

ARMSTRONG POWER SYSTEMS

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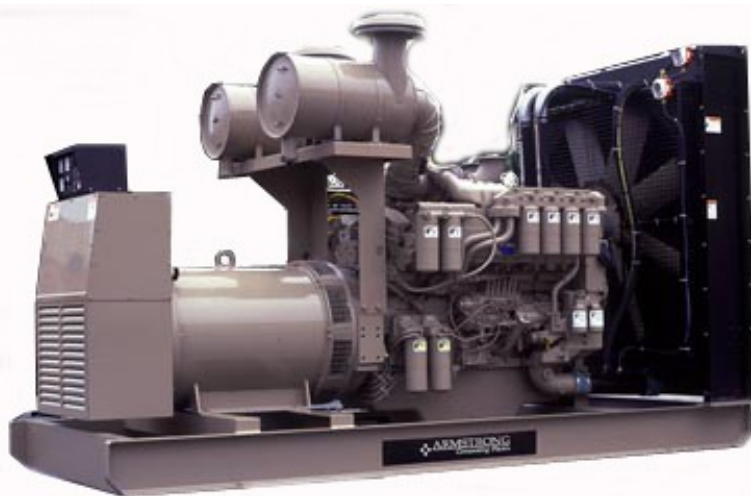
OWNERS MANUAL

CUMMINS SERIES:

**MODELS A50CU, A75CU, A05CU, A200CU, A300CU, A400CU,
A500CU, A600CU, A830CU, A1000CU**

SAVE THESE INSTRUCTIONS

This manual contains important instructions regarding for all Armstrong Power Systems LLC power generator Models. The information contained here must be followed during installation and maintenance of the generator and batteries. Keep this



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This manual contains important instructions regarding for all Armstrong Power Systems LLC power generator Models. The information contained here must be followed during installation and maintenance of the generator and batteries. Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the new owner.

You are now the owner of a Armstrong Power generator powered by CUMMINS engine. All our components keep the highest standards in quality, efficiency and durability.

Each unit pass thru a complete test and inspection to guarantee the quality of your unit. We provide warranty on every component subject to the warranty coverage and limitations.

To get the best results from your new generator please read carefully this document before starting the unit and follow the instructions.

If you have any question regarding your equipment please call your dealer or contact us. Please have the generator model, and serial numbers when you call. Parts may be obtained directly from our distributors.

Once again thank you for your trust in Armstrong Power and welcome to our family.

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WARRANTY CERTIFICATE

The warranty period for the power generator begins on the date of sale and continues for a period of 2 years or 1500 hours (what ever comes first).

Responsibilities: a) As the owner, you are responsible for the performance of the required maintenance listed on your operators manual. b) Armstrong Power may deny your warranty coverage if your engine or part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Coverage: Armstrong Power warrants that your unit shall be free from defects in materials and workmanship which cause the unit to fail. During the period mentioned above from the date of the original sale.

Limitations: this warranty certificate shall not cover any of the following. a) Repair or replacement required because of misuse or neglect, improper maintenance, repairs improperly performed or replacements not conforming to Armstrong Power specifications that adversely affect performance and/or durability, and alteration or modifications not recommended or approved in writing by Armstrong Power. b) Replacement of parts and other services and adjustments necessary for required maintenance at and after the first scheduled replacement point.





IMPORTANT SAFETY INSTRUCTIONS

1. INTRODUCTION

This manual provides general safety information for installing, operating and maintenance of Armstrong Power equipments. The purchaser should comply with the instructions and information in this manual, and is strongly advised that all personnel to be associated with the equipment supplied should be made familiar with the information contained herein.

It is essential that the personnel engaged in the installation, commissioning and maintenance of this equipment are both competent and experienced in these fields, and that they comply with the relevant statutory requirements and regulations, including the provisions of the Health and Safety act 1974, and any such modifications and amendments which may subsequently become a legal requirement.

The equipment supplied by Armstrong Power should be installed by, or under the supervision of, competent personnel in accordance with good engineering practice, established codes of practice, those statutory requirements applicable to the installation site, the IEE regulations as applicable and, where the appropriate, in accordance with any instructions specifically advised by the company.

You are requested, in accordance with the needs of safe operation and the provisions of the act, to take such steps as are necessary to ensure that the appropriate information on the proper use and handling of our equipment is made available by yourself to all those concerned. Similarly, this information must be available to anyone who may purchase, or otherwise acquire from your self, such products for use in their own premises.

2. GENERAL

The generating set is designed to be safe when used in the correct manner. The following safety precautions, if followed will minimize the possibility of accidents. Before performing any procedure or operating technique, it is up to the user to ensure that it's safe. The generating set should only be operated by personnel who are authorized and trained.

Warning:

- Read and understand all safety precautions, and warnings before operating the generating set.
- Failure to follow the instructions, procedures and safety precautions in this manual may increase the possibility of accidents and injuries.
- Never start the generating set unless it is safe to do so.
- Do not attempt to operate the generating set with a known unsafe condition.
- If the generating set is unsafe, fit danger notices and disconnect the battery negative (-) lead so that it cannot be started until the condition is corrected.
- Disconnect the battery negative (-)lead prior to attempting any repairs or cleaning inside the enclosure, if equipped.
- Appropriate firefighting equipment is to hand.
- The metal work on every part of the generating set must be connected by means of an earth continuity conductor to an effective earth point.
- Care must be taken to avoid spillage from the batteries.
- No loose items or combustible material should be left on or against any part of the generator.
- Do not risk injury by coming into contact with moving parts of the plant, or by allowing anything to be drawn in by the cooling fan or intake system.
- Install and operate this generating set only in full compliance with relevant National, local or federal codes, standards or other requirements.

3. FIRE AND EXPLOSION



Risk of serious injuries or death

Fuels and fumes associated with generating sets can be flammable and potentially explosive. Proper care in handling these materials can dramatically limit the risk of fire or explosion. However, safety dictates that fully charged BC and ABC fire extinguishers are kept on hand. Personnel must know how to operate them.

- The acids in the battery can cause explosion.
- Avoid any contact between the tools and the terminals in the battery.
- Never use metallic objects on the neck or hands when handling the set.
- Never connect the negative terminal from the battery to the positive terminal from the starter.
- Don't smoke or allow sparks, flames or other sources of ignition around the fuel or batteries.
- Use adequate equipment to take fuel from the set.
- Never test the battery by touching together the terminals.
- Ensure the generating set room is properly ventilated.
- Don't touch the battery charger or the connections during the battery charging process.
- Always disconnect the negative terminal from the battery before to start any work on the unit.
- Keep the room, the floor and the generating set clean. When spills of fuel, oil, battery electrolyte or coolant occur they should be cleaned up immediately.
- Never store flammable liquids near the engine.
- Store oily rags in covered metal containers.
- Avoid refilling the fuel tank while the engine is running.
- Do not attempt to operate the generating set with any known leaks in the fuel system.

4. INSTALLATION, HANDLING AND TOWING

- Make electrical connections in compliance with relevant electrical codes, standards or other requirements. This includes requirements for grounding and ground/earth faults.
- For stationary generating sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant codes, standards or other requirements.
- Engine exhaust emissions are hazardous to personnel. The exhaust for all indoor generating sets must be piped outdoors via leak-free piping in compliance with relevant codes, standards and other requirements. Ensure hot exhaust silencers, piping and turbochargers, if equipped, are clear of combustible material and are guarded for personnel protection per safety requirements. Ensure that fumes from the exhaust outlet will not be hazard.
- Never lift the generating set by attaching to the engine or alternator lifting lugs. Use a sling with a "spreader bar" connected to the base frame.
- Ensure the lifting rigging and supporting structure is in good condition and has capacity suitable for the load.
- Keep all personnel away from the generating set when it is suspended.
- Make sure all personnel are out of the generating set canopy or container, if equipped, before closing and latching enclosure doors.
- When towing a mobile generating set, observe all codes, standards or other regulations and traffic laws. These include those regulations specifying required equipment and maximum and minimum speeds. Ensure brakes, if fitted, are in good order.
- Do not permit personnel to ride in or on the mobile generating set. Do not permit personnel to stand or ride on the drawbar or to stand or walk between the generating set and the towing vehicle.
- Do not install or use the generating set in any classification of hazardous environment unless it has been specifically designed for that environment.

5. MECHANICAL



The generating set is designed with guards for protection from moving parts. Care must still be taken to protect personnel and equipment from other mechanical hazards when working around the generating set.

- Do not attempt to operate the generating set with safety guards removed. While the generating set is running do not attempt to reach under or around the guards to do maintenance or for any other reason.
- Keep hands, arms, long hair, loose clothing and jewellery away from pulleys, belts and other moving parts.



Attention!! Some moving parts can not be seen clearly when the set is running.

- Keep access doors on enclosures, if equipped, closed and locked when not required to be open.
- Avoid contact with hot oil, hot coolant, hot exhaust gases, hot surfaces and sharp edges and corners.
- Wear protective clothing including gloves and hat when working around the generating set.
- Do not attempt to remove the radiator filler cap until the coolant has cooled. Then loosen the cap slowly to relieve any excess pressure before removing the cap completely.
- Ethyl ether starting aids **must not** be used on engines with combustion air preheating devices. These starting aids will reduce the efficient working life of the engine.

6. CHEMICAL



Fuels, oils coolants, lubricants and battery electrolyte used in this generating set are typical of the industry. However they can be hazardous to personnel if not treated properly.



- Do not swallow or have skin contact with fuel, oil, coolant, lubricants and battery electrolyte. If swallowed, seek medical treatment immediately. Do not induce vomiting if fuel is swallowed. For skin contact, wash with soap and water.
- Do not wear clothes that has been contaminated by fuel or lube oil.
- Wear an acid resistant apron and face shield or goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.
- Always keep good ventilation when the equipment is working. Carbon Monoxide inhalation cause death. Always maintain inspection routine of the exhaust system.

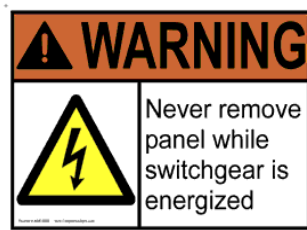
7. NOISE



Generating sets that are not equipped with sound attenuating enclosures can produce noise levels in excess of 105 dBA. Prolonged exposure to noise levels above 85 dBA is hazardous to hearing.

- Ear protection must be worn when operating or working around an operating set.

8. ELECTRICAL



Safe and efficient operation of electrical equipment can be achieved only if the equipment is correctly installed, operated and maintained.



- The generating set must be connected to the load only by trained and qualified electricians who are authorized to do so, and in compliance with relevant electric codes, standards and other regulations.
- Ensure the generating set, is effectively grounded/earthed in accordance with all relevant regulations prior operation.
- The generating sets should be shutdown with the battery negative (-) terminal disconnected prior to attempting to connect or disconnect load connections.
- Do not attempt to connect or disconnect load connections while standing in water or on wet or soggy ground.
- Do not touch electrical energized parts of the generating set and/or interconnecting cables or conductors with any part of the body or with any non insulated conductive object.
- Place the control panel cover as soon as connection or disconnection of the load cables is complete. **Do not** operate the generating set without the cover securely on place.
- Connect the generating set only to loads and/or electrical systems that are compatible with it's electrical characteristics and that are within it's rated capacity.
- Be sure all power is disconnected from the electrical equipment being serviced.
- Keep all electrical equipment clean and dry. Replace any wiring where the insulation is cracked, cut, abraded or otherwise degraded. Replace terminals that are worn, discolored or corrode. Keep terminals clean and tight.
- Insulate all connections and disconnected wires.
- Use only class BC or Class ABC extinguishers on electrical fires.

9. FIRST AID FOR ELECTRIC SHOCK

Identification / look out for:

- Unconsciousness and Burns
- Establish site of entry and exit of electric shock

What to do:

- Switch off the main switch.
- Break the contact between electrical source and patient using dry non-conductive object like wooden stick.
- Call for help.
- If breathing and heartbeat has stopped begin CPR

1. CALL

Check the victim for unresponsiveness. If there is no response, Call 911 and return to the victim. In most locations the emergency dispatcher can assist you with CPR instructions.

2. BLOW



Tilt the head back and listen for breathing. If not breathing normally, pinch nose and cover the mouth with yours and blow until you see the chest rise. Give 2 breaths. Each breath should take 1 seconds.

3. PUMP



If the victim is still not breathing normally, coughing or moving, begin chest compressions. Push down on the chest $1\frac{1}{2}$ to 2 inches 30 times right between the nipples. Pump at the rate of 100/minute, faster than once per second.

CONTINUE WITH 2 BREATHS AND 30 PUMPS UNTIL HELP ARRIVES.

In unconscious patient with intact breathing and pulse recovery position ensures the prevention of tongue falling back and blocking the airway.

What to do:

- Place the patient on their back.
- Lift the chin to ensure the air way is open.
- Patient's arm on your side should be positioned so as to make a right angle with his body, with elbow bent and palm facing out.
- Patient's other arm on opposite side should be placed across the chest, with back of their hand against the cheek on your side of the patient.
- Pull up the patient's knee joint (side away from you) as it bends with the foot flat on the ground. Roll over the patient in this position towards your side.
- By tilting the patient's head back ensure that the airway is open.
- The uppermost leg should be adjusted in such a way that the hip and knee are at right angles.

Seek immediate medical help / ambulance.

10. SPECIAL CONSIDERATIONS FOR BATTERY

CAUTION – 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 and seek medical attention, and
- 4) Spilled electrolyte is to be washed down with an acid neutralizing agent. A common practice is to use a solution of one pound (500 grams) bicarbonate of soda to one gallon (4 liters) of water. The bicarbonate of soda solution is to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.

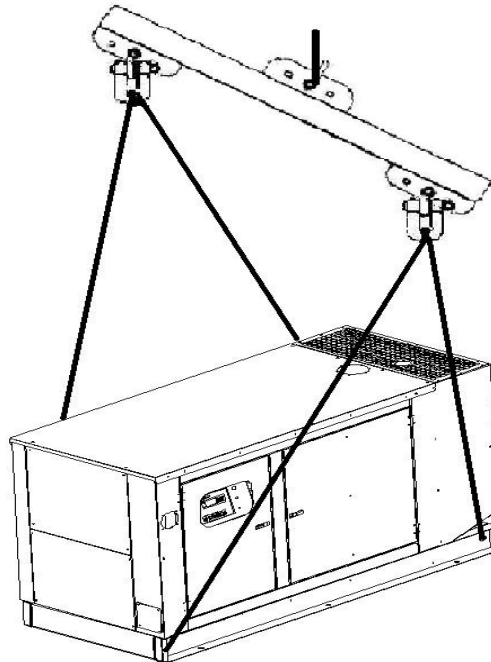
CAUTION – Lead-acid batteries present a risk of fire because they generate hydrogen gas. The following procedures are to be followed:

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

ARMSTRONG

POWER SYSTEMS

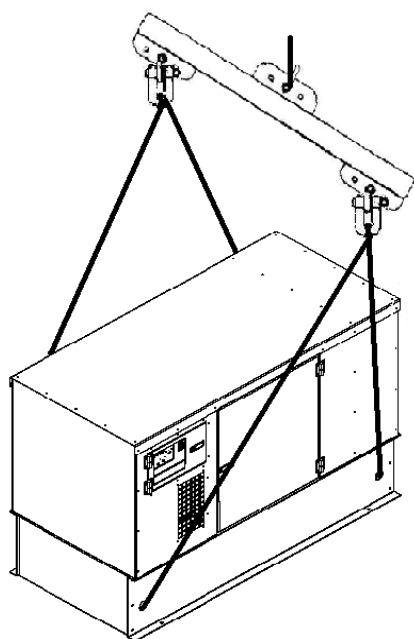
GENERATING SET INSTALLATION



1. LOCATION

The generating set sub base tank or frame (if it's the case) is specifically designed for ease of moving the set. Improper handling can cause serious damage to the generator and components.

Never lift the generating set by attaching lugs to the engine or alternator. Shackles and chains of suitable length and lifting capacity must be used. A spreader bar is required to prevent damaging the set.



See the drawings:

The location for a generator is dependent on applicable codes and associated support systems for the generator such as ventilation, wiring, fuel, and exhaust.

The following factors should be considered:

- The ideal location for any generator is away from extreme ambient temperatures and where the generator is protected from adverse weather conditions. It is recommended that generator be as close to the load it is supporting as possible.
- The structure where the Generator Set will be set upon must be strong enough to support the weight of the Gen-Set, its' auxiliary equipment, and other equipment mounted on the structure.
- The structure must meet a 1 hour non-combustion fire rating.
- The installation site must be clean, dry and not subject to flooding.
- Because of excessive ambient temperatures associated with the use of stand-alone metal sheds from exposure to sunlight, a concrete pad with a supported

roof and an outside security enclosure (fence) to protect the unit from vandalism, birds, rodents, and other small animals is recommended.

- The Gen-Set generates heat while running. Installing the Gen-Set in a tightly enclosed building or shed is not recommended. The site must provide for adequate cooling and ventilation with a minimum of duct work. Adequate ventilation for a generator is specified in cubic feet per minute.
- The site must permit engine exhaust gases to be piped away to an area that is uninhabited by people or animals. Care must be given to ensure that exhaust gases do not re-enter an occupied area.
- The outside site must provide access to the generator to allow for maintenance, service, and repair. A three foot (.914 meter) service clearance around the unit is recommended.
- Fuel supply and ease of refueling must be taken into consideration.
- Adequate normal and emergency lighting must be provided in any installation.

1.1. GROUND/FLOOR LOADING

The foundation for the generator must support the total weight of the generator. This includes fuel, oil, and the weight of any associated support systems.

Plan for 3 feet (1 Meters) of access around the generator for maintenance, service and repair.

When calculating the floor loading, ensure the fuel weight, cooling system fluids (where applicable), piping, pumps, power cables/runways and supporting structures are included in the calculations.

2. MOUNTING

A concrete foundation with anchored mounting bolts, is recommended. Steel Beams are an acceptable alternative. Foundations help in the servicing and repair of Gen-Set's and protect the unit from moisture that could occur from seepage. The concrete base that the generator is mounted to should be separate and independent from the surrounding structure.

The following applies to concrete bases:

A Single (See Figure 1) or Double (See Figure 2) pedestal base may be used. A height of at least 6 inches higher than floor level is recommended.

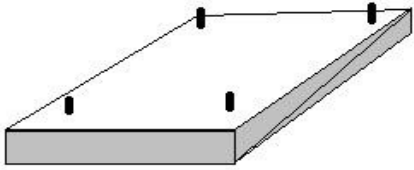


Figure 1- Single Pedestal Concrete Mount

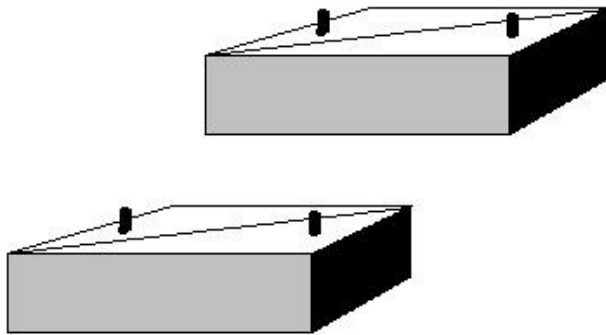
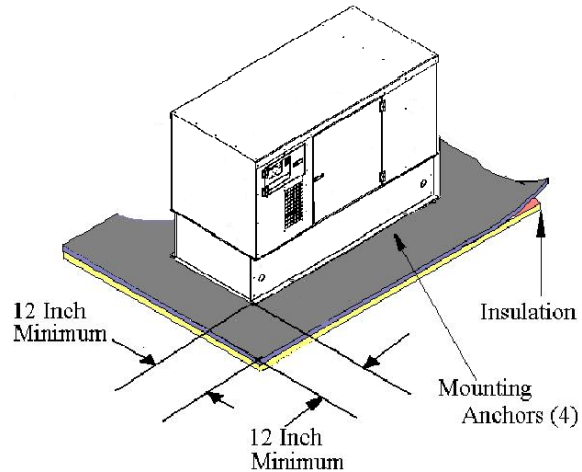


Figure 2 - Double Pedestal Concrete Mount

- A double pedestal base allows easier cleaning under most generator's.
- Double pedestals provide better access for inspecting for oil or fuel tank leaks.
- The generator should be retained to the pedestal base with fasteners that are recommended by the generator set manufacturer.
- The concrete base should extend beyond the generator's "Footprint" by at least 12 Inches (305 mm) on all sides.
- The higher the mounting base is made, the easier the unit will be to work on when performing maintenance, service, or repairs. Typically bases are required to be raised at least 6 inches (153 mm) above floor level. Placing the unit higher than 6 inches sometimes has the advantage of making it easier to change the unit's oil.
- Passing fuel lines and electrical conduit for a "stub-up" through the concrete base is a standard practice of gen-set installers.

- Concrete foundations are typically mixed by volume. The typical ratio of cement, sand, and aggregate is 1:2:3 with a maximum 4 inch (102 mm) slump and 28 day compressive strength of 2500 psi (173 kPa).
- A generator can typically be mounted to a combustible floor or roof, dependent upon code, however, the surface beneath the engine and beyond the engine to a minimum distance of 12 inches (305 mm) must be



covered with a non combustible insulation and a minimum of 24 gage sheet metal between the insulation and the generator. See Figure 3.

Figure 3. Combustible Floor and Roof

- Optional vibration isolators beyond those already built in the generator also help reduce transmitted noise, however, it is recommended that one verify that the generator manufacturer recommends the use of an isolator.
- Insulation must be a non-combustible material, typically a Fiberglas mat.

3. VENTILATION

3.1. OUTDOOR INSTALLATIONS - AIR COOLED UNITS

If your generator is expected to be in temperatures lower than -20°F(-29°C) a cold weather package may be required.

The following general rules apply:

- Where strong prevailing winds are anticipated, face the engine end away from the wind.
- Plan the installation carefully to prevent the cooling air vents on the generator from becoming clogged by leaves, grass, snow, etc.

4. ELECTRICAL SYSTEM

There are a number of different generator systems and typical loads in the context of electrical systems. Most systems, unless they contain automated switch gear, have a means of disconnect between the generator and the load. This is typically a transfer switch or disconnect. Ensure the contacts on the switch are rated for the size of your system.

4.1. GENERAL ELECTRICAL SYSTEM

When mounting electrical panels, a 3 foot clearance is required and the use of an emergency light to illuminate the unit during operation is typically required. Power for the emergency light should be from both the primary utility and the generator. This is highly recommend so that in the event of a malfunction there is a light source to see to work on the unit. Refer to your local building and electrical codes to ensure compliance.

4.2. CONDUCTOR SIZING CONNECTION

This information is dependent upon your generator output and intended load. When connecting cables to the generator, make connections at the generator first. Make the connections at the load last. Failure to do so may constitute a fire or safety hazard.

All ampacities are typically calculated at 75 ° C (Celsius) (167 ° F(Fahrenheit)) in the conductor size charts. Building wire conductors should be rated at 90°C(194°F) to allow for different ambient temperatures that these conductors may pass through.

All conductors are typically required by electrical code to be copper. The recommended conductor sizes are based on maximum current. Ampacities are found in NEC Article 310, Table 310-16. Conductor resistances are found in NEC Table 8 "Conductor Properties".

4.3. CONNECTING THE GENERATOR

Please refer to the electrical drawing of the unit and your transfer switch documentation for information related.

Leave the installation only to a trained personnel and don't forget to observe the local laws and permit requirements.

Errors during the installation may damage the equipment and electrical devices connected to the unit and may create fire and electrocution risks.

5. EXHAUST SYSTEM

5.1. GENERAL (EXHAUST SYSTEM)

Generator engines give off deadly carbon monoxide gas through their exhaust systems.

Carbon monoxide gas, if breathed in sufficient concentrations, can cause unconsciousness or death. Exhaust gases must be piped safely away from any room or enclosure that houses a generator and to a well ventilated area where

people will not be endangered.

Besides the possibility of carbon monoxide poisoning, exhaust piping becomes extremely hot during operation and remains hot for a long time after shutdown. For that reason, the following precautions are necessary:

- Avoid contact with hot engines, exhaust manifolds, exhaust piping and mufflers. Any of these can cause severe burns.
- Where piping must pass through combustible walls or ceilings, special precautions must be taken to prevent fire or heat damage such as using heat thimbles through walls and ceilings.

5.2. GENERAL RULES FOR EXHAUST SYSTEM

When installing an exhaust system for a generator, the following rules should be considered:

- Exhaust piping should be of wrought iron or steel having adequate strength and durability.
- Exhaust fittings may be of cast iron. A 9 inch spacing (10 inches (250mm) recommended) from the exhaust pipe and walls is also required by most local codes.
- Low points in horizontal runs of piping should be provided with condensation traps, as well as condensation drains.
- Piping and mufflers must be properly supported and connected.
- A flexible length of exhaust pipe is required between the engine exhaust manifold and rigid exhaust piping.
- Exhaust piping must be terminated safely outside a structure that houses a generator, in such a way that hot gases and sparks will be discharged harmlessly and will not blow against any combustible surface or material.
- Exhaust piping must not terminate under loading platforms, structures, or near any opening in a building.
- Where necessary, exhaust piping must be guarded and/or insulated to prevent burns.
- Provide a clearance of at least 9 inches (229mm)(10 inches (250mm) recommended) between exhaust piping and any combustible material.
- Keep exhaust piping well clear of fuel tanks, fuel lines, etc.

5.3. RAIN CAP

A rain cap is recommended on the end of the exhaust pipe. The rain cap is attached to the end of the pipe and opens due to the pressure from the exhaust discharge force. The rain cap protects the exhaust system from the environment when the system is not running.

5.4. SPARK ARRESTOR

Use of a spark arrestor is required by the U.S. Department of Forestry if located on lands under their jurisdiction. The spark arrestor is recommended in areas where combustible

6. INSTALLATION CHECKLIST

BATTERY INSTALLATION

- ☐ Battery is connected properly.
- ☐ Recommended battery is installed.
- ☐ Cables are clean and tight.
- ☐ Terminals are coated with anti-corrosion grease, and terminal covers are positioned.

FUEL SYSTEM

- ☐ Complies with local and NFPA codes.
- ☐ Fuel is connected and checked for leaks.
- ☐ Correct fuel pressure (11-14 inches of water (0.6 psi) at all load ranges).
- ☐ Load block adjusted for maximum power for natural gas fuel.

LOCATION

- ☐ Unit is fastened to the appropriate mounting pad.
- ☐ Louvers are free from obstruction.
- ☐ Exhaust is clear of flammable objects and debris.

ELECTRICAL CONNECTIONS

- ☐ Complies with local code requirements and all National Electrical Codes.
- ☐ Utility is connected and present.
- ☐ Transfer switch is connected.
- ☐ All wires running outside of the generator are in NEC-approved conduit. *Note: Utility wires and transfer switch control wires must be in separate conduit.
- ☐ Unit is grounded to an approved earth ground.

COOLING AND VENTILATING

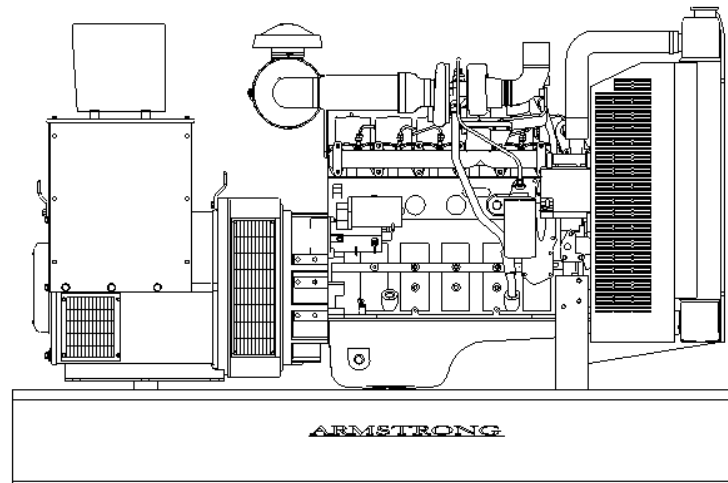
- ☐ All inlets and outlets are free from obstruction.

OTHER

- ☐ Verify that the unit is filled to the proper level with the proper break-in oil. Adjust as required.



GENERATING SET OPERATION AND MAINTENANCE



7. PRE-OPERATION CHECK

BREAK-IN

During the engine break-in period, observe the following by all means:

- Change engine oil and oil filter cartridge after the first 50 hours of operation

2. DAILY CHECK

To prevent trouble from occurring, it is important to know the conditions of the engine well. Check it before starting.

CAUTION

To avoid personal injury:

- Be sure to install shields and safeguards attached to the engine when operating.
- Stop the engine at a flat and wide space when checking.
- Keep dust or fuel away from the battery, wiring, muffler and engine to prevent a fire.

Check and clear them before operating everyday. Pay attention to the heat of the exhaust pipe or exhaust gas so that it can not ignite trash.

- 1) Oil or water leaks
- 2) Engine oil level and contamination
- 3) Amount of fuel
- 4) Amount of coolant
- 5) Dust in air cleaner dust cup
- 6) Damaged parts and loosened bolts and nuts
- 7) Emergency stop off.
- 8) Battery connections
- 9) Wiring in good condition

3. CONTROL PANEL

The **DSE 5120** automatic mains failure module has been primarily designed to start and stop the generator depending upon the mains supply status.

External autostart from a switch and user operated manual start is also provided. Additionally, you have the facility to view all the system operating parameters via the LCD display.

The **DSE 5120** module monitors the engine, indicating the operational status and fault conditions automatically shutting down the engine and giving a true first up fault condition of an engine failure by a flashing COMMON ALARM LED. Exact failure mode information is indicated by the LCD display on the front panel.



7.1. Automatic Mode of Operation



This mode is activated by pressing the pushbutton. An LED indicator beside the button confirms this action.

When the mains supply fails (or **Remote Start** signal (if configured) is applied) the following sequence is initiated:

The mains available LED extinguishes (if the sequence was started by mains failure) and the relevant mains over/under voltage LED will illuminate.

The **Remote Start Active** indicator illuminates if the sequence is started by the remote start input. To allow for short term mains supply brownouts or false start signals the Start Delay timer is initiated. After this delay, if the pre-heat output option is selected then the pre-heat timer is initiated, and the corresponding auxiliary output will energize.

After the above delays the **Fuel Solenoid** is energized, then one second later, the **Starter Motor** is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts (fixed at 3), the start sequence will be terminated and **Fail to Start** fault will be displayed accompanied by a flashing shutdown symbol.



Fail to start



Shut Down

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output.

After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilize without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected is initiated, allowing the engine to stabilize before accepting the load.

If the mains supply returns (or the remote start signal is removed if the start sequence was initiated by remote start), before the warm up timer has expired, the mains supply is kept on load and the return timer will begin.

At the end of the warming timer, If the mains supply is still failed, or the remote start signal is still active, the load is transferred to the generator - First the mains load switching device is opened, then $\frac{3}{4}$ second later, the **close generator** output is activated.

On return of the mains supply the mains in limit LED will illuminate, and the under/overvolts LEDs will extinguish. Additionally (or upon removal of the **Remote Start** signal if

the start was initiated by remote start), the **return** delay timer is initiated after which the **load Transfer** signal is de-energized, removing the load. $\frac{3}{4}$ second later, the mains load switch is closed, returning the mains on load. If the generator set has been on load, The **Cooling** timer is then initiated, allowing the engine a cooling down period off load before shutting down.

Once the **Cooling** timer expires the **Fuel Solenoid** is de-energized, bringing the generator to a stop. Should the mains supply fail, or **Remote Start** signal be re-activated during the cooling down period, the set will return on load.

7.2. Manual Operation

To initiate a start sequence in **MANUAL**, press the pushbutton. When the controller is in the manual mode (indicated by an LED indicator beside the button), pressing the **START** (I) button will initiate the start sequence.



If the **pre-heat** output option is selected this timer is then initiated, and the auxiliary output selected is energized. After the above delay the **Fuel Solenoid** is energized, then the **Starter Motor** is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts (fixed at 3), the start sequence will be terminated and **Fail to Start** fault will be displayed accompanied by a flashing shutdown indicator.



Fail to start
Shut Down



When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the fly-wheel housing can be used for speed detection (This is selected using the front panel editor or PC). After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilize without triggering the fault. Once the engine is running, the **Warm Up** timer, if selected is initiated, allowing the engine to stabilize before it can be loaded.

The generator will run off load, unless the mains supply fails, or a **Remote Start** signal is applied. The generator will continue to run **On** load regardless of the state of the mains supply and/or remote start input until the **Auto** mode is selected, the **Stop** button is pressed, or an electrical trip or shutdown alarm is detected. Selecting **STOP** (O) de-energizes the **FUEL SOLENOID**, bringing the generator to a stop.

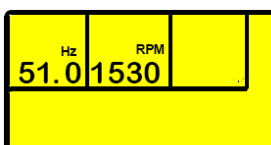
7.3. Protections

The module will indicate that an alarm has occurred in several ways:

- The “Common alarm” LED will illuminate (**Warning** = Red steady, **Shutdown** = Red Flashing)

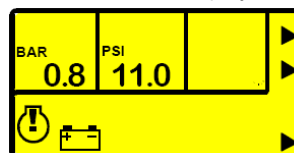


- If appropriate, the LCD display or LED indicators will display the appropriate alarm icon i.e. for battery charging failure.

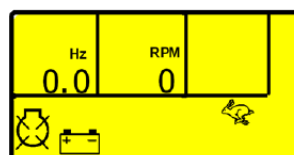


If no alarms are present the LCD will extinguish any alarm icons.

In the event of a warning alarm the LCD will display the appropriate icon. If a shutdown then occurs the module will display the appropriate icon. The original warning alarm icon will remain displayed.



Charge alternator warning (all symbols steady)



Charge alternator warning indicator still present, common alarm indicator has changed to a shutdown symbol and is now flashing. Also present is the flashing over-speed LED.

Overspeed and Shutdown alarm Icons are displayed flashing. The original warning will remain displayed as long as the triggering conditions remain. Any subsequent warnings or shutdowns that occur will be displayed steady, therefore only the first-up shutdown will appear flashing.

Warnings

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition. In the event of a warning alarm the LCD will display:

BATTERY CHARGE FAILURE

If the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator the icon will illuminate.

FAIL TO STOP

If the module detects the engine is still running when the Fail to stop timer expires, then the module will display:

AUXILIARY INPUTS

If an auxiliary input has been configured as a warning the appropriate LCD segment will be displayed.

**SHUTDOWNS**

Shutdowns are latching and stop the Generator. The alarm must be cleared, and the fault removed to reset the module. In the event of a shutdown alarm the LCD will display:



FAIL TO START, if the engine does not fire after the pre-set number of attempts has been made a shutdown will be initiated. The icon will illuminate.

**EMERGENCY STOP**

Removal of the **Positive DC** Supply from the Emergency Stop input initiates the following sequence, firstly it will initiate a controlled shutdown of the Generator and prevent any attempt to restart the Generator until the Emergency Stop push-button has been reset. Secondly it removes the **Positive DC** supply from both the Fuel Solenoid and Starter Solenoid. The icon will illuminate.

**LOW OIL PRESSURE**

If the module detects that the engine oil pressure has fallen below the low oil pressure trip setting level after the **Safety On** timer has expired, a shutdown will occur. The icon will illuminate.

**HIGH ENGINE TEMPERATURE**

If the module detects that the engine coolant temperature has exceeded the high engine temperature trip setting level after the **Safety On** timer has expired, a shutdown will occur.

The icon will illuminate.

**OVERSPEED / OVERFREQUENCY**

If the engine speed exceeds the pre-set trip a shutdown is initiated. The icon will illuminate. Overspeed is not delayed, it is an **immediate shutdown**.

**UNDERSPEED / UNDERFREQUENCY**

If the engine speed falls below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. The icon will illuminate.

**OIL PRESSURE SENDER OPEN CIRCUIT**

If the module detects a loss of signal from the oil pressure sender (open circuit) a shutdown is initiated. The LCD will indicate: (Steady) (And '—' on the engine oil pressure instrument). Sender failure is not delayed, it is an **immediate shutdown**.



AUXILIARY INPUTS, if an auxiliary input has been configured as a shutdown the appropriate LCD segment will be displayed:

**LOSS OF SPEED SIGNAL**

If the speed sensing signal is lost during cranking, a shutdown is initiated. The icon will illuminate (Steady). As engine speed cannot be determined, the entire "fail to stop" timer is observed before the alarm can be reset and the engine restarted.

**7.4. DESCRIPTION OF CONTROLS.**

The following section details the function and meaning of the various controls on the module.



Typical LCD screens

Instruments

The LCD displays the various engine parameters such as 'ENGINE SPEED', 'OIL PRESSURE', 'HOURS RUN', etc. Each instrument is displayed with the appropriate units of measure. In this example, the values being displayed are Generator phase to phase AC voltages

L1-L2	L2-L3	L3-L1
417	409	399
		~ V

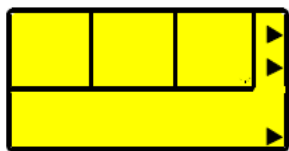
Alarm Icons

The LCD also displays the exact nature of any alarm condition that may have occurred such as **LOW OIL PRESSURE** using appropriate icons. This allows very specific alarm conditions to be brought to the operators' attention. Refer to the 'Protections' section of this manual for details of the alarms.

Hz	RPM	
0.0	0	
⚠	⚠	⚠

User Defined Indications

The LCD displays the user-defined indications when configured and active. The icons will illuminate and point to the appropriate text insert label. These indications can be used to indicate internal states (i.e. Engine Running, Safety On, etc).



User Defined

Alarms

The LCD displays the user-defined alarms when configured and active. The icons will illuminate and point to the appropriate text insert label. These alarms can be used to indicate the operation of external alarms (i.e. 'Low Fuel Level', 'Low Coolant level' etc) or to indicate internal alarms (i.e. Fail to Stop, MPU fault, etc).

LCD Display Areas

Instrument Values

L1-L2N	L2-L3N	L3-L1N
BAR °F Hz	PSI °C RPM	~ AV ⚠
888.8	888.8	888.8
⚠	⚠	⚠

Display Information & Units of Measure

L1-L2N	L2-L3N	L3-L1N
BAR °F Hz	PSI °C RPM	~ AV ⚠
888.8	888.8	888.8
⚠	⚠	⚠

Alarm Icons

L1-L2N	L2-L3N	L3-L1N
BAR °F Hz	PSI °C RPM	~ AV ⚠
888.8	888.8	888.8
⚠	⚠	⚠

User Definable Alarms/Indicators

L1-L2N	L2-L3N	L3-L1N
BAR °F Hz	PSI °C RPM	~ AV ⚠
888.8	888.8	888.8
⚠	⚠	⚠

NOTE:- The Engine Hours Run counter will only display the accumulated hours to the nearest 12 Minutes (0.2Hr). The accumulated time will be recorded in HH:MM however.

CAUTION:

If the DC supply to the module is interrupted the hours run counter will not remember any 'undisplayed' minutes accumulated since the last 12 Minute display update.

i.e.

10 Hours 38 Minutes accumulated before DC supply is removed... (10.6 Hours displayed) would become ...10 Hours 36Minutes on restoration of DC supply. (10.6 Hours still displayed) This will only occur in the event of a total DC supply break and will NOT occur if the module is simply switched to the Stop/Reset position.

VIEWING THE INSTRUMENTS

It is possible to manually scroll to display the different instruments by repeatedly operating the scroll button. Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity the module will revert to the initial display (Hz/RPM).

Instrument Page Order:-

- Frequency / RPM
AC Voltage Line-Neutral

- AC Voltage Line-Line
- AC Line Current
- Oil Pressure
- Coolant temperature
- Engine Hours Run

Manually Selecting an Instrument

Initial display (Hz/RPM)		
Pressing the DOWN button the LCD will then show (Generator L-N voltages)		
Pressing the DOWN button the LCD will then show (Generator L-L voltages)		

- DC Battery Voltage



Pressing the button again will scroll through each individual instrument eventually returning to the original instrument displayed.

NOTE:-Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity the module will revert to the initial display.

Indicators

COMMON ALARM LCD indicators

These indicate when an alarm condition is present. The Alarm icons or LEDs will detail the exact nature of the



(warning) or

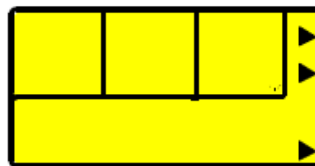


(shutdown)

alarm. (warning) or (shutdown)

USER CONFIGURABLE LCD INDICATORS

These LCD's can be configured by the user to indicate any on of the **different functions** based around the following:



WARNINGS and SHUTDOWNS

Specific indication of a particular warning or shutdown condition, backed up by LCD indication (!)- Such as Low Oil Pressure Shutdown, Low Coolant level, etc.

STATUS INDICATIONS

Indication of specific functions or sequences derived from



the modules operating state - Such as Safety On, Pre-heating, Generator Available, etc.

Controls



This button places the module into its **Stop/reset** mode. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and this position is selected, the module will automatically instruct the changeover device to unload the generator ('**Load transfer**' becomes inactive (if used)). The fuel supply will be removed and engine will be brought to a standstill. Should a **remote start signal** be present while operating in this mode, a remote start will not occur.


Manual



This mode is used to allow manual control of the generator functions. Once in **Manual mode** the module will respond to the start (I) button and start the engine and run off load. If the engine is running off-load in the **Manual mode** and either **remote start signal** becomes present or the mains supply fails, the module will automatically instruct the changeover device to place the generator on load ('**Load transfer**' becomes active (if used)). Should the **remote start signal**

then be removed the generator will remain on load until either the 'STOP/RESET' or 'AUTO' positions is selected.


Auto

This button places  the module into its 'Automatic' mode. This mode allows the module to control the function of the generator automatically. The module will monitor the **remote start input** and the mains supply and once a start condition is signaled the set will be automatically started and placed on load ('Load transfer' becomes active (if used)). If the starting signal is removed or the mains supply returns, the module will automatically transfer the load from the generator and shut the set down observing the **stop delay timer** and **cooling timer** as necessary. The module will then await the next start event. For further details please see the more detailed description of 'Auto Operation' earlier in this manual.

Test

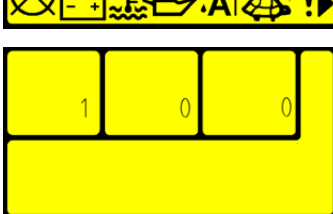
This mode is used  to allow on load test of the generator functions. Once in **Test mode** the module will respond to the start (I) button and start the engine and run on load until either the 'STOP/RESET' or 'AUTO' positions is selected.

Start

This button is  only active in MANUAL or TEST modes. Pressing this button in manual mode will start the engine and run off load. If the generator is running offload in the **Manual mode** and a **remote start signal** becomes present or the mains supply returns, the module will automatically instruct the changeover device to place the generator on load ('Load transfer' becomes active (if used)). Should the **remote start signal** then be removed the generator will remain on load until either the 'STOP/RESET' or 'AUTO' positions is selected.

Power Up LCD display

When DC power is first applied to the 5120 controller, a short LCD test is performed that illuminates all LCD segments. After this, the module's software revision number is shown briefly.



For example, this display is showing software revision 1.00

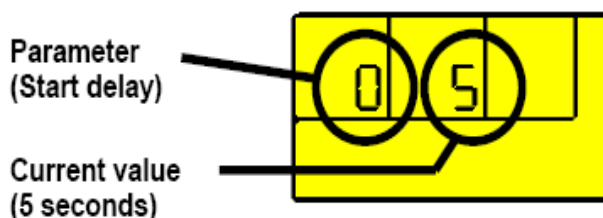
ENTERING CONFIGURATION MODE

NOTE:- Configuration mode can ONLY be entered when the module is in the STOP mode and the engine is at rest.

Press the **DOWN** and **STOP** buttons to enter configuration mode.



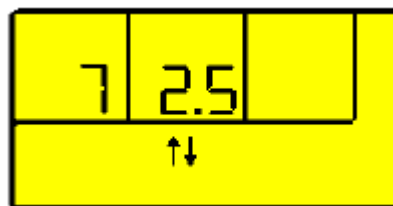
The first configurable parameter is displayed. In this example, the Start delay timer (parameter 0) is currently set to 5s.



Editing Analog Values

Enter the front panel configuration editor as described previously. Press the ✓ button to enter adjust mode. When in adjust mode (indicated by the flashing icons in the module display), pressing the + or - buttons will change the selected parameter to the desired value. Press the ✓ button to 'save' the value. The icons will stop flashing to confirm that it has been saved.

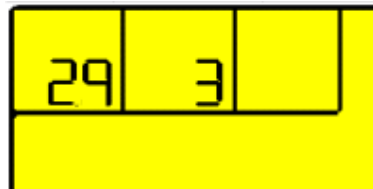
To select the next parameter to edit, press the + button. Continuing to press the + / - buttons will cycle through the adjustable parameters in the order shown in the following lists. Timers display in seconds up to 59 seconds, then in minutes up to the timer's maximum value. For instance, the parameter being displayed in this example is the cooling timer (parameter 7). It's current value is 2.5mins (2mins 30secs).



7.5 EDITING A 'LIST' VALUE

Some configuration parameters have a list of options to select from. These include input and output settings.

This example shows the setting for LCD indicator 3 (parameter 29). It's current setting is 3 ('Close Generator' from the lists shown below.)



NOTE:- When in adjust mode (indicated by the flashing icons in the module display), pressing the (stop mode) but-

ton will cancel any changes made to the current parameter, reverting to the last 'saved' value. This also exits adjust mode.

NOTE:- To exit the front panel configuration editor at any time press the STOP button. Ensure you save any changes you have made by pressing the ✓ button first if necessary.

Timers and Analogue Settings

Parameter	Type	Default	Max
0 - Start delay	Timer	5s	60s
1 - Preheat	Timer	0s	60s
2 - Crank attempt	Timer	10s	60s
3 - Crank rest	Timer	10s	60s
4 - Safety delay	Timer	8s	60s
5 - Warming up	Timer	0s	60m
6 - Return delay	Timer	30s	60m
7 - Cooling run	Timer	60s	60m
8 - E.T.S. solenoid hold	Timer	0s	60s
9 - Sensor fail delay	Timer	2s	5s
10 - Fail to Stop Delay	Timer	60s	60s
11 - Low Oil Pressure	Trip	15PSI	150PSI
12 - High Temperature	Trip	95°C	150°C
13 - Under Speed	Trip	1250RPM	3600RPM
14 - Over Speed	Trip	1750RPM	5000RPM
15 - Gen Under frequency	Trip	40Hz	60Hz
16 - Gen Over frequency	Trip	57Hz	72Hz
17 - Charge Alt Failure	Warning	8V DC	25V DC
18 - Flywheel teeth	Value	0	300
19 - CT Primary	Value	500A	6000A

NOTE:- Setting a timer to zero (0) will disable it. Timer settings increment from 0 to 60s in steps of 1s and from 1 minute to the maximum value in steps of 30 seconds (0.5 minutes) (where applicable)

NOTE:- Setting Flywheel teeth to zero (0) will disable magnetic pickup speed sensing. In this instance, engine speed is derived from the alternator output frequency.

NOTE:- CT values increment from 10-100 in steps of 10A, and from 100 to 6000A in steps of 50A. CT secondary must be 5A.

Parameter	Selections
20 - Alternator poles	0,2,4,6,8
21 - Oil pressure input	0 - Not used
	1 - Digital, close for low pressure
	2 - Digital, open for low pressure
	3 - VDO 0-5bar
	4 - VDO 0-10bar
	5 - Datcon 5bar
	6 - Datcon 10bar
	7 - Datcon 7bar
	8 - Murphy 7bar
	9 - User configured
22 - Coolant temp input	0 - Not used
	1 - Digital, close for high temperature
	2 - Digital, open for high temperature
	3 - VDO 40°C to 120°C
	4 - Datcon High
	5 - Datcon Low
	6 - Murphy
	7 - Cummins
	8 - PT100
	9 - User configured

Parameter	Selections
23 - Fast loading enabled	0 - No
	1 - Yes
24 - AC system	0 - 3 phases 4 wires
	1 - 1 phase 2 wire
	2 - 3 phases 3 wires
	3 - 2 phases 3 wires
25 - Oil pressure display units	0 - Bar/PSI
	1 - kPa

7.6 Panel Trouble Shooting

SYMPTOM	POSSIBLE REMEDY
Unit is inoperative	Check the battery and wiring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts Check the operating temperature is not above 70 °C. Check the DC fuse.
Unit locks out on Emergency Stop	If an Emergency Stop Switch is not fitted, ensure that a positive is connected to the Emergency Stop input. Check emergency stop switch is functioning correctly. Check Wiring is not open circuit.
Intermittent Magnetic Pick-up sensor fault	Ensure that Magnetic pick-up screen is only connected at one end, if connected at both ends, this enables the screen to act as an aerial and will pick up random voltages.
Low oil Pressure fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch/sender and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sender is compatible with the 5110 Module and is correctly configured.
High engine temperature fault operates after engine has fired.	Check engine temperature. Check switch/sender and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sender is compatible with the 5120 Module.
Shutdown fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Warning fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Fail to Start is activated after pre-set number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the module. Check the speed sensing signal is present on the 5120 inputs. Refer to engine manual.
Continuous starting of generator when in AUTO	Check that there is no signal present on the "Remote Start" input. Check configured polarity is correct. Check the mains supply levels.
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has timed out. If remote start fault, check signal is on "Remote Start" input. Confirm input is configured to be used as "Remote Start".
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of module. Check pre-heat has been selected in your configuration.

NOTE:- The above fault finding is provided as a guide check-list only. As it is possible for the module to be configured to provide a wide range of different features always refer to the source of your module configuration if in doubt.

8. BREAKER-INSTALLATION INFORMATION

Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A500CU	600	50	63.8	0.8	3	60
A500CU	480	50	79.8	0.8	3	60
A500CU	460	50	83.2	0.8	3	60
A500CU	440	50	87.0	0.8	3	60
A500CU	240	50	159.6	0.8	3	60
A500CU	220	50	174.1	0.8	3	60
A500CU	208	50	184.1	0.8	3	60
A500CU	240	50	220.8	1	1	60
A500CU	240	50	276.0	0.8	1	60
A500CU	416	42	72.9	0.8	3	50
A500CU	400	42	75.9	0.8	3	50
A500CU	380	42	79.9	0.8	3	50
A500CU	220	42	137.9	0.8	3	50
A500CU	190	42	159.7	0.8	3	50
A500CU	220	42	190.9	1	1	50
A500CU	220	42	238.64	0.8	1	50

A750CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A750CU	600	75	90.3	0.8	3	60
A750CU	480	75	112.9	0.8	3	60
A750CU	460	75	117.8	0.8	3	60
A750CU	440	75	123.2	0.8	3	60
A750CU	240	75	225.8	0.8	3	60
A750CU	220	75	246.3	0.8	3	60
A750CU	208	75	260.5	0.8	3	60
A750CU	240	75	312.5	1	1	60
A750CU	240	75	390.6	0.8	1	60
A750CU	416	65	112.9	0.8	3	50
A750CU	400	65	117.4	0.8	3	50
A750CU	380	65	123.6	0.8	3	50
A750CU	190	65	247.2	0.8	3	50
A750CU	220	65	295.45	1	1	50
A750CU	220	65	369.3	0.8	1	50

A1050CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A1050CU	600	105	127.6	0.8	3	60
A1050CU	480	105	159.6	0.8	3	60
A1050CU	460	105	166.5	0.8	3	60
A1050CU	440	105	174.1	0.8	3	60
A1050CU	240	105	319.1	0.8	3	60
A1050CU	220	105	348.1	0.8	3	60
A1050CU	208	105	368.2	0.8	3	60
A1050CU	240	105	441.7	1	1	60
A1050CU	240	105	552.1	0.8	1	60
A1050CU	416	90	156.3	0.8	3	50
A1050CU	400	90	162.6	0.8	3	50
A1050CU	380	90	171.1	0.8	3	50
A1050CU	220	90	295.6	0.8	3	50
A1050CU	190	90	342.3	0.8	3	50
A1050CU	220	90	409.1	1	1	50
A1050CU	220	90	511.4	0.8	1	50

A1250CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A1250CU	600	126	151.7	0.8	3	60
A1250CU	480	126	189.7	0.8	3	60
A1250CU	460	126	197.9	0.8	3	60
A1250CU	440	126	206.9	0.8	3	60
A1250CU	240	126	379.3	0.8	3	60
A1250CU	220	126	413.8	0.8	3	60
A1250CU	208	126	437.7	0.8	3	60
A1250CU	240	126	525.0	1	1	60
A1250CU	240	126	656.3	0.8	1	60

A1500CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A1500CU	600	158	190.3	0.8	3	60
A1500CU	480	158	237.8	0.8	3	60
A1500CU	460	158	248.2	0.8	3	60
A1500CU	440	158	259.5	0.8	3	60
A1500CU	240	158	475.7	0.8	3	60
A1500CU	220	158	518.9	0.8	3	60
A1500CU	208	158	548.9	0.8	3	60
A1500CU	240	158	658.3	1	1	60
A1500CU	240	158	822.9	0.8	1	60
A1500CU	416	160	277.9	0.8	3	50
A1500CU	400	160	289.0	0.8	3	50
A1500CU	380	160	304.2	0.8	3	50
A1500CU	220	160	525.5	0.8	3	50
A1500CU	190	160	608.5	0.8	3	50
A1500CU	220	160	727.3	1	1	50
A1500CU	220	160	909.09	0.8	1	50

A2000CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A2000CU	600	200	252.9	0.8	3	60
A2000CU	480	200	316.1	0.8	3	60
A2000CU	460	200	329.9	0.8	3	60
A2000CU	440	200	344.9	0.8	3	60
A2000CU	240	200	632.2	0.8	3	60
A2000CU	220	200	689.7	0.8	3	60
A2000CU	208	200	729.5	0.8	3	60
A2000CU	240	200	875.0	1	1	60
A2000CU	240	200	1093.8	0.8	1	60
A2000CU	416	175	304.0	0.8	3	50
A2000CU	400	175	316.1	0.8	3	50
A2000CU	380	175	332.8	0.8	3	50
A2000CU	220	175	574.8	0.8	3	50
A2000CU	190	175	665.5	0.8	3	50
A2000CU	220	175	795.5	1	1	50
A2000CU	220	175	994.32	0.8	1	50

A2500CU Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A2500CU	600	250	301.1	0.8	3	60
A2500CU	480	250	376.3	0.8	3	60
A2500CU	460	250	392.7	0.8	3	60
A2500CU	440	250	410.5	0.8	3	60
A2500CU	240	250	752.6	0.8	3	60
A2500CU	220	250	821.1	0.8	3	60
A2500CU	208	250	868.4	0.8	3	60
A2500CU	416	220	382.1	0.8	3	50
A2500CU	400	220	397.4	0.8	3	50
A2500CU	380	220	418.3	0.8	3	50
A2500CU	220	220	722.5	0.8	3	50
A2500CU	190	220	836.6	0.8	3	50

A300CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A300CU	600	308	370.9	0.8	3	60
A300CU	480	308	463.6	0.8	3	60
A300CU	460	308	483.8	0.8	3	60
A300CU	440	308	505.8	0.8	3	60
A300CU	240	308	927.3	0.8	3	60
A300CU	220	308	1011.6	0.8	3	60
A300CU	208	308	1069.9	0.8	3	60
A300CU	416	280	486.3	0.8	3	50
A300CU	400	280	505.8	0.8	3	50
A300CU	380	280	532.4	0.8	3	50
A300CU	220	280	919.6	0.8	3	50
A300CU	190	280	1064.8	0.8	3	50

A400CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A400CU	600	400	481.7	0.8	3	60
A400CU	480	400	602.1	0.8	3	60
A400CU	460	400	628.3	0.8	3	60
A400CU	440	400	656.9	0.8	3	60
A400CU	240	400	1204.2	0.8	3	60
A400CU	220	400	1313.7	0.8	3	60
A400CU	208	400	1389.5	0.8	3	60
A400CU	416	360	625.3	0.8	3	50
A400CU	400	360	650.3	0.8	3	50
A400CU	380	360	684.5	0.8	3	50
A400CU	220	360	1182.3	0.8	3	50
A400CU	190	360	1369.0	0.8	3	50

A500CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A500CU	600	500	602.1	0.8	3	60
A500CU	480	500	752.6	0.8	3	60
A500CU	460	500	785.4	0.8	3	60
A500CU	440	500	821.1	0.8	3	60
A500CU	240	500	1505.3	0.8	3	60
A500CU	220	500	1642.1	0.8	3	60
A500CU	208	500	1736.9	0.8	3	60

A600CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A600CU	600	600	722.5	0.8	3	60
A600CU	480	600	903.2	0.8	3	60
A600CU	460	600	942.4	0.8	3	60
A600CU	440	600	985.3	0.8	3	60
A600CU	240	600	1806.4	0.8	3	60
A600CU	220	600	1970.6	0.8	3	60
A600CU	208	600	2084.3	0.8	3	60

A830CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A830CU	480	827	1204.2	0.8	3	60
A830CU	460	827	1256.6	0.8	3	60
A830CU	440	827	1313.7	0.8	3	60
A830CU	240	827	2408.5	0.8	3	60
A830CU	220	827	2627.4	0.8	3	60
A830CU	208	827	2779.0	0.8	3	60

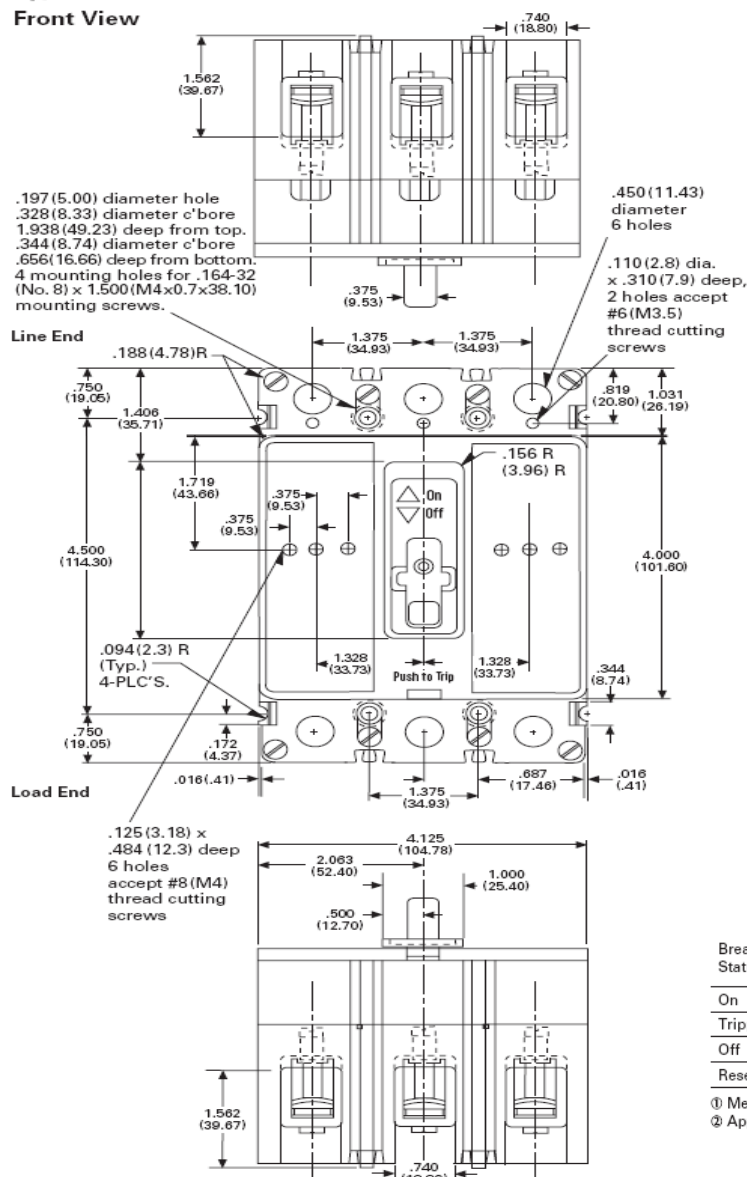
A1000CU						
Genset Model	Voltage	Standby kW	A	PF	PHASE	Hz
A1000CU	480	1000	1505.3	0.8	3	60
A1000CU	460	1000	1570.7	0.8	3	60
A1000CU	440	1000	1642.1	0.8	3	60
A1000CU	240	1000	3010.6	0.8	3	60
A1000CU	220	1000	3284.3	0.8	3	60
A1000CU	208	1000	3473.8	0.8	3	60

PHASE CONFIGURATIONS				
Voltage	PF	PHASE	Hz	PHASE CONFIGURATION
600	0.8	3	60	WYE
480	0.8	3	60	WYE
460	0.8	3	60	WYE
440	0.8	3	60	WYE
240	0.8	3	60	DELTA
220	0.8	3	60	WYE
208	0.8	3	60	WYE
240	1	1	60	DELTA
240	0.8	1	60	DELTA
416	0.8	3	50	WYE
400	0.8	3	50	WYE
380	0.8	3	50	WYE
220	0.8	3	50	WYE
190	0.8	3	50	WYE
220	1	1	50	DELTA
220	0.8	1	50	DELTA

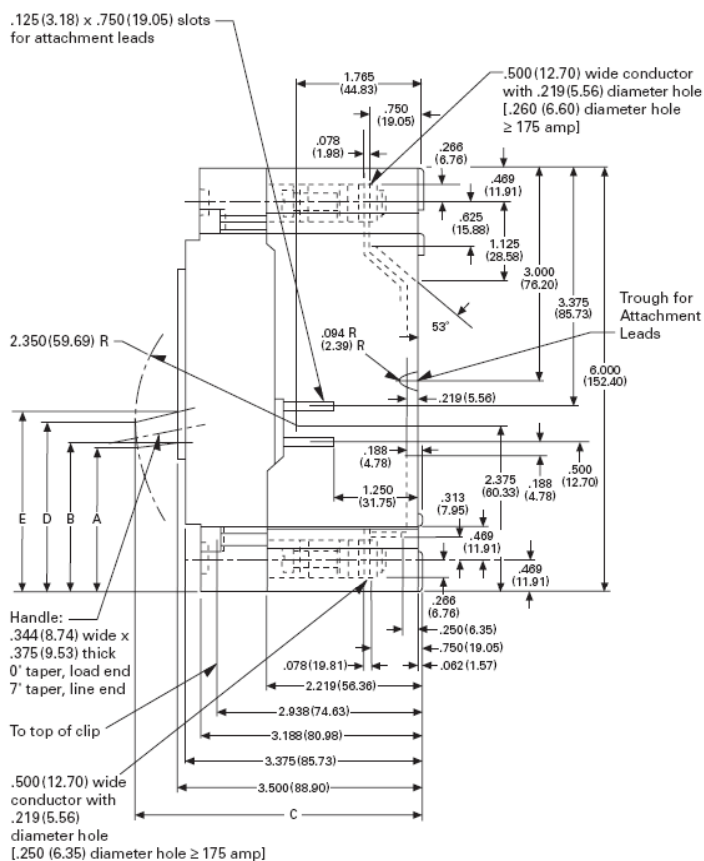
FG MOLDED CASE
15-150 AMPS

Type FG Three-Pole

Front View



Side View



Breaker Status	Dimensions					Handle Force, Lbs.①
	A	B	C	D	E	
On	3.07 (77.98)	2.92 (74.17)	3.96 (100.58)	3.40 (86.36)	3.33 (84.58)	14 (6.35 kgs.)
Tripped	2.65 (67.31)	2.57 (65.28)	4.06 (103.12)	2.99 (75.94)	2.98 (75.69)	14 Φ (1.81 kgs.)
Off	2.08 (52.83)	2.14 (54.36)	4.12 (104.65)	2.42 (61.47)	2.56 (65.02)	16 (7.26 kgs.)
Reset	1.98 (50.29)	2.05 (52.07)	4.11 (104.39)	2.30 (58.42)	2.48 (63.10)	21 (9.53 kgs.)

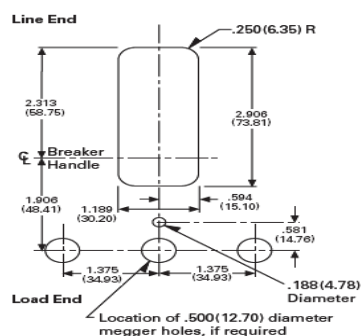
① Measured .125 (3.175) above Escutcheon.

② Applied by breaker handle to external handle mechanism.

Westinghouse Molded Case Circuit Breakers, FG Engine Generator

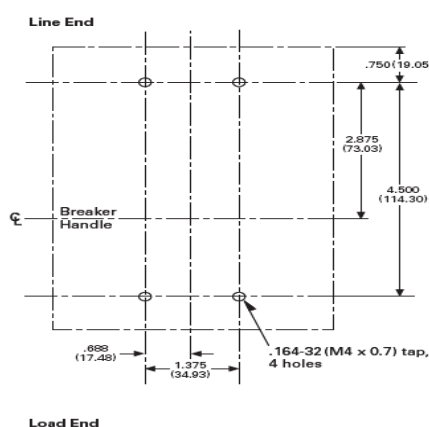
Type FG Three-Pole

Front Cover Cutout

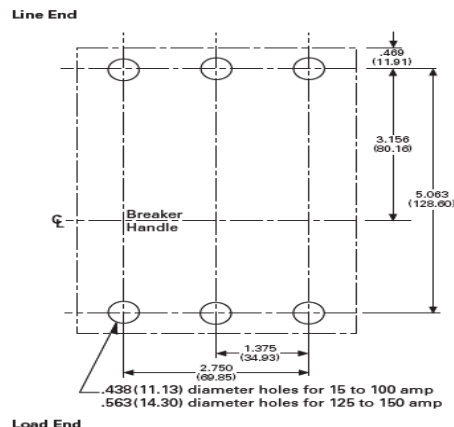


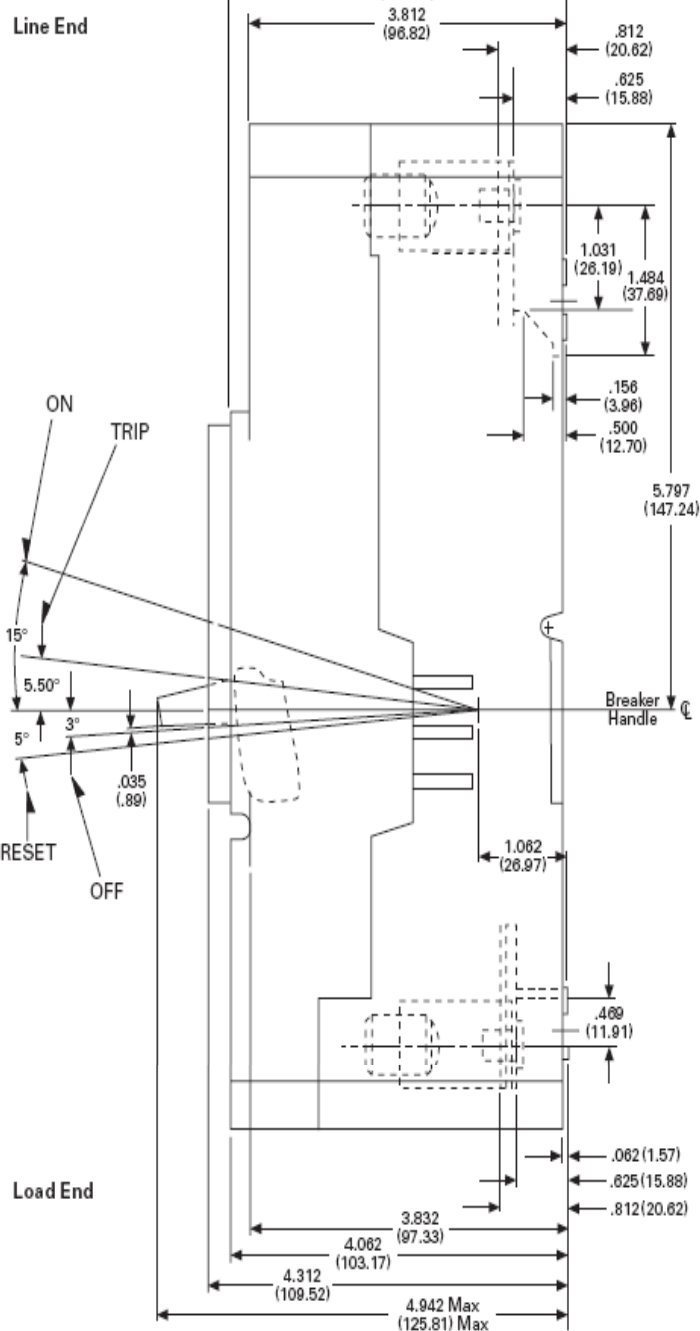
Drilling Plans

Front Connected



Rear Connected





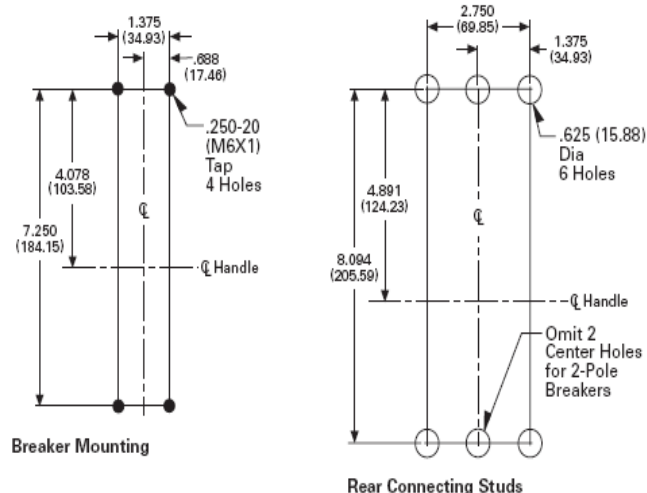
Front Connected Terminals

Catalog Number	Cable	Amp Rating	Wire Size	Torque
T250KB	Cu Single	70-250	#4 to 350 MCM	180 Lb-in (20.3 Nm)
TA250KB	Cu-Al Single	70-250	#4 to 350 MCM	275 Lb-in (31.1 Nm)

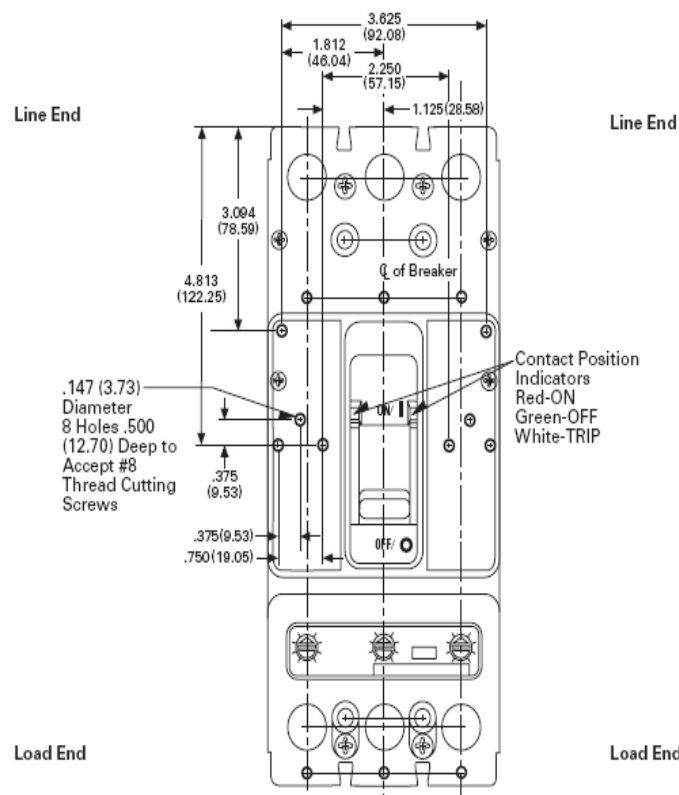
Westinghouse Molded Case Circuit Breakers, JG Engine Generator

Type JG Three-Pole

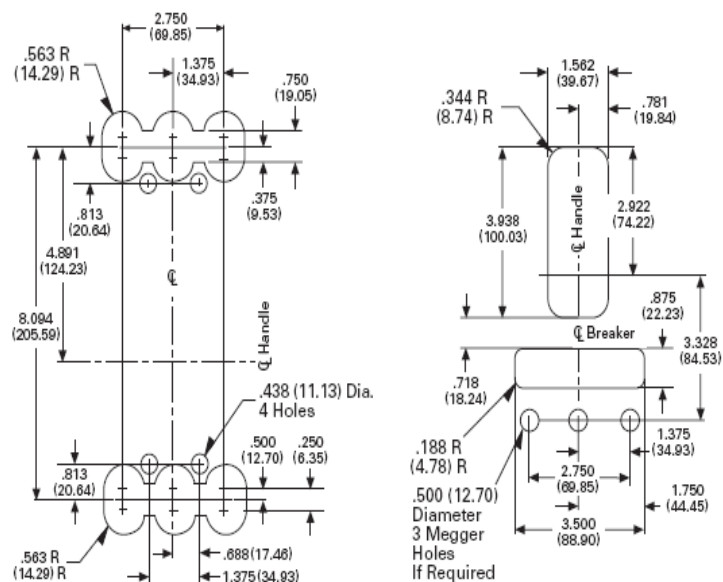
Drilling Plans



Breaker Shown in OFF Position

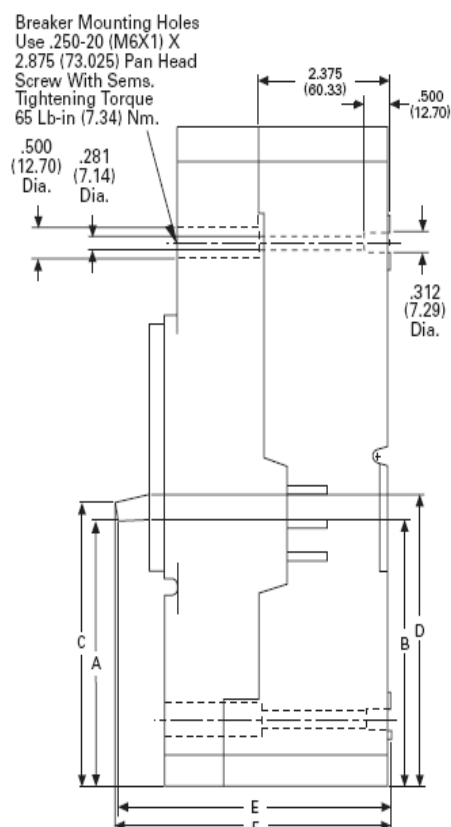


Reproduced from drawings 1491D65 and 1491D67



Drawout Support Blocks

Front Cover Cutout



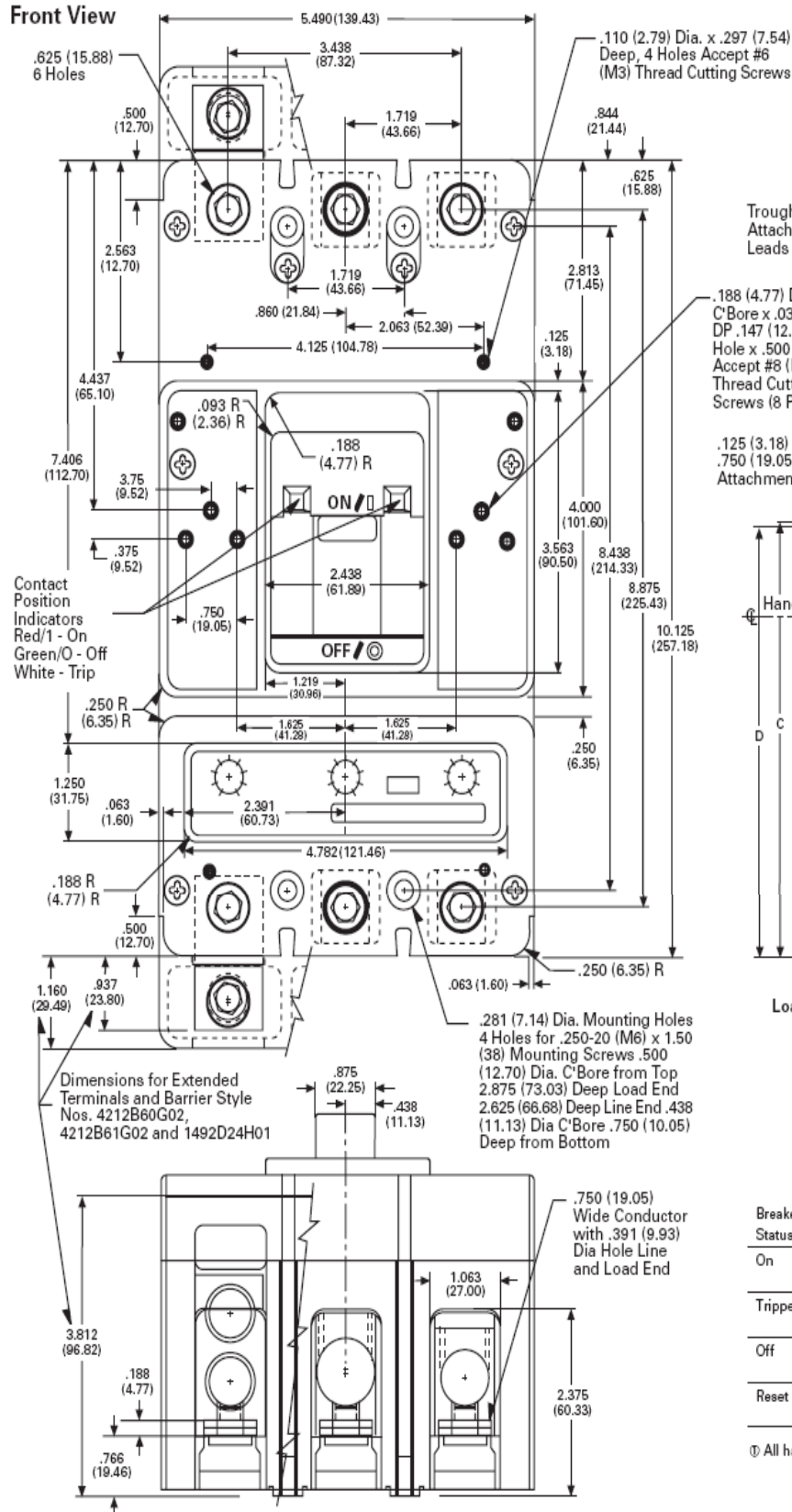
Dimensions in parentheses in millimeters

Breaker Status	Dimension						Hdl. Oper. Force
	A	B	C	D	E	F	
On	5.24 (132.10)	5.12 (130.05)	5.54 (140.72)	5.49 (139.45)	4.77 (121.58)	4.72 (119.89)	32 Lb. (142.3 Nm)
Tripped	4.79 (121.67)	4.71 (119.63)	5.10 (129.54)	5.10 (129.54)	4.87 (123.70)	4.85 (123.19)	
Off	4.02 (102.11)	4.06 (103.12)	4.33 (109.82)	4.45 (113.03)	4.91 (124.71)	4.95 (125.73)	22 Lb. (97.9 Nm)
Reset	3.91 (99.31)	3.96 (100.58)	4.21 (106.93)	4.36 (110.74)	4.90 (124.46)	4.95 (125.73)	38 Lb. (169.0 Nm)

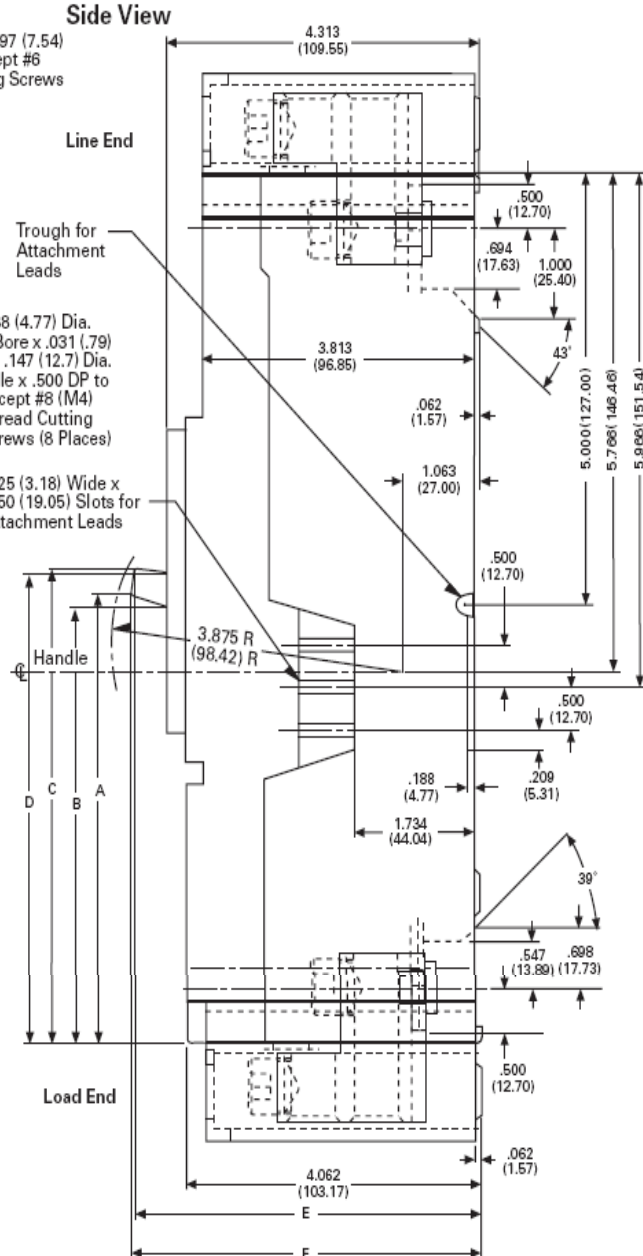
KG MOLDED CASE 300-400 AMPS

Type KG Three-Pole

Front View



Side View



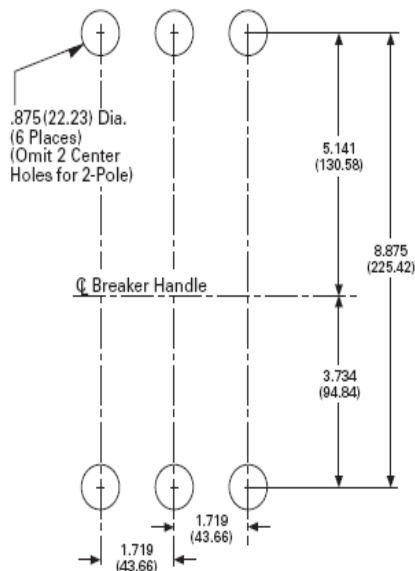
Breaker Status	Dimensions						Handle Force ^①
	A	B	C	D	E	F	
On	5.39 (136.9)	5.20 (132.1)	5.69 (144.5)	5.61 (142.5)	4.72 (119.9)	4.77 (121.2)	30 lbs. (13.61 kgs.)
Tripped	4.77 (121.2)	4.69 (119.1)	5.08 (129.0)	5.11 (129.8)	4.89 (124.2)	4.89 (124.2)	—
Off	4.16 (105.7)	4.21 (106.9)	4.46 (113.3)	4.64 (117.9)	4.95 (125.7)	4.91 (124.7)	25 lbs. (11.34 kgs.)
Reset	4.07 (103.4)	4.14 (105.2)	4.57 (116.1)	4.56 (115.8)	4.95 (125.7)	4.90 (124.5)	35 lbs. (15.87 kgs.)

① All handle forces measured approximately 0.125 (3.17) from top of handle.

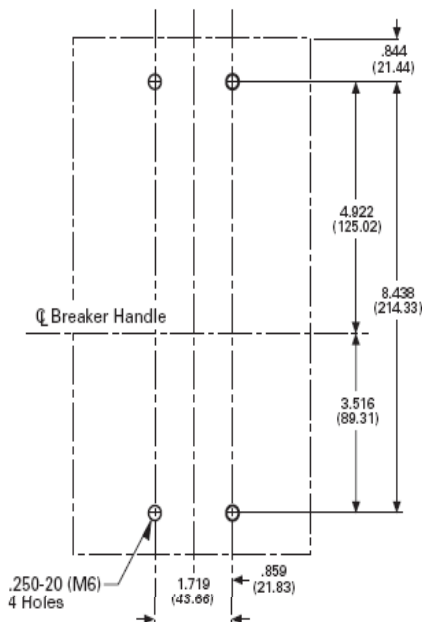
Westinghouse Molded Case Circuit Breakers, KG Engine Generator

Type KG Three-Pole

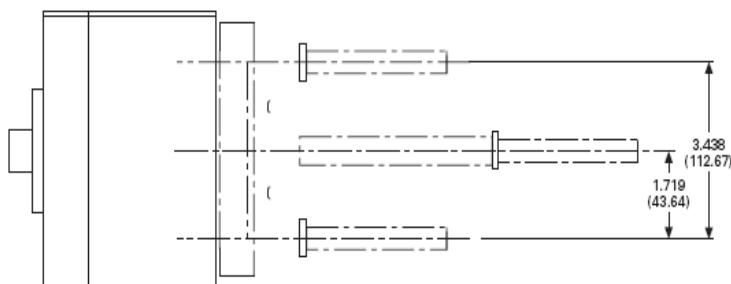
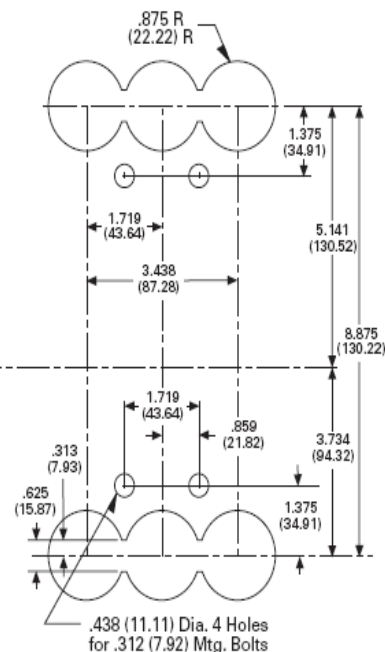
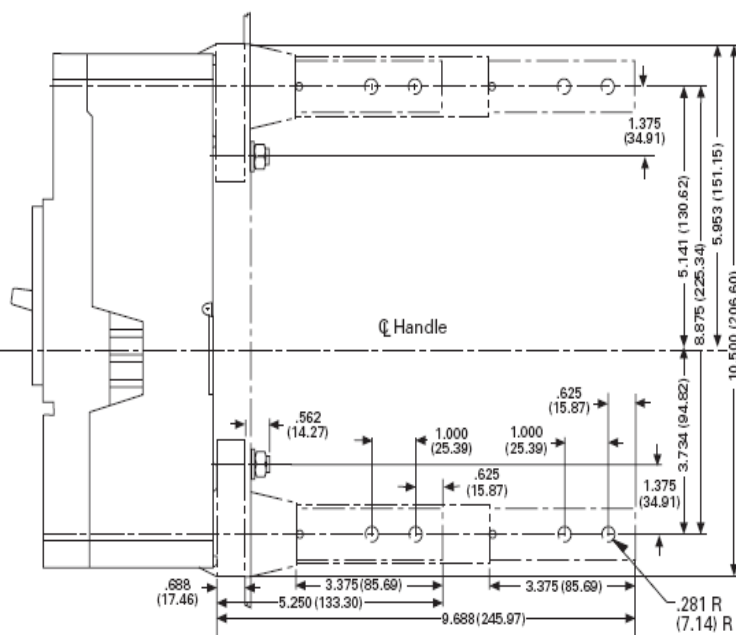
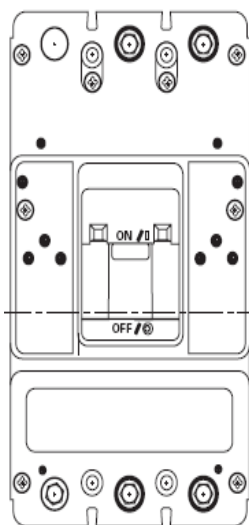
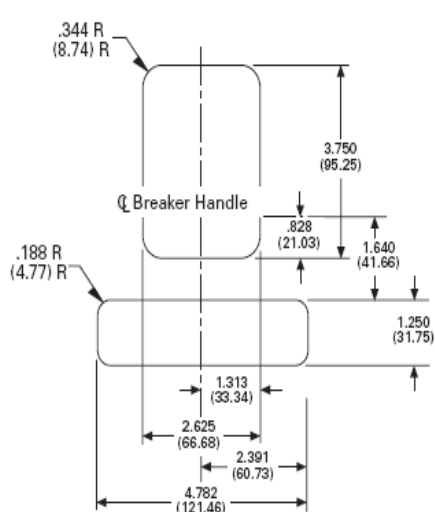
Rear Connected Studs



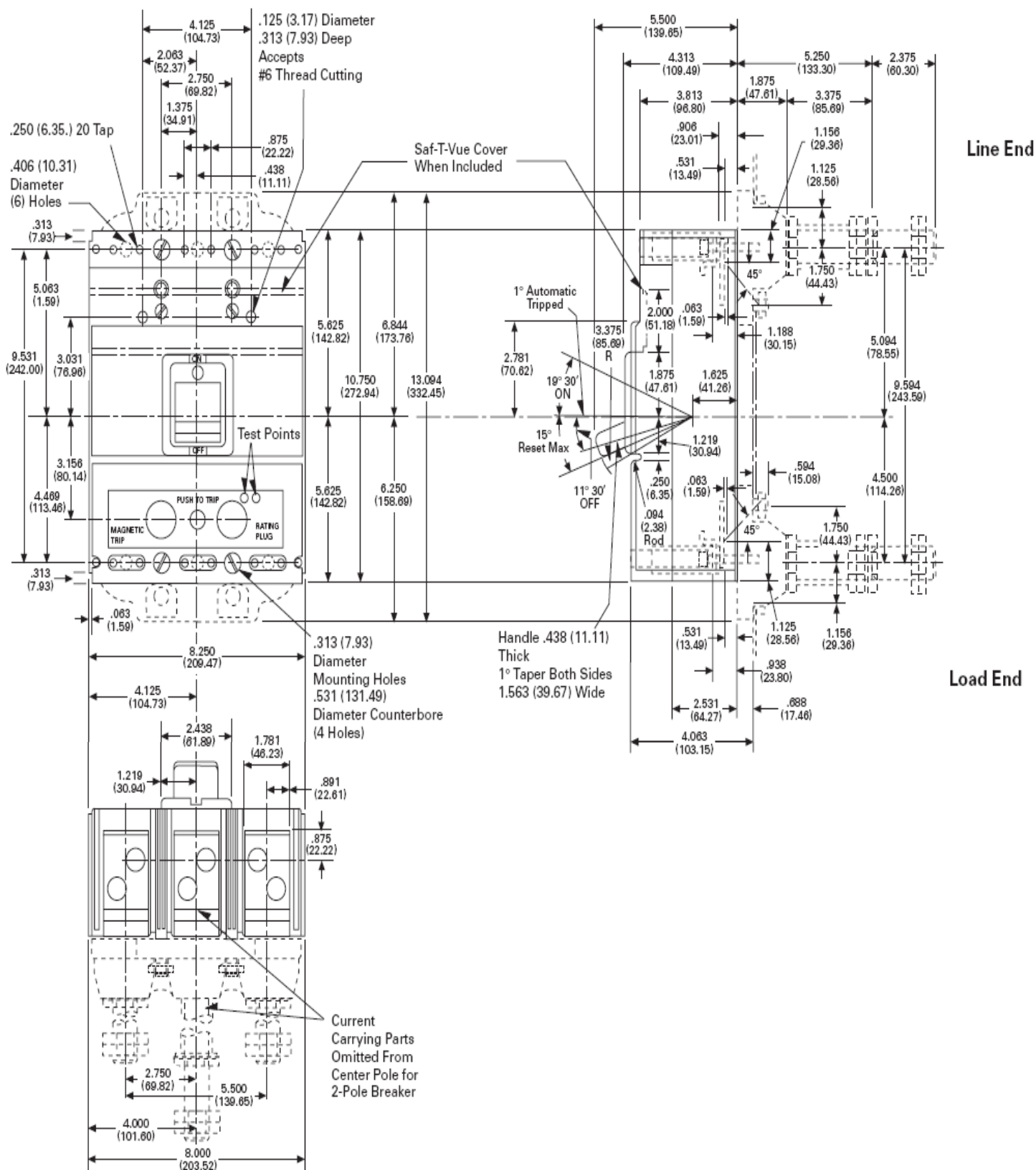
Front Connected Terminals



Front Cover Cutout



Front View



Westinghouse Molded Case Circuit Breakers, LG Engine Generator Type LG Three-Pole

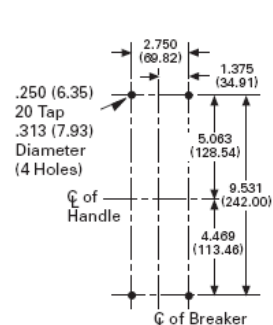
**Drilling Plans
For Mounting Bolts**
(Front Connected Terminals)

For Rear Connected Studs
(Insulated Panel)

For Plug-In Block

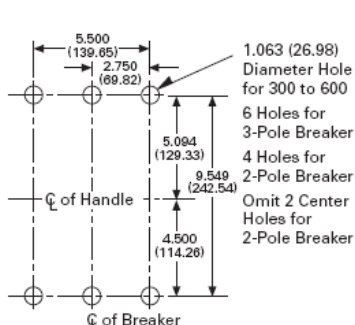
Front Cover Cutout

Line End



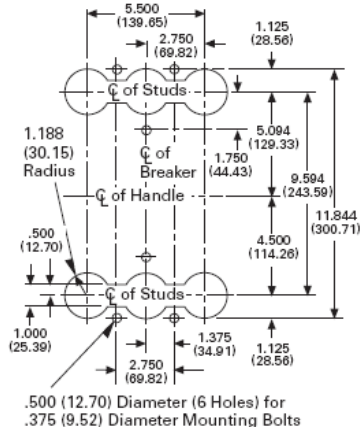
Load End

Line End

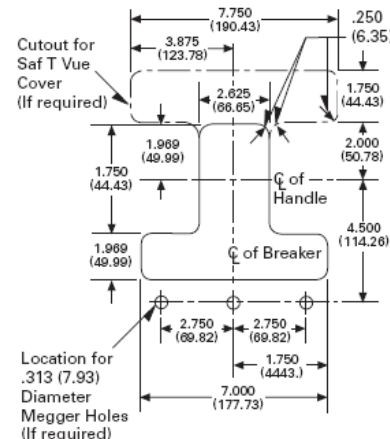


Load End

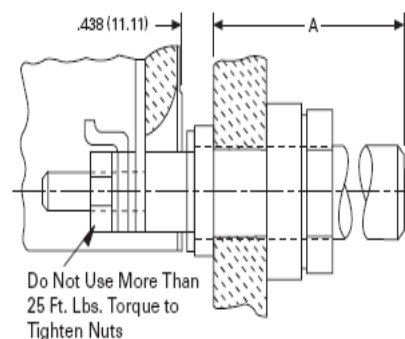
Line End



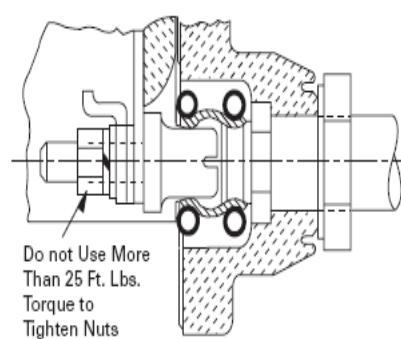
Load End



Rear Connected Studs



Plug-In- Adapter Kit



Terminal Arrangements

Copper Cable Only
(Must be Ordered Separately)
Cat. #TA600LA Wire Size (2) 250-500 MCM

Optional AL/CU Cable
(Must be Ordered Separately)
Cat. #TA600LA Wire Size (2) 250-500 MCM

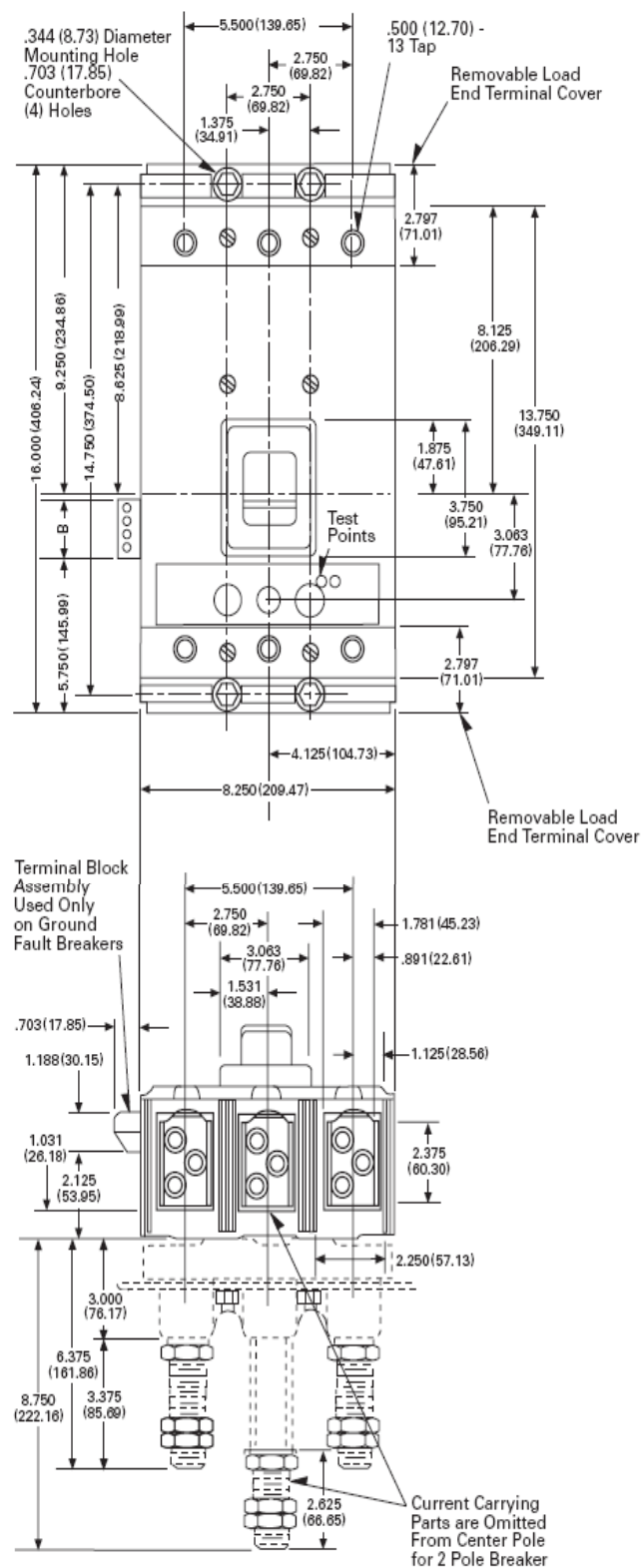
Ampere Rating	Style Number	Thread Size	Dimension A
300 to 600	314C960G07	1-12	5 ¹⁶ / ₃₂
300 to 600	314C960G08	1-12	7 ³¹ / ₃₂
300 to 600	314C960G09	1-12	10 ¹⁶ / ₃₂

Poles	Ampere Rating	Kit Style Number	Thread Size
2	300 to 600	313C644G50	1-12
3	300 to 600	313C644G51	1-12

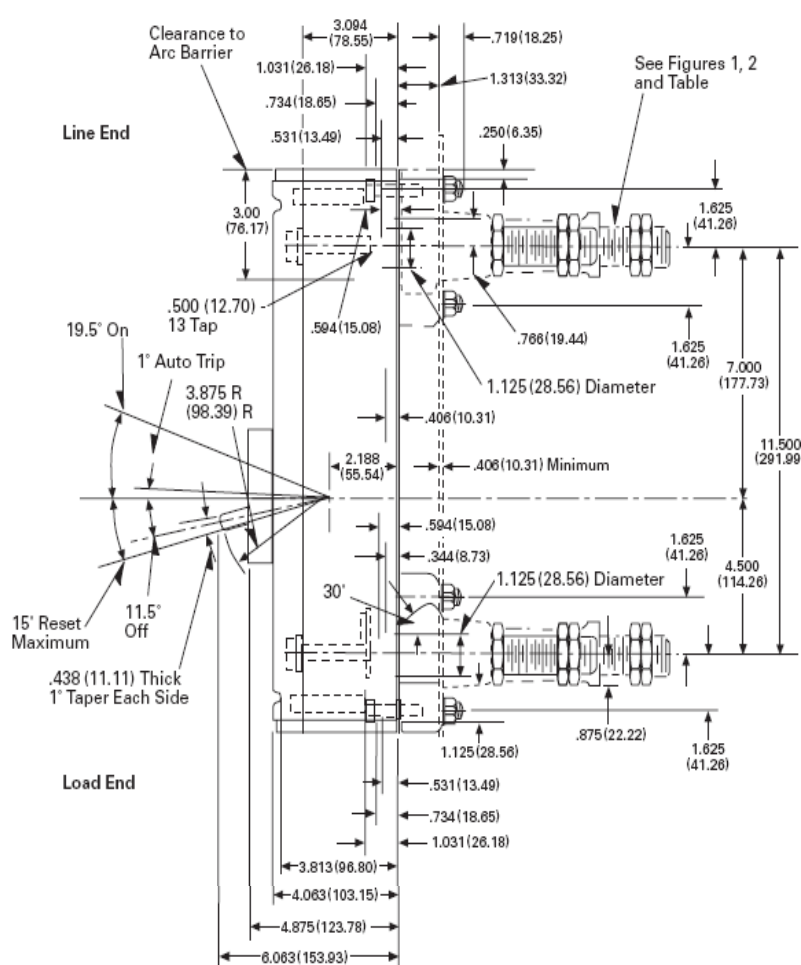
MG MOLDED CASE 700-800 AMPS

Type MG Three-Pole

Front View



Side View



Handle Forces (From End of Handle)

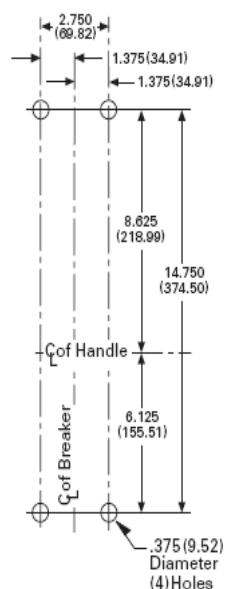
On	50 lbs. (22.68 kgs.)
Off	24 lbs. (10.89 kgs.)
Reset	60 lbs. (27.22 kgs.)

Reproduced from drawing 2605D21
Dimensions in parentheses in millimeters

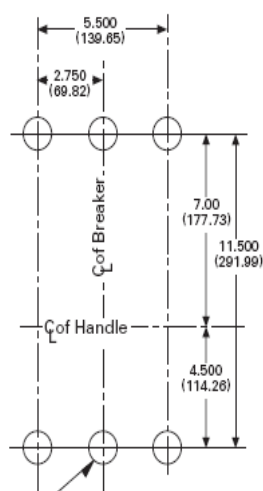
Westinghouse Molded Case Circuit Breakers, Type MG Three-Pole

MG 700-800 Amperes

For Mounting Block (Front Connected Terminals)

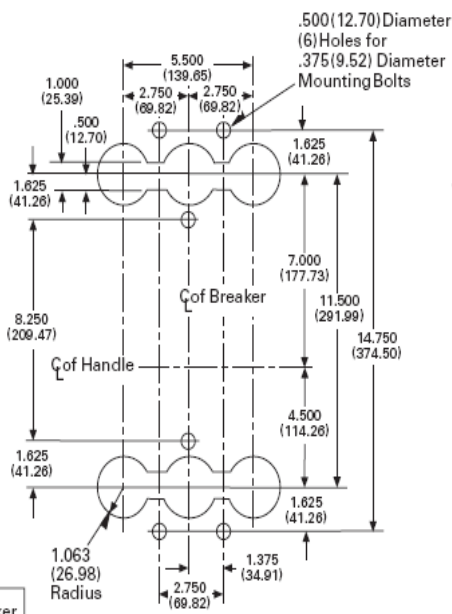


For Rear Connected Studs

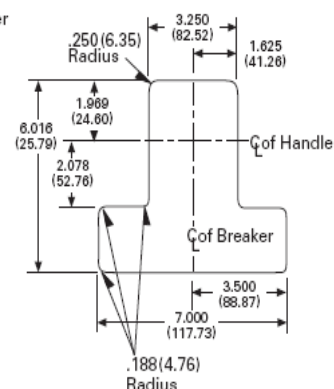


.813 (20.63) Diameter Hole for 250 Amp to 400 Amps
 1.063 (26.98) Diameter Hole for 450 Amp to 600 Amps
 1.188 (30.15) Diameter Hole for 700 Amp to 800 Amps

For Plug-In Adapter Kit



Front Cover Cutout



Front Connected Terminals

(Must be Ordered Separately)

Amp Rating	Catalog Number	Wire Size Number of Cables
For Al/Cu Cable		
600	TA700MA1	(2) #1-500 MCM
800	TA800MA2	(3) 3/0-400 MCM
For Copper Cable		
600	T600MA1	(2) 2/0-500 MCM
800	T800MA1	(3) 3/0-300 MCM

Rear Connected Studs

2 Required Per Pole (Not Supplied With Breaker)

Stud Ampere Rating	Stud Style Number	Thread Size	Dimension A
250-400	314C960G04	3/4-16	5 ²⁹ / ₃₂
250-400	314C960G05	3/4-16	8 ¹³ / ₃₂
250-400	314C960G06	3/4-16	10 ²⁹ / ₃₂
450-600	314C960G07	1-12	5 ²⁹ / ₃₂
450-600	314C960G08	1-12	8 ¹³ / ₃₂
450-600	314C960G09	1-12	10 ²⁹ / ₃₂
700-800	314C960G10	1 1/8-12	5 ²⁹ / ₃₂
700-800	314C960G11	1 1/8-12	8 ¹³ / ₃₂
700-800	314C960G12	1 1/8-12	10 ²⁹ / ₃₂

Plug-In Adapter Kit

1 Kit Per Breaker (Not Supplied With Breaker)

Poles	Ampere Rating	Kit Style Number	Thread Size	Fig.
2	125-600	313C644G27	1 1/8-12	1
3	125-600	313C644G28	1 1/8-12	1
2	700-800	313C544G01	1 1/8-12	2
3	700-800	313C544G02	1 1/8-12	2

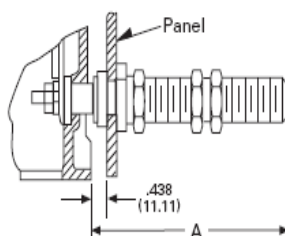


Figure 1

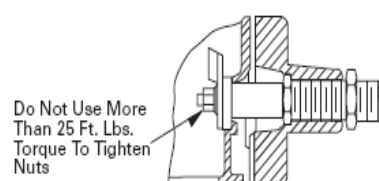
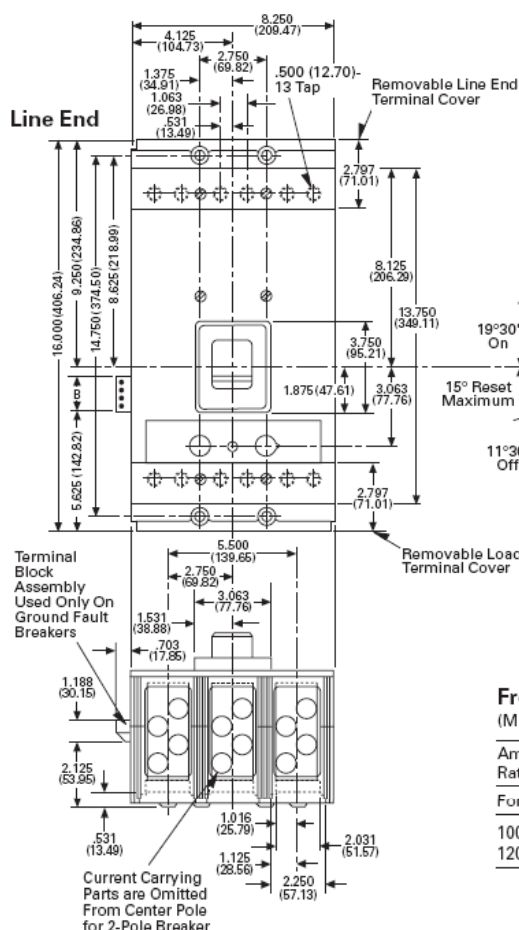


Figure 2

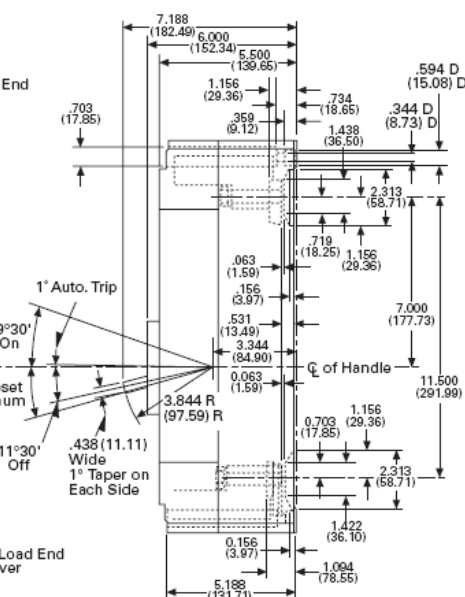
NG MOLDED CASE

Type NG Three-Pole

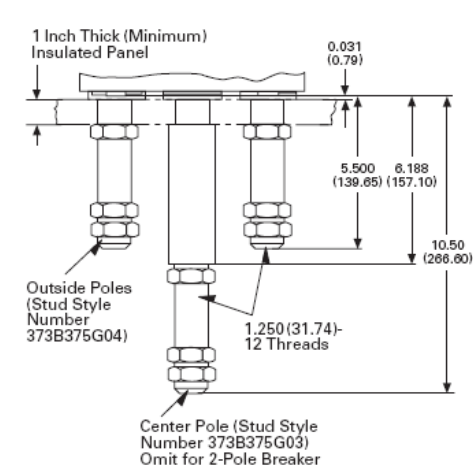
Front View



Side View



Bolted Rear Connected Studs



Front Connected Terminals

(Must be Ordered Separately)

Amp Rating	Catalog Number	Wire Size
		Number of Cables
For Al/Cu Cable		
1000	TA1000NB1	(3) 3/0-400 MCM
1200	TA1200NB1	(4) 4/0-500 MCM

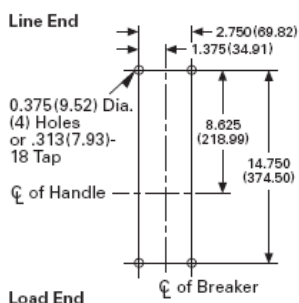
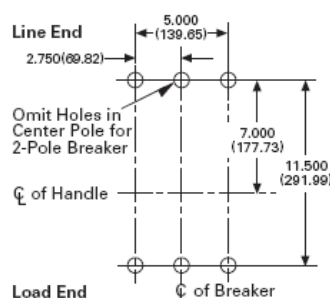
Load End

	B
2 Terminal Unit	1 ³ / ₁₆
3 Terminal Unit	1 ⁹ / ₁₆

900-1200 AMPS

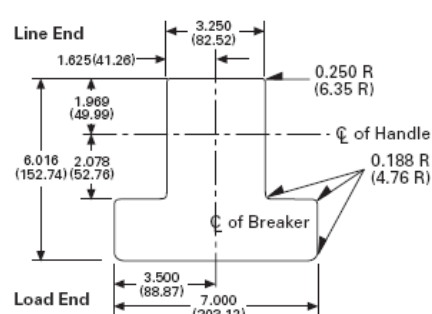
Westinghouse Molded Case Circuit Breakers, Type NG Three-Pole

NG 900-1200 Amperes


Drilling Plans
For Mounting BoltsFor Rear Connected Studs
(Insulated Panel)

Amp Rating	Hole Dia.
700-800	1 ³ / ₁₆
900-1200	1 ¹ / ₈

Front Cover Cutout



1600-2500 AMPS

Maximum Rated Current (Amperes)	RG ①																																																																	
	1600, 2000, 2500																																																																	
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9. ENGINE

9.1. CHECKS DURING OPERATION

While running, make the following checks to see that all parts are working correctly.

Radiator Cooling water (Coolant)

To avoid personal injury:

- Do not remove radiator cap until coolant temperature is well below its boiling point. Then loosen cap slightly to the stop position, to relieve any pressure, before removing cap completely.

When the engine overheats and hot coolant overflows through the overflow pipe and cannot be stopped, stop the engine immediately and make the following checks to determine the cause of trouble:

1. Check to see if there is any coolant leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fins and tube;
4. Check to see if the fan belt is too loose;
5. Check to see if radiator water pipe is clogged; and
6. Check to see if anti-freeze is mixed into coolant in warm seasons.

Fuel

To avoid personal injury:

- Fluid escaping from pinholes may be invisible. Do not use hands to search for suspected leaks; Use a piece of cardboard or wood, instead. If injured by escaping fluid, see a medical doctor at once. This fluid can produce gangrene or a severe allergic reaction.
- Check any leaks from fuel pipes or fuel injection pipes. Use eye protection when checking for leaks. Be careful not to empty the fuel tank. Otherwise air may enter the fuel system, requiring fuel system bleeding.

While the engine is run within the rated output range:

- The color of exhaust remains colorless.
- If the output slightly exceeds the rated level, exhaust may become a little colored with the output level kept constant.
- If the engine is run continuously with dark exhaust emission, it may lead to trouble with the engine.
- Immediately stop the engine if;
- The engine suddenly slow down or accelerates.
- Unusual noises suddenly appear.
- Exhaust fumes suddenly become very dark.

9.2. MAINTENANCE SCHEDULE

Perform maintenance at whichever interval that occurs first. At each scheduled maintenance interval, perform all previous maintenance checks that are due for scheduled maintenance.

Daily or Refueling - Maintenance Check⁽⁴⁾

- Air Intake Piping - Inspect

- Air Tank and Reservoirs - Drain
- Cooling Fan - Check/Correct
- Crankcase Breather Tube - Inspect
- Drive Belts - Check/Correct
- Engine Coolant Level - Check/Correct
- Engine Lubricating Oil Level - Check/Correct
- Fuel-Water Separator - Drain

Every 250 Hours or 3 Months - Maintenance Check^(1, 4)

- Air Cleaner Restriction - Check/Correct
- Air Compressor Mounting Hardware - Check/Correct
- Charge Air Cooler - Check/Correct
- Charge Air Piping - Check/Correct
- Fuel Injection Pump Mounting Hardware - Check/Correct
- Lubricating Oil and Filters - Change
- Radiator Hoses - Check

Every 500 Hours or 6 Months - Maintenance Check^(2, 3, 4)

- Engine Coolant - Antifreeze Check
- Fuel Filter, Canister-Type - Replace
- Fuel Filter, Spin-on-Type - Replace
- Lubricating Oil and Filters - Change

Every 1000 Hours or 1 Year - Maintenance Check⁽⁴⁾

- Cooling Fan Belt Tensioner - Check/Correct
- Fan Hub, Belt-Driven - Check/Correct
- Overhead Set - Adjust

Every 2000 Hours or 2 Years - Maintenance Check^(3, 4)

- Air Compressor Discharge Line - Check/Correct
- Cooling System - Drain, Flush, and Fill
- Vibration Damper, Rubber - Check
- Vibration Damper, Viscous - Check

1. NOTE: The lubricating oil and lubricating oil filter interval can be adjusted based on application, fuel consumption, gross vehicle weight, and idle time. For engines whose aspiration is jacket water-cooled, turbocharged only, or natural, refer to Table in the Oil Drain Intervals section.
2. The lubricating oil and lubricating oil filter interval can be adjusted based on application, fuel consumption, gross vehicle weight, and idle time. For

Table 1: Jacket Water Cooled, Turbocharged Only, or Naturally Aspirated Engines			
Cummins Engine Standard Classification	American Petroleum Institute Classification	International Classifications	All Engine Ratings
(CES)	(API)		
CES-20078, CES-20077, CES-20076, CES-20072, CES-20071	API CI-4/SK, API CI-4, API CH-4, API CH-4/SJ	ACEA E-5, Global DHD-I	250 Hours or 3 Months
CES-20075	API CF-4/SG	ACEA E-3, ACEA E-2, JAMA DH-I	150 Hours or 6 Weeks
	API CG-4/SH, API CD, API CE	ACEA E-I	Obsolete. Do not use.

Table 2: Charge Air Cooled Engines			
Cummins Engine Standard Classification	American Petroleum Institute Classification	International Classifications	All Engine Ratings
(CES)	(API)		
CES-20078, CES-20077, CES-20076, CES-20072, CES-20071	API CI-4/SK, API CI-4, API CH-4, API CH-4/SJ	ACEA E-5, Global DHD-I	500 Hours or 6 Months
CES-20075	API CF-4/SG	ACEA E-3, ACEA E-2, JAMA DH-I	250 Hours or 3 Weeks
	API CG-4/SH, API CD, API CE	ACEA E-I	Obsolete. Do not use.

9.3. CUMMINS/FLEETGUARD® FILTER SPECIFICATIONS

Fleetguard® is a subsidiary of Cummins Inc. Fleetguard® filters are developed through joint testing at Cummins and Fleetguard®. Fleetguard® filters are standard on new Cummins engines. Cummins Inc. recommends their use.

Fleetguard® products meet all Cummins Source Approval Test standards to provide the quality filtration necessary to achieve the engine's design life. If other brands are substituted, the purchaser should insist on products that the supplier has tested to meet Cummins high-quality standards.

Cummins can not be responsible for problems caused by non-genuine filters that do not meet Cummins performance or durability requirements.

Filter Part Numbers						
	Lubricating Oil Filter B3.9	Lubricating Oil Filter B4.5	Lubricating Oil Filter B5.9	Fuel Filter B3.9	Fuel Filter B4.5	Fuel Filter B5.9
Cummins Part Number	3934429	3934429	3934430	3966139	3991350	3900632
Fleetguard® Part Number	LF9100	LF9100	LF9098	FF9413	FS19608	FF9417

WARNING

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

CAUTION

Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the fuel pump and the fuel injectors.

Cummins Inc. recommends the use of ASTM number 2D fuel. The use of number 2 diesel fuel will result in optimum engine performance.

At operating temperatures below 0 °C [32 °F], acceptable performance can be obtained by using blends of number 2D and number 1D.

NOTE: Lighter fuels can reduce fuel economy.

NOTE: Engines equipped with diesel particulate filters require the use of diesel fuel with 30 ppm sulfur maximum. There are no acceptable substitutes.

The viscosity of the fuel **must** be kept above 1.3 cSt at 40 °C [104 °F] to provide adequate pumping and lubricating characteristics to fuel system components.

The following chart lists acceptable substitute fuels for this engine.

Acceptable Substitute Fuels									
Number 1D Diesel ^{(1) (2) (3)}	Number 2D Diesel ⁽³⁾	Number 1K Kerosene	Jet-A	Jet-A1	JP-5	JP-8	Jet-B	JP-4	CITE
A	OK	Not OK	A	A	A	A	Not OK	Not OK	Not OK
An "A" means OK only if fuel lubricity is adequate. This means the BOCLE number is 3100 or greater as measured by ASTM specification D6078, Scuffing Load Ball On Cylinder Evaluator (SLBOCLE). Lubricity can also be measured by ASTM, specification D6079, ISO 12156, High Frequency Reciprocating Rig (HFRR) in which the fuel must have a wear scar diameter of 0.45 mm [0.02 in] or less.									
Any adjustment to compensate for reduced performance with a fuel system using alternate fuel is not warrantable.									
Winter blend fuels, such as found at commercial fuel-dispensing outlets, are combinations of number 1D and 2D diesel fuels and are acceptable.									

CAUTION

A sulfated ash limit of 1.85 percent has been placed on all engine lubricating oils recommended for use in Cummins engines. Higher ash oils can cause valve and/or piston damage and lead to excessive oil consumption.

CAUTION

The use of a synthetic-base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.

The use of quality engine lubricating oils, combined with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability.

Cummins Inc. recommends the use of high-quality SAE 15W-40 heavy-duty engine oil, such as Valvoline® Premium Blue®, which meets performance specifications as listed below.

Cummins Engineering Standard Classification (CES)	American Petroleum Institute Classification (API)	International Classifications	Comments
	API CD API CE API CG-4/SH	ACEA E-I	OBSOLETE. DO NOT USE.
CES-20075	API CF-4/SG	ACEA E-2 ACEA E-3 JAMA DH-I	Minimum acceptable oil classification for midrange engines.
CES-20071 CES-20076	API CH-4/SJ API CH-4	Global DHD-I	Acceptable oil classification for midrange engines.
CES-20072 CES-20077	API CH-4	ACEA E-5 Global DHD-I	Similar in performance to CES-20071 but validated under European test standards. Excellent oil for midrange engines.
CES-20078	API CI-4/SK API CI-4		Excellent oil for midrange engines.

NOTE: In areas where CH-4/SJ or CG-4/SH oils are not available, refer to Oil Drain Intervals in Section 2.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control.

As the engine oil becomes contaminated, essential oil additives are depleted. Lubricating oils protect the engine as long as these additives are functioning properly. Progressive contamination of the oil between oil and filter change intervals is normal. The amount of contamination will vary depending on the operation of the engine, kilometers or miles on the oil, fuel consumed, and new oil added.

Extending oil and filter change intervals beyond the recommendations will decrease engine life due to factors such as corrosion, deposits, and wear.

Special “break-in” engine lubricating oils are not recommended for new or rebuilt Cummins engines. Use the same type of oil during the break-in as is used in normal operation.

The use of low-viscosity oils, such as 10W or 10W-30, can be used to aid in starting the engine and in providing sufficient oil flow at ambient temperatures below -5 °C [23 °F]. However, continuous use of low-viscosity oils can decrease engine life due to wear. Refer to the accompanying chart.

If an engine is operated in ambient temperatures consistently below -23 °C [-9 °F] and there are no provisions to keep the engine warm when it is not in operation, use a synthetic CH/SI or CH/SK or higher API classification engine oil with adequate low-temperature properties such as 5W-20 or 5W-30.

The oil supplier is responsible for meeting the performance service specifications represented with its product.

Use low-silicate antifreeze that meets ASTM4985 (GM6038M specification) criteria. Fully formulated coolant must meet ASTM D-6210/D-6211. Cummins Inc. recommends using either a 50/50 mixture of good-quality water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system.

Good-quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

Water Quality	
Calcium Magnesium (hardness)	Maximum 170 ppm as (CaCO ₃ + MgCO ₃)
Chloride	40 ppm as (Cl)
Sulfur	100 ppm as (SO ₄)

Cummins Inc. recommends using Fleetguard® Compleat. It is available in both glycol forms (ethylene and propylene). Fully formulated antifreeze must be mixed with good-quality water at a 50/50 ratio (40- to 60-percent working range). A 50/50 mixture of antifreeze and water gives a -36 °C [-33 °F] freezing point and a 108 °C [226 °F] boiling point, which is adequate for locations in North America. The actual lowest freezing point of ethylene glycol antifreeze is at 68 percent. Using higher concentrations of antifreeze will raise the freezing point of the solution and increase the possibility of a silica gel problem.

Do not use sealing additives in the cooling system. The use of sealing additives will:

- Buildup in coolant low-flow areas
- Plug the radiator and oil cooler Possibly damage the water pump seal.

Do **not** use soluble oils in the cooling system. The use of soluble oils will:

- Corrode brass and copper
- Damage heat transfer surfaces
- Damage seals and hoses.

10.ALTERNATOR

For safety purposes it is necessary that any testing or maintenance carried out on electrical machine are performed by qualified and authorized personnel, and all operation must be performed when the machine is stopped, at ambient temperature and disconnected from any supply source (including the auxiliary circuits such as the anti-condensation heaters). **Furthermore all measures must be taken to avoid restarting the gen-set during maintenance.**

10.1. INSPECTION AND MAINTENANCE INTERVALS

Inspection and maintenance should take into account the importance of the plant ambient conditions (dust etc.) and operating conditions.

As a general rule, the machine should be subjected to a first inspection after approx. 500 operating hours (in any case not more than 1 year) and subsequent inspections when performing maintenance on prime mover.

When performing inspection check that:

- The generator operates smoothly, without noise or irregular vibrations due to bearing deterioration
- The operating data complies with that detailed on the rating plate
- The air inlet openings are not obstructed
- The supply cables show no signs of deterioration and connections are firmly tight
- The electrical connections are in perfect condition (undamaged)
- Screws and nuts are firmly tightened.

10.2. MAINTENANCE OF BEARINGS

The lifetime of bearings is determined by multiple factors and specifically by:

- The lifetime of the grease.
- The environmental conditions and working temperature.
- The external loads and vibrations.

The bearings (D.E. and N.D.E. side are prelubricated sealed type (life lubrication), with sufficient grease quantity for a long operating time.

The life expected time is, in case of normal operating condition, of about 20000 hours for all bearings.

In case of complete overhaul of genset, the bearing of the generator should be changed.

On request prelubricated bearings with regreasing system can be mounted. When regreasing use 20/ 30 grams of grease.

Following types of grease are to be recommended for normal application:

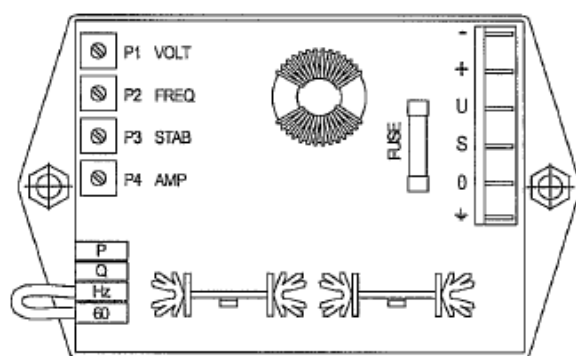
MOBIL OIL: MOBILUX 3

SHELL: ALVANIA 3

AGIP: GR MW 3

ESSO: BEACON 3

10.3. VOLTAGE REGULATOR



The generators are provided with automatic voltage regulator. The AVR is provided with potentiometers to adapt the characteristics of the AVR to different operating conditions.

The AVR is provided with adjustable stability circuitry to allow operations in a wide range of applications.

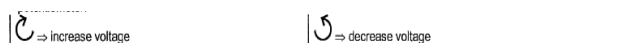
The AVR is equipped also with protecting circuit allowing the generator to operate underspeed if not loaded.

ATTENTION! it is not advisable to have the generator operating loaded when the frequency (speed) is below the rated value: this kind of operation is an overload for the whole generator excitation system.

CONNECTION OF AVR

The AVR is connected to the terminals of the generator and to exciter FAST-ON terminals.

USE OF POTENTIOMETERS



P1/VOLT- Potentiometer for adjusting the output voltage of the generator; it allows a wide range of voltage setting (i.e. between 350 and 470 V; or between 170 and 260 V depending on winding connections)). When resetting the potentiometer, the voltage has to be set in the range +5%,-5% around the rated voltage of the machine. In order to obtain

a finer regulation, or to adjust the voltage from control panel or to limit the voltage range, it is possible to insert an external potentiometer.

P2/FREQ- Potentiometer for changing the low speed protection. Usually it is set in order to reduce the excitation when the speed is 10 % below the rated value at 50 Hz. By removing the bridge which is normally shorting the auxiliary terminals 60-Hz of the regulator, the low speed protection acts properly for 60 Hz.

P3/STAB- Potentiometer for stability adjust. By rotating it clockwise the stability of the regulator increases, but the response time becomes longer.

P4/AMP- Potentiometer for changing the overexcitation limit device. The overexcitation limit device helps to protect the excitation system. This device is delayed to avoid transitory conditions (in case of overexcitation).

On the AVR there is a protecting fuse. In case it should be necessary to replace it, high speed fuses should be used; in addition they should have high breaking resistance with a rated voltage of 500V, and rated current of 10A. The AVR is connected to the terminals of the generator and to exciter using FAST-ON terminals.

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