PTS-30
PTS-35
PTS-40
PTS-50

Operators Manual
&
Supplemental Manual
For
Stand-By Generators

Power Technology Southeast, Inc.
634 State Road #44 Leesburg, FL 34748-8103
♦ (352) 365-2777 ♦ Fax (352) 787-5545 ♦

9/2008
MANPT30-40

FORWARD

You are now the proud owner of a Power Technology Generator powered by a Kubota engine. This engine is a product of Kubota's quality engineering and manufacturing. The engine is made with fine materials and manufactured under the strictest quality control standards and will assure you long satisfactory service. To obtain the best use of your engine, please read this manual carefully. It will help you become familiar with the operation of the engine and contains many helpful hints regarding engine maintenance. Continuing improvements and advancements in product design may have caused changes to your engine, which are not included in this manual.

Please contact Power Technology's Customer Service Department for latest information on your Kubota engine or for the number of your local Kubota dealer.

TO OUR CUSTOMERS

Thank you for your purchase of a Power Technology Generator. The information contained in this manual applies to PTS-30, PTS-35 and PTS-40 generators and optional equipment available for Stand-By systems. Your generator was custom built to your specific requirements and may or may not be equipped with each of these options listed. Installation requirements will vary depending on your application; therefore Power Technology can only suggest general installation requirements. (See Installation Requirements in Section 3) Follow all Safety Instructions as outlined in Sections 1 and 3 of this manual. Other important Safety Precautions are posted through out the manual as well.

In the event you experience a problem with your generator please contact the sales dealer, one of our authorized service centers or Power Technology's Customer Service Department directly at 1-800-760-0027 from 8:00 a.m. to 5:00 p.m. EST. Please have the generator model and serial numbers available when you call. This will help expedite service and parts to you. Parts may be obtained directly through Power Technology and shipped the same day if ordered by 3:00 p.m. EST.

Generator Model Number_____

Generator Serial Number_____

POWER TECHNOLOGY SOUTHEAST, INC.
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www.PowerTech-Gen.com

Limited Warranty on Power Tech Generators

Power Technology Southeast, Inc. warrants to you, the original purchaser, that each product of our manufacture is free from defects in materials, and workmanship. That each generator will deliver its rated output as indicated on The Power Technology Nameplate, if properly installed, serviced, and operated under normal conditions in accordance with Power Technology's instructions.

THE WARRANTY COVERAGE TERMS:
2 years from date of purchase, or 3000 hours whichever comes first, or 36 months from the date of manufacture. Parts, and labor, including diagnostic labor, removal, and reinstallation are covered for the first 12 months from date in service or 1000 hours whichever comes first.
Parts and labor are covered only on the following generator and engine parts for 2 years or 3000 hours whichever comes first. Generator Parts: Main Rotor and Main Stator. Engine Parts: Cylinder Block, cylinder head, crankshaft, camshaft, cylinder head gears, connecting rods, flywheel and flywheel housing, intake and exhaust manifold (only if flexible connection is used).

3) Stand-by Units are covered for a period of 1 year from date of installation, or 1000 hours, or 24 months from the date of manufacture whichever comes first.
4) Replacement Parts are warranted: 30 days. (Excluding the following: voltage regulators, fuses, controllers, capacitors, brushes, and switches)

WHAT POWER TECHNOLOGY WILL DO:
Power Tech will at our option, repair or replace any part covered by this warranty which becomes defective, malfunctions or otherwise fails to conform to this warranty under normal use and service during the term of this warranty.

WHAT YOU MUST DO TO OBTAIN WARRANTY SERVICE:
In order to obtain warranty repairs you must deliver the product, together with proof of purchase to an authorized Power Tech service facility. In the case of repairs pertaining to the engine only, you must use an authorized dealer or distributor of that make of engine, to be covered under their warranty. Engines used in the manufacture of Power Tech products are warranted solely by the engine manufacturer.

PRIOR APPROVAL IS REQUIRED FOR ANY WARRANTY SERVICE
Failure to obtain authorization prior to the repair being performed will result in the claim being denied.
All claims must be submitted within 30 days of the repair. Along with the following: a copy of the original repair order, Power Tech authorization number, Power Tech serial number, and operation hours shown on the genset mounted hour meter.

THIS WARRANTY DOES NOT COVER THE FOLLOWING:
A. Normal wear items, including but not limited to: turbo-chargers, fuel injector (s), starter, alternator, and electronic components, as well as normal engine and/or generator wear. **A1.** Travel time and fuel charges to and from the repair facility or travel time and fuel charges for mobile service. (Except stationary units with a maximum of 2-hours travel time.) **B.** Defects, malfunctions or failure resulting from accidents, abuse, misuse, improper servicing, improper installation, improper storage, and lack of performance of required maintenance service. **C.** Products which have been subjected to alteration, modification, neglect or unauthorized repairs. **D.** Troubleshooting, routine service, tune-ups, replacement of filters, belts, coolant, lubricants, hoses, clamps, exhaust system components, fuel system components, gaskets and/or seals. **E.** Electrical items damaged by welding or jump-starting. **F.** Damage caused by water ingestion or electrolysis. **G.** Damage caused by ingestion of substances other than clean filtered air, fuel, or intake water. **H.** Damage caused by faulty repairs performed by a repair facility not authorized in writing by Power Tech. **I.** Damage caused by operation with improper fuel or at speeds, loads, conditions, modifications, or installation contrary to published specifications or recommendations. **J.** Original installation charges and startup costs. **K.** Removal and re-installation charges of more than 1-hour labor for outside units, 2-hours for compartment mounted units, and 3-hours for below deck marine units. Customer is responsible for additional labor/charges due to difficult access, removal or installation. **L.** Starting batteries and labor or charges related to battery service. **M.** Loss of revenue or the rental of equipment due to down time. **N.** Generator repairs made within the warranty period other than by an authorized Power Tech service dealer without prior written approval from Power Tech warranty department. **O.** Damage caused by negligent maintenance such as but not limited to: Failure to provide the specified type and quantity of lubricating oil, cooling air flow, and proper coolant mixture and level. Failure to provide adequate air intake/or maintenance of the air intake system. Failure to provide scheduled maintenance as prescribed in supplied manuals. **P.** Engine fluids such as fuel, oil or coolant/antifreeze. **Q.** Shop supplies such as adhesives, cleaning agents, rags, paint, or other miscellaneous supplies. **R.** Use of other than factory supplied or approved repair parts or procedures. Replacement of a failed Power Tech component with a non-Power Tech component voids the Power Tech warranty on that component and any and all failures related to that component. **S.** Fuel injection pumps repaired by anyone other than the factory authorized dealer or distributor of that engine. **T.** Expenses incurred investigating performance complaints unless defective Power Tech materials or workmanship are discovered. **U.** Generator sets used in rental applications. **V.** Cleaning, service, or repair of generator sets the have not been kept free of dirt, debris, or other items that prevent the unit from being able to operate properly. **W.** Any generator set not application approved. **X.** Loss of excitation due to prolonged storage. **Y.** Any damage attributed to low battery monitoring or automatic generator starting systems. **Z.** Optional accessories are warranted solely by the manufacturer of that item including but not limited to the following item: Block heaters, oil pan heaters, electric cooling fans, air-bag isolators, compartment heaters, fuel tanks, trailers, battery chargers, battery monitors.

To obtain warranty service: For your nearest Power Tech authorized service center, on the World Wide Web at: http://www.powertech-gen.com/parts_service.php
Call 1-352-365-2777 or write to Power Tech Warranty Department, P.O. Box 490133 Leesburg, FL 34749 USA.
Power Tech must be notified in writing within five (5) business days of any product failure.

General Conditions:
This Warranty is the sole property of the original owner /user.
A transfer of ownership shall terminate this Warranty.
This Warranty is only valid within the contiguous United States and Canada.
Warranty coverage is available outside the U.S. and Canada; please speak to a factory representative for those details.
This Warranty does not cover any products or parts not purchased from Power Technology.
Power Technology reserves the right to make design improvements and model changes without any obligation to change units or parts previously manufactured.
Warranty registration card must be completed and mailed to Power Tech at the above address to validate the Warranty.

This is the only express warranty on Power Tech products
No person, agent, or dealer is authorized to give any Warranties on behalf of Power Technology Southeast, Inc., and not to assume for Power Technology Southeast, Inc. any other liability in connection with any of its products unless made in writing and signed by an officer of Power Technology Southeast, Inc.
LIMITATIONS ON OUR RESPONSIBILITY WITH RESPECT TO PRODUCTS PURCHASED AND USED FOR PERSONAL, FAMILY OR HOUSEHOLD USE:
Our responsibility is to repair or replace defective parts as stated above. We will not be responsible for any other expenses, losses or inconvenience which you may Sustain as a result of the purchase, use, malfunction or defective condition of our products. ANY IMPLIED WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL BE LIMITED IN DURATION TO THE PERIOD SET FORTH ABOVE.
Some states do not allow limitations on how long an implied Warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above Limitations or exclusions may not apply to you. This Warranty gives you specific legal rights and you may have other rights which vary from state to state.
This Warranty is in lieu of all other Warranties, expressed or implied and of any other obligations or liability on our part.
Our responsibility for any and all losses and IN NO EVENT WILL WE BE LIABLE FOR LOSS OF USE, LOSS OF PROFITS, INCONVIENCE, COMMERCIAL LOSS OR OTHER INCIDENTIAL OR CONSEQUENTIAL DAMAGES WHATSOEVER.

Power Technology S.E., Inc.
P.O. Box 490133 Leesburg, FL 34749 USA.

POWER TECHNOLOGY SOUTHEAST, INC.
Export Warranty on All Power Technology Products

The Power Technology standard commercial warranty shall be modified as follows for all sales and delivery of products outside of the United States and Canada.

The terms of the warranty shall be for a period of 12 months from the delivery to the first retail user.

Dealer shelf life shall be 6 months from date of shipment. In no case shall the warranty period exceed 18 months from date of shipment.

Warranty shall cover defected materials and workmanship for the above time period. Power Technology shall supply replacement parts at no charge. The customer shall be responsible for all transportation costs, import duties, legal documents including but not limited to import licenses, customs declaration or inspection services.

In all cases if local warranty services are available through manufacturers representation, manufacturers' standard warranty shall supersede Power Technology's warranty and any warranty or parts and labor shall be that of the manufacturer. The terms and conditions of the manufacturer warranty shall be those offered by the manufacturer for the country or region covered by the manufacturers' representative.

SECTION 1
"SAFETY"

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels attached the machine itself. It warns of the potential for personal injury. It is essential that you carefully read the instructions and safety regulations before you attempt to assemble or use this unit.

WARNING: Indicates a potentially hazardous situation, which may possibly result in serious injury or possible death.

CAUTION: Indicates a potentially hazardous situation, which may possibly result in minor injury.

IMPORTANT: Indicates that equipment or property damage may result if instructions are not followed.

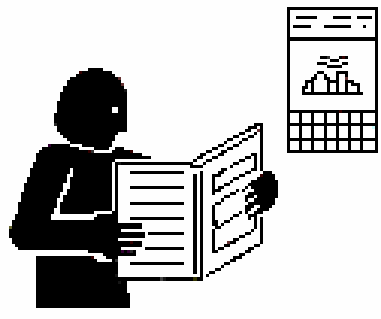
NOTE: Indicates helpful information.

SAFE OPERATION

Cautious operation is your best insurance against an accident. Read and understand this section carefully before operating the engine. All operators, no matter how knowledgeable they may be, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's responsibility to instruct all operators in safe operation. Be sure to observe the following for safe operation.

OBSERVE SAFETY INSTRUCTIONS

- Read, understand and follow this "OPERATORS MANUAL" and "LABELS ON THE ENGINE" before starting and operating the engine.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- Before allowing other people to use your engine, explain how to operate and have them read this manual before operation.
- DO NOT modify the engine. UNAUTHORIZED MODIFICATIONS to the engine may impair the function and/or safety and affect engine life.



WEAR SAFETY CLOTHING

- DO NOT wear loose, torn or bulky clothing around machinery. Entanglement in rotating parts, controls or projections may cause personal injury.
- Use additional safety items, e.g. hardhat, eye protection, gloves, etc., as appropriate or required.
- DO NOT operate machinery or equipment while under the influence of alcohol, medication, or other drugs, or while fatigued.
- DO NOT wear radio or music headphones while operating engine.

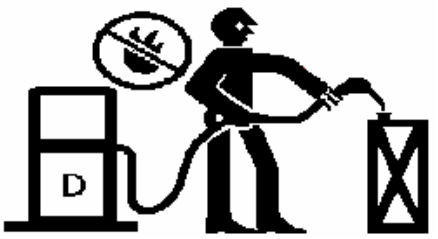
CHECK BEFORE OPERATING THE ENGINE

- If the engine is malfunctioning DO NOT operate until repairs are made.
- Be sure all guards and shields are in place before operating the engine. Replace any that are damaged or missing.
- Check to see that the area around the engine is clear of foreigr objects before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings or other facilities.
- DO NOT allow children or livestock to approach the machine while in operation.
- DO NOT start the engine by shorting across starter terminals.

KEEP AREA AROUND THE ENGINE CLEAN

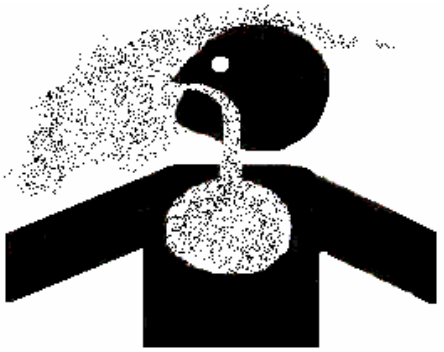
- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash.
- DO NOT stop the engine without idling; Temperatures around the engine rises suddenly. Keep the engine idling for about 5 minutes before stopping.

SAFE HANDLING OF FUEL AND LUBRICANTS



- Always stop the engine before refueling or lubricating.
- DO NOT smoke or allow flames or sparks in your working area. Fuel is extremely flammable and explosive. Never store flammable liquids in the engine compartment.
- Refuel at a well-ventilated and open place. If fuel or lubricants spill, clean up immediately and properly dispose of.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire.

EXHAUST GASES AND FIRE PREVENTION



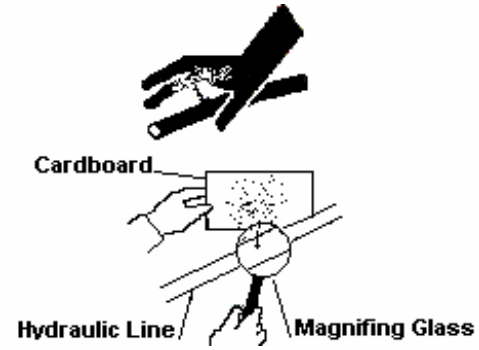
- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well-ventilated area where there are no people or livestock near by.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, oil or any other combustible materials to exhaust gas. Keep the engine and mufflers clean all the time.
- To avoid a fire, be alert for leaks of flammables from hoses and lines. Be sure to check for leaks from hoses and pipes, such as fuel and hydraulic by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wires are in good condition. Keep all power connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.

CALIFORNIA
Proposition 65 Warning

Diesel Engine Exhaust and some of it's constituents are known by the State of California to cause Cancer, Birth Defects and Other Reproductive harm.

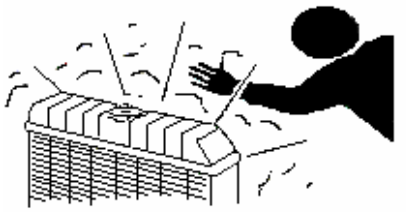
ESCAPING FLUIDS

- Relieve all pressure in the air, oil and cooling systems before any lines, fittings or related items are removed or disconnected.
- Be alert for possible pressure release when disconnecting any dev from a system that is pressurized. DO NOT check for pressure leaks with your hands. High-pressure oil or fuel can cause personal injury.
- Escaping hydraulic fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reaction.



CAUTIONS AGAINST BURNS AND BATTERY EXPLOSION

- To avoid burns, be alert for hot components during operation and just after the engine has been shut off. Such as the muffler, muffler cover, radiator, piping, engine body, coolants, engine oil, etc.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Wait approximately ten minutes for the radiator to cool before removing the cap.
- Be sure the radiator drain valve / petcock and hose clamps are tighten. Check radiator pressure cap and oil fill cap before operating the engine.
- The battery presents an explosive hazard. When the battery is being activated, hydrogen and oxygen gases are extremely explosive.
- Keep sparks and open flames away from the battery, especially during charging. DO NOT strike a match near the battery.
- DO NOT check a batteries charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge a battery if frozen, it may possibly explode. Frozen batteries must be warm up to at least 61°F (16°C) before charging.



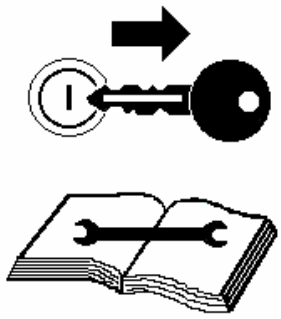
KEEP HANDS AND BODY AWAY FROM ROTATING PARTS

- Keep your hands and body away from all rotating parts, such as cooling fan, v-belts, pulleys and flywheel. Contact with these rotating parts can cause serious personal injury.
- Be sure to stop the engine before adjusting belt tension or checking the cooling fan.
- DO NOT run the engine without safety guards installed. Be sure the safety guards are properly aligned and securely fastened before operating the engine.

ANTI-FREEZE AND DISPOSAL OF FLUIDS

- Anti-freeze contains toxic chemicals. Wear rubber gloves when handling anti-freeze. In case of contact with skin, wash immediately to avoid personal injury.
- DO NOT mix different types of Anti-freeze. The mixture can produce a chemical reaction resulting in the formation of harmful substances. Only use anti-freeze that is recommended and approved by Caterpillar.
- Be mindful of the environment. Before draining any fluids, be prepared to dispose of them in a manner consistent with environmental protection regulations in your location.
- When draining fluids from the engine, use appropriate containers to hold the different fluids, do not mix fuel, oil or coolant together.
- Dispose of spent filter cartridges and batteries properly.
- DO NOT pollute the soil, or any water source. Never pour fluids down a drain.

CONDUCTING SAFETY CHECKS AND MAINTENANCE



- When performing safety checks or engine service, be sure the engine is level and well supported. Use approved stands designed for this type of service. DO NOT service an engine that is only supported by a lift jack or hoist.
- Detach the battery from the engine before conducting service. Put a "DO NOT OPERATE!" tag in the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the 12V DC power at the battery.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, servicing and cleaning.
- Check or conduct maintenance after the engine, radiator, muffler, or muffler cover has cooled off completely.
- Always use the appropriate tools and jig-fixture when performing any service work. Be sure to understand and follow the instructions included with these tools.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. Serious personal injury or damage to the cooling fan may occur.
- Replace fuel hoses and hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and are aged gradually.
- When service is performed with two or more people present, take care to perform all work safely. Be aware of their location especially when starting the engine.
- Keep a first aid kit and fire extinguisher handy at all times.

OPERATING THE ENGINE
PT-ECU-64 CONTROLLED

ENGINE STARTING CONTROLS

1) Generator Main Switch must be in the ON position.
2) Toggle the Start/Stop Switch to the Start position.
3) Glow Plugs will preheat for 8 seconds. LED flashes slowly.
4) Preheating will cease during engine cranking cycle. LED continues flashing.
5) Engine begins an 8 seconds crank cycle, After 4 seconds of cranking the PT-ECU-64 will check for an AC signal from the generator. If an AC signal is verified the engine will start and the LED will remain ON during the normal run operation. If the AC signal is not verified the PT-ECU-64 will terminate the cranking cycle and LED will flash a fault code.
6) Starter disengages immediately after engine run is verified.
7) PT-ECU-64 deactivates the Low Oil Pressure and High Water Temperature Switches for 6 seconds, this will assure oil pressure build-up time. If oil pressure does not build-up the engine will immediately shut down and go into a fault mode. Likewise for a high temperature situation.
8) If engine will not start on the first attempt the PT-ECU-64 will initiate the start cycle 2 more times before going into a fault mode. Glow Plugs will preheat for 8 seconds per attempt. Engine will crank for 8 seconds per attempt.
9) To shut down the engine under normal operations, toggle the Start/Stop Switch to the Stop position.
10) If a fault occurs turn Generator Main Switch OFF and then ON to reset PT-ECU-64.

CHECKING ENGINE AFTER STARTING

1) Allow the engine to warm up 3 to 5 minutes before applying a load. In colder climates allow a few extra minutes longer.
2) Perform a visual inspection of all areas of the engine and generator.
3) Listen for any abnormal noises.
4) Check for any abnormal exhaust gases.

STOPPING THE ENGINE

It is recommended to disconnect or reduce the power load from the generator before shutting down the engine. Then follow the steps outlined above for normal shut down.

IMPORTANT: Damage to the Starter Motor, Starter Solenoid, Run Solenoid or any generator component due to excessive or prolonged starting attempts attributed to an external Low Battery Control Monitoring or Auto-Start System will not be covered by the Power Technology Southeast, Inc. Limited Warranty.

OPERATING THE ENGINE
NON-ECU CONTROLLED

ENGINE STARTING CONTROLS

1. **Main Switch:** Turns power On or Off to the engine start circuit.
2. **ON Position:** Must be in this position for the engine to start and run.
3. **OFF Position:** Used to cut the power to the start circuit of the engine. Always turn the switch to the OFF position when servicing the generator set or engine.
4. **Start:** Position to use for starting the engine. The switch will return to the original position when released.
5. **Stop:** Position used to stop the engine. The switch will return to the original position when released.
6. **Preheat / Prime:** Preheats combustion chamber before starting. Primes fuel system.

STARTING THE ENGINE

1. Before starting the engine, be sure to disconnect the power supply from power line. The engine may be hard to start if a load is connected.
2. Press the Start / Stop switch to the "Stop" position for six (6) seconds. This will preheat the combustion chambers and aid in starting.
3. Press the Start / Stop switch to the "Start" position. This will engage the starter motor and start the engine.
4. Release the Start / Stop switch when the engine starts.

CHECK ENGINE AFTER STARTING

1. Allow the engine to warm up 3 to 5 minutes before applying a load. In colder climates allow a few extra minutes longer.
2. Check all areas of engine and generator during warm up. Visual inspection.
3. Listen for abnormal noises.
4. Check for abnormal exhaust gas.

STOPPING THE ENGINE

First, disconnect the power load. Next press the Start / Stop switch to the Stop position, the engine will shut down.

NOTE:
Failure to follow this procedure may harm the generator and cause a premature malfunction.

IMPORTANT:
If the engine fails to start on the first attempt, wait approximately 30 seconds than follow the starting procedure again. Do not run the starter for more than 30 seconds per starting attempt. Allow the starter to cool 2 minutes between subsequent starting attempts.

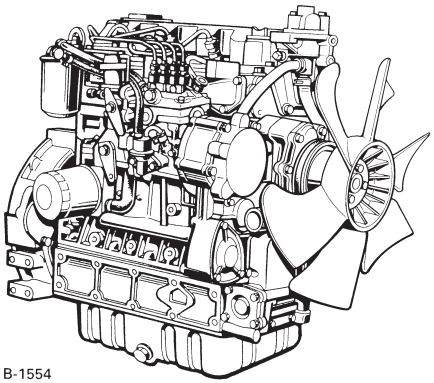
IMPORTANT:
Damage to the Starter Motor, Starter Solenoid, Run Solenoid or any generator component due to excessive or prolonged starting attempts attributed to an external Low Battery Control Monitoring or Auto-Start System will not be covered by the Power Technology Southeast, Inc. Limited Warranty.

OPERATOR'S MANUAL

ENGLISH

KUBOTA
DIESEL ENGINE

MODELS **V3600-E3 · V3600-T-E3 · V3800-DI-T-E3 · V3300-E3BG · V3600-T-E3BG · V3800-DI-T-E3BG**



B-1554

1J411-8911-4

READ AND SAVE THIS MANUAL

Kubota

ENGLISH

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ENGLISH

FOREWORD

You are now the proud owner of a KUBOTA Engine. This engine is a product of KUBOTA quality engineering and manufacturing. It is made of fine materials and under a rigid quality control system. It will give you long, satisfactory service. To obtain the best use of your engine, please read this manual carefully. It will help you become familiar with the operation of the engine and contains many helpful hints about engine maintenance. It is KUBOTA's policy to utilize as quickly as possible every advance in our research. The immediate use of new techniques in the manufacture of products may cause some small parts of this manual to be outdated. KUBOTA distributors and dealers will have the most up-to-date information. Please do not hesitate to consult with them.

SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully. It is essential that you read the instructions and safety regulations before you attempt to assemble or use this unit.

DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING : Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

CAUTION : Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.

NOTE : Gives helpful information.

SAFE OPERATION

Careful operation is your best assurance against an accident. Read and understand this section carefully before operating the engine. All operators, no matter how much experience they may have, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's obligation to provide all operators with this information and instruct them on safe operation.

Be sure to observe the following for safe operation.

1. OBSERVE SAFETY INSTRUCTIONS

- Read and understand carefully this "OPERATOR'S MANUAL" and "LABELS ON THE ENGINE" before attempting to start and operate the engine.
- Learn how to operate and work safely. Know your equipment and its limitations. Always keep the engine in good condition.
- Before allowing other people to use your engine, explain how to operate and have them read this manual before operation.
- DO NOT modify the engine. UNAUTHORIZED MODIFICATIONS to the engine may impair the function and/or safety and affect engine life. If the engine does not perform properly, consult your local Kubota Engine Distributor first.

1AAACAAAP008B

2. WEAR SAFE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

- DO NOT wear loose, torn or bulky clothing around the machine that may catch on working controls and projections or into fans, pulleys and other moving parts causing personal injury.
- Use additional safety items-PPE, e.g. hard hat, safety protection, safety goggles, gloves, etc., as appropriate or required.
- DO NOT operate the machine or any equipment attached to it while under the influence of alcohol, medication, or other drugs, or while fatigued.
- DO NOT wear radio or music headphones while operating the engine.

1AEAAAAAP0130

3. CHECK BEFORE STARTING & OPERATING THE ENGINE

- Be sure to inspect the engine before operation. Do not operate the engine if there is something wrong with it. Repair it immediately.
- Ensure all guards and shields are in place before operating the engine. Replace any that are damaged or missing.
- Check to see that you and others are a safe distance from the engine before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings and other facilities.
- DO NOT allow children or livestock to approach the machine while the engine is running.
- DO NOT start the engine by shorting across starter terminals. The machine may start in gear and move. Do not bypass or defeat any safety devices.

1BAABADAP0010

4. KEEP THE ENGINE AND SURROUNDINGS CLEAN

- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash to avoid a fire. Store flammable fluids in proper containers and cabinets away from sparks and heat.
- Check for and repair leaks immediately.
- DO NOT stop the engine without idling; Allow the engine to cool down, first. Keep the engine idling for about 5 minutes before stopping unless there is a safety problem that requires immediate shut down.

1AEAAAAAP0120

5. SAFE HANDLING OF FUEL AND LUBRICANTS -KEEP AWAY FROM FIRE

- Always stop the engine before refueling and/or lubricating.
- DO NOT smoke or allow flames or sparks in your work area. Fuel is extremely flammable and explosive under certain conditions.
- Refuel at a well ventilated and open place. When fuel and/or lubricants are spilled, refuel after letting the engine cool down.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire or severe engine damage.
- Do not use unapproved containers e.g. buckets, bottles, jars. Use approved fuel storage containers and dispensers.

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6. EXHAUST GASES & FIRE PREVENTION

- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well ventilated location and where there are no people or livestock near the engine.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, mowed grass, oil or any other combustible materials to exhaust gas. Keep the engine and muffler clean at all times.
- To avoid a fire, be alert for leaks of flammable substances from hoses and lines. Be sure to check for leaks from hoses or pipes, such as fuel and hydraulic fluid by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wirings are in good condition. Keep all electrical connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.

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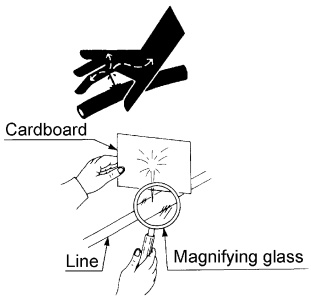
7. ESCAPING FLUID

- Relieve all pressure in the air, the oil and the cooling systems before disconnecting any lines, fittings or related items.
- Be cautious of possible pressure relief when disconnecting any device from a pressurized system that utilizes pressure. DO NOT check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- Escaping fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reaction.



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8. CAUTIONS AGAINST BURNS & BATTERY EXPLOSION

- To avoid burns, be cautious of hot components, e.g. muffler, muffler cover, radiator, hoses, engine body, coolants, engine oil, etc. during operation and after the engine has been shut off.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from the radiator. Wait until the radiator is completely cool to the touch before removing the cap. Wear safety goggles.
- Be sure to close the coolant drain valve, secure the pressure cap, and fasten the pipe band before operating. If these parts are taken off, or loosened, it will result in serious personal injury.
- The battery presents an explosive hazard. When the battery is being charged, hydrogen and oxygen gases are extremely explosive.
- DO NOT use or charge the battery if its fluid level is below the LOWER mark.
  Otherwise, the component parts may deteriorate earlier than expected, which may shorten the service life or cause an explosion. Immediately, add distilled water until the fluid level is between the UPPER and LOWER marks.
- Keep sparks and open flames away from the battery, especially during charging. DO NOT strike a match near the battery.
- DO NOT check the battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge a frozen battery. There is a risk of explosion. When frozen, warm the battery up to at least 16° C (61° F).

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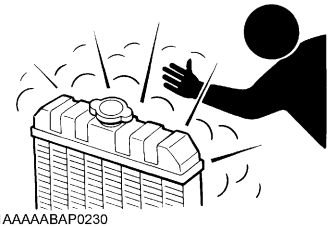

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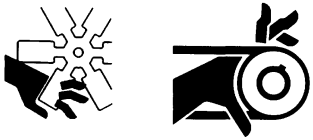
9. KEEP HANDS AND BODY AWAY FROM ROTATING PARTS

- Be sure to stop the engine before checking or adjusting the belt tension and cooling fan.
- Keep your hands and body away from rotating parts, such as the cooling fan, V-belt, fan drive pulley or flywheel. Contact with rotating parts can cause severe personal injury.
- DO NOT run the engine without safety guards. Install safety guards securely before operation.



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10. ANTI-FREEZE & DISPOSAL OF FLUIDS

- Anti-freeze contains poison. Wear rubber gloves to avoid personal injury. In case of contact with skin, wash it off immediately.
- DO NOT mix different types of Anti-freeze. The mixture can produce a chemical reaction causing harmful substances. Use approved or genuine KUBOTA Anti-freeze.
- Be mindful of the environment and the ecology. Before draining any fluids, determine the correct way to dispose of them. Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.
- When draining fluids from the engine, place a suitable container underneath the engine body.
- DO NOT pour waste onto the ground, down a drain, or into any water source. Dispose of waste fluids according to environmental regulations.

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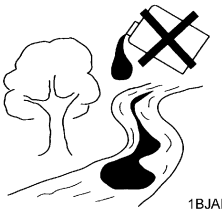

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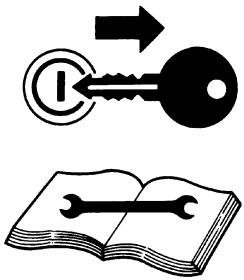
11. CONDUCTING SAFETY CHECKS & MAINTENANCE

- When inspecting the engine or servicing, place the engine on a large flat surface. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or the correct stands to support the engine before servicing.
- Disconnect the battery from the engine before conducting service. Put a "DO NOT OPERATE!" tag on the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the battery's ground cable (-) first and reconnect it last.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, service and cleaning.
- Check or conduct maintenance after the engine, coolant, muffler, or muffler cover have cooled off completely.
- Always use the appropriate tools and fixtures. Verify that they are in good condition before performing any service work. Make sure you understand how to use them before service.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. This practice can cause serious personal injury or premature damage to the cooling fan and belt.



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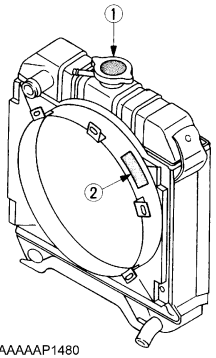
- Replace fuel pipes and lubricant pipes with their hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and age gradually.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Keep a first aid kit and fire extinguisher handy at all times.

12. WARNING AND CAUTION LABELS



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① Part No.19077-8724-1 or 16667-8724-1
(55mm in diameter) (37mm in diameter)

1ABACAAAP036K

② Part No.TA040-4957-1
Stay clear of engine
fan and fan belt


1AGAMAAAP2620

13. CARE OF WARNING AND CAUTION LABELS

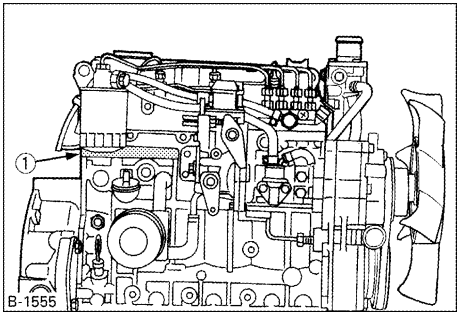
1. Keep warning and caution labels clean and free from obstructing material.
2. Clean warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing warning and caution labels with new labels from your local KUBOTA dealer.
4. If a component with warning and caution label(s) affixed is replaced with a new part, make sure the new label(s) is (are) attached in the same location(s) as the replaced component.
5. Mount new warning and caution labels by applying to a clean dry surface and pressing any bubbles to the outside edge.

ENGLISH

SERVICING OF THE ENGINE

Your dealer is interested in your new engine and has the desire to help you get the most value from it. After reading this manual thoroughly, you will find that you can do some of the regular maintenance yourself.
However, when in need of parts or major service, be sure to see your KUBOTA dealer.
For service, contact the KUBOTA Dealership from which you purchased your engine or your local KUBOTA dealer.
When in need of parts, be prepared to give your dealer the engine serial number.
Locate the serial number now and record them in the space provided.

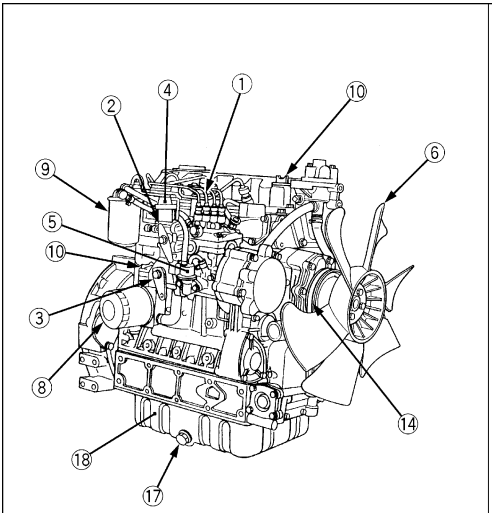
	Type	Serial No.
Engine		
Date of Purchase		
Name of Dealer		
(To be filled in by purchaser)		



(1) Engine serial number

ENGLISH

NAMES OF PARTS



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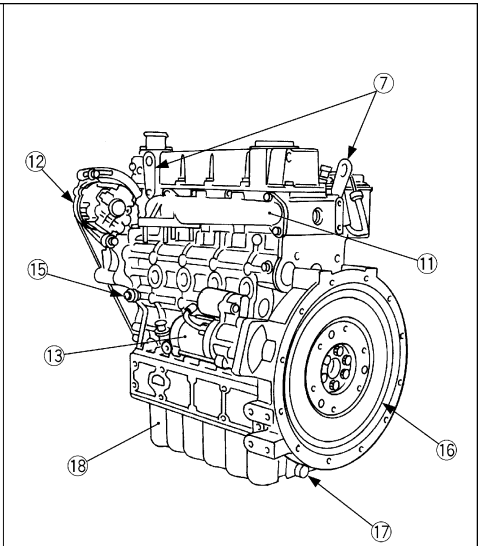

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(1) Intake manifold
(2) Speed control lever
(3) Engine stop lever
(4) Shut off solenoid
(5) Fuel feed pump
(6) Cooling fan
(7) Engine hook
(8) Oil filter cartridge
(9) Fuel filter
(10) Oil filler plug
(11) Exhaust manifold
(12) Alternator
(13) Starter
(14) Fan belt
(15) Oil pressure switch
(16) Flywheel
(17) Oil drain plug
(18) Oil pan

PRE-OPERATION CHECK

BREAK-IN

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

1. Change engine oil and oil filter cartridge after the first 50 hours of operation. (See "**ENGINE OIL**" in "**PERIODIC SERVICE**" section.)
2. When ambient temperature is low, operate the machine after the engine has been completely warmed up.

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.**

Item		Ref. page
1. Parts which had trouble in previous operation		-
2. By walking around the machine	(1) Oil or water leaks	15 to 20
	(2) Engine oil level and contamination	15
	(3) Amount of fuel	12
	(4) Amount of coolant	18
	(5) Dust in air cleaner dust cup	21
	(6) Damaged parts and loosened bolts and nuts	-
3. By inserting the key into the starter switch	(1) Proper functions of meters and pilot lamps; no stains on these parts	-
	(2) Proper function of glow lamp timer	-
4. By starting the engine	(1) Color of exhaust fumes	7
	(2) Unusual engine noise	7
	(3) Engine start-up condition	5
	(4) Slow-down and acceleration behavior	7

ENGLISH

OPERATING THE ENGINE

STARTING THE ENGINE(NORMAL)

CAUTION

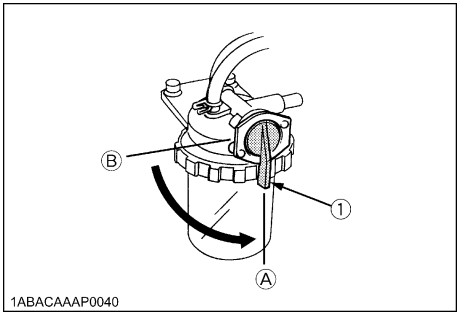
To avoid personal injury:

- **Do not allow children to approach the machine while the engine is running.**
- **Be sure to install the machine on which the engine is installed, on a flat place.**
- **Do not run the engine on gradients.**
- **Do not run the engine in an enclosed area. Exhaust gas can cause air pollution and exhaust gas poisoning.**
- **Keep your hands away from rotating parts (such as fan, pulley, belt, flywheel etc.) during operation.**
- **Do not operate the machine while under the influence of alcohol or drugs.**
- **Do not wear loose, torn or bulky clothing around the machine. It may catch on moving parts or controls, leading to the risk of accident. Use additional safety items, e.g. hard hat, safety boots or shoes, eye and hearing protection, gloves, etc., as appropriate or required.**
- **Do not wear radio or music headphones while operating engine.**
- **Check to see if it is safe around the engine before starting.**
- **Reinstall safeguards and shields securely and clear all maintenance tools when starting the engine after maintenance.**

IMPORTANT :

- Do not use ether or any starting fluid for starting the engine, or a severe damage will occur.
- When starting the engine after a long storage (of more than 3 months), first set the stop lever to the "STOP" position and then activate the starter for about 10 seconds to allow oil to reach every engine part.

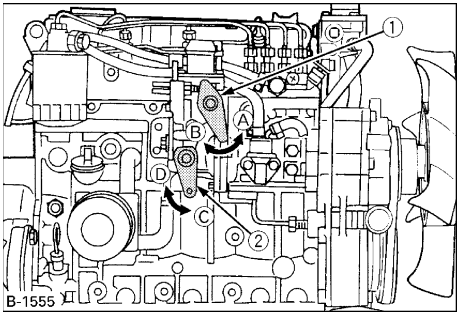
1. Set the fuel lever to the "ON" position.



(1) Fuel lever
(A) "ON"
(B) "OFF"

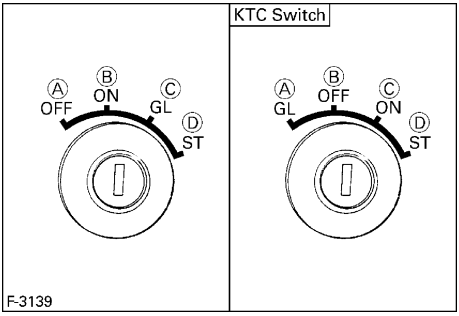
2. Place the engine stop lever to the "START" position.

3. Place the speed control lever at more than half "OPERATION".



(1) Speed control lever
(2) Engine stop lever
(A) "IDLING"
(B) "OPERATION"
(C) "START"
(D) "STOP"

4. Insert the key into the key switch and turn it "ON".



(A) "SWITCHED OFF"
(B) "OPERATION"
(C) "PREHEATING"
(D) "STARTING"

(A) "PREHEATING"
(B) "SWITCHED OFF"
(C) "OPERATION"
(D) "STARTING"

5. Turn the starter switch to the "PREHEATING" position to allow the glow lamp to redden.

NOTE :
(with lamp timer in use)
- The glow lamp goes out in about 5 seconds when the lamp timer is up. Refer to this for pre-heating. Even with the glow lamp off, the glow plug can be pre-heated by turning the starter switch to the "PRE-HEATING" position.

6. Turn the key to the "STARTING" position and the engine should start. Release the key immediately when the engine starts.

7. Check to see that the oil pressure lamp and charge lamp are off. If the lamps are still on, immediately stop the engine, and determine the cause.
(See "**CHECKS DURING OPERATION**" in "**OPERATING THE ENGINE**" section.)

NOTE :
- If the oil pressure lamp should be still on, immediately stop the engine and check;
  - if there is enough engine oil.
  - if the engine oil has dirt in it.
  - if the wiring is faulty.

8. Warm up the engine at medium speed without load.

IMPORTANT :
- If the glow lamp should redden too quickly or too slowly, immediately ask your KUBOTA dealer to check and repair it.
- If the engine does not catch or start at 10 seconds after the starter switch is set at "STARTING" position, wait for another 30 seconds and then begin the engine starting sequence again. Do not allow the starter motor to run continuously for more than 20 seconds.

COLD WEATHER STARTING

If the ambient temperature is below -5°C(23°F)* and the engine is very cold, start it in the following manner:
Take steps (1) through (4) above.

5. Turn the key to the "PREHEATING" position and keep it there for a certain period mentioned below.

IMPORTANT :
- Shown below are the standard preheating times for various temperatures. This operation, however, is not required, when the engine is warmed up.

Ambient temperature	Preheating time	
	V3600-E3 V3600-T-E3 V3300-E3BG V3600-T-E3BG	V3800-DI-T-E3 V3800-DI-T-E3BG
Above 10°C (50°F)	NO NEED	
10°C (50°F) to -5°C (23°F)	Approx.5 seconds	Approx.15 seconds
Below -5°C (23°F)	Approx.10 seconds	Approx.30 seconds
Limit of continuous use	20 seconds	30 seconds

6. Turn the key to the "STARTING" position and the engine should start.
(If the engine fails to start after 10 seconds, turn off the key for 5 to 30 seconds. Then repeat steps (5) and (6).)

IMPORTANT :
- Do not allow the starter motor to run continuously for more than 20 seconds.
- Be sure to warm up the engine, not only in winter, but also in warmer seasons. An insufficiently warmed-up engine can shorten its service life.
- When there is fear of temperature dropping below -15°C (5°F) detach the battery from the machine, and keep it indoors in a safe area, to be reinstalled just before the next operation.

ENGLISH

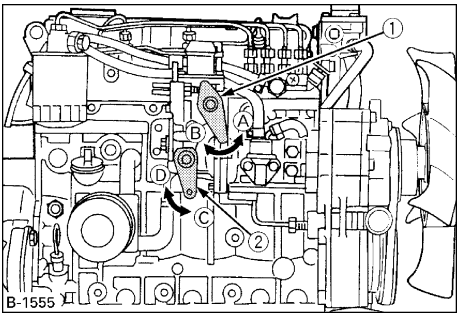
STOPPING THE ENGINE

1. **Return the speed control lever to low idle, and run the engine under idling conditions.**

IMPORTANT :
- If equipped with a turbo-charger, allow the engine to idle for 5 minutes before shutting it off after a full load operation.
  Failure to do so may lead to turbo-charger trouble.

2. **The engine should stop with the starter switch placed at the OFF position. (In case of non-stopping, set the engine stop lever to the "STOP" position manually.)**

3. **After stopping the engine, remove the key.(Be sure to return the engine stop lever to the START position to be ready for the next starting in case of manually stopping.)**



(1) Speed control lever
(2) Engine stop lever
(A) "IDLING"
(B) "OPERATION"
(C) "START"
(D) "STOP"

CHECKS DURING OPERATION

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

■Radiator Cooling water(Coolant)

⚠ WARNING

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.**

If the coolant temperature warning lamp lights up or if steam or coolant does not stop squirting from the radiator overflow pipe, turn off the load and **keep the engine idling (COOLING-DOWN) for at least 5 minutes** to let it cool down gradually. Then stop the engine and take the following inspection and servicing.
1. Check to see if the coolant runs short or 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; and
5. Check to see if radiator water pipe is clogged.

■Oil pressure lamp

The lamp lights up to warn the operator that the engine oil pressure has dropped below the prescribed level. If this should happen during operation or should not go off even after the engine is accelerated more than 1000rpm, immediately stop the engine and check the following:
1. Engine oil level (See "**ENGINE OIL**" in "**PERIODIC SERVICE**" section.)

■Charge lamp

The lamp lights up to warn the operator that the battery charge is low. If this should happen during operation, immediately stop the engine and check the following:
1. Cable broken
2. Poor connection at alternator terminal
3. Fan belt too loose or damaged

■**Fuel**

CAUTION

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. (See "**FUEL**" in "**PERIODIC SERVICE**" section.)

■**Color of exhaust**

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 slows down or accelerates.
- Unusual noises are suddenly heard.
- Exhaust fumes suddenly become very dark.
- The oil pressure lamp or the water temperature alarm lamp lights up.

REVERSED ENGINE REVOLUTION AND REMEDIES

CAUTION

To avoid personal injury:

- **Reversed engine operation can make the machine reverse and run it backwards. It may lead to serious trouble.**
- **Reversed engine operation may make exhaust gas gush out into the intake side and ignite the air cleaner; It could catch fire.**

Reversed engine revolution must be stopped immediately since engine oil circulation is cut quickly, leading to serious trouble.

■**How to tell when the engine starts running backwards**

1. Lubricating oil pressure drops sharply. Oil pressure warning light, if used, will light.
2. Since the intake and exhaust sides are reversed, the sound of the engine changes, and exhaust gas will come out of the air cleaner.
3. A louder knocking sound will be heard when the engine starts running backwards.

■**Remedies**

1. Immediately turn the starter switch to the "OFF" position and set the engine stop lever to the "STOP" position to stop the engine.
2. After stopping the engine, check the air cleaner, intake rubber tube and other parts and replace parts as needed.

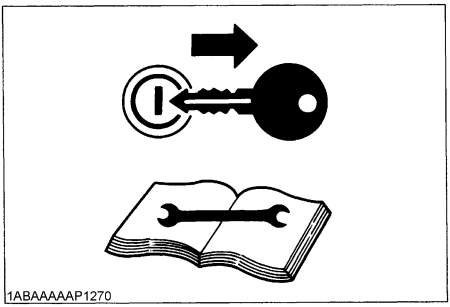
ENGLISH

MAINTENANCE

CAUTION

To avoid personal injury:

- **Be sure to conduct daily checks, periodic maintenance, refueling or cleaning on a level surface with the engine shut off and remove the key.**
- **Before allowing other people to use your engine, explain how to operate, and have them read this manual before operation.**
- **When cleaning any parts, do not use gasoline but use regular cleanser.**
- **Always use proper tools, that are in good condition. Make sure you understand how to use them, before performing any service work.**
- **When installing, be sure to tighten all bolts lest they should be loose. Tighten the bolts by the specified torque.**
- **Do not put any tools on the battery, or battery terminals may short out. Severe burns or fire could result. Detach the battery from the engine before maintenance.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result.**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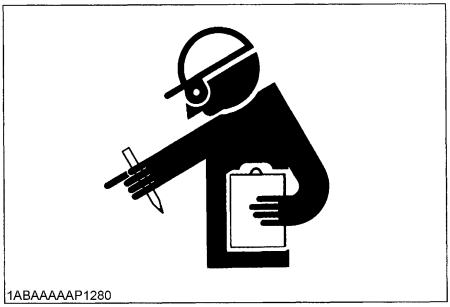
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SERVICE INTERVALS

Observe the following for service and maintenance.

Interval	Item	Ref. page		
Every 50 hours	Check of fuel pipes and clamp bands	14		@
	Draining water separator	-		
See NOTE	Change of engine oil	15 to 17	◎	
Every 250 hours	Cleaning of air cleaner element	21	*1	@
	Cleaning of fuel filter	14		
	Check of fan belt tightness	22		
	Check of radiator hoses and clamp bands	19		
	Check of intake air line	-		@
Every 500 hours	Replacement of oil filter cartridge	17	◎	
	Replacement of fuel filter cartridge	15		@
	Removal of sediment in fuel tank	-		
	Cleaning of water jacket (radiator interior)	18 to 20		
	Replacement of fan belt	22		
	Cleaning of water separator	-		
Every year	Replacement of air cleaner element	21	*2	@
Every 1000 hours	Check of valve clearance	-	*3	
Every 1500 hours	Check of fuel injection nozzle injection pressure	-	*3	@
Every 3000 hours	Check of turbo charger	-	*3	@
	Check of injection pump	-	*3	@
	Check of fuel injection timer	-	*3	@
Every two years	Change of radiator coolant (L.L.C.)	19 to 20		
	Replacement of radiator hoses and clamp bands	19		
	Replacement of fuel pipes and clamp bands	14	*3	@
	Replacement of intake air line	-	*4	@
	Replacement of fan belt (or every 500 hours)	22		

IMPORTANT :

- The jobs indicated by ◎ must be done after the first 50 hours of operation.

*1 Air cleaner should be cleaned more often in dusty conditions than in normal conditions.
*2 After 6 times of cleaning.
*3 Consult your local KUBOTA Dealer for this service.
*4 Replace only if necessary.

- When the battery is used for less than 100 hours in a year, check its electrolyte yearly. (for refillable battery's only)
- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.
  Please see the Warranty Statement in detail.

NOTE :

- **Changing interval of engine oil**

Models	Interval
V3600-E3, V3600-T-E3, V3300-E3BG, V3600-T-E3BG	250 Hrs or 1 year whichever comes first
V3800-DI-T-E3, V3800-DI-T-E3BG	500 Hrs or 1 year whichever comes first
Initial	50 Hrs

- API service classification: above CF-4 grade
- Ambient temperature: below 35°C (95°F)

NOTE :

Lubricating oil

With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Non-Road engine runs on high sulfur fuel, it is advisable to use a "CF or better" classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

○ : Recommendable × : Not recommendable

Lubricating oil classification	Fuel		Remarks
	Low-sulfur	High-sulfur	
CF	○	○	*TBN≧10
CF-4	○	×	
CG-4	○	×	
CH-4	○	×	
CI-4	○	×	

*TBN: Total Base Number
**Fuel

- Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half).
- DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of low sulfur fuel or ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S500 or S15 diesel fuel as an alternative to No.2-D, and use No.1-D S500 or S15 diesel fuel as an alternative to No.1-D for ambient temperatures below -10°C (14°F).
  1) No.1-D or No.2-D, S500 : Low Sulfur Diesel (LSD) less than 500 ppm or 0.05 wt.%
     No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

- CJ-4 classification oil is intended for use in engines equipped with DPF (Diesel Particulate Filter) and is Not Recommended for use in Kubota E3 specification engines.
- Oil used in the engine should have API classification and Proper SAE Engine Oil according to the ambient temperatures as shown below:

Above 25°C (77°F)	SAE30, SAE10W-30 or 15W-40
0 to 25°C (32°F to 77°F)	SAE20, SAE10W-30 or 15W-40
Below 0°C (32°F)	SAE10W, SAE10W-30 or 15W-40

- Recommended API classification
  Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used : (Low Sulfur, Ultra Low Sulfur or High Sulfur Fuels).

Fuel type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	**CF** (If the "CF-4, CG-4, CH-4 or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	---
Low Sulfur Fuel [Sulfur Content < 0.05 % (500 ppm)] or Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	**CF, CF-4, CG-4, CH-4 or CI-4**	**CF or CI-4** (Class CF-4, CG-4 and CH-4 engine, oils cannot be used on EGR type engines.)

EGR: Exhaust Gas Re-circulation

ENGLISH

PERIODIC SERVICE

FUEL

Fuel is flammable and can be dangerous. You should handle fuel with care.

CAUTION

To avoid personal injury:

- **Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.**
- **Be careful not to spill fuel during refueling. If fuel should spill, wipe it off at once, or it may cause a fire.**
- **Do not fail to stop the engine before refueling. Keep the engine away from the fire.**
- **Be sure to stop the engine while refueling or bleeding and when cleaning or changing fuel filter or fuel pipes. Do not smoke when working around the battery or when refueling.**
- **Check the above fuel systems at a well ventilated and wide place.**
- **When fuel and lubricant are spilled, refuel after letting the engine cool off.**
- **Always keep spilled fuel and lubricant away from engine.**

■Fuel level check and refueling

1. Check to see that the fuel level is above the lower limit of the fuel level gauge.
2. If the fuel is too low, add fuel to the upper limit. Do not overfill.

Flash Point, °C (°F)	Water and Sediment, volume %	Carbon Residue on, 10 percent Residuum, %	Ash, weight %
Min	Max	Max	Max
52 (125)	0.05	0.35	0.01

Distillation Temperatures, °C(°F) 90% Point		Viscosity Kinematic cSt or mm^2/s at 40°C		Viscosity Saybolt, SUS at 37.8°C(100°F)	
Min	Max	Min	Max	Min	Max
282 (540)	338 (640)	1.9	4.1	32.6	40.1

Sulfur, weight %	Copper Strip Corrosion	Cetane Number
Max	Max	Min
0.50	No. 3	40

- Cetane Rating : The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below -20 °C (-4 °F) or elevations above 1500 m (5000 ft).
- Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.
- Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.
- If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half).
- DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).
- Diesel fuels specified to EN 590 or ASTM D975 are recommended.
- No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)
- Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of low sulfur fuel or ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S500 or S15 diesel fuel as an alternative to No.2-D, and use No.1-D S500 or S15 diesel fuel as an alternative to No.1-D for ambient temperatures below -10 °C (14 °F).
  1) SAE : Society of Automotive Engineers
  2) EN : European Norm
  3) ASTM : American Society of Testing and Materials
  4) US EPA : United States Environmental Protection Agency
  5) No.1-D or No.2-D, S500 : Low Sulfur Diesel (LSD) less than 500 ppm or 0.05 wt.%
     No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

IMPORTANT :
- Be sure to use a strainer when filling the fuel tank, or dirt or sand in the fuel may cause trouble in the fuel injection pump.
- For fuel, always use diesel fuel. You are required not to use alternative fuel, because its quality is unknown or it may be inferior in quality. Kerosene, which is very low in cetane rating, adversely affects the engine. Diesel fuel differs in grades depending on the temperature.
- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.

■Air bleeding the fuel system

CAUTION

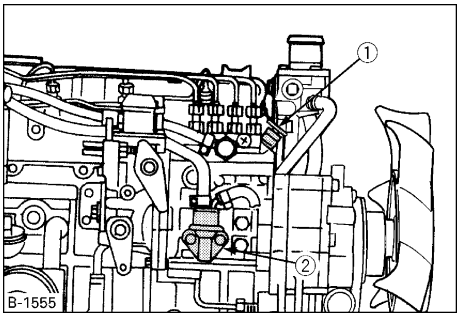
To avoid personal injury;
- **Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.**

Air bleeding of the fuel system is required if;
- after the fuel filter and pipes have been detached and refitted;
- after the fuel tank has become empty; or
- before the engine is to be used after a long storage.

[PROCEDURE Ⓐ] (gravity feed fuel tanks only)
1. Fill the fuel tank to the fullest extent. Open the fuel filter lever.
2. Open the joint bolt on top of the fuel injection pump.
3. Turn the engine, continue it for about 10 seconds, then stop it, or move the fuel feed pump lever by hand (optional).
4. Close the Joint bolt on top of the fuel injection pump.

IMPORTANT :
- Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.

[GRAVITY FEED SYSTEM]



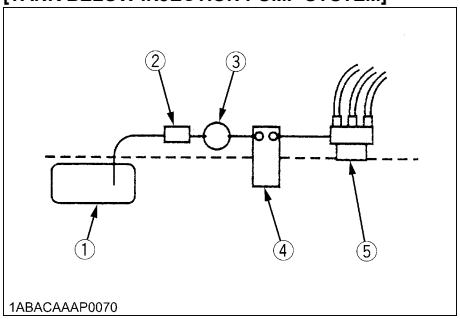
(1) Joint bolt
(2) Fuel feed pump

NOTE :
- For the engine equipped with automatic venting (optional) no manual bleeding of fuel lines is required.

[PROCEDURE Ⓑ] (fuel tanks lower than injection pump)
1. For fuel tanks that are lower than the injection pump. The fuel system must be pressurized by the fuel system electric fuel pump.
2. If an electric fuel pump is not used, you must manually actuate the pump by lever to bleed.
3. The primary fuel filter ③ must be on the pressure side of the pump if the fuel tank is lower than the injection pump.
4. To bleed follow (2) through (4) above. (PROCEDURE Ⓐ)

IMPORTANT :
- Tighten air vent plug of the fuel injection pump except when bleeding, or it may stop the engine suddenly.

[TANK BELOW INJECTION PUMP SYSTEM]



(1) Fuel tank below injection pump
(2) Pre-filter
(3) Electric or Mechanical pump
(4) Main Filter
(5) Injection pump

■Checking the fuel pipes

CAUTION

To avoid personal injury;

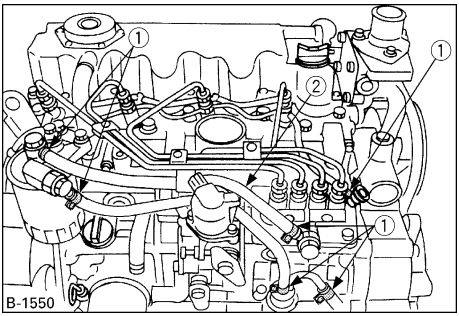
- **Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.**

Check the fuel pipes every 50 hours of operation. When if;

1. If the clamp band is loose, apply oil to the screw of the band, and tighten the band securely.
2. If the fuel pipes, made of rubber, became worn out, replace them and clamp bands every 2 years.
3. If the fuel pipes and clamp bands are found worn or damaged before 2 years' time, replace or repair them at once.
4. After replacement of the pipes and bands, air-bleed the fuel system.

IMPORTANT :

- When the fuel pipes are not installed, plug them at both ends with clean cloth or paper to prevent dirt from entering. Dirt in the pipes can cause fuel injection pump malfunction.

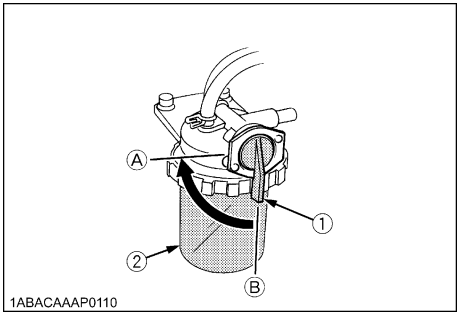


(1) Clamp band
(2) Fuel pipe

■Cleaning the fuel filter pot

Every 100 hours of operation, clean the fuel filter in a clean place to prevent dust intrusion.

1. Close the fuel filter lever.

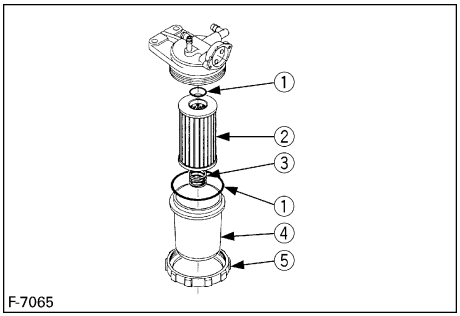


(1) Fuel filter lever
(2) Fuel filter pot
(A) "OFF"
(B) "ON"

2. Remove the top cap, and rinse the inside with diesel fuel.
3. Take out the element, and rinse it with diesel fuel.
4. After cleaning, reinstall the fuel filter, keeping out of dust and dirt.
5. Air-bleed the injection pump.

IMPORTANT :

- Entrance of dust and dirt can cause a malfunction of the fuel injection pump and the injection nozzle. Wash the fuel filter cup periodically.



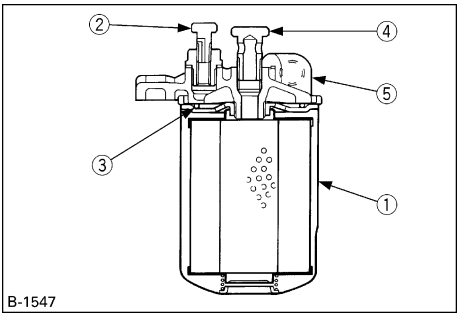
(1) O ring
(2) Filter element
(3) Spring
(4) Filter bowl
(5) Screw ring

■Fuel filter cartridge replacement

1. Replace the fuel filter cartridge with a new one every 500 operating hours.
2. Apply fuel oil thinly over the gasket and tighten the cartridge into position by hand-tightening only.
3. Finally, vent the air.

IMPORTANT :

- Replace the fuel filter cartridge periodically to prevent wear of the fuel injection pump plunger or the injection nozzle, due to dirt in the fuel.



(1) Fuel filter cartridge
(2) Air vent plug
(3) O ring
(4) Pipe joint
(5) Cover

NOTE :

- The fuel filter cartridge and water separator should be replaced more earlier according to the fuel classification in use.

ENGINE OIL

⚠ CAUTION

To avoid personal injury:

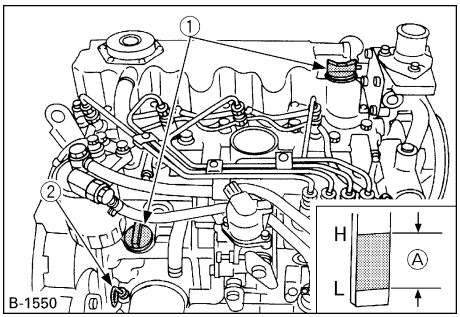
- **Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.**
- **Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning procedure.**
- **Contact with engine oil can damage your skin. Put on gloves when using engine oil. If you come in contact with engine oil, wash it off immediately.**

IMPORTANT :

- Do not operate a diesel engine when engine oil is overfilled. This oil can drain through the air intake system, which cause engine disacceleration and oil leaks from breather pipings. It could result in a over-running or oil hammering of engine in case of the engine with suction blow-by gases breathered in.

■Checking oil level and adding engine oil

1. Check the engine oil level before starting or more than 5 minutes after stopping the engine.
2. Remove the oil level gauge, wipe it clean and reinstall it.
3. Take the oil level gauge out again, and check the oil level.



(1) Oil filler plug
(2) Oil level gauge
[Lower end of oil level gauge]
(A) Engine oil level within this range is proper.

4. If the oil level is too low, remove the oil filler plug, and add new oil to the prescribed level.
5. After adding oil, wait more than 5 minutes and check the oil level again. It takes some time for the oil to drain down to the oil pan.

Models	Engine oil quantity
V3600-E3, V3600-T-E3, V3800-DI-T-E3, V3300-E3BG, V3600-T-E3BG, V3800-DI-T-E3BG	13.2 L (3.49 U.S. gal.)

* API service classification: above CF grade

IMPORTANT :

- Engine oil should be MIL-L-2104C or have properties of API classification CF or higher.
  Change the type of engine oil according to the ambient temperature.

above 25°C (77°F)	SAE30 or SAE10W-30 SAE15W-40
0°C to 25°C (32°F to 77°F)	SAE20 or SAE10W-30 SAE15W-40
below 0°C (32°F)	SAE10W or SAE10W-30 SAE15W-40

- When using oil of different brands from the previous one, be sure to drain all the previous oil before adding the new engine oil.

NOTE :

- Be sure to inspect the engine, locating it on a level place. If placed on gradients accurately, oil quantity may not be measured.

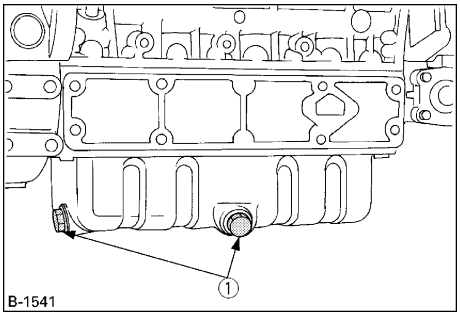
■Changing engine oil

CAUTION

To avoid personal injury:

- **Be sure to stop the engine before draining engine oil.**
- **When draining engine oil, place some container underneath the engine and dispose it according to local regulations.**
- **Do not drain oil after running the engine. Allow engine to cool down sufficiently.**

1. Change oil after the initial 50 hours of operation and every 500 (for DI spec), 250 (for IDI spec) hours thereafter.
   When the annual operating hours are below 500 (DI spec) or 250 (IDI spec), replace the oil every year.
2. Remove the drain plug at the bottom of the engine, and drain all the old oil. Drain oil will drain easier when the oil is warm.
3. When letting out the oil, remove the filler plug too. With the filler plug still in place, it would be difficult to discharge the oil completely.
4. Add new engine oil up to the upper limit of the oil level gauge. Be careful not to add oil above the upper limit of the oil level gauge.



(1) Oil drain plug

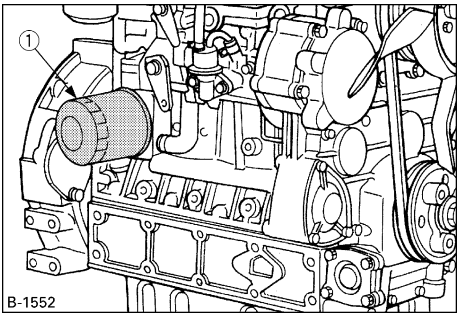
■Replacing the oil filter cartridge

CAUTION

To avoid personal injury:

- **Be sure to stop the engine before changing the oil filter cartridge.**
- **Allow engine to cool down sufficiently, oil can be hot and cause burns.**

1. Replace the oil filter cartridge. Oil filter cartridge should be replaced after the initial 50 hours of operation and every 500 hours thereafter.
2. Remove the old oil filter cartridge with a filter wrench.
3. Apply a film of oil to the gasket for the new cartridge.
4. Screw in the cartridge by hand. When the gasket contacts the seal surface, tighten the cartridge enough by hand. Because, if you tighten the cartridge with a wrench, it will be tightened too much.



(1) Oil filter cartridge

5. After the new cartridge has been replaced, the engine oil level normally decreases a little. Thus, run the engine for a while and check for oil leaks through the seal before checking the engine oil level. Add oil if necessary.

NOTE :

- Wipe off any oil sticking to the machine completely.

RADIATOR

Coolant will last for one day's work if filled all the way up before operation start. Make it a rule to check the coolant level before every operation.

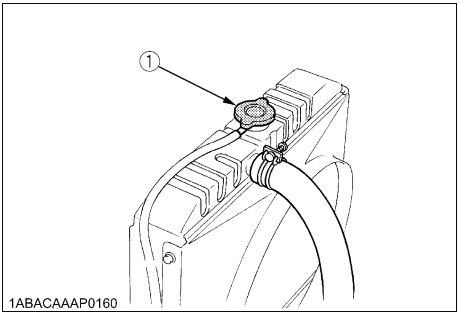
WARNING

To avoid personal injury:

- **Do not stop the engine suddenly, stop it after about 5 minutes of unloaded idling.**
- **Work only after letting the engine and radiator cool off completely (more than 30 minutes after it has been stopped).**
- **Do not remove the radiator cap while coolant is hot. When cool to the touch, rotate cap to the first stop to allow excess pressure to escape. Then remove cap completely.**
  If overheats should occur, steam may gush out from the radiator or recovery tank; Severe burns could result.

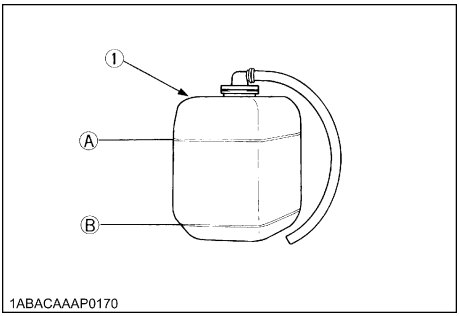
■Checking coolant level, adding coolant

1. Remove the radiator cap, after the engine has completely cooled, and check to see that coolant reaches the supply port.



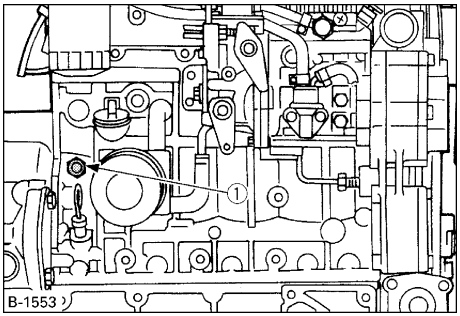
(1) Radiator pressure cap

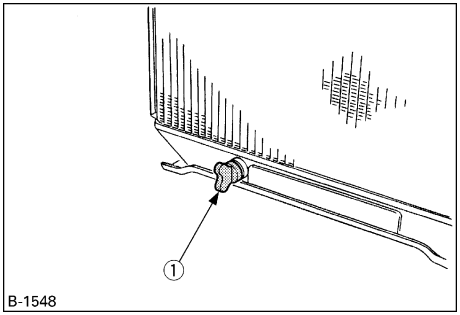
2. If the radiator is provided with a recovery tank, check the coolant level of the recovery tank. When it is between the "FULL" and "LOW " marks, the coolant will last for one day's work.



(1) Recovery tank (A) "FULL"
(B) "LOW "

3. When the coolant level drops due to evaporation, add water only up to the full level.
4. Check to see that two drain cocks; one is at the crankcase side and the other is at the lower part of the radiator as figures below.





(1) Coolant drain cock

IMPORTANT :

- If the radiator cap has to be removed, follow the caution and securely retighten the cap.
- If coolant should be leak, consult your local KUBOTA dealer.
- Make sure that muddy or sea water does not enter the radiator.
- Use clean, fresh water and 50% anti-freeze to fill the recovery tank.
- Do not refill recovery tank with coolant over the "FULL" level mark.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and decrease quickly.

■Changing coolant

1. To drain coolant, always open both drain cocks and simultaneously open the radiator cap as well. With the radiator cap kept closed, a complete drain of water is impossible.
2. Remove the overflow pipe of the radiator pressure cap to drain the recovery tank.
3. Prescribed coolant volume (U.S.gallons)

Models	Quantity
V3600-E3, V3600-T-E3, V3800-DI-T-E3, V3300-E3BG, V3600-T-E3BG, V3800-DI-T-E3BG	9.0 L (2.38 U.S. gal.)

NOTE :

- Coolant quantities shown are for standard radiators.

4. An improperly tightened radiator cap or a gap between the cap and the seat quickens loss of coolant.
5. Check and clean the plug threads and surface and the pucking thims of the water drain plug to prevent dirt and debris from the entering the engine.
6. Coolant (Radiator cleaner and anti-freeze)

Season	Coolant
All seasons	Pure water and anti-freeze (See "**Anti-freeze**" in "**RADIATOR**" section.)

■Remedies for quick decrease of coolant

1. Check any dust and dirt between the radiator fins and tube. If any, remove them from the fins and the tube.
2. Check the tightness of the fan belt. If loose, tighten it securely.
3. Check the internal blockage in the radiator hose. If scale forms in the hose, clean with the scale inhibitor or its equivalent.

■Checking radiator hoses and clamp

CAUTION

To avoid personal injury:

- **Be sure to check radiator hoses and clamp bands periodically. If radiator hose is damaged or coolant leaks, overheats or severe burns could occur.**

Check to see if radiator hoses are properly fixed every 250 hours of operation or 6 months, whichever comes first.

1. If clamp bands are loose or water leaks, tighten clamp bands securely.
2. Replace hoses and tighten clamp bands securely, if radiator hoses are swollen, hardened or cracked.

Replace hoses and clamp bands every 2 years or earlier, if checked and found that hoses are swollen, hardened or cracked.

■Precaution at overheating

The event that the coolant temperature is nearly or more than the boiling point is called **"OVERHEATING"**.
While running, make the following checks to see that all parts are working correctly. **If anything is unusual, inspect it, referring to the relevant description in "MAINTENANCE" and "PERIODIC SERVICE" section**.

◆ Coolant

If the coolant temperature warning lamp lights up or if steam or coolant does not stop squirting from the radiator overflow pipe, turn off the load and **keep the engine idling (COOLING-DOWN) for at least 5 minutes** to let it cool down gradually. Then stop the engine and take the following inspection and servicing.

1. Check to see if the coolant runs short or 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; and
5. Check to see if radiator water pipe is clogged.

■Cleaning radiator core(outside)

If dust is between the fin and tube, wash it away with running water.

IMPORTANT :

- Do not clean radiator with firm tools such as spatulas or screwdrivers. They may damage specified fin or tube. It can cause coolant leaks or decrease cooling performance.

■Anti-freeze

⚠ CAUTION

To avoid personal injury:

- When using anti-freeze, put on some protection such as rubber gloves (Anti-freeze contains poison.).
- If should drink anti-freeze, throw up at once and take medical attention.
- When anti-freeze comes in contact with the skin or clothing, wash it off immediately.
- Do not mix different types of anti-freeze. The mixture can produce chemical reaction causing harmful substances.
- Anti-freeze is extremely flammable and explosive under certain conditions. Keep fire and children away from anti-freeze.
- When draining fluids from the engine, place some container underneath the engine body.
- Do not pour waste onto the grounds, down a drain, or into any water source.
- Also, observe the relevant environmental protection regulations when disposing of anti-freeze.

Always use a 50/50 mix of long-life coolant and clean soft water in KUBOTA engines.
Contact KUBOTA concerning coolant for extreme conditions.

1. Long-life coolant (hereafter LLC) comes in several types. Use ethylene glycol (EG) type for this engine.
2. Before employing LLC-mixed cooling water, flush the radiator with fresh water. Repeat this procedure 2 or 3 times to clean up the radiator and engine block from inside.
3. Mixing the LLC
   Premix 50% LLC with 50% clean soft water. When mixing, stir it up well, and then fill into the radiator.
4. The procedure for the mixing of water and anti-freeze differs according to the make of the anti-freeze. Refer to SAE J1034 standard, more specifically also to SAE J814c.

Vol % Anti-freeze	Freezing Point		Boiling Point *	
	°C	°F	°C	°F
50	-37	-34	108	226

*At 1.013×10^5 Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

5. Adding the LLC
   (1) Add only water if the coolant level reduces in the cooling system by evaporation.
   (2) If there is a coolant leak, add the LLC of the same manufacturer and type in the same coolant percentage.
   *Never add any long-life coolant of different manufacturer. (Different brands may have different additive components, and the engine may fail to perform as specified.)
6. When the LLC is mixed, do not employ any radiator cleaning agent. The LLC contains anti-corrosive agent. If mixed with the cleaning agent, sludge may build up, adversely affecting the engine parts.
7. Kubota's genuine long-life coolant has a service life of 2 years. Be sure to change the coolant every 2 years.

NOTE :

- The above data represent industry standards that necessitate a minimum glycol content in the concentrated anti-freeze.

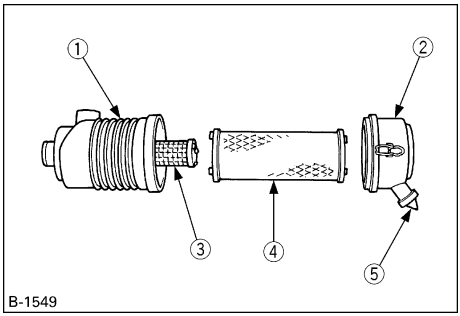
■Radiator cement

As the radiator is solidly constructed, there is little possibility of water leakage. Should this happen, however, radiator cement can easily fix it. If leakage is serious, contact your local KUBOTA dealer.

AIR CLEANER

Since the air cleaner employed on this engine is a dry type, never apply oil to it.

1. Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place. This will get rid of large particles of dust and dirt.
2. Wipe the inside air cleaner clean with cloth if it is dirty or wet.
3. Avoid touching the primary element except when cleaning.
4. When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205 kPa (2.1 kgf/cm^2, 30 psi).
5. Replace the primary element every year or every 6 cleanings. If the primary element is stained heavily, replace it soon. At this time, replace the secondary element too.
6. The secondary element should be removed only if it is to be replaced.
7. To protect the engine, do not remove the secondary element in servicing the primary element.



B-1549

(1) Air cleaner body
(2) Cover
(3) Secondary element
(4) Primary element
(5) Evacuator valve

IMPORTANT :

- Make sure the hooking clip for the element is tight enough. If it is loose, dust and dirt may be sucked in, wearing down the cylinder liner and piston ring earlier and thereby resulting in poor power output.
- Do not overservice the air cleaner element. Overservicing may cause dirt to enter the engine causing premature wear. Use the dust indicator as a guide on when to service.

■Cleaning Primary Air Filter Element

To clean the element, use clean dry compressed air on the inside of the element.
Air pressure at the nozzle must not exceed 205 kPa (2.1 kgf/cm^2; 30 psi).
Maintain reasonable distance between the nozzle and the filter.

■Evacuator valve

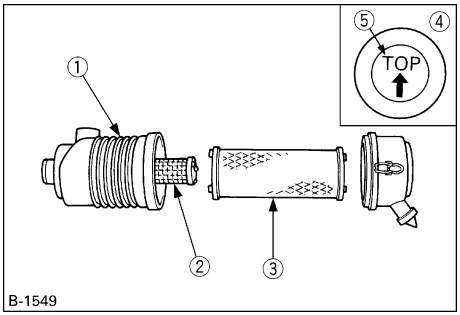
Open the evacuator valve once a week under ordinary conditions - or daily when used in a dusty place - to get rid of large particles of dust and dirt.

■For the air cleaner with a dust cup (optional)

Remove and clean out the dust cup before it becomes half full with dust; usually once a week, or even every day if the working surroundings are dusty.
Install the air cleaner dust cup with "TOP" indicated on the rear of the cup in the up position. (However, it may be installed in either direction when the cover is placed at the lower part.)

IMPORTANT :

- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.

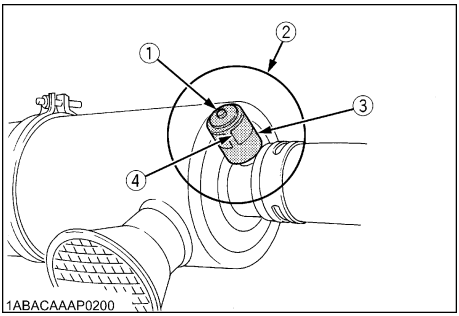


B-1549

(1) Air cleaner body
(2) Secondary element
(3) Primary element
(4) Dust cup
(5) “Top“ mark

■Dust indicator (optional)

If the red signal on the dust indicator attached to the air cleaner is visible, the air cleaner has reached the service level.
Clean the element immediately, and reset the signal with the "RESET" button.



(1) "RESET" button
(2) Dust indicator
(3) Service level
(4) Signal

ELECTRIC WIRING

CAUTION

To avoid personal injury:

◆Shorting of electric cable or wiring may cause a fire.

- **Check to see if electric cables and wiring are swollen, hardened or cracked.**
- **Keep dust and water away from all power connections.**
  Loose wiring terminal parts, make bad connections. Be sure to repair them before starting the engine.

Damaged wiring reduces the capacity of electrical parts. Change or repair damaged wiring immediately.

FAN BELT

■Adjusting Fan Belt Tension

CAUTION

To avoid personal injury:

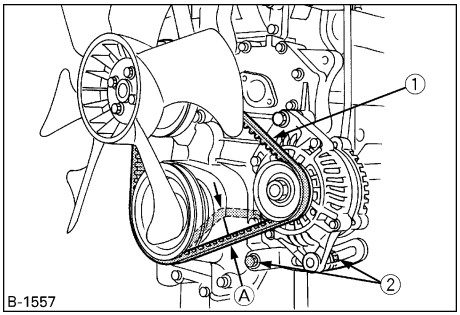
- **Be sure to stop the engine and remove the key before checking the belt tension.**
- **Be sure to reinstall the detached safety shield after maintenance or checking.**

Proper fan belt tension	A deflection of between 10 to 12 mm (0.39 to 0.47 in.) when the belt is pressed in the middle of the span.

1. Stop the engine and remove the key.
2. Apply moderate thumb pressure to belt between the pulleys.
3. If tension is incorrect, loosen the alternator mounting bolts and, using a lever placed between the alternator and the engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace fan belt if it is damaged.

IMPORTANT :

- If belt is loosen or damaged and the fan is damaged, it could result in overheats or insufficient charging. Correct or replace belt.



(1) Fan belt
(2) Bolt and nut
(A) 10 to 12 mm (0.39 to 0.47 in.) (under load of 6~7 kgf (13.2~15.4 lbs))

CARRIAGE AND STORAGE

CARRIAGE

CAUTION

To avoid personal injury:

- **Fix the engine securely not to fall during operation.**
- **Do not stand near or under the engine while carrying it.**
- **The engine is heavy. In handling it, be very alert not to get your hands and body caught in.**

1. Use carrier such as crane when carrying the engine, or hurt your waist and yourself. Support the engine securely with rope not to fall while carrying it.
2. When lifting the engine, put the hook securely to metal fittings attached to the engine. Use strong hook and fittings enough to hang the engine.

STORAGE

CAUTION

To avoid personal injury:

- **Do not clean the machine with engine running.**
- **To avoid the danger of exhaust fume poisoning, do not operate the engine in a closed building without proper ventilation.**
- **When storing the engine just after running, let the engine cool off.**

Before storing the engine for more than a few months, remove any dirt on the machine, and:

1. Drain the coolant in the radiator. Open the cock at the bottom of the radiator, and remove the pressure cap to drain water completely. Leave the cock open. Hang a note written "No water" on the pressure cap. Since water may freeze when the temperature drops below 0°C (32°F), it is very important that no water is left in the machine.
2. Remove dirty engine oil, fill with new oil and run the engine for about 5 minutes to let the oil penetrate to all the parts.
3. Check all the bolts and nuts, and tighten if necessary.
4. Remove the battery from the engine, adjust the electrolyte level, and recharge it. Store the battery in a dry and dark place.
5. When the engine is not used for a long period of time, run it for about 5 minutes under no load every 2 to 3 months to keep it free from rust. If the engine is stored without any running, moisture in the air may condense into dew over the sliding parts of the engine, resulting in rust there.
6. If you forget to run the engine for longer than 5 to 6 months, apply enough engine oil to the valve guide and valve stem seal and make sure the valve works smoothly before starting the engine.
7. Store the engine in a flat place and remove the key from engine.
8. Do not store the engine in a place where has flammable materials such as dry grass or straw.
9. When covering the engine for storage, let engine and muffler cool off completely.
10. Operate the engine after checking and repairing damaged wirings or pipes, and clearing flammable materials carried by mouse.

TROUBLESHOOTING

If the engine does not function properly, use the following chart to identify and correct the cause.

■When it is difficult to start the engine

Cause	Countermeasures
Fuel is thick and doesn't flow.	* Check the fuel tank and fuel filter. * Remove water, dirt and other impurities. * As all fuel will be filtered by the filter, if there should be water or other foreign matters on the filter, clean the filter with kerosene.
Air or water mixed in fuel system	* If air is in the fuel filter or injection lines, the fuel pump will not work properly. * To attain proper fuel injection pressure, check carefully for loosened fuel line coupling, loose cap nut, etc. * Loosen joint bolt stop fuel filter and air vent screws of fuel injection pump to eliminate all the air in the fuel system.
Engine oil becomes thick in cold weather and engine cranks slow.	* Change grade of oil according to the weather (temperature.)
Battery is discharged and the engine will not crank.	* Charge battery. * In winter, always remove battery from machine, charge fully and keep indoors. Install in machine at time of use.

■When output is insufficient

Cause	Countermeasures
Fuel is insufficient.	* Check fuel system.
Overheating of moving parts	* Check lubricating oil system. * Check to see if lubricating oil filter is working properly. * Filter element deposited with impurities would cause poor lubrication. Change element.
Air cleaner is dirty	* Clean the element every 100 hours of operation.
Injection pump wear	* Do not use poor quality fuel as it will cause wear of the pump. Only use No. 2-D diesel fuel. (See "**FUEL**" in "**PERIODIC SERVICE**" section.)

■When engine suddenly stops

Cause	Countermeasures
Lack of fuel	* Check the fuel tank and refill the fuel, if necessary. * Also check the fuel system for air or leaks.
Bad nozzle	* If necessary, replace with a new nozzle.
Moving parts are overheated due to shortage of lubrication oil or improper lubrication.	* Check amount of engine oil with oil level gauge. * Check lubricating oil system. * At every 2 times of oil change, oil filter cartridge should be replaced.

■When color of exhaust is especially bad

Cause	Countermeasures
Fuel is of extremely poor quality.	* Select good quality fuel. Use No. 2-D diesel fuel only.
Nozzle is bad.	* If necessary, replace with new nozzle.

■When engine must be stopped immediately

Cause	Countermeasures
Color of exhaust suddenly turns dark.	* Check the fuel injection system, especially the fuel injection nozzle.
Bearing parts are overheated.	* Check the lubricating system.
Oil lamp lights up during operation.	* Check the lubricating system. * Check the function of the relieve valve in the lubricating system. * Check pressure switch. * Check filter base gasket.

NOTE :

- If the cause of trouble can not be found, contact your KUBOTA dealer.

■When engine overheats

Cause	Countermeasures
Engine oil insufficient	* Check oil level. Replenish oil as required.
Fan belt broken or elongated	* Change belt or adjust belt tension.
Coolant insufficient	* Replenish coolant.
Excessive concentration of antifreeze	* Add water only or change to coolant with the specified mixing ratio.
Radiator net or radiator fin clogged with dust	* Clean net or fin carefully.
Inside of radiator or coolant flow route corroded	* Clean or replace radiator and parts.
Fan or radiator or radiator cap defective	* Replace defective parts.
Thermostat defective	* Check thermostat and replace if necessary.
Temperature gauge or sensor defective	* Check temperature with thermometer and replace if necessary.
Overload running	* Reduce load.
Head gasket defective or water leakage	* Replace parts.
Unsuitable fuel used	* Use the specified fuel.

SPECIFICATIONS

Model	V3600-E3	V3600-T-E3
Type	Vertical, water-cooled, 4-cycle diesel	
Number of cylinders	4	
Bore and stroke mm (in.)	98 × 120 (3.86 × 4.72)	
Total displacement L(cu.in.)	3.620 (220.9)	
Combustion type	Spherical type (E-TVCS)	
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	45.8 / 2600 (61.4 / 2600)	58.8 / 2600 (78.8 / 2600)
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	39.8 / 2600 (29.7 / 2600)	51.1 / 2600 (68.5 / 2600)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—	—
Maximum bare speed min^{-1}(rpm)	2800	
Maximum bare idling speed min^{-1}(rpm)	775 to 825	
Order of firing	1-3-4-2	
Direction of rotation	Counter-clockwise (viewed from flywheel side)	
Injection pump	Bosch type mini pump	
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)	
Injection timing (Before T.D.C.)	0.14 rad (8°)	0.07 rad (4°)
Compression ratio	22.6	21.8
Fuel	Diesel fuel oil No.2-D	
Lubricant (API classification)	above CF grade	
Dimension mm (in.) (length × width × height)	745 × 536 × 741.5 (29.33 × 21.10 × 29.19)	745 × 538.5 × 794 (29.33 × 21.20 × 31.26)
Dry weight kg (lbs.)	264 (582)	275 (606.3)
Starting system	Cell starter (with glow plug)	
Starting motor	12V, 3.0kW	
Charging generator	12V, 1080W(KEA), 720W(EU)	
Recommended battery capacity	12V, 136AH (400 CCA or higher) 0°F (-17.8°C) SAE rating	

NOTE :

- Specifications are subject to change without notice.

Model	V3800-DI-T-E3
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	100 × 120 (3.94 × 4.72)
Total displacement L(cu.in.)	3.769 (230)
Combustion type	Direct injection type (E-CDIS)
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	71.4 / 2600 (95.7 / 2600)
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	62.0 / 2600 (83.1 / 2600)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—
Maximum bare speed min^{-1}(rpm)	2800
Maximum bare idling speed min^{-1}(rpm)	775 to 825
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	First opening pressure 18.63 (190, 2275) Second opening pressure 23.54 (240, 3128)
Injection timing (Before T.D.C.)	0.10 rad (6°)
Compression ratio	19.0
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	745 × 549 × 794 (29.33 × 21.61 × 31.26)
Dry weight kg (lbs.)	288 (634.9)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V, 1080W(KEA), 720W(EU)
Recommended battery capacity	12V, 136AH (400 CCA or higher) 0°F (-17.8°C) SAE rating

NOTE :

- Specifications are subject to change without notice.

Model	V3300-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	98 × 110 (3.86 × 4.33)
Total displacement L(cu.in.)	3.318 (202.49)
Combustion type	Spherical type (E-TVCS)
SAE NET Continuous kW / min^{-1}(rpm)	30.6 / 1800 (41.0 / 1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	25.0 / 1500 (33.5 / 1500)
SAE Standby kW / min^{-1}(rpm)	33.6 / 1800 (45.0 / 1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	27.5 / 1500 (36.9 / 1500)
Maximum bare speed min^{-1}(rpm)	1890
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)
Injection timing (Before T.D.C.)	0.17 rad (10°)
Compression ratio	22.6
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	769 × 536 × 770 (30.28 × 20.10 × 30.31)
Dry weight kg (lbs.)	276 (608)
Starting system	Cell starter (with air heater)
Starting motor	12V, 2.5kW
Charging generator	12V 540W
Recommended battery capacity	12V, 88AH

NOTE :
- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):
- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.

Model	V3600-T-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	98 × 120 (3.86 × 4.72)
Total displacement L(cu.in.)	3.620 (220.9)
Combustion type	Spherical type (E-TVCS)
SAE NET Continuous kW / min^{-1}(rpm)	39.2/1800 (52.5/1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	32.1/1500 (43.0/1500)
SAE Standby kW / min^{-1}(rpm)	43.1/1800 (57.8/1800)
H.P. (SAEJ1349) (HP / min^{-1} (rpm))	35.3/1500 (47.3/1500)
Maximum bare speed min^{-1}(rpm)	1890
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	13.93 (142, 2020)
Injection timing (Before T.D.C.)	0.09 rad (5°)
Compression ratio	21.8
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	769 × 539 × 803 (30.28 × 21.22 × 31.61)
Dry weight kg (lbs.)	283 (624)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V 540W
Recommended battery capacity	12V, 88AH

NOTE :
- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):
- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.

Model	V3800-DI-T-E3BG
Type	Vertical, water-cooled, 4-cycle diesel
Number of cylinders	4
Bore and stroke mm (in.)	100 × 120 (3.94 × 4.72)
Total displacement L(cu.in.)	3.769 (230)
Combustion type	Direct injection type (E-CDIS)
SAE NET Intermittent kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	—
SAE NET Continuous kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	48.0 / 1800 (64.4 / 1800)
SAE Standby kW / min^{-1}(rpm) H.P. (SAEJ1349) (HP / min^{-1} (rpm))	52.8 / 1800 (70.8 / 1800)
Maximum bare speed min^{-1}(rpm)	1800
Maximum bare idling speed min^{-1}(rpm)	—
Order of firing	1-3-4-2
Direction of rotation	Counter-clockwise (viewed from flywheel side)
Injection pump	Bosch type mini pump
Injection pressure MPa (kgf / cm^2, psi)	First opening pressure 18.63 (190, 2275) Second opening pressure 23.54 (240, 3128)
Injection timing (Before T.D.C.)	0.11 rad (6.5°)
Compression ratio	19.0
Fuel	Diesel fuel oil No.2-D
Lubricant (API classification)	above CF grade
Dimension mm (in.) (length × width × height)	768.6 × 535.5 × 797 (30.26 × 21.08 × 31.38)
Dry weight kg (lbs.)	290 (639.3)
Starting system	Cell starter (with air heater)
Starting motor	12V, 3.0kW
Charging generator	12V, 540W
Recommended battery capacity	12V, 88AH

NOTE :

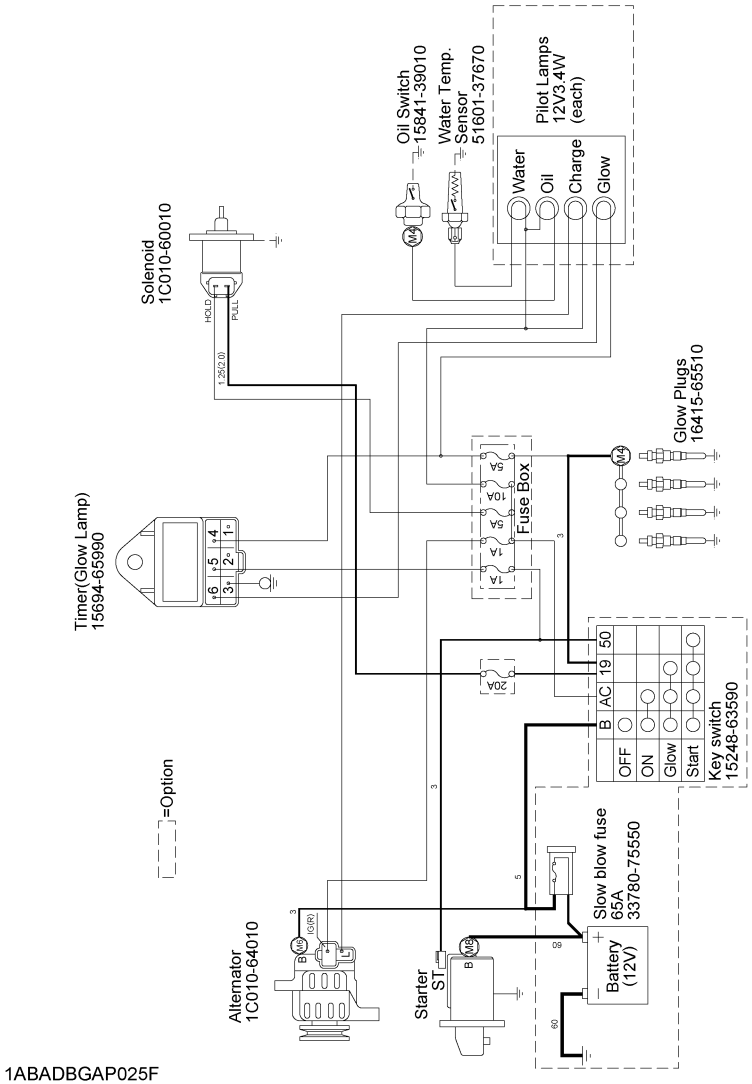
- Specifications are subject to change without notice.

NOTE (FOR E3BG or T-E3BG type):

- Flywheel type is SAE clutch No.11-1/2, SAE clutch No.10 or its equivalent.
- Flywheel housing type is SAE No.3 or its equivalent.
- Governor drop is within 5%.
- Continuous will operate at the stated rating continuously and have a 10% overload capability for one hour in 12 hours.
- Standby will operate at the stated full rating for one hour in 12 hours. No overload capacity is specified for this rating.

WIRING DIAGRAMS

■**V3600-E3, V3600-T-E3, V3300-E3BG, V3600-T-E3BG**



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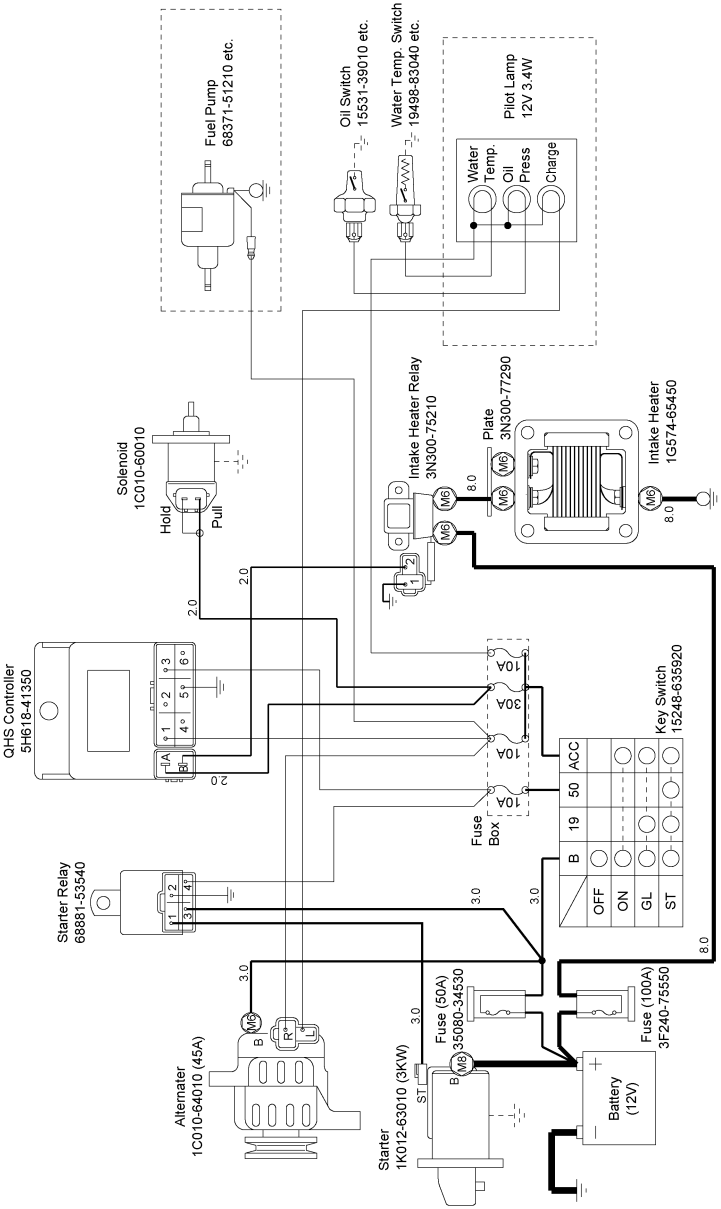
ENGLISH

■V3800-DI-T-E3



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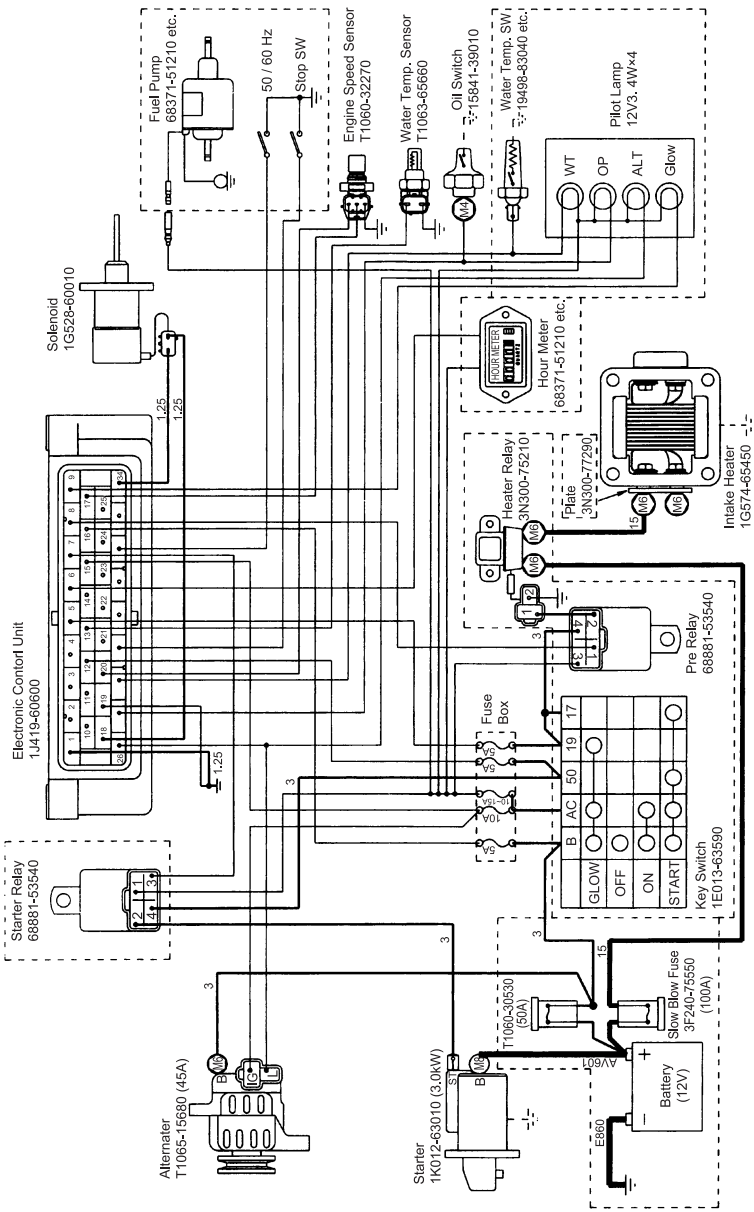
■V3800-DI-T-E3BG



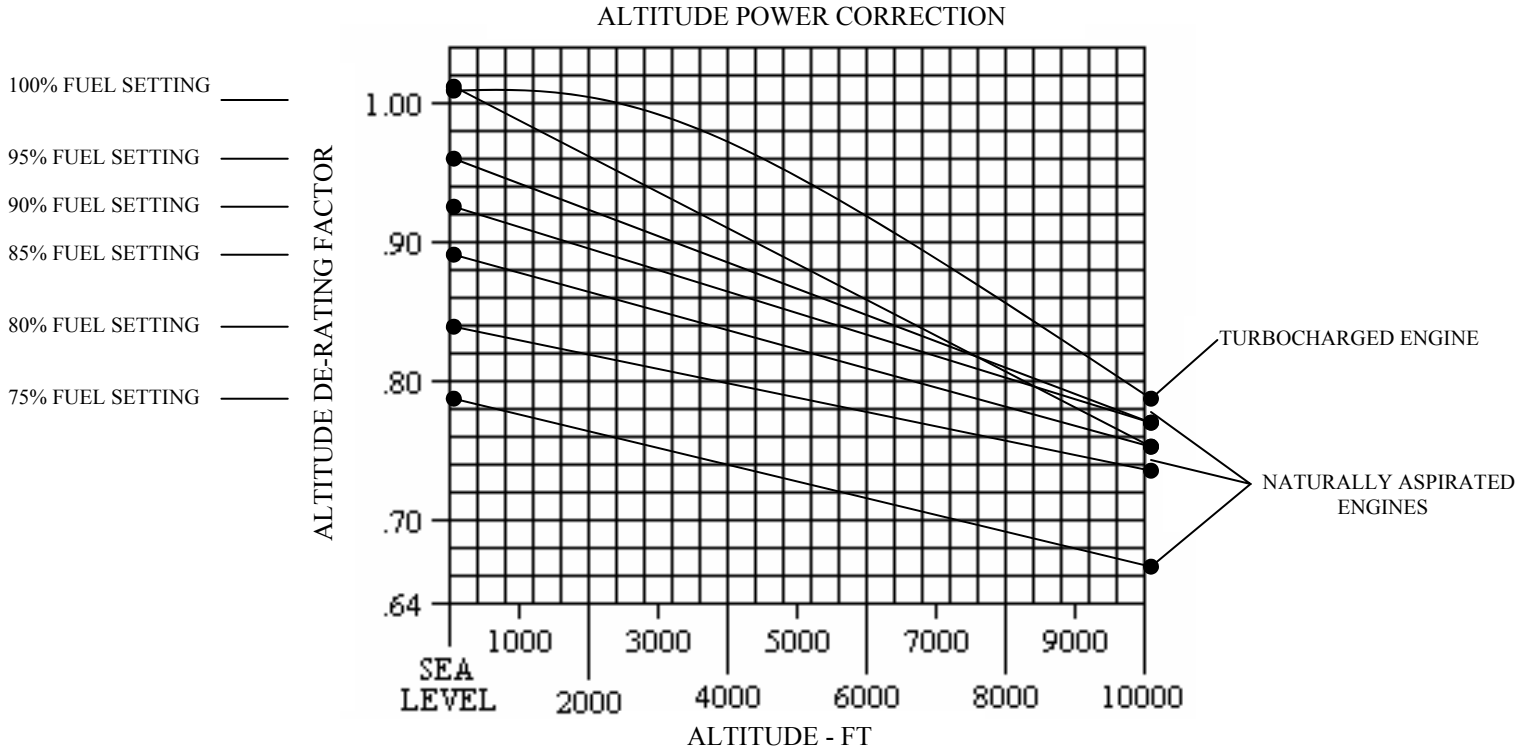
ENGINE POWER FACTORS

ALTITUDE POWER LOSS FACTORS

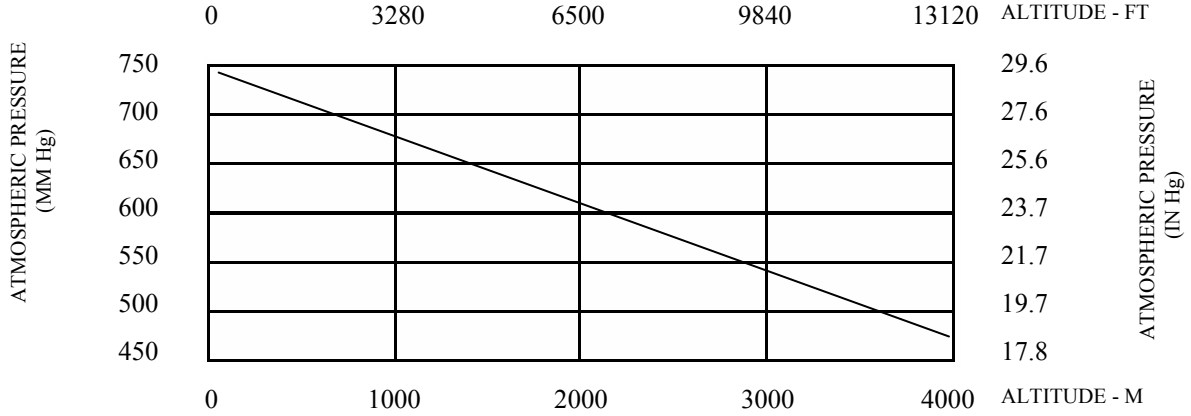
High altitudes can cause sizeable losses or reductions in available power. The exact amount of loss can be difficult to estimate, because these losses vary with the type of engine. Generally, two stroke engines lose more power than four stroke engines, and turbocharged or supercharged engines lose less power than naturally aspirated engines.

Naturally aspirated 4-cycle engines will lose roughly 3% power per 1000 feet in altitude rise. Therefore, an engine producing 100 HP at sea level will produce approximately 91 HP at 3000 feet elevation.

POWER DE-RATING WITH REDUCED FUEL FOR HIGH ALTITUDES



ATMOSPHERIC PRESSURE vs ALTITUDE



ATMOSPHERIC TEMPERATURE & HUMIDITY POWER LOSSES

These losses are generally considered to be nominal with values seldom exceeding 5%. Natural atmospheric variations, however, can combine causing nearly 20% de-rating. For example, air of 120°F (50°C) at 100% humidity. Even 100°F (40°C) temperature at 90% to 100% humidity will cause a 10% de-rating. The local and/or field operating conditions must be evaluated and the power de-rated from SAE J-1349 per these factors.

ATMOSPHERIC FACTORS CHART
POWER AVAILABLE DUE TO TEMPERATURE AND HUMIDITY VARIATIONS

TEMPERATURE		RELATIVE HUMIDITY							
°C	°F	30%	40%	50%	60%	70%	80%	90%	100%
25	77	1.000	.997	.992	.990	.984	.980	.977	.973
30	86	.985	.980	.973	.969	.964	.957	.954	.949
35	95	.966	.960	.953	.947	.940	.934	.928	.920
40	104	.948	.940	.931	.924	.915	.907	.899	.892
45	113	.928	.919	.907	.897	.886	.878	.867	.855
50	122	.910	.895	.882	.869	.854	.841	.830	.815

ACCESSORY POWER REQUIREMENTS

Additional power deductions should be made for any accessories that are installed. These deductions are necessary to accurately identify the expected net power available for the prime power requirement. The accessory items are variable for each installation / application, and can't be determined or deducted by the engine manufacturer. The following accessories are typical in a Stand-By Generator application.

Auxiliary Alternator / Generator End
Engine Alternator
Drive Belts and Pulleys
Cooling Fan

Engine Maintenance Service Schedule

Maintenance Service Item	*See Note	Daily	Min. Every 25 Hours	Every 100 Hours	Every 250 Hours	Every 500 Hours	Every 1000 Hours	Remarks
Engine Oil Level Deterioration & Leakage		X						
Engine Oil Change	*			X				Or Once a Year
Oil Filter Change				X				Or Once a Year
Coolant Level		X						
Coolant Leakage		X						
Coolant Change							X	Or Once a Year
Fuel Level		X						As Necessary
Fuel Leakage		X						
Fuel Filter Re-placement						X		Or Once a Year
Air Filter Re-placement	**					X		Or Once a Year
Damaged Worn Or Loose Belts		X						Or Every Two Years
Replace Fuel Hoses							X	Or Every Two Years
Check Radiator Hoses & Clamps						X		Once a Year
Abnormal Engine Noise		X						
Abnormal Generator Noise		X						
Muffler Condition		X						
Exhaust Gas Condition		X						

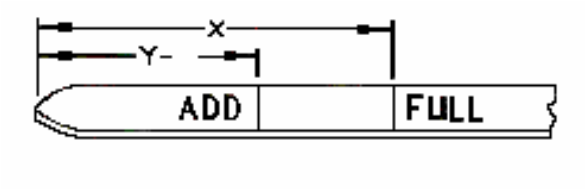
* Engine oil and filter must be changed after the first 50 hours of operation. Then every 100 hours or once a year whichever comes first.

** Air filter replacement interval will vary depending on operating conditions. Adverse conditions may require frequent service.

NOTE: Under normal operation items such as Belts, Hoses and Filters are not covered by Power Technology Southeast, Inc. Limited Warranty.

ENGINE OIL MAINTENANCE

CHECKING ENGINE OIL LEVEL



(Y) “ADD” mark. (X) “FULL” mark.

1. Maintain the engine oil level between “ADD” mark and “FULL” mark on oil level gauge. Do not fill crankcase above “FULL” mark.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

The refill capacities for the engine crankcase Reflect the approximate capacity of the crankcase or sump plus a standard oil filter. Auxiliary oil filter systems will require additional oil.

LUBRICATING OIL SPECIFICATION

Use only good quality lubricating oil, which meets the following Specification

API Class
CF
Engine Oil

V-3300 & V-3300-T ENGINE REFILL CAPACITIES

Crankcase Oil Sump and Filter	14 Qts. (13.2L)

LUBRICATING OIL VISCOSITY RECOMMENDATIONS

The minimum ambient temperature during cold engine start-up and the maximum ambient temperature during engine operation determine the proper SAE viscosity grade of oil.

Refer to the Engine Oil Viscosity Table below (Minimum Temperature) in order to determine the required oil viscosity for starting an engine in cold conditions.

Refer to the Engine Oil Viscosity Table below (Maximum Temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Ambient Temperature	Oil Viscosity
Above 25°C (77°F)	SAE 10W-30 SAE 30 or SAE 10W-40
0 to 25°C (32° to 77°F)	SAE 10W-30 SAE 20 or SAE10W-40
Below 0°C (32°F)	SAE 10W-30 SAE 10W or SAE 10W-40

ENGINE COOLANT MAINTENANCE

COOLANT RECOMMENDATIONS

For optimum performance, Power Technology recommends a 1:1 mixture of water / glycol.

NOTE: Use a mixture that will provide protection against the lowest ambient temperature.
NOTE: 100 percent pure glycol will freeze at a temperature of –23°C (-9°F).

Most conventional heavy-duty coolant / antifreezes use Ethylene Glycol. Propylene Glycol may also be used in a 1:1 mixture with water. Ethylene and Propylene Glycol provide similar protection against freezing and boiling. See the tables below.

ETHYLENE GLYCOL

Concentration	Freeze Protection	Boil Protection
50 Percent	-36°C (-33°F)	106°C (223°F)
60 Percent	-51°C (-60°F)	111°C (232°F)

PROPYLENE GLYCOL

Concentration	Freeze Protection	Boil Protection
50 Percent	-29°C (-20°F)	106°C (223°F)

NOTE: Do not use Propylene Glycol in concentrations that exceed 50 percent glycol because of Propylene Glycol's reduced heat transfer capability. Use Ethylene Glycol in conditions that require additional protection against boiling or freezing.

CHECKING RADIATOR COOLANT LEVEL

Remove the radiator cap after the engine has completely cooled and check to see that coolant reaches the supply port.

1. Fill to the bottom of the fill neck and check after every 25 hours of operation.

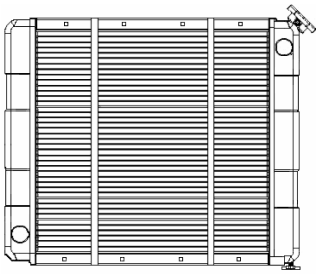
COOLANT SERVICE LIFE

Coolant Type	Service Life
Commercial Heavy-Duty Coolant/Antifreeze that Meets "ASTM D5345"	3000 Service Hours or Two Years
Commercial Heavy-Duty Coolant/Antifreeze that Meets "ASTM D4985"	3000 Service Hours or One Year

NOTE: Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 or D4656 specification. This type of coolant/antifreeze is made for light duty automotive applications.

CHECKING RESERVOIR TANK COOLANT LEVEL

(At a Minimum of 25 Hours of Operation) Ensure that the coolant level of the radiator reservoir tank is between the upper limit (FULL) and the lower limit (LOW) on the side of the reservoir tank.



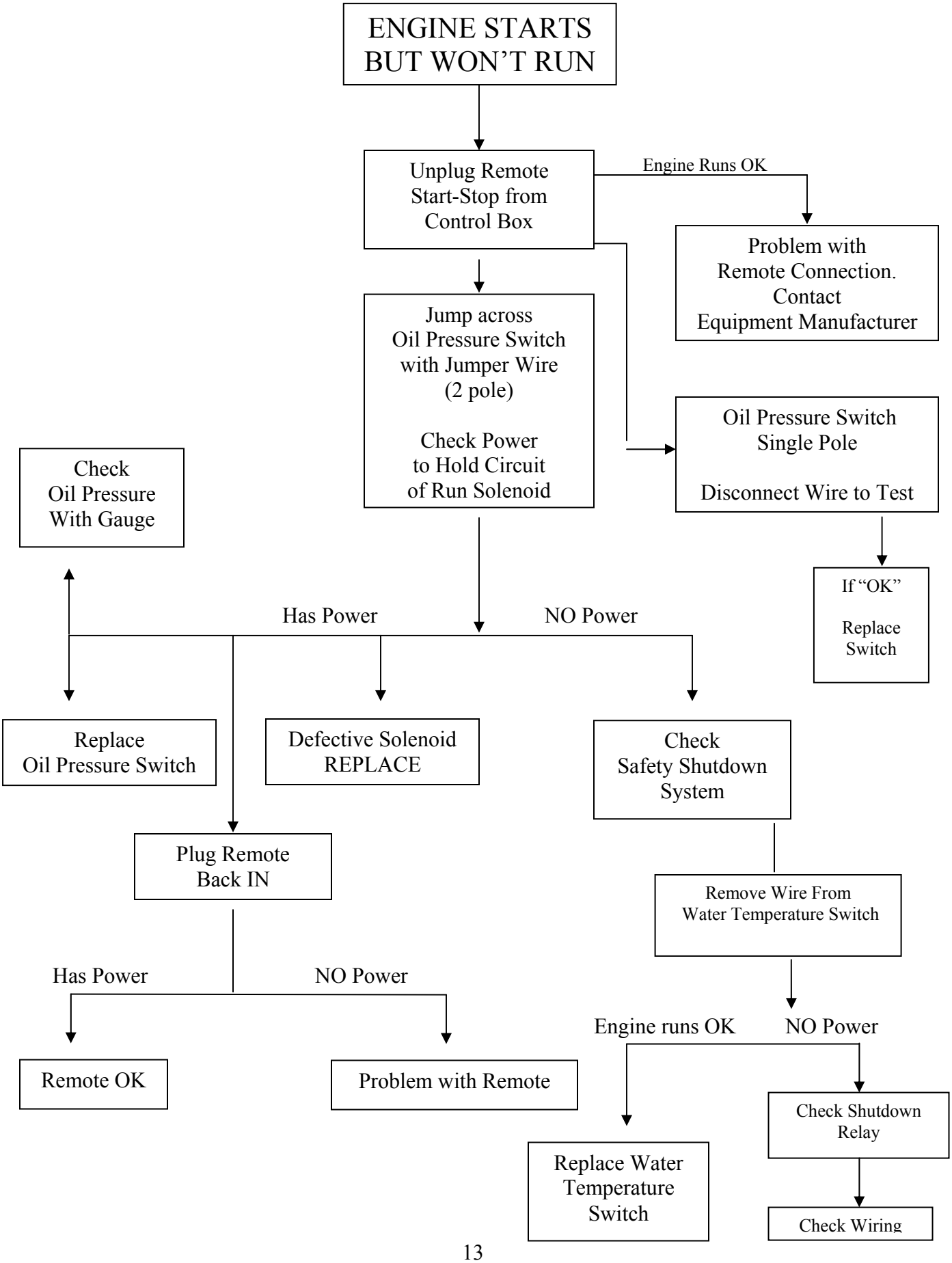
CLEANING RADIATOR CORE

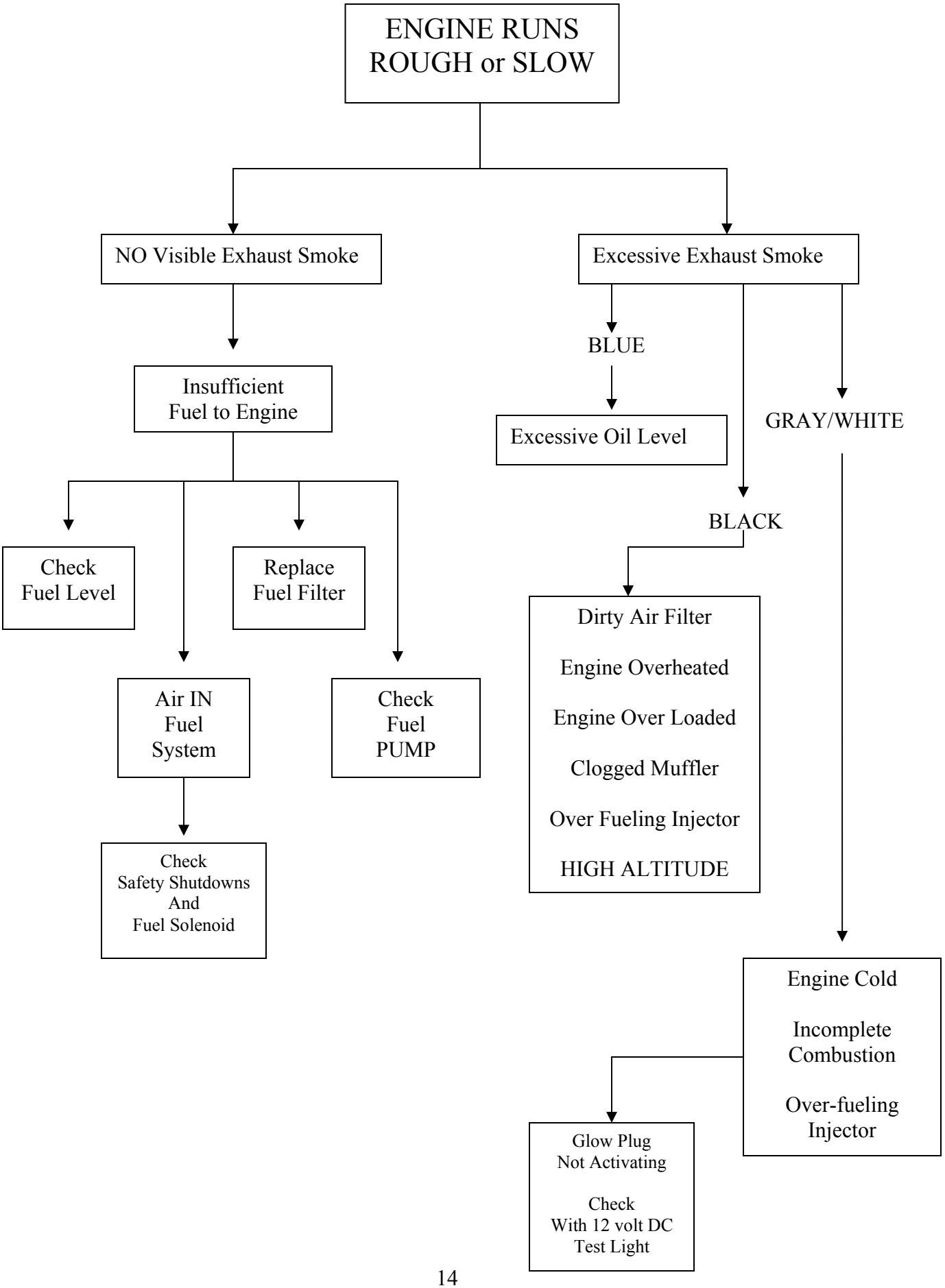
Visually inspect the core for any obstructions such as dirt or debris. Use running water to clean particles from between fins.
IMPORTANT: Never use hard objects to clean radiator core, damage to core could result.

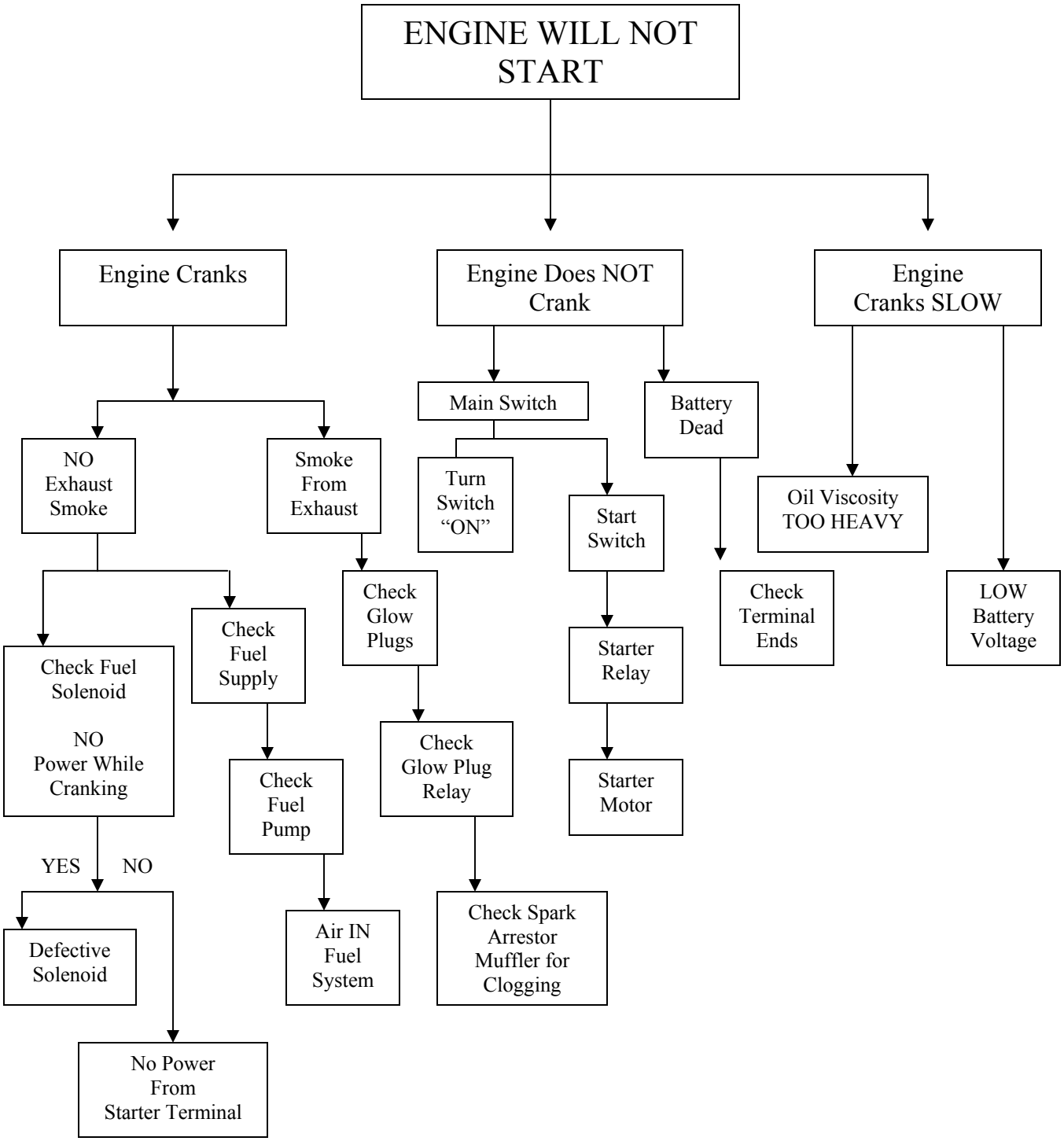
OPERATING HOURS and SERVICE LOG

THIS SERVICE LOG IS PROVIDED TO HELP YOU KEEP AN ACCUMULATIVE RECORD OF OPERATION HOURS ON YOUR GENERATOR SET AND THE DATES REQUIRED SERVICES WERE PERFORMED. ENTER TIME TO THE NEAREST HOUR.

OPERATING HOURS			SERVICE RECORD	
DATE	HRs. RUN	CUMLATIVE	DATE	SERVICES


ENGINE STARTS BUT WON'T RUN
Unplug Remote Start-Stop from Control Box
Engine Runs OK
Problem with Remote Connection. Contact Equipment Manufacturer
Jump across Oil Pressure Switch with Jumper Wire (2 pole)
Check Power to Hold Circuit of Run Solenoid
Oil Pressure Switch Single Pole
Disconnect Wire to Test
If "OK"
Replace Switch
Check Oil Pressure With Gauge
Has Power
NO Power
Replace Oil Pressure Switch
Defective Solenoid REPLACE
Check Safety Shutdown System
Plug Remote Back IN
Remove Wire From Water Temperature Switch
Has Power
NO Power
Engine runs OK
NO Power
Remote OK
Problem with Remote
Check Shutdown Relay
Replace Water Temperature Switch
Check Wiring


ENGINE RUNS ROUGH or SLOW
NO Visible Exhaust Smoke
Excessive Exhaust Smoke
Insufficient Fuel to Engine
BLUE
Excessive Oil Level
GRAY/WHITE
BLACK
Check Fuel Level
Replace Fuel Filter
Air IN Fuel System
Check Fuel PUMP
Check Safety Shutdowns And Fuel Solenoid
Dirty Air Filter
Engine Overheated
Engine Over Loaded
Clogged Muffler
Over Fueling Injector
HIGH ALTITUDE
Engine Cold
Incomplete Combustion
Over-fueling Injector
Glow Plug Not Activating
Check With 12 volt DC Test Light


ENGINE WILL NOT START
Engine Cranks
Engine Does NOT Crank
Engine Cranks SLOW
NO Exhaust Smoke
Smoke From Exhaust
Main Switch
Battery Dead
Turn Switch "ON"
Start Switch
Oil Viscosity TOO HEAVY
Check Glow Plugs
Check Terminal Ends
LOW Battery Voltage
Check Fuel Solenoid
NO Power While Cranking
Check Fuel Supply
Starter Relay
Check Glow Plug Relay
Check Fuel Pump
Starter Motor
YES
NO
Defective Solenoid
Air IN Fuel System
Check Spark Arrestor Muffler for Clogging
No Power From Starter Terminal

SECTION 3
"GENERATOR END"

SAFTEY PRECAUTIONS

A generator set can be potentially dangerous if not properly maintained and operated. The best Safe Guard against a dangerous situation is education, good judgment and common sense. For safe trouble free operation of your generator set some general precautions are listed below. Be sure to read, understand and follow these precautions. Please call Power Technology Southeast, Inc. with any concerns you may have with your generator set.

1) **HOT PIPING:** An engine and exhaust system may get extremely hot while running. Do not work on a generator set until it has sufficiently cooled.

2) **DANGEROUS FUELS:** Use extreme caution when handling, storing and using fuels. All fuels are highly explosive in a vaporous state. Store fuel in a well ventilated area away from spark producing equipment. Keep fuels and all chemicals out of the reach of children. Never add fuel to the tank while the engine is running. Spilled fuel may ignite on contact with hot parts or from ignition spark. Always keep fuel lines and connections tight and in good condition. Don't replace flexible fuel lines with rigid lines. If you notice any fuel leakage, fuel accumulation or electrical sparks, DO NOT OPERATE THE GENERATOR SET.

3) **EXPLOSIVE BATTERY GASES:** The gases generated by a battery being charged are highly explosive. Do not smoke or permit any flames or sparks to occur near a battery at any time, especially when it is being charged. Avoid contact between terminals with tools to prevent sparks and possible burns. Always remove wristwatch, rings, or other jewelry before handling a battery. Any compartment containing batteries should be well ventilated to prevent the accumulation of explosive gases. To avoid sparks never disturb the battery charging connections while the battery is being charged. Always turn off the battery charger before disconnecting terminal clips.

4) **ELECTROCUTION:** Failure to install a generator set with an electrical system consistent with governing regulations and standards is UNLAWFUL and may cause ELECTROCUTION of vehicle occupants. Your generator set must not be used to "Back Feed" by connecting it to a building or outdoor electrical circuit. Back feeding can cause serious injury or death to utility personnel working to repair a power outage and may also seriously injure persons in your vehicle. Unauthorized connections are unlawful in some states and/or localities. A transfer switch must be installed to prevent interconnection of the generator set power and outside power.

5) **MOVING PARTS:** Keep hands, feet, and clothing away from belts and related pulleys when unit is running. Replace guards, covers, and screens before operating the generator set. Serious personal injury may occur from contact with moving parts.

6) **HIGH VOLTAGE:** Remember the function of a generator set is to produce electricity. Wherever electricity is present there is a potential danger of electrocution. Apply the same precautions to the vehicles electrical appliances as you would for any home appliance. Keep away from electrical circuits and wiring while the generator set is running. Have electrical service performed only by qualified electricians. Be sure any unauthorized person; especially children are denied access to the generator set. Keep the compartment door securely latched or locked at all times. Be sure the generator is properly grounded. Never touch electrical leads or appliances with wet hands, or when standing on wet ground.

7) **EXPLOSION:** Never connect the negative (-) battery cable to the positive (+) connection terminal of the starter solenoid, or test the battery by shorting terminals together. This could ignite fuel vapors or cause the battery to explode. To disconnect the battery remove the negative battery cable first and reconnect it last. Do not modify the fuel tank or propulsion engine fuel system. Your vehicle must be equipped with a fuel pick-up arrangement as described in the Fuel System section of this manual. Fuel tank and installation must conform to applicable regulations.

8) **HOT COOLANT:** Allow engine to cool and release pressure from the cooling system before opening the radiator pressure cap. To release the pressure, cover the radiator cap with a thick cloth then turn it slowly counterclockwise to the first stop. After the pressure is released and the engine has cooled, remove the cap.

9) **LETHAL EXHAUST GAS:** When installing an exhaust system position the tail pipe end so that the discharged gases may not be drawn into the vehicle interior through windows, doors, air conditioners, etc. The engine powering your generator set discharges deadly carbon monoxide as part of the exhaust gas when running. It is essential that the exhaust system be leak proof and routinely inspected.

10) **EXCESSIVE NOISE:** Never operate the generator set without an adequate muffler or with a faulty exhaust system. Exposure to excessive noise can lead to a hearing impairment.

11) **ELECTRICAL SHOCK:** A battery can cause electrical burns and shocks. Use reasonable care when working near the battery to avoid electrical connections by contacting the battery terminals with tools. Remove wristwatch, rings and all jewelry when working on the generator set.

12) **BACKFIRE:** A sudden backfire can cause serious burns. Do not operate your generator set without its air cleaner / flame arrestor in place.

13) **FLASH FIRE:** A sudden flash fire can cause serious burns. To avoid the possibility of a flash fire do not smoke or permit a flame or spark to occur near the carburetor, fuel lines, fuel filter, fuel pump or other potential source of spilled fuel or vapors.

14) **FIRE HAZARD:** Be careful when parking your vehicle to prevent grass fires from being started by hot exhaust gases or exhaust system. Keep away from hot engine and generator parts to avoid burning yourself. Keep the generator set and compartment clean and free of debris, especially combustible materials. Never store fuel, oil or rags in the generator compartment.

15) **MARINE APPLICATION:** RV generator sets do not comply with United States Coast Guard (USCG) requirements. They must not be used for marine applications. Use only generator sets specified for marine use in a marine application. USCG regulation 33CFR183 requires a generator set to be ignition protected for use in a gasoline-fueled environment.

16) **UNIT STARTS WITHOUT NOTICE:** To prevent accidental starting on the units with remote start / stop switch, always disconnect the battery by removing the negative (-) terminal first and then the positive (+). Always disconnect the unit in this manner before working on the generator or any equipment connected to it.

17) **LOOSE COMPONENTS:** Periodically check for and tighten any fasteners that may have become loose from vibration or road shock. Serious damage may possibly occur if components become dislodged or misaligned.

INSTALLATION
REQUIREMENTS & RECCOMENDATIONS

Installation requirements may vary with each application depending on generator specification and optional equipment. Listed below are general recommendations for installing a Power Technology Stand-By Generator. Only qualified and licensed personnel should be employed to perform the installation. Follow all Safety Procedures outlined in this manual as well as those in the optional equipment manuals.

Depending on location, Local and or State Building Codes may apply to the installation. Be sure to check with the appropriate authorities prior to installation and obtain the required permits which apply.

NOTE: Damage to the generator and optional equipment due to improper installation may not be covered by Power Technology Southeast, Inc. Limited Warranty.

LOCATING THE GENERATOR:

A permanent location for the generator is a major factor to consider when planning an installation. These units are large and extremely heavy and will require a substantial foundation like a concrete slab to support its weight. Placing the generator directly on the earth is not recommended, dirt and debris can be drawn into the generator causing untimely component failure. Another consideration is water drainage, low lying areas prone to flooding should be avoided. Therefore planning for a permanent location is an important first step in the installation. Local and or State Building Codes may mandate dimensions and materials used in a foundation or slab.

SERVICABILITY:

As with any machine the generator will require periodic maintenance. Be sure the generator is accessible on all sides. Recommended clearance between the generator and other objects is at least 2 feet. This clearance is also required for proper ventilation and cooling. Avoid locating the generator next to an object which may cause an air flow restriction.

EXHAUST ROUTING:

The exhaust from the generator must be safely routed away from all building openings. Avoid exhausting near windows, doors, air handlers, roof eves and vents. Avoid exhausting into confined areas with little or no air circulation. Avoid exhausting near neighboring structures as well. The exhaust system should be routinely inspected and maintained. Local and or State Building Codes may mandate exhaust routing.

ELECTRICAL CONNECTION:

In most installations the generator is connected to a buildings existing electrical system as a back-up electrical supply. This means the generator will be wired into the buildings electrical panel typically through an automatic transfer switch. Wiring and connections must be made by a licensed electrician in accordance with Local and or State Building Codes.

FUEL STORAGE:

Depending upon the specific application, the type of fuel storage tank and capacity must be considered. Typically a fuel storage tank which meets UL 142 Specifications is required. Location and connections may be mandated by Local and or State Building Codes. Consult your fuel supplier as to fuel maintenance and extended storage requirements. Adding a fuel stabilizer may be necessary to extend the usable fuel life.

GENERATOR ASSEMBLY INFORMATION

EXCITER TYPE GENERATOR

The exciter pole pieces contain residual magnetism, which sets up lines of force across the air gap to the exciter armature. When the exciter begins to rotate a voltage is induced and current flow is initiated in the exciter armature AC windings. This voltage is fed to the rotating rectifier assembly, rectified and fed to the alternator field, which sets up lines of force across the air gap to the alternator stator windings and to the output circuit.

A static voltage regulator is connected to the generator output. The regulator will rectify part of the output voltage to provide a DC voltage to the exciter field coils. This will increase the density of the lines of force in the exciter, increasing the voltage induced into the exciter armature windings, and therefore, to the rotating rectifiers. The rotating rectifier output will be increased which will increase the alternator field strength and generator output will build up its rated voltage. Adjustment of the generator output to the rated voltage level is accomplished by controlling the current fed to the exciter field coils. Regulation is automatic with the static type voltage regulator. An additional voltage adjustment range is provided if desired by turning the Voltage Adjust Rheostat.

ELECTRONIC VOLTAGE REGULATION

Electronic Voltage Regulator (EVR) also referred to, as an Automatic Voltage Regulator (AVR) is a very reliable device, which uses solid-state electronics to maintain voltage accuracy at ±2% of the regulated voltage. The Voltage Regulator is designed to automatically regulate and maintain the generated AC voltage through out the load range that is from no load to full load.

VOLTAGE CONNECTION

The generator may be connected at the terminal board to deliver 120/240 volts to a 3 wire grounded neutral system, or 120-volts only to a 2 wire distribution system. If any equipment requires 240-volts, then the 120/240-volt connection must be used. If all equipment requires 120-volts then the 120-volt connection is preferred, even if two lines leave the same switch box. The two lines at the inputs to the switch box are both connected to the un-grounded 120-volt lines from the generator. The 120-volt connection enables the Electronic Voltage Regulator (EVR) to hold the voltage very close to the 115 or 120 volts, as initially adjusted, regardless of the power distribution amount the different distribution lines. The 120-volt connection is recommended if the entire electrical load requires only 115 or 120 volts.

Although the 120/240-volt connection may also be used when all loads requires only 110 volts, it should be pointed out that this connection, the 240-volts, is regulated and the lightly loaded phase, or line, will deliver a high line to neutral voltage and the heavily loaded phase will deliver a low line to neutral voltage. The heavily loaded line may have such a low voltage that air conditioning will have more difficulty in starting, and long starting lines may overload generator and trip circuit breakers

EXCITER FIELD COIL VOLTAGE SOURCE

Field coil DC voltage is obtained by rectifying the voltage from the phase to neutral line of the generator output, or either appropriate terminal to provide the needed voltage reference.

The rectifier bridge is an internal part of the static regulator. The static regulator senses a change in the generator output and automatically regulates current flow in the exciter field coil circuit to increase or decrease the exciter field strength. An adjustable rheostat sized to be compatible with the regulator is used to provide adjustment of the regulator sensing circuit.

ROTATING FIELD ASSEMBLY (ROTOR)

The rotating field assembly consists basically of four members: 1) the shaft assembly, 2) the core assembly, 3) the field coil damper windings, and 4) balance lugs to provide a high degree of static and dynamic balance.

CORE ASSEMBLY

The core assembly consists of a quantity of thin steel plates compressed and fastened together to form a single laminated assembly. The field windings are wound around this assembly.

FIELD COIL

Field coils of heavily insulated wire are "wet" wound directly onto the poles. Field coil leads are brought out to the rectifier assembly for connection to the source of DC excitation voltage.

BALANCE

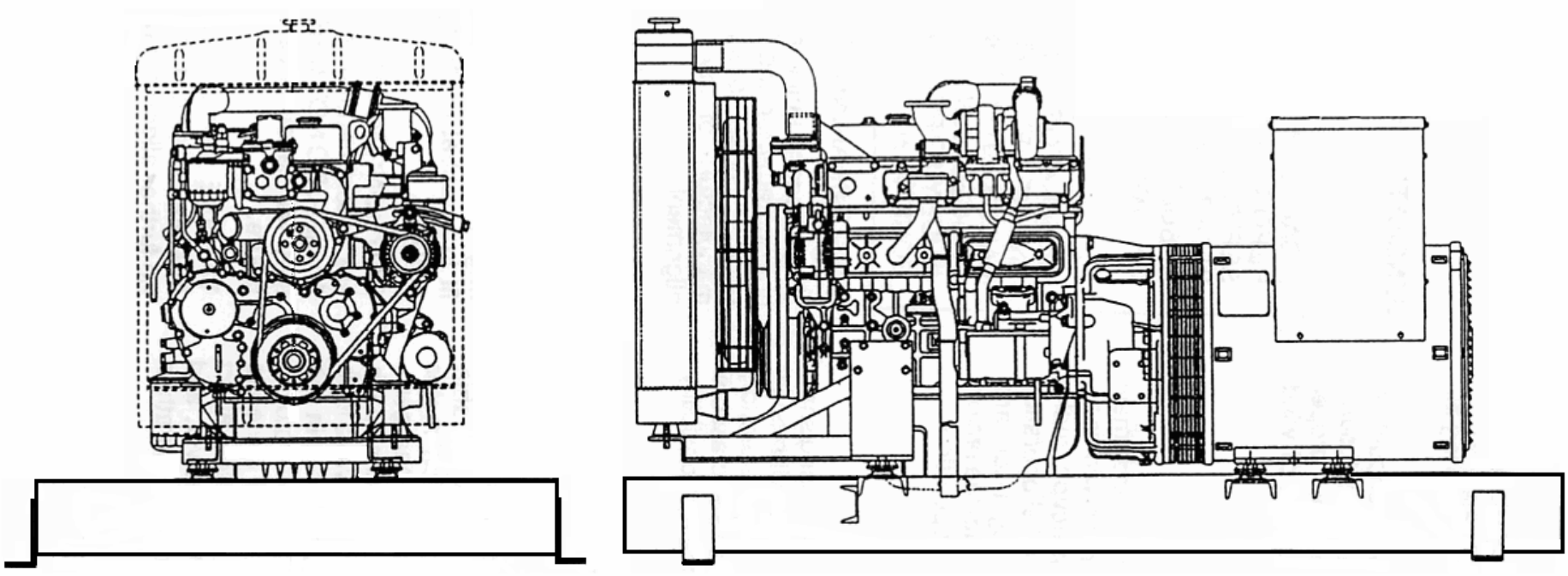
The rotor assembly is precision balanced to a high degree of static and dynamic balance. Although the balance will remain dynamically stable at speeds in excess of the design frequencies, the prime mover should be adequately governed to prevent excessive over speed. High centrifugal forces created by excessive over speed may damage the rotor windings and field coils.

BEARING

The generator rotor assembly is suspended on a shielded factory lubricated ball bearing. A visual inspection of the bearing is recommended at typical service intervals. If signs of abnormal wear or leakage are observed, the bearing should be replaced. Never use liquids of any kind to clean the generator end and bearing.

STATOR ASSEMBLY

The stator assembly consists of laminations of steel mounted in a rolled steel frame. Random wound stator coils are fitted into the insulated slots.



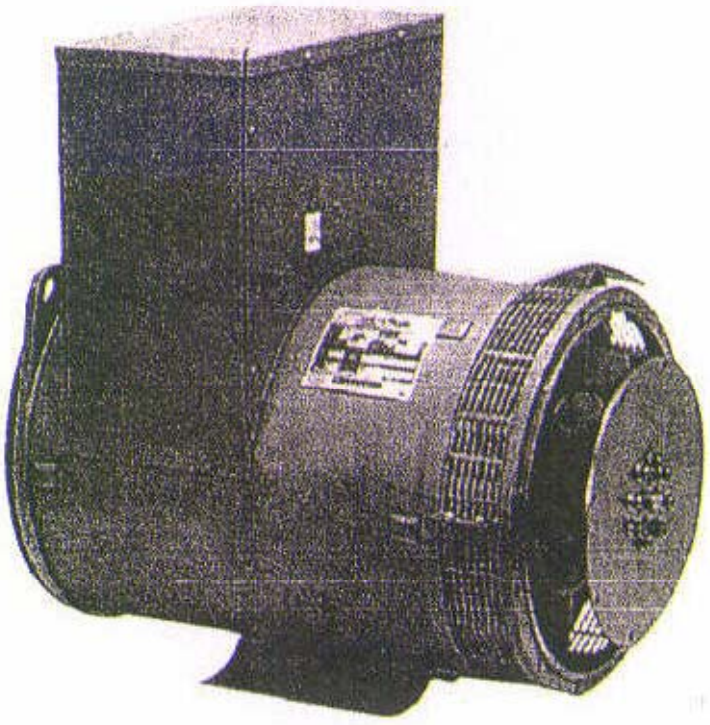
KUBOTA V-3300 & V-3300T ENGINE with MARATHON GENERATOR END

SECTION A:

GENERATOR

MAGNAPLUS GENERATOR

280 -- 430 Frame
Installation, Operation and Maintenance Manual



MARATHON® ELECTRIC
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CONTENTS

SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating,and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised.or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified,trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous.Each installation may well create its own set of hazards'

When in doubt, ask, Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator,it is recommended that it be carefully examined for possible shipping damage.The generator was given to the freight carrier in good condition, thus,the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before acception the shipment.Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tage shipped with the unit. When lifting,attach an overhead crane to the lifting lug(s) on the generator frame.Apply lifting forces in a vertical direction.When transporting single bearing generators,the generator's rotor must be adequately supported to prevent damage..I

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean,dry area which is not subject to rapid changes in temperature and humidity.If the generator is stored for a long period of time,the generator should be tested,cleaned and dried as required before being put into service.See the maintenance section of this manual for further information.If the unit has been stored in an area where it has been subject to vibration,it is recommended that the bearing(s) be inspected and replaced as necessary.

PRINCIPLES OF OPERATION

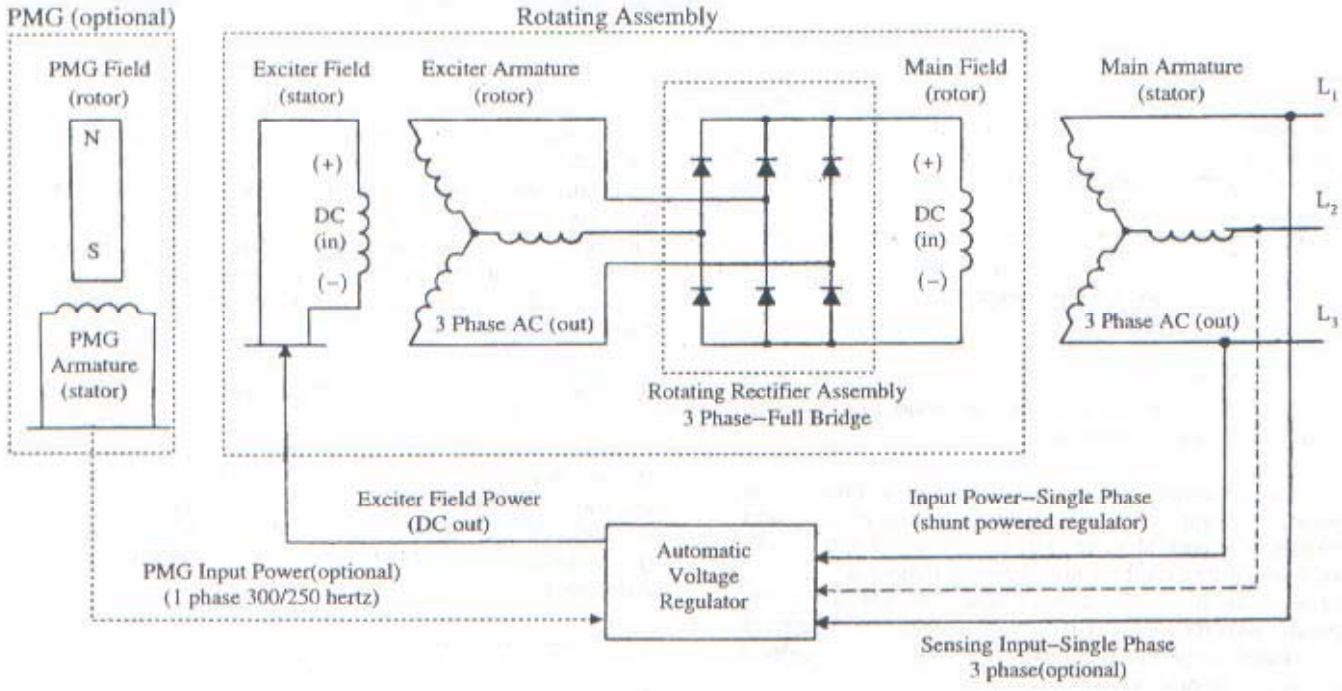


FIGURE 1–MagnaPLUS Circuit Diagram

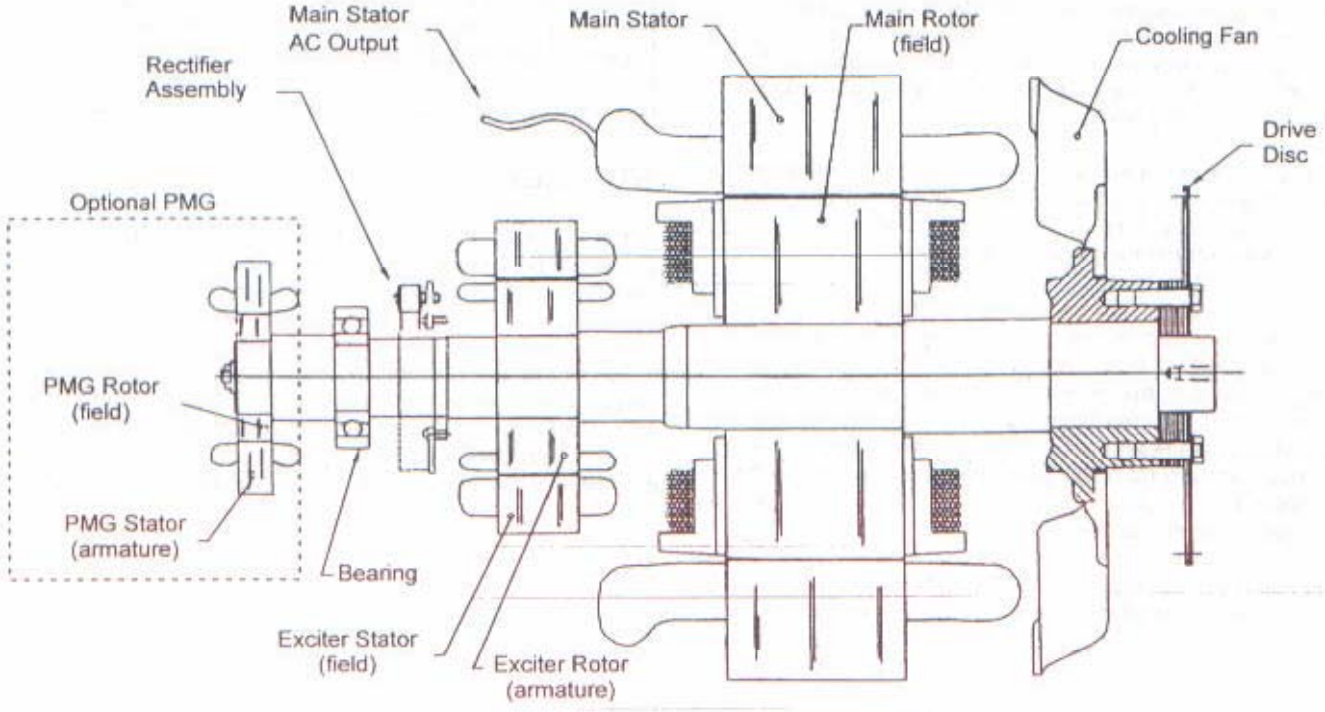


FIGURE 2--Typical MagnaPLUS Layout Diagram

PRINCIPLE OF OPERATION

MagnaPLUS generators are a brushless,self excited, externally voltage regulated,synchronous AC generator, The generator is made up of six major components: main stator (armature),main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology,note the following: stators are stationary, rotors rotate, a field is an electrical input, and an armature is an electrical output. These system components are electrically interconnected as shown in figure 1 and physically located as shown in figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor(armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator.After the generator has established the initial residual voltage,the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. The generator's terminal voltage is changed by adjusting the regulators reference set point. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, a large surge of current is drawn by the motor. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus generators generally supply 3 to 4 horsepower per generator KW in motor starting capability. For specific data contact Marathon Electric.

PARALLEL OPERATION

All MagnaPlus generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.).These switching circuits introduce high frequency harmonics which distort the normal wave form of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems which can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Marathon Electric for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected anc tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags,skids and rotor support blocking.For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START,DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING

Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs,there may be a hub spacer,spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension("G" dimension per SAE J620c).Holes are provided in the periphery of the coupling discs which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS. Split lock washers when biting into the drive disc cause stress risers which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary.Use grzde 5 or greater mounting bolts. MagnaPLUS generator frames are constructed with two or three bolt holes per foot. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame,thus no real need to secure the feet with more than one bolt per foot.

GENERATOR MOUNTING

Two Bearing Generators--Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increase bearing life, and ensure minimum coupling wear.It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grage 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING

Two Bearing Units--Belt Driven

Two bearing MagnaPLUS generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Marathon Electric recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

END PLAY TESTING

Refer to the engine manual for recommended end play specifications and measurement procedures. If end play is not to specification, it is an indication that the generator shaft is not moving freely inthe assembly, and normal life of the thrust bearing could be impaired.Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.
2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.
3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases the amplitude of these vibrations at critical speeds may cause damage to either the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect onthe entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS generator is designed for heavy duty industrial applications; however, dirt, moisture, heat and vibration are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

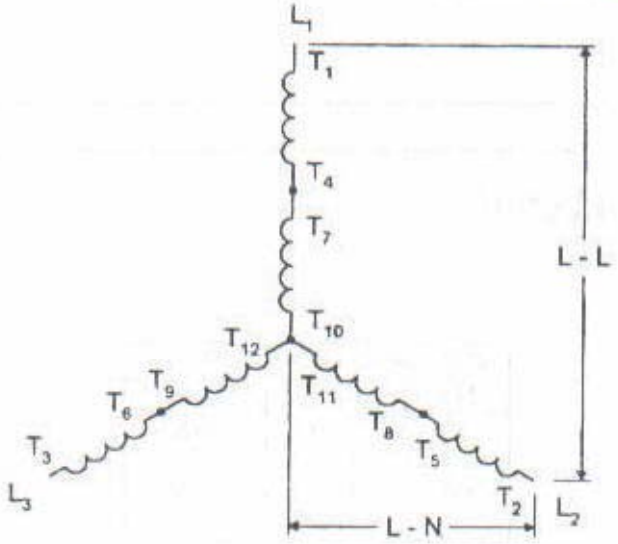
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration,it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are:6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame-5.4 NM (4 Ft Lb); 360 & 430 frame-27 NM (20 Ft Lb).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded(earthed) or left above ground potential(floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

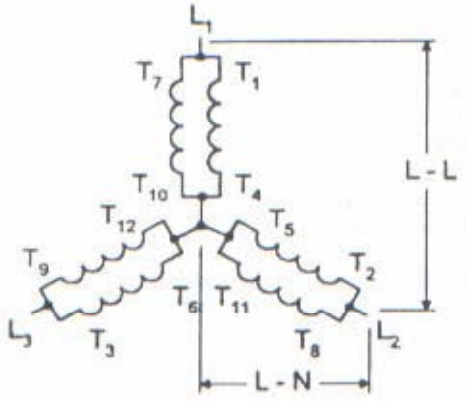
The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12, These three leads are internally connected inside the generator and brought out as a single lead (TO).Ten lead generators can only be connected in a wye configuration

HIGH WYE CONNECTION



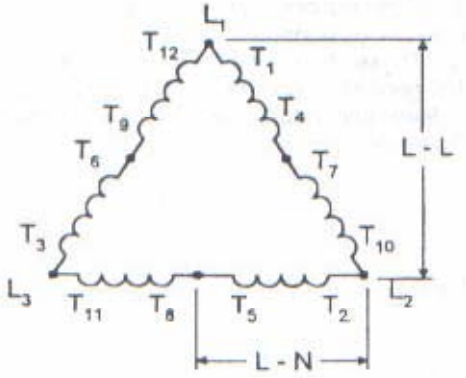
VOLTAGE (HIGH WYE)		
Hz	L–L	L–N
60	480	277
	460	266
	440	254
	416	240
	380	219
50	416	240
	400	231
	380	219

LOW WYE CONNECTION



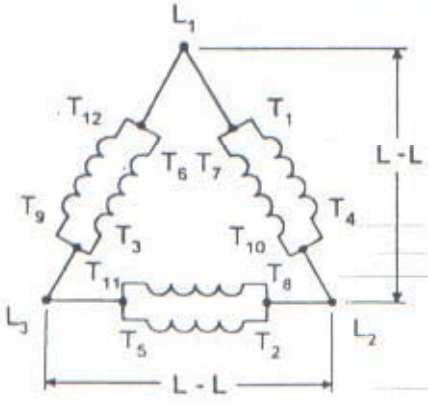
VOLTAGE (LOW WYE)		
Hz	L–L	L–N
60	240	139
	230	133
	220	127
	208	120
	190	110
50	208	120
	200	115
	190	110

HIGH DELTA CONNECTION



VOLTAGE (HIGH DELTA)		
Hz	L–L	L–N
60	277	139
	240	120
50	240	120
	220	110
	200	100

LOW DELTA CONNECTION



VOLTAGE (LOW DELTA)		
Hz	L–L	L–N
60	120	NA
	110	NA
50	110	NA
	100	NA

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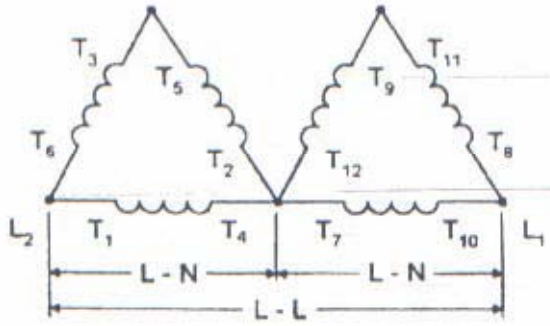
A Subsidiary of Regal-Beloit Corporation

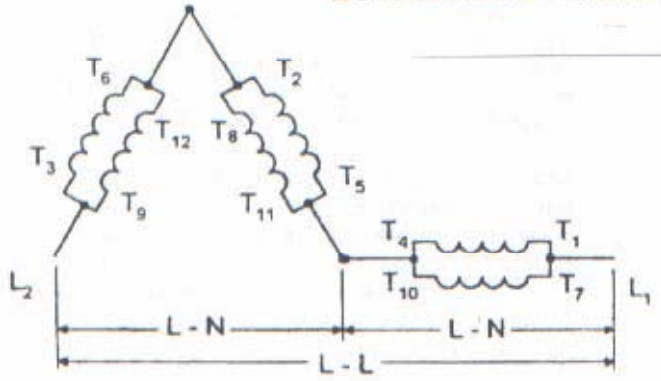
DOUBLE DELTA--SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	L–L	L–N
60	240	120
	220	110
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings

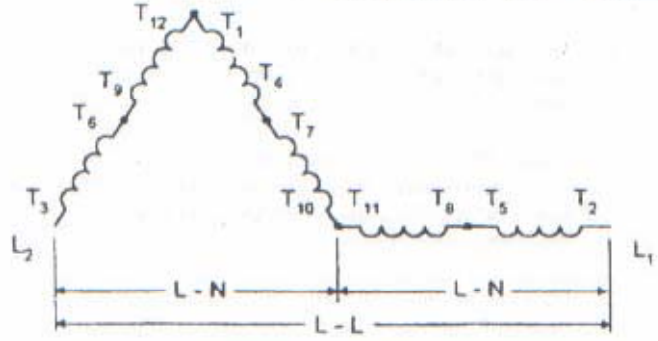
LOW ZIG ZAG--SINGLE PHASE CONNECTION



VOLTAGE (LOWZIGZAG)		
Hz	L–L	L–N
60	240	120
	220	110
50	220	110
	200	100

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings

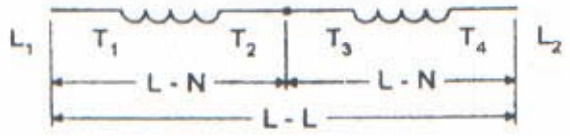
HIGH ZIG ZAG -- SINGLE PHASE CONNECTION



VOLTAGE (HIGH ZIGZAG)		
Hz	L–L	L–N
60	480	240
	460	220
50	415	208
	380	190

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings

DEDICATED SINGLE PHASE CONNECTION



VOLTAGE (DEDICATED)		
Hz	L–L	L–N
60	240	120
	220	110
50	220	110
	200	100

OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended.

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.
2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.
3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

WARNING

MAGNAPLUS GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

4. Verify that all equipment is properly grounded (earthed).
5. Clear the surrounding area of any materials that could be drawn into the generator.
6. Check all fasteners for tightness.
7. Check all accesss plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.
8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.
8. Remove any masking materials affixed during painting. Inspect the generator,prime mover,and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

Note:It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.
2. Open the input power to the automatic voltage regulator.Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)
3. Verify that all prime mover start-up procedures have been followed.
4. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.
5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced, shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

   With the regulator de-energized, the residual voltage should be 10-25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

> WARNING
>
> THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE.CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to t he load.

9. Monitor the generator output current to verify that itis at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary(Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator, however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should befollowed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling air flow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the winding. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service centerequipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

> WARNING
>
> THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE.CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance, check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the bench mark reading, it is an indication of problems in either the exciter, main field, or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum,the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture,wet windings should be thoroughly dried out before operating the unit.If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. The method selected will be influenced by winding wetness and situation limitations.

Space Heaters

An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator, Thisprocess can be accelerated by enclosing the unit with a covering and inserting additional heating units. A hole shouldbe left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air

Another method to dry the generator is to run the set with no excitation (see startup procedure item #2).The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 C(180° F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires,frayed insulation, cracked brackets,missing hardware,etc.Check for foreign objects which may have been drawn into the generator. Verify that the generator's air gaps(main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set suing the generator fan.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE.CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

CONSTANT EXCITATION TEST (12V BATTERY TEST)

The generator "no load" voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.
2. Disconnect the regulator's F+ (F1) and F-(F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.
3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator's terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes,surge suppressor,and windings.

Continuity / Resistance Test

The generator has four components which can be checked using an ohm meter: exciter stator, exciter rotor, main stator and main rotor. Each of these components are comprised of various windings which form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohm meter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases,low insulation resistanceis caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter) A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators,diodes,surge protectors,capacitors, protective relays,etc.) from the winding circuit before checking the insulation.Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor.Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the enginein order to gain access to a given area of the rectifier assembly. NEVER use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (figure 4).The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester,place one test probe on the diode lead terminal post. In succession,touch the other test probe to the lead screw hole in each heat sin. Reverse the probes and repeat the procedure. Your have now tested the three diodes connected to this terminal post inboth the forward and reverse direction. Repeat the procedure using the other diode terminal post.

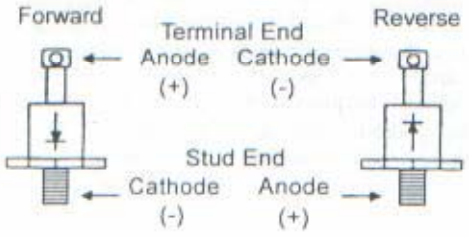


FIGURE 3: DIODE POLARITY

When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased),the diode will switch on and conduct electricity (figure 3).This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The resultsof these tests should indicate one of three conditions:

1. Good Diode: Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery-light tester will have the light "on" in one direction and "off" in the other.

2. Shorted condition: Ohmmeter reading will be zero,or very low in both directions. The continuity tester will have the light "on" in both directions.

3. Open condition: Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes,etc.All 6 diodes are essentially in the same circuit. When a diode is stressed to failure,there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures,it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. All service procedures should be conducted by qualified maintenance personnel. Replacement parts may be ordered through an authorized service center or directly from the factory.

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. **Shutdown the generator set.** Remove the exciter field leads F+ and F- from the regulator.

CAUTION:
Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is crawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

BEARING REMOVAL

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged,replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.

Prior to proceeding with bracket removal,disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing.Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. if worn or damaged,repair or replace prior to reassembly.

Drive End Bearing Bracket Removal, Two Bearing Units.

Remove any drive arrangement from the generator shaft extension.Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket.The shaft extension must be supported bdfore proceeding further. A hoist and sling, jack,or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws.Using a flat bladed screw driver or chisel,pry the bracket back from the frame.After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged,sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

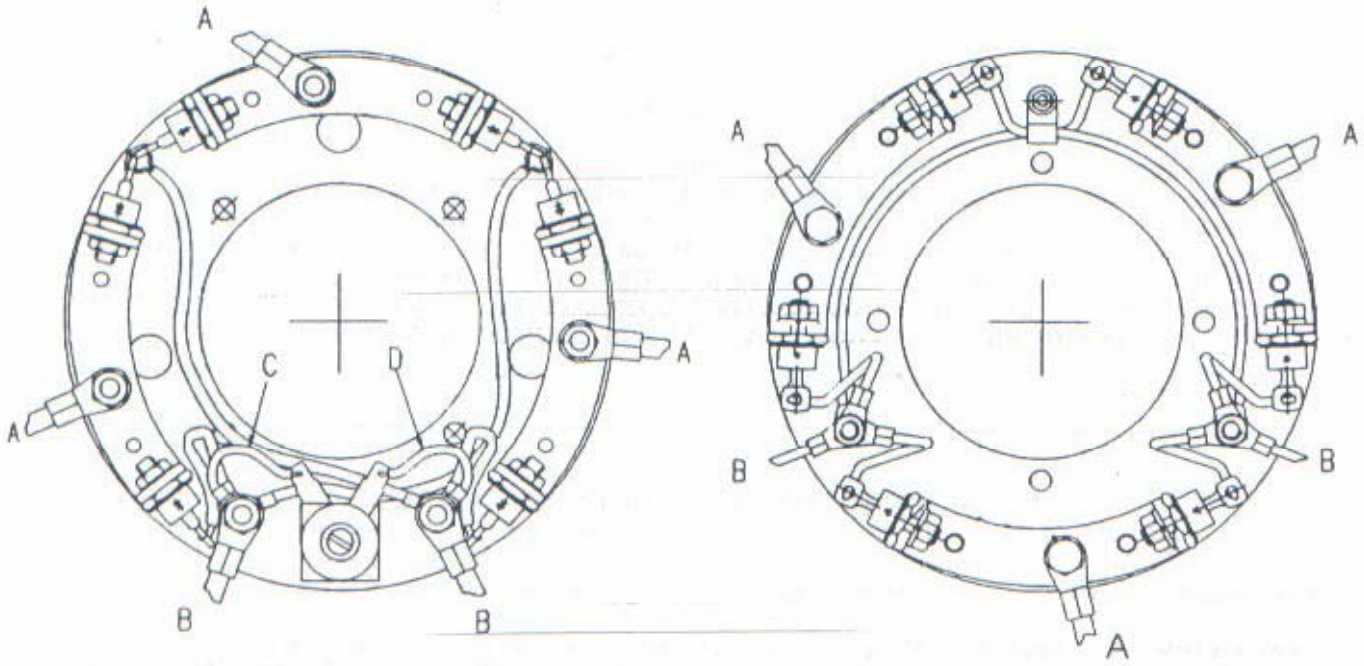
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time the it is removed from the shaft. ALWAYS install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C(212°F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used todrive the bearing to its final position.Using light taps with a soft mallet, apply pressure to the inner race only.

RECTIFIER ASSEMBLY REMOVAL

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 4). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

DIODE REPLACEMENT

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut which could cause damage to the device. Torque to 28 pound-inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.



430 FRAME 280 / 360 FRAME

A-Exciter Rotor Lead, B-Main Rotor Lead, C-Red(+)Suppressor Lead, D-Black(-)Suppressor Lead

FIGURE 4: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes:how long the unit had been operating;what loads were on line;weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation?Has the prime mover experienced an over-speed condition?If yes,what was the maximum speed,and how long did the unit operate at the televated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections,open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary-check regulator fuse and input power from the PMG.
Defective diodes, suppressor,or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE,NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawing supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW(RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate air flow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric.
Improper generator voltage or frequency	Check name plates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION: Compare required voltage, frequency, and KVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Marathon Electric for information regarding generator capacity.

SPECIFICATIONS

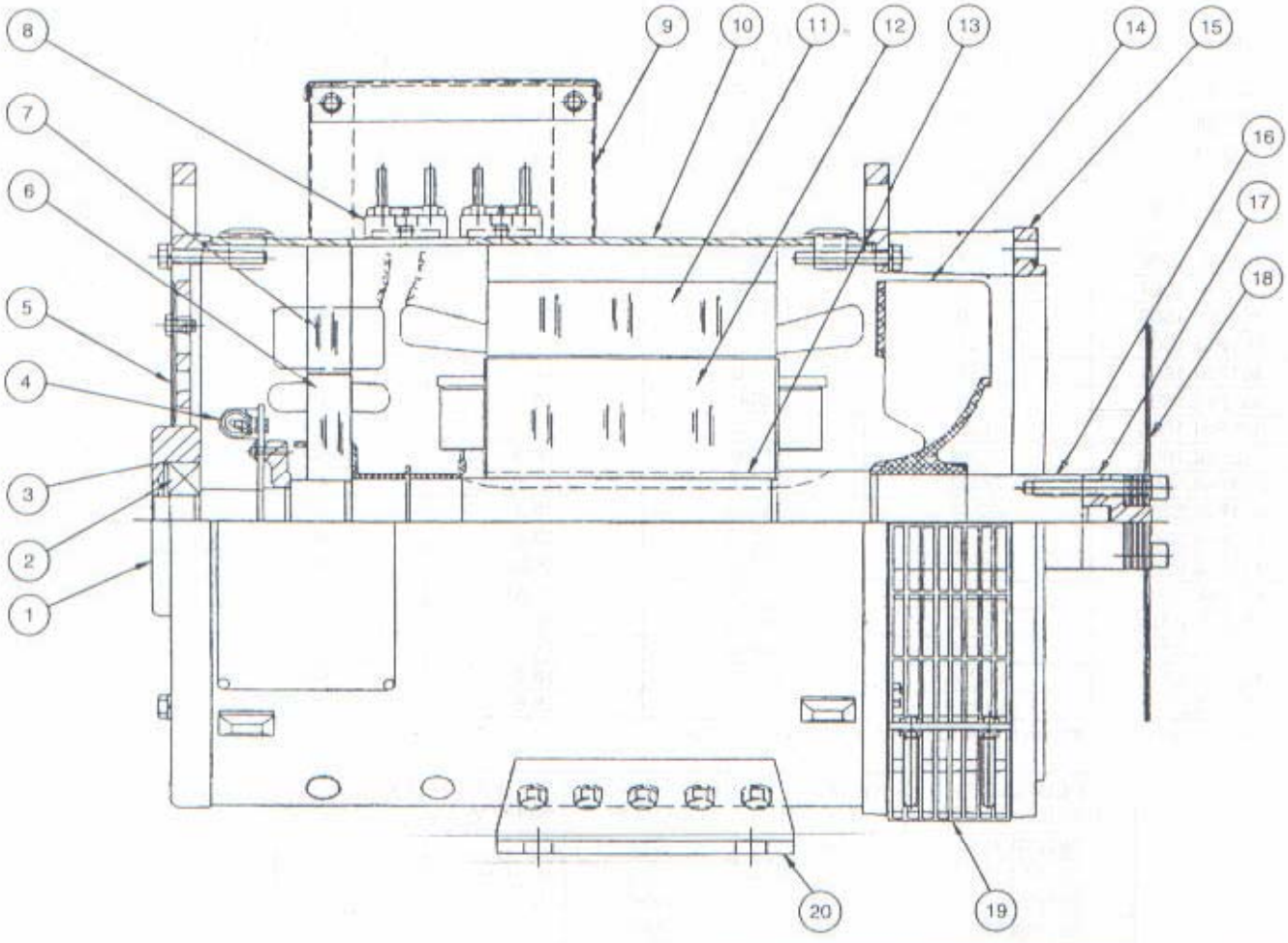
MODEL /FRAME SIZE	EXCITER RESISTANCE	
	STATOR	ROTOR
281, 282, 283, 284	23.0	.120
361, 362, 363–three phase	23.5	.120
361, 362, 363–dedicated single phase	23.0	.135
431, 432, 433–three phase	20.33	.076
431, 432–dedicated single phase	18.0	.105

MODEL	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS 480 V / 60HZ	NO LOAD TERMINAL VOLTAGE WITH 12 VDC FIXED EXCITATION HIGH WYE / 60 HZ	HIGH WYE / 50 HZ
	STATOR*	ROTOR			
281PSL1500	4.20	.400	11.0	485	400
281PSL1501	4.15	.400	11.0	490	404
281PSL1502	3.20	.439	9.0	528	435
282PSL1503	2.00	.470	10.4	500	415
282PSL1504	1.51	.512	11.3	490	400
282PSL1505	1.00	.575	10.0	515	415
283PSL1506	.681	.654	11.0	495	400
283PSL1507	.480	.758	12.0	480	390
284PSL1508	.346	.875	12.0	480	375
361PSL1600	.381	.750	11.8	485	400
361PSL1601	.264	.810	12.5	475	385
361PSL1602	.181	.990	14.1	460	370
362PSL1604	.138	1.05	12.2	480	380
362PSL1606	.0980	1.20	10.8	500	405
363PSL1607	.0692	1.37	12.2	475	380
431PSL6202	.0214	.8114	15.1	440	360
431PSL6204	.0477	.6373	13.6	455	385
431PSL6206	.0371	.6793	13.82	455	370
431PSL6208	.0133	.715	12.20	475	390
432PSL6210	.0214	.8114	15.1	440	360
432PSL6212	.0226	.8656	14.1	445	385
433PSL6216	.01215	1.0672	16.2	425	345
433PSL6220	.01214	.9743	15.6	430	350

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS / 60 HZ
	STATOR	ROTOR	
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282PSL1514	.436	.450	9.2
282PSL1515	.240	.520	9.7
283PSL1516	.160	.620	13.3
284PSL1517	.0918	.760	12.2
284PSL1518	.0610	.857	16.6
361PSL1611	.0695	.750	17.5
361PSL1612	.0434	.857	16.1
361PSL1613	.0369	.926	13.6
362PSL1615	.0191	1.20	17.0
363PSL1617	.0119	1.35	23.0
431PSL1811	.0248	.516	9.9
431PSL1813	.0129	.615	13.8
432PSL1814	.00931	.643	15.1
432PSL1815	.00723	.852	11.2

PARTS LIST – SINGLE BEARING
Typical Generator Cross Section



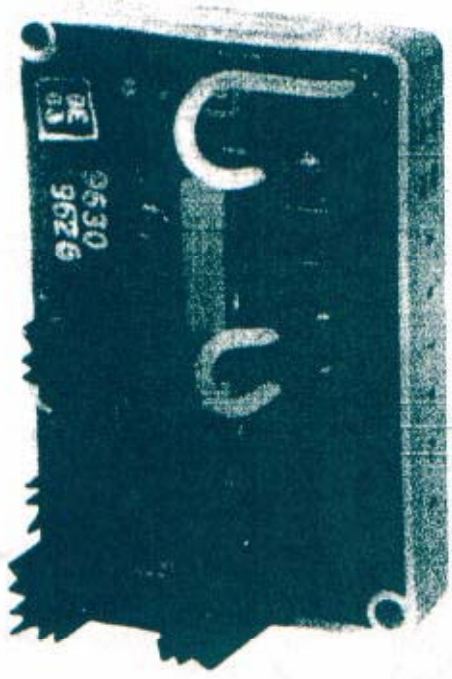
Reference Number	Part Name	Reference Number	Part Name
1	End Bracket(under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring(280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	Mounting Adapter (SAE)
6	Exciter Sotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board(terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus.Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

SECTION B:

VOLTAGE REGULATORS
and
ENGINE CONTROLLERS

SE350
VOLTAGE REGULATOR
INSTRUCTION MANUAL



MARATHON ELECTRIC®

A Subsidiary of Regal-Beloit Corporation

INTRODUCTION

The SE350 voltage regulator is an encapsulated electronic voltage regulator which controls the output of a brushless AC generator by regulating the current into the exciter field.

SPECIFICATION	SE350 REGULATOR
Sensing & Power Input	190-240 Vac
Burden	500 VA
Output Power - Continuous	73 Vdc at 3.5 Adc (255w)
Output Power - Forcing (240 Vac Input Power)	105 Vdc at 5 Adc (525w)
Regulation	1.0%
Remote Voltage Adjustment Range	±10% with 2000 ohm rheostat ±5% with 1000 ohm rheostat
Frequency Compensation	Adjustable
Roll Off Frequency	54-61 Hz for 60 Hz Operation 45-51 Hz for 50 Hz Operation
Weight	6.5 oz.
Operating Temperature	-40°C to +60°C
Storage Temperature	-65°C to +85°C
Power Dissipation	8 watts maximum
Size	3.94" L X 2.66" W X 2.20" H
Voltage Buildup	Internal provisions for automatic voltage build up from generator residual voltage as low as 10 Vac.
EMI Suppression	Internal electromagnetic interference filter (EMI Filter)

WARNING

TO PREVENT PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD INSTALL, OPERATE, OR SERVICE THIS DEVICE.

CAUTION: DO NOT megger or high-pot the generator with the regulator connected. DO NOT high-pot the regulator.

INSTALLATION

MOUNTING

The SE 350 voltage regulator can be mounted in any plane. See Figure 1 for mounting dimensions.

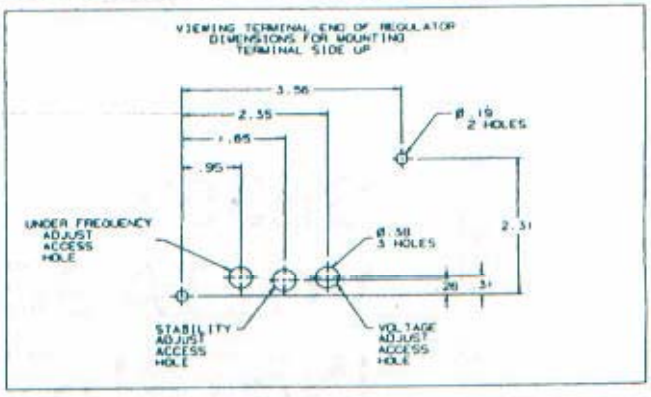


Figure 1

EXCITER POWER CIRCUIT

Connect the regulator wire F+ to the generator F+ or F1 field terminal. Connect the regulator wire F- to the generator F- or F2 field terminal. See Figure 2 for typical connection diagram.

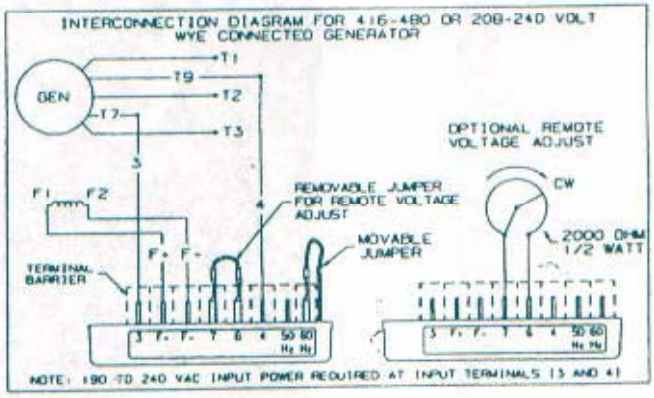


Figure 2

SENSING/POWER INPUT CIRCUIT

Input power and sensing is achieved through terminals 3 and 4. **The voltage input requirement of the SE350 is 190 to 240 Vac.**

See Figure 2 for typical connection diagram

FUSE

A 4 Amp 250V - 5 X 20 mm fuse is supplied with the regulator (Part A-527066). See Figure 3 for location of fuse.

VOLTAGE ADJUST

The screwdriver adjustable potentiometer adjusts the generator output voltage. Adjustment clockwise increases the generator output voltage.

When using a remote voltage adjust rheostat, remove the jumper wire across terminals 6 and 7 and install a 2000 ohm 1/2 watt (minimum) rheostat. (See Figure 2.) This will give ±10% voltage variation from the nominal. (For ±5% voltage variation use a 1000 ohm 1/2 watt rheostat).

STABILITY ADJUST

System stability is the ability of the generator to respond to load transients. Decreasing the stability makes the generator less sluggish and faster to respond to load transients. If the stability of the regulator is decreased too much, the generator will tend to hunt under steady state conditions.

The screwdriver adjustable potentiometer adjusts the system stability. Adjustment clockwise increases the stability. Increasing the stability increases the response time of the generator. Conversely, decreasing the stability decreases the response time of the generator.

V/HZ ROLL-OFF FREQUENCY SELECTION

The roll off point is the frequency where the generator voltage starts to decrease. This reduces the Kilowatt load to the engine, which allows the engine to recover in speed under any load transient condition.

Use jumper to select 50 HZ or 60 Hz. The screwdriver adjustable potentiometer sets the roll-off frequency from 54-61 Hz in the 60 Hz setting or from 45-51 Hz in the 50 Hz setting.

The SE350 has the roll-off point preset to 58 Hz in the 60 Hz mode and 48 Hz in the 50 Hz mode. To change the roll-off point, adjust engine speed to the desired rated speed. (50 or 60 Hz). Set the voltage to the desired setting at rated speed. Adjust engine speed to the desired roll-off point. Turn the potentiometer counterclockwise until the voltage starts to drop off. Then adjust the potentiometer clockwise until the voltage returns to rated. Re-adjust engine speed to rated speed.

START-UP PROCEDURE

PRELIMINARY SET-UP

Ensure the voltage regulator is correctly connected to the generator. Refer to the specific connection diagram supplied with the generator.

Set the regulator voltage adjust to full counter-clockwise (minimum voltage level).

Set the remote voltage adjust (if used) to the center position.

Set the stability control full clockwise (maximum stability level).

Connect the positive lead of a 100V D.C. voltmeter to F1 and the negative lead of the voltmeter to F2 or use an appropriate AC voltmeter on the generator output leads.

SYSTEM START-UP

Start and run the generator at no load and rated speed. The generator voltage should build up to a minimum level. (Actual level is dependent upon connection). If it does not build up, refer to field flashing section in generator manual.

Slowly adjust the voltage control until the generator voltage reaches the nominal value. If used, adjust the remote voltage rheostat to set the generator voltage to the exact value desired.

Turn the stability adjust counter-clockwise until instability is shown on either of the voltmeters mentioned in the "PRELIMINARY SET-UP" section. With the system operating in an unstable condition, slowly adjust the stability control clockwise until generator stability is reached.

Interrupt regulator power for a short time (approximately 1-2 seconds).

If the generator remains stable, no further adjustment is necessary. If the generator does not remain stable, increase the stability slightly and interrupt regulator power again.

This procedure should be repeated until system stability is reached and maintained.

Symptom	Cause	Action
Residual Voltage - No Output	Residual voltage at regulator power input wires 3 & 4 below 10Vac.	Check wiring diagram for proper connections.
		Flash generator field. Refer to field flashing section in generator manual.
	Acceleration time to rated speed too long.	Reduce acceleration time.
		Interrupt power input to regulator after acheiving rated speed.
	Field leads F1, F2 not connected.	Connect field leads F1, F2.
	Power input leads not connected.	Connect power input leads 3, 4.
	Blown or missing fuse.	Replace fuse.
	Defective regulator.	Replace regulator.
	Defective generator.	Consult generator manual.
Output Voltage Low	Incorrect connections.	Check wiring diagram for proper connections.
	Voltage adjust turned down.	Rotate voltage adjust CW until desired voltage is reached.
	Remote voltage adjust is turned down.	Rotate remote voltage adjust CW until desired voltage is reached.
	Defective regulator.	Replace regulator.
Output Voltage High	Voltage adjust turned too high.	Rotate voltage adjust CCW until desired voltage is reached.
	Remote voltage adjust is turned too high.	Rotate remote voltage adjust CCW until desired voltage is reached.
Output Voltage High - No Adjustment	Defective regulator.	Replace regulator.
Remote Voltage Adjust Operates Backwards	Voltage adjust wire backwards.	Reverse the wiring of the remote voltage adjust.
Generator Output Voltage Hunting	Stability adjust not set properly.	Rotate the stability adjust in a CW direction until hunting stops.
Poor Regulation	Defective regulator.	Replace regulator.

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MARATHON® ELECTRIC
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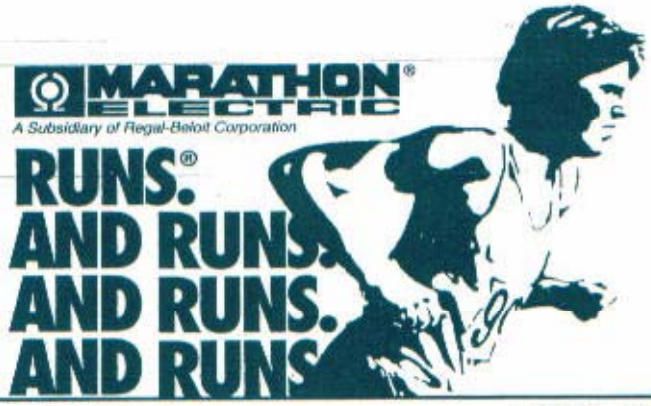
RUNS.® AND RUNS. AND RUNS. AND RUNS



BASLER AVC63-4 ANALOG VOLTAGE CONTROLLER

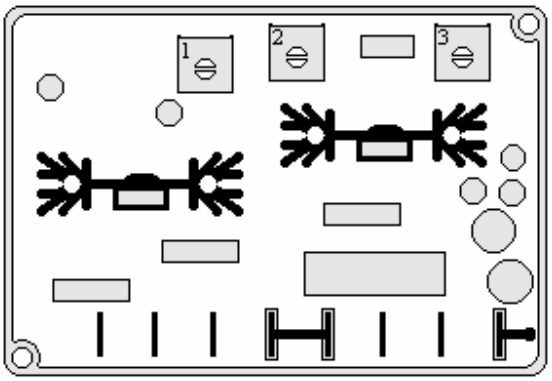
The AVC63-4 voltage regulator is designed for use on 50/60 Hz brushless generators. Features include frequency compensation, over excitation shutdown, a solid-state build-up circuit and EMI filtering. The AVC63-4 attaches to the generator with spade type wire terminals for a secure connection. The AVC63-4 has three adjustable potentiometers for fine-tuning the output voltage, stability and under frequency. The regulator is encapsulated in a protective plastic shell and back filled with an electronic compound, which provides protection from environmental hazards.

AVC63-4 Specifications:

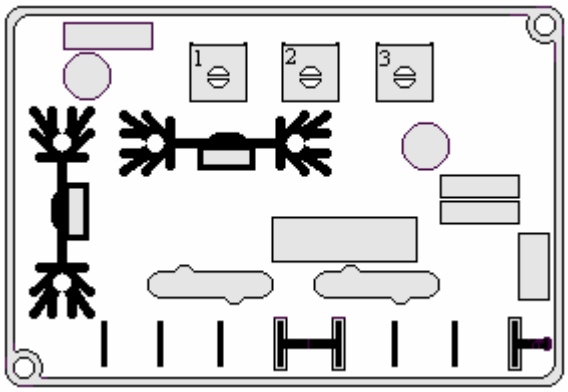
DC Output Power	4 Amps at 63V DC 7 Amps at 100V DC 9 Amps at 134V DC
Exciter Field DC resistance	15 Ohms Min. – 100 Ohms Max.
AC Power Input	190 – 240V AC, Single Phase, 50/60 Hz ±10%, Burden: 500VA
Sensing Input	190 – 240V AC, Single Phase, 50/60 Hz ±10%, Common with AC Power Input
Voltage Adjust Range	171 – 264V AC
Regulation Accuracy	Better than ±1.0% No Load to Full Load
Response Time	Less Than ±1.5% Change in Sensing Voltage
EMI Suppression	Internal Electromagnetic Interference Filter
Over Excitation Shutdown	Field Voltage shuts down after time delay if exciter field voltage exceeds 100V DC, ±5%
Voltage Build-Up	Internal provisions for automatic voltage build-up from generator residual voltage as low as 6V AC
Power Dissipation	8-Watts Max.
Operating Temperature	-40°F (-40°C) to 140°F (60°C)

1) Voltage Control
2) Stability Control
3) Underfrequency Control

Previous Version



Current Version



Previous versions of the AVC63-4 controller, sold prior to mid-2003, are slightly different in appearance and control adjustment. The controller version can be determined by the location of the heat sinks. The above illustrations show the heat sink locations of both versions. Adjustment of the Under frequency

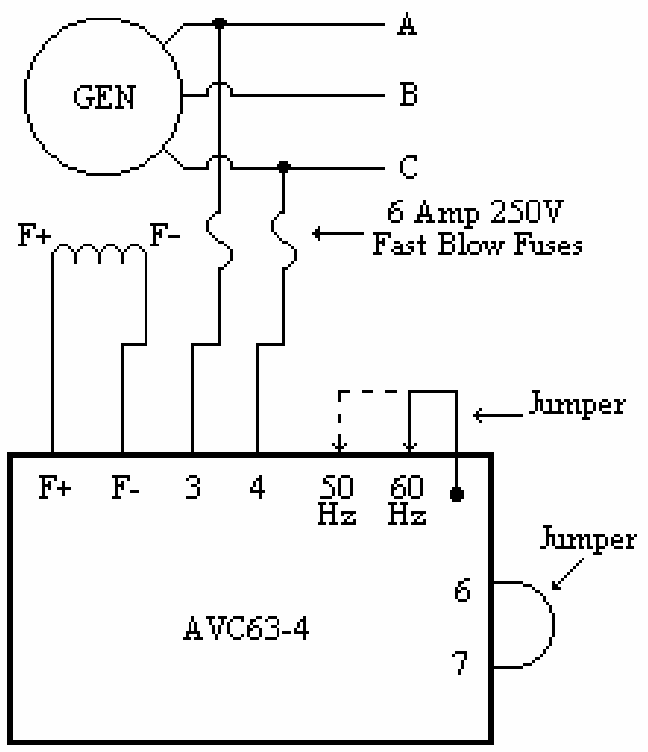
BASLER MODEL AVC63-4 VOLTAGE REGULATOR

Control is different on previous versions of the AVC63-4. When adjusting the Underfrequency Control on previous versions, clockwise rotation decreased the corner frequency while counterclockwise increased the corner frequency.

NOTE: Further reference to corner frequency adjustments of the AVC63-4 are for the Current Version and should be reversed for the Previous Version.

JUMPER CONTROLS:

Two jumpers connect to the controller terminals: the Corner Frequency Jumper and the Voltage Adjust Rheostat Jumper.



Corner Frequency Jumper
The AVC63-4 is typically set with this jumper connected to the 60 Hz terminal. This gives a corner frequency of 55 Hz. For 50 Hz operation and a corner frequency of 45 Hz, the Corner Frequency Jumper must be moved to the 50 Hz terminal.

Voltage Adjust Rheostat Jumper
The Avc63-4 is typically set with the Voltage Adjust Rheostat Jumper connected across terminals 6 and 7. This enables adjustment of the generator output voltage through the controller's internal voltage control potentiometer. Clockwise rotation of the voltage control increases generator voltage.

POTENTIOMETER CONTROLS:

The AVC63-4 potentiometer controls are located on the components and terminals side of the controller. Voltage control, Stability control and Underfrequency control allow for fine-tuning the controller to a specific application.

INPUT POWER / SENSING INPUT:

Power for the exciter field and AVC63-4 is derived from the generator output. The acceptable power input range is 171 to 264 V AC and is connected to terminals 3 and 4.

EXCITER FIELD POWER CIRCUIT:

Controller terminal F+ is connected to the brushless exciter field positive terminal and controller terminal F- is connected to the brushless exciter field negative terminal.

BASLER MODEL AVC63-4 VOLTAGE REGULATOR

IMPORTANT: The exciter field DC resistance must be 15 Ohms or higher and less than 100 Ohms. If the exciter field DC resistance is less than 15 Ohms and the full load field current does not exceed the maximum continuous current rating of the controller, a resistor of ample wattage must be added in series with the field to increase the total resistance to 15 Ohms.

FREQUENCY COMPENSATION:

The frequency compensation feature improves system load pickup performance by restraining voltage recovery until the frequency has also started to recover. The corner frequency range is set for 50 Hz or 60 Hz by connecting the Corner Frequency Jumper to the appropriate terminal. The corner frequency setting is adjusted by the Underfrequency Control potentiometer. Clockwise rotation increases the corner frequency and Counterclockwise rotation decreases the corner frequency. (Current Version)

OVEREXCITATION SHUTDOWN:

The overexcitation shutdown feature removes controller output power, after a time delay, if the exciter field voltage exceeds 100V DC, ±5%. The time delay is inversely proportional to the magnitude of the detected overvoltage – up to 135V DC. Beyond 140V DC, the field voltage is removed after approximately two seconds. Once the output power is removed, the controller can be reset by decreasing the input voltage to less than 10V AC for two seconds, minimum. This can be achieved by stopping the prime mover or by interrupting the controller input power with a reset switch.

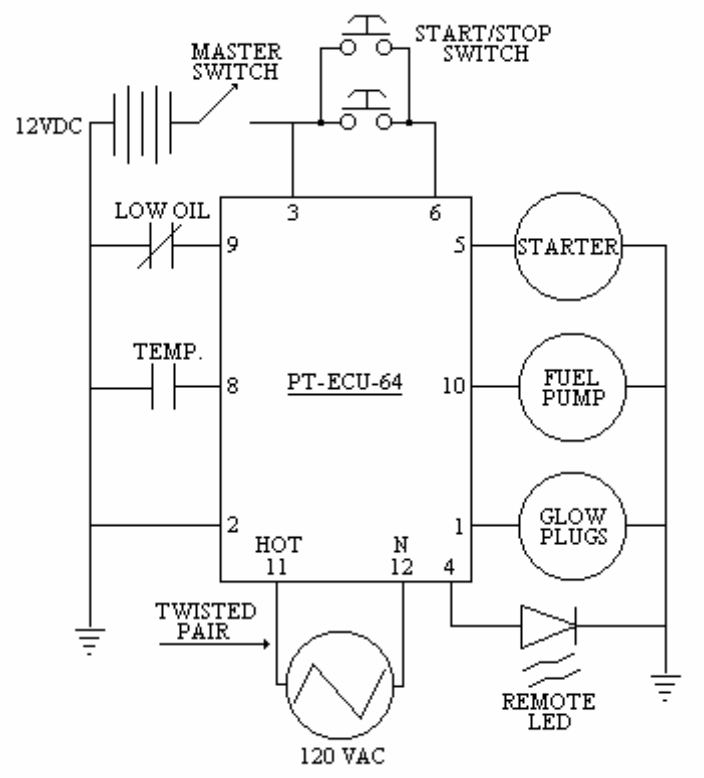
SYSTEM START-UP:

Start engine, allow a few minutes to warm-up to operating temperature and rated speed. Generator voltage should build up. If the voltage does not build up it may be necessary to Field Flash the generator. (See section on Field Flashing) Slowly adjust the controller's voltage control potentiometer until the generator voltage reaches the nominal level. Apply and remove the generator load to verify stability. If the generator responds too slowly or hunts (oscillates) adjust the controller's stability control with no load applied. Also check the stability of the governor system (mechanical or electronic) if applicable. Next check the regulation under normal operating conditions. If not acceptable, check the engine speed. Be sure to use an average-sensing voltmeter not an RMS-sensing voltmeter and should be connected at the same point as the controller sensing. Verify the corner frequency setting by slowly reducing the generator frequency until the generator output voltage just starts to decrease. If adjustment of the corner frequency is required, (Current Version) rotate the underfrequency control fully counterclockwise. Reduce the generator frequency from nominal (either 50Hz or 60 Hz) to the desired corner frequency. Slowly adjust the underfrequency control clockwise until the generator output voltage just starts to decrease.

PT-ECU-64 ENGINE CONTROL MODULE

1) Generator Main Switch must be in the ON position.
2) Toggle the Start/Stop Switch to the Start position.
3) Glow Plugs will preheat for 8 seconds. LED flashes slowly.
4) Preheating will cease during engine cranking cycle. LED continues flashing.
5) Engine begins an 8 seconds crank cycle, After 4 seconds of cranking the PT-ECU-64 will check for an AC signal from the generator. If an AC signal is verified the engine will start and the LED will remain ON during the normal run operation. If the AC signal is not verified the PT-ECU-64 will terminate the cranking cycle and LED will flash a fault code.
6) Starter disengages immediately after engine run is verified.
7) PT-ECU-64 deactivates the Low Oil Pressure and High Water Temperature Switches for 6 seconds, this will assure oil pressure build-up time. If oil pressure does not build-up the engine will immediately shut down and go into a fault mode. Likewise for a high temperature situation.
8) If engine will not start on the first attempt the PT-ECU-64 will initiate the start cycle 2 more times before going into a fault mode. Glow Plugs will preheat for 8 seconds per attempt. Engine will crank for 8 seconds per attempt.
9) To shut down the engine under normal operations, toggle the Start/Stop Switch to the stop position.
10) If a fault occurs turn Generator Main Switch OFF and then ON to reset PT-ECU-64.

Fault Codes:	LED Flashes
Failure to start	1
Engine High Water Temperature	2
Low Oil Pressure	3
No AC Signal	4
Low Coolant Level (Option)	5

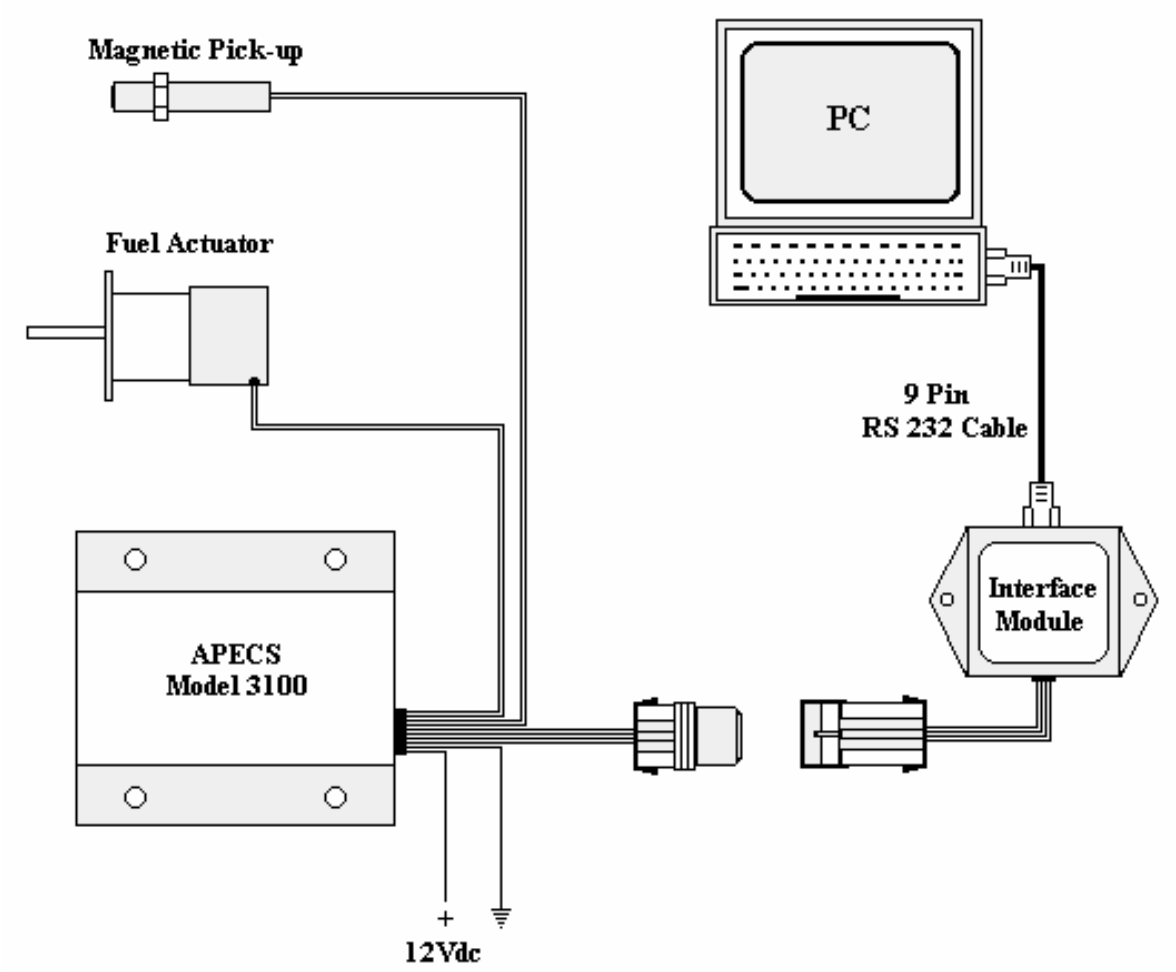


APECS 3100 ELECTRONIC
ENGINE SPEED GOVERNING SYSTEM

APECS Advanced Proportional Engine Control System is an engine speed governing system that maintains the engine speed / RPMs by adjusting the Fuel Control Actuator controlling the fuel injection unit. The APECS microprocessor-based Controller processes the signal received from a speed sensor, in this application a Magnetic Pick-up and compares it to the programmed settings. These setting are maintained regardless of the load applied to the engine.

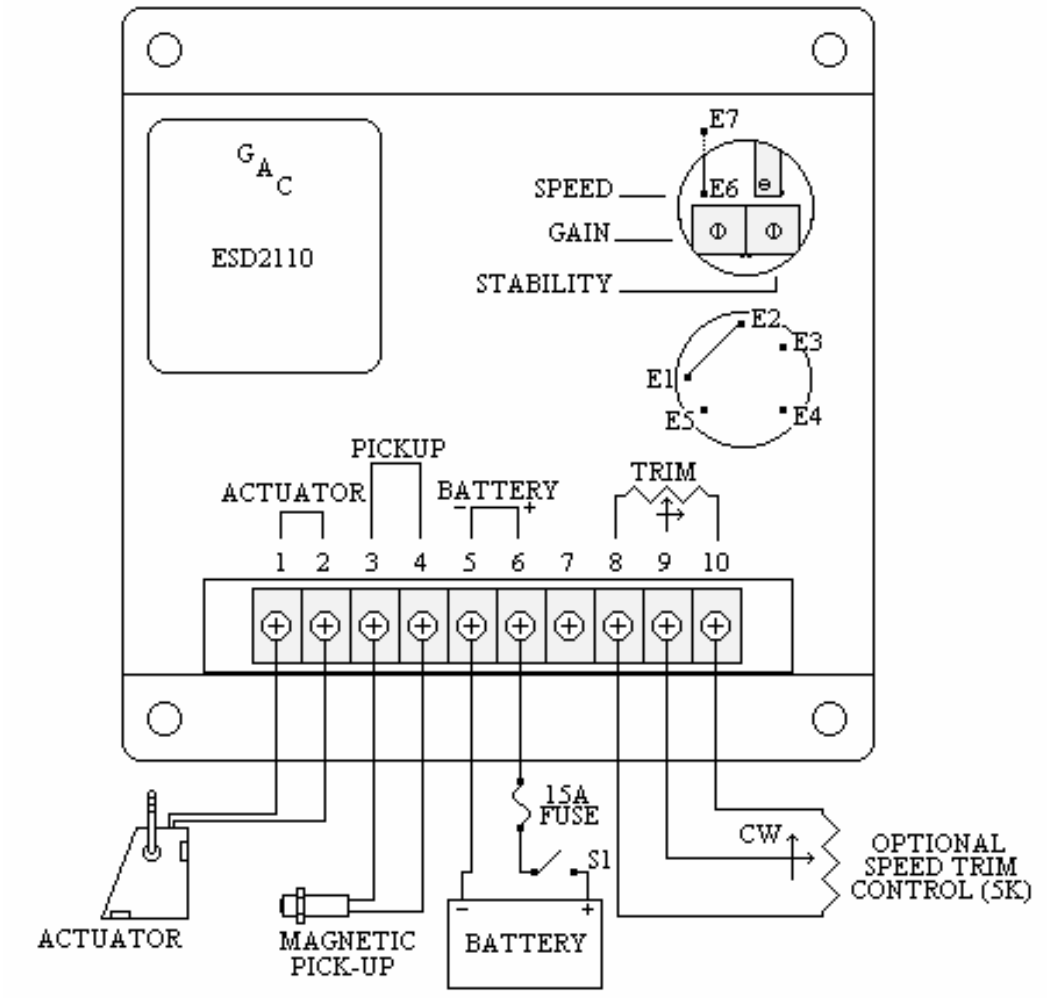
The APECS Controller is software programmable and must utilize the CALT calibration tool for configuring and adjusting the settings. CALT is a software based calibrating and monitoring tool, which permits the user to calibrate the controller as well as make adjustments to the program even while in operation. CALT allows adjustments to the PID gain settings for proper tuning of an application. The PID gains adjustments will improve response time, steady state and stability in the engines performance. The APECS Controller retains these settings in memory during shut down periods. The settings can also be saved to file for later viewing and printing and may be used to program another controller.

CALT can be run on an IBM compatible PC, a laptop computer is desirable for its convenience and portability. The APECS Controller is accessed through an Interface Module, which provides a connection to the PCs serial port with a 9 pin RS-232 cable.



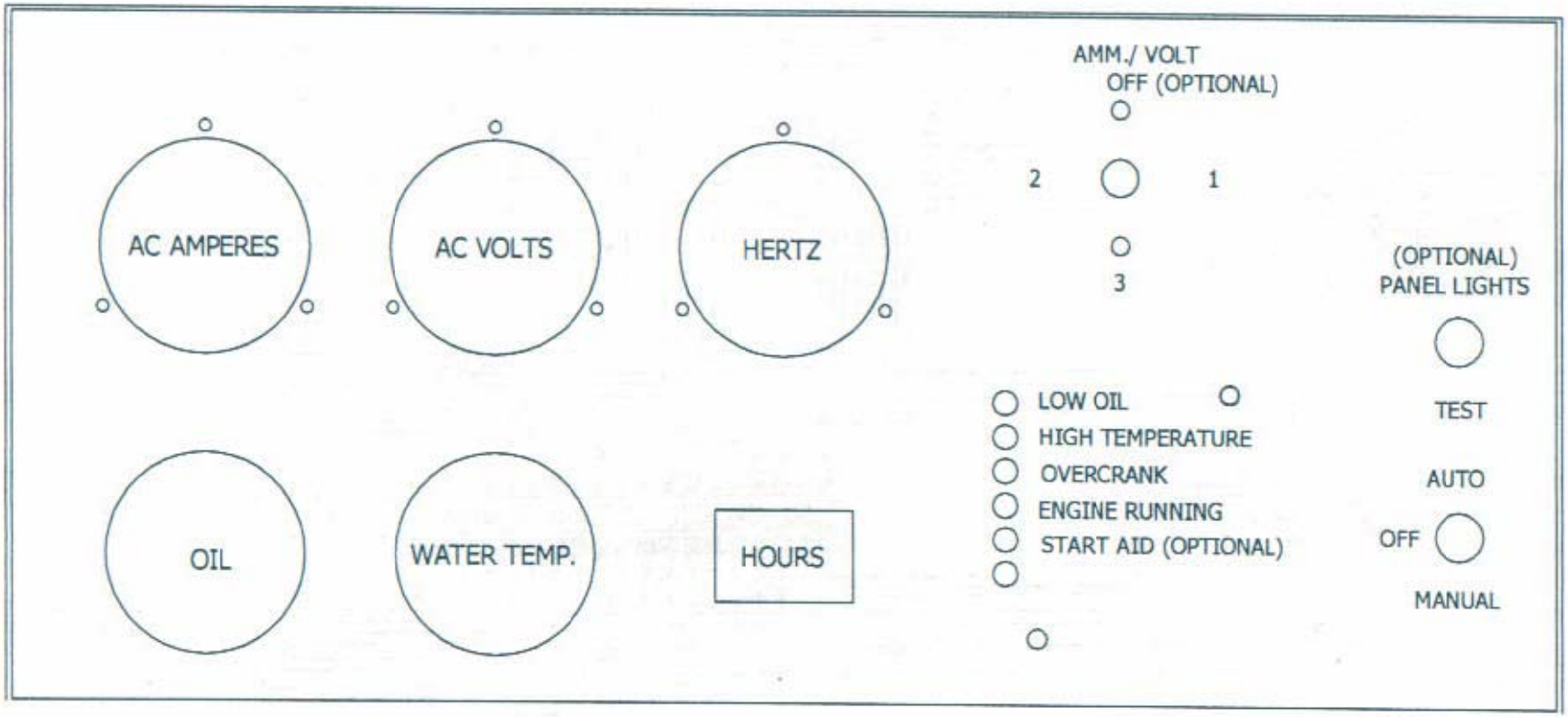
GAC ESD2100 SERIES SPEED CONTROL UNIT

The ESD2100 Speed Control Unit is part of an engine governing system designed to control engine speed and stability throughout the load range. Operating in combination with a magnetic pick-up and electric actuator the ESD2100 will maintain the proper engine speed by adjusting the fueling system according to the applied load. By maintaining a set engine speed the generator voltage output and frequency will remain constant and stable.



SECTION C:

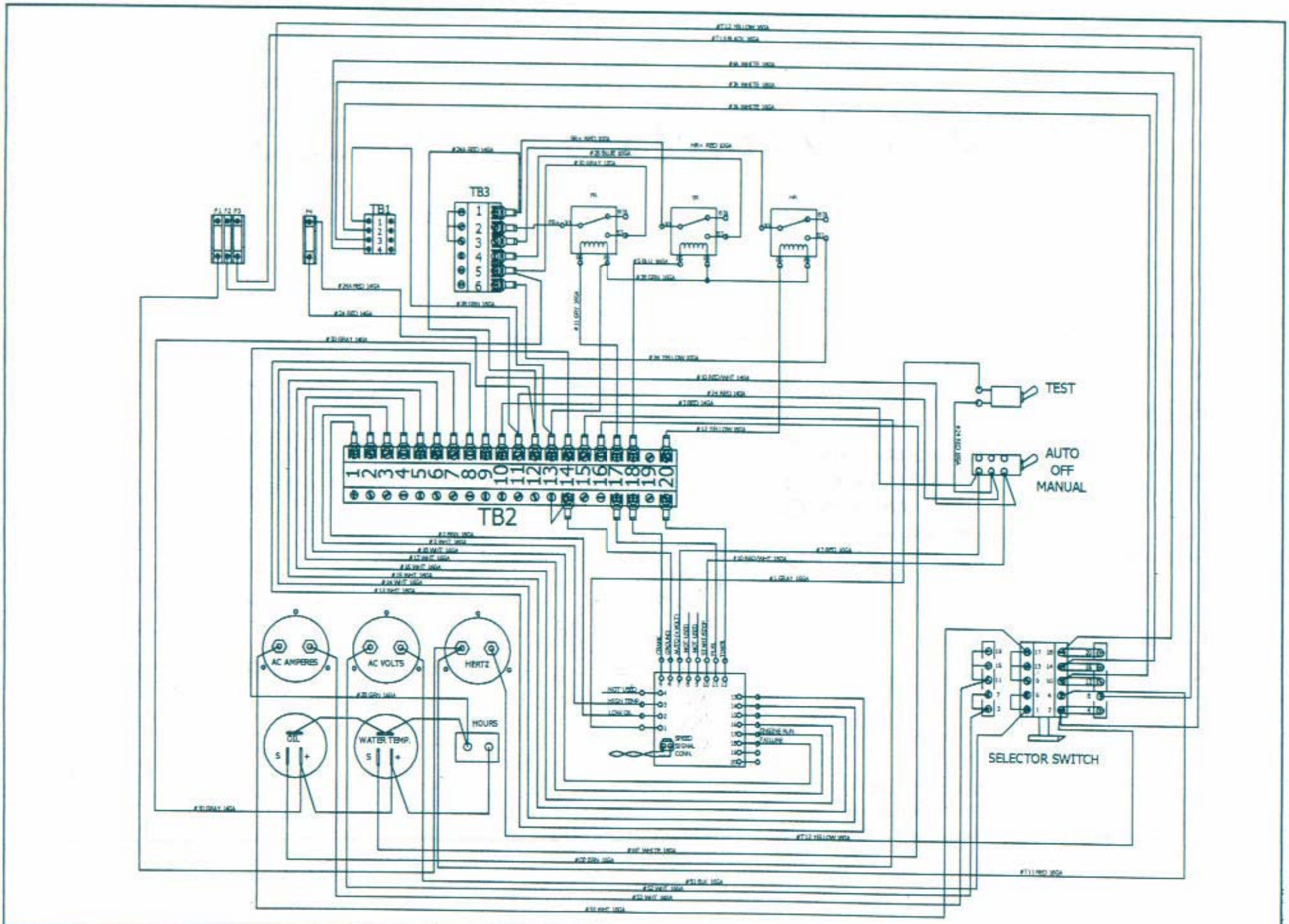
WIRING SCHEMATICS



REDCO PANEL ASSEMBLY/ 09SREDCO

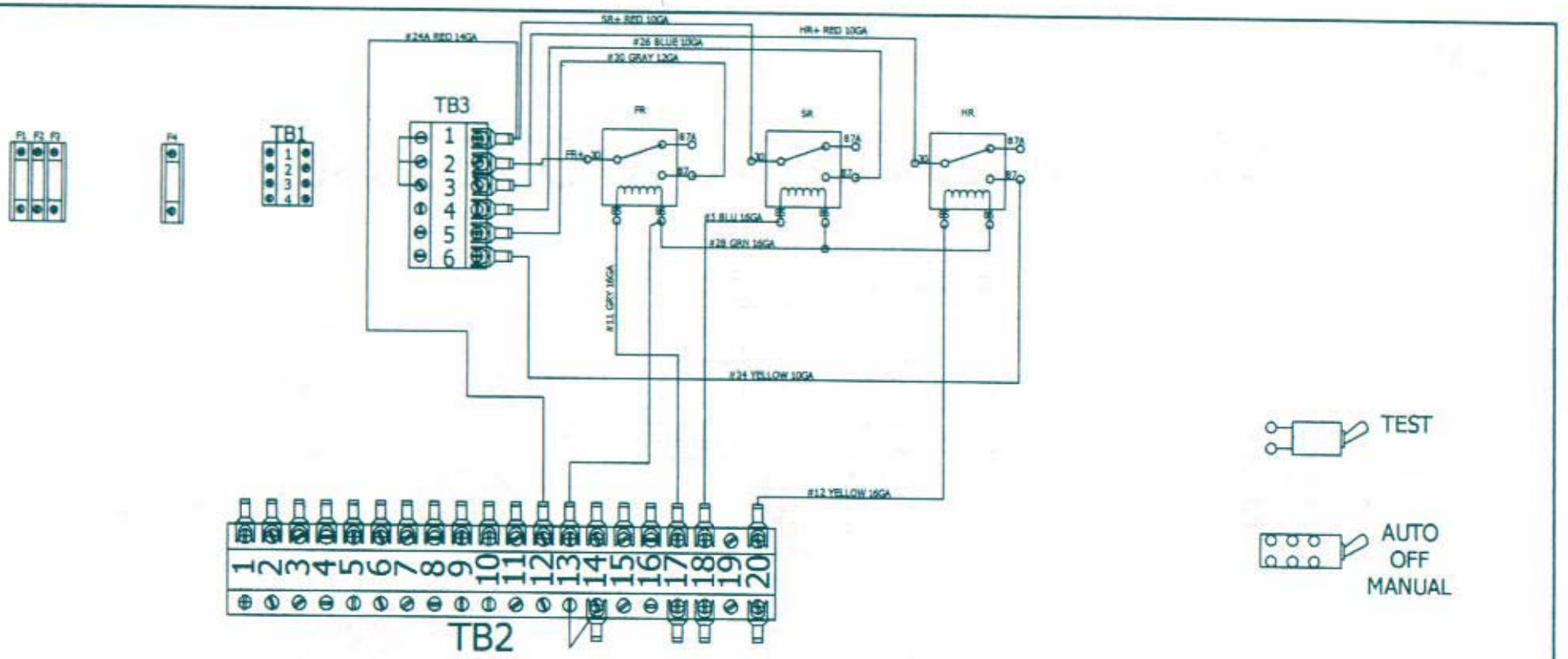
POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

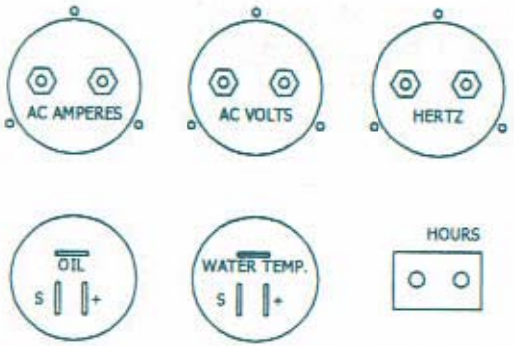
FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: WIRING	BEND ALLOW.: NA		1of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY D. DODIER	SCALE : NOT TO SCALE		

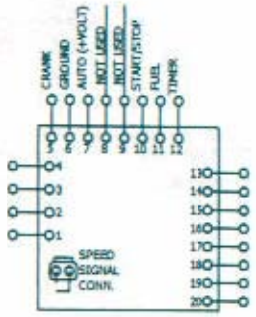


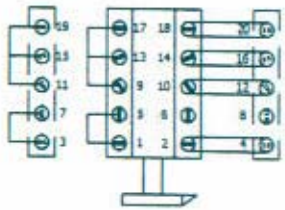
POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SHCEMATIC	BEND ALLOW.: NA		2of9
PART NO: 09SREDCO WIRING	DATE : 04DEC02		
DWN. BY : GUY D. DODIER	SCALE : NOT TO SCALE		







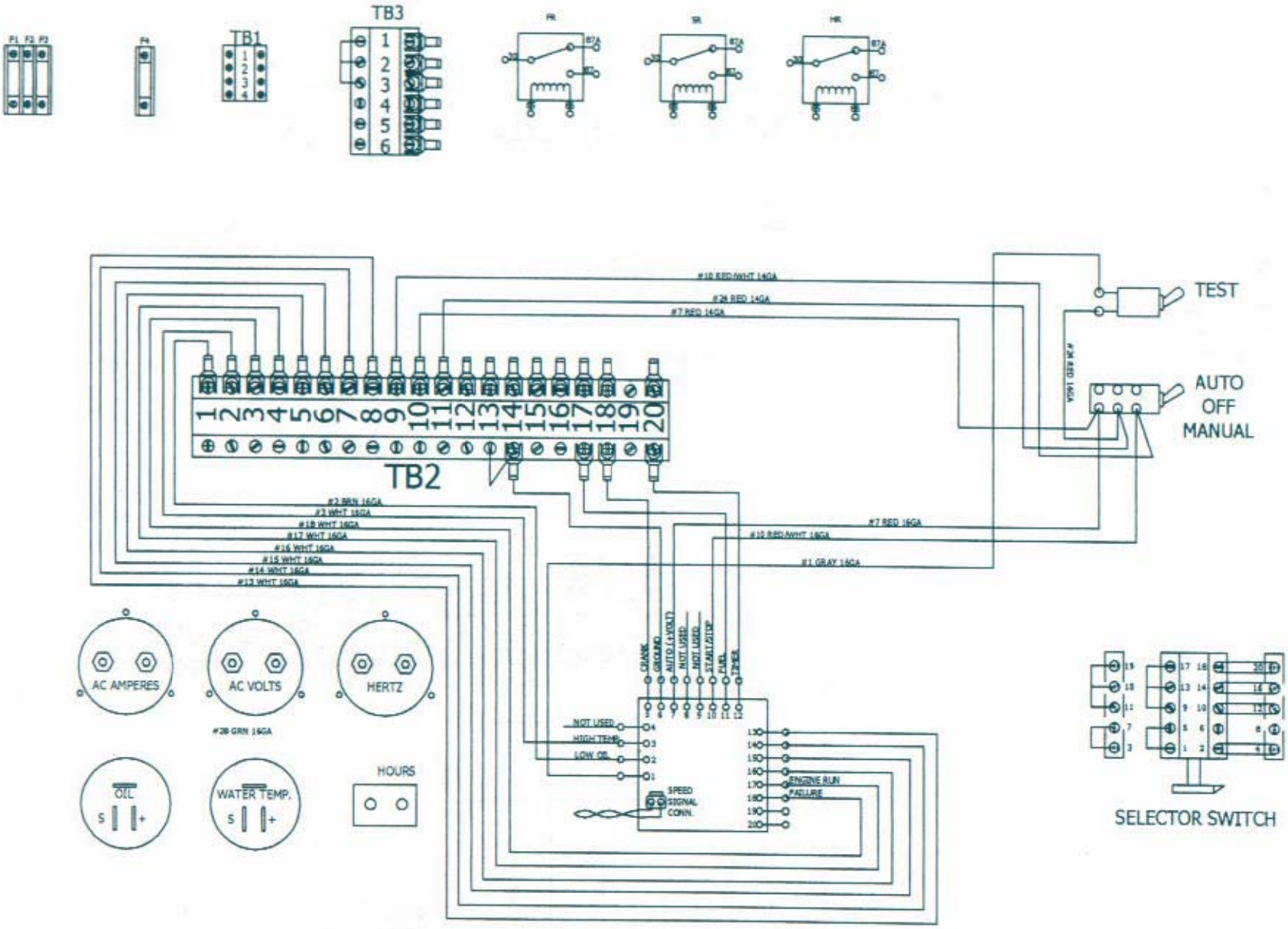


SELECTOR SWITCH

09SREDCO RELAYS WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

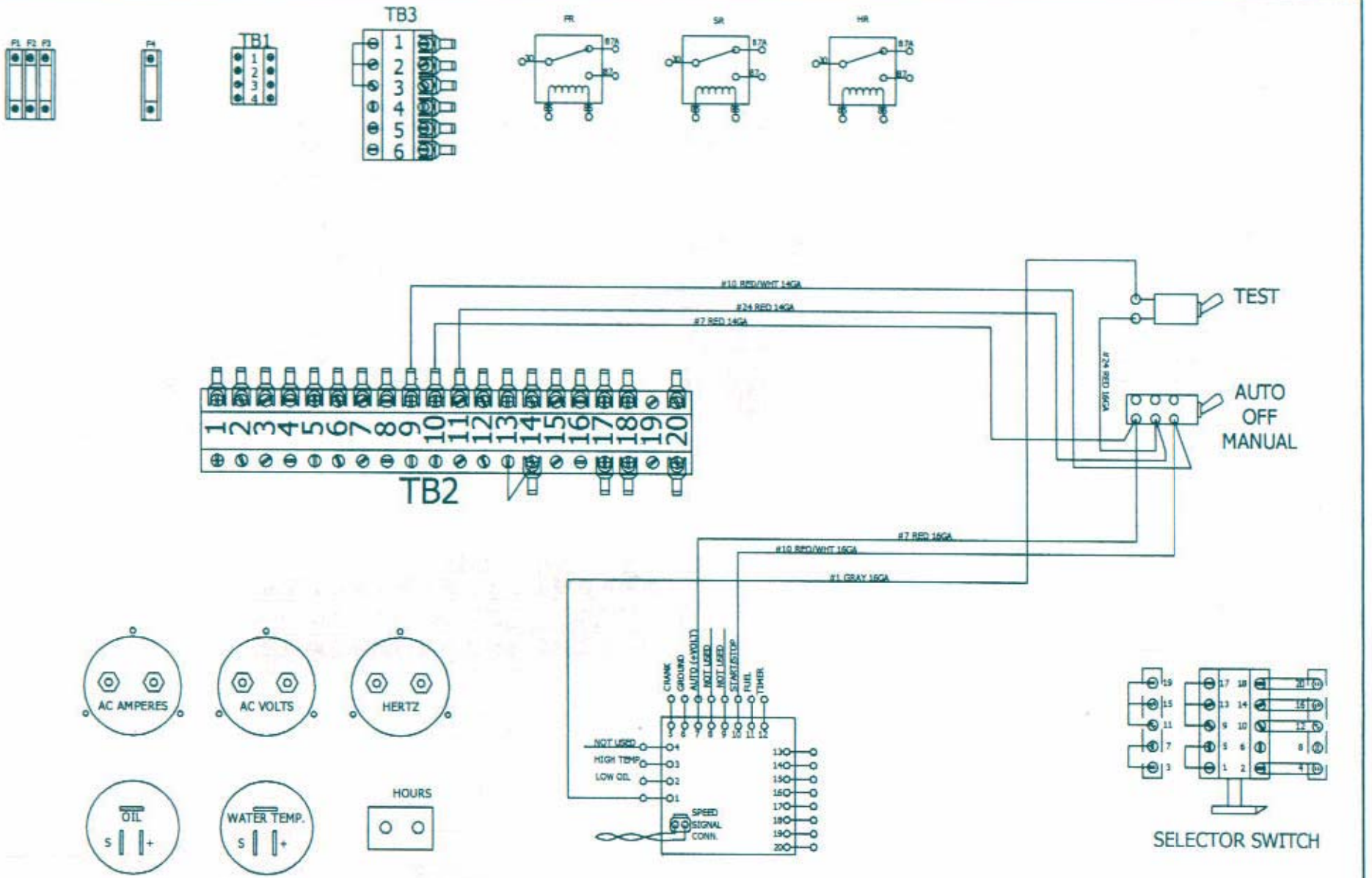
FOR : POWER TECHNOLOGY	MATERIAL:	REV.	SHEET
TYPE: SHCEMATIC	BEND ALLOW.:		3of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY DODIER	SCALE : NOT TO SCALE		



09SREDCO AUTO START WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

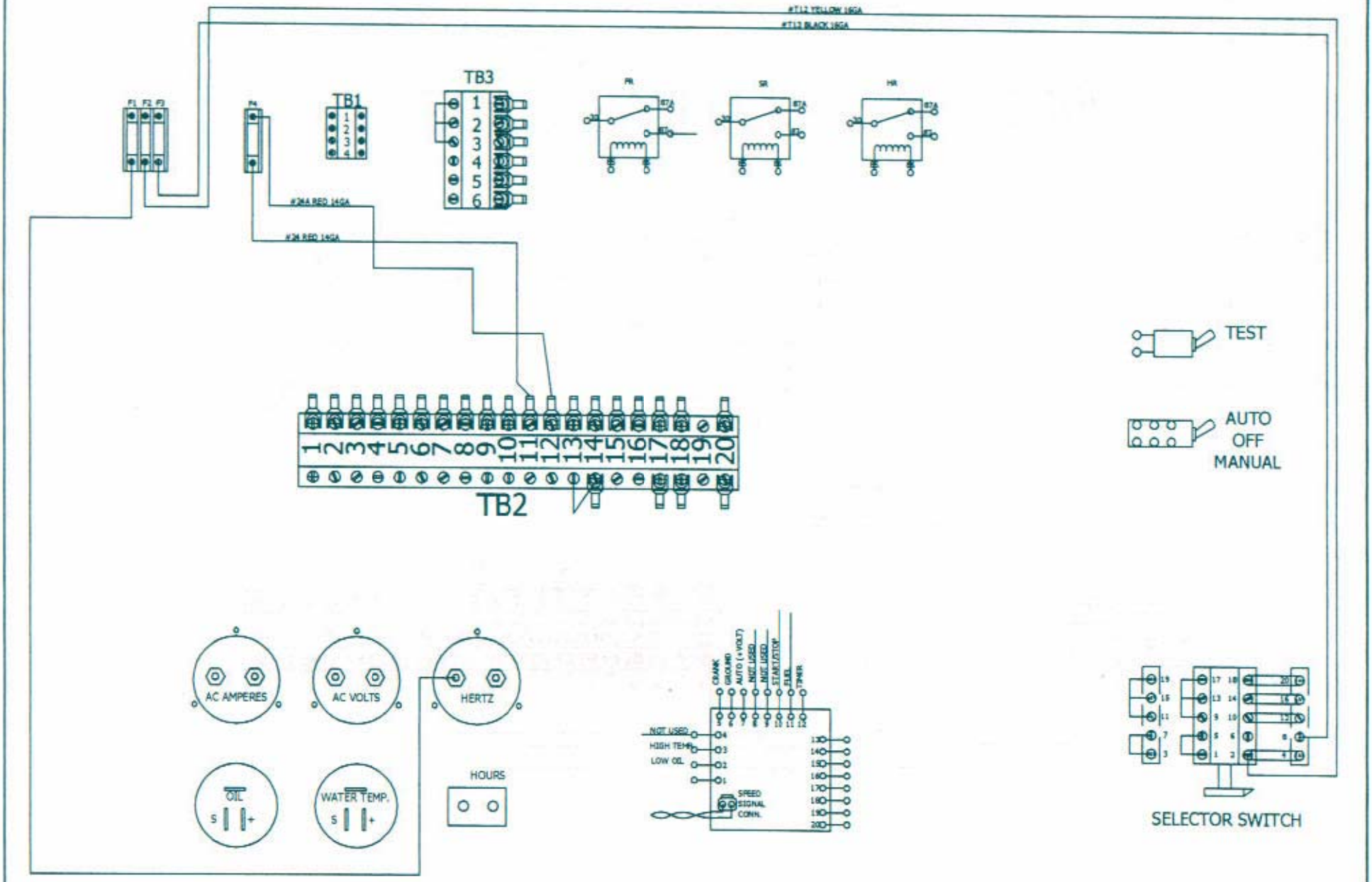
FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.:NA		4of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY DODIER	SCALE : NOT TO SCALE		



09SREDCO SWITCHES WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

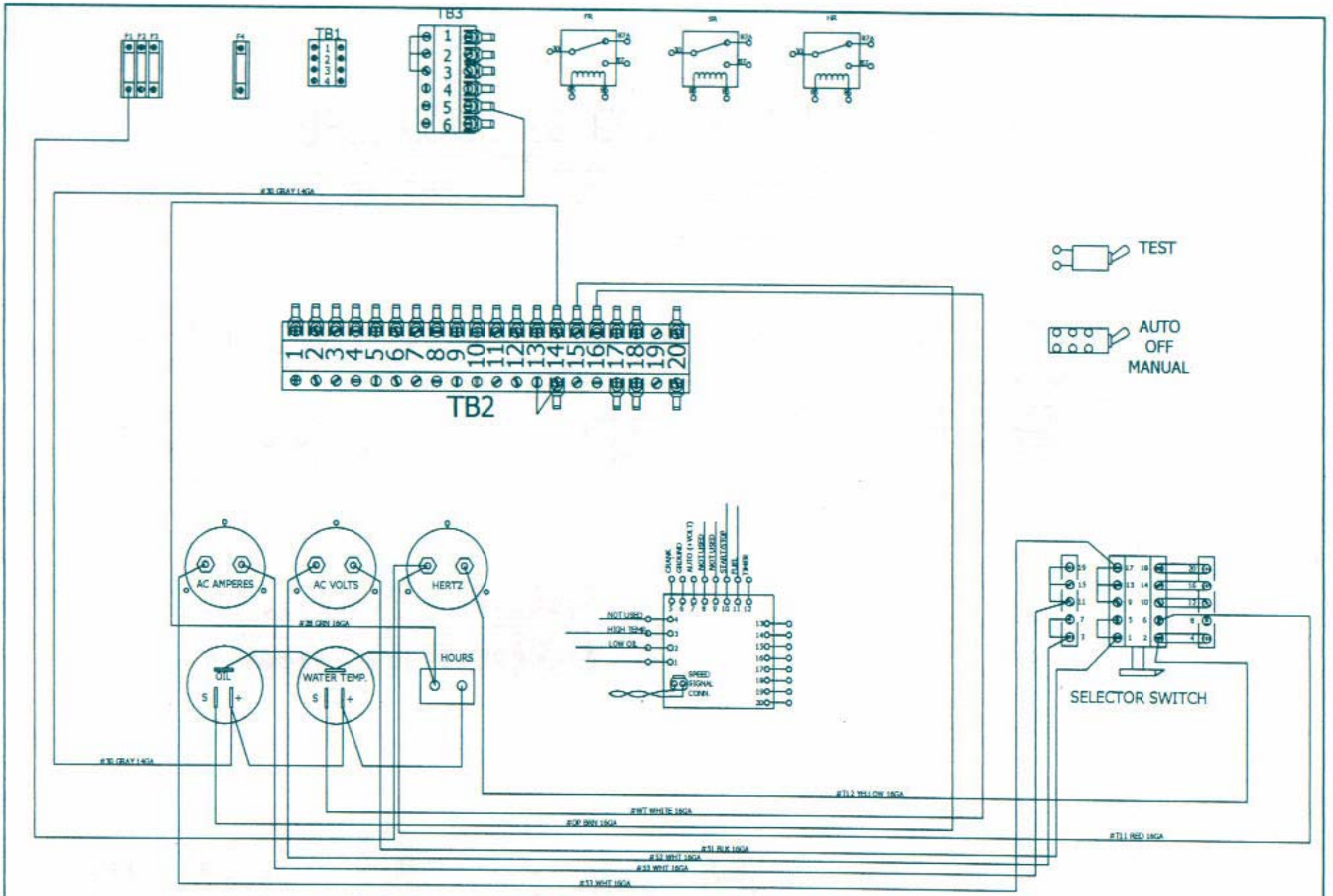
FOR: POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.: NA		5of9
PART NO: 09SREDCO	DATE: 04DEC02		
DWN. BY: GUY DODIER	SCALE: NOT TO SCALE		



09SREDCO FUSES WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

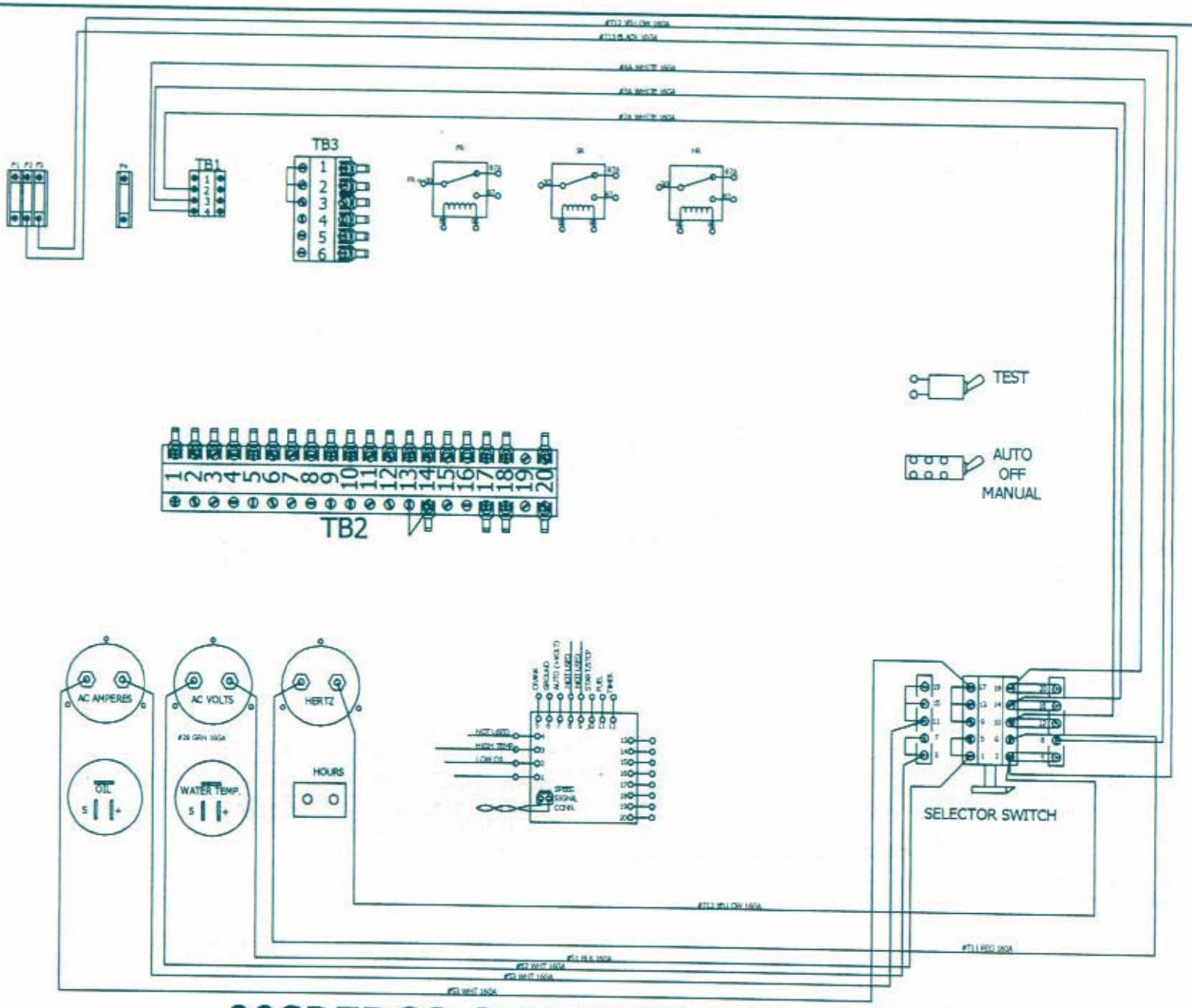
FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.: NA		6of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY DODIER	SCALE : NOT TO SCALE		



09SREDCO GAUGES WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.: NA		7of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY DODIER	SCALE : NOT TO SCALE		

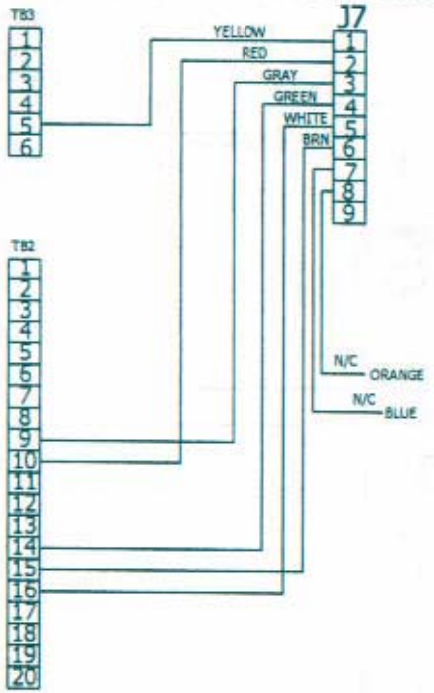


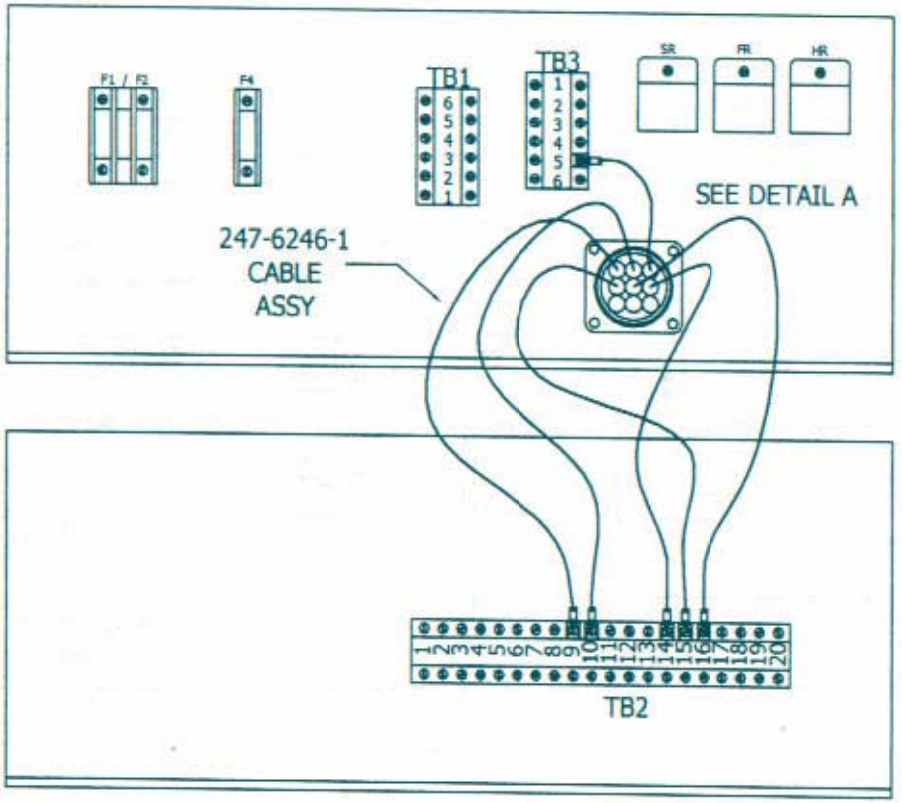
09SREDCO SELECTOR SWITCH WIRING

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.: NA		8of9
PART NO: 09SREDCO	DATE : 04DEC02		
DWN. BY : GUY DODIER	SCALE : NOT TO SCALE		

SEE DETAIL B FOR
PIN LOCATIONS



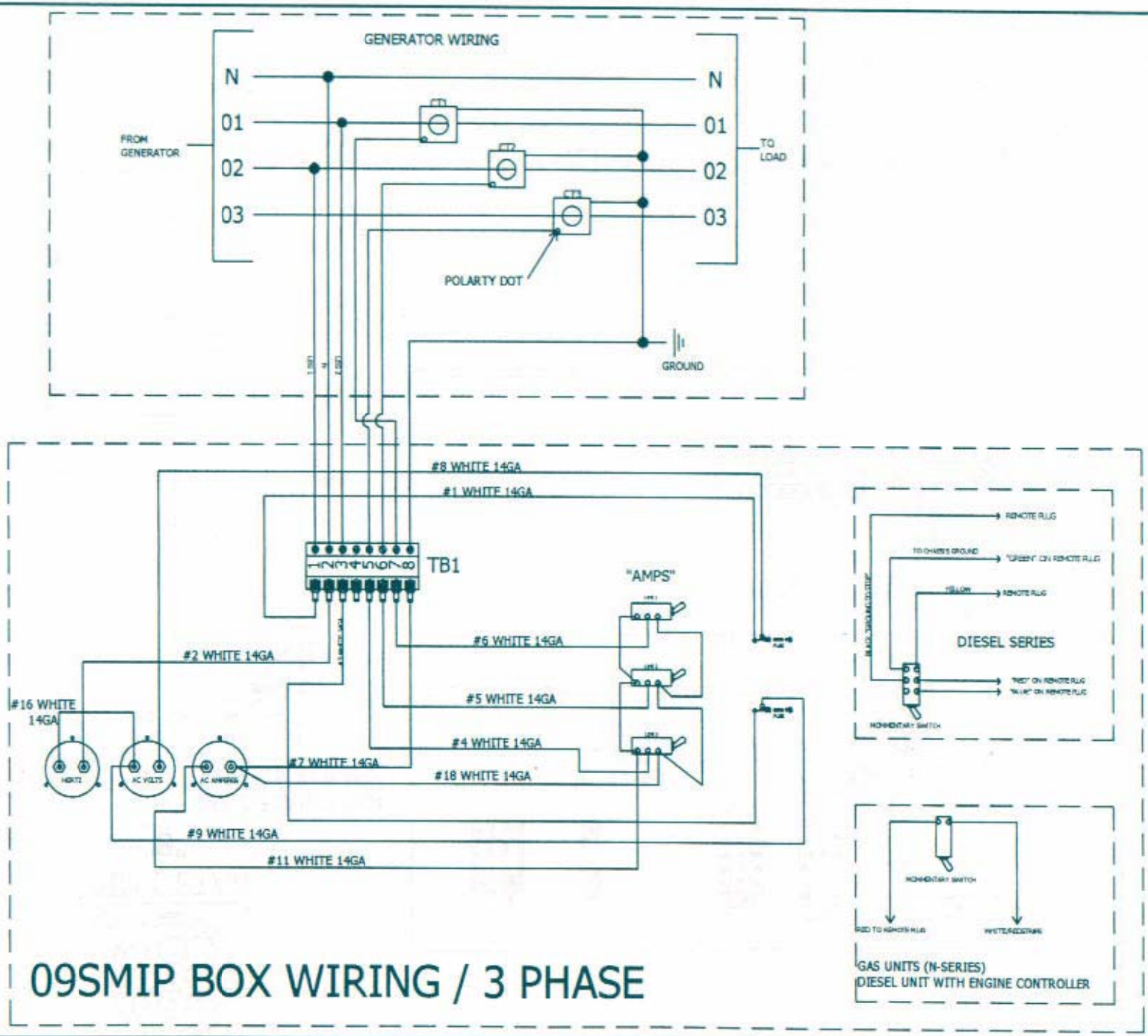


WIRING
DIAGRAM

REDCO PANEL ASSEMBLY/ 09SREDCO

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

FOR : POWER TECHNOLOGY	MATERIAL: .060 STEEL	REV.	SHEET
TYPE: FABRICATION	BEND ALLOW.: .051		9of9
PART NO: 07PT800	DATE : 26FEB01		
DWN. BY : GUY D. DODIER	SCALE : NOT TO SCALE		

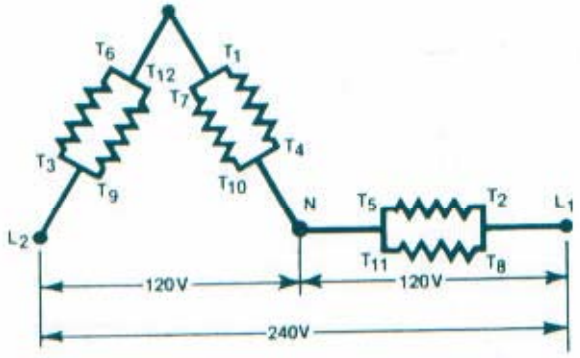


09SMIP BOX WIRING / 3 PHASE

POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FLORIDA 34748-8102
(352)365-2777 FAX (352)787-5545

FOR : POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE: SCHEMATIC	BEND ALLOW.: NA		1of1
PART NO: 09SMIP	DATE : 10DEC02		
DWN. BY : GUY D. DODIER	SCALE : NOT TO SCALE		

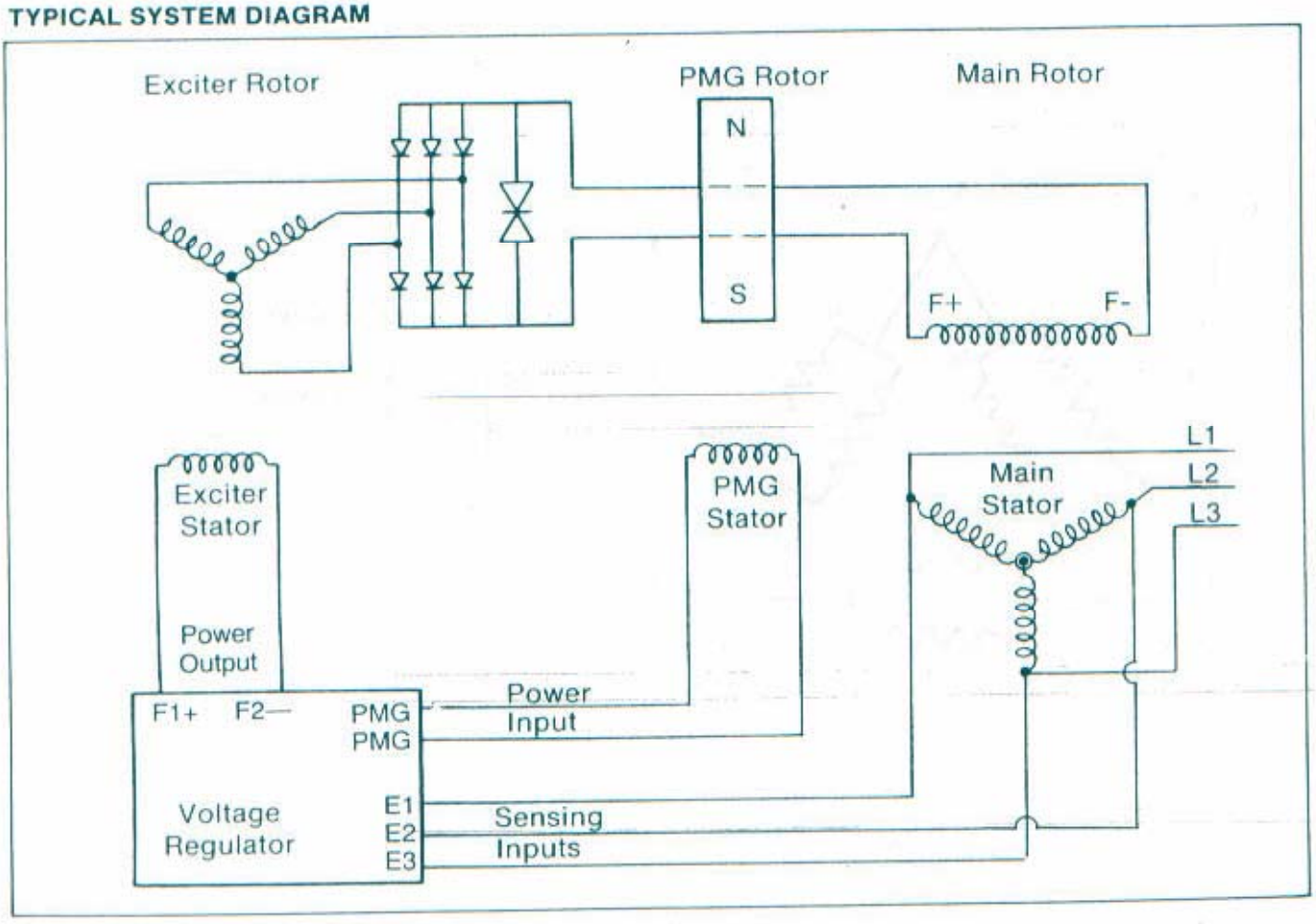
12 LEAD ZIG-ZAG



ZIG-ZAG connection with 12 lead machine only.

VOLTAGE		CONNECT	L_1	L_2	NEUTRAL
	L-L				
60 HZ	120/240	T_3 T_9	T_2	T_3	T_4
		T_2 T_8			
		T_1 T_6 T_7 T_{12}			
		T_4 T_{10} T_5 T_{11}			

TYPICAL SYSTEM DIAGRAM

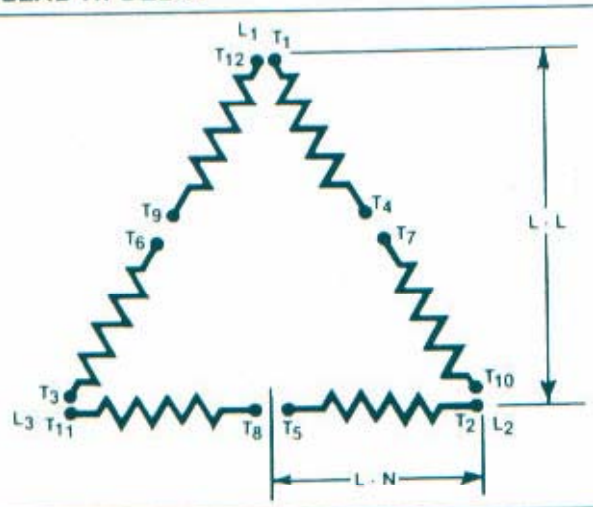


MARATHON ELECTRIC

INSTALLATION

SECTION 3

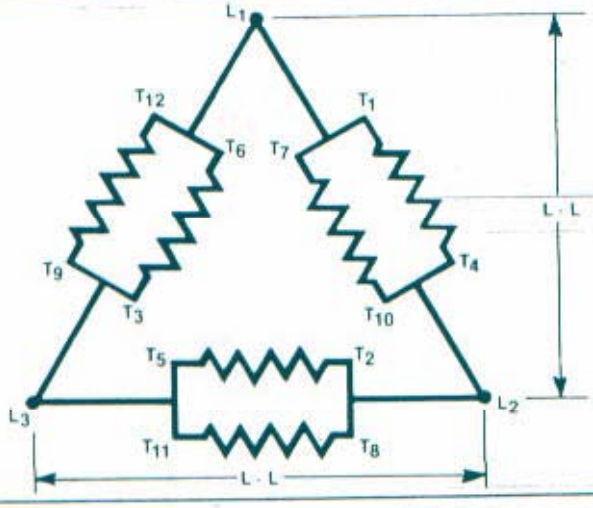
12 LEAD HI DELTA



Delta connection with 12 lead generators only.

VOLTAGE			CONNECT	L_1	L_2	L_3
	L-L	L-N				
60 HZ	240 277	120 139	T_4 T_7	T_1	T_2	T_3
			T_5 T_8			
50 HZ	200 220 240	100 110 220	T_6 T_9			
			T_1 T_{12}			
			T_2 T_{10}			
			T_3 T_{11}			

12 LEAD LOW DELTA



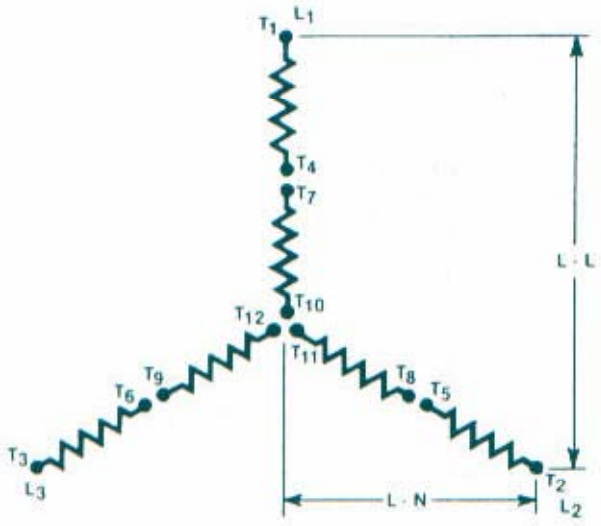
Delta connection with 12 lead generators only.

VOLTAGE		CONNECT	L_1	L_2	L_3
	L-L				
60 HZ	120 139	T_1 T_7 T_6 T_{12}	T_1	T_2	T_3
		T_2 T_8 T_4 T_{10}			
50 HZ	100 120	T_3 T_9 T_5 T_{11}			

INSTALLATION

SECTION 3

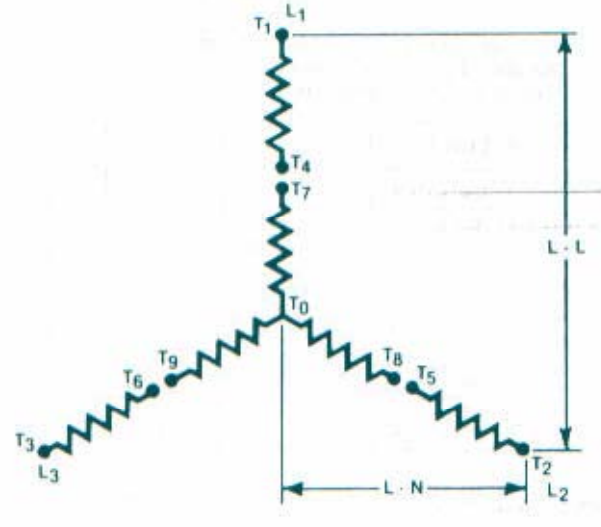
12 LEAD HI WYE



Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	380 416 440 460 480	219 240 254 266 277	T_{10} T_{11} T_{12}	T_1	T_2	T_3	T_{10} T_{11} T_{12}
			T_4 T_7				
			T_5 T_8				
50 HZ	380 400 416	219 231 240	T_6 T_9				

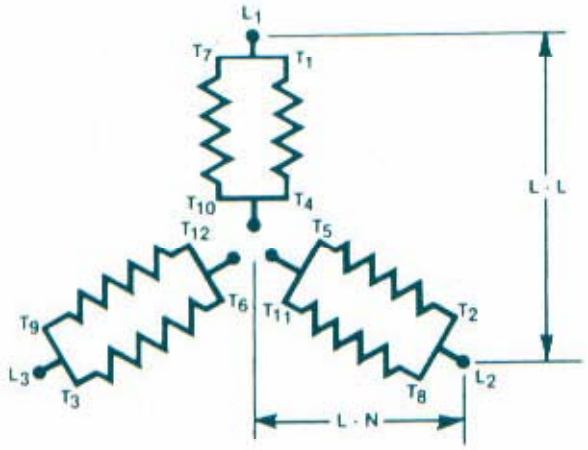
10 LEAD HI WYE



Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	380 416 440 460 480	219 240 254 266 277	T_4 T_7	T_1	T_2	T_3	T_0
			T_5 T_8				
			T_6 T_9				
50 HZ	380 400 416	219 231 240					

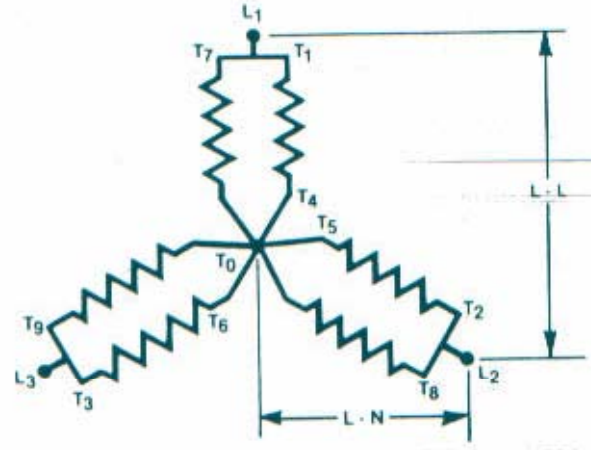
12 LEAD LOW WYE



Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

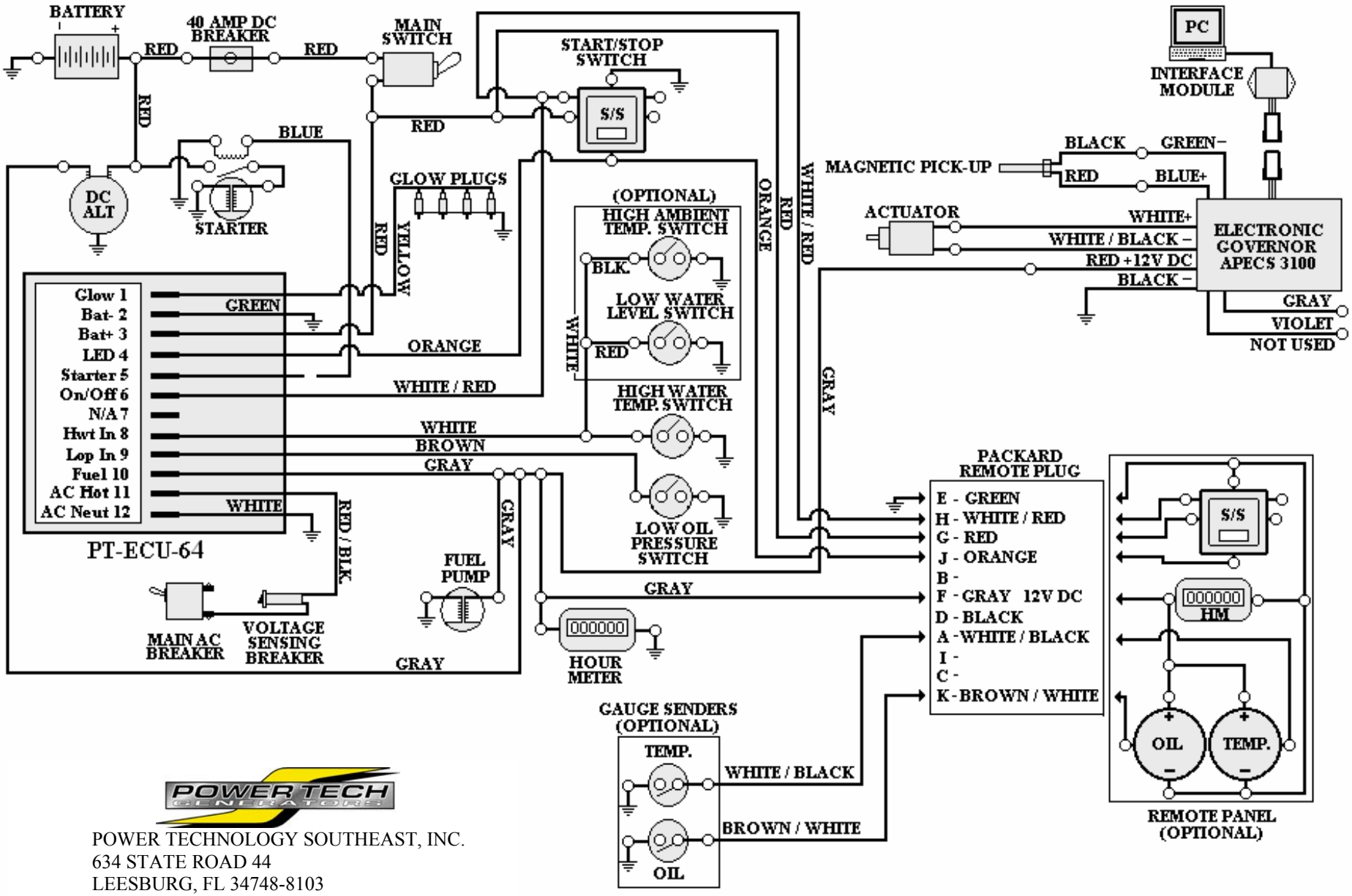
VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	190 208 220 230 240	110 120 127 133 139	T_{10} T_{11} T_{12} T_4 T_5 T_6	T_1	T_2	T_3	T_{10} T_{11} T_{12} T_4 T_5 T_6
			T_1 T_7				
			T_2 T_8				
50 HZ	190 200 208	110 115 120	T_3 T_9				

10 LEAD LOW WYE



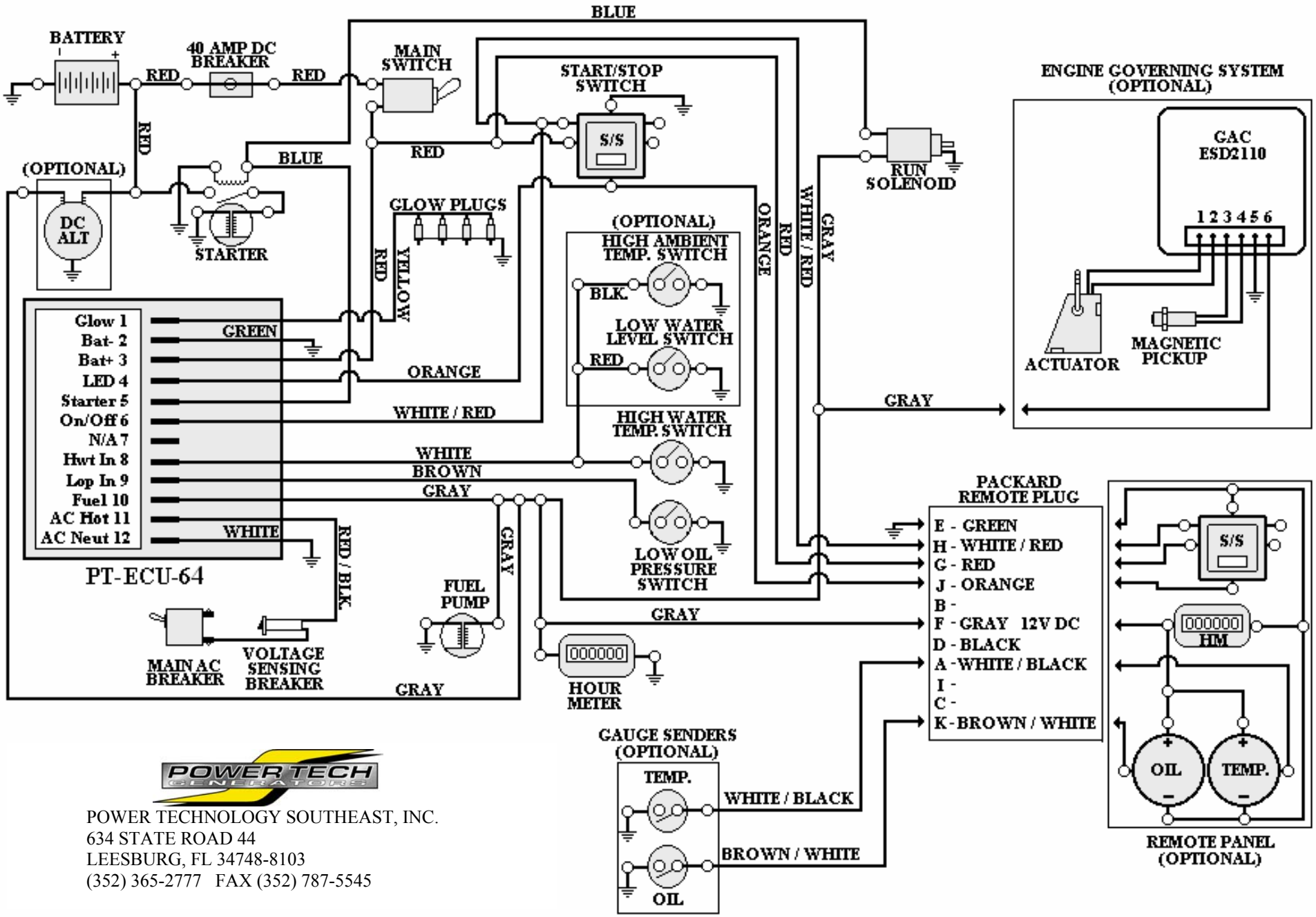
Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	190 208 220 230 240	110 120 127 133 139	T_1 T_7	T_1	T_2	T_3	T_4 T_5 T_6 T_0
			T_2 T_8				
			T_3 T_9				
50 HZ	190 200 208	110 115 120	T_4 T_5 T_6 T_0				



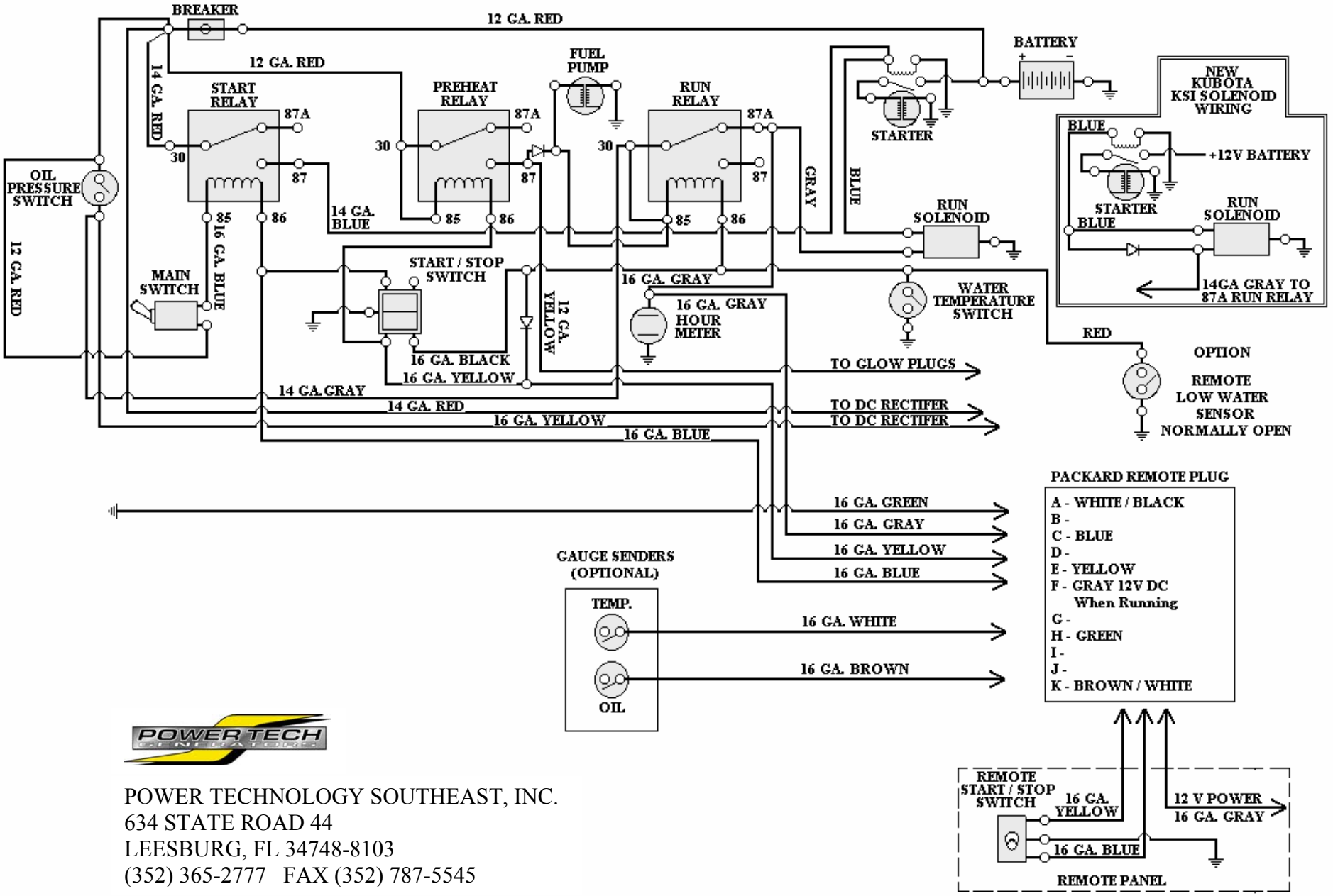
POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FL 34748-8103
(352) 365-2777 FAX (352) 787-5545

12-VOLT DC ENGINE CONTROL CIRCUIT
PT-ECU-64



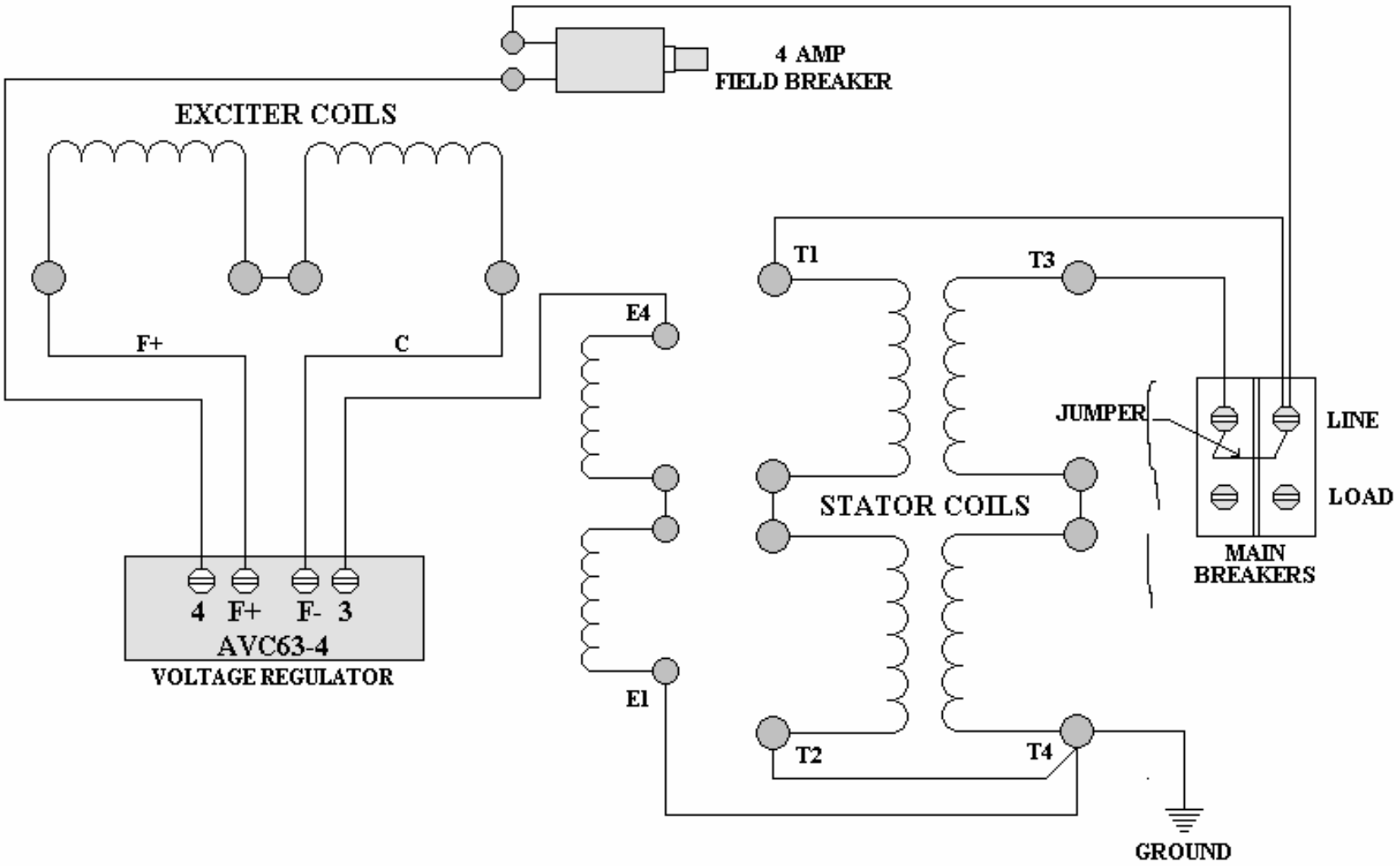
POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FL 34748-8103
(352) 365-2777 FAX (352) 787-5545

12V DC ENGINE CONTROL CIRCUIT
GAC ESD 2110

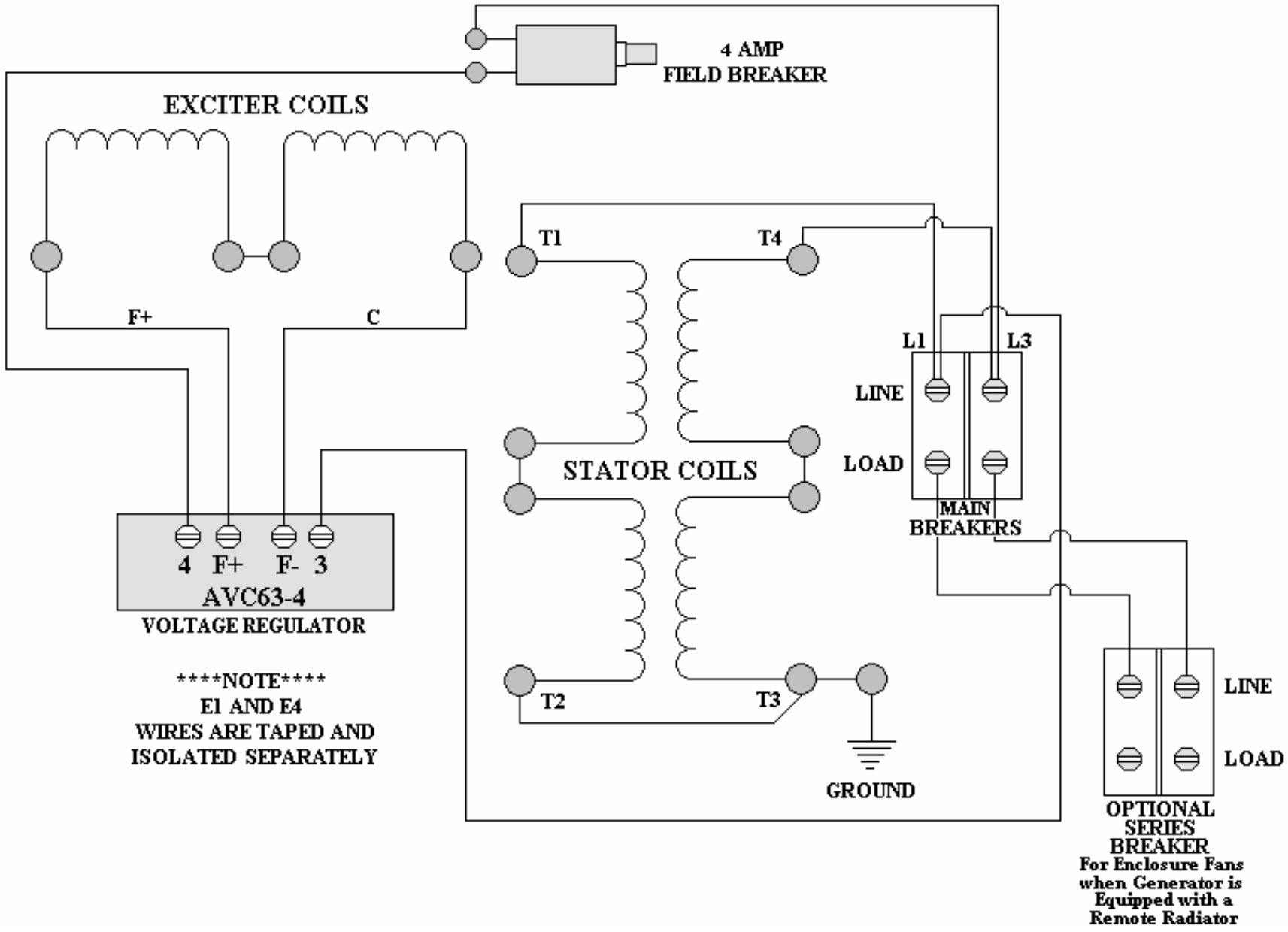


POWER TECHNOLOGY SOUTHEAST, INC.
634 STATE ROAD 44
LEESBURG, FL 34748-8103
(352) 365-2777 FAX (352) 787-5545

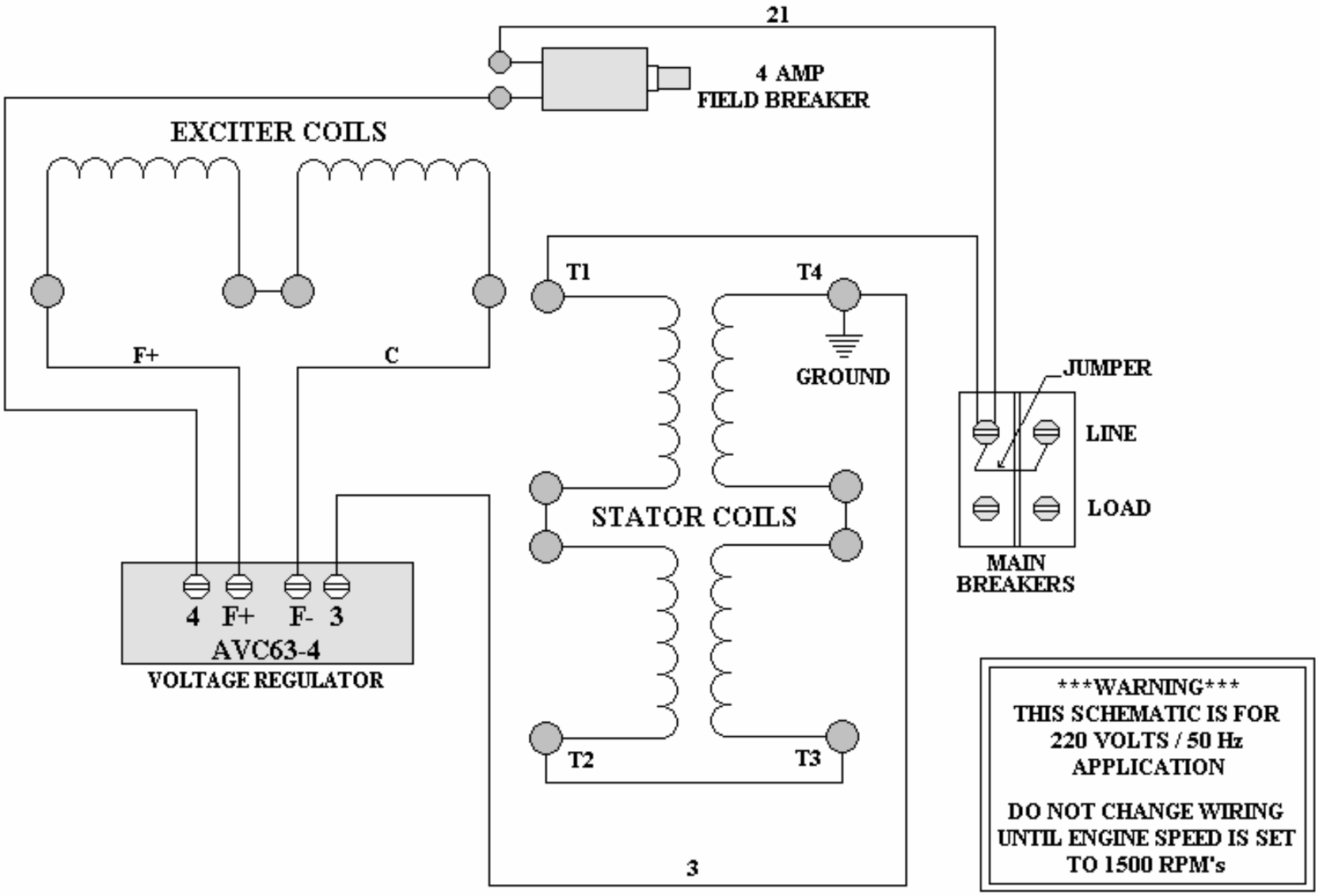
12 VOLT DC ENGINE CONTROL CIRCUIT SERIES 200 BOX



120 VOLT, SINGLE PHASE, 4 WIRE
CONNECTION “M” SERIES EXCITER TYPE



120 / 240 VOLT, SINGLE PHASE, 4 WIRE
CONNECTION “M” SERIES EXCITER TYPE



220 VOLT, SINGLE PHASE, 4 WIRE
EUROPEAN CONNECTION "M" SERIES EXCITER TYPE

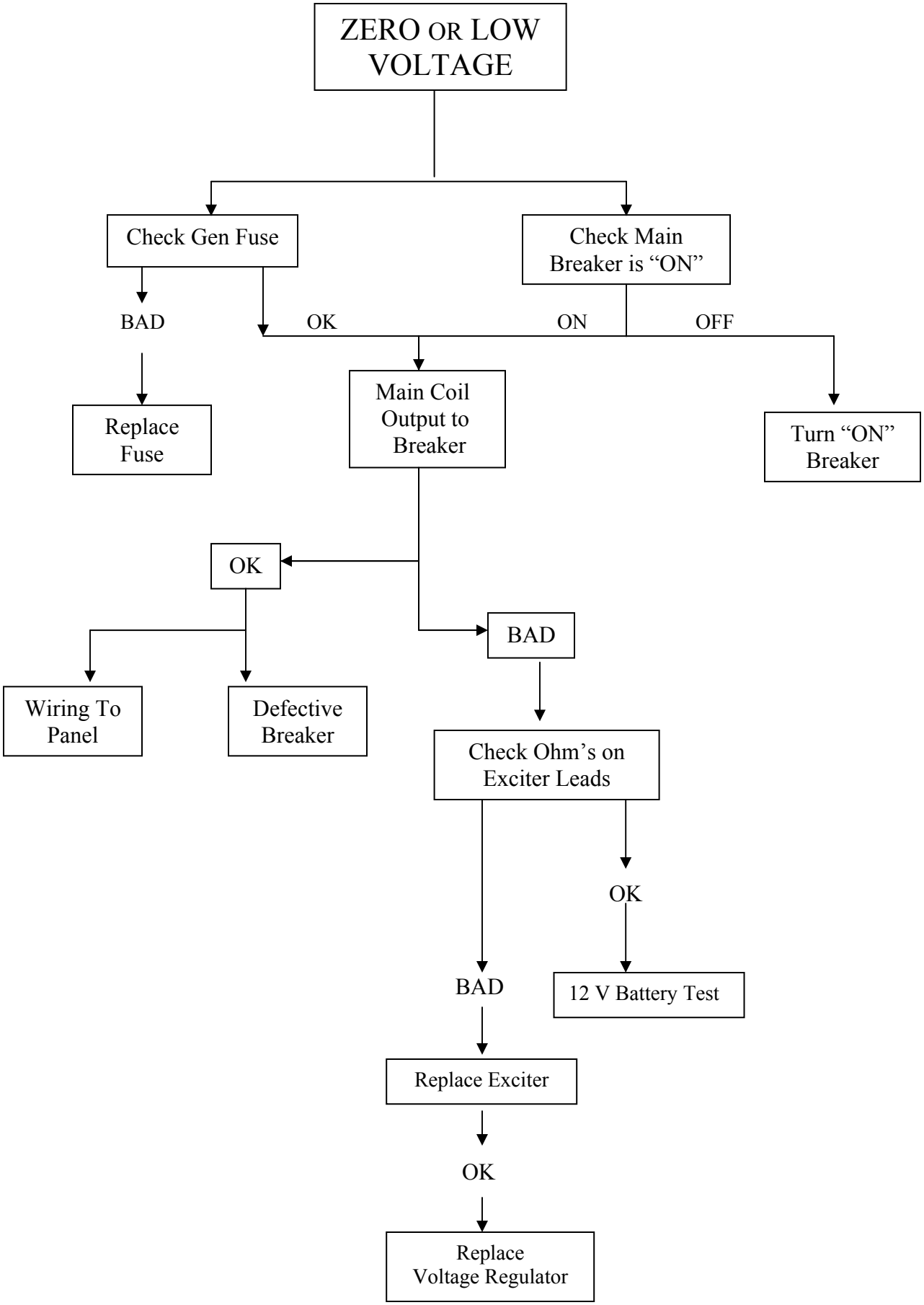
RESISTANCE CHART

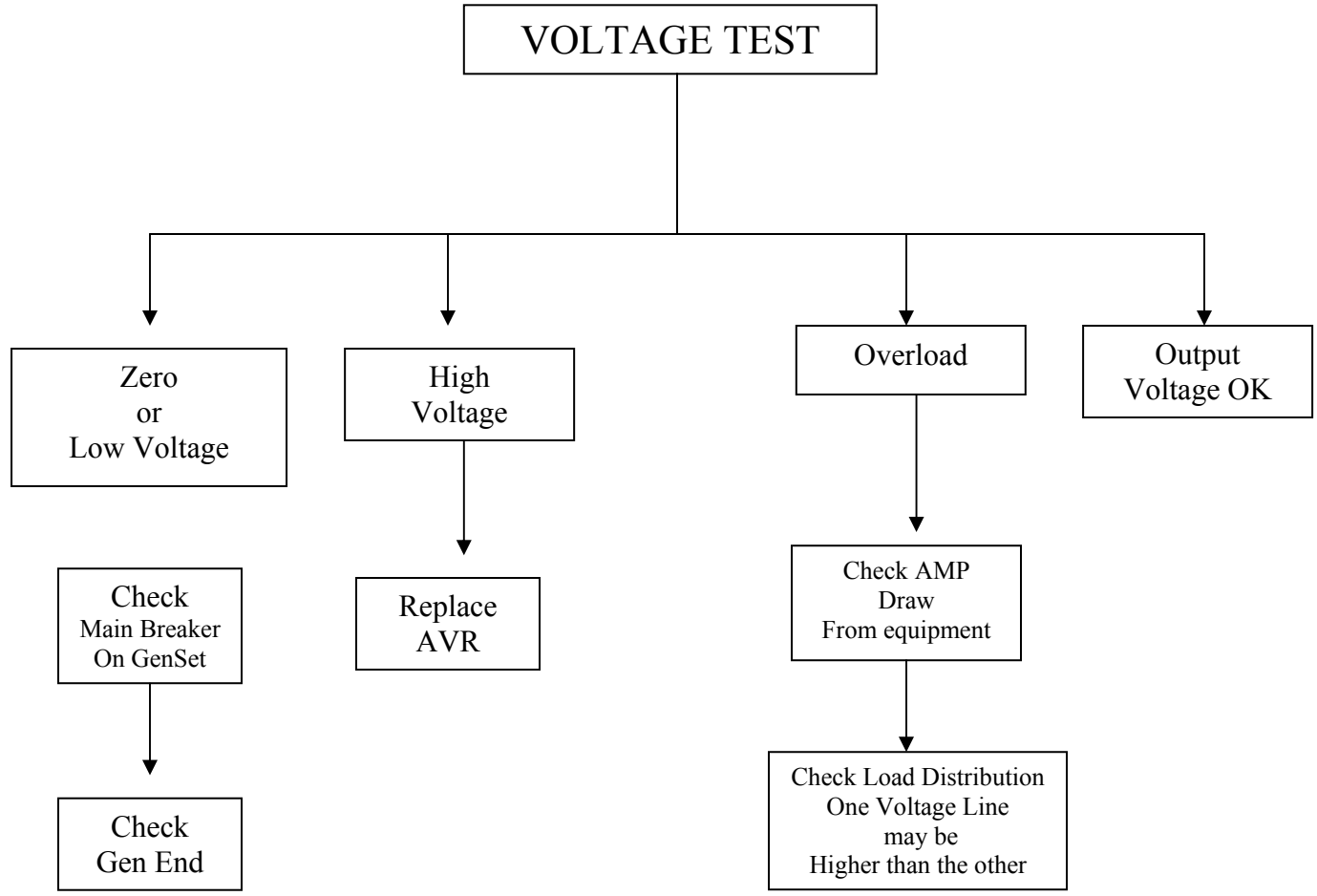
"M" SERIES EXCITER TYPE

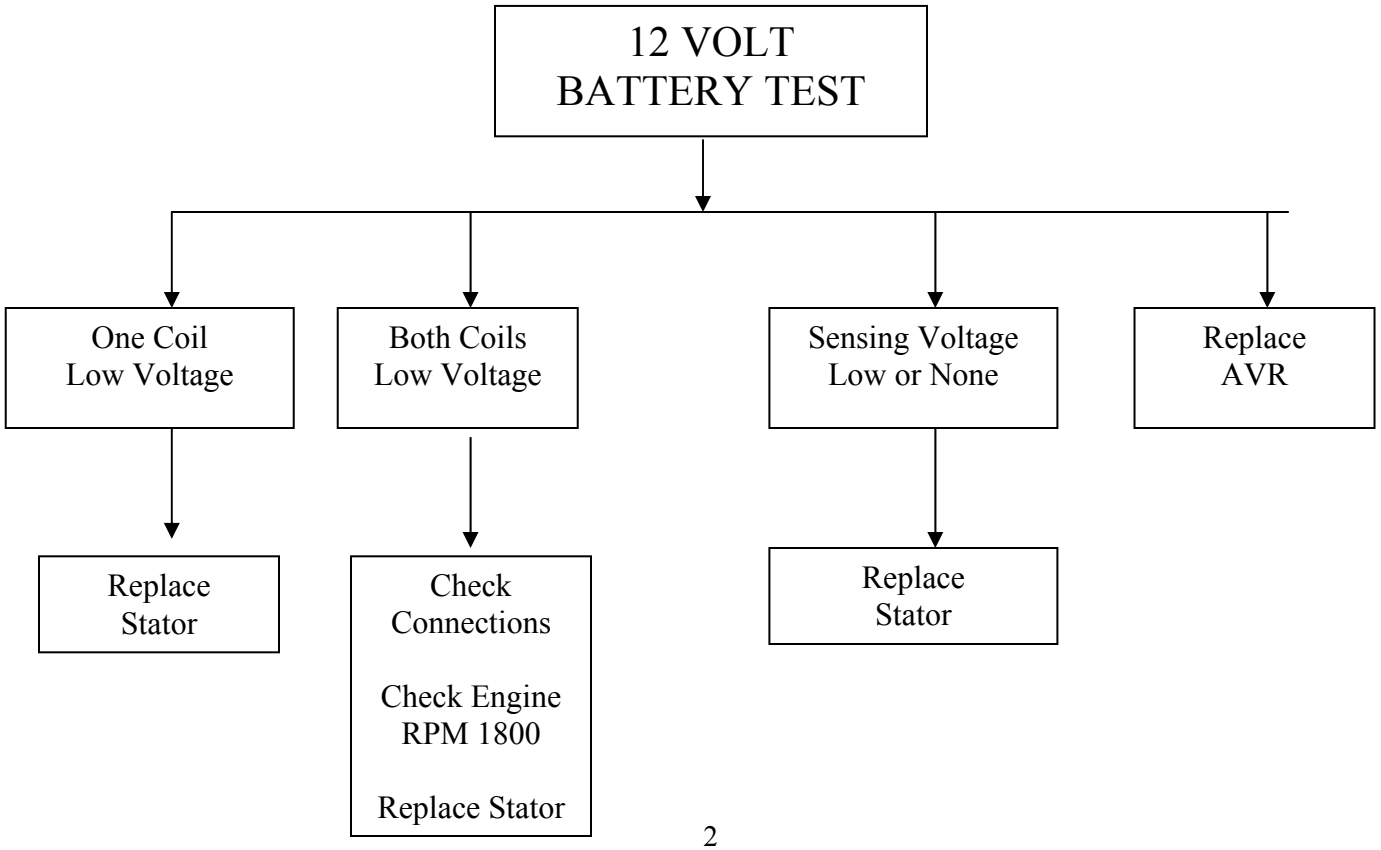
KW	30	35	40
Main Stator	Less Than 1.0 Ohm / Phase	Less Than 1.0 Ohm / Phase	Less Than 1.0 Ohm / Phase
Main Rotor	0.75	0.875	0.75
Exciter Stator	23.0 – 28.0	23.0 – 28.0	23.0 – 28.0
Exciter Rotor	0.12	0.12	0.12

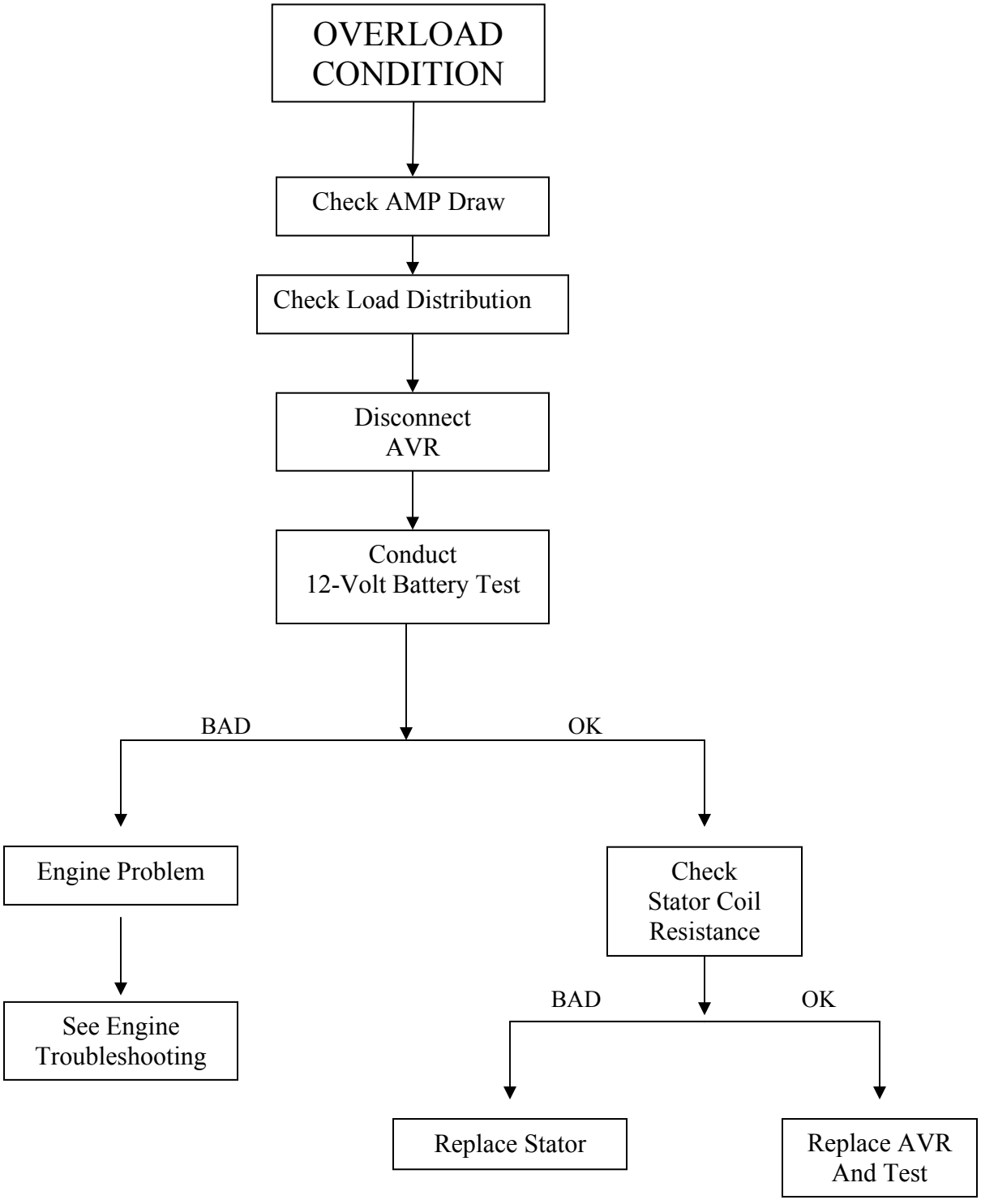
SECTION D:

GENERATOR END TROUBLESHOOTING GUIDE


ZERO OR LOW VOLTAGE
Check Gen Fuse
Check Main Breaker is "ON"
BAD
OK
ON
OFF
Replace Fuse
Main Coil Output to Breaker
Turn "ON" Breaker
OK
BAD
Wiring To Panel
Defective Breaker
Check Ohm's on Exciter Leads
OK
BAD
12 V Battery Test
Replace Exciter
OK
Replace Voltage Regulator


VOLTAGE TEST
Zero
or
Low Voltage
High
Voltage
Overload
Output
Voltage OK
Check
Main Breaker
On GenSet
Replace
AVR
Check AMP
Draw
From equipment
Check
Gen End
Check Load Distribution
One Voltage Line
may be
Higher than the other


12 VOLT
BATTERY TEST
One Coil
Low Voltage
Both Coils
Low Voltage
Sensing Voltage
Low or None
Replace
AVR
Replace
Stator
Check
Connections
Check Engine
RPM 1800
Replace Stator
Replace
Stator


OVERLOAD CONDITION
Check AMP Draw
Check Load Distribution
Disconnect AVR
Conduct 12-Volt Battery Test
BAD
OK
Engine Problem
See Engine Troubleshooting
Check Stator Coil Resistance
BAD
OK
Replace Stator
Replace AVR And Test

INSTALLATION INSTRUCTIONS

PHILLIPS & TEMRO INDUSTRIES AUTOMOTIVE ENGINE PRE-HEATER

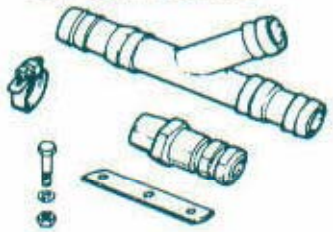
NRTL/C

OPERATING PRINCIPLE: The heater operates on the principle of thermosyphoning by which cold coolant is drawn from the bottom of the engine block, heated in the tank, and returned to the top of the engine block. Ideal engine warm-up time is 2-3 hours.

Verify the contents of the package with the following parts list before proceeding with installation.

DESCRIPTION	QTY	PART NO
Heater	1	
Y-fitting	1	220-2131
Mounting Bracket	2	N/A
Mounting Kit		
-Hex Bolt 1/4" – 20 x 3/4"	2	N/A
-Hex Nut 1/4" – 20	2	N/A
-Split Lock Washer 1/4"	2	N/A
-Hose Nipple (1/4" NPT)	1	220-2093
-Hose Clamp	6	N/A

KIT COMPONENTS



DANGER: ELECTRIC SHOCK. DO NOT OPERATE HEATER WITHOUT PROTECTIVE COVER. DEATH OR SERIOUS INJURY MAY RESULT

WARNING: FIRE HAZARD. USE COOLANT ONLY. EXPLOSION COULD RESULT IN DEATH OR INJURY.

ELECTRIC SHOCK. DO NOT OPERATE THE HEATER WITH ANY FOREIGN MATERIALS ADJACENT TO IT. THIS COULD RESULT IN DEATH OR INJURY.

ELECTRIC SHOCK. NO OPERATOR SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL. DISCONNECT HEATER FROM POWER BEFORE SERVICING TO PREVENT DEATH OR INJURY.

CAUTION: NEVER PLUG IN HEATER IF ELEMENT IS NOT IMMERSED IN COOLANT, AS SHORTENED HEATER LIFE WILL RESULT.

NEVER RUN ENGINE WHILE HEATER IS PLUGGED IN, AS ELEMENT BURNOUT WILL RESULT.

1.0 HEATER INSTALLATION INSTRUCTIONS

1.1 Preparation

1.1.1 Drain and flush cooling system to remove contaminants. Recycle or dispose of engine coolant properly to prevent environmental contamination.

1.1.2 Determine Heater Inlet Connection - Preferred heater inlet connection is to the engine block drain hole. When block drain is inaccessible, this connection can be made to the lowest accessible point in the engine block on the suction side of the system pump or by installing the proper size hose fitting in the lower radiator hose. Plan to keep the inlet hose length from the engine as short as possible.

1.1.3 Determine the Heater Outlet Connection – Plan to splice the heater outlet hose into the hose line coming from the passenger compartment heater to the engine block. Keep the outlet hose length as short as possible but maintain a minimum rise of 12 inches to ensure proper circulation. Avoid selecting a heater location that requires the hose to be routed in a manner that will restrict coolant flow such as routing over the top of the engine block. Avoid sharp bends or loops to ensure against airlocks. Coolant may not circulate if airlocks are present. See Figures 1 to 4 below.

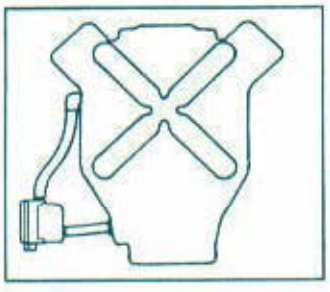


Figure 1 – Correct Installation

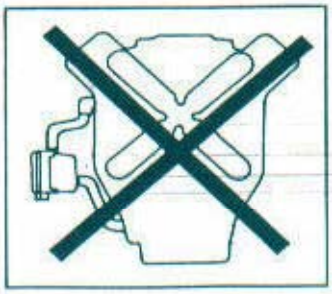


Figure 2 – Incorrect: Heater Mounted Too High

Figure 3 – Incorrect: Outlet Hose Looped Over Top of Engine

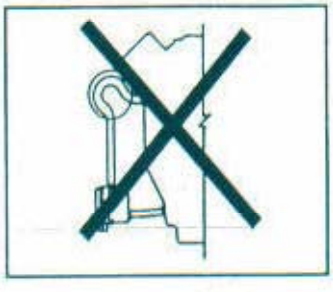


Figure 4 – Incorrect: Sharp Loop or Bend in Hose

1.2 Mounting

1.2.1 Once heater inlet and outlet connections have been determined, select a location to mount the heater that meets the following conditions:

1.2.1.1 Mount the heater to the firewall or inside the fender. See Figure 5.

CAUTION: DO NOT MOUNT THE HEATER TO THE ENGINE BLOCK, AS A SHORTENED HEATER LIFE WILL RESULT FROM EXCESSIVE VIBRATION.

PROPERTY DAMAGE. MAINTAIN A MINIMUM CLEARANCE OF 3" BETWEEN HEATER AND OTHER ENGINE COMPONENTS. FAILURE TO MAINTAIN MINIMUM CLEARANCE MAY RESULT IN HEAT DAMAGE.

1.2.1.2 It is best to mount the heater below the lowest point of the cooling system to ensure that adequate pressure head is provided to the heater inlet and to ensure that thermosyphon coolant flow is maximized. See Figure 1. Coolant flow may be restricted if the heater is mounted too high. See Figure 2.

1.2.1.3 Heater must be mounted with the heater outlet pointing upward as indicated by the arrow on the tank body. Otherwise, coolant flow will be impeded and the heater will be prevented from maintaining the desired engine temperature. Also, excessive cycling of the heater may occur causing shortened heater life.

1.2.1.4 The heater has a unique multi-point mounting system that accommodates different applications. Figures 6 through 8 illustrate three possible mounting configurations. Select a mounting surface that is smooth and free of fasteners. Secure the heater in the selected location using the bolts, nuts, and lock washers provided.

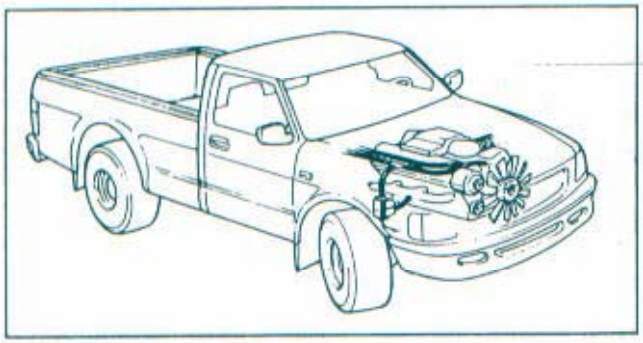


Figure 5 – Typical Installation

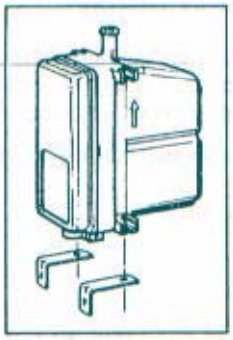


Figure 6 –Bottom Mount

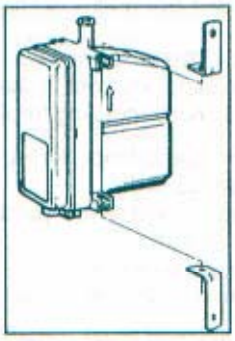


Figure 7 –Side Mount

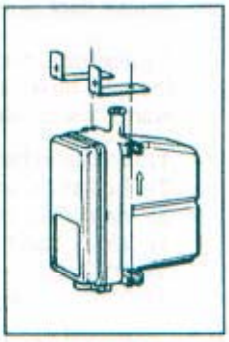


Figure 8 –Top Mount

1.3 Plumbing

1.3.1 General - Recommended hose size for both inlet and outlet connections is 5/8" for heaters up to 1500 watts and 3/4" for 2250 watt heaters. Use standard heater hose and hose clamps per standards SAE J20 & SAE J1508.

CAUTION: DO NOT USE HOSE SMALLER THAN THE RECOMMENDED SIZE HOSE, AS COOLANT FLOW WILL BE RESTRICTED AND SHORTENED HEATER LIFE WILL RESULT.

ENSURE HOSE CONNECTIONS ARE ROUTED AS PER INSTRUCTIONS, AS COOLANT FLOW MAY BY-PASS THE ENGINE RADIATOR CAUSING THE ENGINE TO OVERHEAT. CONSULT THE VENDOR FOR DIFFICULT APPLICATIONS.

1.3.2 Heater Connections - Determine the lengths of hose required for the installation. Cut hose cleanly and squarely to length. Slide clamp onto hose. Push hose on fitting until hose bottoms against casting. Position hose clamp 1/8" from the end and secure with a screwdriver or wrench. Maximum recommended torque is 30 in-lbs. Do not over tighten.

WARNING BURN HAZARD. ENSURE HOSE CLAMPS ARE PROPERLY TIGHTENED. OVER TIGHTENED HOSE CLAMPS MAY DAMAGE HOSES SO THAT THEY LEAK HOT COOLANT. UNDER TIGHTENED HOSE CLAMPS MAY CAUSE THE HOSES TO COME LOOSE DUE TO VIBRATION DURING ENGINE OPERATION AND SPRAY HOT COOLANT.

1.3.3 Inlet (bottom connection) - Install the hose nipple in the drain plug hole. If there is no drain plug, connect the heater inlet hose to the lowest accessible point in the engine block on the suction side of the cooling system pump. Use any opening in the lower part of the block or install proper size hose fitting in the lower radiator hose.

1.3.4 Outlet (top connection) - Near the engine block, cut heater hose from passenger compartment heater to engine block inlet, slip on hose clamps and insert Y-fitting as per Figure 9. Connect the heater outlet tube to the remaining opening on the Y-fitting then tighten hose clamp.

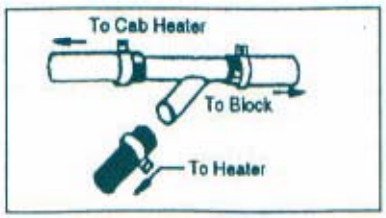


Figure 9 – Y-Fitting

1.4 **Cord Installation Procedure** - Using industry-accepted methods, secure cord to prevent contact with heated surfaces or moving parts.

WARNING: ELECTRIC SHOCK. ENSURE POWER CORD IS FASTENED TO EXISTING WIRING IN ENGINE COMPARTMENT TO PREVENT DAMAGE FROM CONTACT WITH HOT OR MOVING PARTS.

ELECTRIC SHOCK. DO NOT ENERGIZE HEATER WHILE STANDING IN WATER OR IF POWER PLUG IS WET. USE GFCI 3-WIRE GROUNDED OUTDOOR EXTENSION CORD. USE 14-GAGE WIRE EXTENSION CORD FOR HEATERS HIGHER THAN 1500 WATTS.

1.5 **Refilling Antifreeze** - Always pre-mix water, antifreeze, and coolant additives before installing in engine. Refill the engine with the heater outlet hose disconnected at the engine until the outlet hose is full of coolant. Connect the outlet hose and continue refilling the engine. It may be necessary to bleed cooling system at highest point to eliminate airlocks. Tighten all hose clamps. Re-tighten all hose clamps after 2 weeks as the hoses may set.

CAUTION: USE A 50/50 SOLUTION OF ETHYLENE GLYCOL (ANTI-FREEZE) AND WATER FOR OPTIMUM HEATER PERFORMANCE. DO NOT USE MORE THAN 60% CONCENTRATION OF ANTI-FREEZE, AS A SHORTENED HEATER LIFE WILL RESULT.

DO NOT USE HEATER IN COOLING SYSTEM CONTAINING ANY FORM OF ANTI-LEAK ADDITIVE, AS A SHORTENED HEATER LIFE WILL RESULT.

1.6 **Installation Inspection** - Run engine up to operating temperature and check installation for leaks. Check all pipe fittings and hose connections at the heater as well as at the engine. Run the engine until all air is bled from the cooling system. Let engine cool down and add additional coolant if necessary.

1.7 **Operation Check** - The heater case will warm up quickly and become hot to the touch. The outlet hose should be warm and the inlet hose comparatively cool, if the coolant is circulating freely. If the inlet hose gets very warm before entire system is warm, the coolant is not circulating freely due to one or more of the following reasons:

1) airlock in hoses due to loops, kinks, excessive lengths, or routing over top of engine;
2) heater mounted too high;
3) heater not mounted with arrow pointing up;
4) dirt in cooling system;
5) improper coolant mixture; or
6) Y-fitting not directing flow of coolant properly.

Leave the heater plugged in for a period of up to one hour, checking at regular intervals by feeling heater hose at both inlet and outlet. If the heater appears to be operating incorrectly or not at all, consult your vendor for further instructions.

2.0 HEATER MAINTENANCE INSTRUCTIONS

2.1 **Regular Maintenance** - Periodically check all hoses for damage due to ageing, elevated temperatures (particularly the portion of hose immediately above the heater outlet), over-torqued hose clamps, abrasion, weathering, and engine fluids. Replace damaged hoses as required. Seasonally check hose clamp torque and adjust accordingly.

Limited Warranty

This limited warranty is expressly limited to the Company's products that have been purchased by the original consumer purchaser or for purposes of resale or use in the ordinary course of the purchaser's business. The term original consumer purchaser is defined as a person who purchases Company products for personal, family, or household use.

The Company's products are warranted against defects in materials and workmanship for a period of one year from date of purchase by purchaser. The exclusive remedy for any product found to be defective under this limited warranty consists of the repair or replacement of the defective product. This limited warranty does not apply to defects which arise from normal wear and tear, accident, misuse, abuse, neglect, mishandling, misapplication, faulty installation, modification, improper or extraordinary use or use inconsistent with any instruction or recommendation issued by the Company.

The foregoing limited warranty is exclusive and in lieu of all other warranties, whether written or oral, express, implied or statutory.

NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY. THE LIMITED WARRANTY CONTAINED HEREIN DOES NOT EXTEND TO INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THIS PRODUCT, OR ARISING OUT OF A BREACH OF THIS WARRANTY.

To obtain performance of this limited warranty, the alleged defective product must be returned, together with reasonable proof of purchase, postage or freight prepaid, directly to:

IN U.S.A.
Warranty Department
Phillips & Temro Industries Inc.
9700 West 74th Street
Eden Prairie, MN 55344

IN CANADA
Warranty Department
Phillips & Temro Industries Ltd.
100 Paquin Road
Winnipeg, Manitoba R3J 3V4

The Company will return the repaired or replaced product, postage or freight prepaid. Final determination of defects shall be made in accordance with procedures established by the Company.

This limited warranty gives the original consumer purchaser specific rights. You may have other rights which vary from state to state or province to province depending upon the location of your residence. Some states do not allow the exclusion or limitation of incidental or consequential damages.

Manufacturer's rights retained:

The Company reserves the right to make changes in design, additions or improvements to any of its products at any time without incurring any obligation whatsoever to install or replace the same or improve upon products previously manufactured.

MASTER CONTROL SYSTEMS, INC.
P.O. BOX 276
910 NORTH SHORE DRIVE
LAKE BLUFF, ILLINOIS 60044 USA
847/295-1010 FAX: 847/295-0704

INSTALLATION AND OPERATING

MODEL MBC-19 BATTERY CHARGER

INSTALLATION INSTRUCTIONS

The Charger cabinet must be mounted in a vertical position preferably on a wall in close proximity to the battery. The areas above and below the Charger must be clear for at lest 5 inches to allow free air flow for cooling. The Charger cabinet must not be located in areas subject to falling or spraying water.

The Charger should not be subject to severe shock or vibration. If it is necessary to mount the unit on an engine skid, select a point subject to the least amount of shock and vibration and install suitable vibration dampers when needed.

For wiring, use wire having insulation which is unaffected by the environment of the installation. For engine starting battery installations, use flexible stranded copper wire having insulation which is unaffected by oil or engine heat.

The bushings supplied with the Charger are in 7/8 (2.2 cm) diameter holes for ½ inch nominal (1.2 cm nominal) conduit fittings. Discard bushing(s) when conduit(s) is used.

See Drawings for Mounting Dimensions and External Wiring Information.

OPERATING PROCEDURES

GENERAL: The Model MBC-19 Battery Chargers are constant voltage single rate (semi-float) regulated (line compensated) battery chargers. They have a Crank Disconnect (DK) Relay as standard equipment.

OUTPUT CAPACITY: These Chargers are capable of supplying up to 100% of their D.C. rated output current without allowing the battery to be depleted. Loads across the battery which are less than the Charger's rated current will be supplied by the Charger with the remaining Charger output being available to charge the battery, if required. For loads greater than the rated output the Charger will supply at least its rated output (if the crank disconnect terminals DK1 and DK2 are not energized) with the battery supplying the remainder.

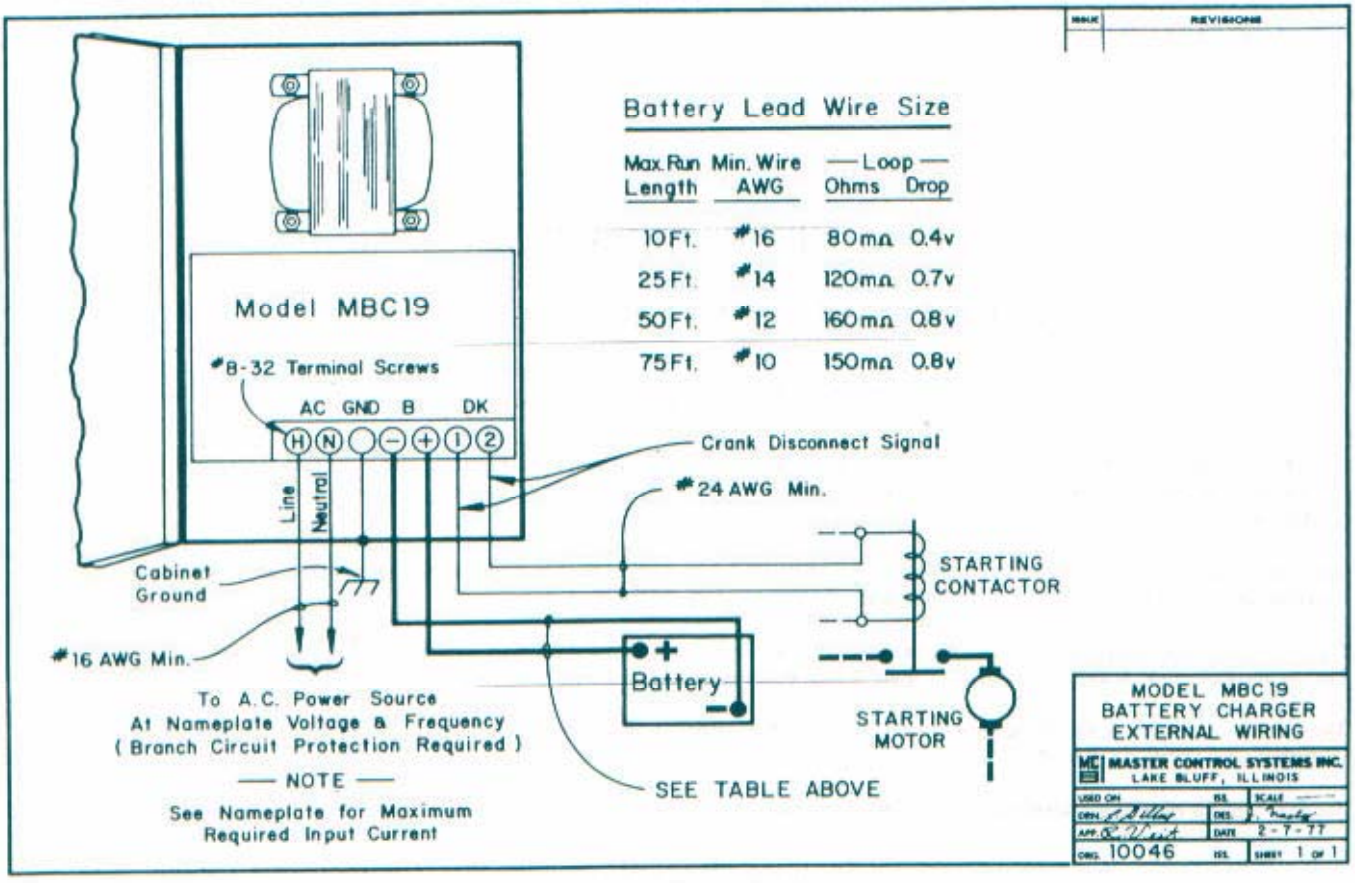
BATTERY CAPACITY: is limited to 115 ampere hours; except, where A.C. line voltage is not abnormally high, the maximum battery may be twice the 115 ampere hour limit.

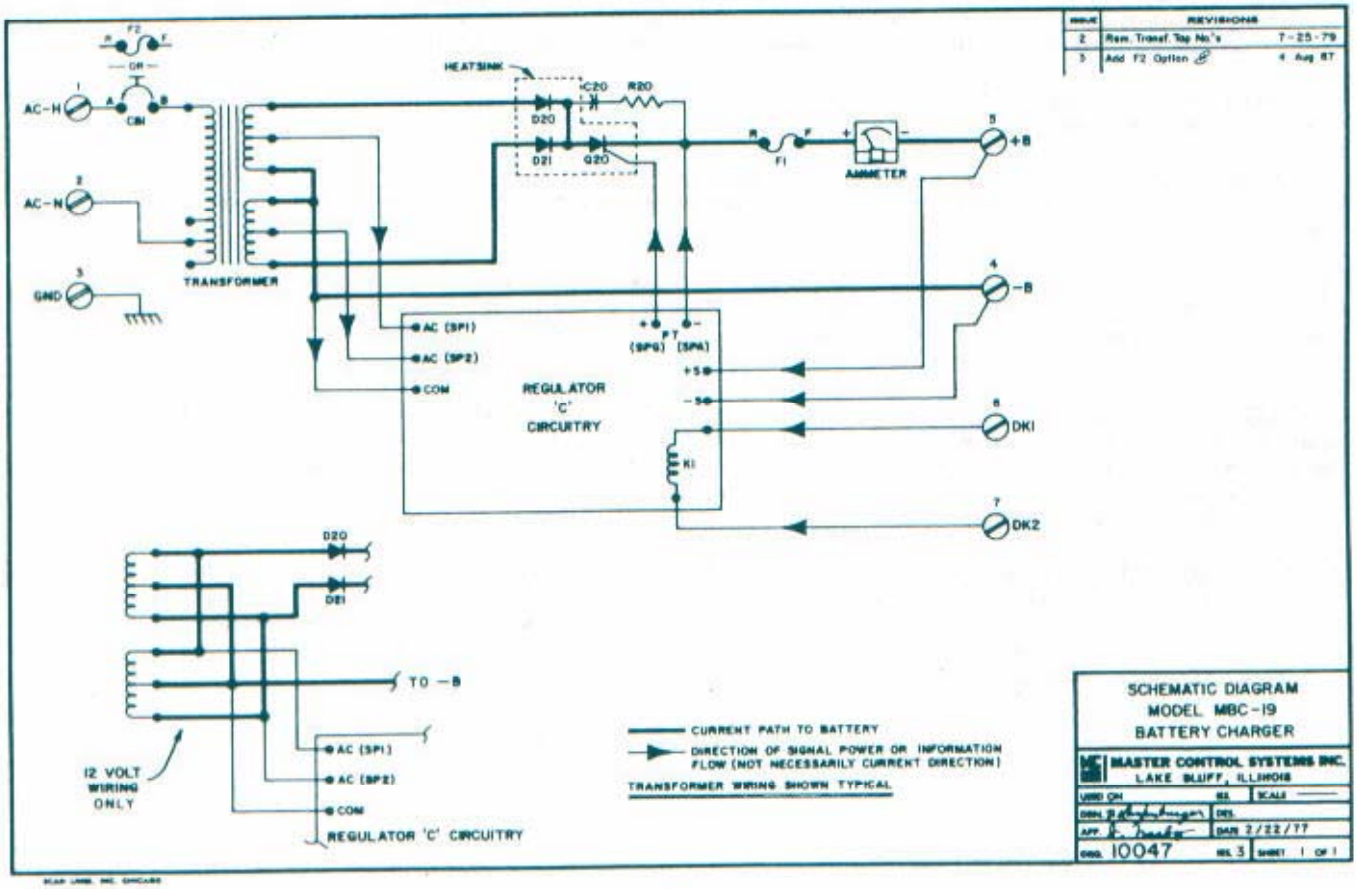
LINE REGULATION: The Charger is regulated (line compensated) and requires no tap settings. The line voltage regulation (output change) is 1% maximum for a 10% line voltage change. The Charger will operate with line changes of up to +15% of nominal with reduced current rating on low line voltages.

WATER CONSUMPTION: The unit is a semi-float Charger which has an output voltage somewhat higher than float level voltages. This allows the Charger to charge a battery in reasonable time and maintain the charge with minimal gassing. With semi-float Chargers, the battery water level should be checked at least once a month until a water consumption pattern is established. Longest battery life will be obtained when distilled water is used to fill batteries.

EQUALIZING: The MBC-19 Models are single rate semi-float Chargers. They do not have means for equalizing the battery. In engine starting applications, running the engine periodically will allow a battery charging generator or alternator, to equalize the battery after the cranking energy has been returned to the battery. A battery equalized in this manner will be indicated by a zero charge current reading of the battery charger ammeter after the engine is stopped. After a time interval the battery voltage will drop and the Charger will show a small output current (which is dependent upon leakage and load current).

CRANK DISCONNECT: In applications requiring battery output currents which exceed the Charger output ratings, such as engine cranking, a crank disconnect signal must be supplied to the Charger. This signal should be a DC voltage of the same nominal value as the Charger DC rated voltage. The signal may be either polarity and is supplied to terminals DK1 and DK2. The current required by the disconnect relay is less than 20mA on 12 volt units and 10mA on 24 volts units. Wiring these terminals to the starter contactor or starter motor terminals would provide the required signal on engine starting application.


Model MBC19
#8-32 Terminal Screws
AC GND B DK
H N − + 1 2
Line
Neutral
Cabinet Ground
#16 AWG Min.
To A.C. Power Source
At Nameplate Voltage & Frequency
(Branch Circuit Protection Required)
— NOTE —
See Nameplate for Maximum Required Input Current
Crank Disconnect Signal
#24 AWG Min.
STARTING CONTACTOR
Battery
STARTING MOTOR
SEE TABLE ABOVE
Battery Lead Wire Size
Max. Run Length | Min. Wire AWG | Loop Ohms | Loop Drop
10 Ft. | #16 | 80mΩ | 0.4v
25 Ft. | #14 | 120mΩ | 0.7v
50 Ft. | #12 | 160mΩ | 0.8v
75 Ft. | #10 | 150mΩ | 0.8v
REVISIONS
MODEL MBC19
BATTERY CHARGER
EXTERNAL WIRING
MASTER CONTROL SYSTEMS INC.
LAKE BLUFF, ILLINOIS
DRN. DES.
APP. DATE 2-7-77
DWG. 10046 REV. SHEET 1 OF 1


AC-H
AC-N
GND
CB
TRANSFORMER
HEATSINK
D20
D21
C20
R20
G20
F1
AMMETER
+B
−B
DK1
DK2
K1
AC (SP1)
AC (SP2)
COM
PT (SP6) (SP4)
+S
−S
REGULATOR 'C' CIRCUITRY
TO −B
12 VOLT WIRING ONLY
CURRENT PATH TO BATTERY
DIRECTION OF SIGNAL POWER OR INFORMATION FLOW (NOT NECESSARILY CURRENT DIRECTION)
TRANSFORMER WIRING SHOWN TYPICAL
REVISIONS
2 Rem. Transf. Tap No's 7-25-79
3 Add F2 Option 4 Aug 87
SCHEMATIC DIAGRAM
MODEL MBC-19
BATTERY CHARGER
MASTER CONTROL SYSTEMS INC.
LAKE BLUFF, ILLINOIS
DRN. DES.
APP. DATE 2/22/77
DWG. 10047 REV. 3 SHEET 1 OF 1

BATTERY CONDITION: A fully charged battery will be indicated by a low Charger output current and, for lead acid batteries, a full charge specific gravity hydrometer reading in all cells. A battery which has approached end of life will have a reduced ampere hour capacity (something less than the battery's rate capacity). An adequate check of a battery for capacity in an engine starting application is to monitor the battery voltage while it is cranking the engine during expected worst case starting attempt. If the battery was fully charged its cranking voltage should be at least 75% of nominal voltage (9 volts minimum on a 12 volt lead acid battery). Batteries which have sufficient capacity but which are not fully charged may not pass this test.

TO PUT THE CHARGER INTO OPERATION: Connect per installation instructions and apply A.C. power.

WARNING: Always disconnect, turn off, or remove A.C. power from the Charger before attempting to service the Charger or before connecting or disconnecting Charger or battery leads. Similarly, do not connect or disconnect battery leads with any loads connected to prevent arcs or sparks at the battery.

CAUTION: If the battery leads (+B and -B) are to be disconnected from the Charger they must either be insulated or disconnected at the battery first to prevent short circuiting the battery.

NORMAL OPERATION: When power is first applied the Charger will normally supply at least rated current as indicated on the Charger ammeter. As the battery charge builds up the charge current will reduce finally to a level required to maintain the battery charge and supply any additional loads. The charge current should reduce to lower values within 30 hours or less for properly sized Chargers. The following voltages apply to 12 volt systems and are proportional to other systems.

When connected to a fully discharged battery the charge current will be higher than rated current for part of the charge cycle. A very deep discharged battery can cause Charger shutdown (if its terminal voltage is less than 5 volts) for up to several hours before high charge currents can flow. Note that for a deep discharged battery to eventually allow Charger to turn on, there must be no other loads on the Charger (or battery).

CHARGER MAINTENANCE: There are no field adjustments to be made on these Chargers. The only adjustable device is the float voltage adjustment on the regulator P.C. board which is factory set using precision equipment.

LOW VOLTAGE SHUTDOWN: These Chargers are normally supplied with low voltage shutdown which causes the Chargers to reduce its output current at any time the battery output terminal voltage drops below 5 volts. The charger will shut off completely if the output terminal voltage drops below 2.5 volts. This provides reverse polarity and short circuit protection.

THEORY OF OPERATION

GENERAL: Refer to wiring diagram for schematic representation. Note that while the transformer winding configuration changes with Charger voltage and current ratings, the typical winding configuration is representative of the Charger operation.

A.C. PATH: The A.C. power is applied to the power transformer primary through circuit breaker CB1 or A.C. Fuse F2. Note that the primary taps shown are factory wiring options to accommodate different battery types. The 'GND' terminal is tied directly to the chassis which is in electrical contact with the cabinet. The primary and secondary circuits are electrically isolated from each other and from chassis or cabinet ground. The transformer, then, isolates the A.C. power and transforms the voltage to the level required by the battery. The regulator circuits has its own regulated power supply to power the circuitry and the reference element providing the double regulated reference voltage for the highly regulated operation.

D.C. PATH: The Main power rectifiers (D20 & D21) and SCR are all mounted on the heat sink. Rectification is full wave center tap with the rectifier output going directly to the SCR (Q20). Battery charger current will flow when the SCR (Silicon Controlled Rectifier) is turned on and vice versa. The resistor R20 and capacitor C20 form a 'snubber' network to prevent false SCR turn on due to line surges or transients. When the SCR is turned on by the regulator circuit charge current will flow through the SCR, fuse F1, and ammeter, and terminal '+B' to the battery positive post. The charge current return path is from battery negative through terminal '-B' to the transformer center tap.

The regulator board has its own regulated power supply which is supplied via the 'AC' pins and terminals 15 and 16. The wiring options shown on the drawing are to provide approximately 12 VAC to the regulator board. The return line for this supply is the 'RET' pin which connects to the transformer center tap via terminal '-B'. The local regulated supply on the board supplies the reference element providing the double regulated reference voltage for low line regulation error.

VOLTAGE SENSING: The regulator senses the battery terminal voltage via the '+B' and '-B' terminals. The regulator will turn on the SCR sooner in each half line cycle when the sensed battery voltage is below the internal regulated reference voltage. Turning on the SCR sooner in each half cycle will allow more charge current to flow. When the battery voltage increases (with charge level) above the fixed reference voltage, the regulator will turn on the SCR later in each half cycle causing reduced charge currents. The battery voltage sensing network is high in impedance (approximately 3K ohm) and will not cause battery discharge on power outage.

CRANK DISCONNECT: The crank disconnect relay is supplied by the 'DK' terminals. This reed relay shunts the SCR pulse transformer input, when operated, which prevents SCR turn on.

SHUTDOWN: Shutdown sense signal comes from the '+B' terminal. Any time the voltage on that terminal drops below 5.0 volts the shutdown sense circuit begins to 'steal' the SCR drive signal which reduces charge current. If the terminal voltage falls below 2.5 volts, sufficient SCR drive signal is stolen to prevent SCR turn-on causing all charge current to stop. Output current will return when the +B voltage rises above 2.5 volts.

TROUBLESHOOTING HINTS

FOR MODEL MBC19 BATTERY CHARGER

GENERAL: Record the battery voltage and charger output current before proceeding with any tests. (Whenever possible, battery voltage readings should be taken at the battery posts, battery terminals, and charger output terminals with an accurate voltmeter). It is important to check voltages initially at all three points since a poor connection will vary readings and effect charger performance.

If battery post voltage is equal to that in Table A, and the charger shows no output, the charger is operating properly.

NOTE: Do not adjust the sealed trimpot on the printed circuit board since accurate field adjustments are extremely difficult to obtain. Improper settings will lead to either undercharging or overcharging of the battery.

SYMPTOM I. No Output (charger will not turn on unless connected to a battery. Output will not be apparent when connected to a fully charged battery unless a load is applied).

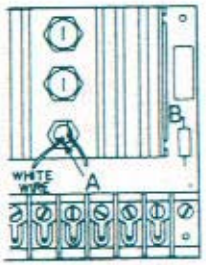
CHECK:

A. If battery voltage is low (See Table A) and no output is indicated:
   1. Verify nameplated input voltage is present at A.C. input terminals.
   2. Check input (A.C.) circuit breaker (or fuse) and D.C. fuse.
   3. Remove wires from the DK1 and DK2 terminals (an improperly wired disconnect circuit can cause charger to turn off).
   4. Verify that battery voltage is above charger shutdown voltage (5 volts). This feature provides reverse polarity and short circuit protection.
   5. The SCR assembly can be checked by momentarily connecting a jumper between the gate of the SCR (Point A) and the capacitor side lead (Point B) of the R20 resistor (See Fig. 1). If the ammeter deflects, the SCR is operational. (Since this will cause the SCR to be wide open, the jumper can only be connected momentarily or a fuse may be blown).

TABLE A*

CHARGER MODEL	BATTERY TYPE	VOLTAGE
MBC19	Lead Acid	2.3 VPC
	Maint. Free (Lead Calcium)	2.35 VPC
	Nicad	1.45 VPC

FIGURE 1



*NOTE: Number of cells stamped on nameplate must correspond with number of cells in battery bank. Proper voltages can be determined by multiplying number of cells by VPC listed above. Example: Typical 24 volt battery bank consists of 12 lead acid cells at 2.3 VPC = 27.6 volts.

SYMPTOM II. Battery is incapable of cranking engine or carrying substantial loads.

CHECK: Standing battery voltage:

A. If the measured battery post voltage is equal to voltages shown in Table A, but drops 75% of nominal when the engine is cranking, then the batteries do not have sufficient capacity and should be replaced. (This battery charger monitors battery voltage and will supply sufficient output to bring battery voltage up to the proper level; however, batteries with diminished capacities are still capable of reaching normal voltages).

B. If the measured battery post voltage is lower than the values shown in Table A and charger output current is indicated on the ammeter, the condition may be normal die to recent deep discharge of the battery. If the voltage does not increase and the charger output does not decrease within 24 hours, the condition may be caused by a shorted battery cell or an improperly coordinated charger and battery system. (See III., Overcharging/Excessive Gassing).

C. If the measured battery port voltage is lower than the values shown in Table A an no charger output current is indicated on the ammeter, a bad connection may exist. To verify proper connections, measure the voltage at the charger output terminals and compare them to the battery post voltage reading. If they differ by more that 1%, then a bad connection between the battery posts and the charger output terminals exists. Clean and tighten all connections.

D. If the measured battery post voltage is lower than the values shown in Table A and charger output is only indicated on the ammeter immediately after engine cranking , Consult factory.

SYMPTOM III. Overcharging/Excessive Gassing (Ammeter indicating charge rate in excess of any continuous load)

CHECK:

A. If battery voltage is equal to voltages in Table A, disconnect any load, interrupt A.C. supply, and wait approximately 15 minutes. If voltage drops below voltages in Table A, the battery is not capable of maintaining a full charge, and higher than normal output is needed to maintain proper voltage at the battery. This may cause excessive gassing. Battery should be replaced.

NOTE: Anytime battery voltage is equal to voltage in Table A, the battery charger is not overcharging.

B. If battery voltage is higher than voltage in Table A, consult factory.

SYMPTOM IV. Fuse Blowing

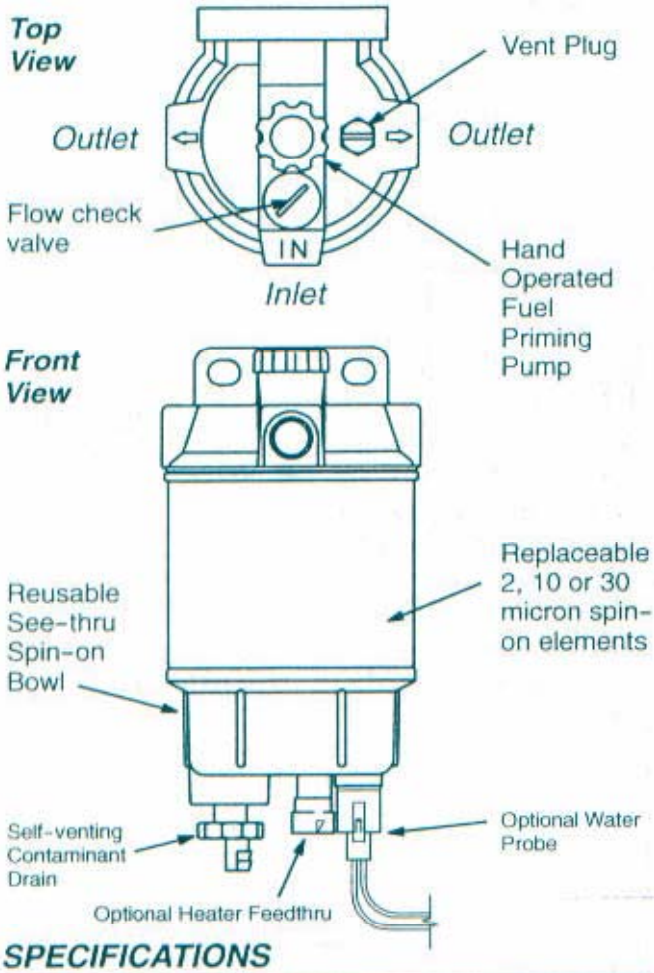
CHECK:

A. Fuses blow immediately when installed.
   1. Verify fuses being used match ratings on fuse nameplated.
   2. Disconnect charge leads at charger, install new fuse.
      a. If problem clears, an external short exists.
      b. If fuse still blows, consult factory.

B. Fuse blow during engine cranking.
   1. Disconnect terminals are not properly wired.

200R Spin-on Series Fuel Filter/Water Separators for Diesel Engines

RACOR
Parker
Filtration
Parker Hannifin Corporation
Racor Division
P.O. Box 3208, 3400 Finch Road
Modesto, CA 95353 USA
(209) 521-7860 / (800) 344-3286
www.parker.com/racor



Racor's 215R, 230R, and 245R Fuel Filter/Water Separators are specifically designed to handle todays tough diesel filtration problems. These units feature a standard in-head fuel priming pump and are different from one another only in flow capacity and element size.

These units may be used on the suction (vacuum) side or pressure side (up to 30 PSI) of the fuel transfer pump. The die-cast aluminum mounting head features two outlets and one inlet for installation to most fuel systems. The fuel ports are standard SAEJ476 1/4" NPTF (tapered dryseal pipe thread). Many varieties of fittings are available from Racor or hardware dealers. (Fittings may not be supplied with this unit).

A vent plug is fitted to easily evacuate trapped air, making fuel priming an easy, no-mess experience.

Engines will benefit from near 100% water separation and fuel filtration with Racor's proprietary *Aquabloc*™ water repelling media. The replaceable spin-on filter elements are available in 2, 10, and 30 micron ratings.

The reusable see-through contaminant collection bowl allows the operator to check contamination build-up at a glance. The contaminant drain is opened by rotating the knob counterclockwise (if facing the bowls bottom side).

OPTIONAL FEATURES:

An available option is a water probe which alerts the operator when it's time to drain the bowl. (The probe must be used with a 12 or 24 vdc powered Water Detection Kit. See Accessories for available models). For use with diesel fuel systems, only.

A powerful 12 or 24 vdc 200 watt In-bowl heater option is available to quickly warm the element fuel thus providing easier starting and optimum operating efficiency in cold weather or climates. ***Danger! Accessories are not intended for use with gasoline or flammable liquid applications.***

Additionally, a metal bowl is available for severe service, heavy duty, or marine applications. This bowl features a 3/8"NPT drain plug which may be replaced by a UL listed drain valve (refer to parts list).

For marine applications, specify Models: 215RMAM, 230RMAM or 245RMAM. *Note: Heaters may not be used with these models.*

SPECIFICATIONS

MODEL		215R	230R	245R
Maximum Flow Rate	GPH	15	30	45
	LPH	57	114	170
Replacement Element Series		R15	R20	R25
Fuel Ports (SAEJ476)	NPT	1/4"	1/4"	1/4"
Clean Pressure Drop	PSI	0.12	0.31	0.61
	kPa	0.82	2.14	4.21
Height	in.	8.3	9.0	10.5
	mm	211	229	267
Width	in.	4	4	4
	mm	102	102	102
Depth	in.	4	4	4
	mm	102	102	102
Weight, Dry	lbs.	1.8	2	2.2
	kgs.	.80	.90	1.0
Operating Temp.		- 40° /+255°F / - 40°/+121°C		

PART NUMBER IDENTIFICATION

The example below illustrates how part numbers are constructed.

245R	*M*	*P*	*12*	*2*
215R = 15 GPH 230R = 30 GPH 245R = 45 GPH	Metal bowl. *(Omit if not desired)* *Specify* ***MAM*** *for UL Marine Models.*	In-bowl Water Probe. *(Omit if not desired)*	In-bowl Fuel Heater: 12 vdc or 24 vdc. *Not for marine use. (Omit if not desired)*	Filter Micron Rating: *Specify one:* 2, 10 or 30

INSTALLATION INSTRUCTIONS

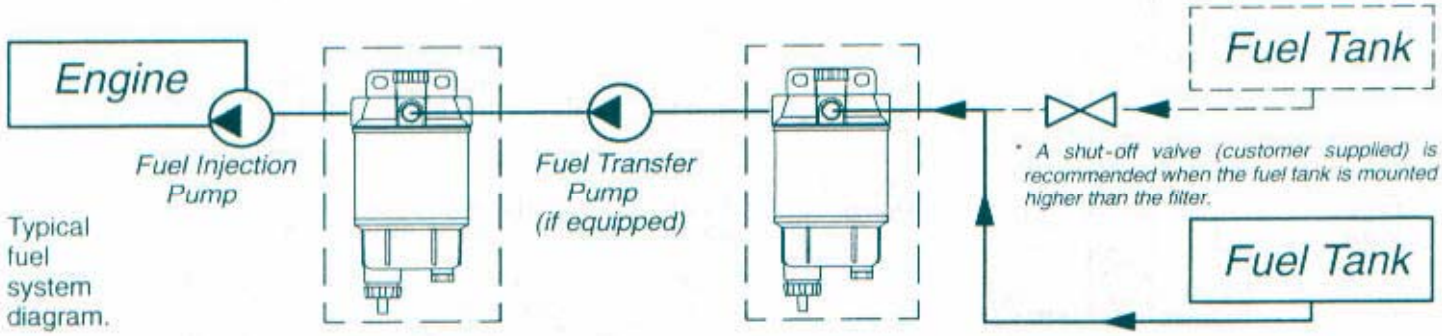
Determine the LOCATION: The Racor 215R, 230R, and 245R Models may be located on the suction (vacuum) side or pressure side (up to 30 PSI) of the fuel transfer pump. For optimum water separation efficiency, install the unit on the suction side.

Determine the FILTRATION: Primary (30 micron), Secondary (10 micron), or Final (2 micron) filtration. The first filter downstream from the fuel tank to the engine is a primary filter. Typically, this filter is rated for 30 microns, however, a 10 micron filter may also be used. Between this filter and the engine is a secondary filter (optional) and it should be rated for 10 micron filtration. The final filter prior to the engine injection pump should be equipped with a 2 micron filter.

BEFORE INSTALLING THE UNIT:

1. Ensure fuel port fittings are in hand along with fuel line, hardware and all needed tools and materials.
2. Maintain a safe working environment. The engine must be off and obtain good ventilation and lighting. Do not smoke or allow open flames near the installation. Eye protection is recommended and have fluid 'drip' pans and absorbant shop cloths available to anticipate spills.
3. The chosen mounting location should allow 2 inches below the unit for draining water and replacing elements.
4. Pipe thread paste is recommended on port fitting connections. Do not use pipe tape - a loose piece could clog the system.

Typical fuel system diagram.



SECONDARY / FINAL FILTER LOCATION
Shown on the pressure side of the pump. (Could also be on the suction side of the pump). Use a 2 (or 10) micron filter.

PRIMARY FILTER LOCATION AND ***MARINE MODEL LOCATION***
Shown on the suction side of the pump. Use a 30 (or 10) micron filter.

BRASS 1/4"NPT FITTINGS CHART

Description	Hose I.D.	Part Number	Qty.
Hose Barb	1/4"	951-N4-H4	1
	5/16"	951-N4-H5	1
	3/8"	951-N4-H6	1
Elbow Hose Barb	5/16"	953-N4-H5	1
	3/8"	953-N4-H6	1

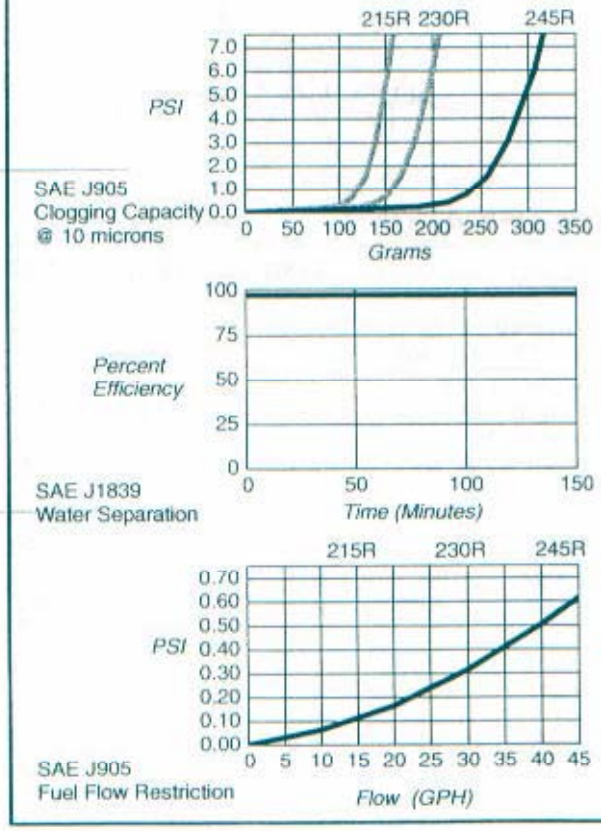
OPERATING INSTRUCTIONS

PRIMING. Loosen the vent plug. Operate the primer pump until fuel purges at the vent plug. Close the vent plug, start the engine and check for leaks. Follow manufacturer's priming procedures if applicable. Correct as necessary with the engine off.

TROUBLESHOOTING PROCEDURES

A major cause of power loss or hard starting is the result of an air leak. If your unit will not prime or fails to hold prime, first check that the vent plug and drain valve are properly closed and that the element and bowl are tightened. Check fitting connections and ensure the fuel lines are not pinched or clogged with contaminants. If problems persist and the element is new, call your Racor Distributor or Racor Customer Service for assistance.

PERFORMANCE INFORMATION



INSTALLING OPTIONAL FEATURES

NOTE: RACOR ELECTRICAL OPTIONS ARE FOR USE WITH DIESEL FUEL APPLICATIONS ONLY.

WATER PROBE.

Racor 200R Series units can be specified with a water probe. The probe senses continuity values and ***must*** be used with a special electronic detector to function properly. Due to the various models available, these electronic detectors are sold separately. Installation instructions are supplied with each kit. See Accessories for part numbers.

IN-BOWL HEATER (NOT FOR MARINE MODELS).

The in-bowl heater is a cold weather starting aid with an internal automatic thermostat that turns the heater on if the fuel temperature drops below 45°F (7°C). Heat is supplied just below the replacement element to melt the wax crystals and allow fuel to efficiently pass through the element. The heater will automatically turn off at about 75°F (24°C). The 200 watt heater is available in 12 or 24 vdc (volts, direct current).

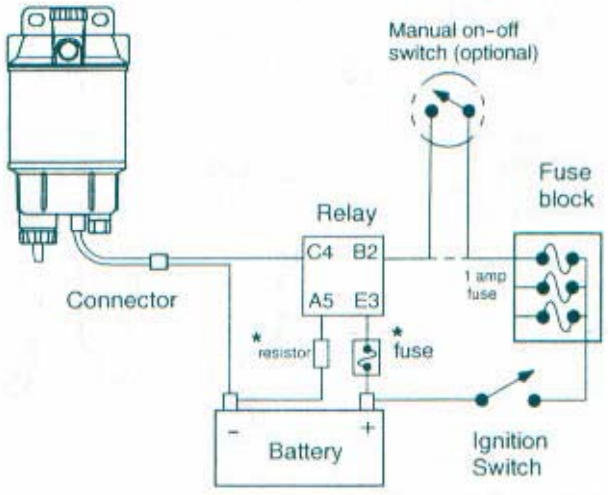
The heater is operated by turning on the ignition switch for a minimum of five minutes prior to starting the engine.

CUSTOMER SUPPLIED ITEMS.

1. Because of the heater power demand: 20 amps for 12 vdc and 10 amps for 24 vdc, an additional relay is recommended for the safest method of installation. Racor offers two relay kits, available from your dealer: RK11861 for 12 vdc systems or RK11862 for 24 vdc systems.
   These kits include an in-line fuse holder (and fuse) and the RK11862 kit also includes a resistor. Use the 25 amp fuse with 12 vdc and the 15 amp fuse (and resistor) with 24 vdc systems.
2. An on-off toggle switch may be used to control power to the heater relay. This allows the operator to cut power to the heater relay during summer use.
3. All wires should be 14 AWG (American Wire Gauge), minimum.

INSTALLATION.

1. Either heater wire may be used for Hot (+) or Ground (-).
2. Wire / terminal connections should be soldered and crimped.
3. Run wires in protected locations. Avoid hot surfaces and places that could pinch or rub on the wires.



*For 24 vdc systems install the resistor and use the 15 amp fuse.

SERVICE

Frequency of water draining or element replacement is determined by the contamination levels present in diesel fuel. If the fuel tank is located higher than the Racor, close the fuel tank outlet valve prior to servicing.

DRAINING THE COLLECTION BOWL.

Water is heavier than diesel fuel and will settle to the bottom of the bowl and appear different in color. The bowl must be drained before contaminants reach the bottom of the element or when the Water Detector (if equipped) indicates it's time to 'drain water'. Inspect or drain the collection bowl of water daily.

1. Open the drain and operate the pump to drain off contaminants. Close the drain.
   MARINE MODELS: Remove the drain plug to drain off contaminants. Replace drain plug to bowl snugly.

ELEMENT REPLACEMENT.

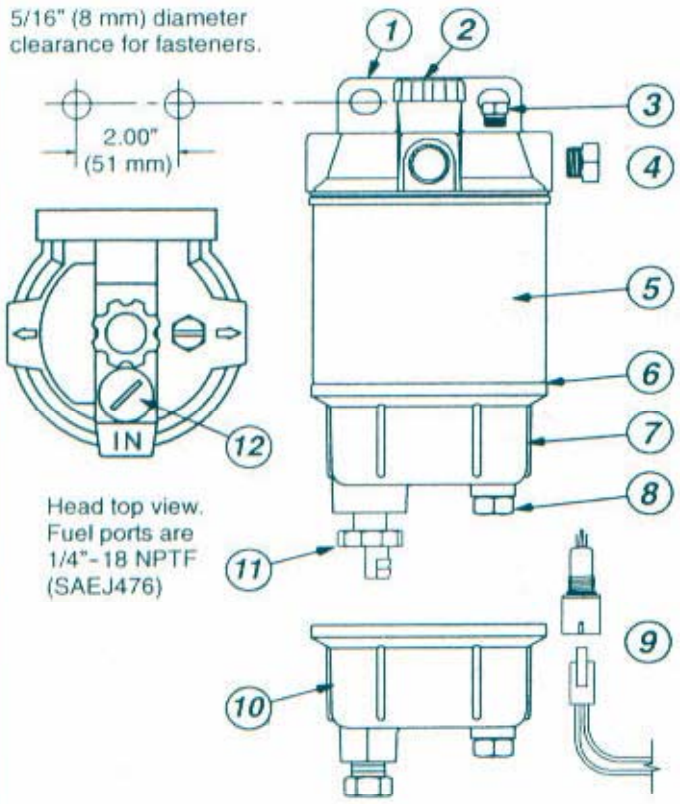
Element replacement frequency is determined by the contamination level in diesel fuels. Fuel flow to the engine becomes restricted as the element slowly plugs with contaminants, resulting in noticeable power loss and/or hard starting.

Replace the element every 10,000 miles, every 500 hours of operation, every other oil change, annually or if a power loss is noticed, which ever comes first. If a vacuum gauge has been installed on the outlet side of the filter, change the element between 6 to 10 inches of mercury (restriction). The actual measurement varies in different fuel systems.

Note: Always carry an extra element as one tankful of excessively contaminated fuel can plug a filter.

1. Drain off some fuel by loosening the vent plug and opening the drain valve. (Marine models: remove the drain plug).
2. Disconnect the water sensor and heater connectors, if equipped.
3. Spin the element and bowl off together. Remove the bowl and clean the O-ring gland.
4. Apply a coating of clean fuel or motor oil to the new O-ring and element seal.
5. Spin the bowl onto the new element and then spin them both onto the filter head snugly by hand only. DO NOT USE TOOLS.
6. Close the bowl drain. (Marine models: replace the drain plug. Apply thread sealant to threads, if needed).
7. Connect the water sensor and heater connectors, if equipped.
8. With the vent plug still loosened, operate the primer pump until fuel purges at the vent plug. Close the vent plug, start the engine and check for leaks. Correct as necessary with the engine off.
9. Follow manufacturer's priming procedures, if applicable.

REPLACEMENT PARTS LIST



Item	Part No.	Description	Qty.
1	RK20046	Head, 1/4"-18 NPTF Ports	1
2	RK20025	Primer Pump Assembly	1
3	RK20179	Plastic Vent Plug, 3/8"-16 UNF	1
4	RK12041	Metal Plug, 1/4"-18 NPTF	1
5	R15S	215R, 2 mic. Replacement Element	1
	R15T	215R,10 mic. Replacement Element	1
	R15P	215R,30 mic. Replacement Element	1
	R20S	230R, 2 mic. Replacement Element	1
	R20T	230R,10 mic. Replacement Element	1
	R20P	230R,30 mic. Replacement Element	1
	R25S	245R, 2 mic. Replacement Element	1
	R25T	245R,10 mic. Replacement Element	1
	R25P	245R,30 mic. Replacement Element	1
6	RK22244	Bowl O-ring	1
7	RK22350-02	See-thru Bowl Assembly	1
	RK22354-01	12vdc Heater and See-thru Bowl	1
	RK22354-02	24vdc Heater and See-thru Bowl	1
8	RK20022	Metal Plug, 1/2"-20 UNF	1
9	RK30964**	Water Probe and Connector Kit	1
10	RK22368	Marine Metal Bowl, NPT drain & 1/2"port	1
11	RK30476	Self-Venting Drain Knob	1
12	RK20011	Check Ball and Plastic Cap	1
	RK20742	Marine Metal Check Ball Cap	1
	RK20075	Complete Gasket/O-ring Kit	1

***Must be used with a Water Detection Kit. See Accessories below.*

ACCESSORIES

Accessory kits are intended for use with diesel fuel only. Order kits from your Racor dealer.

Water Detection Kit # RK 20725

This 12 vdc under dash module illuminates an LED when power is on and then when water is detected. The 'DRAIN' LED will remain illuminated until the water is drained below the probe tips. The unit automatically resets. Hardware and instructions included. Wire/terminals are customer supplied. Measures 2 3/4" by 1" by 1 1/2" deep.

Water Detection Kit # RK 20726

This 2" diameter gauge type module is ideal for in-dash applications. The corrosion resistant body is waterproof from the face side and may be used with 12 or 24 vdc electrical systems. The unit illuminates an LED and sounds a momentary buzzer at every 'power-up' and then when water is detected. The unit automatically resets. Hardware and instructions are included however, wire and terminals are customer supplied. Fits standard 2 1/16" diameter panel openings. Measures 2 1/4" (major) diameter by 3 1/8" deep (to end of threaded connector studs).

Water Detection and Element Restriction Kit # RK 11-1570 (not shown)

Similar to RK 20726 above except the unit features two LEDs. Illuminates and sounds a momentary buzzer at every 'power-up' and then when water or filter restriction is detected (vacuum switch set at factory for 7 inHg). Automatically resets. Hardware and instructions are included. Wire and terminals are customer supplied.

Gauge-Type Element Restriction Monitor Kit #1606B

This 2" diameter gauge is also ideal for in-dash applications. Fuel flow to the engine becomes restricted as the element slowly plugs with contaminants. The gauge monitors the filter restriction and informs the operator of filter condition anytime the engine is running. Hardware and instructions included however, plated steel 'Tee' and vacuum tubing not supplied. These items may be ordered from your Racor dealer.

Racor's policy is one of continual improvement in design and manufacturing to insure still finer products; therefore, specifications, equipment and product information, while correct at the time of publication, is subject to change without notice.

Product Brochure Part Number 22360, Rev. C

Athlon™ Generator User's Manual

SAFETY PRECAUTIONS!!!!

Safety precautions are absolutely necessary during installation and maintenance of your Athlon ™ generator. Warning messages are contained throughout this document, often marked with a cautionary symbol, such as ⚠. These messages are for your protection.

Before any work is done:

- Be sure installation conforms to all applicable safety and local electrical codes. Licensed electricians should perform all installations.
- Never operate the generator with protective, access, or terminal box covers removed.
- Before conducting any maintenance, be sure to disable the engine start circuits.
- Avoid accidental closure by disabling closing circuits and any circuit breakers feeding into or from the generator – follow OSHA lockout/tagout procedures.
- Insure proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements.

Lifting or moving your generator involves a hazardous set of operations, as noted in the installation and maintenance sections of this manual. Improper lifting or moving of the unit may well result in damage to the generator, and more importantly, injury to service personnel.

As an initial step in installation, insure that all generator leads are properly connected inside the saddle (connection) box. Residual voltage is always present at the generator terminals and at the automatic voltage regulator panel connections. Therefore, always assume that there will be voltage present at the generator terminals.

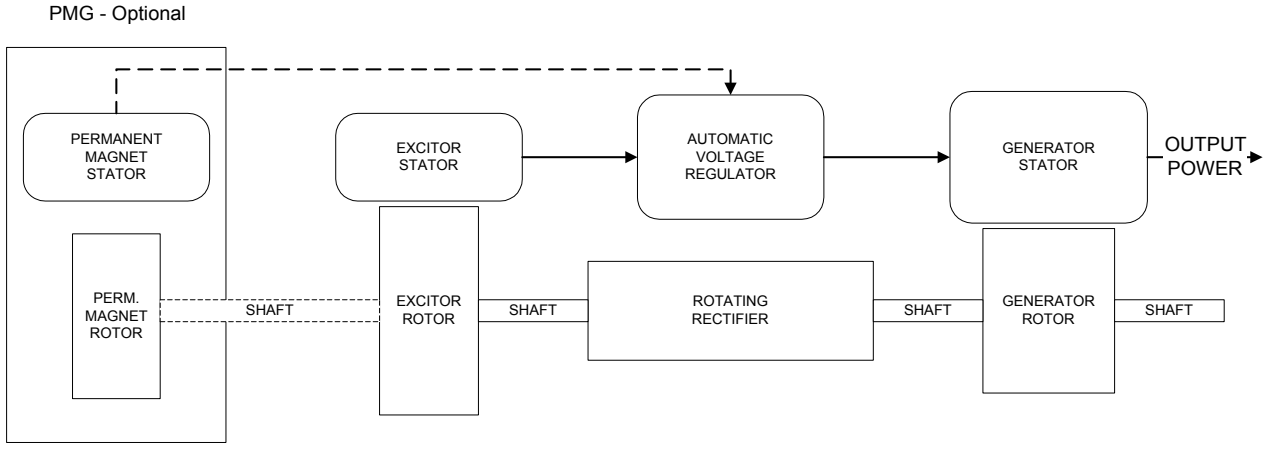
This manual is only a supplement to the proper training of installation and service personnel. Qualified, trained technicians MUST do installation and repairs. The cautions and warnings point out known conditions and situations that are considered potentially hazardous. Each installation WILL also have its own set of hazards that will only be identified by personnel that have been properly trained.

TABLE OF CONTENTS

1. PRINCIPLE OF OPERATION

Athlon^{TM} generators are brushless, self excited or permanent magnet generator (PMG) excited, synchronous AC generators. All units utilize sophisticated Automatic Voltage Regulators (AVR) to control the output voltages and frequencies.

The self excited generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator (AVR). The optional PMG adds the PMG excitation to the unit.



In the self excited units, the generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter field resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. Adjusting the regulator's reference set point changes the generator's terminal voltage. Consult the regulator manual for specific adjustment and operating instructions.

Motor Starting

When a motor is started, the motor draws a large surge of current. This starting current is equivalent to the motor's locked rotor or stall current and is 5 to 10 times normal full load current. When the generator

supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling.

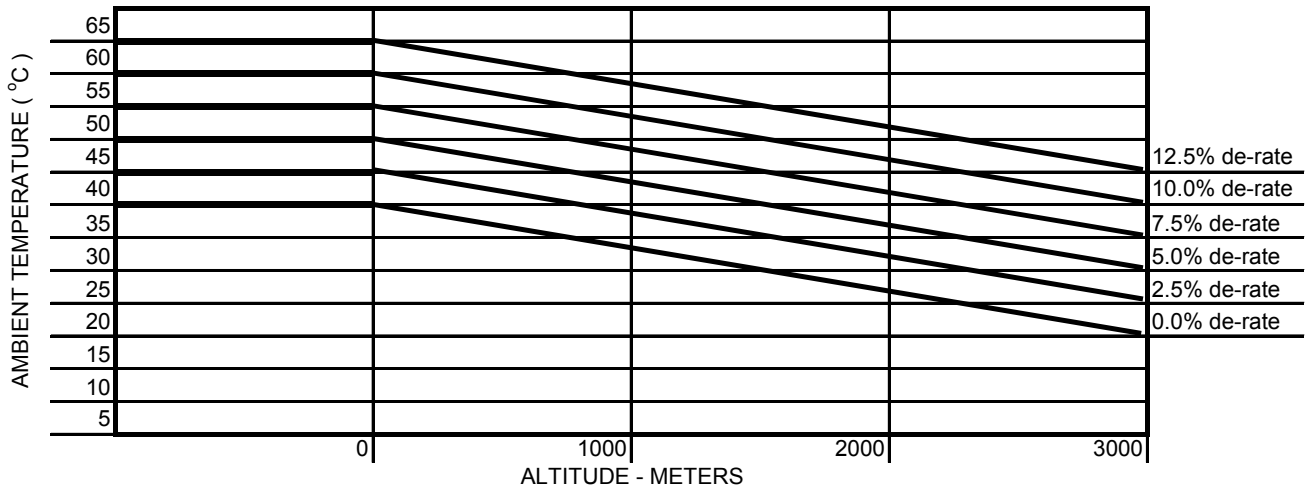
Special Conditions

Outdoor Operations – Generators subjected to outside operation must be protected from the environments by fiberglass or metal housings with the proper forced air (fan) ventilation. Direct generator contact of rain, snow, or dust must be avoided. Space heaters are also recommended for certain environmental conditions.

Sand & Dust – Generator windings are protected against harsh environments. However, severe conditions may demand further protection. Special enclosures and filters may be necessary to protect the generator from contaminants carried into the generator by required airflow.

High Humidity & tropical Climates – Although the normal generator windings are humidity and moisture resistant, in service areas that are particularly moist or humid, such as tropical environments and all marine applications, additional protection is recommended. Special winding insulations are available, as well as space heaters, to compensate for these harsh environments.

Altitude & High Ambient Temperature Operations – For applications over 1000 meters (3300 feet) elevation or where the temperature of the ventilating air to the generator exceeds 40°C (104°F), de-rating of the generator is necessary.



Non-Linear Loading – When subjected to non-linear loads, generator output is affected, causing additional heat in the generator rotor and stator. Solid-state electronic devices, such as SCR devices, can introduce high frequency harmonics, which adversely affect the normal waveform of the generator. To account for these phenomena, generators must be oversized. Please consult the factory when faced with a significant non-linear load.

2. INSTALLATION

Different generating set configurations will require different levels of site installation. For example, most enclosed sets that include switchboards and circuit breakers will require little or no connectors, pass-throughs or wiring for grounding whereas open configurations will likely require both. Please read and follow each section as it applies to the specific generating set being installed.

2.1 LIFTING

⚠ The Lifting Lugs on the generator are meant to support the generator only. Once assembled as a set, the lifting lugs on the generator cannot be used to lift the assembly. Severe personal injury or equipment damage may result.

Each generator is provided with two lifting lugs and should be used with a shackle and pin type safety lifting aid fitted to chains rated well above the minimum lifting force. The chains should then be attached to a beam, acting as a spreader, to provide even distribution of weight on the chains and help ensure the generator remains as level as possible when lifted. The use of rope is highly discouraged. The lugs are positioned to allow the generator to be lifted as close to its center of gravity as possible thereby allowing the generator to remain level with ground when lifted. However, design constraints limit the location of the lugs, so there is no guarantee that the generator will stay perfectly horizontal to the ground as it is lifted. Care must be exercised to prevent personal injury or equipment damage.

Each generator has been carefully inspected and tested before shipment from the factory. However, it is highly recommended that the generator be thoroughly inspected. Check all bolts to insure they are tight, and examine the insulation on lead wires for chafing. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

2.2 ENGINE – GENERATOR ASSEMBLY

During assembly, the generator and engine shafts must be properly aligned and allowed to rotate so that the engine flywheel holes and the generator coupling holes can be lined up and coupling bolts installed and tightened. In order to help with alignment, it may be necessary to add shims to the generator's feet. This holds true for both single and dual bearing generators.

⚠ Disable and lockout any engine starting devices before installing or servicing the generator. Also note that improper alignment can result in equipment damage and/or personnel injury.

2.2.1 SINGLE BEARING GENERATORS

The generator frame housing and SAE coupling plates have been coated with a rust preventative to prevent corrosion during shipping and storage. This coating MUST BE REMOVED prior to assembly with the engine. Use a petroleum-based degreaser and clean all mating surfaces.

To make the alignment of the shafts and bolt holes of single bearing generators easier, place two dowels at diametrically opposite holes on the engine flywheel. The generator coupling plate can then be aligned with the engine flywheel as the generator is placed onto the base. Once the bolt patterns of the two plates are lined up, the dowels must be removed and coupling bolts and nuts installed in every bolt hole. Bolt sizes and required torque values are shown in Appendix D, SAE Data.

The combined engine – generator shaft will need to be rotated as the coupling hardware is installed and should be done with care so as to ensure the safety of the installer(s) and protection of the assembly's

components. Be sure to follow approved working practices, particularly when reaching inside the assembly to install and fastened coupling hardware.

2.2. 2 TWO BEARING GENERATORS

Following the coupling manufacturer's guidelines for proper fit and alignment, a flexible coupling should be used to join the engine to the generator.

For belt-driven generators, avoid axial load on the bearings by verifying the alignment of the pulleys and belts. Using a screw-type tensioning mechanism is recommended to maintain pulley alignment while providing accurate belt tension adjustment.

Adapter guards must be installed after the coupling assembly is finished. The motor-generator set builder is responsible for providing a suitable guard for open coupled sets.

2.3 GROUNDING

The generator frame must be firmly mounted to the generator set base plate. Once the generator is mounted, be sure there is a solid electrical connection for ground by checking for continuity between the generator frame and the base plate. A properly rated ground conductor must be attached to the generator frame and base plate if anti-vibration mounts are used between the two. Normally this conductor can be half the cross-sectional area of one of the main power wires. Refer to all local electrical codes regarding grounding of the unit.

2.4 PREOPERATIVE CHECKOUT

2.4.1 INSULATION RESISTANCE

The resistance of the insulation windings must be measured after both final assembly and installation of the generator set but before the unit is started for the first time. To measure the resistance of the windings, follow the steps below.

1) Disconnect the AVR.
2) Disconnect any conductors between ground and neutral.
3) Using a 500V Megger insulation tester or a similar device, test the resistance between one of the output lead terminals and ground. Resistance should be greater than 5MΩ.
4) If resistance is less than 5MΩ, follow the dry out procedure in this manual.
5) Repeat step 3 for the remaining two output leads.
6) NOTE: During manufacture, the windings are tested at high voltage. Further high voltage testing may degrade insulation and reduce operating life. If high voltage testing is required for customer acceptance, tests must be performed at lower voltages, i.e., Test Voltage = 0.8(2 X Rated Voltage + 1000).

2.4.2 DIRECTION OF ROTATION

Viewing from the drive end, the direction of rotation is clockwise which follows the same direction of rotation used most often by diesel engine manufacturers.
The generator can be driven counter-clockwise with small efficiency reduction and a higher noise level. This will also change the phase rotation. To correct this, the output cables will need to be rewired. Contact the factory for details.

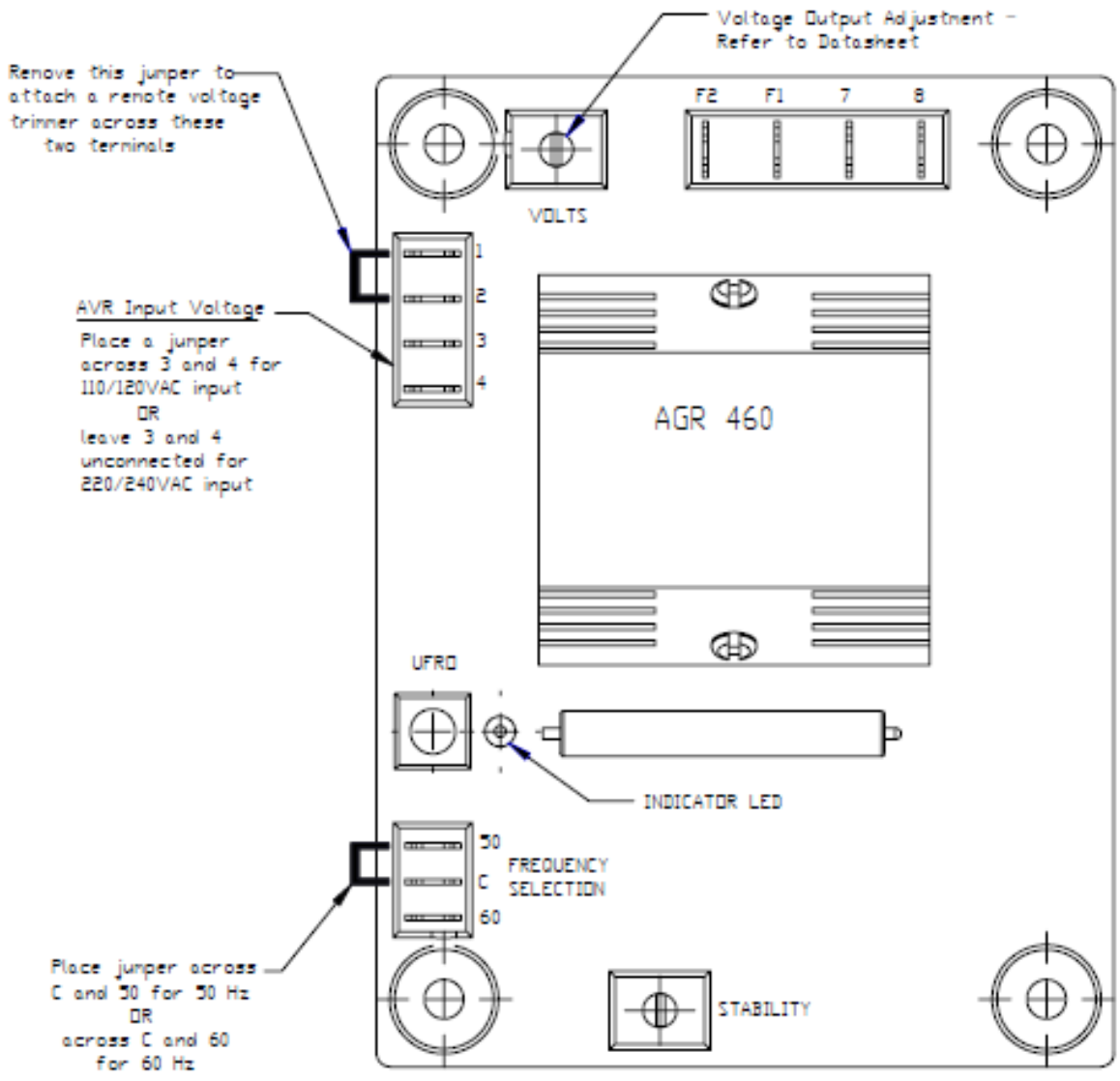
2.4.3 VOLTAGE AND FREQUENCY

Verify that the voltage and frequency outputs listed on the generator nameplate match those required for the generator set application.

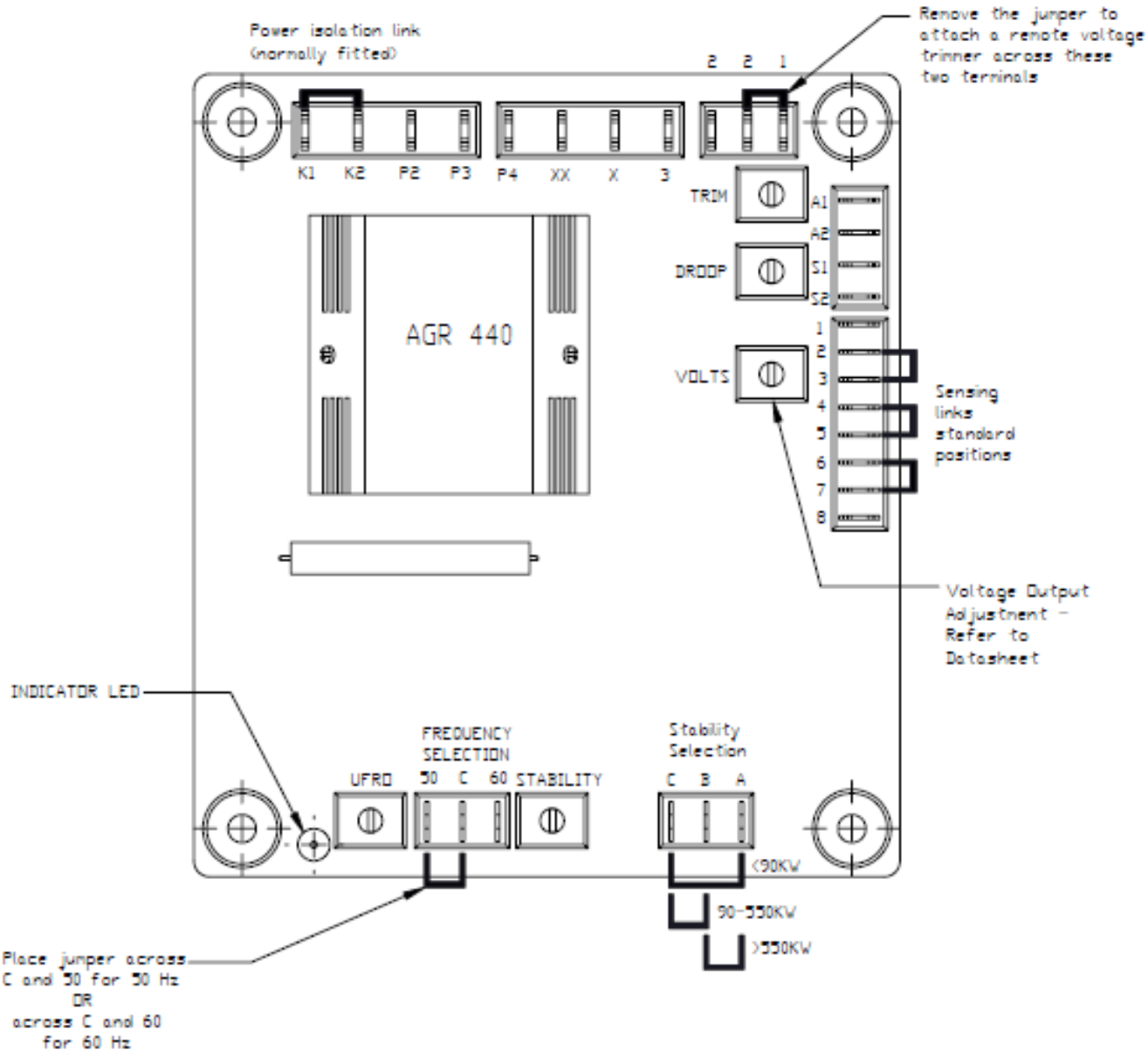
2.4.4 AVR SETTINGS

The automatic voltage regulator (AVR) settings are pre-adjusted by the factory to give acceptable performance for initial testing. However, if adjustments need to be made, the AVR can be accessed by removing the saddle box cover. In some generators, the AVR will have a cover over it, which will need to be removed to gain access. The generator will have one of four AVR models: AGR460, AGR440, AGR341, or AGR321. A basic overview of adjustments is given below. The complete datasheet for each model is provided below in Appendix E. Please refer to the nameplate on the generator frame to determine which AVR model is installed in the generator.

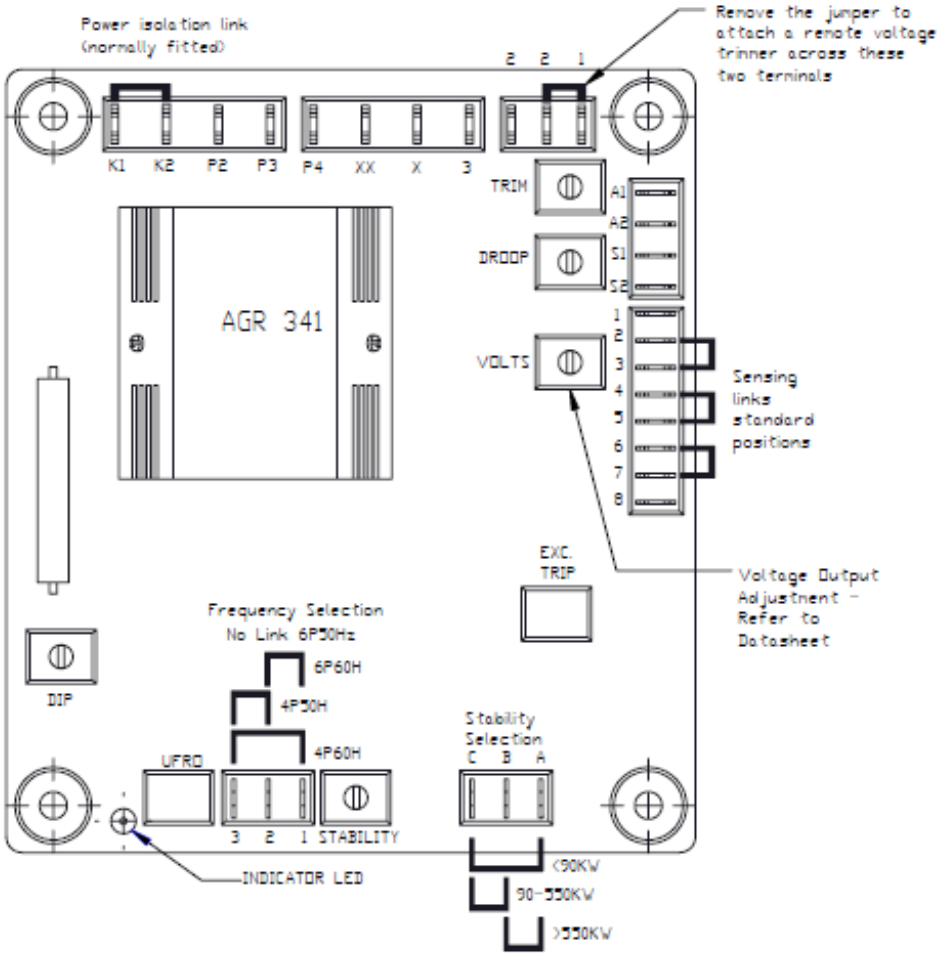
2.4.4.1 AGR460


Voltage Output Adjustment -
Refer to Datasheet
Remove this junper to
attach a remote voltage
trimmer across these
two terminals
F2
F1
7
8
VOLTS
1
2
3
4
AVR Input Voltage
Place a junper
across 3 and 4 for
110/120VAC input
OR
leave 3 and 4
unconnected for
220/240VAC input
AGR 460
UFRO
INDICATOR LED
50
C
60
FREQUENCY
SELECTION
Place junper across
C and 50 for 50 Hz
OR
across C and 60
for 60 Hz
STABILITY

2.4.4.2 AGR440


Power isolation link
(normally fitted)
Remove the jumper to attach a remote voltage trimmer across these two terminals
2 2 1
K1 K2 P2 P3 P4 XX X 3
TRIM
DROOP
VOLTS
A1
A2
S1
S2
1 2 3 4 5 6 7 8
AGR 440
Sensing links standard positions
Voltage Output Adjustment - Refer to Datasheet
INDICATOR LED
FREQUENCY SELECTION
UFRO 50 C 60 STABILITY
Stability Selection
C B A
<90KW
90-330KW
>330KW
Place jumper across C and 50 for 50 Hz
OR
across C and 60 for 60 Hz

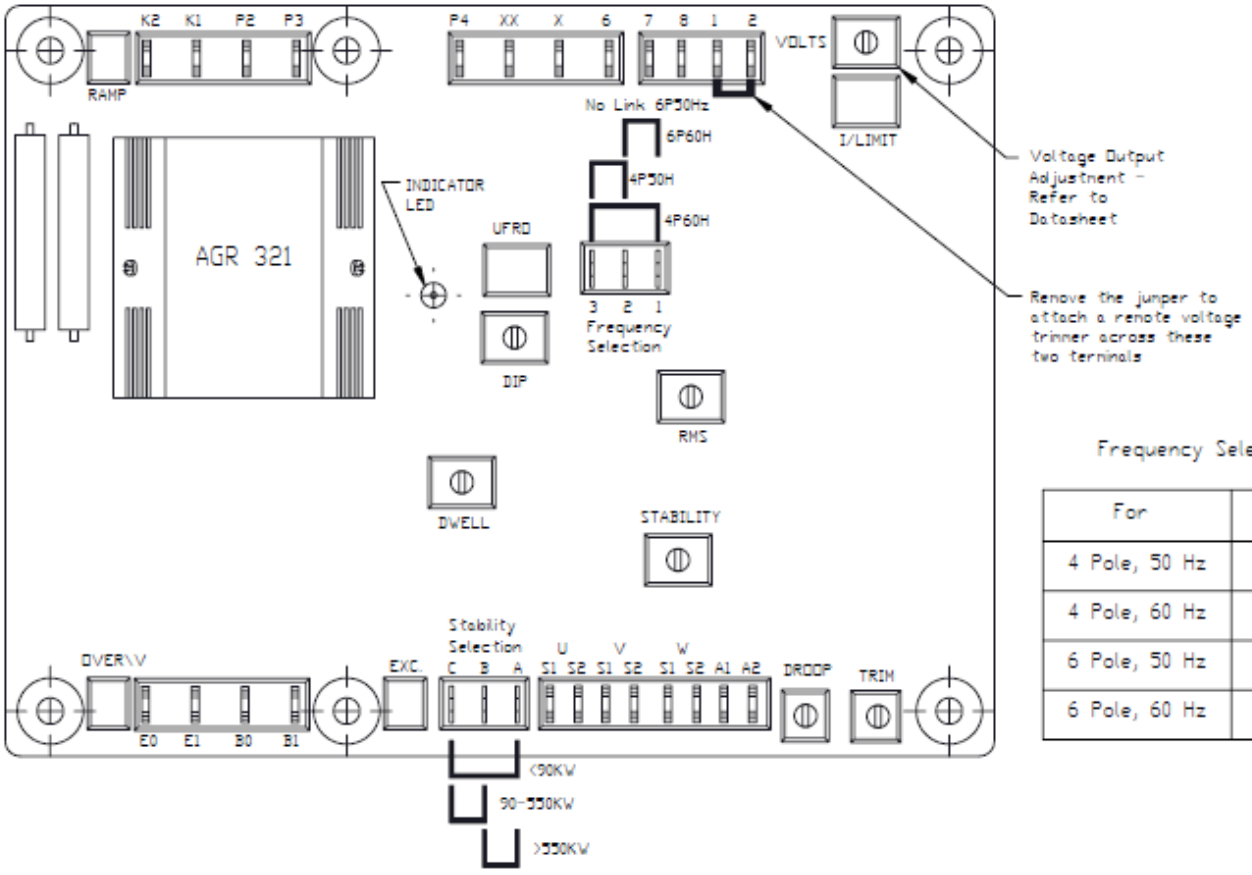
2.4.4.3 AGR341



Frequency Selection

For	Link
4 Pole, 50 Hz	2 & 3
4 Pole, 60 Hz	1 & 3
6 Pole, 50 Hz	No Link
6 Pole, 60 Hz	1 & 2

2.4.4.4 AGR321



Frequency Selection

For	Link
4 Pole, 50 Hz	2 & 3
4 Pole, 60 Hz	1 & 3
6 Pole, 50 Hz	No Link
6 Pole, 60 Hz	1 & 2

3. OPERATION

3.1 TESTING OF GENERATOR SET

⚠ While testing, covers may need to be removed to make adjustments, which will expose live circuits and components. Only qualified personnel should perform testing and adjustments.

3.1.1 TEST EQUIPMENT

Use a voltmeter, frequency meter and a current and/or power meter to perform basic checkout of the generating set. Measurements should be made either line-to-line or line-to-neutral. Using a power factor meter is recommended if applying a reactive load, i.e., inductive or capacitive. Be sure the AVR is exposed to make adjustments.

3.1.2 STARTING UP FOR THE FIRST TIME

Once generator set assembly is complete, be sure all of the engine manufacturer's pre-start procedures or checkouts have been performed. Verify that the generator will not be run beyond 125% of its rated speed by checking the adjustment of the engine governor. Damage to the generator may result if the speed governor is set too high. Take special care during the initial setting of the speed governor. If in doubt, set low and slowly increase speed to proper level.

To adjust the voltage output:

1. Connect a voltmeter and frequency meter or a DMM capable of both functions to the output of the generator, either line-to-line or line-to-neutral. Be sure the expected voltage, which is different between the two types of connections, is known.
2. Refer to sections 2.4.4 to find the diagram of the specific AVR in the generator.
3. Find the potentiometer label 'volts'.
4. Using a small flathead screwdriver, turn the volt potentiometer counterclockwise until it stops.
5. Run the generating set with no load.
6. Verify the frequency output is correct.
7. Slowly turn the volt potentiometer clockwise until the desired voltage is reached.

   Again, please note the type of connection, line-to-line or line-to-neutral, the voltmeter is hooked up to when setting the voltage.

The stability control of the AVR is preset at the factory and will not normally require further adjustment. However, if the voltage output oscillates (changes constantly) the stability can be adjusted following the instructions below.

1. Connect a voltmeter to the output of the generator, either line-to-line or line-to-neutral.
2. Run the generating set with no load and verify that the generator shaft speed is stable and spinning at the proper rpm.
3. Refer to sections 2.4.4 to find the diagram of the specific AVR in the generator.
4. Find the potentiometer label 'stability'.
5. Using a small flathead screwdriver, turn the stability potentiometer clockwise until it stops.
6. Slowly turn the stability potentiometer counterclockwise until the generator voltage begins to oscillate.
7. Turn the stability potentiometer clockwise slightly – just until the voltage stabilizes.
8. The stability should be set so that the voltage output is stable but close to the unstable range.

3.1.3 LOAD TESTING

3.1.3.1 AVR ADJUSTMENTS

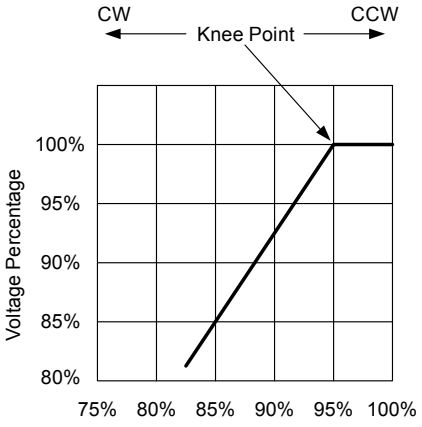
After adjusting the voltage and stability, the AVR will not typically require further adjustment. However, if voltage collapse or poor voltage regulation result when a load is applied, additional adjustments may need to be made. Please see the subsections below on the other possible adjustments to determine if one or more of these will fix the problem being experienced. Be sure to read through each carefully to be sure the correct adjustment is being made and to be sure it is done correctly.

3.1.3.1.1 UNDER FREQUENCY ROLL OFF (UFRO)

The UFRO is an under speed protection circuit that produces a volts/frequency (speed) characteristic whenever the speed of the generator shaft goes below a set threshold called the knee point. The UFRO needs adjustment if the generator is under load and a) the LED remains constantly lit or b) if voltage regulation is poor.

The knee point can be adjusted by using a small flathead screwdriver to turn the UFRO potentiometer. Please refer to the proper AVR diagram in section 2.4.4 to locate the UFRO potentiometer. Turning the UFRO potentiometer clockwise will lower the knee point frequency (speed) setting and turn off the LED. Ideally, the knee point should be set so that the LED lights whenever the frequency becomes less than the nominal frequency. For a 50 Hz generator, this would be about 47 Hz, while for a 60 Hz generator; it would be about 57 Hz.

The figure below shows the relationship between voltage and frequency within the UFRO. Note when the UFRO potentiometer is turned counterclockwise (CCW) the knee point is shifted to the right. If it is turned clockwise (CW) the knee point is shifted to the left.



(Typical Setting Shown)

3.1.3.1.2 EXCITATION TRIP (EXC TRIP)

Only for AGR341 & AGR321 AVRs

In the event of a short circuit from line-to-line or line-to-neutral or a large overload, PMG-excited AVRs such as the AGR341 and AGR321 provide maximum excitation power. Therefore, these AVRs utilize an over excitation circuit to protect the generator windings. This circuit detects high excitation and after a set amount of time, typically 8-10 seconds, it removes the excitation. If the excitation trip is not set properly, the output of the generator will fail when loaded or slightly overloaded and the LED will stay lit. The

voltage across terminals X and XX should be within 5% of 70 volts. This is the correct setting of the excitation trip. Stop the generator to reset. See wiring diagrams, Appendix E.

3.1.3.1.3 OVER VOLTAGE (OVER/V)

Only for the AGR321 AVR

The over voltage function removes generator excitation (AVR output) if the AVR sensing input is lost. In addition, this AVR includes an output to trip an optional external circuit breaker.

Correct setting of the over voltage function can be verified by measuring the voltage across terminals E0 and E1 which should be within 5% of 300V. If incorrect, the voltage can be adjusted by using a small flathead screwdriver to turn the over voltage potentiometer – turning it clockwise will increase the voltage and vice versa.

If the over voltage setting is incorrect, the generator output voltage will drop either when load is removed or when no load is applied and the LED will come on and stay lit. Stop the generator to reset.

3.1.3.1.4 OTHER ADJUSTMENTS/OPTIONS

Please refer to the proper AVR datasheet in Appendix E.

3.2.1 CONDUIT PASS-THROUGH

In order to run the output power wires from the generator terminal box, a hole will need to be cut into one of the two side panels on the saddle box. By default, the right panel – if facing the back of the generator – should be used. The left panel can be used if the generator was specially ordered for left side installation. Both panels are removable. Remove the proper panel before drilling or punching to avoid introducing metal debris inside the saddle box, which may cause a short or other damage.

Some type of conduit pass-through should be used to protect the wires from sharp edges and protect the saddle box from exposure to the elements or a harsh operating environment. The pass-through should minimize unsupported cable weight, apply no axial strain along the cables and support the cables outside the saddle box. Be sure the supports allow for vibration without introducing excessive force on the cables and allow a sufficient bending radius for all bends. An insulated or non-magnetic pass-through plate should be installed if single core cables are used.

Verify the winding resistance by following the steps in section 5.6.2 before final connections are made.

When making electrical connections to the terminal block, be sure the output cable connectors are placed on top of the existing generator winding connectors.

3.2.2 TERMINAL TORQUE SETTINGS

Before making any electrical terminal connections for the first time, clean plated surfaces with a degreasing agent then lightly abrade them to remove any tarnish. Do not score the surface.

All generator connections including links, CT's, accessories, cables, etc. should be torqued to 45 Nm or 33 ft-lbs.

Generator output cables should be connected to terminals using 8.8 grade steel bolts in addition to anti-vibration hardware. The torque value on all electrical connections should be checked periodically.

3.2.3 GROUNDING

The generator neutral output does not come connected to the frame/ground. If the neutral is supposed to be earthed (connected to the ground), use a conductor no smaller than half the diameter of a main power

wire to connect the neutral terminal to the earth terminal, both located inside the saddle box. If unsure, check the continuity between the neutral terminal inside the saddle box and any inner, unpainted panel in the saddle box.

The gen-set builder is responsible for verifying the generator frame, generating set bedplate and the main ground output terminal are electrically bonded. If unsure about the ground connection or simply to verify, remove the saddle box cover and perform a continuity check between the main ground output terminal and any inner, unpainted panel in the saddle box. Also check for continuity between the main ground output terminal and the generator set bedplate.

3.2.4 PROTECTION

The installer and/or end user is responsible for making sure that all local electrical and safety codes and regulations pertaining to the installation site are followed.

4. SERVICE

Performing routine service will help keep your generator running smoothly. The condition of the winding and bearings should be examined periodically, especially if the generator has been idle for a long time. Also, regular inspection and maintenance is required for generators fitted with air filters.

4.1 AIR FILTERS

⚠ Removal of filters exposes live parts. Unit must be OFF. Air filters for the removal of airborne particulate matter (dust) are offered as an additional option. Filters need to be ordered concurrently with the generator. Air filters need to be charged with oil before the engine-generator is used. Filter maintenance periods will depend upon the severity of the site conditions. Regular inspection of the elements will determine when cleaning is necessary.

4.1.1 CLEANING PROCEDURE

Remove the filter elements from their housings and wash the elements with a suitable degreaser material. Dry the elements completely before charging.

4.1.2 CHARGING AIR FILTERS

The following must be done before using the unit for the first time, and after every filter cleaning. Soak the filter element in SAE 20W50 oil or *Filterkote Type K*. Allow elements to completely drain before reassembling the filters and putting the unit into service.

4.2 WINDING CONDITION

⚠ Service and troubleshooting procedures performed improperly can result in severe personal injury or death. These procedures should only be performed by qualified personnel. Before carrying out any service or troubleshooting procedure, be sure engine-starting circuits are disabled and any anti-condensation heater supply is isolated.

Typical Insulation Resistance Values

The following information is provided to assist in determining the condition of the windings.

In operation, generators may be exposed to water. Units that have been in storage for may be exposed to temperature and humidity variations, which can cause significant condensation. Wet windings must be completely dried out before operating the generator. Otherwise, serious damage to the generator can occur.

A new or unused generator will have an insulation resistance (IR) value of around 25 MΩ, assuming it has been stored in a clean, dry area. If the value is below 10 MΩ, then the generator should undergo a drying out procedure and tested again.

Generators in service should have an IR value above 1 MΩ. If not, the generator should undergo a drying out procedure and tested again.

If the IR rating for all phase-to-phase and neutral to phase measurements are above 1 MΩ then the windings are in working order. If the IR value is still below 1 MΩ for any of the measurements, then the windings may need to be replaced.

4.2.1 WINDING CONDITION ASSESSMENT

Be sure to disconnect the AVR and ground the leads of the Resistance Temperature Detector (RTD) before conducting this test. To determine the condition of the windings, the insulation resistance is measured from each phase-to-phase and from each phase to neutral. This measurement should be conducted as part of regular maintenance after extended shutdown periods, or if the insulation resistance value is suspected to be low, e.g., wet or dirty windings.

Caution is necessary when it is possible that alternator windings may be excessively damp or dirty. A low voltage, typically 500V, Mugger (mega-ohm meter) or similar instrument should be used to obtain the initial measurement of the insulation resistance. Test voltages should be applied gradually and only for a short period, only long enough to make a determination about the status.

In no event should high voltage tests be conducted until the alternator windings have been dried and cleaned as required.

Insulation Test Procedure

Disconnect all electronic components including Avers, electronic protection equipment, etc. If present, ground all resistance temperature detection devices. Short out all diodes on the rotating rectifier. Examine the system under test and look for any connected components that might cause false readings or that could be damaged by the test voltage.

Conduct the insulation test in accordance with the operating instructions for the test instrument.

Test the insulation resistance from each phase-to-phase and from earth to each phase. New or unused generators should have insulation values between 10 MΩ to 25 MΩ or greater. Used generators should be above 1 MΩ. If the winding resistance is low it must be dried (see below) or repaired.

4.2.2 DRYING METHODS

Dry Run

In some cases, a generator with a low IR value can simply be run without excitation. The natural flow of ambient air through the generator will tend to dry the windings. This may raise the IR above 1.0 MΩ and allow the unit to be put into service. To do so, run the generator for 10 minutes with AVR terminals K1 and K2 open, and inspect the windings to see if they look dry. Re-measure the insulation resistances. If all the IR values are above 1.0 MΩ, the windings are good. If not, use one of the other drying methods.

Forced Air Drying

Remove all covers from the generator to allow the moisture to escape. Be sure air can flow freely into one side of the generator and out another. At a minimum, there should be two openings.

Using two electric fan heaters rated 1 to 3 kW; direct hot air into one of the openings. Make sure the heat source is at least 300 mm (12 inches) away from the windings to prevent overheating and insulation damage. Heat at the entry point should not exceed 80°C (180°F). A period of 3 hours is typical to restore the IR of a generator.

If the generator will not be run immediately, insure that anti-condensation heaters, if installed, are in operation, and retest windings before running.

Short Circuit Method

The short circuit method is a process that should only be performed by a technician qualified in the safe operating practices required around generator sets. Contact the factory for detailed instructions, should this method be chosen.

4.3 BEARINGS

All bearings are supplied from the factory pre-packed with Athlon™ Generator grease, conforming to the specifications of Kluber Asonic GHY 72 grease. Do not mix with any grease of different specifications. Mixing grease of differing specifications will reduce bearing life.

The specification for Athlon™ grease is available on request from the factory. Lifetime Lubricated bearings are fitted with integral seals and are not greasable.

The life expectancy of bearings in service is a direct function of the working conditions and the environment. High levels of vibration from the drive engine or misalignment of the set will stress the bearing and reduce its service life.

If the vibration limits set out in BS5000-3 and ISO 8528-9 are exceeded, bearing life will be reduced.

Long stationary periods in an environment where the generator is subject to vibration can also cause false brinelling (surface failure), which puts flats on the balls, and grooves on the races, leading to premature failure. Very humid atmospheric or wet conditions can emulsify the grease, causing corrosion and deterioration of the grease, leading to premature failure of the bearings.

For normal situations, users may expect to be able to obtain 30,000 hours service life from Lifetime Lubricated bearings, and 40,000 hours from greasable bearings

5. TROUBLE SHOOTING GUIDE

Athlon™ generators are provided with excitation control systems. Four automatic voltage regulator (AVR) systems are available across the range of generator models and sizes. The following will assist the user in determining any faults. Follow the guide for the proper AVR in question.

5.1 AGR460 AVR

SYMPTOMS	SOLUTIONS
Generator produces no voltage	• Check speed with tachometer • Check residual voltage and flash the field as necessary – see section 5.3 • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces unstable voltage	• Check speed with tachometer. • Verify generator connections • Replace defective or worn rheostat • Test and adjust or replace AVR
Generator produces high voltage	• Check speed with tachometer • Verify generator connections • Check load PF. Leading PF can cause voltage to climb. • Test and adjust or replace AVR
Generator produces low voltage at no load	• Check speed with tachometer • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces low voltage with load applied	• Check speed with tachometer • Check diodes • Test and adjust or replace AVR

5.2 AGR440 AVR

SYMPTOMS	SOLUTIONS
Generator produces no voltage	• Check speed with tachometer • Check residual voltage and flash the field as necessary - see Section 5.3 • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces unstable voltage	• Check speed with tachometer. • Verify generator connections • Replace defective or worn rheostat • Test and adjust or replace AVR
Generator produces high voltage	• Check speed with tachometer • Verify generator connections • Check load PF. Leading PF can cause voltage to climb. • Test and adjust or replace AVR
Generator produces low voltage at no load	• Check speed with tachometer • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces low voltage with load applied	• Check speed with tachometer • Check diodes • Test and adjust or replace AVR

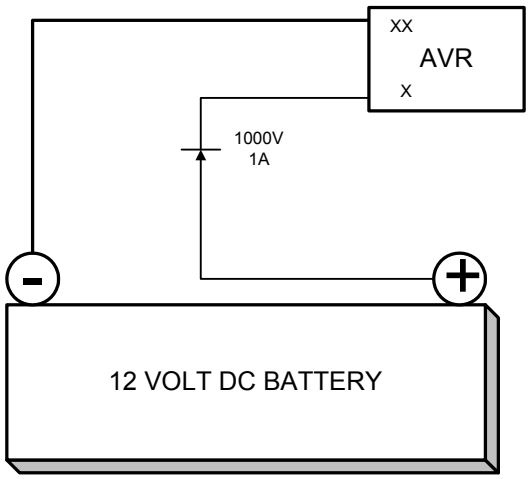
5.3 RESIDUAL VOLTAGE CHECK (This procedure is appropriate for use to with either AGR460 or AGR440 regulators.)

With the generator set stationary, remove the regulator access cover and leads X and XX from the AVR. Start the unit and measure voltage across the regulator terminals 7-8 on AGR460 AVR or P2-P3 on AGR440 AVR. Stop the set, and replace leads X and XX on the AVR terminals. If the measured voltage was above 5 volts, the generator should operate normally.

If the measured voltage was below 5 volts, follow the process described below.

Using a 12-volt DC battery as a power supply, clip leads from battery negative to AVR terminal XX, and from battery positive through a diode to AVR terminal X. See figure below.

⚠ Important! A diode must be used as shown below to insure the AVR is not damaged.



NOTE: If the generator set battery is used for field flashing, the generator main stator neutral must be disconnected from ground.

Restart the unit and note output voltage from main stator, which should be approximately nominal voltage, or voltage at AVR terminals 7 and 8 on AGR460, P2-P3 on AGR440, which should be between 170 and 250 volts.

Stop the unit, unclip the battery supply from terminals X and XX, reinstall the regulator cover and restart the set. The generator should now operate normally. If no voltage rise is noted, then a fault exists in either the generator or the AVR.

Follow Section 5.6 to check generator windings and rotating diodes.

5.4 AGR341 AVR

SYMPTOMS	SOLUTIONS
Generator produces no voltage	• Check link K1-K2 on auxiliary terminals of AVR • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces low voltage with load applied	• Check speed with tachometer • Check diodes • Test and adjust or replace AVR
Generator produces high voltage	• Check speed with tachometer • Verify generator connections • Check load PF. Leading PF can cause voltage to climb. • Test and adjust or replace AVR
Generator produces unstable voltage	• Check speed with tachometer. • Verify generator connections • Replace defective or worn rheostat • Test and adjust or replace AVR

.

5.5 AGR321 AVR

SYMPTOMS	SOLUTIONS
Generator produces no voltage	• Check link K1-K2 on auxiliary terminals of AVR • Verify generator connections • Check diodes • Test and adjust or replace AVR
Generator produces low voltage with load applied	• Check speed with tachometer • Check diodes • Test and adjust or replace AVR
Generator produces high voltage	• Check speed with tachometer • Verify generator connections • Check load PF. Leading PF can cause voltage to climb. • Test and adjust or replace AVR
Generator produces unstable voltage	• Check speed with tachometer. • Verify generator connections • Replace defective or worn rheostat • Test and adjust or replace AVR

5.6 EXCITATION TESTS

5.6.1 CHECKING PMG (on units fitted w/PMG)

With the unit operating, measure voltages at the regulator terminals P2, P3 and P4. These should be balanced and within the following ranges:

50 Hz generators - 170-180 volts
60 Hz generators - 200-216 volts

Should the voltages be unbalanced, stop the set, remove the PMG sheet metal cover from the non-drive end bracket and disconnect the multi-pin plug in the PMG output leads. Check leads P2, P3, and P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within +/-10% of 2.3 ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct, then the PMG rotor must be replaced.

5.6.2 CHECKING GENERATOR WINDINGS AND ROTATING DIODES

This procedure is carried out with leads X and XX disconnected at the AVR. Connect a 12-volt DC power supply to leads X and XX. Start the set and run at rated speed. Measure the voltages at the main output terminals U, V and W. If voltages are balanced and within +/-10% of the generator nominal voltage, refer to 5.6.2.1. Check voltages at AVR terminals 6, 7 and 8. These should be balanced and between 170-250 volts.

If voltages at the main terminals are balanced but voltage at 6, 7 and 8 are unbalanced, check continuity of leads 6, 7 and 8. If voltages are unbalanced, refer to 5.6.2.2.

5.6.2.1 BALANCED MAIN TERMINAL VOLTAGES

Exciter windings, main windings and main rotating diodes are considered to be within acceptable limits if all voltages are balanced within 1% at the main terminals. Faults in the AVR or transformer control are then assumed and described below.

If voltages are balanced but low, the probability is that there is a fault in the main excitation windings or rotating diode.

Rectifier Diodes

Diodes on the main rectifier assembly can be checked with a multimeter. The diode function must be checked, not simply the resistance measurement. The leads connected to each diode should be disconnected at the terminal end, thus isolating the AVR from the generator. Forward and reverse resistance should then be checked. A properly functioning diode will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30K ohms or greater, while forward biased resistance will be less than 10 ohms. A open (bad) diode will give a infinite reading in both directions while a shorted (bad) diode will have a very low resistance in both directions.

Replacement of Faulty Diodes

The following procedure can be used to replace faulty diodes as shown below. However, diode failures after a break-in period are usually traceable to an external fault, such as lightening strike. To avoid continuing problems, it is recommended that the entire rectifier assembly be replaced.

The rectifier assembly is split into positive and negative plates. The main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative-biased diodes and the positive

plate carrying positive-biased diodes. Insure that correct polarity diodes are fitted to each respective plate. The recommended torque for tightening diodes is 4.06 - 4.74 Nm (36-42 in lb).

Surge Suppressor

The surge suppressor is a metal-oxide varistor (“variable resistor” used to protect circuits against excessive voltage by acting as a spark gap) connected across the two rectifier plates to prevent transient reverse voltages in the field winding from damaging the diodes. The varistor should read virtual infinity in both directions with an ohmmeter. A defective unit will show visible signs of failure, and should be replaced.

Main Excitation Windings

If the output is still low when separately excited, the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts), since the fault is in one of these windings. The exciter stator resistance is measured across leads X and XX. The exciter rotor is connected to six studs, which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings. Resistance values should be within +/-10% of the values given in the tables below.

Winding Resistances

Frame Size	Main Rotor	Exciter Stator	Exciter Rotor	PM Stator
AG164A	0.44	19	0.26	
AG164B	0.48	19	0.26	
AG164C	0.52	19	0.26	
AG164D	0.56	19	0.26	
AG184E	0.64	20	0.21	
AG184F	0.74	22	0.23	
AG184G	0.83	22	0.23	
AG184H	0.89	24	0.24	
AG184J	0.96	24	0.24	
AG224C	0.59	21	0.142	
AG224D	0.64	21	0.142	
AG224E	0.69	20	0.156	
AG224F	0.83	20	0.156	
AG224G	0.94	20	0.156	
AG274C	1.12	20	0.156	
AG274D	1.26	20	0.156	
AG274E	1.34	20	0.182	
AG274F	1.52	20	0.182	
AG274G	0.69	20	0.182	
AG274H	0.82	20	0.182	
AG274J	2.08	20	0.182	
AG274K	2.08	20	0.182	
AG4C	0.91	18	0.136	2.6
AG4D	1.04	18	0.136	2.6
AG4E	1.17	18	0.136	2.6
AG4F	1.35	18	0.136	2.6
AG5C	1.55	17	0.184	2.6
AG5D	1.77	17	0.184	2.6
AG5E	1.96	17	0.184	2.6
AG5F	2.16	17	0.184	5.6
AG6G	1.75	17	0.158	5.6
AG6H	1.88	17	0.158	5.6
AG6J	2.09	17	0.158	5.6
AG6K	2.36	17	0.158	5.6

5.6.2.2 UNBALANCED MAIN TERMINAL VOLTAGES

Unbalanced voltages indicate a fault on the main stator winding or main cables to the circuit breaker. These faults may also cause noticeable load increase on the engine.

Disconnect the main cables and separate the winding leads U1-U2, (U5-U6), V1-V2, (V5-V6), W1-W2, (W5-W6) to isolate each winding section.

5.6.2.2 AVR PERFORMANCE TESTING

AVR CONTROLLED GENERATORS			
Frame Size	Section Resistance	Frame Size	Section Resistance
AG164A	0.81	AG4C	0.0083
AG164B	0.51	AG4D	0.0062
AG164C	0.36	AG4E	0.0045
AG164D	0.30	AG4F	0.0037
AG184E	0.20	AG5C	0.0033
AG184F	0.13	AG5D	0.0025
AG184G	0.11	AG5E	0.0022
AG184H	0.085	AG5F	0.0019
AG184J	0.074	AG6G	0.0017
AG224C	0.09	AG6H	0.0013
AG224D	0.065	AG6J	0.0011
AG224E	0.05	AG6K	0.0085
AG224F	0.033		
AG224G	0.028		
AG274C	0.03		
AG274D	0.019	AG162D	0.68
AG274E	0.016	AG162E	0.42
AG274F	0.012	AG162F	0.31
AG274G	0.01	AG162G	0.21
AG274H	0.008	AG182H	0.16
AG274J	0.006	AG182J	0.13
AG274K	0.006	AG182K	0.10

All models of automatic voltage regulators can be tested as follows:

1. Remove exciter field leads X & XX (F1 & F2) from the AVR terminals X & XX (F1 & F2).
2. Connect a 60W 240V incandescent bulb to AVR terminals X & XX (F1 & F2).
3. Turn the AVR VOLTS control potentiometer fully clockwise.
4. Connect a 12V; 1.0A DC supply to the exciter field leads X & XX (F1 & F2) with X (F1) to the positive.
5. Start the generating set and run at rated speed.
6. Check that the generator output voltage is within +/- 10% of rated voltage.

The bulb should light for approximately 8 seconds and then turn off. Failure to turn off indicates a faulty protection circuit and the AVR should be replaced. Turning the "VOLTS" control potentiometer fully counter-clockwise should turn off the lamp with all AVR types. Should the bulb fail to light, the AVR has failed and should be replaced.

IMPORTANT: After testing, turn potentiometer fully counter-clockwise.

APPENDIX A

ATHLON™ GENERATOR WARRANTY

NOTE: This warranty is extended only to Athlon™ industrial or commercial clients. It does not extend to customers of Athlon™ clients.

WARRANTY PERIOD

Athlon™ warrants Standby Duty Generators to be free from defects in materials and workmanship for a period of 24 months from date of commissioning, 30 months from date of shipment, or 1200 hours of run time, whichever occurs first. Athlon™ warrants Continuous Duty Generators to be free from defects in materials and workmanship for a period of 12 months from date of commissioning, 18 months from date of shipment, or 5000 hours of run time, whichever occurs first.

CORRECTION OF DEFECTS

Athlon™ will repair or at its option replace any defect that, under proper use, appears in the Generator(s) during the warranty period, given that upon examination by Athlon™, the defect is solely due to defective material or workmanship. The defective part is to be promptly returned, FOB Athlon™ plant or other destination specified by Athlon™. All identification marks and numbers must be intact to aid identification.

Any part repaired or replaced under warranty will be returned to the customer by Athlon™, free of charge. Athlon™ shall not be liable for any expenses that may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement part supplied by us. Athlon™ shall have no liability for defects in any items, which have not been properly installed in accordance with recommended installation practices. This warranty shall be conditioned upon Athlon™ receiving written notice of any defect within 45 days after the defect is discovered. In no event shall Athlon's™ liability for such defective or nonconforming products exceed the purchase price paid by Buyer for the item(s)

.

In all cases of claims, the Athlon™ decision shall be final on all questions as to defects and the exchange of a part or parts.

EXCLUSIONS

This warranty does not (1) cover any tax, duty, custom, inspection or testing fee, or any other charge of any nature related thereto, nor does it cover the costs of disassembling or removing defective equipment or reassembling, reinstalling, or testing repaired or replaced equipment or finishing the reinstallation thereof, (2) apply and shall be void with respect to equipment operated in excess of rated capacity or otherwise not in accordance with installation, maintenance, or operating instructions, or to equipment which has been subjected to abuse, negligence, misuse, misapplication, accident, damages by circumstances beyond Athlon's™ control, due to improper installation, operation, maintenance or storage, or to other than normal use or service, and (3) apply to equipment or components not manufactured by or for Athlon™.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES (EXCEPT TITLE), INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NO EMPLOYEE, REPRESENTATIVE, OR AGENT OF ATHLON™ OTHER THAN AN OFFICER OF THE CORPORATION IS AUTHORIZED TO ALTER OR MODIFY ANY PROVISION OF THIS WARRANTY OR TO MAKE ANY GUARANTEE, WARRANTY, OR REPRESENTATION, EXPRESS OR IMPLIED, ORALLY OR IN WRITING, WHICH IS CONTRARY TO THE FOREGOING.

APPENDIX B

GENERATOR DATA

MODEL NUMBER

Athlon™ Generators use a model number system conforming to that used by many manufacturers of similar types and models of generators. For example, Athlon™ Generator Model AG224D can be interpreted as shown below:

AG	22	4	D
Manufacturer	Frame Number	Number of Poles	Core Designation

Frame Number – refers to the frame size of the generator and follows industry standard. Athlon™ offers frame sizes of 16, 18, 22, 27, 4, 5, and 6.

Number of Poles – refers to the number of poles in the stator. Athlon ™ generators typically use 4 poles for an input of 1500 RPM for 50 Hz output or an input of 1800 RPM for 60 Hz output. Athlon™ also offers two poles to allow the use of small engines running at higher speeds: 3000 RPM yields 50 Hz while 3600 RPM yields 60 Hz.

Core Designation – refers to the core length size which correlates to the KVA output for a given frame size.

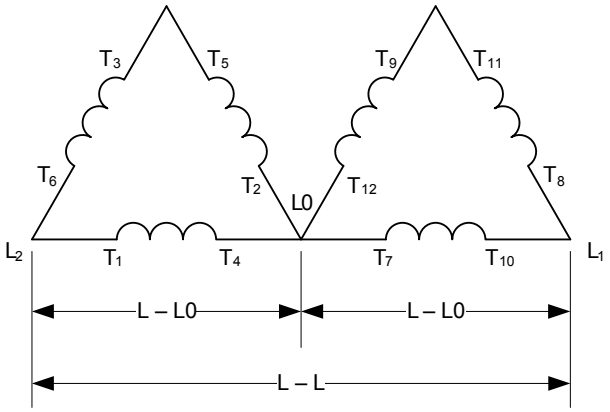
SERIAL NUMBER LOCATION

Each generator has a serial number stamped on the Nameplate supplied with each unit. It is important to record and preserve this serial number for use when ordering parts, or requesting service.

CONNECTION DIAGRAMS

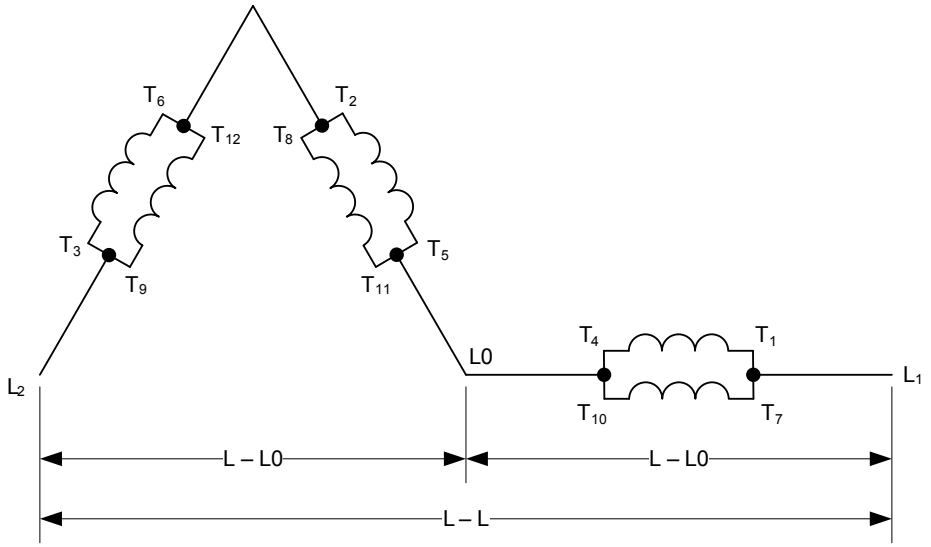
Terminal Ends	
IEC	NEMA
U1	T1
U2	T4
U5	T7
U6	T10
V1	T2
V2	T5
V5	T8
V6	T11
W1	T3
W2	T6
W5	T9
W6	T12

Double Delta 1PH 3W



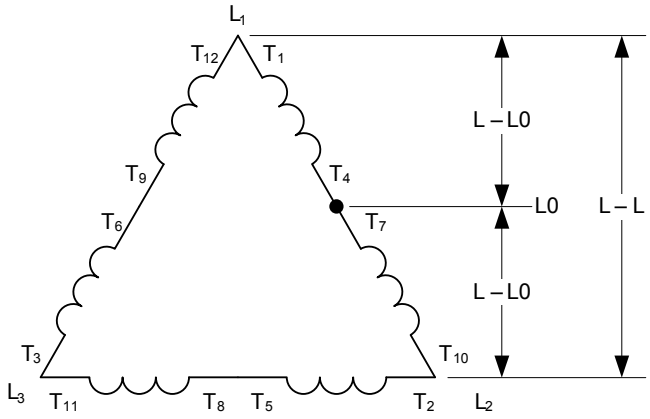
DOUBLE DELTA		
1 PH 3 W		
HZ	L-L	L-L0
60	200	100
	220	110
	240	120
50	220	110

Parallel Low Zig Zag 1PH 3W



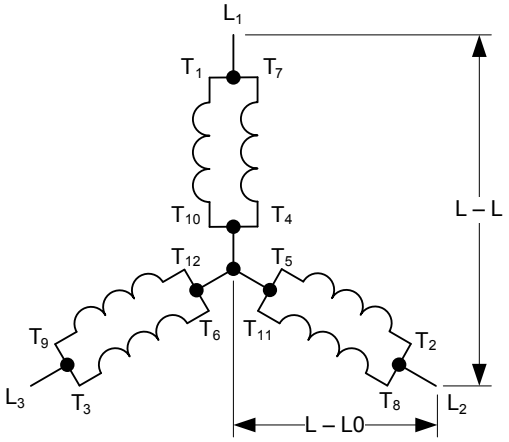
PARALLEL LOW ZIG ZAG		
1 PH 3 W		
HZ	L-L	L-L0
60	200	100
	220	110
	240	120
50	220	110

Series High Delta 3PH 4W



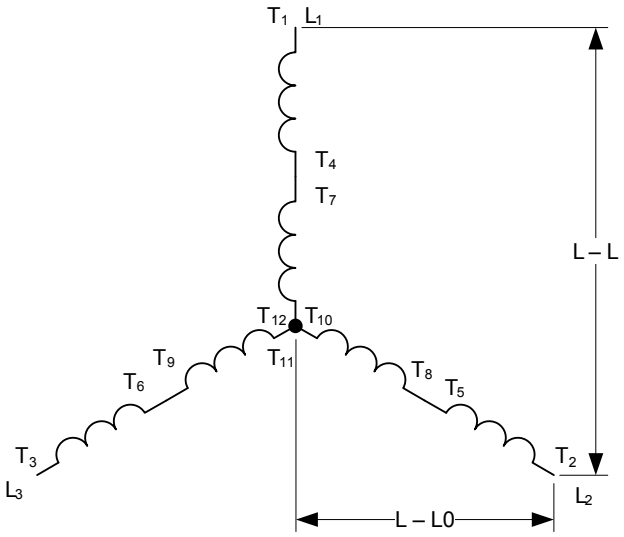
SERIES HIGH DELTA		
3 PH 4 W		
HZ	L-L	L-L0
60	240	120
	277	139
50	200	100
	220	110
	240	120

Parallel Low Wye (Star) 3PH 4W



PARALLEL LOW WYE (STAR)		
3 PH 4 W		
HZ	L-L	L-L0
60	208	120
	220	127
	230	133
	240	139
50	190	110
	400	115
	415	127

Series High Wye (Star) 3PH 4W



SERIES HIGH WYE (STAR)		
3 PH 4 W		
HZ	L-L	L-L0
60	416	240
	440	254
	460	266
	480	277
50	380	219
	400	231
	415	240

APPENDIX C

PARALLEL OPERATION

Paralleling Basics

The following points are basic criteria, which must be met before two units can be paralleled.

Additional paralleling circuitry

- Voltage regulator-paralleling provisions (Note: AVR Model AG460 is not suitable for parallel operation).
- Paralleling current transformer(s)
- Paralleling provisions on governor controls

Before operating generator sets in parallel, each set should be checked by starting, operating, and adjusting the sets as individual units before attempting paralleling. The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation. The generators must have the same phase rotation. The voltage and frequency must be the same for all sets with voltages in phase.

Voltage Regulator

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more AC generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to allow the voltage regulator to control the reactive or VAR load while it is in parallel operation. Additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

A droop kit accessory is required for parallel operation. When operating in parallel with other generators, it is important that:

- Frequency must match within close limits.
- Voltages must match within close limits.
- Phase angle of voltages must match within close limits.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, wattmeter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

Reactive Load Control

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive load to the generator with the lower field current. This is known as the reactive circulating current, and there are two methods of controlling it in parallel operation:

- Reactive droop compensation: The bus voltage droops, or decreases, as the reactive lagging power factor load is increased.
- Reactive differential compensation: The reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage.

Droop

Athlon Generators use the droop method. The method of kVAr sharing is to create a generator voltage characteristic, which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (C.T.), which provides a signal dependent on current phase angle (i.e. power factor) to the AVR.

If parallel operation is envisioned for your generator, please contact the factory at time of ordering, so that the proper accessories can be provided.

APPENDIX D

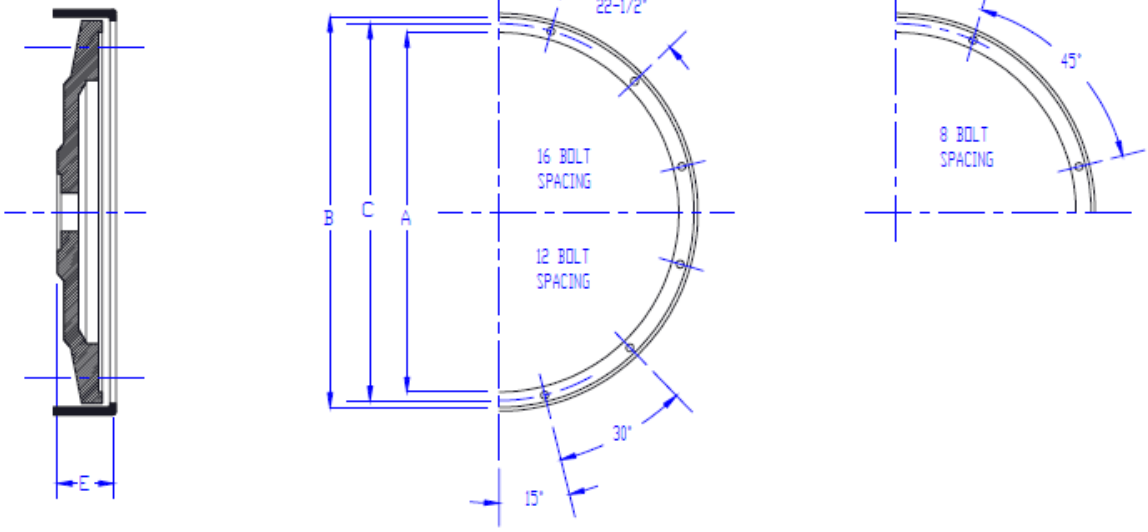
SAE DATA

SAE ADAPTOR / COUPLING COMBINATIONS

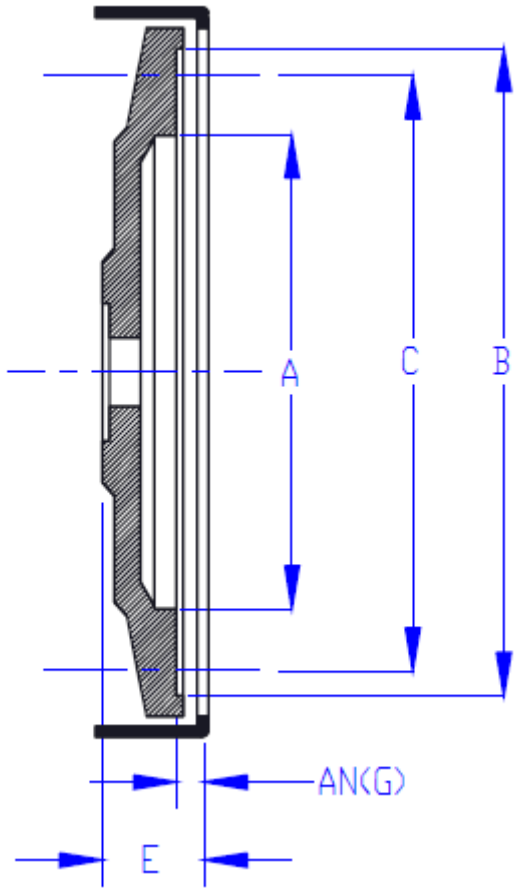
Adaptor	Coupling	AG16	AG18	AG22	AG27	AG4	AG5	AG6
6	6.5	A						
	7.5	A						
5	6.5	O	A					
	7.5	A	A					
	ALPHA	A	A					
4	6.5	A	A					
	7.5	O	A	X				
	8	O	O*	A				
	10	O	O*	A				
	11.5	A						
3	8		X	A				
	10	A	O*	O	O			
	11.5	A	O*	O	O			
2	10			A	A			
	11.5		X	O	O	A		
1	11.5			A	A	A		
	14			A	O	O	A	A
	17.75D				X	A	A	
1/2	14					A	A	A
	18						A	A
	17.75D					A	A	A
0	14						A	A
	18					O	A	O
	17.75D					A	O	A
0	18						A	A
	21						A	A
	24						A	A
A - Available O - Most Common X - Special Order								

- **AG184 H & J - Only Coupling & Adaptor Combinations Available**

Standard Industrial Flywheel Housings						
SAE No.	A	B	C	E	# Holes	Size
0	31	34-3/4	33-1/2	3-15/16	16	1/2-13
0	25-1/2	28	26-3/4	3-15/16	16	1/2-13
1/2	23	25-1/2	24-3/8	3-15/16	12	1/2-13
1	20-1/8	21-3/4	20-7/8	3-15/16	12	7/16-14
2	17-5/8	19-1/4	18-3/8	3-15/16	12	3/8-16
3	16-1/8	17/3/4	16-3/8	3-15/16	12	3/8-16
4	14-1/4	15-7/8	15	3-15/16	12	3/8-16
5	12-3/8	14	13-1/8	2-13/16	8	3/8-16
6	10-1/2	12-1/8	11-1/4	2-13/16	8	3/8-16



Standard Industrial Flywheels							
Nom. Clutch Diameter	A	B	C	E	AN(G)	# Holes	Bolt Size
6-1/2	7-1/4	8-1/2	7-7/8	2-13/16	1-3/16	6	5/16-18
7-1/2	8-18	9-1/2	8-3/4	2-13/16	1-3/16	8	5/16-18
8	8-7/8	10-3/8	9-5/8	3-15/16	2-7/16	6	3/8-16
10	10-7/8	12-3/8	11-5/8	3-15/16	2-1/8	8	3/8-16
11-1/2	12-3/8	16-1/8	13-1/8	3-15/16	1-9/16	8	3/8-16
14	16-1/8	18-1/8	17-1/4	3-15/16	1	8	1/2-13
16	18-1/8	20-3/8	19-1/4	3-15/16	5/8	8	1/2-13
18	19-5/8	22-1/2	21-3/8	3-15/16	5/8	6	5/8-11
21	23	26-1/2	25-1/4	3-15/16	0	12	5/8-11
24	25-3/8	28-7/8	27-1/4	3-15/16	0	12	3/4-10
Delco Industrial Flywheels							
15.5D	---	15-1/2	13-7/8	---	23/32	8(4X2)	5/8-11
17.75D	---	17-3/4	15-1/2	---	23/32	8(4X2)	5/8-11



SAE PLATE BOLT TORQUE VALUES

Model Number	Bolt Size	Torque (Nm)	Torque (Ft-lb)
AG16	M10 X 30 mm	75	55
AG18	M10 X 50 mm	75	55
AG22	M16 X 35 mm	320	236
AG27	M16 X 55 mm	320	236
AG4	M20 X 55 mm	625	461
AG5	M16 X 65 mm	625	461
AG6	M 24 X 65 mm	1072	791

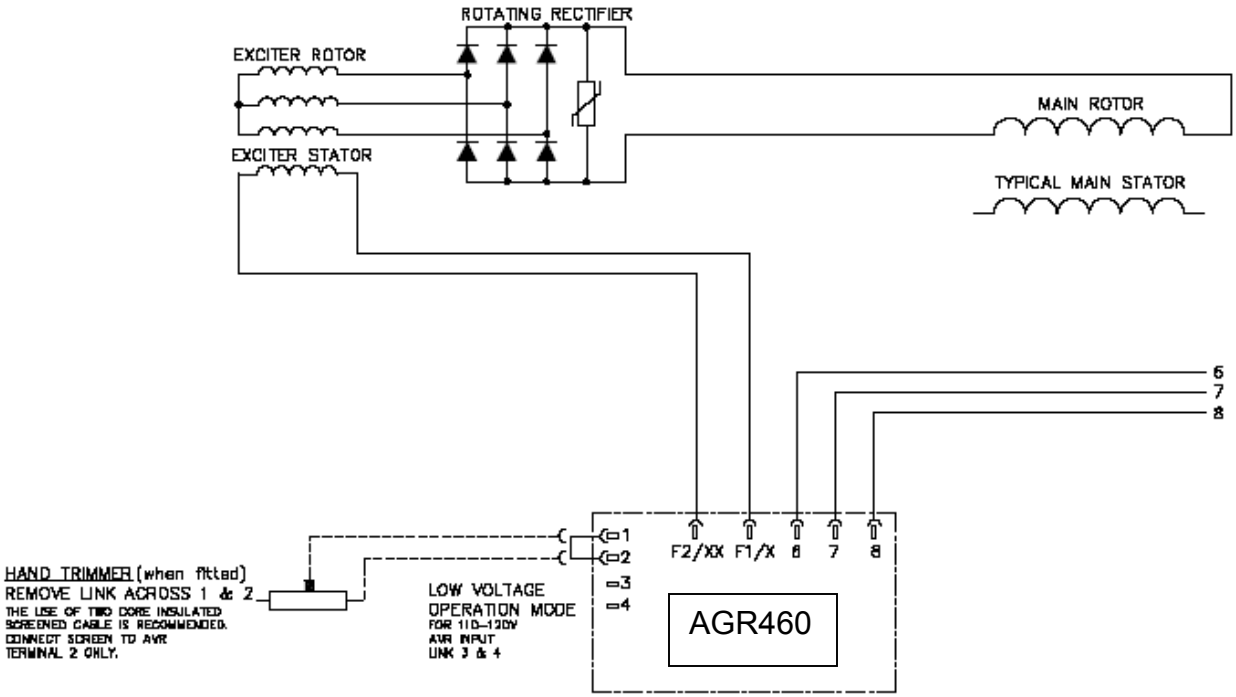
APPENDIX E

AVR DATA SHEETS

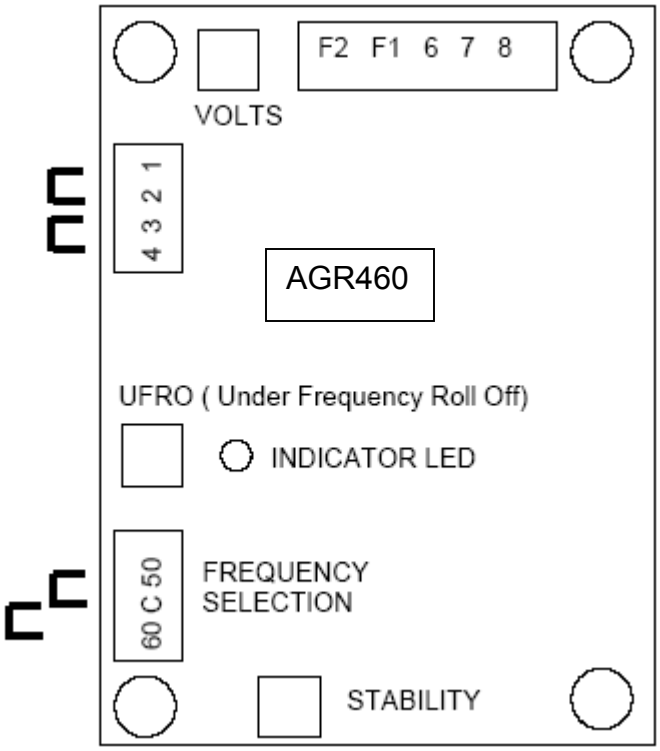
AGR460 AUTOMATIC VOLTAGE REGULATOR

SPECIFICATIONS		
Input Voltage	 Frequency Phase	95-132V or 190-264V AC (jumper) 50/60 Hz nominal Single Phase
Output Voltage	 Current Resistance	Max 90V DC @ 207V AC input Continuous 4A DC; Intermittent 6A -10 sec Minimum 15 Ohms
Regulation	+/- 1.0% [1]	
Thermal Drift	0.05% per degree C in AVR ambient [2]	
System Response	AVR response Field Current to 90% Machine Volts to 97%	20 ms 80 ms 300 ms
External Voltage Adjustment	+/- 10% w/ 1k ohm – 1 watt trimmer [3]	
Under Frequency Protection	Set Point Slope	95% Hz [4] 170% down to 30 Hz
Unit Power Dissipation	10 Watts Max	
Build-up Voltage	4 Volts at AVR terminals	
Environment Specifications Operating	Temperature Relative Humidity 0-70^{0}C Storage Temperature Vibration	-40^{0}C to +70^{0}C 0-95% non condensing -55^{0}C to +80^{0}C 20 -100 Hz – 50 mm/sec; 100 - 2K Hz – 3.3g
NOTES	1 - with 4% Engine Governing 2 - after 10 minutes 3 - some de-rating may occur at voltage extremes 4 - factory set, semi sealed, select w/ jumper	

WIRING DIAGRAM



OPERATION



CONTROL FUNCTION		ROTATION
VOLTS	Output Voltage Adjustment	Clockwise to Increase Voltage
STABILITY	Voltage Hunting Prevention	Clockwise to Increase Dampening
UFRO [1]	Setting of UFRO knee point	Clockwise Reduces Knee Point

1 – Under Frequency Roll Off (UFRO)

ADJUSTMENT OF AVR CONTROLS - AGR460

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can be changed by careful adjustment of the VOLTS control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 and 2 on the AVR will be fitted with a jumper if no hand trimmer is required. Terminals 3 and 4 are jumpered only for special low voltage applications.

CAUTION Do not increase the voltage above the rated generator voltage. If in doubt, refer to the name plate mounted on the generator case.

CAUTION Do not ground any of the hand trimmer terminals as these could be above ground potential. Failure to do so could cause equipment damage.

CAUTION

1. Before running generator, turn the VOLTS control fully counter-clockwise.
2. Turn remote volts trimmer (if fitted) to midway position.
3. Turn STABILITY control to midway position.
4. Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.
5. Start generator set, and run at no load at nominal frequency e.g. 50-53Hz or 60-63Hz.
6. If the red Light Emitting Diode (LED) is lighted, refer to the Under Frequency Roll Off (UFRO) adjustment.
7. Carefully turn VOLTS control clockwise until rated voltage is reached.
8. If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator.

The correct setting can be found by running the generator at no load and slowly turning the stability control counter-clockwise until the generator voltage starts to become unstable.

The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an under-speed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a preset threshold known as the "knee" point.

The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating.

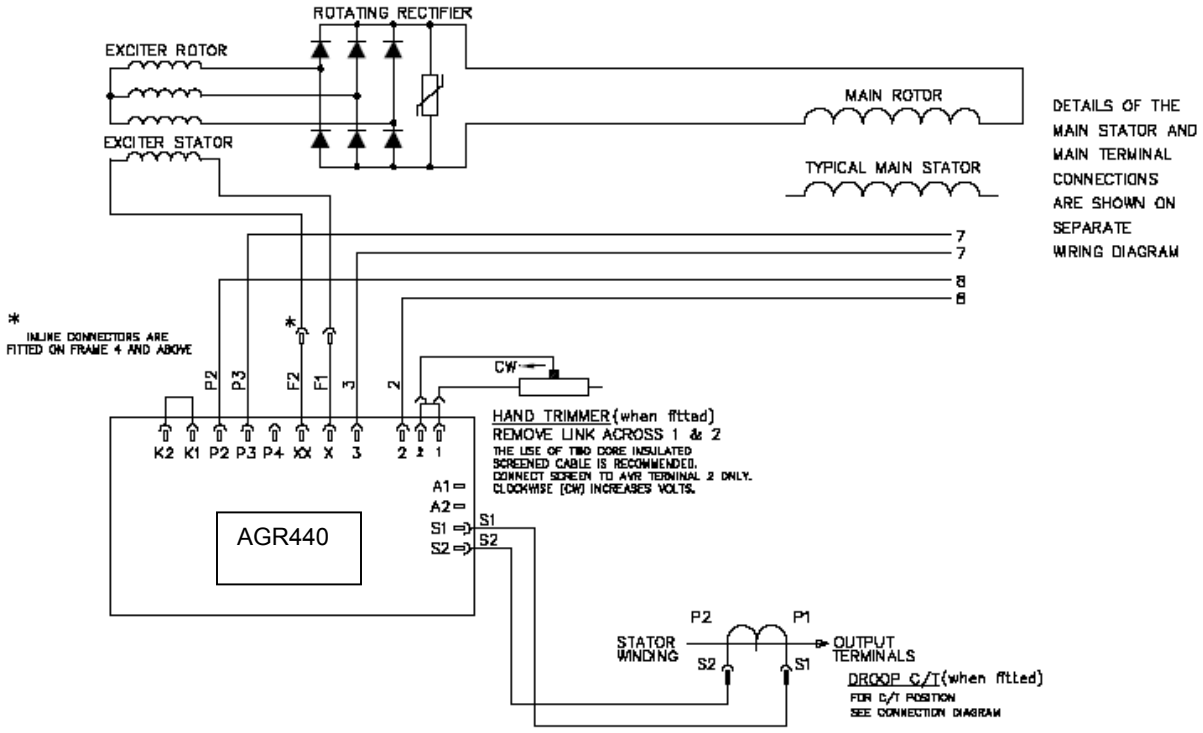
The UFRO adjustment is preset and sealed and only requires the selection of 50 / 60Hz using the jumper link.

For optimum setting, the LED should light as the frequency falls just below nominal, i.e. 47 Hz on a 50 Hz system or 57 Hz on a 60 Hz system.

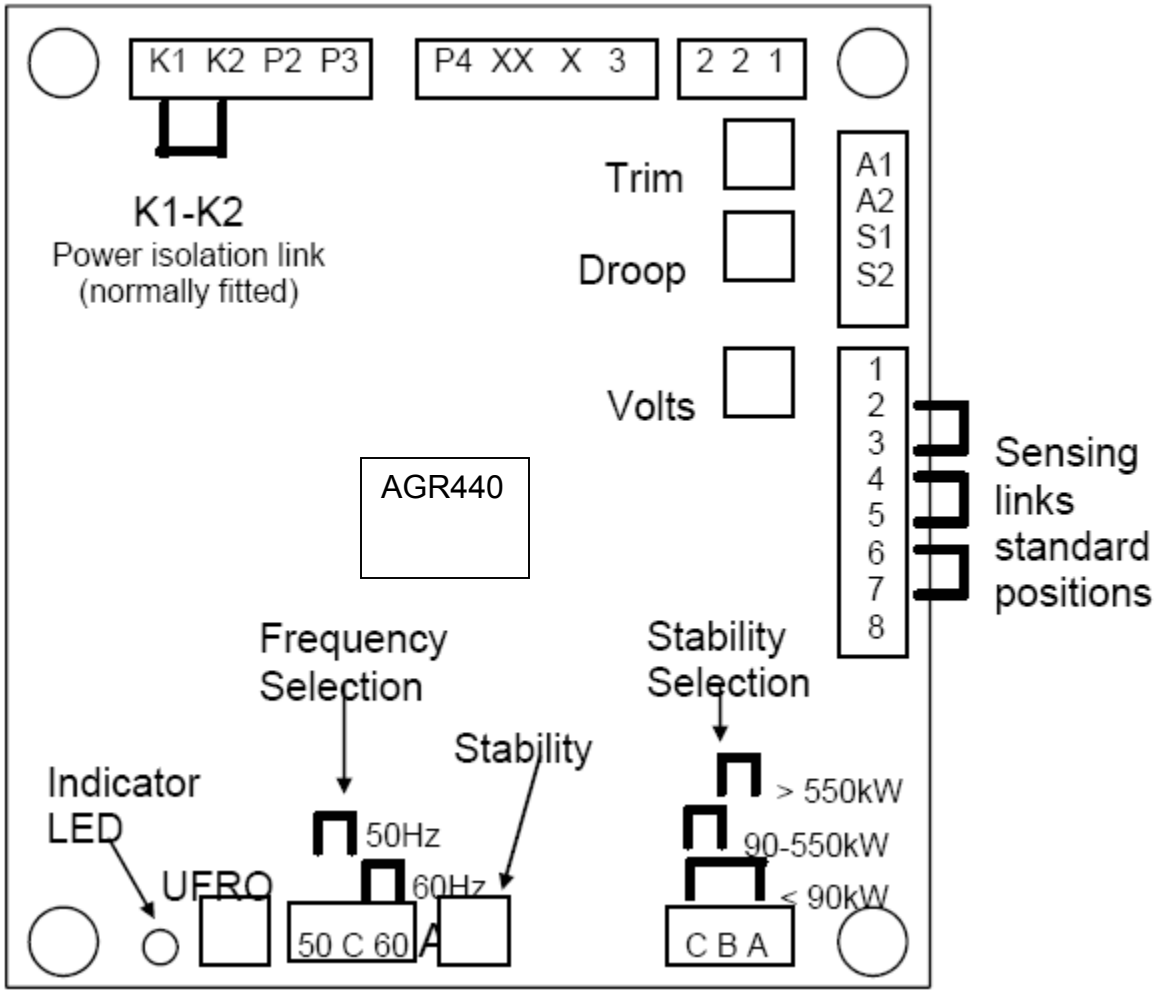
AGR440 AUTOMATIC VOLTAGE REGULATOR

SPECIFICATIONS		
Input Voltage	 Frequency Phase	95-132V or 190-264V AC (jumper) 50/60 Hz nominal Single Phase
Output Voltage	 Current Resistance	Max 90V DC @ 207V AC input Continuous 4A DC; Intermittent 6A -10 sec Minimum 15 Ohms
Regulation	+/- 1.0% [1]	
Thermal Drift	0.04% per degree C in AVR ambient [2]	
System Response	AVR response Field Current to 90% Machine Volts to 97%	20 ms 80 ms 300 ms
External Voltage Adjustment	+/- 10% w/ 1k ohm – 1 watt trimmer [3]	
Under Frequency Protection	Set Point Slope	95% Hz [4] 170% down to 30 Hz
Unit Power Dissipation	12 Watts Max	
Build-up Voltage	4 Volts at AVR terminals	
Analog Input	Maximum Input +/- 5 VDC [5] Sensitivity 1V per 5% Generator Voltage (adjustable) Input Resistance 1K Ohms	
Quadrature Droop Input	10 Ohms burden Max Sensitivity 0.07A for 5% droop 0 PF Max Input 0.33A	
Environment Specifications Operating Temperature Relative Humidity 0-70^{0}C Storage Temperature Vibration		-40^{0}C to +70^{0}C 0-95% non condensing -55^{0}C to +80^{0}C 20 -100 Hz – 50 mm/sec; 100 - 2K Hz – 3.3g
NOTES	1 - with 4% Engine Governing 2 - after 10 minutes 3 - some de-rating may occur at voltage extremes 4 - factory set, semi sealed, select w/ jumper 5 - device connected must be galvanically isolated from ground, >500 VAC	

WIRING DIAGRAM



OPERATION



CONTROL FUNCTIO	N	ROTATION
VOLTS	Output Voltage Adjustment	Clockwise to Increase Voltage
STABILITY	Voltage Hunting Prevention	Clockwise to Increase Dampening
UFRO [1]	Setting of UFRO knee point	Clockwise Reduces Knee Point
DROOP	To set gen. droop to 5% at 0 PF	Clockwise Increases Droop
VTRIM	To Optimize Analog Input Sensitivity	Clockwise Increases Gain

1 – Under Frequency Roll Off (UFRO)

ADJUSTMENT OF AVR CONTROLS - AGR440

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can bechanged by careful adjustment of the VOLTS control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 and 2 on the AVR will be fitted with a jumper if no hand trimmer is required.

CAUTION Do not increase the voltage above the rated generator voltage. If in doubt, refer to the name plate mounted on the generator case.

CAUTION Do not ground any of the hand trimmer terminals as these could be above ground potential. Failure to do so could cause equipment damage.

CAUTION
1. Before running generator, turn the VOLTS control fully counter-clockwise.
2. Turn remote volts trimmer (if fitted) to midway position.
3. Turn STABILITY control to midway position.
4. Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.
5. Start generator set, and run on no load at nominal frequency e.g. 50-53 Hz or 60-63 Hz.
6. If the red Light Emitting Diode (LED) is lit, refer to the Under Frequency Roll Off (UFRO) adjustment.
7. Carefully turn VOLTS control clockwise until rated voltage is reached.
8. If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator.

The correct setting can be found by running the generator at no load and slowly turning the stability control counter-clockwise until the generator voltage starts to become unstable.

The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

OPTIMUM RESPONSE SELECTION

The stability selection jumper should be correctly linked, A-B, B-C or A-C at the bottom of the board for the frame size of the generator.

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an under-speed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a preset threshold known as the "knee" point.

The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating.

The UFRO adjustment is preset and sealed and only requires the selection of 50 / 60 Hz using the jumper link.

For optimum setting, the LED should illuminate as the frequency falls just below nominal, i.e. 47 Hz on a 50 Hz system or 57 Hz on a 60 Hz system.

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a power factor dependent signal for the AVR. The C.T. is connected to S1, S2 on the AVR.

The DROOP adjustment is normally preset in the works to give 5% voltage droop at full load zero power factor.

Clockwise increases the amount of C.T. signal injected into the AVR and increases the droop with lagging power factor (cos Ø). With the control fully counter-clockwise there is no droop.

TRIM ADJUSTMENT

An analog input (A1 A2) is provided to connect to the Power Factor Controller or other devices. It is designed to accept dc signals up to +/- 5 volts.

CAUTION Any devices connected to this input must be fully floating and galvanically isolated from ground, with an insulation capability of 500 VAC. Failure to do this could result in equipment damage.

The dc signal applied to this input adds to the AVR sensing circuit. A1 is connected to the AVR 0 volts. Positive on A2 increases excitation. Negative on A2 decreases excitation.

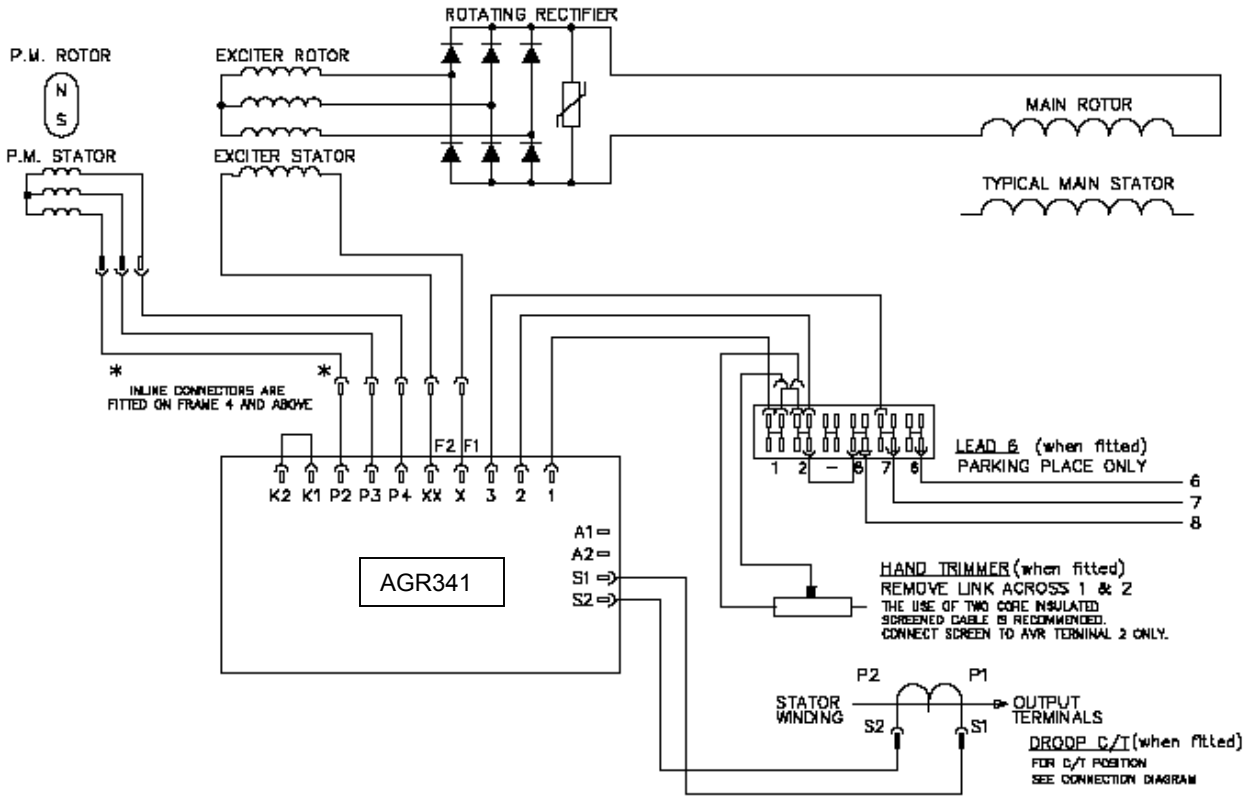
The TRIM control allows the user to adjust the sensitivity of the input. With TRIM fully counter-clockwise the externally applied signal has no effect. Clockwise it has maximum effect.

Normal setting is fully clockwise when used with a Power Factor Controller.

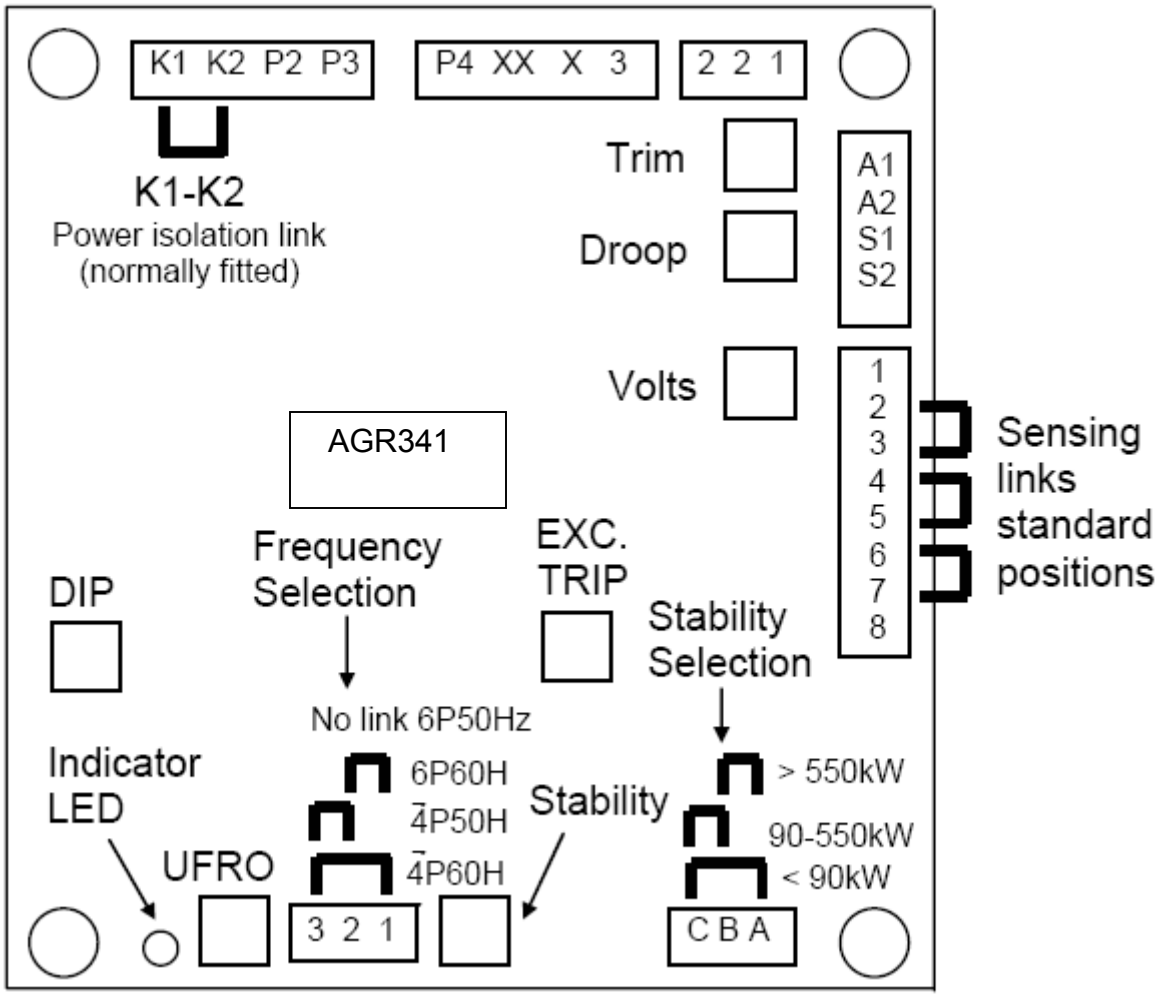
AGR341 AUTOMATIC VOLTAGE REGULATOR

SPECIFICATIONS		
Sensing Input	Voltage Frequency Phase	190-264V AC 50/60 Hz nominal Single Phase
Power Input (PMG)	Voltage Frequency Current	140-220 VAC 100-120 Hz nominal 3 Amps per Phase
Output Voltage	 Current Resistance	Max 120 VDC Continuous 2.7 ADC; Intermittent 6A -10 sec Minimum 15 Ohms
Regulation	+/- 1.0% [1]	
Thermal Drift	0.03% per degree C in AVR ambient [2]	
Soft Start Ramp Time	3 Seconds	
System Response	AVR response Field Current to 90% Machine Volts to 97%	10 ms 80 ms 300 ms
External Voltage Adjustment	+/- 10% w/ 1k ohm – 1 watt trimmer [3]	
Under Frequency Protection	Set Point Slope	95% Hz [4] 170% down to 30 Hz
Unit Power Dissipation	12 Watts Max	
Analog Input	Maximum Input +/- 5 VDC [5] Sensitivity 1V per 5% Generator Voltage (adjustable) Input Resistance 1K Ohms	
Quadrature Droop Input	10 Ohms burden Max Sensitivity 0.07A for 5% droop 0PF Max Input 0.33A	
Over-Excitation Protection	Set Point 75 VDC Time Delay 10 seconds (fixed)	
Environment Specifications Operating Temperature Relative Humidity 0-70^{0}C Storage Temperature Vibration		-40^{0}C to +70^{0}C 0-95% non condensing -55^{0}C to +80^{0}C 20 -100 Hz – 50 mm/sec; 100 - 2K Hz – 3.3g
NOTES	1 - with 4% Engine Governing 2 - after 10 minutes 3 - some de-rating may occur at voltage extremes 4 - factory set, semi sealed, select w/ jumper 5 - device connected must be galvanically isolated from ground, >500 VAC	

WIRING DIAGRAM



OPERATION



CONTROL FUNCTIO	N	ROTATION
VOLTS	Output Voltage Adjustment	Clockwise to Increase Voltage
STABILITY	Voltage Hunting Prevention	Clockwise to Increase Dampening
UFRO [1]	Setting of UFRO knee point	Clockwise Reduces Knee Point
DROOP	To set gen. droop to 5% at 0PF	Clockwise Increases Droop
VTRIM	To Optimize Analog Input Sensitivity	Clockwise Increases Gain
EXC TRIP	To set Over-Excitation Cutoff	Clockwise Increases Cutoff Level
DIP	To set Frequency Related Voltage Dip	Clockwise Increases Voltage Dip

1 – Under Frequency Roll Off (UFRO)

ADJUSTMENT OF AVR CONTROLS - AGR341

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can be changed by careful adjustment of the VOLTS control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 and 2 on the AVR will be fitted with a jumper if no hand trimmer is required.

CAUTION! Do not increase the voltage above the rated generator voltage. If in doubt, refer to the name plate mounted on the generator case.

CAUTION! Do not ground any of the hand trimmer terminals, as these could be above ground potential. Failure to observe this could cause equipment damage.

CAUTION!
1. Before running generator, turn the VOLTS control fully counter-clockwise.
2. Turn remote volts trimmer (if fitted) to midway position.
3. Turn STABILITY control to midway position.
4. Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.
5. Start generator set, and run on no load at nominal frequency e.g. 50-53 Hz or 60-63 Hz.
6. If the red Light Emitting Diode (LED) is lit, refer to the Under Frequency Roll Off (UFRO) adjustment.
7. Carefully turn VOLTS control clockwise until rated voltage is reached.
8. If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator.

The correct setting can be found by running the generator at no load and slowly turning the stability control counter-clockwise until the generator voltage starts to become unstable.

The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

OPTIMUM RESPONSE SELECTION

The stability selection ‘jumper’ should be correctly linked, A-B, B-C or A-C at the bottom of the board for the frame size of the generator.

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an under-speed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a preset threshold known as the "knee" point.

The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating.

The UFRO adjustment is preset and sealed and only requires the selection of 50 / 60 Hz, 4 pole / 6 pole using the jumper. Adjustment of the UFRO potentiometer will only be necessary if the AVR is being fitted to a 6 pole generator to replace an AVR of an earlier type.

For optimum setting, the LED should light as the frequency falls just below nominal, i.e. 47 Hz on a 50 Hz system or 57 Hz on a 60 Hz system.

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a power factor dependent signal for the AVR. The C.T. is connected to S1, S2 on the AVR.

The DROOP adjustment is normally preset in the works to give 5% voltage droop at full load zero power factor. Clockwise increases the amount of C.T. signal injected into the AVR and increases the droop with lagging power

factor (cos Ø). With the control fully counterclockwise there is no droop.

TRIM ADJUSTMENT

An analog input (A1 A2) is provided to connect to a Power Factor Controller or other devices. It is designed to accept dc signals up to +/- 5 volts.

CAUTION! Any devices connected to this input must be fully floating and galvanically isolated from ground, with an insulation capability of 500 VAC. Failure to do this could result in equipment damage.

The dc signal applied to this input adds to the AVR sensing circuit. A1 is connected to the AVR 0 volts. Positive on A2 increases excitation. Negative on A2 decreases excitation.

The TRIM control allows the operator to adjust the sensitivity of the input. With TRIM fully counter-clockwise the externally applied signal has no effect. Clockwise it has maximum effect.

Normal setting is fully clockwise when used with a Power Factor Controller.

DIP ADJUSTMENT

The DIP adjustment allows some control over the generator voltage dip upon the application of load. This feature is mostly used, when the generator is coupled to turbo charged engines with limited block load acceptance and operates only when the speed is below the UFRO knee point, (LED lit).

With the DIP potentiometer fully counterclockwise, the generator voltage characteristics will follow the normal V/Hz line as the speed falls below nominal. Turning the DIP potentiometer more clockwise increases the V/Hz slope, providing a greater voltage dip and aiding engine recovery. The DIP potentiometer can be set at any desired position to suit a particular engine type.

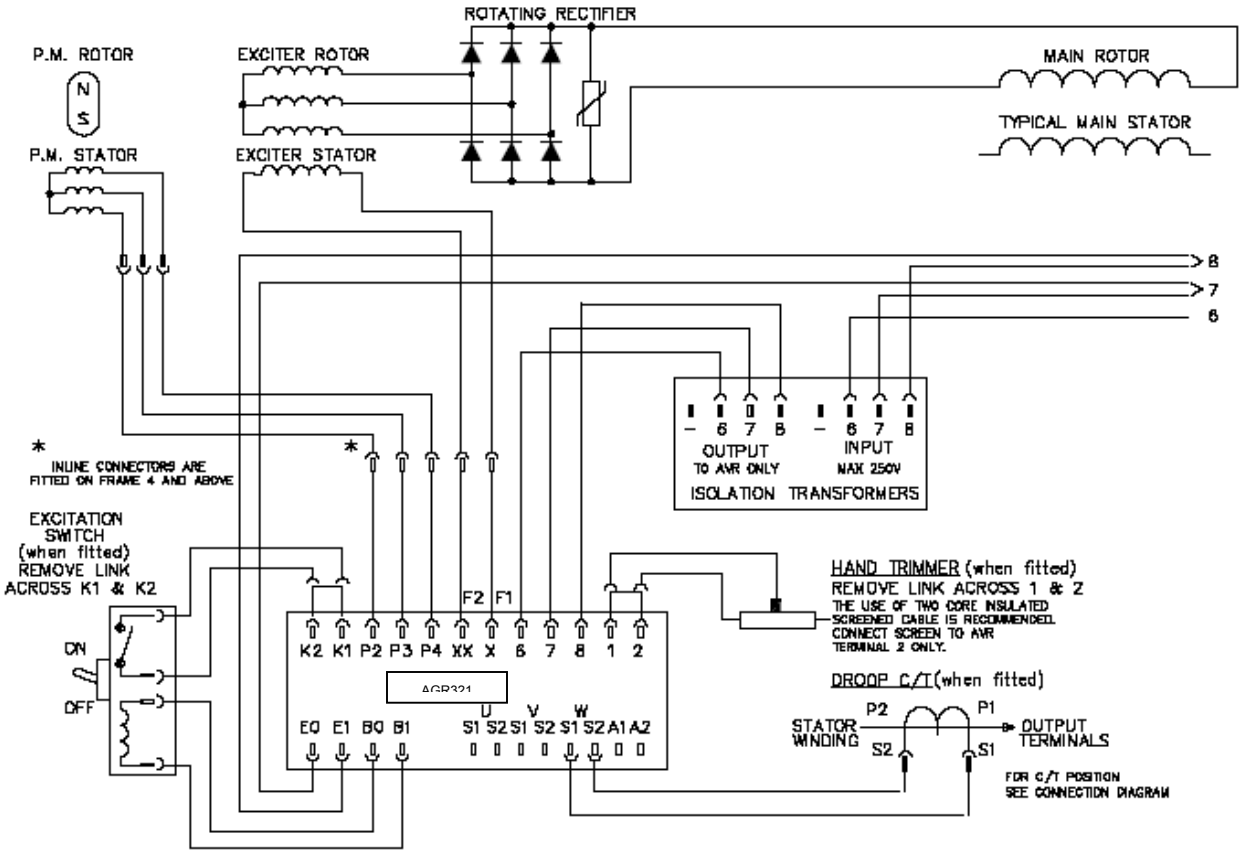
OVER EXCITATION (EXC TRIP) ADJUSTMENT

The adjustment is set and sealed in the unit and should not be altered. An over excitation condition is indicated on the common LED which also indicates under speed operation. The generator must be stopped to reset an over excitation condition.

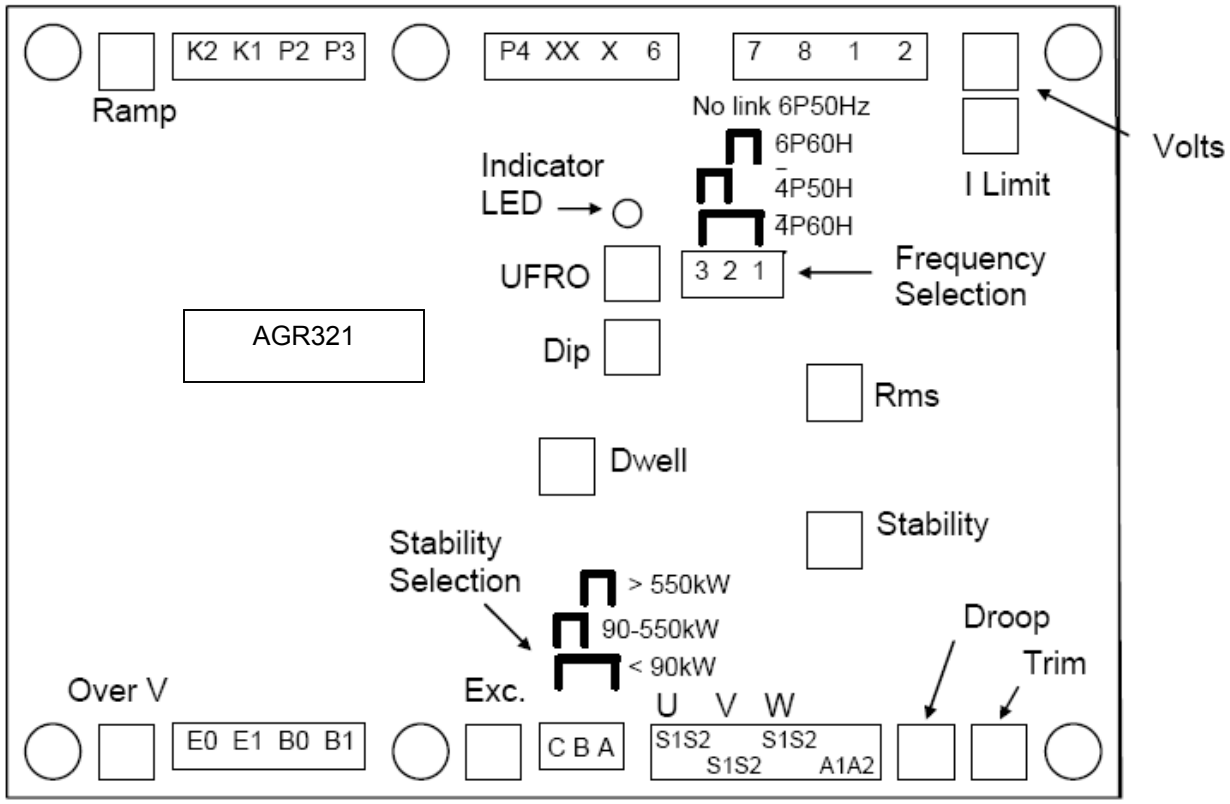
AGR321 AUTOMATIC VOLTAGE REGULATOR

SPECIFICATIONS		
Sensing Input	Voltage Frequency Phase	190-264V AC 50/60 Hz nominal Single or Three Phase
Power Input (PMG)	Voltage Frequency Current	140-220 VAC (max), 3 Phase 3 Wire 100-120 Hz nominal 3 Amps per Phase
Output Voltage	 Current Resistance	Max 120 VDC Continuous 3.7 ADC; Intermittent 6A -10 sec [6] Minimum 15 Ohms
Regulation	+/- 0.5% [1]	
Thermal Drift	0.02% per degree C in AVR ambient [2]	
Soft Start Ramp Time	0.4 to 4 Seconds	
System Response	AVR response Field Current to 90% Machine Volts to 97%	10 ms 80 ms 300 ms
External Voltage Adjustment	+/- 10% w/ 1k ohm – 1 watt trimmer [3]	
Under Frequency Protection	Set Point Slope Max Dwell	95% Hz [4] 100-300% down to 30 Hz 20% Volts/S Recovery
Unit Power Dissipation	18 Watts Max	
Analog Input	Maximum Input +/- 5 VDC [5] Sensitivity 1V per 5% Generator Voltage (adjustable) Input Resistance 1K Ohms	
Quadrature Droop Input	10 Ohms burden Max Sensitivity 0.22A for 5% droop 0PF Max Input 0.33A	
Current Limit Input	10 Ohms Burden Sensitivity Range 0.5-1 A	
Over Voltage detector Input	Set Point 300 V, Time delay 1 second (fixed) CB Trip Coil Voltage 10-30 VDC CB Trip Coil Resistance 20-60 Ohms	
Over-Excitation Protection	Set Point 75 VDC Time Delay 8-15 seconds (fixed)	
Environment Specifications Operating	Temperature Relative Humidity 0-70^{0}C Storage Temperature Vibration	-40^{0}C to +70^{0}C 0-95% non condensing -55^{0}C to +80^{0}C 20 -100 Hz – 50 mm/sec; 100 - 2K Hz – 3.3g
NOTES	1 - with 4% Engine Governing 2 - after 10 minutes 3 - some de-rating may occur at voltage extremes 4 - factory set, semi sealed, select w/ jumper 5 - device connected must be galvanically isolated from ground, >500 VAC 6 - De-rating linear from 3.7 A at 50^{0}C to 2.7 A at 70^{0}C	

WIRING DIAGRAM



OPERATION



CONTROL FUNCTIO	N	ROTATION
VOLTS	Output Voltage Adjustment	Clockwise to Increase Voltage
STABILITY	Voltage Hunting Prevention	Clockwise to Increase Dampening
UFRO [1]	Setting of UFRO knee point	Clockwise Reduces Knee Point
DROOP	To set gen. droop to 5% at 0PF	Clockwise Increases Droop
VTRIM	To Optimize Analog Input Sensitivity	Clockwise Increases Gain
EXC TRIP	To set Over-Excitation Cutoff	Clockwise Increases Cutoff Level
DIP	To set Frequency Related Voltage Dip	Clockwise Increases Voltage Dip
DWELL	To set Frequency Related recovery Time	Clockwise Increases Recovery Time
I LIMIT	To set Stator Current Limit	Clockwise Increases Current Limit
OVER V	To set Over-Voltage Trip Level	Clockwise Increases Trip Level
RAMP	To set No-Load Voltage Ramp-Up Time	Clockwise Increases Voltage Ramp Time

1 – Under Frequency Roll Off (UFRO)

ADJUSTMENT OF AVR CONTROLS - AGR321

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can be changed by careful adjustment of the VOLTS control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 and 2 on the AVR will be fitted with a jumper if no hand trimmer is required.

WARNING! Do not increase the voltage above the rated generator voltage. If in doubt, refer to the name plate mounted on the generator case.

WARNING! Do not ground any of the hand trimmer terminals, as these could be above ground potential. Failure to do so could cause equipment damage.

1. Before running generator, turn the VOLTS control fully counter-clockwise.
2. Turn remote volts trimmer (if fitted) to midway position.
3. Turn STABILITY control to midway position.
4. Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.
5. Start generator set, and run on no load at nominal frequency e.g. 50-53 Hz or 60-63 Hz.
6. If the red Light Emitting Diode (LED) is lit, refer to the Under Frequency Roll Off (UFRO) adjustment.
7. Carefully turn VOLTS control clockwise until rated voltage is reached.
8. If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator. A jumper link selector is provided to optimize the response of the stability circuit to various size generators. The jumper should be positioned as shown in the diagram according to the kW rating of the generator. The correct setting of the stability adjustment can be found by running the generator at no load and slowly turning the stability control counter-clockwise until the generator voltage starts to become unstable. The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an under-speed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a preset threshold known as the "knee" point. The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating. The UFRO adjustment is preset and sealed and only requires the selection of 50 or 60 Hz and 4 pole or 6 pole, using the jumper link. For optimum setting, the LED should light as the frequency falls just below nominal, i.e. 47 Hz on a 50 Hz system or 57 Hz on a 60 Hz system.

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a power factor dependent signal for the AVR. The C.T. is connected to S1, S2 on the AVR, (see generator wiring diagram for details). The DROOP adjustment is normally preset in the works to give 5% voltage droop at full load zero power factor. Clockwise increases the amount of C.T. signal injected into the AVR and increases the droop with lagging power factor (cos Ø). With the control fully counter-clockwise there is no droop.

TRIM ADJUSTMENT

An analog input (A1 A2) is provided to connect to a Power Factor Controller or other devices. It is designed to accept dc signals up to +/- 5 volts.

WARNING! Any devices connected to this input must be fully floating and galvanically isolated from ground, with an insulation capability of 500V ac. Failure to observe this could result in equipment damage.

The dc signal applied to this input adds to the AVR sensing circuit. A1 is connected to the AVR 0 volts. Positive on A2 increases excitation. Negative on A2 decreases excitation. The TRIM control allows the user to adjust the sensitivity of the input. With TRIM fully counter-clockwise the externally applied signal has no effect. Clockwise it has maximum effect. Normal setting is fully clockwise when used with a Power Factor Controller.

OVER EXCITATION (EXC) ADJUSTMENT

This adjustment is set and sealed in the unit and should not be tampered with. An over excitation condition is indicated by the illumination of the red LED which also indicates under-speed running and over-voltage. The generator must be stopped to reset an over-excitation trip.

DIP ADJUSTMENT

This feature is mostly used when the generator is coupled to turbo charged engines with limited block load acceptance. The feature works by increasing the V/Hz slope to give greater voltage roll off in proportion to speed. With the DIP control fully counter-clockwise, the generator voltage will follow the normal V/Hz line as the speed falls below nominal. Turning the DIP control clockwise provides greater voltage roll off aiding engine recovery.

DWELL

This feature is mostly used when the generator is coupled to turbo charged engines with limited block load acceptance. The feature works by introducing a delay between speed recovery and voltage recovery and allows a greater DIP setting without instability. With the DWELL control fully counter-clockwise, the generator voltage will follow the V/Hz line. Turning the DWELL control clockwise increase the delay time between speed recovery and voltage recovery.

CURRENT LIMIT (I LIMIT) ADJUSTMENT

This feature is mostly used to limit short circuit current or to provide a current limit on motor starting. To use this feature, current limit CT's of the correct ratio need to be connected to the AVR S1 S2 terminals. There is an internal time limit of 10 seconds. Consult the factory before using this feature.

OVER VOLTAGE (OVER V) ADJUSTMENT

This adjustment is set and sealed in the unit and should not be tampered with. An over voltage condition is indicated by the illumination of the red LED which also indicates under-speed running and over-excitation. The generator must be stopped to reset an over-voltage trip.

RAMP

The AVR includes a soft start or voltage ramp-up circuit to control the rate of voltage build up, when the generator runs up to speed. This is normally pre-set and sealed to give a voltage ramp-up time of approximately 3 seconds. If required, this can be adjusted between the limits defined in the specification.

APPENDIX F

ATHLON™ GENERATOR CERTIFICATIONS

Athlon™ Generators are designed and manufactured for safe and reliable operation, in factories certified to ISO 9001:2000. Athlon™ Generators are rated for standby or continuous duty.

Athlon™ AC synchronous generators are brushless 4 pole, self-ventilated alternators, which create 60 Hz power at 1800 RPM or 50 Hz power at 1500 RPM. The generators can be provided in one or two bearing configurations. They are designed and built in accordance with IEC 6003 1-1 & -2 requirements, BS4990 & 5000, NEMA MG1 2006, CSA & C/UL, and CE.

Athlon™ Generators carry the following quality marks from internationally recognized agencies:

CSA INTERNATIONAL

Certificate of Compliance

Certificate: 2240891 **Master Contract:** 248614

Project: 2240891 **Date Issued:** November 13, 2009

Issued to: **Athlon Generator LLC**
15885B Kings Highway
Montross, VA 22520
USA

The products listed below are eligible to bear the CSA Mark shown With adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indictor for Canada only

C US

Issued by: K. Atkins

Authorized by: Len Candeloro
Product Group Manager

PRODUCTS

CLASS 4211 01 - MOTORS AND GENERATORS
CLASS 4211 81 - MOTORS AND GENERATORS - CERTIFIED TO U.S. STANDARDS

Three-phase Brushless Alternator, Self Excited, 60 Hz, Insulation Class H, 0.8 Power Factor, 40 °C Ambient, AG Series. Model No and ratings as follows:

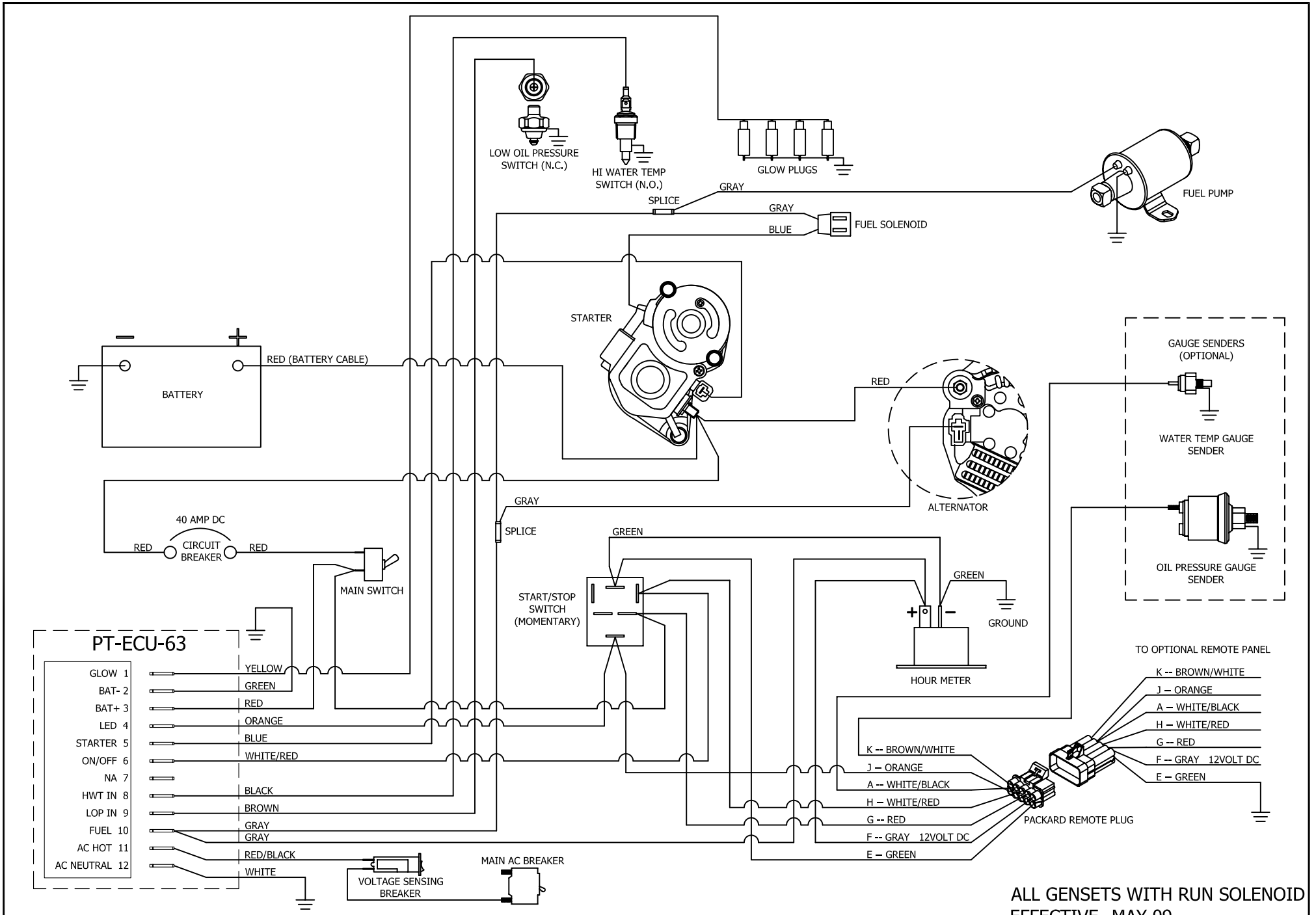
APPLICABLE REQUIREMENTS

CAN/CSA-C22.2 No.0-M91	-	General Requirements – Canadian Electrical Code, Part II
CAN/CSA-C22.2 No.0.4-04	-	Bonding of Electrical Equipment
CSA-C22.2 No.100-04	-	Motors and Generators
ANSI/UL 1004-1 1st Edition	-	Rotating Electrical Machines – General Requirements
ANSI/UL 1004-4 1st Edition	-	Electric Generators

The 'C' and 'US' indicators adjacent to the CSA Mark signify that the product has been evaluated to the applicable CSA and ANSI/UL Standards, for use in Canada and the U.S., respectively. This 'US' indicator includes products eligible to bear the 'NRTL' indicator. NRTL, i.e. National Recognized Testing Laboratory, is a designation granted by the U.S. Occupational Safety and Health Administration (OSHA) to laboratories which have been recognized to perform certification to U.S. Standards.

DQD 507 Rev. 2004-06-30

ATHLON™ GENERATOR LLC
Montross, Virginia



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FOR :	POWER TECHNOLOGY	MATERIAL: NA	REV.	SHEET
TYPE:	SCHEMATIC	BEND ALLOW.: NA		1of1
PART:	12V DC ENGINE CONTROL (PT-ECU-63)	DATE : 18MAY09		
DWN. BY :	KM	SCALE : NOT TO SCALE		