy Reduction Maintenance Setting)

  NOTE: Use only Micrologic P or H trip units with the blue ERMS label for energy reduction maintenance setting systems. Review the I/O module user guide 0613IB1317 and ERMS installation instructions NHA37346 for details on installation, testing, and operation of the ERMS system.
- light and load control
- custom

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User-Defined Applications

User-defined applications are processed by the I/O application module in addition to the pre-defined application selected.

The user-defined applications are available depending on:

- the pre-defined application selected
- the I/O application module resources (inputs and outputs) not used by the application.

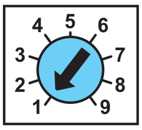
The resources required by user-defined applications are assigned using the customer engineering tool:

- protection
- control
- energy management
- monitoring.

Mounting

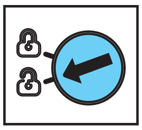
The I/O application module is a DIN rail mounted device. Install on a steel DIN rail that is properly grounded near the device.

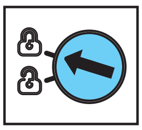
Application Rotary Switch



The application rotary switch enables the selection of the pre-defined application. It has nine positions and each position is assigned to a pre-defined application. The factory set position of the switch is pre-defined application one.

Setting Locking Pad





The setting locking pad on the front panel of the I/O application module enables the setting of the I/O application module by the customer engineering tool.

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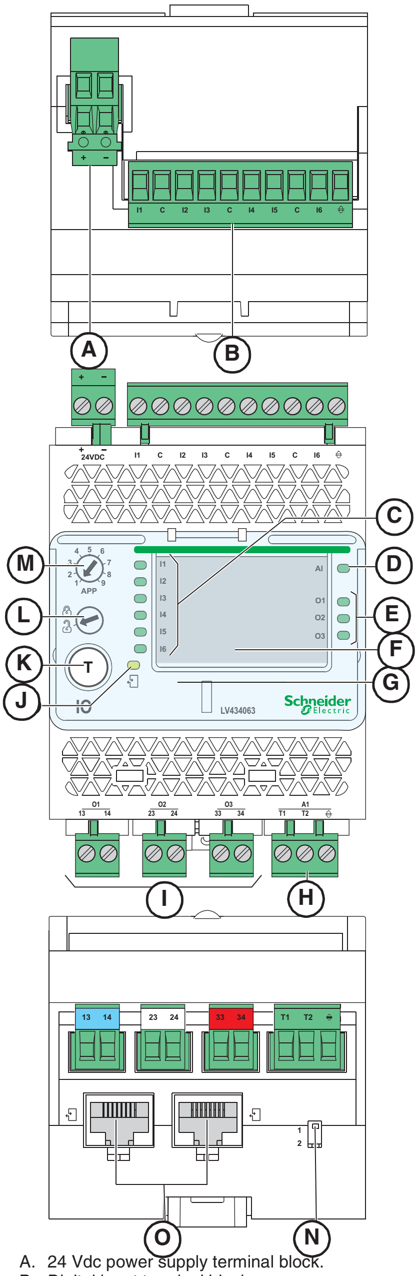

A. 24 Vdc power supply terminal block.
B. Digital input terminal block:
6 inputs, 3 commons and 1 shield.
C. 6 input status LEDs.
D. Analog input status LED.
E. 3 output status LEDs.
F. I/O application module identification labels.
G. Sealable transparent cover.
H. Analog input terminal block.
I. Digital output terminal blocks.
J. ULP status LED.
K. Test/reset button (accessible with cover closed).
L. Setting locking pad.
M. Application rotary switch: 1 to 9.
N. Switch for I/O addressing (IO 1 or IO 2).
O. ULP connectors.

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General Characteristics		
Environmental Characteristics	Conforming to standards	UL 508, UL 60950, IED 60950, 60947-6-2
	Certification	cULus, EAC, FCC, CE
	Ambient temperature	Storage: -40 to +185°F (-40 to +85°C) Operation: -13 to +158°F (-25 to +70°C)
	Protective Treatment	ULVO, conforming to IEC 60068-2-30
	Pollution	Level 3
Mechanical Characteristics	Shock resistance	Conforming to IEC 60068-2-27 15g/11ms, 1/2 sinusoidal
	Resistance to sinusoidal vibrations	Conforming to IEC 60068-2-6
Electrical Characteristics	Power Supply	24 Vdc, -20%/+10% (19.2 to 26.4 Vdc)
	Consumption	Typical: 24 Vdc, 165 mA at 20°C Maximum with gateway: 26.4 Vdc, 420 mA at 60°C
Physical Characteristics	Dimensions	2.83 x 4.52 X 2.79 in. (72 x 115 x 71 mm)
	Mounting	DIN rail
	Weight	0.51 lb. (229.5 g)
	Degree of protection of the installed I/O application module	• On the front panel (wall mounted enclosure): IP4x • I/O parts: IP3x • Connectors: IP2x
	Connections	Screw type terminal blocks
Technical Characteristics 24 Vdc power supply	Power supply type	Regulated switch type
	Rated power	72 W
	Input voltage	• 100–120 Vac for single phase • 200–500 Vac phase-to-phase maximum
	PFC filter	With IEC 61000-3-2
	Output voltage	24 Vdc
	Power supply out current	3 A
	NOTE: It is recommended to use an UL listed/UL listed recognized limited voltage/limited current or a class 2 power supply with a 24 Vdc, 3 A maximum.	
Digital Inputs	Digital input type	Self powered digital input with current limitations as per IEC 61131-2 type 2 standards (7 mA)
	Input limit values at state 1 (close)	19.8–25.2 Vdc, 6.1–8.8 mA
	Input limit values at state 0 (open	0–19.8 Vdc, 0 mA
	Maximum cable length	33 ft (10 m)
	NOTE: For a length greater than 10 m (33 ft) and up to 300 m (1,000 ft), it is mandatory to use a shielded twisted cable. The shield cable is connected to the I/O functional ground of the I/O application module.	
Digital Outputs	Digital output type	Bistable relay
	Rated load	5 A at 250 Vac
	Rated carry current	5 A
	Maximum switching voltage	380 Vac, 125 Vdc
	Maximum switch current	5 A
	Maximum switching power	1250 VA, 150 W
	Minimum permissible load	10 mA at 5 Vdc
	Contact resistance	30 mΩ
	Maximum operating frequency	• 18000 operations/hr (Mechanical) • 1800 operations/hr (Electrical)
	Digital output relay protection by an external fuse	External fuse of 5 A or less
	Maximum cable length	10 m (33 ft)
Analog Inputs	The I/O application module analog input can be connected to a Pt100 temperature sensor	
	Range	-22 to 392°F (-30 to 200°C)
	Accuracy	-22 to 68°F (-30 to 20°C): ±3.6°F (2°C) 68 to 284°F (20 to 140°C): ±1.8°F (1°C) 284 to 392°F (140 to 200°C): ±3.6°F (2°C)
	Refresh interval	5 s

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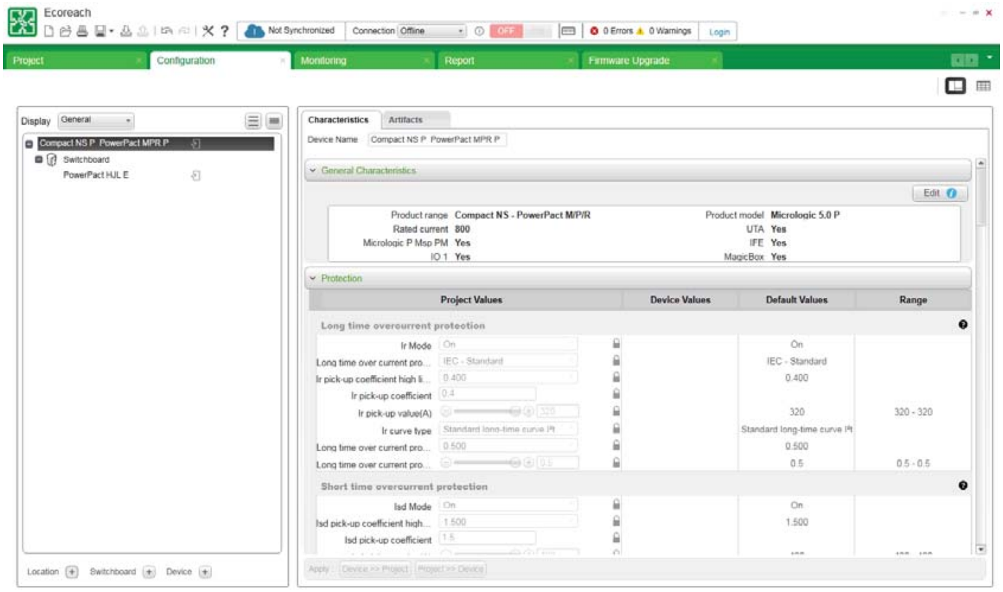
Electrical Asset Manager Configuration Engineering Tool (Ecoreach™)

Introduction

The Ecoreach engineering tool is a software application that helps the user to manage a project as part of designing, testing, site commissioning, and maintenance of the project life cycle. It enables the user to prepare the settings of the devices offline (without connecting to the device) and configure them when connected with the devices. It also provides other value-added features for the user to manage the project such as: safe repository in cloud, attach artifacts to each device or at the project level, organize devices in switchboard, manage a hierarchical structure of the installation, etc.



Compatible Devices (Configuration and Device Management)

The Ecoreach engineering tool is compatible with the following devices:

- Compact NSX100-630 (IEC) circuit breakers
- PowerPact (UL) circuit breakers
- Compact NS630b-3200 (IEC) circuit breakers
- Masterpact NT/NW (IEC and UL) circuit breakers
- Compatible devices (Device Management in the project)
- Switches (Compact NSX, Masterpact & PowerPact Family)
- Third party devices.

References:

The Ecoreach software package can be downloaded from our website:

www.schneider-electric.com

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Features

The Ecoreach engineering tool includes the Schneider Electric customer engineering tools such as the Remote Setting Utility (RSU) and Remote Control Utility (RCU) with additional features.

The Ecoreach engineering tool supports the connection of Schneider Electric communicable devices to:

- create projects by device discovery, selection of devices, and importing a Bill of Material (BOM)
- monitor the status of protection and I/O status
- read information (alarms, measurements, parameters)
- check protection discrimination between two devices
- upload and download of configuration or settings in batch mode to multiple devices.
- carry out commands and tests
- generate and print a device settings report and communication test report
- manage multiple devices with a electrical and communication hierarchy model
- manage artifacts (project documents)
- check consistency in settings between devices on a communication network
- compare configuration settings between PC and device (online)
- download latest firmware.

The Ecoreach engineering tool enables the user to access the advanced features of the software once the project is saved in the Schneider Electric cloud.

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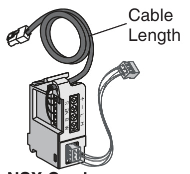
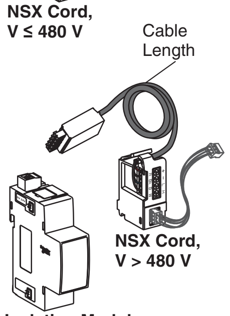
Section 8—Accessories for Micrologic™ Trip Units

NSX Cord



NSX Cord, V ≤ 480 V



Isolation Module for NSX Cord with V > 480 V

Micrologic trip units are connected to the Modbus communication interface module (IFM) or front display module through the internal terminal block for the NSX cord equipped with an RJ45 connector.

The NSX cord is available in two cable lengths:

- 4.27 ft. (1.3 m)
- 9.84 ft. (3 m)

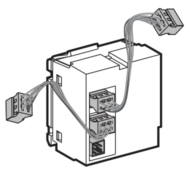
Lengths up to 32.8 ft. (10 m) are possible using extensions.

- For voltage V ≤ 480 V, available in 3 prefabricated lengths: 0.35 m, 1.3 m and 3 m.
- For voltages V > 480 V, a special 1.3 m cable with an insulation accessory is required.
- A set of cables with RJ45 connectors is available to adapt to different distances between devices.

Table 73: NSX Cord Catalog Numbers

Description	Catalog No.
NSX Cord 4.27 ft. (1.3 m), V ≤ 480 V	**S434201**
NSX Cord 9.84 ft. (3 m), V ≤ 480 V	**S434202**
NSX Cord 4.27 ft. (1.3 m), V > 480 V	**S434204**
NSX Cord 9.84 ft. (3 m), V > 480 V	**S434303**

Breaker Status and Control Module (BSCM)



Functions

The optional BSCM Breaker Status & Control Module is used to acquire device status indications and control the communicating remote-control function. It includes a memory used to manage the maintenance indicators.

Status indications

Indication of device status:
Auxiliary switch (OF), alarm switch (SD), and overcurrent trip switch (SDE).

Maintenance indicators

The BSCM manages the following indicators:

- mechanical operation counter
- electrical operation counter
- history of status indications.

It is possible to assign an alarm to the operation counters.

Controls

The BSCM can be used to carry out communicating remote control operations using the communicating motor operator (open, close and reset) in different modes (manual, auto).

Mounting

The BSCM can be installed on all PowerPact H-, J-, and L-frame circuit breakers and automatic switches with Micrologic trip units. It simply clips into the auxiliary contact slots. It occupies the slots of one auxiliary switch (OF) and one overcurrent trip switch (SDE). The BSCM is supplied with 24 Vdc power automatically through the NSX cord when the communication network is installed.

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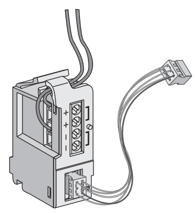
Catalog Numbers

Table 74: BSCM Catalog Numbers

Description	Catalog No.
Replacement BSCM	**S434205**
BSCM with NSX Cord 1.3 m, V ≤ 480 V	**S434201BS**
BSCM with NSX Cord 3 m, V ≤ 480 V	**S434202BS**
BSCM with NSX Cord 1.3 m, V > 480 V	**S434204BS**
BSCM with NSX Cord 3 m, V > 480 V	**S434303BS**

24 Vdc Power-Supply Terminal Block



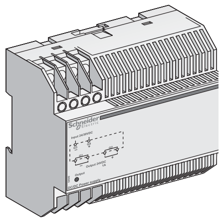
24 Vdc Terminal Block

The Micrologic 5/6 trip unit display is operational when current is flowing through the circuit breaker. To power the Micrologic 5/6 trip unit when the trip unit is not connected to an FDM121 or to the communication network, a 24 Vdc power-supply terminal block can be installed only on Micrologic 5/6 trip units. When used, it excludes connection of an NSX cord.

Table 75: 24 Vdc Catalog Number

Description	Catalog No.
24 Vdc Terminal Block Unit Mount	**S434210**

External 24 Vdc Power-Supply Module



External 24 Vdc
Power-Supply Module

An external 24 Vdc power supply is required for installation in a communication network, whatever the type of trip unit.

On installations without a communication network, the power supply is available as an option for Micrologic 5/6 trip units in order to:

- modify settings when the circuit breaker is open
- display measurements when the current flowing through the circuit breaker is low (15 to 50 A depending on the rating)
- maintain the display of the cause of tripping and interrupted current.

A single external 24 Vdc supply may be used for the entire network, depending on the number of devices in the communication network. The required characteristics are:

- output voltage: 24 Vdc ± 5%
- ripple: ± 1%

Table 76: Available External Power-Supply Modules (1 A)

Available External Power-Supply Modules		Input Voltage	Output Power	Cat. No.
Power supply	Vdc (±5%)	24–30	24 Vdc 1 A	**685823**
		48–60		**685824**
		100–125		**685825**
	Vac (+10%, -15%)	110–130		**685826**
		200–240		**685827**
		380–415		**685829**

To determine the required output current of the 24 Vdc power supply, it is necessary to sum up the currents consumed by the different loads supplied.

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Table 77: Power Requirements

Module	Typical Consumption 24 Vdc at 68°F (20°C)	Maximum Consumption 19.2 Vdc at 140°F (60°C)
Micrologic 5/6 trip units	30 mA	55 mA
BSCM	9 mA	15 mA
FDM121	21 mA	30 mA
IFM	21 mA	30 mA
Isolated Modbus Repeater Module	15 mA	19 mA

For installation recommendations, see page page 156.

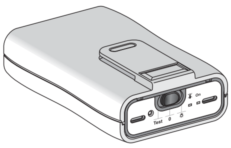

Battery Module

Battery Module

The battery module is a back-up supply for the external power-supply module. The input/output voltages are 24 Vdc and it can supply power for approximately three hours (100 mA).

Table 78: Battery Module

Description	Catalog No.
Battery Module	**685831**


Pocket Tester

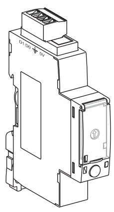
Pocket Tester

The pocket tester connects to the Micrologic trip unit test connector. It powers up the Micrologic trip unit and the Ready LED. It supplies the screen, allows settings to be made using the keypad, and provides thermal imaging inhibit functions.

Table 79: Pocket Tester

Description	Catalog No.
Pocket Tester	**S434206**

The pocket tester runs off of two Alkaline AA batteries.



Isolated Modbus Repeater Module

Since Modbus interface modules (part number STRV00210) are not isolated, an isolated Modbus Repeater Module needs to be inserted between the Modbus network inside the equipment and the Modbus network outside the equipment.

Table 80: Catalog Number

Description	Catalog No.
Isolated Modbus Repeater Module	**STRV00211**

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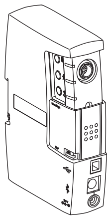
UST Test Adapter (UTA) Tester for Test and Maintenance


UTA Tester Module

The UTA Tester includes:

- configuration and maintenance module
- power supply (110–220 Vac / 50-60 Hz 24 Vdc - 1 A)
- special Micrologic cable for connection to the trip-unit test connector
- standard USB cable
- standard RJ45 cable
- user manual

Table 81: UTA Tester Catalog Numbers

Description	Catalog No.
UTA Tester (complete)	**STRV00910**
Spare 110-240 V power supply	**TRV00915**
Spare Micrologic cable	**TRV00917**
Spare UTA Tester Module	**STRV00911**
Bluetooth/Modbus Option for UTA Tester	**TCSWAAC13FB**

Included in the UTA Tester, the UTA Tester module tests Micrologic trip unit operation and provides access to all parameters and settings. It connects to the Micrologic trip unit test connector and can operate in two modes.

- Stand-alone mode to:
  - — supply the Micrologic trip unit with power and check operation using the Ready LED
  - — Provides ground-fault inhibit and thermal memory inhibit
- PC mode, connected to a PC with a USB or Bluetooth link. This mode provides access to protection settings, alarm settings and readings of all indicators. Using the associated RSU software utility, it is possible to store, in a dedicated file for each device, all the data that can transferred to another device.
  This mode also offers operating-test functions:
  - — check on trip time delay (trip curve)
  - — check on non-tripping time (coordination)
  - — check on ZSI (Zone Selective Interlocking) function
  - — alarm simulation
  - — display of setting curves
  - — display of currents
  - — printing of test reports
  - — optional Bluetooth link (to PC).

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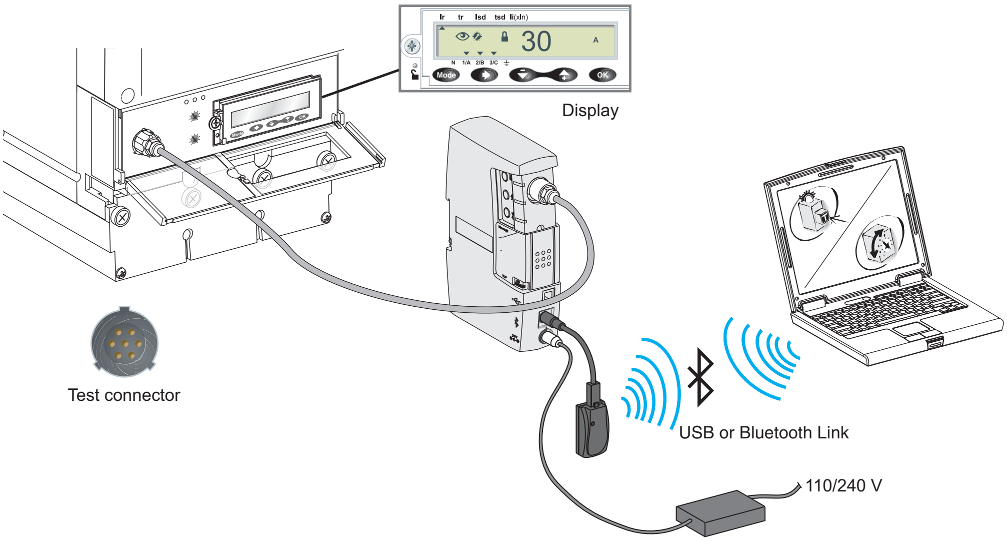

Universal Logic Plug System


ULP Symbol

The Universal Logic Plug (ULP) system allows the PowerPact H-, J- and L-frame circuit breakers to become metering and supervision tools to assist for energy efficiency. For easy connection of the different modules, the prefabricated cables are identified by a ULP symbol. The connection points on compatible modules are marked in the same manner.

Table 82: ULP Accessories Catalog Numbers

Description	Qty	Catalog No.
RJ45 connectors, female/female	10	**TRV00870**
ULP Line termination	10	**TRV00880**
RJ45/RJ45 male cord L= 0.3 m	10	**TRV00803**
RJ45/RJ45 male cord L= 0.6 m	10	**TRV00806**
RJ45/RJ45 male cord L = 1 m	5	**TRV00810**
RJ45/RJ45 male cord L = 2 m	5	**TRV00820**
RJ45/RJ45 male cord L = 3 m	5	**TRV00830**
RJ45/RJ45 male cord L = 5 m	1	**TRV00850**
Modbus Line Terminations	2	**VW3A8306DRC**

For more information about the ULP System, see bulletin 48940-329-01, *ULP (Universal Logic Plug) Connection System—User Guide.*

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External Neutral Current Transformer (ENCT)

External neutral current transformer

The external neutral current transformer is a sensor required for a three-pole circuit breaker in a system with a distributed neutral to measure the neutral current in order to:

- protect the neutral conductor
- protect against ground faults.

This current transformer can be connected to Micrologic 5/6 trip units. The transformer rating must be compatible with that of the circuit breaker.

Table 83: Current Transformers

Circuit Breaker	Rating	Catalog No.
H-Frame	60–100 A	**S429521**
	150 A	**S430562**
J-Frame	250 A	**S430563**
L-Frame	400–600 A	**S432575**

For installation recommendations, see page 155.

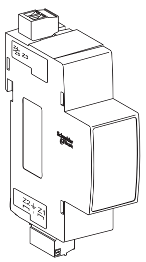
External Neutral Voltage Tap (ENVT)

External Neutral Voltage Tap

The external neutral voltage tap is required for Micrologic E power metering with a three-pole circuit breaker in a system with a distributed neutral. It is used to connect the neutral to the Micrologic trip unit to measure phase-to-neutral (Ph-N) voltages.

The ENVT is included with the Micrologic 5/6 electronic trip unit.

Zone Selective Interlock (ZSI) Module



A ZSI terminal block may be used to interconnect a number of Micrologic trip units to provide zone selective interlocking for short-time (I_{sd}) and ground-fault (I_g) protection, without a time delay. For PowerPact H- and J-frame circuit breakers, the ZSI function is available only in relation to the upstream circuit breaker (ZSI out). For PowerPact L-frame circuit breakers, the ZSI function is available in relation to the upstream circuit breaker (ZSI out) and downstream circuit breakers (ZSI in).

Table 84: ZSI Catalog Number

Description	Catalog No.
ZSI Module	**S434212**

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I-Line™ Wiring Harness

Accessories installed in I-Line circuit breakers require the use of optional wiring harnesses (not provided). The wiring harness allows the accessory wiring to exit the circuit breaker through wiring channels in the side of the circuit breakers. Wire harnesses may also be used for unit-mount applications.

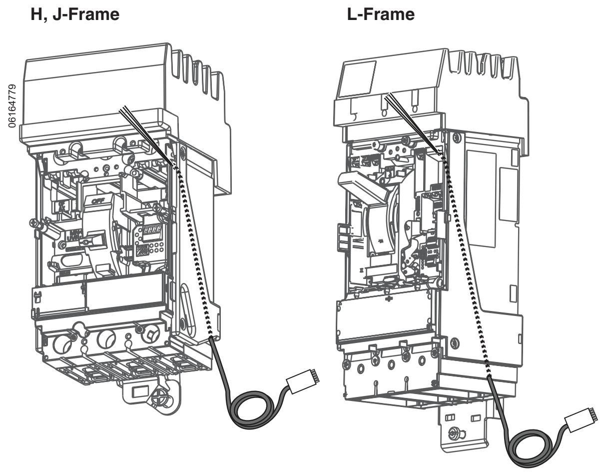

Table 85: Wiring Harness Catalog Numbers

Description	Catalog No.
Auxiliary Switch (OF) I-Line Wire Harness	**S434500**
Alarm Switch (SD)/Overcurrent Trip Switch (SDE) I-Line Wire Harness	**S434501**
SDx/SDTAM I-Line Wire Harness	**S434502**
Undervoltage Trip (MN) I-Line Wire Harness	**S434503**
Shunt Trip (MX) I-Line Wire Harness	**S434504**
24 Vdc Power Supply Terminal Block I-Line Wire Harness	**S434505**
Motor Operator (MT) I-Line Wire Harness	**S434506**
Communicating Motor Operator (MTc) I-Line Wire Harness	**S434507**
NSX Cord I-Line Wire Harness	**S434508**
ZSI (H/J-Frame, Out Only) I-Line Wire Harness	**S434300**
ZSI (L-Frame, In and Out) I-Line Wire Harness	**S434301**
ENCT I-Line Wire Harness	**S434302**

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Section 9—Accessories and Auxiliaries

All PowerPact™ H-, J-, and L-frame circuit breakers and automatic switches have slots for the electrical auxiliaries .

H- and J-Frame

- 4 indication contacts
  - 2 ON/OFF (auxiliary switches [OF1 and OF2])
  - 1 trip indication (alarm switch [SD])
  - 1 fault-trip indication (overcurrent trip switch [SDE])
- one remote-tripping release
  - either 1 undervoltage trip (MN)
  - or 1 shunt trip (MX)

L-Frame

- 5 indication contacts
  - 3 ON/OFF auxiliary switches (OF1, OF2, and OF3)
  - 1 trip indication (alarm switch [SD])
  - 1 fault-trip indication (overcurrent trip switch [SDE])
- one remote-tripping release
  - either 1 undervoltage trip (MN)
  - or 1 shunt trip (MX)

Circuit breakers equipped with Micrologic™ trip units may be equipped with a fault-trip indication to identify the type of fault by installing

- one indication module with two outputs (see page 119)
  - either an SDx module with Micrologic 3.x / 5.x A or E / 6.x A or E
  - or an SDTAM module with Micrologic 2.x M.

  This module occupies the slots of one auxiliary switch (OF) contact and an undervoltage trip (MN)/shunt trip (MX).

All these auxiliaries may be installed with a motor operator.

Communication Network

Communication networks require specific auxiliaries.

Communication of status indications:

- 1 BSCM module
- 1 NSX cord (internal terminal block) for both communication and 24 Vdc supply to the BSCM.

Communication of status conditions is compatible with a standard motor operator.

Communication of status indications and controls requires, in addition to the previous auxiliaries:

- 1 communicating motor operator connected to the BSCM.

Communication of measurements is available on Micrologic 5/6. The system consists of:

- 1 NSX cord (internal terminal block) for both communication and 24 Vdc supply to the Micrologic.

Communication of measurements is compatible with a standard or communicating motor operator.

Communication of status indications, controls and measurements is available on Micrologic 5/6. The system consists of:

- 1 BSCM module
- 1 NSX cord (internal terminal block) for both communication and 24 Vdc supply to the BSCM and the Micrologic
- 1 communicating motor operator connected to the BSCM.

Installation of SDx or SDTAM is compatible with communication network.

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PowerPact H-, J-, and L-Frame Circuit Breakers
Accessories and Auxiliaries

Table 86: Standard Auxiliary Possibilities Based on Trip Unit

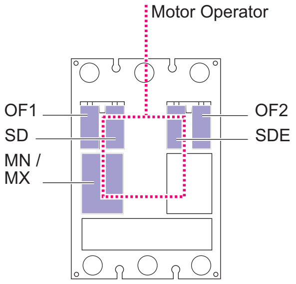
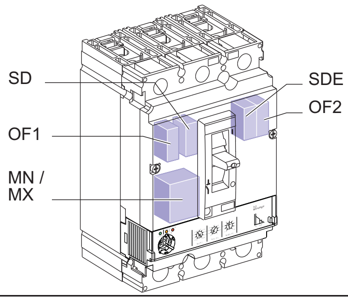
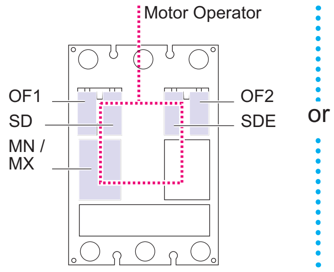
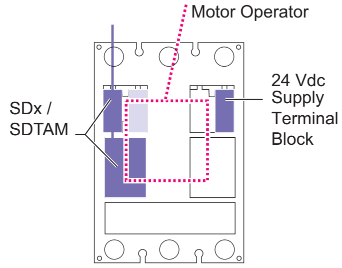
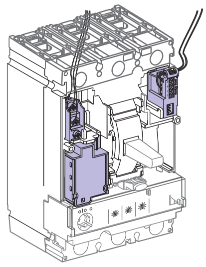
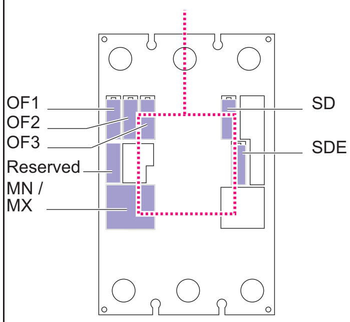
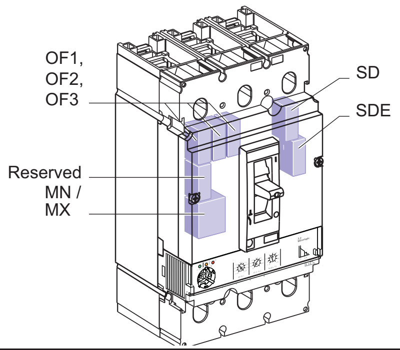
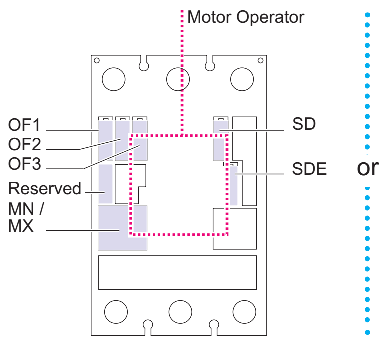
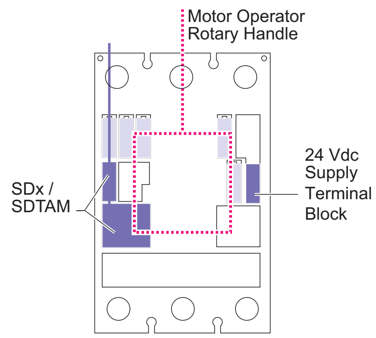
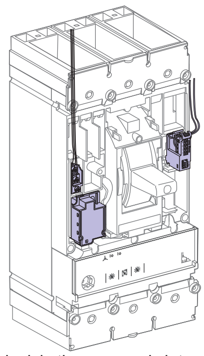
Type	Trip Unit	Auxiliary Possibilities
H-Frame J-Frame	Micrologic 3	 
H-Frame J-Frame	Micrologic 5 Micrologic 6	   *The SDx or SDTAM uses the OF1 and MN/MX slots.* *External connection is made via a terminal block in the OF1 slot.* *The 24 Vdc supply provides for the Micrologic 5 / 6 display when the device is OFF or under low-load conditions.*
L-Frame	Micrologic 1.3 M Micrologic 3	 
L-Frame	Micrologic 5 Micrologic 6	   **NOTE:** External connection is made using a terminal block in the reserved slot. The 24 V DC supply provides for the Micrologic 5 / 6 display when the device is OFF or under low-load conditions.

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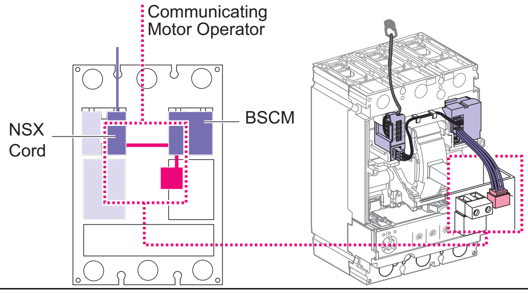
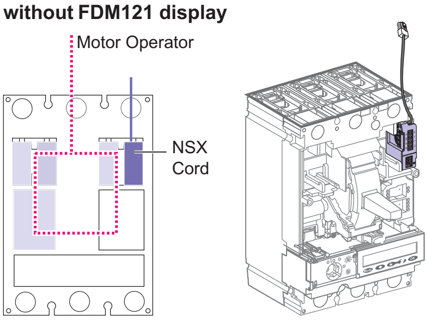
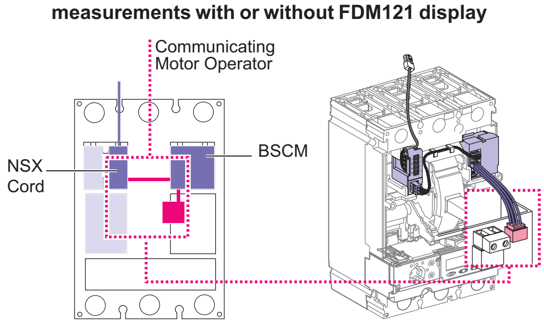
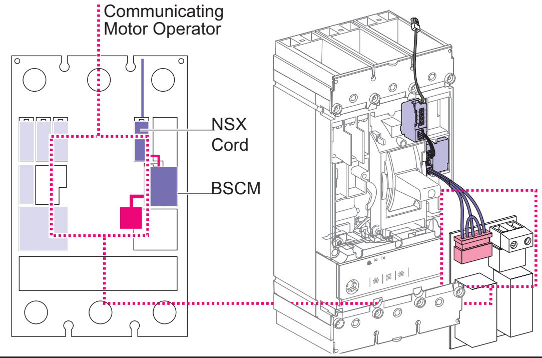
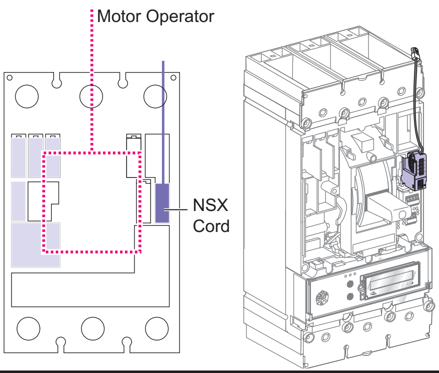
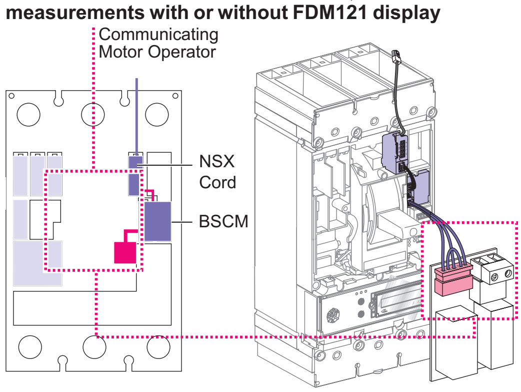
Table 87: Communication Network Auxiliary Possibilities Based on Trip Unit

<table>
<tr><th>Type</th><th>Trip Unit</th><th colspan="2">Auxiliary Possibilities</th></tr>
<tr><td>H-Frame
J-Frame</td><td>Micrologic 3</td><td colspan="2">Communication of status indications and controls

</td></tr>
<tr><td>H-Frame
J-Frame</td><td>Micrologic 5
Micrologic 6</td><td>Communication of measurements with or without FDM121 display

</td><td>or
Communication of status indications, controls and measurements with or without FDM121 display

</td></tr>
<tr><td>L-Frame</td><td>Micrologic 1.3 M
Micrologic 3</td><td colspan="2">Communication of status indications and controls

</td></tr>
<tr><td>L-Frame</td><td>Micrologic 5
Micrologic 6</td><td>Communication of status indications

</td><td>or
Communication of status indications, controls and measurements with or without FDM121 display

</td></tr>
</table>

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Accessory Connections

Electrical accessories are fitted with numbered terminal blocks for wires with the following maximum size:

- 16 AWG (1.5 mm^2) for auxiliary switches (OF1 or OF2), and shunt trip (MX) or undervoltage trip (MN)
- 14 AWG (2.5 mm^2) for the motor operator

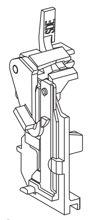
Auxiliary switch wiring exits fixed mounted devices through a knock-out in the front cover.

NOTE: See page 140 for plug-in and page 142 for drawout options.

Auxiliary and Alarm Indication Contacts

Auxiliary indication contacts provide remote information of the circuit breaker status and can thus be used for indications, electrical locking, relays, etc.

Auxiliary Switch (OF)/
Alarm Switch (SD)



Overcurrent Trip
Switch Actuator (SDE)

Table 88: Auxiliary and Alarm Indication Contacts

Applications	**Open/Closed—Auxiliary Switches (OF)** • Indicates the position of the circuit breaker contacts **Trip Indication—Alarm Switch (SD)** • Indicates that the circuit breaker has tripped due to an overload, short circuit or ground fault, the operation of a shunt trip or undervoltage trip or the “push-to-trip” button • Resets when the circuit breaker is reset **Overcurrent Trip Switch (SDE)** • Indicates that the circuit breaker has tripped due to an overload, short circuit or ground fault • Resets when the circuit breaker is reset The above switches are also available in low-level versions (with gold flash plating) capable of switching very low loads (e.g., for controlling PLCs or electronic circuits) **Rotary Handle Indicator: CAO (early-break) and CAF (early-make)** • Fitted in the rotary handle module (see page 127)
Installation & Connection	• The auxiliary switch (OF), alarm switch (SD), and overcurrent trip switch (SDE) indication contacts snap into cavities behind the front accessory cover of the circuit breaker. • One model serves for all indication functions depending on where it is fitted in the circuit breaker. • The overcurrent trip switch (SDE) in a circuit breaker equipped with a thermal-magnetic or Micrologic 1/2/3 trip unit requires the SDE actuator.
Standards	• The internal accessories comply with requirements of Underwriters Laboratories® Inc. (UL®). • UL 489 and Canadian Standard Association C22.2 No. 5-02 Standards. • All internal accessories are Listed for field installation per UL file E103955 and Certified under CSA file LR 69561. • Auxiliary indicator contacts comply with UL 489, CSA C22.2 No. 5-02 and IEC 60947-5 Standards. “Low-level” indicator contacts are not UL Recognized.

Table 89: Electrical Characteristics

Characteristic	Standard		Low-Level[1]	
Supplied as Standard (Form C)	4		4	
Maximum Number of Contacts	4		4	
Rated Thermal Current	6 A		5 A	
Minimum Load	100 mA at 24 V		1 mA at 4 V	
Operational Current	AC	DC	AC	DC
24 V	6 A	6 A	5 A	5 A
48 V	6 A	2.5 A	5 A	2.5 A
110 V	6 A	0.6 A	5 A	0.6
220/240 V	6 A	—	5 A	—
250 V	—	0.6 A	5 A	0.3 A
380/440 V	6 A	—	5 A	—
480 V	6 A	—	5 A	—
660/690 V	6 A	—	—	—

1 If the maximum voltage and current is exceeded, the low-level function of the switch will be lost but the switch will continue to function as a standard switch.

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Table 90: Auxiliary Switch Catalog Numbers

Contacts	Factory-Installed Suffix	Field-Installable Kit No.	Kit Qty.
1A/1B Standard	AA	**S29450**	1
2A/2B Standard	AB	**S29450**	2
1A/1B Low-Level (Gold)	AE	**S29452**	1
2A/2B Low-Level (Gold)	AF	**S29452**	2

Table 91: Alarm/Overcurrent Trip Switch Catalog Numbers

Suffix	Switch	Kit No.	Kit Qty.
PowerPact L-Frame PowerPact H/J-Frame with Micrologic 5/6 trip units			
BC	Alarm Switch	S29450	1
BH	Alarm Switch Low-Level	S29452	1
BD	Overcurrent Trip Switch Standard	S29450	1
BJ	Overcurrent Trip Switch Low-Level	S29452	1
BE	Alarm Switch and Overcurrent Trip Switch, Standard	S29450	2
BK	Alarm Switch and Overcurrent Trip Switch, Low-Level	S29452	2
PowerPact H/J-Frame with Thermal-Magnetic or Micrologic 1/2/3 trip units			
BC	Alarm Switch	S29450	1
BH	Alarm Switch, Low-Level	S29452	1
BD	Overcurrent Trip Switch, Standard SDE Actuator	S29450 S29451	1 1
BJ	Overcurrent Trip Switch, Low-Level SDE Actuator	S29452 S29451	1 1
BE	Alarm Switch and Overcurrent Trip Switch, Standard SDE Actuators	S29450 S29451	2 2
BK	Alarm Switch and Overcurrent Trip Switch, Low-Level SDE Actuators	S29452 S29451	2 2

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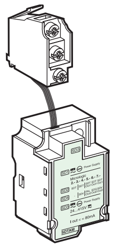
SDx and SDTAM Modules for Micrologic Trip Units

SDx and SDTAM are relay modules with two outputs. They send different signals depending on the type of fault. They may not be used together.

SDx Module



SDx module with terminal block.

The SDx module remotely monitors the trip or alarm conditions of PowerPact H-, J-, and L-frame circuit breakers equipped with electronic protection.

An SDx relay module installed inside the circuit breaker can be used to remote the overload trip signal.

This module receives the signal from the Micrologic electronic trip unit through an optical link and makes it available on the terminal block. The signal is cleared when the circuit breaker is closed. These outputs can be reprogrammed to be assigned to other types of tripping or alarm.

The SDx module may be used in 400 Hz systems for voltages from 24 to 440 V.

The SD2 output, available on all Micrologic trip units, corresponds to the overload-trip indication.

The SD4 output, available on Micrologic 5/6, is assigned to:

- overload pre-alarm (Micrologic 5)
- ground-fault trip indication (Micrologic 6)

These two outputs automatically reset when the device is closed (turned ON).

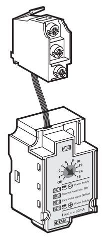
For Micrologic 5/6, the SD2 and SD4 outputs can be reprogrammed to be assigned to other types of tripping or alarm.

It is possible to assign a function output characteristics:

- latching with a time delay. Return to the initial state occurs at the end of the time delay
- permanent latching. Return to the initial state takes place through the communication function.

Static outputs: 24–415 Vac / Vdc; 80 mA max.

SDTAM Module



SDTAM module with terminal block.

The SDTAM module, linked to the contactor controller, opens the contactor when an overload or other motor fault occurs, thus avoiding opening of the circuit breaker. The SDTAM module is specifically for the motor-protection Micrologic trip units 2 M (2.2 M and 2.3 M).

Micrologic 2 M

The SD4 output opens the contactor 400 ms before normal circuit-breaker opening in the following cases:

- overload (long-time protection for the trip class)
- phase unbalance or phase loss

The SD2 output serves to memorize contactor opening by SDTAM.

Output characteristics

Output reset can be:

- manual by a pushbutton included in the wiring diagram
- automatic after an adjustable time delay (1 to 15 minutes) to take into account the motor-cooling time

Static outputs: 24–415 Vac / Vdc; 80 mA max. a (+) 24–415 V.

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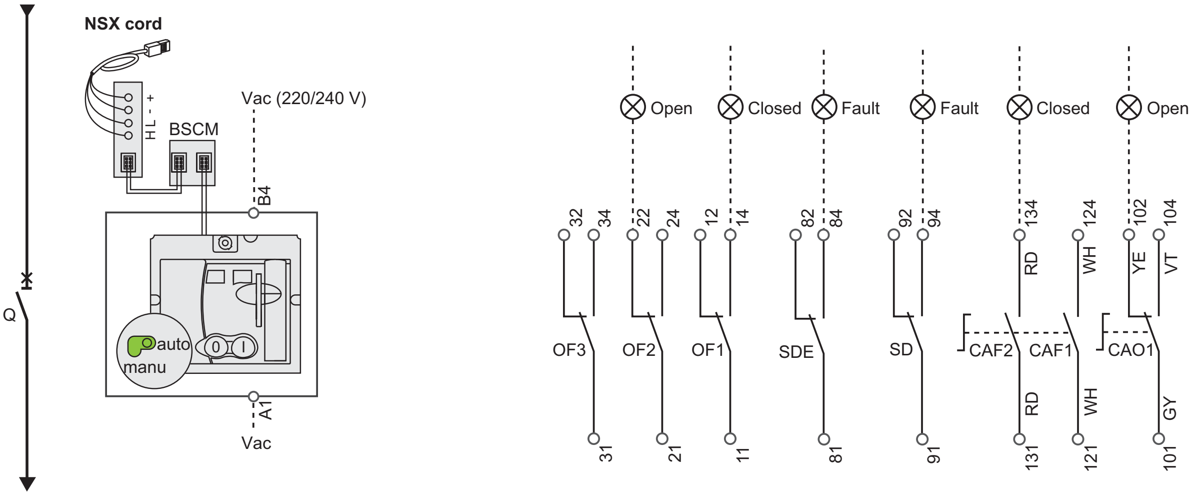

NOTE: Schematic of the communicating motor operator .

Table 92: SDx and SDTAM Catalog Numbers

Contacts	Factory-Installed Suffix	Field-Installable Kit No.
SDx	V	**S429532**
SDTAM (motor trip units only)	V	**S429424**

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Shunt Trip (MX) and Undervoltage Trip (MN)

A voltage release can be used to trip the circuit breaker using a control signal.

Table 93: Shunt Trip and Undervoltage Trip

Applications	**Shunt Trip (MX)** • Trips the circuit breaker when the control voltage rises above 70% of its rated voltage • Impulse type ≥ 20 ms or maintained control signals • AC shunt trips are suitable for ground-fault protection when combined with a Class I ground-fault sensing element • Continuous duty rated coil **Undervoltage Trip (MN)** • Trips the circuit breaker when the control voltage drops below a tripping threshold • Drops out between 35% and 70% of the rated voltage • Continuous duty rated coil • Circuit breaker closing is possible only if the voltage exceeds 85% of the rated voltage. If an undervoltage condition exists, operation of the closing mechanism of the circuit breaker will not permit the main contacts to touch, even momentarily. This is commonly called “Kiss Free”.
Installation and Connection	• Accessories are common to H-, J-, and L-frame circuit breakers and snap into cavities under the front accessory cover of the circuit breaker • Each terminal may be connected by one 18–14 AWG (1.0–2.5 mm^2) stranded copper wire
Operation	• The circuit breaker must be reset locally after being tripped by shunt trip (MX) or undervoltage trip (MN) • Tripping by the shunt trip or undervoltage trip has priority over manual (or motor operator) closing; in the presence of a standing trip order such an action does not result in any closing, even temporarily, of the main contacts • Endurance: 50% of the rated mechanical endurance of the circuit breaker

Table 94: Electrical Characteristics

		AC	DC
Rated Voltage (V)		24, 48, 120, 208/277, 380/480, 525, 600	12, 24, 30, 48, 60, 125, 250
Power Requirements	Pickup (shunt trip)	< 10 VA	< 5 W
	Seal-in (undervoltage trip)	< 5 VA	< 5 W
Clearing Time (ms)		< 50	< 50

Table 95: Shunt Trip and Undervoltage Trip Suffix Codes and Kit Numbers

Voltage	Shunt Trip (MX)		Undervoltage Release (MN)	
	Factory-Installed Suffix	Field-Installable Kit No.	Factory-Installed Suffix	Field-Installable Kit No.
24 Vac	SK	**S29384**	UK	**S29404**
48 Vac	SL	**S29385**	UL	**S29405**
120 Vac	SA	**S29386**	UA	**S29406**
208/277 Vac	SD	**S29387**	UD	**S29407**
380/480 Vac	SH	**S29388**	UH	**S29408**
525/600 Vac	SJ	**S29389**	UJ	**S29409**
12 Vdc	SN	**S29382**	UN	**S29402**
24 Vdc	SO	**S29390**	UO	**S29410**
30 Vdc	SU	**S29391**	UU	**S29411**
48 Vdc	SP	**S29392**	UP	**S29412**
60 Vdc	SV	**S29383**	UV	**S29403**
125 Vdc	SR	**S29393**	UR	**S29413**
250 Vdc	SS	**S29394**	US	**S29414**

Table 96: Adjustable and Fixed Time Delay Units for Undervoltage Trip

Rated Input Voltage	Field-Installable Kit No.		Use Only with These Undervoltage Releases (MN)
	Adjustable	Fixed	
48 Vac/dc	S33680	S29426	S29412
100/130 Vac/dc	S33681	—	S29413
220/250 Vac/dc	S33682	S29427	S29414

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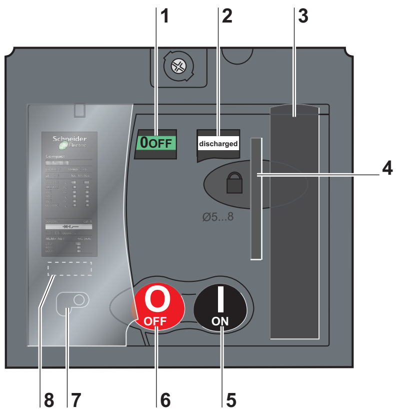
Motor Operator

The motor operator remotely operates the circuit breaker featuring easy and sure operation:

- All circuit breaker indications and information remain visible and accessible, including trip unit settings and circuit breaker connection
- Suitability for isolation is maintained and padlocking remains possible
- Double insulation front face



1. Contact position indicator (suitability for isolation)
2. Spring status indicator (charged, discharged)
3. Manual spring-charging handle
4. Keylock device
   Locking device (off position) using one to three padlocks, diameter 0.2–0.32 in. (5–8 mm), not supplied
5. ON push button
6. OFF push button
7. Manual/auto mode selection switch; the position of the switch can be indicated remotely
8. Operation counter

Applications:

- Local motor-driven operation, centralized operation, automatic distribution control
- Normal/standby manual transfer or switching to a replacement source to optimize energy costs
- Load shedding and reconnection to optimize energy costs
- Less than five cycle closing time for source synchronization

Installation and Connection

- All installations are available for H- and J-frame circuit breakers.
  All installations are available for L-frame circuit breakers except I-Line
- Connections of the motor operator module are to a built-in terminal block behind its front cover
- Stranded copper wire 14 AWG (2.5 mm^2)

Automatic Operation

The motor operator is connected in series with the overcurrent trip switch (SDE).

- ON and OFF by two impulse type or continuous control signals
- Depending on the wiring, resetting can be done locally, remotely or automatically
- Mandatory manual reset following tripping due to an electrical fault (with overcurrent trip switch)

Manual Operation

- Transfer to manual mode with possibility of remote mode indication
- ON and OFF by two push buttons
- Recharging of stored-energy system by pumping the lever
- Padlocking in off position

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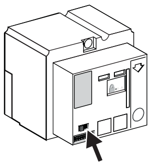

Table 97: Motor Operator Characteristics

Response Time (ms)	Opening		< 600
	Closing		< 80
Operating Frequency	cycles/minute max.		4
Power Requirements[1]	AC (VA)	Opening	≤500
		Closing	≤500
	DC (W)	Opening	≤500
		Closing	≤500

1 For H- and J-frame, the inrush current is 2x operating current for 10 ms.

Table 98: Motor Operator and Accessory Suffix Codes and Catalog Numbers

Device[1]	Control Voltage	Factory-Installed Suffix	Field-Installable Kit No.		
			H-Frame	J-Frame	L-Frame
Communicating Motor Operator	220/240 Vac 50/60 Hz	NC	**S429441**	**S431549**	**S432652**
Motor Operator	48/60 Vac 50/60 Hz	ML	**S29440**	**S31548**	**S432639**
	110/130 Vac 50/60 Hz	MA	**S29433**	**S31540**	**S432640**
	208/277 Vac 60 Hz	MD	**S29434**	**S31541**	**S432641**
	380/415 Vac 50/60 Hz	MF	—	—	**S432642**
	440/480 Vac 60 Hz	MH	**S29435**	**S31542**	**S432647**
	24/30 Vdc	MO	**S29436**	**S31543**	**S432643**
	48/60 Vdc	MV	**S29437**	**S31544**	**S432644**
	110/130 Vdc	MR	**S29438**	**S31545**	**S432645**
	250 Vdc	MS	**S29439**	**S31546**	**S432646**
Lock Mounting Hardware	—	—	—	—	**S32649**
Ronis® Lock	—	—	**S41940**	**S41940**	**S41940**
Profalux® Lock	—	—	**S42888**	**S42888**	**S42888**
Mounting Hardware with Ronis Lock	—	—	**S429449**	**S429449**	—
Operations Counter	—	—	—	—	**S32648**
Adapter for I-Line Circuit Breaker			**S37420**	**S37420**	—

1 For NSX cord (communication suffixes EA, EB, ED, and EE) any motor operator may be selected.
For BSCM + NSX cord (communication suffixes EB, EH, EK, and EL) only the communicating motor operator may be selected.

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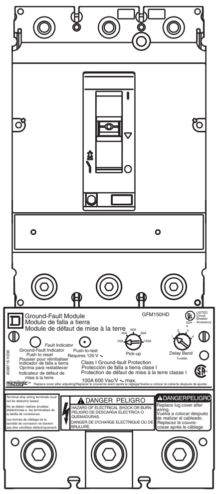
Add-On Ground-Fault Module (GFM) (H- and J-Frame Only)



J-Frame Circuit Breaker with GFM Installed

The Micrologic Ground-Fault Module (GFM) is a UL Listed/CSA Certified circuit breaker accessory which protects equipment from damage caused by ground faults. It is an add-on module which, when connected to a PowerPact H- or J-frame thermal-magnetic circuit breaker only, provides ground-fault sensing and ground-fault relay functions.

HD/JD ground-fault modules feature:

- Adjustable ground-fault pickup levels
- Adjustable ground-fault time delays
- Integral ground-fault push-to-test feature
- Ground-fault indicator (mechanical for local, contacts for remote)
- All GFMs are supplied for I-Line™ mounting as standard, easily convertible to unit mount by removing the I-Line bracket.
- Fault-powered (through the sensing current transformer) for electronics, shunt trip, and integral test feature. Meets NEC 230.95(C).
- A 12 Vdc shunt trip module (Catalog No. S29382) is required in the circuit breaker. This may be field installed or factory installed when the circuit breaker is ordered with an -SN suffix.
- UL 1053 – Ground-fault Sensing and Relaying Equipment

The GFM system requires the following:

- H-frame (15–150 A) or J-frame (150–250 A) molded case circuit breaker
- Shunt trip for circuit breaker (may be factory-installed or field-installed)
- Bus bar connection (terminal nut inserts) for OFF end of circuit breaker
- Optional neutral current transformer, catalog number GFM25CT (must be ordered for 4-wire applications).

Table 99: Ground-Fault Module

Catalog No.	Rating	Sensitivity	Time Delay (Approximate)
GFM150HD	150 A	20, 40, 60, 80, 100 A	0.2, 0.3, 0.4, 0.6 sec
GFM250JD	250 A	40, 80, 120, 160, 200 A	0.2, 0.3, 0.4, 0.6 sec

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Earth Leakage Module (ELM) (H- and J-Frame Only)


J-Frame Circuit Breaker with ELM Installed

The Earth Leakage Module (ELM) is an add-on module which, when connected to a PowerPact H- or J-frame MCCB, provides low-level ground-fault sensing and ground-fault relay functions.

Because these ELMs are highly sensitive (30 mA to 3 A), they provide much greater protection than GFMs (20 to 200 amperes sensitivity). The ELMs provide greater protection of control circuits and other sensitive equipment. The associated circuit breaker must have a 48 Vdc shunt trip), which may be field-installed (kit S29392) or factory-installed (suffix –SP) in the H- or J-frame circuit breaker.

The add-on Earth Leakage Module (ELM) features:

- Adjustable ground-fault pickup levels as low as 30 mA
- Adjustable ground-fault time delays from instantaneous to 500 msec (time delay can be applied to any setting)
- Integral ground fault push-to-test feature
- Ground-fault indicator; pop-up button for local status and contacts for remote indication (to be used only with the tripping option)
- All ELMs are supplied for I-Line mounting and are easily convertible to unit-mount by removing the I-Line mounting feet
- Three poles; 240 to 600 Vac maximum: 3-phase, 3-wire (no neutral) and 1-phase, 2-wire applications
- Line-power obtained through internal bus to provide power for electronics, shunt trip, and integral test feature
- A shunt trip is required in the circuit breaker; it may be field-installed or factory-installed in the PowerPact H and J circuit breakers.
- UL 1053—Ground-fault Sensing and Relaying Equipment

Table 100: ELM Selection Chart [1]

Companion Circuit Breaker		Enclosure Space Required I-Line Equipment	Catalog No.	Pick-Up Adjustments	Ground-Fault Time Delay Adjustments
Prefix	Size				
HD, HG, HJ, HL	15–150 A	LA	**ELM150HD**	30 mA 100 mA 300 mA 1A 3A	Instantaneous 60 ms 100 ms 500 msec
JD, JG, JJ, JL	150–250 A	LA	**ELM250JD**		

1 At 250 A, the ELM250JD can be used with standard (80%) rated circuit breakers only.

Factory-Installed ELMs

The catalog number for circuit breakers with factory-installed ELM should include the special suffixes SP and VL or VM:

H D M 3 6 150 SP VL

where

- H = H-fame (or J = J-frame)
- D = D interruption level (or G, J or L)
- M = Lugs on ON end and terminal nuts on OFF end (required)
- SP = Factory-installed 48 Vdc shunt trip (S29392, required)
- VL= Earth Leakage Module (ELM) <150 A (H-frame) or
  VM = Earth Leakage Module (ELM) <250 A (J-frame)

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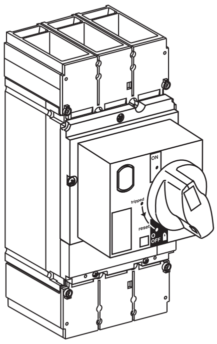
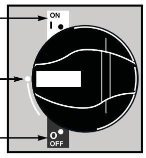
Rotary Operating Handles

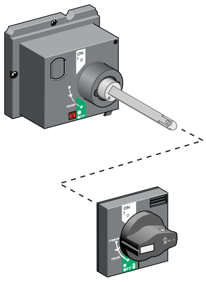
Directly Mounted Rotary Operating Handles



Directly Mounted Rotary Operating Handle

Installation	The directly mounted rotary operating handle replaces the circuit breaker front accessory cover (secured by screws).
Operation	The direct rotary handle maintains: • Suitability for isolation • Indication of three positions: I (ON), Tripped and O (OFF) • Access to the “push-to-trip” button • Visibility of, and access to, trip unit settings • The circuit breaker may be locked in the OFF position by using one to three padlocks (not supplied) 
Models	• Standard with black handle • VDE type with red handle and yellow bezel for machine tool control
Variations	Accessories transform the standard direct rotary handle for the following situations: • Motor control centers (MCCs): – Opening of door prevented when circuit breaker is on – Closing of circuit breaker inhibited when door is open • Machine tool control; complies with CNOMO E03.81.501N; degree of protection IP54 • Early make or early break contacts may be installed into direct mount rotary handle
Standards	The directly-mounted rotary operating handle is UL Listed under file E103955 and CSA Certified under file LR 69561

Door-Mounted (Extended) Rotary Operating Handle



Door Mounted Rotary Operating Handle

Installation	The door-mounted (extended) rotary operating handle is made up of: • A unit that replaces the front accessory cover of the circuit breaker (secured by screws) • An assembly (handle and front plate) on the door that is always secured in the same position, whether the circuit breaker is installed vertically or horizontally • An adjustable extension shaft • The handle mechanism can be used in NEMA 3R and 12 enclosure applications
Operation	The door mounted operating handle makes it possible to operate a circuit breaker installed in an enclosure with the enclosure door closed. The door mounted operating handle maintains: • Suitability for isolation • Indication of the three positions OFF (O), ON (I) and tripped • Visibility of and access to trip unit settings when the door is open • Degree of protection: IP40 as per IEC 529 Defeatable interlock prevents opening of door when circuit breaker is on The circuit breaker may be locked in the off position by using one to three padlocks, padlock shackle diameter 0.19–0.31 in. (5–8 mm); padlocks are not supplied; locking prevents opening of the enclosure door
Shaft Length	The shaft length is the distance between the back of the circuit breaker and the door: • Minimum shaft length is 7.4 in. (185 mm) • Maximum shaft length is 24 in. (600 mm) • Extended shaft length must be adjusted
Models	• Standard with black handle • VDE type with red handle and yellow bezel for machine tool control
Variations	For drawout configurations, the extended rotary handle is also available with a telescopic shaft containing two stable positions
Standards	The door-mounted rotary operating handle is UL Listed under file E103955 and CSA Certified under file LR 69561

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Table 101: Rotary Operated Handles

Device		Description	H- and J-Frame[1] Factory Installed Suffix	H- and J-Frame[1] Field Installable Kit No.	L-Frame Factory Installed Suffix	L-Frame Field Installable Kit No.
Direct Mounted	Standard Handle Black	Handle only	RD10	S29337	RD10	S32597
	Standard Black Handle with	One early-break switch	RD12	S29337 + S29345	RD12	S32597 + S32605
		Two early-make switches	RD13	S29337 + S29346	RD13	S32597 + S29346
	Red handle on yellow bezel	Handle Only	RD20	S29339	RD20	S32599
		One early-break switch	RD22	S29339 + S29345	RD22	S32599 + S32605
		Two early-make switches	RD23	S29339 + S29346	RD23	S32599 + S29346
	MCC Conversion Accessory		—	S429341	—	S32606
	CNOMO Conversion Accessory		—	S29342	—	S32602
Door Mounted	Standard black handle	Handle Only	RE10	S29338	RE10	S32598
	Standard Black Handle with:	Two early make switches	RE13	S29338 + S29345	RE13	S32598 + S32605
	Red handle on yellow bezel	Handle Only	RE20	S29340	RE20	S32600
Telescoping			RT10	S29343	RT10	S32603
Accessories	Key lock adapter		—	S429344	—	S32604
	Key locks	Ronis 1351.500	—	S41940	—	S41940
		Profalux KS5 B24 D4Z	—	S42888	—	S42888
		2 Ronis keylocks with 1 key	—	S41950	—	S41950
		2 Profalux keylocks with 1 key	—	S42878	—	S42878
	Indication Auxiliary Switch	One early-break switch	—	S29345	—	S32605
		Two early-make switches	—	S29346	—	S29346

1 Not available in H-frame two-pole modules.

Class 9421 NEMA Door Mounted Rotary Operating Handles

Installation	The extended rotary operating handle is made up of: • A mounting plate that provides a rotary actuator for a standard toggle circuit breaker • Handle assemblies available for NEMA 3, 3R, 4, and 4X • Available in standard or short (3 in.) handle assemblies
Operation	The door mounted operating handle makes it possible to operate a circuit breaker installed in an enclosure with the enclosure door closed. Provides ON (I) and OFF (O) indication The circuit breaker may be locked in the off position
Shaft Length	The shaft length is the distance between the back of the circuit breaker and the door: • Minimum mounting depth is 5.5 in. (138 mm) • Maximum mounting depth is 10.75 in. (273 mm) with standard shaft • Maximum mounting depth is 21.3 in. (543 mm) with long shaft

H- and J-Frame Class 9421 Door-Mounted Operating Mechanism

Description	Catalog No.
Standard Shaft Kit	**9421LJ1**
Long Shaft Kit	**9421LJ4**

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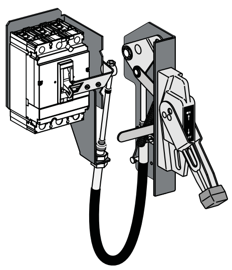
Table 102: H- and J-Frame Component Parts

Description		Catalog No.
Standard Handle Assembly	Type 1, 3R, 12	**9421LH6**
	NEMA Type 3 and 4, Painted	**9421LH46**
	NEMA Type 3 and 4, Chrome Plated	**9421LC46**
Operating Mechanism	Includes Lockout	**9421LJ7**
Standard Shaft	Support Bracket Not Required	**9421LS8**
Long Shaft	Support Bracket Included	**9421LS13**

Table 103: L-Frame NEMA Door-Mounted Rotary Operated Handles

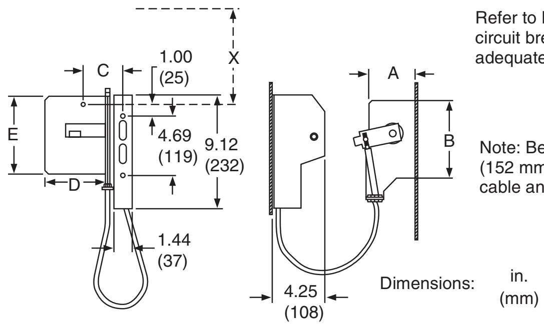
Handle Type	Poles	Operating Mechanism Included in Kit	Mounting Depth Min–Max	Kit Number
Painted 6 in.	3	9421LS8 and 9421LC46	7-1/4 to 12-1/16 in. (184 to 306 mm)	**9421LD1**
		9421LS13 and 9421LH46	7-1/4 to 22-5/8 in. (184 to 575 mm)	**9421LD4**

Class 9422 Cable Operating Handle



Flange-mounted handle cable operating mechanism is for use with Class 9422 Type A handle operators especially designed for tall, deep enclosures where placement flexibility is required.

Applications	• The cable operator maintains: Suitability for isolation Indication of three positions: O (OFF), I (ON) and tripped Access to push-to-test • The circuit breaker may be locked in the off position by one to three padlocks • Door can be locked closed due to interlocking features of the handle operator
Installation	• Handle is mounted on flange of enclosure using specified mounting dimensions while circuit breaker and operating mechanism are mounted to inside of enclosure using two screws • Cable lengths available in 3-, 5- or 10-foot lengths to accommodate a variety of mounting locations Handles are available in painted NEMA 1, 3, 3R, 4 (sheet steel) and 12 ratings or chrome (NEMA 4, 4X)



Refer to NEC Article 430-10 for minimum dimension X from circuit breaker top mounting hole to wall or barrier to ensure adequate wire bending space.

Note: Bend radius in cable must never be less than 6 in. (152 mm). Electrical clearances must be maintained between cable and live electrical parts.

Table 104: Class 9422 Cable Operating Mechanisms and A1 Handles

Description		H- and J-Frame Kit Number	L-Frame Kit Number
Cable Mechanism Length	36 in. (914 mm)	**9422CSF30**	**9422CSJ30**
	60 in (1524 mm)	**9422CSF50**	**9422CSJ50**
	84 in. (2134 m)	**9422CSF70**	—
	120 in. (3048 mm)	**9422CSF10**	**9422CSJ10**
A1 painted flange handle		—	**9422A1**
Operating Mechanism Only		—	**9422RSI**

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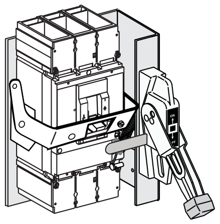
Class 9422 Flange-Mounted Variable-Depth Operating Mechanism

Threaded-rod flange-mounted variable depth operating mechanism

Designed for installation in custom built control enclosures where main or branch circuit protective devices are required.

- All circuit breaker operating mechanisms are suitable for either right- or left-hand flange mounting, convertible on the job.
- H- and J-frame variable mounting depth range: 5.88–17.75 in. (149–451 mm).
- H- and J-frame operating mechanism 9422RQ1 does not include handle mechanism.



Designed for installation in custom-built control enclosures where main or branch circuit protective devices are required. All circuit breaker operating mechanisms are suitable for either right- or left-hand flange mounting, convertible in the field.

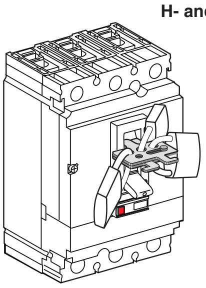
Table 105: L-Frame Flange-Mounted Operating Mechanism

Description	Depth	Kit Number
Variable Depth Mechanism	9.00–17.75 in. (229–451 mm)	**9422RSI**

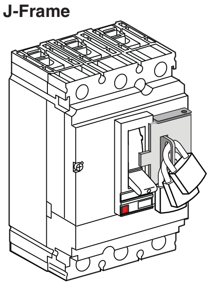
Locking Systems

Padlocking systems can receive up to three padlocks with diameters of 0.19–0.31 in. (5–8 mm); padlocks not supplied.

H- and J-Frame

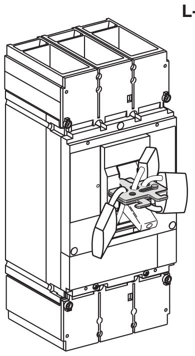


Removable Attachment

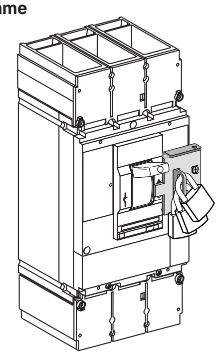


Fixed Padlock Attachment

L-Frame



Removable Attachment



Fixed Padlock Attachment

Table 106: Device Locking, Interlocking Options

Device	Description		Field-Installed Cat. No.	
			H- and J-Frame	L-Frame
Handle Padlocking Device[1]	Removable (lock OFF only)		S29370	S29370
	Fixed (lock OFF or ON)		S29371	S32631
	Fixed (lock OFF only)[2]		S37422	NJPAF
Key Locking	Provision and 2 locks keyed alike	Ronis	—	S41950
		Profalux	—	S42878

1 Rotary handles and motor operators have integral padlocking capability.
2 Not available in HD or HG two-pole modules.

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Manual Mechanical Interlocking Systems

Some installations use two power supply sources to counter any temporary loss in the main supply. A mechanical interlocking system is required to safely switch between the two sources. The replacement source can be a generator set or another network.

Managing multiple power sources can be controlled manually by mechanical interlocks.

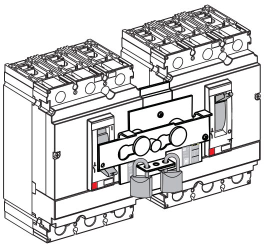
The mechanical interlocking system is made up of:

- two H-, J-, or L-frame devices (circuit breakers or switches) controlled manually
- mechanical interlocking, which prevents handle movement from the OFF position while the other device is in the ON position.

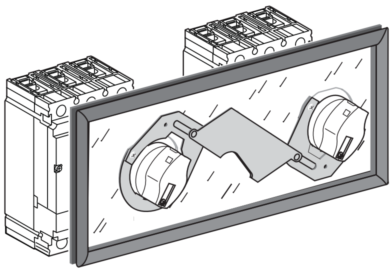
Since it is controlled manually by a maintenance technician, switchover time from the normal source to the replacement source can vary.

Figure 9: Interlocking Systems

H- and J-Frame

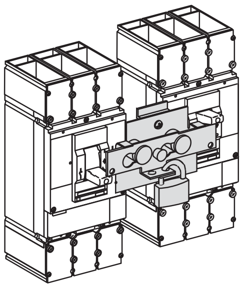


Interlocking with Toggle Control (S29354)

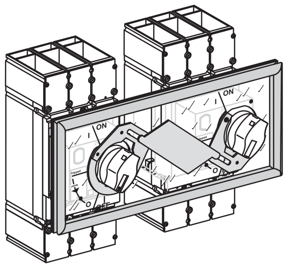


Interlocking with Rotary Handles (S29369)

L-Frame



Interlocking with Toggle Control (S32614)



Interlocking with Rotary Handles (S32621)

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Interlocking of Circuit Breakers with Toggle Control

Two devices can be interlocked using this system. Two identical interlocking systems can be used to interlock three devices installed side by side.

Authorized positions:

- one device closed (ON), the others open (OFF)
- all devices open (OFF)

The system is locked using one or two padlocks (shackle diameter 0.19–0.31 in. [5 to 8 mm]). This system can be expanded to more than three devices.

There are two interlocking-system models:

- one for PowerPact H- and J-frame circuit breakers
- one for PowerPact L-frame circuit breakers

All toggle-controlled unit-mount or plug-in PowerPact H-, J-, and L-frame circuit breakers and automatic switches of the same frame size can be interlocked. The devices must be either all unit-mount or all plug-in versions. Interlocking is not available for I-Line constructions.

The toggle interlock system can receive one or two padlocks with diameters of 0.19–0.31 in. (5–8 mm). Both interlocked circuit breakers must be unit-mount or both plug-in. Two sliding interlocking bars can be used to interlock three circuit breakers installed side-by-side, in which case one circuit breaker is in the ON (I) position and the two others in the OFF (O) position. (Kit S29354, not available for two-pole HD and HG devices.)

Interlocking of Two Devices with Rotary Handles

Interlocking involves padlocking the rotary handles on two devices which may be either circuit breakers or automatic switches.

Authorized positions:

- one device closed (ON), the other open (OFF)
- both devices open (OFF).

The system is locked using up to three padlocks (shackle diameter 0.19–0.31 in. [5 to 8 mm]).

There are two interlocking-system models:

- one for PowerPact H- and J-frame circuit breakers
- one for PowerPact L-frame circuit breakers

All rotary-handle unit-mount or plug-in PowerPact H-, J-, and L-frame circuit breakers and automatic switches of the same frame size can be interlocked. The devices must be either all unit-mount or all plug-in versions. Interlocking is not available for I-Line constructions

The rotary handles are padlocked with the devices in the OFF (I) position. The interlock mechanism inhibits the two devices from being closed (ON/I) at the same time, but allows for both devices to be open (OFF/O) simultaneously. (Kit S29369. Not available for two-pole HD and HG devices.)

Table 107: Interlocking Accessories

Accessory	Means	Kit Number	
		H-, J-Frame	L-Frame
Interlocking (UL listed)	Mechanical for circuit breakers with rotary handles[1]	S29369	S32621
	Mechanical for circuit breakers with toggles[1]	S29354	S32614

[1] Not available in HD or HG two-pole modules.

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Interlocking Devices using Keylocks (Captive Keys)

Interlocking using keylocks makes it possible to interlock two or more devices that are physically distant or that have very different characteristics, for example medium-voltage and low-voltage devices or a PowerPact H-, J-, and L-frame circuit breaker and automatic switch.

Each device is equipped with an identical keylock and the key is captive on the closed (ON) device. A single key is available for all devices. It is necessary to first open (OFF position) the device with the key before the key can be withdrawn and used to close another device.

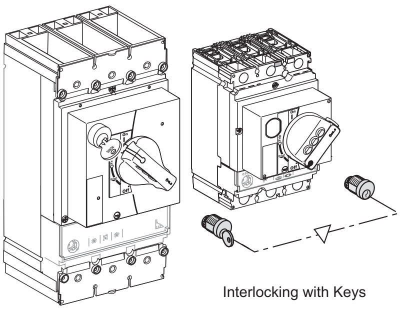
All rotary-handle PowerPact H-, J-, and L-frame circuit breakers and automatic switches can be interlocked between each other or with any other device equipped with the same type of keylock.

For circuit breakers equipped with rotary handles or a motor operator. Interlocking with keys may be easily implemented by equipping each of the circuit breakers, either unit-mount or drawout, with a directly mounted rotary operating handle and a standard keylock, with only one key for the two keylocks. This solution enables interlocking between two circuit breakers that are geographically distant or that have significantly different characteristics.

Use:

- A keylock adapter (one required for each circuit breaker)
- Two identical keylocks with a single key

See Table 101 for more information.


Interlocking with Keys

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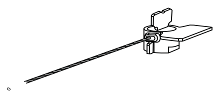
Sealing Accessory



The sealing accessory kits includes the elements required to fit seals to prevent:

- Front accessory cover removal
- Rotary handle removal
- Opening of the motor operator
- Access to accessories
- Access to trip unit settings
- Access to ground-fault protection settings
- Trip unit removal
- Terminal cover removal
- Access to power connections

Table 108: Sealing Accessory Kits

Description	Kit No.	Qty.
Trip Unit Sealing Accessory Kit	**MICROTUSEAL**	6
Front Cover Screws Sealing Accessory Kit	**S29375**	6

Front-Panel Escutcheons

- For unit-mount or plug-in installation.
- Front-panel escutcheons for toggle handles secures to the panel from the front.
- Front-panel escutcheons for motor-operated or rotary-operating handle secures to the panel by four screws from the front.

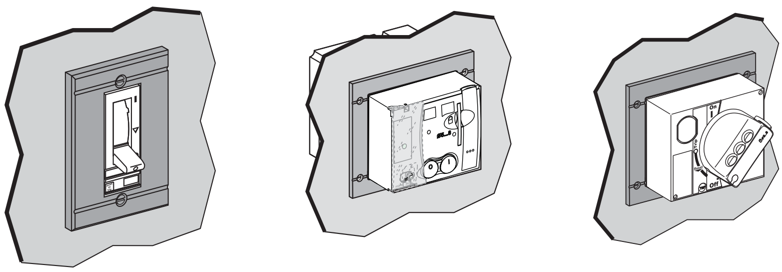


Table 109: Front-Panel Escutcheons

Description	Kit Number	
	H-, J-Frame	L-Frame
Front Panel Escutcheon for Toggle Circuit Breakers	**S29315**	**32556**
Front Panel Escutcheon for Rotary Handle, Motor Operator or Extended Escutcheon	**S29317**	**S32558**

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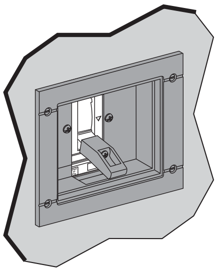
Toggle Collars (For Drawout Mounting)



Toggle collars make it possible to maintain degrees of protection regardless of the circuit breaker position (connected, disconnected):

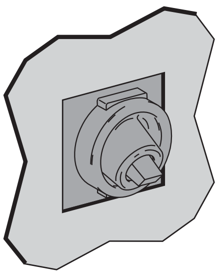
- Front panel escutcheons are required (identical to those for rotary handle and ammeter module)
- Toggle collars are secured by two screws on the circuit breaker
- Front panel escutcheons are secured on the enclosure
- Toggle extension is supplied with the toggle collar

Front panel escutcheons for motor operator and rotary operating handles are the same as for the unit-mount circuit breakers.

Table 110: Toggle Collars

Description	H-, J-Frame Kit Number	L-Frame Kit Number
Toggle Collar	**S29284**	**S32534**

Toggle Boot



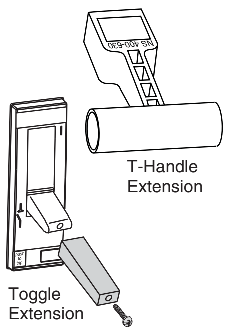
- NEMA 1, 2, 3, 3R protection
- Fits on front of circuit breaker

Table 111: Toggle Boot

Description	Kit Number	
	H-, J-Frame[1]	L-Frame
Toggle Boot	**S29319**	**S32560**

[1] Not available for HD and HG two-pole modules.

Handle Extension



Designed to extend the circuit breaker handle for easier manual circuit breaker operation.

Table 112: Handle Extensions

Description	Qty.	Kit Number	
		H-, J-Frame	L-Frame
T-Handle Extension (Temporary)	1	—	**32595**
Toggle Extension (Fixed)	5	**S29313**	**S432553**

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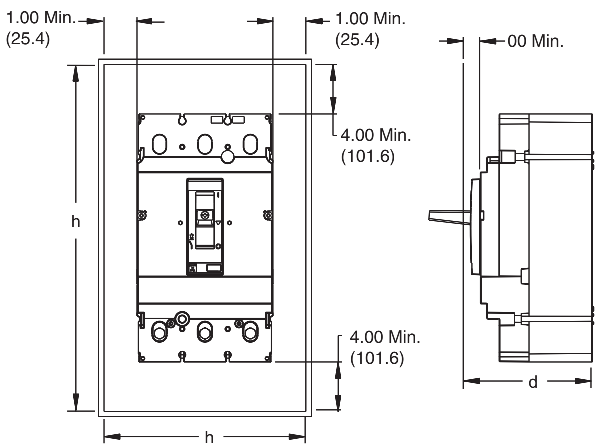
Circuit Breaker Enclosures and Enclosure Accessories

- Square D™ brand circuit breaker enclosures are UL Listed/CSA Certified and are suitable for use as service entrance equipment, except as footnoted.
- The short circuit rating of an enclosed circuit breaker is equal to the rating of the circuit breaker installed, except as footnoted.
- Circuit breakers are ordered and shipped separately for field installation.

Table 113: Minimum Enclosure Dimensions



Circuit Breaker	Amperage	Enclosure Dimensions (h x w x d) Standard (80%)	100% Rated
HD/HG /HJ/HL	15–150 A	15.6 x 6.12 x 3.49 in. (396 x 155 x 89 mm)	15.6 x 6.12 x 3.49 in. (396 x 155 x 89 mm)
HR		18.13 x 8.63 x 4.13 in. (461 x 219 x 105 mm)	62 x 22.5 x 14 in. (1575 x 572 x 356 mm)
JD/JG/ JJ/JL[1]	150–250 A	18.72 x 6.12 x 3.49 in. (476 x 155 x 89 mm)	18.72 x 6.12 x 3.49 in. (476 x 155 x 89 mm)
JR		28.5 x 12.38 x 5.38 in. (724 x 314 x 137 mm)	62 x 22.5 x 14 in. (1575 x 572 x 356 mm)
LD/LG/ LJ/LL	250–600 A	35.48 x 12.00 x 4.45 in. 901 x 305 x 113 mm)	35.48 x 12.00 x 4.45 in. (901 x 305 x 113 mm)
LR		40.5 x 13.75 x 4.33 in. (1030 x 350 x 110 mm)	40.5 x 13.75 x 4.33 in. (1030 x 350 x 110 mm)

1 Minimum enclosure insulation required if circuit breaker side < 4.13 in. (105 mm) from metal.

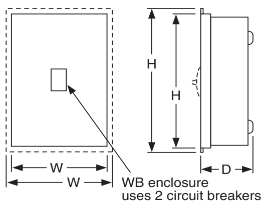
Table 114: Circuit Breaker Enclosure Catalog Numbers

Circuit Breaker Cat. No. Prefix	Rating	Poles	Enclosure Cat. No. NEMA 1 Flush	NEMA 1 Surface	NEMA 3R[1]	NEMA 4, 4X, 5, 3, 3R Stainless Steel	NEMA 12/3R, 5 (Without Knockouts)[2]
HDL,HGL,HJL,HLL	15–150 A	2, 3	J250F	J250S	J250R	J250DS	J250AWK
JDL,JGL,JJL,JLL	150–250 A	2, 3					
HDL	15–100 A	3	—	HD100S[3, 4, 5]	—	—	—
JDL	150–250 A	3	—	JD250S[3, 5, 6]	—	—	—

1 Enclosures with NRB or RB suffix have provisions for 3/4 in. through 2-1/2 in. bolt-on hubs in top endwall. Enclosures with R suffix have blank endwalls and require field cut opening.
2 Suitable for rainproof NEMA 3R application by removing drain screw from bottom endwall.
3 Copper wire only.
4 Maximum short circuit current rating is 25 kA, 240 Vac.
5 Order service ground kit PKOGTA2 if required.
6 Maximum short circuit current rating is 18 kA, 480 Vac.

Table 115: Dimensions

Cat. No.	Series	H		W		D	
HD100S	A01	17.00 in.	431.8 mm	7.90 in.	200.7 mm	4.75 in.	120.7 mm
J250F	A01	32.40 in.	823 mm	15.40 in.	391 mm	6.00 in.	152 mm
J250S	A01	31.36 in.	797 mm	14.36 in.	365 mm	6.00 in.	152 mm
J250R	A01	31.05 in.	789 mm	14.47 in.	368 mm	6.28 in.	160 mm
J250DS	A01	32.26 in.	819 mm	9.72 in.	247 mm	7.94 in.	202 mm
J250AWK	A01	32.26 in.	819 mm	9.72 in.	247 mm	7.94 in.	202 mm



NEMA Type 1

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Table 116: Insulated Grounded Neutral Assembly

Circuit Breaker		Neutral Assembly For Use With		Terminal Lug Data—Total Available (Line plus Load) AWG/kcmil
Cat. No. Prefix	Ampere Rating	NEMA 1 & 3R	NEMA 4, 4X, 5, 12 & 12K	
		Cat. No.	Cat. No.	
HDL, HGL, HJL, HLL	15–100 A	**SN100FA**	**SN100FA**	(4) 14–1/0 Cu or (4) 12–1/0 Al
HDL, HGL, HJL, HLL	125–150 A	**SN400LA**	**SN400LA**	(2) 1–600 or (4) 1–250 Al/Cu, plus (2) 4–300 Al/Cu
JDL, JGL, JJL, JLL	150–250 A	**SN400LA**	**SN400LA**	(2) 1–600 or (4) 1–250 Al/Cu, plus (2) 4–300 Al/Cu

Table 117: Service Ground Kits

Circuit Breaker Cat. No. Prefix	Ground Bar Cat. No.	Number of Terminals	Conductors Per Terminal	Wire Range
HDL, HGL, HJL, HLL, JDL, JGL, JJL, JLL	PKOGTJ250	2	1	6 AWG–300 kcmil Al/Cu

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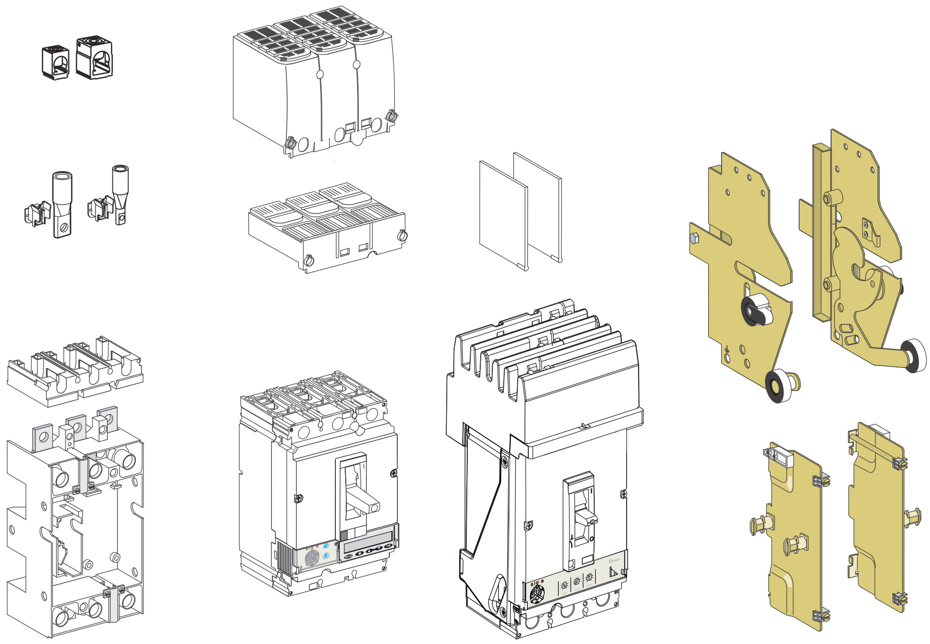
Section 10—Circuit Breaker Mounting and Connections



Mounting Configurations

The PowerPact™ H-, J-, and L-frame circuit breakers are available in a variety of configurations.

Table 118: Mounting Options

Termination Letter	Poles		Options Code Suffix	
	H-, J-Frame	L-Frame		
A = I-Line	3 Pole Only	3 Pole Only	For factory-installed terminations, place termination letter in the third block of the circuit breaker catalog number. L G D 3 6 4 0 0 U 3 1 X H J 0 0 Termination No. Options Code	(N, and D Terminations Only)
F = Bus Bar	3 Pole Only	3 or 4 Pole		H = Plug-In or Drawout
L = Lugs on Both Ends	3 Pole Only	3 or 4 Pole		J = No Stationary part
M = Lugs ON End	3 Pole Only	3 or 4 Pole		0 = No Switches
P = Lugs OFF End	3 Pole Only	3 or 4 Pole		0 = No Shutters
N = Plug-In	3 Pole Only	3 or 4 Pole		
D = Drawout	3 Pole Only	3 or 4 Pole		
S = Rear Connection	3 Pole Only	3 or 4 Pole		

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Refer to circuit breaker installation bulletin before installing circuit breaker, accessories, or wiring.

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Unit-Mount Circuit Breakers

The standard lugs can be removed for the installation of compression-type lugs or bus connections. All lugs are UL Listed/CSA Certified for their proper application and marked for use with aluminum and copper (Al/Cu) or copper only (Cu) conductors. Lugs suitable for copper and aluminum conductors are made of tin-plated aluminum.

Mounting

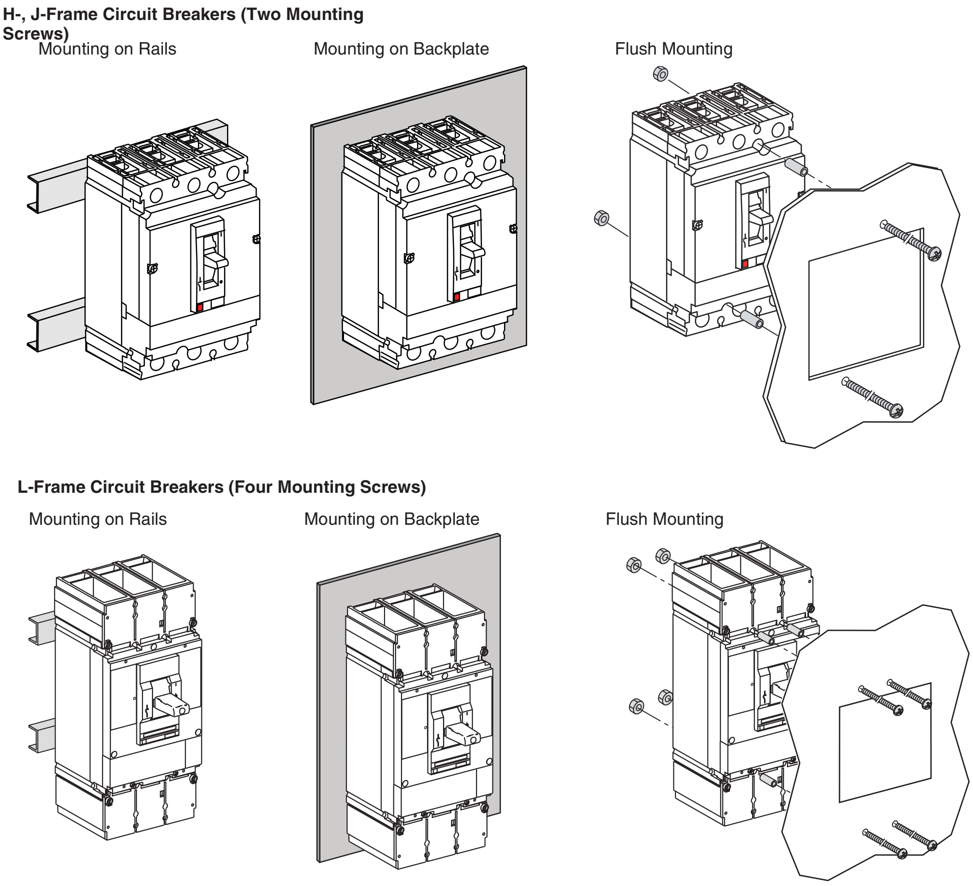
H-, J-, and L-frame circuit breakers may be mounted vertically, horizontally or flat on their back without any derating of characteristics.

Unit-mount H- and J-frame circuit breakers are supplied with two mounting screws, unit-mount L-frame circuit breakers are supplied with four mounting screws. These mounting screws are inserted through mounting holes molded into the circuit breaker case and threaded into the mounting enclosure, rails or through the panel door for flush mounting.

A DIN rail mounting bracket (catalog no. S29305) is available for the H- and J-frame circuit breakers.

NOTE: DIN rail mounting is not compatible with motor operated applications.

Figure 10: Unit-Mounting Options



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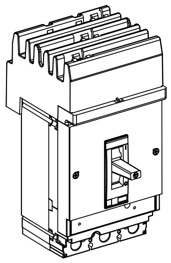
I-Line™ Circuit breakers



PowerPact H-, J-, and L-frame circuit breakers are available in I-Line construction for easy installation and removal in I-Line applications.

I-Line circuit breakers use “blow-on” type line side connectors. In case of a short circuit, increased magnetic flux causes the plug-on connectors of the circuit breaker to tighten their grasp on the bus bars. The I-Line connectors and circuit breaker mounting bracket are integral parts of I-Line circuit breakers and cannot be removed or replaced. I-Line circuit breakers come with mechanical load side lugs, or optional terminal nut to connect to bus bars or to compression (crimp) lugs.

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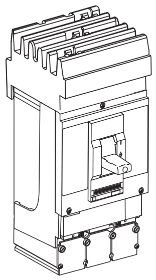
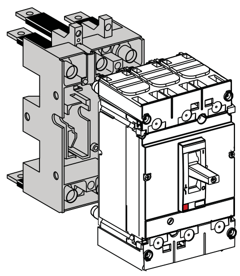


Table 119: Phase Options—Example HDA36150

Phase Option Number	Phase Connection	Two-Pole Example	three-pole Example
1	AB	**HDA261501**	—
2	AC	**HDA261502**	—
3	BA	**HDA261503**	—
4	BC	**HDA261504**	—
5	CA	**HDA261505**	—
6	CB	**HDA261506**	—
Standard	ABC	—	**HDA36150**
6	CBA	—	**HDA361506**

Plug-In Circuit Breaker Mounting



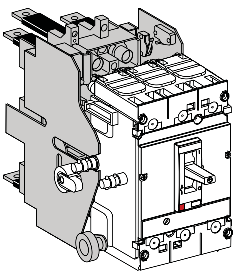
Plug-In Mounting

The plug-in base is mounted through a panel. The plug-in configuration makes it possible to:

- Extract and/or rapidly replace the circuit breaker without having to touch connections
- Allow for addition of future circuits at a later date

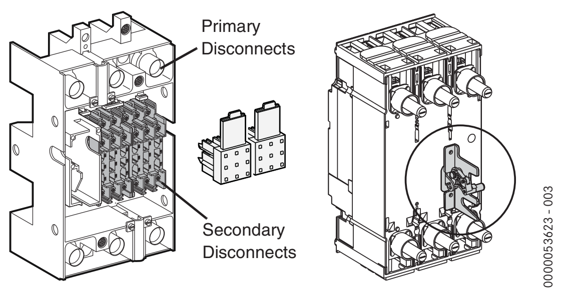
When the circuit breaker is in the connected position, the primary voltage is fed through the circuit breaker by means of multiple finger disconnects. Control voltage of internal accessories is provided through secondary disconnects.

Parts of a Plug-In Configuration



Drawout Mounting

- Plug-in Base: The plug-in base provides mounting through a front panel or mounting on rails.
- Disconnects: Provides both primary and secondary disconnect to the circuit breaker.
- Safety Trip Interlock: The safety trip causes automatic tripping if the circuit breaker is ON before engaging or withdrawing it; the safety trip does not prevent the circuit breaker operation, even when the circuit breaker is disconnected.
- Plug-in Base: The plug-in base provides mounting through a front panel or mounting on rails.
- Mandatory short terminal shields.



Safety Trip Interlock Mounted on Back of Circuit Breaker

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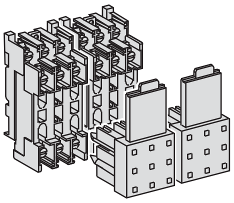
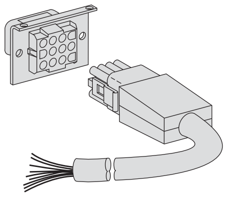


Disconnecting Blocks



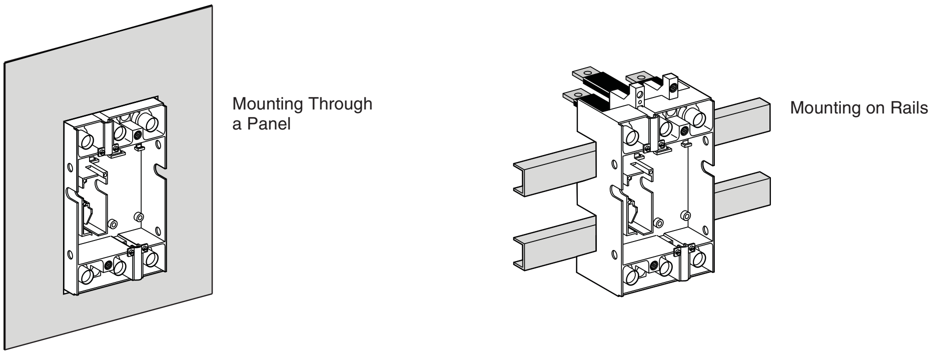
Manual Auxiliary Connector

Accessory circuits exit the circuit breaker using one to three secondary disconnecting blocks (nine wires each). Circuit breaker connection wires for the options installed with trip unit STR53UP exit through the automatic secondary disconnecting blocks. These are made up of:

- A moving part connected to the circuit breaker through a support (one support per circuit breaker).
- A fixed part mounted on the plug-in base, equipped with connectors for wire up to 14 AWG (2.5 mm^2).

For test purposes, circuit breakers may be equipped with one to three manual auxiliary connectors, which allow the auxiliaries to remain connected when in the "disconnected" position.

Figure 11: Plug-In Base (Mounting Options)



The L-frame plug-in mounting is Listed under UL file E113555 and Certified under CSA file LR 69561.

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Drawout Mounting

The cradle is made up of two side plates installed on the plug-in base and two other plates mounted on the circuit breaker.

The drawout mounting provides all of the functions of the plug-in base, plus:

- Disconnected position—the power circuit is disconnected, the circuit breaker is simply withdrawn and may still be operated (on, off, push-to-trip)
- Circuit breaker may be locked using 1 to 3 padlocks, diameter 0.19 to 0.31 inch (5–8 mm), to prevent connection
- Auxiliaries can be tested using manual auxiliary connector

Drawout mounting is on a backplate:

- Through a front panel or on rails
- Horizontally or vertically

Accessories for drawout circuit breakers:

- *Auxiliary contacts indicator* for installation on the fixed part of the cradle, indicating the “connected” and “disconnected” position
- *Toggle collar* for circuit breakers with toggle through front panel, intended to maintain the degree of protections whatever the position of the circuit breakers (supplied with a toggle extension)
- *Keylock* which can be used to
  - — Prevent insertion for connection
  - — Lock the circuit breaker in the connected or disconnected position
- *Telescopic shaft* for extended rotary handles
- *Control voltage,* which is provided through automatic secondary disconnect in the connected position only. Electrical accessories can be tested in the disconnected position with an external wiring harness.

The drawout-mounted cradle is listed under UL file E113555 and certified under CSA file LR69561.

Figure 12: Drawout Mounting Positions

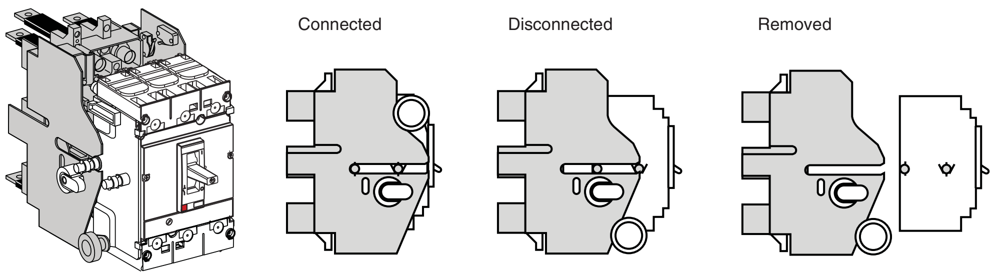

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Table 120: Plug-In and Drawout Mountings for H- and J-Frame Circuit Breakers (Three-Pole or Two-Pole in a Three-Pole module)

Description			Factory Installed Suffix	Field-Installed Cat. No.
Complete Factory-Assembled Circuit Breakers	Plug-in base shipped with circuit breaker		N	—
	Drawout cradle shipped with circuit breaker		D	—
Special Order Options for Plug-In and Drawout Circuit Breakers	Plug-In Base	Circuit breaker only	HJ00	
		Plug-in base kit		**S29278**
	Drawout Cradle	Circuit breaker only	HJ00	
		Plug-in base kit		**S29278**
		Cradle side plates (fixed part of chassis)		**S29282**
		Circuit breaker side plates (moving part of chassis)		**S29283**
Accessories for Plug-In and Drawout	H-Frame Shutter Kit (set of two)			**S37442**
	J-Frame Shutter Kit (set of two)			**S37443**
	Secondary Disconnect Blocks	Fixed part 9-wire connector (mounted on base)		**S29273**
		Moving part 9-wire connector (mounted on circuit breaker)		**S29274**
		Support for 2-moving connectors		**S29275**
	Extended escutcheon with extended toggle collar			**S29284**
	Two position indicating switches (connected/disconnected)			**S29287**
	H-Frame Short Terminal Covers (Three-Pole)			**S37436**
	J-Frame Short Terminal Covers (Three-Pole)			**S37440**

Table 121: Plug-In and Drawout Mountings for L-Frame Circuit Breakers

Description		Poles	Plug-in Mounting			Drawout Mounting		
			Factory Installed Suffix	Field-Installed		Factory Installed Suffix	Field-Installed	
				Qty	Kit. No.		Qty	Kit. No.
Kit (stationary and moving parts)		3	N		—	D		—
		4	N		—	D		—
Stationary Part	Plug-in base	3			**S32514**			**S32514**
		4			**S32515**			**S32515**
	Fixed part of chassis							**S32532**
Moving Part	Circuit breaker only		HJ00			HJ00		
	Moving part of chassis							**S32533**
	Short terminal covers	3		2x[1]	**S32562**		2x[1]	**S32562**
		4		2x[1]	**S32563**		2x[1]	**S32563**

1 Order two of kit.

Handle Escutcheon

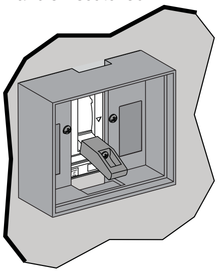

Table 122: Plug-In and Drawout Accessories

Plug-In and Drawout Accessories			Field-Installed Kit No.	
			H-, J-Frame	L-Frame
Secondary Disconnecting Blocks[1]	Fixed Part	9-Wire Connector	**S29273**	**S29273**
	Moving Part	9-Wire Connector	**S29274**	**S32523**
		Support for Moving Connectors	2x[2] **S29275**	3x[3] **S32525**
Manual Auxiliary Connector	9-Wire Connector for Disconnected Operation		—	**S29272**
Shutter	Two Shutters for Plug-In Base		**29271**	**32521**
Classic Accessories	Extended Escutcheon for Toggle Collar		**S29284**	**S32534**
	Locking Device (Key Lock is Not Included)		**S29286**	**S29286**
	Two Position Indicator Contacts (Connected/Disconnected)		**S29287**	**S29287**

1 Included when electrical accessories are factory installed.
2 Order two of kit.
3 Order three of kit.

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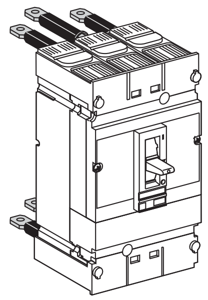
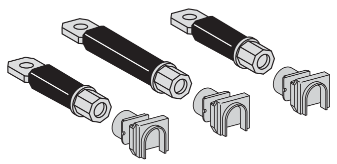
Connection

Rear Connection



For connection of bus bars or cables with compression lugs. Rear connections are easily installed on the circuit breaker terminals. The same connection may be installed flat, edgewise or at a 45° angle. All combinations are possible. The circuit breaker is mounted on a backplate.

One Long and Two Short



Four Positions Possible for Each Connector

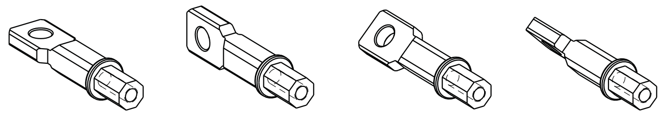


Table 123: Rear Connections

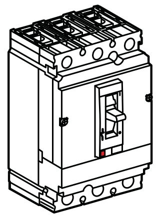
Device	Description	H-Frame Poles	H-Frame Factory-Installed Termination No.	H-Frame Field-Installable Cat. No.	J-Frame Poles	J-Frame Factory-Installed Termination No.	J-Frame Field-Installed Cat. No.	L-Frame Poles	L-Frame Factory-Installed Termination No.	L-Frame Field-Installed Cat. No.
Mixed Rear Connection Kit[1]		2	S	—	2	S	—	3	S	**S32477**
		3	S	**S37432**	3	S	**S37437**	4	S	**S32478**
Consisting of:	Short rear connections (set of 2)	2 or 3	—	2x[2] **S37433**	2 or 3	—	2x[2] **S37438**	3	—	2x[2,3] **S432475**
	Long rear connections (set of 2)		—	**S37434**		—	**S37439** [4]		—	2x[3] **S432476**
	Short terminal cover	3	—	**S37436**	3	—	**S37440**	3	—	2x[5] **S32562**
	Short terminal cover	4	—	—	—	—	—	4	—	2x[5] **S32563**

1 Kit contains four short rear connections, two long rear connections (four long rear connections for four-pole), hardware and two terminal covers.
2 Order two kits (two in kit x two kits for total of four).
3 Parts only, no hardware is included. See Table 124, below.
4 For use with three-pole circuit breakers only.
5 Order two kits (kit contains only one terminal cover, two terminal covers are required per circuit breaker).

Table 124: L-Frame Rear Connection Hardware

Description	Cat. No.
Set of 4 M10 x 25 terminal screws and washers for one side.	**S36967**

Mechanical Lugs



Unit-mount H-, J-, and L-frame circuit breakers can be ordered with mechanical line and load side lugs. The standard lugs can be removed for the installation of compression-type lugs or bus connections. All lugs are UL Listed/CSA Certified for their proper application and marked for use with aluminum and copper (Al/Cu) or copper only (Cu) conductors. Lugs suitable for copper and aluminum conductors are made of tin-plated aluminum. Lugs suitable for use with copper conductors only are made of copper.

Mechanical Lugs for the H- and J-frame circuit breakers lay on top of the circuit breaker terminals and can be installed without the use of any tools. The lugs are held in place with snap features built into the insulating retainer and are secured with the clamp force applied to the wire binding screw.

Mechanical lugs are sold either factory installed or as field installable kits.

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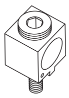
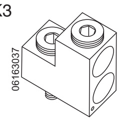
Table 125: Mechanical Lug Kits for H-Frame and J-Frame Circuit Breakers

	Circuit Breaker Application				Number of Wires Per Lug and Wire Range	Kit Cat. No.	Qty Per Kit
	Standard	Ampere Rating	Optional	Ampere Rating			
Al Lugs for Use with Al or Cu Wire	HD, HG, HJ, HL	15–150 A			(1) 14–3/0 AWG Al or Cu	**AL150HD**	3
	JD, JG, JJ, JL	150–175 A			(1) 4-4/0 AWG Al or Cu	**AL175JD**	3
	JD, JG, JJ, JL	200–250 A	JD, JG, JJ, JL	150–175 A	(1) 3/0–350 kcmil Al or Cu	**AL250JD**	3
Cu Lugs for Use with Cu Wire Only			HD, HG, HJ, HL	15–150 A	(1) 14–2/0 AWG Cu	**CU150HD**	3
			JD, JG, JJ, JL	150–250 A	(1) 1/0–300 kcmil Cu	**CU250JD**	3
Control Wire Terminal for H-frame lug kit						**S37423**	2
Control Wire Terminal for J-frame lug kit						**S37424**	2

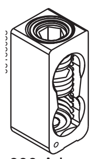
Table 126: Mechanical Lug Kits for L-Frame Circuit Breakers[1]



400 A Lug
AL400L6IK3



600 A Lug
AL600LS52K3



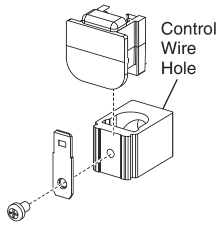
600 A Lug
AL600LF52K3

	Circuit Breaker Application				Number of Wires Per Lug and Wire Range[2]	Kit Cat. No.	Qty Per Kit	Type of Terminal Shield[3]
	Ampere Rating	Poles	Unit Mount	I-Line				
Al Lugs for Use with Al or Cu Wire	250	3	X	X	(1) 2 AWG–500 kcmil Al	**AL400L61K3**	3	Short
		4	X	—	(1) 2 AWG–600 kcmil Cu	**AL400L61K4**	4	Medium
	400/600	3	X	—	(2) 2/0 AWG–500 kcmil Al or Cu	**AL600LS52K3[4]**	3	Medium
		4	X	—		**AL600LS52K4[4]**	4	Medium
	400/600	3	X	X	(2) 3/0 AWG–500 kcmil Al or Cu	**AL600LF52K3[4]**	3	Short
Cu Lugs for Use with Cu Wire Only	250/400	3	X	X	(1) 2 AWG–500 kcmil Al	**CU400L61K3**	3	Short
		4	X	—	(1) 2 AWG–600 kcmil Cu	**CU400L61K4**	4	Medium
	400/600	3	X	—	(2) 2/0 AWG–500 kcmil Al or Cu	**CU600LS52K3[4]**	3	Medium
		4	X	—		**CU600LS52K4[4]**	4	Medium
	400/600	3	X	X	(2) 3/0 AWG–500 kcmil Al or Cu	**CU600LF52K3[4]**	3	Short

1 For lug pack information, see Figure 36 on page 177.
2 For control wire installation, use an 8-32 x 1/4 in. screw (not provided) into tapped control wire hole in lower left hand corner of lug.
3 For terminal shield dimensions, see Figure 36 on page 177.
4 Terminal shields are included in mechanical lug kits.

Voltage Takeoff (Control Wire Terminals) for Mechanical Lugs and Terminal Nuts

Mechanical Lug Control Wire Terminal



Powerpact H- and J-Frame mechanical lugs may be equipped with a separate control wire termination. The kit is available factory installed or as a field installable kit. The adaptor is secured underneath the lug and has a tab extension suitable for attachment of a 0.250 inch slip-on connector.

All L-frame mechanical lugs are pre-tapped for control wires. For control wire installation, use an 8-32 x 1/4 in. screw (not provided) into tapped control wire hole in lower left hand corner of the lug.

Fully insulated type connectors must be used to prevent live parts from extending into the wiring gutter area.

Busbar Control Wire Terminal

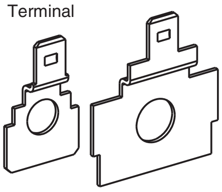


Table 127: Control Wire Terminals

Description	Frame	Cat. No.	Qty Per Kit
Mechanical Lugs			
Control Wire Terminal for H-Frame Lugs	HD/HG/HJ/HL	**S37423**	2
Control Wire Terminal for J-Frame Lugs	JD/JG/JJ/JL	**S37424**	2
Busbar Connection			
Control Wire Terminal for H-Frame Terminal Nut	HD/HG/HJ/HL	**S37429**	2
Control Wire Terminal for J-Frame Terminal Nut	JD/JG/JJ/JL	**S37430**	2

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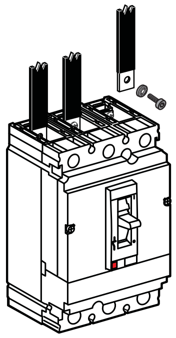
Bus-Bar Connections



The H-, J- and L-frame circuit breakers may be equipped with captive nuts and screws for direct connection to bars or to compression (crimp) lugs.

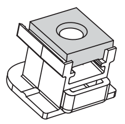
For H- and J-frame, these are readily field-installable, simply by removing the mechanical lug and replacing with the appropriate terminal nut inset described in Table 128. They are also available factory-installed, using the Product Selector or by using the catalog suffixes below.

For L-frame, the mechanical lug can be removed, leaving the threaded nut insert intact. This configuration may be ordered with the suffixes described below. Connection hardware (terminal screws) must be ordered as in table 128.

Table 128: Factory-Installed Terminal Nut Inserts for Bus or Crimp Lug Connection

Cat. No. Termination (Position 4)	Special Terminations Options	Description
F	—	Terminal nut insert on both ends; no lugs either end
M	—	Terminal nut insert on OFF end; lugs on ON end only
P	—	Terminal nut insert on ON end; lugs on OFF end only
A	-TA	I-Line on ON end; English terminal nuts on OFF end[1]
A	-TB	I-Line on ON end; Metric terminal nuts on OFF end[1]
F, M, or P	-TW	For -F, Metric terminal nuts on both ends[1]
F, M, or P	-TX	For -M, lugs on ON end; Metric terminal nuts on OFF end For -P, Metric terminal nuts on ON end; lugs on OFF end

1 For H- and J-frame only. L-frame terminal nuts are metric only.



Terminal Nut Insert

Table 129: Terminal Nuts for Bus Bar Connection of H-Frame and J-Frame Circuit Breakers

Description	Frame	Tap	Cat. No.	Qty Per Kit	Torque
H-Frame Terminal Nut Insert–English	HD/HG/HJ/HL	1/4-20	**S37425**	2	80–90 lb-in (9–10.2 N•m)
H-Frame Terminal Nut Insert–English	HD/HG/HJ/HL	1/4-20	**S37444**	3	
H-Frame Terminal Nut Insert–Metric	HD/HG/HJ/HL	M6	**S37426**	2	
J-Frame Terminal Nut Insert–English	JD/JG/JJ/JL	1/4-20	**S37427**	2	80–90 lb-in (9–10.2 N•m)
J-Frame Terminal Nut Insert–English	JD/JG/JJ/JL	1/4-20	**S37445**	3	
J-Frame Terminal Nut Insert–Metric	JD/JG/JJ/JL	M8	**S37428**	2	

Table 130: Bar Dimensions

Dimension	H-Frame	J-Frame	L-Frame
A	0.250 in. (6.4 mm)	0.3125 in. (7.9 mm)	0.4 in. (10.2 mm)
B	0.125–0.375 in. (3.2–9.5 mm)	0.125–0.375 in. (3.2–9.5 mm)	0.11–0.39 in. (2.8–9.9 mm)
C	0.50 in. (12.7 mm)	0.50–0.75 in. (12.7–19.0 mm)	1.35 in. (34.3 mm)
D	0.3 in. (7.6 mm)	0.625 in. (15.9 mm)	<0.51 in. 13 mm)
E	0.3 in. (7.6 mm)	0.375 in. (9.5 mm)	0.64 in. (16.3 mm)

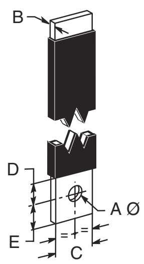


Table 131: L-Frame Bus Bar Connections Hardware

Description	Cat. No.
Set of 4 M10 x 25 terminal screws and washers for one side.	**S36967**

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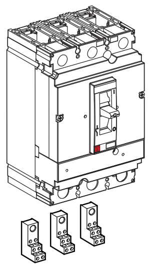
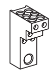
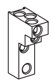
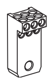
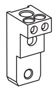
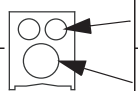
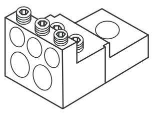
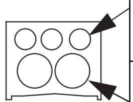
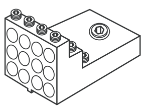
Power Distribution Connectors



The power distribution connectors (PDC) can be used for multiple load wire connections on one circuit breaker. Use in place of standard distribution blocks to save space and time. Field installable kit includes tin-plated aluminum lug, connectors, and required mounting hardware.

- For use on load end of circuit breaker only
- For use in UL 508 Industrial Control applications
- For use in UL 1995/CSA C22.2 No. 236 heating and cooling equipment
- For copper wire only

Table 132: Power Distribution Connectors

Frame		Kit Number	Qty per Kit	Wires per Terminal	Wire Range	Wire Binding Screw Torque
H-Frame		**PDC6HD6**	3	6	8–6 AWG (10–16 mm²)	25 lb-in. (2.8 N•m)
					14–10 AWG (2.5–6 mm²)	20 lb-in. (2.3 N•m)
		**PDC3HD2**	3	3	2 AWG (35 mm²)	40 lb-in. (4.5 N•m)
					14–3 AWG (2.5–35 mm²)	35 lb-in. (4.0 N•m)
J-Frame		**PDC6JD4**	3	6	8–4 AWG (10–25 mm²)	35 lb-in. (4.0 N•m)
					14–10 AWG (2.5–6 mm²)	20 lb-in. (2.3 N•m)
		**PDC3JD20**	3	3 total 2 	14–6 AWG Cu (2.5–16 mm²) or 4–1 AWG Cu (25–50 mm²)	35 lb-in. (4.0 N•m) 40 lb-in. (4.5 N•m)
				and 1	3–2/0 AWG Cu (35–70 mm²)	50 lb-in. (5.6 N•m)
L-Frame		**PDC5DG20L3** [1]	3	5 total 3 	4–1 AWG (25–50 mm²) or 14–6 AWG (2.5–16 mm²)	40 lb-in. (4.5 N•m) 35 lb-in . (4.0 N•m)
				and 2	3–2/0 AWG (35–70 mm²)	50 lb-in. (5.6 N•m)
		**PDC12DG4L3** [1]	3	12	8–4 AWG (10–25 mm²)	35 lb-in. (4.0 N•m)
					14–10 AWG (2.5–6 mm²)	20 lb-in. (2.3 N•m)

[1] Kit includes terminal shield.

See Table 135 for the phase barriers for power distribution connectors.

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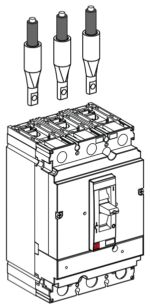

Compression Lugs

Both copper and aluminum compression lug kits are available for the H-, J-, and L-frame circuit breakers. Each kit contains required insulators and all mounting hardware. Compression lugs require the long lug cover pack, see Figure 36 on page 177.

Table 133: Compression Lug Kits for Al/Cu Connectors

Circuit Breaker	Lug Kit	Rating at 75°C		Poles	Wires per Lug	Wire Range	Lugs per Terminal	Lugs per Kit
		Al	Cu					
Al/Cu Connectors								
H-Frame	**YA060HD**	≤ 60 A	≤ 60 A	3	1	6–2 AWG Cu or Al (16–35 mm^2)	1	3
	YA150HD	≤ 150 A	≤ 150 A	3	1	1/0–4/0 AWG Cu or Al (50–95 mm^2)	1	3
J-Frame	**YA150JD**	≤ 200 A	≤ 200 A	3	1	1–3/0 AWG Cu or Al (50–95 mm^2)	1	3
	YA250J35	≤ 250 A	≤ 250 A	3	1	3/0 AWG–350 kcmil Cu or Al (95–185 mm^2)	1	3
L-Frame	**YA400L31K3**	230 A	285 A	3	1	4-300 kcmil Al/Cu (25–150 mm^2)	1	3
	YA600L32K3	460 A	570 A	3	2	4-300 kcmil A/Cu (25–150 mm^2)	2	6
	YA400L51K3	310 A	380 A	3	1	2/0-500 kcmil A/Cu (70–240 mm^2)	1	3
	YA600L52K3	620 A	760 A	3	2	2/0-500 kcmil Al/Cu (70–240 mm^2)	2	6
	YA400L71K3	385 A	380 A	3	1	500-750 kcmil Al (240–400 mm^2) 500 kcmil Cu (240 mm^2)	1	3
	YA600L32K4	460 A	380 A	4	2	4-300 kcmil A/Cu (25–150 mm^2)	1	8
	YA400L51K4	310 A	380 A	4	1	2/0-500 kcmil Al/Cu (70–240 mm^2)	2	4
	YA600L52K4	620 A	760 A	4	2	2/0-500 kcmil Al/Cu (70–240 mm^2)	1	8
	YA400L71K4	385 A	475 A	4	1	500-750 kcmil Al (240–400 mm^2) 500 kcmil Cu (240 mm^2)	2	4

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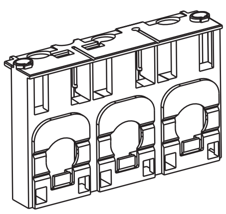
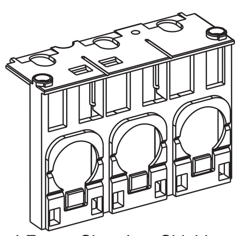
Table 134: Compression Lug Kits for Cu Connectors

Circuit Breaker	Lug Kit	Rating at 75 C Al	Rating at 75 C Cu	Poles	Wires per Lug	Wire Range	Lugs per Terminal	Lugs per Kit
H-Frame	**CYA060HD**	—	≤ 60 A	3	1	6–1/0 AWG Cu ($16–50\ mm^2$)	1	3
	CYA150HD	—	≤ 150 A	3	1	4–2/0 AWG Cu ($25–70\ mm^2$)	1	3
J-Frame	**CYA150JD**	—	≤ 150 A	3	1	4–2/0 AWG Cu ($25–70\ mm^2$)	1	3
	CYA250J3	—	≤ 250 A	3	1	2/0 AWG–300 kcmil Cu ($70–185\ mm^2$)	1	3
L-Frame	**CYA400L31K3**	—	285 A	3	1	2/0-300 kcmil Cu ($70–150\ mm^2$)	1	3
	CYA600L32K3	—	570 A	3	2	2/0-300 kcmil Cu ($70–150\ mm^2$)	2	6
	CYA400L51K3	—	380 A	3	1	250-500 kcmil Cu ($150–240\ mm^2$)	1	3
	CYA600L52K3	—	760 A	3	2	250-500 kcmil Cu ($150–240\ mm^2$)	2	6
	CYA400L31K4	—	285 A	4	1	2/0-300 kcmil Cu ($70–150\ mm^2$)	1	4
	CYA600L32K4	—	570 A	4	2	2/0-300 kcmil Cu ($70–150\ mm^2$)	2	8
	CYA400L51K4	—	380 A	4	1	250-500 kcmil Cu ($150–240\ mm^2$)	1	4
	CYA600L52K4	—	760 A	4	2	250-500 kcmil Cu ($150–240\ mm^2$)	2	8

Terminal Shields



H-Frame Short Lug Shield



J-Frame Short Lug Shield

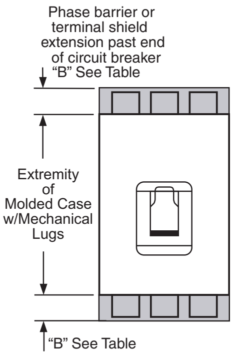


Table 135: Terminal Shields and Phase Barriers

Used With	Description				Dimension B	Cat. No.	Qty Per Kit
H- and J-Frame Mechanical Lugs	Short Lug Shield	Frame	Max. Wire Size				
		H-Frame 60 A	3 AWG		0.50 in.	**S37446**	1
		H-Frame 150 A	3/0 AWG		0.50 in.	**S37447**	1
		J-Frame	350 kcmil		0.24 in.	**S37448**	1
H- and J-Frame Power Distribution Connectors and Compression Lugs		Compatible with:					
		PDC	Compression Lugs				
			Aluminum	Copper			
	H-Frame Long Lug Shield	**PDC6HD6**	**YA060HD**	**CYA060HD**	2.24 in.	**S37449**	1
		PDC3HD2	**YA150HD**	**CYA150HD**			
	J-Frame Long Lug Shield	**PDC6JD4**	**YA150JD**	**CYA150JD**	1.68 in.	**S37450**	1
		PDC3JD2	—	**CYA250J3**			

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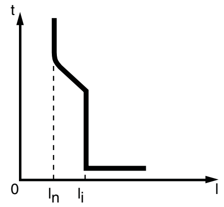
Section 11—Installation Recommendations

Operating Conditions

Temperature Derating

- PowerPact™ H-, J-, and L-frame circuit breakers may be used between -13°F and 158°F (-2°C and +70°C). For temperatures higher than 104°F (40°C) inside the enclosure, devices must be derated.
- Circuit breakers should be put into service under normal ambient, operating-temperature conditions.
- The permissible storage-temperature range for PowerPact H-, J-, and L-frame circuit breakers in the original packing is -58°F[1] and 185°F (-50°C[1] and +85°C).



H-Frame Trip Curve

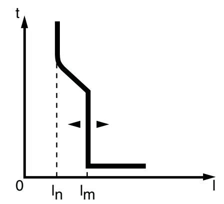
(I_n) Fixed threshold thermal protection against overload

(I_i) **Fixed** threshold instantaneous protection against short circuits

Table 136: Temperature Derating for H-Frame Trip Unit Thermal Protection—Long-Time

Temperature[1]		Rating (A) I_n															
°C	°F																
-10	14	23	30	38	46	53	60	68	76	88	103	112	123	137	160	180	221
0	32	21	28	36	43	49	56	63	71	83	97	107	117	131	151	171	207
10	50	20	26	33	40	46	52	59	66	77	90	101	111	126	141	161	194
20	68	18	24	31	37	42	48	54	62	72	84	96	105	120	132	152	180
30	86	17	22	28	34	39	44	50	56	66	77	88	98	110	121	139	165
40	104	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**125**	**150**
50	122	12	17	21	25	30	34	38	43	53	62	72	80	86	95	109	131
60	140	9	14	17	20	24	28	31	35	46	53	63	70	72	80	93	111

1 Shaded areas indicate temperature rerated values, non-shaded areas inside an enclosure are standard circuit breaker ampere ratings at 104°F (40°C).



J-Frame Trip Unit

(I_n) Fixed threshold thermal protection against overload

(I_m) Adjustable instantaneous protection against short circuits

Table 137: Temperature Derating for J-Frame Trip Unit Thermal Protection—Long-Time

Temperature[1]		Rating (A) I_n				
°C	°F					
-10	14	221	264	289	330	377
0	32	207	247	273	310	354
10	50	194	230	256	290	330
20	68	180	213	240	270	307
30	86	165	194	220	248	279
40	104	**150**	**175**	**200**	**225**	**250**
50	122	131	150	176	193	214
60	140	111	124	151	160	177

1 Shaded areas indicate temperature rerated values, non-shaded areas are standard circuit breaker ampere ratings at 104°F (40°C).

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1 -40°F (-40°C) for Micrologic trip units with an LCD screen.

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PowerPact H-, J- and L-Frame Circuit Breakers Equipped with Electronic Trip Units

Electronic trip units are not affected by variations in temperature. If the trip units are used in high-temperature environments, the Micrologic™ trip unit setting must nevertheless take into account the temperature limits of the circuit breaker.

Changes in temperature do not affect measurements by electronic trip units.

- The built-in CT sensors with Rogowski coils measure the current.
- The control electronics compare the value of the current to the settings defined for 104°F (40°C).

Because temperature has no effect on the CT measurements, the tripping thresholds do not need to be modified.

However, the temperature rise caused by the flow of current combined with the ambient temperature increases the temperature of the device. To avoid reaching the thermal withstand value, it is necessary to limit the current flowing through the device, that is the maximum I_r setting as a function of the temperature.

The table below indicates the maximum long-time (LT) protection setting I_r (A) depending on the ambient temperature.

Table 138: Derating Circuit Breakers with Micrologic Trip Units

Type of Device	Rating	Temperature						
		104°F (40°C)	113°F (45°C)	122°F (50°C)	131°F (55°C)	140°F (60°C)	149°F (65°C)	158°F (70°C)
H-Frame								
Unit-mount, plug-in or drawout	60 A	No derating						
	100 A	No derating						
	150 A	No derating						
J-Frame								
Unit-mount	250 A	250	250	250	245	237	230	225
Plug-in or drawout	250 A	250	245	237	230	225	220	215
L-Frame								
Unit-mount	400 A	400	400	400	390	380	370	360
Plug-in or drawout	400 A	400	390	380	370	360	350	340
Unit-mount	600 A	600	600	600	585	570	550	535
Plug-in or drawout	600 A	570	550	535	520	505	490	475

Example. A unit-mount PowerPact L-frame circuit breaker equipped with a Micrologic can have a maximum I_r setting of:

- 400 A up to 122°F (50°C)
- 380 A up to 140°F (60°C)

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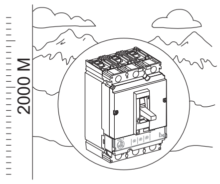

Altitude Derating

Altitude does not significantly affect the characteristics of PowerPact H-, J-, and L-frame circuit breakers circuit breakers up to 6560 ft. (2000 m). Above this altitude, it is necessary to take into account the decrease in the dielectric strength and cooling capacity of air.

The following table gives the corrections to be applied for altitudes above 6560 ft. (2000 m). The breaking capacities remain unchanged.

Table 139: Altitude Derating

Altitude		6560 ft (2000 m)	9840 ft (3000 m)	13120 ft (4000 m)	16400 ft (5000 m)
Dielectric withstand voltage		3000 V	2500 V	2100 V	1800 V
Insulation voltage	V_i	800 V	700 V	600 V	500 V
Maximum operational voltage	V_e	690 V	590 V	520 V	460 V
Average current capacity (A) at 104°F (40°C)	I_n x	1 0.	0.96	0.93	0.9

Frequency Derating

Application of H- and J-frame circuit breakers at frequencies above 60 Hz requires that special consideration be given to the effects of high frequency on the circuit breaker characteristics. Thermal and instantaneous operations must be treated separately.

At frequencies below 60 Hz, the thermal derating of PowerPact H and J-frame circuit breakers is negligible. However, at frequencies above 60 Hz, thermal derating is required.

One of the most common high frequency applications is at 400 Hz. For 400 Hz derating information, see Page 27.

For more information, refer to Data Bulletin 0100DB0101, *Determining Current Carrying Capacity in Special Applications*.

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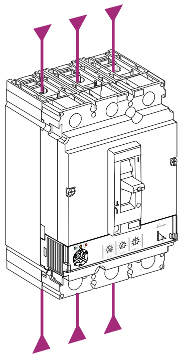
Installation in Equipment

Power from the Top or Bottom



PowerPact H-, J-, and L-frame circuit breakers with factory-sealed trip units can be supplied from either the top or the bottom without any reduction in performance. This capability facilitates connection when installed in end-use equipment.

All connection and insulation accessories can be used on circuit breakers supplied either from the top or bottom.

Weight

The table below presents the weights of the circuit breakers and the main accessories, which must be summed to obtain the total weight. The values are valid for all performance categories.

Table 140: Weights

Type of Device	Poles	Circuit Breakers	Base	Cradle	Motor Operator
H-frame, 100 A	2	3.95 lbs. (1.79 kg)	1.75 lbs. (0.8 kg)	4.85 lbs. (2.2 kg)	2.65 lbs. (1.2 kg)
	3	4.52 lbs. (2.05 kg)	1.75 lbs. (0.8 kg)	4.85 lbs. (2.2 kg)	2.65 lbs. (1.2 kg)
H-frame, 150 A	2	4.08 lbs. (1.85 kg)	1.75 lbs. (0.8 kg)	4.85 lbs. (2.2 kg)	2.65 lbs. (1.2 kg)
	3	4.85 lbs. (2.2 kg)	1.75 lbs. (0.8 kg)	4.85 lbs. (2.2 kg)	2.65 lbs. (1.2 kg)
J-frame, 250 A	3	5.29 lbs. (2.4 kg)	1.75 lbs. (0.8 kg)	4.85 lbs. (2.2 kg)	2.65 lbs. (1.2 kg)
L-frame, 600 A	3	13.65 lbs. (6.19 kg)	5.29 lbs. (2.4 kg)	4.85 lbs. (2.2 kg)	6.17 lbs. (2.8 kg)
	4	17.92 lbs. (8.13 kg)	6.17 lbs. (2.8 kg)	4.85 lbs. (2.2 kg)	6.17 lbs. (2.8 kg)

Safety Clearances and Minimum Distances

General Rules

When installing a circuit breaker, minimum distances (safety clearances) must be maintained between the device and panels, bars and other protection devices installed nearby. These distances, which depend on the voltage, are defined by tests carried out in accordance with UL standards.

If installation is not checked by type tests, it is also necessary to:

- use insulated bars for circuit-breaker connections
- segregate the busbars using phase barriers

For PowerPact H-, J-, and L-frame devices, terminal shields and interphase barriers are recommended and may be mandatory depending on the operating voltage of the device and type of installation (unit-mount, drawout, etc.).

Power Connections

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The table below indicates the connection requirements for PowerPact H-, J-, and L-frame devices to ensure insulation of live parts for the various types of connection.

- unit-mount devices with front connection or rear connection
- plug-in or drawout devices.

Connection accessories such as crimp lugs, terminal extensions (straight, right-angle, double-L and 45°) and spreaders are supplied with interphase barriers. Long terminal shields provide a degree of protection of IP40 (ingress).

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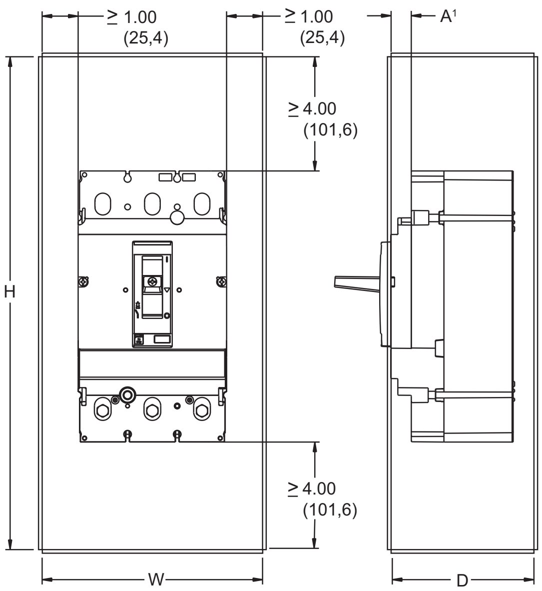
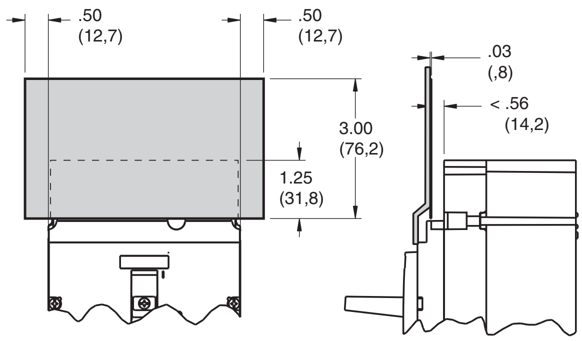
Safety Clearance

Safety Clearances



If dimension A < 0.56 in. for H- and J-frame circuit breaker, attach fiber insulating plate, not provided, to enclosure cover.

H- and J-Frame Fiber Insulating Plate



Dimensions: in. (mm)

Control Wiring

Remote Tripping by Undervoltage Trip (MN) or Shunt Trip (MX)

Power requirements are approximately:

- 30 VA for pick-up of the undervoltage trip (MN) and shunt trip (MX)
- 300–500 VA for the motor operator.

Table 141: Recommended Maximum Cable Lengths[1]

Power Supply Voltage (Vdc)		12 Vdc		24 Vdc		48 Vdc	
Cable cross-section		16 AWG (1.5 mm²)	14 AWG (2.5mm²)	16 AWG (1.5 mm²)	14 AWG (2.5mm²)	16 AWG (1.5 mm²)	14 AWG (2.5mm²)
Undervoltage Trip (MN)	V source 100%	49 ft. (15 m)	—	525 ft. (160 m)	—	2100 ft. (640 m)	—
	V source 85%	23 ft. (7 m)	—	131 ft. (40 m)	—	525 ft. (160 m)	—
Shunt Trip (MX)	V source 100%	197 ft. (60 m)	—	787 ft. (240 m)	—	3150 ft. (960 m)	—
	V source 85%	98 ft. (30 m)	—	394 ft. (120 m)	—	1575 ft. (480 m)	—
Motor Operator	V source 100%		—	33 ft. (10 m)	52 ft. (16 m)	213 ft. (65 m)	361 ft. (110 m)
	V source 85%	—	—	6.6 ft. (2 m)	13 ft (4 m)	56 ft. (17 m)	82 ft. (25 m)

[1] The indicated length is that of each of the two wires.

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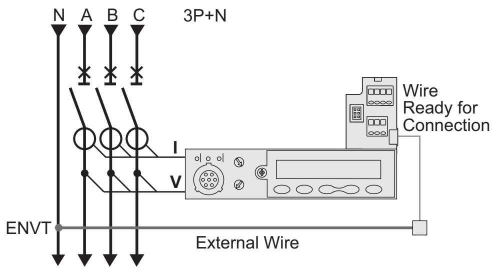
External Neutral Voltage Tap (ENVT)



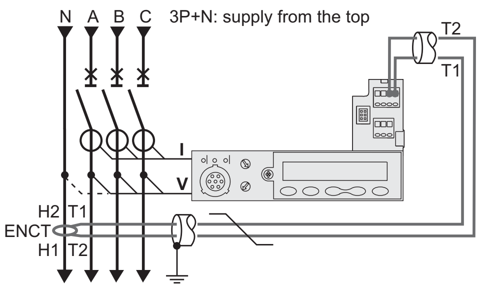
External neutral voltage tap (ENVT)

This connection is required for accurate power measurements on three-pole circuit breakers equipped with Micrologic 5/6 E trip units in installations with a distributed neutral. It can be used to measure phase-neutral voltages and calculate power using the 3 wattmeter method.

PowerPact H-, J-, and L-frame three-pole circuit breakers come with a wire installed on the device for the connection to the ENVT. This wire is equipped with a connector for connection to an external wire with:

- cross-sectional area of 18–14 AWG (1 mm² to 2.5 mm²)
- maximum length of 32.8 ft. (10 m).

External Neutral Current Transformer (ENCT)



This connection is required to protect the neutral on three-pole circuit breakers equipped with Micrologic 5/6 A or E trip units in installations with a distributed neutral. For Micrologic 6 A or E, it is required for ground-fault protection.

The ENCT is connected in the same way for unit-mount, plug-in or drawout devices:

- unit-mount devices are connected using terminals T1 and T2 of the internal terminal block.
- plug-in and drawout devices are not connected using the auxiliary terminals.

The wires must be connected/disconnected inside the devices using terminals T1 and T2.

The ENCT must be connected to the Micrologic trip unit by a shielded twisted pair. The shielding should be connected to the enclosure earth only at the CT end, no more than 12 in. (30 cm) from the CT.

- the power connections of the CT to the neutral (H2 and H1) must be made in the same way for power supply from the top or the bottom (see figure). Make sure they are not reversed for devices with power supply from the bottom.
- cross-sectional area of 22–16 AWG (0.4 mm² to 1.5 mm²)
- maximum length of 32.8 ft. (10 m).

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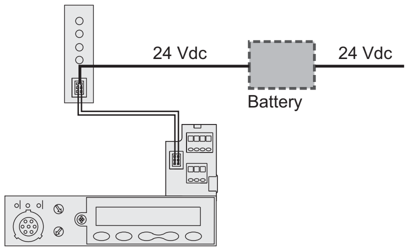
24 Vdc Power Supply Module

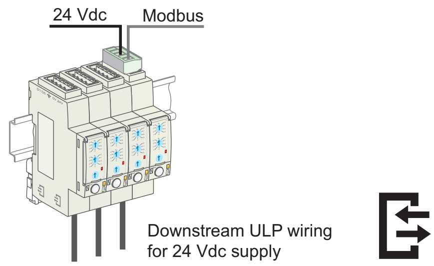
An external 24 Vdc power supply is required for installations with communication networks, regardless of the type of trip unit.

On installations without communication networks, the power supply is available as an option for Micrologic 5/6 to:

- modify settings when the circuit breaker is open (OFF position)
- display measurements when the current flowing through the circuit breaker is low
- maintain the display of the cause of tripping



Power supply, without the communication function, using the terminal block with a backup battery.



Power supply, with the communication function, using the Modbus interface.

To determine power requirements of devices, see page 90.

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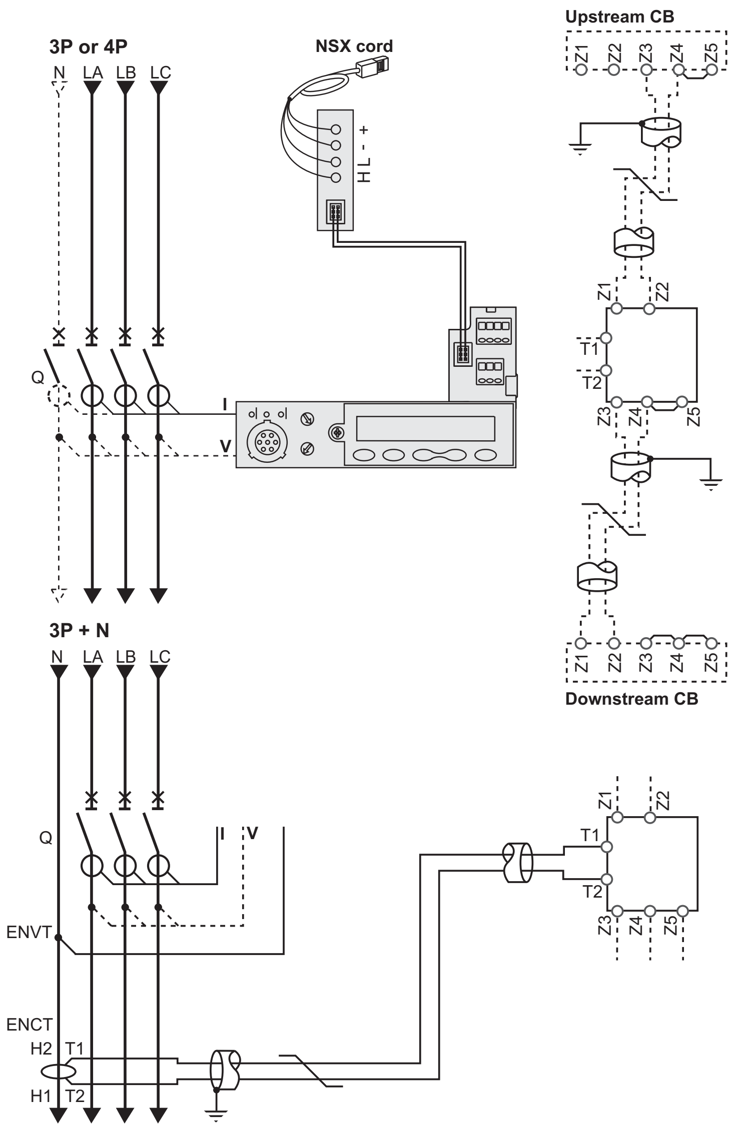
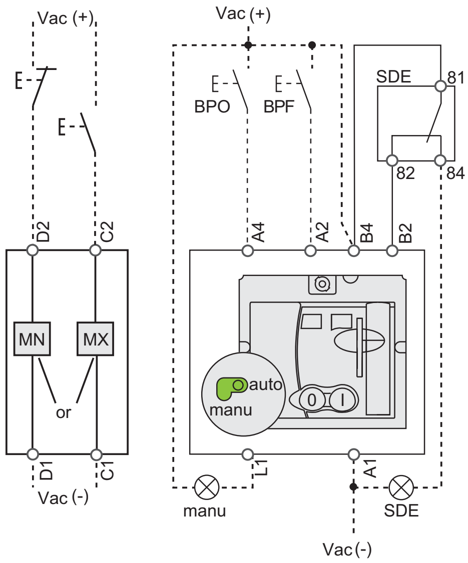
Section 12—Wiring Diagrams

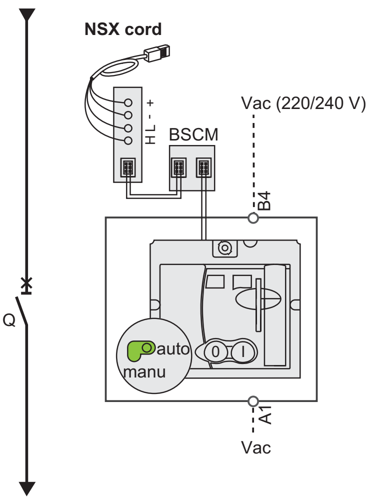
Unit-Mount Circuit Breakers

Power	Micrologic Trip Unit[1]	Remote Operation





Motor Operator



NOTE: Schematic of the communicating motor operator .

Communicating Motor Operator

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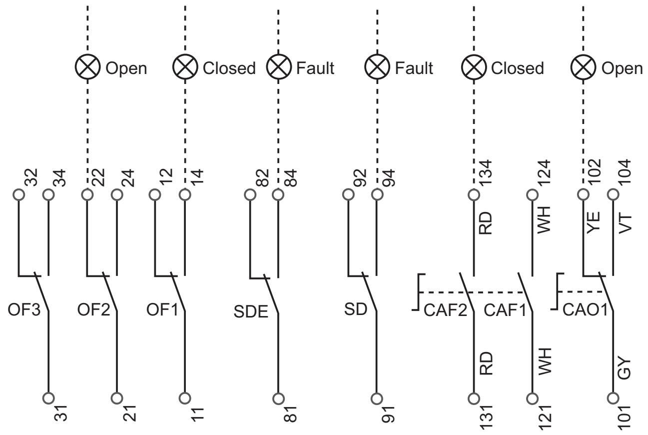
Unit-Mount Circuit Breakers *(continued)*

Indication Contacts



The diagram is shown with circuits de-energized, relays in normal position, and all devices open, connected, and charged.
Terminal connections shown as O must be connected by the customer.

Micrologic Trip Unit A or E

A/E	Communication H (WH), L(BL): data -(BK), +(RD): 24 Vdc power supply
A/E	ZSI (Zone Selective Interlocking) Z1: ZSI OUT SOURCE Z2: ZSI OUT Z3: ZSI IN SOURCE Z4: ZSI IN ST (short time) Z5: ZSI IN GF (ground fault) (Z3, Z4, and Z5 for L-frame circuit breaker only)
A/E	ENCT: External Neutral Current Transformer: -Shielded cable with 1 twisted pair (T1, T2) -Shielding earthed at CT end only -Connection L = 12 in. (30 cm) max. -Maximum length of 33 ft. (10 m) -Cable size of 22 AWG -Recommended cable: Belden 9451SB or equivalent
E	ENVT: External Neutral Voltage Tap for Connection to the Neutral using a Three-Pole Circuit Breaker

Color Code for Auxiliary Wiring

RD: Red	VI: Violet
WH: White	GY: Gray
YE: Yellow	OR: Orange
BK: Black	BL: Blue
GN: Green	

Remote Operation

MN	Undervoltage Release
or	
MX	Shunt Release
Motor Operator	
A4	Opening Order
A2	Closing Order
B4, A1	Power Supply to Motor Operator
L1	Manual Position (manu)
B2	Overcurrent Trip Switch Interlocking (mandatory for correct operation)
BPO	Opening Pushbutton
BPF	Closing Pushbutton
Communicating Motor Operator	
B4, A1	Motor Operator Power Supply
BSCM	Breaker Status and Control Module

Indication Contacts

OF2/OF1	Device ON/OFF Auxiliary Switches
OF3	Device ON/OFF Auxiliary Switches (L-Frame)
SDE	Overcurrent Trip Switch (short-circuit, overload, ground fault, earth leakage)
SD	Alarm Switch
CAF2/CAF1	Early-Make Contact (rotary handle only)
CAO1	Early-Break Contact (rotary handle only)

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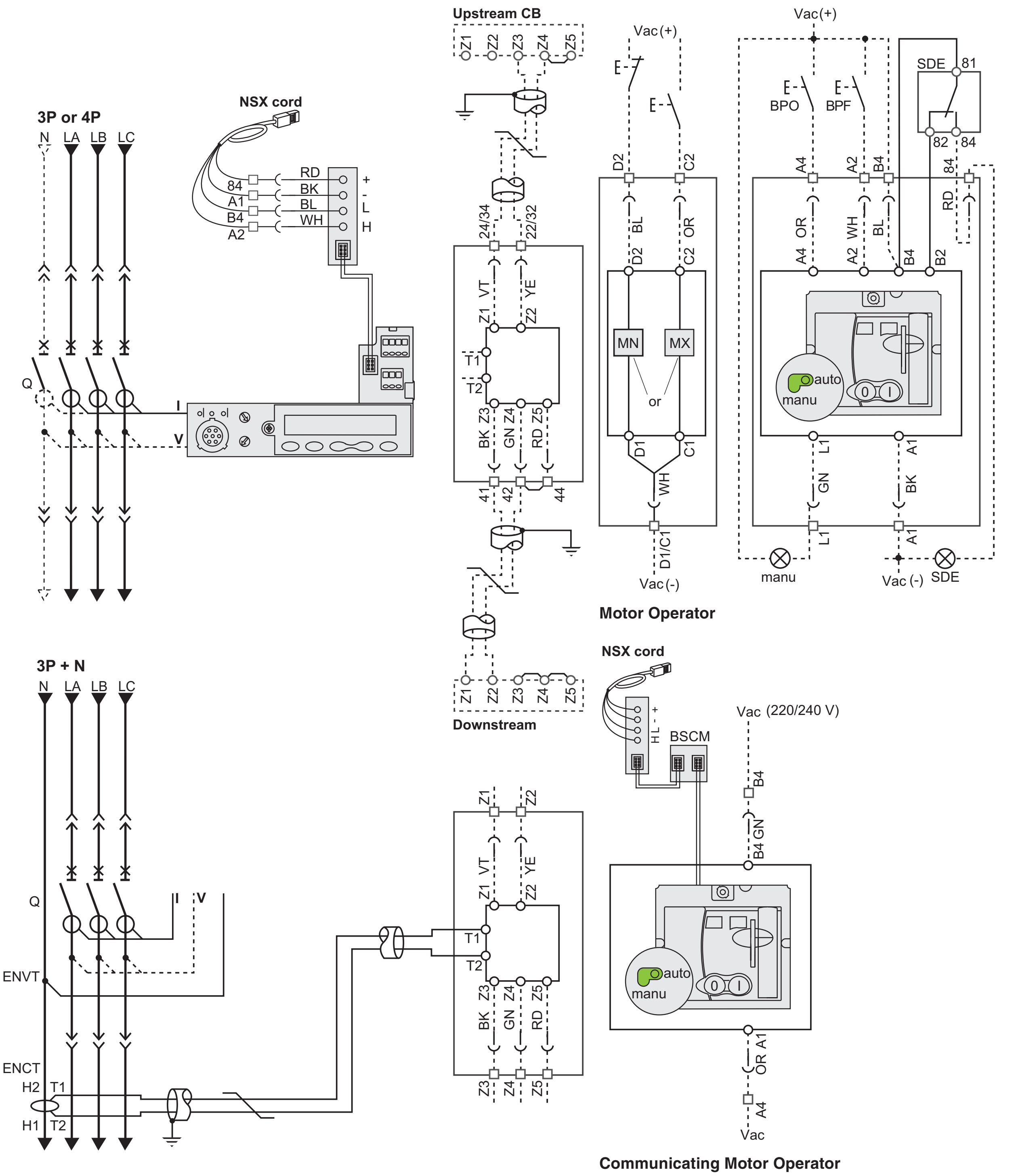
Plug-In and Drawout Circuit Breakers

Power	Micrologic Trip Unit	Remote Operation



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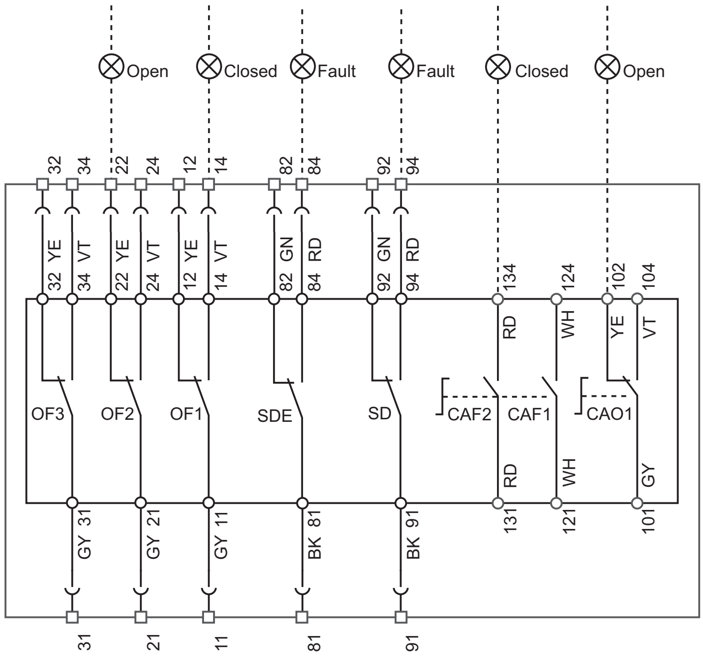
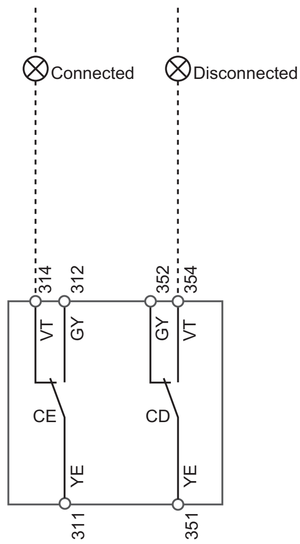
PowerPact H-, J-, and L-Frame Circuit Breakers
Wiring Diagrams

Plug-In and Drawout Circuit Breakers *(continued)*

Indication Contacts	Carriage Switches





The diagram is shown with circuits de-energized, relays in normal position, and all devices open, connected, and charged.

Terminal connections shown as ☐ and O must be connected by the customer.

Micrologic Trip Unit A or E

A/E	Communication H (WH), L(BL): data -(BK), +(RD): 24 Vdc power supply
A/E	ZSI (Zone Selective Interlocking) Z1: ZSI OUT SOURCE Z2: ZSI OUT Z3: ZSI IN SOURCE Z4: ZSI IN ST (short time) Z5: ZSI IN GF (ground fault) (Z3, Z4, and Z5 for L-frame circuit breaker only)
A/E	ENCT: External Neutral Current Transformer: -Shielded cable with 1 twisted pair (T1, T2) -Shielding earthed at CT end only Connection L = 12 in. (30 cm) max. -Maximum length of 33 ft. (10 m) -Cable size of 22 AWG -Recommended cable: Belden 9451SB or equivalent
E	ENVT: External Neutral Voltage Tap for Connection to the Neutral using a Three-Pole Circuit Breaker

Color Code for Auxiliary Wiring

RD: Red	VI: Violet
WH: White	GY: Gray
YE: Yellow	OR: Orange
BK: Black	BL: Blue
GN: Green	

Remote Operation

MN	Undervoltage Release
or	
MX	Shunt Release
Motor Operator	
A4	Opening Order
A2	Closing Order
B4, A1	Power Supply to Motor Operator
L1	Manual Position (manu)
B2	Overcurrent Trip Switch Interlocking (mandatory for correct operation)
BPO	Opening Pushbutton
BP	Closing Pushbutton
Communicating Motor Operator	
B4, A1	Motor Operator Power Supply
BSCM	Breaker Status and Control Module

Indication Contacts

OF2/OF1	Device ON/OFF Auxiliary Switches
OF3	Device ON/OFF Auxiliary Switches (L-Frame)
SDE	Overcurrent Trip Switch (short-circuit, overload, ground fault, earth leakage)
SD	Alarm Switch
CAF2/CAF1	Early-Make Contact (rotary handle only)
CAO1	Early-Break Contact (rotary handle only)

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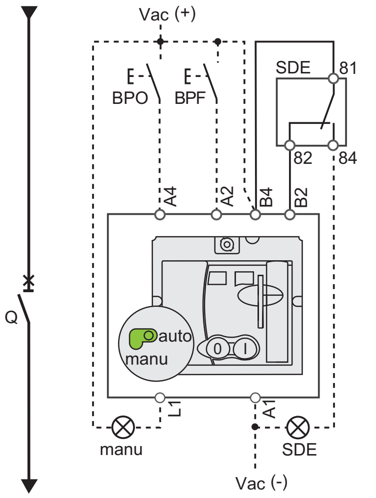
Motor Operator

NOTE: The diagram is shown with circuits de-energized, relays in normal position, and all devices open, connected, and charged.

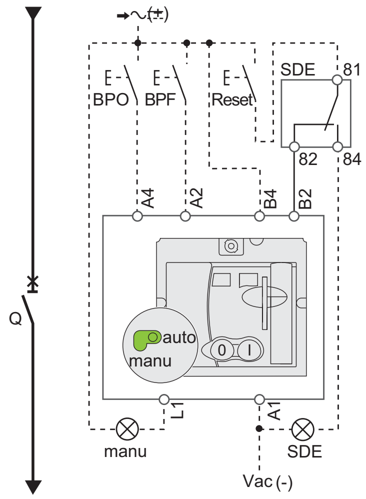
After tripping initiated by the “Push to trip” button, the undervoltage release (MN), or the shunt release (MX), device can be reset automatically, remotely, or manually.

Following tripping due to an electrical fault, reset must be carried out manually.

Motor Operator with Automatic Reset



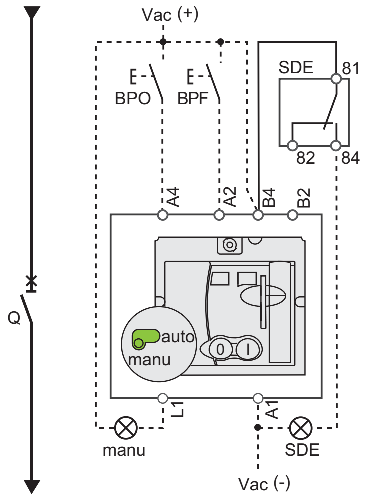
Motor Operator with Remote Reset



Symbols

Q:	Circuit Breaker
A4:	Opening Order
A2:	Closing Order
B4, A1:	Motor Operator Power Supply
L1:	Manual Position (manu)
B2:	Overcurrent Trip Switch Interlocking (mandatory for correct operation)
BPO:	Opening Pushbutton
BPF:	Closing Pushbutton
SDE:	Fault-Trip Indication Contact (short-circuit, overload, ground fault, earth leakage)

Motor Operator with Manual Reset



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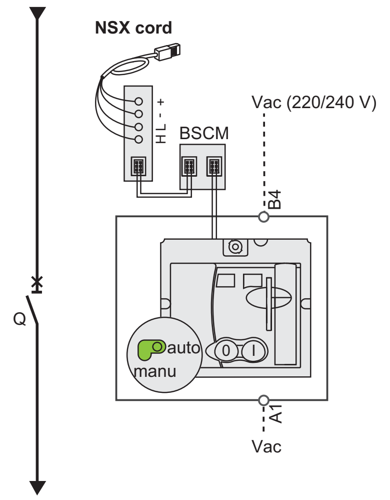
Motor Operator *(continued)*

Symbols

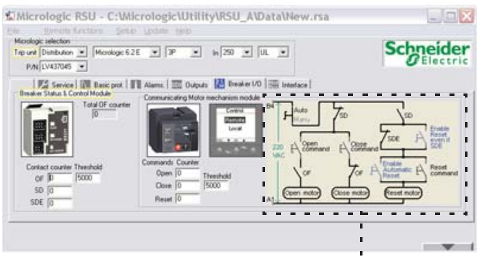
Q: Circuit Breaker
B4, A1: Motor Operator Power Supply
BSCM: Breaker Status and Control Module

Communicating Motor Operator

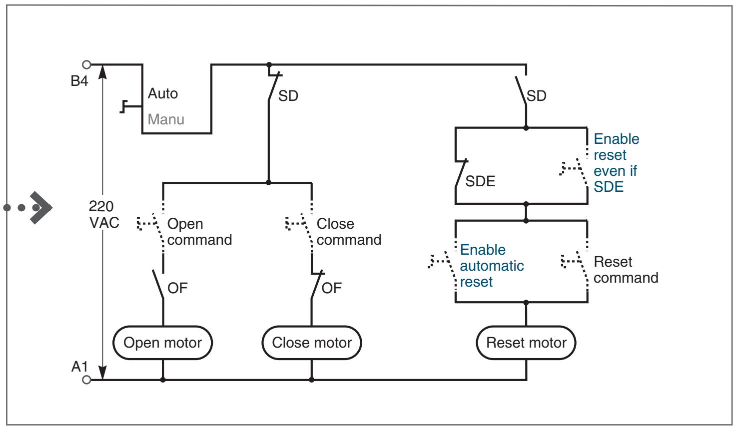


NOTE: Schematic of the communicating motor operator .

RSU Screen for Communicating Motor Operator



RSU utility setup screen for the communicating motor operator



Single-line diagram of communicating motor operator

Opening, closing and reset orders are transmitted through the communication network. The “Enable automatic reset” and “Enable reset even if SDE” parameters must be set using the RSU software using the screen by clicking the blue text.

“Auto/Manu” is a switch on the front of the motor operator.

Terminal connections shown as O must be connected by the customer.

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SDx Module with Micrologic™ Trip Unit

NOTE: The diagram is shown with circuits de-energized, relays in normal position, and all devices open, connected, and charged.

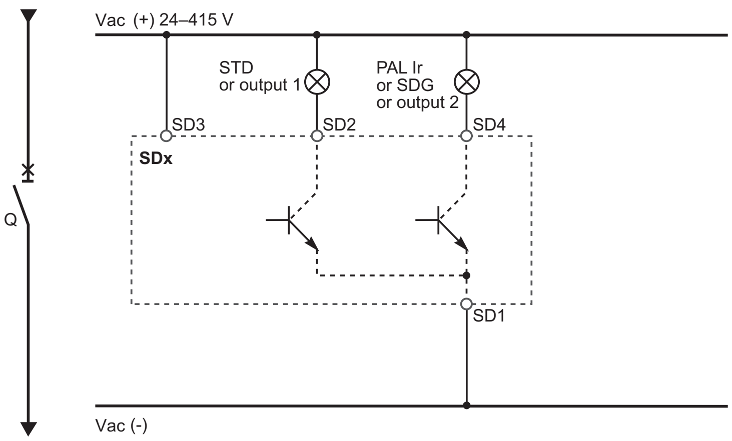
Symbols

SD1, SD3: SDx Module Power Supply
SD2: Output 1 (80 mA max.)
SD4: Output 2 (80 mA max.)

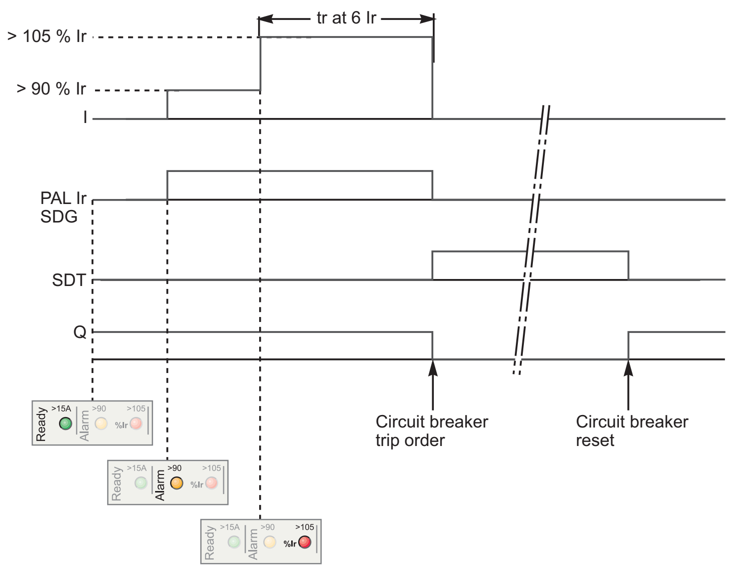
	SD2	SD4
Micrologic 3	SDT	—
Micrologic 5	SDT or Output 1	PAL I_r or Output 2
Micrologic 6	SDT or Output 1	SDG or Output 2

Terminal connections shown as O must be connected by the customer.

Connection



Operation



I: Charge Current
PAL I_r: Thermal Overload Pre-Alarm
SDG: Ground-Fault Signal
SDT: Thermal-Fault Signal
Q: Circuit Breaker

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SDTAM Module with Micrologic M Trip Unit

NOTE: The diagram is shown with circuits de-energized, relays in normal position, and all devices open, connected, and charged.

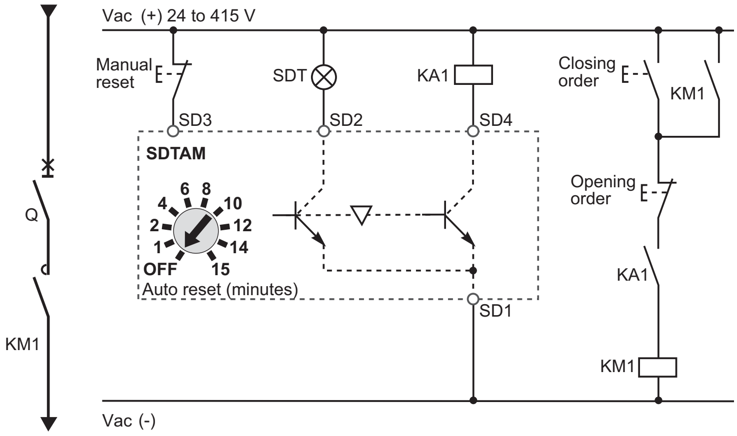
Symbols

SD1, SD3:	SDTAM Module Power Supply
SD2:	Thermal Fault Signal (80 mA max.)
SD4:	Contactor Control Output (80 mA max.)

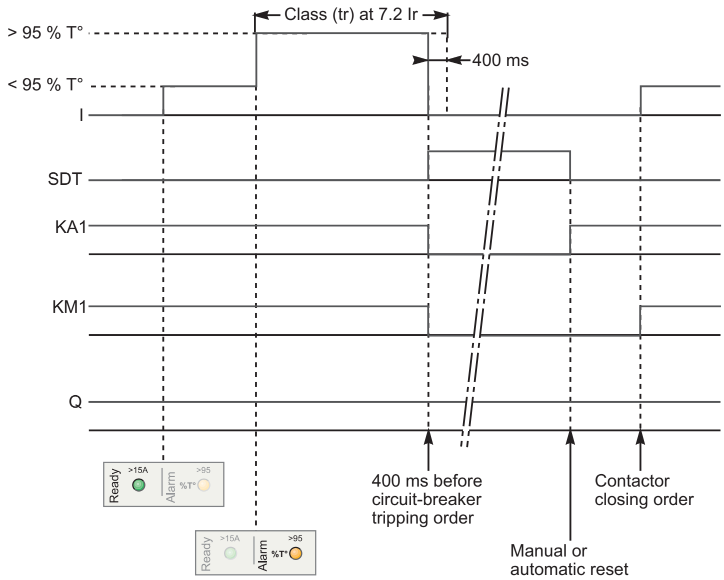
	SD2	SD4
Micrologic 2 M	SDT	KA1

Terminal connections shown as O must be connected by the customer.

Connection



Operation



I:	Charge Current
SDT:	Thermal Fault Signal
KA1:	Auxiliary Relay (RBN or RTBT Relay)
KM1:	Motor Contactor
Q:	Circuit Breaker

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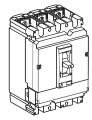
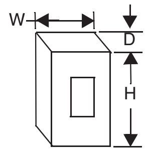
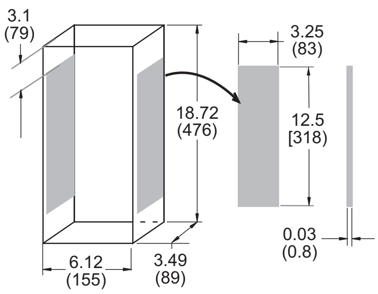
Section 13—Circuit Breaker Dimensions

Table 142: Enclosure Dimensions

		 H x W x D	
		Standard (80%) Rated	100% Rated
HD/HG/HJ/HL	15–150 A	15.6 x 6.12 x 3.49 in. (396 x 155 x 89 mm)	15.6 x 6.12 x 3.49 in. (396 x 155 x 89 mm)
HR		18.13 x 8.63 x 4.13 in. (461 x 219 x 105 mm)	62 x 22.5 x 14 in. (1575 x 572 x 356 mm)
JD/JG/ JJ/JL[1]	150–250 A	18.72 x 6.12 x 3.49 in. (476 x 155 x 89 mm)	18.72 x 6.12 x 3.49 in. (476 x 155 x 89 mm)
JR		28.5 x 12.38 x 5.38 in. (724 x 314 x 137 mm)	62 x 22.5 x 14 in. (1575 x 572 x 356 mm)
LD/LG/LJ/ LL	250–600 A	35.48 x 12.00 x 4.45 in. (901 x 305 x 113 mm)	35.48 x 12.00 x 4.45 in. (901 x 305 x 113 mm)
LR		40.5 x 13.75 x 4.33 in. (1030 x 350 x 110 mm)	40.5 x 13.75 x 4.33 in. (1030 x 350 x 110 mm)

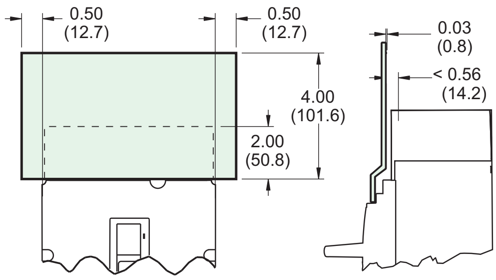
1 Minimum enclosure insulation required if circuit breaker side < 4.13 in. (105 mm) from metal.

J-Frame Minimum Enclosure Insulation



Dimensions: in.
(mm)

L-Frame Minimum Enclosure Insulation for Rear Connection



Dimensions: in.
(mm)

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PowerPact™ H-Frame Circuit Breakers

Figure 13: 15–150 A Bus Bar PowerPact H-Frame Two-Pole HD/HG Thermal-Magnetic Only Circuit Breaker

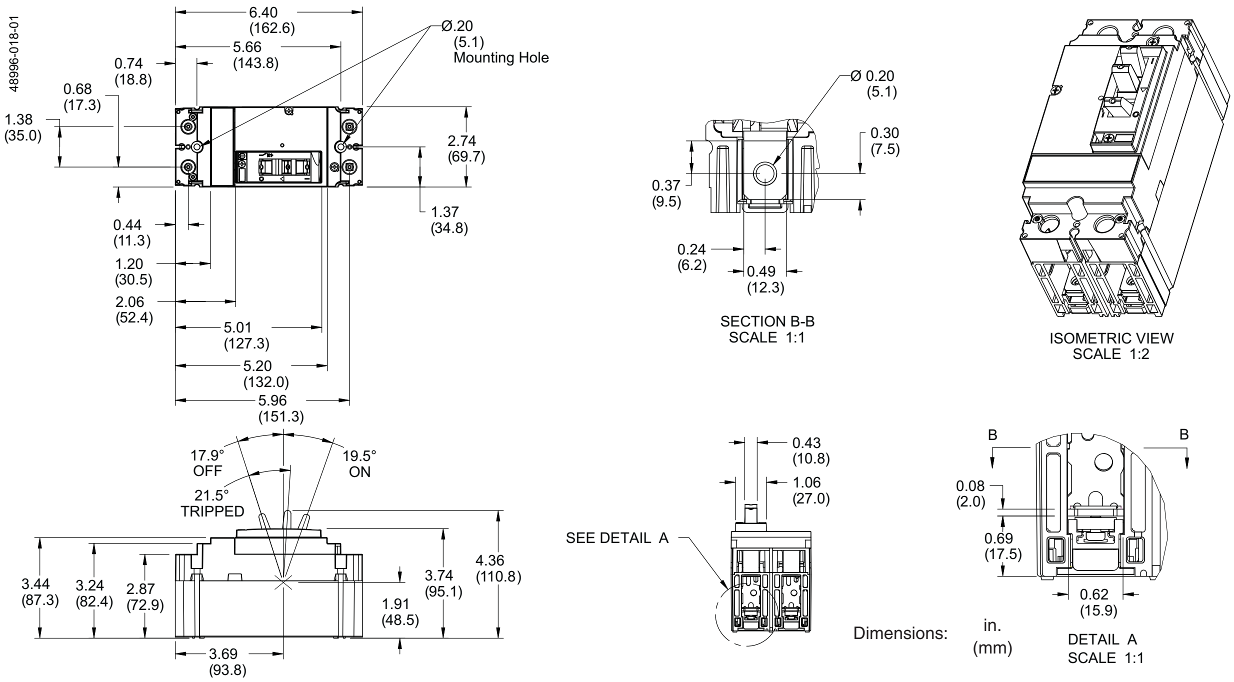

Figure 14: 15–150 A Unit Mount PowerPact H-Frame Two-Pole HD/HG Thermal-Magnetic Only Circuit Breaker

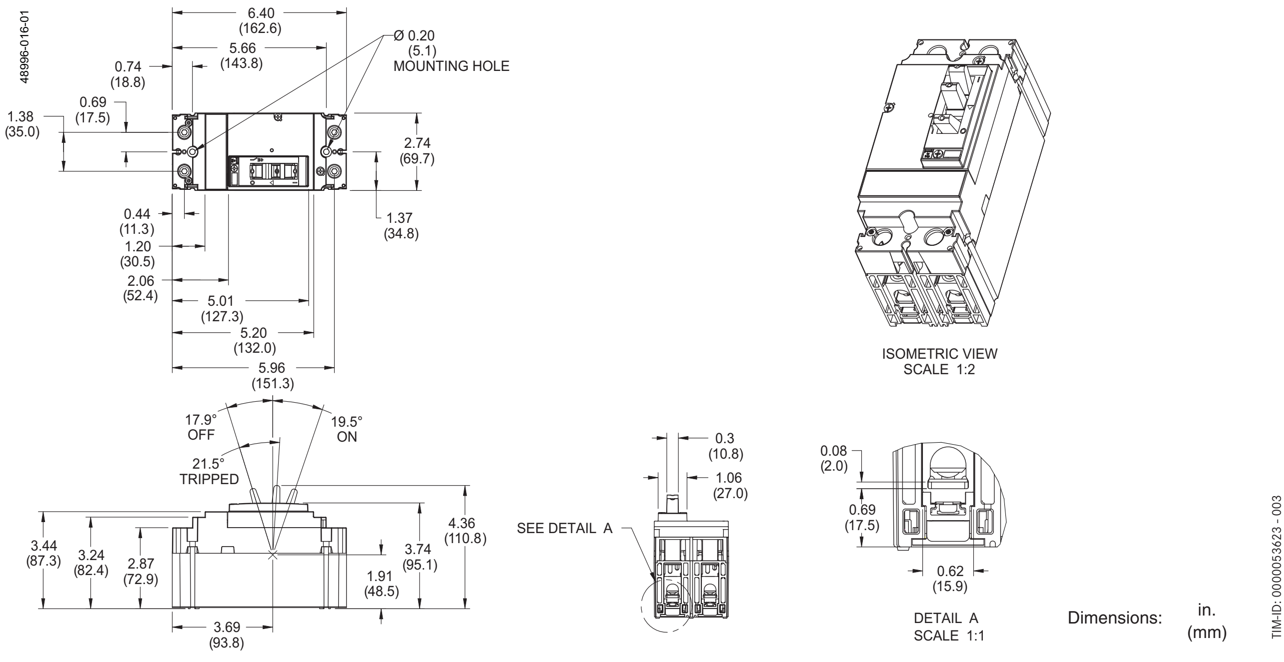

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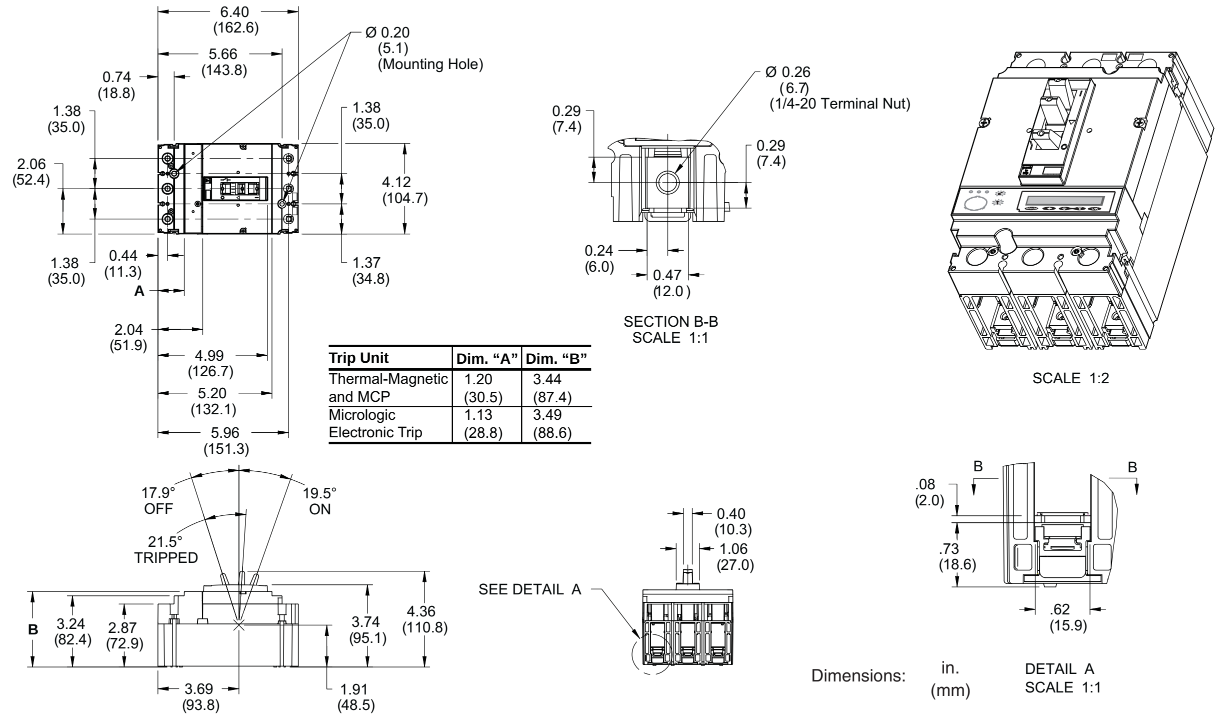
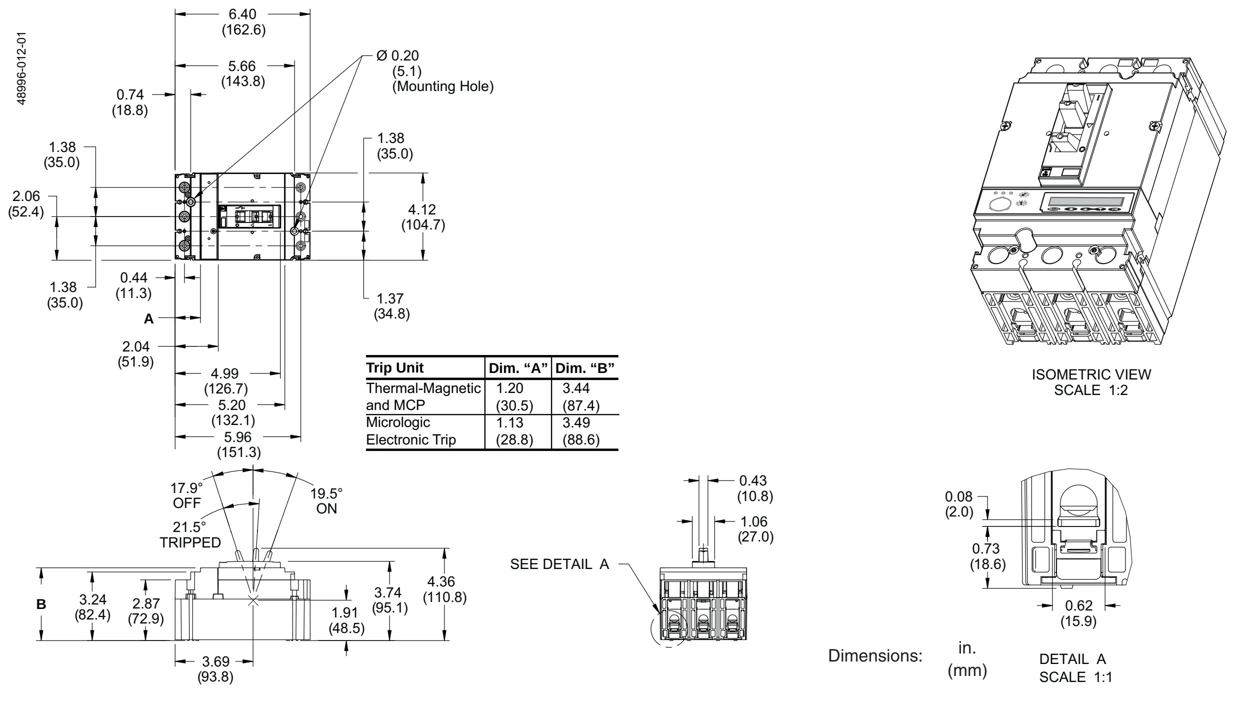
Figure 15: 15–150 A Bus Bar PowerPact H-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.20 (30.5)	3.44 (87.4)
Micrologic Electronic Trip	1.13 (28.8)	3.49 (88.6)

Figure 16: 15–150 A Lug-Lug PowerPact H-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.20 (30.5)	3.44 (87.4)
Micrologic Electronic Trip	1.13 (28.8)	3.49 (88.6)

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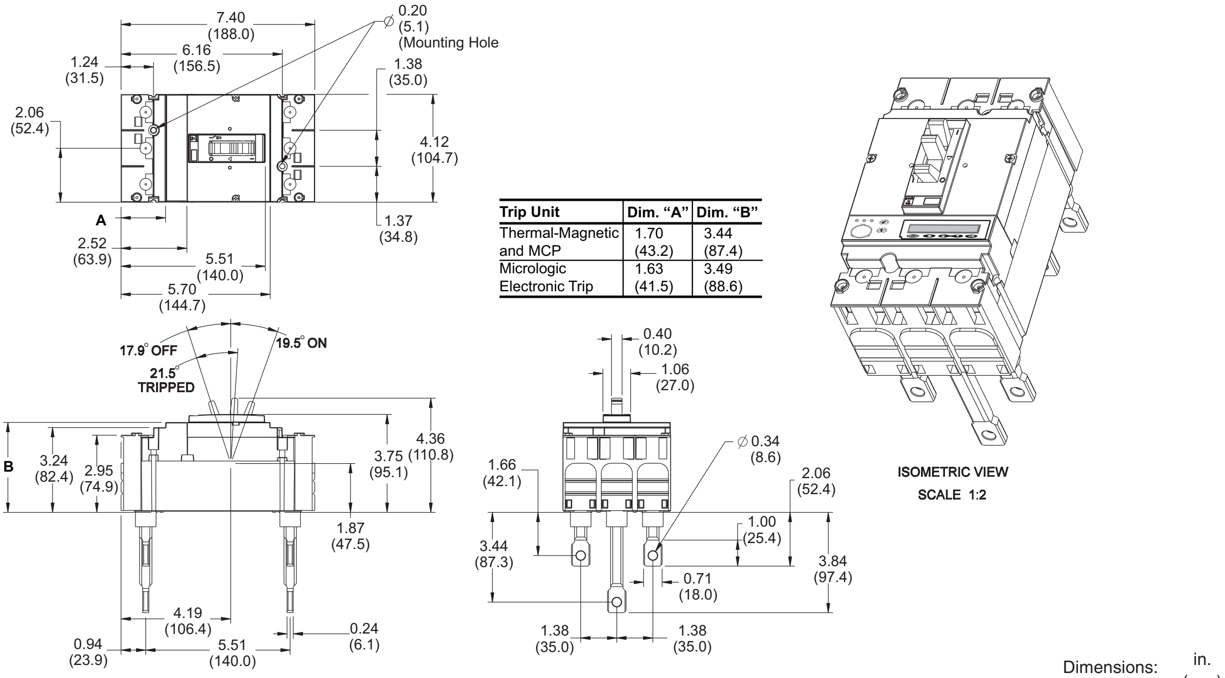
PowerPact H-, J-, and L-Frame Circuit Breakers
Circuit Breaker Dimensions

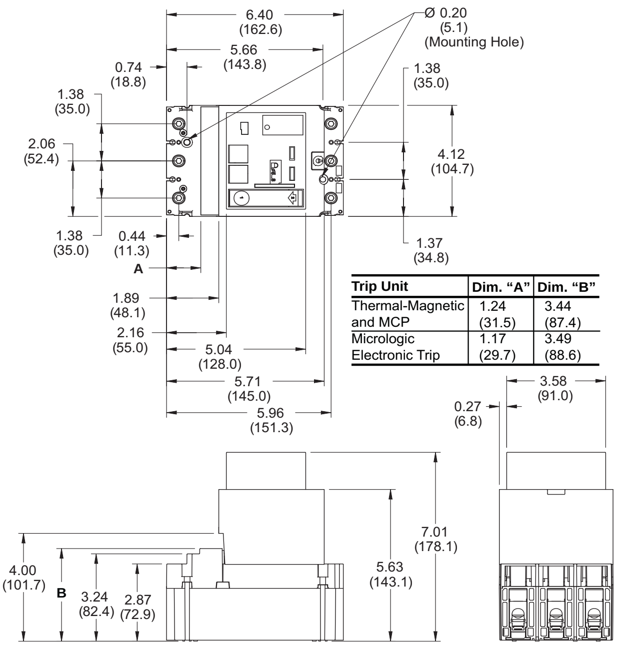
Figure 17: 15–150 A Rear Connected PowerPact H-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.70 (43.2)	3.44 (87.4)
Micrologic Electronic Trip	1.63 (41.5)	3.49 (88.6)

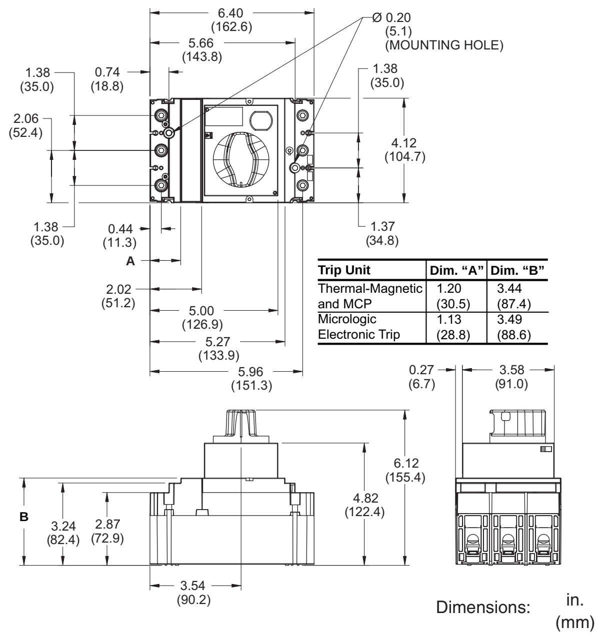
Dimensions: in. (mm)

Figure 18: Motor Operator Detail (PowerPact H-Frame Circuit Breaker)



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.24 (31.5)	3.44 (87.4)
Micrologic Electronic Trip	1.17 (29.7)	3.49 (88.6)

Figure 19: Rotary Handle Detail (PowerPact H-Frame Circuit Breaker)



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.20 (30.5)	3.44 (87.4)
Micrologic Electronic Trip	1.13 (28.8)	3.49 (88.6)

Dimensions: in. (mm)

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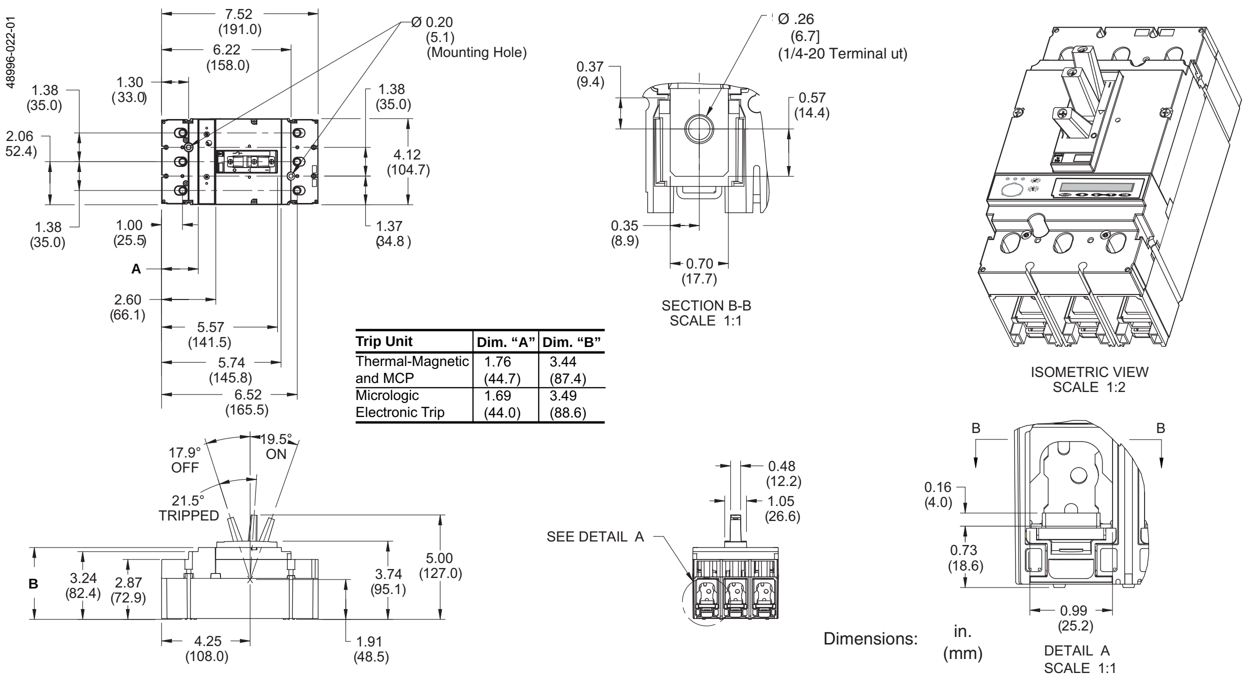
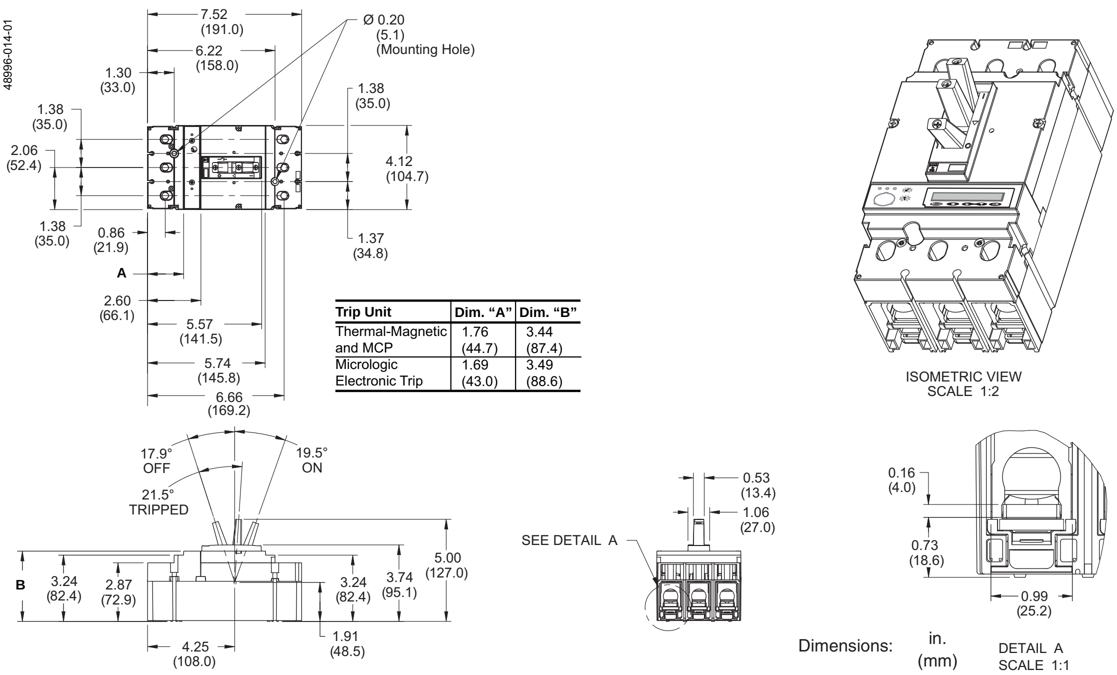
PowerPact J-Frame Circuit Breakers

Figure 20: 150–250 A Bus Bar PowerPact J-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.76 (44.7)	3.44 (87.4)
Micrologic Electronic Trip	1.69 (44.0)	3.49 (88.6)

Figure 21: 150–250 A Lug-Lug PowerPact J-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.76 (44.7)	3.44 (87.4)
Micrologic Electronic Trip	1.69 (43.0)	3.49 (88.6)

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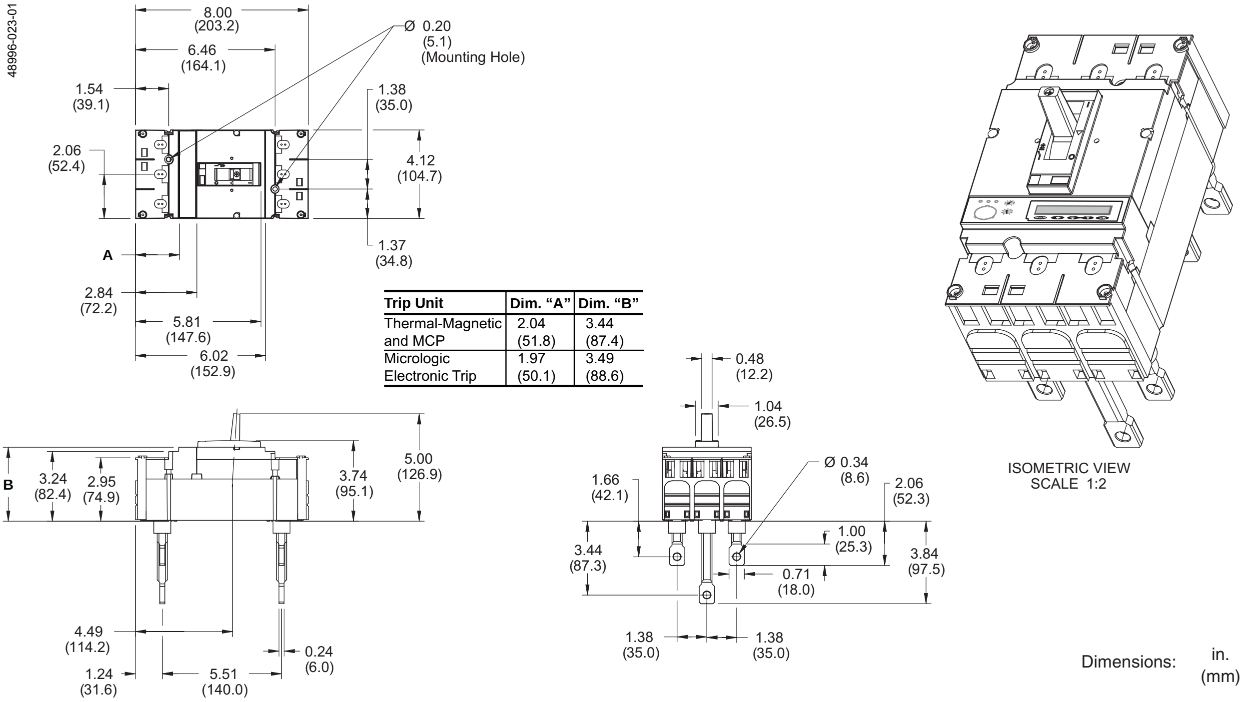
PowerPact H-, J-, and L-Frame Circuit Breakers
Circuit Breaker Dimensions

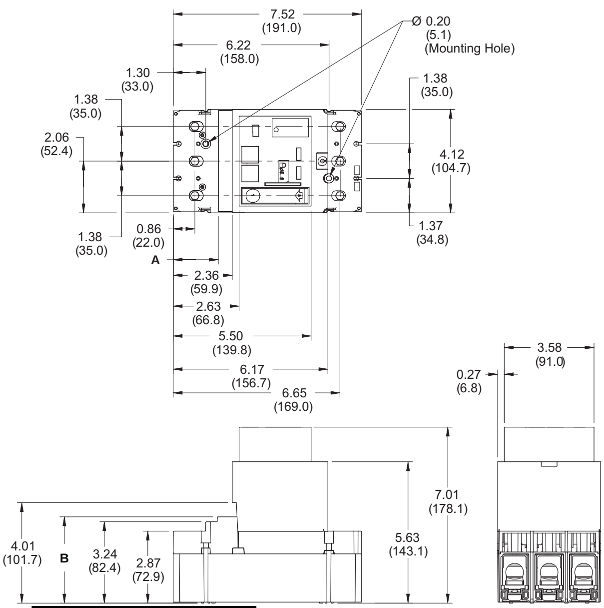
Figure 22: 150–250 A Rear Connected PowerPact J-Frame Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	2.04 (51.8)	3.44 (87.4)
Micrologic Electronic Trip	1.97 (50.1)	3.49 (88.6)

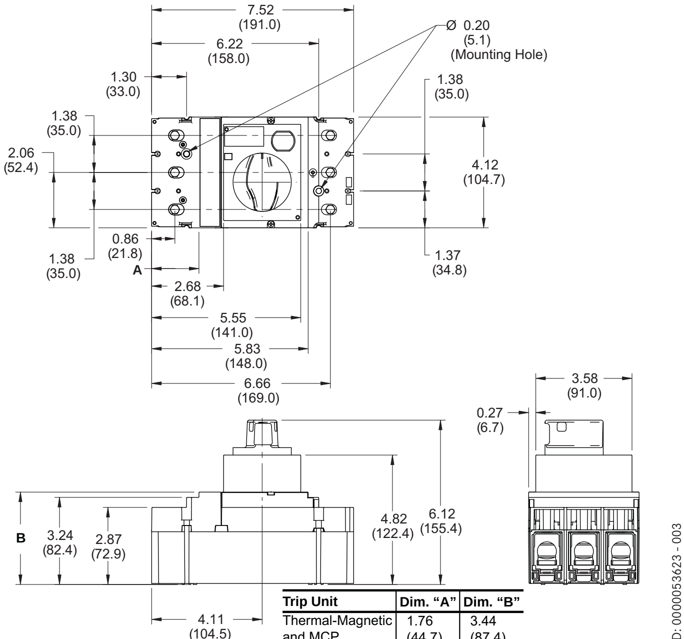
Dimensions: in. (mm)

Figure 23: Motor Operator Detail (PowerPact J-Frame Circuit Breaker)



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.80 (45.7)	3.44 (87.4)
Micrologic Electronic Trip	1.73 (44.0)	3.49 (88.6)

Figure 24: Rotary Handle Detail (PowerPact J-Frame Circuit Breaker)



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	1.76 (44.7)	3.44 (87.4)
Micrologic Electronic Trip	1.69 (43.0)	3.49 (88.6)

Dimensions: in. (mm)

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PowerPact H- and J-Frame Plug-In Circuit Breakers

Figure 25: 15–250 A PowerPact H- and J-Frame Three-Pole Circuit Breaker Plug-In Base

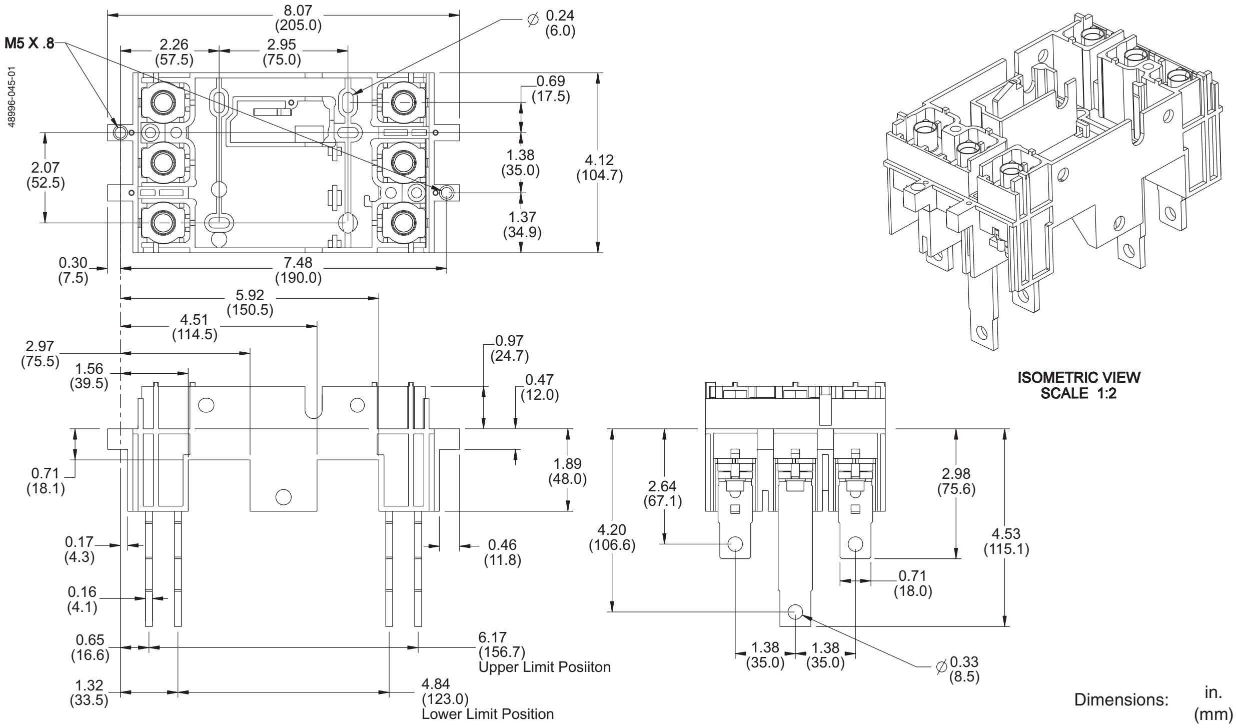
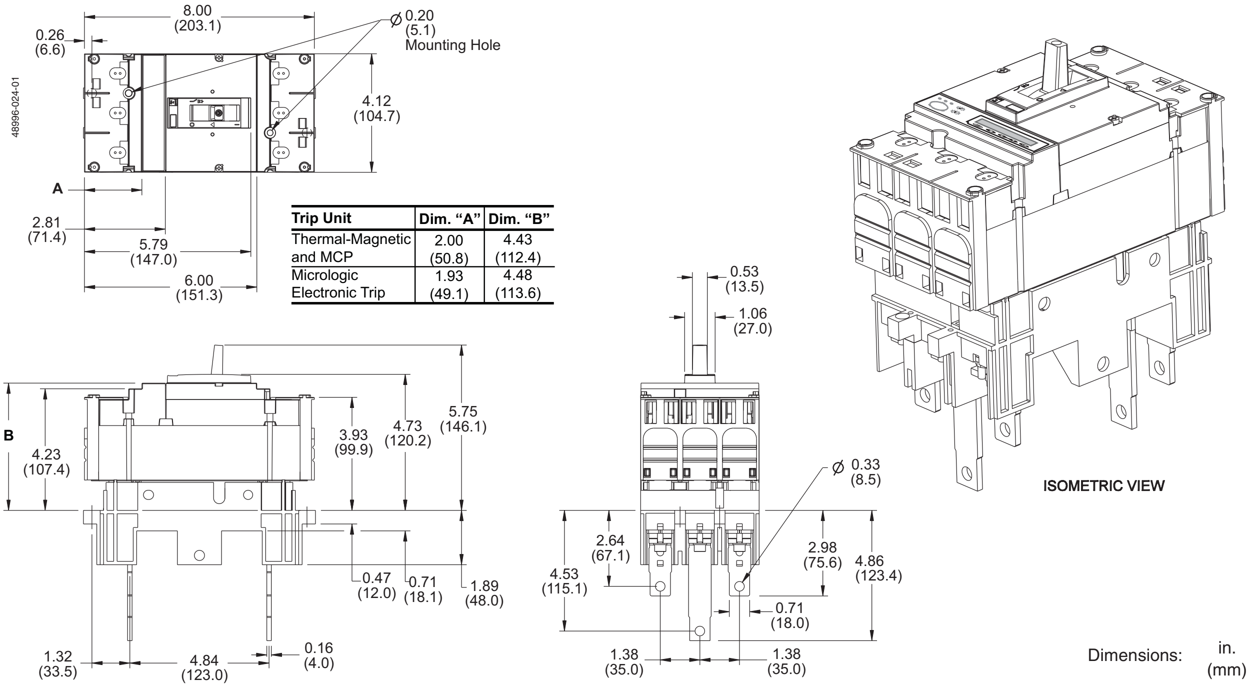


Figure 26: 15–250 A PowerPact H- and J-Frame Plug-In Three-Pole Circuit Breaker



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	2.00 (50.8)	4.43 (112.4)
Micrologic Electronic Trip	1.93 (49.1)	4.48 (113.6)

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PowerPact H- and J-Frame Drawout Circuit Breakers

Figure 27: 15–250 A PowerPact H- and J-Frame Three-Pole Circuit Breaker Cradle

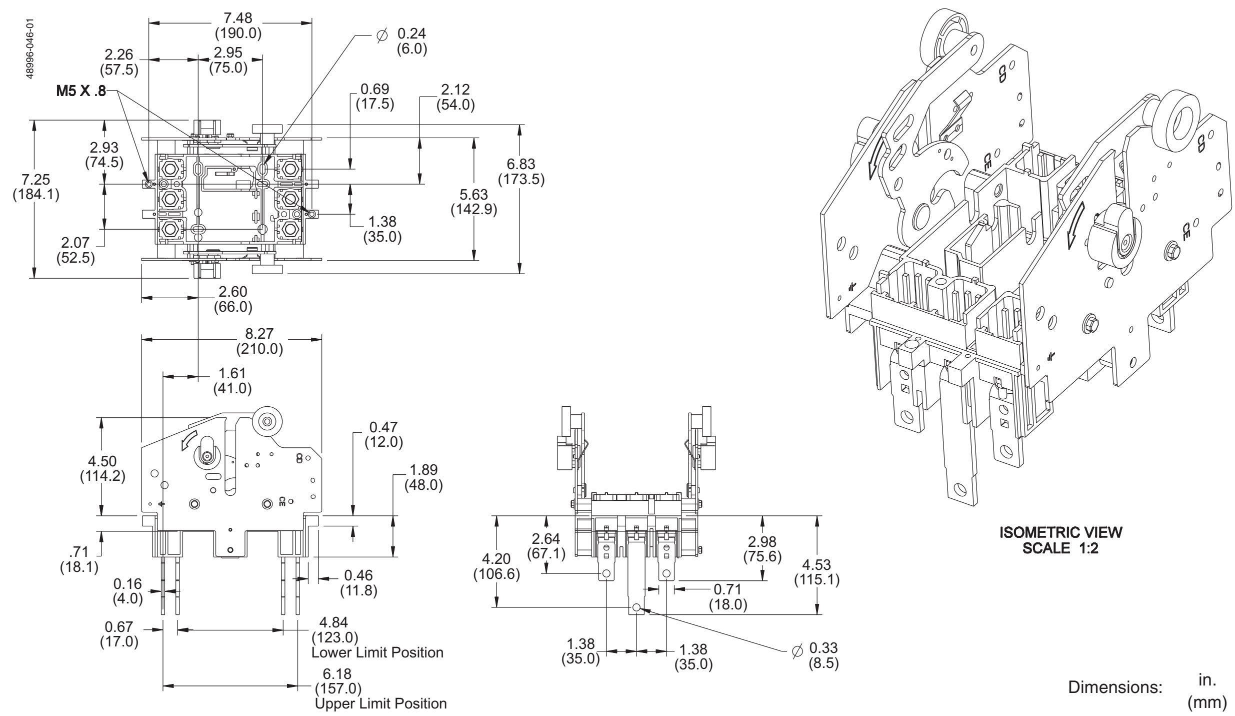
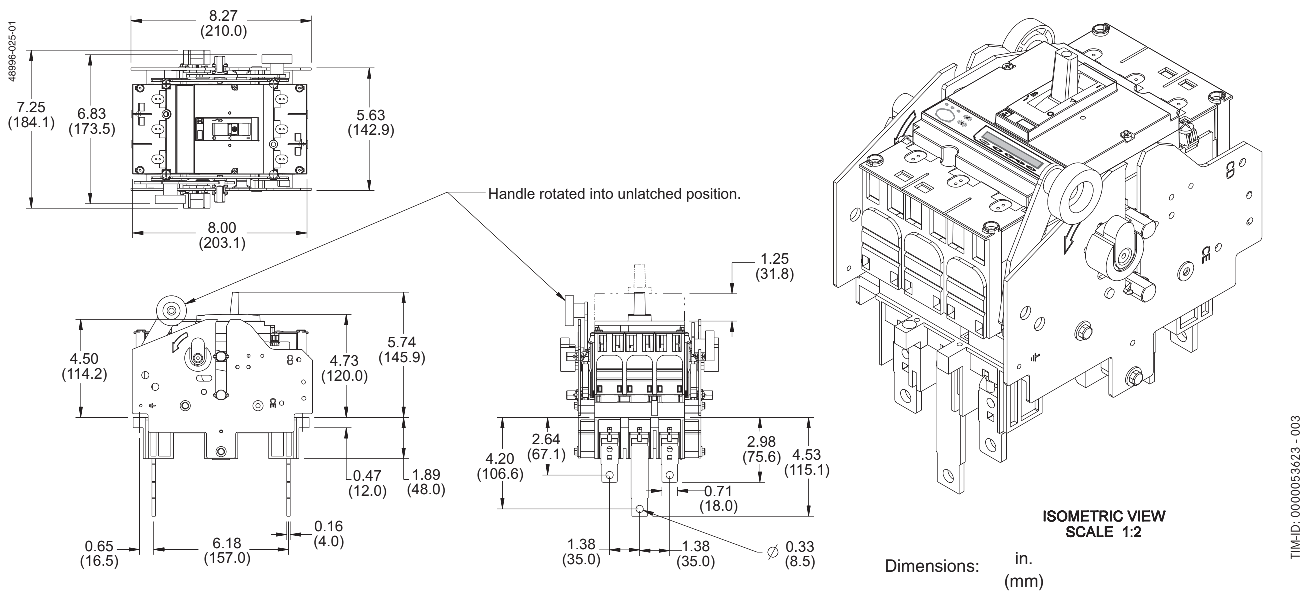


Figure 28: 15–250 A PowerPact H- and J-Frame Drawout Three-Pole Circuit Breaker



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PowerPact H- and J-Frame Circuit Breaker Mounting

Figure 29: PowerPact H-Frame Two-Pole HD/HG Thermal-Magnetic Only Circuit Breaker

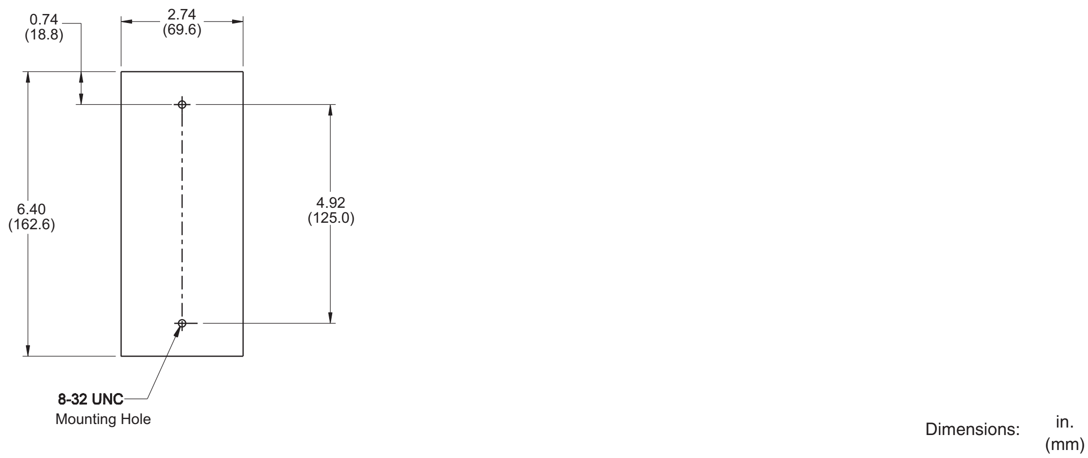
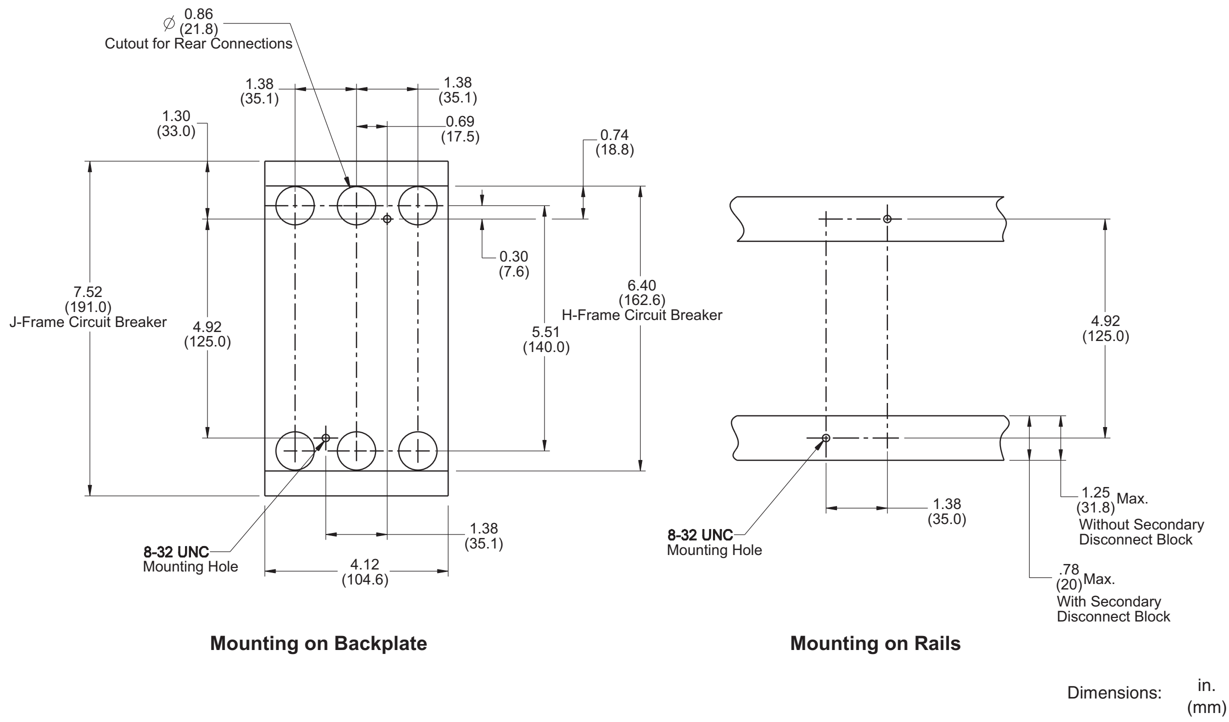


Figure 30: PowerPact H- and J-Frame Three-Pole Circuit Breaker



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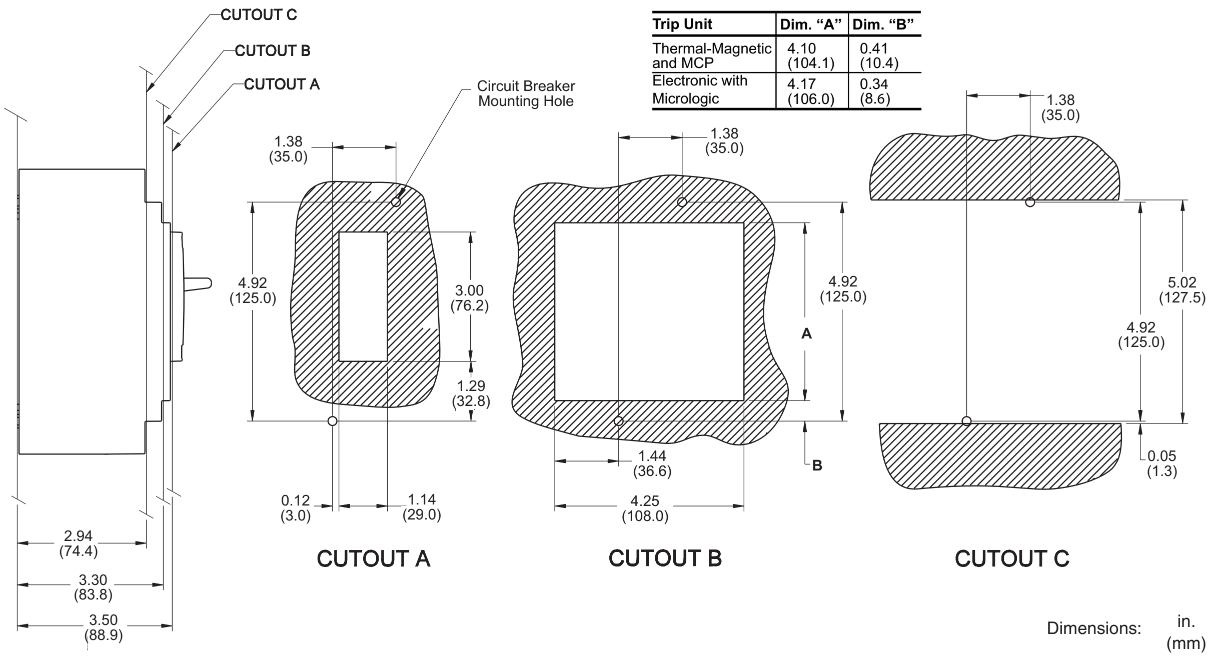
PowerPact H- and J-Frame Circuit Breaker Door Cutouts

Figure 31: PowerPact H- and J-Frame Circuit Breaker Toggle Handle Door Cutout



Trip Unit	Dim. "A"	Dim. "B"
Thermal-Magnetic and MCP	4.10 (104.1)	0.41 (10.4)
Electronic with Micrologic	4.17 (106.0)	0.34 (8.6)

Figure 32: PowerPact H- and J-Frame Circuit Breaker Toggle Handle With Escutcheon Door Cutout

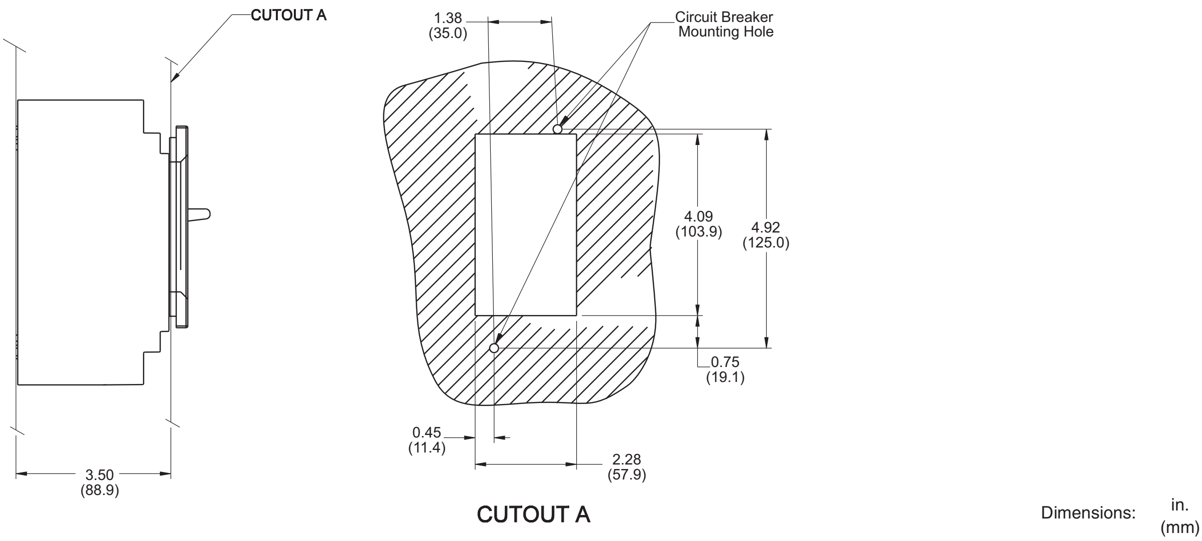


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Figure 33: PowerPact H- and J-Frame Circuit Breaker Fixed Rotary Handle Cutout

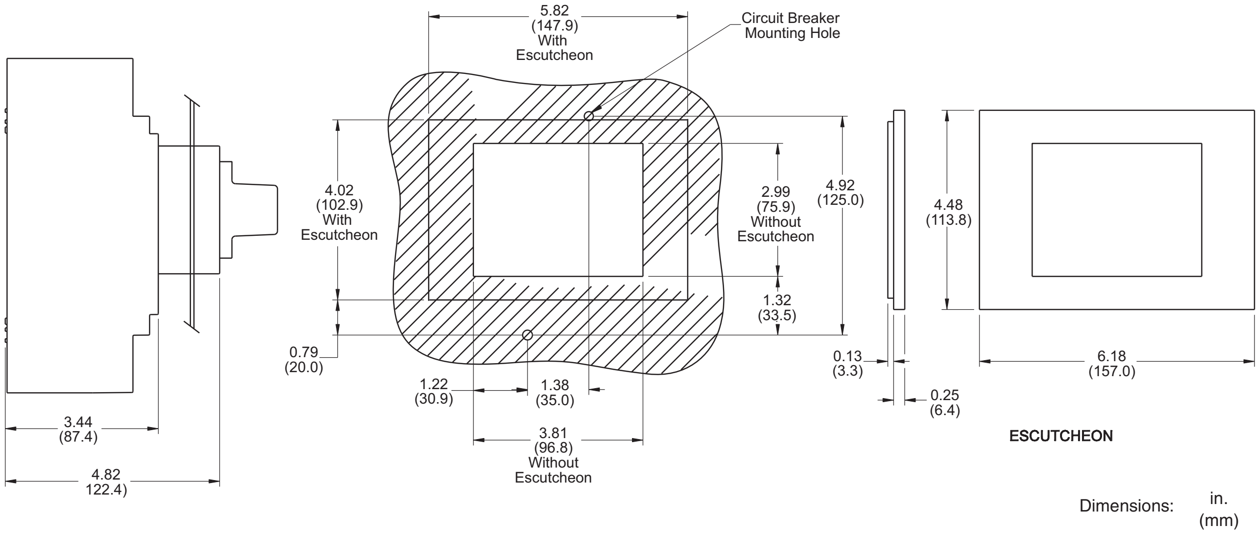

Figure 34: PowerPact H- and J-Frame Circuit Breaker Door Mounted Rotary Handle Cutout

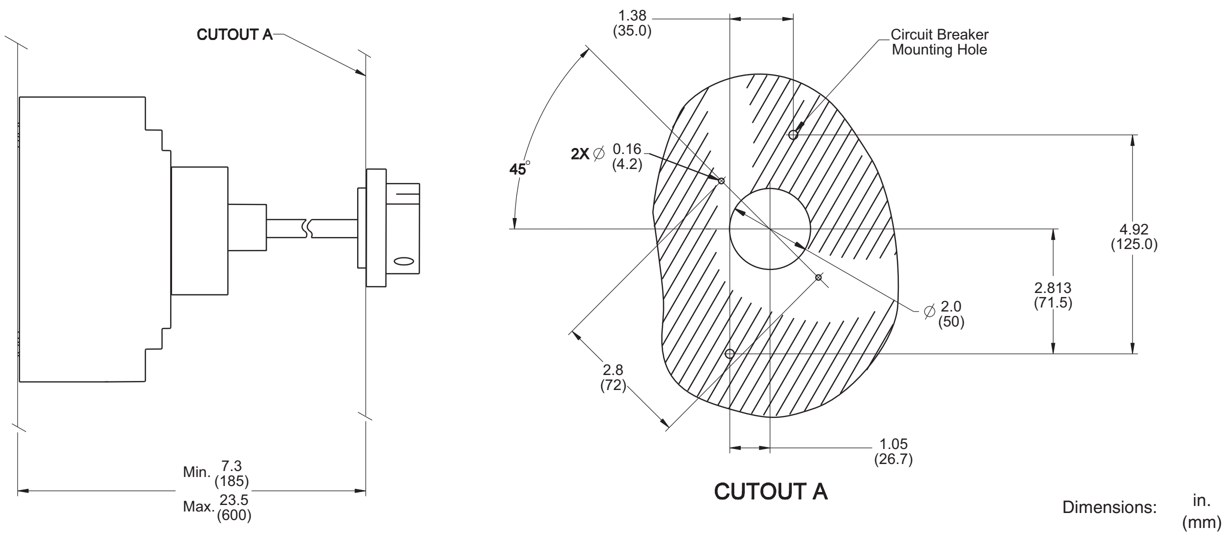

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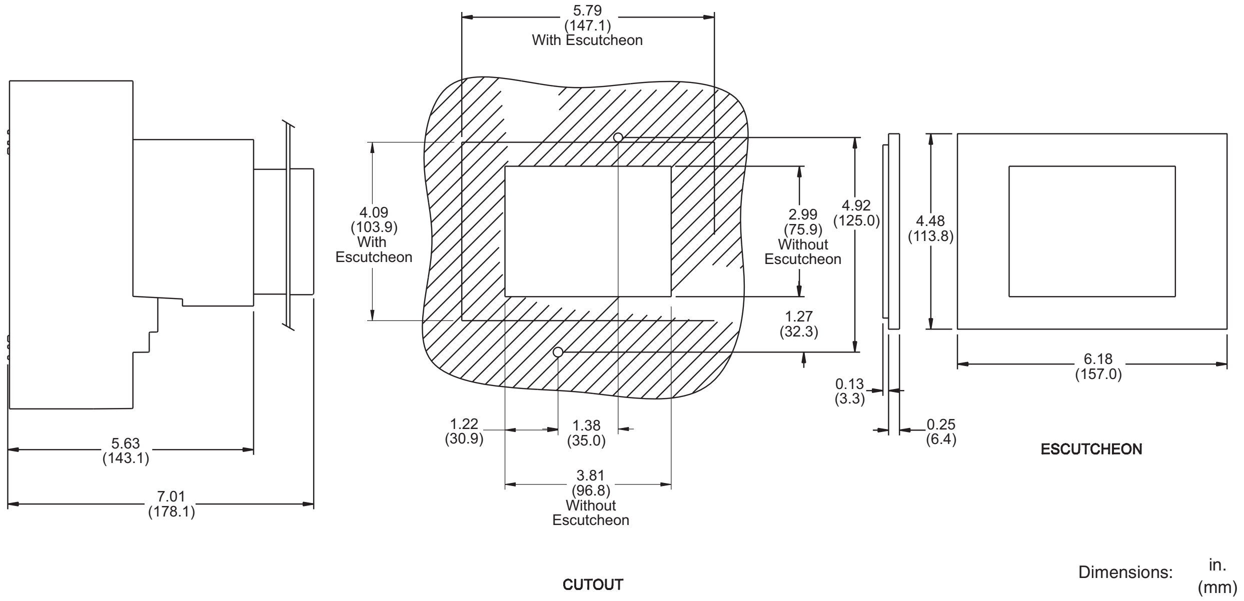
Figure 35: PowerPact H- and J-Frame Circuit Breaker Motor Operator Cutout



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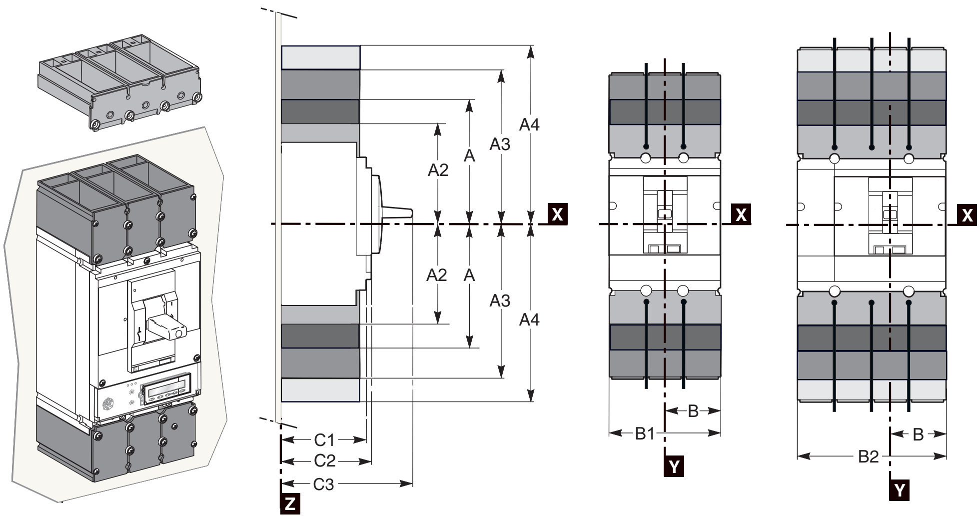
PowerPact L-Frame Circuit Breakers

Figure 36: PowerPact L-Frame Fixed Mounted Circuit Breaker



A2 = Short Lug Pack
AL400L61K3
CU400L61K3
AL600LF52K3
CU600LF5283

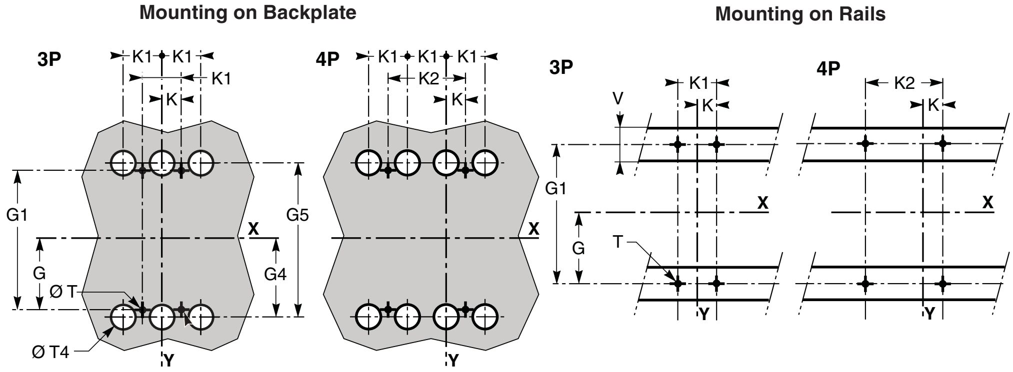
A = Medium Lug Pack
AL400L61K4
CU400L61K4
AL600LS52K3
AL600LS52K4
CU600LS52K3
CU600LS52K4

A3 = Long Lug Pack
Compression Lug Kits

A4 = 500 Vdc Lug Pack

	A	A2	A3	A4	B	B1	B2	C1	C2	C3
inch	6.69	5.65	7.87	9.53	2.76	5.51	7.28	3.76	4.33	6.61
mm	170	143.5	200	242	70	140	185	105	110	168

Figure 37: PowerPact L-Frame Circuit Breaker Mounting



	G	G1	G4	G5	K[1]	K1	K2	T	T4[2]	U[3]
inch	3.93	7.87	4.46	8.93	0.88	1.77	3.54	0.23	1.25	1.38
mm	100	200	113.5	227	22.5	45	90	6	32	35

1 For 2 pole circuit breaker, the middle holes are not required.
2 For rear connected circuit breakers only.
3 V is ≤ 78 in. (20 mm) on C-frame circuit breakers with secondary disconnecting blocks.

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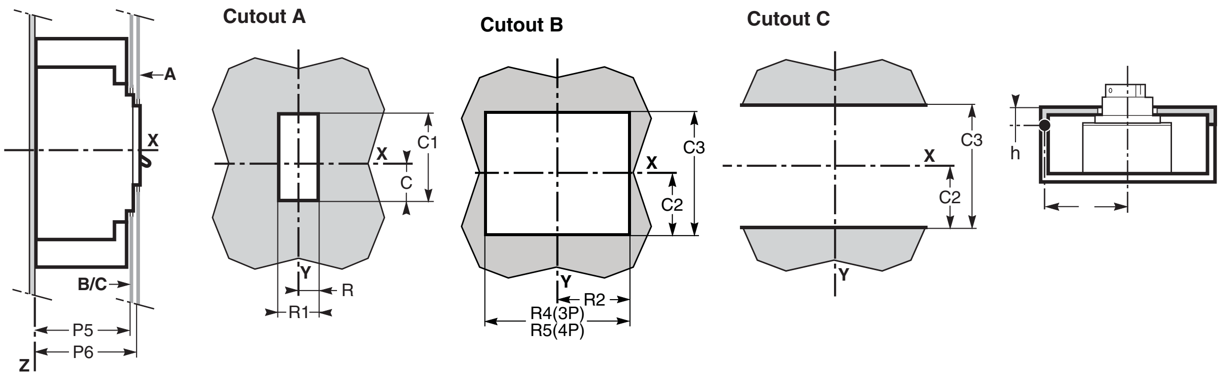
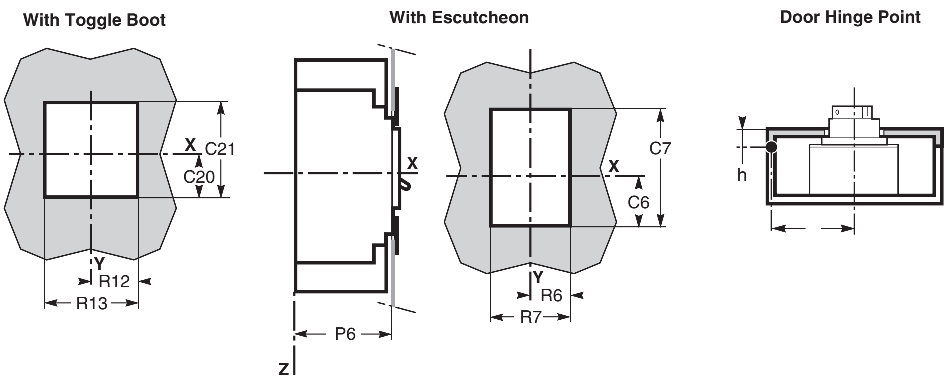
Figure 38: Front Panel Cutouts for PowerPact L-Frame Fixed or Plug-In Circuit Breakers



	C	C1	C2	C3	P5	P6	R	R1	R2	R4	R5	∆
inch	1.63	4.56	3.64	7.24	4.21	4.40	1.24	2.48	2.81	5.62	7.40	3.93 + (5 x h)
mm	41.5	116	92.5	184	107	112	31.5	63	71.5	143	188	100 + (5 x h)

Figure 39: PowerPact L-Frame Circuit Breaker Front Panel Cutouts for Toggle Boot and Escutcheon



	C6	C7	C20	C21	P6	R6	R7	R12	R13	∆
inch	2.2	6	1.83	5.00	4.40	3.5	7	2.48	4.96	3.93 + (5 x h)
mm	56.5	155	46.5	126	112	90	180	63	126	100 + (5 x h)

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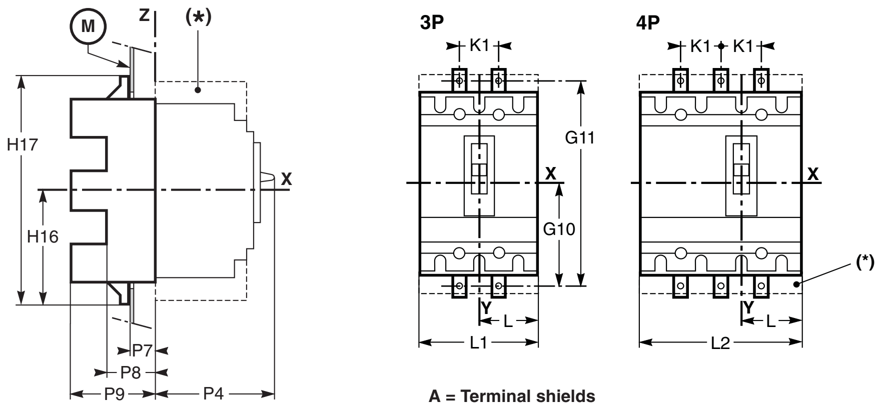
PowerPact L-Frame Plug-In and Drawout Mounting

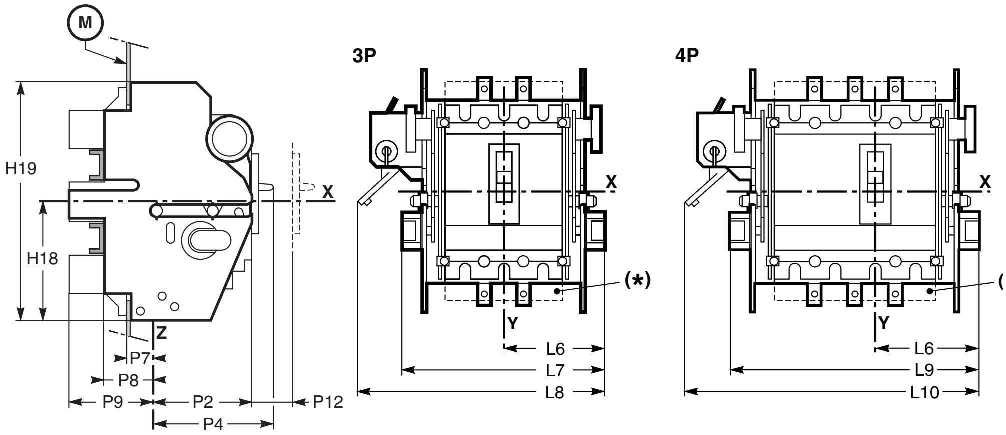
Figure 40: PowerPact L-Frame Plug-In Circuit Breaker (On Base)



A = Terminal shields
M = Through front panel

	G10	G11	H16	H17	K1	L	L1	L2	P4	P7	P8	P9
inch	5.90	11.8	6.20	12.40	1.77	2.75	5.51	7.28	6.61	1.06	1.77	3.93
mm	150	300	157.5	315	45	70	140	185	168	27	45	100

Figure 41: PowerPact L-Frame Drawout Circuit Breaker (on Cradle)



M = Through front panel

	H18	H19	L6	L7	L8	L10	P2	P4	P7	P8	P9	P12	L9
inch	5.51	11.02	4.33	8.66	98.46	11.61	4.33	6.61	1.06	1.77	3.93	1.25	10.43
mm	140	280	110	220	250	295	110	168	27	45	100	32	265

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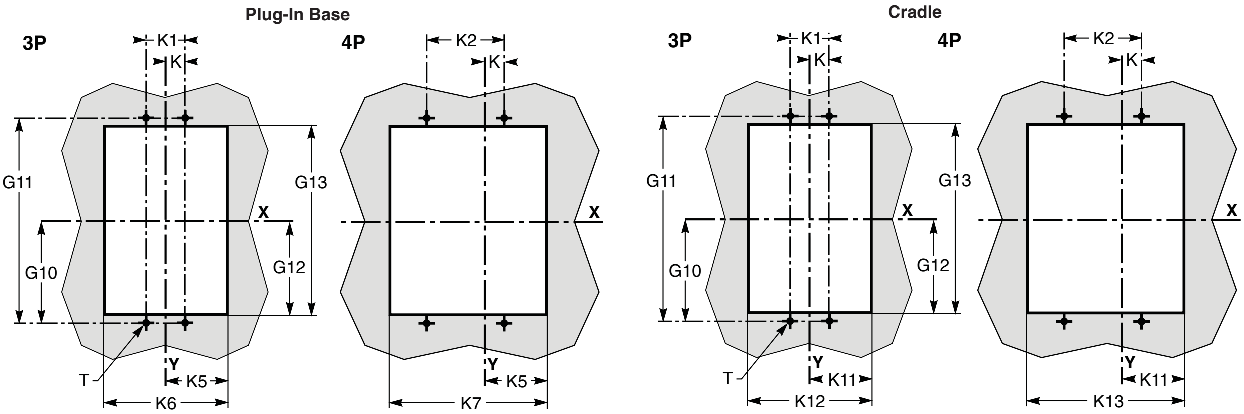
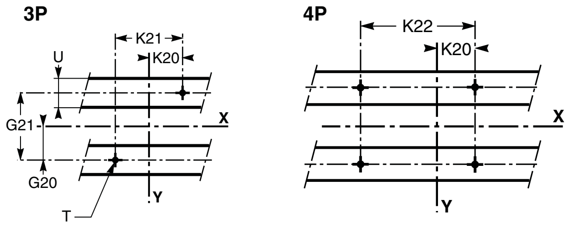
Figure 42: PowerPact L-Frame Circuit Breaker Mounting Through a Backplate



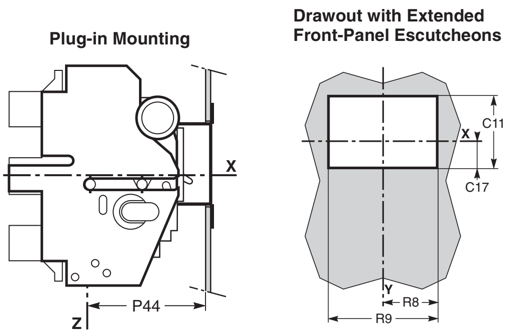
	G10	G11	G12	G13	K	K1	K2	K5	K6	K7	K11	K12	K13
inch	5.90	11.8	5.39	10.7	0.88	1.77	3.54	2.81	2.81	7.4	7.40	3.60	8.98
mm	150	300	137	274	22.5	45	90	71.5	143	188	91.5	183	228

Figure 43: PowerPact L-Frame Circuit Breaker Mounting on Rails (Plug-In Base or Cradle)



	G20	G21	K20	K21	K22	T
inch	2.95	5.90	8.97	1.96	5.71	0.24
mm	75	150	50	100	145	6

Figure 44: PowerPact L-Frame Circuit Breaker Front-Panel Cutouts



	C11	C17	P44	R8	R9
inch	6.10	2.22	5.78	3.54	7.08
mm	155	56.5	147	90	180

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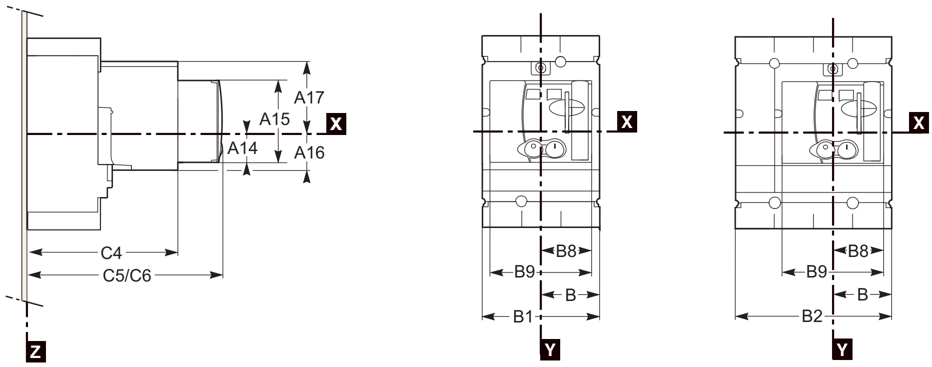
PowerPact L-Frame Circuit Breaker Handles and Handle Operators

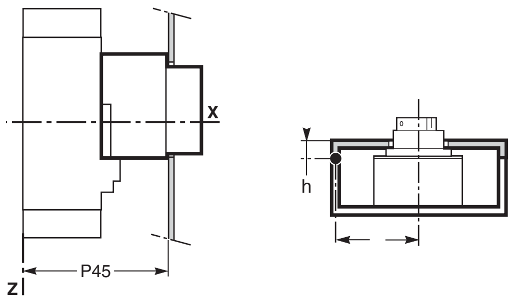
Figure 45: PowerPact L-Frame Circuit Breaker Motor Operators



C5: without keylock
C6: with keylock

	A14	A15	A16	A17	B	B1	B2	B8	B9	C4	C5	C6	D1
inch	1.57	4.84	2.05	3.94	2.76	5.51	7.28	2.42	4.84	8.46	10.08	10.16	3.94
mm	40	123	52	100	70	140	185	61.5	123	215	256	258	100

Figure 46: PowerPact L-Frame Circuit Breaker Motor Operator Front-Panel Cutouts



	C22	C23	P45	R14	R15	Δ
inch	1.63	4.96	8.54	2.53	5.08	3.93 + (5 x h)
mm	41.5	126	217	64.5	129	100 + (5 x h)

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Figure 47: PowerPact L-Frame Circuit Breaker Cable-Operating Handles

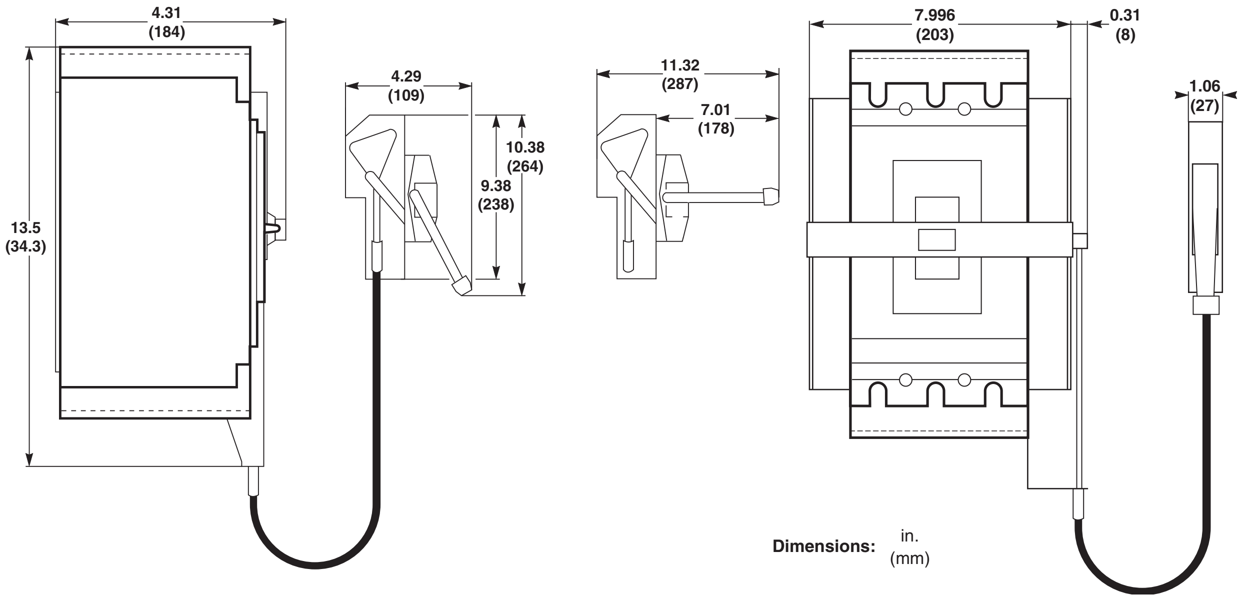
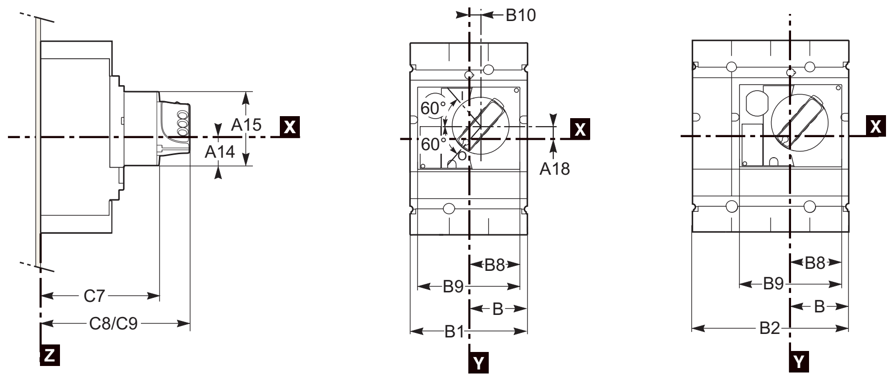


Figure 48: PowerPact L-Frame Circuit Breaker Rotary-Operating Handles



C8: without keylock
C9: with keylock

	A14	A15	A18	B	B1	B2	B8	B9	B10	C7	C8	C9	D1
inch	1.57	4.84	0.97	2.76	5.51	7.28	2.42	4.84	0.20	5.71	7.05	7.40	3.94
mm	40	123	24.6	70	140	185	61.5	123	5	145	179	188	100

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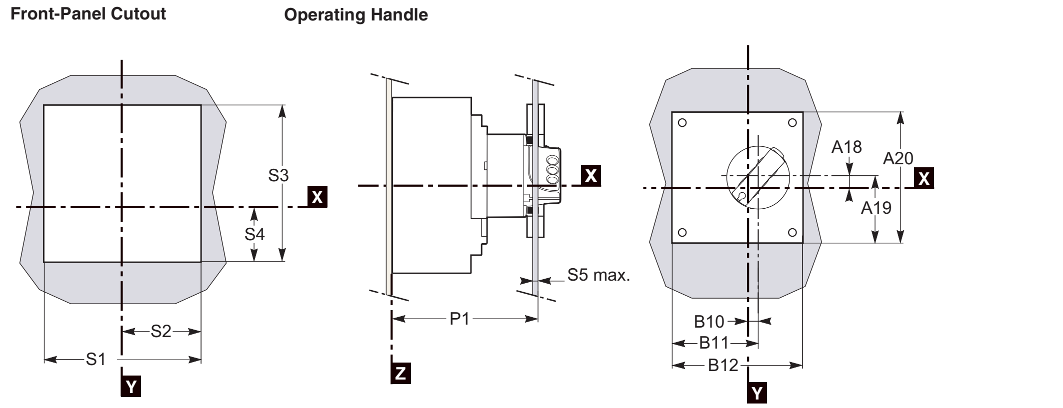
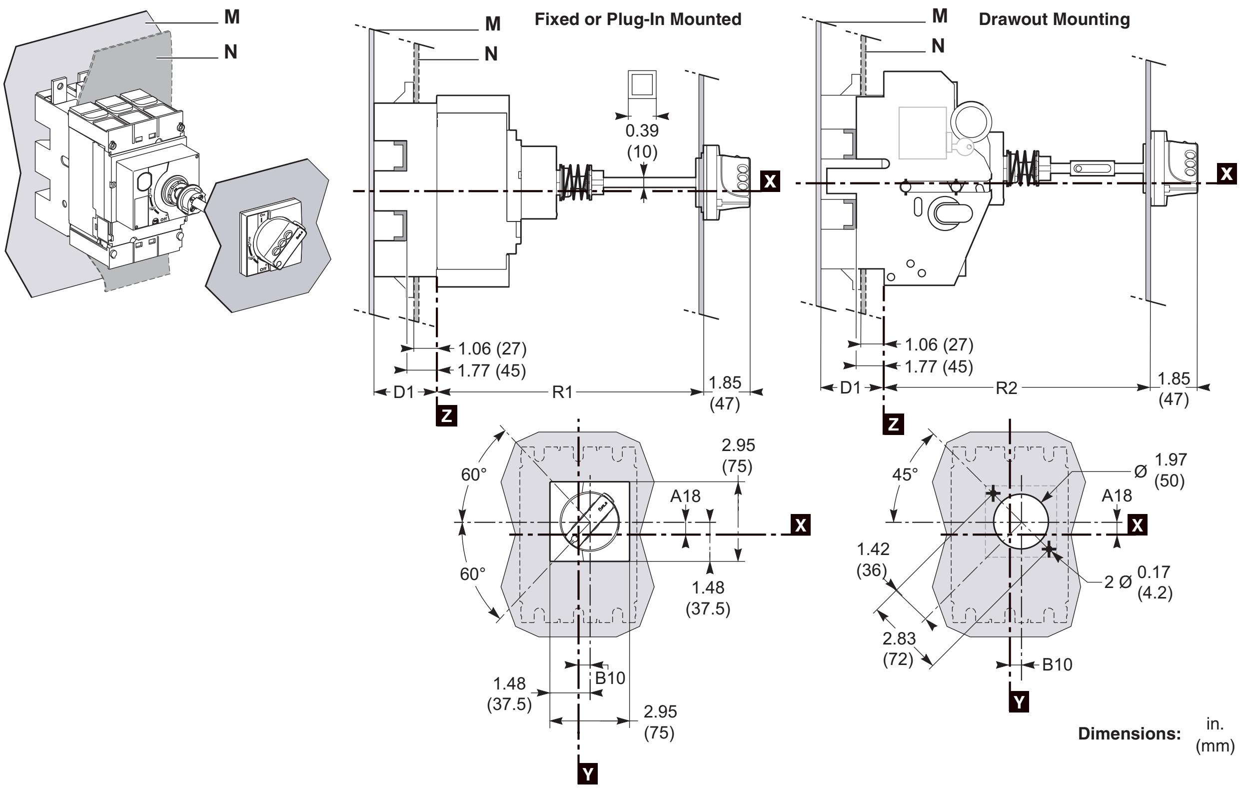
Figure 49: PowerPact L-Frame Motor-Control Center Circuit Breaker Direct Rotary-Operating Handle



	A18	A19	A20	B10	B11	B12	P1	S1	S2	S3	S4	S5
inch	0.97	3.27	6.30	0.20	3.35	6.30	5.87	5.71	2.95	5.71	2.01	0.04–0.12
mm	24.6	83	160	5	85	160	149	145	75	145	51	1–3

Figure 50: PowerPact L-Frame Circuit Breaker Extended Rotary Handle Mounting



	R1 min	R1 max	R2 min	R2 max	A18	B10	D1
inch	7.68	23.62	10.71	23.62	0.97	0.20	3.94
mm	195	600	272	600	24.6	5	100

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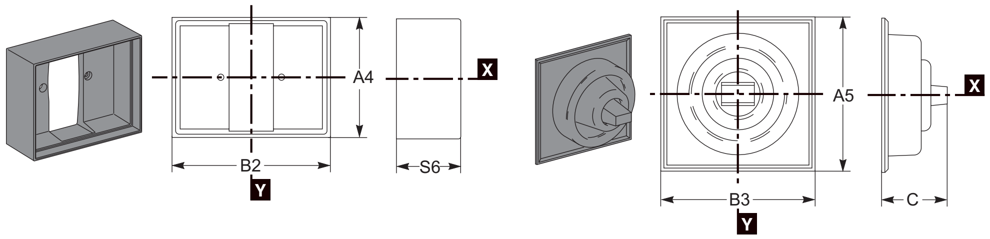
L-Frame Circuit Breaker Front Accessories

Figure 51: PowerPact L-Frame Circuit Breaker Extended Escutcheons

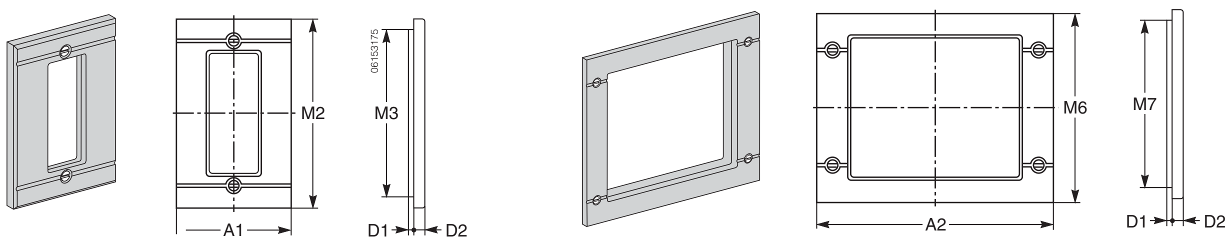
For toggle **IP43 toggle cover**



	A4	A5	B2	B3	C	S6
inch	4.82	5.43	4.82	5.43	2.36	1.38
mm	122.5	134	122.5	134	60	35

Figure 52: PowerPact L-Frame Circuit Breaker Front-Panel Escutcheons

For Toggle **For Extended Escutcheon, Motor Operator Module or Rotary Handle**



	A1	A2	D1	D2	M2	M3	M6	M7
inch	4.01	7.44	0.13	0.25	6.10	5.59	6.45	5.94
mm	102	189	3.5	6.5	115	142	164	151

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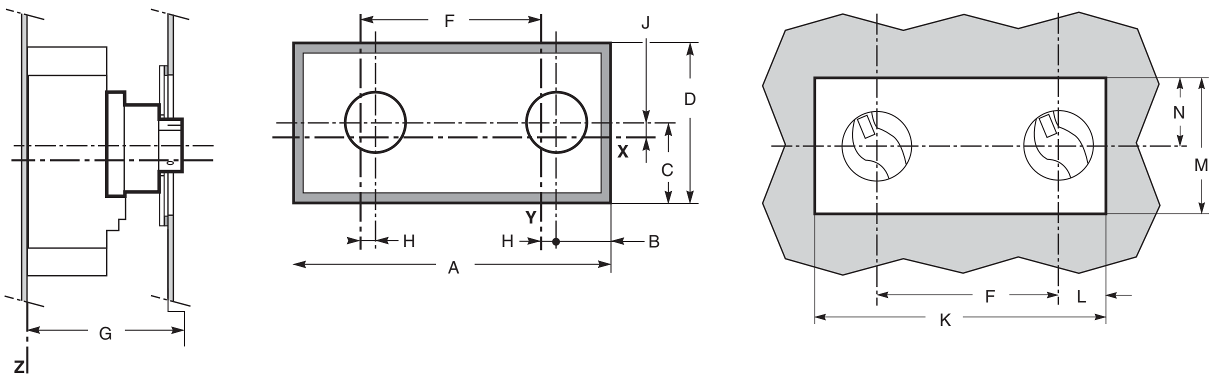
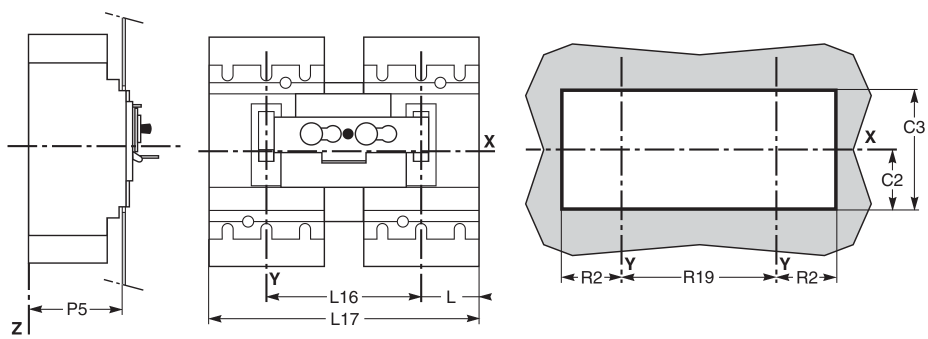
PowerPact L-Frame Circuit Breaker Interlocking Systems

Figure 53: PowerPact L-Frame Circuit Breaker Interlocking Systems with Rotary-Operating Handles



	A	B	C	D	F	G	H	J	K	L	M	N
inch	16.38	4.53	3.94	7.87	8.27	6.18	0.20	0.97	15.20	3.94	6.89	2.93
mm	416	115	100	200	210	157	5	24.6	386	100	175	74.5

Figure 54: PowerPact L-Frame Circuit Breaker Interlocking Systems with Toggle Handles



	C2	C3	L	L16	L17	R2	R19	P5
inch	3.64	7.24	2.75	7.28	12.79	2.81	7.28	4.21
mm	92.5	184	70	185	325	71.5	185	107

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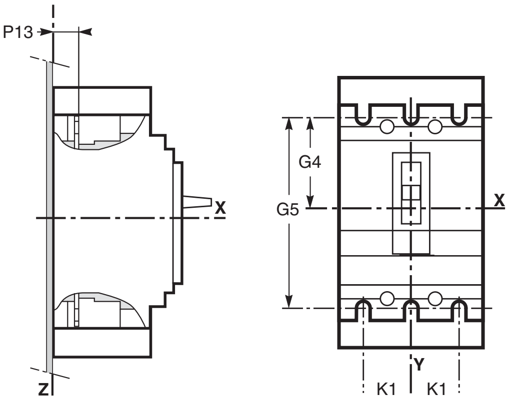
PowerPact H-, J-, and L-Frame Circuit Breakers
Circuit Breaker Dimensions

PowerPact L-Frame Circuit Breaker Connectors

Figure 55: PowerPact L-Frame Circuit Breaker Fixed-Mounted Connections



	G4	G5	K1	P13
inch	4.46	8.93	1.77	1.02
mm	113.5	227	45	526

Figure 56: PowerPact L-Frame Circuit Breaker Front Connections

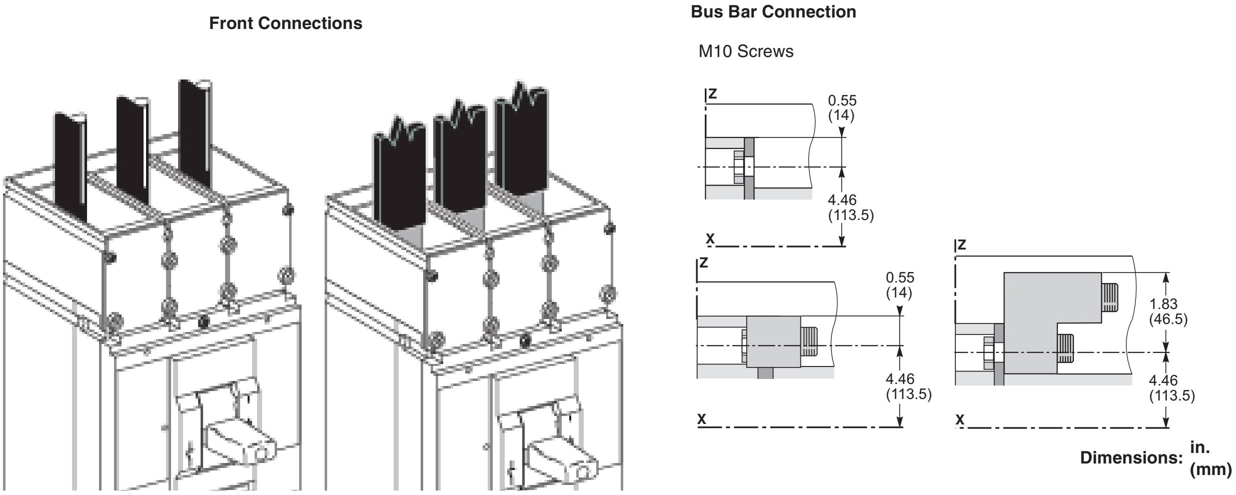


Figure 57: PowerPact L-Frame Circuit Breaker Rear Connections

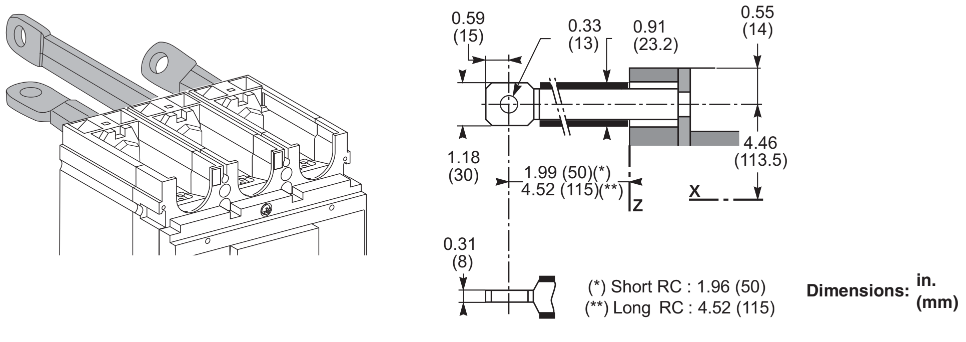


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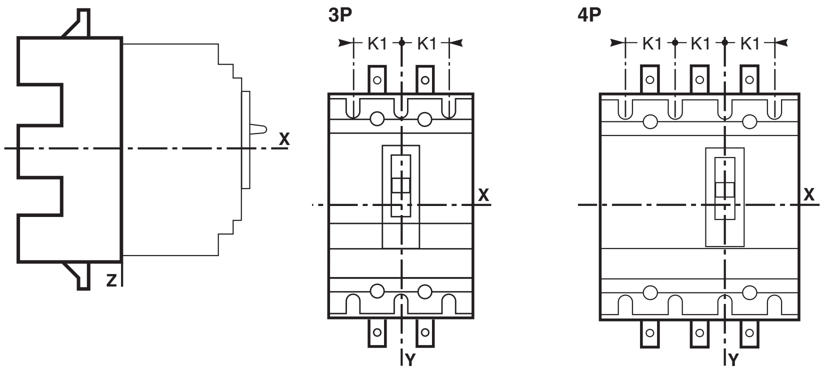
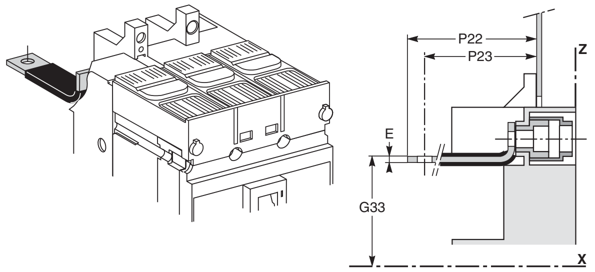
Figure 58: PowerPact L-Frame Circuit Breaker Plug-In or Drawout Mounting Connections



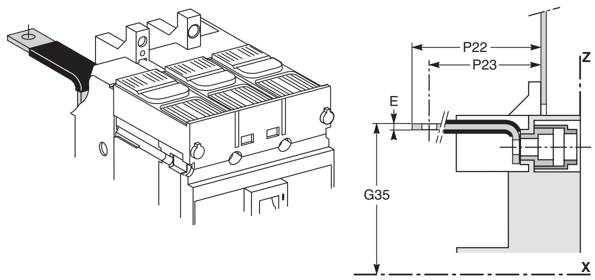
	K1
inch	1.77
mm	45

Figure 59: PowerPact L-Frame Circuit Breaker Rear Connections Fitted at Lower Limit



	E	G33	P22	P23
inch	0.23	4.09	4.50–7.14	3.93–6.57
mm	6	104	114.5–181.5	100–167

Figure 60: PowerPact L-Frame Circuit Breaker Rear Connections Fitted at Upper Limit



	E	G35	P22	P23
inch	0.23	5.07	4.50–7.14	3.93–6.57
mm	6	129	114.5–181.5	100–167

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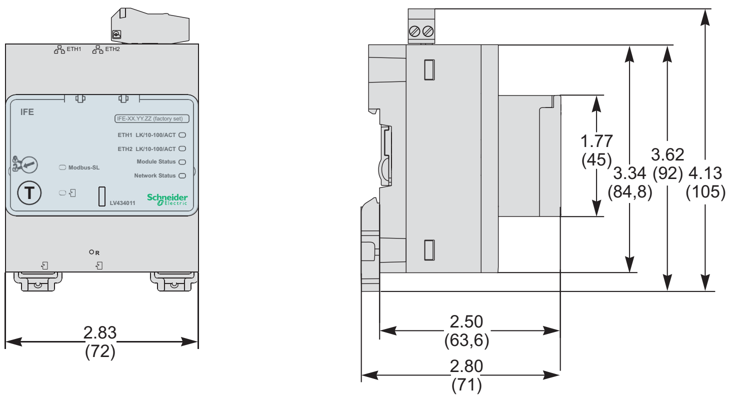
Section 14—Accessory Dimensional Drawings

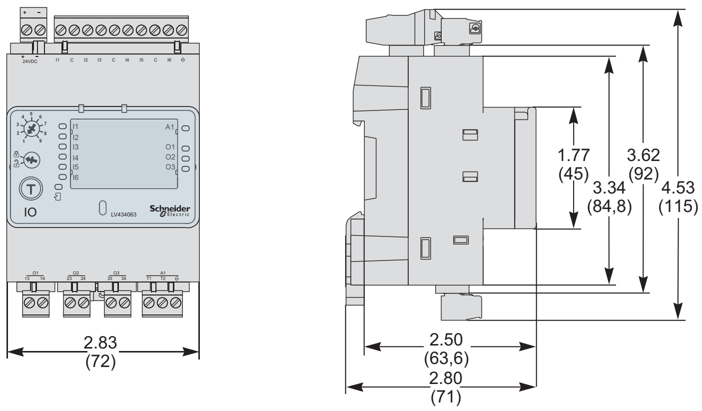
Accessory Dimensions

Figure 61: IFE Ethernet Interface



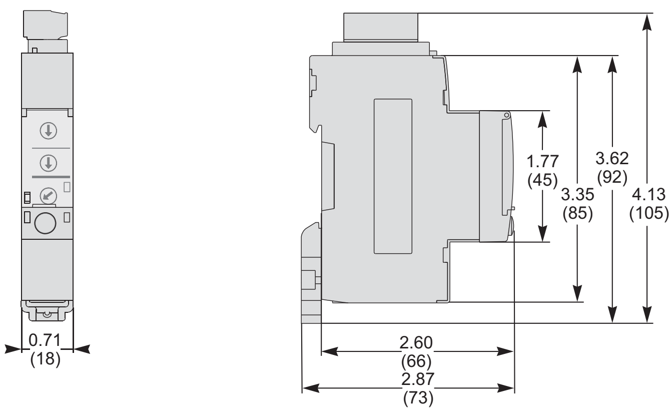
Dimensions: in. (mm)

Figure 62: I/O (Input/Output) Application Module



Dimensions: in. (mm)

Figure 63: IFM Modbus-SL Interface



Dimensions: in. (mm)

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Figure 64: FDM121 Switchboard Display Dimensions

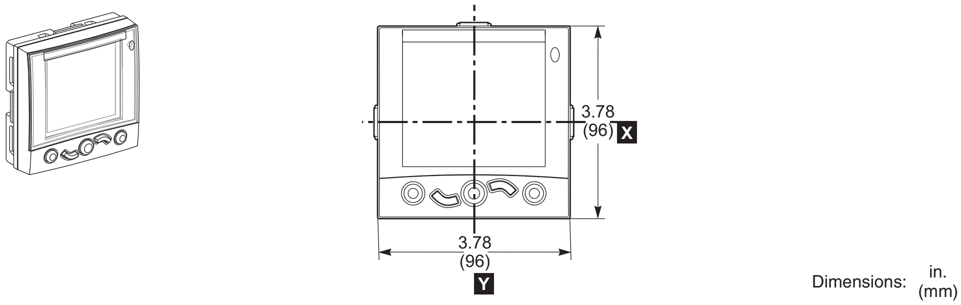

Figure 65: FDM121 Switchboard Display Mounting Through Panel

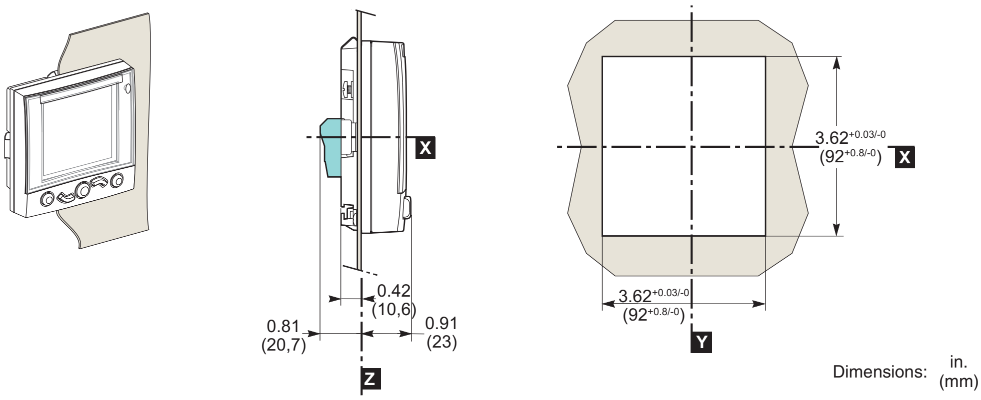

Figure 66: FDM121 Switchboard Display Mounting On Panel

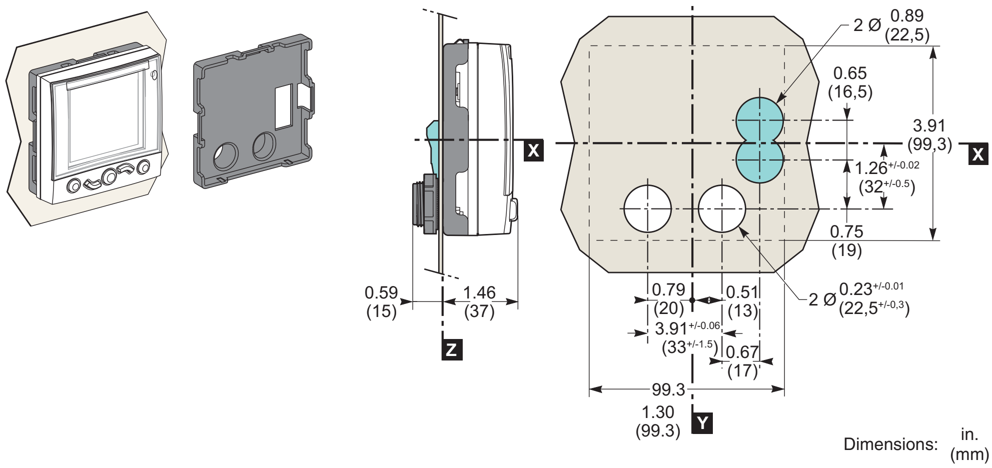

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Figure 67: FDM128 Switchboard Display Dimensions

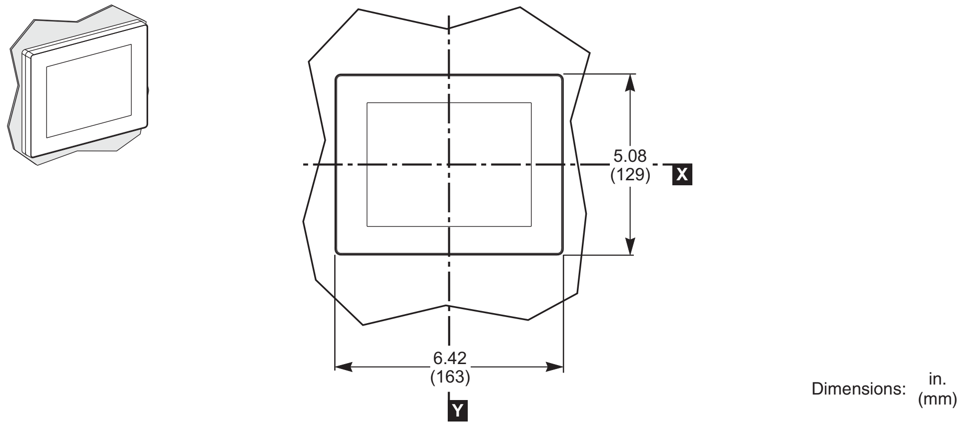

Figure 68: FDM128 Switchboard Display Mounting on Panel

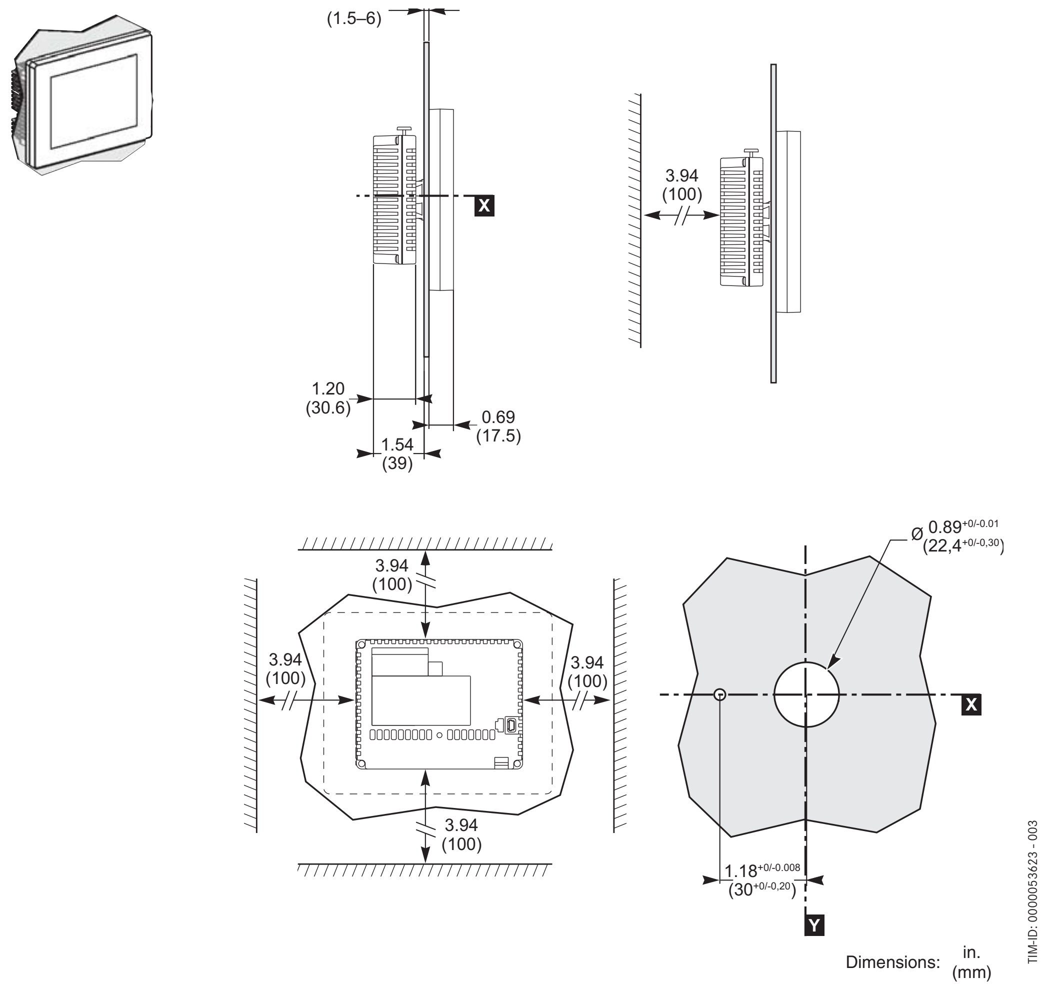

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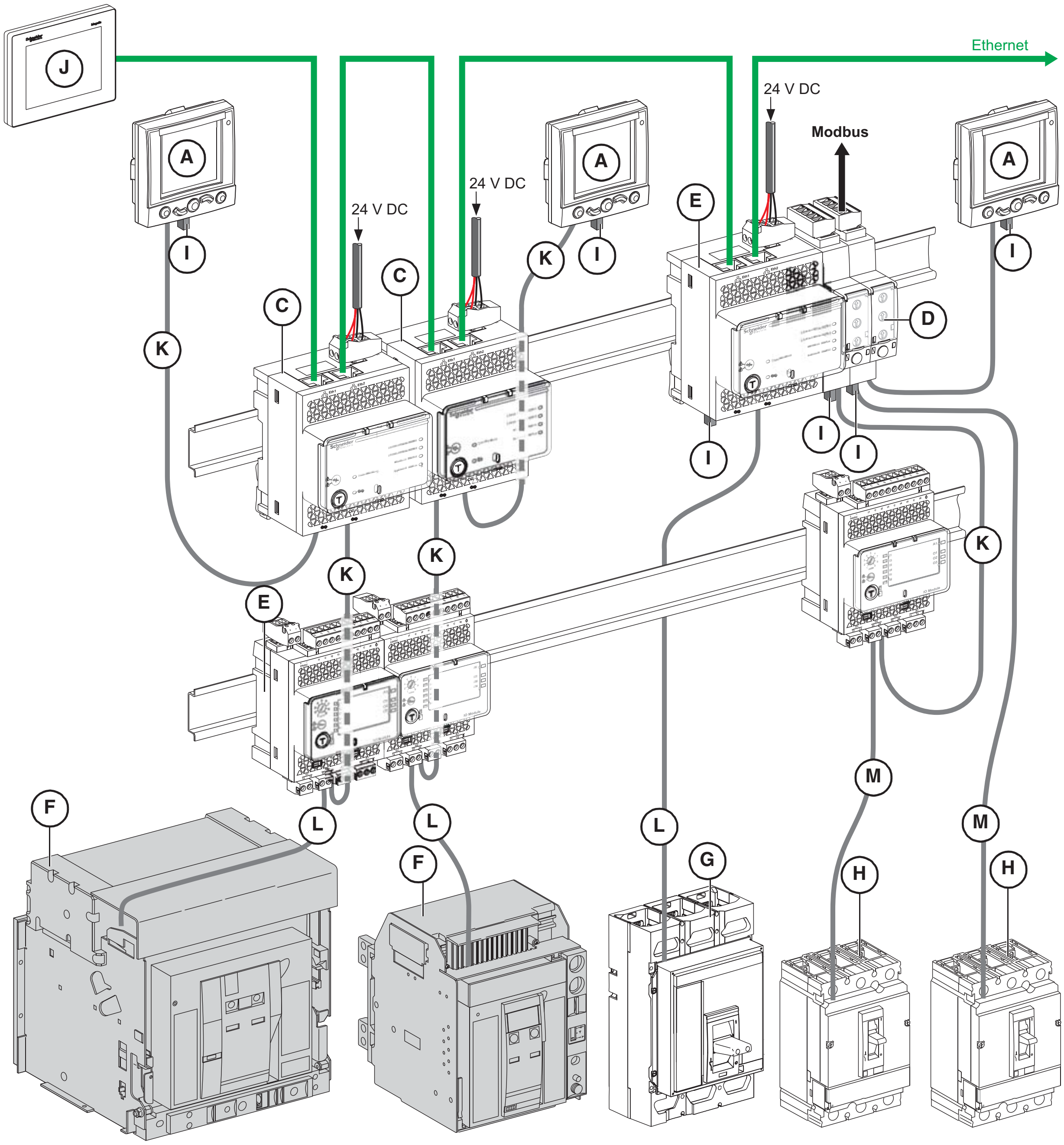
Figure 69: Circuit Breaker Communication



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A. FDM121 (TRV00121)
B. IFE master (LV434011)
C. IFE (LV434010)
D. IFM (TRV00210)
E. IO application module (LV434063)
F. Masterpact NT/NW
G. PowerPact P/R
H. PowerPact H/J/L
I. ULP termination (TRV00880)
J. FDM128 (LV434128)
K. ULP cable
L. Circuit breaker ULP cord
M. NSX cord

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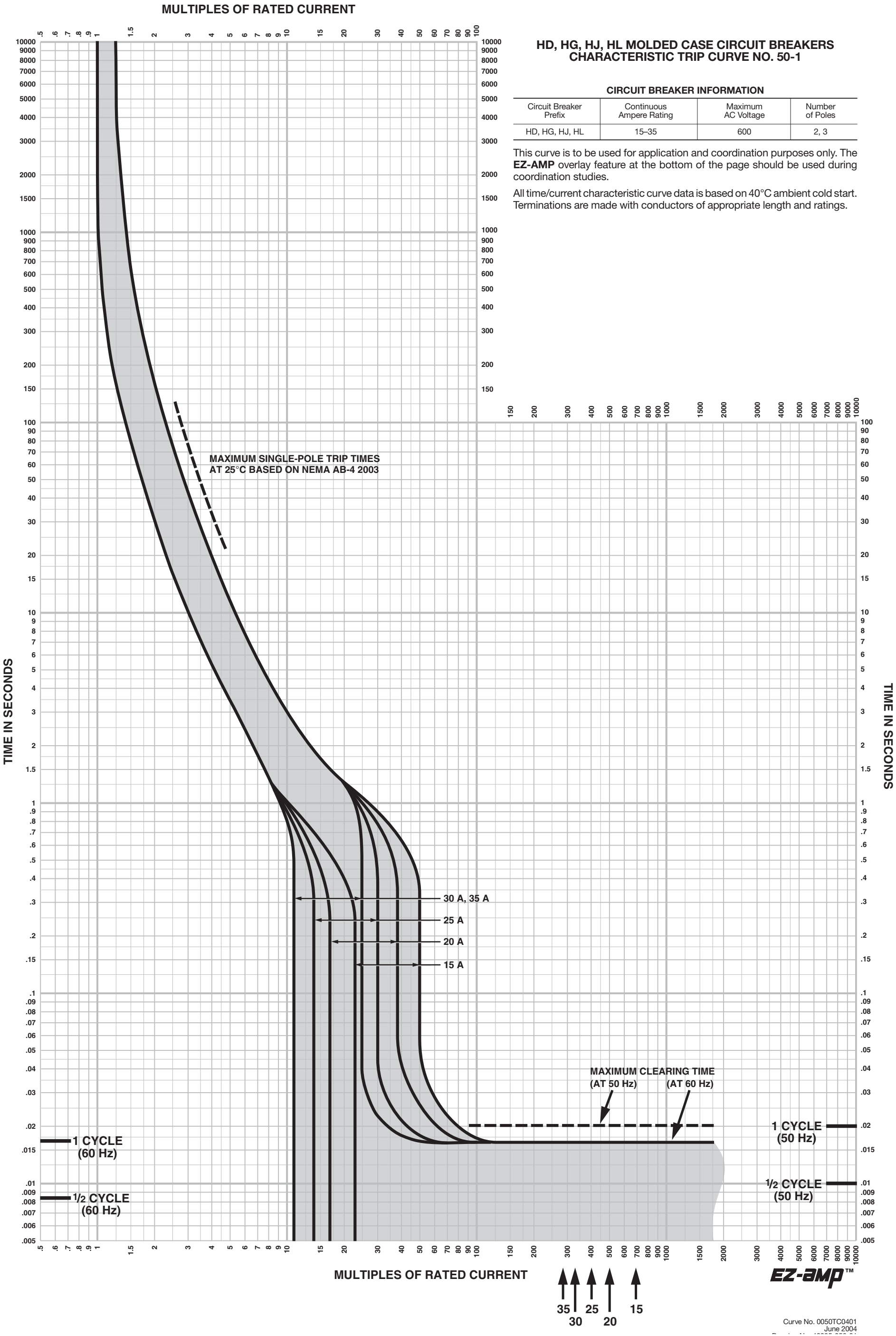
Section 15—Trip Curves

PowerPact H- and J-Frame Thermal-Magnetic Trip Circuit Breakers

Figure 70: H-Frame 15–35 A (HD, HG, HJ, and HL) Thermal-Magnetic Trip



HD, HG, HJ, HL MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-1

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
HD, HG, HJ, HL	15–35	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

Curve No. 0050TC0401
June 2004

TIM-ID: 0000053623 - 003

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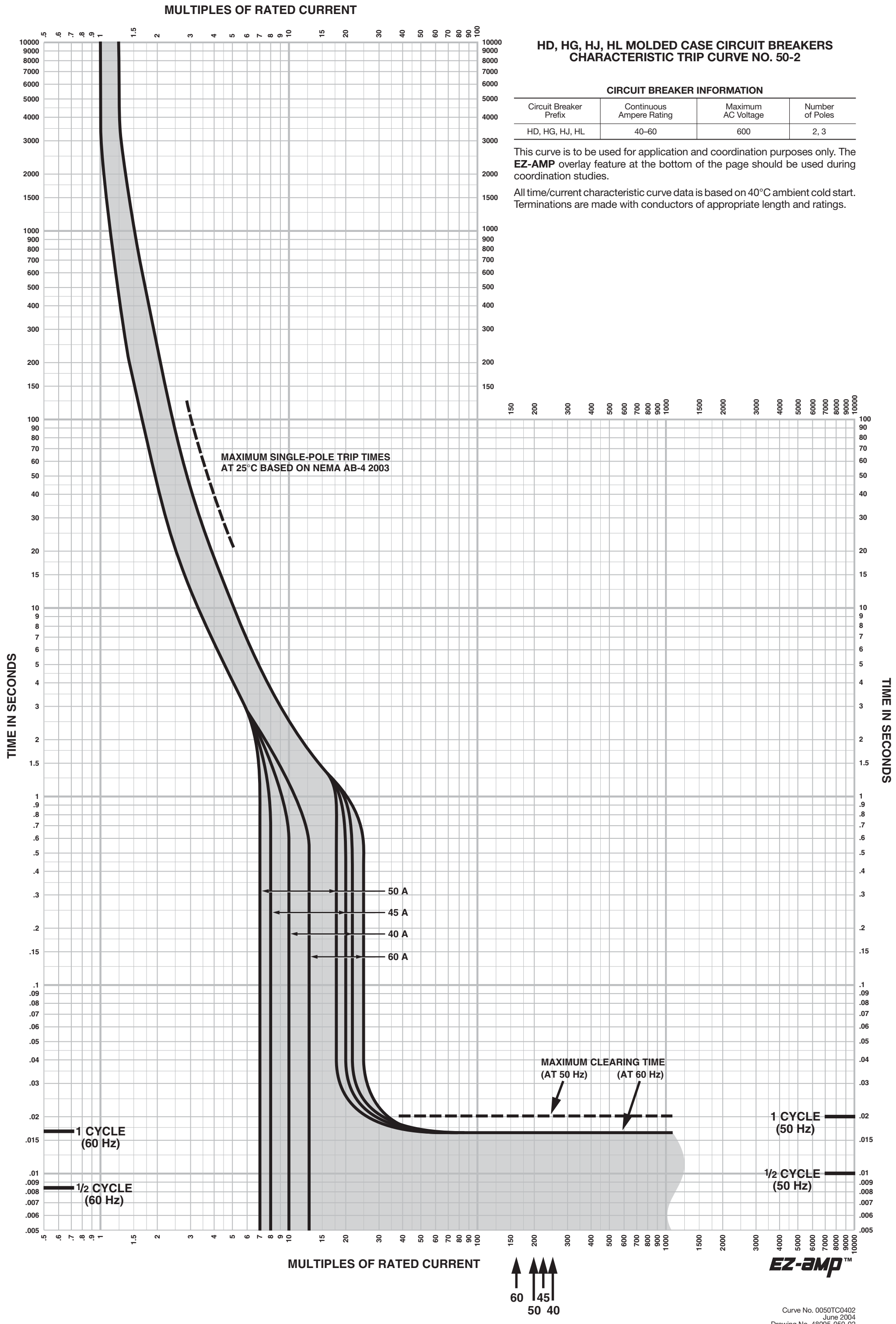
Figure 71: H-Frame 40–60 A (HD, HG, HJ, and HL) Thermal-Magnetic Trip



HD, HG, HJ, HL MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-2

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
HD, HG, HJ, HL	40–60	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

Curve No. 0050TC0402
June 2004
Drawing No. 48095-050-02

TIM-ID: 0000053623 - 003

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Figure 72: H-Frame 70–100 A (HD, HG, HJ, and HL) Thermal-Magnetic Trip

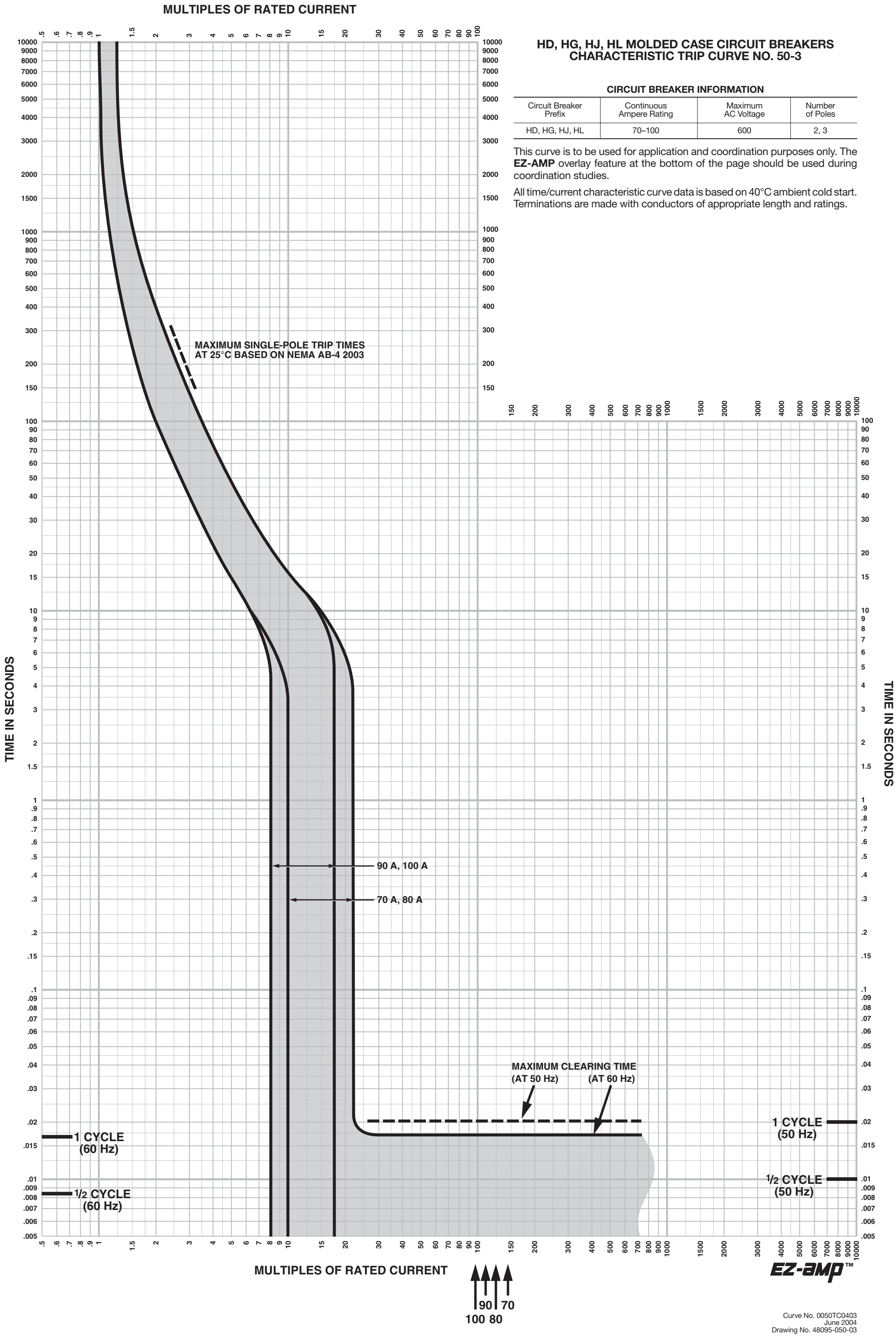
HD, HG, HJ, HL MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 50-3

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
HD, HG, HJ, HL	70–100	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.



Curve No. 0050TC0403
June 2004
Drawing No. 48095-050-03

TIM-ID: 0000053623 - 003

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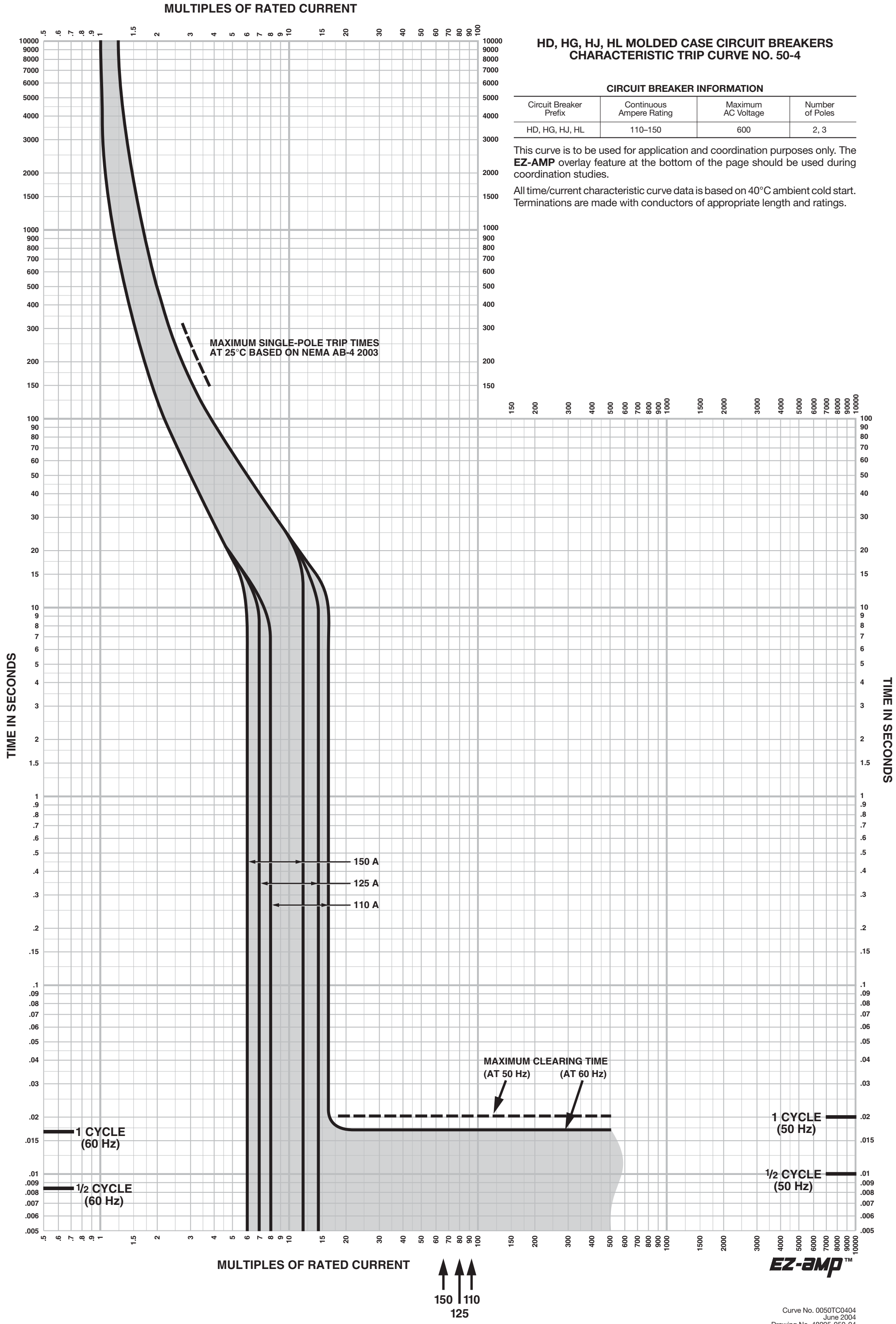
Figure 73: H-Frame 110–150 A (HD, HG, HJ, and HL) Thermal-Magnetic Trip



HD, HG, HJ, HL MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-4

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
HD, HG, HJ, HL	110–150	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

Curve No. 0050TC0404
June 2004
Drawing No. 48095-050-04

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Figure 74: HG and HL 30 A 500Vdc Thermal-Magnetic Trip

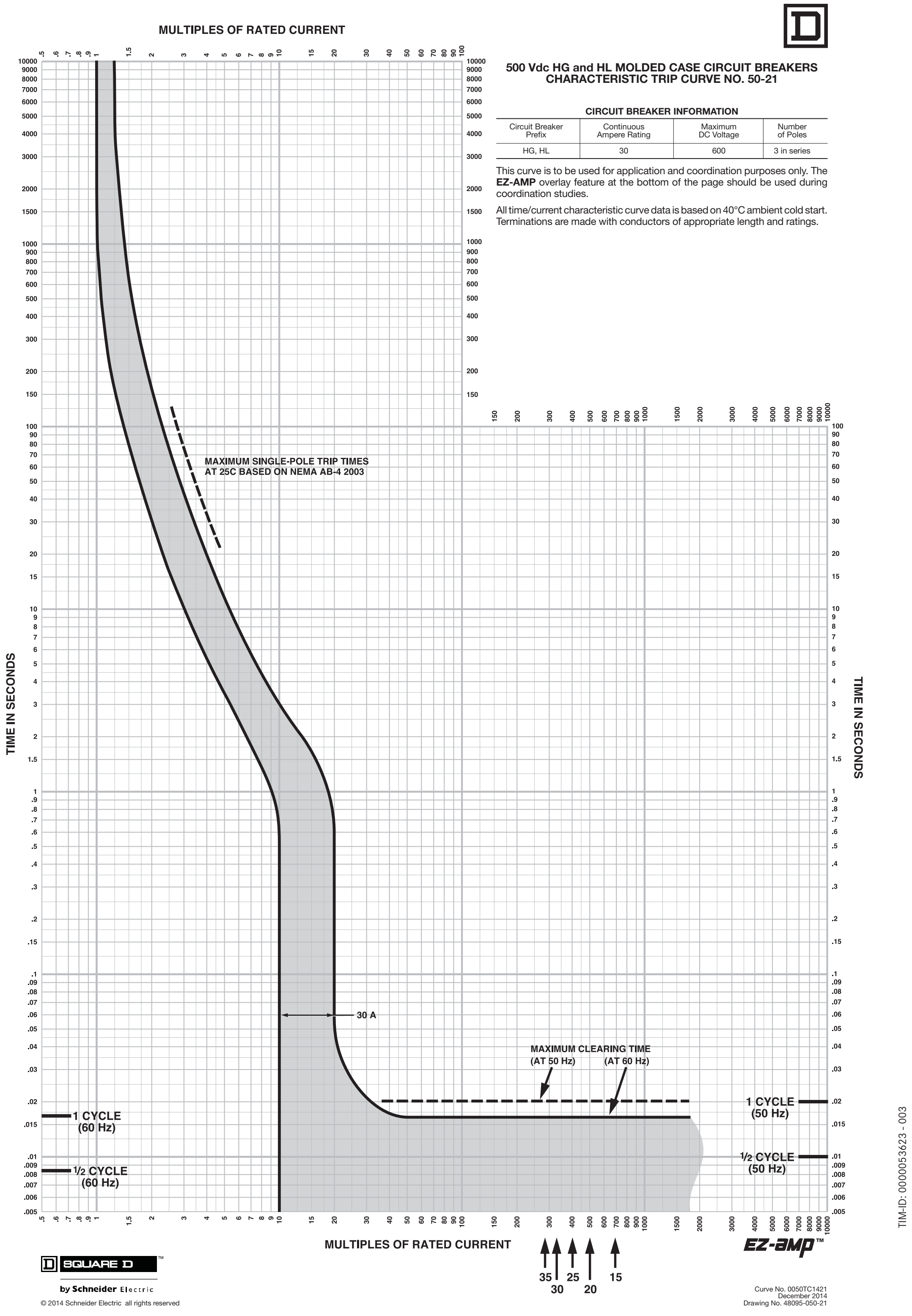

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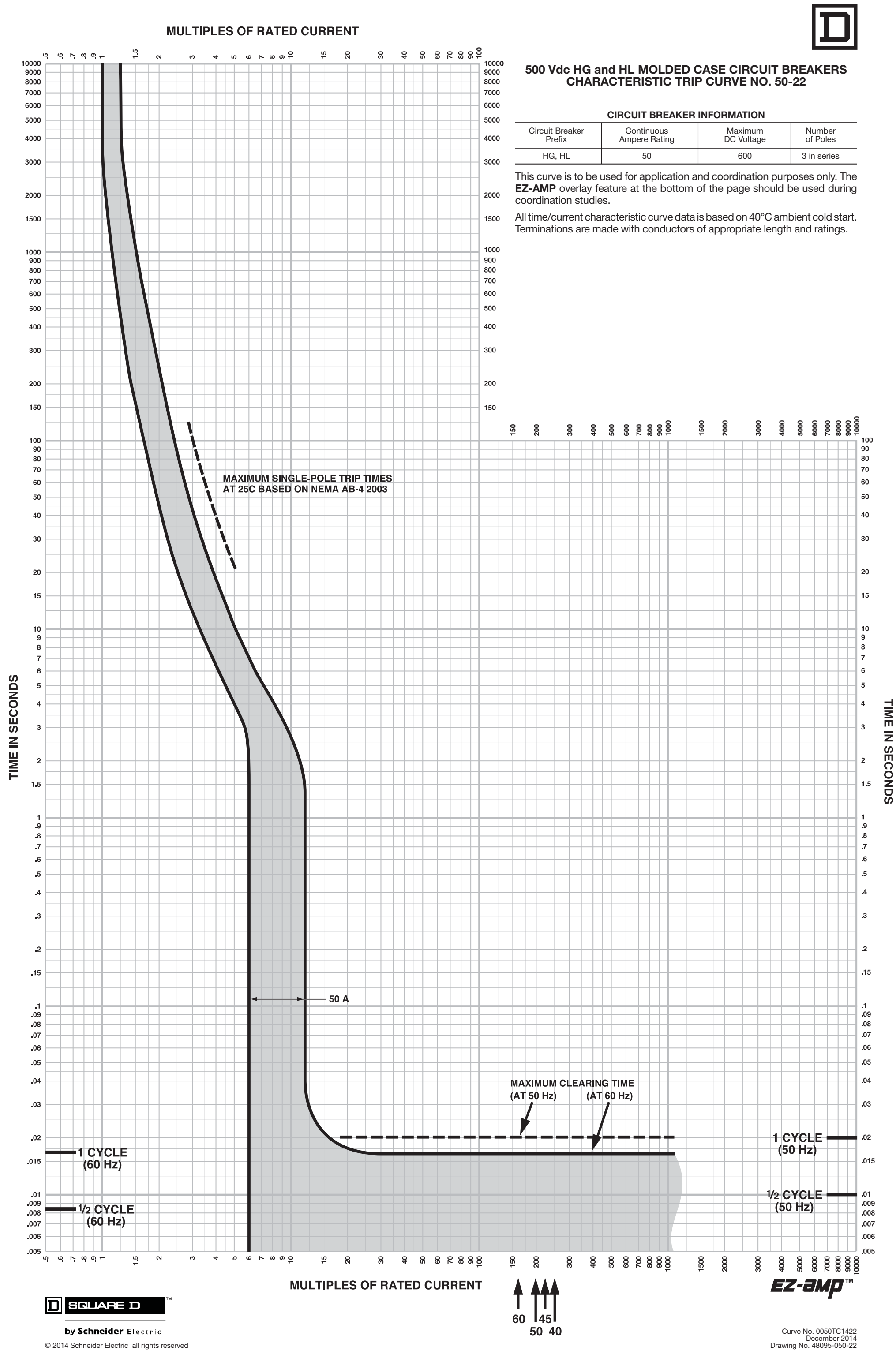
Figure 75: HG and HL 50 A 500Vdc Thermal-Magnetic Trip



Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
HG, HL	50	600	3 in series

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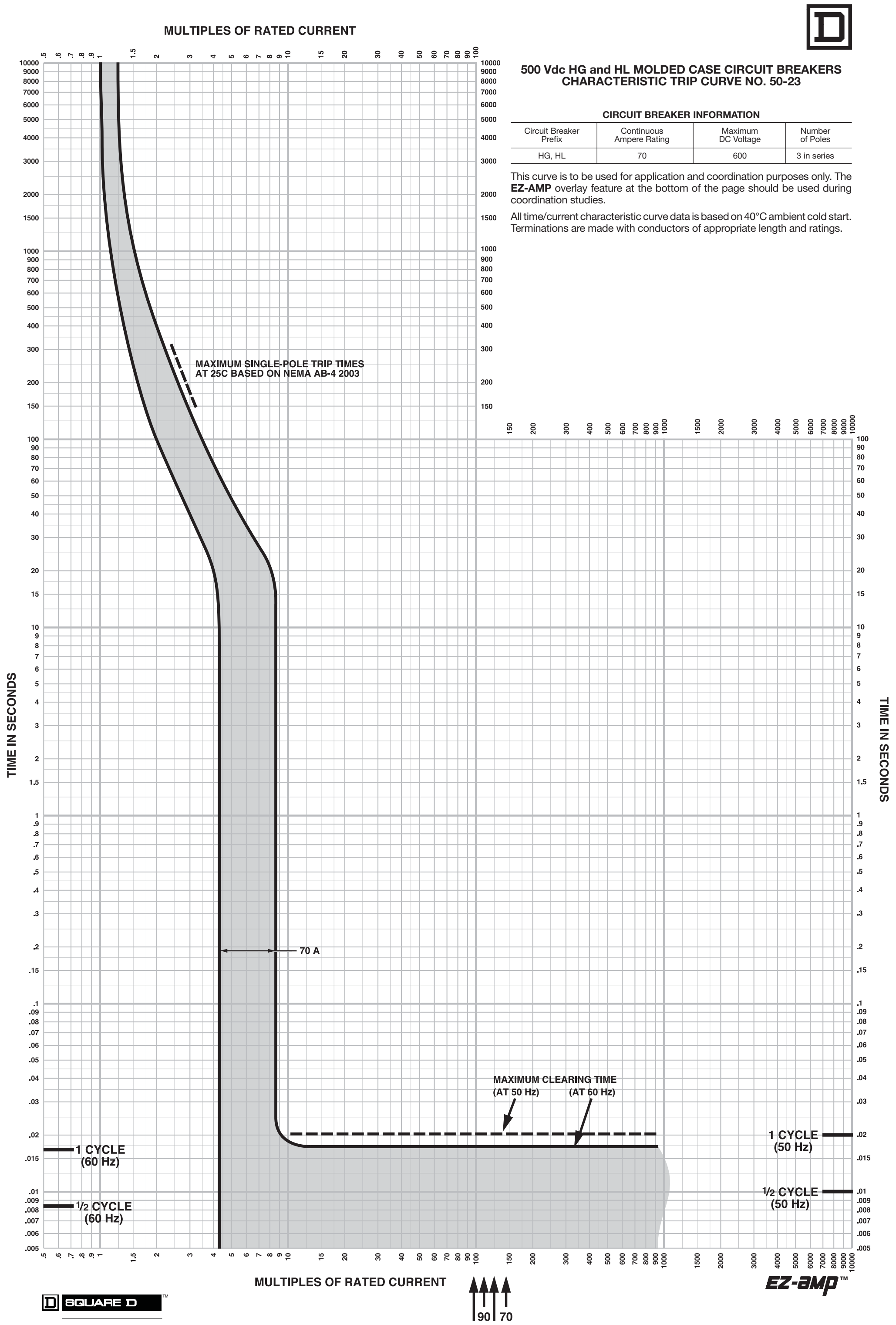
Figure 76: HG and HL 370 A 500Vdc Thermal-Magnetic Trip



500 Vdc HG and HL MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-23

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
HG, HL	70	600	3 in series

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

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Curve No. 0050TC1423
December 2014
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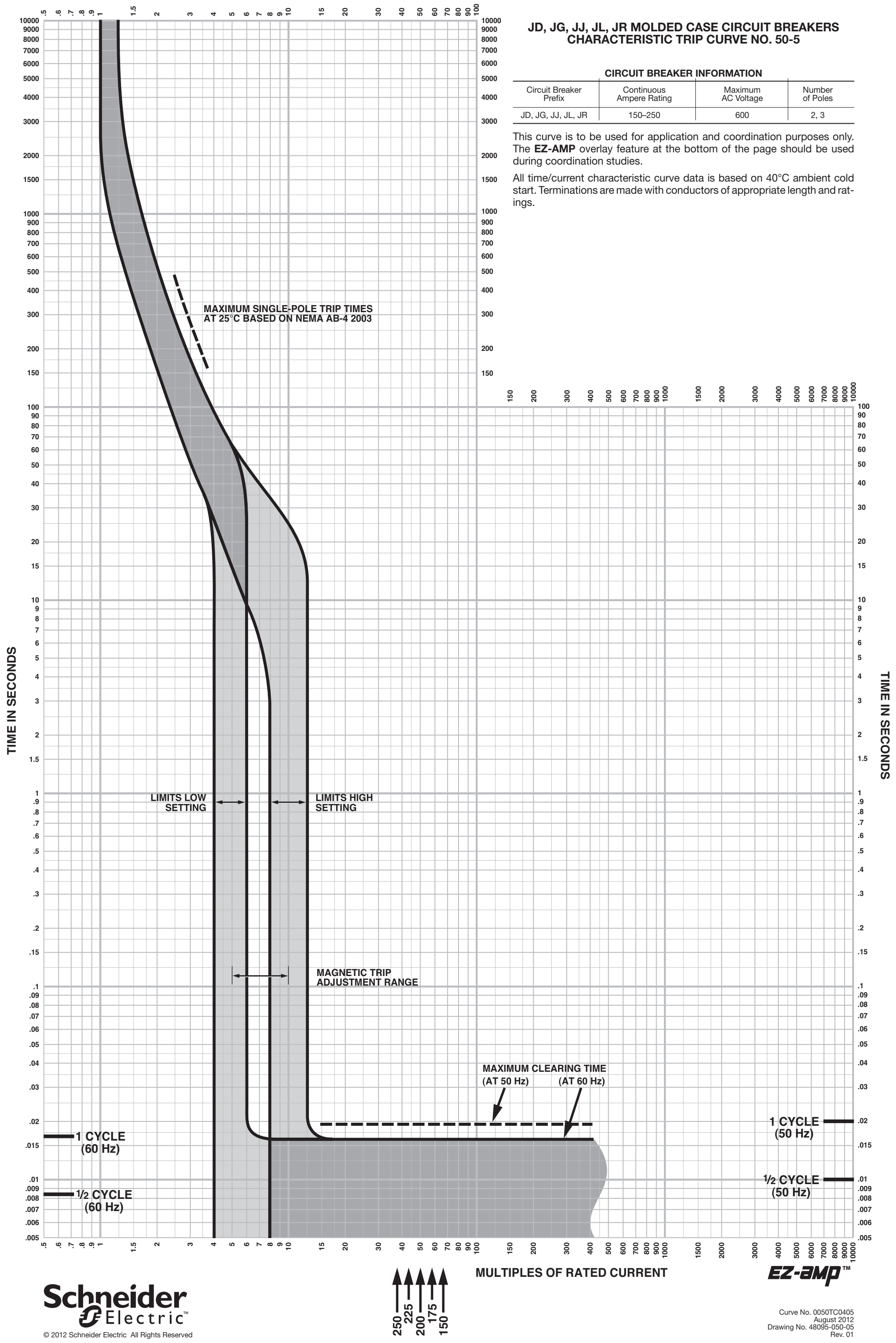
Figure 77: J-Frame 150–250 A (JD, JG, JJ, JL, and JR) Thermal-Magnetic Trip



CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
JD, JG, JJ, JL, JR	150–250	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

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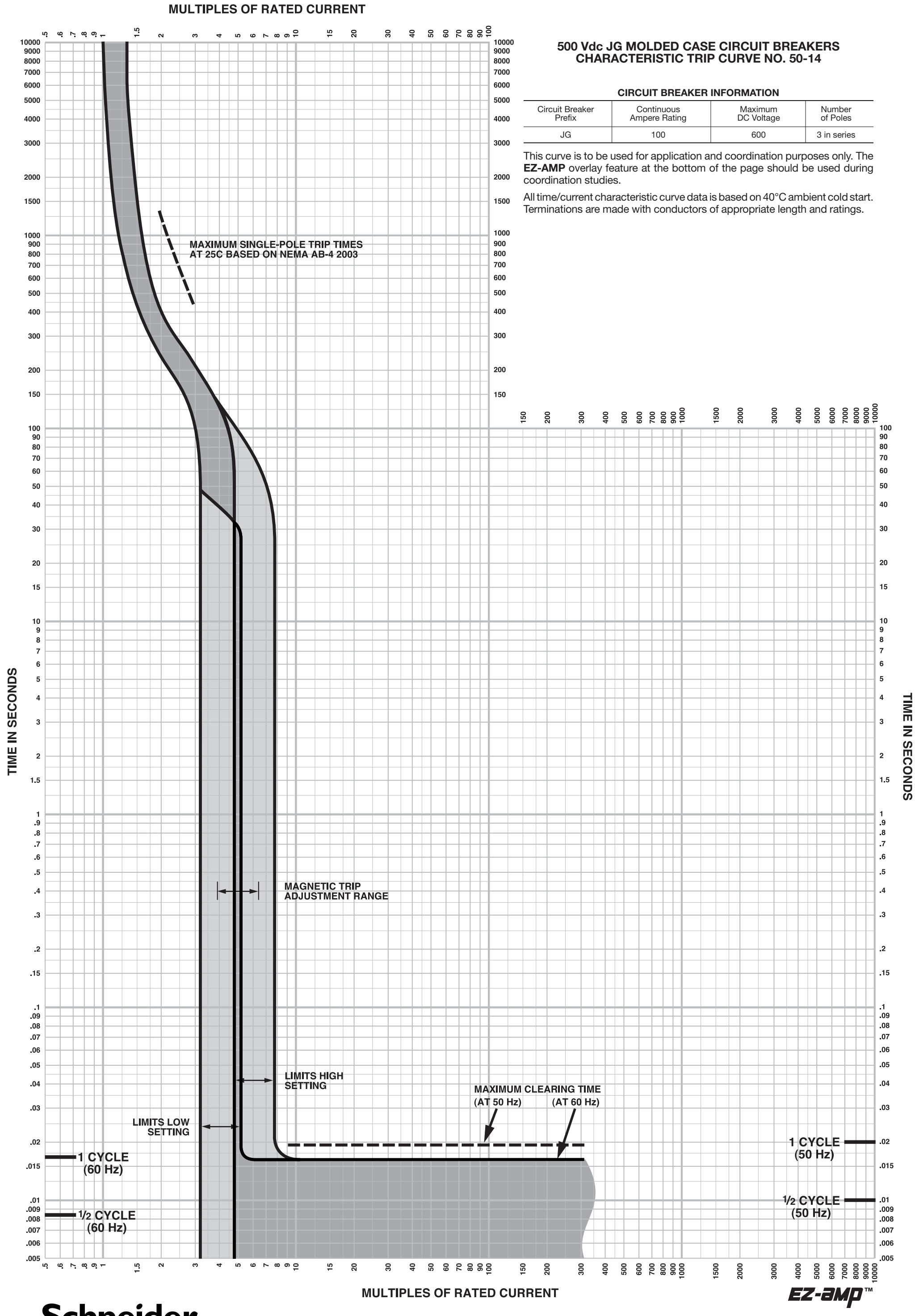
Figure 78: J-Frame 100 A (JG) 500 Vdc Thermal-Magnetic 500 Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 50-14

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	100	600	3 in series

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September 2009
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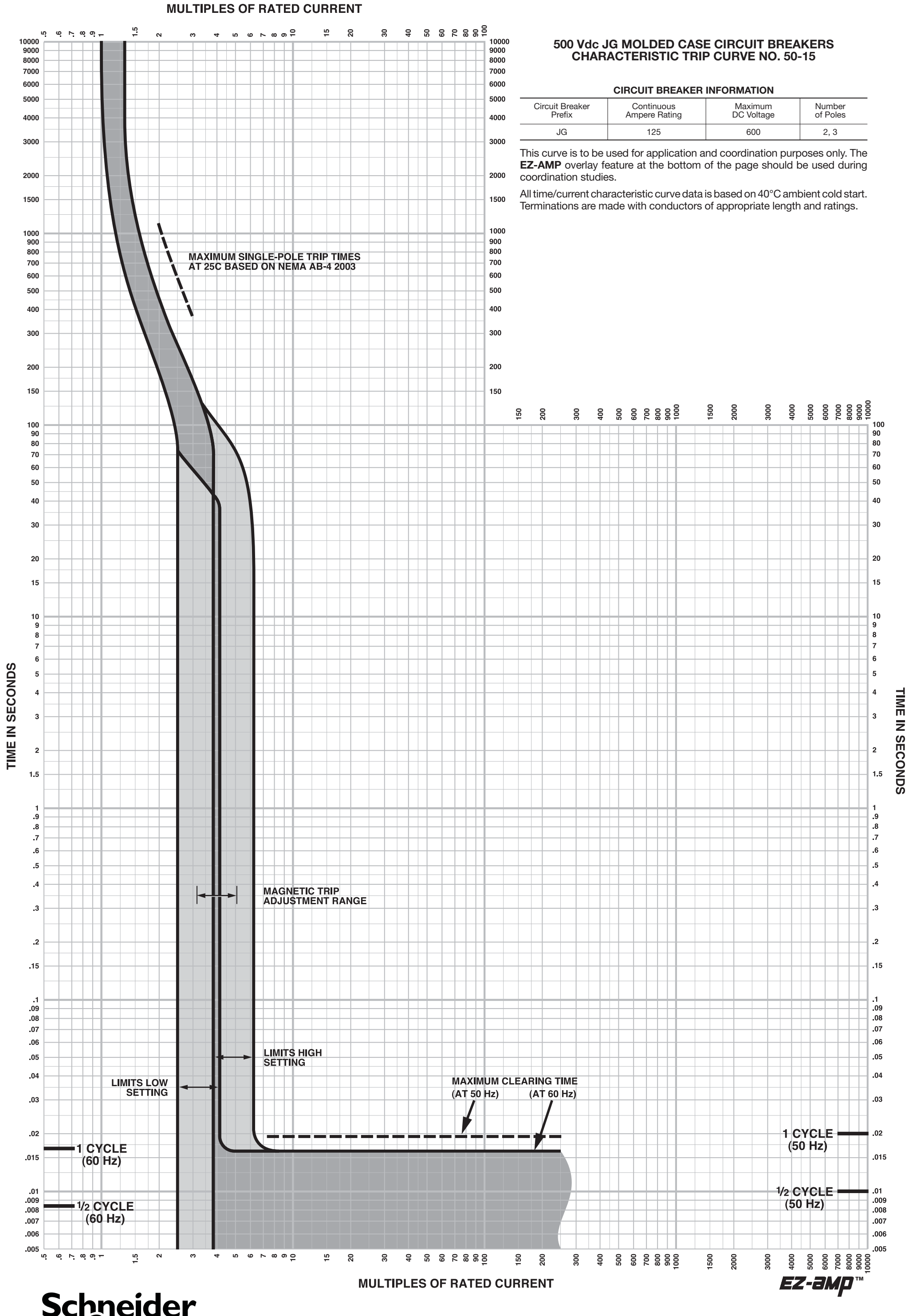
Figure 79: J-Frame 125 A (JG) 500 Vdc Thermal-Magnetic Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 50-15

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	125	600	2, 3

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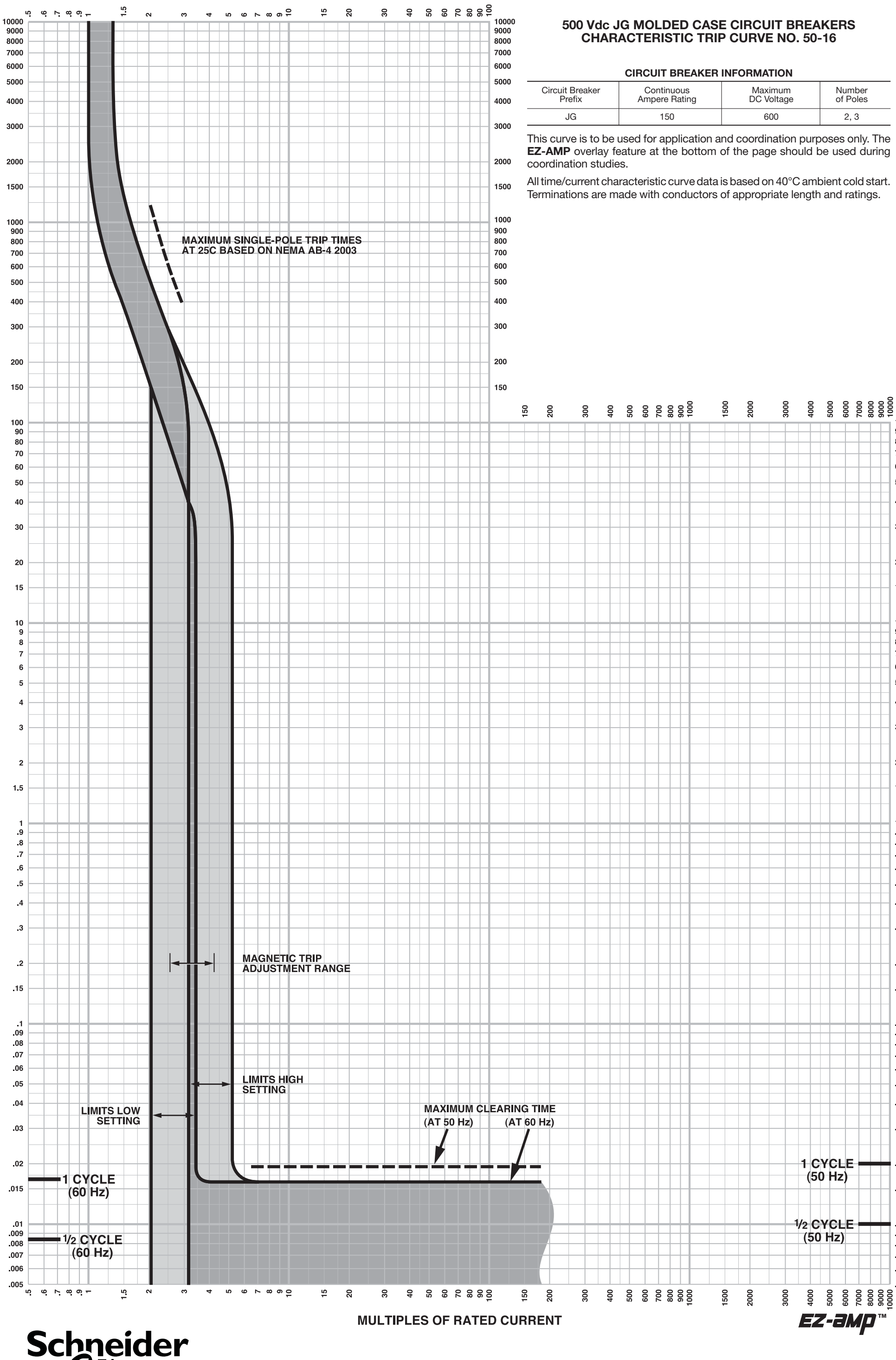
Figure 80: J-Frame 150 A (JG) 500 Vdc Thermal-Magnetic Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-16

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	150	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

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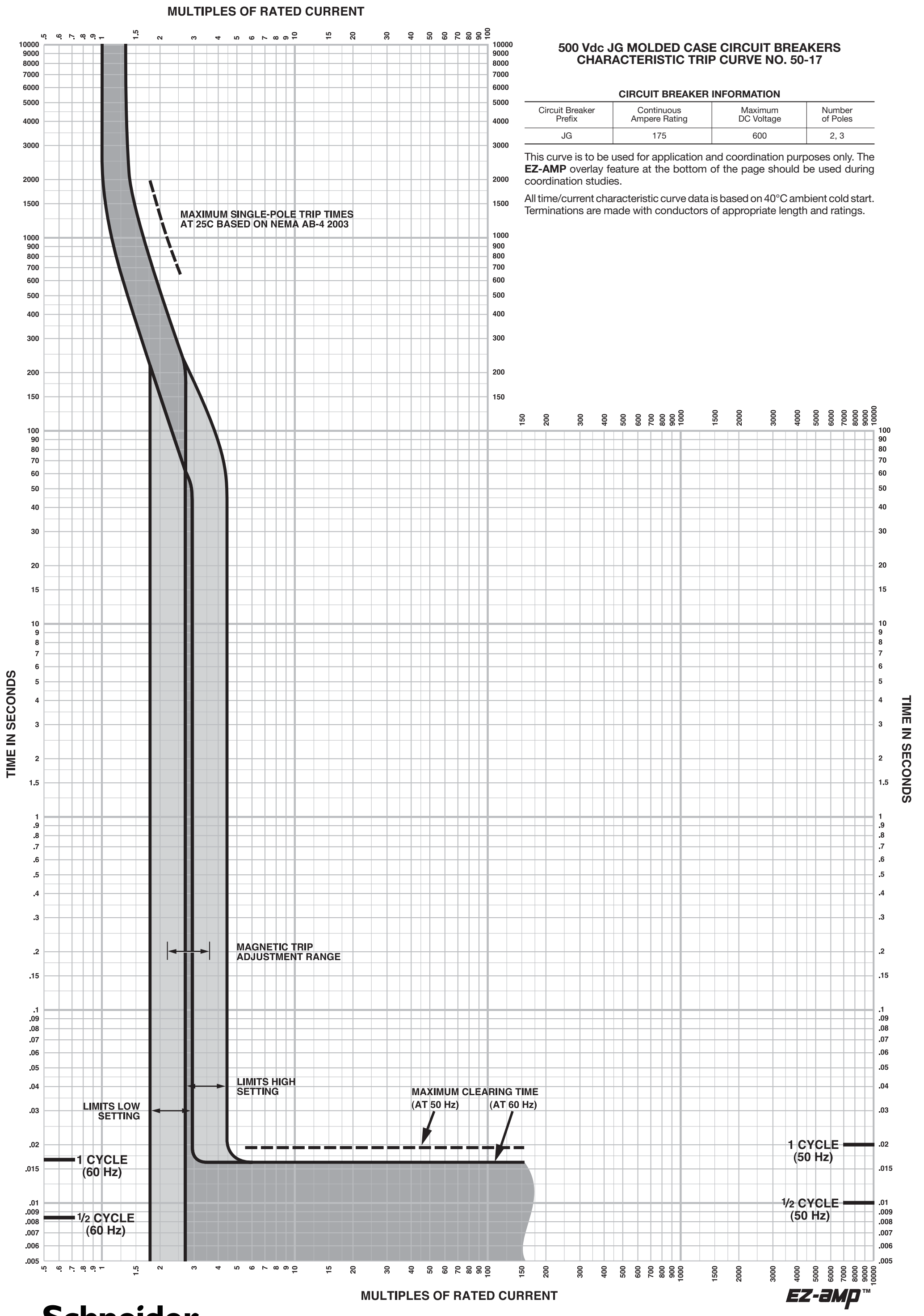
Figure 81: J-Frame 175 A (JG) 500 Vdc Thermal-Magnetic Trip



CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	175	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

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Curve No. 0050TC0917
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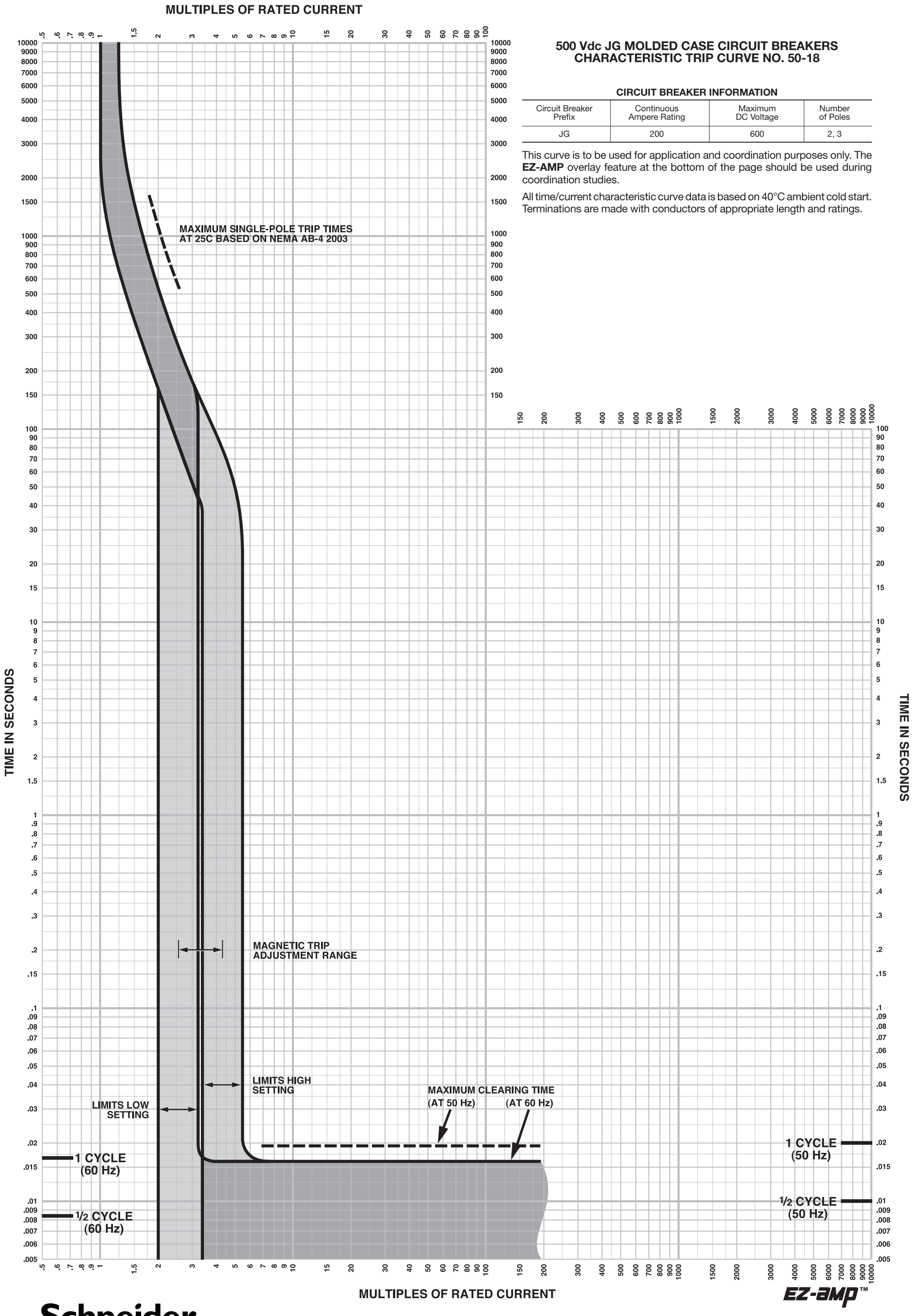
Figure 82: J-Frame 200 A (JG) 500 Vdc Thermal-Magnetic Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 50-18

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	200	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

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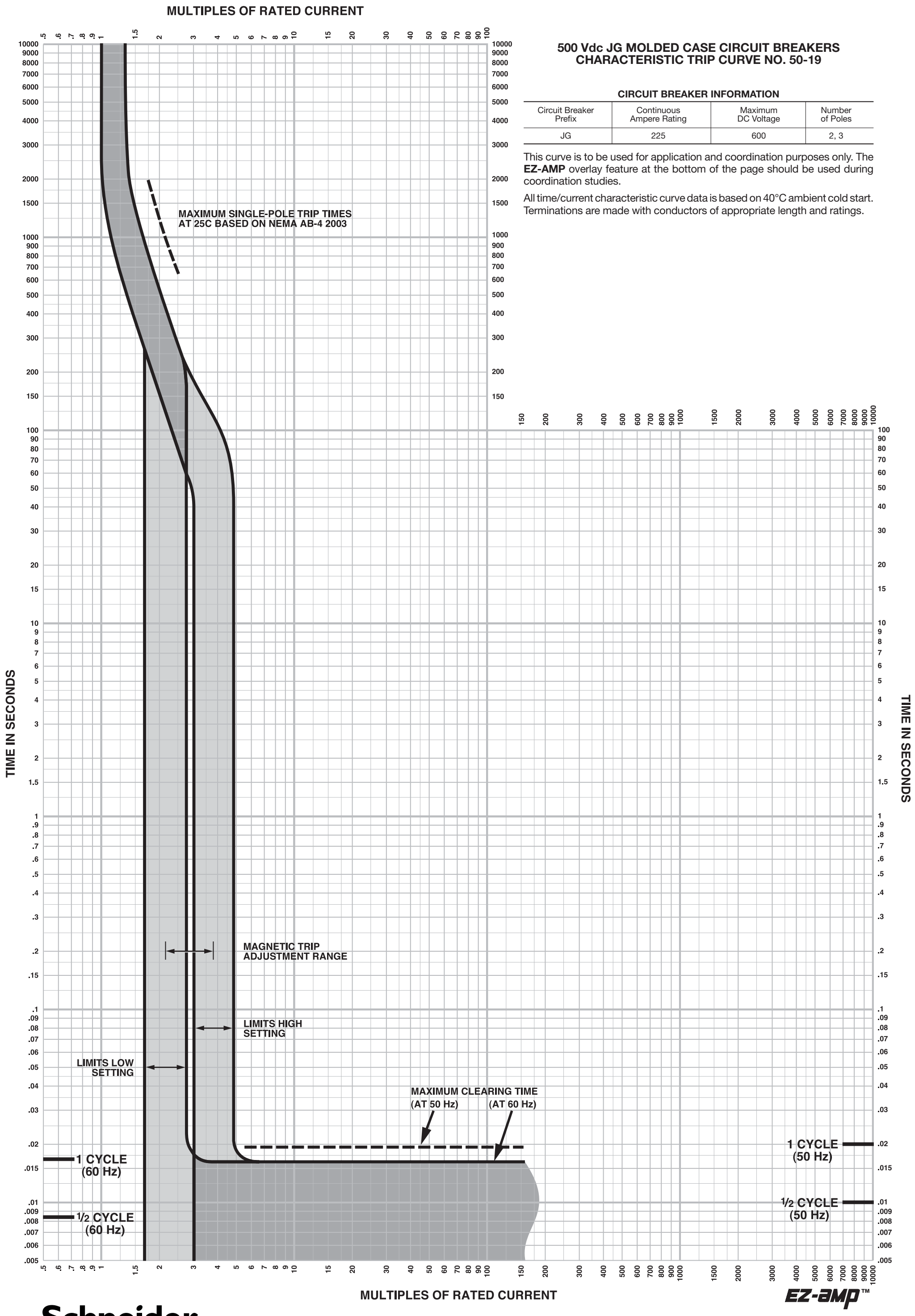
Figure 83: J-Frame 225 A (JG) 500 Vdc Thermal-Magnetic Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 50-19

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	225	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

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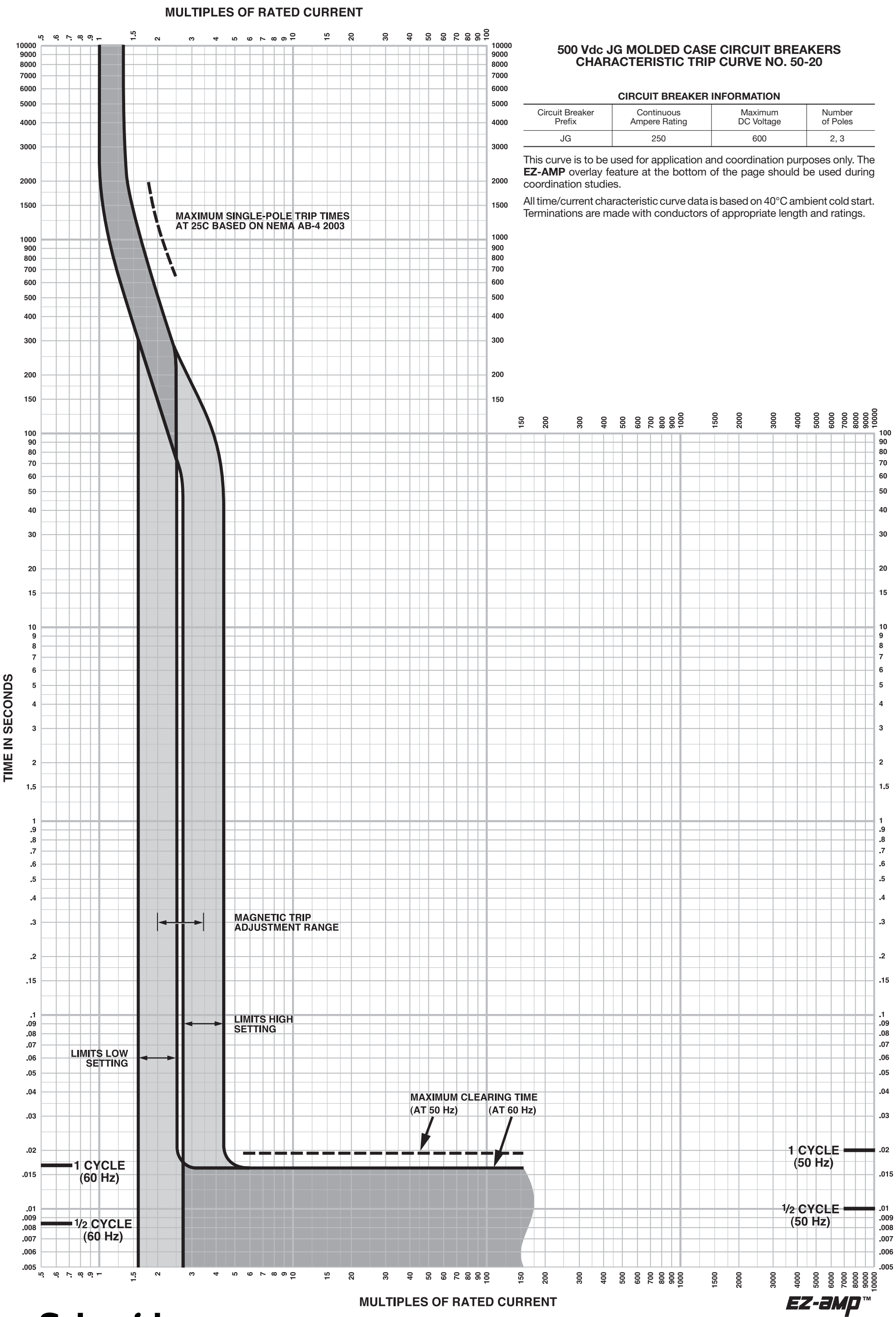
PowerPact H-, J-, and L-Frame Circuit Breakers
Trip Curves

Figure 84: J-Frame 250 A (JG) 500 Vdc Thermal-Magnetic Trip



500 Vdc JG MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 50-20

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum DC Voltage	Number of Poles
JG	250	600	2, 3

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

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Curve No. 0050TC0920
September 2009
Drawing No. 48095-050-20

TIM-ID: 0000053623 - 003

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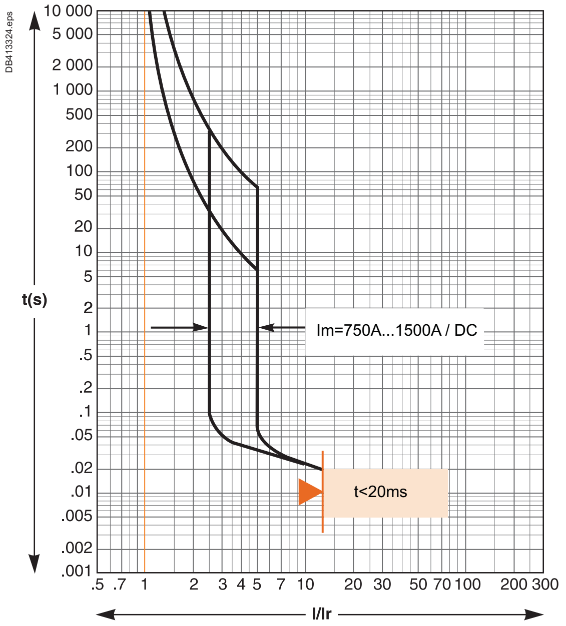
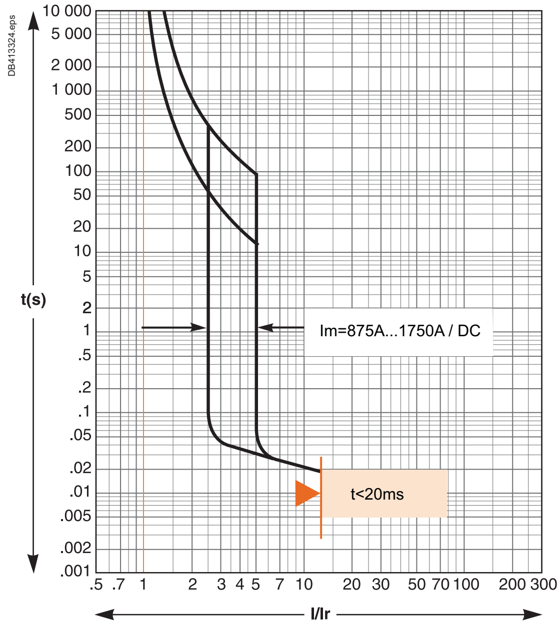
Figure 85: **L-Frame 300–450 A (LG and LL) 500 Vdc Thermal-Magnetic Trip**

L-Frame 300A



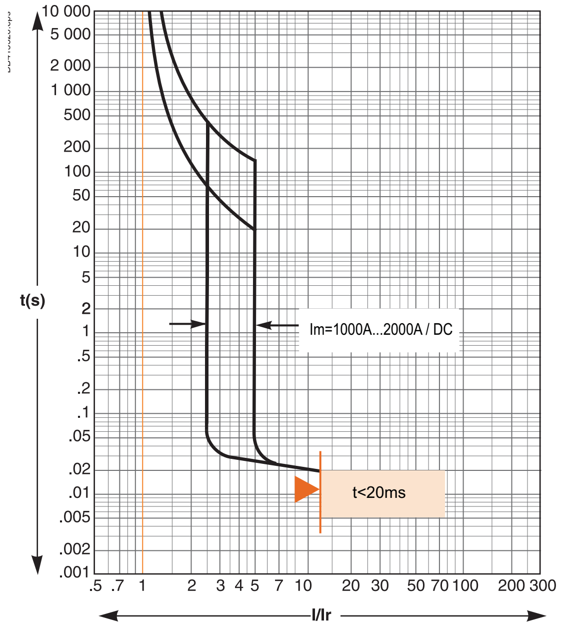
Reflex tripping

L-Frame 350A



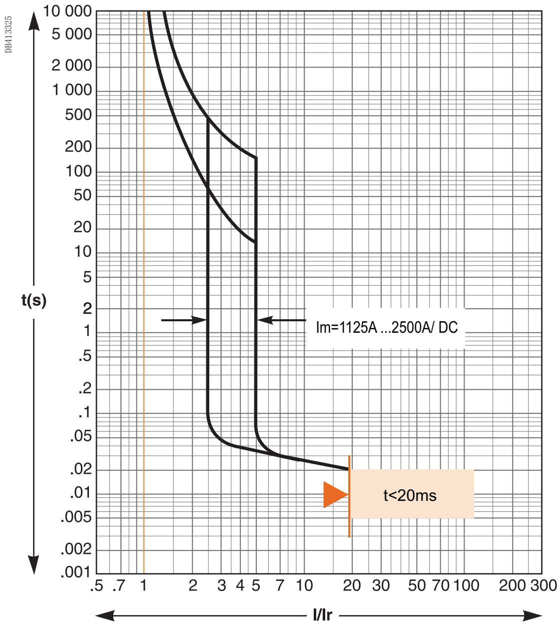
Reflex tripping

L-Frame 400A



Reflex tripping

L-Frame 450A



Reflex tripping

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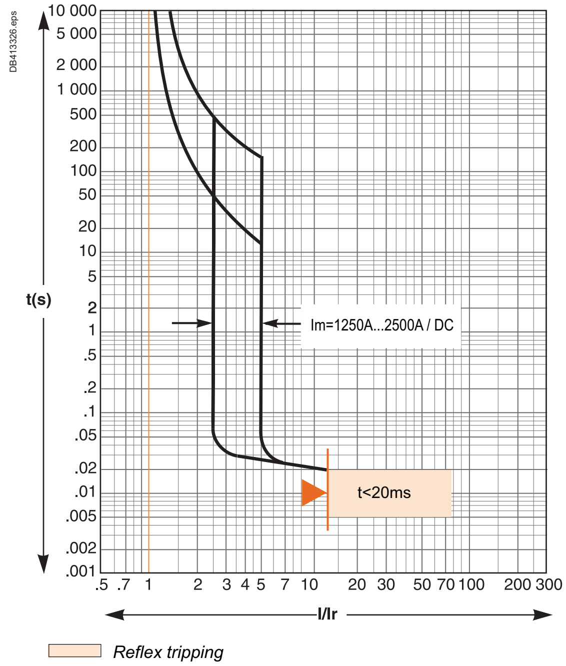
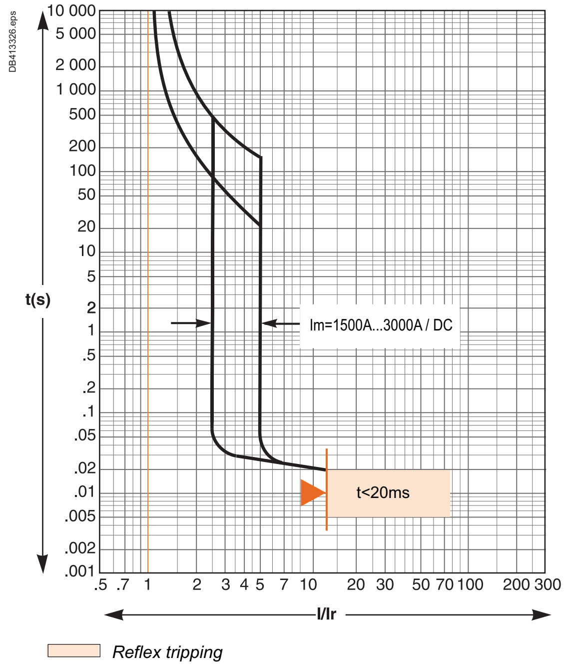
Figure 86: L-Frame 500–800 A (LG and LL) 500 Vdc Thermal-Magnetic Trip

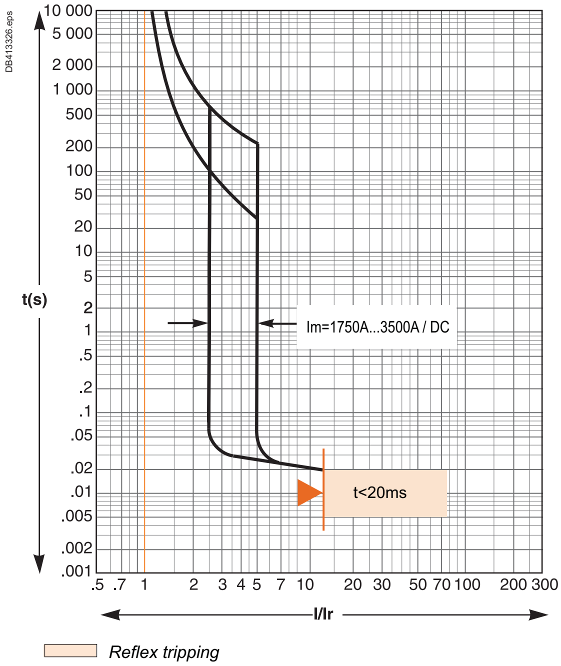
L-Frame 500A



L-Frame 600A



L-Frame 700A



L-Frame 800A

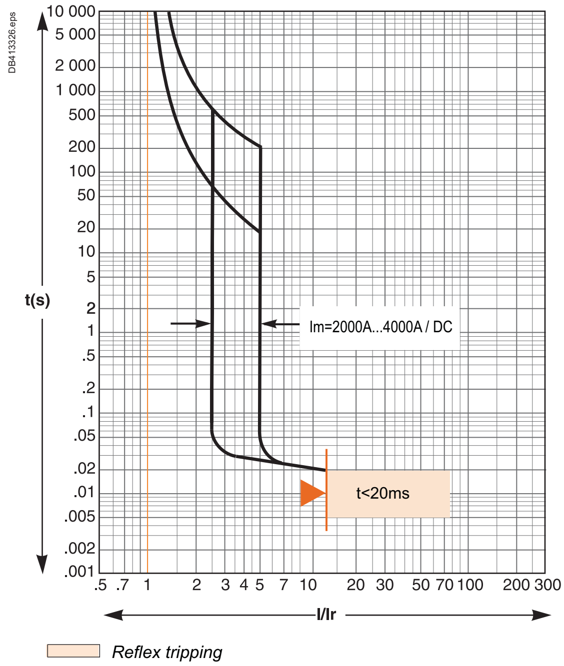


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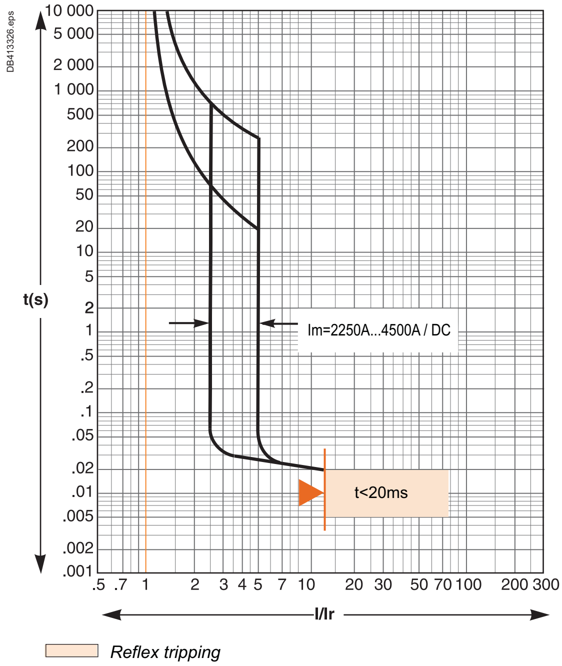
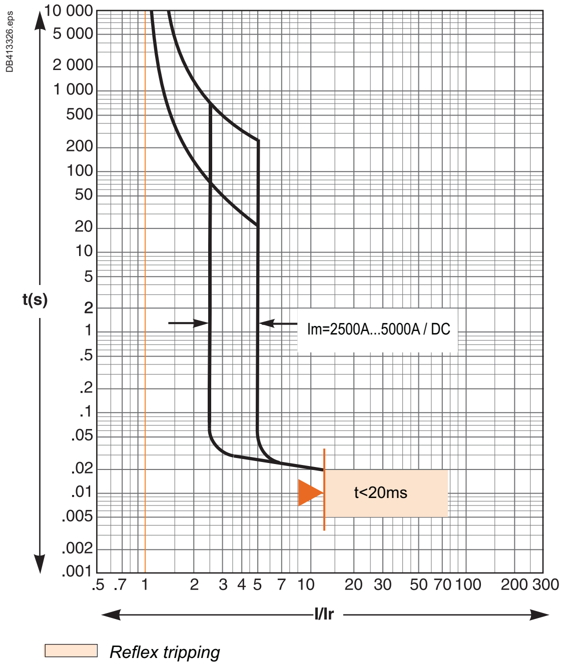
Figure 87: L-Frame 900–1200 A (LG and LL) 500 Vdc Thermal-Magnetic Trip

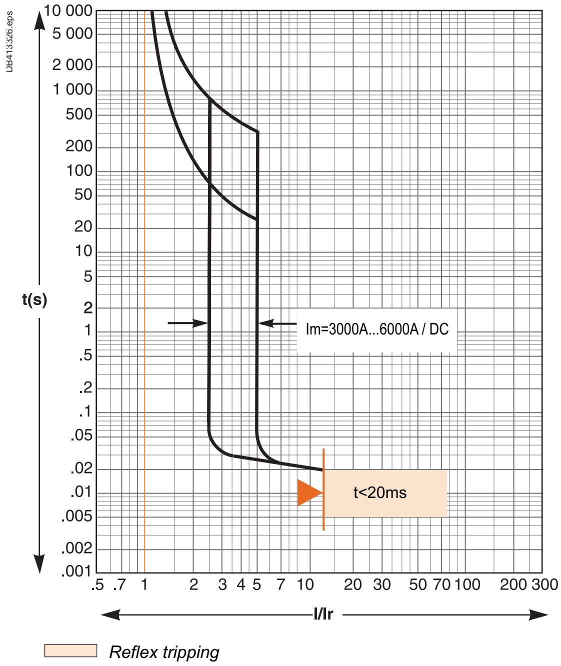
L-Frame 900A



L-Frame 1000A



L-Frame 1200A



TIM-ID: 0000053623 - 003

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Figure 88: H-Frame 150 A Typical Peak Let-Through Curves

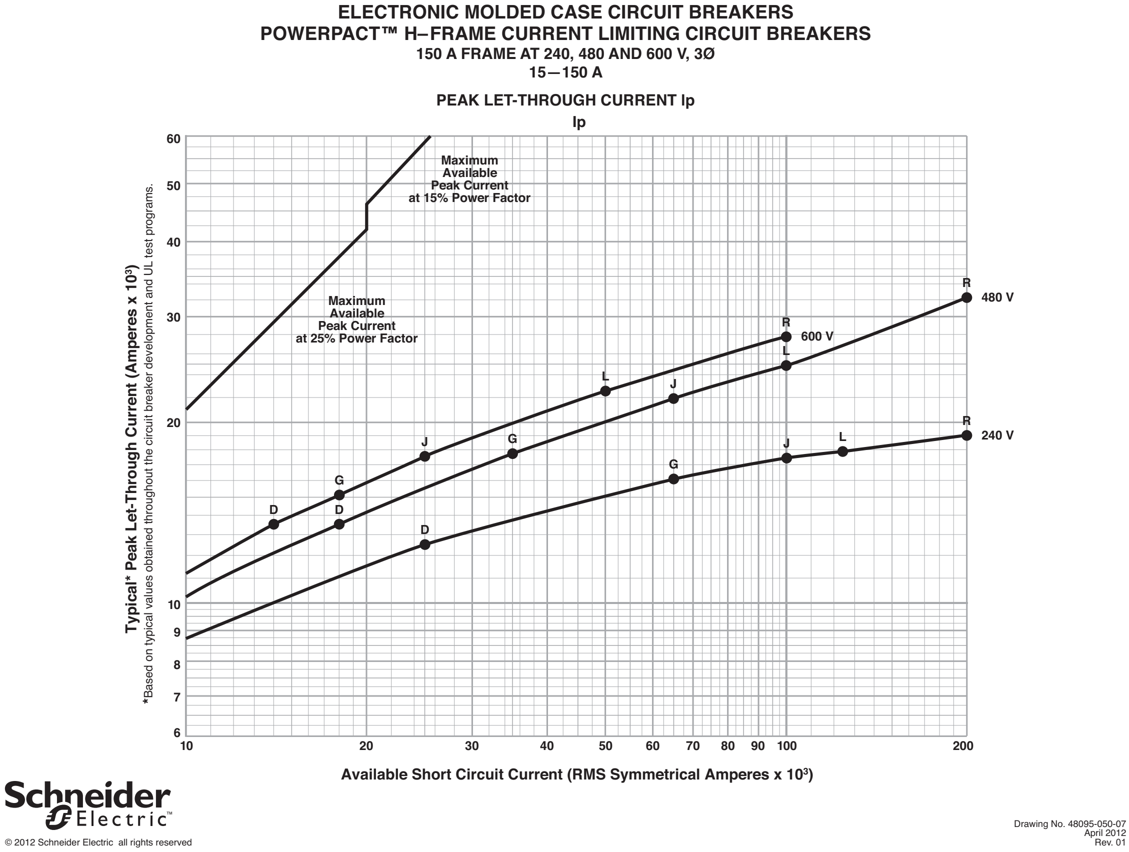

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Figure 89: H-Frame 150 A Typical I²t Let-Through Curves

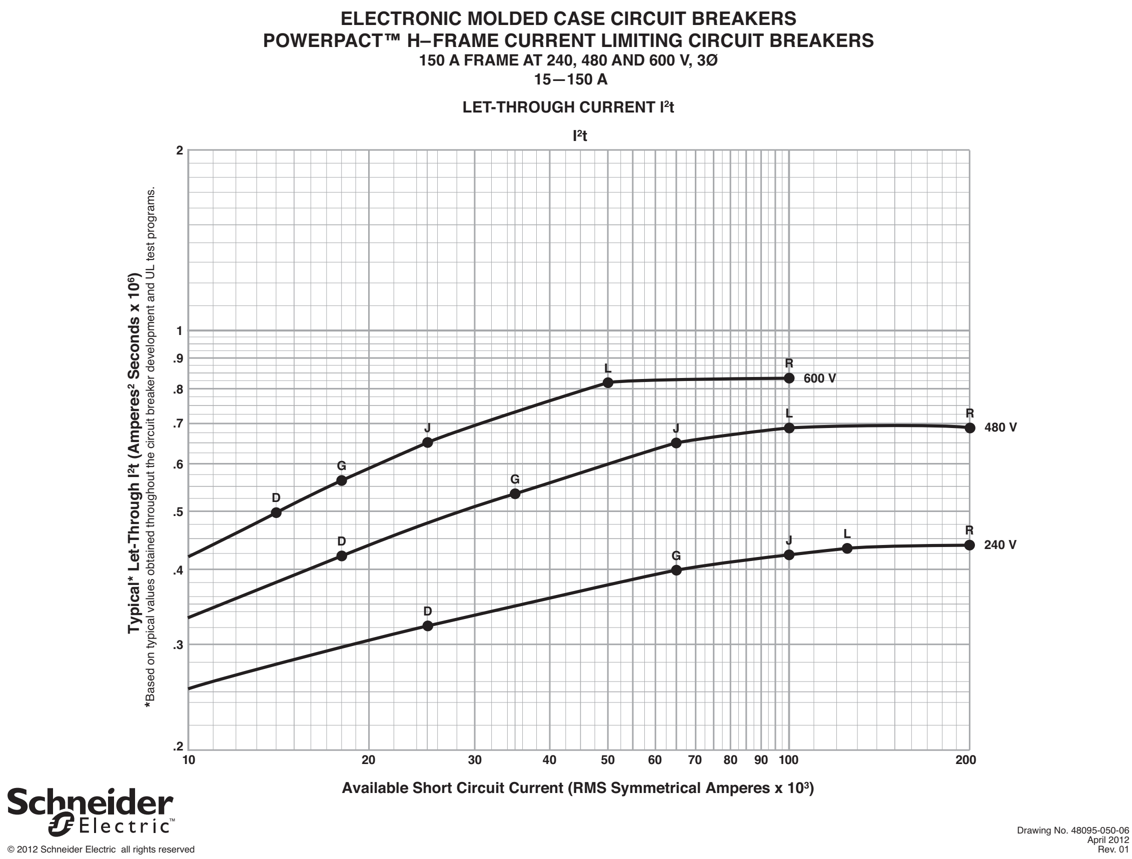

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Figure 90: J-Frame 250 A Typical Peak Let-Through Curves

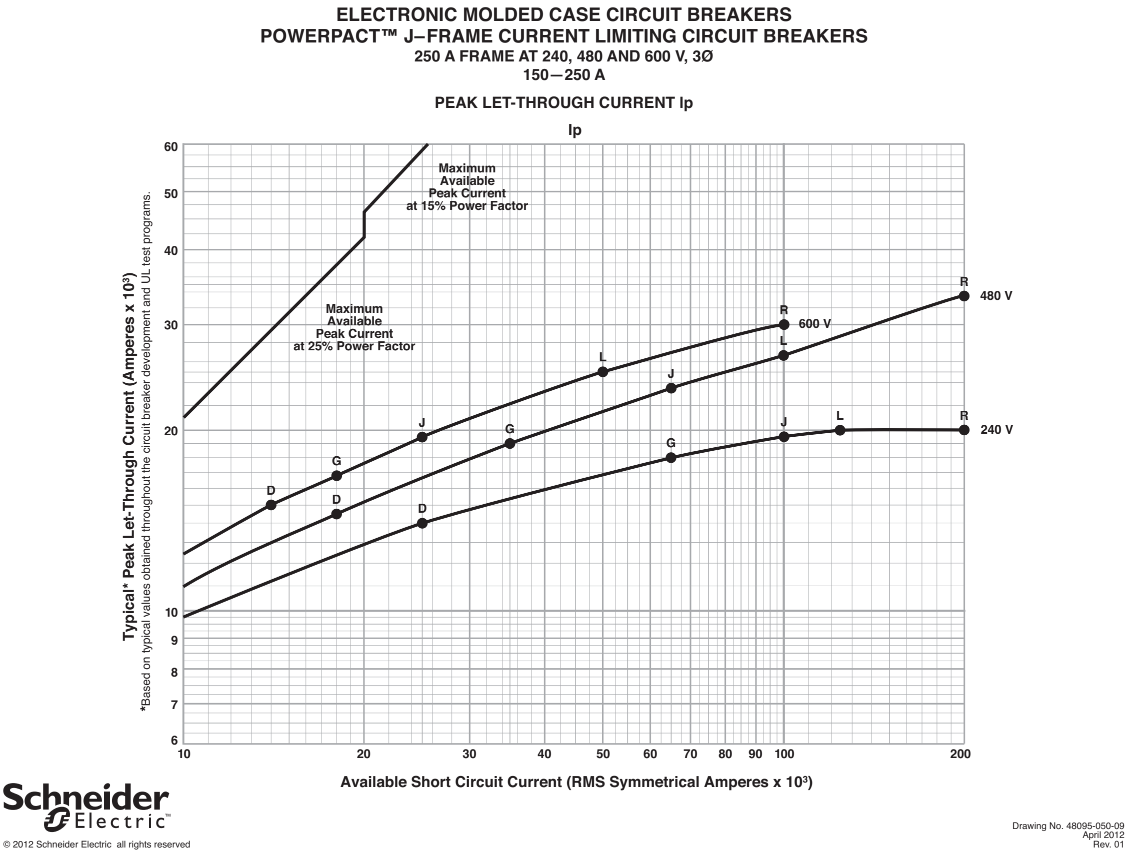

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Figure 91: J-Frame 250 A Typical I²t Let-Through Curves

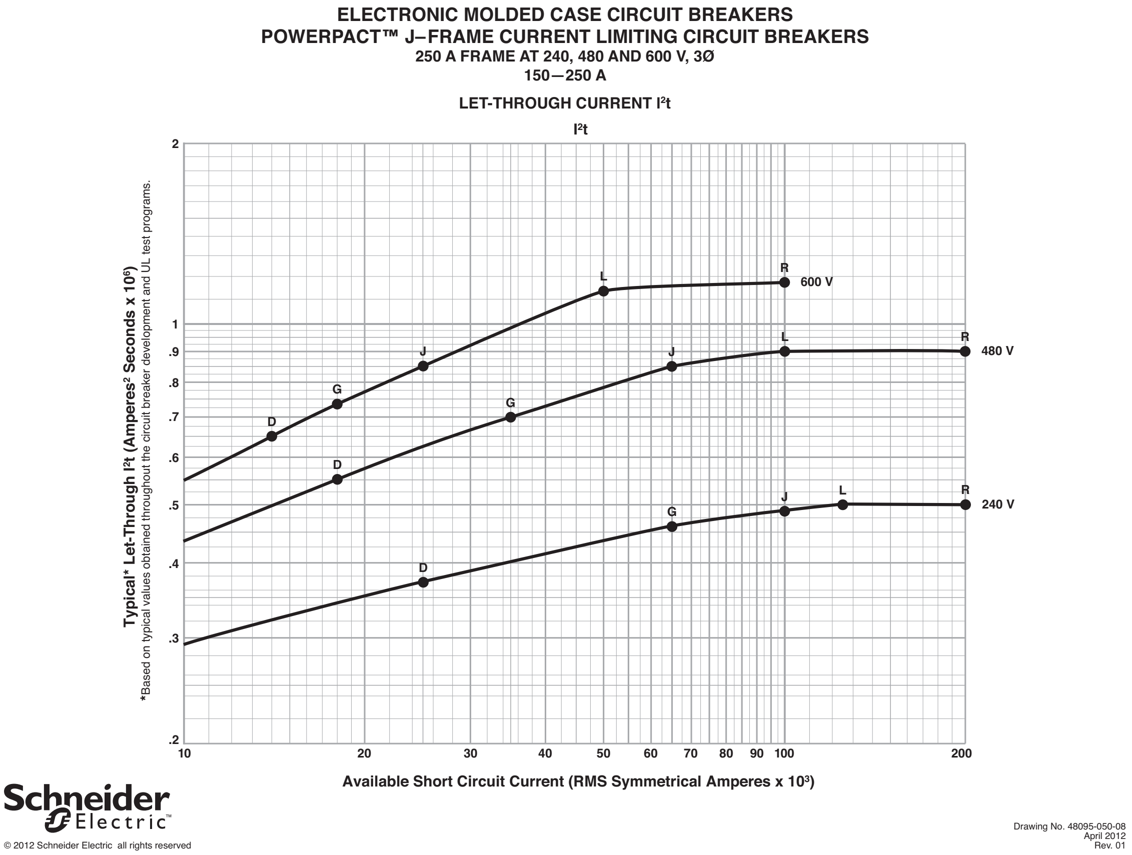

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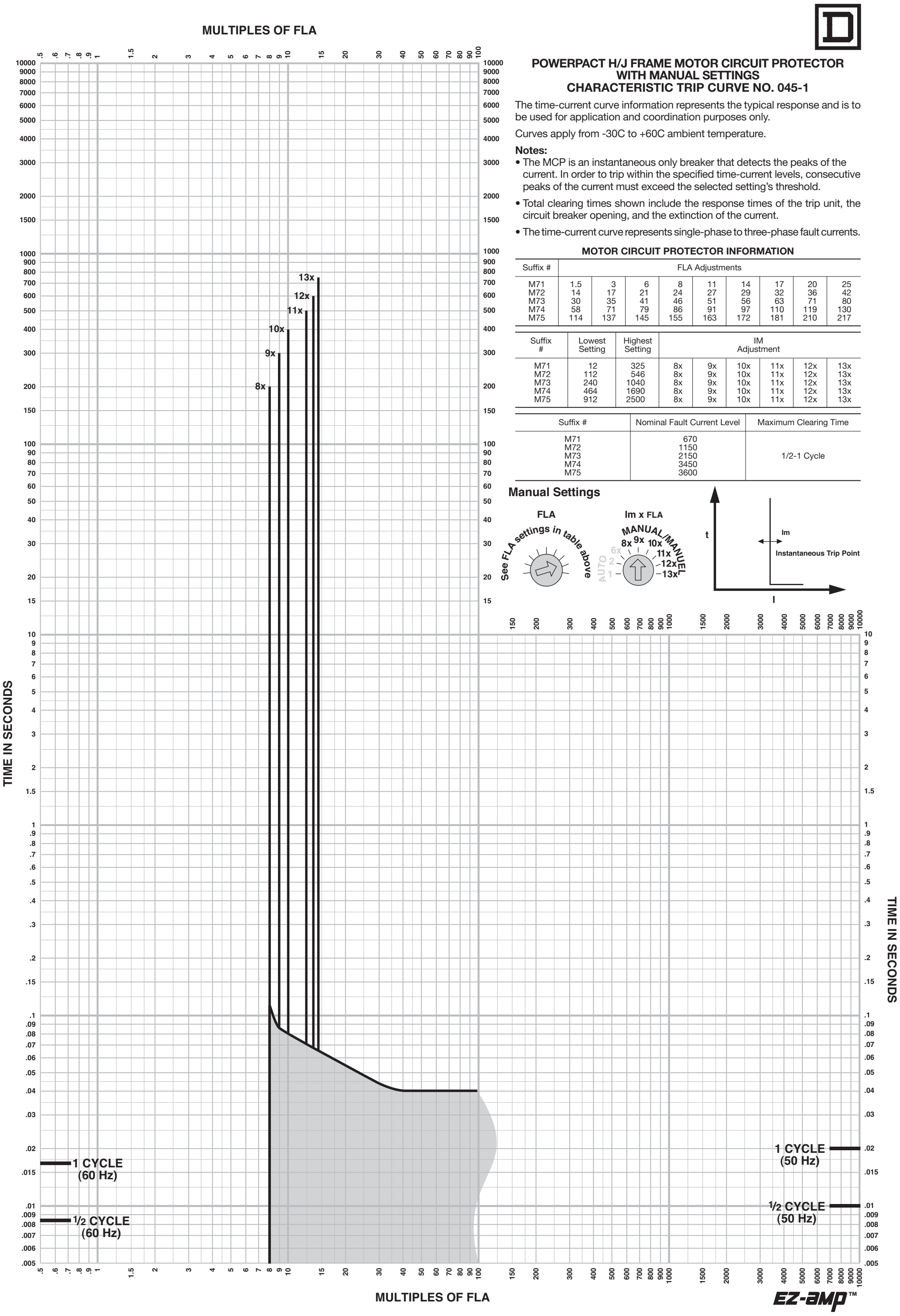
Figure 92: H- and J-Frame Motor Circuit Protector



POWERPACT H/J FRAME MOTOR CIRCUIT PROTECTOR WITH MANUAL SETTINGS CHARACTERISTIC TRIP CURVE NO. 045-1

The time-current curve information represents the typical response and is to be used for application and coordination purposes only.

Curves apply from -30C to +60C ambient temperature.

Notes:

- The MCP is an instantaneous only breaker that detects the peaks of the current. In order to trip within the specified time-current levels, consecutive peaks of the current must exceed the selected setting's threshold.
- Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
- The time-current curve represents single-phase to three-phase fault currents.

MOTOR CIRCUIT PROTECTOR INFORMATION

Suffix #	FLA Adjustments								
M71	1.5	3	6	8	11	14	17	20	25
M72	14	17	21	24	27	29	32	36	42
M73	30	35	41	46	51	56	63	71	80
M74	58	71	79	86	91	97	110	119	130
M75	114	137	145	155	163	172	181	210	217

Suffix #	Lowest Setting	Highest Setting	IM Adjustment					
M71	12	325	8x	9x	10x	11x	12x	13x
M72	112	546	8x	9x	10x	11x	12x	13x
M73	240	1040	8x	9x	10x	11x	12x	13x
M74	464	1690	8x	9x	10x	11x	12x	13x
M75	912	2500	8x	9x	10x	11x	12x	13x

Suffix #	Nominal Fault Current Level	Maximum Clearing Time
M71	670	1/2-1 Cycle
M72	1150	
M73	2150	
M74	3450	
M75	3600	

Curve No. 0045TC0601
August 2006
Drawing No. 48095-045-01

TIM-ID: 0000053623 - 003

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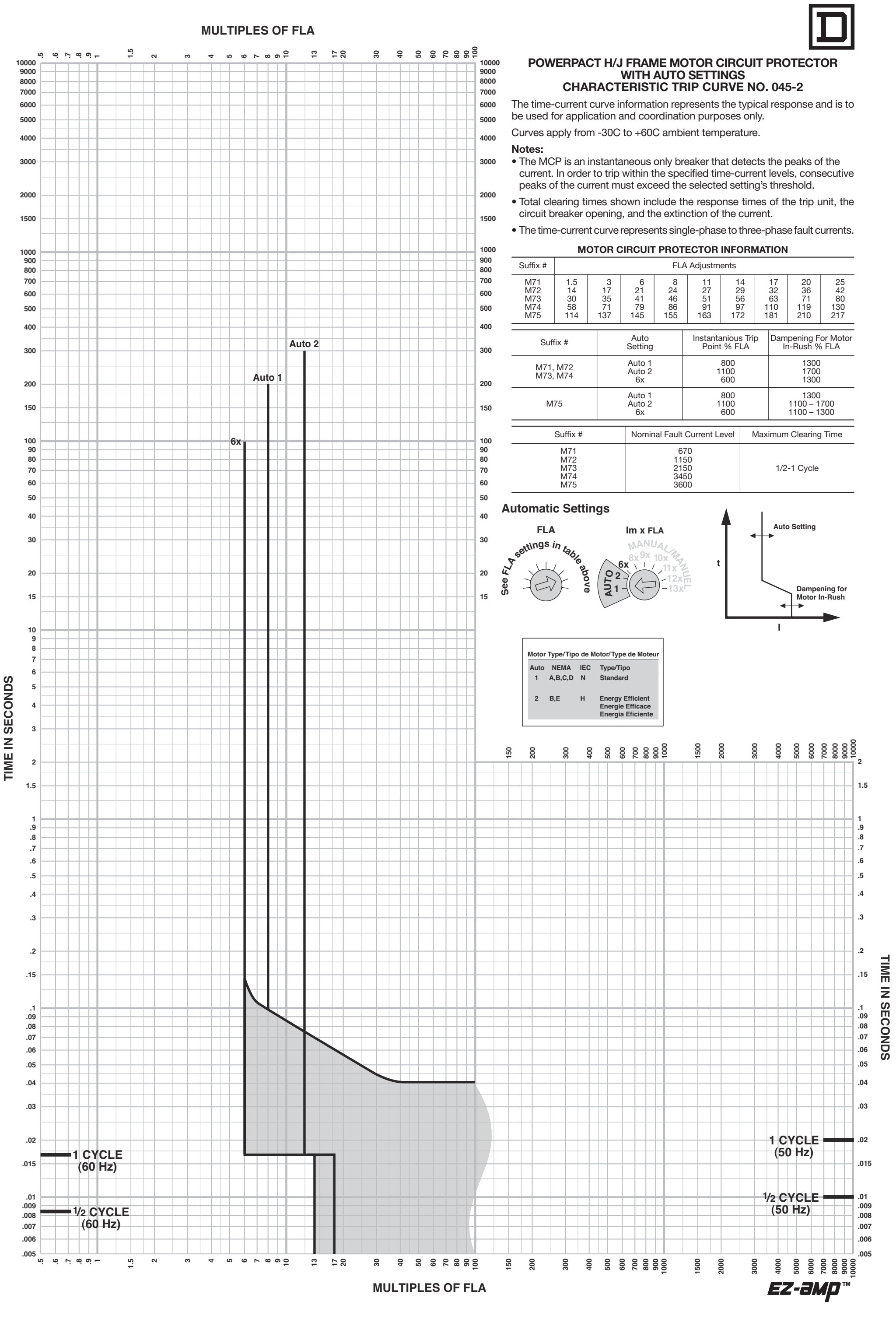
Figure 93: H- and J-Frame Motor Circuit Protector



POWERPACT H/J FRAME MOTOR CIRCUIT PROTECTOR WITH AUTO SETTINGS CHARACTERISTIC TRIP CURVE NO. 045-2

The time-current curve information represents the typical response and is to be used for application and coordination purposes only.

Curves apply from -30C to +60C ambient temperature.

Notes:
- The MCP is an instantaneous only breaker that detects the peaks of the current. In order to trip within the specified time-current levels, consecutive peaks of the current must exceed the selected setting's threshold.
- Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
- The time-current curve represents single-phase to three-phase fault currents.

MOTOR CIRCUIT PROTECTOR INFORMATION

Suffix #	FLA Adjustments								
M71	1.5	3	6	8	11	14	17	20	25
M72	14	17	21	24	27	29	32	36	42
M73	30	35	41	46	51	56	63	71	80
M74	58	71	79	86	91	97	110	119	130
M75	114	137	145	155	163	172	181	210	217

Suffix #	Auto Setting	Instantanious Trip Point % FLA	Dampening For Motor In-Rush % FLA
M71, M72 M73, M74	Auto 1	800	1300
	Auto 2	1100	1700
	6x	600	1300
M75	Auto 1	800	1300
	Auto 2	1100	1100 – 1700
	6x	600	1100 – 1300

Suffix #	Nominal Fault Current Level	Maximum Clearing Time
M71	670	1/2-1 Cycle
M72	1150	
M73	2150	
M74	3450	
M75	3600	

Automatic Settings

FLA
See FLA settings in table above
Im x FLA
MANUAL/MANUEL
AUTO
1
2
6x
8x
9x
10x
11x
12x
13x
Auto Setting
t
Dampening for Motor In-Rush
I

Motor Type/Tipo de Motor/Type de Moteur

Auto	NEMA	IEC	Type/Tipo
1	A,B,C,D	N	Standard
2	B,E	H	Energy Efficient Energie Efficace Energia Eficiente

Curve No. 0045TC0602
August 2006
Drawing No. 48095-045-02

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PowerPact H-, J-, and L-Frame Circuit Breakers
Trip Curves

Figure 94: H-Frame UL Listed Current-Limiting Circuit Breaker

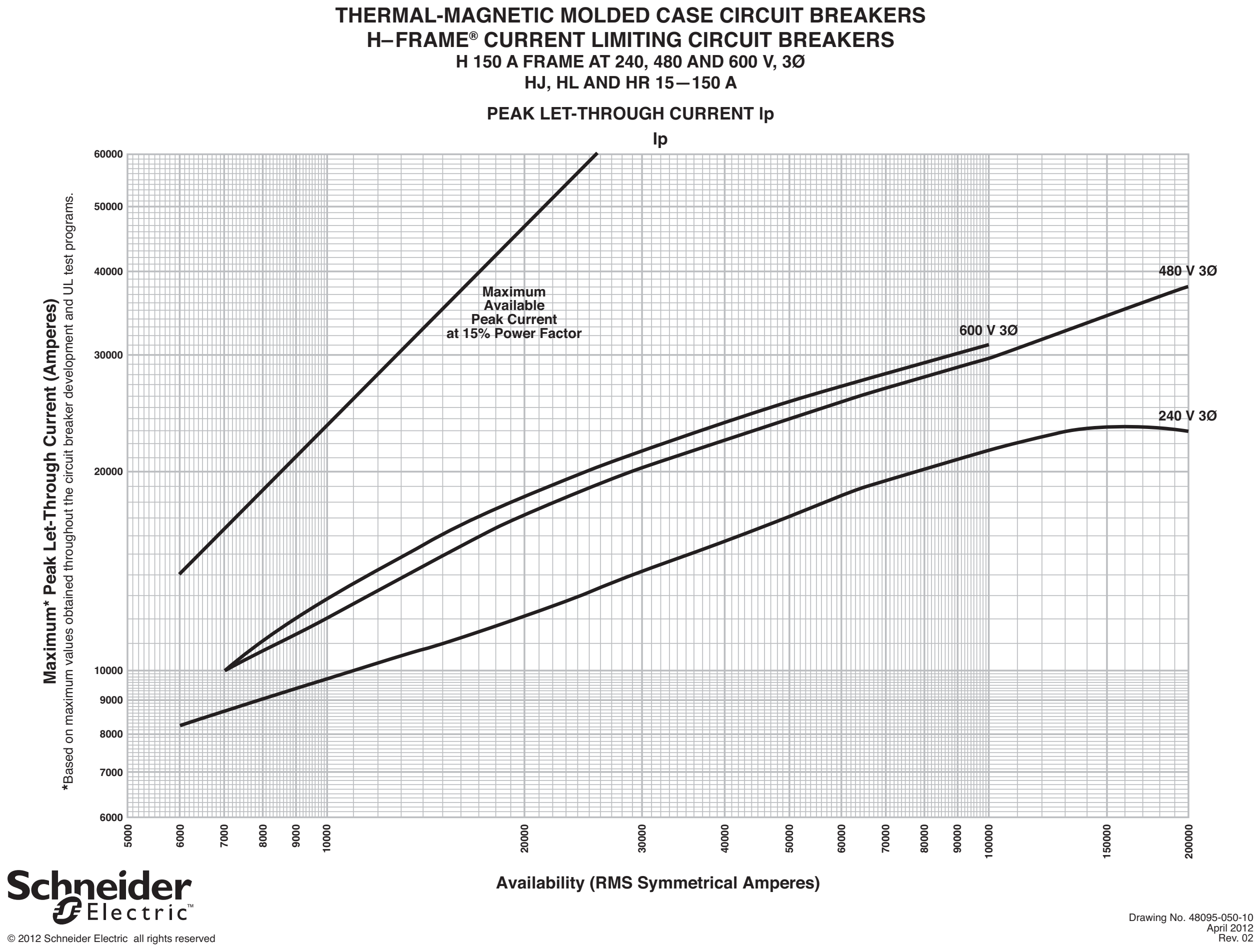

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Figure 95: H-Frame UL Listed Current-Limiting Circuit Breaker

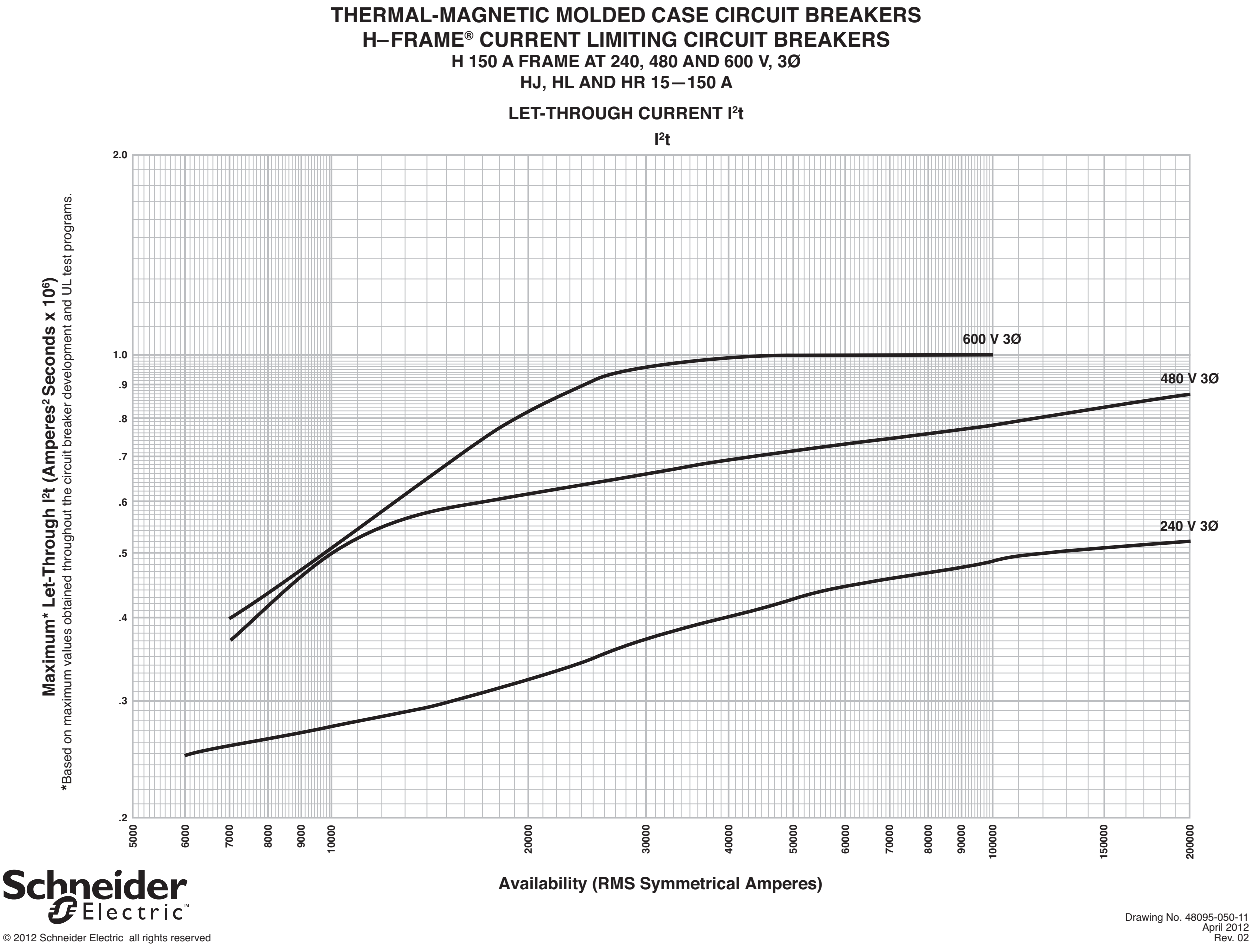

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Figure 96: J-Frame UL Listed Current -Limiting Circuit Breaker

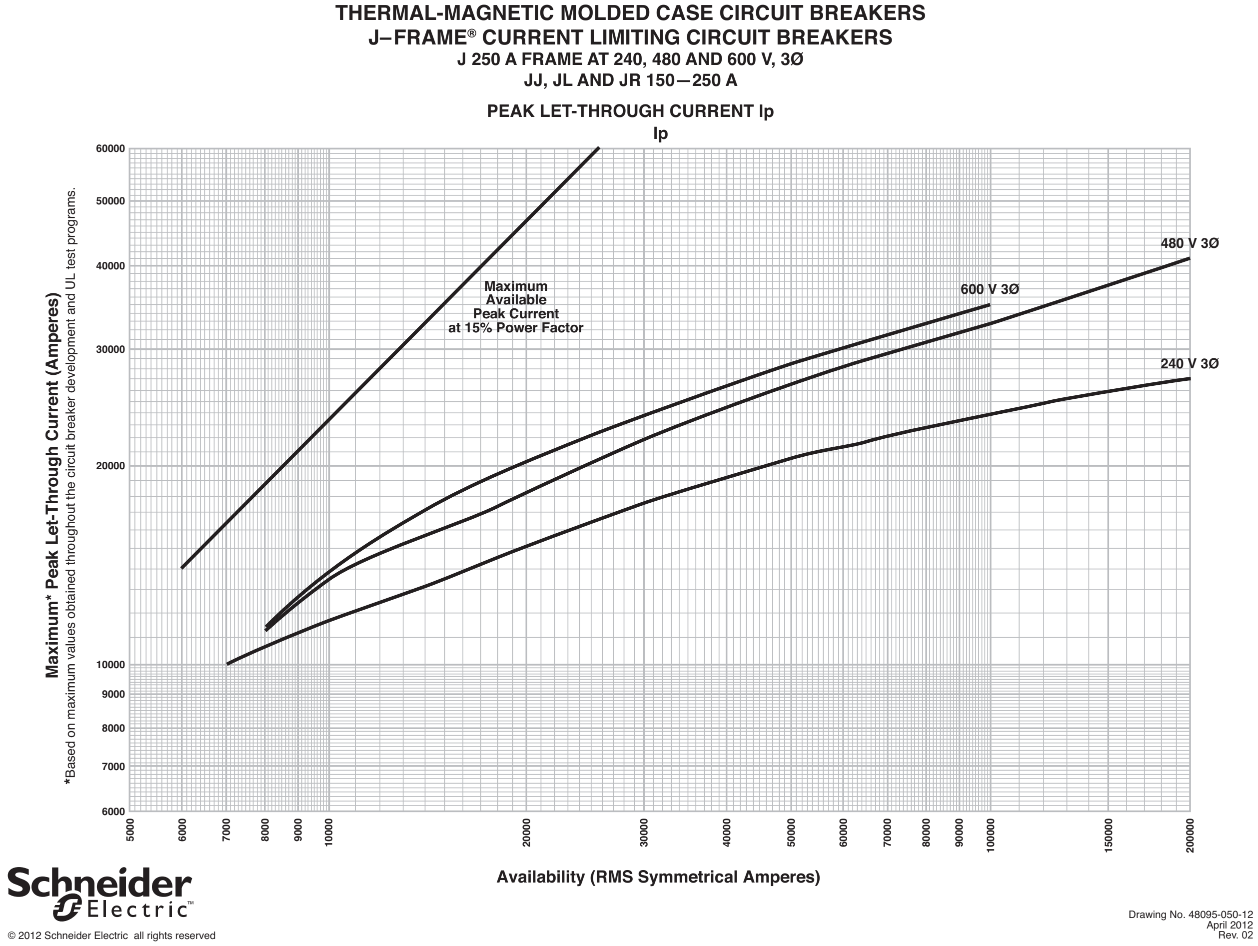

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Figure 97: J-Frame UL Listed Current-Limiting Circuit Breaker

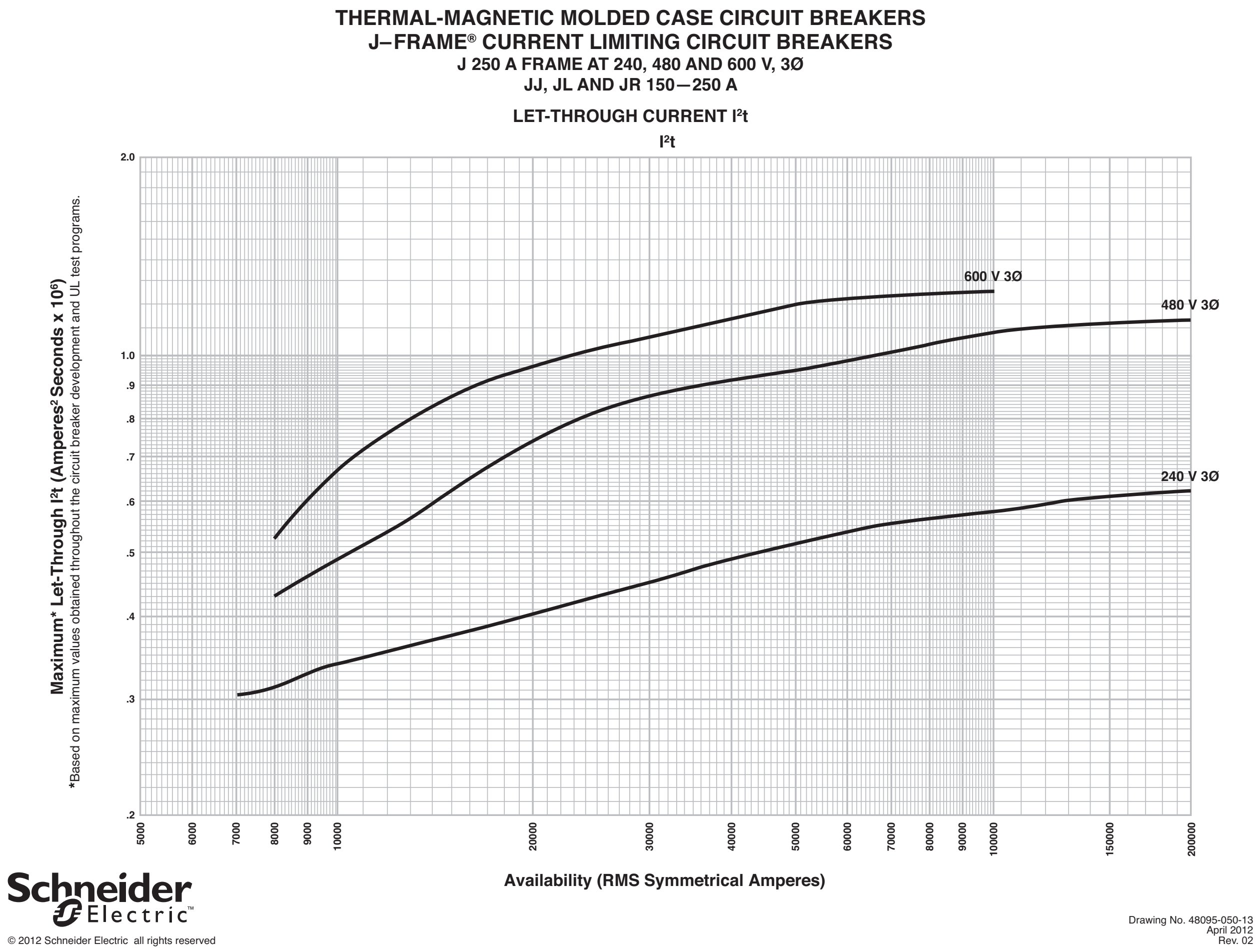

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Figure 98: Ground Fault Module GFM150HD Trip Curve

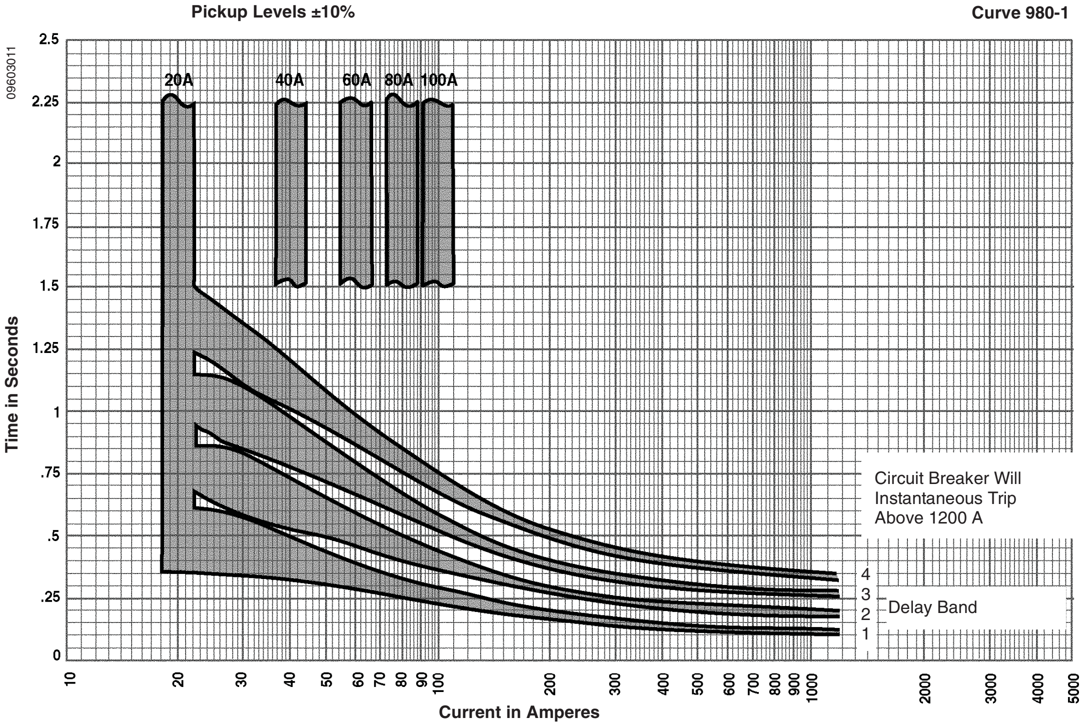

Figure 99: Ground Fault Module GFM250JD Trip Curve

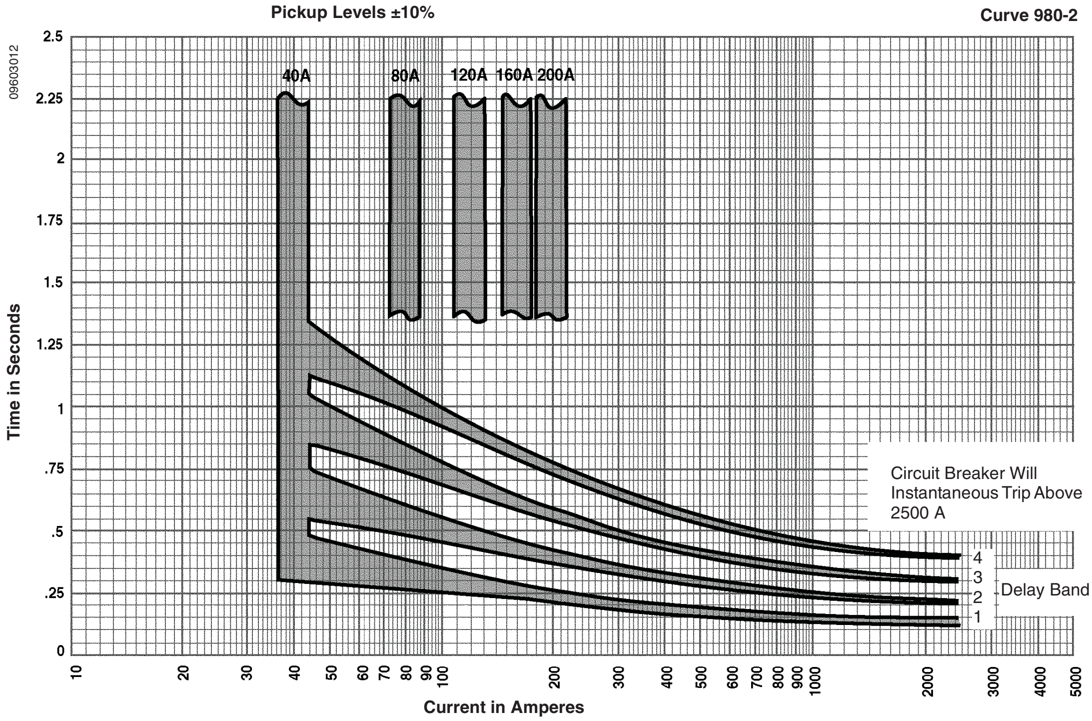

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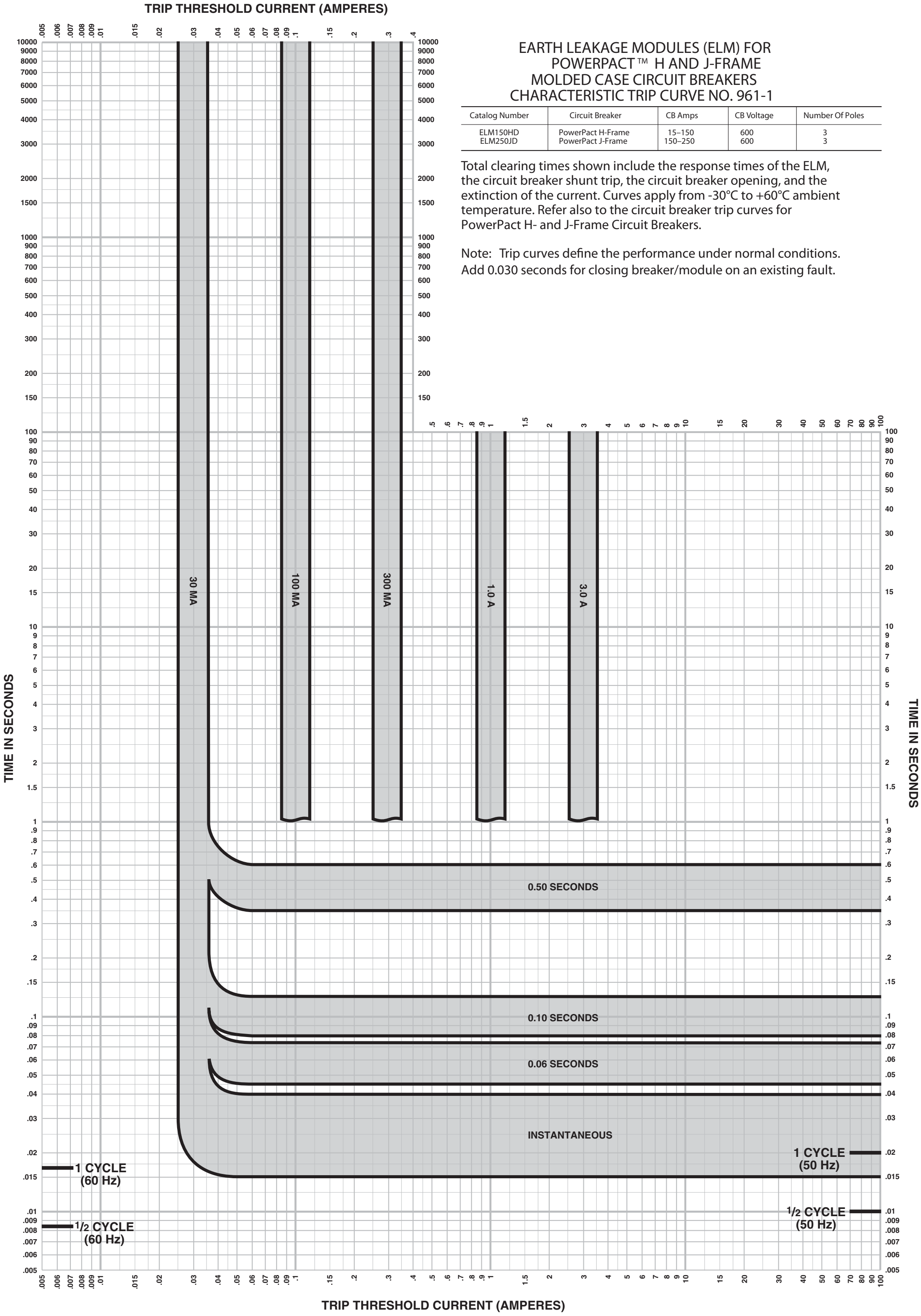
Figure 100: Earth Leakage Module Trip Curve



EARTH LEAKAGE MODULES (ELM) FOR POWERPACT™ H AND J-FRAME MOLDED CASE CIRCUIT BREAKERS CHARACTERISTIC TRIP CURVE NO. 961-1

Catalog Number	Circuit Breaker	CB Amps	CB Voltage	Number Of Poles
ELM150HD	PowerPact H-Frame	15–150	600	3
ELM250JD	PowerPact J-Frame	150–250	600	3

Total clearing times shown include the response times of the ELM, the circuit breaker shunt trip, the circuit breaker opening, and the extinction of the current. Curves apply from -30°C to +60°C ambient temperature. Refer also to the circuit breaker trip curves for PowerPact H- and J-Frame Circuit Breakers.

Note: Trip curves define the performance under normal conditions. Add 0.030 seconds for closing breaker/module on an existing fault.

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PowerPact H- and J-Frame Thermal-Magnetic Trip MCP Instantaneous Trip Points

Table 143: M71 Instantaneous Trip Points

		Automatic Setting (A)		Manual Adjustment (A)						
	I_m Setting	1	2	6x	8x	9x	10x	11x	12x	13x
Motor Type	NEMA	A, B, C, D	B, E	(FLA) x (I_m)						
	IEC	N	H							
FLA	1.5	12	16.5	9	12	13.5	15	16.5	18	19.5
	3	24	33	18	24	27	30	33	36	39
	6	48	66	36	48	54	60	66	72	78
	8	64	88	48	64	72	80	88	96	104
	11	88	121	66	88	99	110	121	132	143
	14	112	154	84	112	126	140	154	168	182
	17	136	187	102	136	153	170	187	204	221
	20	160	220	120	160	180	200	220	240	260
	25	200	275	150	200	225	250	275	300	325
Dampening for motor in-rush (% FLA)		1300%	1700%	1300%	—					

Table 144: M72 Instantaneous Trip Points

		Automatic Setting (A)[1]		Manual Adjustment (A)[1]						
	I_m Setting	1	2	6x	8x	9x	10x	11x	12x	13x
Motor Type	NEMA	A, B, C, D	B, E	(FLA) x (I_m)						
	IEC	N	H							
FLA	14	112	154	84	112	126	140	154	168	182
	17	136	187	102	136	153	170	187	204	221
	21	168	231	126	168	189	210	231	252	273
	24	192	264	144	192	216	240	264	288	312
	27	216	297	162	216	243	270	297	324	351
	29	232	319	174	232	261	290	319	348	377
	32	256	352	192	256	288	320	352	384	416
	36	288	396	216	288	324	360	396	432	468
	42	336	462	252	336	378	420	462	504	546
Dampening for motor in-rush (% FLA)		1300%	1700%	1300%	—					

1 ± 5% of nominal amperage shown above.

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Table 145: M73 Instantaneous Trip Points

		Automatic Setting (A)[1]		Manual Adjustment (A)[1]						
	I_m Setting	1	2	6x	8x	9x	10x	11x	12x	13x
Motor Type	NEMA	A, B, C, D	B, E	(FLA) x (I_m)						
	IEC	N	H							
FLA	30	240	330	180	240	270	300	330	360	390
	35	280	385	210	280	315	350	385	420	455
	41	328	451	246	328	369	410	451	492	533
	46	368	506	276	368	414	460	506	552	598
	51	408	561	306	408	459	510	561	612	663
	56	448	616	336	448	504	560	616	672	728
	63	504	693	378	504	567	630	693	756	819
	71	568	781	426	568	639	710	781	852	923
	80	640	880	480	640	720	800	880	960	1040
Dampening for motor in-rush (% FLA)		1300%	1700%	1300%	—					

[1] ± 5% of nominal amperage shown above.

Table 146: M74 Instantaneous Trip Points

		Automatic Setting (A)[1]		Manual Adjustment (A)[1]						
	I_m Setting	1	2	6x	8x	9x	10x	11x	12x	13x
Motor Type	NEMA	A, B, C, D	B, E	(FLA) x (I_m)						
	IEC	N	H							
FLA	58	464	638	348	464	522	580	638	696	754
	71	568	781	426	568	639	710	781	852	923
	79	632	869	474	632	711	790	869	948	1027
	86	688	946	516	688	774	860	946	1032	1118
	91	728	1001	546	728	819	910	1001	1092	1183
	97	776	1067	582	776	873	970	1067	1164	1261
	110	880	1210	660	880	990	1100	1210	1320	1430
	119	952	1309	714	952	1071	1190	1309	1428	1547
	130	1040	1430	780	1040	1170	1300	1430	1560	1690
Dampening for motor in-rush (% FLA)		1300%	1700%	1300%	—					

[1] ± 5% of nominal amperage shown above.

Table 147: M75 Instantaneous Trip Points

		Automatic Setting (A)[1]		Manual Adjustment (A)[1]						
	I_m Setting	1	2	6x	8x	9x	10x	11x	12x	13x
Motor Type	NEMA	A, B, C, D	B, E	(FLA) x (I_m)						
	IEC	N	H							
FLA	114	912	1254	684	912	1026	1140	1254	1368	1482
	137	1096	1507	822	1096	1233	1370	1507	1644	1781
	145	1160	1595	870	1160	1305	1450	1595	1740	1885
	155	1240	1705	930	1240	1395	1550	1705	1860	2015
	163	1304	1793	978	1304	1467	1630	1793	1956	2119
	172	1376	1892	1032	1376	1548	1720	1892	2064	2236
	181	1448	1991	1086	1448	1629	1810	1991	2172	2353
	210	1680	2310	1260	1680	1890	2100	2310	2500 [2]	2500 [2]
	217	1736	2387	1302	1736	1953	2170	2387	2500 [2]	2500 [2]
Dampening for motor in-rush (% FLA)		1100–1300%	1100–1700%	1100–1300%	—					

[1] ± 5% of nominal amperage shown above.
[2] 2500 A maximum instantaneous trip point.

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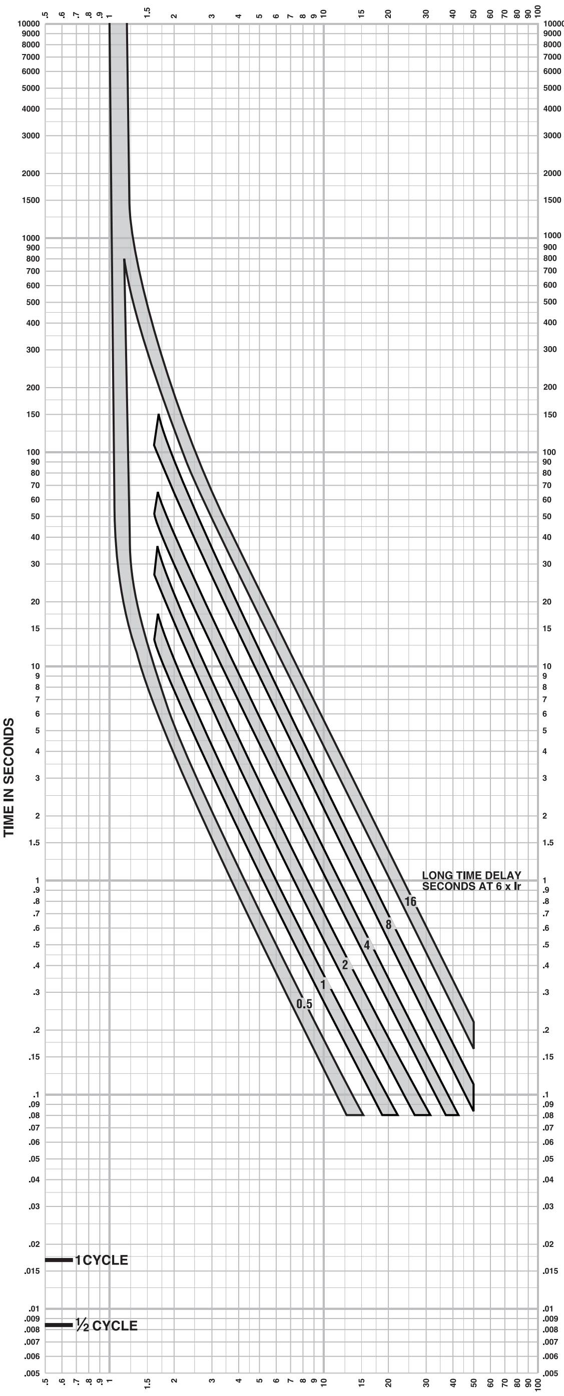
PowerPact H-Frame Electronic Trip Circuit Breakers—60/100/150 A Frame

Figure 101: Micrologic 3.2 Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2 Long Time Trip Curve
60A, 100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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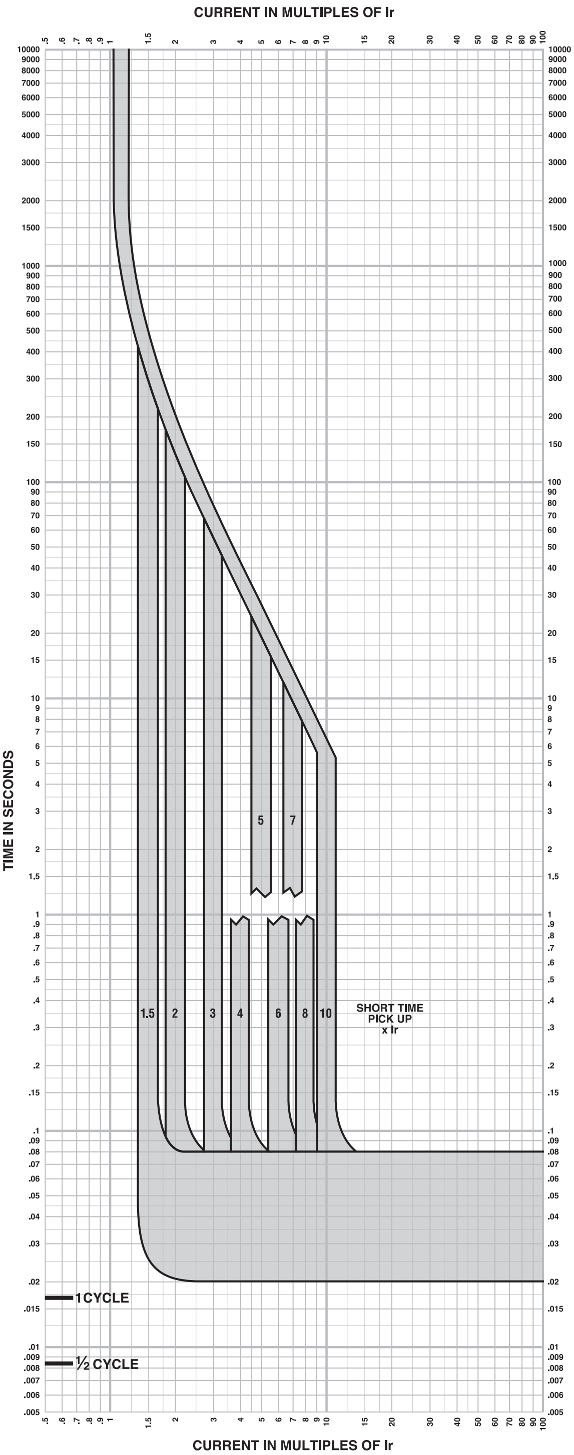
Figure 102: Micrologic 3.2S Electronic Trip Unit Long Time / Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2S Long Time/
Short Time Trip Curve
60A, 100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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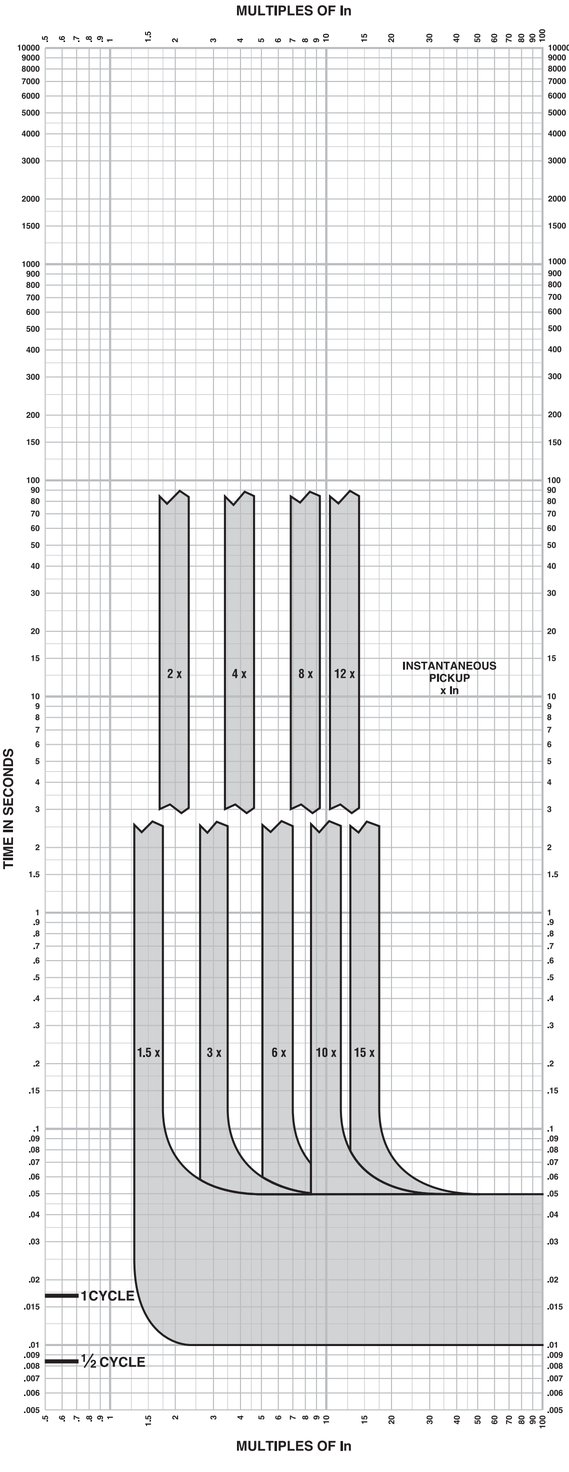
Figure 103: Micrologic 3.2/3.2S/5.2A/5.2E/6.2A/6.2E Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2/3.2S/5.2A or E/6.2A or E
Instantaneous Trip Curve
60A, 100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. In = Maximum dial setting of Ir.
   60A H-Frame: In = 60A = Max Ir setting
   100A H-Frame: In = 100A = Max Ir setting
   150A H-Frame: In = 150A = Max Ir setting

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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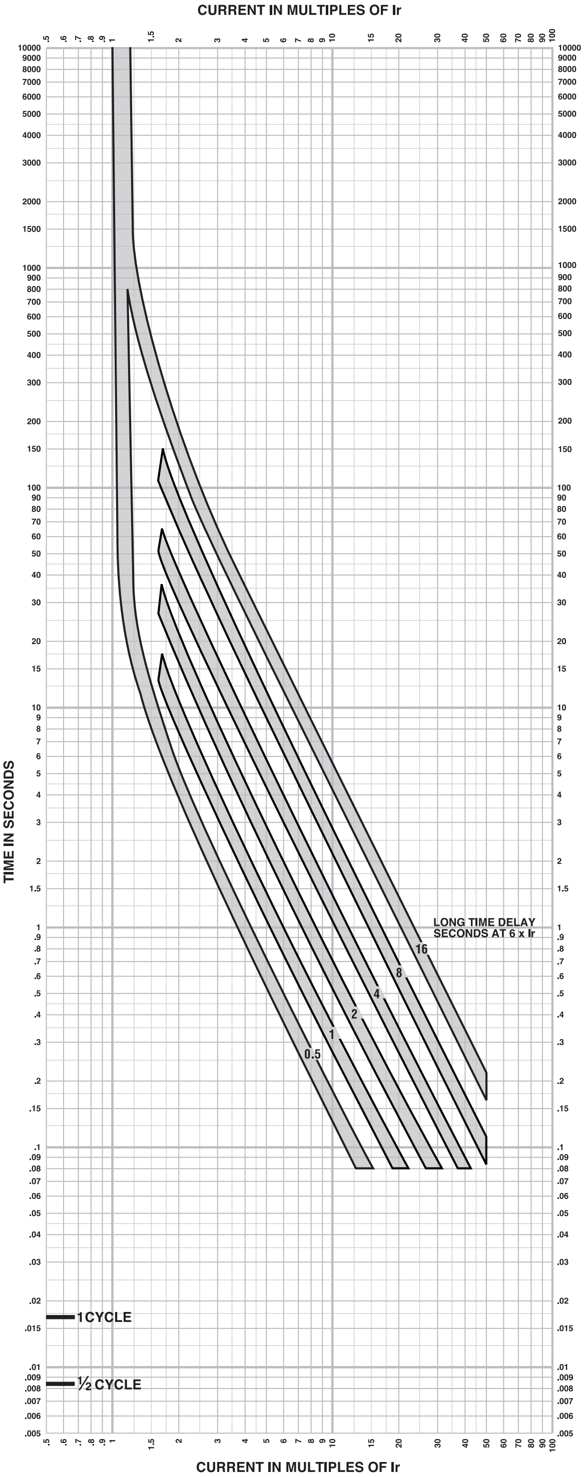
Figure 104: Micrologic 5.2A/5.2E/6.2A/6.2E Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.2A or E/6.2A or E
Long Time Trip Curve
60A, 100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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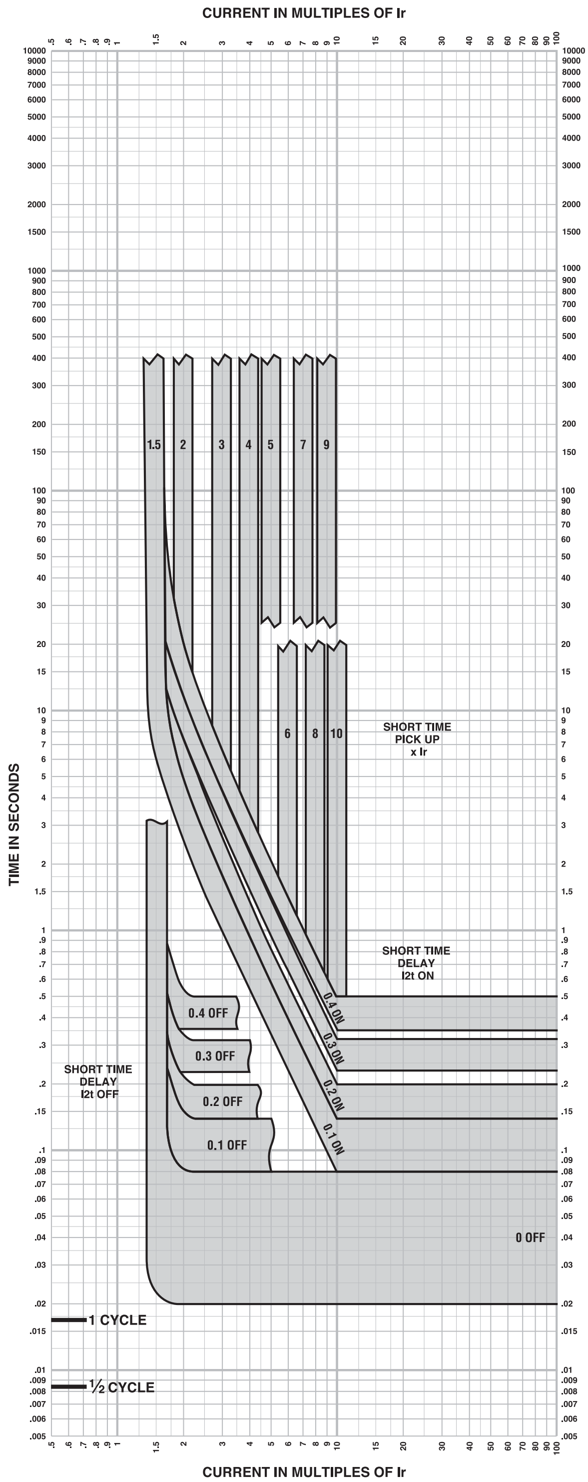
Figure 105: Micrologic 5.2A/5.2E/6.2A/6.2E Electronic Trip Unit Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.2A or E/6.2A or E
Short Time Trip Curve
60A, 100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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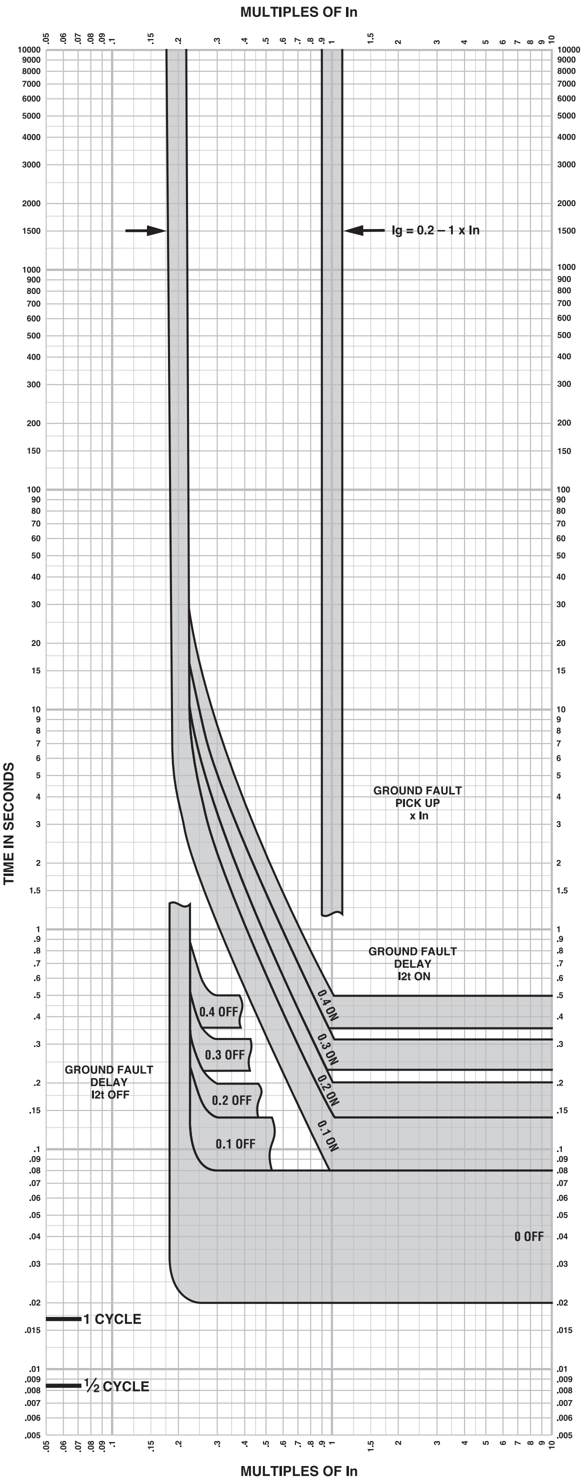
Figure 106: Micrologic 6.2A/6.2E Electronic Trip Unit Ground Fault Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 6.2A or E
Ground Fault Trip Curve
100A, 150A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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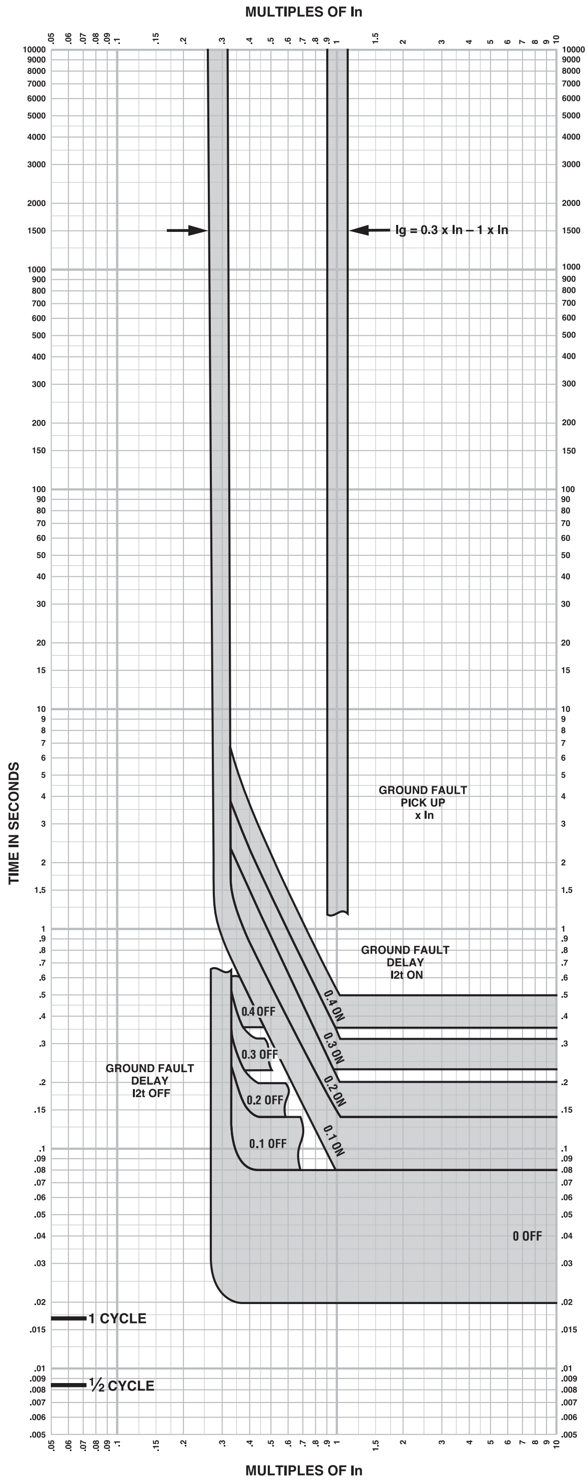
Figure 107: Micrologic 6.2A/6.2E Electronic Trip Unit Ground Fault Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 6.2A or E
Ground Fault Trip Curve
60A H-Frame

The time-current curve information is to be used for application and coordination purposes only.

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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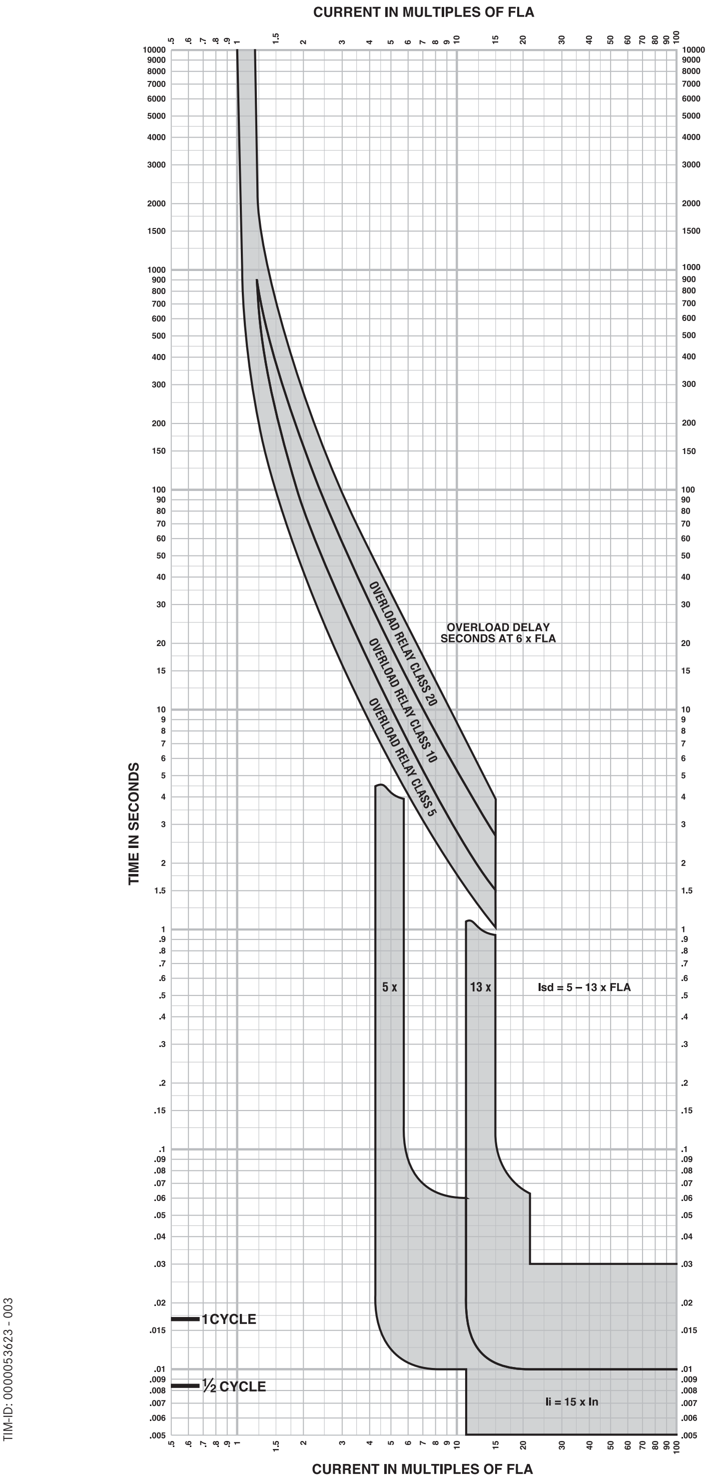
Figure 108: Micrologic 2.2 M Electronic Trip Unit Overload Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 2.2M Overload Trip Curve
30A, 50A, 100A, 150A H-Frame, 250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. If overload still exists past overload relay delay, MCP will open 0.4 seconds later.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. Isd minimum and maximum only shown.
4. Ii = 15 x In
   In = 30A, 50A, 100A, 150A, 250A
   MCP will trip <30ms at 15 x In

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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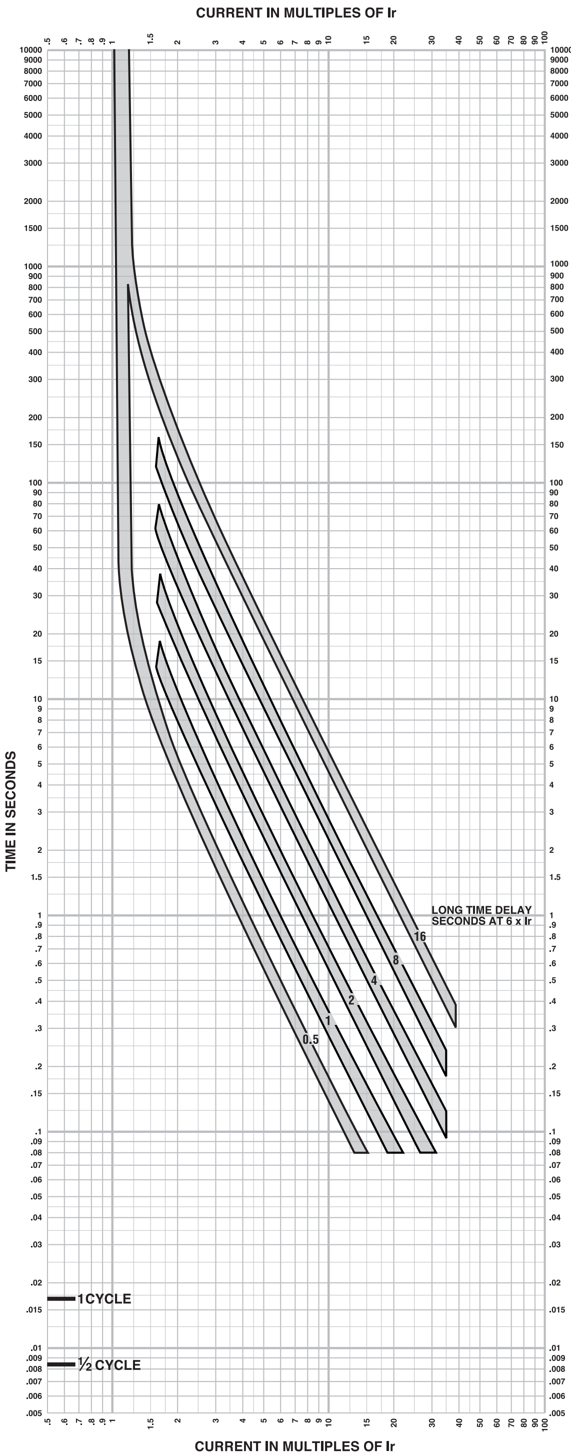
J-Frame Electronic Trip Circuit Breakers—250 A Frame

Figure 109: Micrologic 3.2 and 3.2-W Electronic Trip Unit Long-Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2 and 3.2-W
Long Time Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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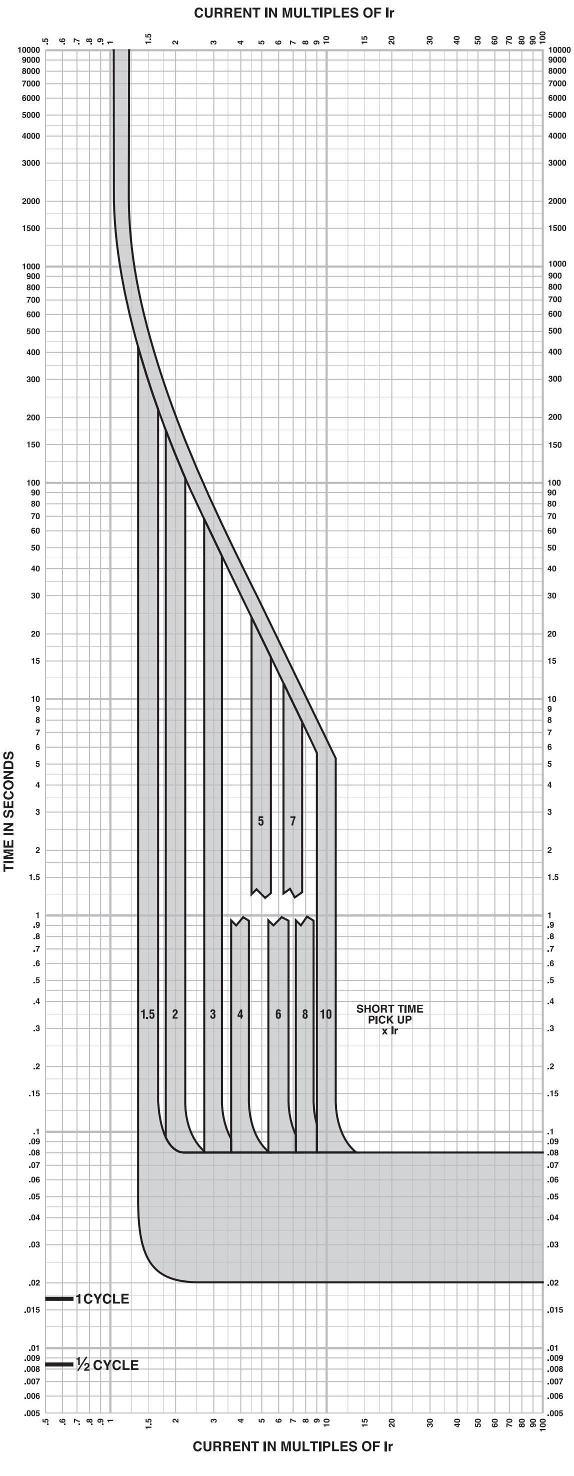
Figure 110: Micrologic 3.2S and 3.2S-W Electronic Trip Unit Long Time / Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2S and 3.2S-W
Long Time/Short Time Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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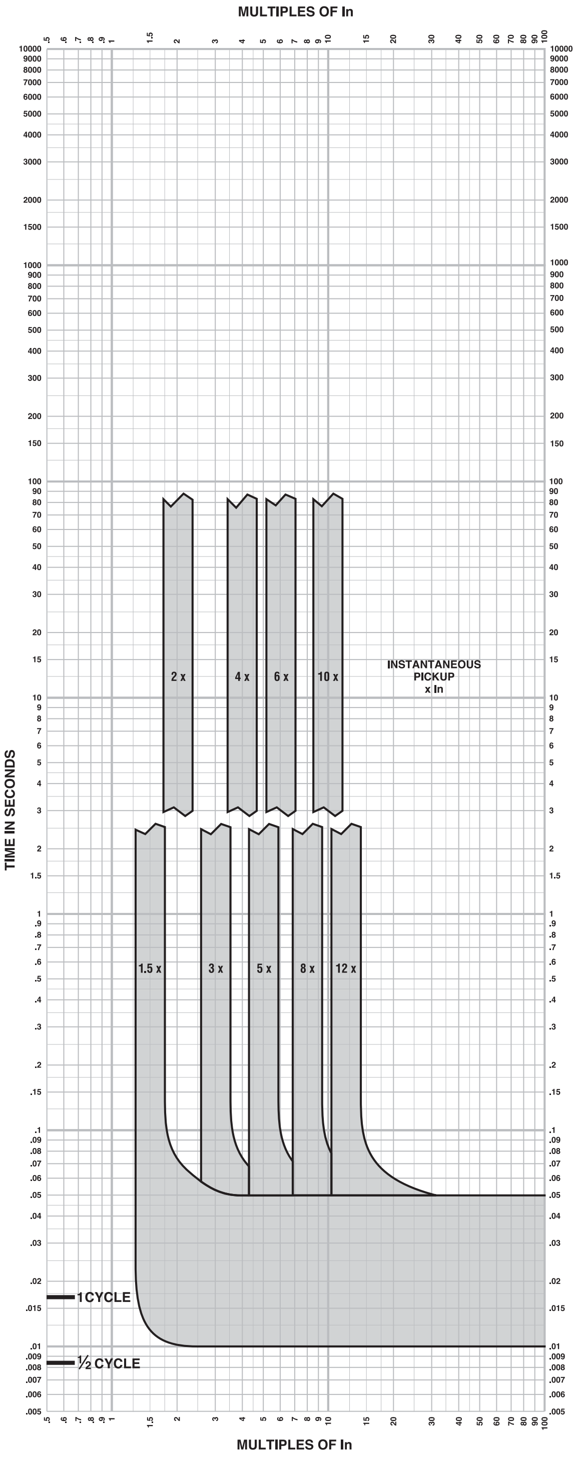
Figure 111: Micrologic 3.2, 3.2-W, 3.2S, 3.2S-W, 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W Electronic Trip Curve Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.2, 3.2-W, 3.2S, 3.2S-W, 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W
Instantaneous Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. In = Maximum dial setting of Ir.
   250A J-Frame: In = 250A = Max Ir setting

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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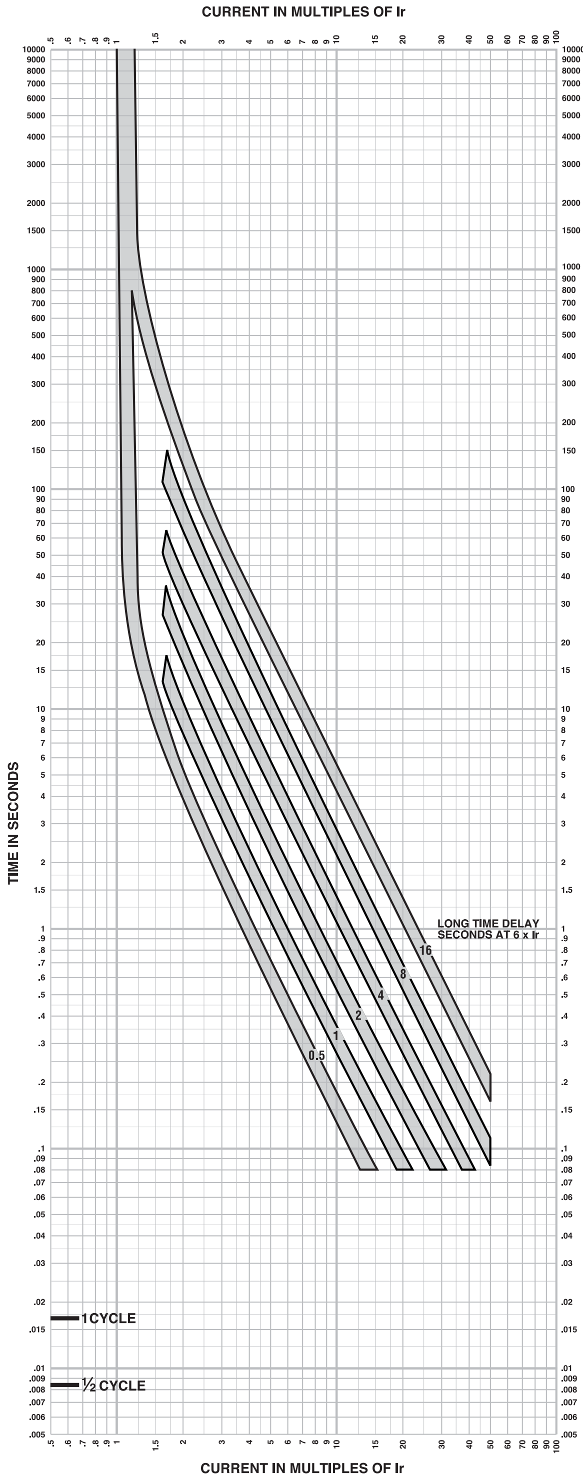
Figure 112: Micrologic 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W
Long Time Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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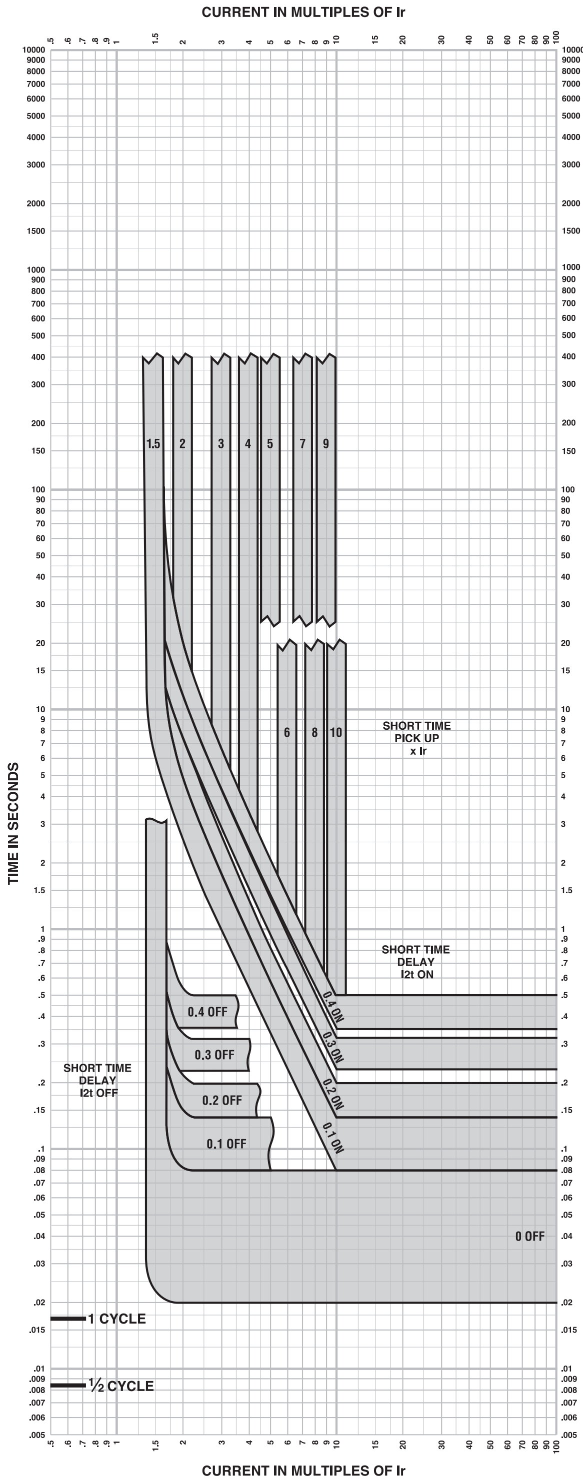
Figure 113: Micrologic 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W Electronic Trip Unit Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.2A, 5.2A-W, 5.2E, 5.2E-W, 6.2A, 6.2A-W, 6.2E, and 6.2E-W
Short Time Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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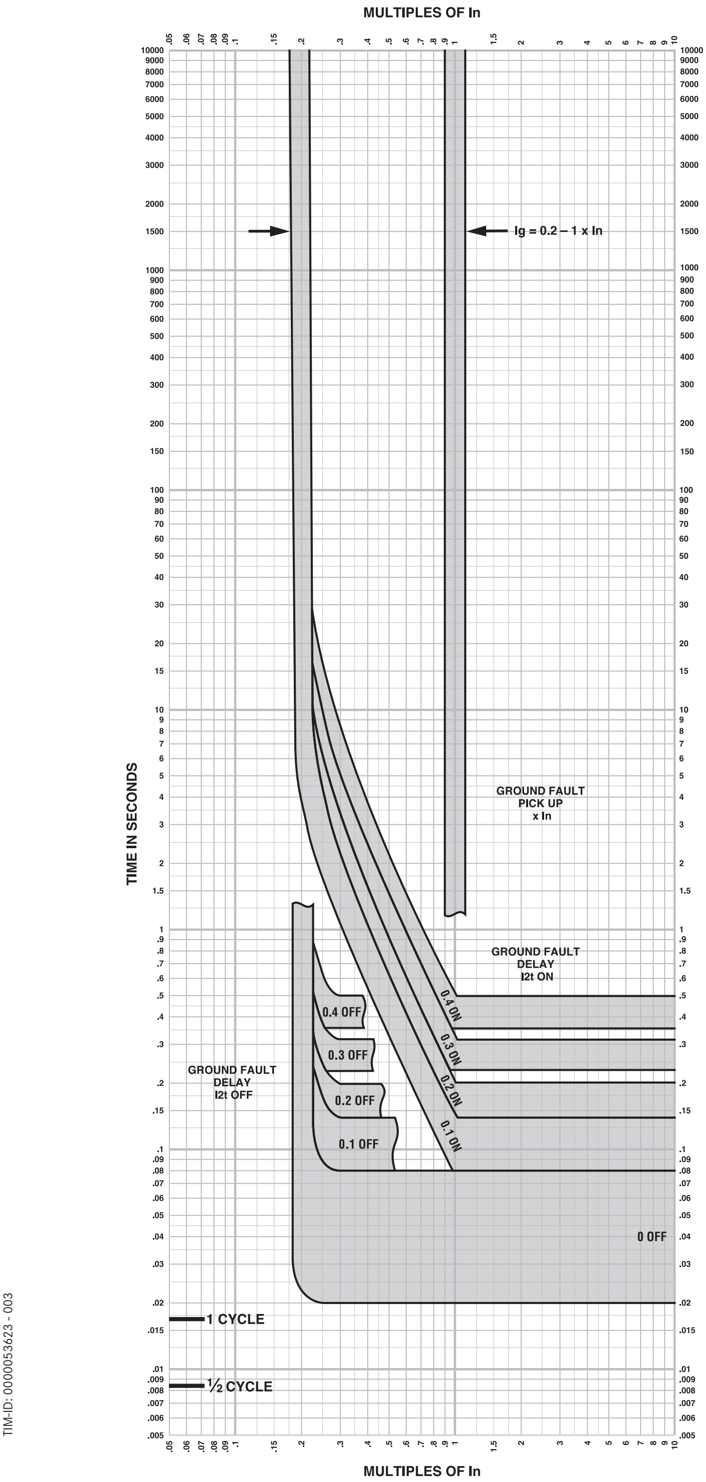
Figure 114: Micrologic 6.2A, 6.2A-W, 6.2E, and 6.2E-W Electronic Trip Unit Ground Fault Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 6.2A, 6.2A-W, 6.2E, and 6.2E-W
Ground Fault Trip Curve
250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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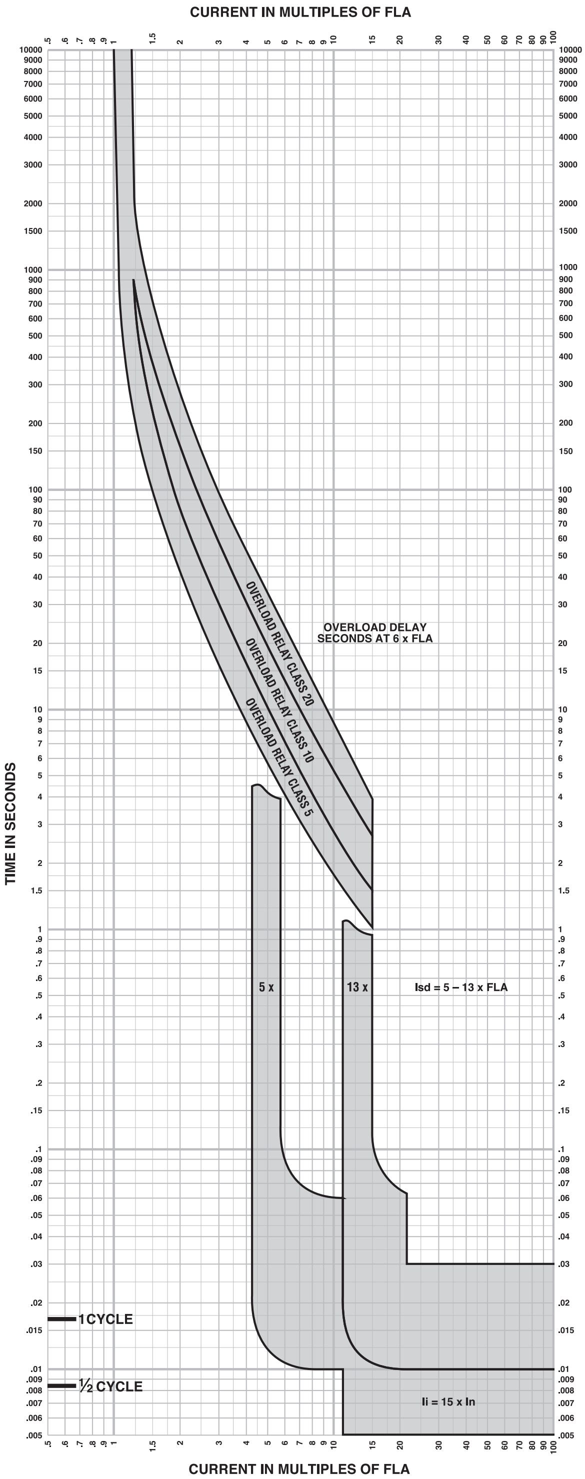
Figure 115: Micrologic 2.2 M Electronic Trip Unit Overload Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 2.2M Overload Trip Curve
30A, 50A, 100A, 150A H-Frame, 250A J-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. If overload still exists past overload relay delay, MCP will open 0.4 seconds later.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. Isd minimum and maximum only shown.
4. Ii = 15 x In
   In = 30A, 50A, 100A, 150A, 250A
   MCP will trip <30ms at 15 x In

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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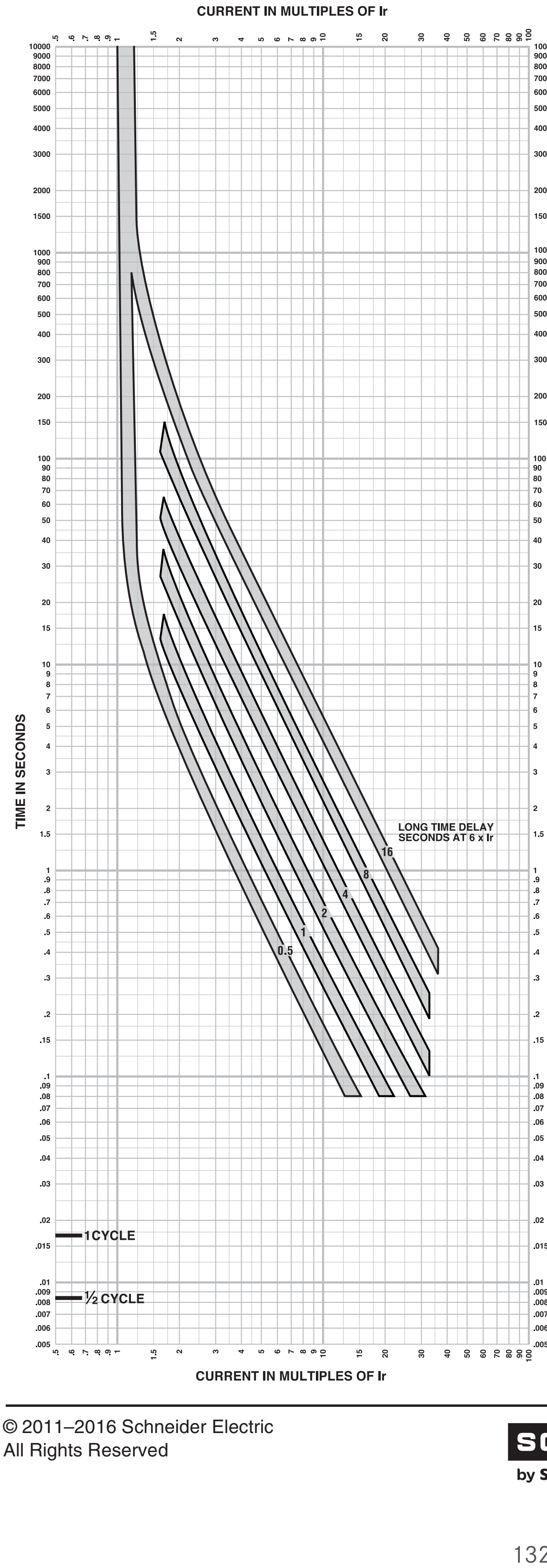
PowerPact L-Frame Electronic Trip Circuit Breakers— 250 A/400 A/600 A Frame

Figure 116: Micrologic 3.3 and 3.3-W Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3 and 3.3-W
Long Time Trip Curve
250A, 400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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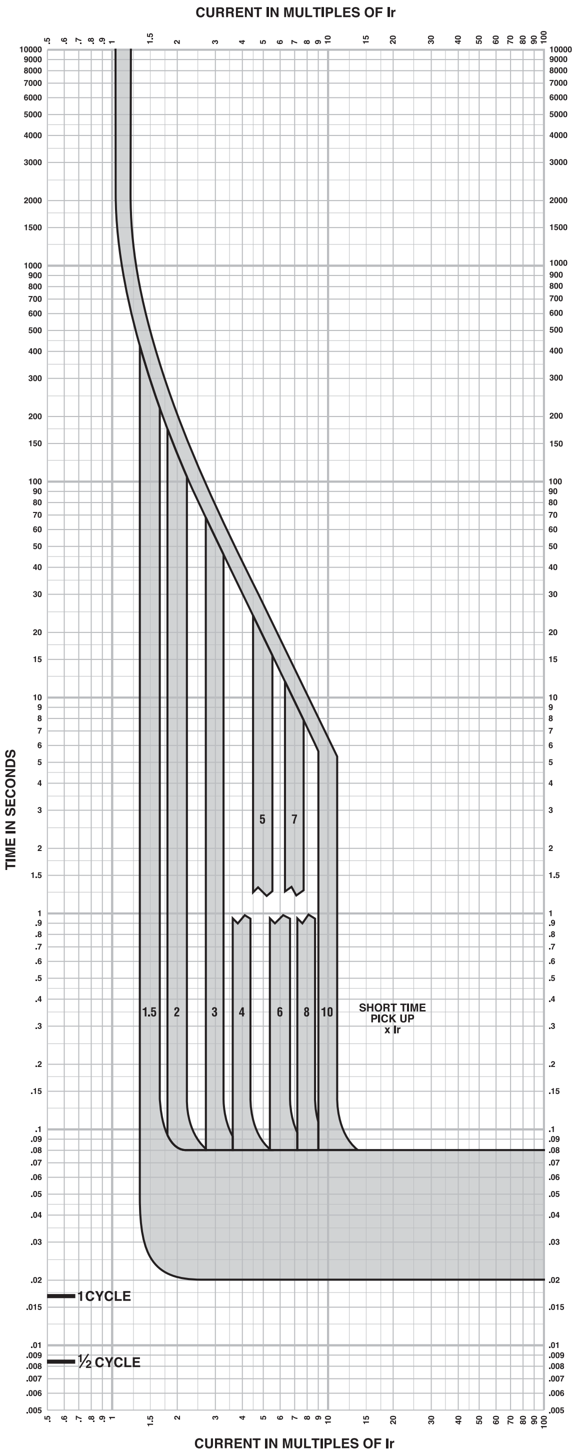
Figure 117: Micrologic 3.3S and 3.3S-W Electronic Trip Unit Long Time/Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3S and 3.3S-W
Long Time/Short Time Trip Curve
250A, 400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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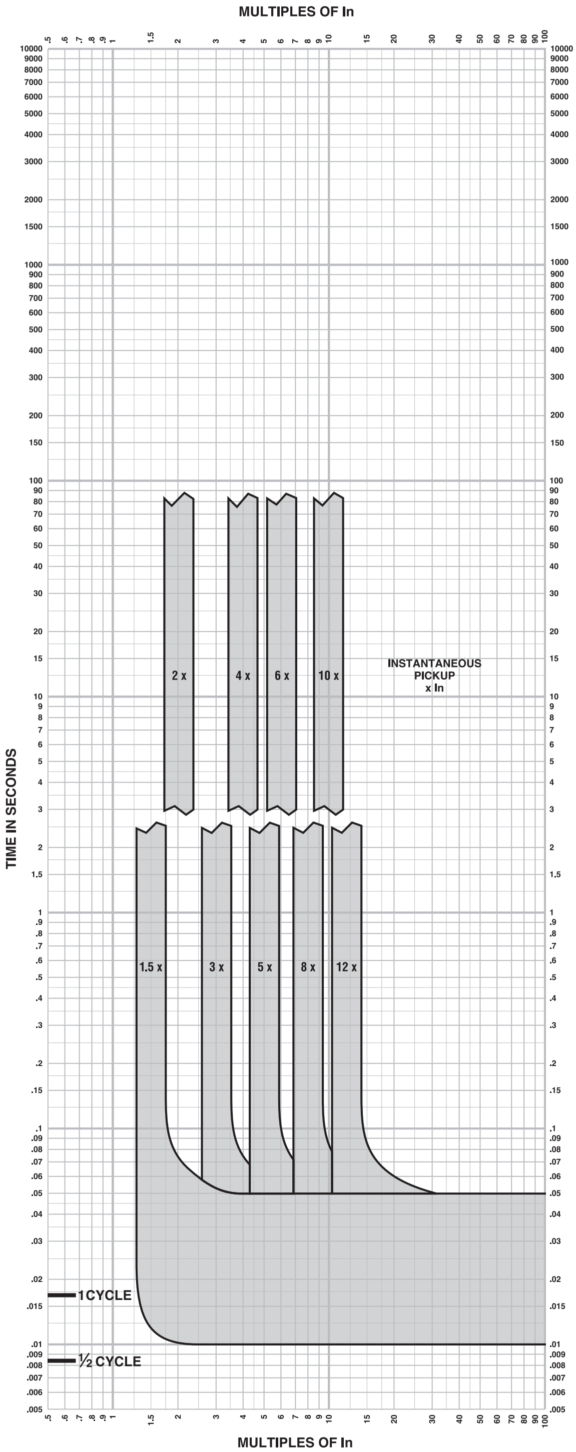
Figure 118: Micrologic 3.3, 3.3-W, 3.3S, and 3.3S-W Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3, 3.3-W, 3.3S, and 3.3S-W
Instantaneous Trip Curve
250A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. In = Maximum dial setting of Ir.
   250A L-Frame: In = 250A = Max Ir setting

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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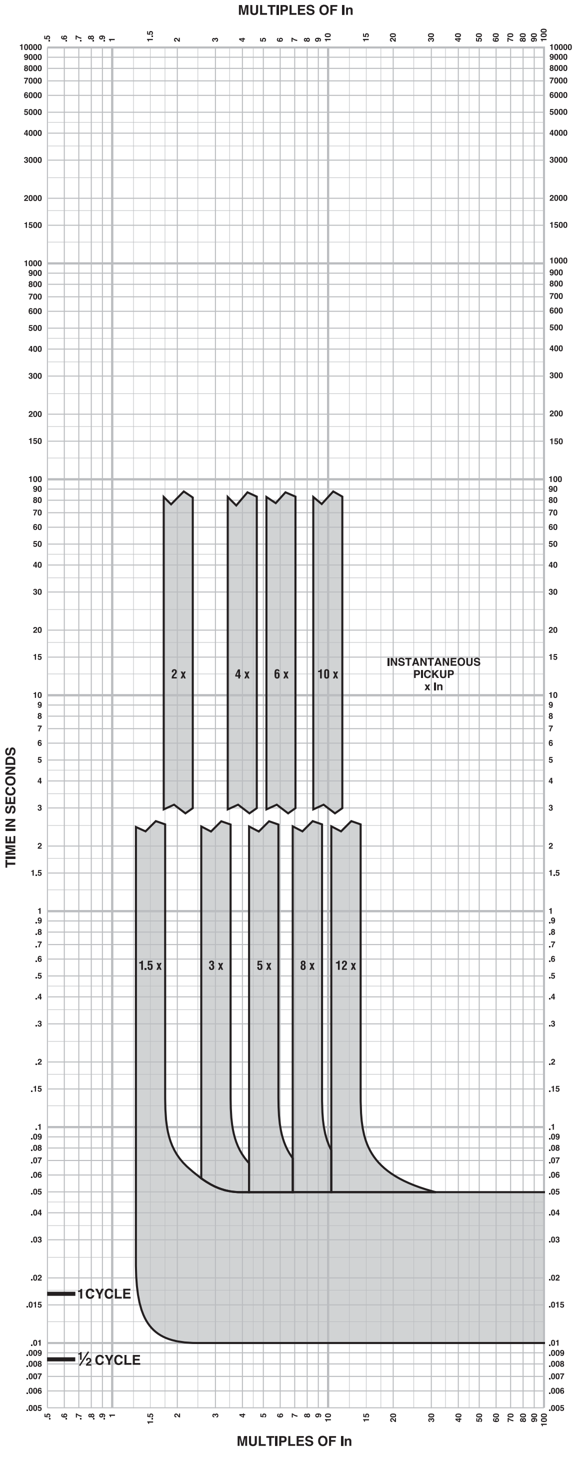
Figure 119: Micrologic 3.3, 3.3-W, 3.3S, 3.3S-W, 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3, 3.3-W, 3.3S, 3.3S-W, 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Instantaneous Trip Curve
400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. In = Maximum dial setting of Ir.
   400A L-Frame: In = 400A = Max Ir setting

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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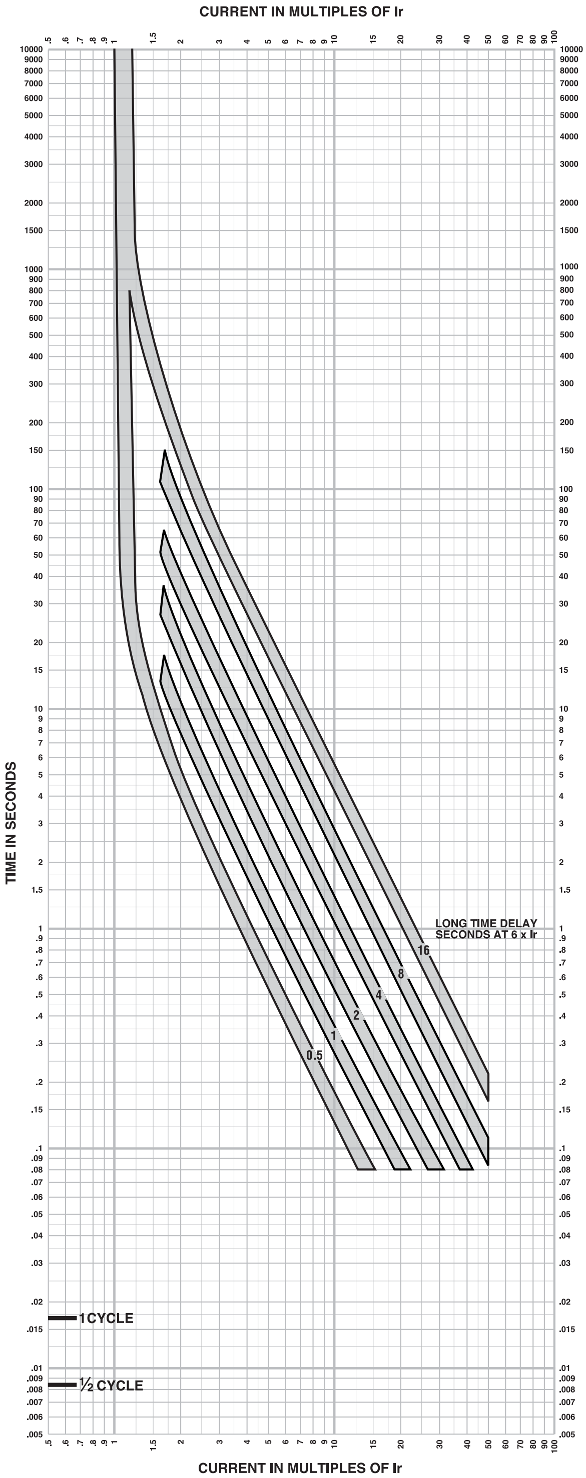
Figure 120: Micrologic 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Long Time Trip Curve
400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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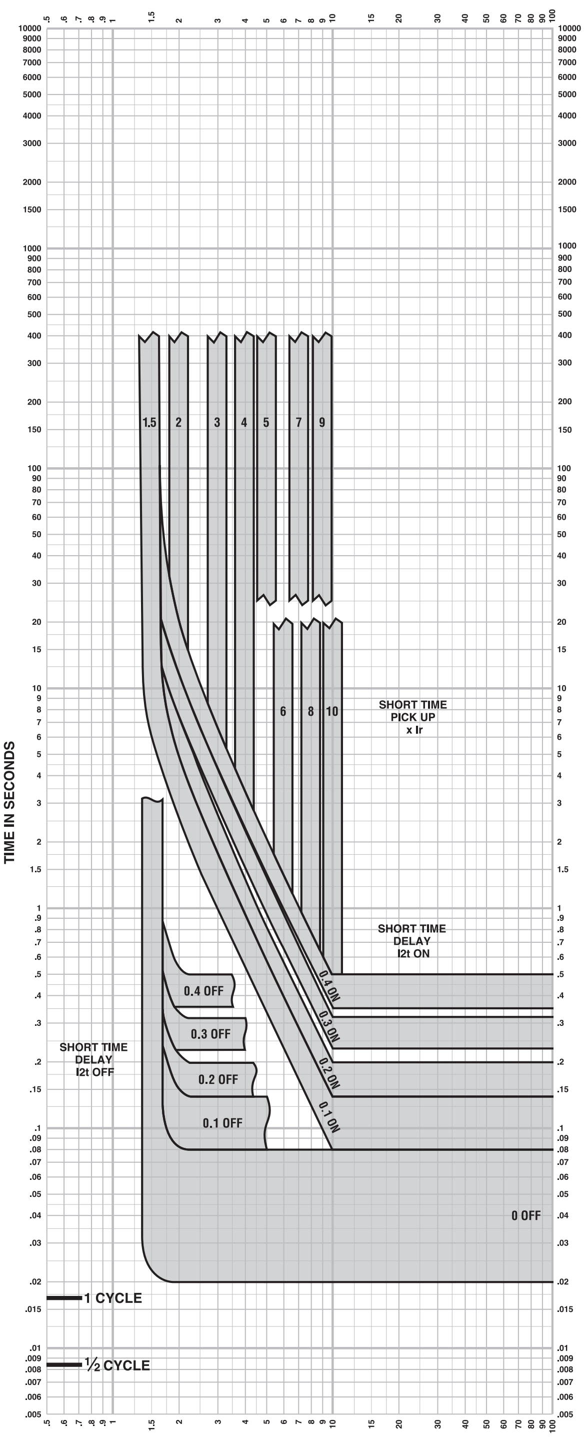
Figure 121: Micrologic 5.3, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Short Time Trip Curve
400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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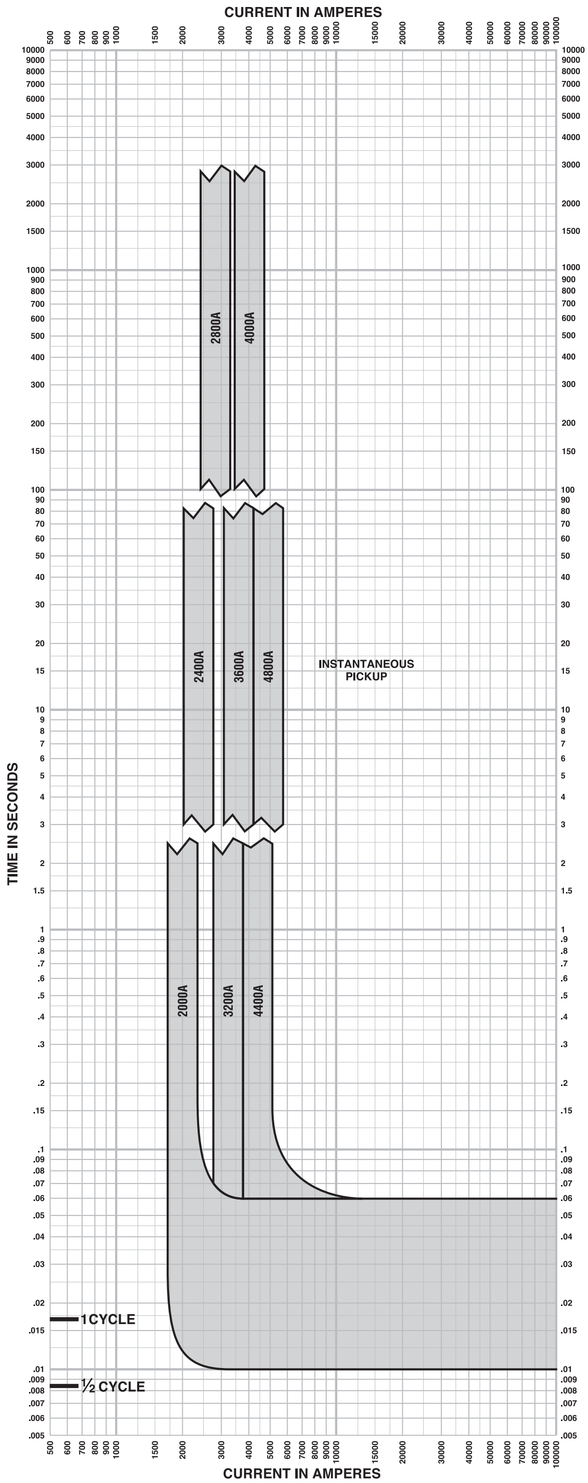
Figure 122: Micrologic 1.3 M Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 1.3M Instantaneous Trip Curve
400A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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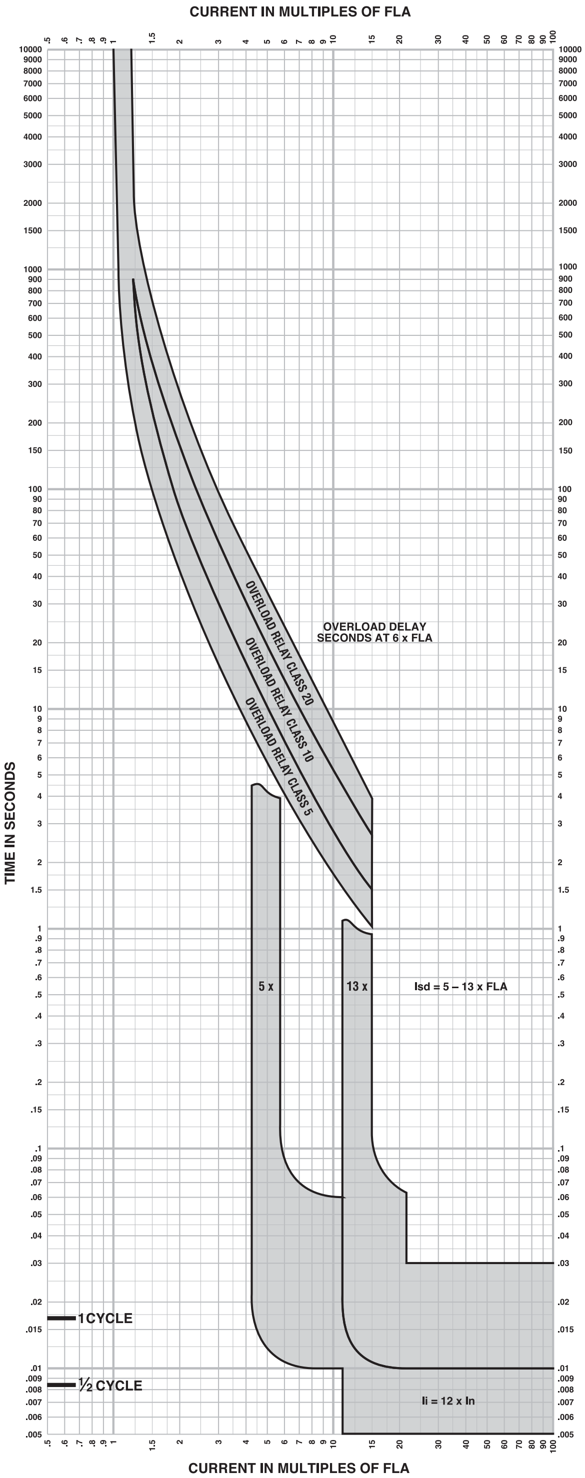
Figure 123: Micrologic 2.3 M Electronic Trip Unit Overload Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 2.3M Overload Trip Curve
400A, 600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. If overload still exists past overload relay delay, MCP will open 0.4 seconds later.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. Isd minimum and maximum only shown.
4. Ii = 12 x In
   In = 400A, 600A
   MCP will trip <30ms at 12 x In

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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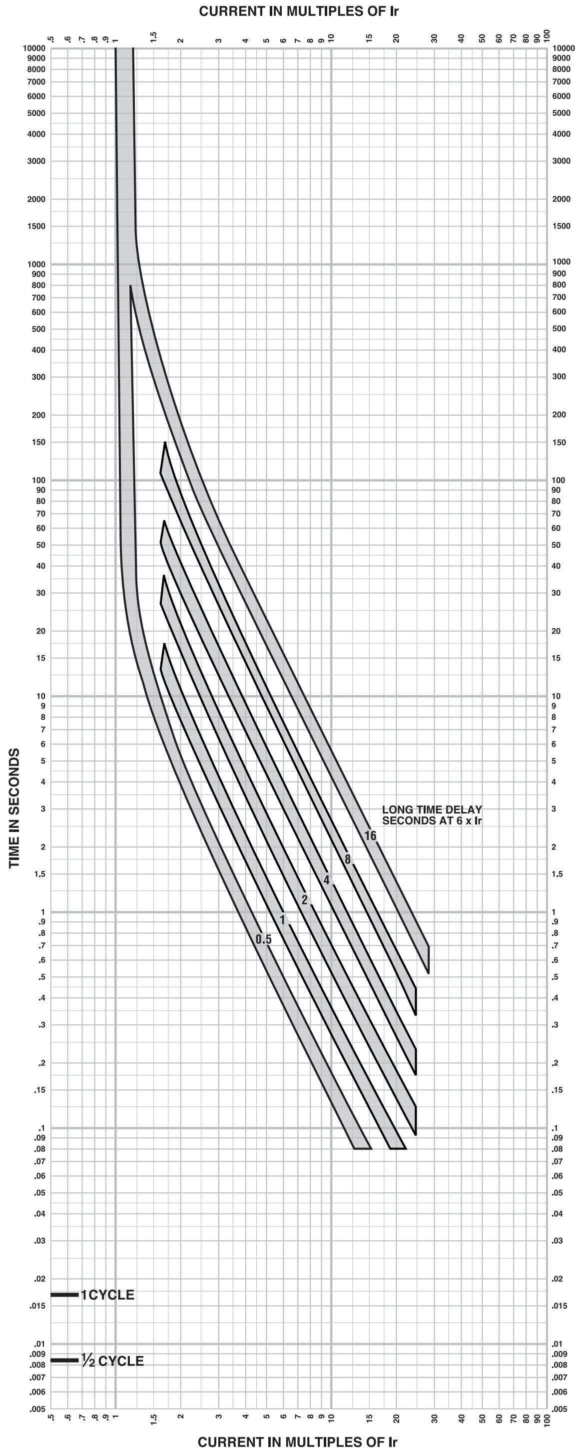
Figure 124: Micrologic 3.3 and 3.3W Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3 and 3.3-W
Long Time Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35°C to +70°C (-31°F to +158°F) ambient temperature.

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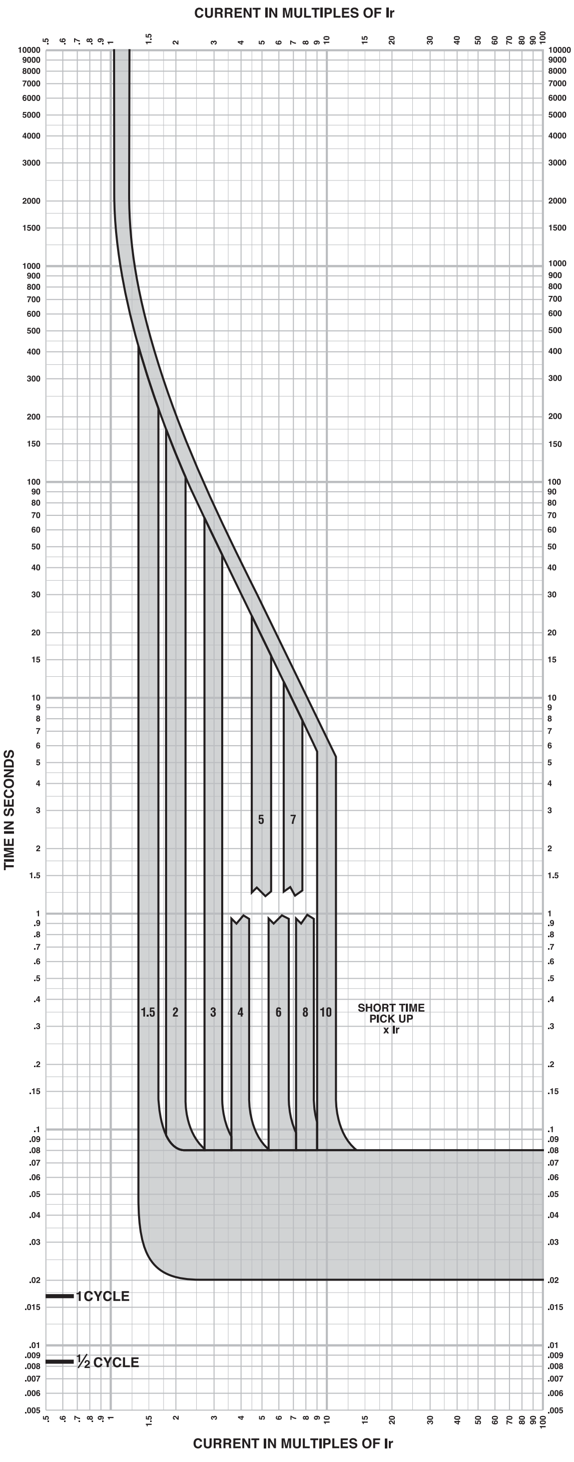
Figure 125: Micrologic 3.3S and 3.3S-W Electronic Trip Unit Long Time/Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3S and 3.3S-W
Long Time/Short Time Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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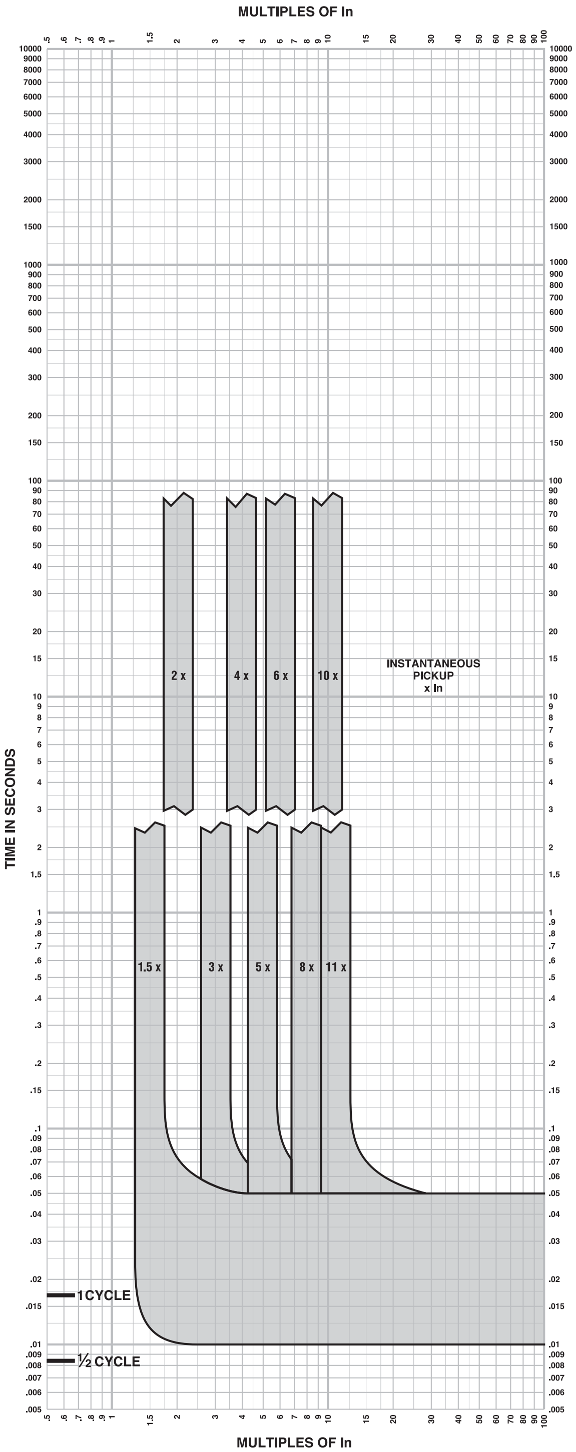
Figure 126: Micrologic 3.3, 3.3-W, 3.3S, 3.3S-W, 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 3.3, 3.3-W, 3.3S, 3.3S-W, 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Instantaneous Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
3. In = Maximum dial setting of Ir.
   600A L-Frame: In = 600A = Max Ir setting

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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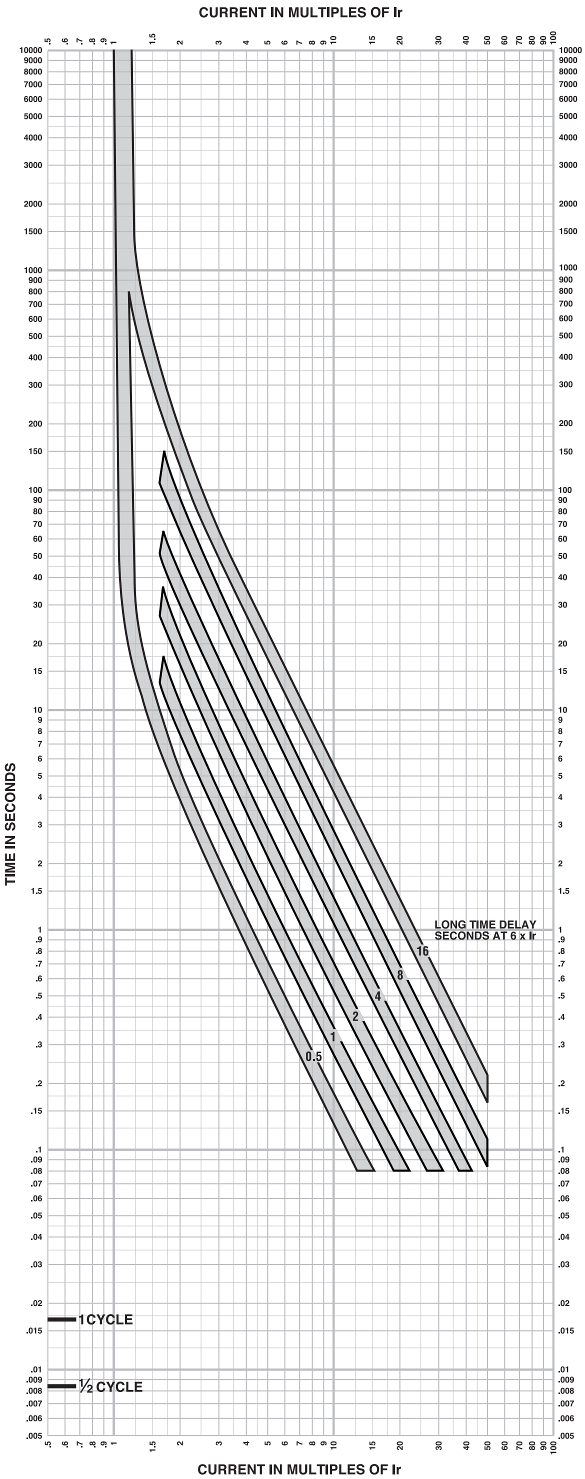
Figure 127: Micrologic 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Long Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Long Time Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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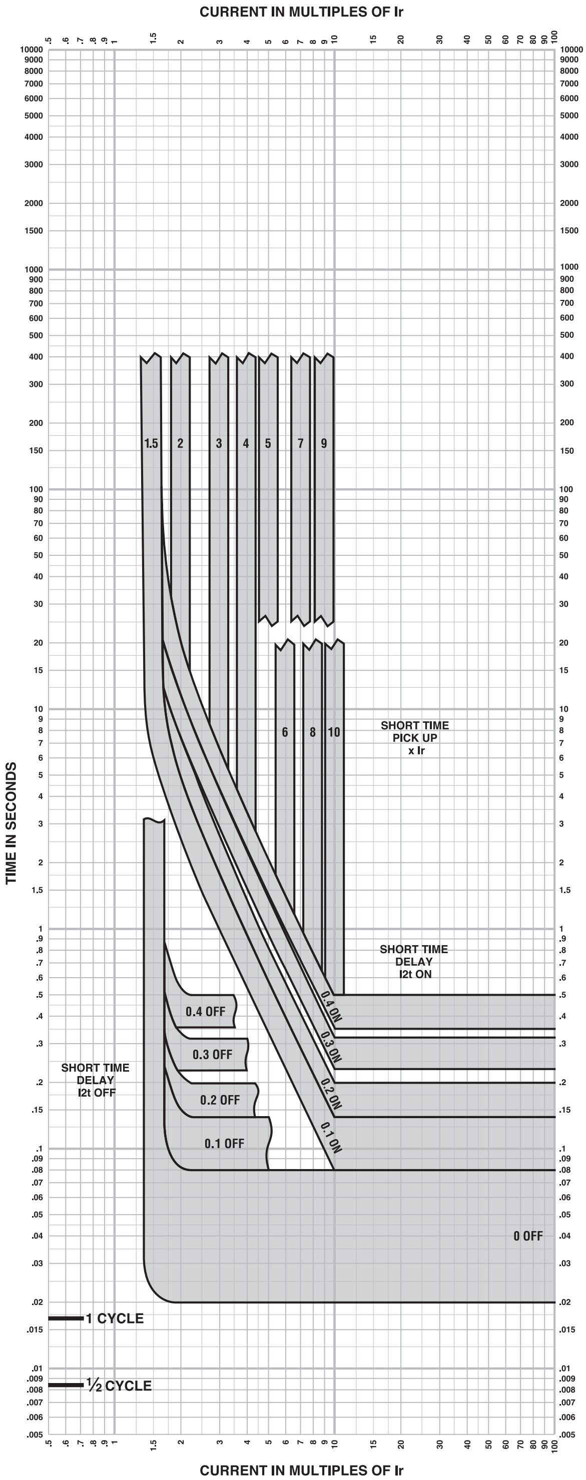
Figure 128: Micrologic 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W Electronic Trip Unit Short Time Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 5.3A, 5.3A-W, 5.3E, 5.3E-W, 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Short Time Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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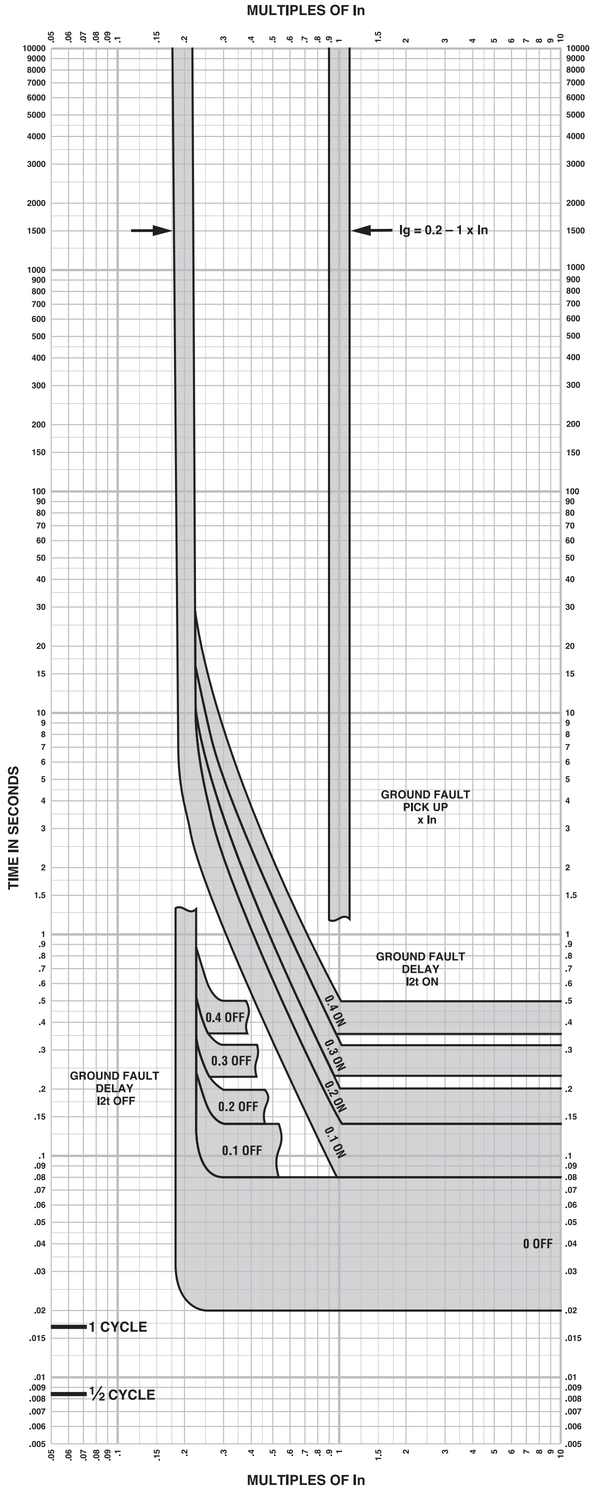
Figure 129: Micrologic 6.3A, 6.3A-W, 6.3E, and 6.3E-W Ground-Fault Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 6.3A, 6.3A-W, 6.3E, and 6.3E-W
Ground Fault Trip Curve
400A, 600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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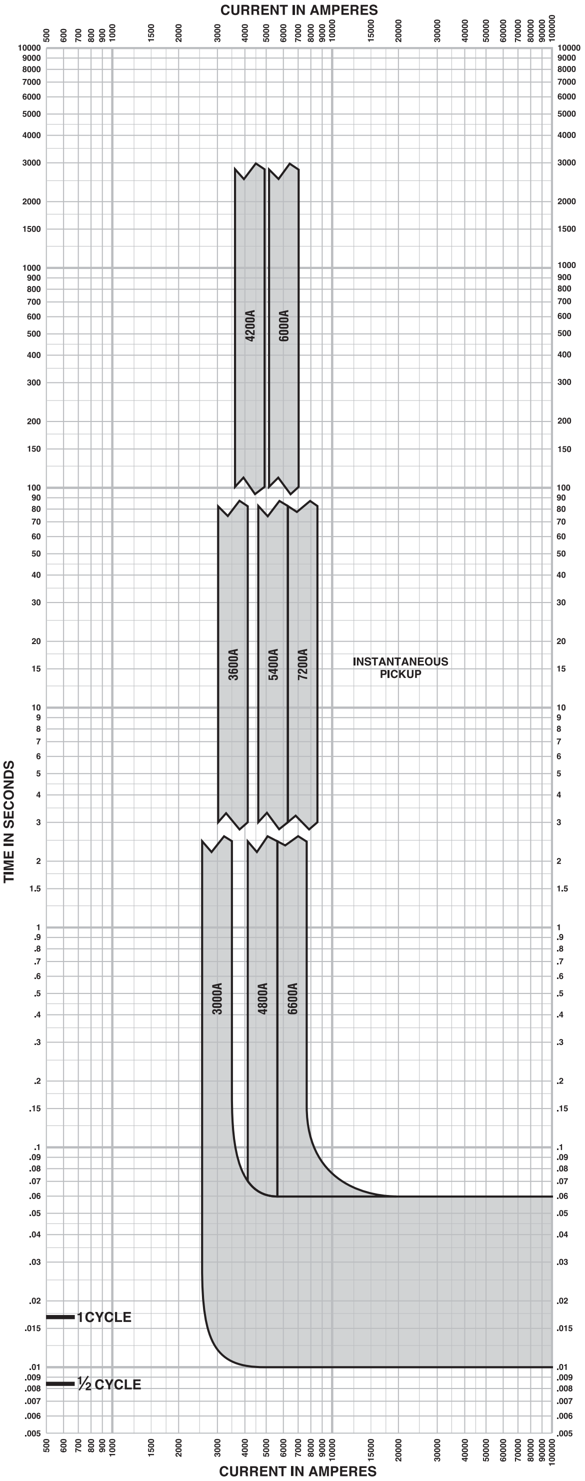
Figure 130: Micrologic 1.3 M Electronic Trip Unit Instantaneous Trip Curve



MICROLOGIC™ ELECTRONIC TRIP UNITS
Micrologic™ 1.3M Instantaneous Trip Curve
600A L-Frame

The time-current curve information is to be used for application and coordination purposes only.

Notes:

1. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

Curves apply from -35ºC to +70ºC (-31ºF to +158ºF) ambient temperature.

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Figure 131: L-Frame 600 A Typical Peak Let-Through Curves

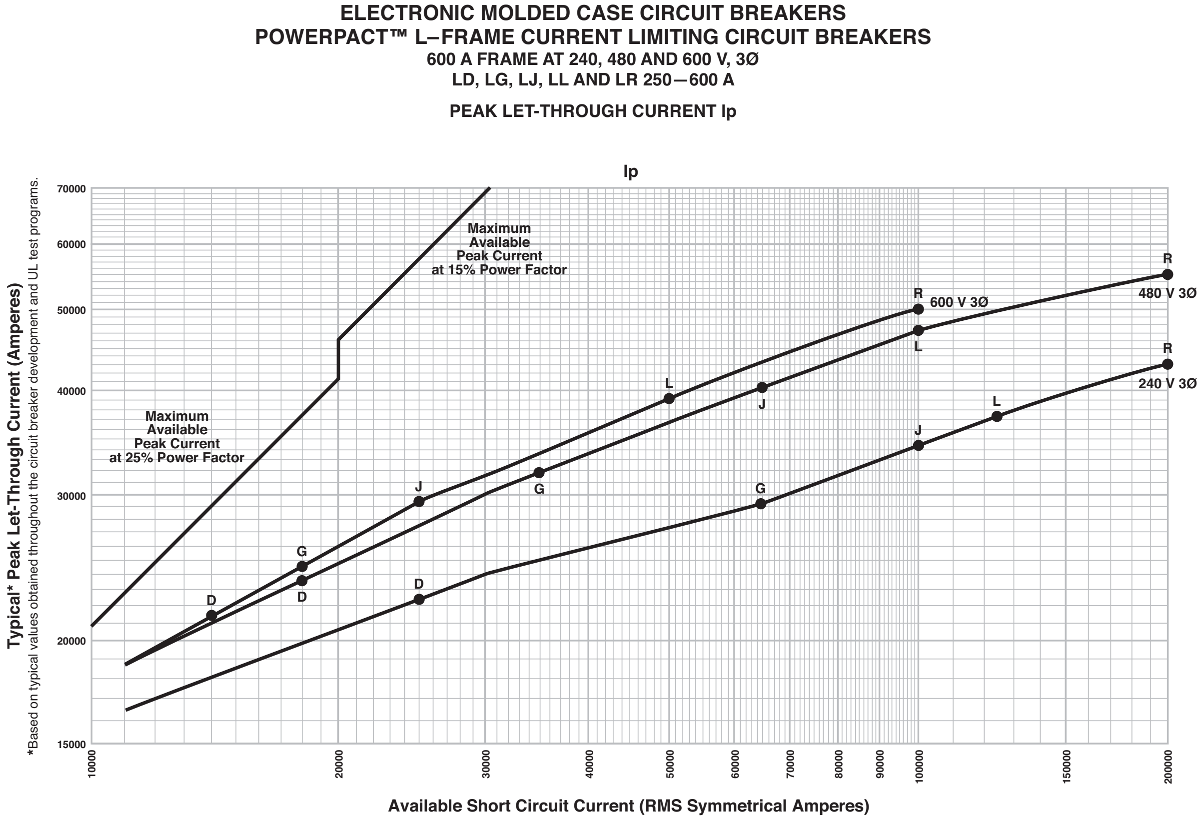

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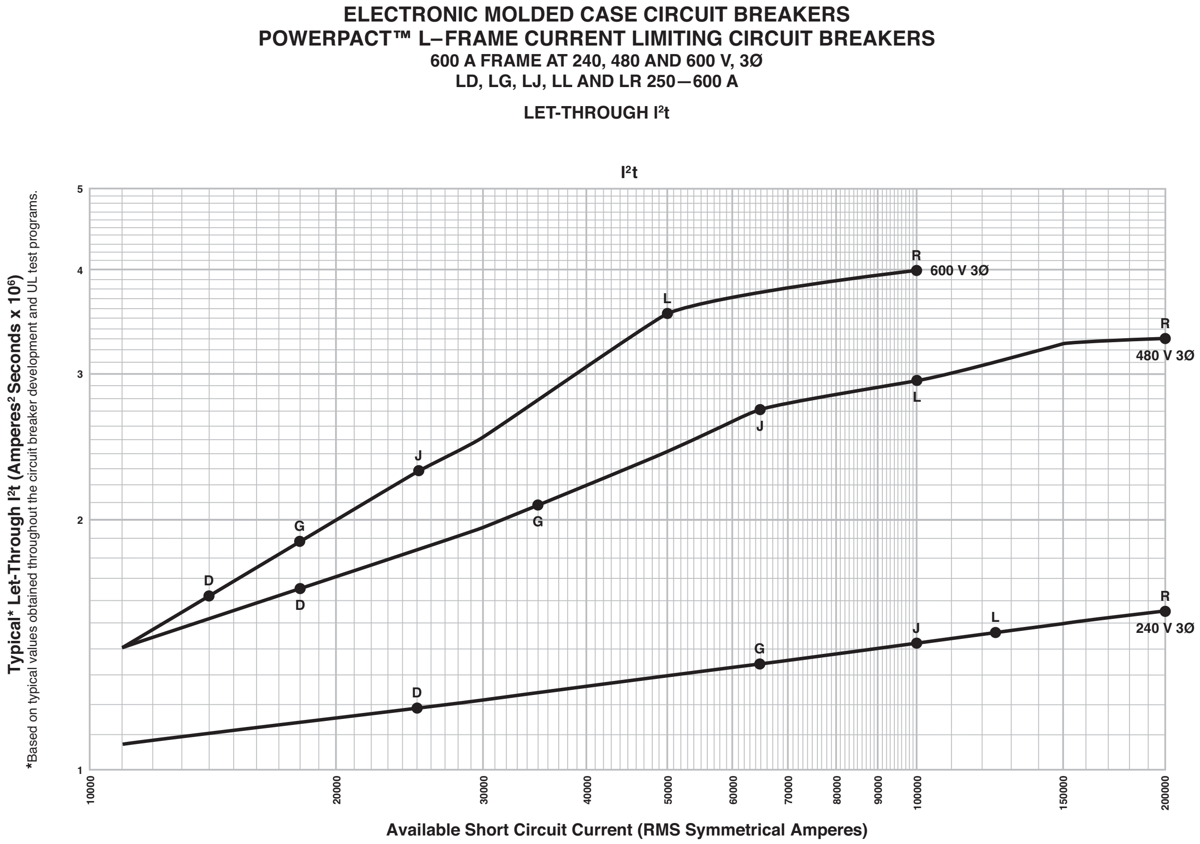
Figure 132: L-Frame 600 A Typical I²t Let-Through Curves



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PowerPact H-, J-, and L-Frame Circuit Breakers
Trip Curves

Figure 133: L-Frame UL Listed Current-Limiting Circuit Breaker

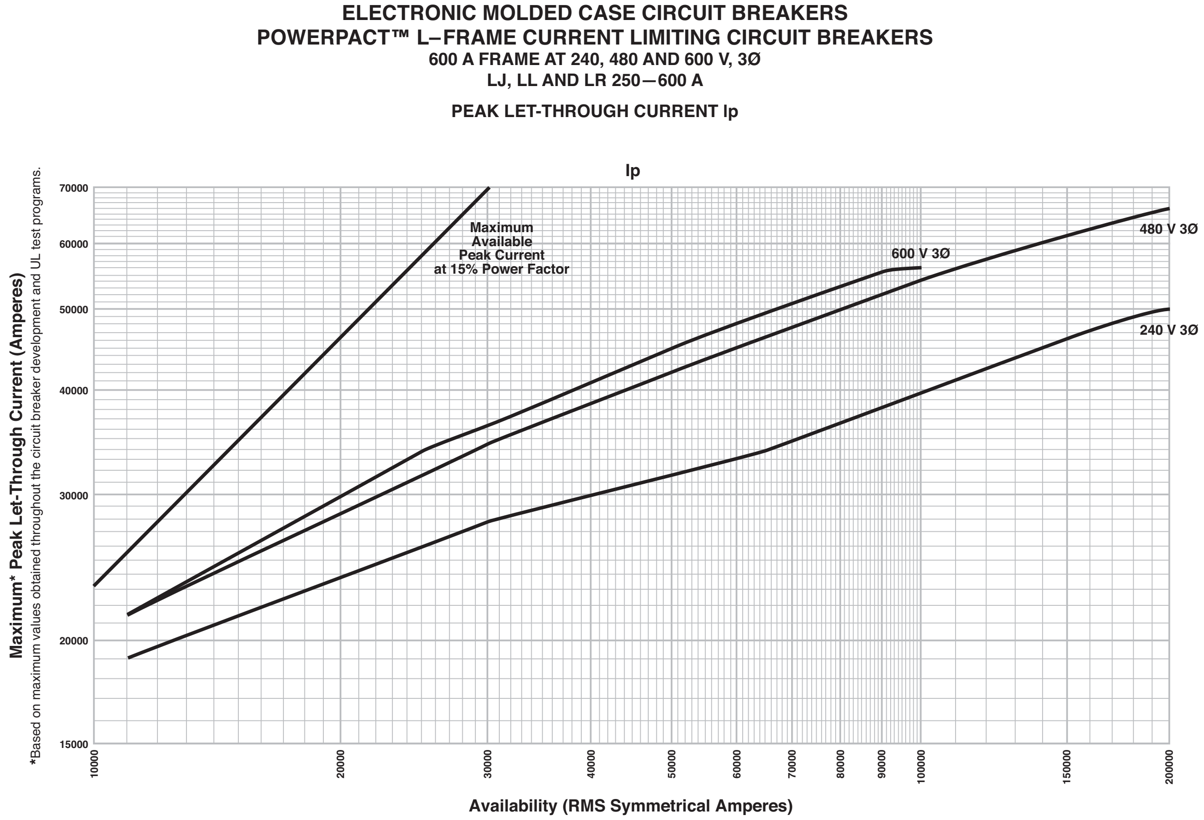

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Figure 134: L-Frame UL Listed Current-Limiting Circuit Breaker

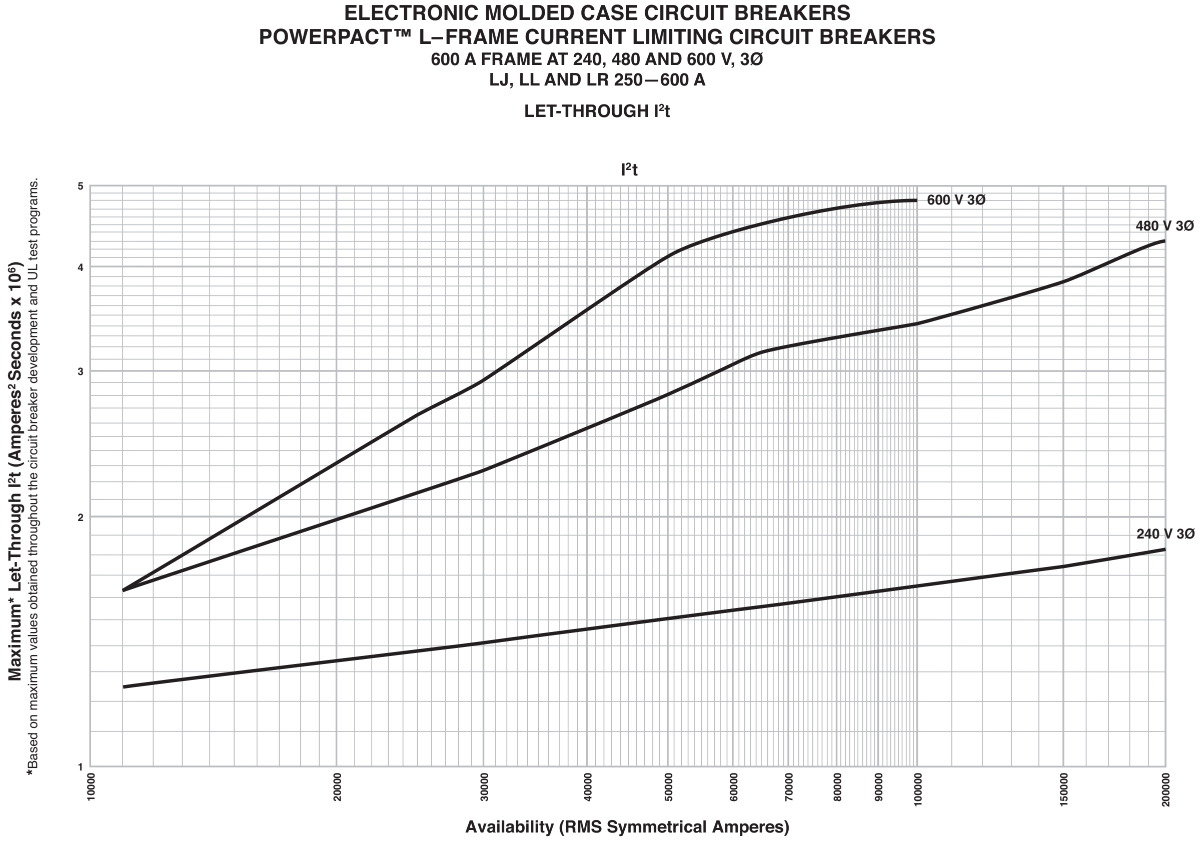
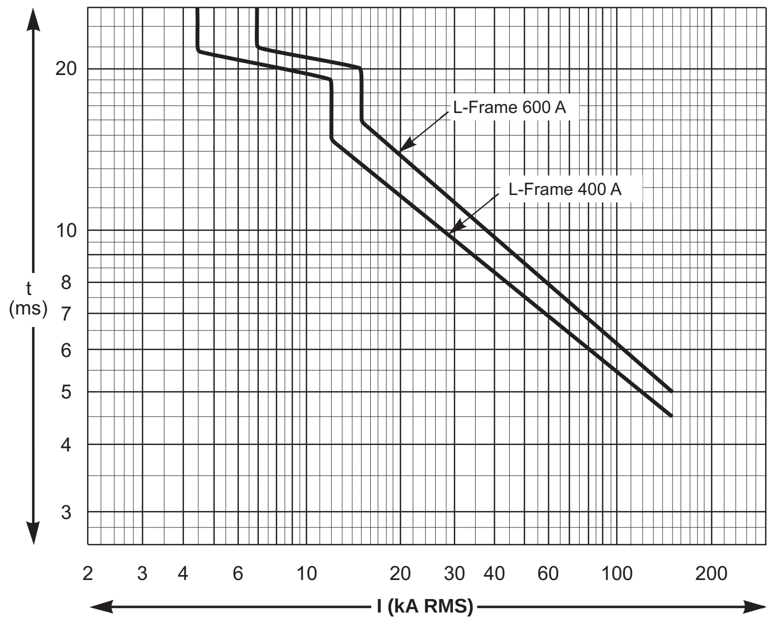


Figure 135: L-Frame Circuit Breaker Reflex Tripping



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Glossary

accessory = An electrical or mechanical device that performs a secondary or minor function apart from overcurrent protection.

accessory cover = A removable cover on the front of a circuit breaker behind which are mounted the trip unit and all electrical accessories.

adjustable rating plug = A component which plugs into the trip unit, establishing the ampere rating of the circuit breaker

AIC = Amperes interrupting capacity.

AIR = See *amperes interrupting rating*.

alarm switch (bell alarm) = See *overcurrent trip switch*.

ambient temperature rating = Temperature at which the continuous current rating (handle rating) of a circuit breaker is based; the temperature of the air immediately surrounding the circuit breaker which can affect the thermal (overload) tripping characteristics of thermal-magnetic circuit breakers. Electronic trip circuit breakers, however, are insensitive to normal (-10° to 50°C) ambient conditions.

ammeter (local current meter) = A module that mounts directly to the circuit breaker trip unit and reports RMS phase and ground-fault current values as seen by the trip unit. Current values are displayed one phase at a time.

ampacity = The current, in amperes, that a conductor or circuit breaker can carry continuously under the conditions of use without exceeding its temperature rating.

ampere = The equivalent of one coulomb per second or the steady current produced by one volt applied across a resistance of one ohm.

amperes interrupting rating = The highest current at rated voltage that an overcurrent protective device is intended to interrupt under specified test conditions (NEC).

ANCE (National Association of Standardization and Certification for the Electrical Sector) = The standards and certification agency accredited by the Mexican government.

ANSI® = American National Standards Institute.

automatic molded case switch = A switch with construction similar to a molded case circuit breaker except that the switch opens only instantaneously at a non-adjustable trip point calibrated to protect only the molded case switch itself.

auxiliary switch = A switch mechanically operated by the main device for signaling, interlocking, or other purposes.

bell alarm = A mechanically-operated switch used to indicate the main contact position of a circuit breaker, which indicates when a circuit breaker has tripped. Also see *overcurrent trip switch*.

BPFE = See *electrical closing push button*.

branch circuit = The circuit between the final overcurrent device protecting the circuit and the outlet(s).

BCM = See *circuit breaker communications module*.

Canadian Standards Association® (CSA®) = Canadian product safety testing and certification organization.

carriage= See *cradle*.

CCM = See *cradle communication module*.

CD = See *cell switch*.

CDM = See *mechanical operation counter*.

CE = See *cell switch*.

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cell switch = A switch which indicates the position of a drawout circuit breaker in relation to the cradle.

- **CD** = Disconnected position cell switch.
- **CE** = Connected position cell switch.
- **CT** = Test position cell switch.

CH = A spring-charged contact inside of the spring charging motor on insulated-case and low-voltage power circuit breakers.

charging handle= See *spring charging handle.*

circuit breaker = A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on an overcurrent without damage to itself when properly applied within its rating.

circuit breaker communications module (BCM) = A module which, when installed in a circuit breaker, receives and transmits information on the communication network.

circuit breaker frame = (1) The circuit breaker housing which contains the current carrying components, the current sensing components, and the tripping and operating mechanism. (2) That portion of an interchangeable trip molded case circuit breaker remaining when the interchangeable trip unit is removed.

close button = A button for manually closing the main contacts after the closing springs are charged.

close button cover = A cover which fits over the close button and blocks access to it. Access to the close button may be permitted through the use of a tool or rod inserted through a small hole in the front of the close button cover.

closing coil (shunt close) = A coil which closes the circuit breaker electrically using an external voltage source when a specified voltage is applied across the coil.

coil clearing switch = A mechanically-operated switch in series with the coil of a shunt trip device which breaks the coil current when the circuit breaker opens.

communication network = A network allowing the flow of information between electrical components, comprised of programmable controller interface units, protocol software and modems.

conductor = A substance or body that allows a current of electricity to pass continuously along it.

continuous current rating (handle rating) (ampere rating) = The designated RMS alternating or direct current in amperes which a device or assembly will carry continuously in free air without tripping or exceeding temperature limits.

continuous load = A load where the maximum current on the circuit is expected to continue.

cradle communications module (CCM) = An external module which allows addressing of the cradle and retention of the address when the drawout circuit breaker is in the disconnected position and which is used to transmit information about the position of the circuit breaker in the cradle to the communication network.

cradle compartment = A compartment containing all connectors, shields, adapters, barriers, spreaders, shutters, keys and interlocking devices for a drawout circuit breaker.

CSA® = See *Canadian Standards Association.*

CT = Current transformer. See also *cell switch*.

current path (of a circuit breaker) = The current-carrying conductors within a circuit breaker between, and including, line and load terminations.

current transformer (current sensor) (CT) = An instrument to measure current, encircling a conductor carrying the current to be measured or controlled.

demand metering = The metering of power or current demand seen by a circuit breaker. It is calculated over a fixed or sliding time window that can be programmed from five to 60 minutes. Depending on the contract signed with the power supplier, specific programming makes it possible to avoid or minimize the cost of overrunning the subscribed power. Maximum demand values are systematically stored and time stamped.

disconnecting contacts = See *main disconnecting contacts* and *secondary disconnecting contacts*.

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drawout circuit breaker = An assembly of a circuit breaker and a supporting structure (cradle) so constructed that the circuit breaker is supported and can be moved to either the main circuit connected or disconnected position without removing connections or mounting supports.

drawout mechanism = A mechanism which engages the drawout cradle assembly and draws the circuit breaker into or out of the equipment. The drawout mechanism includes the drawout mechanism shaft, drawout levering device arms and a drawout position indicator.

drawout position indicator = An indicating means which shows the position of the circuit breaker in the drawout structure.

drawout access cover (drawout shaft cover) = A shutter which allows or restricts access to the drawout shaft.

electrical closing push button (BPFE) = A push button used to electrically close a circuit breaker using a shunt close with communication option. This takes into account all safety functions that are part of the control and monitoring system of the installation.

electrical operator (motor operator) = An electrical device used to open and close a circuit breaker or switch and reset a circuit breaker. See also *spring charging motor*.

electronic trip circuit breaker = A circuit breaker which uses current sensors and electronic circuitry to sense, measure and respond to current levels.

fixed-mounted circuit breaker = A circuit breaker so mounted that it cannot be removed without removing primary and sometimes secondary connections and/or mounting supports.

frame size = The largest ampere rating available in a group of circuit breakers of similar physical configuration.

frequency = The number of cycles per second for an alternating current system.

frequency rating = The range of frequencies within which a product can be applied.

ground fault = An unintentional current path, through ground, back to the source.

ground-fault delay = The length of time the circuit breaker trip unit will delay before initiating a trip signal to the circuit breaker after a ground fault has been detected.

ground-fault module = An electronic accessory used in combination with thermal-magnetic circuit breakers to provide branch circuit ground-fault protection and ground-fault indication.

ground-fault pickup = The level of ground-fault current at which the trip system begins timing.

handle rating = Continuous current rating.

IDMTL = Long-time delay curve which can be varied in slope to enhance selectivity.

IEC® = International Electrotechnical Commission.

IEEE® = Institute of Electrical and Electronics Engineers.

Ig = See *ground-fault pickup.*

Ii = See *instantaneous pickup.*

In = See *sensor rating.*

individually-mounted circuit breaker = A circuit breaker so mounted that it cannot be removed without removing primary and sometimes secondary connections and/or mounting supports.

instantaneous pickup = The current level at which the circuit breaker will trip with no intentional time delay.

instantaneous trip = A qualifying term indicating that no delay is purposely introduced in the tripping action of the circuit breaker during short-circuit conditions.

insulated case circuit breaker (ICCB) = UL Standard 489 Listed non-fused molded case circuit breakers which utilize a two-step stored energy closing mechanism, electronic trip system and drawout construction.

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integral ground-fault protection for equipment = Equipment ground-fault protection on grounded neutral systems provided by components internal to the circuit breaker.

interchangeable trip unit = A trip unit which can be interchanged by a user among circuit breaker frames of the same design.

interrupting rating = The highest current at rated voltage available at the incoming terminals of the circuit breaker. When the circuit breaker can be used at more than one voltage, the interrupting rating will be shown on the circuit breaker for each voltage level. The interrupting rating of a circuit breaker must be equal to or greater than the available short-circuit current at the point at which the circuit breaker is applied to the system.

inverse time = A qualifying term indicating there is purposely introduced a delay in the tripping action of the circuit breaker, which delay decreases as the magnitude of the current increases.

I_r = See *long-time pickup.*

I_{sd} = See *short-time pickup.*

I^2t = See *let-through current.*

I^2 t IN (I^2 t ON) = An inverse time delay characteristic.

I^2 t OUT (I^2 t OFF) = A constant time delay characteristic.

latch check switch = A mechanically-operated switch which senses if the trip latch is reset.

let-through current = The peak current (measured in amperes) which passes through an overcurrent protective device during an interruption.

let-through I^2t = An expression related to energy (measured in ampere-squared seconds) which passes through an overcurrent protective device during an interruption.

LI = A combination of adjustable trip functions including long-time ampere rating, long-time delay, and instantaneous pickup.

lifting adapter = A device used with a crane, chain block or an optional lifting mechanism supplied with switchgear for removing and installing a drawout circuit breaker or fuse truck.

LIG = A combination of adjustable trip functions including long-time ampere rating, long-time delay, instantaneous pickup, ground-fault pickup and ground-fault delay.

limit switch = A switch mechanically operated by a device.

local current meter = An ammeter installed as part of the trip unit.

long-time ampere rating = An adjustment which, in combination with the installed rating plug, establishes the continuous current rating of a full-function electronic trip circuit breaker.

long-time delay = The length of time the circuit breaker will carry a sustained overcurrent (greater than the long-time pickup) before initiating a trip signal.

long-time pickup = The current level at which the circuit breaker long-time delay function begins timing.

low voltage power circuit breaker (LVPCB) = A circuit breaker tested to the ANSI C37 Standards with a two-step stored-energy mechanism, an electronic trip system, and drawout construction.

LS = A combination of adjustable trip functions including long-time ampere rating, long-time delay, short-time pickup, short-time delay and a defeatable instantaneous pickup.

LSG = A combination of adjustable trip functions including long-time ampere rating, long-time delay, short-time pickup, short-time delay, defeatable instantaneous pickup, ground-fault pickup and ground-fault delay.

LSI = A combination of adjustable trip functions including long-time ampere rating, long-time delay, short-time pickup, short-time delay and defeatable instantaneous pickup.

LSIG = A combination of adjustable trip functions including long-time ampere rating, long-time delay, short-time pickup, short-time delay, defeatable instantaneous pickup, ground-fault pickup and ground-fault delay.

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main disconnecting contacts = Spring-loaded and self-aligning contact on the rear of a drawout circuit breaker that provide positive electrical contact when the circuit breaker is in the connected position.

Masterpact™ = The family of universal power circuit breakers including insulated case circuit breakers and low-voltage power circuit breakers.

MCH = See *spring-charging motor.*

MDGF = Modified differential ground-fault system.

manual charging handle = A manually-operated handle which charges the circuit breaker closing springs.

mechanical operation counter (CDM) = A mechanical device which indicates the total number of circuit breaker operating cycles.

Micrologic™ = The family of electronic trip systems available on molded case circuit breakers, insulated case circuit breakers and low-voltage power circuit breakers.

miniature circuit breaker (MCB) = A small circuit breaker which is assembled as an integral unit in a supportive and enclosed housing of insulating material, rated 150 A or less and used in 120 V, 120/240 V, 240 V and 480Y/277 V ac systems and dc systems up to 125 Vdc.

MN = See *undervoltage release.*

Modbus™ communication network = A communication network comprised of programmable controller interface units, protocol software and modems.

molded case circuit breaker (MCCB) = A circuit breaker which is assembled as an integral unit in a supportive and enclosed housing of insulating material, generally 20 to 3000 A in size and used in systems up to 600 Vac and 500 Vdc.

motor circuit protector = A recognized component of construction similar to a circuit breaker except with no thermal elements so that it provides short-circuit protection only.

MX = See *shunt trip.*

National Association of Standardization and Certification for the Electrical Sector = See *ANCE.*

neutral current transformer = A current transformer which encircles the neutral conductor; required on circuit breakers with ground-fault protection, when applied on a grounded system.

NMX® (Norma Mexicana X) = Listing mark indicating certification to non-mandatory Mexican safety standards.

NOM = Listing mark indicating certification to mandatory Mexican safety standards

OF = See *auxiliary switch.*

open/closed indicator = An indicating means which displays the position (open or closed) of the main contacts.

operating mechanism = An internal mechanical system which opens and closes the circuit breaker contacts.

OTS = Overcurrent trip switch (alarm switch, bell alarm). A mechanical switch that operates when the circuit breaker is tripped by the trip system.

overcurrent = Any current in excess of the rated continuous current of equipment or the ampacity of a conductor.

overcurrent mechanism = An internal mechanical system which trips the circuit breaker during an overcurrent.

overcurrent trip element = A device which detects an overcurrent and transmits the energy necessary to open the circuit automatically (UL only).

overcurrent trip switch (SDE) = A mechanically-operated switch which indicates when a circuit breaker has tripped due to overcurrent conditions.

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overload delay = The length of time the circuit breaker will carry a sustained low-level overcurrent before initiating a trip signal.

peak current sensing = A method of determining the current by means of detecting the current peaks.

peak let-through current = The maximum peak current flowing in a circuit during an overcurrent condition.

PF = A switch used to indicate a circuit breaker is ready to close.

phase barrier = A barrier which provides phase-to-phase or phase-to-ground isolation.

PowerLogic™ = The family of electronic circuit monitoring systems available on molded case circuit breakers, insulated case circuit breakers and low-voltage power circuit breakers.

Power-Zone™ = The family of low-voltage and medium-voltage switchgear.

programmable contact module (M6C and M2C) = A programmable module which indicates the type of fault and the instantaneous and delayed threshold overruns. It may be programmed with instantaneous return to the initial state, without return to the initial state, or with return to the initial state following a delay.

primary disconnect contacts = An electrical plug-on connector in the main current path between the drawout components and the cradle mounted in the equipment.

push-to-close button = A button for manually closing the main contacts after the closing springs are charged.

push-to-open button = A button for manually opening the circuit breaker.

push-to-trip button = A button for manually tripping the circuit breaker.

racking device shutter = See *drawout shaft cover***.**

racking interlock = An interlock to prevent racking of a drawout circuit breaker when the enclosure door is open by not allowing the racking crank to be inserted into the circuit breaker.

rating plug = A component which plugs into the full-function electronic trip unit, establishing the maximum continuous current rating of the circuit breaker.

remote reset after fault (RES) = A component which resets the overcurrent trip switch (SDE) and the mechanical operator after tripping.

RES = See *remote reset after fault*.

residual ground-fault sensing = A means of providing equipment ground-fault protection utilizing sensors on each individual phase.

restraint interface module (RIM) = A component which allows zone-selective interlocking communication between Square D™ full-function electronic trip systems, add-on ground-fault modules and zero-sequence ground-fault relays.

RIM = Restraint interface module.

RMS = Root-mean-square.

RMS current sensing = A method of determining the true RMS current of sinusoidal and non-sinusoidal waveforms by sampling the current waveform a number of times per cycle, then calculating the true RMS value.

safety shutter = A device that closes to block access to the main disconnects when the circuit breaker is in the disconnected, test or withdrawn position.

SDE = See *overcurrent trip switch.*

secondary disconnect contacts = An electrical plug-on connector in the secondary (control) circuit between a drawout circuit breaker and its cradle in the equipment.

sensor = The current sensing element within the circuit breaker which provides the sensing function for that circuit breaker.

sensor plug = A component used with a Micrologic trip system to set the sensor size of a circuit breaker.

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sensor size = Maximum ampere rating possible for a specific circuit breaker, based on the size of the current sensor inside the circuit breaker. Sensor size is less than or equal to frame size.

SGR = Source ground return system.

short-circuit delay (STD) = The length of time the circuit breaker will carry a short circuit (current greater than the short-circuit pickup) before initiating a trip signal.

short-circuit pickup = The current level at which the circuit breaker short-circuit delay function begins timing.

short-time delay = The length of time the circuit breaker will carry a short circuit (current greater than the short-time pickup) before initiating a trip signal.

short-time pickup = The current level at which the circuit breaker short-time delay function begins timing.

shunt close (closing coil) (XF) = An accessory which closes the circuit breaker from a remote location using an external voltage source.

shunt trip (MX) = An accessory which trips the circuit breaker from a remote location using an external voltage source.

spring-charging handle = A handle located on the front of the circuit breaker used to manually charge the stored energy mechanism.

spring charging motor = A motor which electrically charges the stored energy closing spring(s).

STD = Short-time delay.

stored energy mechanism (SEM) = A spring mechanism that is compressed or “charged” and then released or “discharged” to close the circuit breaker.

terminal block = The connections for control wiring.

tg = See *ground-fault delay.*

thermal imaging = A trip unit function that accurately maps the heating and cooling effects of load behavior on rated conductors to provide thermal protection without nuisance tripping.

thermal-magnetic circuit breaker = A general purpose term for circuit breakers that use bimetals and electromagnetic assemblies to provide both thermal and magnetic overcurrent protection.

thermal memory = Provides continuous temperature rise status of the wiring for a period of time both before and after the device trips. This allows the circuit breaker to respond to a series of overload conditions which would otherwise go undetected.

t_r = See *long-time delay.*

t_{sd} = See *short-time delay.*

two-step stored energy mechanism = See *stored energy mechanism*.

transformer = A static device with primary winding, connected in series with the conductor (bus) carrying the current to be measured or controlled within the switchgear.

trip button = See *push-to-trip button*.

trip curve = A graphical representation of the response of a circuit breaker to current over a period of time.

trip indicator = A module that mounts directly to the circuit breaker trip unit that displays whether the circuit breaker tripped due to an overload, a short-circuit or a ground-fault condition.

trip indicator reset = A button on the trip indicator module used to reset the trip indicator.

trip system = A system which consists of a Micrologic trip unit and current transformers.

trip unit = A programmable device which measures and times current flowing through the circuit breaker and initiates a trip signal when appropriate.

UL® = See *Underwriters Laboratories Inc.*

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undervoltage trip (MN, UVR) = An accessory which trips the circuit breaker automatically when the monitored circuit voltage falls below a predetermined percentage of its specified value.

Underwriters Laboratories Inc.® (UL®) = An independent, not-for-profit standards development, product safety testing and certification organization.

unit-mount circuit breaker = A circuit breaker mounted such that it cannot be removed without removing primary and sometimes secondary connections or mounting supports.

withstand rating = The level of RMS symmetrical current that a circuit breaker can carry with the contacts in a closed position for a stated period of time–usually stated in cycles.

zero-blind time = Metering method used by the Micrologic H trip unit where a dedicated metering data chain is separate from the protection data chain so that a greater number of data samples can be used for metering. This increases the number of samples taken per time period, which in turn gives the H trip unit a higher degree of metering accuracy.

zero-sequence ground-fault sensing = A means of providing equipment ground-fault protection utilizing an external sensor (surrounding all phase and neutral conductors).

zone-selective interlocking (ZSI) = A communication capability between electronic trip systems and ground-fault relays which permits a short circuit or ground fault to be isolated and cleared by the nearest upstream device with no intentional time delay.

ZSI = Zone-selective interlocking.

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02/2016

2.13 Square D Ground Fault Protection Field Test Instructions

SQUARE D CIRCUIT BREAKERS
Ground Fault Protection Field Test Instructions

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SQUARE D CIRCUIT BREAKERS

Ground Fault Protection Field Test Instructions

SCOPE

MTU Onsite Energy offers several solutions for Equipment Ground Fault Protection, depending on model, series, or configuration. This document applies to the following factory-installed Square D electronic trip circuit breakers with integral ground fault protection. Other instructions are available for ground fault protection integral to the MGC-3000 Series engine generator controller or for GE circuit breakers with ground fault protection if equipped.

Square D circuit breakers covered by these instructions:

- H-Frame with GFM150HD ground fault module
- J-Frame with GFM250JD ground fault module
- L-Frame with Micrologic 6.3A trip unit
- P-Frame with Micrologic 6.0A or 6.0P trip unit
- R-Frame with Micrologic 6.0A or 6.0P trip unit
- NW-Frame with Micrologic 6.0A or 6.0P trip unit

An external neutral current transformer (CT) is also required and is usually factory installed in the generator outlet box or circuit breaker enclosure, or it may be shipped loose for field installation.

INTRODUCTION

Paragraph 230-95(c) of NFPA 70, National Electrical Code, requires that ground fault protection systems for equipment be performance tested when first installed.

Square D recommends testing be done:

- when the equipment is installed at its permanent location.
- yearly as part of annual maintenance or after each unintentional operation of the overcurrent protective device.
- if the distribution system is altered in any way.

Field testing simulates a ground fault greater than the highest pickup setting on the module. The module then triggers the ground fault shunt trip, tripping the circuit breaker.

Field testing determines that:

- installation is correct.
- ground fault protection system is operational.

Field testing is not a check of the calibration of any sensing relay.

Before testing, review instruction manual included with the ground fault module. Testing must be conducted and evaluated by qualified personnel.

⚠	**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH** • Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E. • This equipment must be installed and serviced only by qualified electrical personnel. • Turn off all power supplying this equipment before working on or inside the equipment. • Always use a properly rated voltage sensing device to confirm power is off. • Replace all devices, doors, and covers before turning on power to this equipment.

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SQUARE D CIRCUIT BREAKERS

Ground Fault Protection Field Test Instructions

INSPECTION (AT INSTALLATION ONLY)

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Remove the neutral disconnect link on switchboard to isolate neutral of the wiring system from both supply and ground.
3. With circuit breaker in off position, measure insulation resistance of neutral to ground to ensure no ground connections exist downstream (load side).
4. Visually inspect wiring. Confirm that the grounding connection at the service equipment is upstream (line side) of the circuit breaker neutral CT and that a neutral connection exists from the supply transformer to the service equipment.
5. Reconnect all neutral and ground connections.

GROUND FAULT TEST

H-Frame with GFM150HD and J-Frame with GFM250JD Ground Fault Modules

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Turn off all power supplying this equipment before connecting temporary power source.
- Do not touch terminals 7 or 8 when the temporary power source is connected and turned on.

NOTE: If ground fault test circuit is not connected to 120 VAC power source, connect a temporary 120 VAC power source to the test circuit.

1. Turn off all power supplying this equipment before connecting temporary power source.
2. Remove lug cover (Figure 1, A).
3. Connect 120 VAC 50/60 Hz 60 VA supply to terminals 7 and 8 (Figure 1, B).
4. Replace lug cover.

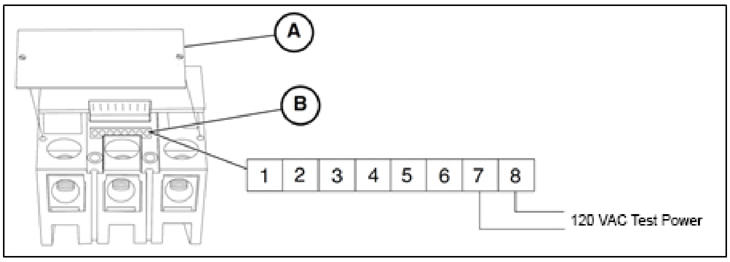

Figure 1: Lug cover for access to terminals 7 and 8

5. Turn 120 VAC ground fault test power on.
6. Test ground fault system. If circuit breaker does not trip, contact the local field office.
   a) Depress **Push-to-test** Button (Figure 2, A).
   b) Circuit breaker will trip and red indicator button will pop up. Press **indicator** button to reset (Figure 2, B).

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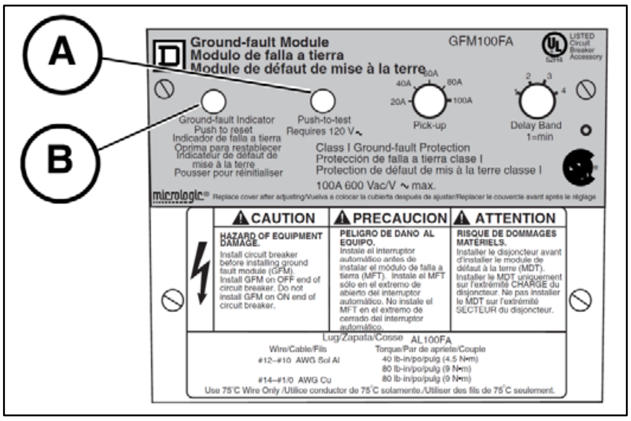

Figure 2: Lug cover for access to terminals 7 and 8

NOTE: If using a temporary 120 VAC power source to test the circuit, turn it off, and then disconnect it.

7. Remove lug cover (Figure 3, C).
8. Disconnect 120 VAC power supply to terminals 7 and 8 (Figure 3, D).
9. Replace lug cover.

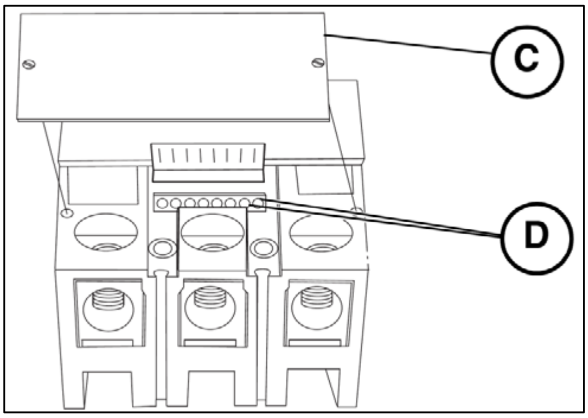

Figure 3: Lug cover for access to terminals 7 and 8

10. Record the results in Table 2.

L-Frame with Micrologic 6.3A Trip Unit

1. Perform the ground fault protection test on the keypad of the Micrologic trip unit. Use this test to check the trip unit's electronic tripping function.

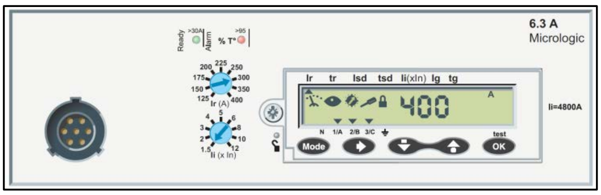

Figure 4: Lug cover for access to terminals 7 and 8

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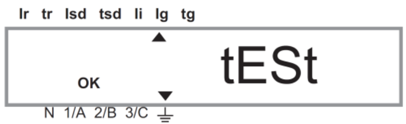
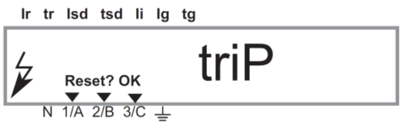
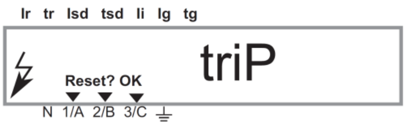
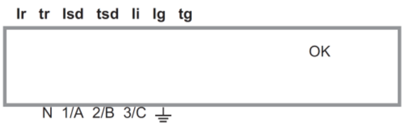
Step	Readout Value	Action	Display
1	Current in most heavily loaded phase	• Access the ground fault protection test function by pressing OK. • The tESt pictogram appears and the OK pictogram blinks.	
2	Peak demand with Reset option showing	• Prompt the ground fault protection test by pressing OK. The ground fault protection trip screen is displayed.	
3	Reset option lit	• Acknowledge the ground fault trip screen by pressing OK. • The Reset OK pictogram blinks.	
4	OK	• Confirm by pressing OK again. • The confirmation OK displays for two seconds.	

Table 1: L-Frame Micrologic 6.3A Test Sequence

11. Record the results in Table 2.

P-Frame, R-Frame, and NW-Frame with Micrologic 6.0A or 6.0P Trip Units

With the trip unit powered and the circuit breaker closed, test the equipment ground fault trip function. The trip unit is powered if:

- Circuit breaker is on and has more than 150 V of load voltage on two phases (circuit breaker is closed or bottom fed).
- The Full-Function or Hand-Held Test Kit is connected and on.
- The 24 Vdc external power supply is connected.
- An external voltage tap is installed and voltage of more than 150 V is present on two phases.

1. To test the trip function, press the ground fault test button (Figure 5, A). Circuit breaker will trip and the trip unit ground fault indicator light will come on.

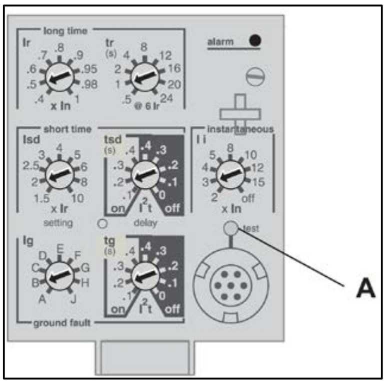


Figure 5: Micrologic 6.0A Trip Unit

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2. Record the results in Table 2.

NOTE: If a complete check of the ground fault system is necessary, use primary injection testing. If the system has multiple sources and/or requires field connections at the job site, use primary injection testing.

Date	Ground Fault Settings	Test Results	Signature

Table 2: Ground Fault Test Record

REFERENCE PUBLICATIONS

Frame	Square D Publication No.	Description
H-Frame J-Frame	48041-088-01	GFM150HD and GFM250JD Ground-Fault Modules with Micrologic Trip System – Instruction Bulletin
	48040-757-04	Field Test Procedure for Micrologic Ground-Fault Module
L-Frame	48940-312-01	Micrologic 5 and 6 Electronic Trip Units for PowerPact H-, J-, L-Frame Circuit Breakers – User Guide
	S1A78233	PowerPact™ L-Frame Electronic Trip Circuit Breaker Installation – Instruction Bulletin
	48940-306-01	PowerPact™ and Compact External Neutral Current Transformer (ENCT) Instruction Bulletin
P-Frame R-Frame	48049-137-05	Micrologic 5.0P and 6.0P Electronic Trip Units v PLogic-2002-AA and Later – Instruction Bulletin
	48049-148-05	P-Frame and NS630b-NS1600 Circuit Breakers – Instruction Bulletin
	8049-243-04	PowerPact™ R-Frame and NS1600b-NS3200 Circuit Breakers – Instruction Bulletin
	48049-273-04	Neutral Current transformers for Masterpact® NT, P-Frame, and NS630b-NS1600 Circuit Breakers – Instruction Bulletin
	48049-222-04	Neutral Current Transformers for Masterpact NW, R-Frame, and NS1600-NS3200 Circuit Breakers – Instruction Bulletin
NW-Frame	HRB28361	Masterpact NW Low-Voltage Power/Insulated Case Circuit Breaker Installation – Instruction Bulletin
	06131B1202	Maintenance Guide for Masterpact NT and NW Circuit Breakers – Instruction Bulletin
	48049-222-04	Neutral Current Transformers for Masterpact NE, R-Frame, and NS1600b-MS3200 Circuit Breakers – Instruction Bulletin

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MAGNAPLUS® GENERATOR

280–430 Frame
Installation, Operation, and Maintenance Manual

TIM-ID: 0000078168 - 001

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CONTENTS

SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS® generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS® generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating, and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised, or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards.

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

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PRINCIPLES OF OPERATION

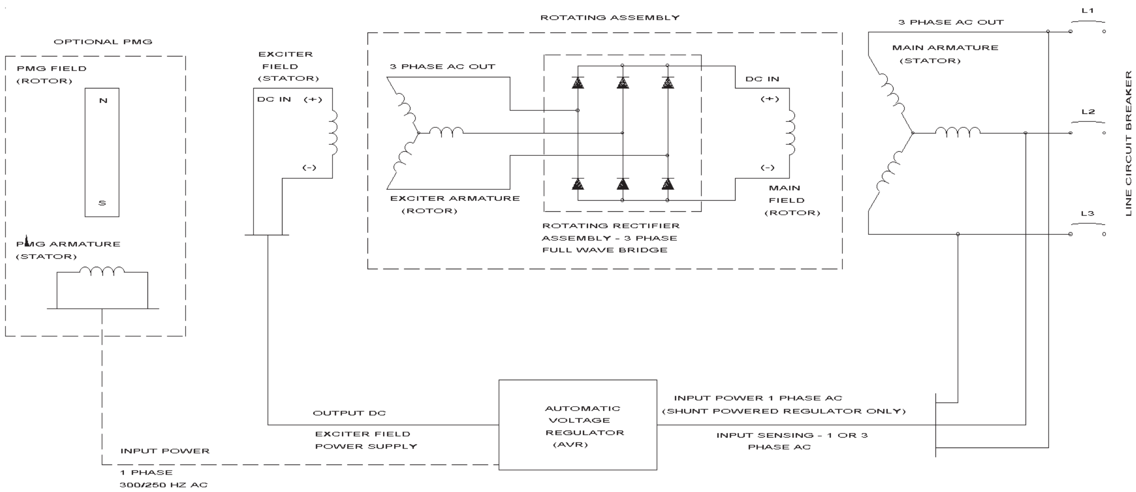

FIGURE 1 -- MagnaPLUS® Circuit Diagram

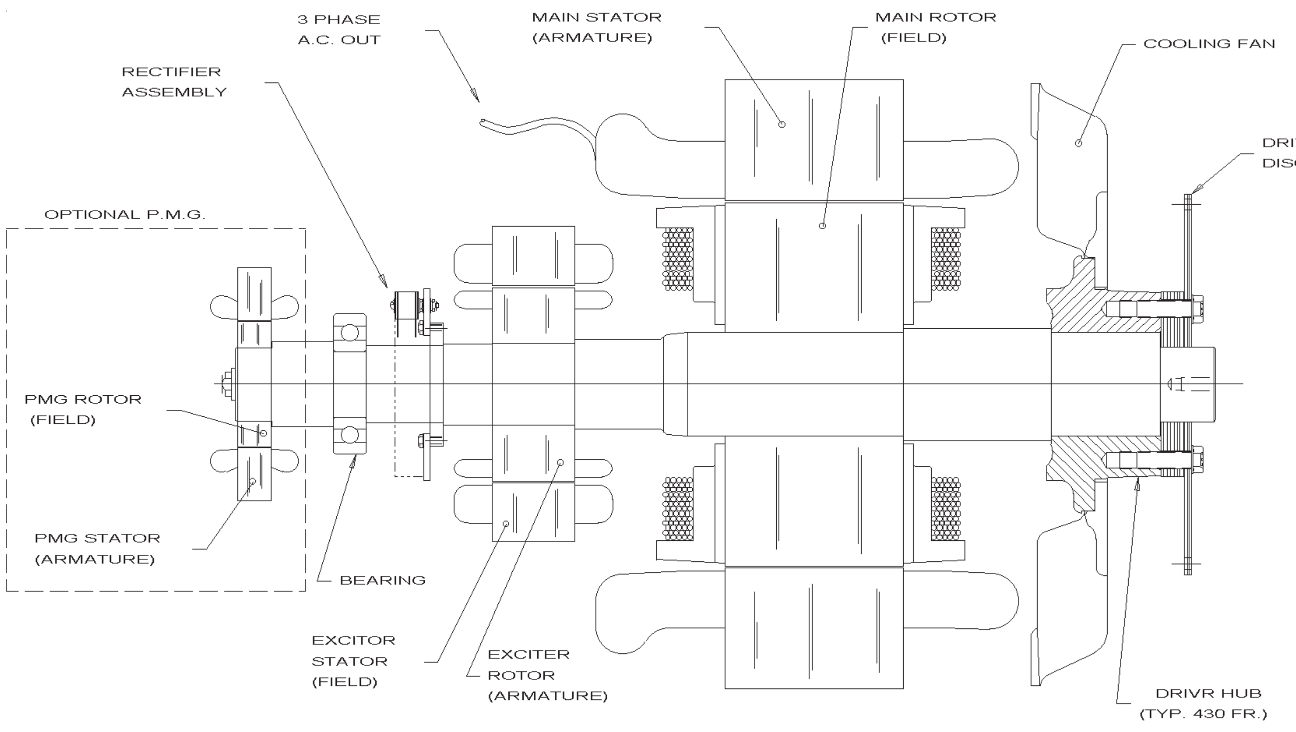

FIGURE 2 -- Typical MagnaPLUS® Layout Diagram

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PRINCIPLE OF OPERATION

MagnaPLUS® generators are brushless, self excited, externally voltage regulated, synchronous AC generator. The generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology, note the following: stators are stationary, rotors rotate, a field is a DC electrical input, and an armature is an AC electrical output. These system components are electrically interconnected as shown in Figure 1 and physically located as shown in Figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter field resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. The generator's terminal voltage is changed by adjusting the regulator's reference set point. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, a large surge of current is drawn by the motor. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus® generators generally supply .3 to .4 horsepower per generator KW in motor starting capability. For specific data contact Marathon Electric.

PARALLEL OPERATION

All MagnaPlus® generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus® generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.). These switching circuits introduce high frequency harmonics which distort the normal wave form of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems which can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Marathon Electric for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

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⚠WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING
Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the coupling discs which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS. Split lock washers when biting into the drive disc cause stress risers which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. MagnaPLUS® generator frames are constructed with two or three bolt holes per foot. The feet should be shimmed where necessary to obtain solid contract with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus no real need to secure the feet with more than one bolt per foot.

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GENERATOR MOUNTING
Two Bearing Generators -- Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increase bearing life, and ensure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grade 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING
Two Bearing Units -- Belt Driven

Two bearing MagnaPLUS® generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Marathon Electric recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

HYDRAULIC DRIVE WITH SHAFT SPLINE
Two Bearing Units

All 280 PDL MagnaPLUS® two bearing hydraulic drive generators are equipped with a Zerk grease fitting mounted in the drive end of the shaft. Prior to assembly to the hydraulic drive motor, lightly coat the hydraulic drive motor shaft, and/or grease the generator spline per the greasing instructions in the MAINTENANCE section, page 12. **DO NOT assemble the generator to the hydraulic drive motor with the spline dry.**

END PLAY TESTING

Refer to the engine manual for recommended end play specifications and measurement procedures. If end play is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.
2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.
3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to either the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS® generator is designed for heavy duty industrial applications; however, dirt, moisture, heat and vibration are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

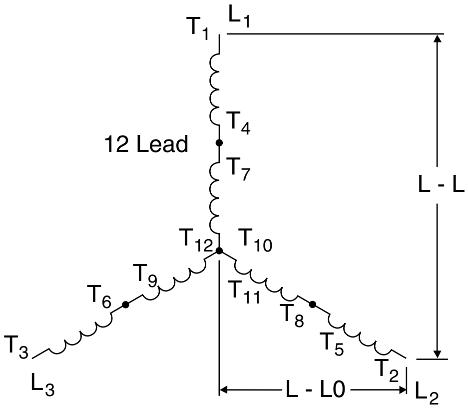
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS® generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are: 6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame -- 5.4 NM (4 Ft Lb); 360 & 430 frame -- 27 NM (20 Ft Lb).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded (earthed) or left above ground potential (floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12. These three leads are internally connected inside the generator and brought out as a single lead (T0). Ten lead generators can only be connected in a wye configuration.

HIGH (SERIES) WYE CONNECTION



VOLTAGE (HIGH WYE)		
Hz	L-L	L-Lo
60	380	219
	416	240
	440	254
	460	266
	480	277
50	380	219
	400	231
	415	240
	440	254

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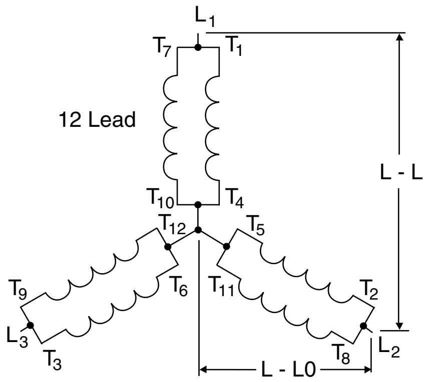
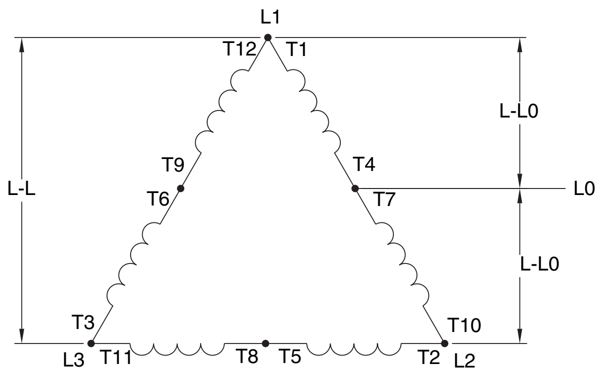
LOW (PARALLEL) WYE CONNECTION



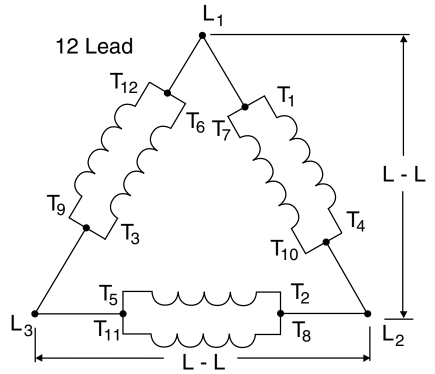
VOLTAGE (LOW WYE)		
Hz	**L-L**	**L-L0**
60	190	110
	208	120
	220	127
	230	133
	240	139
50	190	110
	200	115
	208	120
	220	127

HIGH (SERIES) DELTA CONNECTION



VOLTAGE (HIGH DELTA)		
Hz	**L-L**	**L-L0**
60	240	120
	277	139
50	200	100
	220	110
	240	120

LOW (PARALLEL) DELTA CONNECTION



VOLTAGE (LOW DELTA)	
Hz	**L-L**
60	110
	120
50	100
	110

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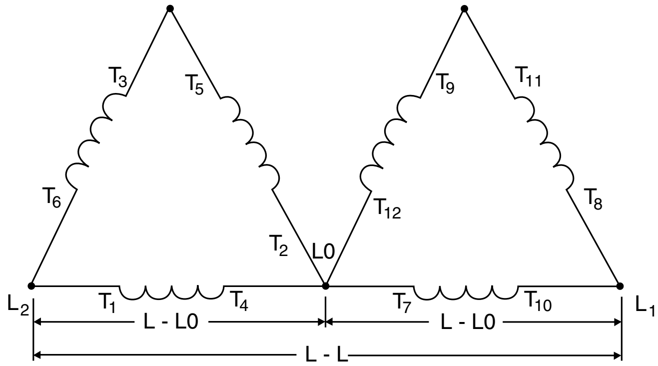
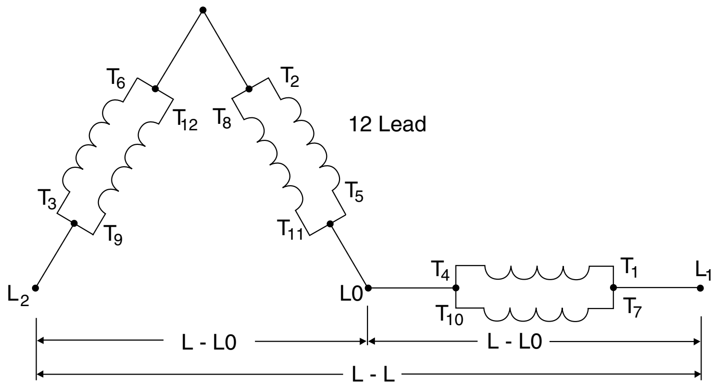
DOUBLE DELTA -- SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	**L-L**	**L-LO**
60	200	100
	220	110
	240	120
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

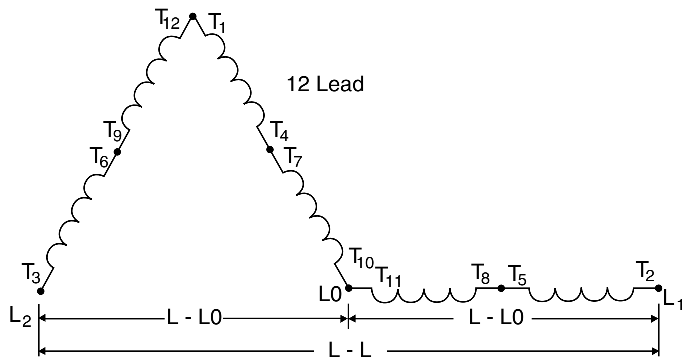
LOW ZIG ZAG -- SINGLE PHASE (PARALLEL) CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	**L-L**	**L-LO**
60	200	100
	220	110
	240	120
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

HIGH ZIG ZAG -- SINGLE PHASE (SERIES) CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	**L-L**	**L-L0**
60	480	240

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

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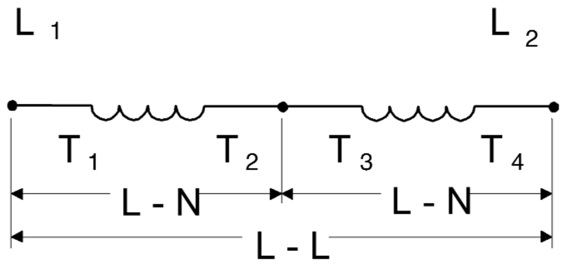
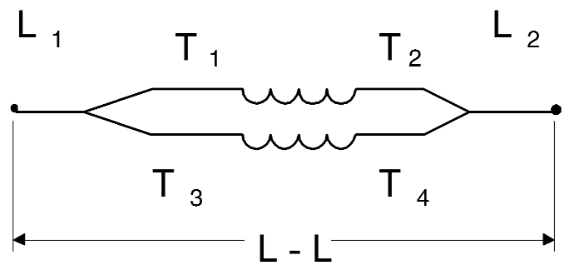
DEDICATED SINGLE PHASE CONNECTION
HIGH VOLTAGE - SERIES CONNECTED



VOLTAGE (DEDICATED)		
Hz	**L-L**	**L-N**
60	240	120
	220	110
50	220	110
	200	100

SINGLE PHASE CONNECTION - SINGLE VOLTAGE PARALLEL



VOLTAGE	
	L-L
60 HZ	120
50 HZ	110

Note: For 120 volt only service. Use an AVC63-4A or a VR63-4C voltage regulator to replace the standard SE350 regulator.

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OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.

2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.

3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

4. Verify that all equipment is properly grounded (earthed).

> **⚠WARNING**
>
> **MAGNAPLUS® GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.**

5. Clear the surrounding area of any materials that could be drawn into the generator.

6. Check all fasteners for tightness.

7. Check all access plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.

8. Review all prime mover prestart up instructions, and ensure that all recommended steps and procedures have been followed.

9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

   Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.

2. Open the input power to the automatic voltage regulator. Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)

3. Verify that all prime mover start-up procedures have been followed.

4. If the unit is provided with space heaters, ensure that they are de energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.

5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced, shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

   With the regulator de energized, the residual voltage should be 10 - 25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

> **⚠WARNING**
>
> **THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.**

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is

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recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to the load.

9. Monitor the generator output current to verify that it is at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary. (Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling air flow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS® generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

⚠WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance, check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the bench mark reading, it is an indication of problems in either the exciter, main field, or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. The method selected will be influenced by winding wetness and situation limitations.

Space Heaters
An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. This process can be accelerated by enclosing the unit with a covering and inserting additional heating units. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

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Forced Air
Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 C (180° F).

HYDRAULIC DRIVE GENERATORS, SHAFT SPLINE LUBRICATION

The shaft spline should be greased prior to initial assembly to the driver, and every three (3) months to reduce maintenance, and prolong the life of the spline coupling per the following procedure:

1. Material: Molybdenum Disulfide - sometimes referred to as “Molly Grease.”

2. Turn the rotor assembly so that the Zerk fitting is in line with the access hole in the top of the drive end bearing bracket as illustrated in Figure 3.

3. Using a hand held grease gun with a solid coupling, apply a small amount of grease into the fitting. DO NOT OVER GREASE. Limit the amount of grease to one (1) trigger pull of the grease gun.

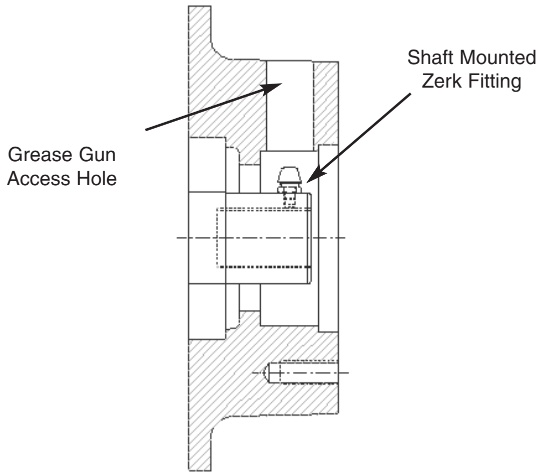

Figure 3--Drive End Bearing Bracket

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects which may have been drawn into the generator. Verify that the generator’s air gaps (main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never “bar over” the engine generator set using the generator fan.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

CONSTANT EXCITATION TEST (12V BATTERY TEST)

The generator “no load” voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.

2. Disconnect the regulator’s F+ (F1) and F- (F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.

3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator’s terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Continuity / Resistance Test

The generator has four components which can be checked using an ohm meter: exciter stator, exciter rotor, main stator and main rotor. Each of these components are comprised of various windings which form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohm meter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor. Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the engine in order to gain access to a given area of the rectifier assembly. NEVER use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (Figure 5). The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester, place one test probe on the diode lead terminal post. In succession, touch the other test probe to the lead screw hole in each heat sink. Reverse the probes and repeat the procedure. You have now tested the three diodes connected to this terminal post in both the forward and reverse direction. Repeat the procedure using the other diode terminal post.

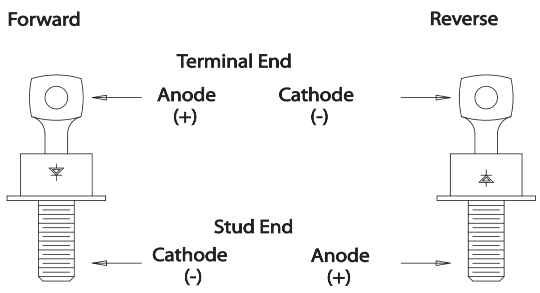

FIGURE 4: DIODE POLARITY

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When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased), the diode will switch on and conduct electricity (Figure 4). This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The results of these tests should indicate one of three conditions:

1. **Good diode:** Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery light tester will have the light "on" in one direction and "off" in the other.

2. **Shorted condition:** Ohmmeter reading will be zero, or very low in both directions. The continuity tester will have the light "on" in both directions.

3. **Open condition:** Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes, etc. All 6 diodes are essentially in the same circuit. When a diode is stressed to failure, there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures, it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. All service procedures should be conducted by qualified maintenance personnel. Replacement parts may be ordered through an authorized service center or directly from the factory.

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. Shutdown the generator set. Remove the exciter field leads F+ and F from the regulator.

CAUTION

Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is drawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

BEARING REMOVAL

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged, replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.
Prior to proceeding with bracket removal, disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Drive End Bearing Bracket Removal,
Two Bearing Units.
Remove any drive arrangement from the generator shaft extension. Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket. The shaft extension must be supported before proceeding further. A hoist and sling, jack, or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws. Using a flat bladed screw driver or chisel, pry the bracket back from the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged, sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time the it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C (212°F) in an oven. Apply a thin coat of clean lubricating oil to the press fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

RECTIFIER ASSEMBLY REMOVAL

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 5). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

DIODE REPLACEMENT

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut which could cause damage to the device. Torque to 28 pound inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.

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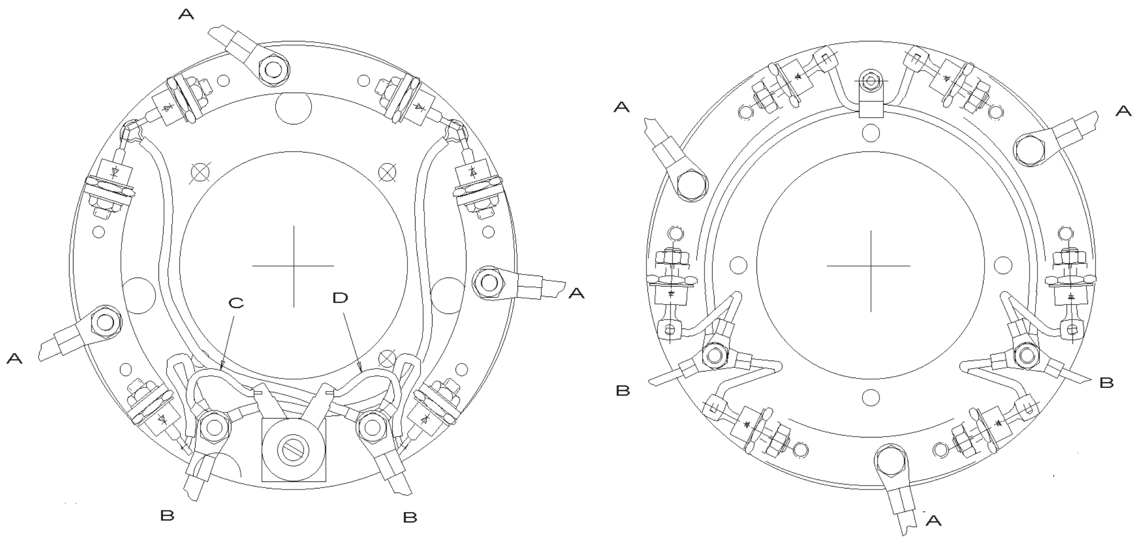

430 FRAME 280 / 360 FRAME
A - Exciter Rotor Lead, B - Main Rotor Lead, C - Red (+) Suppressor Lead, D - Black (-) Suppressor Lead

FIGURE 5: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes: how long the unit had been operating; what loads were on line; weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation? Has the prime mover experienced an over-speed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS® generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

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⚠WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections, open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary -- check regulator fuse and input power from the PMG.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE, NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

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GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawings supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

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GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate air flow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric..
Improper generator voltage or frequency	Check name plates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION

Compare required voltage, frequency, and KVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Marathon Electric for information regarding generator capacity.

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SPECIFICATIONS

MODEL / FRAME SIZE	EXCITER RESISTANCE STATOR	ROTOR
281, 282, 283, 284, 285, 286, 287	18.0	.120
361, 362, 363 -- three phase	23.5	.120
361, 362, 363 -- dedicated single phase	23.0	.135
431, 432, 433 -- three phase	18.5	.120
431, 432 -- dedicated single phase	18.0	.105

MODEL	GENERATOR RESISTANCE STATOR*	ROTOR	EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ
281PSL1500	4.20	.400	11.0
281PSL1501	4.15	.400	11.0
281CSL1502	0.47	0.72	6.40
281PSL1502	3.20	.439	9.0
282PSL1703	1.07	0.34	14.70
282CSL1504	1.24	0.80	6.20
282PSL1704	1.07	0.34	14.70
282CSL1505	0.87	0.90	5.80
282PSL1705	0.74	0.37	14.35
283CSL1506	0.54	1.00	8.20
283PSL1706	0.45	0.40	12.95
283CSL1507	0.44	1.18	9.20
283PSL1707	0.39	0.46	11.20
284CSL1508	0.29	1.36	10.00
284PSL1708	0.27	0.52	14.18
284CSL1542	0.27	1.36	8.30
284PSL1742	0.22	0.54	14.00
285PSL1700	0.20	0.58	11.90
286PSL1701	0.14	0.72	10.68
287PSL1702	0.12	0.79	10.9
361CSL1600	.381	.750	11.8
361CSL1601	.264	.810	12.5
361CSL1602	.181	.990	14.1
362CSL1604	.138	1.05	12.2
362CSL1606	.098	1.20	10.8
363CSL1607	.069	1.37	12.2
431CSL6202	.021	.811	15.1
431CSL6204	.048	.637	13.6
431CSL6206	.037	.679	13.82
431CSL6208	.013	.715	12.20
432PSL6210	.021	.811	15.1
432PSL6212	.023	.866	14.1
433PSL6216	.012	1.067	16.2
433PSL6220	.012	.974	15.6

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE STATOR	ROTOR	EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ
281PSL1500	4.20	.400	11.0
281CSL1513	0.47	0.72	4.3
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282CSL1515	0.21	0.82	6.2
282PSL1714	0.19	0.35	13.0
282PSL1715	0.19	0.35	13.0
282PSL1716	0.11	0.36	12.4
283CSL1517	0.08	1.14	12.7
283PSL1717	0.5	0.41	11.8
283PSL1718	0.07	0.46	10.1
284CSL1518	0.06	1.41	12.5
284CSL1550	0.05	1.48	16
284PSL1750	0.05	0.55	11.1
285PSL1711	0.04	0.58	11.0
286PSL1712	0.03	0.71	9.7
287PSL1713	0.02	0.78	12.3
361PSL1611	.070	.750	17.5
361PSL1612	.043	.857	16.1
361CSL1613	.037	.926	13.6
362CSL1615	.019	1.20	17.0
363CSL1617	.012	1.35	23.0
431PSL6222	.025	.516	9.9
431PSL6224	.013	.615	13.8
431PSL6226	.009	.643	15.1
432PSL6228	.007	.852	11.2

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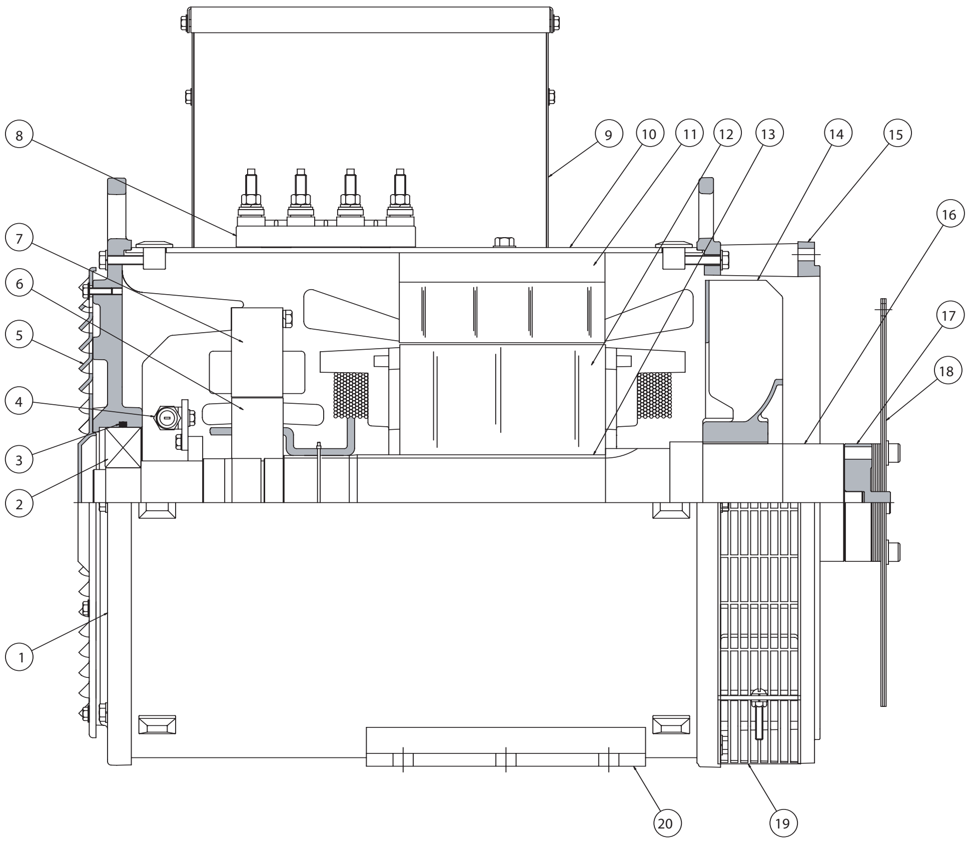
PARTS LIST – SINGLE BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring (280 and 360 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Cover	15	Mounting Adapter (SAE)
6	Exciter Rotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board (terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 360 frame MagnaPLUS®. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

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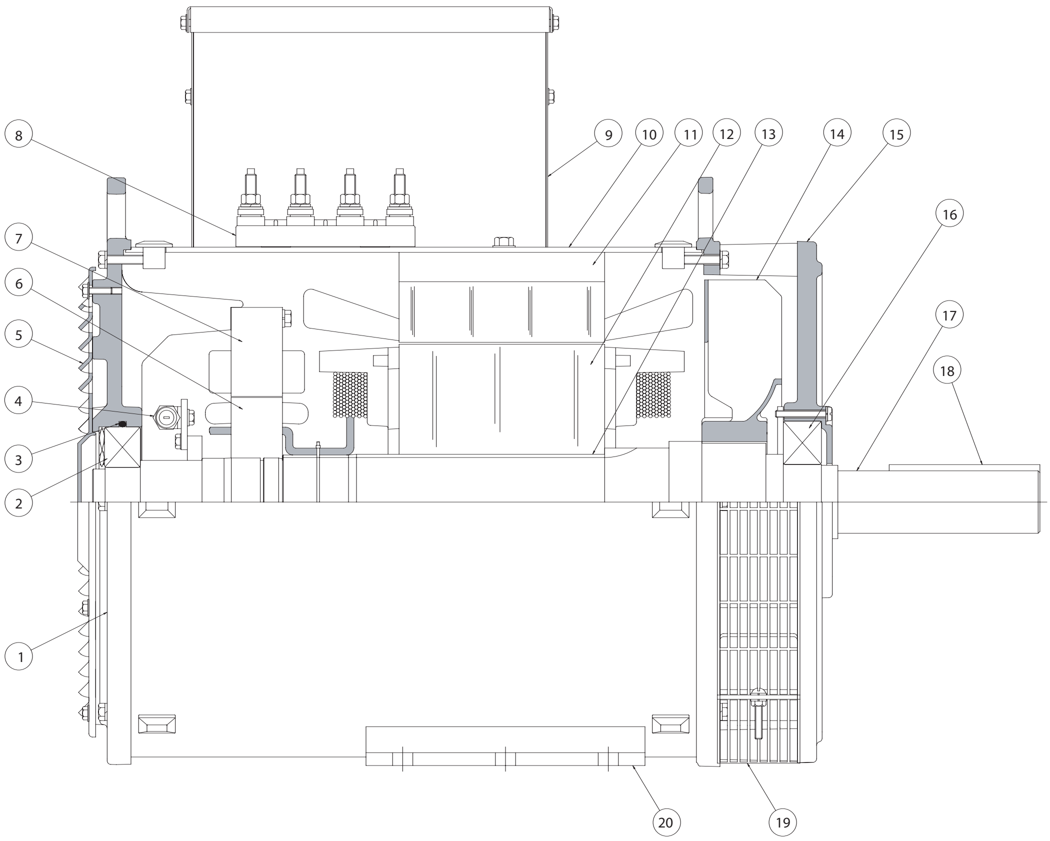
PARTS LIST – DUAL BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing (nondrive end)	12	Main Rotor
3	O-ring (280 and 360 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Cover	15	End Bracket (drive end)
6	Exciter Rotor	16	Bearing (drive end)
7	Exciter Stator	17	Shaft
8	Link Board (terminal block)	18	Key
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 360 frame MagnaPLUS®. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

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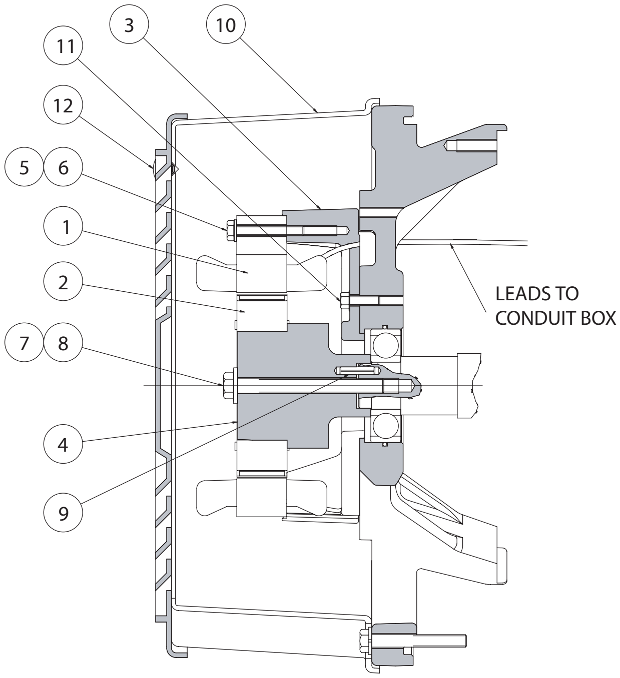
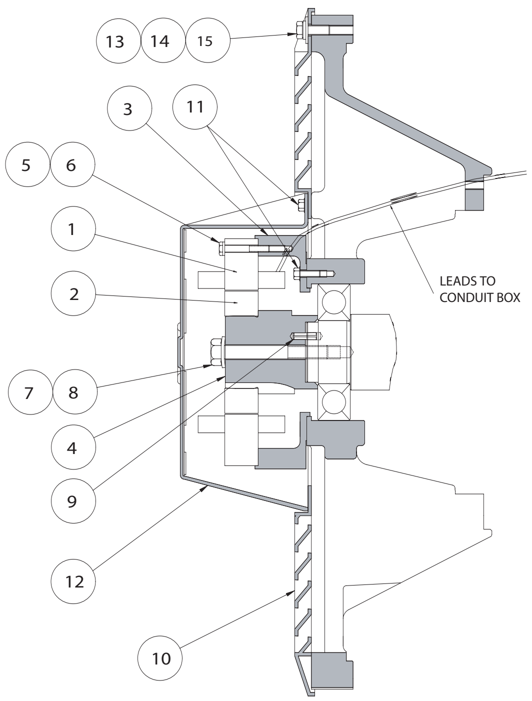
PARTS LIST – PMG GENERATORS



Typical 280 and 360 Frame Add-On PMG

Item	Description	Qty
1	PMG Stator Assembly	1
2	PMG Rotor Assembly	1
3	Stator Adaptor	1
4	Shaft, PMG rotor	1
5	Screw, Hex Hd Flg Lock 1/4 - 20	4
6	Washer, Belleville - 1/4	4
7	Hex Hd Cap Screw, 1/2 - 13 x 4"	1
8	Washer, Belleville - 1/2	4
9	Roll Pin 0.25 x .88	1
10	Drip Cover - PMG Add-on	1
11	Screw, Hex Hd Flg Lock 1/4-20	4
12	Pushpin	4



Typical 430 Frame Add-On PMG

Item	Description	Qty
1	PMG Stator Assembly	1
2	PMG Rotor Assembly	1
3	Stator Adaptor	1
4	Shaft, PMG rotor	1
5	Screw, Hex Hd Flg Lock 1/4 - 20	4
6	Washer, Belleville, 1/4	4
7	Hex Hd Cap Screw, 1/2 - 13 x 4"	1
8	Washer, Belleville, 1/2	1
9	Roll Pin 0.25 x .88	1
10	Air Intake - PMG Add-on	1
11	Screw, Hex Hd Flg Lock 1/4 - 20	4
12	PMG Cover	1
13	Hex Hd Cap Screw, 3/8 - 16	6
14	Washer, flat - 3/8	6
15	Washer, split lock - 3/8	6

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MARATHON ELECTRIC
GENERATORS
A REGAL-BELOIT COMPANY

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INSTRUCTIONS

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FOR ANALOG VOLTAGE CONTROLLER
Model AVC63-4 (P/N 9166800136)
Model AVC63-4D (P/N 9166800134)

Power Systems Group
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INTRODUCTION

AVC63-4 and AVC63-4D analog voltage controllers regulate voltage on 50 or 60 hertz brushless generators. The controllers include frequency compensation, over-excitation shutdown, solid-state buildup circuitry, and EMI filtering.

AVC63-4 adjustment potentiometers are located on the terminals and components side of the controller (see Figure 1). AVC63-4D adjustment potentiometers are accessed through the controller front panel (see Figure 2).

SPECIFICATIONS

Output Power

Maximum Continuous:	4 Adc at 63 Vdc (252 W)
One Minute Forcing:	7 Adc at 100 Vdc (700 W) with 240Vac power input

Exciter Field DC Resistance

15 to 100 Ω

Input Power

Range:	190 - 240 Vac, ±10%, single-phase
Frequency:	50/60 Hz, ±10%
Burden:	500 VA

Sensing Input

190 to 240 Vac, single-phase, 50/60 Hz, ±10%, common with ac power input

Voltage Adjustment Range

171 to 264 Vac

Regulation Accuracy

Better than ±1.0%, no-load to full-load

Response Time

Less than 1.5 cycles for ±5% changes is sensing voltage

EMI Suppression

Internal electromagnetic interference (EMI) filtering

Overexcitation Shutdown

Field voltage shuts down after time delay if exciter field voltage exceeds 100 Vdc, ±5%. (See *Overexcitation Shutdown* for inverse time delay curve and description.)

Voltage Buildup

Automatic voltage buildup occurs for residual generator voltages as low as 6 Vac.

Power Dissipation

8 W maximum

Temperature

Operating:	–40 to 140°F (–40 to 60°C)
Storage:	–85 to 185°F (–65 to 85°C)

Vibration

2 to 27 Hz:	1.3 G
27 to 52 Hz:	0.036 inches, double-amplitude
52 to 1000 Hz:	5 G

Shock

Withstands up to 20 G in each of three mutually perpendicular axes.

Weight

8 oz (220 g) net

Agency Certification

UL recognized and CSA certified

CONTROLS

AVC63-4 and AVC63-4D controls consist of jumpers and screwdriver-adjusted potentiometers.

Jumpers

Two jumpers connect to the controller terminals: the Corner Frequency jumper and the Voltage Adjust Rheostat jumper. These jumpers are shown in Figure 3.

Corner Frequency Jumper

Analog voltage controllers are delivered with the Corner Frequency Jumper set for 60 hertz operation. This gives a corner frequency of 55 hertz. For 50 hertz operation and a corner frequency of 45 hertz, the Corner Frequency jumper must be moved to the 50 Hz terminal.

Voltage Adjust Rheostat Jumper

Analog voltage controllers are delivered with the Voltage Adjust Rheostat jumper connected across terminals 6 and 7. This enables adjustment of the generator output voltage through the controller's internal Voltage Control potentiometer. Clockwise rotation of the voltage control increases generator voltage.

If remote adjustment of the generator output is desired, the Voltage Adjust Rheostat jumper must be replaced with a user-supplied rheostat. A 1000 ohm, ½-watt rheostat will provide adequate voltage adjustment range for most applications. Figure 8 shows the proper remote rheostat connections.

Potentiometer Controls

AVC63-4 potentiometer controls are located on the components and terminals side of the controller and are shown in Figure 1. AVC63-4D potentiometer controls are accessible through the controller front panel and are shown in Figure 2.

INPUT POWER/SENSING INPUT

Power for the exciter field and analog voltage controller is derived from the generator output. The acceptable power input range is 171 to 264 Vac and is connected to terminals 3 and 4. Connect wiring as shown in the interconnection diagram of Figure 8.

EXCITER FIELD POWER CIRCUIT

Controller terminal F+ is connected to the brushless exciter field positive terminal and controller terminal F– is connected to the brushless exciter field negative terminal.

CAUTION
The exciter field dc resistance must be 15 Ω or greater and less than 100 Ω.

If the exciter field dc resistance is less than 15 Ω and the full-load field current does not exceed the maximum continuous current rating of the controller, a resistor of

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sufficient wattage must be added in series with the field to increase the total resistance to 15 Ω.

FREQUENCY COMPENSATION

The frequency compensation feature improves system load pickup performance by restraining voltage recovery until the frequency has also started to recover. Figures 4 and 5 illustrate the underfrequency characteristics of the AVC63-4 and AVC63-4D.

The corner frequency range is set for 50 hertz or 60 hertz by connecting the Corner Frequency jumper to the appropriate terminal. Refer to *Controls, Jumpers* for details about selecting the corner frequency range.

The corner frequency setting is adjusted by the Underfrequency control (potentiometer). Clockwise rotation of the Underfrequency control increases the corner frequency and counterclockwise rotation decreases the corner frequency. If user adjustment of this factory-set potentiometer is desired, follow the *Preliminary Setup* and *System Startup* procedures.

OVEREXCITATION SHUTDOWN

The overexcitation shutdown feature removes controller output power, after a time delay, if the exciter field voltage exceeds 100 Vdc, ±5%. The time delay is inversely proportional to the magnitude of the detected overvoltage—up to 135 Vdc. Beyond 140 Vdc, the field voltage is removed after approximately 2 seconds. Figure 6 shows the over-excitation shutdown time delay characteristic curves.

Once the output power is removed, the controller can be reset by decreasing the input voltage to less than 10 Vac for two seconds, minimum. This can be achieved by stopping the prime mover or by interrupting the controller input power with a reset switch.

INSTALLATION

Mounting

The AVC63-4 and AVC63-4D controllers may be mounted on the generator in any convenient position. Figure 7 shows the outline dimensions and drilling locations. Dimensions are shown in inches with millimeters in parenthesis.

The recommended mounting hardware is two #8 or M4 screws torqued to 9 inch-pounds (0.9 newton meters). Nylon-lined locking nuts are recommended when installing the controller with loose hardware.

Connections

AVC63-4 and AVC63-4D controller terminals consist of quarter-inch, quick-connect tabs.

Figure 8 shows a typical interconnection diagram for the AVC63-4 and AVC63-4D controllers.

OPERATING PROCEDURES

The following procedures provide instructions for adjusting the AVC63-4 and AVC63-4D controllers. Symptoms caused by certain generator system problems or a faulty controller are included along with suggested remedies.

CAUTION

Meggers and high-potential test equipment must not be used. Use of such equipment could damage the semiconductors contained in the controller.

Preliminary Setup

Complete the following steps before proceeding with system startup.

1. Verify that the analog voltage controller specifications conform with the requirements of the generator system.
2. Ensure that the controller jumpers are positioned as follows.
   a. If a remote voltage adjust rheostat will not be used, ensure that the Voltage Adjust Rheostat jumper is connected across terminals 6 and 7.
   b. If a 55 hertz corner frequency for a 60 hertz system is desired, connect the Corner Frequency jumper to the 60 Hz terminal. If a 45 hertz corner frequency for a 50 hertz system is desired, connect the Corner Frequency jumper to the 50 Hz terminal.
3. Ensure that the connections between the generator system and the controller are correct.
4. Install the fuses as shown in Figure 8.
5. Set the controller's Voltage control fully counter-clockwise and the remote voltage adjust rheostat (if used) to the centered position.
6. Adjust the controller's Stability control fully clockwise. This provides the most stability and the slowest response.
7. If user adjustment of the Underfrequency control is required, start with the potentiometer adjusted to the fully counterclockwise position. Then, slowly adjust the potentiometer clockwise to set.

System Startup

NOTE

All voltage readings are to be taken with an average-reading voltmeter.

1. Perform the steps under *Preliminary Setup*.
2. Start the prime mover and bring it up to rated speed. Generator voltage should build up. If it does not build up, perform the steps under *Field Flashing*.
3. Slowly adjust the controller's Voltage control (or remote voltage adjust rheostat) until the generator voltage reaches the nominal level.

   If the voltage does not build up to the rated level:
   a. Check the generator output for excessive load or a short-circuit.
   b. If a minimal residual of 6 volts is not present, perform the steps under *Field Flashing*.
4. Apply and remove the generator load to verify stability.

   If the generator responds too slowly or hunts (oscillates):
   a. Check the generator output for excessive load or a short-circuit. Adjust the controller's Stability control with no load applied.
   b. Check the stability of the governor system.
5. Check regulation under normal operating conditions.

   If the regulation is poor:
   a. Verify that the prime mover is operating at rated speed.
   b. Verify that the voltmeter is connected to the same point as the controller sensing.
   c. Use an average-sensing voltmeter (not an rms-sensing voltmeter).
6. Verify the corner frequency setting by slowly reducing the generator frequency until the generator output voltage just starts to decrease.

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If adjustment of the corner frequency is required:

a. Rotate the Underfrequency control fully counter-clockwise.
b. Reduce the generator frequency from nominal (either 50 Hz or 60 Hz) to the desired corner frequency.
c. Slowly adjust the Underfrequency control clockwise until the generator output voltage just starts to decrease.

Field Flashing

When the controller is operated with the generator for the first time, the polarity of the field's residual magnetism may not be correct or the magnitude may not be high enough. If generator voltage does not increase after startup, stop the prime mover and perform the following steps.

1. With the prime mover at rest, connect a dc source in series with a 3 to 5 Ω limiting resistor to the field's positive (F+) and negative (F–) terminals. The dc source should not be grounded and should not have an output greater than 12 Vdc.
2. Apply the dc voltage for approximately 3 seconds, then remove it.
3. With controller terminals 3 and 4 disconnected, start the prime mover and measure the voltage at the generator output terminals.
4. If the voltage is greater than 6 Vac, voltage buildup should be successful and controller terminals 3 and 4 can be reconnected. If less than 6 Vac is measured, repeat steps 1 through 3. If repeating these steps does not result in generator voltage buildup, contact Basler Electric.

OPERATIONAL TEST

1. Connect the analog voltage controller as shown in Figure 9. Do not apply power. Ensure that the light bulbs are rated for 120 volts and less than 100 watts.
2. Adjust the controller's Voltage control and remote voltage adjust rheostat (if used) fully counterclockwise.
3. Apply 240 Vac, 60 Hz power to the controller. The light bulbs should flash momentarily.
4. Slowly adjust the controller's Voltage control clockwise.

Results

1. Before minimum luminance is reached, the light bulbs should attain maximum luminance to signify the regulation point.
2. At the regulation point, a small change in the Voltage control or remote voltage adjust rheostat position should turn the light bulbs on or off.

CONTROLLER DIFFERENCES

Previous versions of the AVC63-4 controller, sold prior to mid-2003, are slightly different in appearance and control adjustment.

Your controller version can be determined by the location of the heat sinks. Figure 10 shows the heat sink location on the previous and current version of the AVC63-4.

Adjustment of the Underfrequency Control is different on previous versions of the AVC63-4. When adjusting the Underfrequency Control on previous versions, clockwise rotation decreases the corner frequency and counter-clockwise rotation increases the corner frequency. References to the rotation of the Underfrequency control in this publication should be reversed when adjusting the corner frequency on previous versions of the AVC63-4.

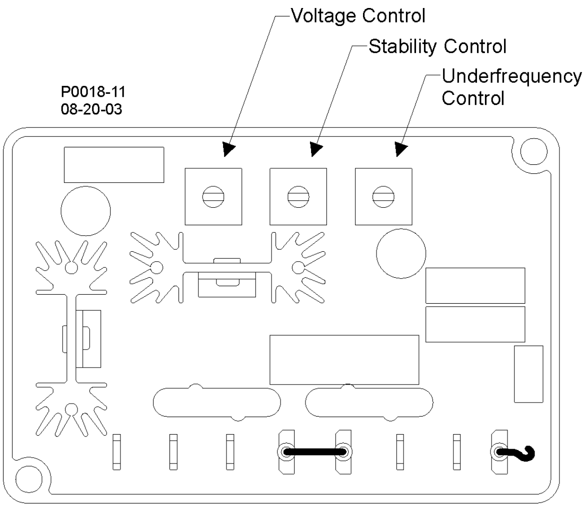

Figure 1. AVC63-4 Potentiometer Control Locations

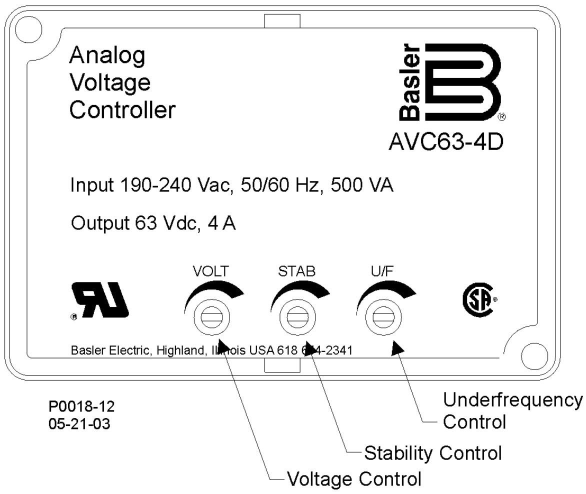

Figure 2. AVC63-4D Potentiometer Control Locations

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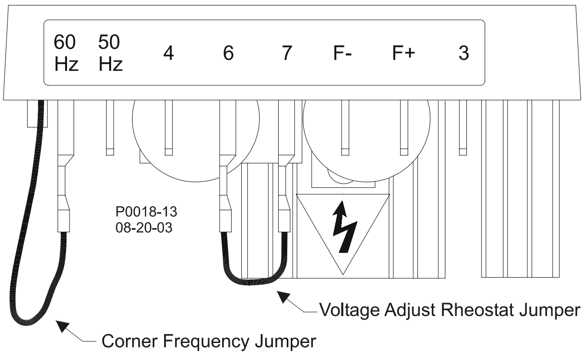


Figure 3. Jumper Locations

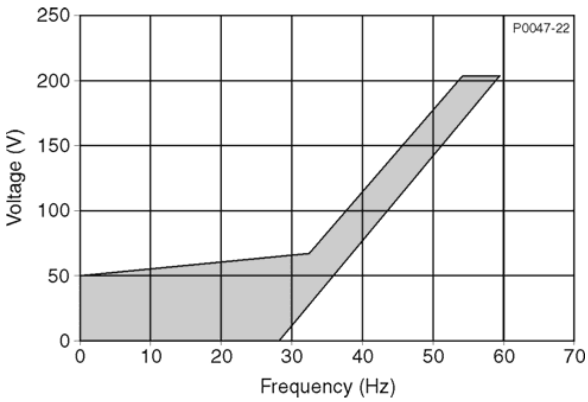


Figure 4. Frequency Compensation Characteristic - 60 Hz

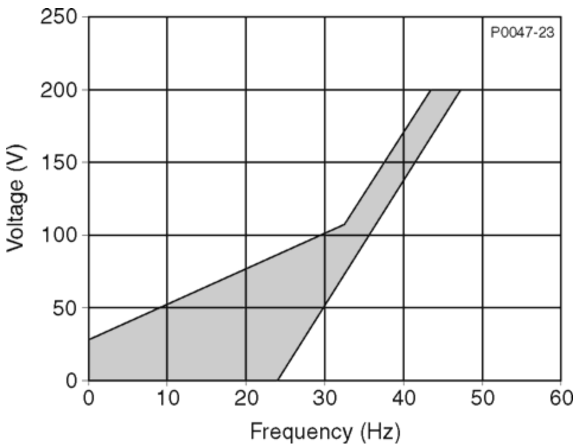


Figure 5. Frequency Compensation Characteristic - 50 Hz

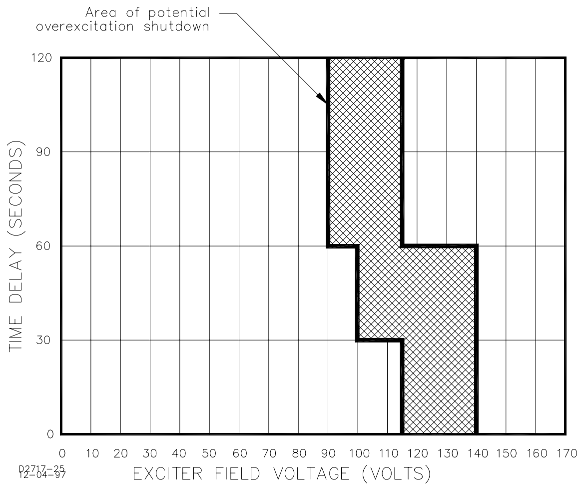
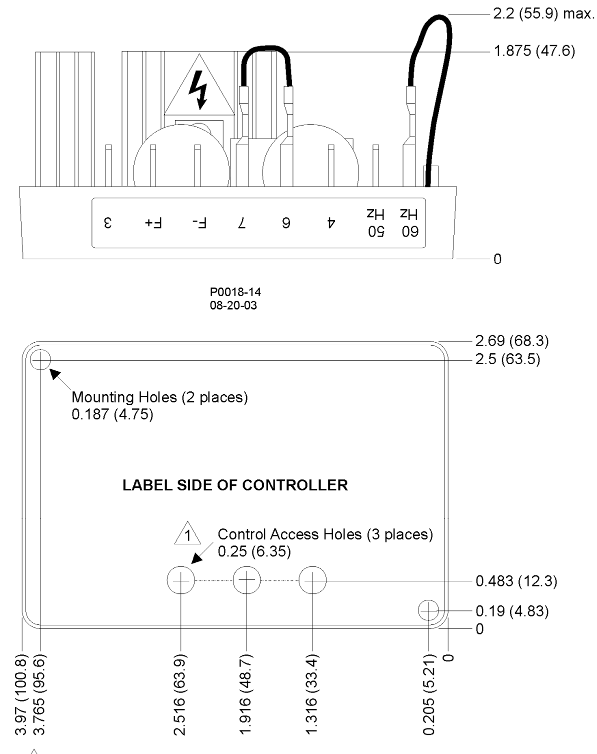


Figure 6. Overexcitation Shutdown
Time Delay Characteristic



1 Control access hole locations apply to AVC63-4D only.

Figure 7. Outline and Drilling Dimensions

TIM-ID: 0000002059 - 001

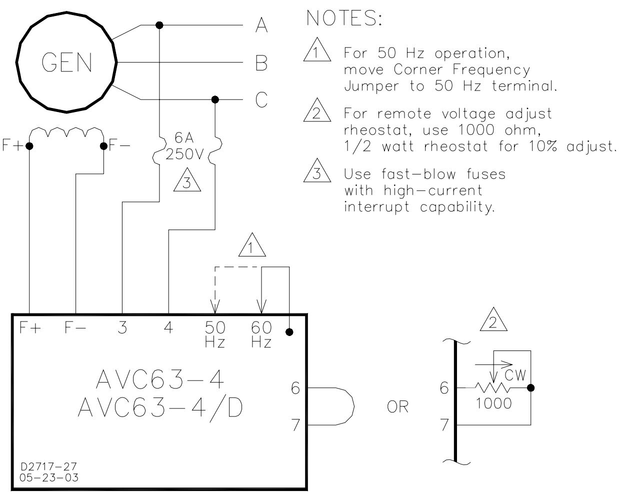


Figure 8. Typical Interconnection, 208/240 V Nominal

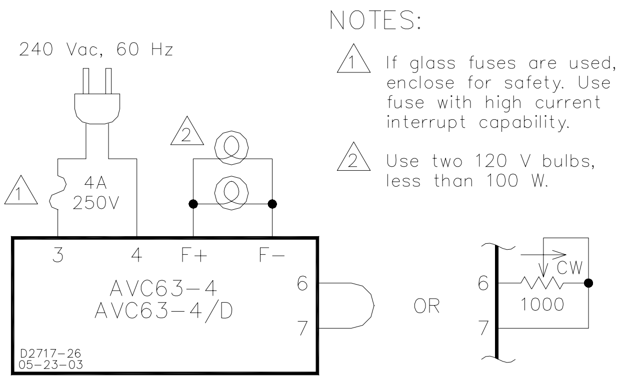


Figure 9. Operational Test Diagram

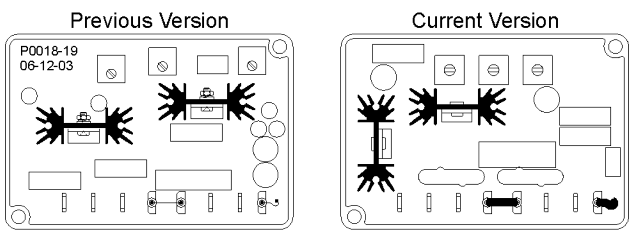


Figure 10. Controller Version Heat Sink Locations

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NOTES

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Generator Set Maintenance

The maintenance system for MTU Onsite Energy products is based on a preventive maintenance concept. Preventive maintenance facilitates advance operational planning and ensures a high level of equipment availability. The maintenance intervals and the scope of required maintenance activities are the result of operational experience and therefore represent recommendations. Severe operating and ambient conditions may require additional maintenance work and/or modification of the maintenance intervals. Maintenance activities are specified with intervals based on hours in operation and time limits. Whichever value is reached first shall apply. All tasks may not be applicable to your system, depending on the configuration of your unit. Only do the maintenance tasks that apply to your unit.

Maintenance and repair work is to be carried out by trained and authorized personnel only. Do not allow unauthorized personnel on or near the engine when the engine is serviced. Work on or around this engine must be performed by people who have the necessary training, skills, and tools to do the work. Improper maintenance or repair work can cause severe injury or death for yourself or bystanders. MTU Onsite Energy recommends that owners, operators, and certified technicians become familiar with applicable national safety standards. To reduce the risk of severe injury or death, follow all codes, standards, regulations, and laws pertaining to installation and application.

This maintenance schedule complements but does not replace the engine maintenance schedule within the engine manual contained in this document. For engine maintenance information, refer to the engine documentation. To ensure you have the most current version of the engine manual, contact the engine manufacturer or MTU Onsite Energy.

Interval [h]	Limit	Maintenance tasks
Daily	-	Check engine oil level.
Daily	-	Drain off water and contamination from fuel prefilter.
Daily	-	Check general condition of engine-generator set and all components. Inspect for leaks or spills.
Daily	-	Check air flow into and out of unit, remove debris from ventilation system.
Daily	-	Inspect service indicator of air filter.
-	1 m	Test run at not below 1/3 load and at least until steady-state temperature is reached (monthly). Refer to Installation and Basic Operation manual.
500	6 m	Test status lights and gauges on controller and annunciator.
500	6 m	Check cooler / radiator elements externally for contamination and leaks.
-	1 a	Clean radiator core face.
500	1 a	Fit new fuel prefilter or new fuel prefilter insert.
500	1 a	Check wiring visually for damage.
500	1 a	Check generator bearings and replace if necessary. Refer to generator manual.
500	1 a	Check voltage regulator and adjust if needed.
500	1 a	Check circuit breaker condition visually and carry out function tests. Refer to circuit breaker manual.
500	1 a	Test jacket water heater / preheater functionality.
-	5 a	Replace controller backup battery (MGC-3000 Series Controller).
-	10 a	Replace controller backup battery (MGC-2000 Series Controller).
w = weeks m = months a = years		

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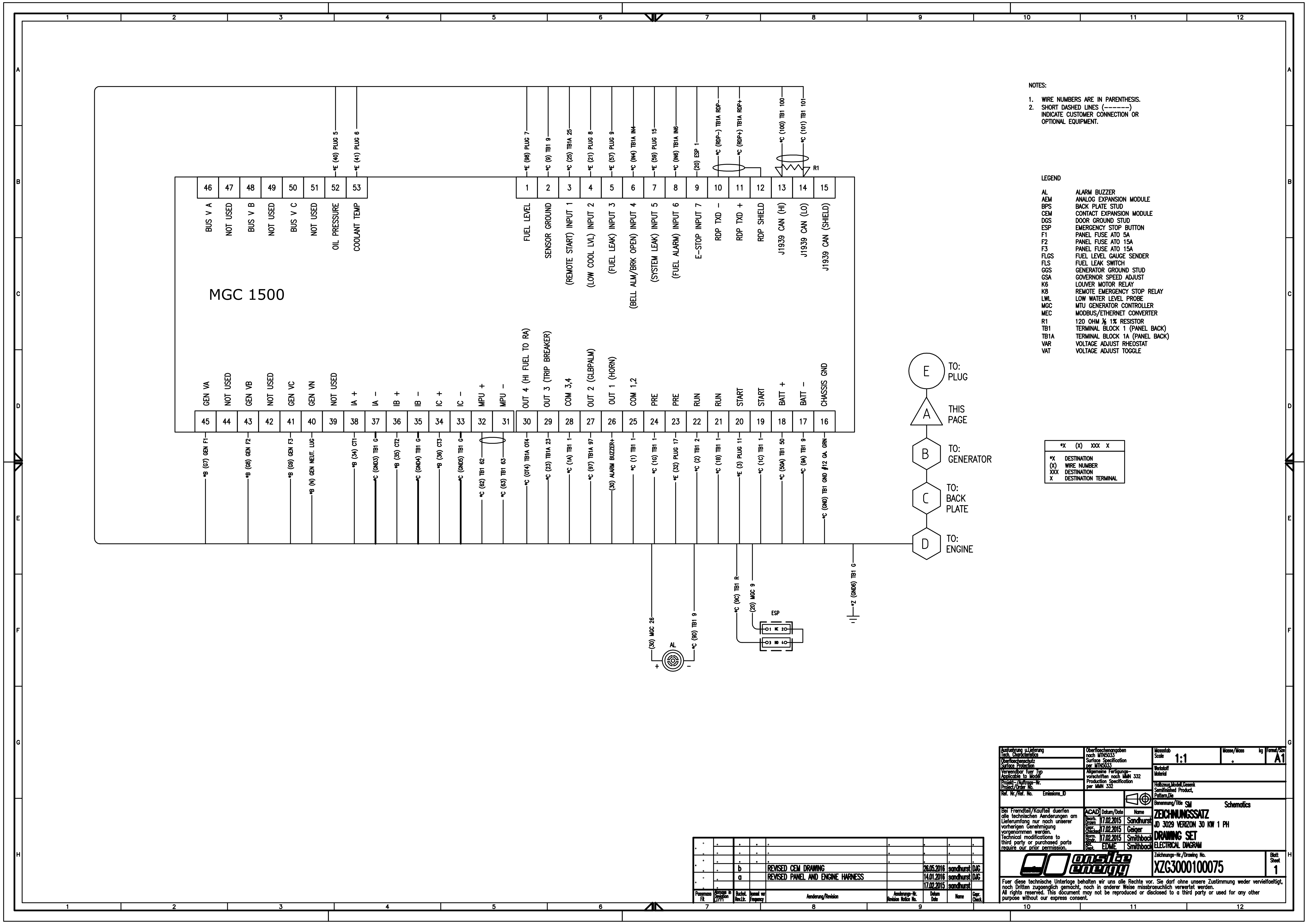
TIM-ID: 0000069565 - 003

TIM-ID: 0000106972 - 001

3 Drawings

3.1 Electrical Drawing XZG3000100075 Sheet 1 of 4



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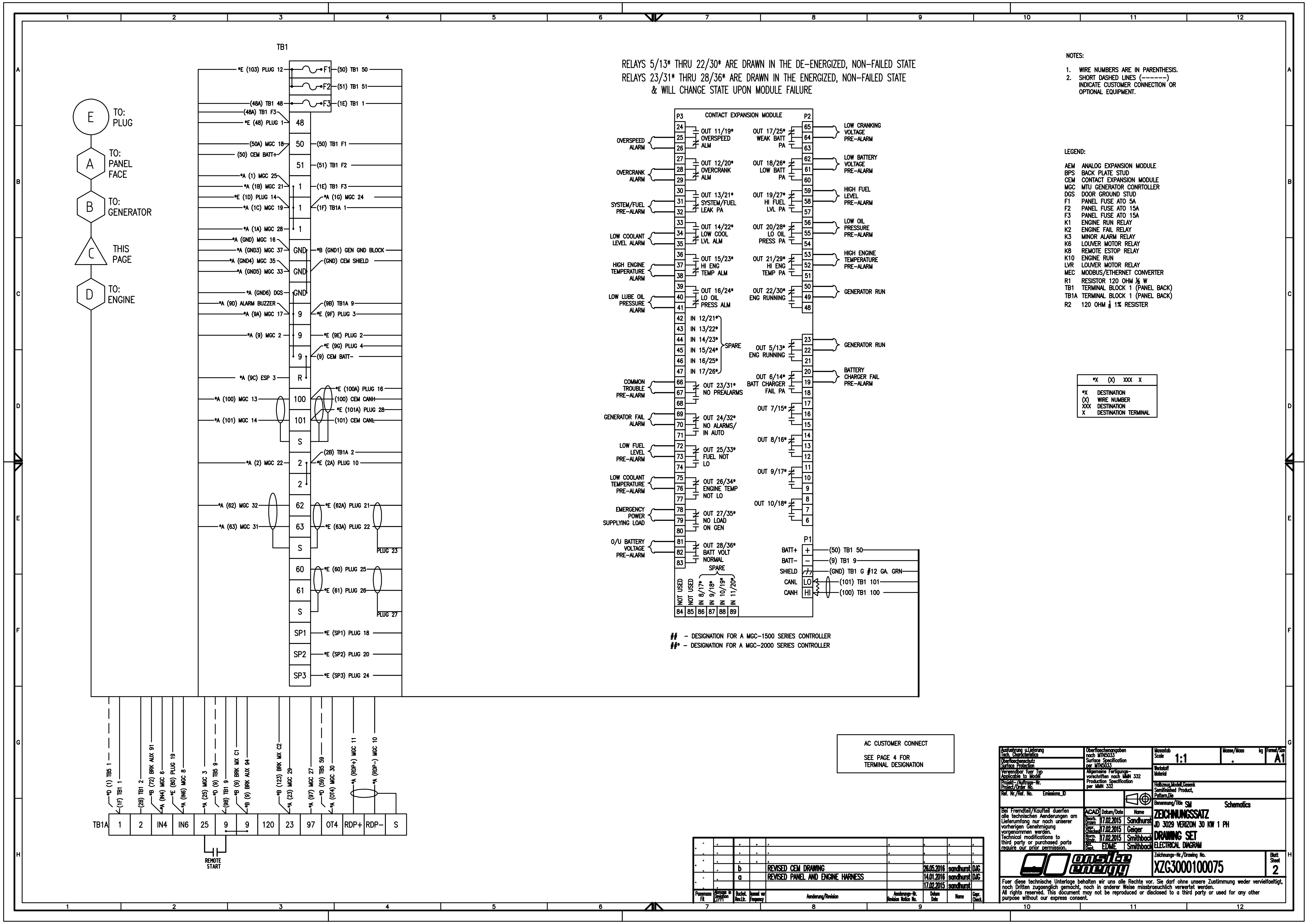
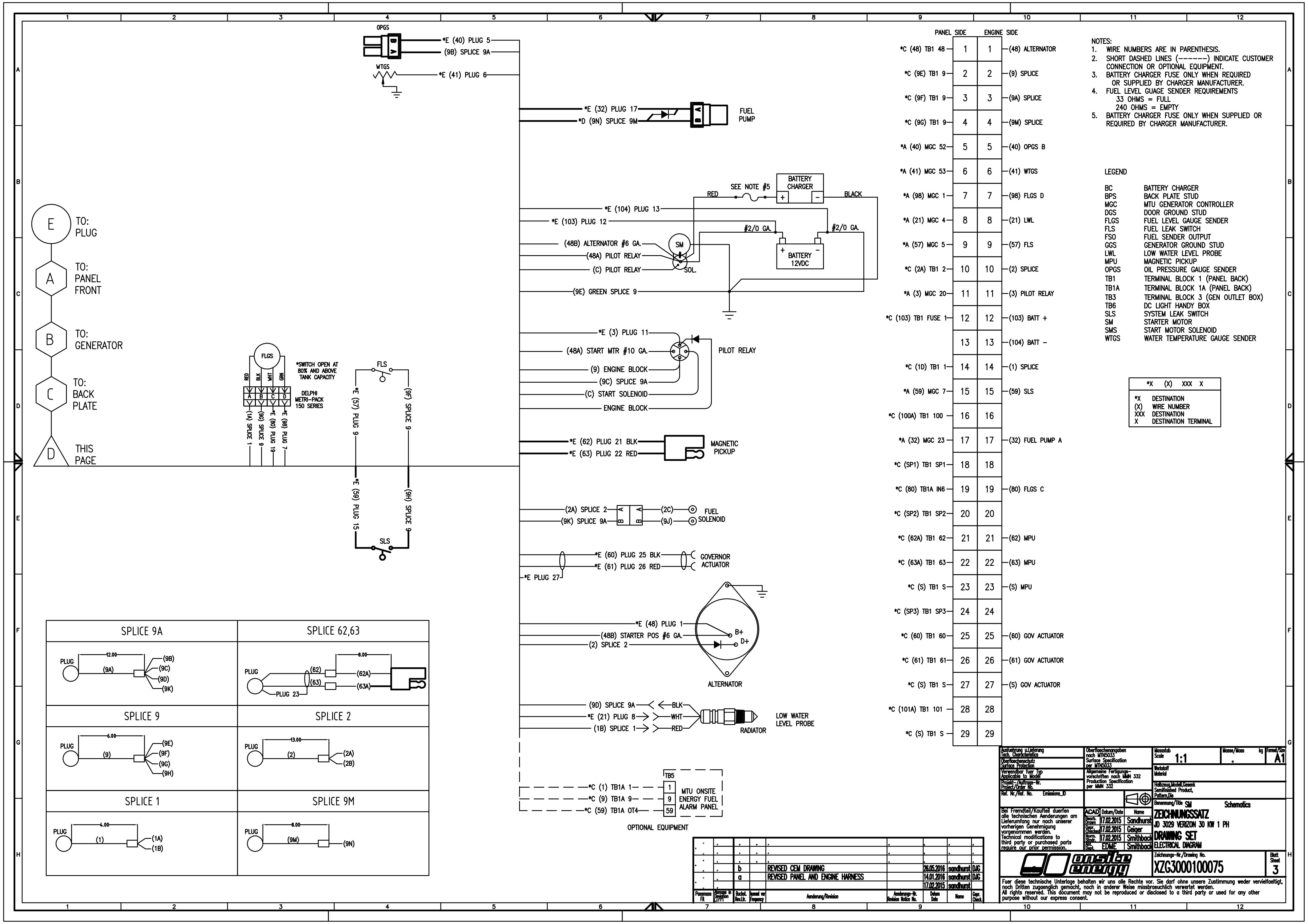
TIM-ID: 0000097204 - 004



RELAYS 5/13* THRU 22/30* ARE DRAWN IN THE DE-ENERGIZED, NON-FAILED STATE
RELAYS 23/31* THRU 28/36* ARE DRAWN IN THE ENERGIZED, NON-FAILED STATE
& WILL CHANGE STATE UPON MODULE FAILURE
CONTACT EXPANSION MODULE
NOTES:
1. WIRE NUMBERS ARE IN PARENTHESIS.
2. SHORT DASHED LINES (------) INDICATE CUSTOMER CONNECTION OR OPTIONAL EQUIPMENT.
LEGEND:
AEM ANALOG EXPANSION MODULE
BPS BACK PLATE STUD
CEM CONTACT EXPANSION MODULE
MGC MTU GENERATOR CONTROLLER
DGS DOOR GROUND STUD
F1 PANEL FUSE ATO 5A
F2 PANEL FUSE ATO 15A
F3 PANEL FUSE ATO 15A
K1 ENGINE RUN RELAY
K2 ENGINE FAIL RELAY
K3 MINOR ALARM RELAY
K6 LOUVER MOTOR RELAY
K8 REMOTE ESTOP RELAY
K10 ENGINE RUN
LVR LOUVER MOTOR RELAY
MEC MODBUS/ETHERNET CONVERTER
R1 RESISTOR 120 OHM ½ W
TB1 TERMINAL BLOCK 1 (PANEL BACK)
TB1A TERMINAL BLOCK 1 (PANEL BACK)
R2 120 OHM ½ 1% RESISTER
*X DESTINATION
(X) WIRE NUMBER
XXX DESTINATION
X DESTINATION TERMINAL
E TO: PLUG
A TO: PANEL FACE
B TO: GENERATOR
C THIS PAGE
D TO: ENGINE
- DESIGNATION FOR A MGC-1500 SERIES CONTROLLER
#* - DESIGNATION FOR A MGC-2000 SERIES CONTROLLER
AC CUSTOMER CONNECT
SEE PAGE 4 FOR TERMINAL DESIGNATION
REMOTE START
b REVISED CEM DRAWING 26.05.2016 sandhurst DJG
a REVISED PANEL AND ENGINE HARNESS 14.01.2016 sandhurst DJG
17.02.2015 sandhurst
ZEICHNUNGSSATZ
JD 3029 VERIZON 30 KW 1 PH
DRAWING SET
ELECTRICAL DIAGRAM
XZG3000100075
Sheet 2
1:1
A1
SM Schematics

TIM-ID: 0000097205 - 004

3.3 Electrical Drawing XZG3000100075 Sheet 3 of 4



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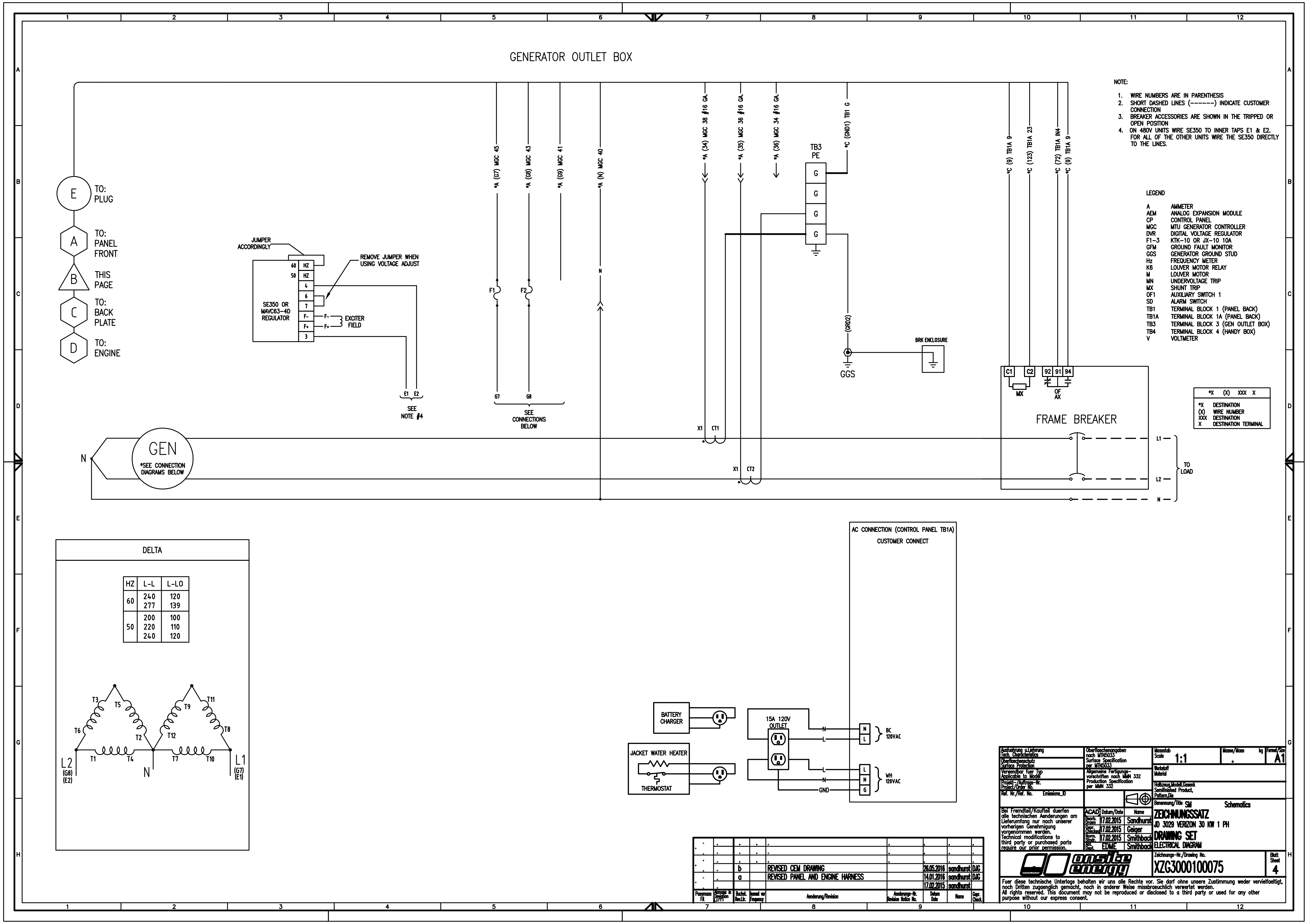
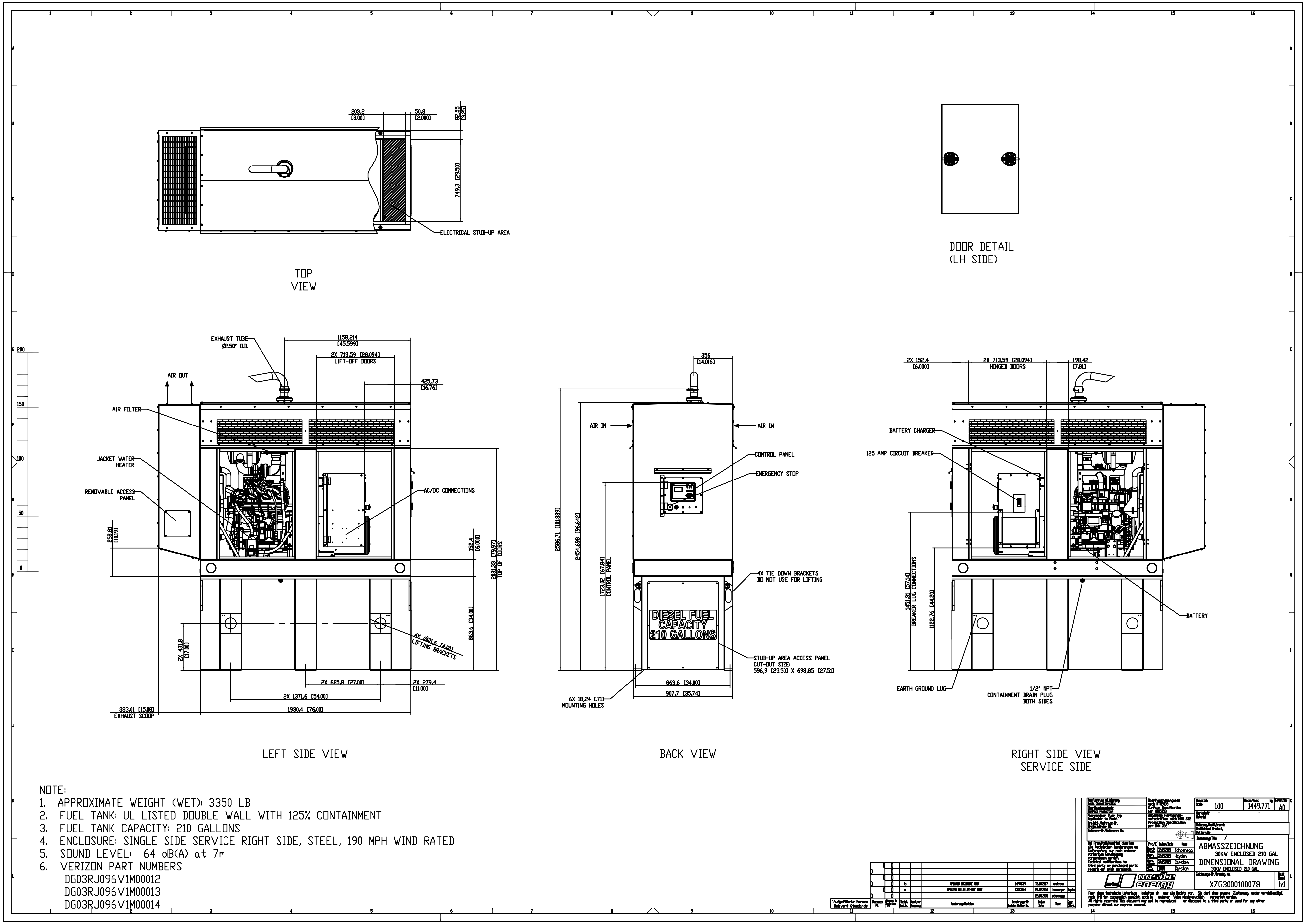

GENERATOR OUTLET BOX
NOTE:
1. WIRE NUMBERS ARE IN PARENTHESIS
2. SHORT DASHED LINES (------) INDICATE CUSTOMER CONNECTION
3. BREAKER ACCESSORIES ARE SHOWN IN THE TRIPPED OR OPEN POSITION
4. ON 480V UNITS WIRE SE350 TO INNER TAPS E1 & E2. FOR ALL OF THE OTHER UNITS WIRE THE SE350 DIRECTLY TO THE LINES.
LEGEND
A AMMETER
AEM ANALOG EXPANSION MODULE
CP CONTROL PANEL
MGC MTU GENERATOR CONTROLLER
DVR DIGITAL VOLTAGE REGULATOR
F1-3 KTK-10 OR JX-10 10A
GFM GROUND FAULT MONITOR
GGS GENERATOR GROUND STUD
Hz FREQUENCY METER
K6 LOUVER MOTOR RELAY
M LOUVER MOTOR
MN UNDERVOLTAGE TRIP
MX SHUNT TRIP
OF1 AUXILIARY SWITCH 1
SD ALARM SWITCH
TB1 TERMINAL BLOCK 1 (PANEL BACK)
TB1A TERMINAL BLOCK 1A (PANEL BACK)
TB3 TERMINAL BLOCK 3 (GEN OUTLET BOX)
TB4 TERMINAL BLOCK 4 (HANDY BOX)
V VOLTMETER
E TO: PLUG
A TO: PANEL FRONT
B THIS PAGE
C TO: BACK PLATE
D TO: ENGINE
JUMPER ACCORDINGLY
REMOVE JUMPER WHEN USING VOLTAGE ADJUST
SE350 OR MAVC63-4D REGULATOR
EXCITER FIELD
SEE NOTE #4
SEE CONNECTIONS BELOW
TB3 PE
GGS
BRK ENCLOSURE
FRAME BREAKER
TO LOAD
GEN
*SEE CONNECTION DIAGRAMS BELOW
*X DESTINATION
(X) WIRE NUMBER
XXX DESTINATION
X DESTINATION TERMINAL
DELTA
HZ L-L L-LO
60 240 120
277 139
50 200 100
220 110
240 120
AC CONNECTION (CONTROL PANEL TB1A)
CUSTOMER CONNECT
BATTERY CHARGER
JACKET WATER HEATER
THERMOSTAT
15A 120V OUTLET
BC 120VAC
WH 120VAC
b REVISED CEM DRAWING 26.05.2016 sandhurst DJG
a REVISED PANEL AND ENGINE HARNESS 14.01.2016 sandhurst DJG
17.02.2015 sandhurst
Scale 1:1
A1
SM Schematics
ZEICHNUNGSSATZ
JD 3029 VERIZON 30 KW 1 PH
DRAWING SET
ELECTRICAL DIAGRAM
17.02.2015 Sandhurst
17.02.2015 Geiger
17.02.2015 Smithback
EDME Smithback
XZG3000100075
Sheet 4
onsite energy

TIM-ID: 0000097207 - 004

3.5 Dimensional Drawing XZG3000100078



NOTE:
1. APPROXIMATE WEIGHT (WET): 3350 LB
2. FUEL TANK: UL LISTED DOUBLE WALL WITH 125% CONTAINMENT
3. FUEL TANK CAPACITY: 210 GALLONS
4. ENCLOSURE: SINGLE SIDE SERVICE RIGHT SIDE, STEEL, 190 MPH WIND RATED
5. SOUND LEVEL: 64 dB(A) at 7m
6. VERIZON PART NUMBERS
   DG03RJ096V1M00012
   DG03RJ096V1M00013
   DG03RJ096V1M00014

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