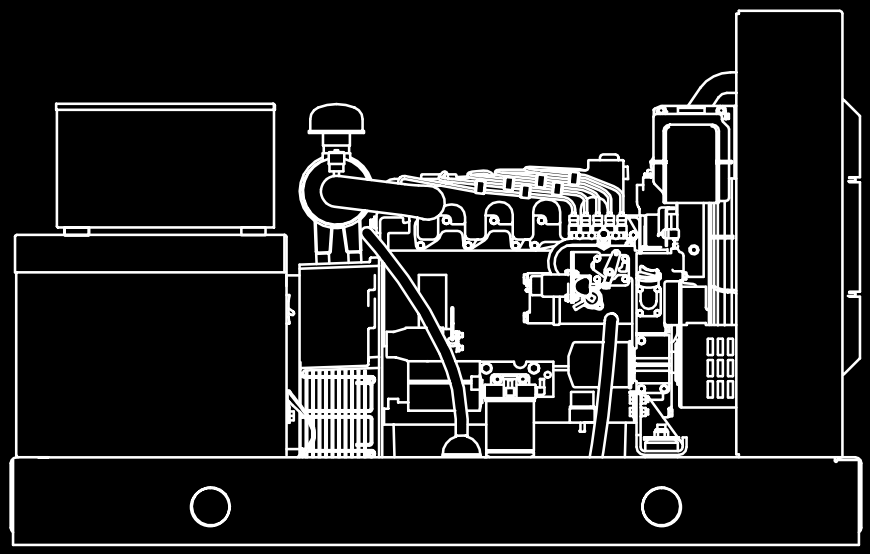
Caution: This document contains mixed page sizes (8.5 x 11 or 11 x 17), which may affect printing. Please adjust your printer settings according to the size of each page you wish to print.

Power Generation

Service Manual

Detector™ Control Generator Sets



Models
DKAC, DKAE, DKAF

Printed in U.S.A.

981-0519 4-2001

Table of Contents

California

Proposition 65 Warning

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

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS – This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries.

Before operating the generator set (genset), read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠ WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠ CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use zinc coated or copper fuel lines with diesel fuel.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (–) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. Do not operate a genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Cummins Power Generation distributor for more information.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

MEDIUM VOLTAGE GENERATOR SETS

(601V to 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

GENERAL

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

Each operator should read this manual before operating the set for the first time. A generator set (genset) must be operated and maintained properly if you are to expect safe, reliable and quiet operation. The manual includes a troubleshooting guide and a maintenance schedule.

The engine manual is included with the set. Where there is conflicting information, this manual takes precedence over the engine manual.

⚠WARNING ***Improper operation and maintenance can lead to severe personal injury or loss of life and property by fire, electrocution, mechanical breakdown or exhaust gas asphyxiation. Read and follow the safety precautions on page iii and carefully observe all instructions and precautions in this manual.***

TEST EQUIPMENT

Most of the tests in this manual can be done with an AC-DC multimeter, frequency meter, Wheatstone bridge (0.001 ohm precision is necessary for measuring stator winding resistance) and load test panel.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearest Cummins Power Generation distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

To contact your local Cummins Power Generation distributor in the United States or Canada, call 1-800-888-6626 (this automated service utilizes touch-tone phones only). By selecting Option 1 (press 1), you will be automatically connected to the distributor nearest you.

If you are unable to contact a distributor using the automated service, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS-ELECTRIC or
ELECTRICAL PRODUCTS

For outside North America, call Cummins Power Generation, 1-763-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Cummins Power Generation using the fax number 1-763-574-8087.

When contacting your distributor, always supply the complete Model, Specification, and Serial Number as shown on the generator set nameplate.

⚠ WARNING

INCORRECT SERVICE OR PARTS REPLACEMENT CAN RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE TRAINED AND EXPERIENCED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

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2. AC Control

AC CONTROL PANEL COMPONENTS

The generator set control box is mounted on top of the generator enclosure, facing the rear or either side. Figure 2-1 points out the components on the control panel that have to do with AC output control. Except for the field circuit breaker and output voltage trimmer, all the components shown are optional. The connection and schematic diagrams are on Pages 7-3 and 7-4 (with meters) and Pages 7-5 and 7-6 (without meters). The external wiring harness diagram is on Page 7-7.

Field Circuit Breaker (CB21): The field circuit breaker protects the generator from over-excitation.

AC Voltmeter (M21): The voltmeter indicates output voltage for the phase selected.

AC Ammeter (M22): The ammeter indicates output amperage for the phase selected. Input to the ammeter is from current transformers CT21, CT22 and CT23.

Phase Selector Switch (S21): The selector switch is used to select the phase for voltage and amperage readings.

Scale Indicator Lamps (DS21 and DS22): The scale indicator lamps indicate whether to read the upper or lower scales of the voltmeter and ammeter.

Frequency/RPM Meter (M23): The frequency meter indicates output frequency in Hertz (Hz) and engine speed in RPM.

Output Voltage Trimmer (R21): The output voltage trimmer can be used to adjust output voltage plus or minus five percent of nominal voltage.

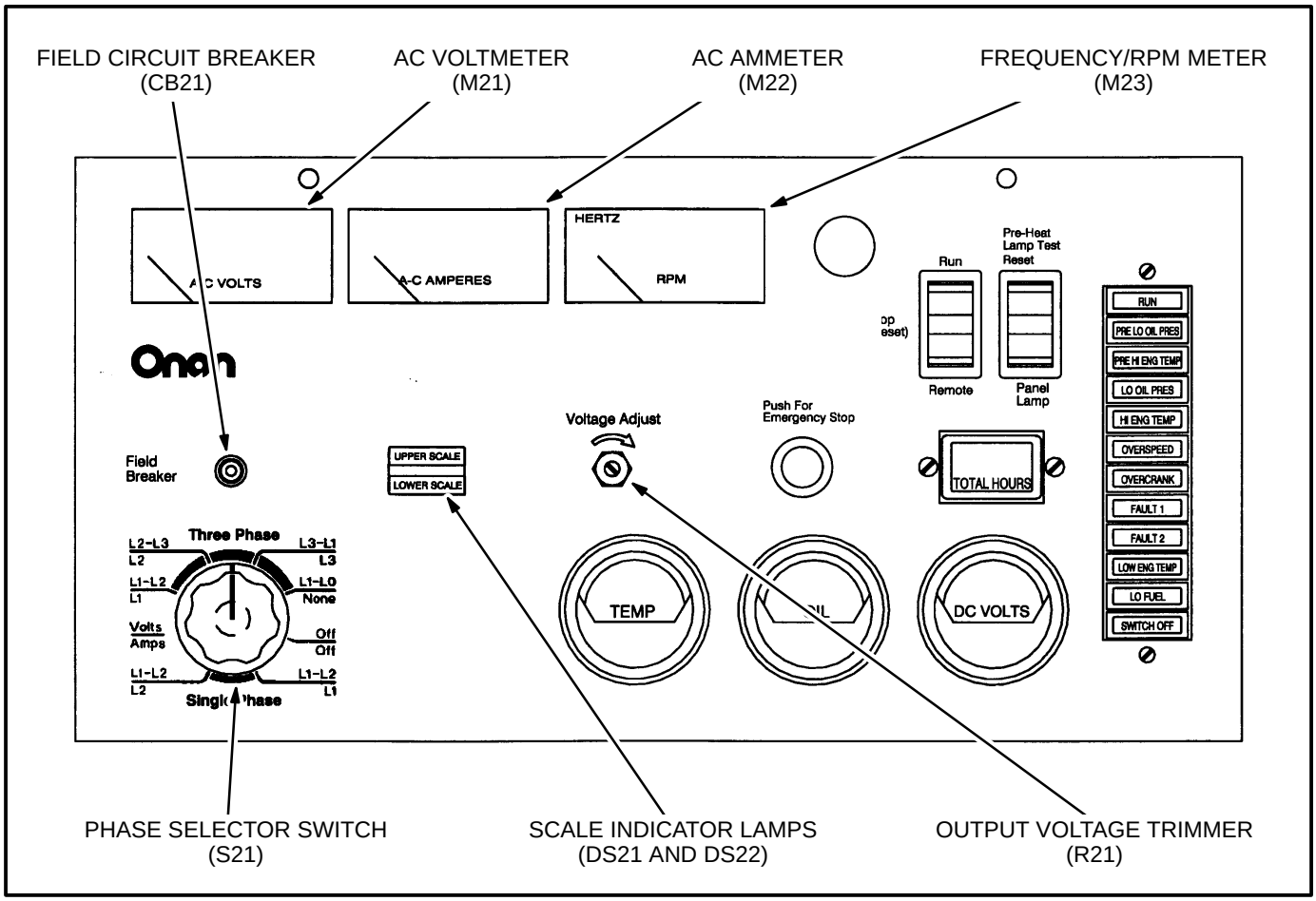


FIGURE 2-1. TYPICAL AC CONTROL PANEL COMPONENTS

CONTROL BOX

Figure 2-2 illustrates the control box with the control panel hinged open. Note the lexan (red plastic) cover secured over the meters to protect from electric shock.

⚠WARNING ***HAZARDOUS VOLTAGE! Touching uninsulated high voltage parts inside the control box can result in severe personal injury or death. Reinstall the protective cover to prevent contact with bare, live meter terminals.***

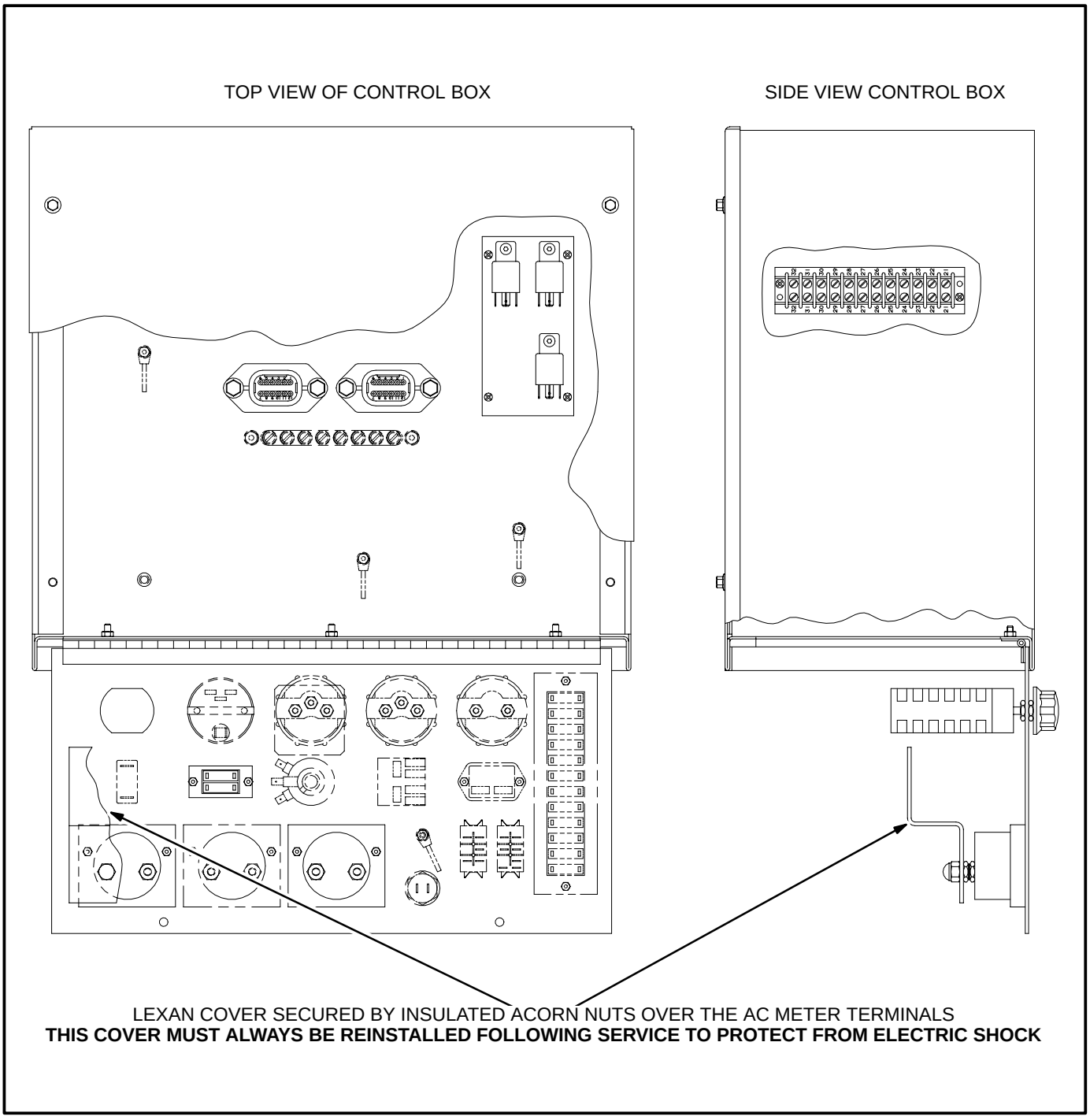


FIGURE 2-2. CONTROL BOX

AC POWER OUTPUT BOX

Figure 2-3 illustrates the power output box, which is part of the right-hand side of the generator enclosure (facing generator end). See the reconnection diagram on Page 7-11 for line connections.

⚠WARNING ***HAZARDOUS VOLTAGE! Touching uninsulated high voltage parts inside the AC power output box can result in severe personal injury or death. Shut down the set and disconnect ALL power sources to the generator set before removing the cover of the AC power output box. See Figure 2-3.***

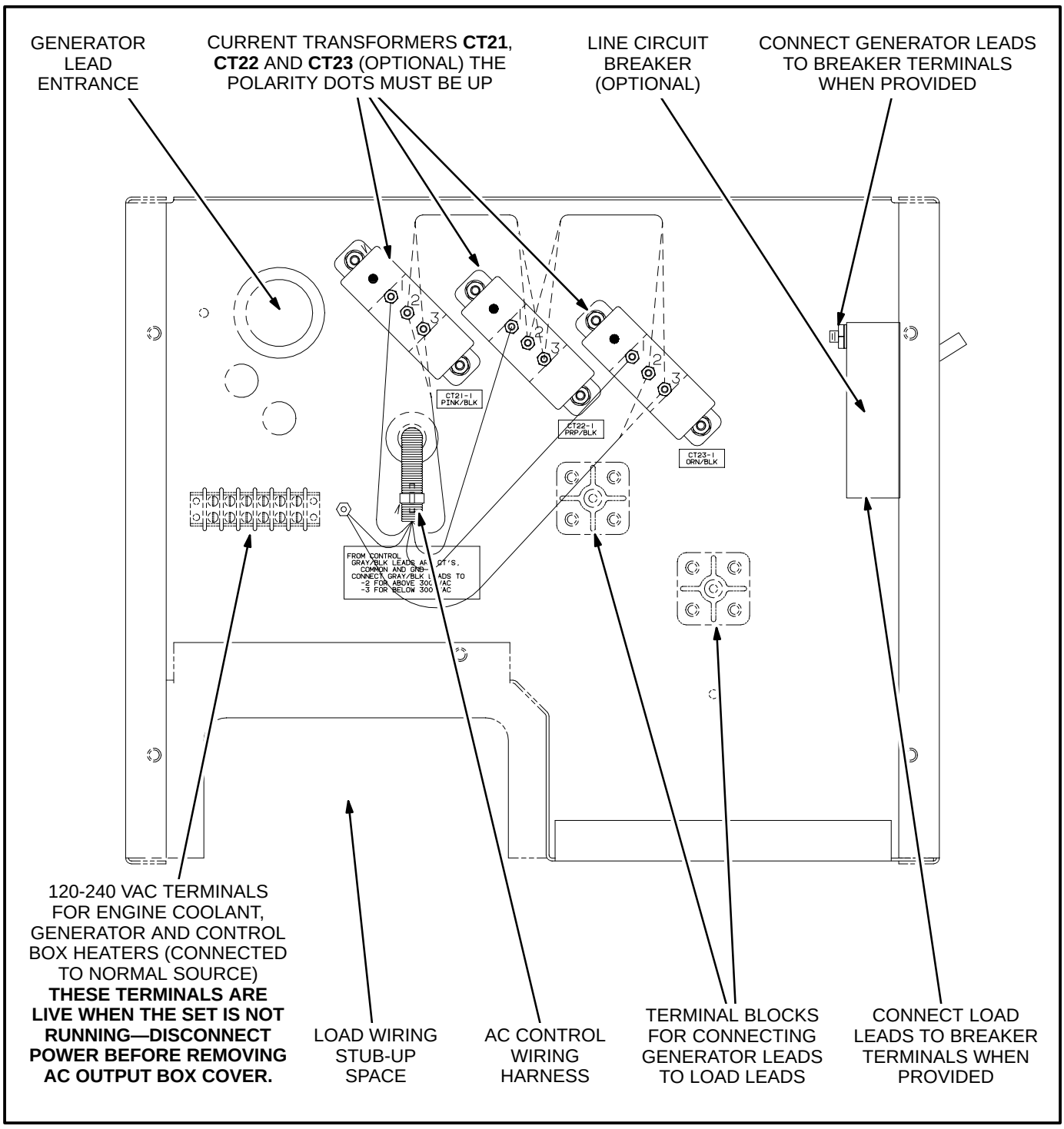


FIGURE 2-3. POWER OUTPUT BOX

VOLTAGE REGULATOR

Figure 2-4 shows the terminals, the three selector switches and the voltage adjusting potentiometer on the voltage regulator board. Figure 2-5 shows the connections.

The voltage regulator is accessible by removing the top cover of the control box. It is mounted on a plate on the wall opposite the control panel. Note the orientation of the voltage regulator on its mounting plate with terminal block **VR21** at the bottom.

Setting Selector Switches

Check and, if necessary, reposition the selector switches as follows when replacing a voltage regulator:

1. Press **S1-(1-4)** and **S1-(2-3)** down on the side marked **OFF**. (S1 is a rocker switch.)
2. Slide **S2** to the left-hand position. (S2 is a slide switch.)
3. **For 60 Hertz operation:** Press **S3-(1-4)** to **OFF** and **S3-(2-3)** to **2** (ON). (S3 is a rocker switch.)
4. **For 50 Hertz operation:** Press **S3-(1-4)** to 1 (ON) and **S3-(2-3)** to **2** (ON). (S3 is a rocker switch.)

Adjusting Voltage

Use the control panel mounted voltage trimmer, if provided, for small voltage adjustments. Measure generator output voltage while the set is running without load at the nominal frequency. (See *Section 6. Governor* for instructions on how to adjust the frequency.) If the trimmer does not provide enough adjustment, lock it at its midpoint. Then turn voltage adjusting pot R32 on the regulator board until rated voltage is obtained.

If there is no output voltage, flash the field as follows:

1. Assemble a 6 volt battery, 10 ohm resistor and 12 amp, 300 volt diode and 18 volt voltage suppressor as shown in Figure 2-5.
2. While the set is running at nominal frequency, momentarily connect the positive (**+**) side of the the circuit to voltage regulator terminal **VR21-F1** and the negative side (**–**) to voltage regulator terminal **VR21-F2**.

   ⚠CAUTION ***The voltage regulator could be damaged if the flashing circuit is connected for more than 5 seconds.***
3. Check output voltage, shut down the set and restart it. See *Troubleshooting* if output voltage does not build up without field flashing.

⚠WARNING ***HAZARDOUS VOLTAGE! Touching uninsulated high voltage parts inside the control and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.***

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.

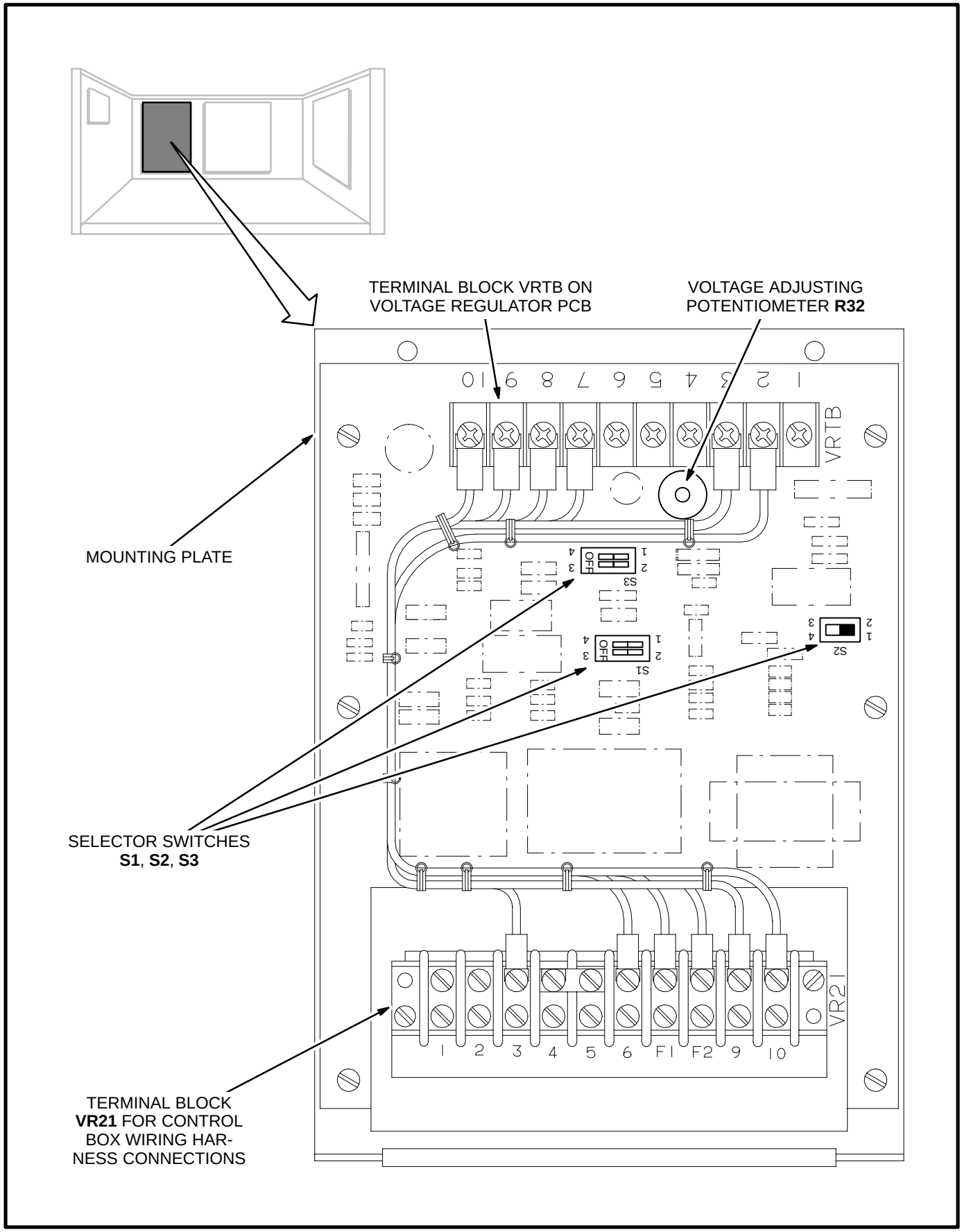


FIGURE 2-4. VOLTAGE REGULATOR TERMINALS, SELECTOR SWITCHES AND VOLTAGE ADJUSTING POT

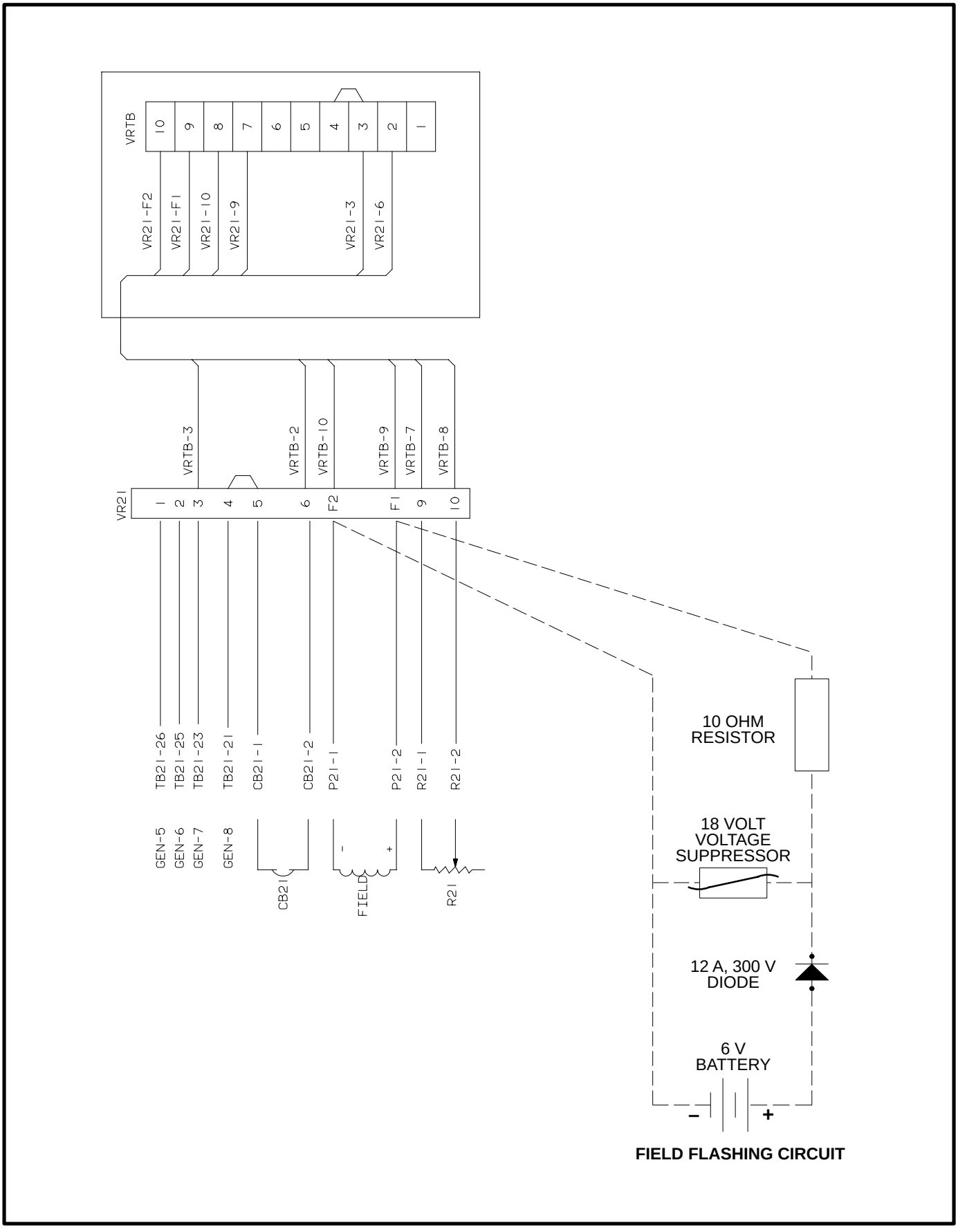


FIGURE 2-5. VOLTAGE REGULATOR CONNECTIONS AND FIELD FLASHING CIRCUIT

PRINCIPLE OF GENERATOR OPERATION

Refer to Figure 2-6 while working through the following explanation.

1. The generator field (main rotor) is rotated by the engine to induce output current (AC) in the main stator windings.

2. Generator output current is proportional to field strength, which is varied to match the load. Output voltage and frequency are held constant by the voltage regulator and engine governor, respectively.

3. Generator field strength is proportional to field current, which is supplied by the exciter.

4. The exciter field (stator) induces current in the exciter rotor windings. A full wave rectifier bridge (rotating rectifiers) mounted on the exciter rotor converts exciter output (3-phase AC) to DC. The exciter rotor is mounted on the main rotor shaft.

5. Exciter output current is proportional to exciter field current.

6. The automatic voltage regulator regulates exciter field current by comparing generator output voltage and frequency with reference values.

7. Exciter field current is supplied by the generator stator through the voltage regulator. Residual field magnetism initiates “self-excitation” during startups.

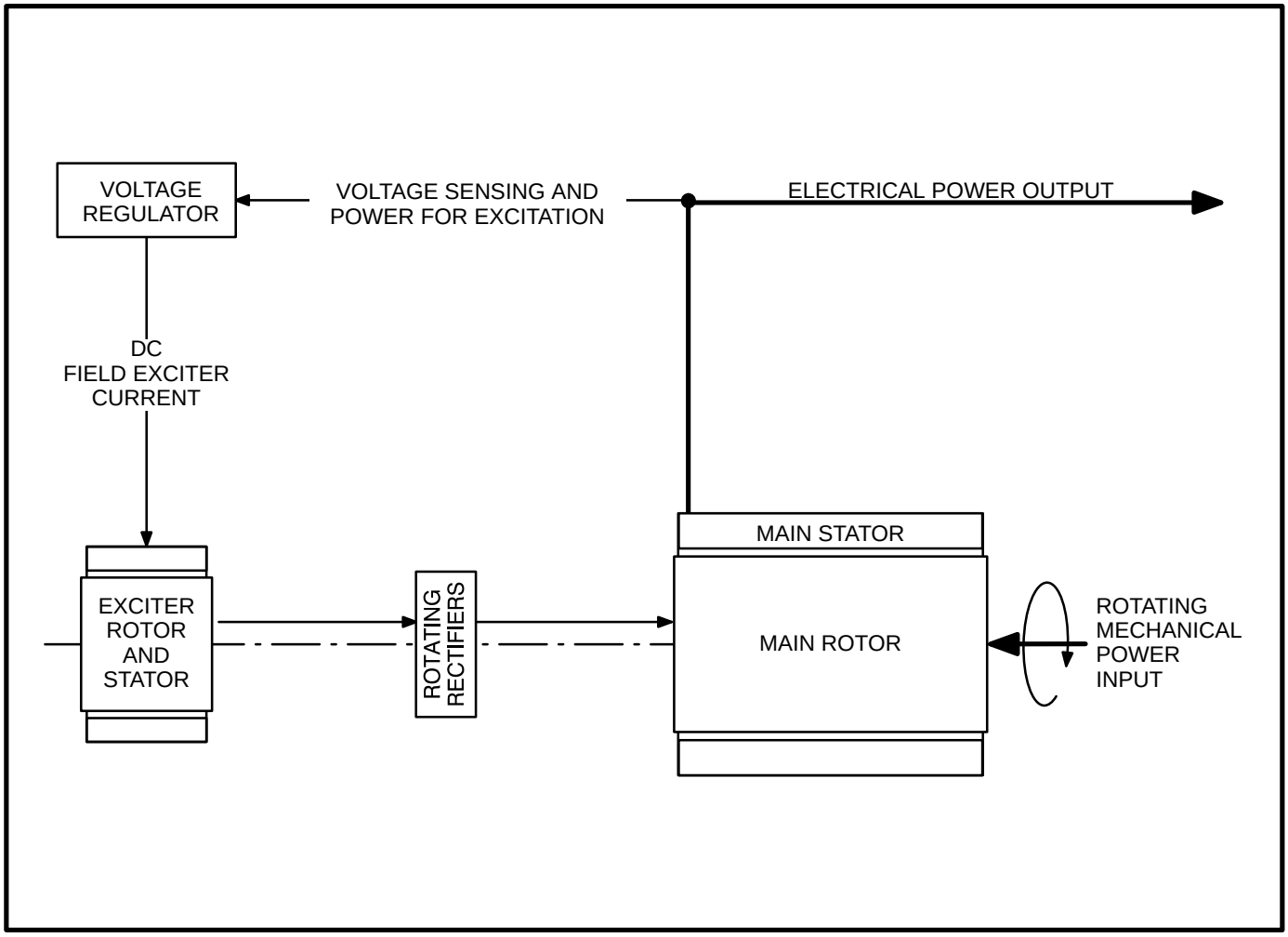


FIGURE 2-6. SCHEMATIC OF GENERATOR OPERATION

3. DC Control

CONTROL PANEL COMPONENTS

The generator set control box is mounted on top of the generator output box, facing the rear or either side. Figure 3-1 points out the components on the control panel that have to do with DC (engine) control and monitoring. Some of the components shown are optional. Page 7-8 is a connection diagram for all the DC components in the control box.

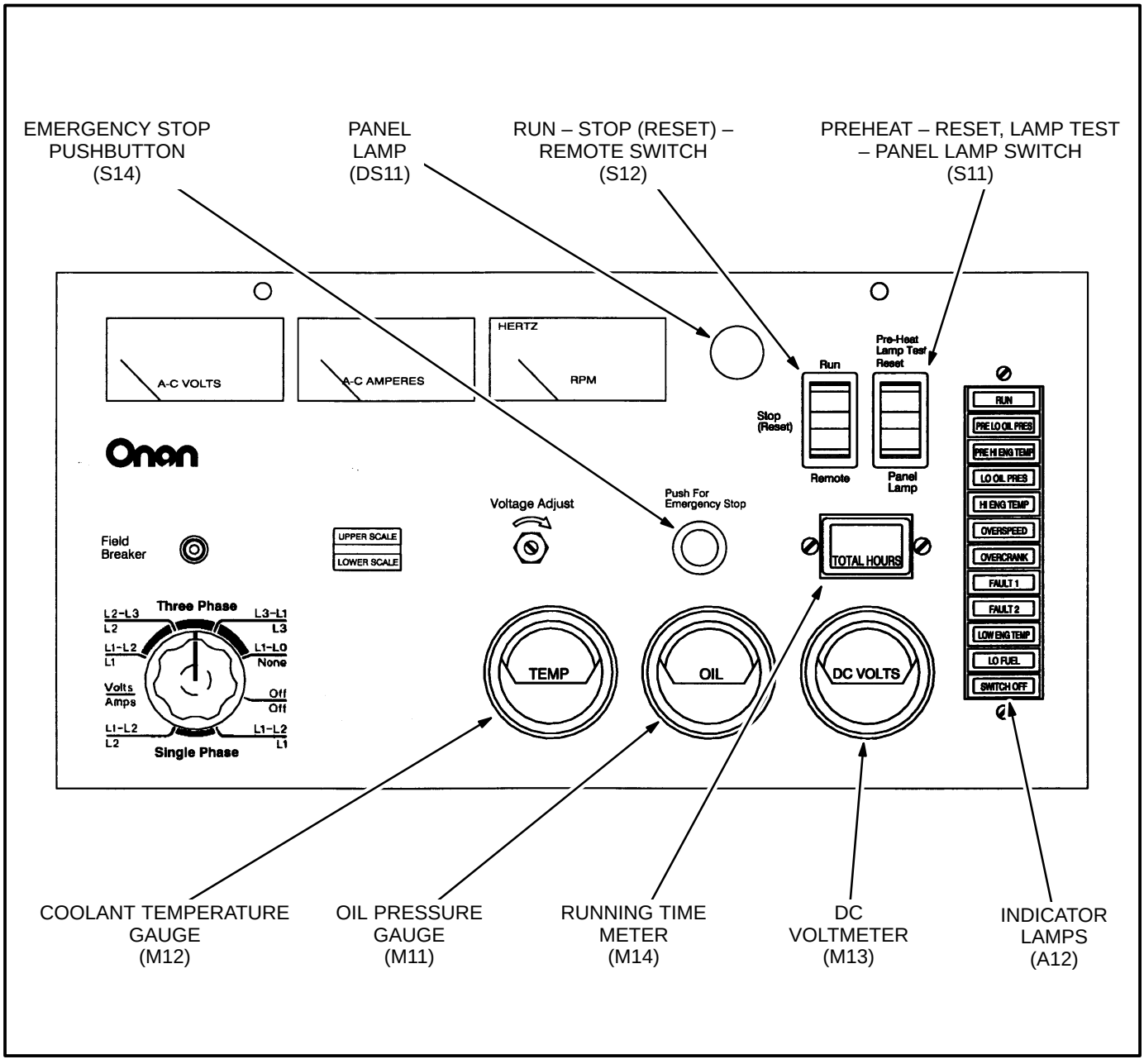


FIGURE 3-1. TYPICAL DC (ENGINE) CONTROL PANEL COMPONENTS

Run – Stop – Remote Switch (S12):

- Push the switch to the **Run** position to start and run the generator set.
- Push the switch to the **Stop** position to stop the set. (The switch must be in the **Stop** position when the reset switch is used to restore generator set operation following a fault shutdown.)
- Push the switch to the **Remote** position to allow a remote controller to automatically run the set.

Preheat – Reset, Lamp Test – Panel Lamp Switch (S11):

- Push the switch to the **Preheat** position (momentary contact) to manually preheat the engine combustion chambers before starting. (This is normally accomplished automatically by the preheat module [A15] inside the control box.)
- Push the switch to the **Reset, Lamp Test** position (momentary contact) to reset the engine control to restore operation following a fault shutdown (the **Run – Stop – Remote** switch must be in the **Stop** position for reset to occur) and to test the indicator lamps. Replace lamps that do not light. Also, this switch has a light which lights following a fault or emergency shutdown. The light remains lit until the engine control has been reset.
- Push the switch to the **Panel Lamp** position to light the panel illumination lamp.

Panel Lamp (DS11): The panel lamp illuminates the control panel.

Coolant Temperature Gauge (M12): The coolant temperature gauge indicates engine coolant temperature.

Oil Pressure Gauge (M11): The oil pressure gauge indicates engine oil pressure.

DC Voltmeter (M13): The DC voltmeter indicates voltage across the battery terminals during operation.

Emergency Stop Button (S14): The emergency stop button is a red, push-in switch used to stop the engine. The button lights up when it is pushed in. The button has to be pulled out and the engine control reset to restore operation.

Running Time Meter (M14): The hour meter indicates the accumulated number of hours the set has run. It cannot be reset.

Tachometer (M16) (Not Shown): The tachometer indicates engine speed in RPM.

Oil Temperature Gauge (M15) (Not Shown): The oil temperature gauge indicates crankcase oil temperature.

Emergency Override Switch (Not Shown): This switch can be used to start and run the set, overriding all alarms and shutdowns.

⚠ CAUTION ***This switch is for emergencies only––where it has been decided that the generator set must run to continue a critical operation, even though it might result in destruction of the set. Read the Warranty regarding possible exclusions when operating the set under these conditions.***

Indicator Lamps (A12): Figure 3-1 illustrates the Detector-12 indicator lamp assembly. The Detector-7 indicator lamp assembly has all but the last five of the following lamps.

- **Run (Green)** This lamp indicates that the generator set is running and that the starter has been disconnected.
- **Pre Low Oil Pressure (Yellow)** This lamp indicates that engine oil pressure is abnormally low (less than 20 psi).
- **Low Oil Pressure (Red)** This lamp indicates that the engine shut down because of excessively low engine oil pressure (less than 14 psi).
- **Pre High Engine Temperature (Yellow)** This lamp indicates that engine coolant temperature is abnormally high (greater than 220° F).
- **High Engine Temperature (Red)** This lamp indicates that the engine shut down because of excessively high engine coolant temperature (greater than 230° F) or low coolant level.

- **Overspeed (Red)** This lamp indicates that the engine shut down because of overspeed.

- **Overcrank (Red)** This lamp indicates that the engine shut down because it did not start during the timed cranking period (approximately 75 seconds, including two rest periods).

- **Fault 1 (Red)** This lamp indicates that the engine shut down because of a system fault. The customer has to make connections to use this lamp. The lamp is a part of a 10 second time delay shutdown circuit. The customer can make reconnections for non-timed shutdown or warning only. See Engine Monitor (A11). Also, the lense might have been changed to indicate more specifically the fault or warning, such as "**CB Trip**" or "**O/U Voltage**".

- **Fault 2 (Red)** This lamp indicates that the engine shut down because of a system fault. The customer has to make connections to use this lamp. The lamp is part of a non-time delay shutdown circuit. The customer can make reconnections for 10 second time delay shutdown or warning only. See Engine Monitor (A11). Also, the lense might have been changed to indicate more specifically the fault or warning, such as "**CB Trip**" or "**O/U Voltage**".

- **Low Engine Temperature (Yellow)** This lamp indicates that engine temperature is less than 70° F, and the possibility that the engine might not start.

- **Low Fuel (Yellow)** This lamp indicates that the fuel level in the supply tank has dropped to less than the reserve necessary to run the set at full load for the prescribed number of hours. The customer has to make connections to use this lamp.

- **Switch-off (Flashing Red)** This lamp indicates that the **Run / Stop / Remote** switch is in the **Stop** position, which prevents remote, automatic operation.

ENGINE MONITOR (A11)

The heart of the engine control system is the engine monitor (A11). It is a printed circuit board assembly mounted on the side wall of the control box (Figure 3-2). It starts and stops the engine in response to the control panel switches, engine sensors and remote control signals.

Terminals and Connectors

See Pages 7-8 through 7-10 for the connection and schematic drawings for the DC control system. See Page 9-12 for typical customer connections at terminal boards **TB1** and **TB2** on the engine monitor and page 9-13 if the set is also equipped with the auxiliary relay board.

Fuses

The engine monitor has five replaceable fuses to protect it from overloads and groundfaults. They are:

F1 Starter solenoid circuit, 20 amps

F2 Fuel solenoid (switched B+) circuits, 20 amps

F3 Continuous B+ out to remote circuits, 15 amps

F4 Engine monitor circuits, 5 amps

F5 Engine gauge circuits, 5 amps.

Function Selection Jumpers

The board has six selection jumpers that can be repositioned to provide the following timed or non-timed warnings or timed or non-timed shutdowns with warnings:

W1 Jumper Position (jumper **W8** must be in the **B** position):

- **A** Non-timed warning under **FLT 2** conditions.
- **B** Non-timed shutdown and warning under **FLT 2** conditions.
- **C** Timed warning under **FLT 2** conditions.
- **D** Timed shutdown and warning under **FLT 2** conditions.

W2 Jumper Position (jumper **W9** must be in the **B** position):

- **A** Non-timed warning under **FLT 1** conditions.
- **B** Non-timed shutdown and warning under **FLT 1** conditions.
- **C** Timed warning under **FLT 1** conditions.
- **D** Timed shutdown and warning under **FLT 1** conditions.

W6 Jumper Position:

- **A** Warning under **Pre-High Engine Temperature** conditions.
- **B** Shutdown and warning under **Pre-High Engine Temperature** conditions.

W7 Jumper Position:

- **A** Warning under **Pre-Low Oil Pressure** conditions.
- **B** Shutdown and warning under **Pre-Low Oil Pressure** conditions.

W8 Jumper Position:

- **A** Warning while running or during standby under **FLT 2** conditions.
- **B** Allows selection of functions with **W1** jumper.

W9 Jumper Position:

- **A** Warning while running or during standby under **FLT 1** conditions.
- **B** Allows selection of functions with **W2** jumper.

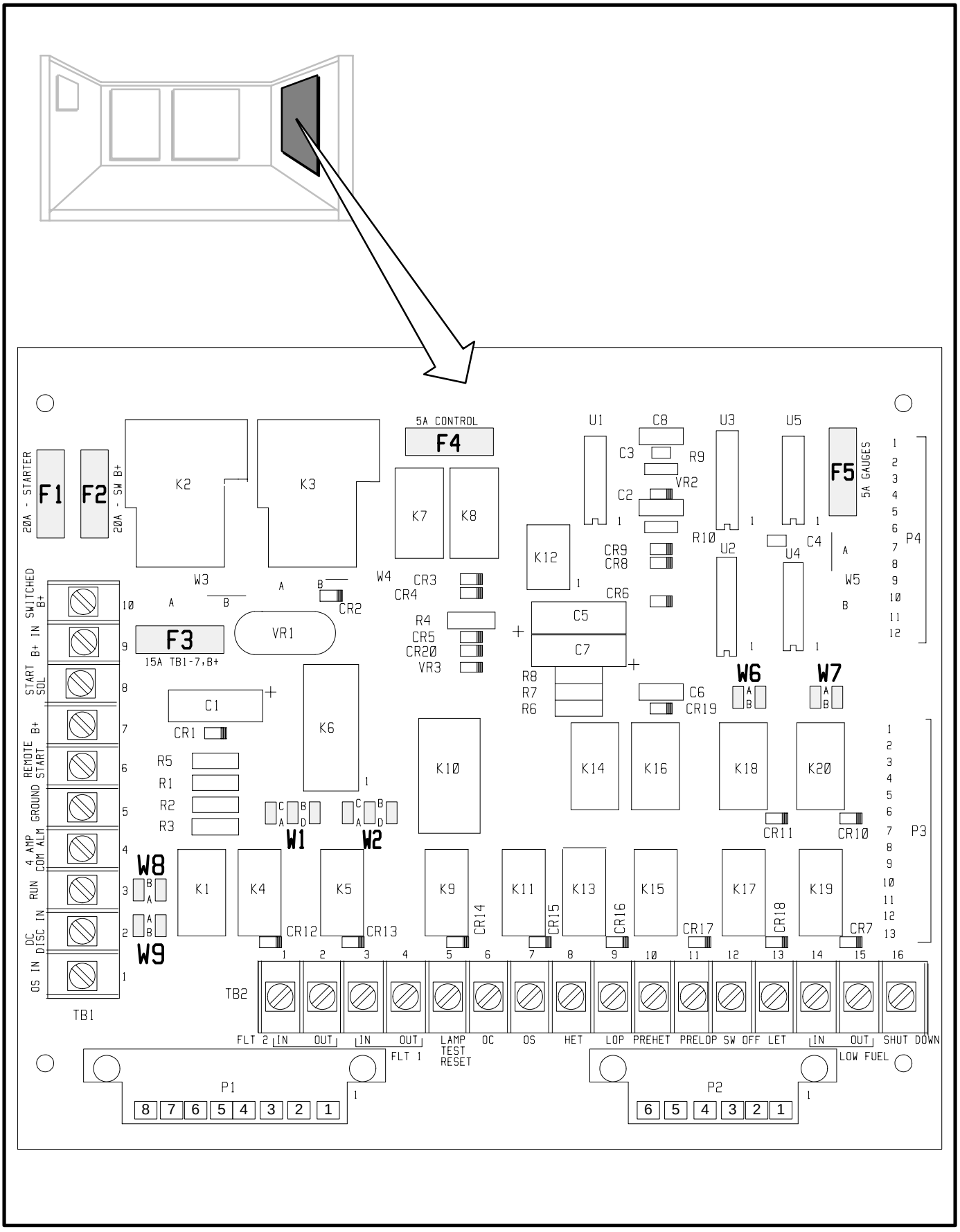


FIGURE 3-2. ENGINE MONITOR FUSES AND FUNCTION SELECTION JUMPERS

OPTIONAL AUXILIARY RELAY BOARD (A28)

The following describes the design/functional criteria for the auxiliary relay board (ARB) with a Detector-7 or -12 Genset control. When provided, the board is mounted on the rear wall of the control box. See Figure 3-3. There are two versions of the ARB; with and without the set of 12 Fault relays. Page 7-13 is a detailed connection diagram for the ARB.

Terminal Blocks:

- **TB1** – ARB TB1 and engine monitor TB1 are identically numbered and provide the same remote control connection points. Note that additional terminals are provided for terminals 5, 7, and 10 of ARB TB1.

- **TB2 through TB5** – Connection points for relays K1 through K3. TB2 provides the N/O and N/C connections (three form 'C' contacts for each relay). TB3 through TB5 provide the common connection points (TB3 for K1, TB4 for K2 and TB5 for K3).

- **TB6 and TB7** – Connection points for fault relays K4 through K15. Three terminals are provided for each relay, which are labeled COM, N/C, N/O.

Plug-In Relays (K1, K2, K3): The ARB can be equipped with up to three 3-pole, double-throw relays. These relays (K1, K2, K3) are field changeable plug-in relays for easy field addition and replacement.

Each relay can be operated as a RUN, COMMON ALARM, or ISOLATED COIL with the changing of a jumper.

The relay contact ratings are:

- 10 amps at 28 VDC or 120 VAC, 80% PF

- 6 amps at 240 VAC, 80% PF

- 3 amps at 480 VAC, 80% PF

Jumper Positions for Plug-In Relays: Jumpers W1, W2 and W3 perform the same functions for their respective relays, W1 for relay K1, W2 for relay K2, and W3 for relay K3. These jumpers control how B+ is connected to the relay coil via TB3-1, TB4-1 or TB5-1. They can be located in any of 3 positions (A, B, C) independently of each other.

- **Jumper Position A (Run)** – The relay operates as a Run relay, energizing when SW B+ is applied from the engine monitor.

- **Jumper Position B (Common Alarm)** – The relay operates as a Common Alarm relay. The relay energizes any time there is an engine shutdown. This signal is provided from the engine.

- **Jumper Position C (Isolated)** – The relay operates as an Isolated relay. The relay coil is energized by a customer applied B+ signal through the terminal block; TB3-1 for relay K1, TB4-1 for relay K2, and TB5-1 for relay K3.

Jumpers W11, W12, and W13 perform the same functions for their respective relays; W11 for relay K1, W12 for relay K2, and W13 for relay K3. These jumpers control how GND is connected to the relay coil via TB3-5, TB4-5 or TB5-5. They can be located in two different positions (A, B) independently of each other.

- **Jumper Position A** – The relay operates isolated from the board. The customer provides the circuit completion through terminal block; TB3-5 for relay K1, TB4-5 for relay K2, and TB5-5 for relay K3. The customer can operate the relay with switched ground logic or use this relay in the middle of more complex logic circuits if needed.

- **Jumper Position B** – The relays operate with the coils connected to ground through the board connections. The coil will require a B+ signal to energize with the jumper in this position.

Fault Relays (K4 through K15): These optional relay modules are used to operate a remote alarm annunciator that has an independent power source. This allows the use of either AC or DC for alarm drives. The relays are energized through the latching relays on the engine monitor and provided N/O and N/C contacts for each external alarm connection.

The 12 relays with form 'C' contacts are rated:

- 10 Amp, 120 VAC

- 10 Amp. 30 VDC

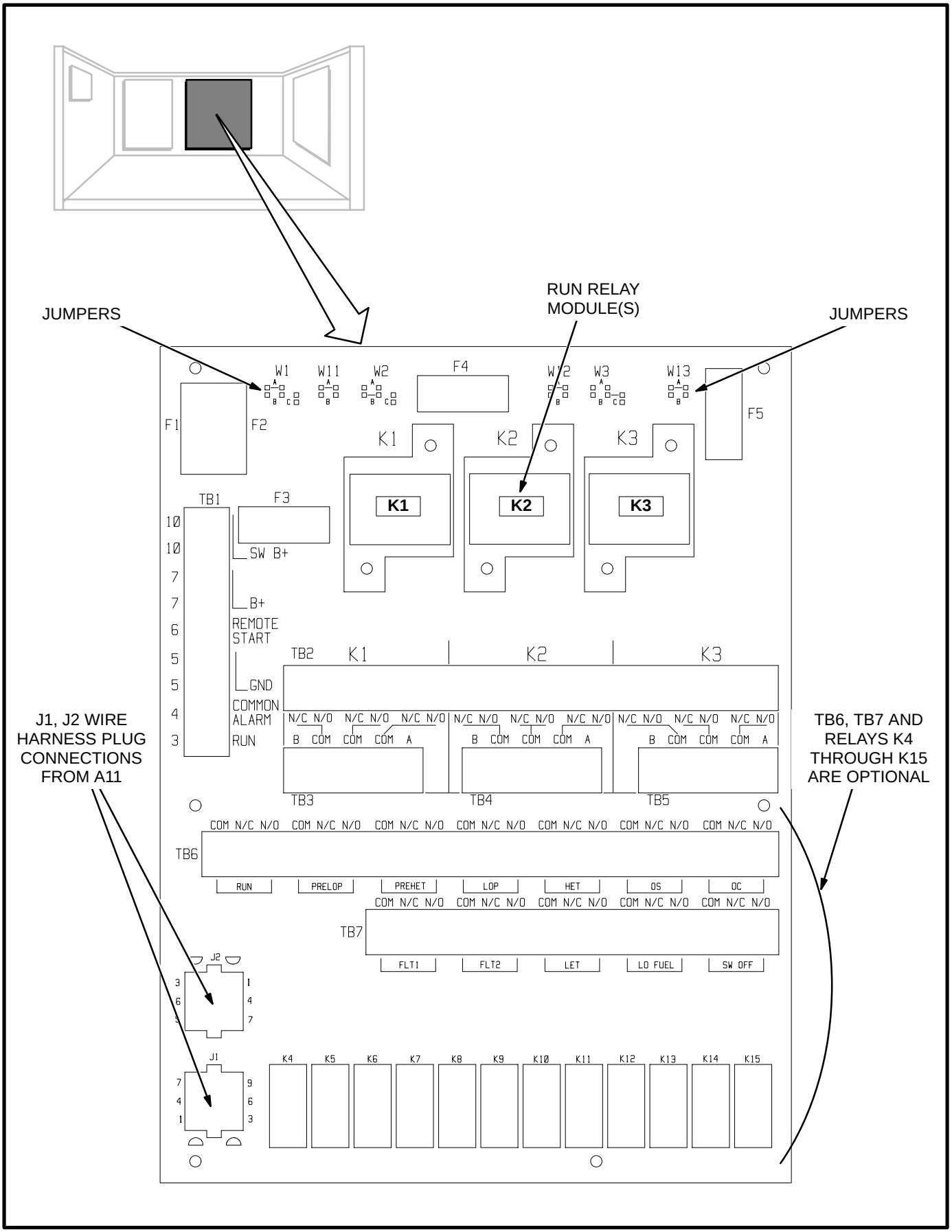


FIGURE 3-3. AUXILIARY RELAY BOARD (ARB)

PREHEAT/TIME-DELAY MODULE (A15)

The start delay is adjustable from 1/2 to 15 seconds and the stop delay from 1 to 30 minutes. Turn the delay adjusting potentiometers clockwise to increase delay and counterclockwise to decrease delay. Preheat occurs during the delayed start period and continues through cranking.

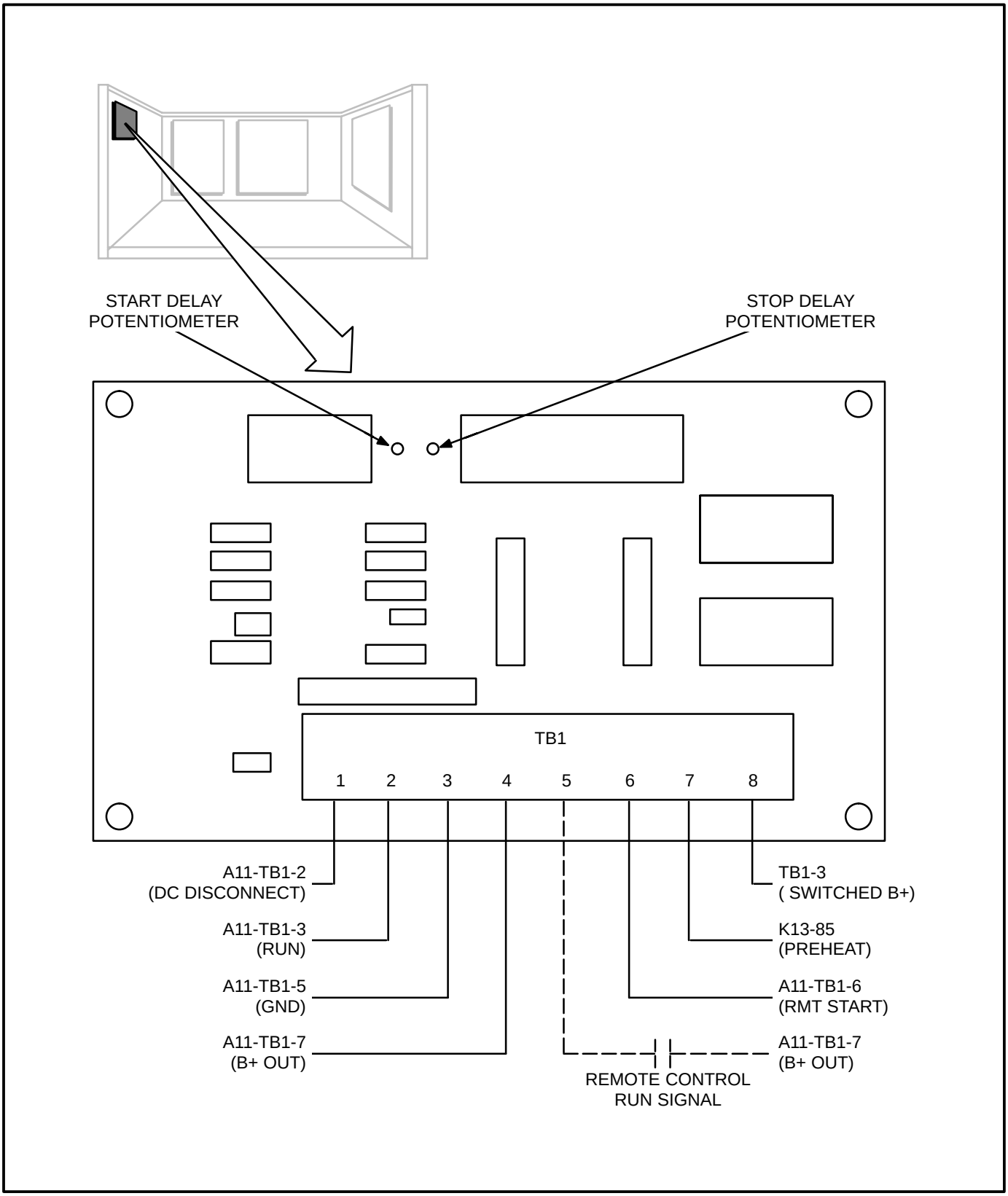


FIGURE 3-4. PREHEAT/TIME-DELAY MODULE

ELECTRONIC OVERSPEED/START DISCONNECT MODULE

The electronic overspeed/start disconnect module is mounted on the generator end bell cover by two screws as shown by Figure 3-5. The magnetic rotor is bolted to the end of the generator shaft as shown. The module is an encapsulated electronic device with wiring harness and disconnect plug.

Start disconnect occurs at about 660 rpm and overspeed shutdown at about 2190 rpm. **For 50 Hertz sets, *if required by the local code*, cut the orange jumper for overspeed shutdown at about 1830 rpm.** There are no other provisions for field adjustment.

To remove the module, disconnect the harness plug and remove the generator end bell cover. The module mounting screw heads are accessible on the back side of the cover.

Torque the rotor bolt to 18 ft-lbs (24 N-m) when remounting the magnetic rotor.

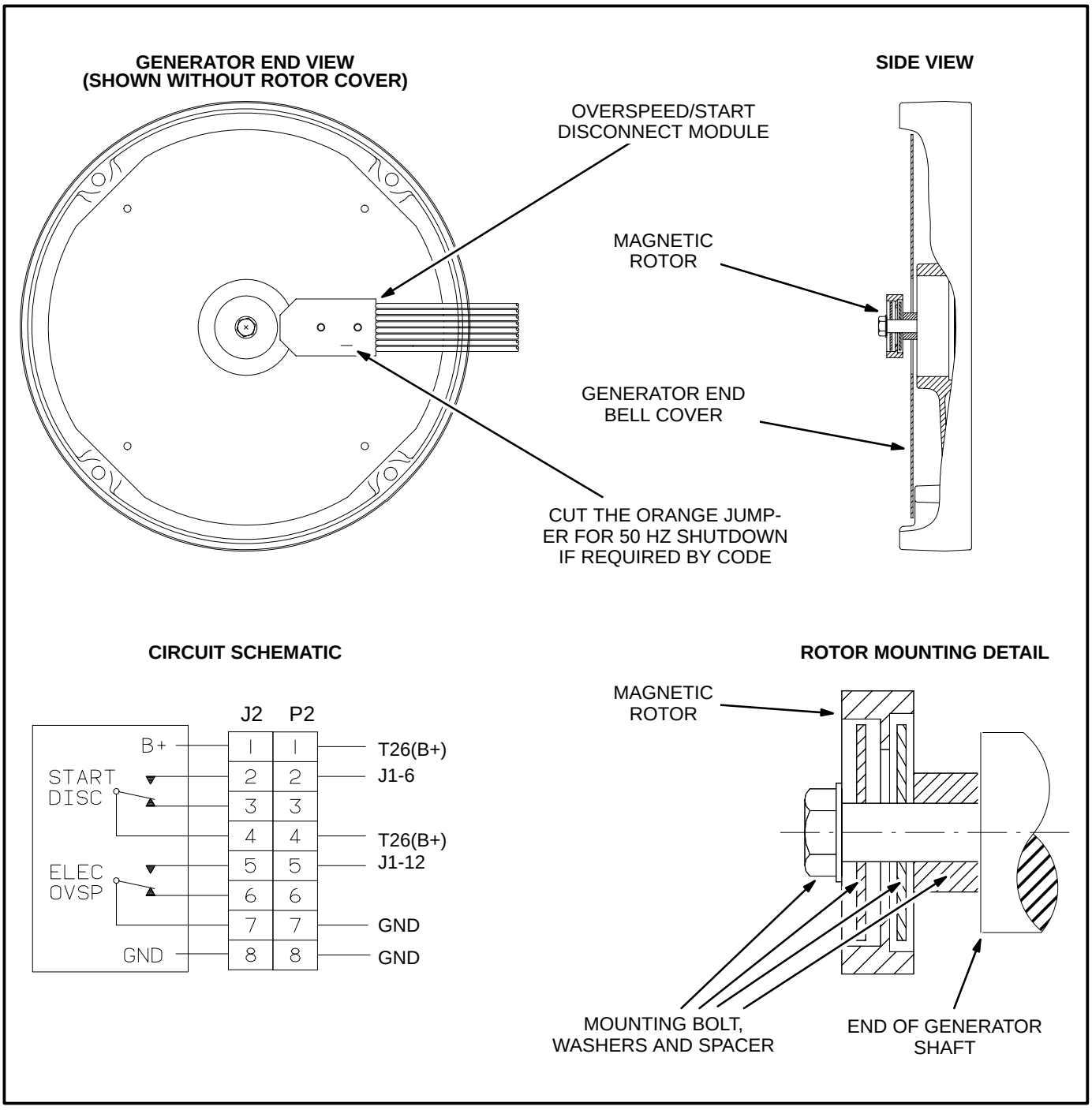


FIGURE 3-5. ELECTRONIC OVERSPEED/START DISCONNECT MODULE

ENGINE GAUGE SENDERS AND SHUTDOWN SWITCHES

Page 7-10 shows the locations of the engine sensors to which the Detector control and control panel gauges respond. The engine temperature and oil pressure warning and shutdown switches close the the monitoring circuit to engine chassis ground.

Always use pipe thread sealant on gauge senders and warning and shutdown switches.

⚠ CAUTION ***Teflon tape is not recommended for switches and senders that are grounded to the engine by thread contact as it may interfere with the ground path.***

Low Coolant Level Switch (S7): The low coolant level switch is located in the radiator top tank and closes the circuit to ground when coolant level falls below the level of the switch sensor. This switch may be connected to shut down the engine and light the **High Engine Temperature** lamp or to light the **Pre High Engine Temperature** light only. See Figure 3-6.

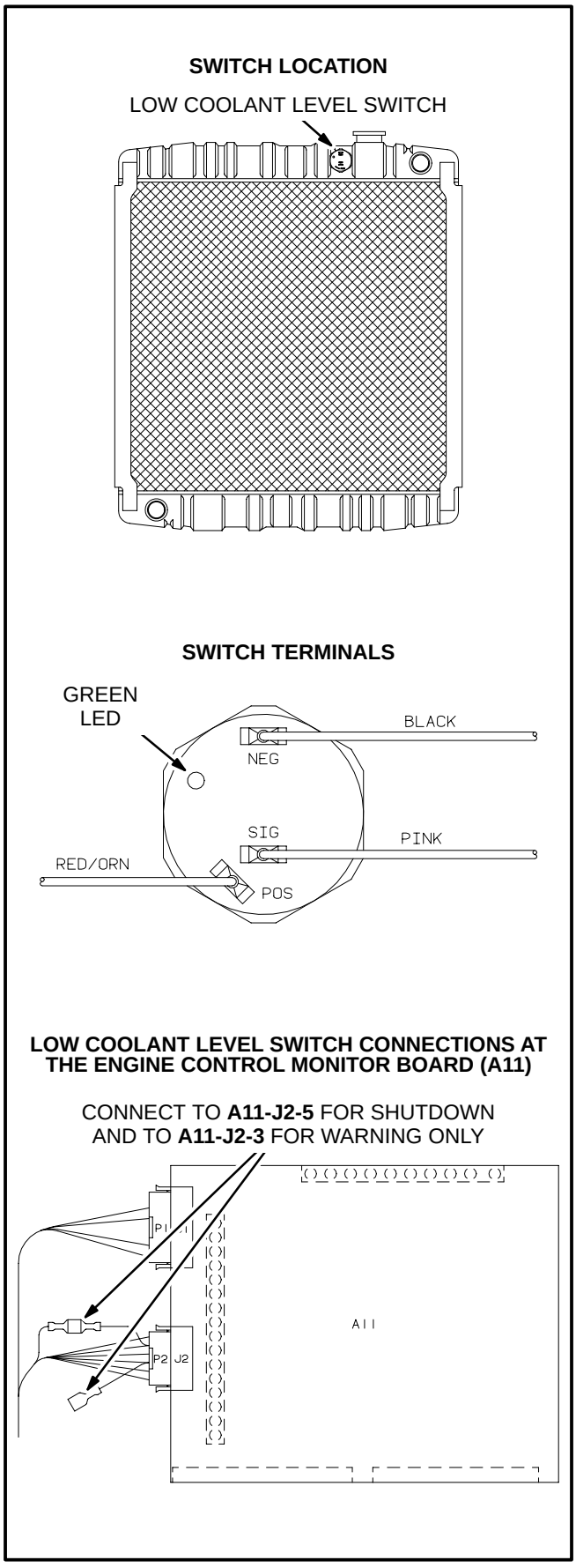
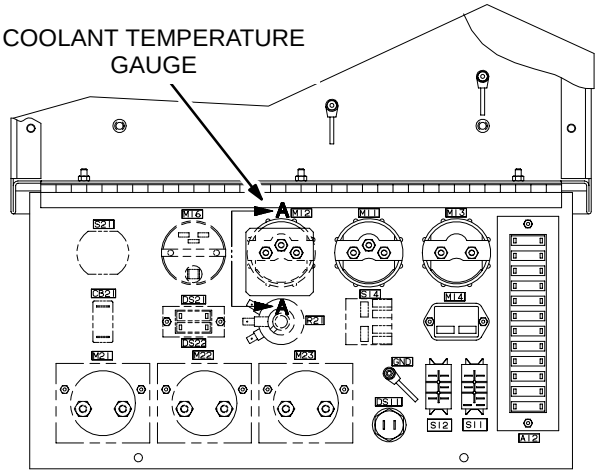


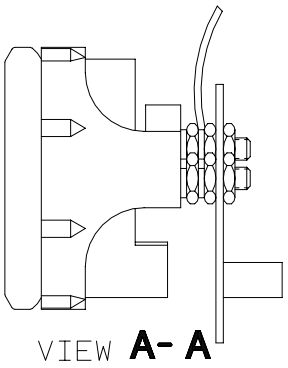
FIGURE 3-6. LOW COOLANT LEVEL SWITCH

Coolant Temperature Gauge and Warning Light Circuits: An electronic PCB assembly is mounted on the back of the coolant temperature gauge (M12) with three terminal nuts. The PCB assembly carries two relays that provide signals for the low coolant and pre-high temperature warning lamps on the basis of the gauge sender output. See Figure 3-7.

BACK OF CONTROL PANEL



PCB MOUNTING ON BACK OF GAUGE



GAUGE AND PCB CONNECTIONS

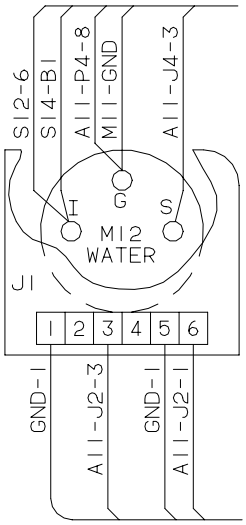


FIGURE 3-7. COOLANT TEMPERATURE GAUGE

RELAYS K11, K12 AND K13

Relays **K11**, **K12** and **K13** are provided for the switched B+, starter and glow plug circuits to handle the higher DC currents in these circuits. They feed through terminal block **TB1** to the engine wiring harness.

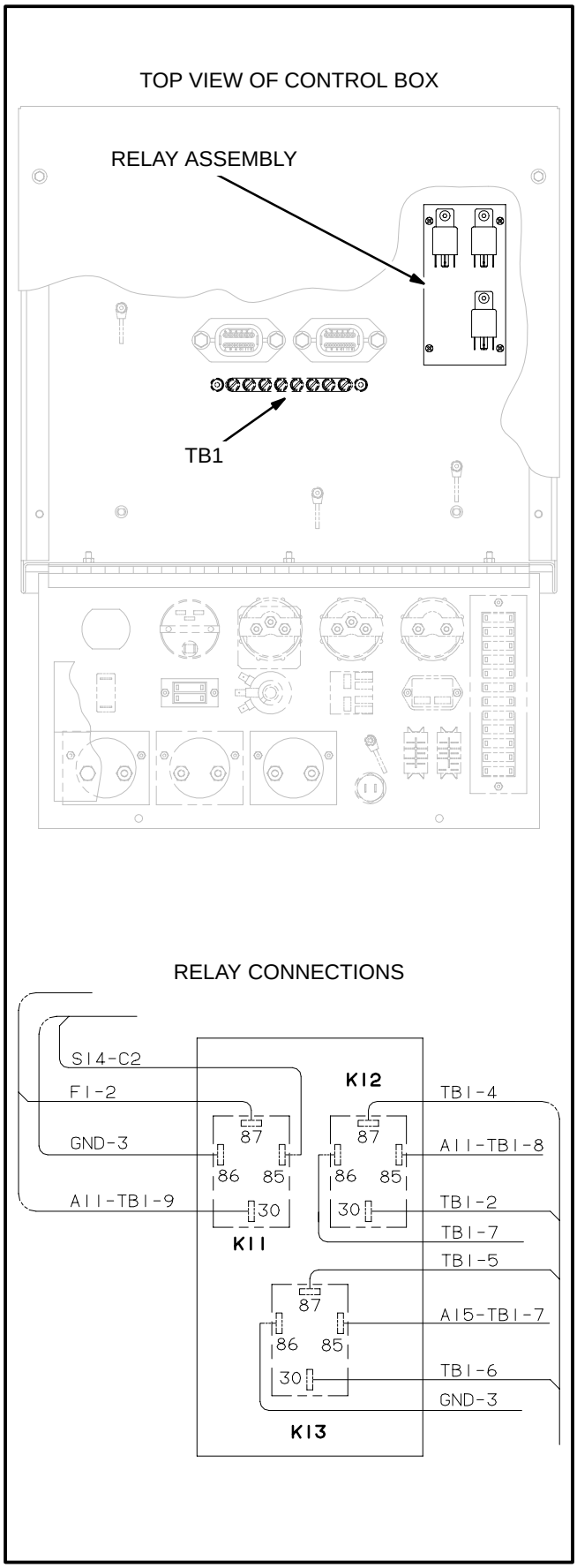


FIGURE 3-8. RELAYS K11, K12 AND K13

SEQUENCE OF OPERATION

The sequence of operation is as follows. Refer to the schematic on Page 7-9.

1. The engine monitor (A11) is powered by cranking battery voltage (12 VDC). Terminal **TB1-9** is connected to battery positive (+) and connector **TB1-5** to battery negative (-).

2. The manual starting cycle begins by pressing and holding preheat switch **S11** in the **Preheat** position for not more than 15 seconds prior to pushing run switch **S12** to the **Run** position. **S11** should be kept in the **Preheat** position while cranking until the engine starts.

3. The automatic starting cycle begins when a start signal is received from the transfer switch and switch **S12** is in the **Remote** position. (The transfer switch is connected by the customer to terminal **5** of time delay/preheat module **A15**. After the preset start delay, **A15** sends the start signal to engine monitor terminal **A11-TB1-6**.)

4. During the start delay period and extending through the cranking period, terminal **A15-7** (time delay/preheat module) energizes the coil of relay **K13**, energizing the cylinder glow plugs.[1]

5. The start signal received at engine monitor terminal **A11-TB1-6** (automatic) or **A11-P4-6** (manual), causes engine monitor **A11** to energize the engine gauges and terminals **A11-TB1-8** and **A11-TB1-10**.

6. **A11-TB1-10** energizes the coil of relay **K11** to energize the SW B+ circuit to engine block terminal **T26**. Fuel solenoid **K1** should pull in.

   To reduce startup current, cranking is delayed until fuel solenoid K1 pulls in. When K1 pulls in, K1-NC contacts open removing B+ from K12-86, allowing starter circuit relay K12 to energize.

7. **A11-TB1-8** energizes the coil of relay **K12** (starter circuit) provided fuel solenoid **K1** has pulled in.

8. With the fuel solenoid pulled in and 12 VDC to the starter and glow plugs, the engine should crank, start and run up to governed speed in a matter of seconds.

9. The engine monitor disconnects the starter when engine speed reaches approximately 660 RPM. There are two, redundant, starter disconnect circuits. One is activated by 120 VAC generator output voltage (plug connectors **A11-P1-1** and **A11-P1-2**). The other is activated by 12 VDC through the start disconnect module (plug connector **A11-P1-5**).[2]

10. Shutdown occurs if the engine does not start within 75 seconds. The **Overcrank** indicator lamp lights and common alarm terminal **A11-TB1-4** is powered.

    The engine monitor has a cycle crank feature whereby the engine is cranked for three 15 second periods alternated with two 15 second rest periods.

11. Shutdown occurs during operation when a low oil pressure (S1), high engine temperature (S2), low coolant level (S7) or engine overspeed condition is sensed or the emergency stop button (S14) is pressed. The appropriate fault indicator lamp lights and common alarm terminal **A11-TB1-4** is powered. (There is no fault lamp for emergency stop. The switch button will light, however, and switch S11 will light for all faults.)

    The low oil pressure and high engine temperature shutdowns have 10 second time delays to allow oil pressure and engine temperature to stabilize during startup.

12. To restore operation after a shutdown fault has been serviced, reset the engine monitor by pushing the panel **Stop** switch and then the **Reset** switch. The set should run or be ready to run when the panel switch is pushed to **Run** or to **Remote**.

    If the emergency stop switch has been used, the control will have to be reset to restore operation. First pull the emergency stop switch button and then push the panel Stop and Reset switches.

13. The set is stopped manually by pressing the panel **Stop** switch or automatically by the transfer switch. (The panel switch must be in the **Remote** position for remote, automatic operation.)

1. The transfer switch may also have a preset start delay period. Preheat is a function of module **A15** only, and does not begin until **A15** receives the start signal.

2. If the starter disconnects normally but the local control panel **Run** indicator light does not come on, the DC start disconnect circuit (start disconnect module) may not be working. If the starter disconnects normally but neither the local nor the remote **Run** indicator light comes on, the AC start disconnect circuit may not be working. See *Section 4. Troubleshooting*.

4. Troubleshooting

These troubleshooting charts are designed to help you think through generator set problems. To save time troubleshooting, read the entire manual ahead of time to understand the generator set. Try to think through problems. Go over what was done during the last service call. The problem could be as simple as an empty fuel tank, closed fuel shutoff valve, loose wire, blown fuse or tripped circuit breaker.

THE ENGINE DOES NOT CRANK IN RUN MODE	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The **Emergency Stop** switch has been used. (The switch button is lit.)	Pull the **Emergency Switch** button. To reset the engine control, push the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. Then push the **Run-Stop-Remote** switch to **Run**.
2. A **Fault Shutdown** is being indicated by one of the red lights on the control panel.	Service the set as necessary. To reset the engine control, push the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. Then push the **Run-Stop-Remote** switch to **Run**.
3. Fuel solenoid **K1** is not functioning properly or is not adjusted properly.	Push the **Run-Stop-Remote** switch to **Run** and watch for fuel solenoid **K1** to pull in. If it does not, push the **Run-Stop-Remote** switch to **Stop** and connect the positive (**+**) terminal on fuel solenoid **K1** to the **BAT** terminal on the starter solenoid with a jumper wire and the negative (**–**) terminal to **GND**. If the fuel solenoid pulls in but the engine does not crank, adjust the fuel solenoid linkage as instructed in Section *6. Governor.* (Relay **K12** in the starter circuit cannot pull in until fuel solenoid **K1** pulls in and opens its set of normally closed contacts.) Replace the the fuel solenoid if it does not pull in.
4. Cranking voltage is too low to crank the engine.	a. Clean and tighten or replace the positive (**+**) and negative (**–**) battery cable connectors and cables at the battery and the set. b. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). c. If the set is in standby service, install a battery charger. d. Replace the engine-driven battery charging alternator if normal battery charging voltage is not between 12 and 14 volts.

THE ENGINE DOES NOT CRANK IN RUN MODE (CONT.)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
5. The **starter motor** or **solenoid** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at starter solenoid terminal **SW**. Replace the starter motor if there is voltage but the motor does not function.
6. Fuse **F1** (see Figure 3-2) on engine monitor board A11 has blown (no voltage [12VDC] at **A11-TB1-8**).	The wire between **A11-TB1-8** and terminal **85** on relay **K12** in the control box may be loose and shorting to ground. Repair as necessary and replace the fuse with one of the same type and amp rating (20 A).
7. Fuse **F2** (see Figure 3-2) on engine monitor board A11 has blown (no voltage [12VDC] at **A11-TB1-10**).	Either the wire between terminal **A11-TB1-10** and emergency stop switch S14 terminal **S14-C-1** or between **S14-C-2** and relay **K11** terminal **85** may be loose and shorting to ground. Repair as necessary and replace the fuse with one of the same type and amp rating (20 A).
8. Fuse **F4** (see Figure 3-2) on engine monitor board A11 has blown.	The lead to terminal **3** on switch **S12** (Run-Stop-Remote) or to terminal **5** on switch **S11** (Lamp Test-Reset–Preheat) or a lead in the indicator lamp (A12) harness or engine gauge (M11 through M16) harness may be loose and shorting to ground. Repair as necessary and replace the fuse with one of the same type and amp rating (5 A).
9. Fuse **F1** in the control box wiring harness has blown (no voltage [12VDC] at **TB1-3** on floor of control box).	a. The customer may have connected too many loads to terminal **T26 (B+)** on the engine block. Remove the extra loads and replace the fuse with one of the same type and amp rating (30 A). b. Check for loose wires that may be shorting to ground, including the leads to **TB1-3** and **A15-TB1-8** (Start/Stop delay module) in the control box and the red/orange leads in the engine wiring harness. Repair as necessary and replace the fuse with one of the same type and amp rating (30 A).
10. The black engine harness grounding lead from control box terminal **TB1-1** (bottom side) to the engine block **GND** terminal is loose, damaged or missing.	Check for electrical continuity (zero ohms) between **TB1-1** on the floor of the control box and the battery negative (**–**) terminal. Repair as necessary.
11. Emergency stop switch **S14** is faulty.	Bypass **S14** with a jumper lead from **A11-TB1-10** to terminal **85** on relay **K11**. If the engine can now start, replace **S14**.

THE ENGINE DOES NOT CRANK IN RUN MODE (CONT.)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
12. Relay **K11** is faulty.	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at relay **K11** terminals **85** and **87** while the engine is cranking. Replace relay **K11** if there is voltage at terminal **85** but not at terminal **87**.
13. Relay **K12** is faulty.	Remove the lead from terminal **86** on relay **K12**, ground terminal **86**, push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at relay **K12** terminals **85** and **87**. Replace relay **K12** if there is voltage at terminal **85** but not at terminal **87**.
14. One of the following leads is loose, damaged or missing: **K12-87** to **TB1-4**, **TB1-4** to starter solenoid terminal **SW** (gray/orange), **K12-86** to **TB1-7**, or **TB1-7** to fuel solenoid **K1** terminal **AUX** (light green/orange).	Check, clean and tighten the connectors at both ends and replace the wire if it is damaged.
15. The **Run-Stop-Remote** switch (S12) or wiring is faulty.	Disconnect pin connector **J4** from engine monitor board A11 and check for electrical continuity (zero ohms) between switch terminals **2** and **3** when the switch is in the **Run** position and between terminals **1** and **2** when it is in the **Remote** position. Replace the switch if either set of contacts is faulty.
16. Engine monitor board **A11** is faulty. (Check fuses **F1**, **F2** and **F4** and for B+ at A11-TB1-9 again.)	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at terminals **A11-TB1-8** and **A11-TB1-10**. Replace engine monitor board **A11** if there is no voltage at either terminal during cranking.

THE ENGINE DOES NOT CRANK IN REMOTE MODE	
⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The **Run-Stop-Remote** switch is at **Stop. (**The **Switch-Off** light will be flashing, if provided.)	Push the **Run-Stop-Remote** switch to **Remote.**
2. The **Emergency Stop** switch has been used. (The switch button is lit.)	Pull the **Emergency Switch** button. To reset the engine control, push the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. Then push the **Run-Stop-Remote** switch to **Remote**.
3. A **Fault Shutdown** is being indicated by one of the red lights on the control panel.	Service the set as necessary. To reset the engine control, push the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. Then push the **Run-Stop-Remote** switch to **Remote.**
4. There is no remote circuit signal (12 VDC at **A15-TB1-5**) because fuse **F3** on engine monitor board A11 has blown.	a. Replace the fuse with one of the same type and amp rating (15 A). b. If fuse **F3** blows again, find and repair the fault in the remote control circuit, such as a loose wire that may be shorting to ground or a shorted relay coil or other component.
5. There is no remote circuit signal (12 VDC at **A15-TB1-5**) because the remote circuit is not functioning properly.	Apply 12 VDC to **A15-TB1-5**. If the engine cranks, find and repair the fault in the remote control circuit.
6. Start delay module **A15** is not functioning properly.	Check for misconnections (see Figure 3-4) and loose connections and replace start/stop delay module **A15** if there is 12 VDC at terminals **A15-TB1-4** and **A15-TB1-5** but not at **A15-TB1-6** after a time delay of up to 15 seconds.
7. Same as Steps 3 through 16 in the **RUN** mode.	Same as Steps 3 through 12 in the **RUN** mode.

THE ENGINE CRANKS BUT DOES NOT START

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The engine is not getting fuel.	a. Open any closed shutoff valve in the fuel line supplying the engine. b. Fill the main fuel supply tank. c. Restore fuel pump prime according to the Operator's Manual. d. Adjust the fuel solenoid linkage as instructed in Section *6. Governor.*
2. The air cleaner is blocked.	Service as necessary.
3. Low engine temperature is causing too low a cranking speed for starting.	a. Plug in, repair or install engine coolant and engine oil heaters. b. Replace the engine oil if it is not of the recommended viscosity for the ambient temperature.
4. Cranking voltage is too low to reach required cranking speed.	a. While cranking the engine, measure voltage directly across the battery terminals and then immediately across the starter motor terminal and the grounding bolt on the block. Cable, terminal or relay contact resistance is too high if the difference is more than 2 volts. Service as necessary. b. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). c. Replace the engine-driven battery charging alternator if normal battery charging voltage is not between 12 and 14 volts.
5. The preheat time delay is not long enough for the ambient temperature.	Adjust preheat/start delay module **A15** for up to 15 seconds preheat time delay if permitted by the applicable Codes. See *Section 3. DC Control*.
6. The glow plugs are not heating.	Each glow plug should be warm to the touch if the engine has just been cranking. First clean and tighten the terminal of any cold glow plug and then replace it if necessary. If none of the glow plugs gets warm, go to Step 7.

THE ENGINE CRANKS BUT DOES NOT START(CONT.)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
7. Preheat/start delay module **A15** is not functioning properly.	If the glow plugs do not warm while cranking in either the **Run** or **Remote** modes, press the **Preheat** switch (S11) for ten seconds and feel the glow plugs. a. If none of the glow plugs gets warm, go to Step 8. b. If any glow plug gets warm, open the control box and check for 12 VDC at terminals **A15-TB1-7** and **A15-TB1-8** on the preheat/start delay module while the engine is cranking. If there is voltage at **A15-TB1-8**, but not at **A15-TB1-7**, replace preheat/start delay module **A15**. If there is voltage at **A15-TB1-7**, check for proper connections between **A15-TB1-7** and terminal **85** on relay **K13**.
8. Relay **K13** is not is not functioning properly.	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at relay **K13** terminals **85** and **87** while the engine is cranking. Replace relay **K13** if there is voltage at terminal **85** but not at terminal **87**. If there is voltage at terminal **87**, check for proper connections of the lead between terminal **87** and terminal **TB1-5** on the floor of the the control box and the white lead in the engine harness between **TB1-6** and the glow plugs.
9. The length of the fuel solenoid plunger link has not been adjusted properly.	Adjust the length of the link according to the instructions in *Section 6. Governor*.
10. The engine fuel system is worn or malfunctioning or has lost prime (fuel lift pump, injection pump, injectors, timing).	Service according to the engine service manual.
11. The engine is worn or malfunctioning mechanically.	Service according to the engine service manual.

THE ENGINE RUNS UNTIL FAULT SHUTDOWN

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The **OVERSPEED** lamp comes on when the engine shuts down.	a. If this is a 60 Hertz set, check to see if the orange jumper on the overspeed module has been cut (Figure 3-5). If it has, replace the module. (Cutting the orange jumper lowers the cutout point for 50 Hertz sets.) b. Reset engine monitor board **A11** by pushing the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset** and restart the set, monitoring engine speed and adjust the governor according to *Section 6, Governors.* c. **Mechanical Governor:** Service or replace the injection pump unit if the set still shuts down due to overspeed. d. **Electronic Governor:** If the governor cannot be adjusted to prevent shutdown due to overspeed, check for binding in the linkage. Repair and adjust the linkage as necessary. (A spring inside the actuator will resist movement, which is normal.) e. If the set still shuts down due to overspeed, re-install the magnetic speed pick-up unit to make sure the clearance with the flywheel gear teeth is correct. Replace the speed-pickup unit if output voltage at cranking speed is less than 2.5 VDC as measured at terminals 10 and 11 on the governor controller. f. Disconnect the actuator leads at governor controller terminals **4** and **5**. Jumper the lead for terminal **4** to the **BAT** terminal on the starter solenoid and touch the lead for terminal **5** to a good ground on the block. Replace the actuator unit if it does not drive the linkage through its full travel when power is connected or return it when power is disconnected. g. Replace the governor controller if the set still shuts down due to overspeed.
2. The **LO OIL PRES** lamp comes on when the engine shuts down.	a. Check the engine oil level, repair any oil leaks and fill to the proper level. Then reset engine monitor board **A11** by pushing the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. b. If the set still shuts down due to low oil pressure, crank the engine by supplying battery positive (**+**) to the **SW** terminal of the starter solenoid and observe oil pressure while cranking the engine. Service the lubricating oil system according to the engine service manual if oil pressure is less than 10 psi. Replace the low oil pressure cutout switch if oil pressure is greater than 10 psi. See Page 7-10 to locate the switch.

THE ENGINE RUNS UNTIL FAULT SHUTDOWN (CONT.)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
3. The **HI ENG TEMP** lamp comes on when the engine shuts down.	a. Check the engine coolant level, repair any coolant leaks and refill as necessary. Then reset engine monitor board **A11** by pushing the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset**. b. If the set still shuts down due to high engine temperature, start the engine and observe coolant temperature as the system heats up. If shutdown occurs before the coolant reaches 225° F (101° C), replace the high engine temperature cutout switch. If coolant temperature exceeds 225° F (101° C), clean and service the entire cooling system as required to restore full cooling capacity. See Page 7-10 to locate the switch. c. If the set still shuts down, disconnect low coolant level switch **S7** at the switch. If the radiator top tank is full and the engine now continues to run, replace switch **S7.**
4. The **FAULT 1** or **FAULT 2** lamp (may be specifically labeled) comes on when the engine shuts down.	Service as required. (The customer has supplied the system fault indicating switches. By means of selection jumpers, either fault may be chosen to display the warning only. See *Section 3, Engine Control*.)

THE ENGINE LACKS POWER OR IS UNSTABLE

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. Fuel delivery to the set is inadequate.	a. Check for and replace clogged fuel lines and filters. b. Check for air in the fuel lines and repair all air leaks. c. Measure the vertical distance between the fuel lift pump on the engine and the bottom of the dip tube in the supply tank. Make necessary provisions so that lift does not exceed 31.5 inches (0.8 metres).
2. The fuel is contaminated or of the wrong type.	Connect the set to a container of fuel of known quality and run the set under various loads. Replace the contents of the fuel supply tank if there is a noticeable improvement in performance.
3. The engine air filter element is dirty.	Replace the air filter element.
4. The governor adjustment is incorrect.	a. Adjust the governor according to *Section 6, Governor.* b. **Mechanical Governor:** Service the fuel injection unit according to the engine service manual if it cannot be adjusted for full power or stable speed. c. **Electronic Governor:** If the governor cannot be adjusted for full power or stable speed, shut down the set and check for binding in the linkage. Repair and adjust the linkage as necessary. (A spring inside the actuator will resist opening the movement, which is normal.) d. Re-install the magnetic speed pick-up unit to make sure the clearance with the flywheel gear teeth is correct. Replace the speed-pickup unit if output voltage at cranking speed is less than 2.5 VDC as measured at terminals **10** and **11** on the governor controller. e. Disconnect the actuator leads at governor controller terminals 4 and 5. Jumper the lead for terminal 4 to the BAT terminal on the starter solenoid and touch the lead for terminal 5 to a good ground on the block. Replace the actuator unit if it does not drive the linkage through its full travel when power is connected or return it when power is disconnected. f. Replace the governor controller if it still cannot be adjusted for full power or stable speed.

THE ENGINE LACKS POWER OR IS UNSTABLE (CONT.)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
5. The engine fuel system (lift pump, injection pump, injectors, timing) is faulty.	Service the fuel system according to the engine service manual.
6. The engine is worn.	Service the engine according to the engine service manual.

AN AMBER WARNING LAMP IS ON	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The **PRE LO OIL PRES** lamp comes on while the engine is running.	Shut down the set if possible or disconnect non-critical loads.(Oil pressure will be less than 20 psi but greater than 14 psi.) Service the engine lubricating system according to the engine service manual.
2. The **PRE HI ENG TEMP** lamp comes on while the engine is running.	Shut down the set if possible or disconnect non-critical loads. (Engine temperature will be greater than 220° F but less than 230° F.) Service the engine cooling system to restore full cooling capacity.
3. The **LOW ENGINE TEMPERATURE** lamp comes on while the set is in standby.	a. Plug in, repair or install engine coolant and engine oil heaters. b. if the engine coolant gauge indicates more than 70° F (21° C), replace the gauge board. See Figure 3-7.
4. The **LO FUEL** lamp comes on.	Fill the main fuel supply tank with the appropriate grade of fuel. (The customer has supplied the fuel level switch to make use of this warning.)
5. The **FAULT 1** or **FAULT 2** lamp (may be a specifically labeled amber lamp) comes on.	Service as required. (The customer has supplied the system fault indicating switches. By means of selection jumpers, either fault may be chosen to shut down the engine. See See *Section 3, Engine Control*.)

THE GREEN RUN LAMP STAYS OFF BUT THE SET RUNS NORMALLY

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The set mounted **RUN** lamp does not light although the starter has disconnected normally and the engine is running	a. Press the panel **Lamp Test** switch and replace the run lamp bulb if it does not light. b. Check for loose or missing wiring between the start disconnect module and pin connector **P1-5** on engine monitor board **A11**. See the connection diagram on Page 7-9. c. Check for 12 VDC at **A11-P1-5** while the set is running. If there is no voltage, check to see that the start disconnect module and rotor are mounted properly and that the LED is blinking (Figure 3-5). Replace the module if is mounted properly but there is no voltage or the LED is not blinking. d. Replace engine monitor board **A11** if there is voltage at **A11-P1-5** while the set is running normally but the **RUN** lamp does not light.
2. Neither the remote nor the set mounted **RUN** lamp light although the starter has disconnected normally and the engine is running.	a. Press the panel **Lamp Test** switch and replace the run lamp bulb if it does not light. Test the remote **RUN** lamp by suitable means and replace it if it does not light. b. If both lamps are good, this indicates that the AC disconnect circuit is not working. Check the AC voltmeter to determine whether or not there is generator output voltage and service as necessary. See There Is No Output Voltage in *Troubleshooting*. c. If there is generator output voltage, check for 120 VAC across pin connectors **P1-1** and **P1-2** on the ECM. If there is no voltage, check for loose or missing leads between the connectors and **TB21-21** and **TB21-32** inside the control box and service as necessary. d. Replace engine monitor board **A11** if there is 120 VAC across pin connectors **P1-1** and **P1-2** but neither **RUN** lamp lights during normal operation.

NO OUTPUT VOLTAGE

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The line circuit breaker is **OFF**.	Find out why the circuit breaker was turned **OFF**, make sure it is safe to reconnect power, and then throw the circuit breaker **ON**.
2. The line circuit breaker has **TRIPPED**.	Shut down the set and service as necessary to clear the short circuit or ground fault that caused tripping, and then **RESET** the circuit breaker and start the set.
3. The line circuit breaker is faulty.	Shut down the set, make sure the power output lines from the set have been disconnected from all other sources of power, attempt to **RESET** the circuit breaker and throw it **ON** and check for electrical continuity across each line contact. Replace the circuit breaker if there is measurable resistance across any contact.
4. Field circuit breaker **CB21** has **TRIPPED**.	**RESET** the circuit breaker. If it keeps tripping, troubleshoot according to the chart, *Field Circuit Breaker Keeps Tripping*.
5. Field circuit breaker **CB21** is faulty.	Shut down the set, attempt to **RESET** the circuit breaker and disconnect either lead. Replace the circuit breaker if there is measurable resistance across the terminals.
6. The field has lost its residual magnetism.	Flash the field according to Figure 2-5 in *Section 2, AC Control*.

NO OUTPUT VOLTAGE (CONT.)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
If flashing the field does not work, isolate the problem to the voltage regulator or to the generator as follows: a. Throw the line circuit breaker **OFF** and shut down the set. ⚠ **CAUTION** ***This test involves unregulated excitation of the generator. To prevent damage to the generator due to overcurrent, make sure that all loads have been disconnected and that all faults have been cleared from the power output terminals of the generator.*** b. Disconnect the field leads from terminals **VR21-F1** and **VR21-F2** on the voltage regulator (See Figure 2-5 in *Section 2, AC Control*) and connect the leads to a **12 volt battery**: **F1** to battery positive (**+**) and **F2** to battery negative (**–**). Polarity must be correct or this test will be inconclusive because the induced and residual magnetic polarities in the exciter stator will be opposed. c. Read output voltage across the generator terminals while the set is running. ⚠ **WARNING** ***HIGH VOLTAGE. Touching uninsulated high voltage parts inside the control box can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and use tools with insulated handles.*** d. If rated output voltage or higher is obtained and the voltages for all phases are balanced, the generator is probably okay. Troubleshoot the voltage regulator—Step 7. e. If the output voltages are not balanced, or are less than ninety percent of rated output voltage, the problem is probably in the generator. If the voltages are unbalanced, first troubleshoot the main stator—Step 12. If the voltages are uniformly low, first troubleshoot the exciter and field circuits—Steps 8, 9, 10 and 11.	
7. Voltage Regulator **VR21** is faulty.	Check all connections against the applicable reconnection diagram (Page 7-11) and rewire as necessary. Replace the voltage regulator if the wiring is correct and there is no output voltage. ⚠ **CAUTION** ***Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.***
8. The exciter field winding is open.	Shut down the set and check exciter field winding resistance according to *Section 5, Servicing the Generator*. Replace the exciter field assembly if winding resistance does not meet specifications.

NO OUTPUT VOLTAGE (CONT.)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
9. The rotating rectifier assembly (diodes **CR1** through **CR6**) is faulty.	Shut down the set and check each diode according to *Section 5, Servicing the Generator*. Service as necessary.
10. The exciter rotor windings are open.	Shut down the set and check exciter winding resistances according to *Section 5, Servicing the Generator*. Replace the generator rotor assembly if exciter rotor winding resistances do not meet specifications.
11. The main rotor winding is open.	Shut down the set and check main rotor winding resistance according to *Section 5, Servicing the Generator*. Replace the generator rotor assembly if main rotor winding resistance does not meet specifications.
12. The stator windings are open.	Shut down the set and check stator winding resistances according to *Section 5, Servicing the Generator*. Replace the generator stator assembly if stator winding resistances do not meet specifications.

OUTPUT VOLTAGE IS TOO HIGH OR TOO LOW

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. Engine speed is too high or too low.	a. Adjust engine speed according to *Section 6, Governor*. b. If engine speed is unstable, troubleshoot according to the chart, *The Engine Lacks Power or is Unstable*.
2. The voltage has been adjusted improperly.	Adjust output voltage according to *Section 2, AC Control*.
3. Improper connections have been made at the generator output terminals.	Shut down the set and reconnect according to the appropriate reconnection diagram. See *Section 7, Wiring Diagrams*.
4. The rotating rectifier assembly (diodes **CR1** through **CR6**) is faulty.	Shut down the set and check each diode according to *Section 5, Servicing the Generator*. Service as necessary.
5. Voltage Regulator VR21 is faulty.	Replace the voltage regulator. ⚠ CAUTION ***Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.***

OUTPUT VOLTAGE IS UNSTABLE

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The voltage has been adjusted improperly.	Adjust output voltage according to *Section 2, AC Control*.
2. The voltage adjusting rheostat on the control panel is faulty (if provided).	Unlock the voltage adjusting screw on the front of the control panel and disconnect either lead from the rheostat. Measure resistance between terminals **1** and **2** while turning the adjusting screw fully one way and then the other. Replace the rheostat if it is open at any point, or if resistance does not vary smoothly from zero to approximately 2,500 ohms.
3. Voltage Regulator **VR21** is faulty.	Replace the voltage regulator. ⚠ **CAUTION** ***Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.***

THE FIELD CIRCUIT BREAKER KEEPS TRIPPING

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The rotating rectifier assembly (diodes **CR1** through **CR6**) is faulty.	Shut down the set and check each diode according to *Section 5, Servicing the Generator*. Service as necessary.
2. The exciter field winding is shorted.	Shut down the set and check exciter field winding resistance according to *Section 5, Servicing the Generator*. Replace the exciter field assembly if winding resistance does not meet specifications.
3. The exciter rotor windings are shorted.	Shut down the set and check exciter winding resistances according to *Section 5, Servicing the Generator*. Replace the generator rotor assembly if exciter rotor winding resistances do not meet specifications.
4. The main rotor winding is shorted.	Shut down the set and check main rotor winding resistance according to *Section 5, Servicing the Generator*. Replace the generator rotor assembly if main rotor winding resistance does not meet specifications.
5. The stator windings are shorted.	Shut down the set and check stator winding resistances according to *Section 5, Servicing the Generator*. Replace the generator stator assembly if stator winding resistances do not meet specifications.
6. Voltage Regulator **VR21** is faulty.	Replace the voltage regulator. ⚠ **CAUTION** ***Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.***

THE PHASE CURRENTS ARE UNBALANCED

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read the safety precautions on pages iii and iv and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The connected loads are distributed unevenly among the phases.	Shut down the set and redistribute the loads as evenly as possible.
2. Improper connections have been made at the generator output terminals.	Shut down the set and reconnect according to the appropriate reconnection diagram. *See Section 7, Wiring Diagrams*.
3. The stator windings are faulty (open or shorted).	Shut down the set and check stator winding resistances according to *Section 5, Servicing the Generator*. Replace the generator stator assembly if stator winding resistances do not meet specifications.
4. A load has a ground fault or short circuit.	Service the faulty equipment as necessary.

5. Generator

TESTING THE GENERATOR

These tests can be performed without removing the generator. Before starting tests, disconnect the starting battery cables (negative [-] first) to make sure the engine will not start while performing these tests.

⚠ CAUTION ***Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.***

⚠ WARNING ***Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).***

Make certain battery area has been well-ventilated before servicing battery. Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur when cable is removed or re-attached, or when negative (–) battery cable is connected and a tool used to connect or disconnect positive (+) battery cable touches frame or other grounded metal part of the set. Always remove negative (–) cable first, and reconnect it last. Make certain hydrogen from battery, engine fuel, and other explosive fumes are fully dissipated. This is especially important if battery has been connected to battery charger.

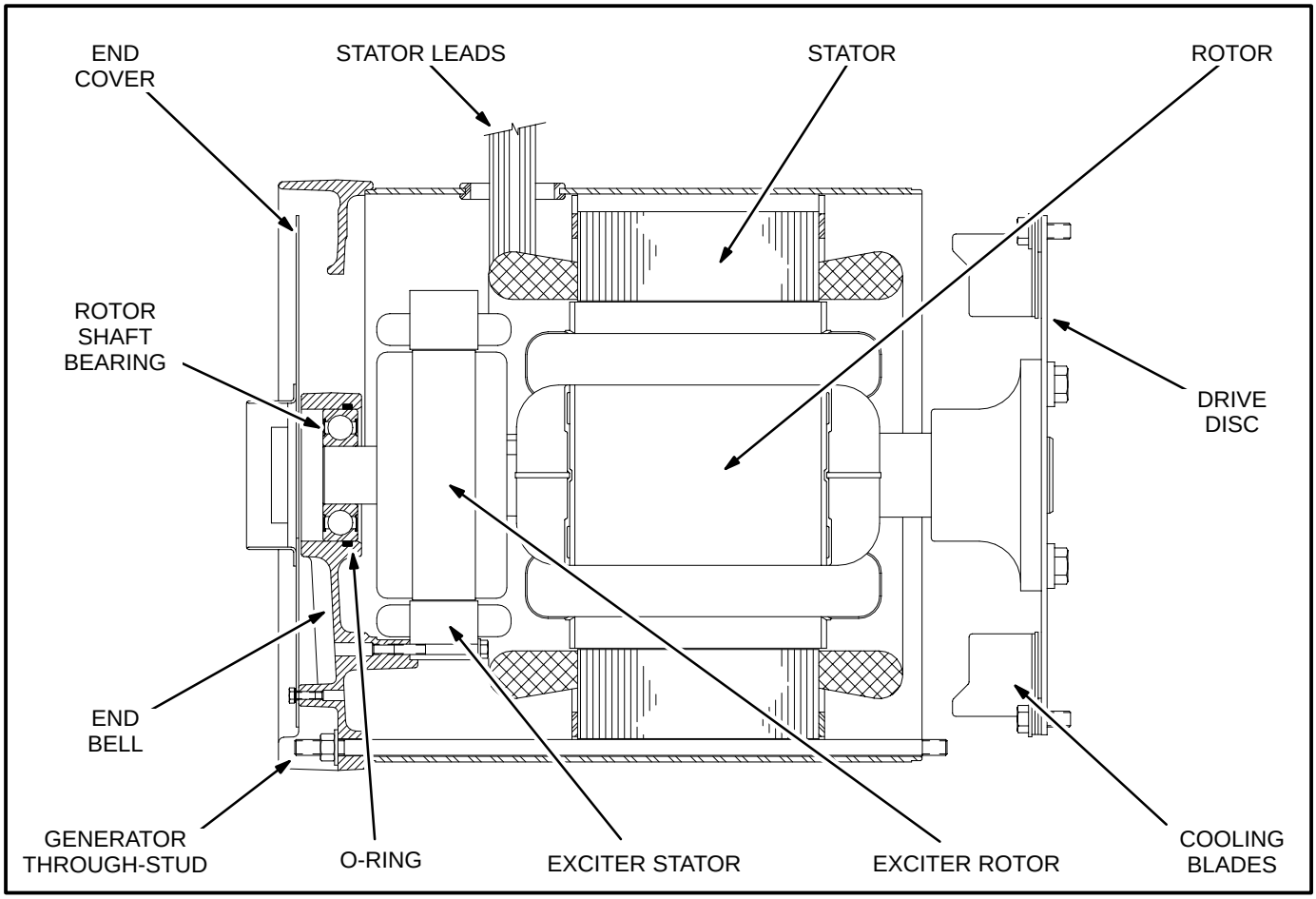


FIGURE 5-1. GENERATOR

Insulation Resistance Testing

Megger Testing: A 500 VDC megger is recommended for insulation testing. A test consists of applying the voltage between the winding and ground for ten minutes and recording resistance values at one minute and at ten minutes after the voltage is first applied.

Resistance values of at least 5 megohms should be obtained for a new generator with dry windings. The polarization index should also be at least 2 (the ratio of the resistance reading at ten minutes to the reading at one minute). For a set that has been in service, the resistance reading should not be less than 1 megohm nor the polarization index less than 2.

Drying the Windings: If low readings are obtained, or the set has been in standby for a long time in high humidity conditions, the windings should be dried out and the test repeated. Use the generator heaters or blow warm air through the generator with a fan. A more effective way is to use a bolted 3-phase short across the generator terminals. To do this:

1. Bolt the three phases of the generator together at the terminals. See Figure 2-3 and the reconnection diagrams on Page 7-11.

2. Disconnect the **F1** and **F2** leads at the voltage regulator and connect them to a variable 12 VDC source. See Figure 2-5.

3. Attach a clamp-on ammeter to the generator leads to measure generator current, adjust the 12 VDC source for zero voltage, start the set and slowly increase the excitation voltage. Obtain the highest current possible without exceeding generator rating.

4. Run the set for approximately one hour and repeat the insulation resistance tests. Replace or rewind the stator or rotor if winding resistance is less than specified.

Exciter Stator

Testing Winding Insulation Resistance: Disconnect exciter stator leads **F1** and **F2** from their connectors in the AC generator wiring harness and isolate them from ground. Connect the megger between one of the leads and ground and conduct the test as instructed in Insulation Resistance Testing in this section.

Testing Winding Resistance: Measure winding resistance between exciter stator leads **F1** and **F2** with a digital ohmmeter. Replace the exciter stator if winding resistance is not 13 to 16 ohms.

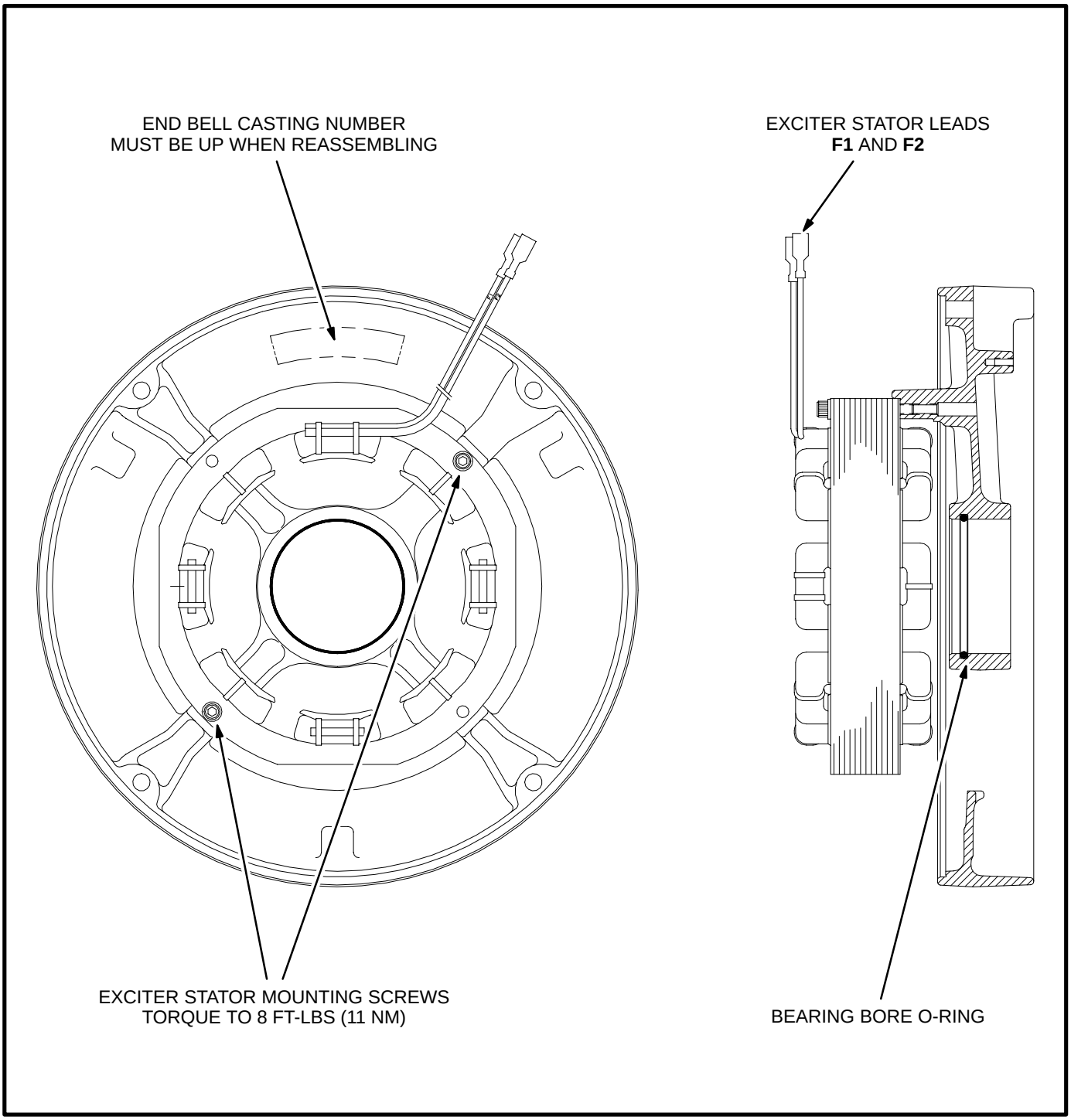


FIGURE 5-2. EXCITER STATOR AND END BELL

Exciter Rotor and Rotating Rectifiers

Testing Exciter Rotor Winding Insulation Resistance: Disconnect all six exciter rotor leads from diode terminals **CR1** through **CR6** and isolate them from ground. Connect the megger between one of the leads and ground and conduct the test as instructed in Insulation Resistance Testing in this section.

Testing Exciter Rotor Winding Resistance: With a Wheatstone bridge, measure electrical resistance across each pair of rotor windings: **T11-T12**, **T21-T22**, **T12-T13**, **T22-T23**, **T13-T11** and **T23-T21**. See the connection schematic. Replace the whole rotor shaft assembly if the resistance of any winding is not 0.58 to 0.71 ohms.

The rotating rectifier assembly is mounted on the back face of the exciter rotor. It consists of one positive (**+**) and one negative (**–**) diode assembly. Each assembly carries three diodes in an epoxy potting. Each diode has a terminal for connecting the appropriate lead from the exciter rotor (**CR1** through **CR6**). Each assembly has a field terminal (**F1+** or **F2–**) for connecting the leads from the main rotor (generator field) and voltage suppressor.

Diode Resistance Test: Using a digital ohmmeter, measure electrical resistance between diode terminals **CR1**, **CR2** and **CR3** and field terminal **F1+** on the positive diode assembly and between diode terminals **CR4**, **CR5** and **CR6** and field terminal **F2–** on the negative diode assembly. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the whole diode assembly.

Replacing a Diode Assembly: Make sure the replacement diode assembly is of the correct polarity, positive (**+**) or negative (**–**). Then disconnect all leads from the defective diode assembly and remove the two mounting screws. Mount the new diode assembly, reconnect all leads and torque the terminal screws to 24 in-lbs (2.6 Nm).

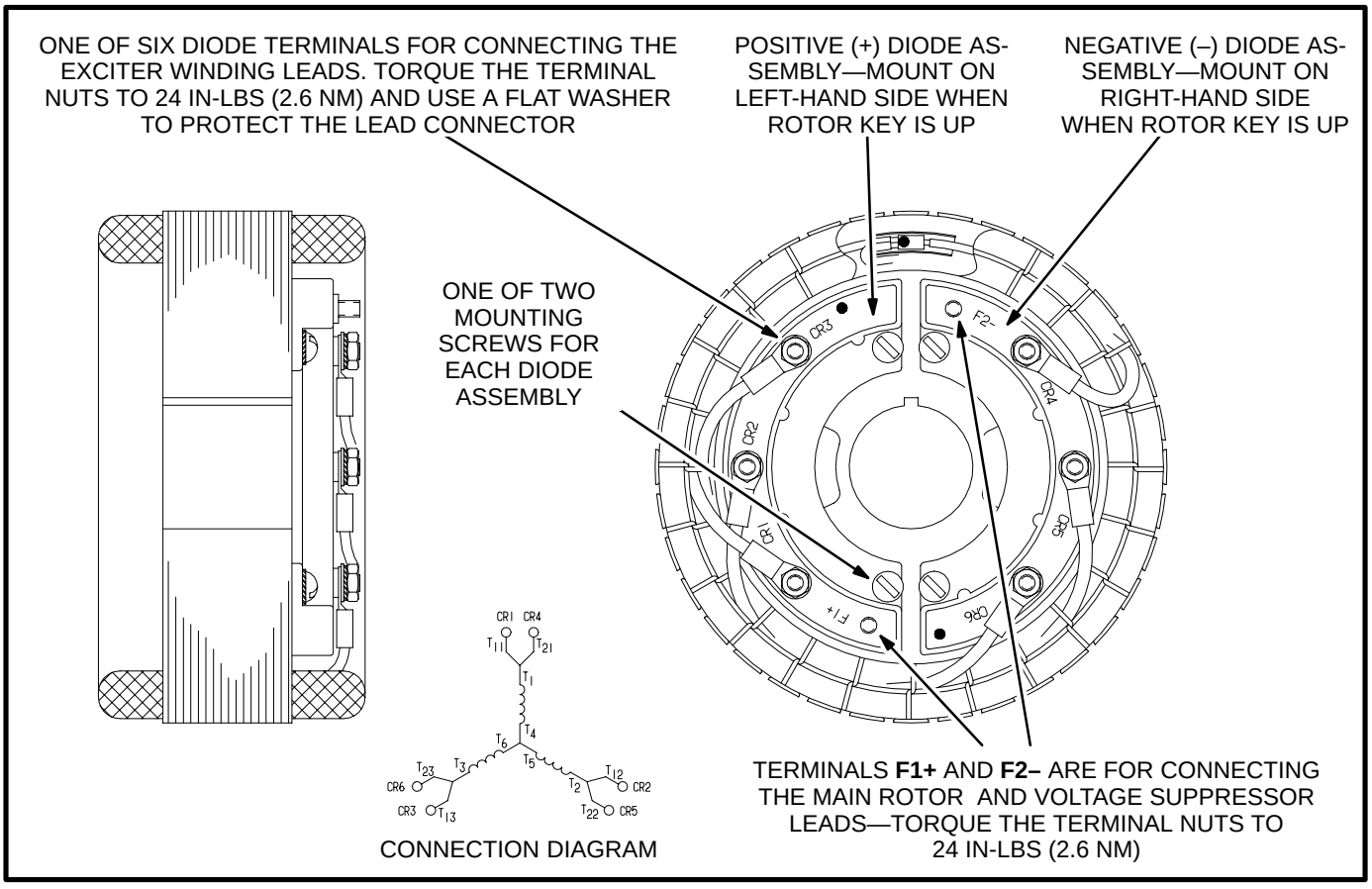


FIGURE 5-3. TESTING THE ROTATING RECTIFIER ASSEMBLY

Main Rotor And Surge Suppressor

Testing Main Rotor Winding Insulation Resistance: Disconnect the main rotor and voltage suppressor leads from terminals **F1+** and **F2+** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2+**).

⚠ CAUTION ***Because of the opposing residual magnetism of the rotor, it might be difficult to re-establish self excitation if the polarity of the main rotor leads is reversed upon reassembly.***

Connect the megger between one of the rotor leads and ground and conduct the test as instructed in Insulation Resistance Testing in this section.

Testing Main Rotor Winding Resistance:

Measure electrical resistance between the two main rotor leads with a digital ohmmeter. Replace the rotor if the resistance is not as specified in Table 4-1.

Surge Suppresser Testing: A voltage suppressor is mounted on the rotor shaft between the main rotor and the exciter rotor. Its leads are connected to terminals **F1+** and **F2–** on the rotating rectifier assemblies. Disconnect the leads from their terminals and measure resistance between the leads with a digital ohmmeter. Replace the entire rotor assembly if resistance is not infinite on the highest scale of the meter.

Reconnect the the rotor and surge suppress0r leads and torque the terminals to 24 in-lbs (2.7 Nm) when reassembling.

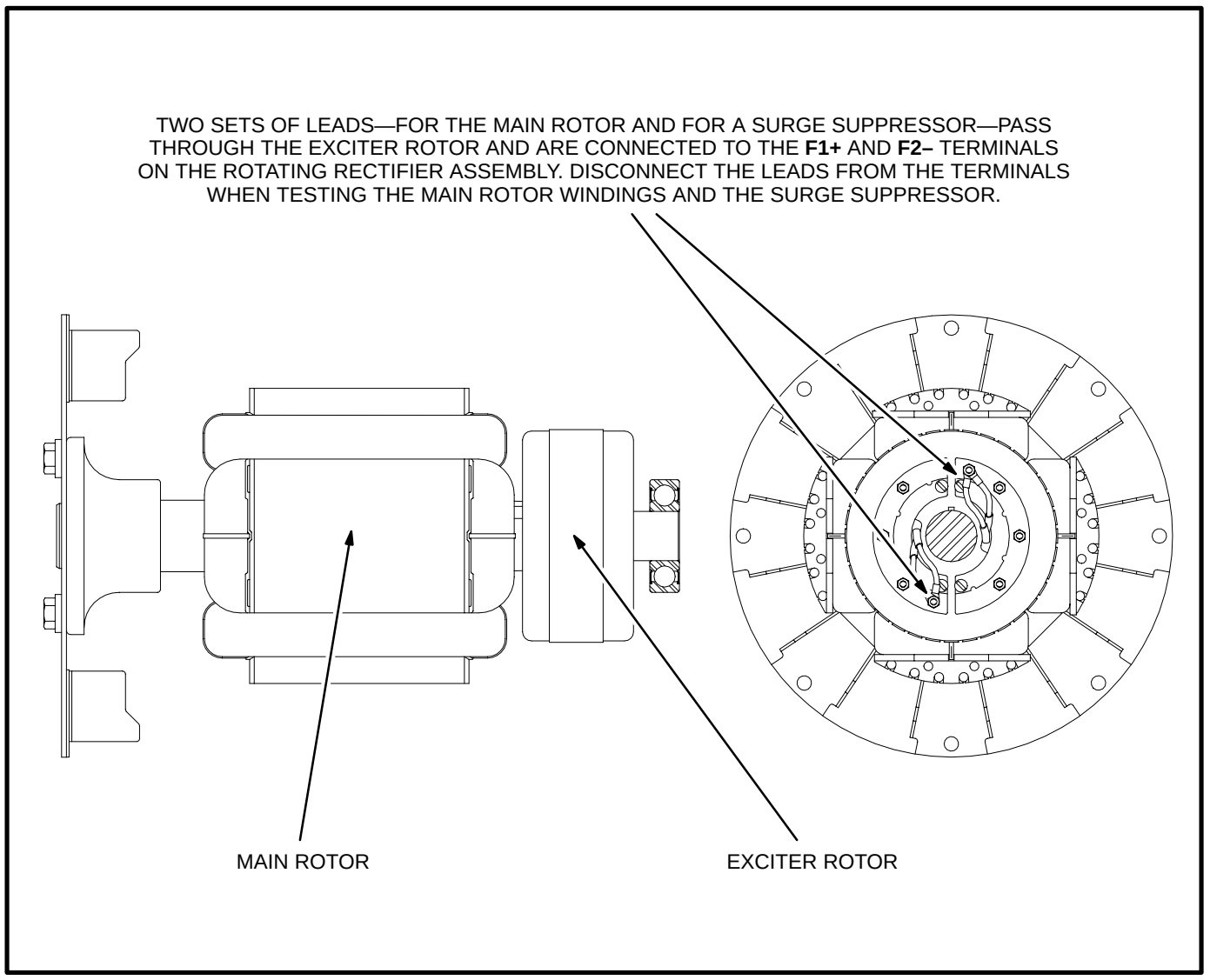


FIGURE 5-4. TESTING THE MAIN ROTOR

Main Stator

Testing Main Stator Winding Insulation Resistance: Disconnect all six neutral leads from each other (Figure 2-3 and Page 7-11). Also disconnect and isolate the leads connected at terminals **1**, **2**, **3**, **4**, **F1** and **F2** on terminal block **VR21** on the voltage regulator (Figure 2-5). Connect the megger between one phase of the stator and ground while grounding the other two phases. Conduct the test as instructed in Insulation Resistance Testing in this section for each phase in turn.

Testing Main Stator Winding Resistance: Disconnect all main stator leads from the terminals to which they are connected. Using a Wheatstone bridge having at least 0.001 ohm precision, measure electrical resistance across each pair of stator leads: **U1-U2**, **V1-V2**, **W1-W2**, **U5-U6**, **V5-V6** and **W5-W6**. Replace the stator if the resistance of any winding is not as specified in Table 4-1.

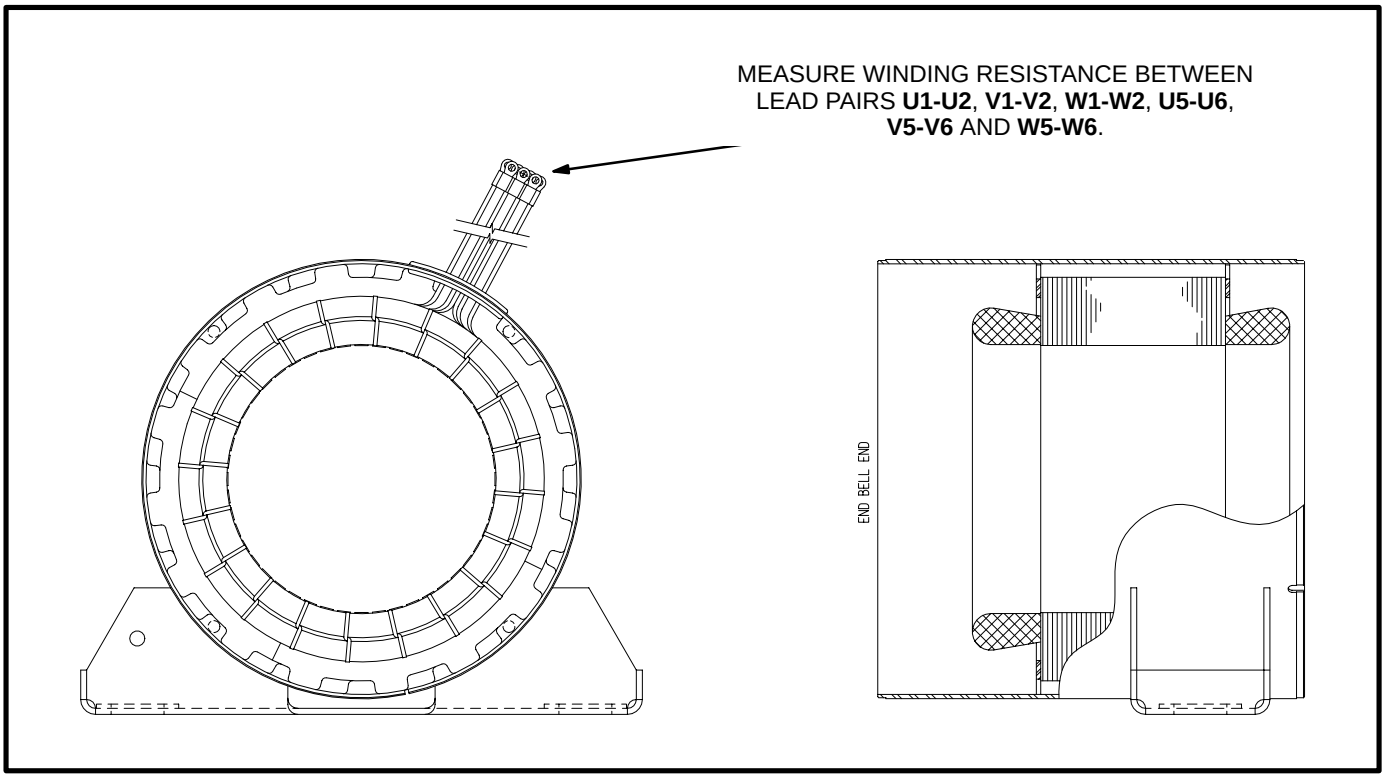


FIGURE 5-5. TESTING THE MAIN STATOR WINDINGS

TABLE 4-1. MAIN STATOR AND ROTOR WINDING RESISTANCES

GENERATOR RATING / STATOR STACK LENGTH			MAIN STATOR WINDING RESISTANCE OHMS[2]	MAIN ROTOR WINDING RESISTANCE OHMS[2]
3–PHASE, 0.8 PF kW	1–PHASE, ΔΔ, 1.0 pf kW	STACK LENGTH[1] mm (inches)		
12	–	87.3 (3.4)	0.486-0.594	1.88-2.30
15	12	109.5 (4.3)	0.296-0.362	2.12-2.59
17.5	–	127 (5.0)	0.275-0.337	2.30-2.81
20	15	146 (5.75)	0.200-0.244	2.48-3.03
25	20	177.8 (7.0)	0.164-0.200	1.78-2.18
30	25	219 (8.62)	0.105-0.129	2.02-2.46
–	30	263.5 (10.37)	0.090-0.110	2.62-3.20

1 – These are for reference only, to help identify the generator. The corresponding rotors have slightly greater (3 mm) stack lengths.

2 – These values are ±10% of nominal at 77° F (25° C).

GENERATOR DISASSEMBLY AND REASSEMBLY

Disassembly

The generator is heavy. You will need an assistant and a hoist of sufficient capacity to remove and service the generator.

⚠WARNING ***Accidentally dropping the generator can damage it and cause severe personal injury and death. The hoist and straps must have sufficient capacity and be attached properly so that the load cannot shift.***

Before starting, disconnect the starting battery cables (negative (-) first) to make sure the set will not start while working on it.

⚠ CAUTION ***Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.***

⚠WARNING ***Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).***

Make certain battery area has been well-ventilated before servicing battery. Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur when cable is removed or re-attached, or when negative (–) battery cable is connected and a tool used to connect or disconnect positive (+) battery cable touches frame or other grounded metal part of the set. Always remove negative (–) cable first, and reconnect it last. Make certain hydrogen from battery, engine fuel, and other explosive fumes are fully dissipated. This is especially important if battery has been connected to battery charger.

1. If the generator set has a housing, remove the roof, rear housing posts, grills and door.
2. Remove the top cover of the control box (four screws), remove the four mounting screws in the bottom of the box and tip the box up on on of its sides for access to the wiring connections on the bottom.
3. Disconnect the AC and DC wiring harnesses from the plugs and terminals on the bottom of the control box. Also, disconnect the control box heater, if provided. For easier reconnections later, make sure each lead is marked clearly.
4. Disconnect all customer connections, if any, inside the control box (at the auxiliary relay board and at preheat module A115). For easier reconnections later, make sure each lead is marked clearly. Move the control box to a safe place.
5. Remove the grill in front of the generator end bell and the saddle on which the control box was mounted.
6. Remove the side access cover on the power output box and disconnect and withdraw the generator output cables and exciter leads. For easier reconnections later, make sure each cable and lead is marked clearly.
7. Disconnect the overspeed/start disconnect module at the lead connector.
8. Disconnect the air tube from the air cleaner assembly. (Remove the air cleaner from the generator adaptor casting if the adaptor is going to be replaced.)
9. If the set has an electric governor, remove the speed pickup unit from the generator adaptor casting.

⚠ CAUTION ***Do not use fan blade to bar over engine. That can damage blades and cause property damage and personal injury.***

10. The generator rotor will be carried inside the stator when the generator is withdrawn from the engine. Bar the engine until one of the four poles of the rotor points straight down so that the rotor will rest on the pole face when the generator is withdrawn.

    ⚠ CAUTION ***The rotor can be damaged if it rests on the edges of the winding slot between two poles.***

11. Using a hoist of sufficient capacity, cinch a lifting strap around the generator, take up hoist slack and remove the two through bolts securing the generator to the rubber isolation mounts.

12. Raise the generator end approximately 1 inch (12 mm) and securely block the engine under the full length and width of the oil pan to distribute the weight. Lower the generator slightly so that the blocks carry most of the weight.

13. Remove the bolts securing the generator drive discs to the flywheel. (They are accessible by removing the screen on the adaptor casting outlet.)

14. Loosen all the bolts and nuts securing the generator adapter to the engine. Adjust the hoist to carry the full weight of the generator, remove the bolts and pull the generator away, keeping it level so that the rotor does not fall out.

    ⚠ CAUTION ***Never withdraw the generator leaving the rotor to hang by the drive discs. The weight of the rotor will damage the drive disc.***

15. Remove the generator end bell cover plate.

16. Remove the overspeed/start disconnect rotor element from the end of the generator shaft.

17. Remove the four nuts and washers on the generator through-studs and tap the end bell free of the stator assembly.

18. If necessary, remove the exciter stator from the generator end bell by removing the two mounting screws.

19. Remove the rotor from the stator with the help of an assistant. Support both ends of the rotor and guide it out. Be careful not to damage the windings.

20. Rest the rotor in a cradle, solidly supporting it on two pole faces—not on the drive discs, blower or exciter.

21. Tap the generator adaptor casting free of the stator assembly.

22. Use a gear puller if it is necessary to replace the rotor bearing.

Reassembly

Reassemble the generator in the following order of steps:

1. Press the rotor bearing on flush with the end of the shaft. (The end of the shaft must not extend more than 0.020 inches (0.5 mm) beyond the side of the bearing. Apply force to the inner race of the rotor bearing when pressing it onto the shaft, otherwise, it will be damaged.

2. Mount the drive disc on the rotor and torque the eight bolts to 68 ft-lbs (92 Nm). Make sure that:

    A. The chamfered edge of the drive disc perimeter faces away from the rotor to make assembly to the flywheel easier.

    B. The fan blade assembly goes on first. (It will be secured with the disc-to-flywheel bolts.)

    C. The rounded edges of the washers are on the disc side.

3. Mount the exciter stator in the end bell, and torque the two mounting screws to 8 ft-lbs (11 Nm). The leads must exit away from the end bell and be in the top half of the assembly (see Figure 5-2).

4. Wipe the bearing bore in the end bell lightly with molybdenum disulfide grease and make sure the rubber O-ring is in place.

5. Fit the generator adaptor and stator assembly together and thread the four generator through-studs into the adaptor casting (the ends with the shorter length of thread). Make sure the stud threads bottom.

6. With the help of an assistant, supporting both ends of the rotor, insert the rotor assembly inside the stator assembly. Rest the rotor on a pole face.

7. Mount the end bell to the stator assembly, making sure the rotor bearing is fully seated in the bore and that the end bell part number is at the top. Pull the field leads out the same opening as the main stator leads and lightly snug down the four stud washers and nuts to keep the assembly together while mounting it to the engine. Do not torque the nuts at this time as it might be necessary to make adjustments as instructed in Step 9.

8. Cinch a lifting strap around the generator and hoist it up to and and in line with the engine. Thread in the eight disc-to-flywheel bolts by hand. They will be torqued in Step 11. Secure the generator adaptor and engine together and torque the bolts to 40 ft-lbs (54 Nm).

9. Take up the hoist slightly and remove the blocks under the engine. Then lower the assembly so that it rests on the skid cross member, re-cinch the hoist strap around the generator adaptor and raise the assembly approximately 1/2 inch (12 mm). Next, measure the vertical distance between each **engine** foot (attachment points for the vibration isolators) and the skid cross member below it. If the measured distances are not equal, lower the engine and re-cinch the strap or realign the hoist so that it pulls straight up, and try again. The distances must be equal. Then, measure the vertical distance between each **generator** foot and the skid cross member below it. The distances must be equal. If they are not, rotate the generator with respect to the engine until the two distances are equal, thus placing all four mounting feet in the same plane. (It may be necessary to loosen the nuts on the generator through-studs slightly in order to rotate the generator.) Once the engine and generator are aligned, torque the nuts on the generator through-studs to 28 ft-lbs (38 Nm).

   If the engine and generator are being installed as an assembly, first secure the engine mounts to the front skid cross member, cinch the lifting strap around the generator adaptor and then align the generator feet as instructed in Step 9.

10. Secure the generator to the skid with the rubber isolation mounts. Torque the through bolts to 68 ft-lbs (92 Nm).

    The vibration isolators for the engine end are color coded red/white; and for the generator end, yellow/white or green/white.

11. Torque the eight drive disc-to-flywheel bolts to 39 ft-lbs (52 Nm).

12. Mount the rotor for the overspeed/start disconnect module on the end of the rotor and torque the bolt to 18 ft-lbs (25 Nm).

13. Secure the end bell cover plate and torque the four screws to 8 in-lbs (3.8 Nm).

14. Reconnect or remount all the other components that were disconnected or removed under Disassembly.

    ⚠ CAUTION ***There may not be any generator AC output until the field is flashed, and therefore, nothing to activate the AC start disconnect circuit. Therefore, to protect the starter from damage, do not start the generator set until the DC start disconnect module has been remounted and reconnected. See Figure 3-5.***

6. Governor

MECHANICAL GOVERNOR ADJUSTMENTS

50/60 Hertz Selector Lever

These generator sets have a 50/60 Hertz selector lever which must be in the proper position for the application (to the right for 60 Hertz and to the left for 50 Hertz). If it is necessary to move the handle; remove the stop bracket, move the lever over and then bolt the bracket on again to prevent the handle from being moved accidentally. See Figure 6-1.

Frequency Adjustment

With the 50/60 Hertz selector lever in the proper position, adjust frequency (speed) by turning the speed adjusting screw while the engine is running at its normal operating temperature under full load. Set the locknut on the adjusting screw when the adjustment is satisfactory.

There is no adjustment for droop. If droop is not within five percent of nominal frequency (3 Hertz for 60 Hertz sets and 2.5 Hertz for 50 Hertz sets), refer to the engine service manual.

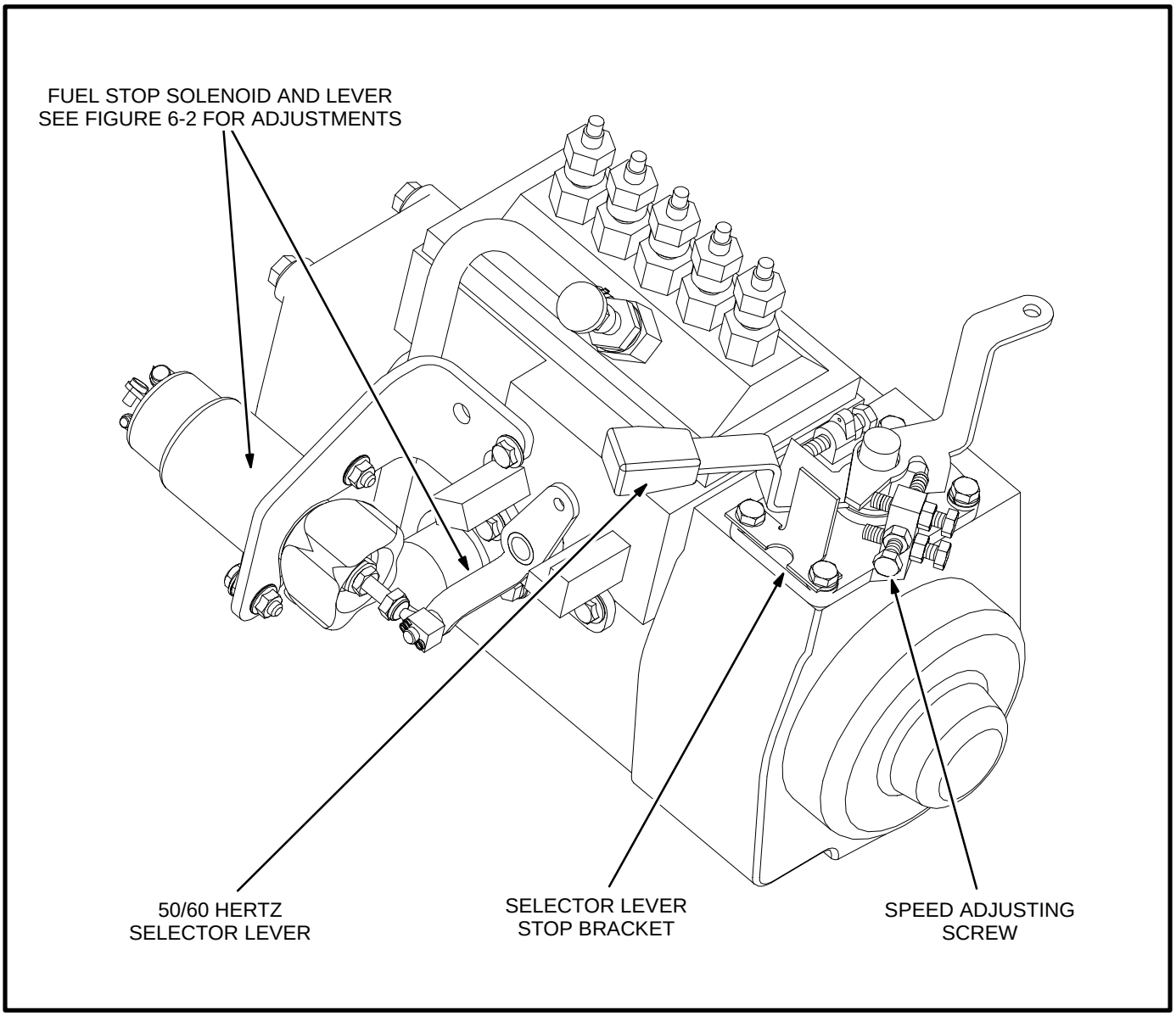


FIGURE 6-1. GOVERNOR AND FUEL INJECTION UNIT

FUEL SHUTOFF SOLENOID

A solenoid is mounted by means of a bracket on the fuel injection unit to actuate the fuel shutoff lever, as shown in Figure 6-2. After mounting the solenoid, it is necessary to check the clearance between the fuel shutoff lever and the lever stop when the solenoid is energized. The clearance must be 1.5-3.0 mm (0.06-0.12 inches).

⚠ CAUTION ***The solenoid will burn out, leading to a shutdown failure, if lack of clearance prevents the solenoid from bottoming. Too much clearance may prevent the set from starting or may prevent full power.***

If necessary, adjust the clearance as follows:

1. Loosen the locknut on the solenoid plunger (the plunger has a 14 mm wrench flat). Turn the hinge link screw as necessary to cause the lever clearance to increase or decrease.
2. Check the clearance again and repeat the adjustment until the specified clearance is obtained.
3. Set the locknut.

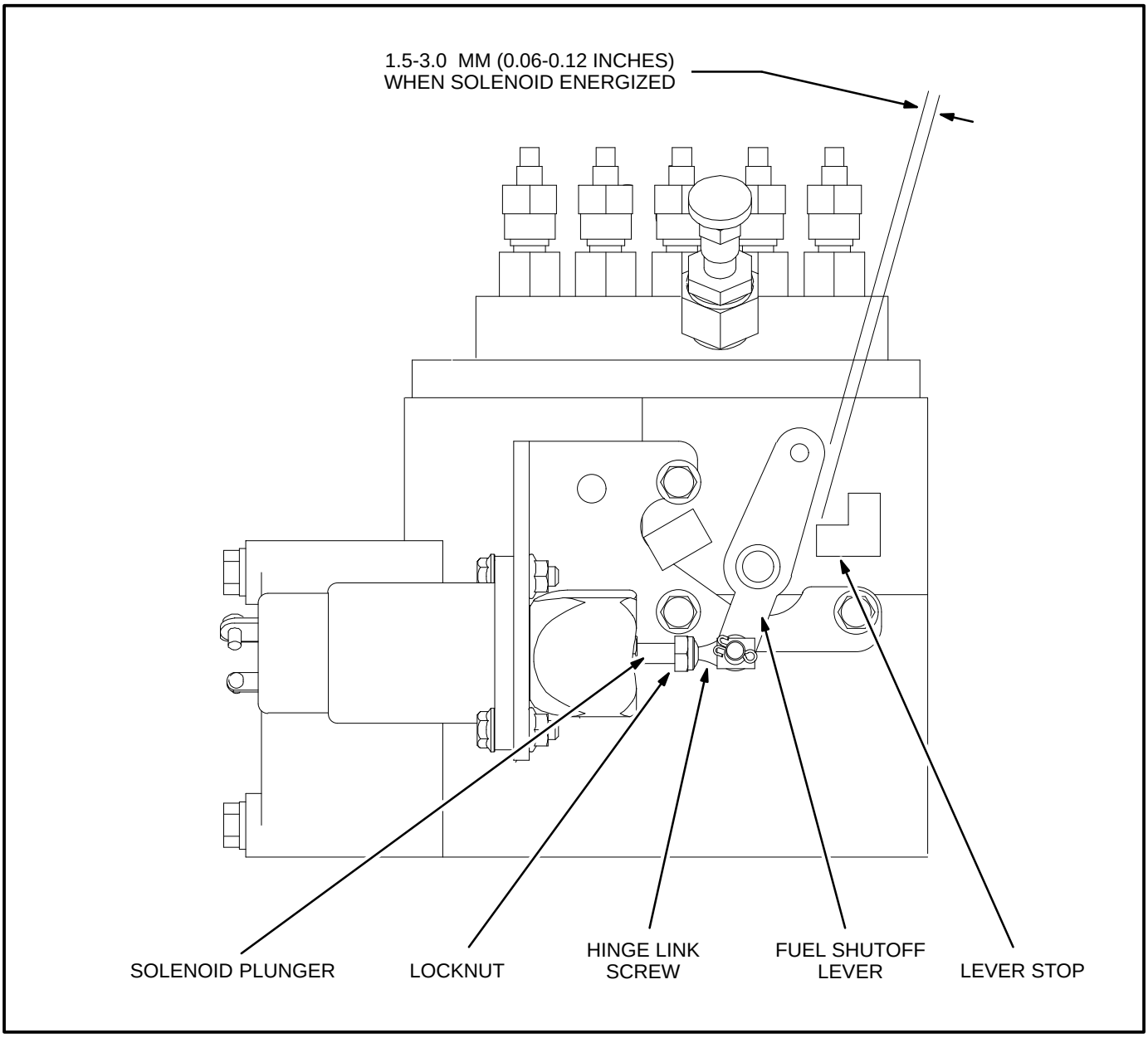


FIGURE 6-2. FUEL SHUTOFF LEVER ADJUSTMENT

ELECTRIC GOVERNOR

If necessary, adjust the linkage according to Figure 6-4, wire the controller according to Figure 6-5 and install the magnetic speed pickup unit according to Figure 6-5. Then adjust the governor controller as follows:

1. Push both selector switches (**S1**, **S2**) on the controller to their **OFF** positions.
2. Set the "**I**" adjustment one division form zero and the **Gain** at the third division from zero.
3. For isochronous operation, set the **Droop** counterclockwise to minimum position.
4. If a remote speed pot is used, set it at its midpoint.
5. Start the set and adjust the **Speed** pot on the governor controller, to obtain the required output frequency: 60 Hertz (1800 RPM) or 50 Hertz (1500 RPM). Warm up the set under load until it is up to normal operating temperature.
6. If the governor system is unstable, slightly reduce "**I**" and **Gain** settings.
7. Turn the **Gain** adjustment clockwise slowly until the actuator lever oscillates. (This will be a faster oscillation than was observed when the "**I**" was adjusted.) Reduce the **Gain** adjustment slowly counterclockwise until the lever is stable. Upset the lever by hand. If the lever oscillates 3 to 5 diminishing oscillations and stops, the setting is correct. If system performance to load changes is satisfactory, skip to Step 8.

   Reduce the Gain setting counterclockwise one division. Turn the "I" adjustment fully clockwise while observing the actuator lever. If the lever does not become unstable, upset it by hand. When the lever slowly oscillates, turn the adjustment counterclockwise slowly until the lever is stable. Upset the lever again; it should oscillate 3 to 5 times and then become stable for optimum response.
8. Set the governor rod locknuts, if necessary, and check again for binding in the linkage.

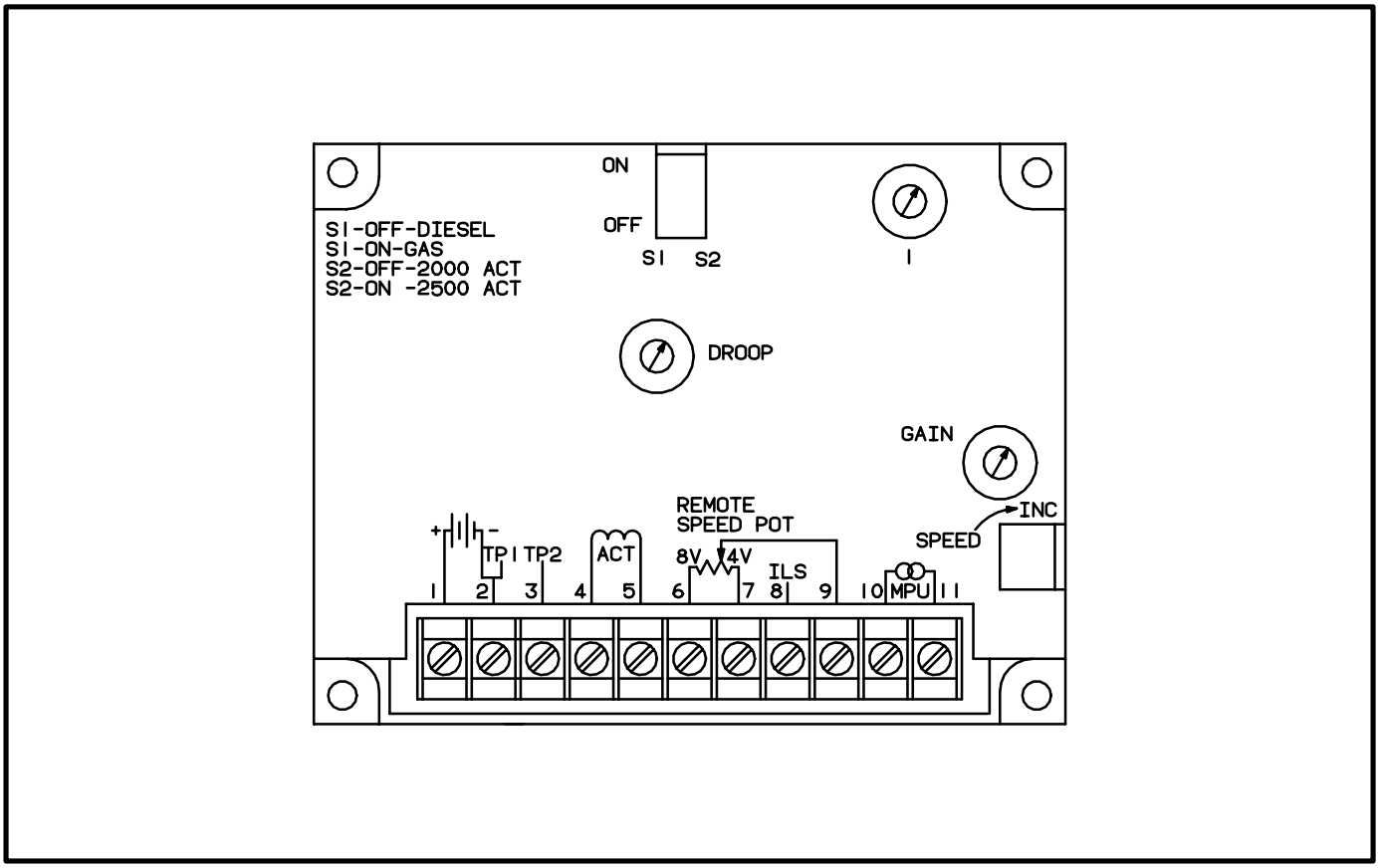
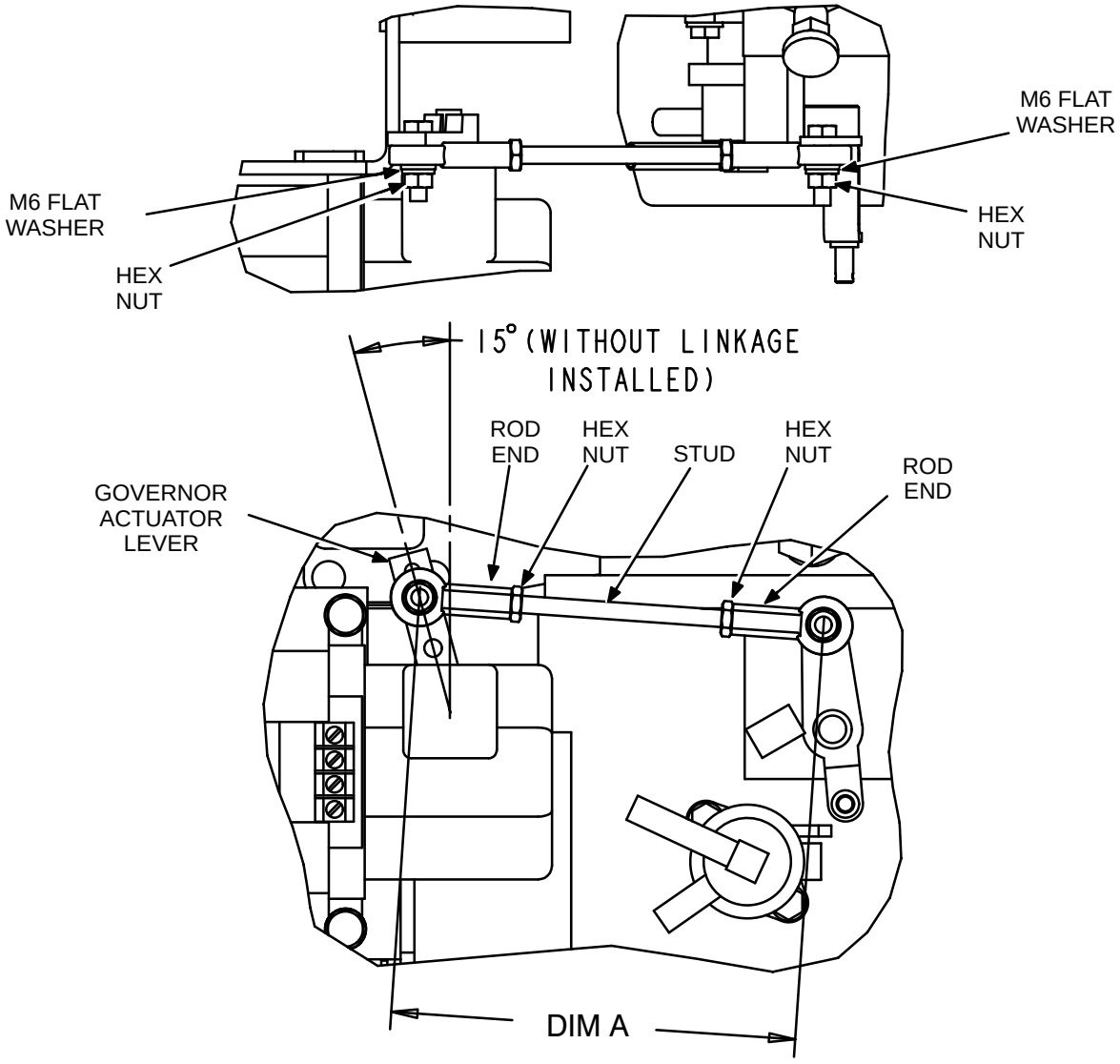


FIGURE 6-3. GOVERNOR CONTROLLER TERMINALS, SWITCHES AND ADJUSTING POTENTIOMETERS

Linkage Adjustment

Figure 6-4 illustrates the arrangement of electric governor components. If necessary adjust the length of the governor linkage until the actuator levers are as shown in Figure 6-4. Tighten all lock nuts.



TABULATION			
		APPROX POT ADJUSTMENT	
MODEL	DIM A	"I" POT	GAIN
DKAE	120	35%	35%
DKAF	145	35%	35%
DKAC	108	35%	35%

FIGURE 6-4. ELECTRIC GOVERNOR LINKAGE

Electric Governor Wiring

Wire the governor according to Figure 6-5.

Magnetic Speed Pickup Unit Installation

To install the magnetic speed sensor, bar the engine until a gear tooth on the flywheel lines up in the center of the mounting hole. Thread the sensor in gently by hand until it just touches the gear tooth. Back it out one quarter turn and set the locknut.

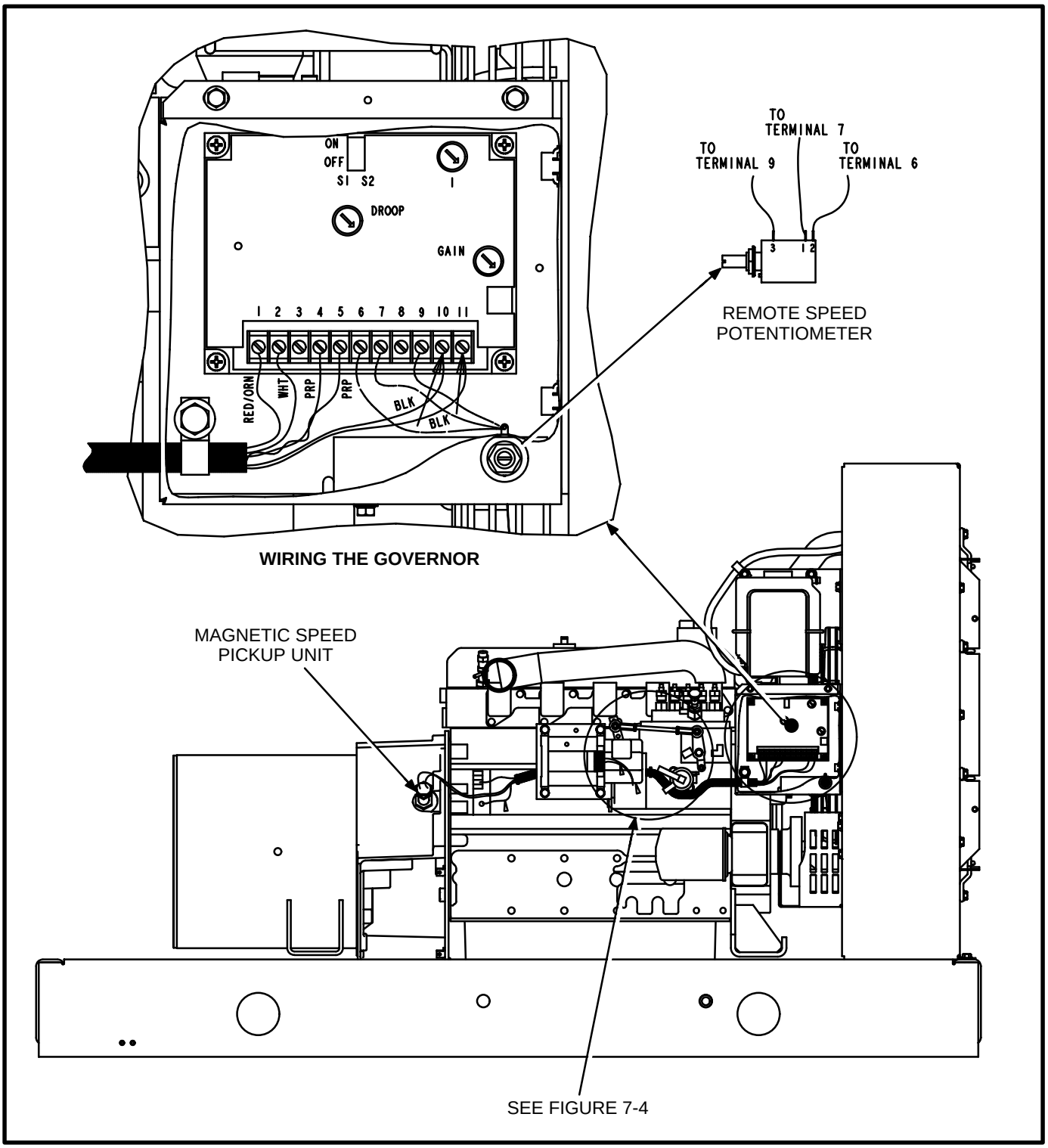
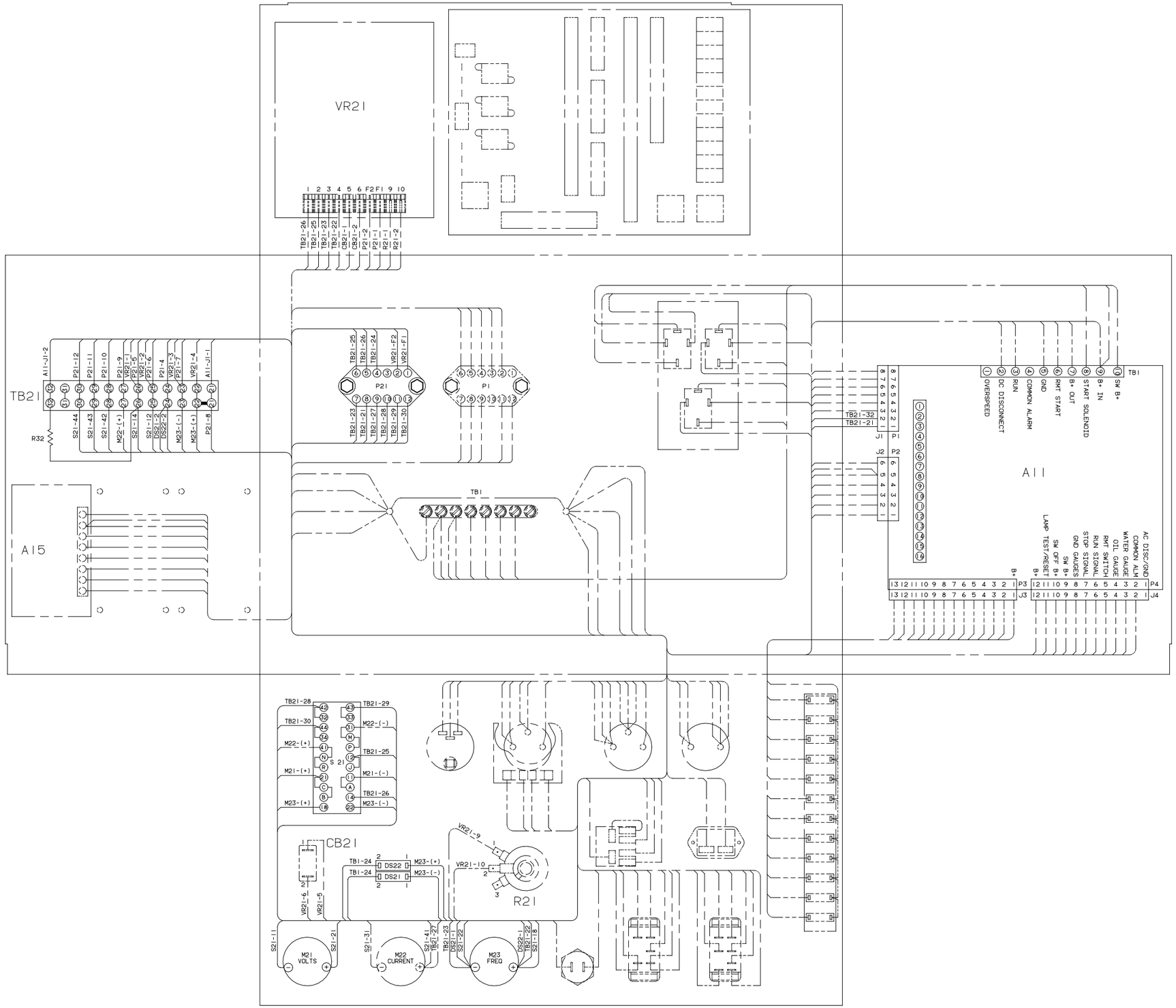


FIGURE 6-5. GOVERNOR WIRING AND MAGNETIC SPEED PICKUP UNIT LOCATION

7. Wiring Diagrams

GENERAL

This section consists of the schematic and connection wiring diagrams referenced in the text. The following drawings are included:



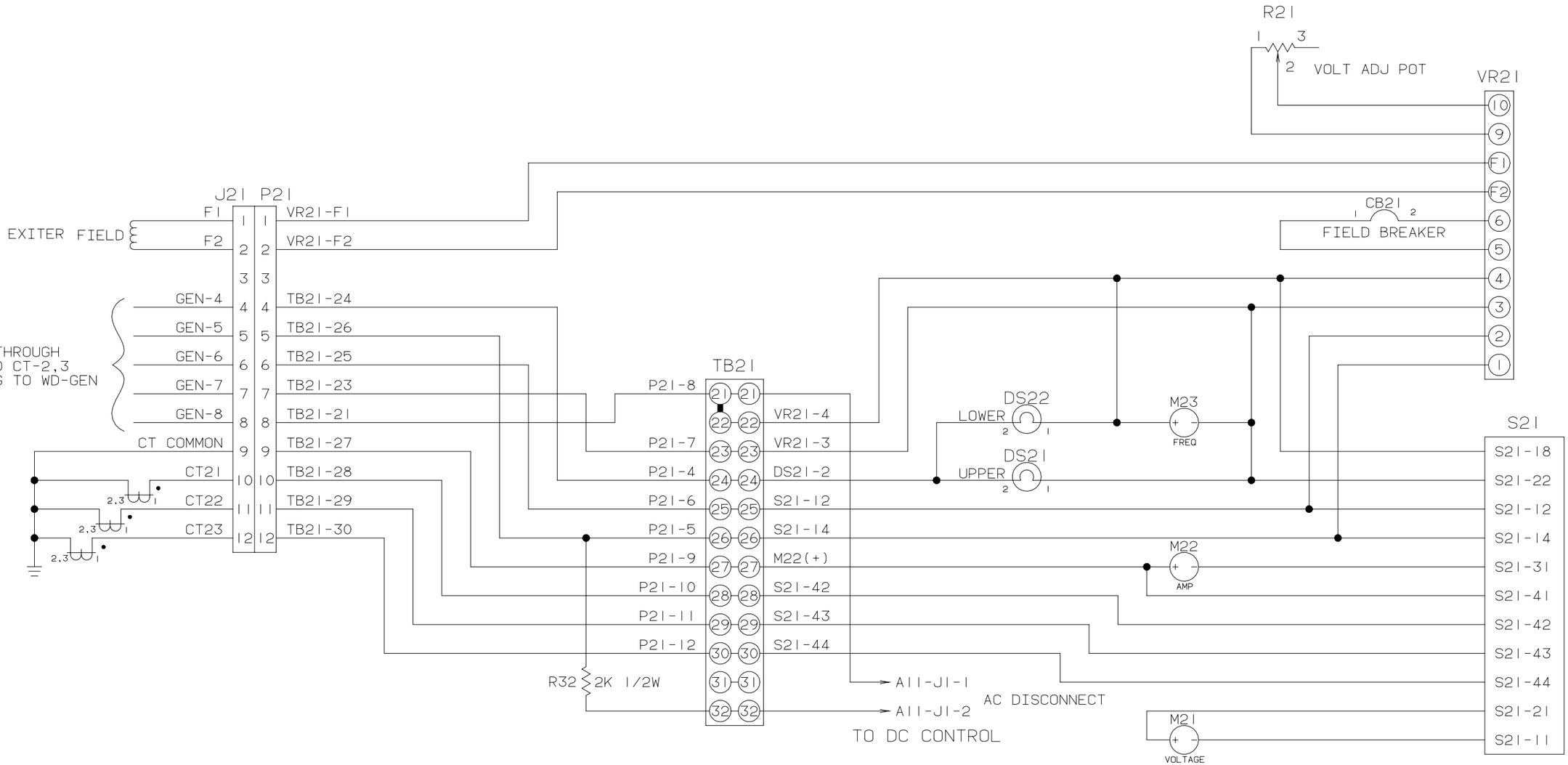
AC CONTROL WITH METERS, SHEET 1

S21 JUMPERS

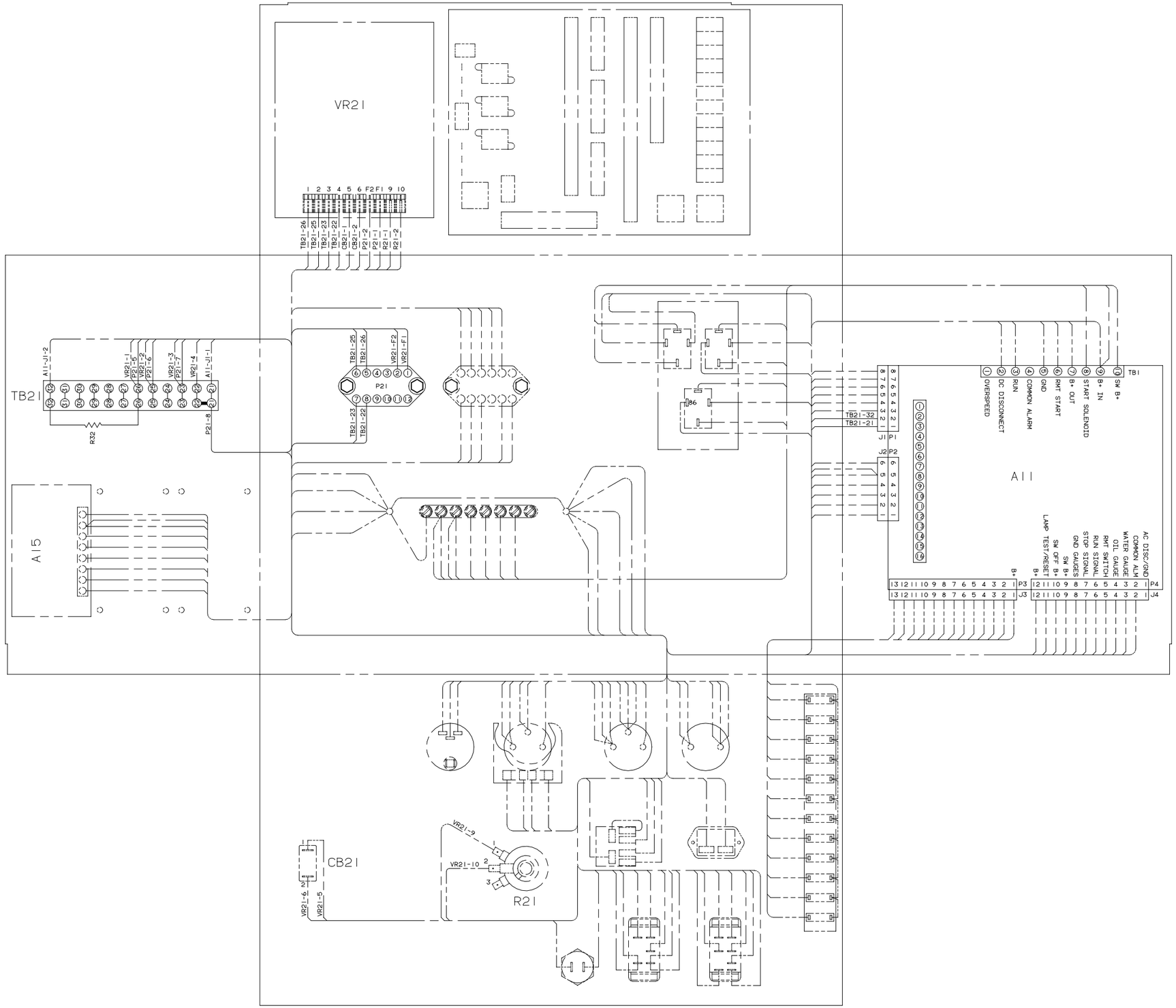
EXTERNAL	INTERNAL
M-P	N-41
34-44	M-31
C-21	A-11
32-42	B-C
12-J	33-43
N-R	

S21 SWITCH LOGIC

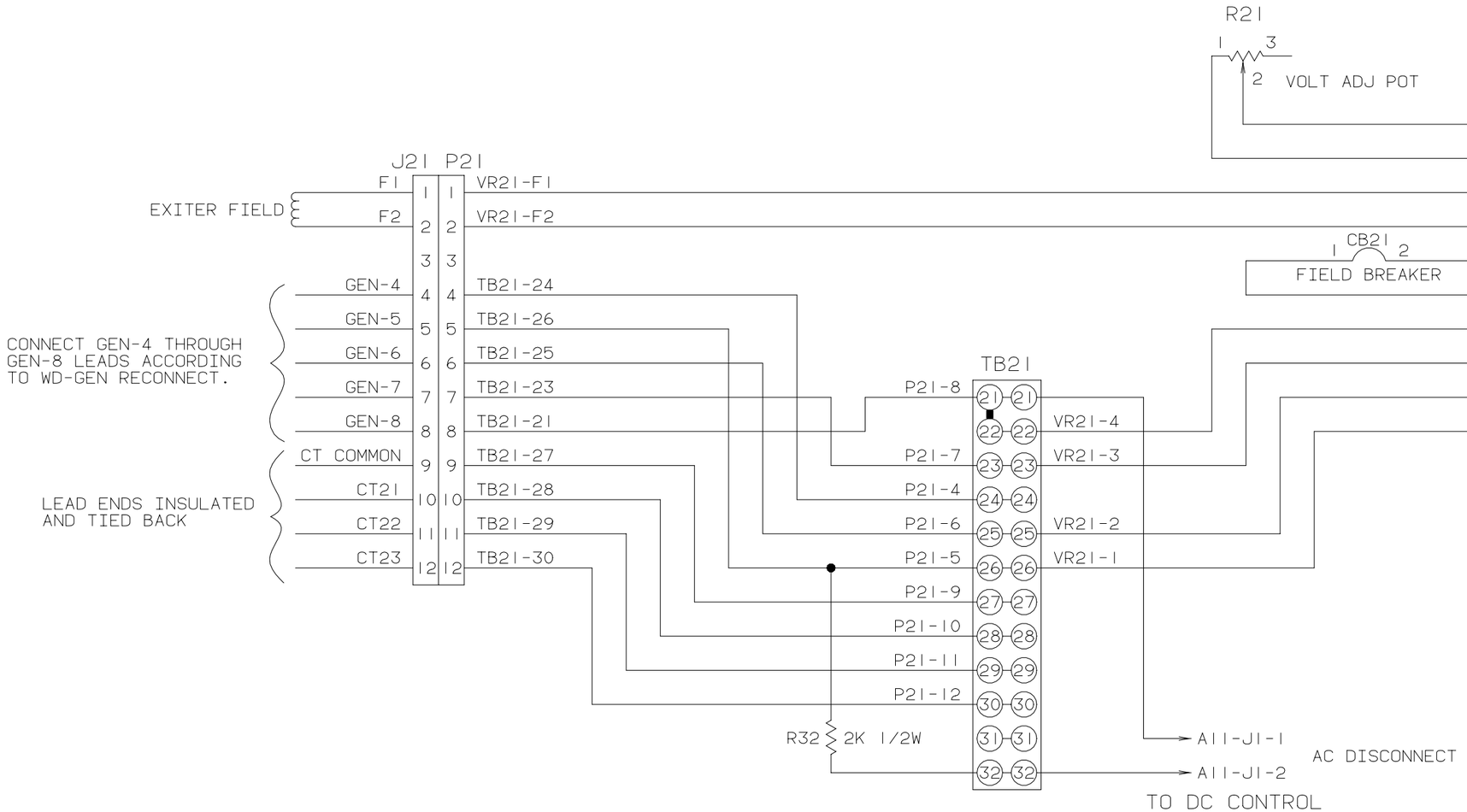
	18-11	22-C	14-21	M-32	41-42	P-43	12-A	J-B	31-34	N-44	R-33
L1-L2 3Ø	X	X		X						X	X
L2-L3 3Ø		X			X	X	X			X	
L3-L1 3Ø	X				X			X	X		X
L1-L0 3Ø	X		X		X					X	X
OFF					X					X	X
L1-L2 1ØA	X	X		X						X	X
L1-L2 1ØB	X	X			X	X				X	

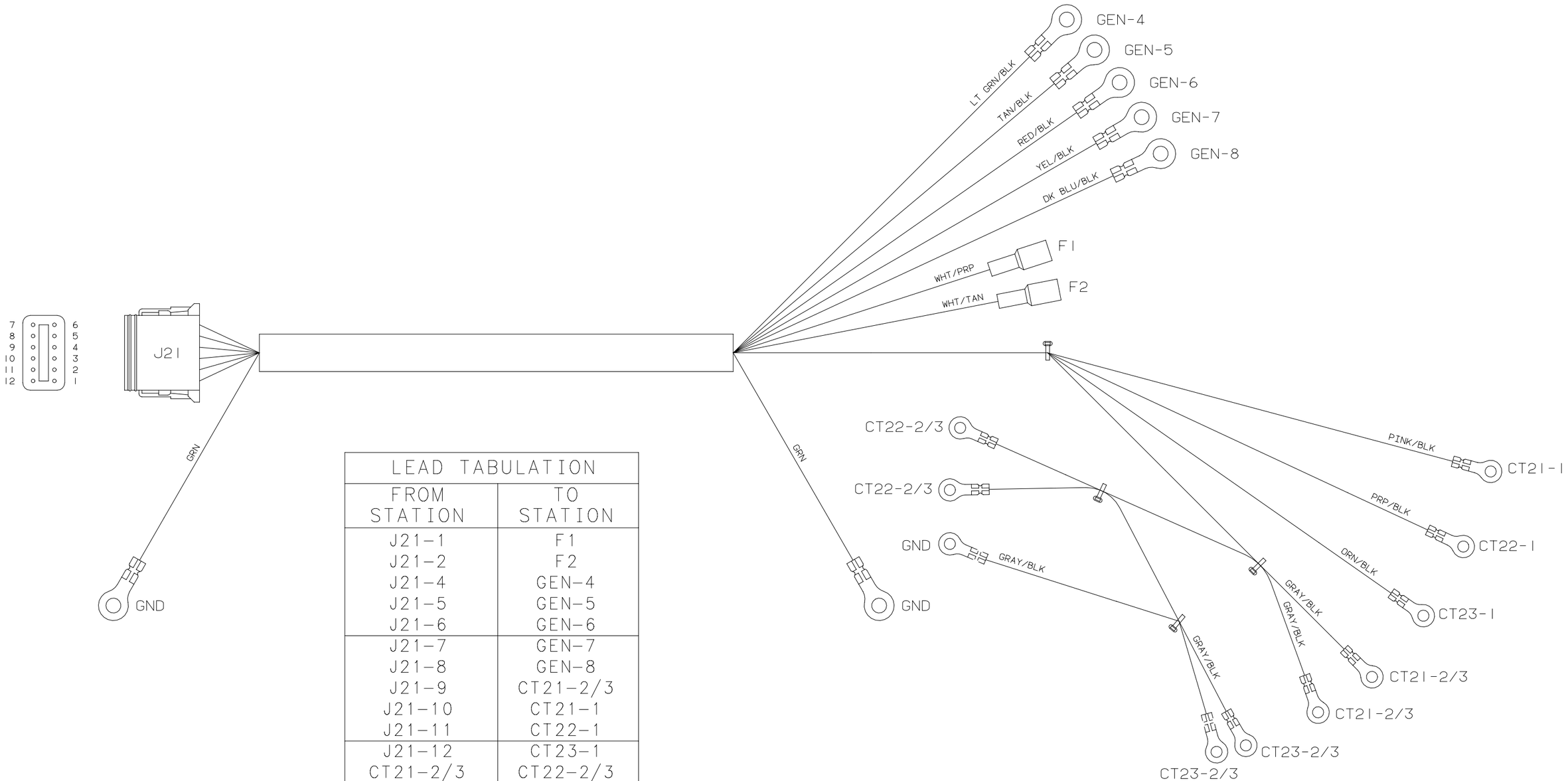


AC CONTROL WITH METERS, SHEET 2



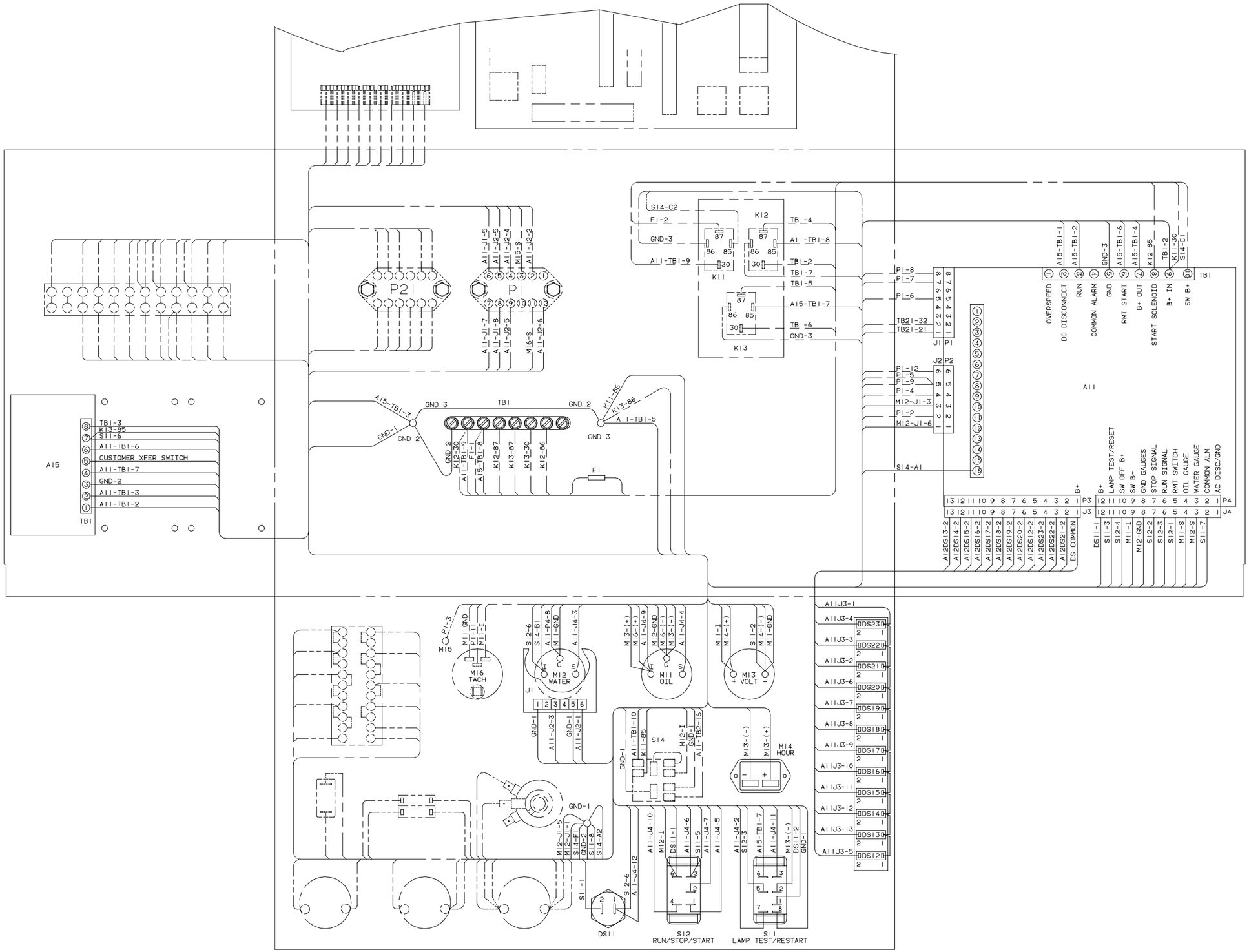
AC CONTROL WITHOUT METERS, SHEET 2



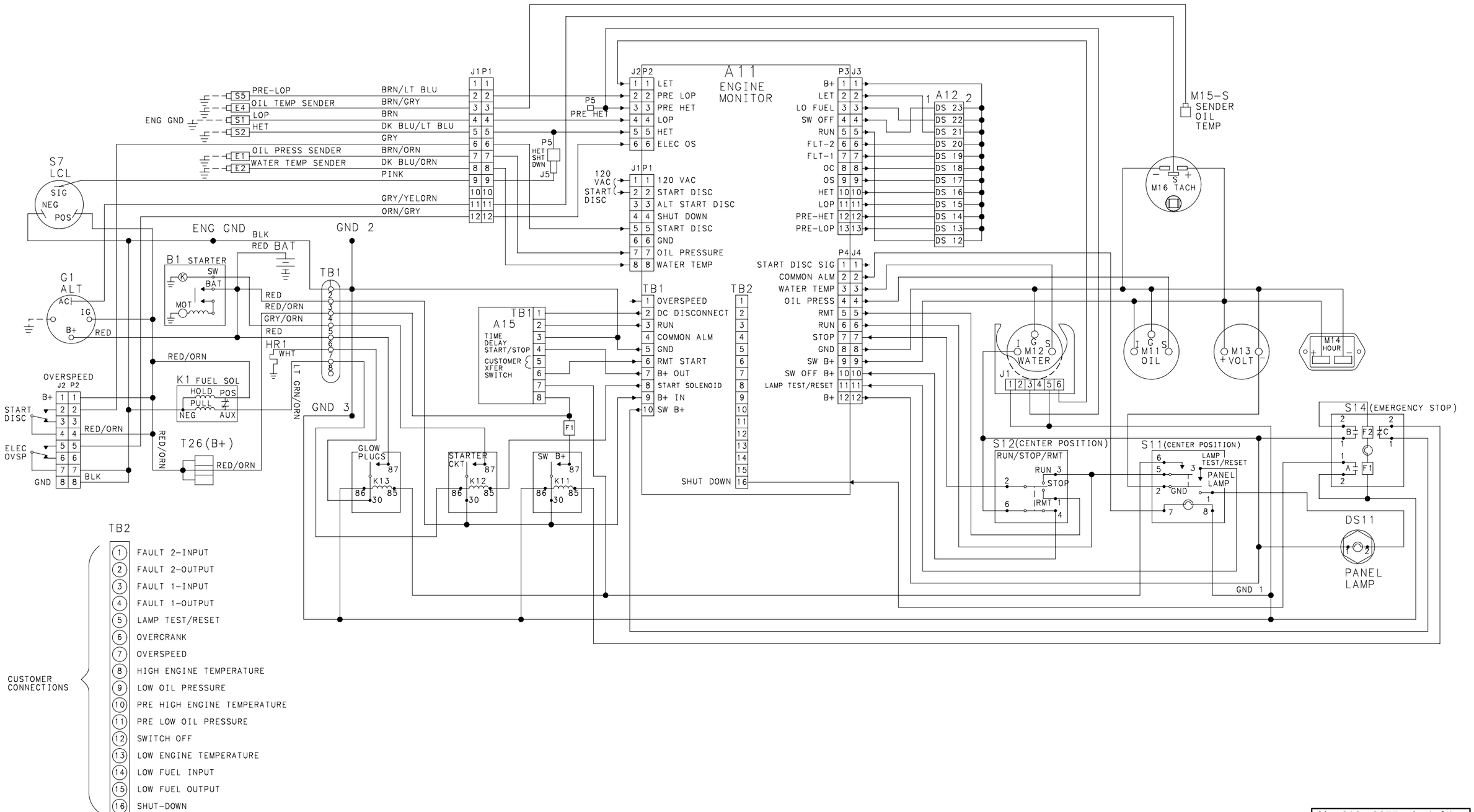


LEAD TABULATION	
FROM STATION	TO STATION
J21-1	F1
J21-2	F2
J21-4	GEN-4
J21-5	GEN-5
J21-6	GEN-6
J21-7	GEN-7
J21-8	GEN-8
J21-9	CT21-2/3
J21-10	CT21-1
J21-11	CT22-1
J21-12	CT23-1
CT21-2/3	CT22-2/3
CT22-2/3	CT23-2/3
GND	GND
CT23-2/3	GND

AC CONTROL WIRING HARNESS (EXTERNAL)



DC CONTROL, SHEET 1



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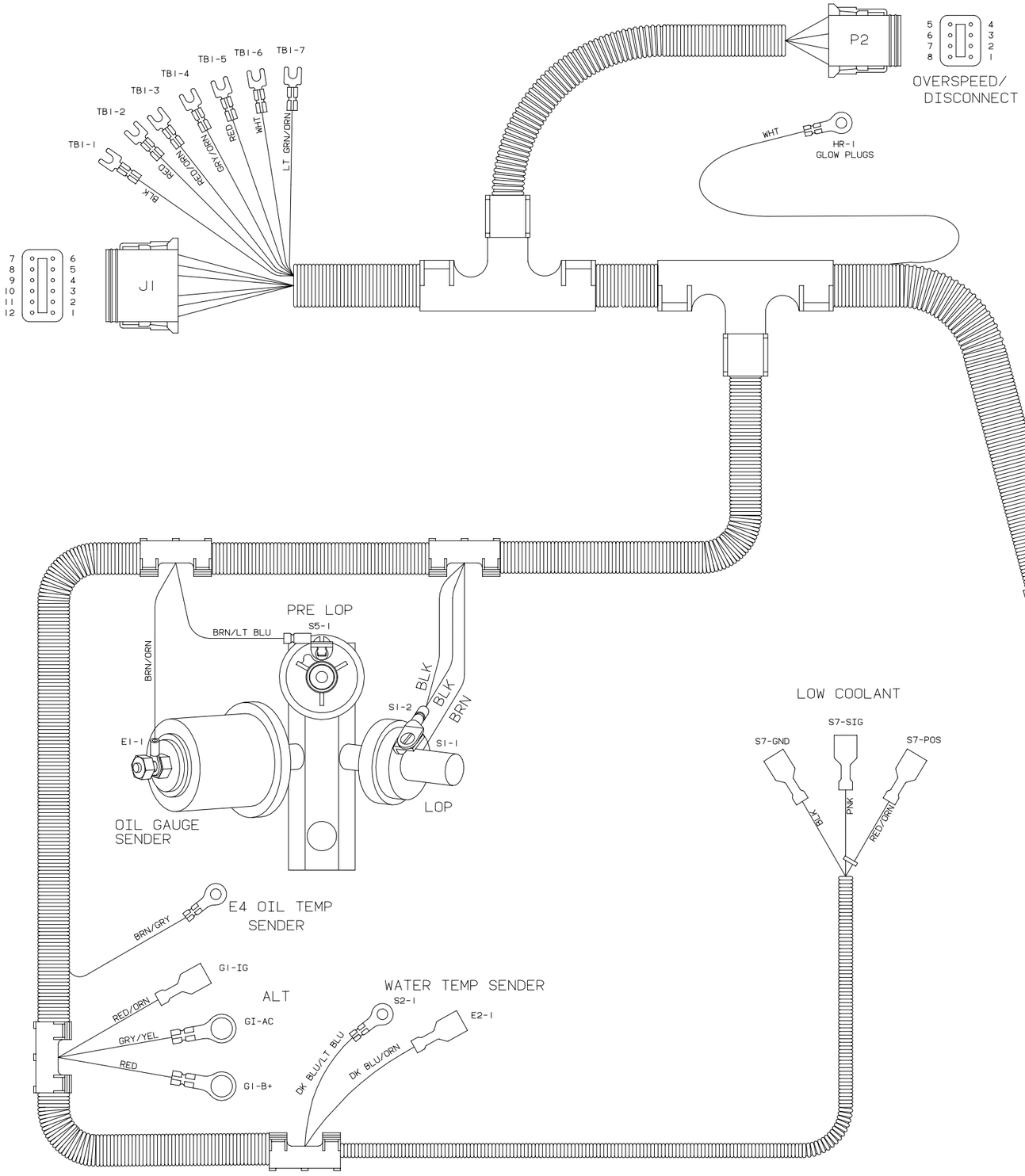
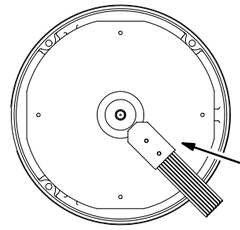
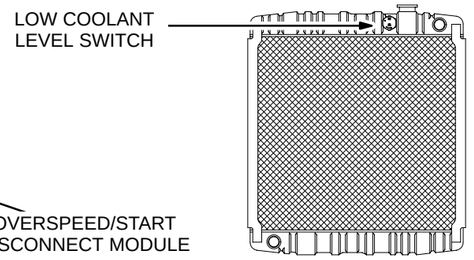
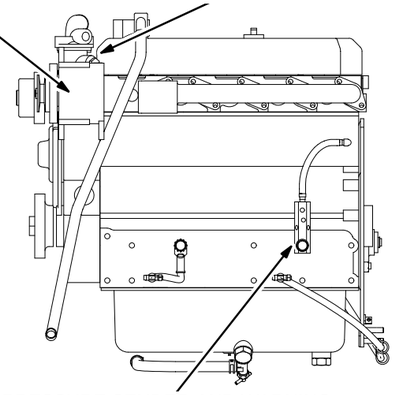
DC CONTROL, SHEET 2

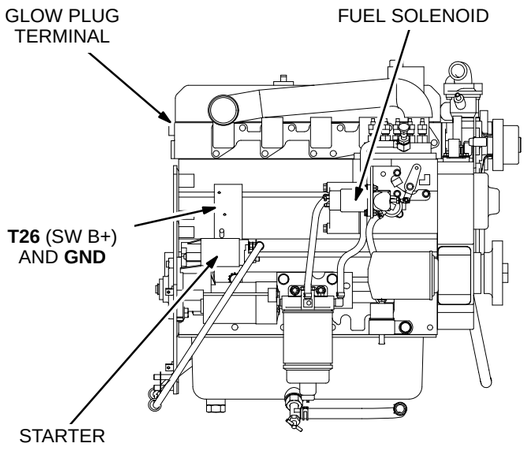
7-9







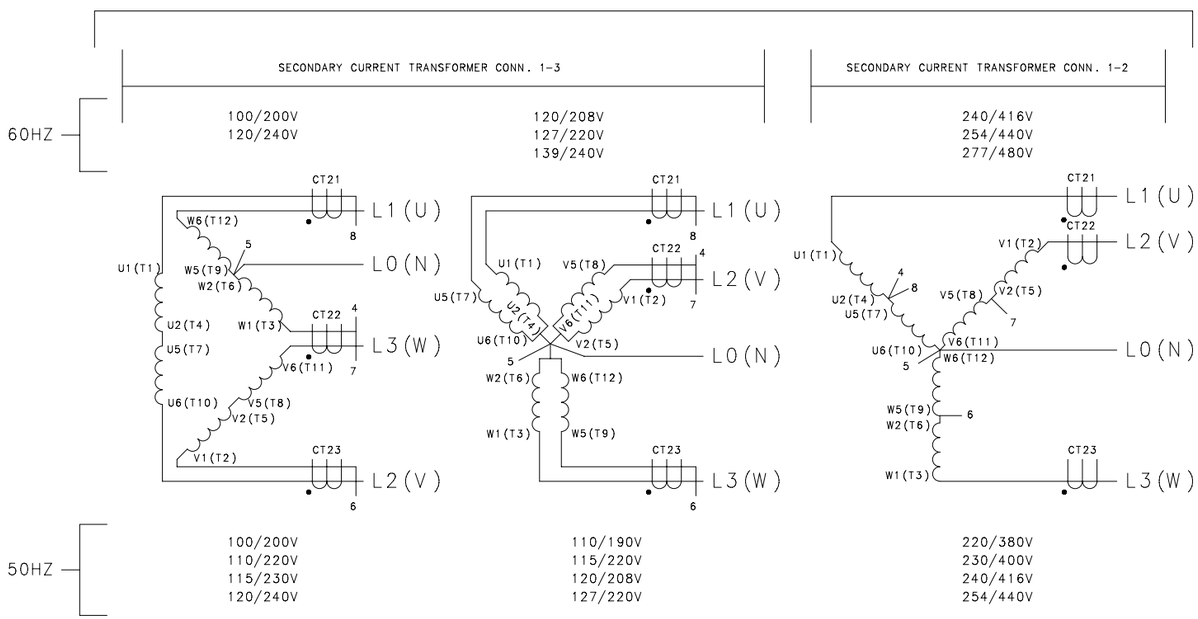




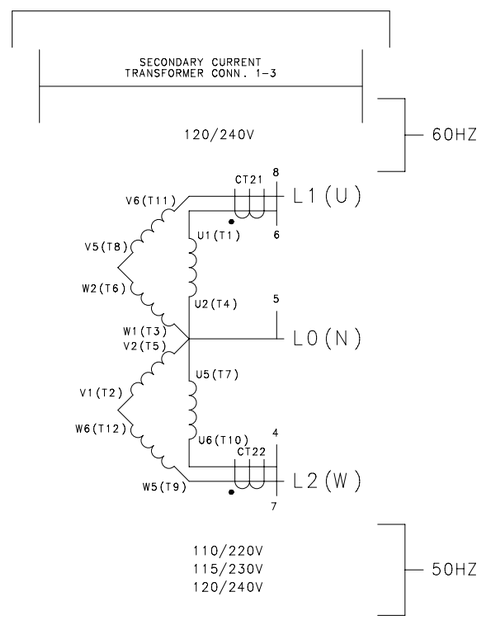
ENGINE WIRING HARNESS, SENSORS AND CONNECTION POINTS

YD GENERATORS

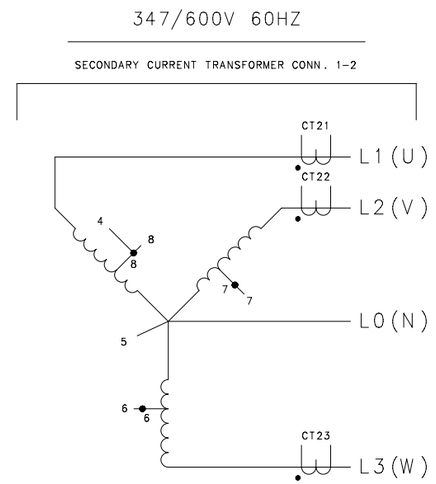
3 PHASE RECONNECTABLE, 12 LEAD



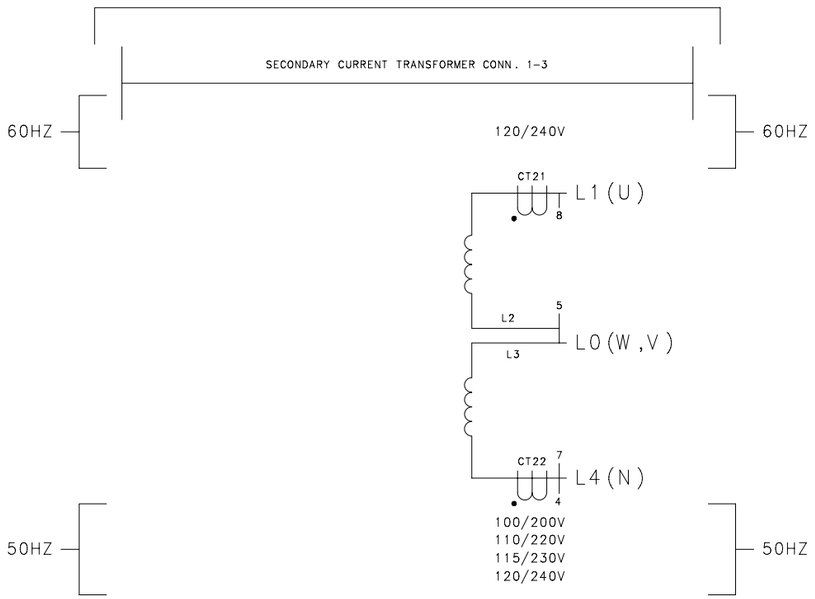
1 PHASE RECONNECTABLE, 12 LEAD



347/600V 60HZ



1 PHASE RECONNECTABLE, 4 LEAD



VOLTAGE SENSING CONTINUITY		
CONTROL INPUT TB21	GENERATOR SENSING LEADS	
-21	8	
-23	7	
-24	4	
-25	6	
-26	5	

NOTES:

(B1) 1. CURRENT TRANSFORMER SECONDARY MUST BE MANUALLY SELECTED.
ABOVE 300 VOLTS AC, TERMINALS 1 & 2;
BELOW 300 VOLTS AC, TERMINALS 1 & 3.
TERMINALS 2/3 ARE COMMON AND CONNECTED TO GROUND.

4. GENERATOR VOLTAGE SENSING LEADS GEN-4,-5,-6,-7, & -8 MUST BE CONNECTED TO GENERATOR OUTPUT LEADS AS SHOWN FOR PROPER METERING AND VOLTAGE REGULATOR OPERATION. FOR 600V, CONNECT LEADS TO GENERATOR TAPS 6,7 & 8 AND TO LO(N) AS SHOWN. LEADS MAY BE COLOR CODED IN LIEU OF MARKING AS FOLLOWS:

GEN-4 LT GRN/BLK
GEN-5 TAN/BLK
GEN-6 RED/BLK
GEN-7 YEL/BLK
GEN-8 DK BLU/BLK

INSULATE AND TIE BACK ANY UNUSED LEADS.

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TB1-10 (SWITCHED B+ OUTPUT) OUTPUT TO RELAY K12, FUSED AT 20 AMPS, ENERGIZED WHEN THE START SIGNAL IS APPLIED AND DE-ENERGIZED AT SHUTDOWN (NORMAL AND FAULT)

TB1-9 (B+ INPUT) BATTERY POSITIVE (+) CONNECTION

TB1-8 (START SOLENOID) OUTPUT TO RELAY K11, FUSED AT 20 AMPS

TB1-7 (B+ OUTPUT) OUTPUT TO TIME DELAY START/STOP MODULE A15, FUSED AT 15 AMPS, AVAILABLE WHEN THE STARTING BATTERIES ARE CONNECTED

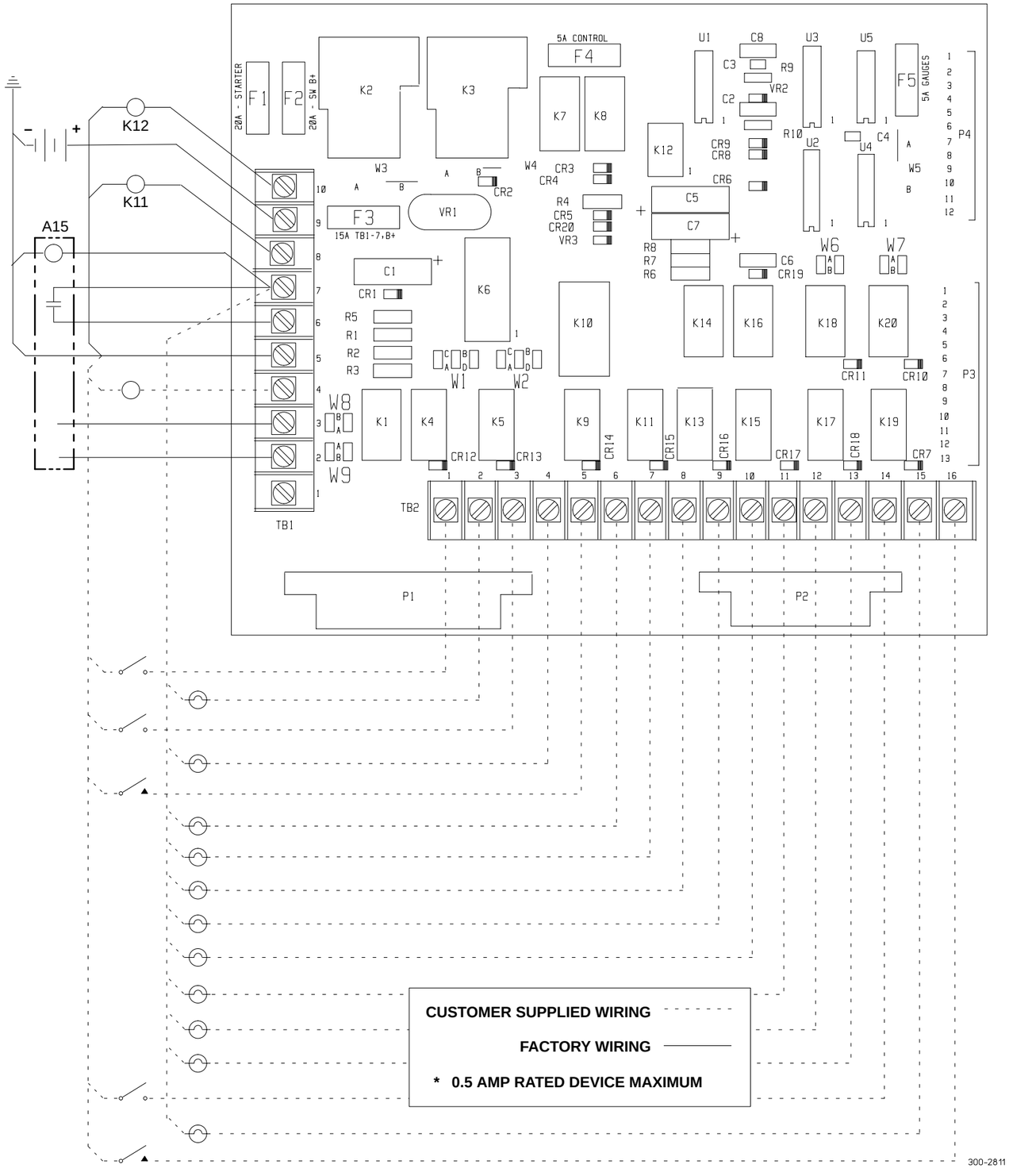
TB1-6 (REMOTE START) CONNECTED TO TIME DELAY START/STOP MODULE A15. CONNECT REMOTE START CONTACT OF THE AUTOMATIC TRANSFER SWITCH TO TERMINAL TB1-5 OF MODULE A15.

TB1-5 (GROUND)

TB1-4 (COMMON ALARM B+ OUTPUT) 4 AMP RATED DEVICE MAXIMUM

TB1-3 (RUN) CONNECTED TO TIME DELAY START/STOP MODULE A15

TB1-2 (DC DISCONNECT) CONNECTED TO TIME DELAY START/STOP MODULE A15



TB2-1 (FAULT 2) GROUND INPUT FROM SENDER

TB2-2 (FAULT 2) GROUND OUTPUT TO LIGHT/RELAY*

TB2-3 (FAULT 1) GROUND INPUT FROM SENDER

TB2-4 (FAULT 1) GROUND OUTPUT TO LIGHT/RELAY*

TB2-5 (REMOTE RESET) MOMENTARY CONTACT TO GROUND

TB2-6 (OVERCRANK FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-7 (OVERSPEED FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-8 (HIGH ENGINE TEMPERATURE FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-9 (LOW OIL PRESSURE FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-10 (PRE-HIGH ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-11 (PRE-LOW OIL PRESSURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-12 (SWITCH OFF WARNING) GROUND OUTPUT TO LIGHT/RELAY*

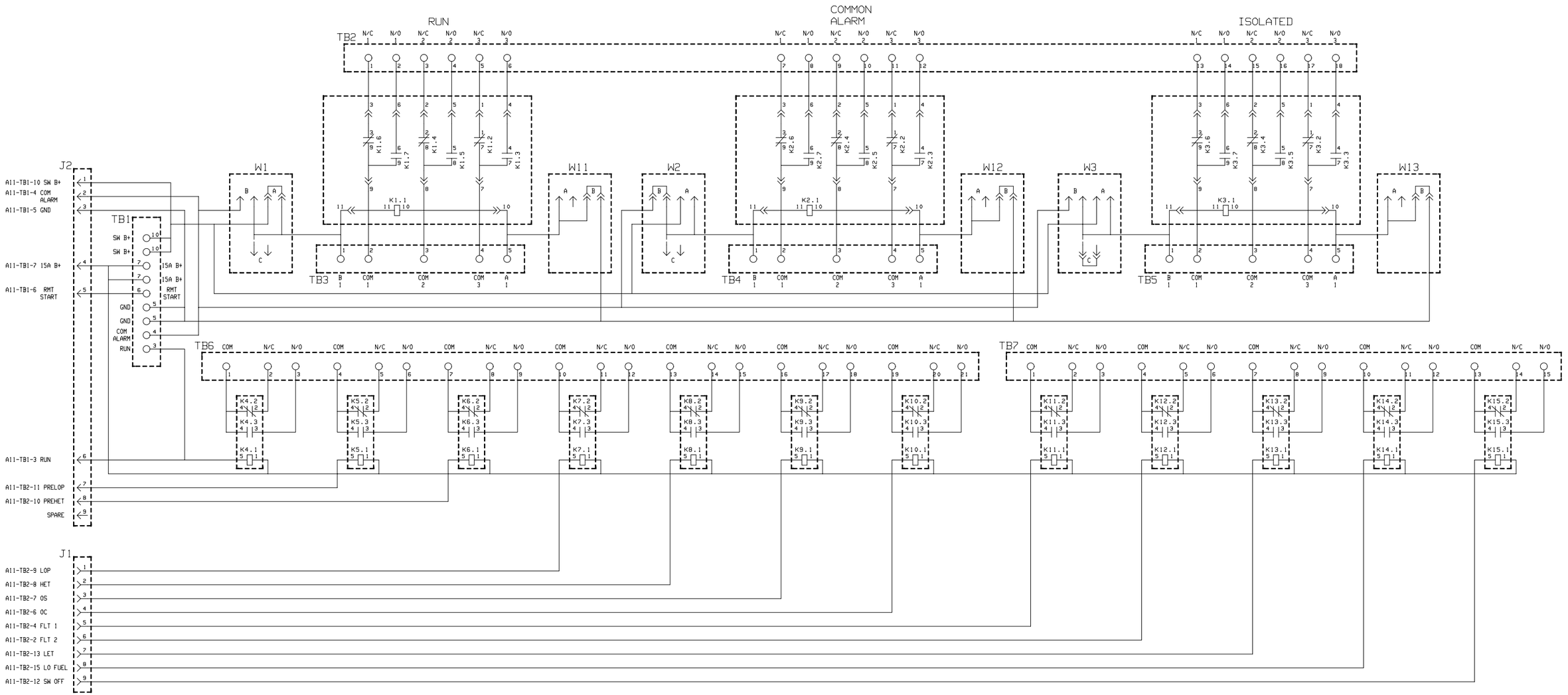
TB2-13 (LOW ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-14 (LOW FUEL WARNING) GROUND INPUT FROM SENDER

TB2-15 (LOW FUEL WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-16 (EMERGENCY SHUT DOWN) MOMENTARY CONTACT TO GROUND

FACTORY AND CUSTOMER CONNECTIONS AT THE ENGINE MONITOR BOARD TERMINALS



CUSTOMER CONNECTIONS AT THE AUXILIARY RELAY BOARD

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
1-800-888-6626
763-528-7229 International Use
Fax: 763-574-8087

Power Generation