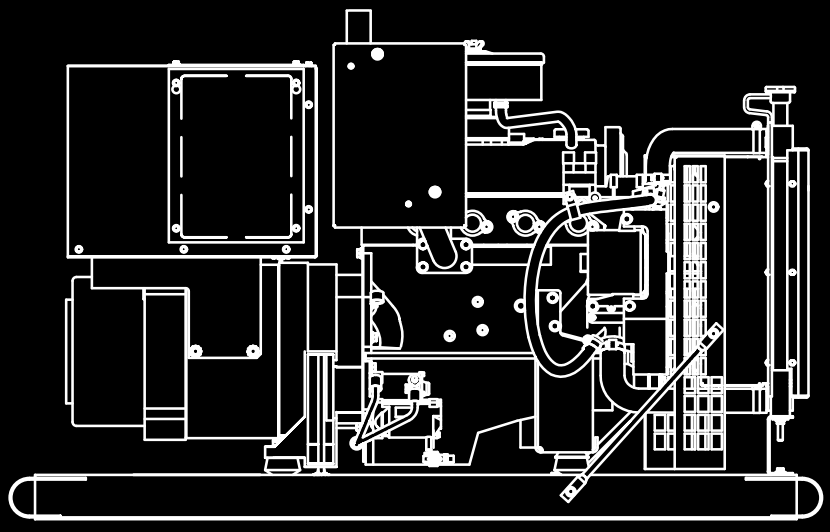
Caution: This document contains mixed page sizes (8.5 x 11 or 11 x 17), which may affect printing. Please adjust your printer settings according to the size of each page you wish to print.

Power Generation

Power Generation

Service Manual

Detector™ /2-Wire Remote Control Generator Sets



Model
GGDB

Printed in U.S.A.

928-0503D 5-2003

Table of Contents

SECTION	TITLE	PAGE
	IMPORTANT SAFETY INSTRUCTIONS	iii
1	**INTRODUCTION**	
	About This Manual	1-1
	Test Equipment	1-1
	How To Obtain Service	1-1
2	**VOLTAGE REGULATOR**	
	Principle Of Generator Operation	2-1
	Voltage Regulator	2-2
3	**ENGINE CONTROL (DETECTOR CONTROL)**	
	General	3-1
	Control Panel Components	3-1
	Control Box Interior	3-4
	Engine Control Monitor (A11)	3-4
	Engine Sensors	3-7
	Auxiliary Control Components	3-11
	Sequence Of Operation	3-15
4	**ENGINE CONTROL (2-WIRE REMOTE CONTROL)**	
	General	4-1
	Control Panel Components	4-1
	Control Box Interior	4-2
	Control Relays	4-2
	Terminal Block TB1	4-2
	Dry Contact Module	4-3
	Engine Sensors/Gauges	4-4
	Electronic Overspeed/Start Disconnect Module (Standard) (Spec A & B)	4-5
	Sequence Of Operation	4-6

⚠ WARNING: ⚠

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

SECTION	TITLE	PAGE
5	**TROUBLESHOOTING (DETECTOR CONTROL)**	
	The Engine Does Not Crank In Run Mode	5-1
	The Engine Does Not Crank In Remote Mode	5-3
	The Engine Cranks But Does Not Start	5-4
	The Engine Runs Until Fault Shutdown	5-6
	The Engine Lacks Power Or Is Unstable	5-9
	An Amber Warning Lamp Is On	5-11
	The Green Run Lamp Stays Off But The Set Runs Normally	5-13
6	**TROUBLESHOOTING (2- WIRE REMOTE CONTROL)**	
	The Engine Does Not Crank In Run Mode	6-1
	The Engine Does Not Crank In Remote Mode	6-3
	The Engine Cranks But Does Not Start	6-4
	The Engine Runs Until Fault Shutdown	6-6
	The Engine Lacks Power Or Is Unstable	6-8
7	**SERVICING THE GENERATOR**	
	Testing The Generator	7-1
	Generator Disassembly	7-7
	Generator Reassembly	7-9
	Troubleshooting	7-10
	No Output Voltage	7-10
	Output Voltage Is Too High Or Too Low	7-13
	Output Voltage Is Unstable	7-14
	The Field Circuit Breaker Keeps Tripping (Detector Control)	7-15
	The Phase Currents Are Unbalanced (3-Phase Generators)	7-16
8	**GOVERNORS AND FUEL SYSTEMS**	
	Electric Governor Adjustment	8-1
	Linkage Adjustment	8-2
	Magnetic Speed Pickup Unit Adjustment	8-3
	Fuel System	8-4
	Ignition Timing	8-6
9	**WIRING DIAGRAMS**	9-1

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 copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Natural gas is lighter than air, and will tend to gather under hoods. Propane is heavier than air, and will tend to gather in sumps or low areas. NFPA code requires all persons handling propane to be trained and qualified.
- 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. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

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.
- 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.

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.
- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- 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

ABOUT THIS MANUAL

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

This service manual is for the GGDB generator set (genset). The manual includes engine and generator troubleshooting guides. Engine service instructions are in the applicable engine service manual. Operating and maintenance instructions are in the applicable Operator's Manual.

This manual does not have instructions for servicing printed circuit board assemblies. Always replace a faulty printed circuit board assembly. Attempts to repair a printed circuit board can lead to costly damage to the equipment.

This manual contains basic (generic) wiring diagrams and schematics that are included to help in troubleshooting. Service personnel must use the actual wiring diagram and schematic shipped with each unit. The wiring diagrams and schematics that are maintained with the unit should be updated when modifications are made to the unit.

Read ***Safety Precautions*** and carefully observe all instructions and precautions in this manual.

TEST EQUIPMENT

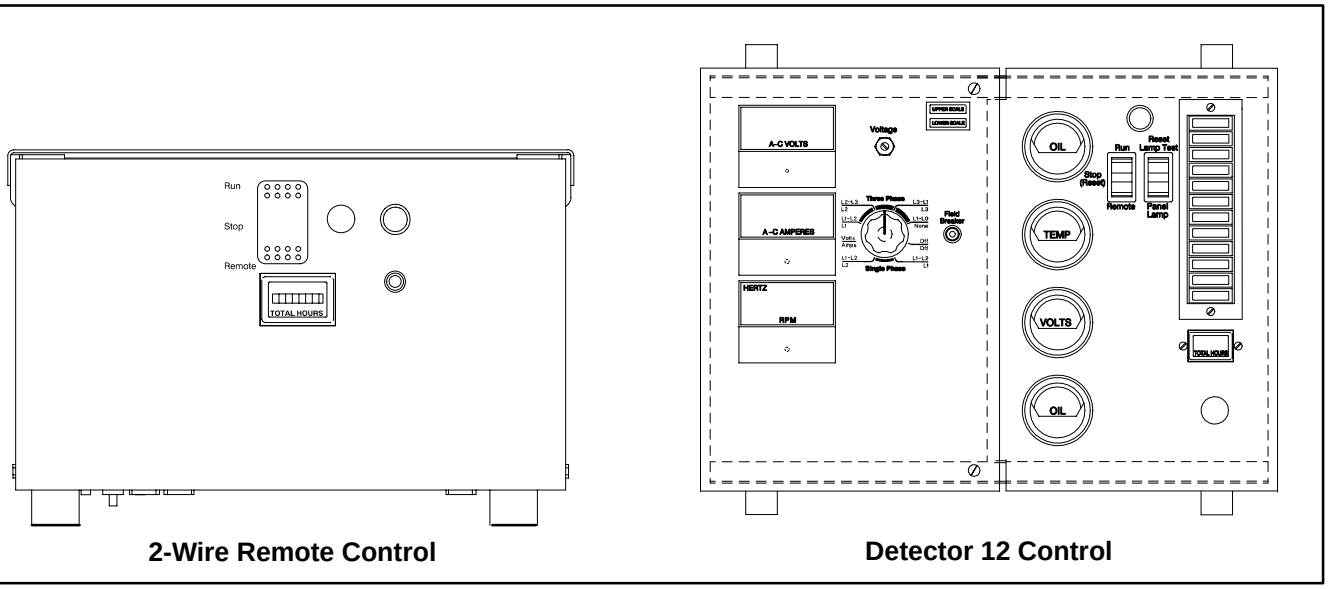
Most of the tests in this manual can be done with an AC-DC multimeter, frequency meter, Wheatstone bridge (0.001 ohm precision is necessary for measuring stator winding resistance) and load test panel.

HOW TO OBTAIN SERVICE

Always give the complete Model, Specification and Serial number of the generator set as shown on the nameplate when seeking additional service information or replacement parts. The nameplate is located on the side of the generator output box.

⚠WARNING ***Incorrect service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and mechanical service. Read and follow Safety Precautions on pages iii and iv.***

There are separate *Engine Control* and *Troubleshooting* sections for gensets using the 2-Wire Remote control or the Detector control (Figure 1-1). Refer to the *Table of Contents* for specific information relating to your genset control. The remaining sections apply to both controls.



2-Wire Remote Control **Detector 12 Control**

FIGURE 1-1. CONTROL PANEL CONFIGURATIONS

THIS PAGE LEFT INTENTIONALLY BLANK

2. Voltage Regulator

PRINCIPLE OF GENERATOR OPERATION

Refer to Figure 2-1 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. Nominal output voltage and frequency are maintained 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 main stator through the voltage regulator. Residual field magnetism initiates “self-excitation” during startups.

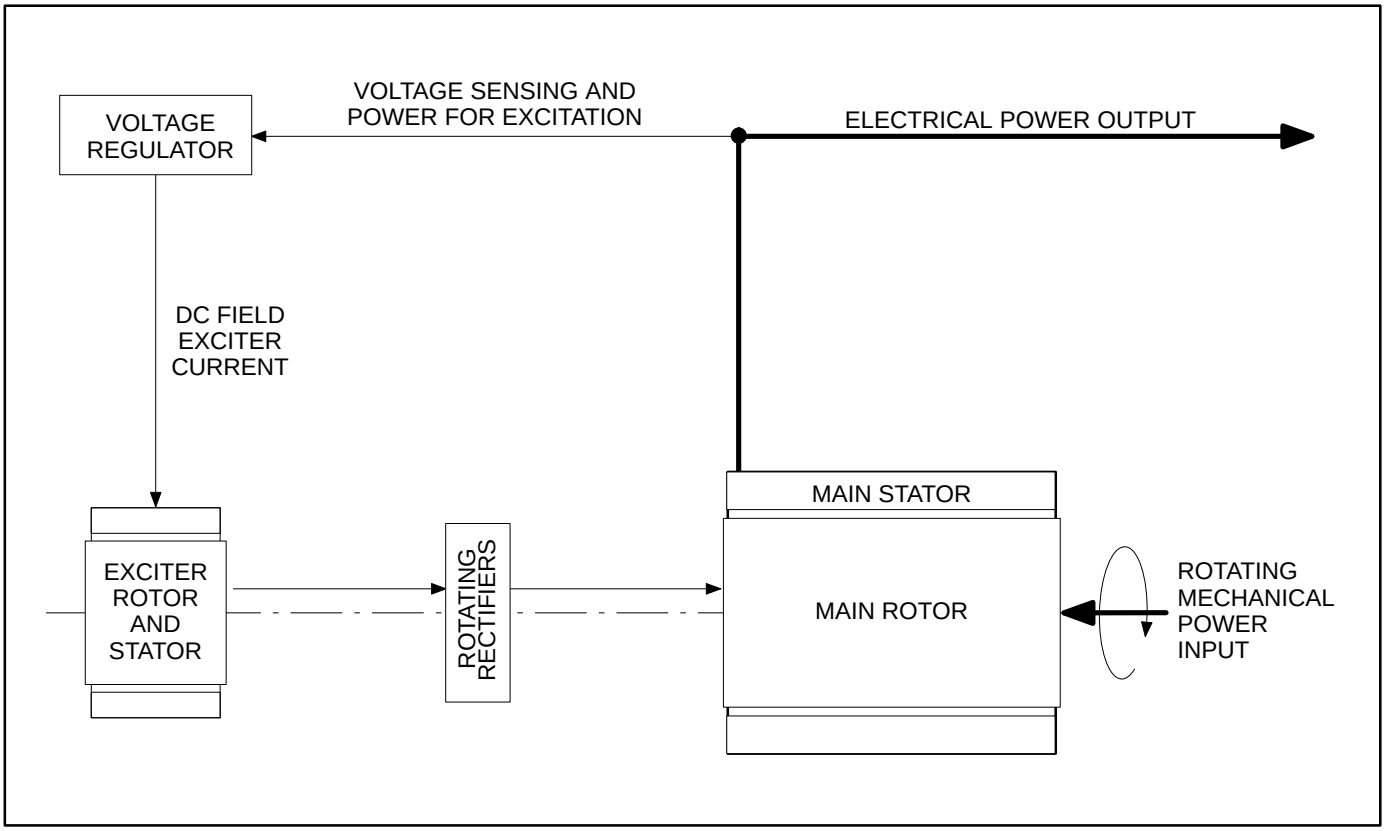


FIGURE 2-1. DIAGRAM OF GENERATOR OPERATION

VOLTAGE REGULATOR

Figures 2-2 and 2-3 illustrate the voltage regulator and its mounting and orientation in the different types of control boxes.

Frequency Selection Jumper

Connect the frequency selection jumper for the application frequency, 50 Hz or 60 Hz.

Voltage Adjustment

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.

If a replacement voltage regulator has been installed, or the voltage trimmer does not provide enough adjustment, adjust voltage as follows:

1. Turn the voltage trimmer (Figure 3-1, Detector control only) to its mid position.
2. Turn the **VOLTS** pot on the voltage regulator fully counterclockwise.
3. Turn the **STABILITY** pot on the voltage regulator to its mid position.
4. Start and operate the generator set at rated frequency and no load. If the **LED** lights, see **UFRO Adjustment**.
5 Slowly turn the **VOLTS** pot clockwise until rated voltage is obtained.
6 See **Stability Adjustment** if voltage is unstable.

Stability Adjustment

If it is necessary to adjust stability, run the generator set at rated frequency and no load. Slowly turn the **STABILITY** pot clockwise until voltage becomes stable and then counterclockwise until it again becomes unstable. Turn the pot slightly clockwise from this position for maximum stability. Readjust voltage after a stability adjustment.

UFRO Adjustment

The **LED** on the voltage regulator indicates that the **UFRO** (under frequency roll off) circuit is in operation. Check first to see that the frequency selection jumper is connected appropriately for the application (50 Hz or 60 Hz).

The **UFRO** pot on the voltage regulator is factory set and sealed. If necessary, adjust it so that the **LED** lights as frequency drops to 47 Hz for a 50 Hz application or 57 Hz for a 60 Hz application. Turn the pot clockwise to reduce the “knee point” frequency.

Field Flashing

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

1 Assemble a 12 volt battery, 10 ohm resistor, 18 volt voltage suppressor and 12 amp, 300 volt diode as shown in Figure 2-2 or 2-3.

2. While the set is running at nominal frequency, momentarily connect the positive (**+**) side of the circuit to voltage regulator terminal **VR21-F1 (x)** and the negative side (**-**) to voltage regulator terminal **VR21-F2 (xx)**.

   ⚠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 in *Section 7*, if output voltage does not build up without field flashing.

⚠WARNING ***HAZARDOUS VOLTAGE! Touching uninsulated 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 hazardous parts.***

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.

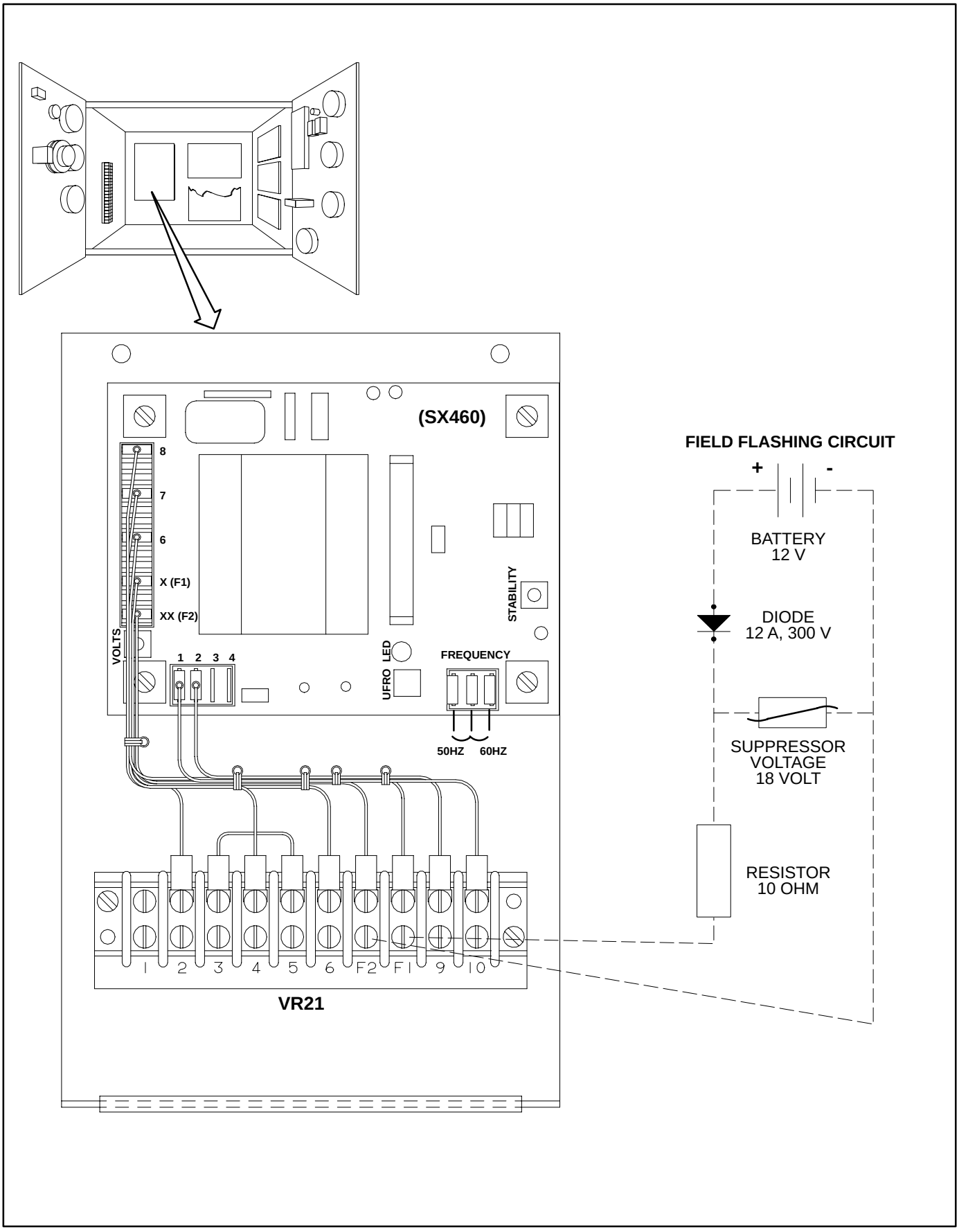


FIGURE 2-2. VOLTAGE REGULATOR WITH DETECTOR CONTROL

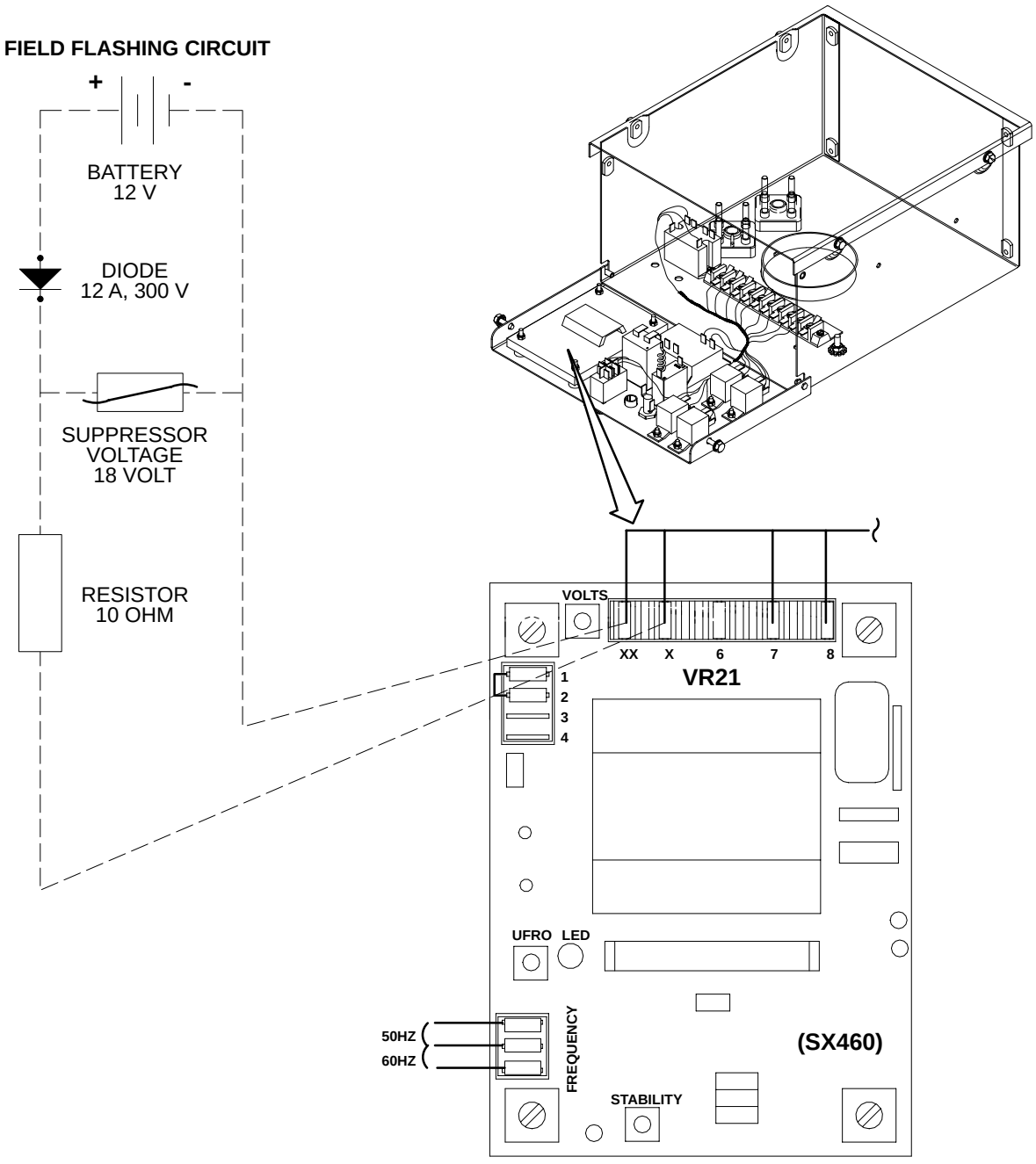


FIGURE 2-3. VOLTAGE REGULATOR WITH 2-WIRE REMOTE CONTROL

3. Engine Control (Detector Control)

GENERAL

The Detector control box is mounted on top of the generator, facing the rear. Figures 3-1, 3-2 and 3-3 show the components on the control panel.

CONTROL PANEL COMPONENTS

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 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.

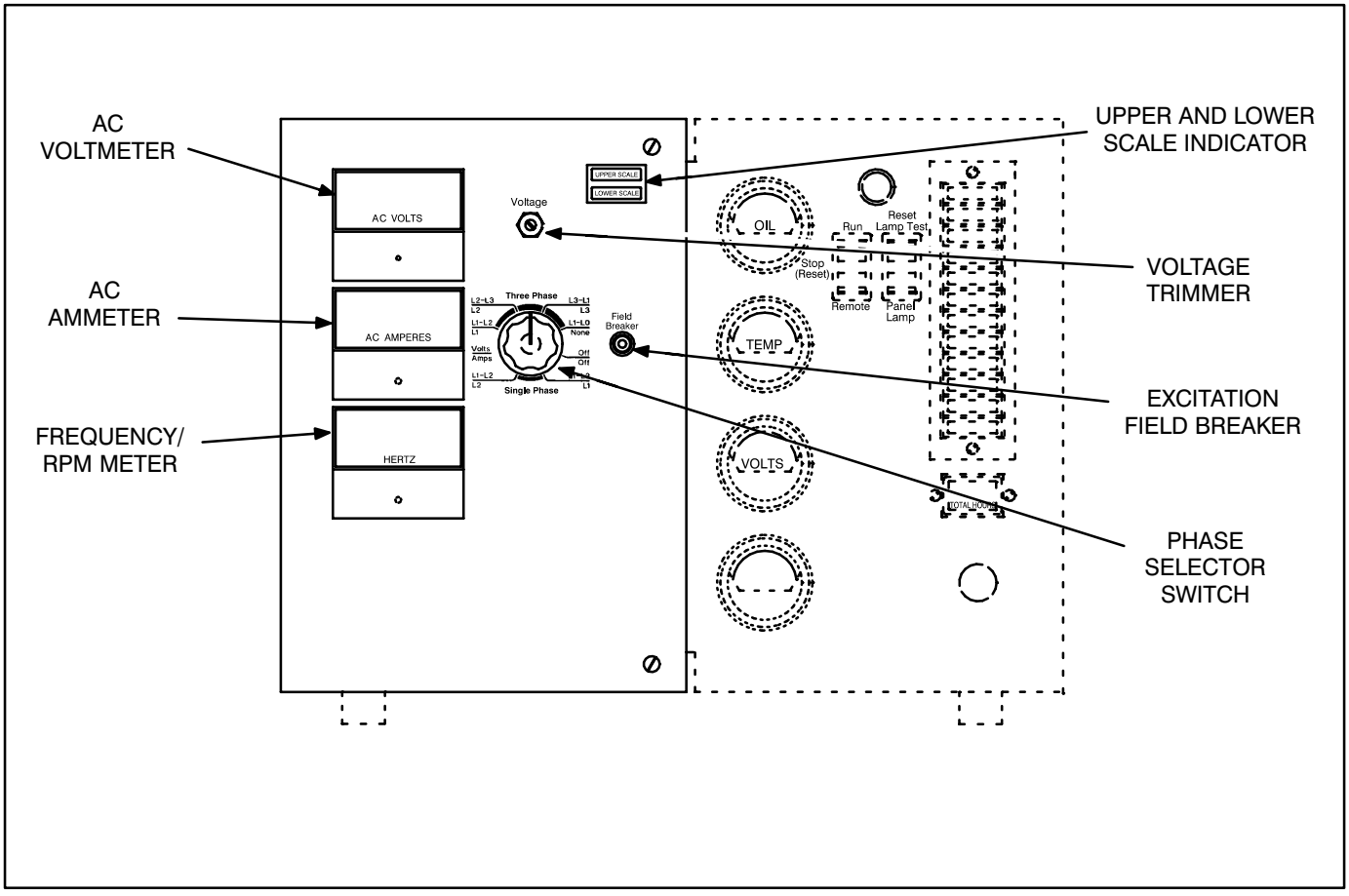


FIGURE 3-1. AC CONTROL PANEL

Run / Stop / Remote Switch (S12) Starts and stops the set locally, or from a remote location wired to the control engine monitor board.

Reset / Lamp Test / Panel Lamp Switch (S11) Resets the fault circuit only when the Run/Stop/Remote switch is in the Stop (Rest) position. Tests fault lamps and turns on the control panel lamp.

Oil Pressure Gauge (M11) Indicates pressure of lubricating oil in engine. Normal oil pressure is 40 to 65 psi (276 to 449 kPa) at normal operating temperature.

Coolant Temperature Gauge (M12) The coolant temperature gauge indicates engine coolant temperature. Engine coolant temperature is typically between 165 to 195° F(74° 91° C).

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

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

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

Emergency Stop Button (S14) (Optional) Push-in switch for emergency shutdown of the engine. To reset, pull switch out and move Run/Stop/Remote switch to Stop position. Then push test switch to Reset/Lamp Test position.

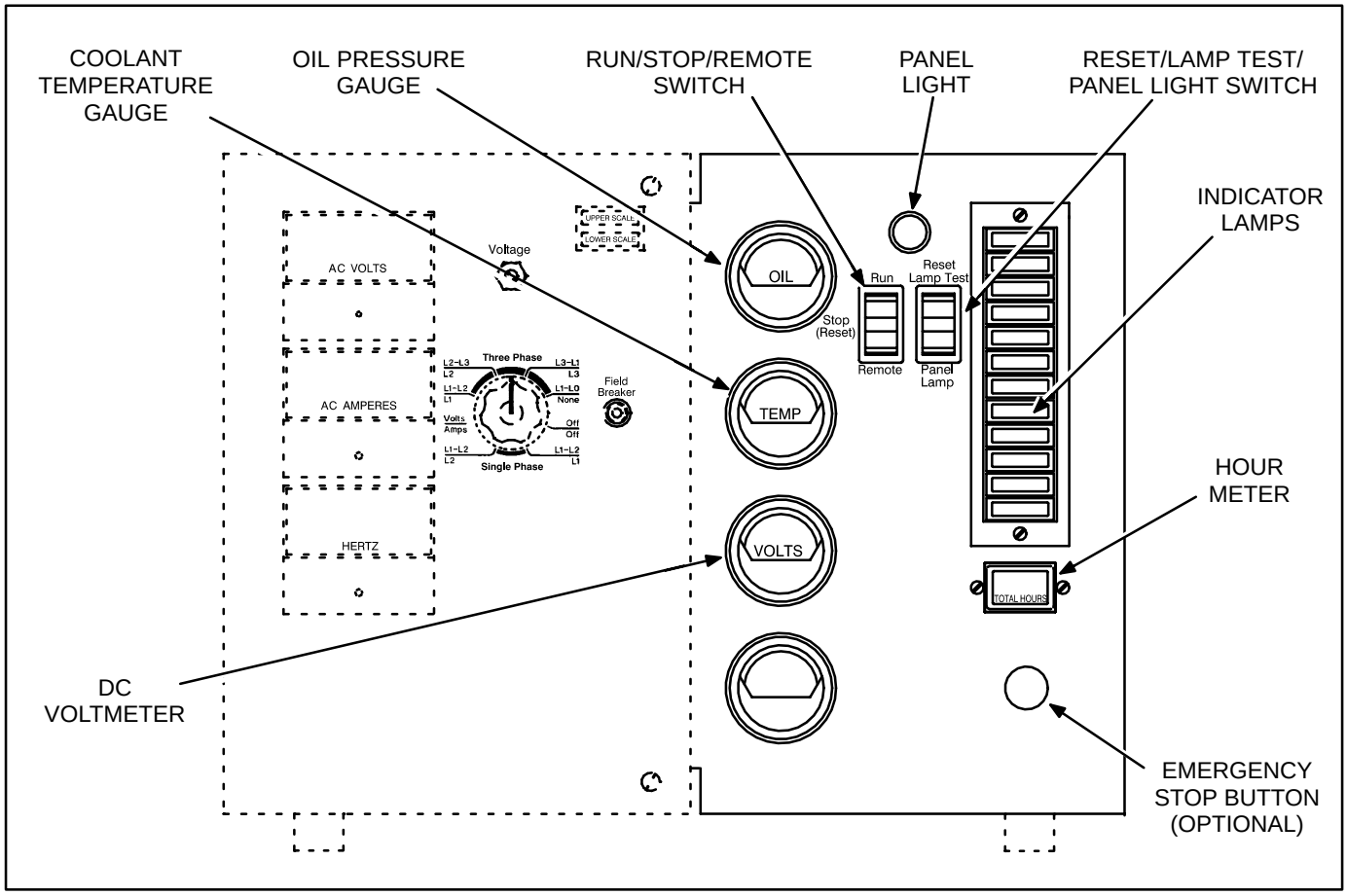


FIGURE 3-2. ENGINE CONTROL PANEL

Fault and Status Indicator Lamps

- **Run (Green)** Indicates that the starter has disconnected and that the set is running.
- **Pre Low Oil Pressure (Yellow)** Indicates that engine oil pressure is abnormally low (less than 20 psi [137 kPa]).
- **Pre High Engine Temperature (Yellow)** Indicates that engine coolant temperature is abnormally high (greater than 220° F [104° C]).
- **Low Oil Pressure (Red)** Indicates that the engine shut down because of excessively low engine oil pressure (less than 14 psi [97 kPa]).
- **High Engine Temperature (Red)** Indicates that the engine shut down because of excessively high engine coolant temperature (greater than 230° F [110° C]).
- **Overspeed (Red)** Indicates that the engine shut down because of overspeed. The overspeed shut down ranges are:
  Mechanical Overspeed Switch (Spec A & B) -
  60 Hz Sets . . . . . 2500 RPM
  50 Hz Sets . . . . . 2100 RPM
  Ignition Module Overspeed Switch (Begin Spec C) -
  50/60 Hz Sets . . . . . 2500 RPM
- **Overcrank (Red)** 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)** Indicates warning or engine shut down because of a system fault. The customer has to make connections to use this lamp and to select warning or engine shut down. The lamp is a part of a 10 second time delay shutdown circuit. The customer can make reconnections for non-timed shutdown. See Engine Control Monitor.
- **Fault 2 (Red)** Indicates warning or engine shut down because of a system fault. The customer has to make connections to use this lamp and to select warning or engine shut down. The lamp is part of a non-time delay shutdown circuit. The customer can make reconnections for 10 second time delay shutdown. See Engine Control Monitor.
- **Low Engine Temperature (Yellow)** Indicates that engine temperature is less than 65° F (18° C) or 90° F (32° C), and the possibility that the engine might not start. (Temperature is selectable on Sensor board.)
- **Low Fuel (Yellow) (Optional)** Indicates fuel supply pressure is 5 inches (127 mm) WC or less. (Single fuel systems only.)
- **Switch-off (Flashing Red)** Indicates that the **Run / Stop / Remote** switch is in the **Stop** position, which prevents remote, automatic operation.

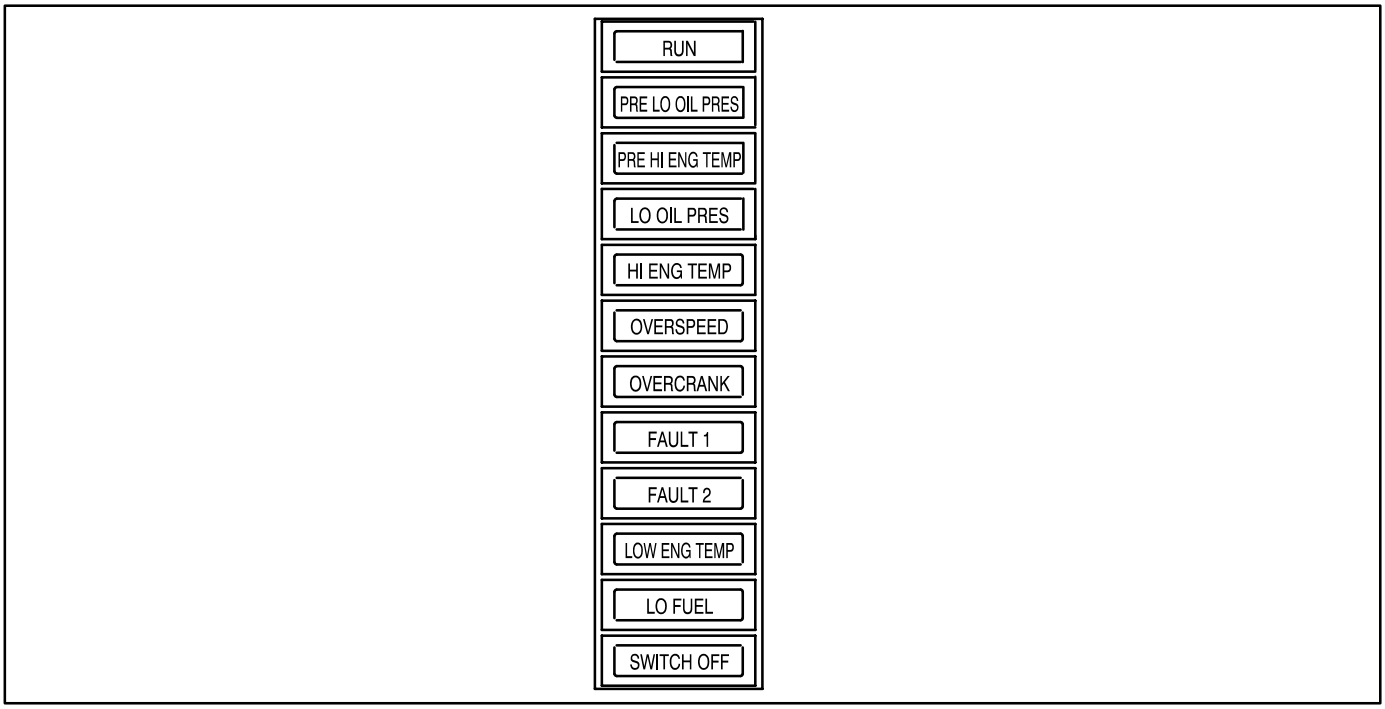


FIGURE 3-3. INDICATOR LAMPS

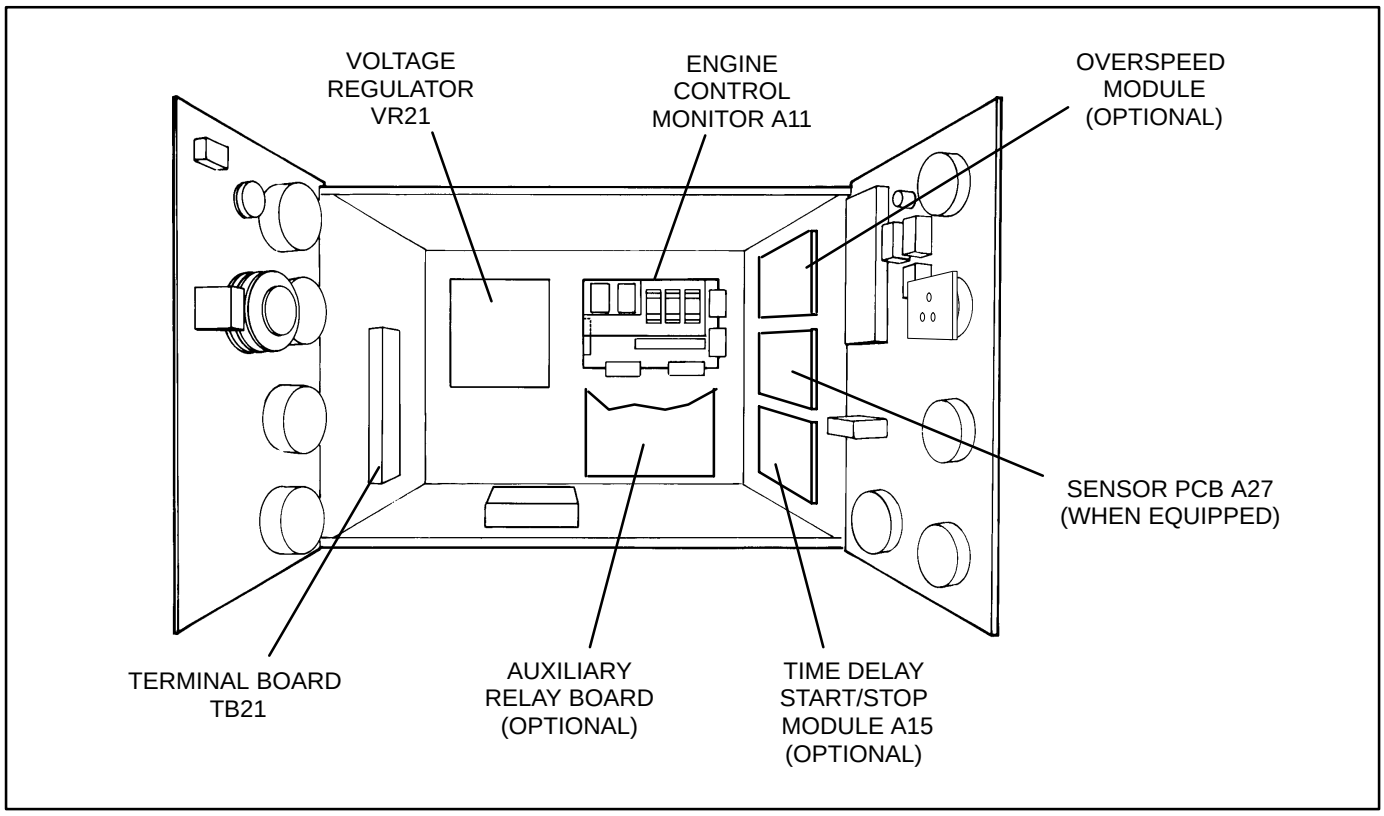


FIGURE 3-3. ARRANGEMENT OF COMPONENTS INSIDE THE CONTROL BOX

CONTROL BOX INTERIOR

Figure 3-4 shows the arrangement of components inside the control box, including the engine control monitor and some of the auxiliary components under the following headings.

ENGINE CONTROL MONITOR (A11)

The heart of the engine control system is the engine control monitor (ECM) (Figure 3-5). It is a printed circuit board assembly mounted on the back wall of the control box. It starts and stops the engine in response to the control panel switches, engine sensors and remote control signals.

Note that there are two versions of the ECM board and that they both perform the same functions. They only differ in that one version contains additional components, which are, LED's (**DS1 - DS9**), terminal board (**TB3**) and function selection jumper **W10**. Figure 3-5 illustrates the ECM version which contains the additional components.

LED's DS1 through DS9

The ECM LED's are provided as an aid in troubleshooting the control circuitry. The LED's indicate the following conditions:

LED	STATUS WHEN ILLUMINATED
DS1	B+ is connected to ECM and fuse F4 is good.
DS2	RUN relay is energized.
DS3	Start Command signal enabled.
DS4	Crank signal enabled.
DS5	DC Starter Disconnect signal enabled.
DS6	AC Starter Disconnect signal enabled.
DS7	LOP/HET signal active (time delay circuit has timed-out).
DS8	Reverse battery voltage.
DS9	Remote Shutdown signal active (grnd at TB2-16)

Terminals and Connectors

See Pages 9-5 through 9-9 for the appropriate connection and schematic drawings for the DC control system. See Page 9-10 for typical customer connections at terminal boards **TB1** and **TB2** on the ECM and page 9-11 if the set is also equipped with the auxiliary relay board.

TB3 provides an alternative direct connection to the ECM for the RUN/STOP/REMOTE switch for troubleshooting or if desired, customer connection.
TB3-1 = REMOTE
TB3-2 = RUN
TB3-3 = STOP

Fuses

The ECM has five replaceable fuses to protect it from overloads and ground faults. 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 ECM circuits, 5 amps.

F5 Engine gauge circuits, 5 amps.

Function Selection Jumpers

ECM 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 and control of the SWITCH OFF indicator:

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

- **A** Non-timed warning under **FLT 2** conditions.
- **B** Non-timed shutdown under **FLT 2** conditions.
- **C** Timed warning under **FLT 2** conditions.
- **D** Timed shutdown 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 under **FLT 1** conditions.
- **C** Timed warning under **FLT 1** conditions.
- **D** Timed shutdown under **FLT 1** conditions.

W6 Jumper Position:

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

W7 Jumper Position:

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

W10 Jumper Position (**SWITCH OFF** Indicator):

- **A** Flashing
- **B** Constant ON
- **C** OFF

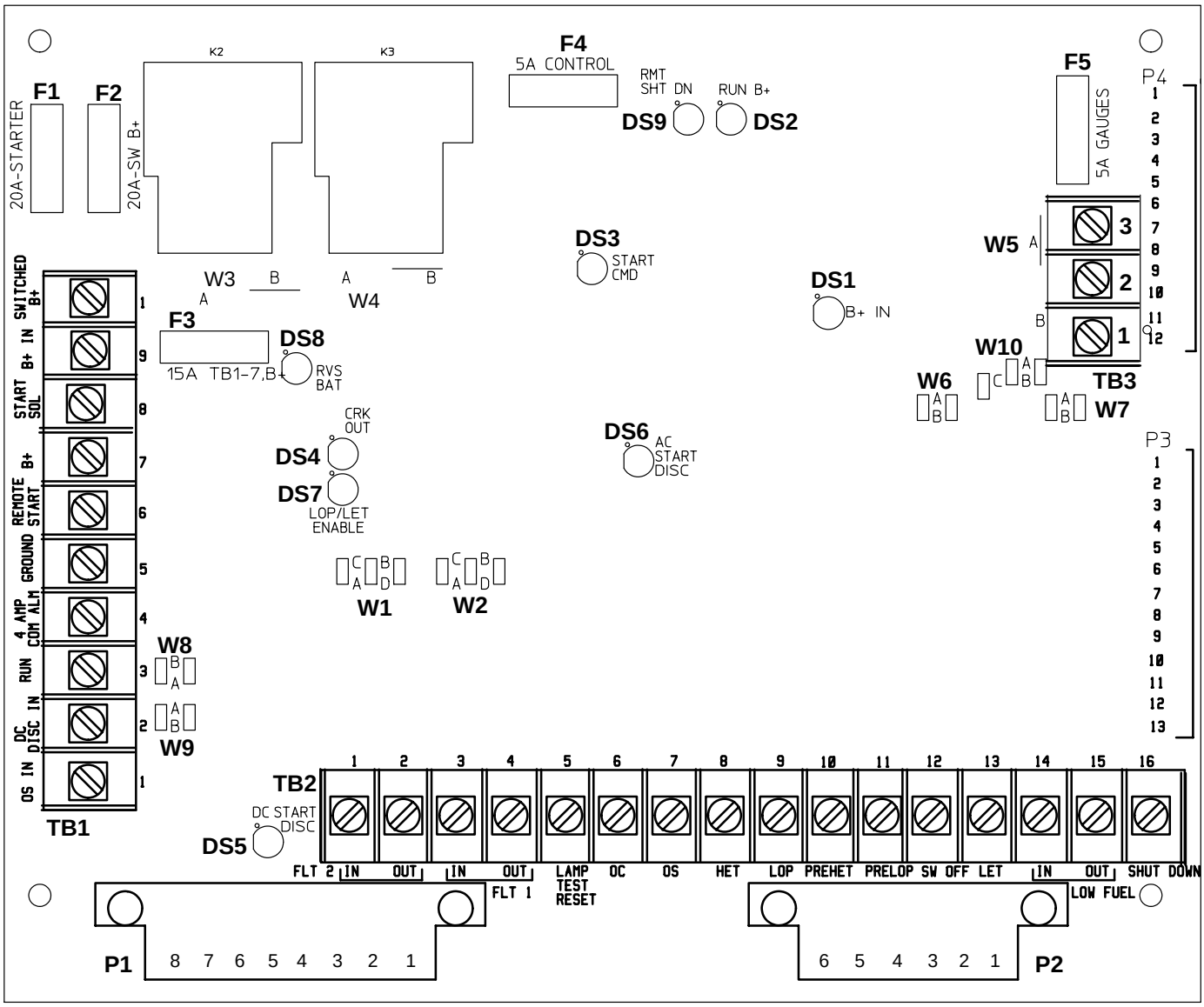


FIGURE 3-5. ENGINE CONTROL MONITOR FUSES AND FUNCTION SELECTION JUMPERS

ENGINE SENSORS

Figure 3-6 shows the locations of the gauge senders. The senders function by varying the resistance with temperature or pressure in series with the gauge. The sensor signals are interpreted by the sensor board (Figure 3-8) which in turn sends these signals to the ECM (Figure 3-5).

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

⚠ CAUTION ***Teflon tape should not be used on switches and senders that are grounded to the engine by thread contact as it may interfere with the ground path.***

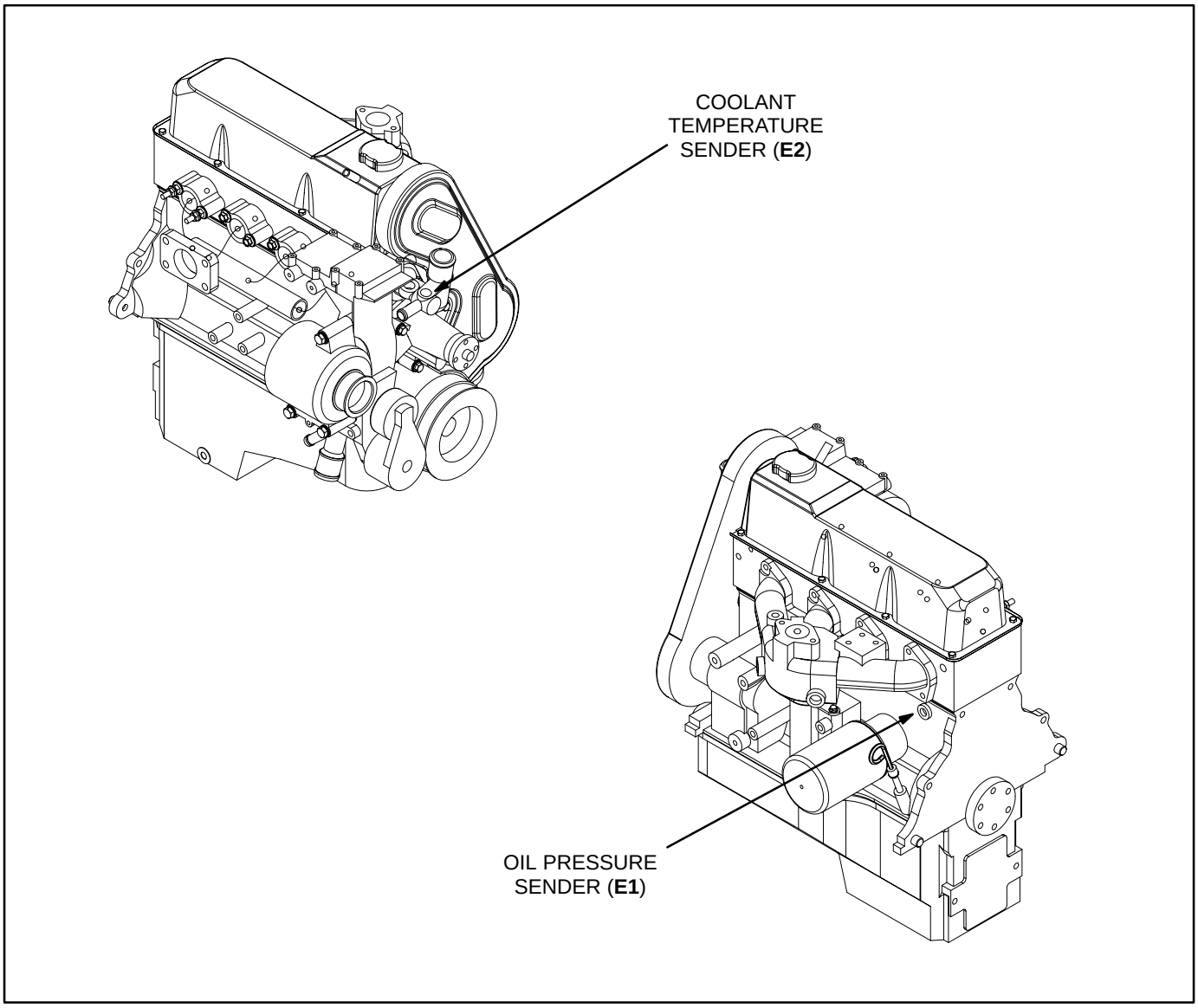


FIGURE 3-6. ENGINE SENSOR LOCATIONS

Low Coolant Level Cutout Switch (Optional) (Spec A & B)

When coolant level in the radiator top tank falls below the switch sensor, the switch closes the circuit to ground. This switch may be connected in parallel with the high engine temperature cutout switch to shut down the engine and light the **High Engine Temperature** lamp or in parallel with the pre-high engine temperature switch to light the **Pre High Engine Temperature** light only.

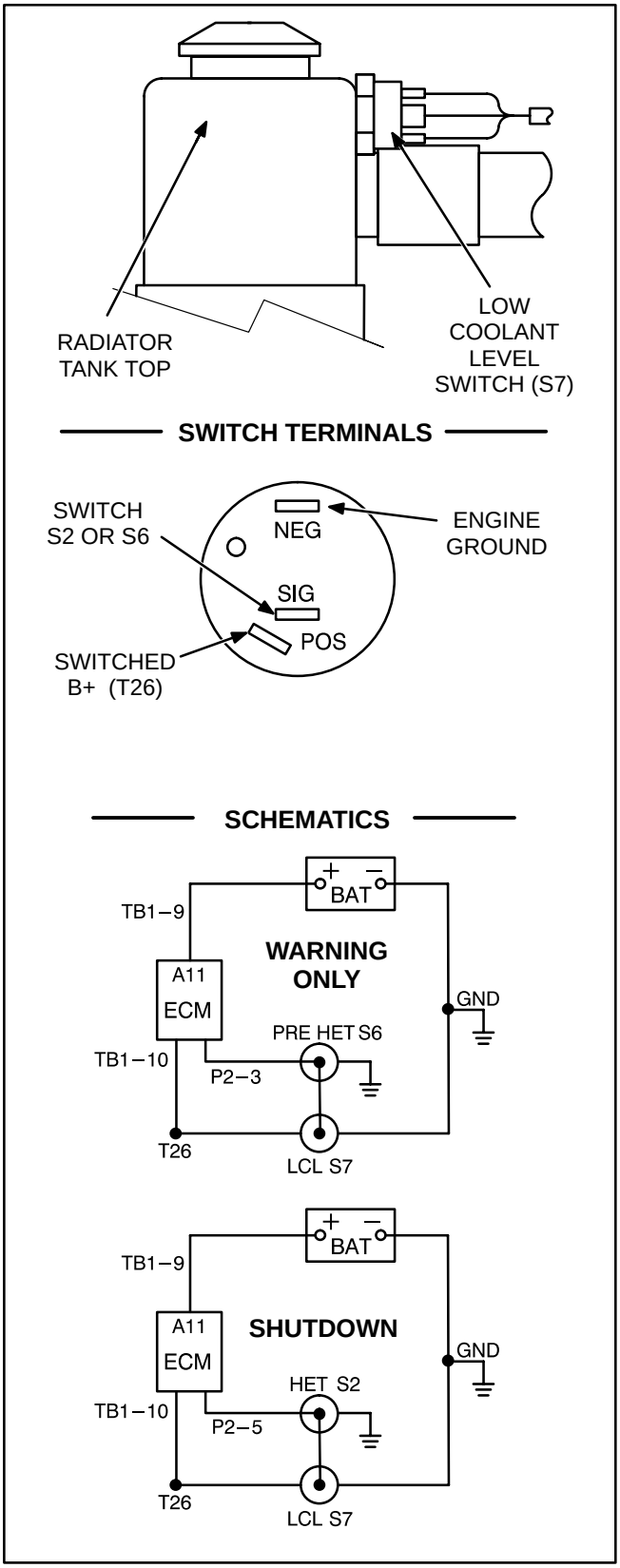


FIGURE 3-7. LOW COOLANT LEVEL SWITCH

Low Coolant Level Cutout Switch (Optional) (Begin Spec C)

When coolant level in the radiator top tank falls below the switch sensor, the switch closes the circuit to ground.

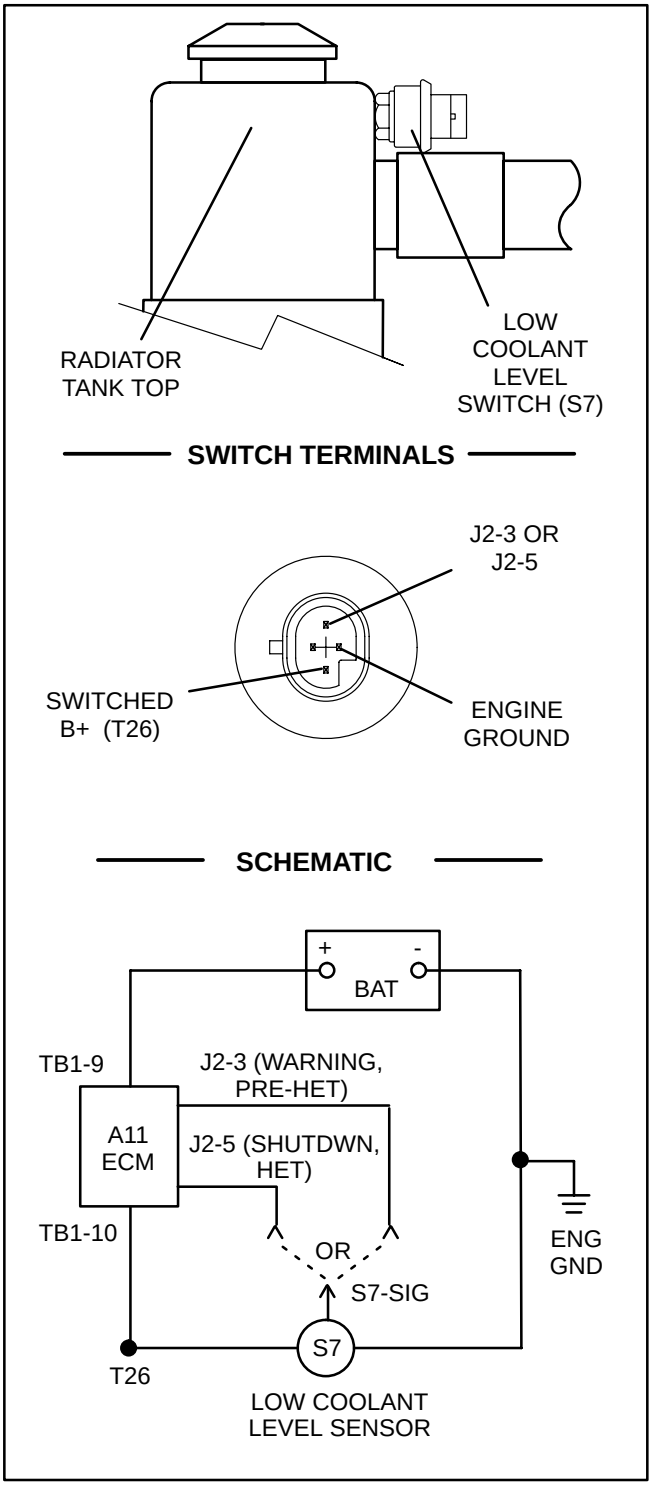


FIGURE 3-7. LOW COOLANT LEVEL SWITCH

Coolant Temperature/Oil Gauge and Warning Light Circuits

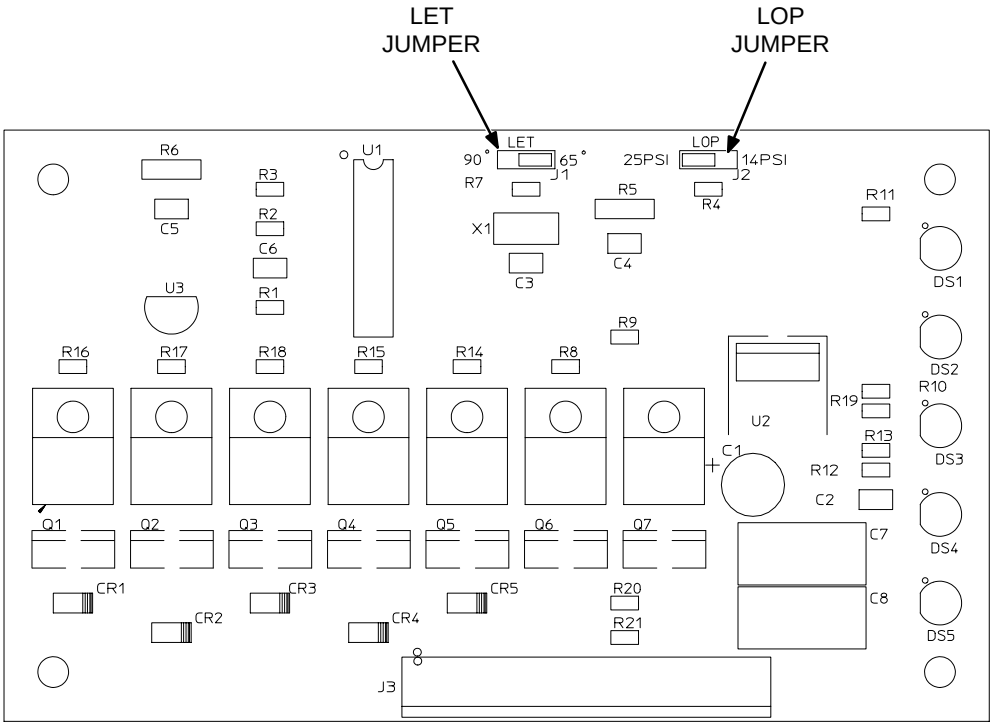
The Sensor board is mounted on the right side of the control box. This Sensor board interprets the output signals of the coolant temperature and the oil pressure senders and in turn sends these signals to the ECM (A11) board for the following functions:

- Pre-HET (pre-high engine temperature)
- HET
- Pre-LOP (pre-low oil pressure)
- LOP
- LET (low engine temperature)
- Oil pressure gauge signal
- Coolant temperature gauge signals

The Sensor board contains two selectable jumpers, one for LET and the other for LOP.

The LET jumper allows a choice of the Low Engine Temperature warning to be either 65° F (18° C) or 90° F (32° C). Select 65° F (18° C) for this generator set.

The LOP jumper allows a choice for Low Oil Pressure shutdown: 14 psi (97 kPa) for naturally aspirated engines, or 25 psi (173 kPa) for turbocharged engines. The associated Pre-LOP warning light changes between 20 psi (138kPa) and 30 psi (207 kPa) respectively. Select 14 psi (97 kPa) for this generator set.



J3 OUTPUTS		J3 INPUTS	
1	LET	9	COOLANT TEMP SENSOR
2	PRE-HET	10	OIL PRESSURE SENSOR
3	HET	11	B+
4	PRE-LOP	12	B-
5	LOP		
6	OIL PWM		
7	H20 PWM		

FIGURE 3-8. SENSOR BOARD PCB ASSEMBLY

AUXILIARY CONTROL COMPONENTS

The set might be equipped with one or more of the following components.

Mechanical Overspeed Switch (Standard) (Spec A & B)

The mechanical overspeed switch is bolted to the end of the generator rotor shaft.

1. Check overspeed cutout RPM and turn the adjustment screw, if necessary, so that shutdown occurs within the following RPM ranges:
   60 Hz Sets . . . . . 2500 RPM
   50 Hz Sets . . . . . 2100 RPM
2. Replace the switch if the cutout speed adjustment results in an air gap between the magnet and the fly arm of less than 0.005 inches (0.13 mm).
3. Torque the center rotor bolt to 18 ft-lbs (25 N-m) when replacing the switch.

Ignition Module Overspeed Switch (Standard) (Begin Spec C)

The ignition module contains a sensor switch that closes at 2500 rpm (50/60 Hz), which activates the shut down circuitry of the engine control module.

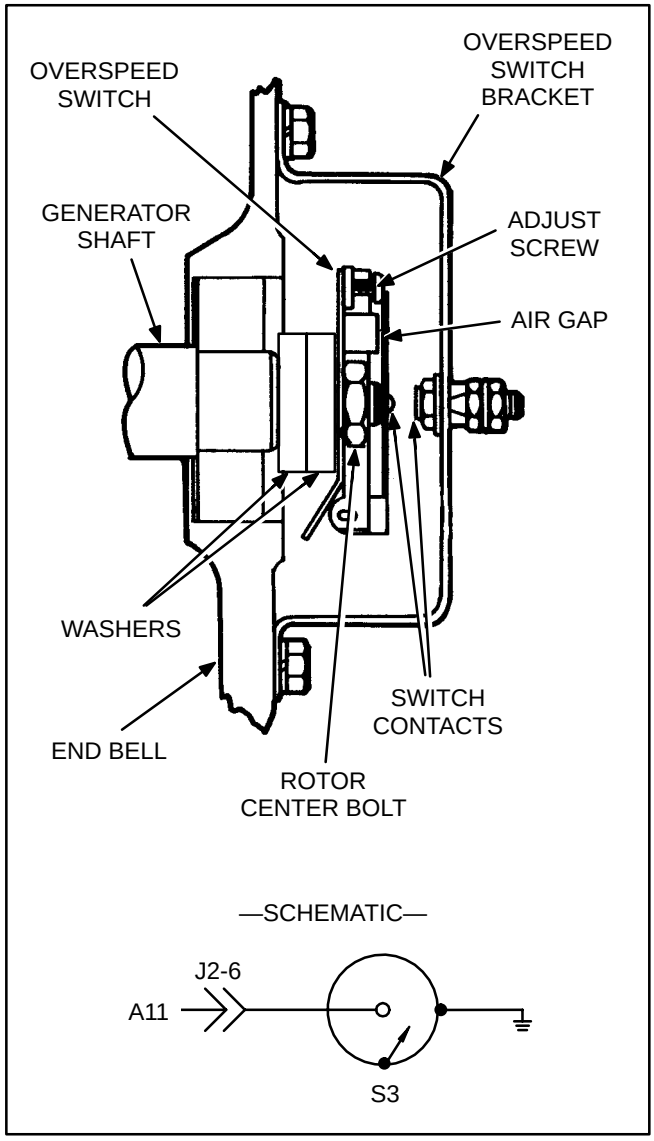


FIGURE 3-9. MECHANICAL OVERSPEED SWITCH

Auxiliary Relay Board (ARB) (Optional)

The following describes the design/functional criteria for the auxiliary relay board (ARB) (Figure 3-10). The board is mounted directly on top of the ECM using standoffs and has access holes for the fuses located on the ECM. Page 9-8 is a detailed connection diagram for the ARB.

Terminal Blocks

TB1 - ARB TB1 and ECM 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 one to three 3-pole, double-throw relays. These relays (K1, K2, K3) are field changeable plug-in relays for easy field addition and replacement.

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

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

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. 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 ECM.

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 ECM.

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. They can be located in two different positions (A, B) independently of one another.

Jumper Position A: The relay operates isolated from the board. The customer provides the circuit completion through terminal block; TB3 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 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 ECM 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

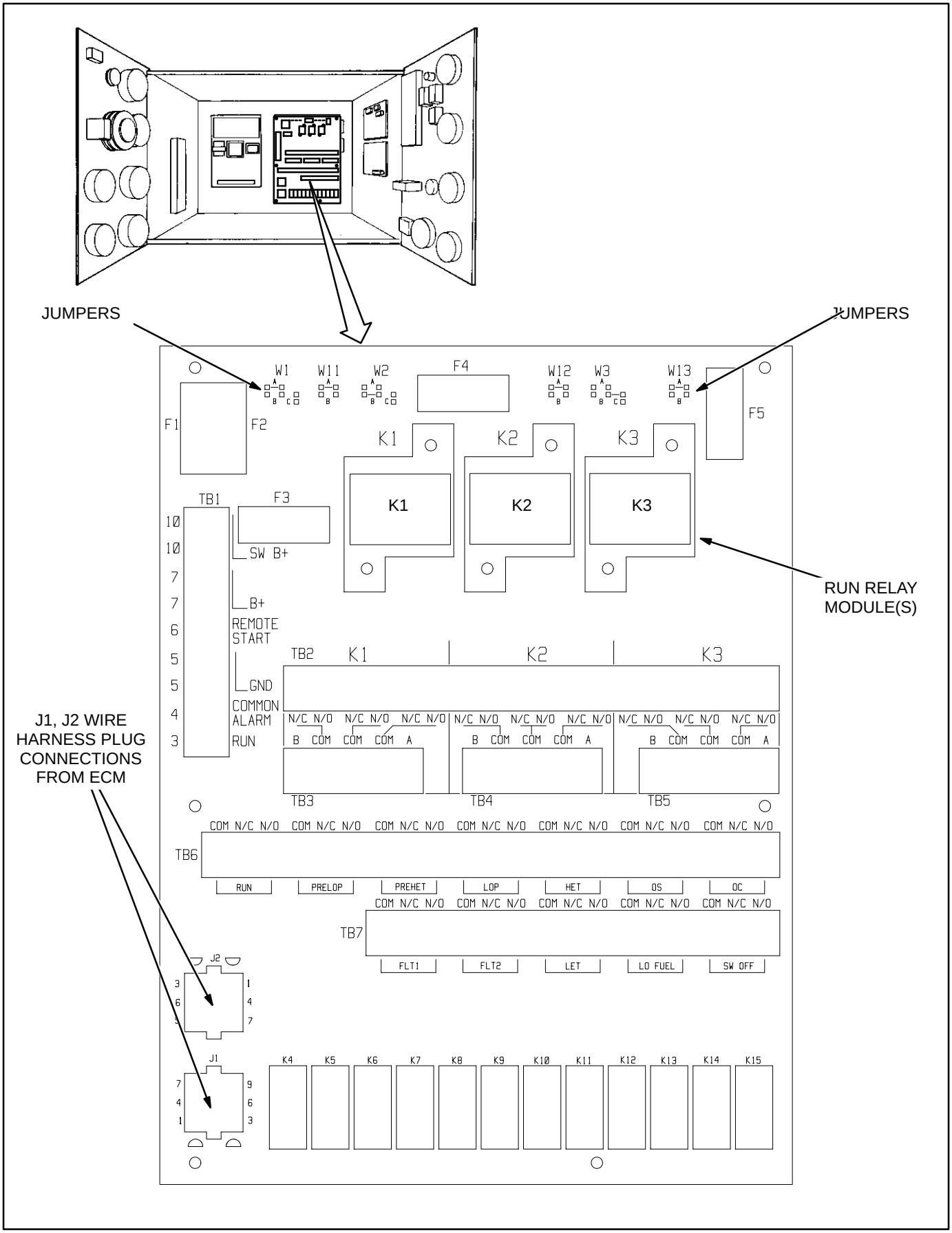


FIGURE 3-10. AUXILIARY RELAY BOARD

Time Delay Start / Stop Module (A15)

The set can be equipped with a module to delay starting and stopping when the start and stop signals are received from the remote controller. It is adjustable to delay starts from 1 to 15 seconds to prevent nuisance starts in installations where momentary power interruptions are frequent. It is adjustable to delay stops 1 to 30 minutes to allow time for the prime source of power to stabilize and the generator set to cool down.

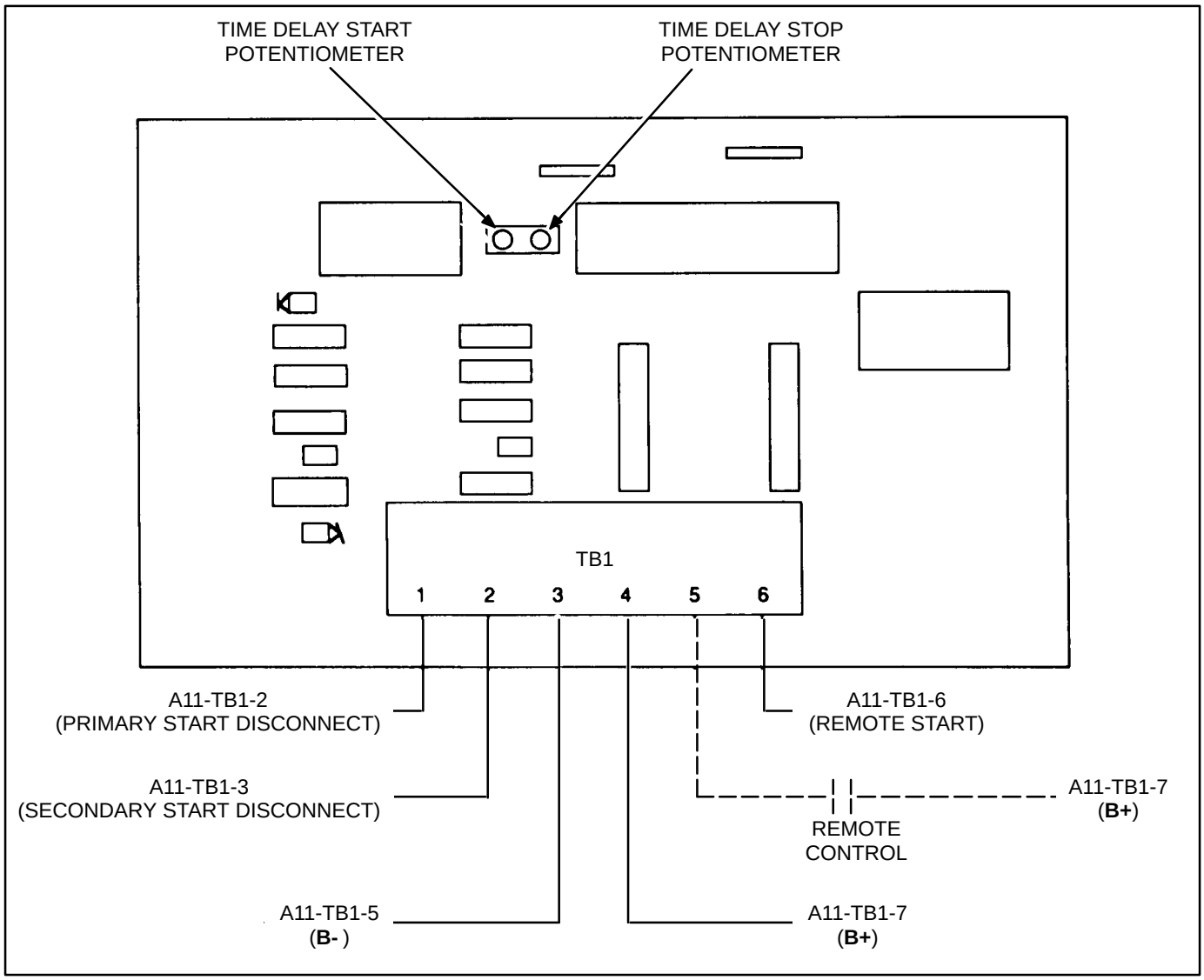


FIGURE 3-11. TIME DELAY START / STOP MODULE

SEQUENCE OF OPERATION

The sequence of operation is as follows. Refer to the schematic on Page 9-6 through 9-9.

1. The ECM is powered by cranking battery voltage (12 VDC). Terminal **TB1-9** is connected to battery positive (**+**) and connector **P1-6** to battery negative (**-**).
2. The starting cycle begins when relay **K7** is powered, either manually by pushing the panel **Run** switch, or automatically by a remote controller connected at terminal **TB1-6**. (The panel switch must be in the **Remote** position for remote, automatic operation.)
3. Relay **K7** powers relays **K2** and **K3**.
4. Relay **K2** powers the engine gauges and terminal **TB1-10**, to which the fuel solenoid is connected.
5. Relay **K3** powers terminal **TB1-8** to which either starter relay **K4** or B1-SW is connected. Engine cranking begins.
6. The engine starts and runs up to governed speed in a matter of seconds.
7. The starter is disconnected when engine speed gets to about 600 RPM. This is done by relay **K10** or **K14**, whichever acts first to open the circuit powering relay **K3**.
8. Relay **K10** is powered by the generator output voltage (120 VAC) through plug-in connectors **P1-1** and **P1-2**. The remote **Run** indicator lamp should light (connected through terminal **TB1-3)**.
9. Relay **K14** is powered by the engine-driven battery charging alternator (12 VDC) through plug-in connector **P1-3**. The panel **Run** indicator lamp should light. Relays **K10** and **K14** are redundant.

   If the starter disconnects normally but neither the panel nor the remote Run indicator lamps light, the AC (**K10**) starter disconnect circuit is not working.

   Both the remote and the panel Run indicator lamps will light even if the DC (**K14**) starter disconnect circuit is not working. Check the DC voltmeter to determine whether or not the battery charging alternator is working.
10. Relays **K2** and **K3** are deenergized (by latching relay **K6**) causing shutdown to occur if the engine does not start within 75 seconds. The **Overcrank** indicator lamp and switch **S11** lamp will light and common alarm terminal **TB1-4** is powered.

    The ECM has a cycle crank feature whereby the engine is cranked for three 15 second periods alternated with two 15 second rest periods.
11. Relay **K3** is de-energized (by latching relay **K6**) causing shutdown to occur during operation when a low oil pressure, high engine temperature or engine overspeed condition is sensed or the optional emergency stop button is pressed. The appropriate fault indicator lamp lights and common alarm terminal **TB1-4** is powered. (There is no fault lamp for emergency stop. The switch button will light, however, and the light in switch **S11**.)

    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. The 10 second time delay begins after K10 or K14 is energized.
12. To restore operation after a shutdown fault has been serviced, reset latching relay **K6** 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 a remote controller. (The panel switch must be in the **Remote** position for remote, automatic operation.)

THIS PAGE LEFT INTENTIONALLY BLANK

-

4. Engine Control (2-Wire Remote Control)

GENERAL

The 2-Wire Remote control box is mounted on top of the generator, facing the rear. Figure 4-1 shows the components on the engine control panel.

CONTROL PANEL COMPONENTS

Run/Stop/Remote Switch (S12) The switch is pushed to the **Run** position to start and run the generator set and the **Stop** position to stop the set. The **Remote** position allows a remote controller to automatically run the set. The switch must be in the **Stop** position when the common fault circuit breaker (described next) is used to restore generator set operation following a fault shutdown.

Common Fault Circuit Breaker The common fault circuit breaker shuts down the engine when any fault shutdown sensor functions. Fault shutdown is indicated when the breaker reset button extends out past normal. Push the button to restore operation (after the engine has been properly serviced). The **Run/Stop/Remote** switch must be in the **Stop** position before resetting the common fault circuit breaker.

The fault shutdowns are low oil pressure, high engine temperature, overcrank and overspeed. The optional fault shutdown available with the Dry Contacts Module is low coolant level.

20A Control Fuse Protects control components and wiring from current overload.

Hour Meter The hour meter indicates the accumulated number of hours the set has run. It cannot be reset.

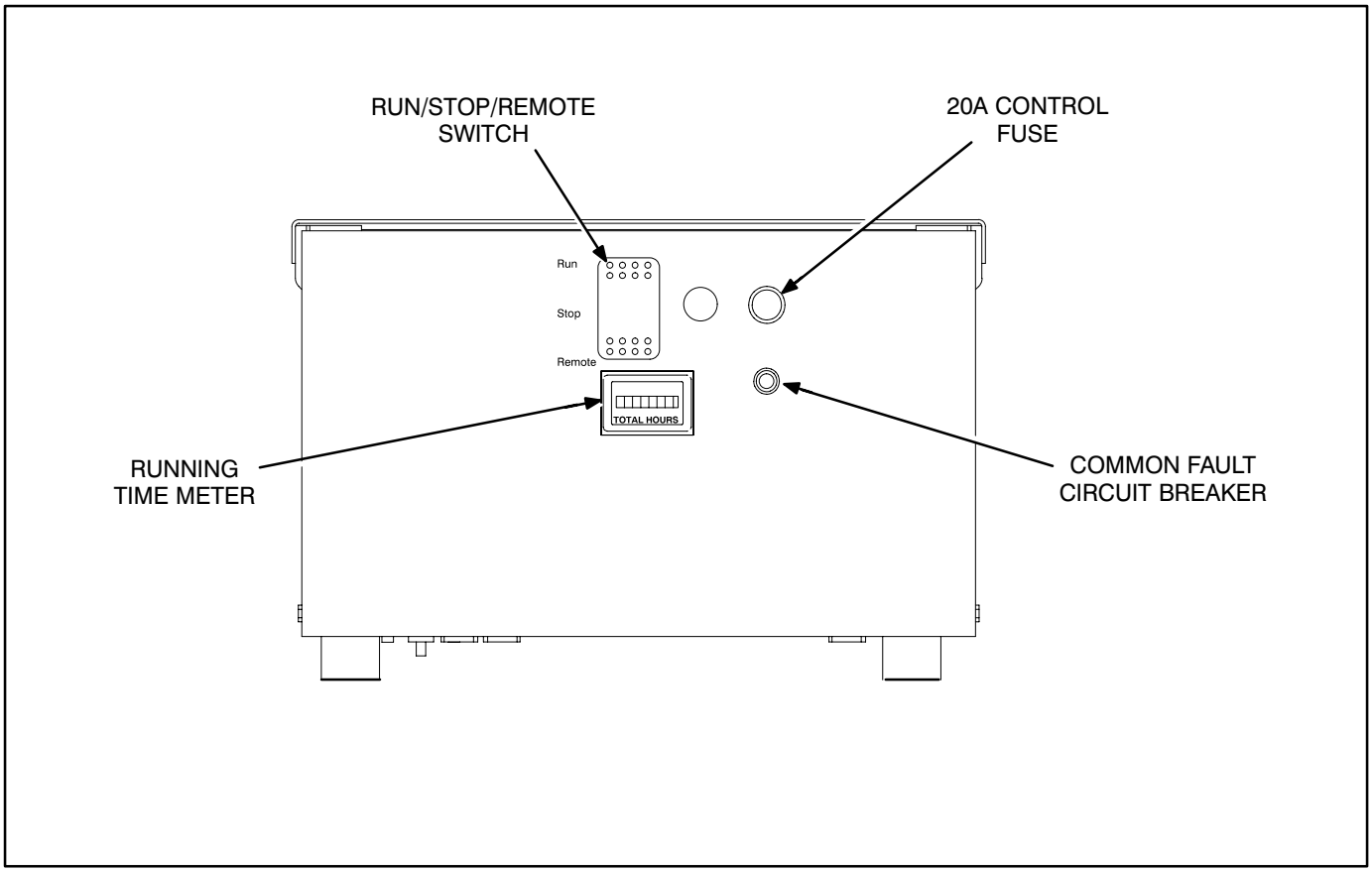


FIGURE 4-1. 2-WIRE REMOTE CONTROL PANEL

CONTROL BOX INTERIOR

Figure 4-2 shows the arrangement of components inside the control box, including the voltage regulator and some of the auxiliary components under the following headings. Refer to *Section 9* for control box *DC Wiring* diagram.

CONTROL RELAYS

A functional description of the control relays shown in Figure 4-2 is provided in the *Sequence of Operation* description at the end of this section.

TERMINAL BLOCK TB1

Terminal block TB1 provides connection points for remote starting and switched B+.

A remote switch can be connected to the remote terminal (TB1-4) and B+ (TB1-3).

Switched B+ auxiliary power is available when the generator set is running. When connecting customer accessories to the 12 volt B+ auxiliary terminals (TB1-5), do not allow the current to exceed 7 amps.

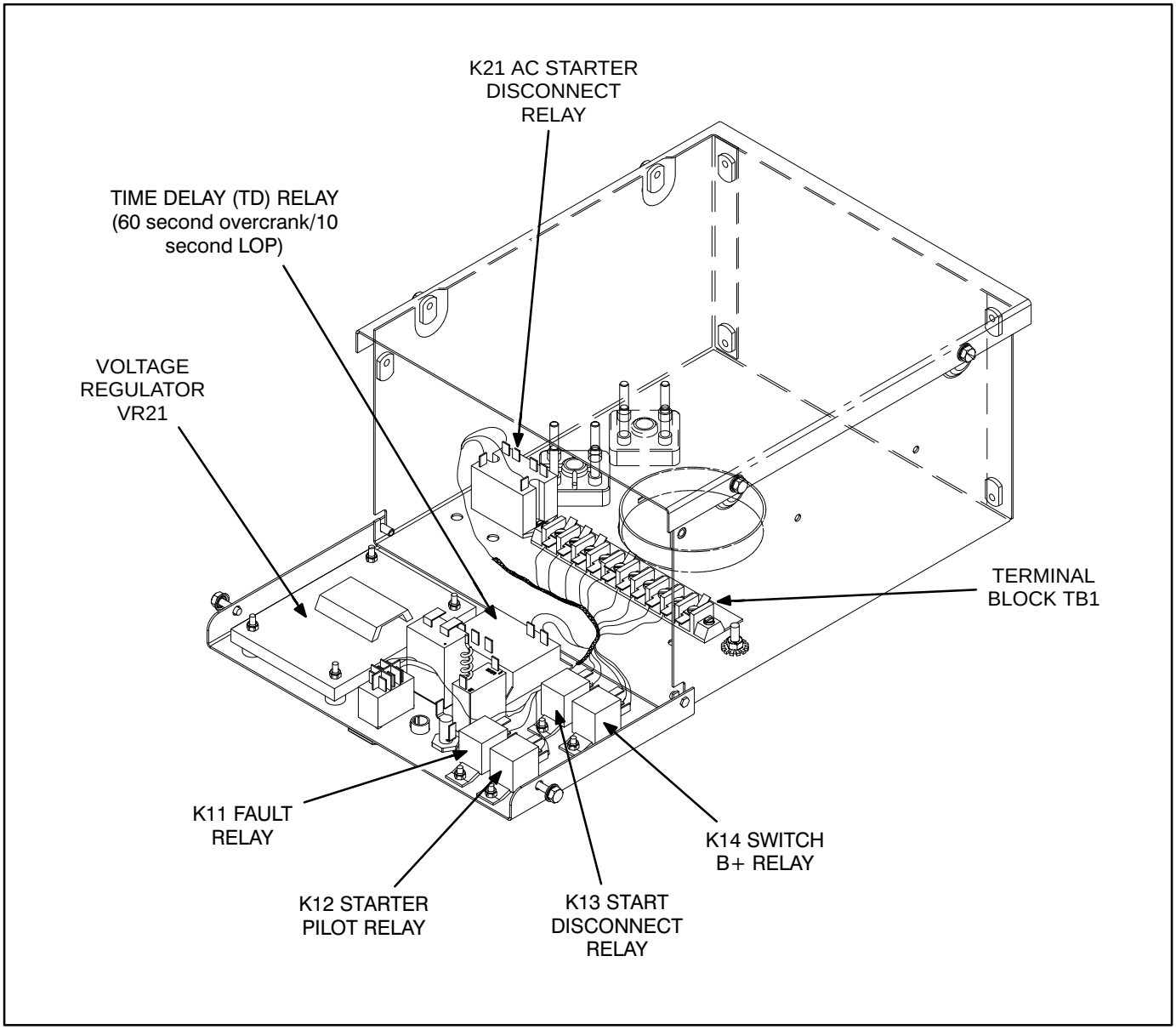


FIGURE 4-2. ARRANGEMENT OF COMPONENTS INSIDE THE CONTROL BOX

DRY CONTACT MODULE (Optional)

The dry contract module provides the capability of attaching a remote monitor device. Connections are made to the terminals of relays **K8** and **K9** located on the dry contact module (Figure 4-3). A detailed connection diagram for the dry contact module is provided in Section 9.

The relay contact ratings are:

CONTACT POSITION	12V COIL VOLTAGE		24V COIL VOLTAGE	
	N.O.	N.C.	N.O.	N.C.
Max carry/break	40 A	30 A	20 A	10 A
Max make	100 A	60 A	50 A	20 A

The following faults will activate relays **K8** or **K9** as follows:

RELAY K8	RELAY K9
Over Crank Low Oil Pressure High Engine Temperature Low Coolant Level Overspeed	Low Fuel Pressure

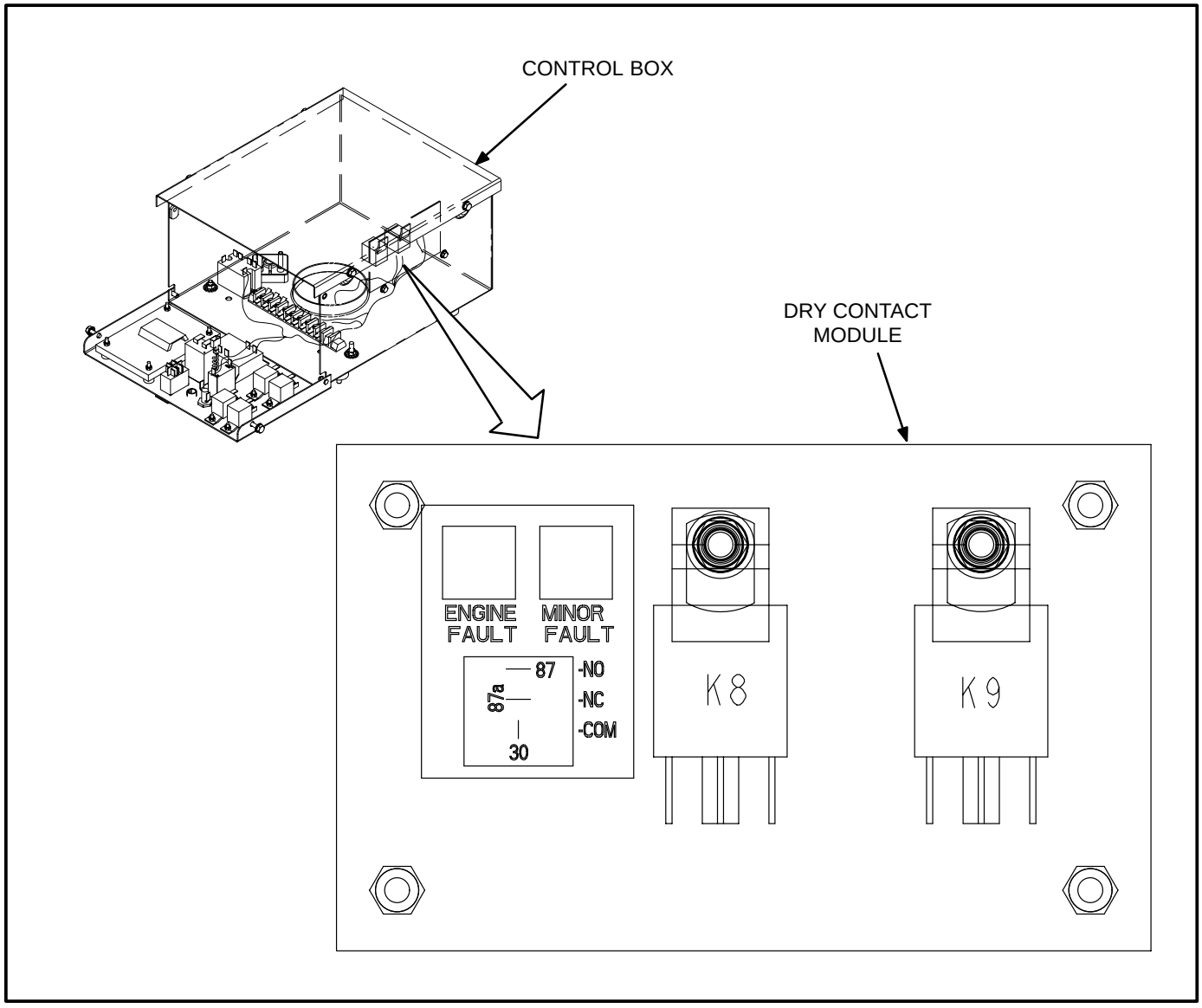


FIGURE 4-3. DRY CONTACT MODULE

ENGINE SENSORS/GAUGES

Figure 4-4 shows the locations of the the coolant temperature and oil pressure sensing switches to which the 2-Wire Remote control responds. The switches function by closing the fault circuit to the engine chassis ground (battery negative [-]).

The high coolant temperature switch is activated when coolant temperature reaches 230° F (110° C). The low oil pressure switch is activated when oil pressure is lower than 14 psi (97kPa).

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

The coolant temperature gauge and oil pressure gauge are optional.

⚠ CAUTION ***Teflon tape should not be used on switches and senders that are grounded to the engine by thread contact as it may interfere with the ground path.***

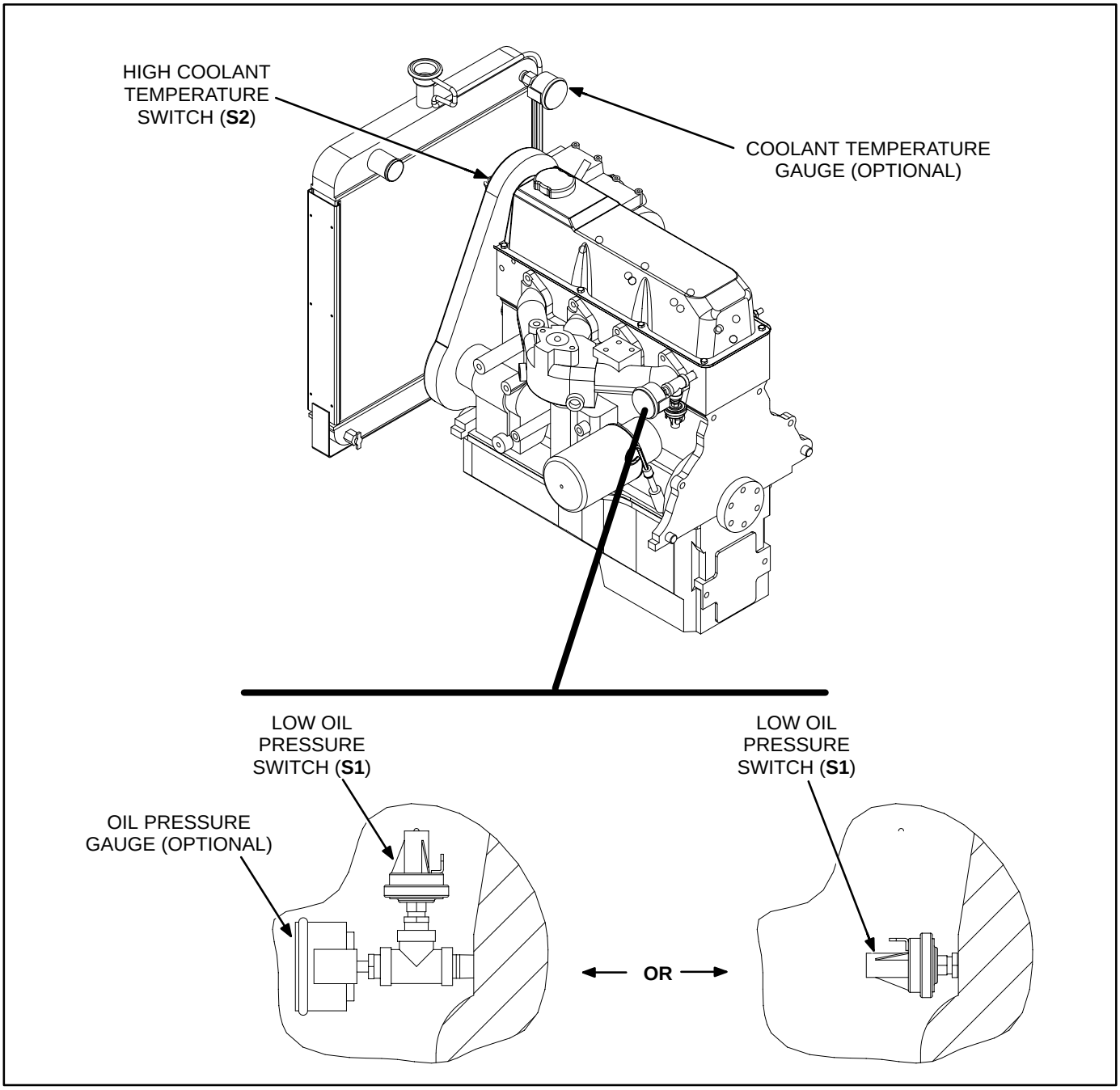


FIGURE 4-4. ENGINE SENSOR LOCATIONS

ELECTRONIC OVERSPEED/START DISCONNECT MODULE (STANDARD) (SPEC A & B)

The electronic overspeed/start disconnect module is mounted on the generator by two screws as shown by Figure 4-5. 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 2500 rpm. (For 60 Hertz sets, the green jumper is cut.) **For 50 Hertz sets, the green and orange jumpers are cut for overspeed shutdown at about 2100 rpm.** There are no other provisions for field adjustment.

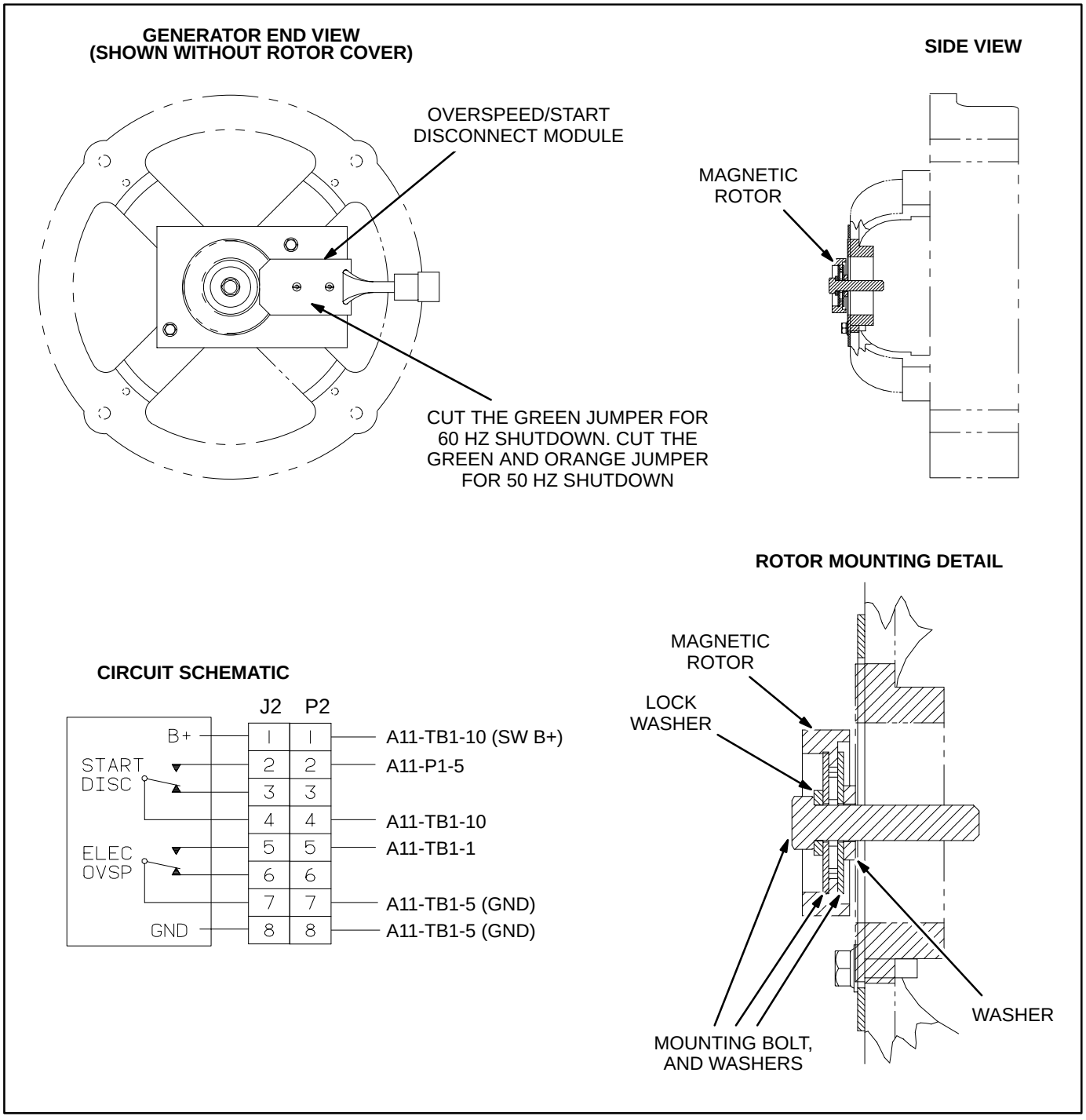


FIGURE 4-5. ELECTRONIC OVERSPEED/START DISCONNECT MODULE

SEQUENCE OF OPERATION

The sequence of operation is as follows. Refer to the schematic on Page 9-13.

1. Terminal **TB1-2** is powered by cranking battery voltage (12 VDC) through a 20 amp fuse and a shunt trip circuit breaker. Terminal **TB1-6** is connected to battery negative.
2. The starting cycle begins when relay **K12**, fuel solenoid valve **K1**, overcrank timer **TD-A** and battery charging alternator field **G1 ALT-1** are powered, either manually by pushing the panel **Run** switch, or automatically by a remote controller connected at terminal **TB1-3**. (The panel switch must be in the **Remote** position for remote, automatic operation.)
3. Relay **K12** powers the starter solenoid and engine cranking begins.
4. The engine starts and runs up to governed speed in a matter of seconds.
5. The starter is disconnected when engine speed gets to about 600 RPM. This is done by the Start Disconnect/Overspeed module energizing relay **K13**. As a backup, the Start Disconnect relay **K21** (connected to gen output) will also energize **K13**. **K13** opens the circuit powering relay **K12**, disengaging the starter.
6. Energizing **K13** de-energizes the 60 second overcrank timer and energizes the 10 second LOP delay timer. After 10 seconds, **TD-3** of the Time Delay Relay goes to ground and activates the LOP switch.
7. All engine shutdowns operate by closing to ground and energizing fault relay **K11**. When **K11** is energized, the shunt trip coil on fault breaker **CB** is energized, causing engine shutdown to occur.
8. To restore operation after a shutdown fault has been serviced, press the panel **Stop** switch and reset **CB**.
9. The set is stopped manually by pressing the panel **Stop** switch or automatically by a remote controller. (The panel switch must be in the **Remote** position for remote, automatic operation.)

5. Troubleshooting (Detector Control)

These troubleshooting charts are designed to help you diagnose generator set problems. To save time troubleshooting, read the entire manual ahead of time to understand the generator set. Go over the options and modifications and review what was done during the last service call. Look the generator set over for any obvious problems. 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 ***Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced persons who know about fuel, electrical and machinery hazards. Read the Safety Precautions page and carefully 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** to start the genset.
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** to start the genset.
3. 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.
4. Fuse **F1** (see Figure 3-4) on ECM has blown (no voltage [B+] at ECM **TB1-8**).	The wire between ECM **TB1-8** and starter pilot solenoid relay **K4 (**or the wires between **TB1-8** - **resistor/diode assembly** - **battery charging alternator, Spec A & B only)** 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). If fuse continues to blow, service or replace the starter, relay **K4**, or the resistor/diode assembly.
5. The wire between ECM **TB1-9** and starter terminal **BAT** is loose damaged or missing.	Check for battery voltage (12 VDC) between ECM **TB1-9** (B+) and the grounding stud (-) on the floor of the control cabinet. Check, clean and tighten the connectors at both ends and replace the wire if it is damaged.

THE ENGINE DOES NOT CRANK IN RUN MODE (CONT.)	
⚠ WARNING ***Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced persons who know about fuel, electrical and machinery hazards. Read the Safety Precautions page and carefully observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
6. The grounding strap between the control box and the battery negative (-) terminal or the ground wire between the control and engine ground is loose, damaged or missing.	Check for continuity (zero ohms) between the grounding stud on the bottom of the control box and the battery negative (-) terminal. If there is no continuity or the grounding strap is loose or damaged, repair as necessary.
7. The **Run-Stop-Remote** switch (S12) or wiring is faulty.	a. Disconnect pin connector **J4** from the ECM 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. b. If the switch works, check for electrical continuity (zero ohms) between **J4-6** and **J4-7** on the wire harness when the switch is in the **Run** position and between **J4-5** and **J4-7** when the switch is in the **Remote** position. Repair the wire harness if there is no electrical continuity in either position of the switch.
8. The **starter motor** or **solenoid** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (B+) at starter solenoid terminal **SW**. Replace the starter motor if there is voltage but the motor does not function.
9. The **Time Delay Start/Stop Module (A15)** is malfunctioning.	Check for constant B+ at A15 terminal **TB1-4**. Check for run signal at ECM **TB1-6**. Voltage at A15 **TB1-6** should be at B+ at the end of the start delay period. Check wiring and connections from A15 **TB1-6** to ECM **TB1-6**.
10. ECM is faulty. (Check fuses **F1** and **F4** and for B+ at **TB1-9** again.)	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (12 VDC) at ECM **TB1-8**. Replace ECM if there is no voltage at ECM **TB1-8** but 12 VDC at ECM **TB1-9**.

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 trained and experienced 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.)	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 auxiliary relay board **A28-TB1-6**) because fuse **F3** on the ECM 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. See *Section 9* for remote connections.
5. There is no remote circuit signal (12 VDC at auxiliary relay board **A28-TB1-6**) because the remote circuit is not functioning properly.	Apply 12 VDC to **A28-TB1-6**. If the engine cranks, find and repair the fault in the remote control circuit. See *Section 9* for remote connections.
6. Auxiliary relay board **A28** is not functioning properly.	Check for misconnections (see *Section 9*) or loose connections and replace auxiliary relay board **A28** if there is 12 VDC at terminal **A28-TB1-6** but not at **A28-J2-6**.
7. Same as Steps 3 through 11 in the **RUN** mode.	See steps 3 through 11 in the preceding **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 trained and experienced 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 fuel shutoff valve. b. Fill the propane supply tank. c. For natural gas fueled sets, check with the gas utility. d. Check fuel pressure at regulator (refer to *Fuel Pressure* in *Section 8*.) (High fuel pressure will prevent solenoid from opening.) e. Check fuel solenoid (VDC present at K1+ lead during cranking). **Duel Fuel Sets Only:** f. Check relay K99. *Refer to wiring diagrams in Section 9*. g. Check pressure switch wiring. Propane - normally closed connected to common. Natural gas - normally open connected to common. h. Check pressure switch function (@ 3.5 inch H_2O or less, should switch from natural gas to LPG). i. Check **S14** vacuum switch (optional) for proper operation.
2. The air cleaner is blocked.	Service as necessary.
3. Fuse **F2** on the ECM has blown.	Replace fuse with one of the same type and amp rating. If fuse **F2** blows again, the wire between ECM **TB1-10** and engine block terminal **T26**, or a wire between terminal **T26** and an accessory may be loose or shorting to ground.
4. Fuel solenoid **K1** does not energize.	a. Fuel solenoid not energized by the ECM. Check for B+ at ECM **TB1-10** when cranking. If no voltage present and fuse **F2** is good replace ECM. b. Connect B+ to fuel solenoid (K1) terminal **BAT**. Replace the fuel solenoid if it does not “click” when energized. If fuel solenoid is working, check for blocked fuel line or fuel filter.
5. Low engine temperature is causing too low a cranking speed for starting.	a. Increase room temperature. b. Plug in, repair or install engine coolant heater. c. Replace the engine oil if it is not of the recommended viscosity for the ambient temperature.

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 trained and experienced 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**
6. 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.
7. Governor inoperable. See *Section 8*.	Replace governor.
8. The magnetic speed pick-up is defective or requires adjustment.	Refer to *Magnetic Speed Pickup Unit Adjustment* in Section 8.
9. Incorrect main fuel valve adjustment.	Refer to *Gaseous Fuel Adjustment* in Section 8.
10. **(Spec A & B)** The engine ignition system is malfunctioning (ignition coil pack, ignition magnetic pickup, spark plugs and high tension spark plug/coil cables.	Service as necessary. Refer to wiring diagrams in *Section 9*.
11. **(Begin Spec C)** The engine ignition system is malfunctioning (ignition coil pack, ignition control module, spark plugs, high tension spark plug/coil cables and crank position sensor.	a. Fuse (10 amp) in Ford ignition module harness is open (**Begin Spec D**). Refer to wiring diagrams in *Section 9*. b. Check ground circuit to ignition module. Remove connector from ignition module to check. c. Check for battery VDC (T26) at coil while cranking. (Red wire with green stripe.) d. Check crank position sensor (315 to 385 ohms). e. Check ignition coil primary (0.5 to 1.3 ohms). Check both primary coils by removing connector from coil and measuring between the center pin (battery VDC) and both outer pins. f. Replace ignition module if above items are OK.

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 trained and experienced 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 and the engine shuts down.	a. Reset the ECM by pushing the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset** and restart the set, monitoring engine speed. **Spec A & B**: Readjust the cutout speed if it is lower than specified. Replace the overspeed switch if it cannot be readjusted (see *Section 3*). **Begin Spec C**: If engine speed is correct and the set still shuts down, replace the ignition control module. b. Adjust the governor (see *Section 8*). c. 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. d. 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 1.5 VAC. (Intermittent open on magnetic speed pick-up lead can also cause an overspeed condition.) e. Replace the governor controller if the set still shuts down due to overspeed.
2. **(Spec C)** The **OVERSPEED** lamp comes on and the engine shuts down **within 1 to 5 seconds** (no overspeed condition detected).	a. Remove **K5-87** lead from **K5** and check lead continuity to ground. If ground present, replace ignition module. b. Connect **K5-87**. Remove lead **K5-30** and check lead continuity to ground. If ground present, replace K5 relay. c. Remove **K5-30** lead from **K5** and start genset. If set shuts down and **OVERSPEED** lamp comes on, replace ECM (A11).
3. **(Begin Spec D)** The **OVERSPEED** lamp comes on and the engine shuts down **within 1 to 5 seconds** (no overspeed condition detected).	a. Remove connector **J2** of the ECM (A11) board and check pin **J2-6** continuity to ground. If ground present, repair defective lead. If lead OK, replace ignition module. (Before replacing ignition module, make sure oil pressure lead #15 from ignition module is not touching ground. This lead is not used and should be open.) b. If ground signal is not present in above step, which indicates ignition module/circuit OK, replace ECM (A11).

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 trained and experienced 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**
4. The **LO OIL PRES** lamp comes on and the engine shuts down **within 10 to 15** seconds (Overspeed lamp is off).	a. Check the engine oil level, repair any oil leaks and fill to the proper level. Then reset the ECM 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, restart the set 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 14 psi (97 kPa). c. If engine oil pressure is proven to be correct and the set still shuts down due to low oil pressure, replace oil pressure sender if the voltage across sensor terminals is greater than 3.1 VDC. See *Section 3* to locate the sender. d. Defective Sensor (A27) board. Remove plug from A27 and start set. If set continues to run, replace A27. Refer to *Section 3* for A27 board connections. e. Check **S14** vacuum switch (optional) for proper operation.
5. The **LO OIL PRES** lamp comes on and the engine shuts down **after 1 or more minutes** (Overspeed lamp is off).	a. See step 3 in this table. b. See steps 1 and 8 in table **Engine Cranks But Does Not Start**.

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 trained and experienced 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**
6. The **HI ENG TEMP** lamp comes on and the engine shuts down.	a. Check the engine coolant level, repair any coolant leaks and refill as necessary. Then reset the ECM 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 coolant temperature exceeds 230° F (110° C), clean and service the entire cooling system as required to restore full cooling capacity. c. If shutdown occurs before the coolant reaches 230° F (110° C), replace temperature sender if the voltage across the sender terminals is less than 1.1 VDC. See *Section 3* to locate the temperature sender. d. Defective Sensor board. Refer to *Section 3* for Sensor board connections. e. Defective engine thermostat. Service the engine according to the engine service manual.
7. The **FAULT 1** or **FAULT 2** lamp comes on and the engine shuts down.	Service as required. (The customer has supplied the system fault indication switches. Either fault can be chosen to display the warning only. See *Section 3*.) If the shutdown was due to low frequency, the set probably ran out of fuel or the governor is out of adjustment. If the shutdown was due to over/under voltage, the voltage regulator may be out of adjustment.

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 trained and experienced 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. Current ambient conditions cause a derate, limiting power to less than rated power.	Determine proper derates for ambient conditions. Refer to specification sheet for site derating factors.
2. The engine air filter element is dirty.	Replace the air filter element.
3. The gaseous fuel is of insufficient energy content.	Check with the propane supplier or the gas utility to confirm the energy content of the gaseous fuel being used. Propane must have approximately 2500 BTU's per cubic foot and natural gas 1000 BTU's per cubic foot.
4. LPG liquid converter frosts.	a. Low coolant. Fill cooling system. b. Air in cooling system. Bleed cooling system.
5. The governor/linkage or gas mixer adjustments are incorrect.	a. Make gas mixer or governor settings and adjustments according to *Section 8, Governor.* b. Check the magnetic speed pick-up unit (MPU) clearance with flywheel. Replace the MPU if output voltage at cranking speed is less than 1.5 VAC. c. 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. d. Replace the governor controller if it still cannot be adjusted for full power or stable speed.
6. Engine misfires on LPG or NG or backfires on LPG at high loads	a. Air fuel ratio too lean. Adjust main fuel valve. Refer to *Gaseous Fuel Adjustment* in *Section 8*. b. Inspect spark plugs/gap (0.044"). c. Check spark plug wires (6,000 ohms/foot). d. Check ignition coil primary (0.5 to 1.3 ohms). e. LPG liquid withdrawal - defective LPL converter.
7. Engine has preignition on LPG at high loads.	a. Check ignition timing, refer to *Section 8*.

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 trained and experienced 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**
8. Gaseous fuel delivery (vapor withdrawal) to the set is inadequate or fuel pressure is to high at light loads.	Check the gas supply pressure at the regulator input. Make necessary provisions so that gas supply pressure is at least 7 inches (178 mm) Water Column (WC) when the set is under full load, and not more than 13.6 inches (345 mm) WC.
9. **(Begin Spec D)** Manifold absolute pressure sensor (MAP) is not functioning properly..	Check between pins **A** and **C** of sensor plug for 5 VDC. If present, sensor may be defective. Low reading or not present, defective harness or ignition control module.
10. 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 trained and experienced 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.	a. Shut down the set if possible or disconnect non-critical loads. Pre low oil pressure will be less than 20 psi (138 kPa) but greater than 14 psi (97 kPa). Service the engine lubricating system according to the engine service manual. b. If engine oil pressure is proven to be correct and the pre lo oil pressure lamp is on, the problem may be the Sensor board or the oil pressure sender. Refer to *Section 3* for Sensor board connections.
2. The **PRE HI ENG TEMP** lamp comes on while the engine is running.	a. Shut down the set if possible or disconnect non-critical loads. Engine temperature will be greater than 220° F (104° C) but less than 230° F (110° C). Service the engine cooling system to restore full cooling capacity. b. If the engine cooling system is functioning properly the Sensor board may be defective. Refer to *Section 3* for Sensor board connections.
3. The **LOW ENGINE TEMPERATURE** lamp comes on while the set is in standby. Warning occurs when engine coolant temperature is 65° F (18° C). **Note: In applications where the ambient temperature falls below 40° F (4° C) low engine temp may be indicated even though the coolant heaters are operating.**	a. Plug in, repair or install engine coolant heater. b. If engine coolant heater is operating properly the Sensor board may be defective. Refer to *Section 3* for Sensor board connections.

AN AMBER WARNING LAMP IS ON (CONT.)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced 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**
4. The **LOW FUEL** lamp (optional) comes on while the set is in standby or the engine is running.	a. Indicates fuel supply pressure is 5 inches (127 mm) WC or less for dual or single fuel systems. With dual fuel system, also indicates that genset is operating on secondary fuel supply. Fill the propane supply tank or for natural gas fueled sets, check with the gas utility. **Dual Fuel Systems:** b. Check operation/wiring of fuel pressure switch (S11). c. Check operation/wiring of K99 relay.
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 *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 trained and experienced 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. The remote **RUN** lamp does light (AC start disconnect is okay).	a. Press the panel **Lamp Test** switch and replace the run lamp bulb if it does not light. b. If the **RUN** lamp, wiring connections and battery charging alternator are all good and the **RUN** lamp does not light, replace the ECM.
2. Both the remote and set mounted **RUN** lamps do 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. 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 the ECM if there is 120 VAC across pin connectors **P1-1** and **P1-2** but neither **RUN** lamp lights during normal operation.

THIS PAGE LEFT INTENTIONALLY BLANK

6. Troubleshooting (2-Wire Remote Control)

These troubleshooting charts are designed to help you diagnose generator set problems. To save time troubleshooting, read the entire manual ahead of time to understand the generator set. Go over the options and modifications and review what was done during the last service call. Look the generator set over for any obvious problems. 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 ***Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced persons who know about fuel, electrical and machinery hazards. Read the Safety Precautions page and carefully observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The common fault circuit breaker has tripped.	Service the set as necessary. To reset the engine control, push the **Run-Stop-Remote** switch to **Stop** and reset the common fault circuit breaker. Then push the **Run-Stop-Remote** switch to **Run**.
2. 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 (12 to 14 VDC) is not obtained.
3. Fuse **F1** on the front of the control panel is blown.	Check for a loose or chaffed wire shorting to ground. Make sure auxiliary loads (louvers, etc.) connected to the control circuitry do not exceed 7 amps.
4. The **starter motor** or **solenoid** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for battery voltage (B+) at starter solenoid terminal **SW**. Replace the starter motor if there is 12 volts present but the motor does not function.
5. The **Run-Stop-Remote (S12)** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for 12 volts at **S12-2**. If voltage is not present replace **S12**.
6. Relay **K21** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Stop** and check for open circuit between **K21-1** and **K21-2**. If continuity, replace **K21**.

THE ENGINE DOES NOT CRANK IN RUN MODE (CONT.)	
⚠ WARNING ***Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced persons who know about fuel, electrical and machinery hazards. Read the Safety Precautions page and carefully observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
7. Relay **K13** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for 12 volts at **K13-87A** . If voltage not present replace **K13**.
8. Relay **K12** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for 12 volts at **K12-86** and **K12-30**. If voltage not present replace **K12**.
9. Relay **K14** is malfunctioning.	Push the **Run-Stop-Remote** switch to **Run** and check for 12 volts at **K14-87** . If voltage not present replace **K14**.

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 trained and experienced 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**.	Push the **Run-Stop-Remote** switch to **Remote.**
2. There is no remote circuit signal being received.	Check for 12 volts at **TB1-3** and **S12-2**. Replace components or wiring as necessary.
3. Same as Steps 1 through 8 in the **RUN** mode.	See steps 1 through 8 in the preceding **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 trained and experienced 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 fuel shutoff valve. b. Fill the propane supply tank. c. For natural gas fueled sets, check with the gas utility. d. Check fuel pressure at regulator (refer to *Fuel Pressure* in *Section 8*.) (High fuel pressure will prevent solenoid from opening.) e. Check fuel solenoid (VDC present at K1+ lead during cranking). **Duel Fuel Sets Only:** f. Check relay K99. *Refer to wiring diagrams in Section 9*. g. Check pressure switch wiring. Propane - normally closed connected to common. Natural gas - normally open connected to common. h. Check pressure switch function (@ 3.5 inch H_2O or less, should switch from natural gas to LPG). i. Check **S14** vacuum switch (optional) for proper operation.
2. The air cleaner is blocked.	Service as necessary.
3. Fuel solenoid **K1** does not energize.	Connect B+ to fuel solenoid (K1) terminal **BAT**. Replace the fuel solenoid if does not “click” when energized. If fuel solenoid is working, check for blocked fuel line or fuel filter.
4. Low engine temperature is causing too low a cranking speed for starting.	a. Increase room temperature. b. Plug in, repair or install engine coolant heater. c. Replace the engine oil if it is not of the recommended viscosity for the ambient temperature.
5. 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.

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 trained and experienced 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**
6. Governor inoperable. See *Section 8*.	Replace governor.
7. The magnetic speed pick-up is defective or requires adjustment.	Refer to *Magnetic Speed Pickup Unit Adjustment* in *Section 8*.
8. Incorrect main fuel valve adjustment.	Refer to *Gaseous Fuel Adjustment* in *Section 8*.
9. **(Spec A & B)** The engine ignition system is malfunctioning (ignition coil pack, ignition magnetic pickup, spark plugs and high tension spark plug/coil cables.	Service as necessary. Refer to wiring diagrams in *Section 9*.
10. **(Begin Spec C)** The engine ignition system is malfunctioning (ignition coil pack, ignition control module, spark plugs, high tension spark plug/coil cables and crank position sensor.	a. Fuse (10 amp) in Ford ignition module harness is open (**Begin Spec D**). Refer to wiring diagrams in *Section 9*. b. Check ground circuit to ignition module. Remove connector from ignition module to check. c. Check for battery VDC (T26) at coil while cranking. (Red wire with green stripe.) d. Check crank position sensor (315 to 385 ohms). e. Check ignition coil primary (0.5 to 1.3 ohms). Check both primary coils by removing connector from coil and measuring between the center pin (battery VDC) and both outer pins. f. Replace ignition module if above items are OK.

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 trained and experienced 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. An **OVERSPEED** condition has caused the engine to shut down.	a. **(Spec A & B):**If this is a 60 Hertz set, check to see if the orange jumper on the overspeed module has been cut (see Figure 4-5). If it has, replace the module. (Cutting the orange jumper lowers the cutout point for 50 Hertz units.) b. Reset the ECM by pushing the **Run-Stop-Remote** switch to **Stop** and the **Reset** switch to **Reset** and restart the set, monitoring engine speed. c. **(Begin Spec C):** If engine speed is correct and the set still shuts down, replace the ignition control module. d. Adjust the governor (see *Section 8*). e. 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. f. 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 1.5 VAC. (Intermittent open on magnetic speed pick-up lead can also cause an overspeed condition.) g. Replace the governor controller if the set still shuts down due to overspeed.
2. A **LO OIL PRES** has caused the engine to shut down.	a. Check the engine oil level, repair any oil leaks and fill to the proper level. Then reset the engine control by pushing the **Run-Stop-Remote** switch to **Stop** and resetting the common fault circuit breaker. b. If the set still shuts down due to low oil pressure, restart the set 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 14 psi (97kPa). c. If engine oil pressure is proven to be correct and the set still shuts down due to low oil pressure, replace the low oil pressure cutout switch. See *Section 4* to locate the switch. d. Check **S14** vacuum switch (optional) for proper operation.

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 trained and experienced 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. A **HI ENG TEMP** has caused the engine to shut down.	a. Check the engine coolant level, repair any coolant leaks and refill as necessary. Then reset the engine control by pushing the **Run-Stop-Remote** switch to **Stop** and resetting the common fault circuit breaker. 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 230° F (110° C), replace the high engine temperature cutout switch. If coolant temperature exceeds 230° F (110° C), clean and service the entire cooling system as required to restore full cooling capacity. See *Section 4* to locate the switch. c. Defective engine thermostat. Service the engine according to the engine service manual.
4. A **LO COOLANT** (level) has caused the engine to shut down.	Check the engine coolant level, repair any coolant leaks and refill as necessary. Then reset the engine control by pushing the **Run-Stop-Remote** switch to **Stop** and resetting the common fault circuit breaker.
5. Engine shuts down within 1 to 5 seconds.	a. Check **S7** low coolant level switch (optional) for proper operation. b. Remove lead **P8-B** from **TB1-9** and check lead continuity to ground. If ground present, repair defective lead. If lead OK, replace ignition module. (**Begin Spec D -** Before replacing ignition module, make sure oil pressure lead #15 from ignition module is not touching ground. This lead is not used and should be open.) c. Check continuity from TD 3 to ground. If present, replace Time Delay.
6. Engine shuts down due to any of the four faults but no signal is supplied to remote monitor device from Dry Contact Module (DCM).	a. Check Engine Relay (**K8**) function on DCM. b. Check fault breaker auxiliary contacts (**CB1/B**) for continuity. c. Check wiring from Engine Relay (**K8**) to remote monitor device.

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 trained and experienced 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.. Current ambient conditions cause a derate, limiting power to less than rated power.	Determine proper derates for ambient conditions. Refer to specification sheet for site derating factors.
2. The engine air filter element is dirty.	Replace the air filter element.
3. The gaseous fuel is of insufficient energy content.	Check with the propane supplier or the gas utility to confirm the energy content of the gaseous fuel being used. Propane must have approximately 2500 BTU's per cubic foot and natural gas 1000 BTU's per cubic foot.
4.. LPG liquid converter frosts.	a. Low coolant. Fill cooling system. b. Air in cooling system. Bleed cooling system.
5. The governor/linkage or gas mixer adjustments are incorrect.	a. Make gas mixer or governor settings and adjustments according to *Section 8, Governor.* b. Check the magnetic speed pick-up unit (MPU) clearance with flywheel. Replace the MPU if output voltage at cranking speed is less than 1.5 VAC. c. 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. d. Replace the governor controller if it still cannot be adjusted for full power or stable speed.
6.. Engine misfires on LPG or NG or backfires on LPG at high loads	a. Air fuel ratio too lean. Adjust main fuel valve. Refer to *Gaseous Fuel Adjustment* in Section 8. b. Inspect spark plugs/gap (0.044"). c. Check spark plug wires (6,000 ohms/foot). d. Check ignition coil primary (0.5 to 1.3 ohms). e. LPG liquid withdrawal - defective LPL converter.
7.. Engine has preignition on LPG at high loads.	a. Check ignition timing, refer to *Section 8*.

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 trained and experienced 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**
8. Gaseous fuel delivery (vapor withdrawal) to the set is inadequate or fuel pressure is to high at light loads.	Check the gas supply pressure at the regulator input. Make necessary provisions so that gas supply pressure is at least 7 inches (178 mm) Water Column (WC) when the set is under full load, and not more than 13.6 inches (345 mm) WC.
9. **(Begin Spec D)** Manifold absolute pressure sensor (MAP) is not functioning properly..	Check between pins **A** and **C** of sensor plug for 5 VDC. If present, sensor may be defective. Low reading or not present, defective harness or ignition control module.
10. The engine is worn.	Service the engine according to the engine service manual.

THIS PAGE LEFT INTENTIONALLY BLANK

7. Servicing the 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.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.***

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.

⚠CAUTION ***Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.***

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.***

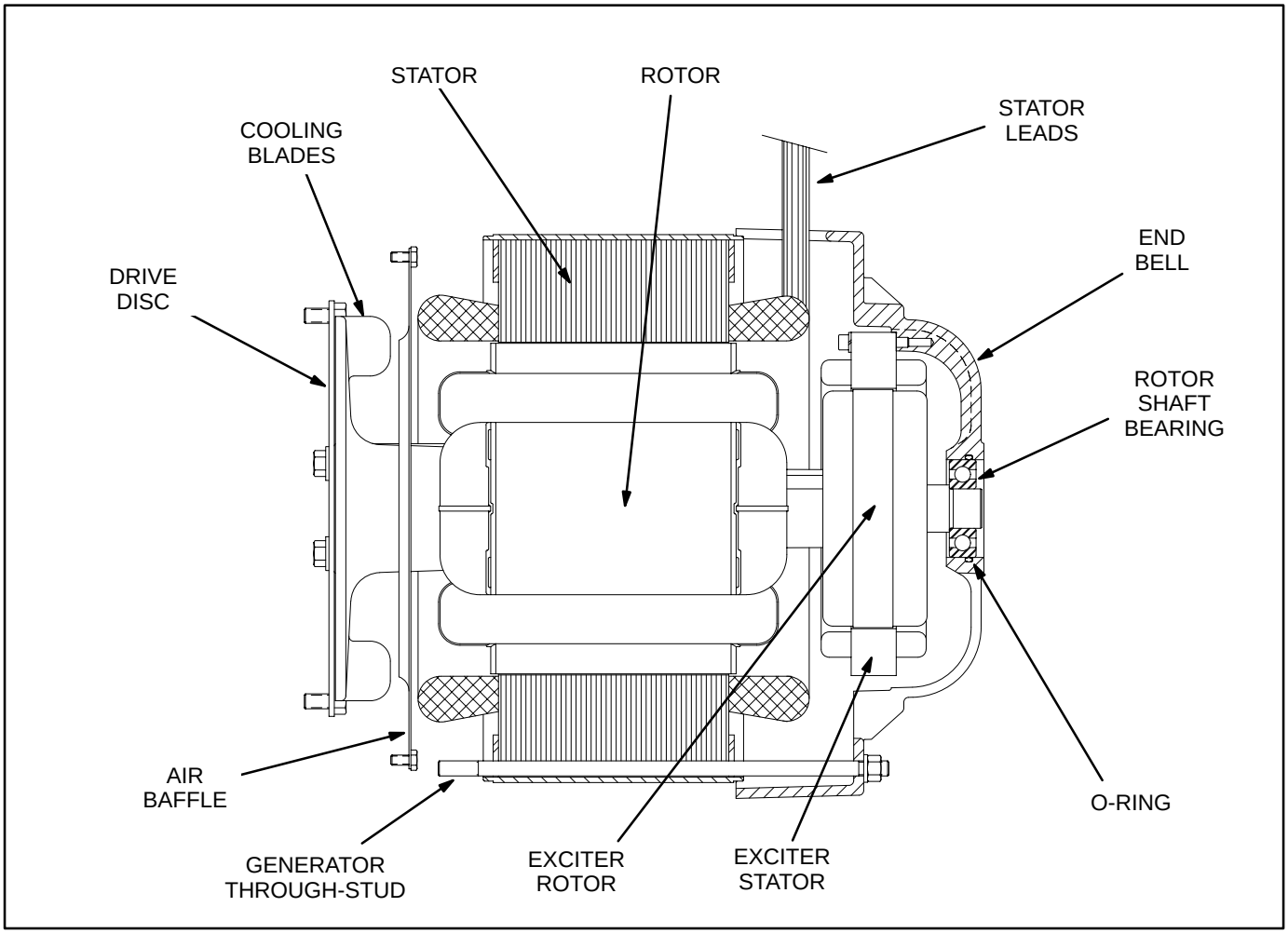


FIGURE 7-1. GENERATOR

Testing Winding Insulation Resistance

A 500 VAC megger is recommended for the winding insulation resistance tests prescribed below. A test consists of applying the test potential between the winding and ground (winding laminations) for a period of 10 minutes and recording resistance at 1 minute and again at 10 minutes.

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.

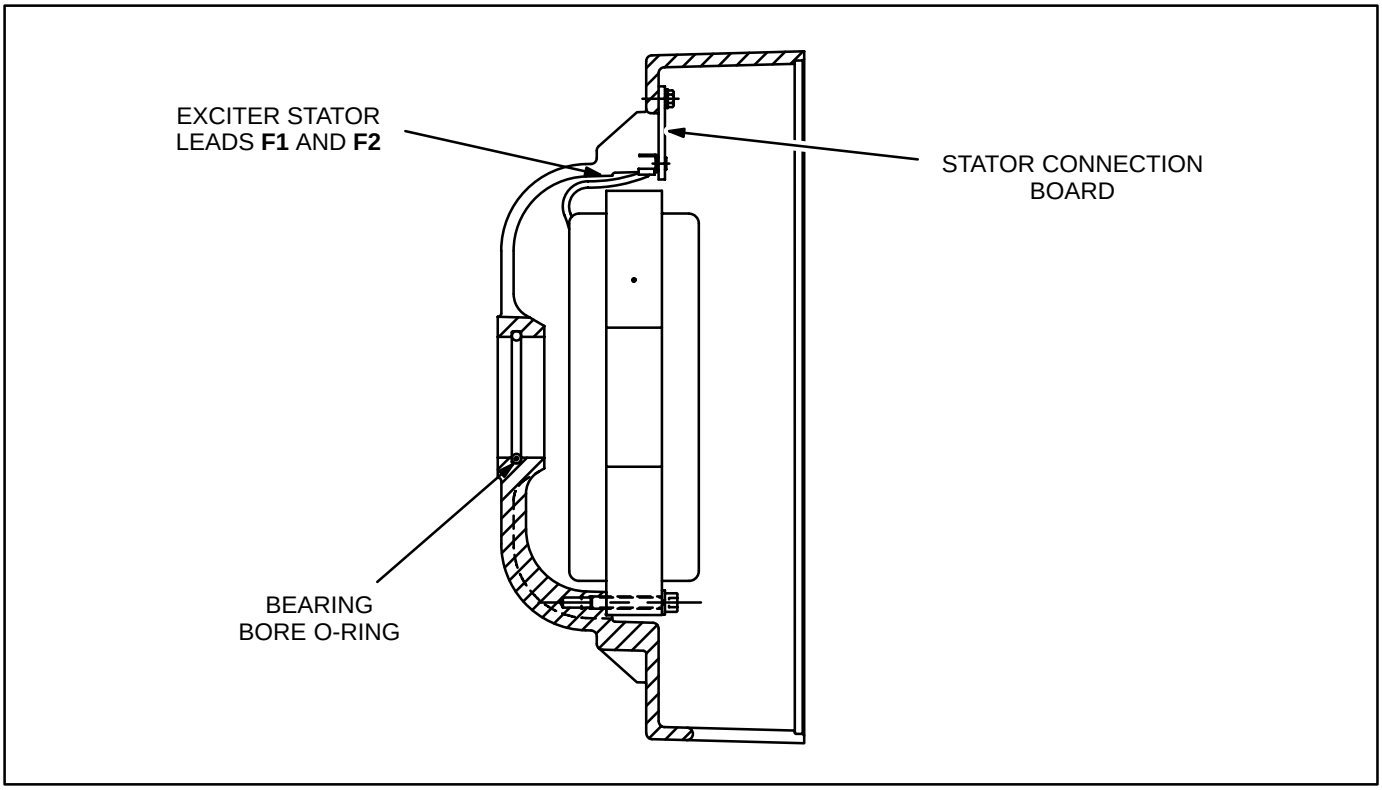
If low readings are obtained or the set has been in standby for a long time in high humidity conditions, the windings should be dried out and the test repeated. Use the generator standby heaters (if so equipped) or blow warm air through the generator with a fan. A more effective way is to use a bolted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

1. Bolt the two (three) phases of the generator together at the terminals. See the reconnection drawing.
2. Disconnect the **F1** and **F2** leads at the voltage regulator and connect them to a variable 12 VDC source. See Figure 2-2 or 2-3.
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 the stator or rotor if its winding resistance is less than specified.

Exciter Stator

Winding Insulation Resistance: Disconnect exciter stator leads **F1** and **F2** from the stator connection board, isolate them from ground, connect either one to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

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.



7-2. EXCITER STATOR AND END BELL

Exciter Rotor and Rotating Rectifiers

Winding Insulation Resistance: Disconnect all six exciter rotor leads from diode terminals **CR1** through **CR6** and isolate them from ground. Connect any lead to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

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 0.49 to 0.59 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).

Diode Resistance: 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 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 lb-in (2.6 N-m).

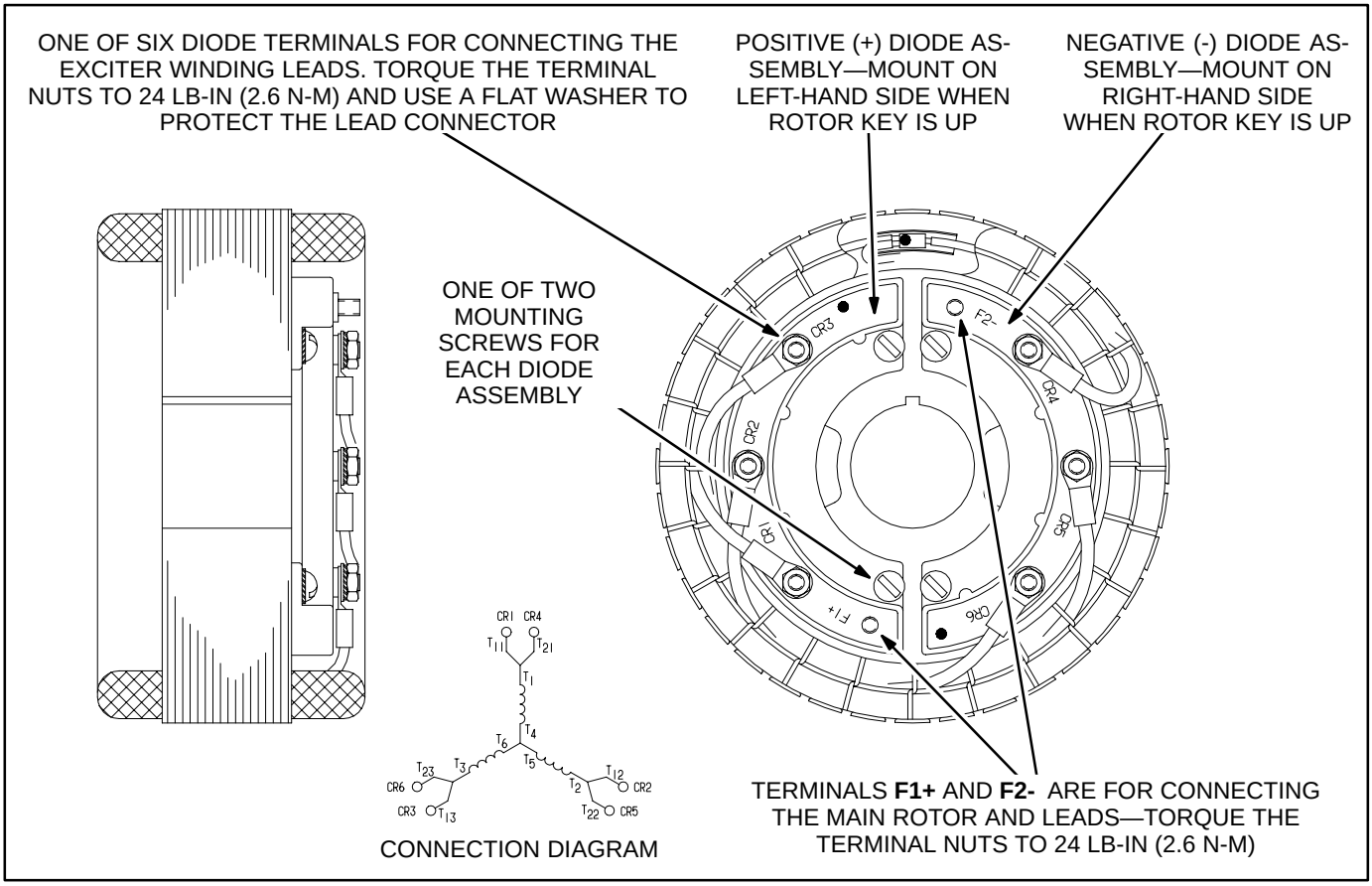


FIGURE 7-3. ROTATING RECTIFIER ASSEMBLY

Main Rotor

Winding Insulation Resistance: Disconnect the main rotor 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 either or both leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

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 7-1.

Reconnect the rotor leads and torque the terminals to 24 lb-in (2.7 N-m) when reassembling.

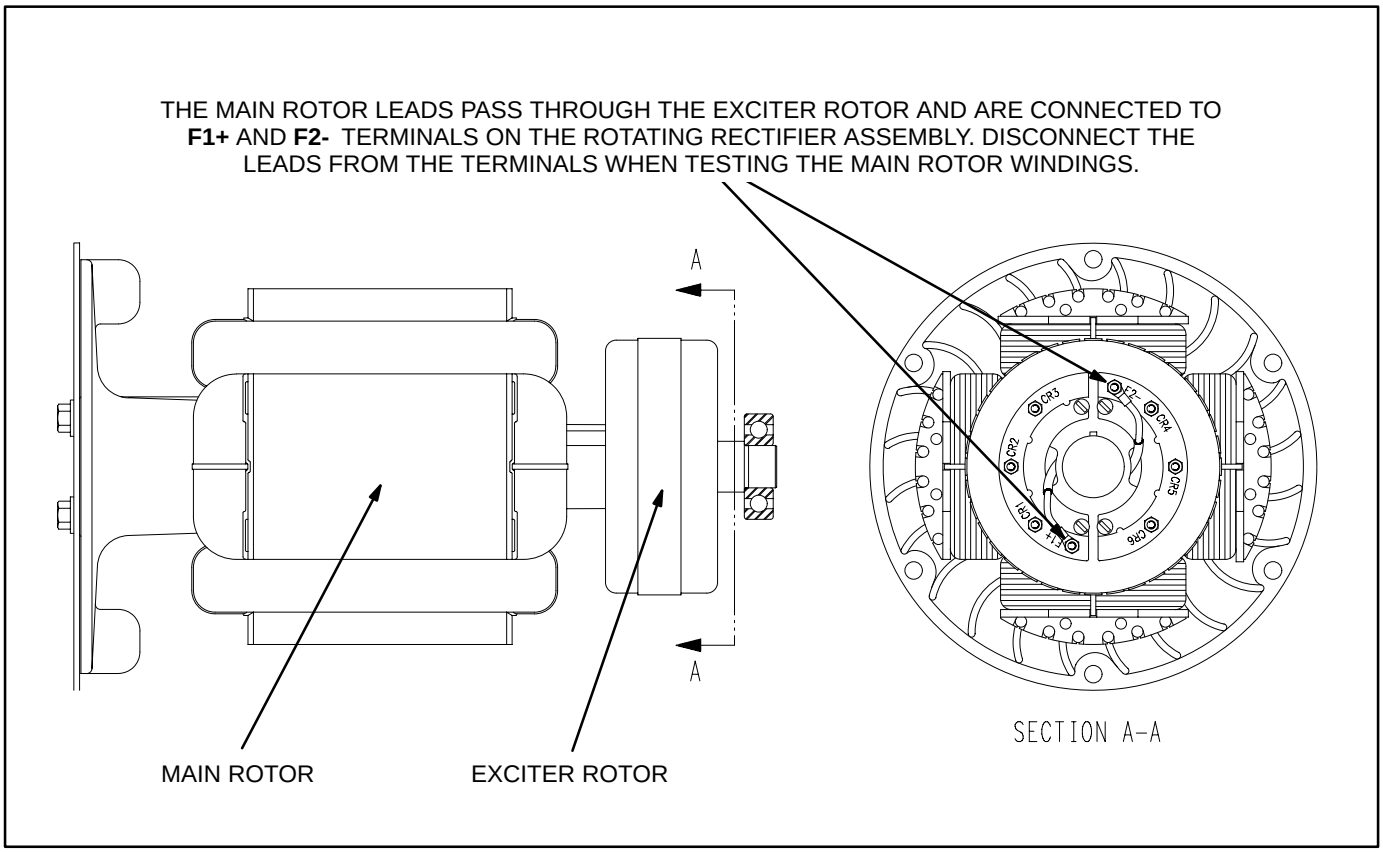


FIGURE 7-4. MAIN ROTOR

Main Stator

Winding Insulation Resistance: Test each winding separately. Disconnect the winding lead from its grounded neutral connection and isolate it (see reconnection drawing). Leave the other windings grounded. Connect either or both winding leads to the megger and conduct the test as instructed under Testing Winding Insulation Resistance.

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 (see reconnection drawing). Replace the stator if the resistance of any winding is not as specified in Table 7-1.

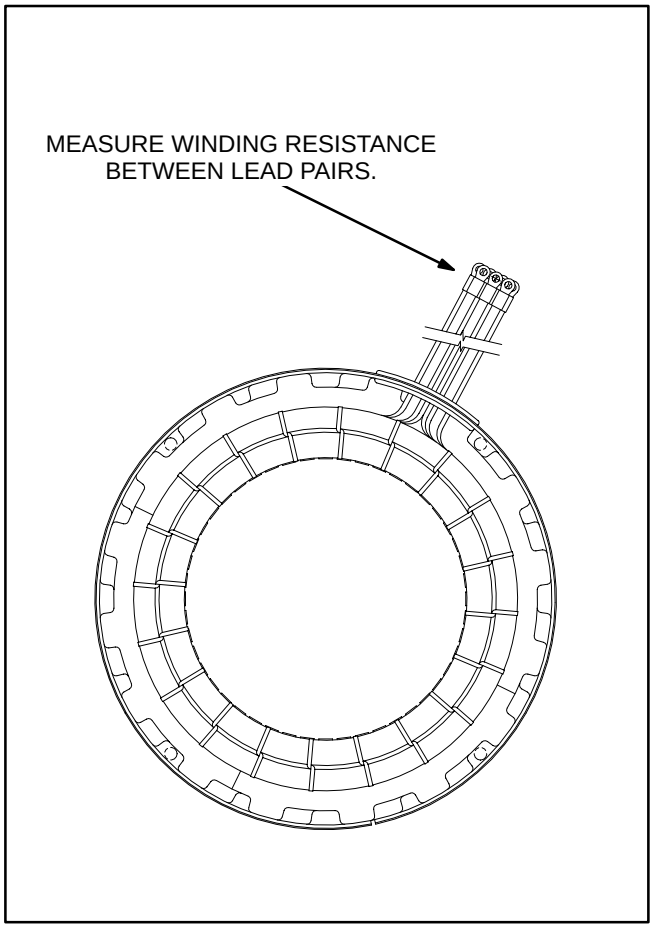
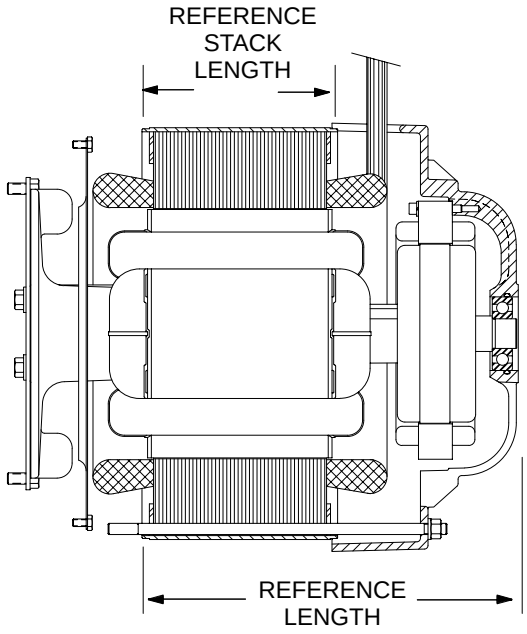


FIGURE 7-5. MAIN STATOR WINDINGS

TABLE 7-1 MAIN STATOR AND ROTOR WINDING RESISTANCES

REFERENCE LENGTH MILLIMETERS (INCHES) (1)	REFERENCE STACK LENGTH MILLIMETERS (INCHES) (1)	MAIN STATOR WINDING RESISTANCE OHMS (2)	MAIN ROTOR WINDING RESISTANCE OHMS (2)
4-Lead Generators (Single-Phase)			
317.5 (12.5)	146 (5.75)	0.053-0.059	2.75
12-Lead Generators (Three-Phase)			
317.5 (12.5)	146 (5.75)	0.108-0.119	2.75
349.5 (13.75)	178 (7.0)	0.104-0.115	1.80
6-Lead, 347/600 Volt Generators (Three-Phase)			
317.5 (12.5)	146 (5.75)	0.47-0.51	2.75



(1) . These are approximate reference dimensions for aiding generator identification. The corresponding rotor stack lengths are slightly greater than the stator stack lengths.

(2) . Stator resistances are ± 5% of nominal at 77° F (25° C) and rotor resistance are± 10%.

GENERATOR DISASSEMBLY

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

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.***

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (-) cable first and reconnect last.

⚠CAUTION ***Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.***

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (-) cable from the battery terminal.***

1. Disconnect all power output and remote control connections and conduit at the generator. For easier reconnections later, make sure each lead is clearly marked.

2. Remove the end bell cover from the generator.

   On generator sets with Sentinel control, disconnect plug from overspeed/start disconnect module (Figure 4-4) and wires from terminals F1 and F2. Remove cable and wires from generator. Remove the overspeed/start disconnect rotor element from the end of the generator shaft.

   On generator sets with Detector control, disconnect wire from overspeed switch (Figure 3-9) and wires from terminals F1 and F2. Remove wires from generator. Remove the overspeed switch bracket from the end bell and the overspeed switch assembly from the end of the generator shaft.

3. Disconnect the generator leads and the engine wiring harness from all terminals inside the control box. For easier reconnections later, make sure each lead is clearly marked. Also, disconnect the control box heater, if provided.

4. Remove the four bolts that secure the two saddle brackets of the control box to the generator (Figure 7-6).

5. Remove the two nuts and washers of the top generator through-studs that secure the bottom of the control housing to the generator.

6. Slide the control housing assembly off of the through-studs to remove the housing.

7. Cinch a hoisting strap around the middle of the generator stator and take up slack with a hoist.

8. Before separating the generator stator from the flywheel housing and end bell, scribe lines to register the parts for easier reassembly.

9. Remove the remaining two nuts and washers on the generator through-studs and tap the end bell free of the stator assembly.

10. Tap the generator stator free of the adaptor housing and carefully draw the stator straight back until it clears the ends of the through-studs.

11. Remove the generator through-studs.

12. If it is necessary to remove the rotor, first remove the air baffle. Cinch a hoisting strap around the middle of the main rotor laminations and then remove the bolts securing the generator drive disc to the flywheel.

13. Remove the two mounting screws if it is necessary to remove the exciter stator from the generator end bell.

14. Use a gear puller if it is necessary to remove the rotor bearing.

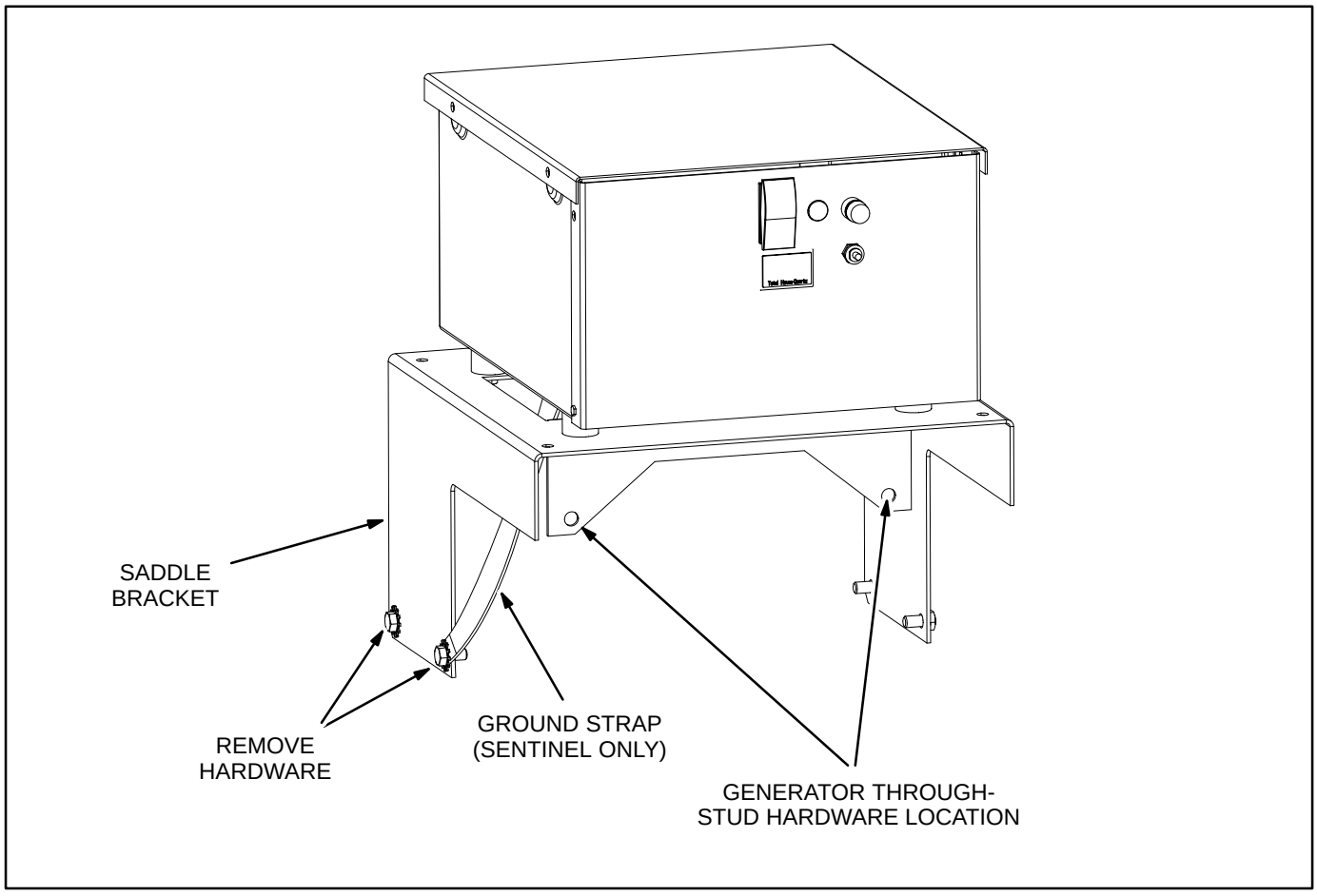


FIGURE 7-6. CONTROL BOX MOUNTING BRACKETS/HARDWARE

GENERATOR REASSEMBLY

Reassembly is the reverse of disassembly. Note the following when reassembling the generator:

1. If the rotor bearing was removed, press a new rotor bearing up to shoulder of shaft (do not lubricate). Apply force to the inner race of the rotor bearing when pressing it onto the shaft so as not to damage the bearing.

2. If the drive disc was removed from the rotor, torque the eight bolts to 37-42 ft-lb (50-57 N-m) when remounting. 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. Install flat washers with smooth, rounded side towards drive disc.

3. If the rotor was removed from the engine flywheel, torque the six drive disc-to-flywheel bolts to 27-29 ft-lb (37-39 N-m) when remounting.

4. If the air baffle was removed, install using four bolts.

5. If the flywheel housing was removed, torque the bolts to 60 ft-lb (81 N-m) when remounting.

6. Thread the generator through-studs into the flywheel housing before attempting to mount and align the generator stator. The ends having the shorter lengths of thread must be threaded into the flywheel housing. Make sure the studs bottom.

7. When mating the generator stator and flywheel housing, make sure the scribed index lines (Step 8, Disassembly) register.

8. If the exciter stator was removed from the generator end bell, torque the two screws to 8 ft-lb (11 N-m) when remounting. Connect the two leads (F1 and F2) to the terminals of the stator connection board.

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

10. 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. Torque the nuts on the generator through-studs to 19-21 ft-lb (26-28 N-m). Pull the field leads out the same opening as the main stator leads.

11. *Sentinel control,* mount the rotor element for the overspeed/start disconnect module on the end of the rotor and torque the bolt to 18 ft-lb (25 N-m).

    On generator sets with Detector control, mount the overspeed switch assembly on the end of the rotor and torque the bolt to 18 ft-lb (25 N-m). Mount the overspeed switch bracket to the end bell.

12. Remount and reconnect all the other components that were disconnected or removed under Disassembly.

13. Route and reconnect the connector/wires from the control box to the overspeed/start disconnect module or overspeed switch and F1/F2 leads to the stator connection board.

14. Secure the end bell cover plate and torque the four screws to 8 in-lb (3.8 N-m).

⚠ CAUTION ***It may be necessary to flash the field to get AC output voltage, which is the means for activating the AC start disconnect circuit. 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 2-2 or 2-3.***

TROUBLESHOOTING

The following generator and voltage regulator troubleshooting tables are referenced by troubleshooting in the generator set control sections. See the Table of Contents for the appropriate generator set control section.

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 trained and experienced 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** (Detector control only).	**RESET** the circuit breaker. If it keeps tripping, troubleshoot according to FIELD CIRCUIT BREAKER KEEPS TRIPPING.
5. Field circuit breaker **CB21** is faulty (Detector control only).	Shut down the set, attempt to **RESET** the circuit breaker, disconnect either lead and measure resistance. Replace the circuit breaker if there is measurable resistance across the terminals.
6. The field has lost its residual magnetism.	Flash the field *(refer to Section 2).*

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 trained and experienced 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 (Item 6 above), 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 *Section 3*) 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. **⚠ DANGER** ***HAZARDOUS 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 live parts. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands.*** 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 reconnection diagram (*Section 9*) 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 instructions in this section. Replace the exciter field assembly if winding resistance does not meet specifications.
9. The rotating rectifier assembly (diodes **CR1** through **CR6**) is faulty.	Shut down the set and check each diode according to instructions in this section. Service as necessary.

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 trained and experienced 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**
10. The exciter rotor windings are open.	Shut down the set and check exciter winding resistances according to instructions in this section. Replace the whole rotor shaft 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 instructions in this section. Replace the whole rotor shaft 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 instructions in this section. Replace the generator stator assembly if 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 trained and experienced 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 speed has not been adjusted properly.	Adjust engine speed (refer to *Section 8)*.
2. The voltage has not been adjusted properly.	Adjust output voltage (refer to *Section 2)*.
3. Connections have not been made properly at the generator output terminals.	Shut down the set and reconnect according to the reconnection diagram in *Section 9.*
4. The rotating rectifier assembly (diodes **CR1** through **CR6**) is faulty.	Shut down the set and check each diode according to instructions in this section. 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 trained and experienced 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 unstable.	See THE ENGINE LACKS POWER OR IS UNSTABLE in the appropriate control troubleshooting section.
2. The voltage has not been adjusted properly.	Adjust output voltage (refer to *Section 2).*
3. 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 1000 ohms.
4. 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 (DETECTOR CONTROL)

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced 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 instructions in this section. Service as necessary.
2. The exciter field winding is shorted.	Shut down the set and check exciter field winding resistance according to instructions in this section. 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 instructions in this section. Replace the whole rotor shaft 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 instructions in this section. Replace the whole rotor shaft 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 instructions in this section. 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 (3-PHASE GENERATORS)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by trained and experienced 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 reconnection diagram in *Section 9.*
3. The stator windings are faulty (open or shorted).	Shut down the set and check stator winding resistances according to instructions in this section. 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.

8. Governors and Fuel Systems

ELECTRIC GOVERNOR ADJUSTMENT

If necessary, adjust the gas mixture, the governor linkage and the magnetic speed pickup unit as instructed in this section before adjusting the governor controller. Make sure that the governor assembly is securely mounted. Also make sure that the governor linkage does not bind or have excessive play in it and that the governor spring is connected between the governor lever and throttle ball ends.

1. Check the dip switch settings (Figure 8-1) to make sure they are set properly, as follows:

	50 Hz (Spec A-D)	60 Hz (Spec A)	60 Hz (Spec B-D)
SW1	Open	Open	Open
SW2	Open	Open	Open
SW3	Closed	Closed	Closed
SW4	Open	Open	Closed

2. Start the set, let the engine warm up under a partial load (at least 1/4 rated load) and then disconnect all loads. (If the governor has been replaced, adjust the Gain to approximately **5** and Stability to **3.5**.

3. Adjust Gain pot until engine is stable and responsive to governor control. (Adjust the Gain pot counterclockwise to eliminate hunting.) Bump throttle lever a couple of times to check for hunting. The unit should respond quickly but should not hunt.

4. Apply full load to the genset and adjust Stability pot to minimize overshoot. (Adjust the Stability pot clockwise to increase stability.) Check stability under a range of loads; from no-load to full-load.

5. Attach a tachometer or frequency meter to the generator output leads if control panel does not come equipped with one of these meters. Adjust Speed Trim pot until desired speed is obtained.

6. Shut down and restart the genset to check for overspeed shutdown on startup.

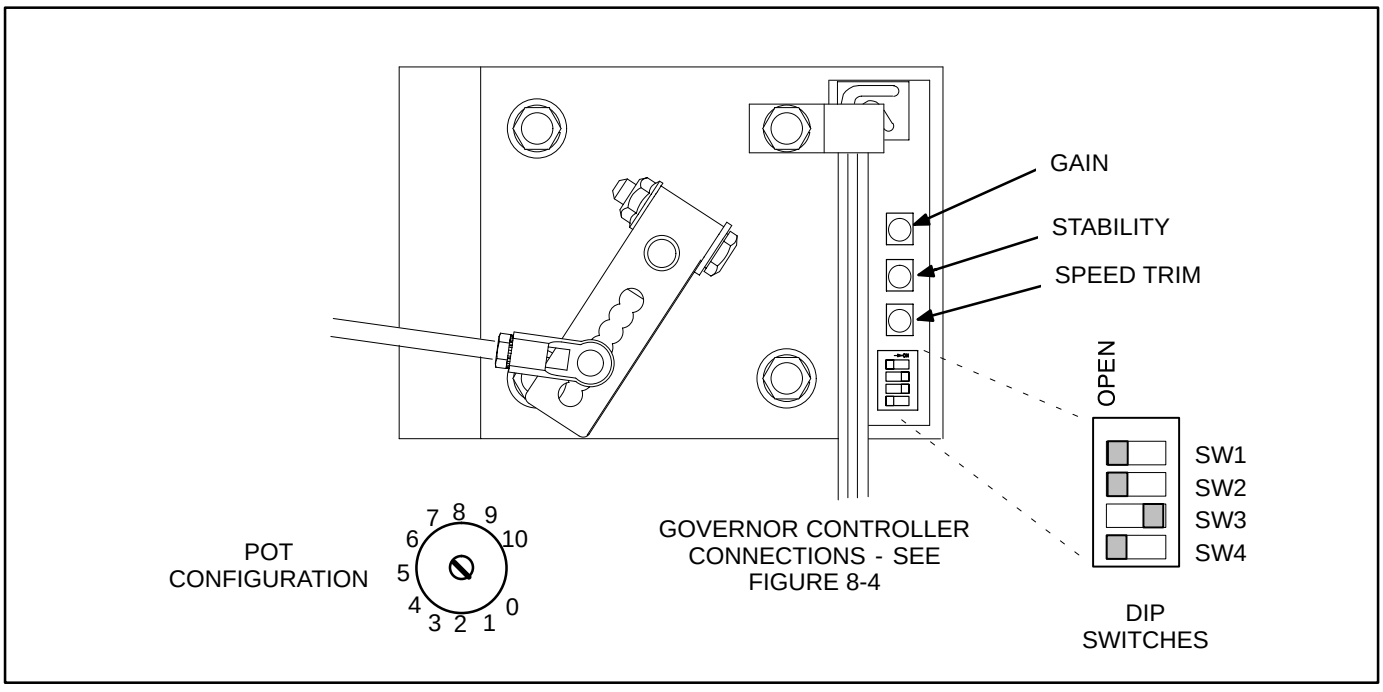


FIGURE 8-1. GOVERNOR CONTROLLER

LINKAGE ADJUSTMENT

Figure 8-2 illustrates the governor linkage. Make sure that the governor controller is securely mounted to the engine bracket. To adjust linkage:

1. With the genset stopped, remove the governor rod and spring from the throttle lever. With the governor actuator shaft rotated to the full counterclockwise position, check that the angle of the governor arm is 64° ±2°. Loosen governor arm screw to adjust the governor arm.
2. Verify that the ball joint screw is mounted in third hole from the “outside end” of the governor arm.
3. Attach governor rod and spring to the throttle lever.
4. With the throttle lever in the closed position, adjust governor rod so that the angle of the governor arm is 64° ±2°.

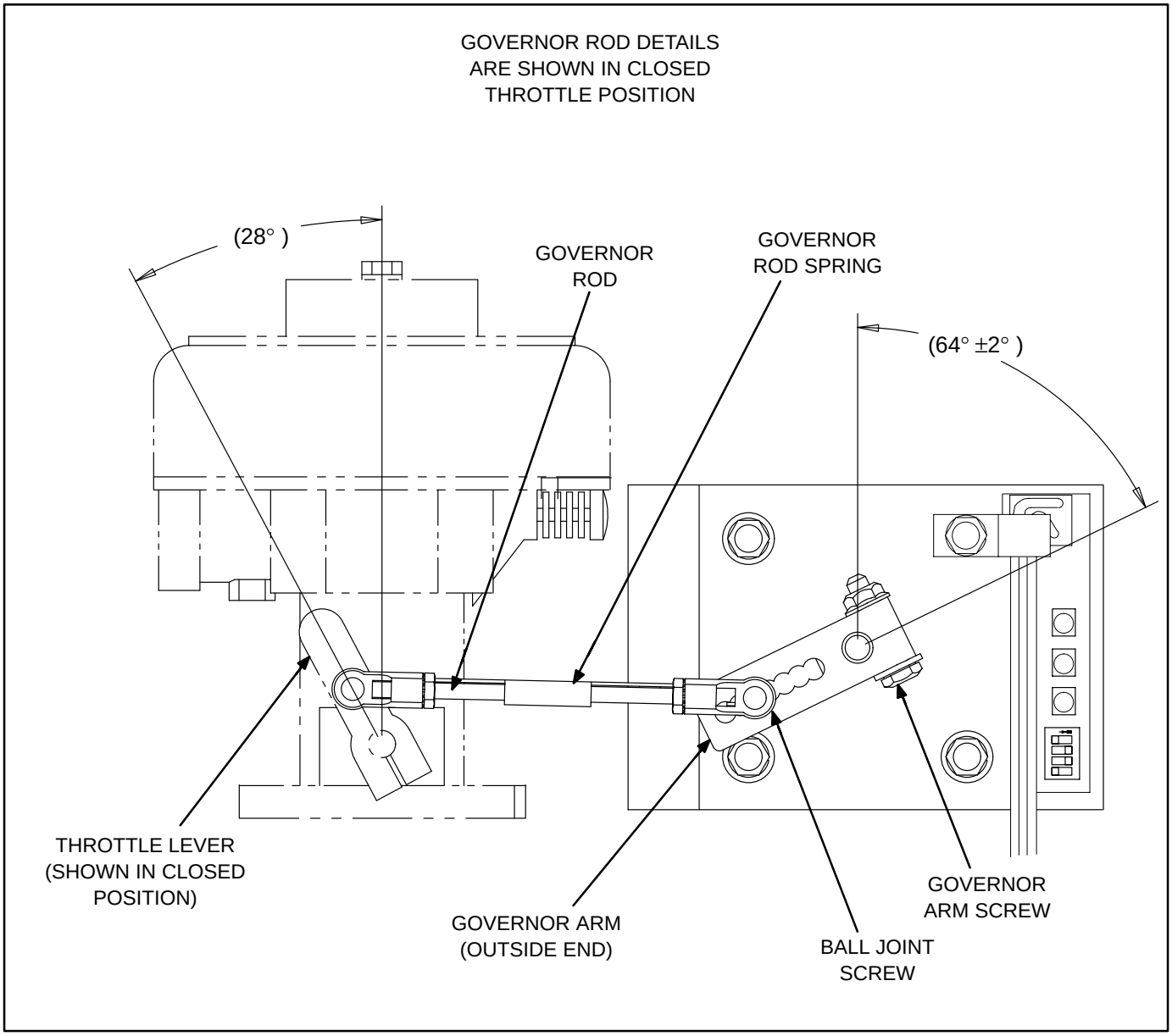


FIGURE 8-2. GOVERNOR LINKAGE

MAGNETIC SPEED PICKUP UNIT ADJUSTMENT

Measure the resistance of the magnetic speed pick-up (MPU). Replace the MPU if the resistance is not between 1,000 ohms and 1,050 ohms.

With the MPU removed from the genset, manually rotate the ring gear until a tooth lines up in the center of the mounting hole. Thread the pickup in gently by hand until it just touches the ring gear tooth. Back it out 1/4 turn and set the locknut.

After adjustment, make sure output voltage of the MPU is correct. Replace the MPU if output voltage at cranking speed is less than 1.5 VAC.

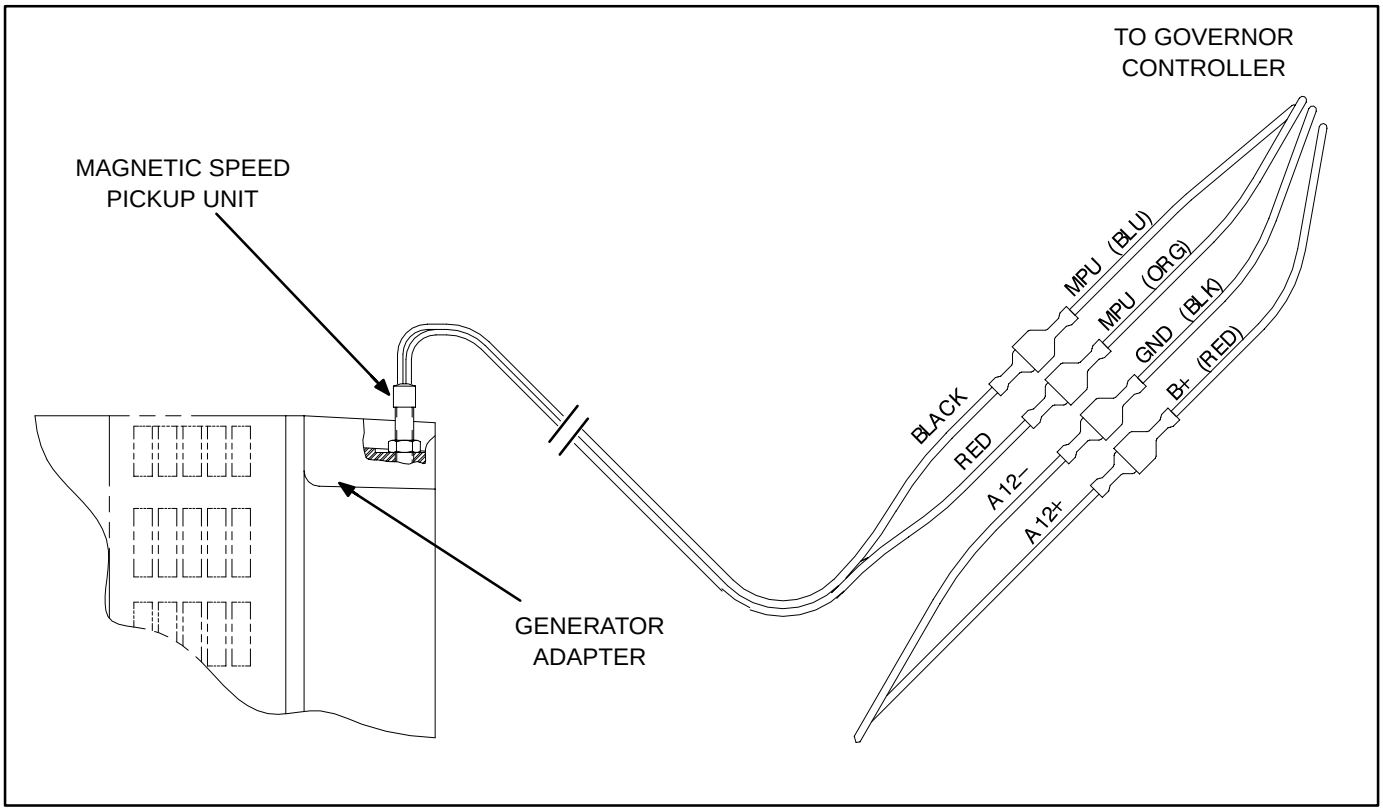


FIGURE 8-3. MAGNETIC SPEED PICKUP UNIT / GOVERNOR CONTROLLER CONNECTIONS

FUEL SYSTEM

The engine is equipped with a gas mixer to run on natural gas or LPG or both (Figure 8-4). If converting the fuel system to a different fuel or to a dual fuel system, the fuel system and the ignition timing may need to be adjusted as noted in this section.

⚠WARNING ***Gaseous fuels are flammable and explosive and can cause severe personal injury or death. Do not allow cigarettes, flame, pilot lights, arcing switches or equipment in area or areas sharing ventilation. Keep a type ABC fire extinguisher handy.***

Natural gas is lighter than air, and will tend to gather under hoods. LPG is heavier than air, and will tend to gather in sumps or low areas. NFPA Standard No. 58 requires all persons handling and operating LPG to be trained in proper handling and operating procedures.

Gaseous and Combination Fuel Systems

An engine equipped for natural gas and LPG has a gas mixer that serves both fuels. Each fuel has a separate shutoff solenoid valve and pressure regulator. The pressure switch is for automatic fuel changeover. (If natural gas pressure is lost while the engine is running, the gas pressure switch causes the natural gas solenoid valve to close and the LPG solenoid valve to open, without stopping the engine. When natural gas pressure is restored, the natural gas solenoid valve opens and the LPG solenoid valve closes.)

Fuel Pressure

The gas pressure regulators in each line provide constant gas pressure at the gas mixer under varying load conditions. There are pressure test ports on both sides of the fuel regulator for measuring supply and regulated fuel pressures (NG or LPG systems). When measuring supply pressure, the most accurate reading would be on the input side of the solenoid valve, as shown in Figure 8-4.

Supply side: The minimum pressure refers to supply pressure under rated load (maximum gas flow).

For LPG and natural gas, the maximum permissible fuel supply pressure (genset operating or not operating) is 13.6 inches (350 mm) WC and the minimum is 7 inches (178 mm) WC, when the genset is operating at rated load.

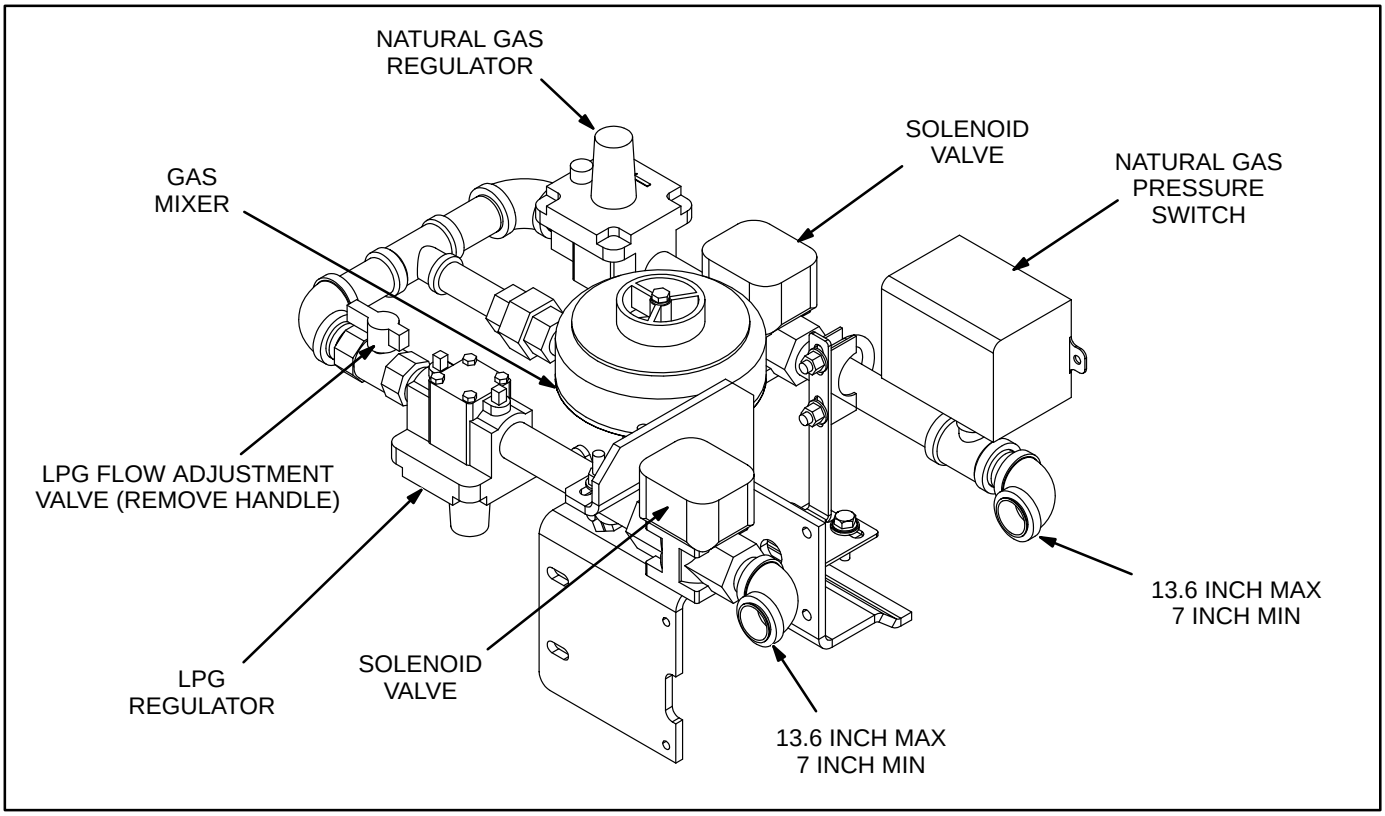


FIGURE 8-4. NATURAL GAS AND LPG VAPOR FUEL SYSTEM

Gaseous Fuel Adjustments: Gas mixers have a power adjust valve and an idle adjustment screw (Figure 8-5). Engines equipped for natural gas and LPG (dual fuel) also have a LPG flow adjustment valve. If necessary, make the following adjustments.

1. Start the engine and let the set warm up under a partial load (at least 1/4 rated load). If the engine is equipped for natural gas and LPG, start with natural gas.

   Step 2 is required only if genset instability is present at no-load through 1/4 of rated load.

2. Disconnect all loads, shut down the set, connect a tachometer and disconnect the governor linkage at the carburetor. Start the engine and close and hold the throttle by hand so that the engine does not overspeed. While holding the throttle closed, adjust the throttle idle position screw (the one next to the throttle lever) to obtain the engine speed of 800 rpm. Reconnect the governor linkage.
3. Connect full rated load and turn the main fuel valve to full-rich. Slowly turn the main fuel valve towards lean until the engine begins to lose speed and then slowly back towards rich until the engine carries the full load smoothly.
4. If the set is equipped for natural gas and LPG, switch to LPG by closing the manual shutoff valve in the natural gas supply line.
5. Reconnect full rated load and turn the LPG flow adjustment valve clockwise until the engine begins to lose speed and then slowly turn it back counterclockwise until the engine carries full load smoothly.

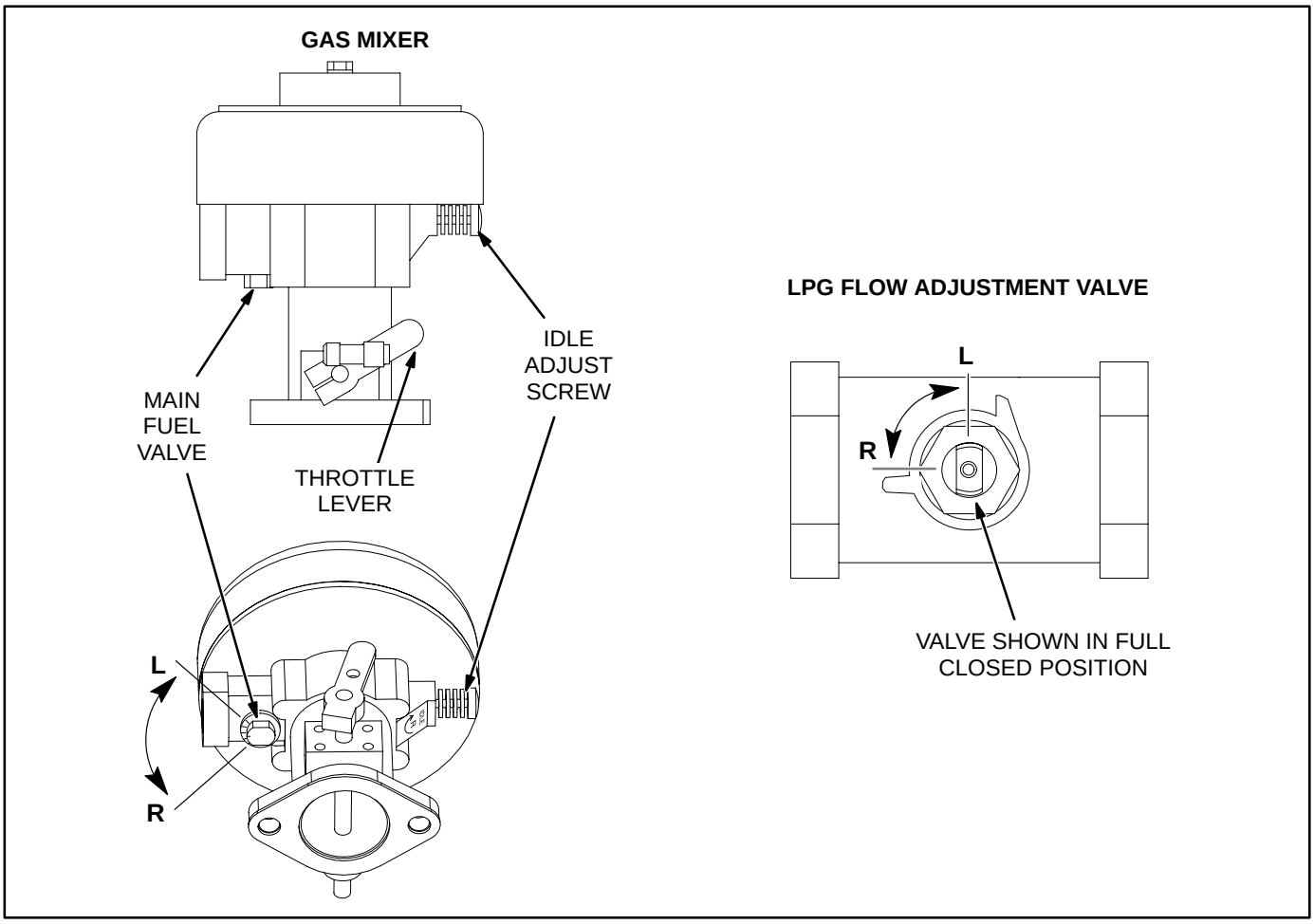


FIGURE 8-5. GASEOUS FUEL ADJUSTMENTS

IGNITION TIMING

The ignition timing is adjustable by connecting or disconnecting leads between the ignition module (IM) and the engine harness (EH) or dual fuel harness (DFH). Modification of these connections is required only when converting the generator set fuel system. Make sure that the lead connections are correct for the type of fuel system being used as follows:

SPEC A AND B

NATURAL GAS (NG) ONLY:

1. Connect EH lead **P10** to IM pin **#6** (yellow/black with wire tie).
2. Connect EH lead **P11** to IM pin **#7** (yellow/black without wire tie).

LPG ONLY:

1. Connect EH lead **P10** to IM pin **#6** (yellow/black with wire tie).
2. Leave EH lead **P11** and IM pin **#7** (yellow/black without wire tie) disconnected.

DUAL FUEL (NG/LPG) ONLY:

1. Connect EH lead **P10** to IM pin **#6** (yellow/black with wire tie).
2. Connect EH lead **P11** to DFH lead **P11**.
3. Connect DFH lead **P7** and IM pin **#7** (yellow/black without wire tie) disconnected.

BEGIN SPEC C

Refer to DC Wiring Diagram (Begin Spec C) in Section 9.

IGNITION/TIMING	
FUEL	**CONNECT P11 TO:**
NAT GAS	P10 (B+)
PROPANE	K1- (GND)
NAT GAS & PROPANE	AUTOMATIC
NAT GAS & LP LIQUID	AUTOMATIC

9. Wiring Diagrams

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

GENERAL

- Page 9-2, Generator Reconnection Diagram

DETECTOR CONTROL

- Page 9-3, AC Control Wiring Diagram
- Page 9-4, Voltage Regulator Installation (Shunt-Excited Generators)
- Page 9-5, DC Control Wiring, Sheet 1 of 9
- Page 9-6, DC Control Wiring, Sheet 2 of 9
- Page 9-7, DC Control Wiring, Sheet 3 of 9
- Page 9-8, DC Control Wiring, Sheet 6 of 9
- Page 9-9, DC Control Wiring, Sheet 9 of 9
- Page 9-10, Typical Customer Connections At The Engine Control Monitor (ECM)
- Page 9-11, Auxiliary Relay Board (ARB)
- Page 9-12, Engine Harness (Spec A & B)
- Page 9-13, Engine Harness (Spec C)
- Page 9-14, Engine Harness (Begin Spec D)

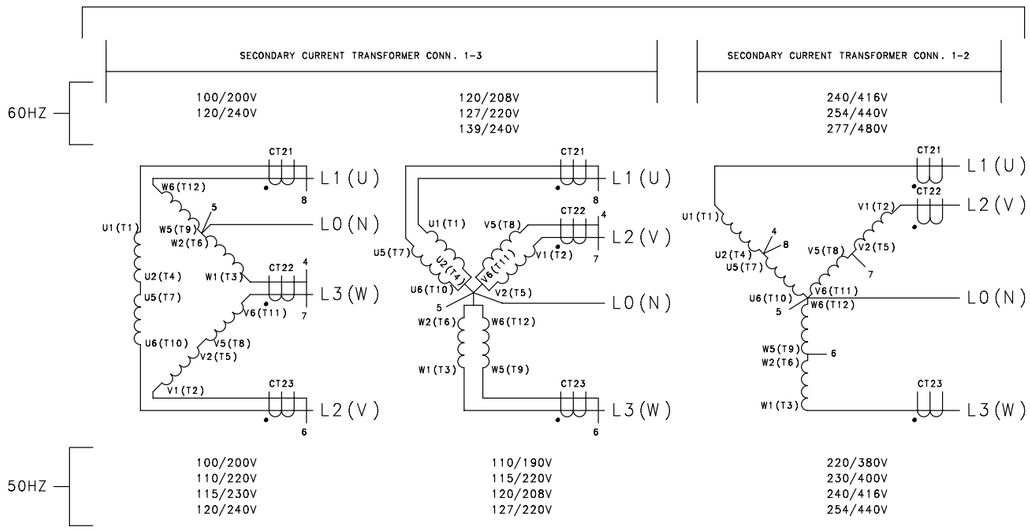
2-WIRE CONTROL

- Page 9-15, DC Wiring Diagram (Spec A)
- Page 9-16, DC Wiring Diagram (Spec A)
- Page 9-17, DC Wiring Diagram (Spec B)
- Page 9-18, DC Wiring Diagram (Spec B)
- Page 9-19, DC Wiring Diagram (Spec C)
- Page 9-20, DC Wiring Diagram (Spec C)
- Page 9-21, DC Wiring Diagram (Begin Spec D)
- Page 9-22, DC Wiring Diagram (Begin Spec D)
- Page 9-23, DC Wiring Diagram (Begin Spec D)
- Page 9-24, DC Wiring Diagram (Begin Spec D)
- Page 9-25, Engine Harness (Spec A & B)
- Page 9-26, Engine Harness (Spec C)
- Page 9-27, Engine Harness (Begin Spec D)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

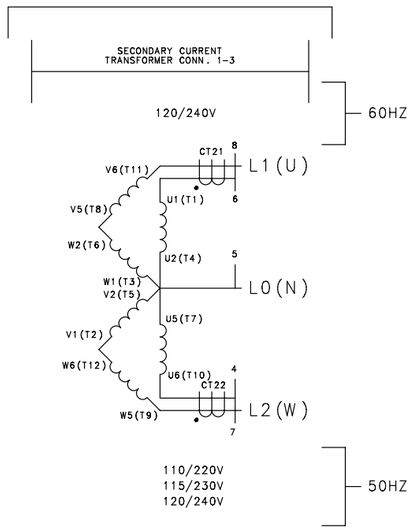
YD GENERATORS

3 PHASE RECONNECTABLE, 12 LEAD



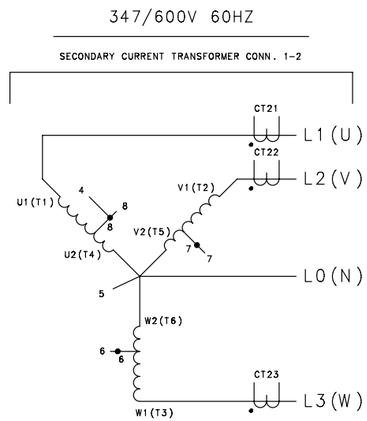
-01 -02 -03

1 PHASE RECONNECTABLE, 12 LEAD



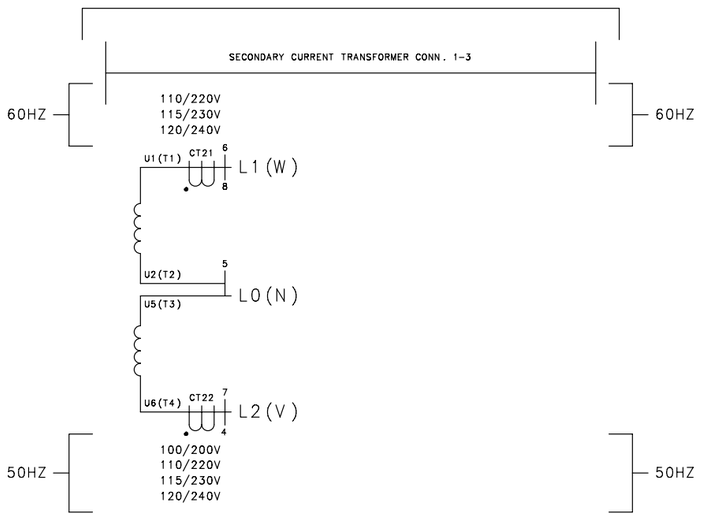
-04

347/600V 60HZ



-06

1 PHASE, 4 LEAD



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

NOTES:

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.
   LEADS MAY BE COLOR CODED IN LIEU OF MARKINGS AS FOLLOWS:
   CT21-1 PNK/BLK
   CT22-1 PRP/BLK
   CT23-1 ORN/BLK
   ALL 2/3 LEADS GRY/BLK

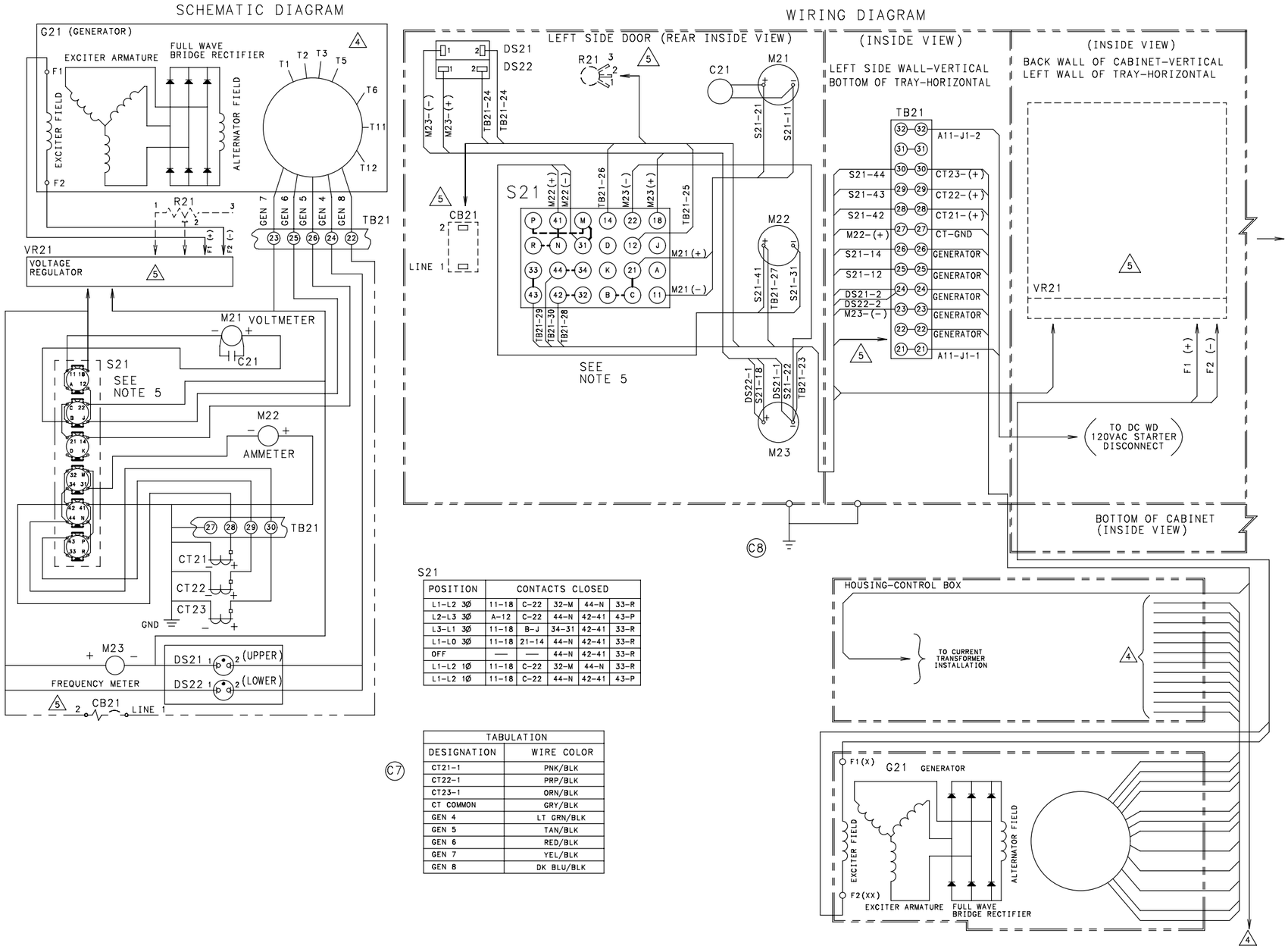
2. GENERATOR VOLTAGE SENSING LEADS GEN-4,-5,-6,-7, & -8 MUST BE CONNECTED TO GENERATOR OUTPUT LEADS AS SHOWN FOR PROPER METERING AND VOLTAGE REGULATOR OPERATION. LEADS MAY BE COLOR CODED IN LIEU OF MARKINGS AS FOLLWS:
   GEN-4 LT GRN/BLK
   GEN-5 TAN/BLK
   GEN-6 RED/BLK
   GEN-7 YEL/BLK
   GEN-8 DK BLU/BLK
   INSULATE AND TIE BACK ANY UNUSED LEADS.

3. 347/600V -DETECTOR: CONNECT GEN VOLTAGE SENSING LEADS TO STATOR TAP LEADS 6,7 & 8 AND TO LO(N) AS SHOWN.
   -NON-DETECTOR: CONNECT STATOR TAP LEADS 6,7 & 8 TO AVR-6,7 & 8.

No. 625-3360 sh 1 of 1
Rev. C Sys: Revisio
Modified 10-97

GENERATOR RECONNECTION DIAGRAM

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



S21

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

C7

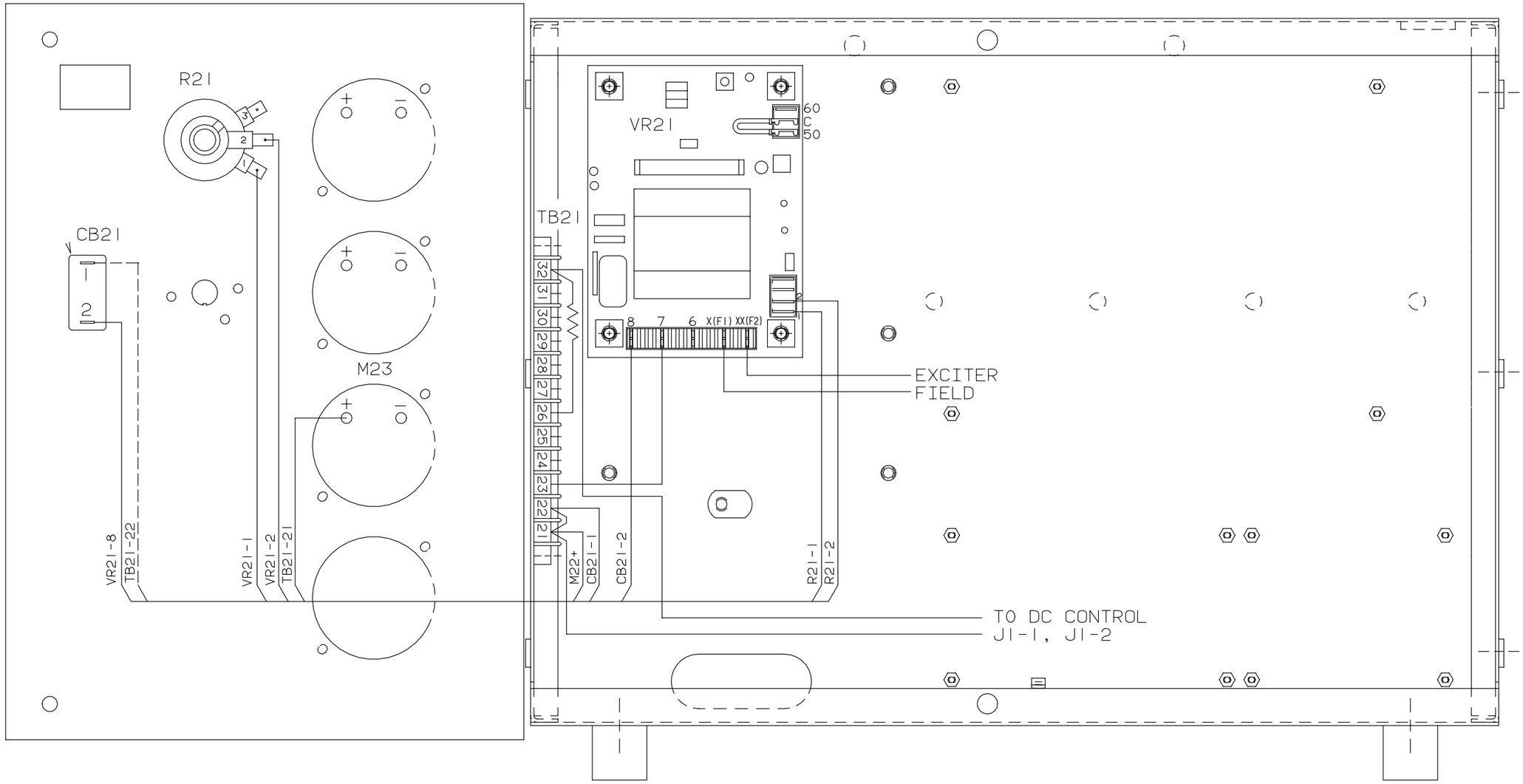
TABULATION	
DESIGNATION	WIRE COLOR
CT21-1	PNK/BLK
CT22-1	PRP/BLK
CT23-1	ORN/BLK
CT COMMON	GRY/BLK
GEN 4	LT GRN/BLK
GEN 5	TAN/BLK
GEN 6	RED/BLK
GEN 7	YEL/BLK
GEN 8	DK BLU/BLK

C8

No. 612-6694 sh 2 of 2
Rev. C Sys: Revisio
Modified 12-97

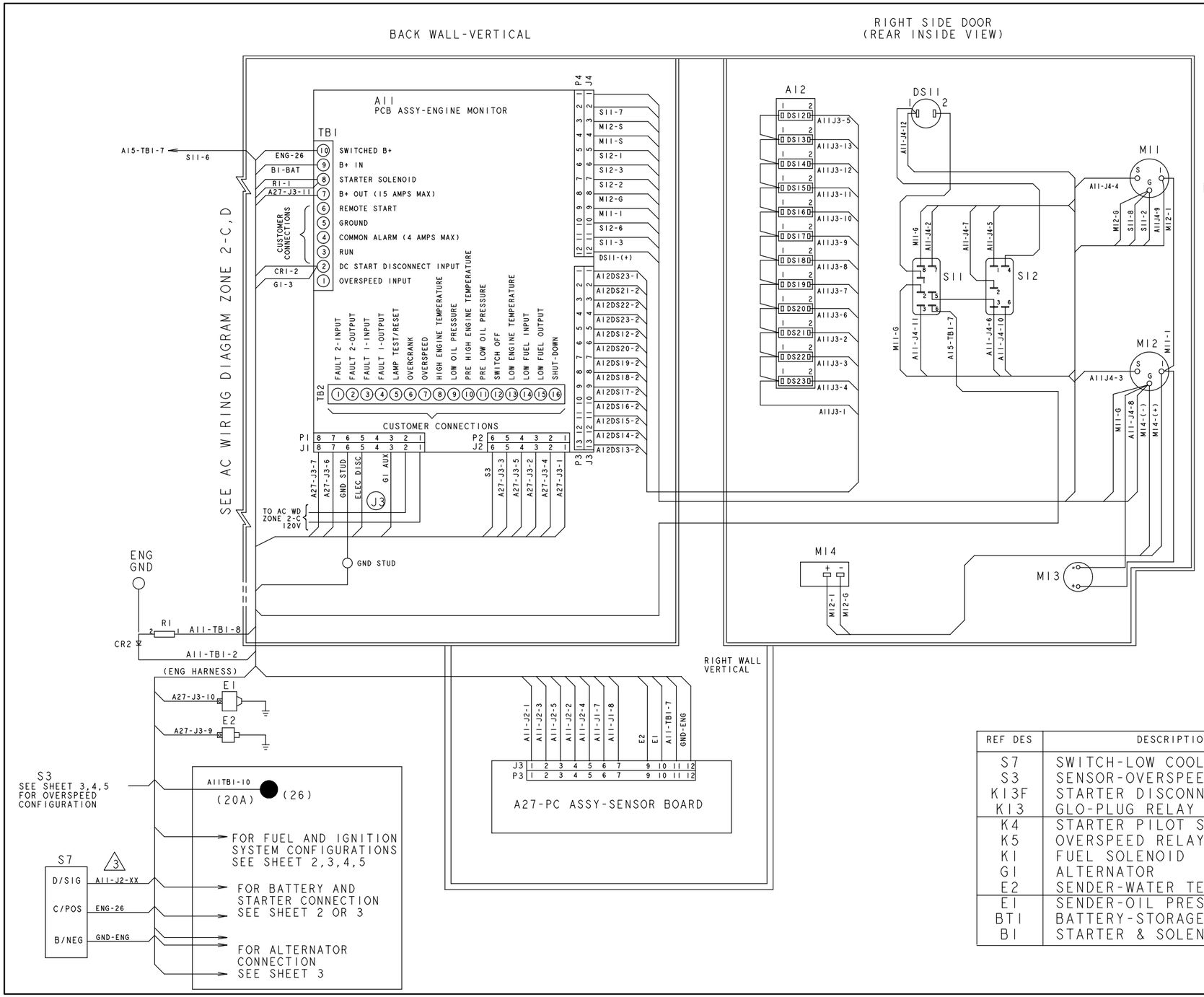
AC CONTROL WIRING DIAGRAM

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



No. 300-4830 sh 1of 1
Rev. F Sys: Revisio
Modified 12/97

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



NOTES:

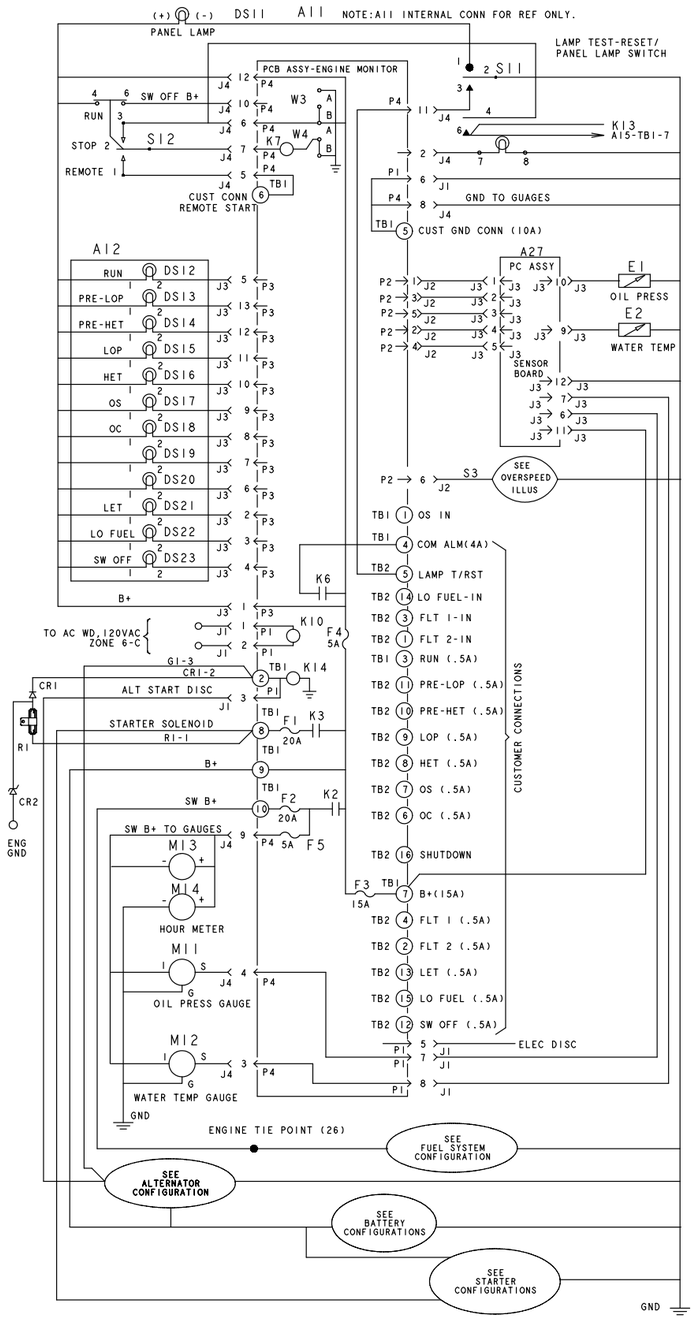
1. ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION.
2. ILLUSTRATION NUMBERS REFER TO DWG. NO. 539-0741.
3. FOR LOW COOLANT SHUTDOWN, CONNECT S7-SIG TO A11-J2-5 FOR LOW COOLANT WARNING, CONNECT S7-SIG TO A11-J2-3
4. TIE ALL UNUSED LEADS INTO HARNESS
5. DASHED LEADS INDICATE WHEN USED.
6. WATER TEMPERATURE GAUGE IS WIRED TO F3 FOR CONTINUOUS OPERATION FOR SPARK IGNITED PRODUCT.

REF DES	DESCRIPTION
S7	SWITCH-LOW COOLANT LEVEL
S3	SENSOR-OVERSPEED
KI3F	STARTER DISCONNECT RELAY
KI3	GLO-PLUG RELAY
K4	STARTER PILOT SOLENOID
K5	OVERSPEED RELAY
KI	FUEL SOLENOID
G1	ALTERNATOR
E2	SENDER-WATER TEMP
EI	SENDER-OIL PRESSURE
BTI	BATTERY-STORAGE
BI	STARTER & SOLENOID

No. 612-6733 sh 1 of 9
Rev. N
Modified 11-02

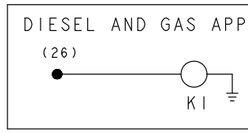
DC CONTROL WIRING DIAGRAM (SHEET 1 OF 9)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

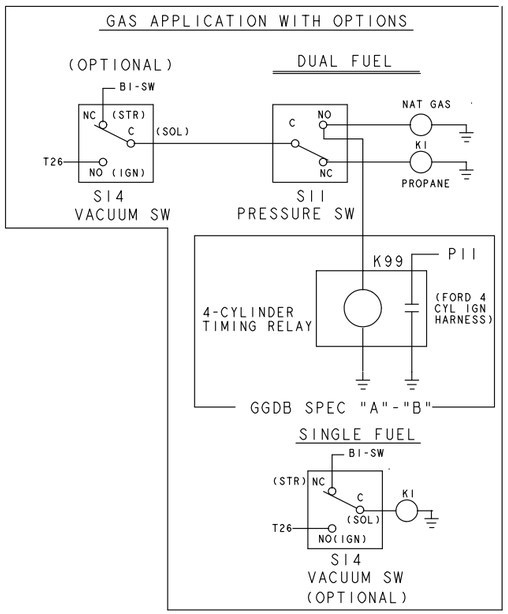


IGNITION FUEL SYSTEMS CONFIGURATIONS

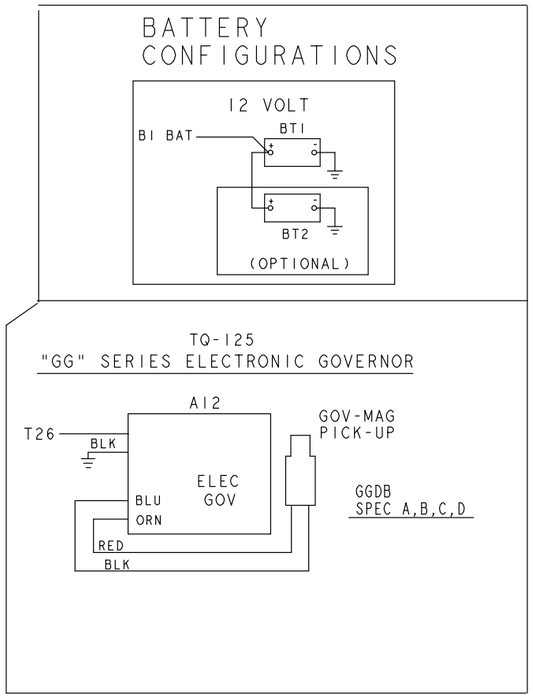
DIESEL AND GAS APPLICATIONS



GAS APPLICATION WITH OPTIONS



BATTERY CONFIGURATIONS

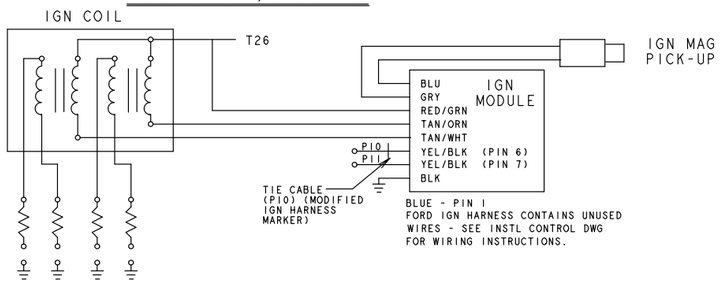


No. 612-6733 sh 2 of 9
Rev. N Sys: Revisio
Modified 11-02

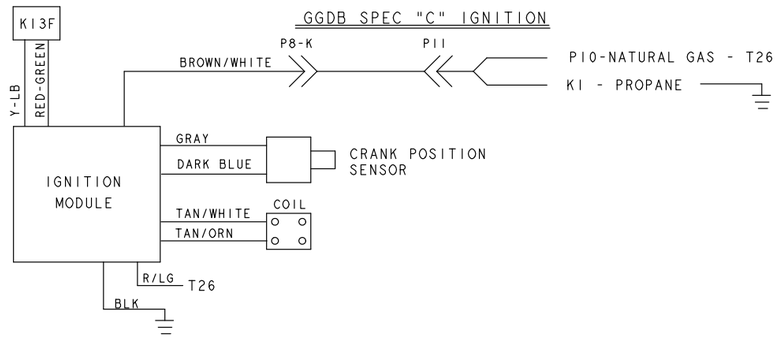
DC CONTROL WIRING DIAGRAM (SHEET 2 OF 6)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

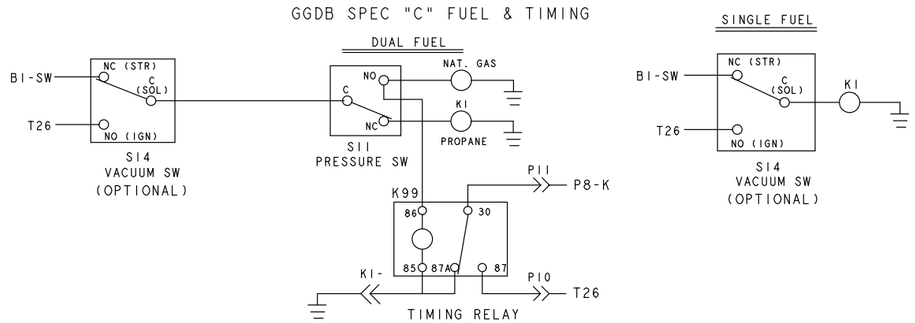
GGDB SPEC A,B IGNITION



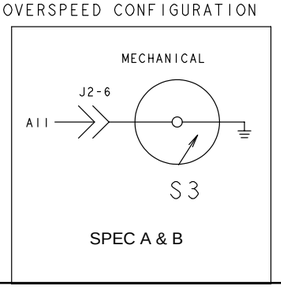
GGDB SPEC "C" IGNITION



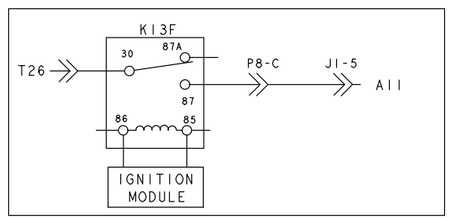
GGDB SPEC "C" FUEL & TIMING



OVERSPEED CONFIGURATION

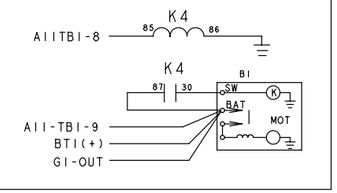


GGDB SPEC "C" START DISCONNECT



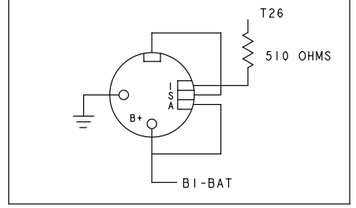
STARTER CONFIGURATIONS

SOLENOID SHIFT DG,DN,GG,GN SERIES
12VDC/24VDC

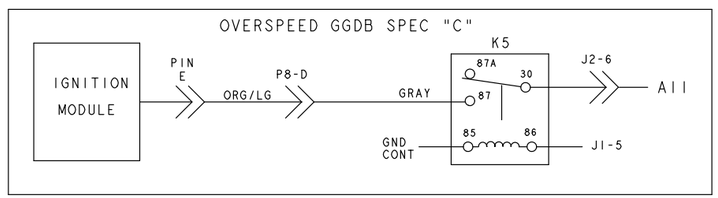


ALTERNATOR CONFIGURATIONS

4-CYL FORD (GGDB)



OVERSPEED GGDB SPEC "C"

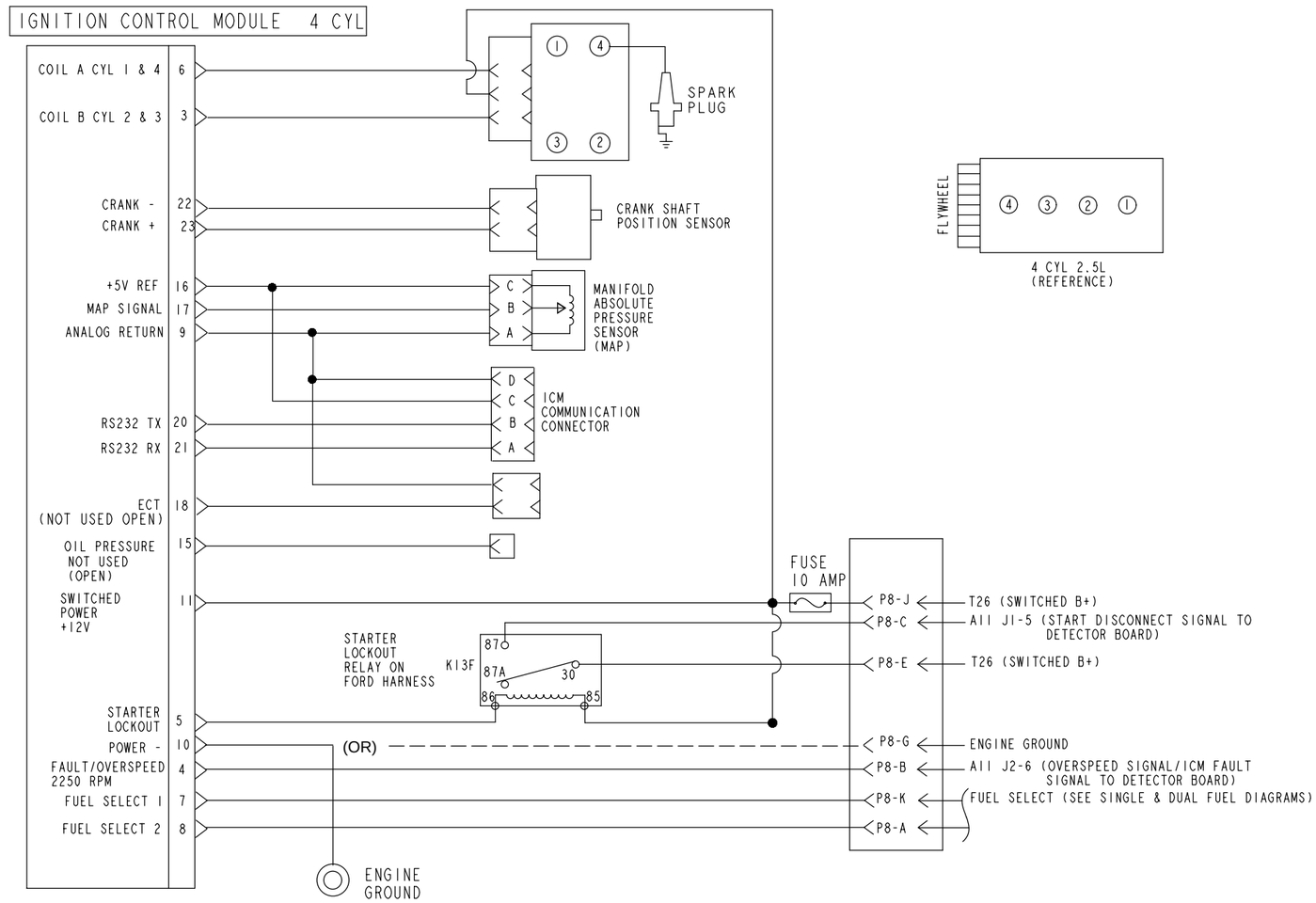


No. 612-6733 sh 3 of 9
Rev. N Sys: Revisio
Modified 11-02

DC CONTROL WIRING DIAGRAM (SHEET 3 OF 6)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

GGDB SPEC D

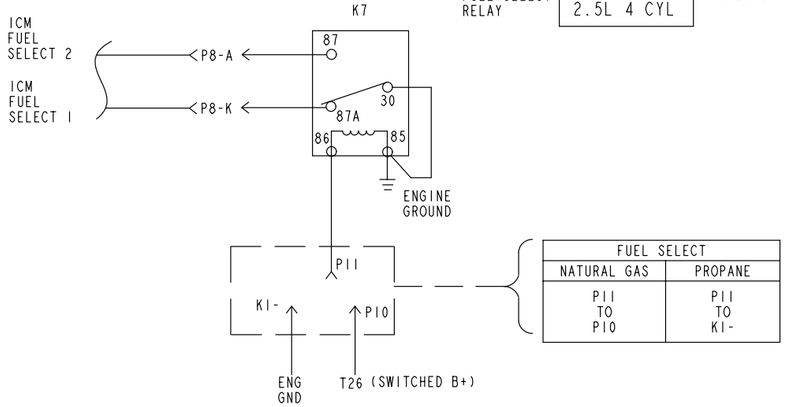


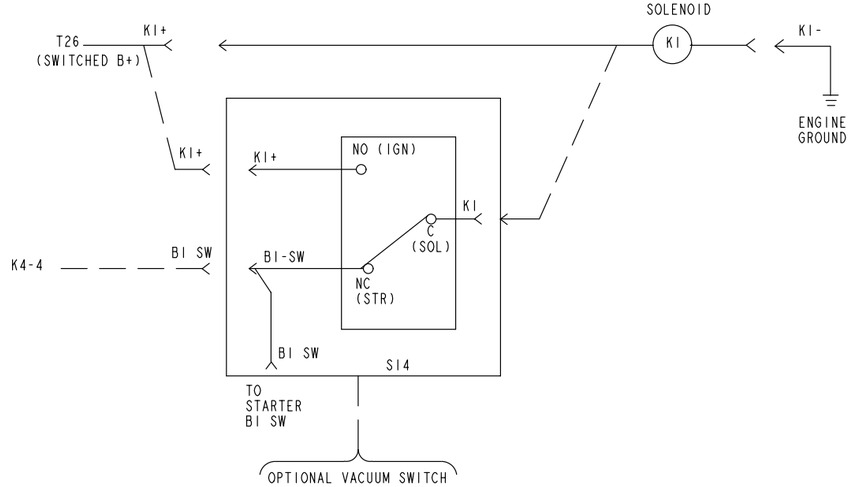
No. 612-6733 sh 6 of 9
Rev. N Sys: Revisio
Modified 11-03

DC CONTROL WIRING, SHEET 6 OF 9

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

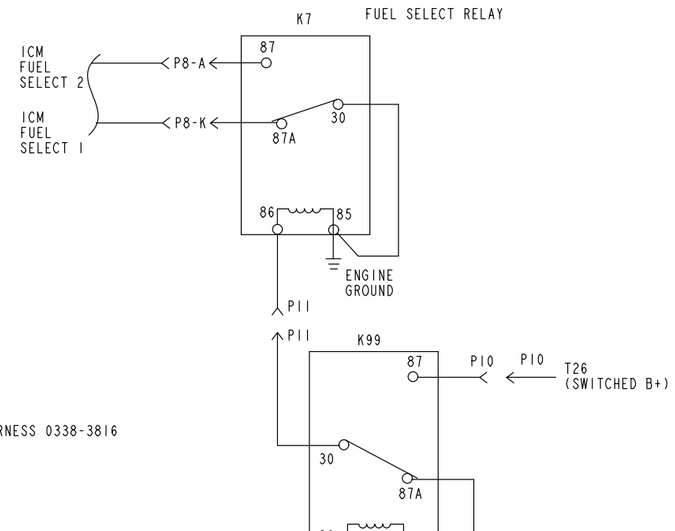
SINGLE FUEL 2.5L 4 CYL — GGDB SPEC D



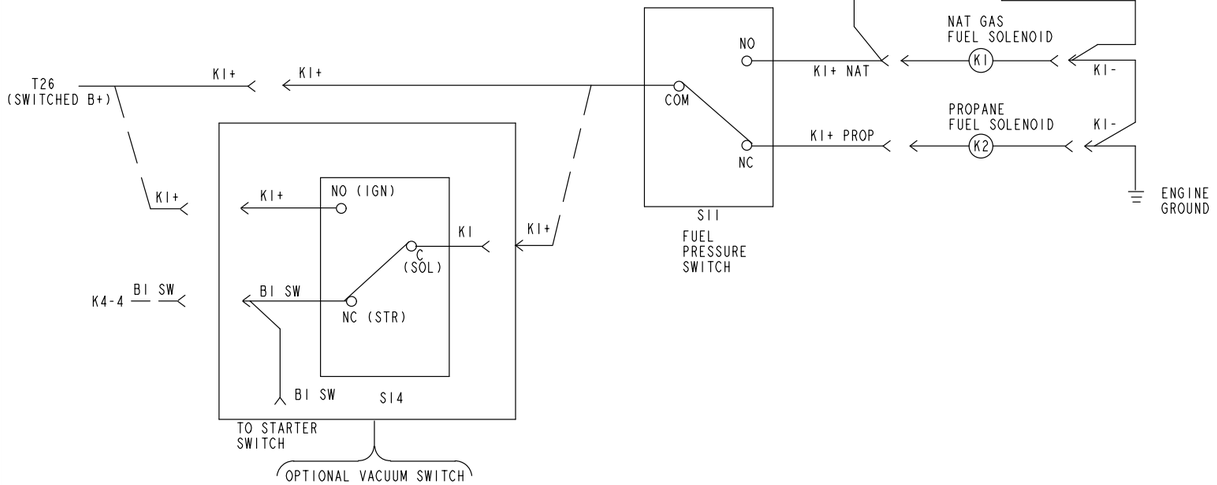


REF: HARNESS 0338-3667

DUAL FUEL 2.5L 4 CYL — GGDB SPEC D



REF: DUAL FUEL HARNESS 0338-3816



REF: HARNESS 0338-3667

No. 612-6733 sh 9 of 9
Rev. N
Modified 11-02

DC CONTROL WIRING, SHEET 9 OF 9

TB1-10 (SWITCHED B+ OUTPUT) 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) FUSED AT 20 AMPS

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

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

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 (WHEN USED)

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

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

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*

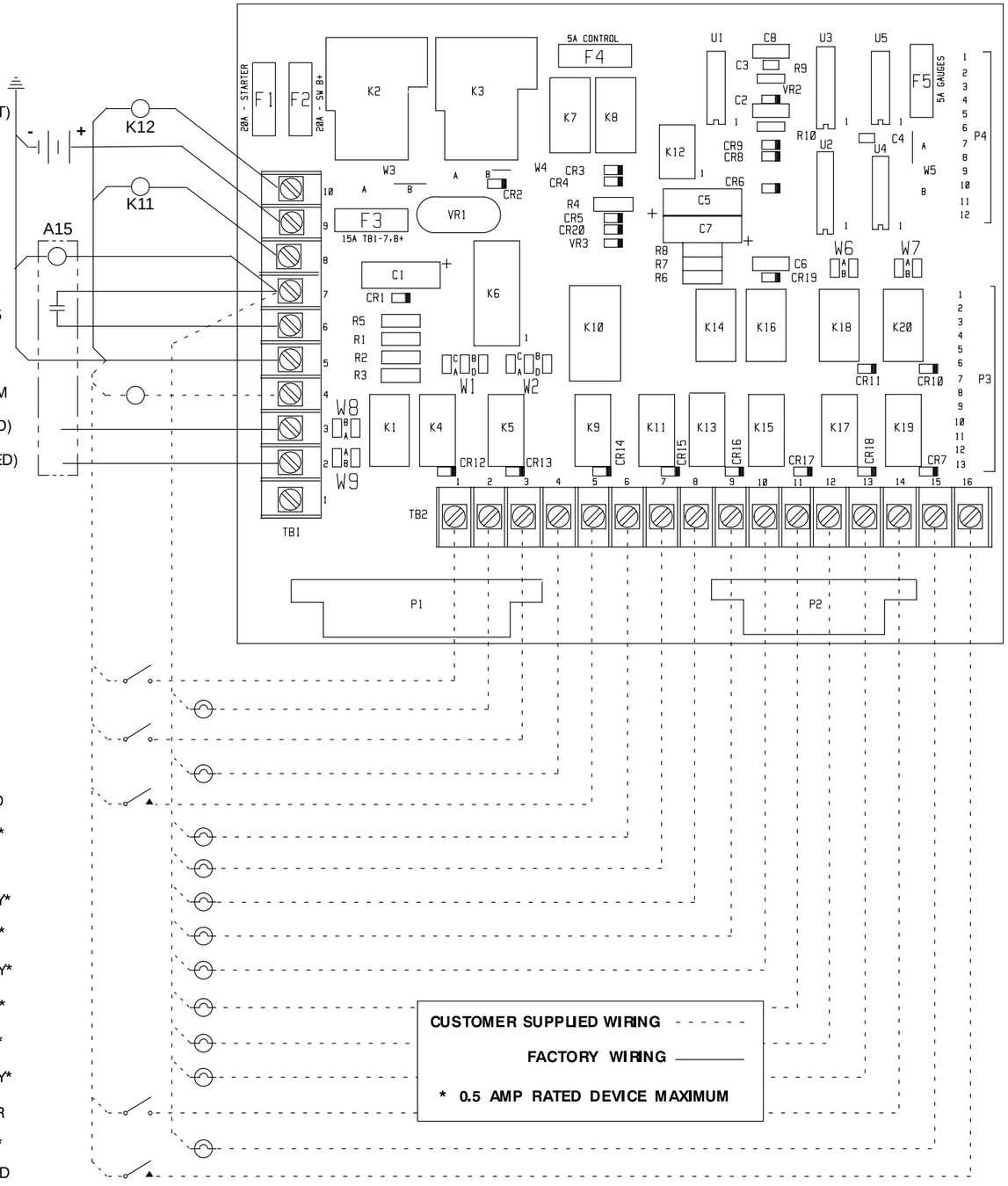
TB2-12 (SWITCH OFF WARNING) GROUND OUTPUT TO LIGHT/RELAY*

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

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

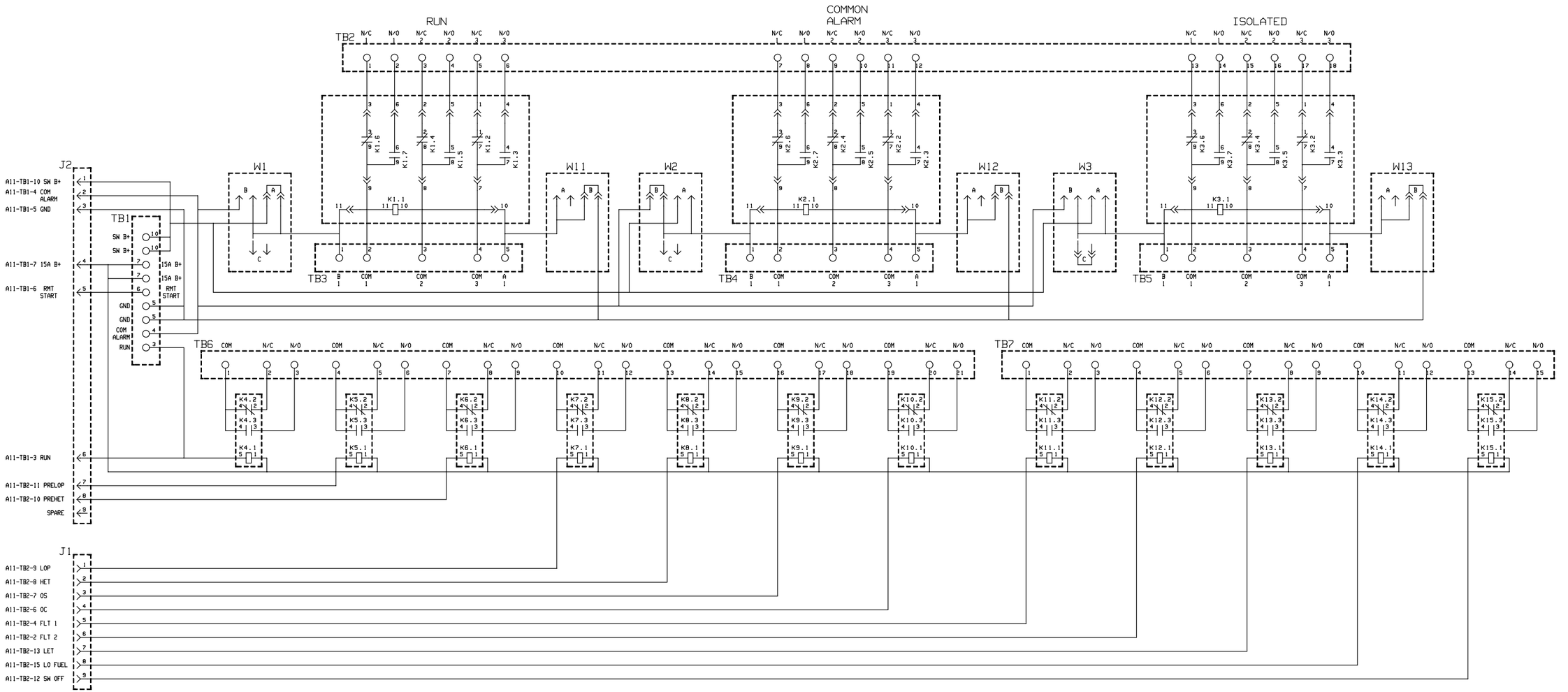
TB2-15 (LOW FUEL WARNING) GROUND OUTPUT TO LIGHT/RELAY*

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



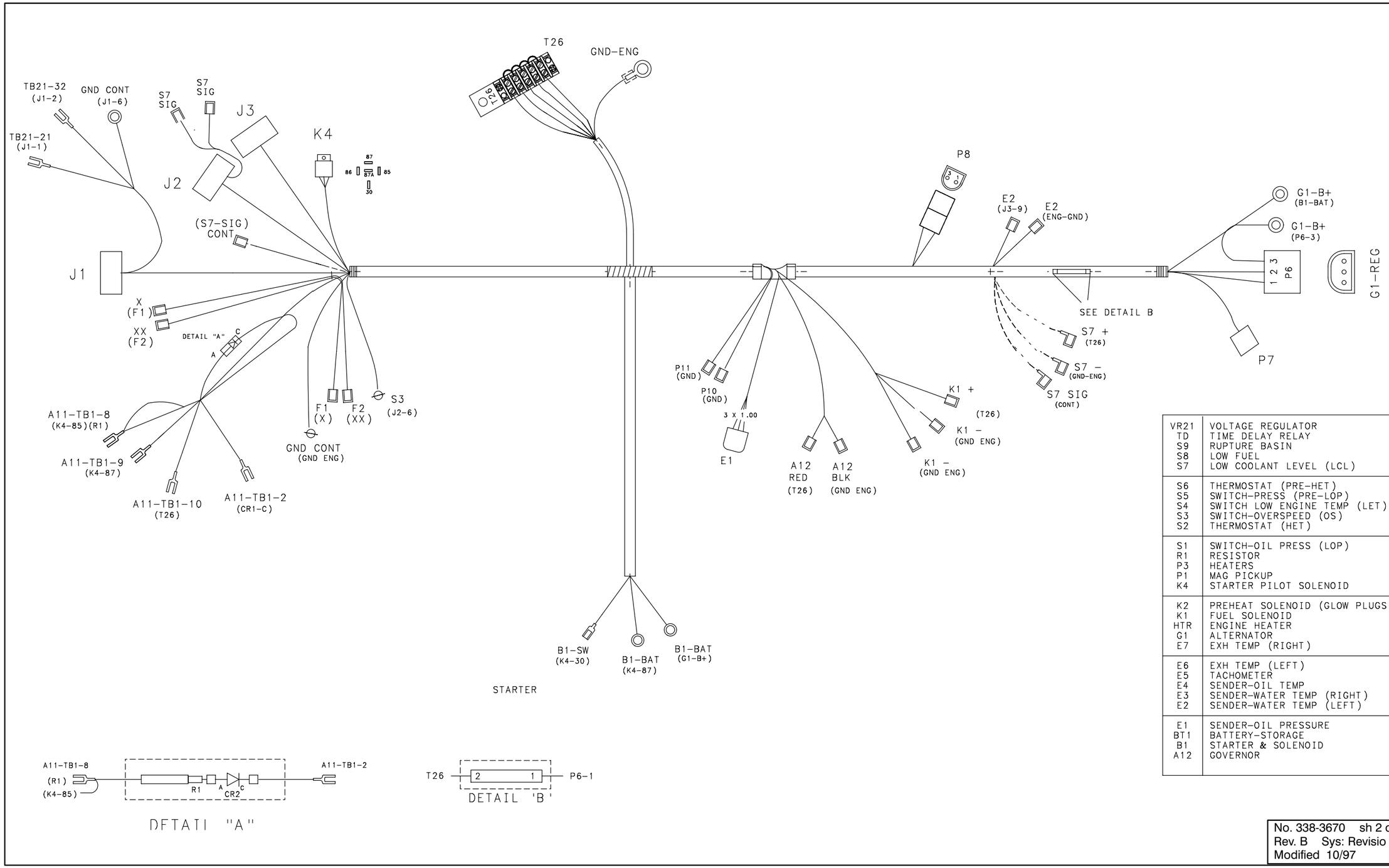
TYPICAL CUSTOMER CONNECTIONS AT THE ENGINE CONTROL MONITOR (ECM)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



No. 300-4111
Rev. B
Modified

AUXILIARY RELAY BOARD (ARB)



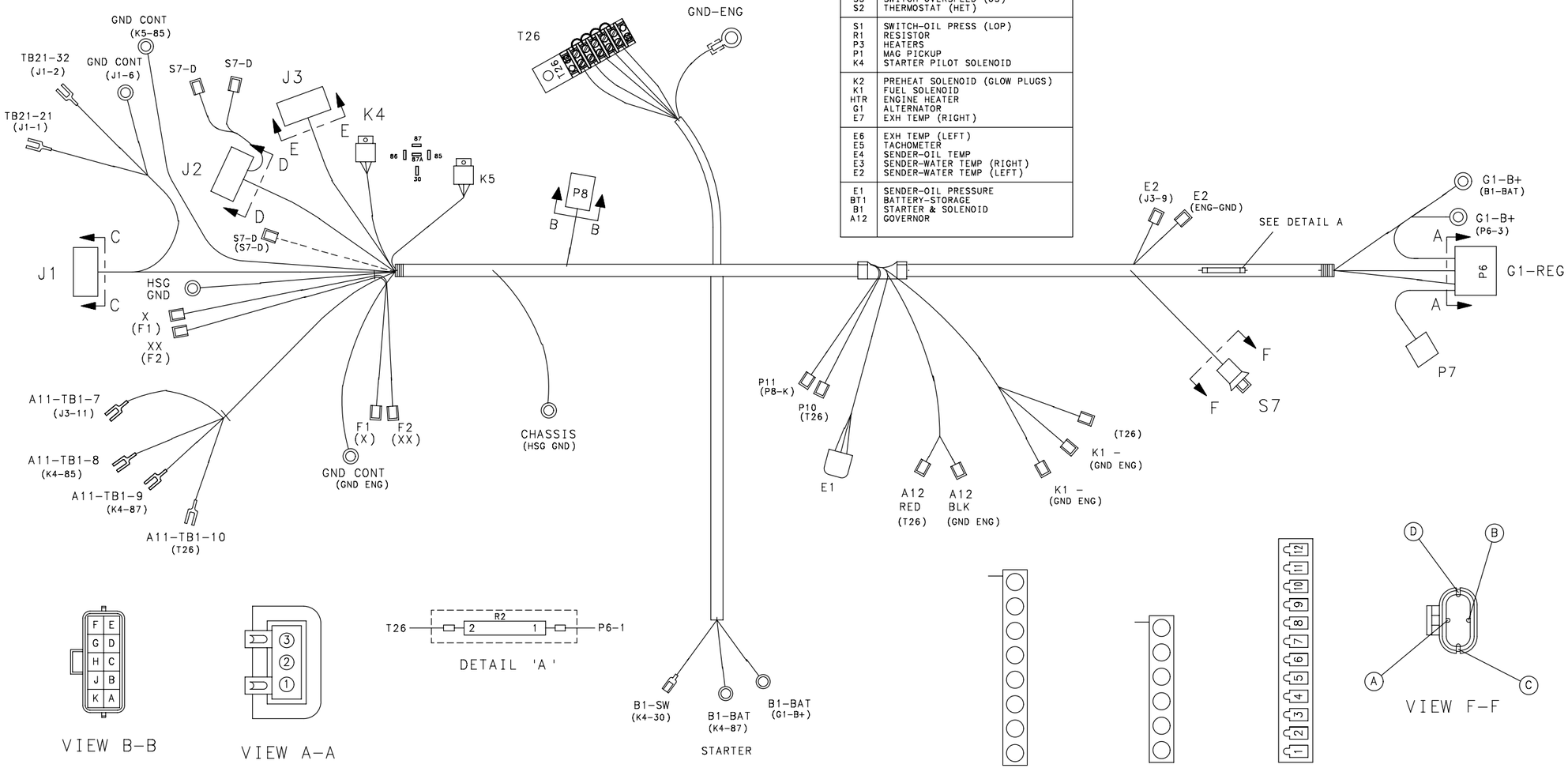
VR21	VOLTAGE REGULATOR
TD	TIME DELAY RELAY
S9	RUPTURE BASIN
S8	LOW FUEL
S7	LOW COOLANT LEVEL (LCL)
S6	THERMOSTAT (PRE-HET)
S5	SWITCH-PRESS (PRE-LOP)
S4	SWITCH LOW ENGINE TEMP (LET)
S3	SWITCH-OVERSPEED (OS)
S2	THERMOSTAT (HET)
S1	SWITCH-OIL PRESS (LOP)
R1	RESISTOR
P3	HEATERS
P1	MAG PICKUP
K4	STARTER PILOT SOLENOID
K2	PREHEAT SOLENOID (GLOW PLUGS)
K1	FUEL SOLENOID
HTR	ENGINE HEATER
G1	ALTERNATOR
E7	EXH TEMP (RIGHT)
E6	EXH TEMP (LEFT)
E5	TACHOMETER
E4	SENDER-OIL TEMP
E3	SENDER-WATER TEMP (RIGHT)
E2	SENDER-WATER TEMP (LEFT)
E1	SENDER-OIL PRESSURE
BT1	BATTERY-STORAGE
B1	STARTER & SOLENOID
A12	GOVERNOR

No. 338-3670 sh 2 of 2
Rev. B Sys: Revisio
Modified 10/97

ENGINE HARNESS (DETECTOR) (SPEC A & B)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

VR21	VOLTAGE REGULATOR
TD	TIME DELAY RELAY
S9	RUPTURE BASIN
S8	LOW FUEL
S7	LOW COOLANT LEVEL (LCL)
S6	THERMOSTAT (PRE-HET)
S5	SWITCH-PRESS (PRE-LOP)
S4	SWITCH LOW ENGINE TEMP (LET)
S3	SWITCH-OVERSPEED (OS)
S2	THERMOSTAT (HET)
S1	SWITCH-OIL PRESS (LOP)
R1	RESISTOR
P3	HEATERS
P1	MAG PICKUP
K4	STARTER PILOT SOLENOID
K2	PREHEAT SOLENOID (GLOW PLUGS)
K1	FUEL SOLENOID
HTR	ENGINE HEATER
G1	ALTERNATOR
E7	EXH TEMP (RIGHT)
E6	EXH TEMP (LEFT)
E5	TACHOMETER
E4	SENDER-OIL TEMP
E3	SENDER-WATER TEMP (RIGHT)
E2	SENDER-WATER TEMP (LEFT)
E1	SENDER-OIL PRESSURE
BT1	BATTERY-STORAGE
B1	STARTER & SOLENOID
A12	GOVERNOR



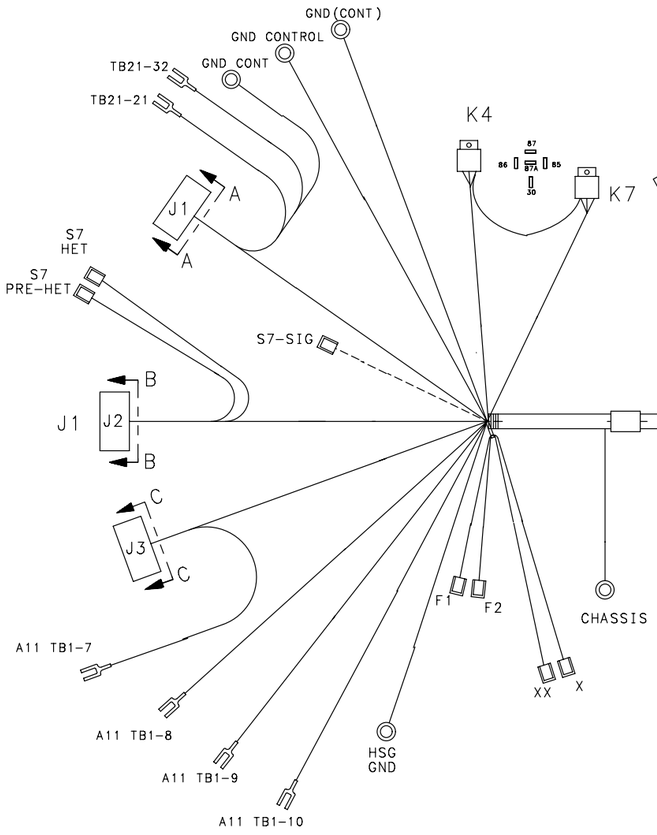
LEAD TABULATION	
FROM	TO
A11 TB1-9	K4-87
B1-BAT	G1 B+
A11 TB1-10	T26
J3-11	A11-TB1-7
J1-1	TB21-21
J1-2	TB21-32
J1-6	GND CONT
J1-7	J3-6
J1-8	J3-7
J2-1	J3-1
J2-2	J3-4
J2-3	J3-2
	S7-D
J2-4	J3-5
J2-5	J3-3
	S7-D
K5-87	P8-D
K1 +	T26
P8-A	T26
A11 TB1-8	K4-85
B1-BAT	K4-87
S7-C	T26
E1-1	T26
T26	A12 RED
J3-9	E2
J3-10	E1-4
J3-12	GND-ENG
GND CONTROL	
A12 BLACK	
E1-2	
K4-86	
K1-	
K1-	
S7-B	
P8-G	
E2	
P6-3	G1-B+
T26	P8-J
K4-30	B1-SW
R2-1	P6-1
R2-2	T26
P6-2	P7
S7-D	S7-D
F1	X
F2	XX
HSG GND	CHASSIS
T26	P10
T26	P8-E
P11	P8-K
K5-30	J2-6
GND CONT	K5-85
J1-5	K5-86
	P8-C

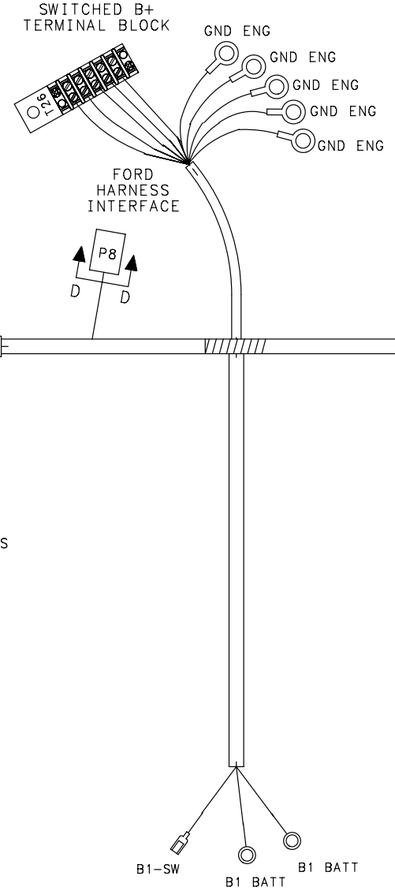
No. 338-3796 sh 2 of 2
Rev. E
Modified 10-01

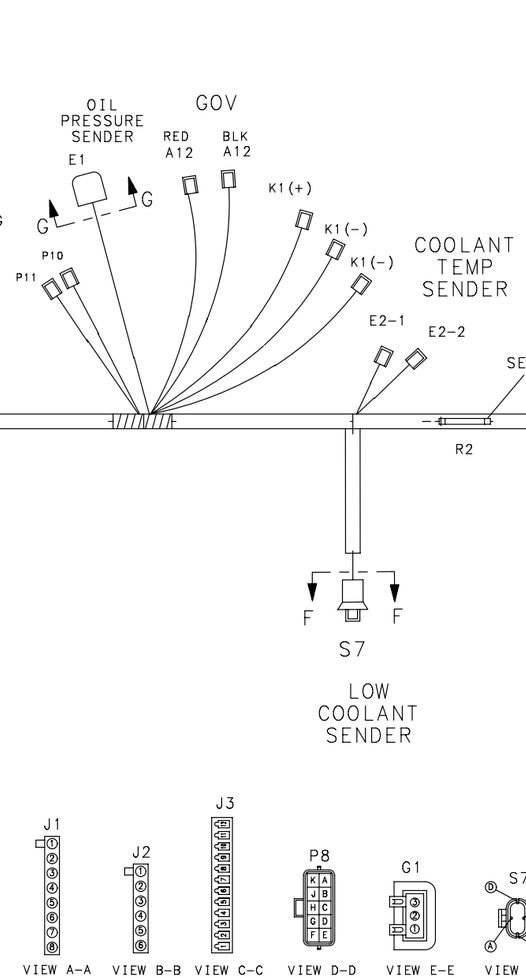
ENGINE HARNESS (DETECTOR) (SPEC C)

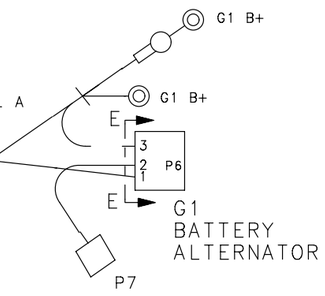
THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

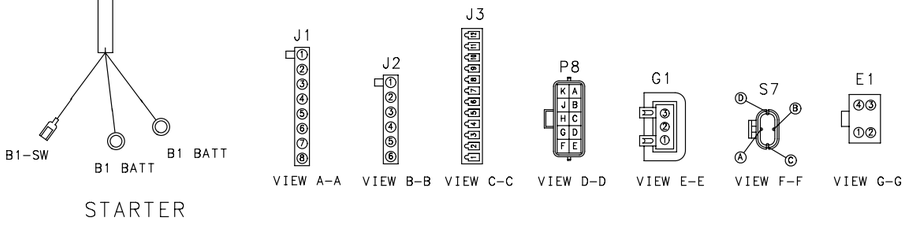
T26	SWITCHED B+ TERMINALS
S7	LOW COOLANT LEVEL SENSOR
PREHET	PRE HIGH ENGINE TEMP
PB	IGNITION HARNESS CONNECTION
MPU	MAG PICKUP
K7	FUEL SELECT RELAY
K4	STARTER PILOT RELAY
K1	FUEL SOLENOID
HET	HIGH ENGINE TEMP
G1	ENGINE ALTERNATOR
E2	SENDER-WATER TEMP
E1	SENDER-OIL PRESSURE
BATT	BATTERY
B1	STARTER & SOLENOID
A12	GOVERNOR
A11	ENGINE MONITOR BOARD

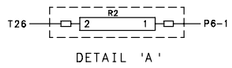










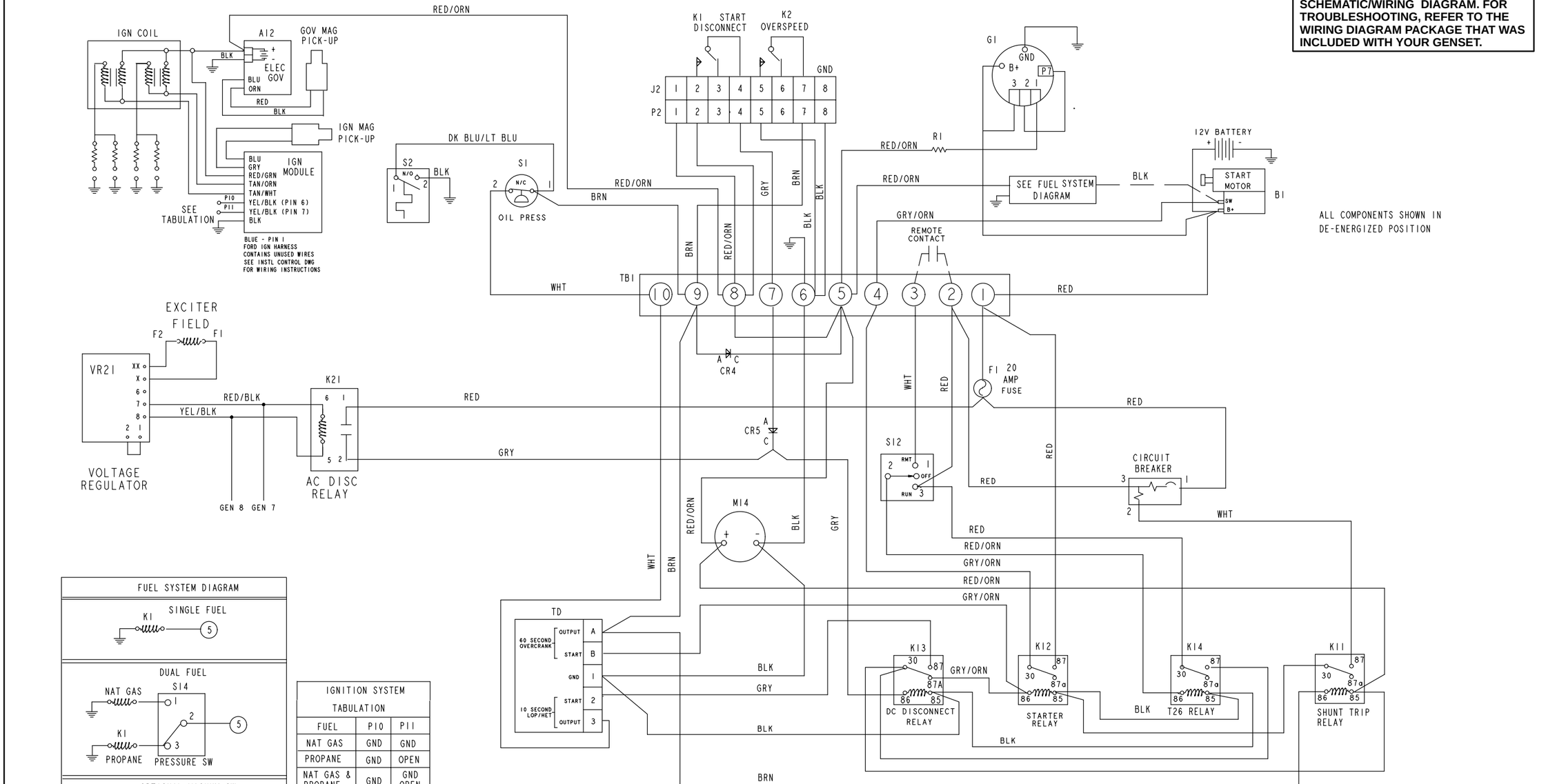


LEAD TABULATION	
FROM	TO
A11 TB1-9	K4-1
B1 BATT	G1 B+
A11 TB1-10	T26
J3-11	A11 TB1-7
J1-1	TB21-21
J1-2	TB21-32
J1-6	GND (CONT)
J1-7	J3-6
J1-8	J3-7
J2-1	J3-1
J2-2	J3-4
J2-3	J3-2
	S7 PRE-HET
J2-4	J3-5
J2-5	J3-3
	S7 HET
K7-87A	P8-K
K1 +	T26
P8-A	K7-87
A11 TB1-8	K4-6
B1 BATT	K4-1
S7-C	T26
E1-1	T26
T26	A12 RED
J3-9	E2-1
J3-10	E1-4
J3-12	GND-ENG
GND CONTROL	
A12 BLACK	GND-ENG
E1-2	
K4-5	GND-ENG
K1(-)	
K1(-)	GND-ENG
S7-B	
P8-G	GND-ENG
E2-2	
P6-3	G1 B+
T26	P8-J
K4-4	B1 SW
R2-1	P6-1
R2-2	T26
P6-2	P7
S7-D	S7-SIG
F1	X
F2	XX
HSG GND	CHASSIS
T26	P10
T26	P8-E
P11	K7-86
P8-B	J2-6
GND (CONT)	K7-85
K7-30	
J1-5	P8-C

No. 338-4298 sh 2 of 2
Rev. A
Modified 11-02

ENGINE HARNESS (DETECTOR) (BEGIN SPEC D)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION

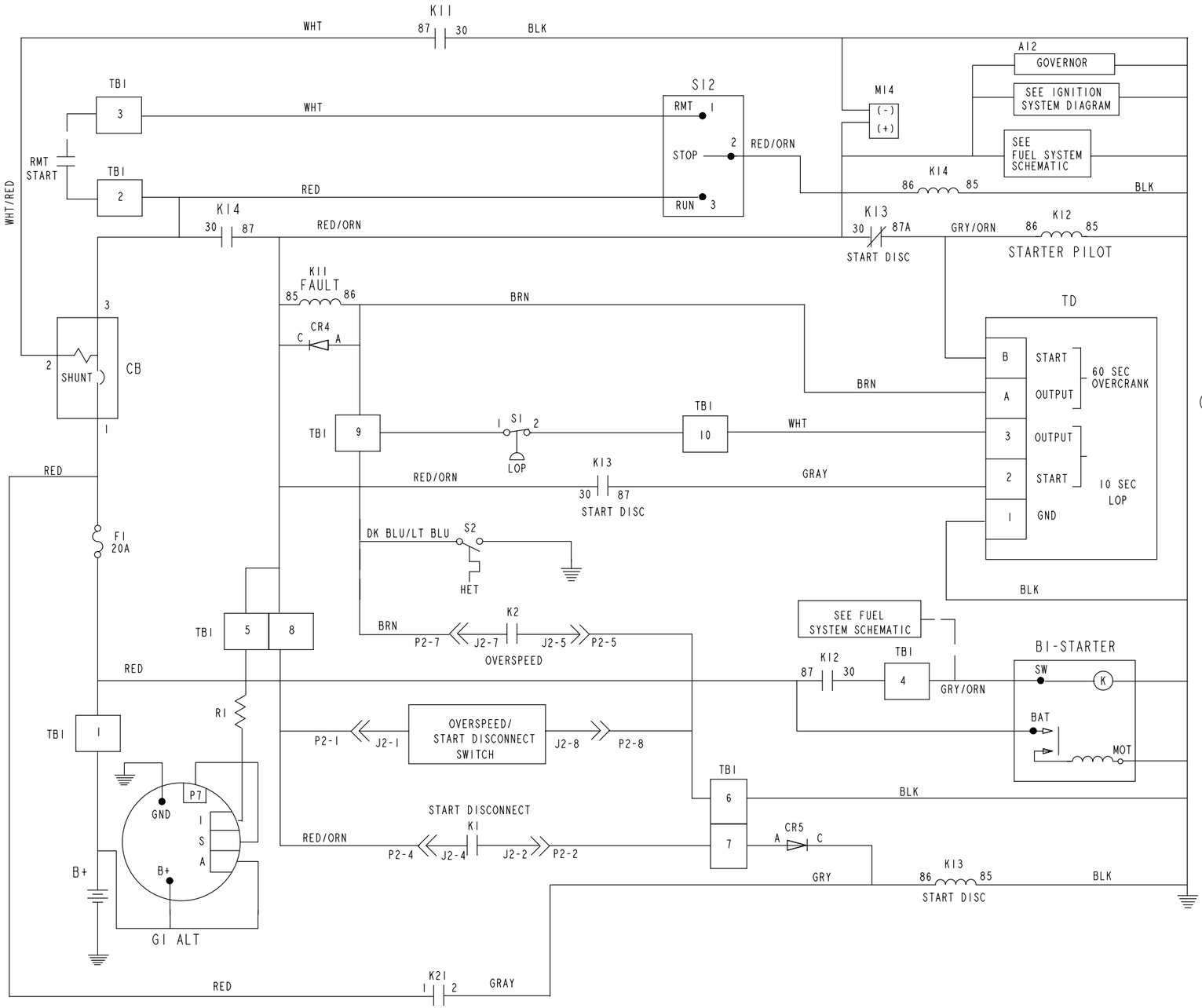
FUEL SYSTEM DIAGRAM

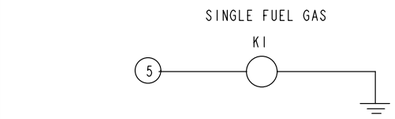
IGNITION SYSTEM TABULATION		
FUEL	P10	P11
NAT GAS	GND	GND
PROPANE	GND	OPEN
NAT GAS & PROPANE	GND	GND OPEN
LP LIQUID	GND	OPEN
NAT GAS & LP LIQUID	GND	GND OPEN

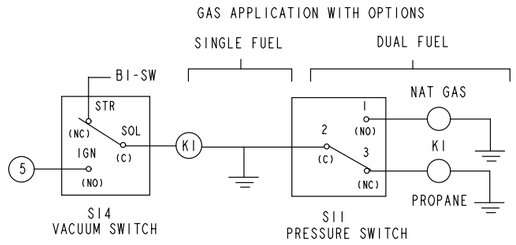
No. 612-6719 sh 2 of 3
Rev. D Sys: Revisio
Modified 1-98

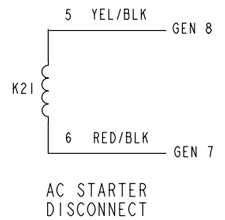
DC WIRING DIAGRAM (SPEC A)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.







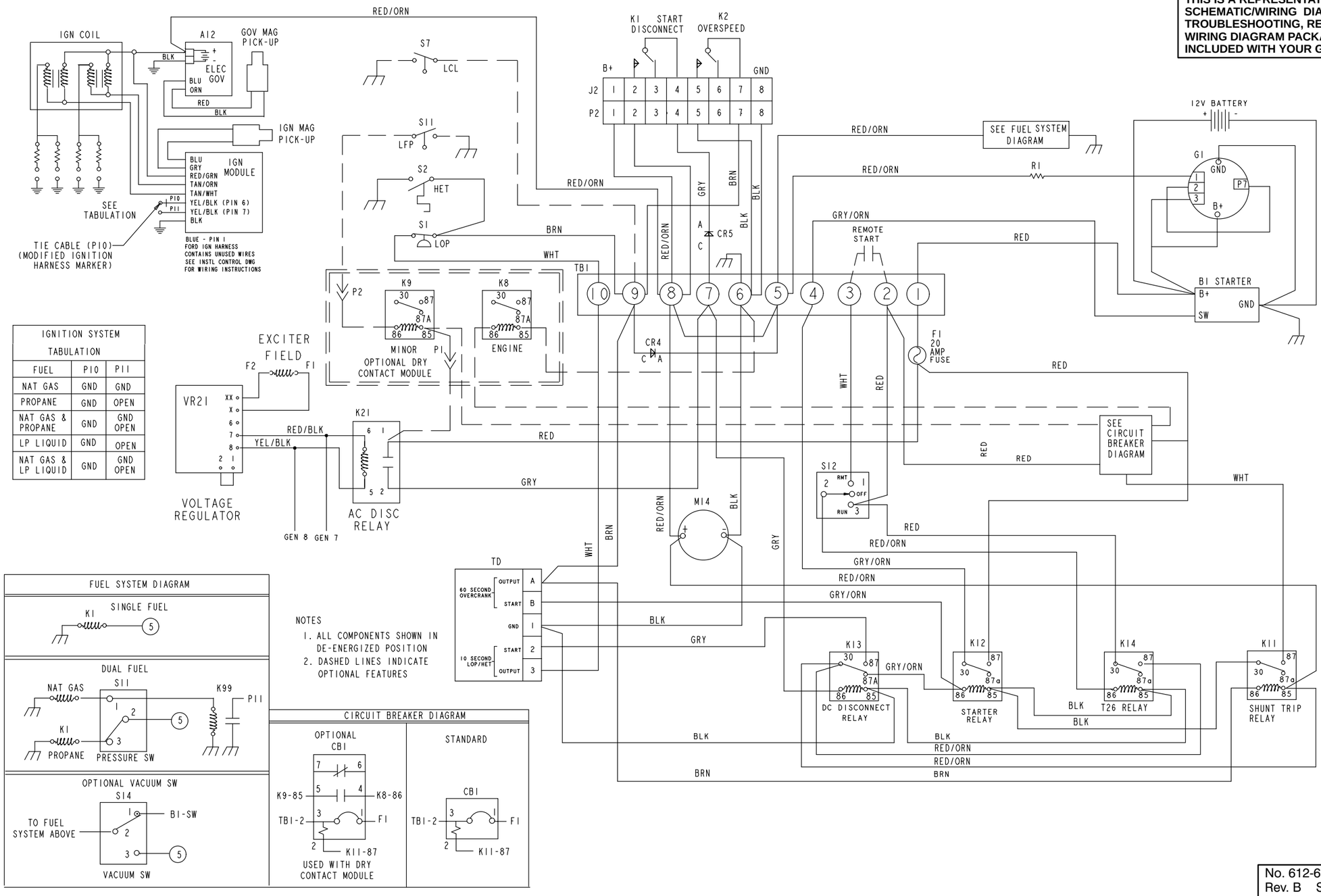


ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION.

No. 612-6719 sh 3 of 3
Rev. D Sys: Revisio
Modified 1/98

DC WIRING DIAGRAM (SPEC A)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



IGNITION SYSTEM TABULATION		
FUEL	P10	P11
NAT GAS	GND	GND
PROPANE	GND	OPEN
NAT GAS & PROPANE	GND	GND OPEN
LP LIQUID	GND	OPEN
NAT GAS & LP LIQUID	GND	GND OPEN

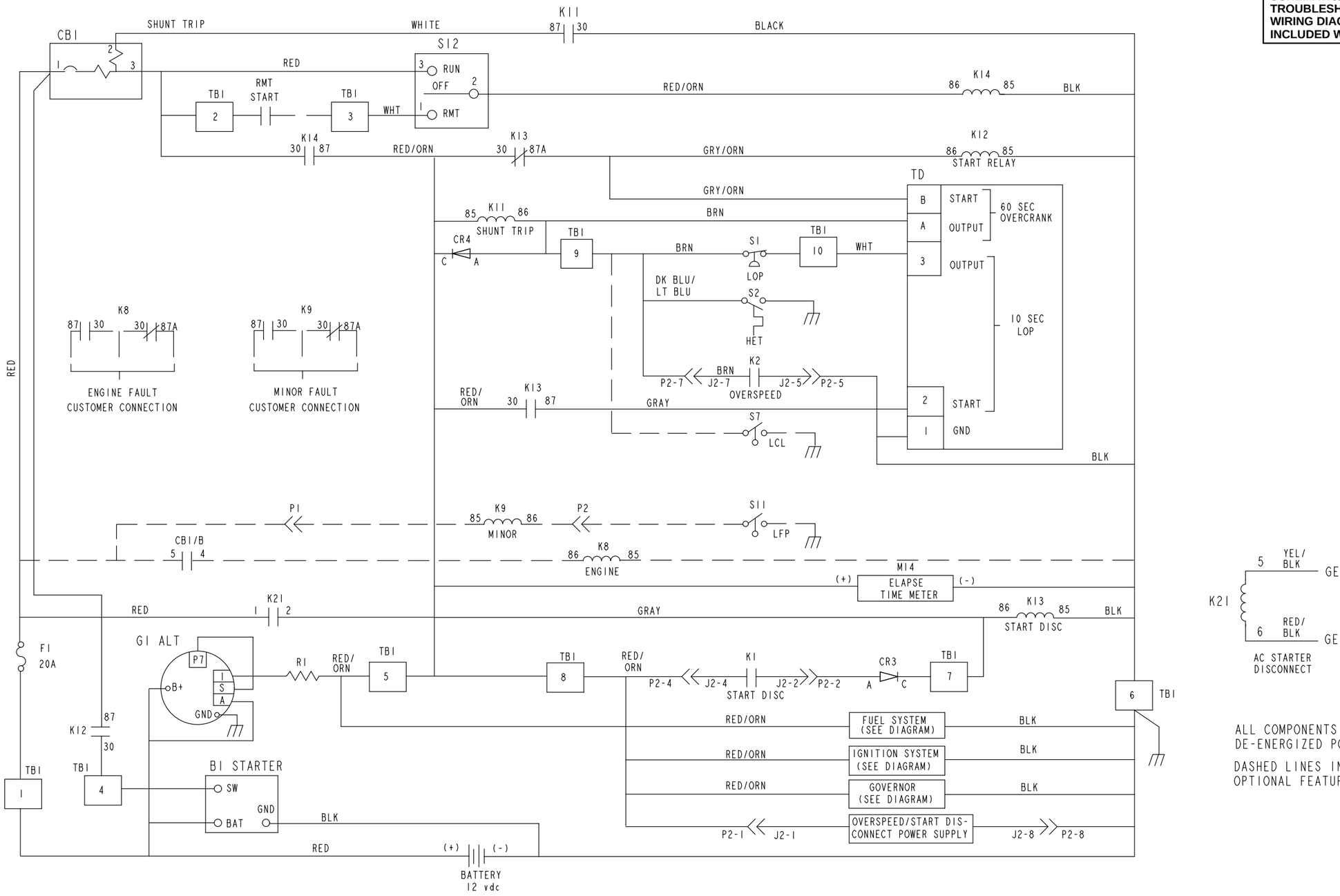
NOTES

1. ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION
2. DASHED LINES INDICATE OPTIONAL FEATURES

No. 612-6736 sh 2 of 3
Rev. B Sys: Revisio
Modified 9/98

DC WIRING DIAGRAM (SPEC B)

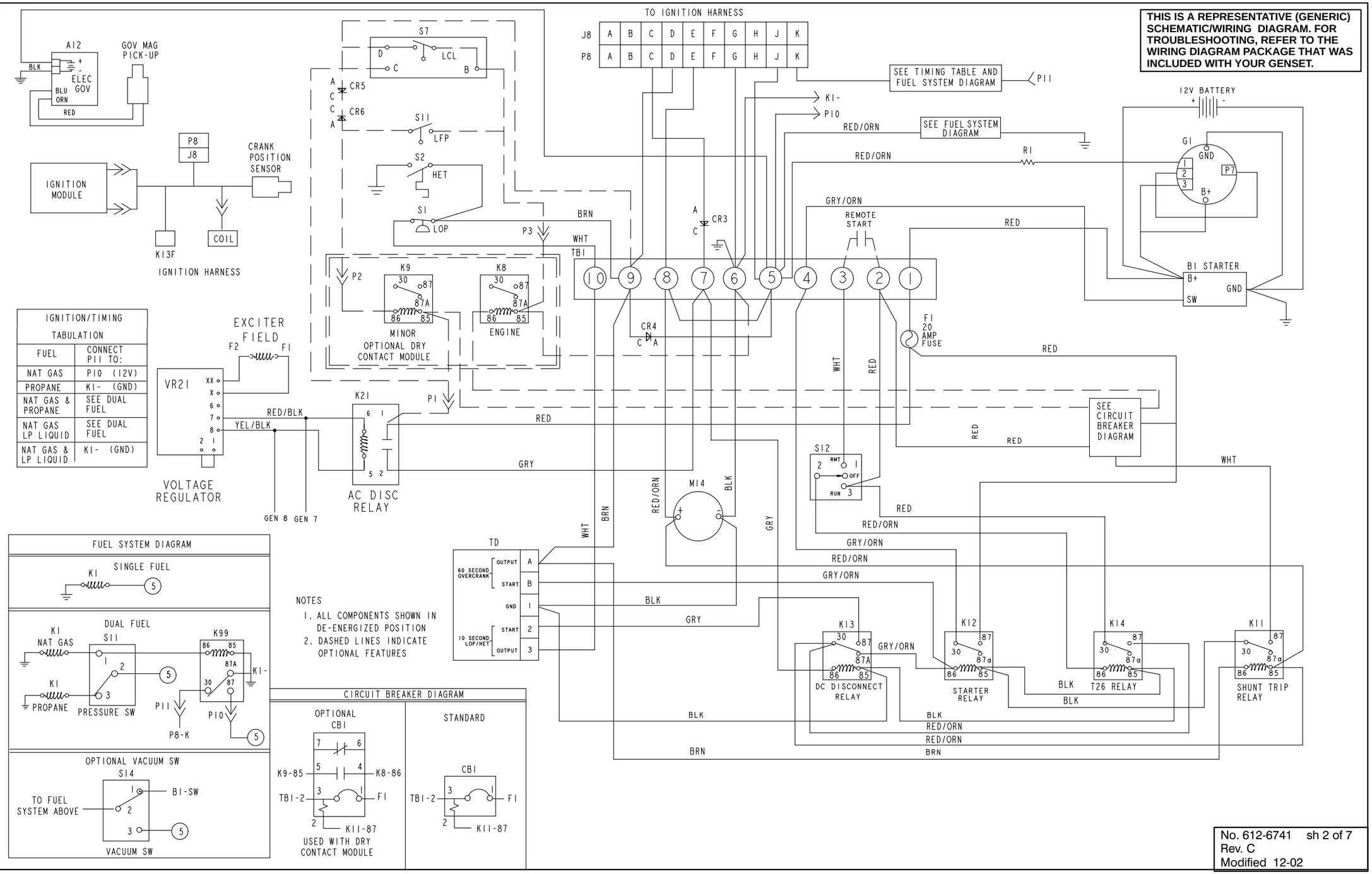
THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



No. 612-6736 sh 3 of 3
Rev. B Sys: Revisio
Modified 9/98

DC WIRING DIAGRAM (SPEC B)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



IGNITION/TIMING TABULATION	
FUEL	CONNECT P11 TO:
NAT GAS	P10 (12V)
PROPANE	K1- (GND)
NAT GAS & PROPANE	SEE DUAL FUEL
NAT GAS LP LIQUID	SEE DUAL FUEL
NAT GAS & LP LIQUID	K1- (GND)

FUEL SYSTEM DIAGRAM

NOTES

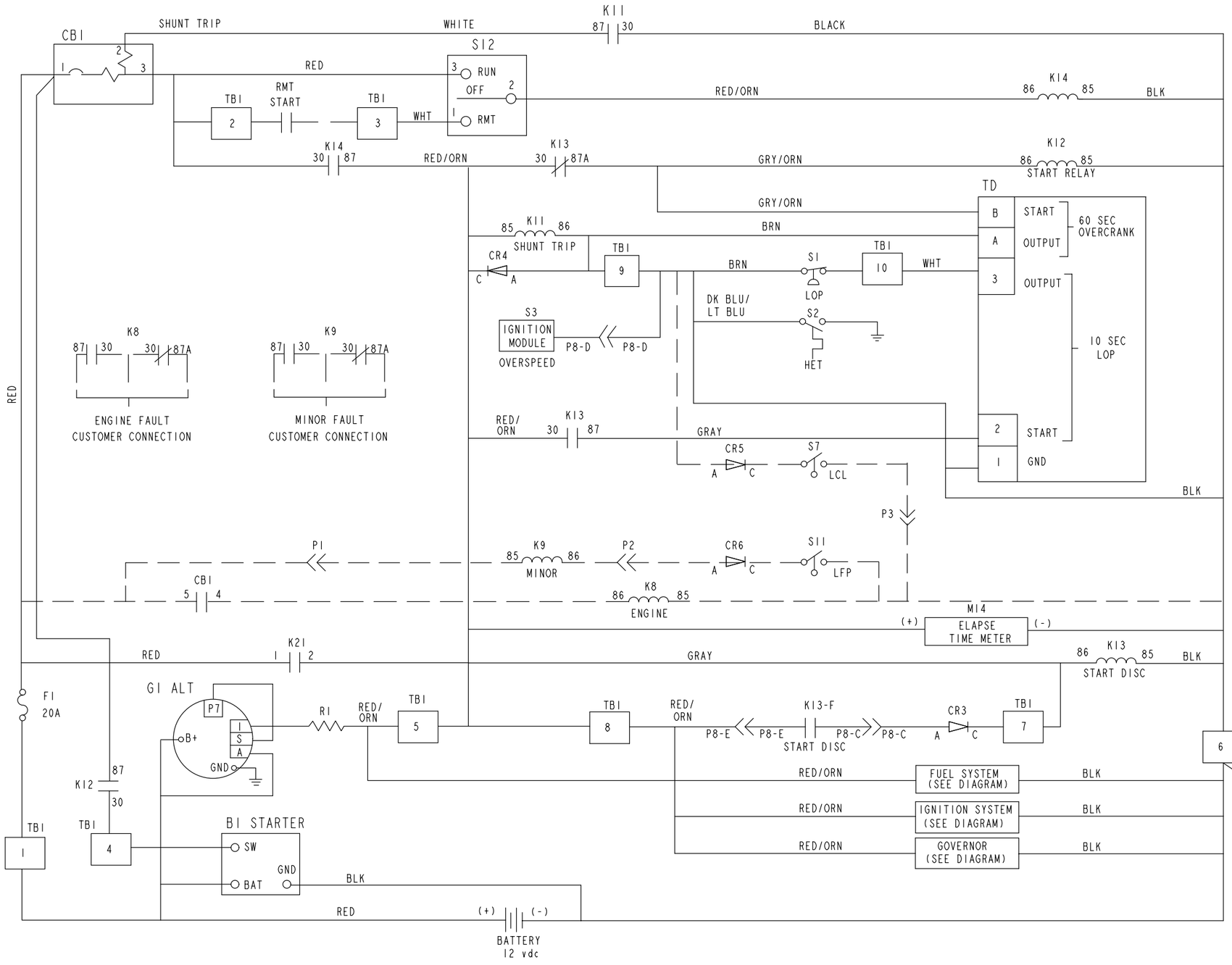
1. ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION
2. DASHED LINES INDICATE OPTIONAL FEATURES

CIRCUIT BREAKER DIAGRAM

No. 612-6741 sh 2 of 7
Rev. C
Modified 12-02

DC WIRING DIAGRAM (SPEC C)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



DESIGNATION	
B1	STARTER MOTOR
CB1	CIRCUIT BREAKER
CR1,2	RECTIFIER
F1	FUSE
G1	GENERATOR
K1	FUEL SOLENOID
K11	RELAY-SHUNT TRIP
K12	RELAY-STARTER
K13	RELAY-DISCONNECT
K13F	RELAY (IGN HARNESS)
K14	RELAY-SW B+
K15	RELAY-PRE HEAT
K21	RELAY-AC DISCONNECT
S1	SWITCH-OIL PRESSURE
S2	SWITCH-HI TEMP
S3	IGNITION MODULE
S6	OVERSPEED
S7	LOW COOLANT LEVEL
S8	LOW FUEL PRESSURE
S9	BASIN FAULT
S11	LOW FUEL PRESSURE
S12	SWITCH-ON-OFF
S15	SWITCH-PRE HEAT
TB1	TERMINAL BLOCK
TD	RELAY-TIME DELAY
VR21	VOLTAGE REGULATION
VR1	VOLTAGE REGULATION

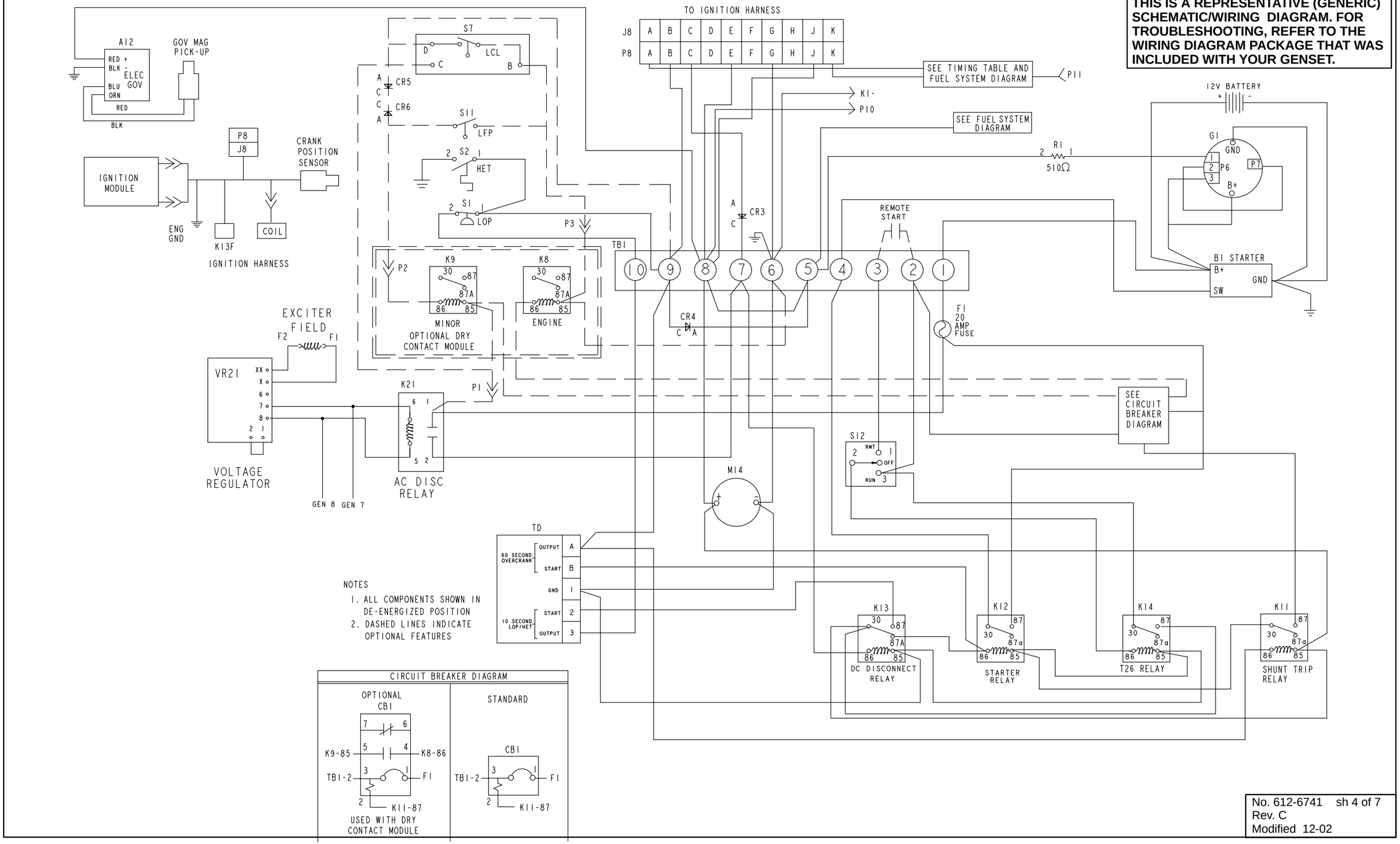
ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION.

DASHED LINES INDICATE OPTIONAL FEATURES

No. 612-6741 sh 3 of 7
Rev. C
Modified 12-02

DC WIRING DIAGRAM (SPEC C)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

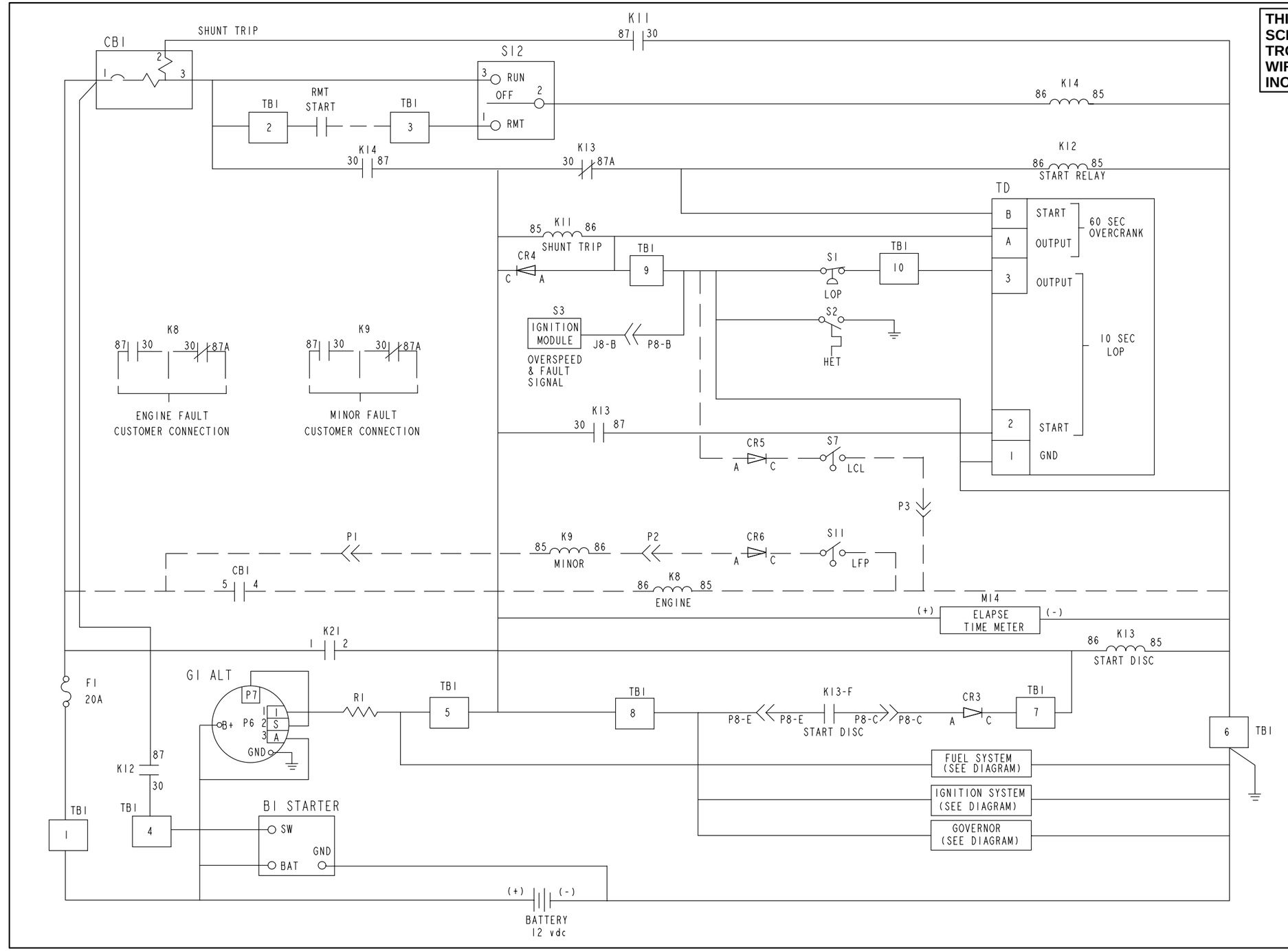


No. 612-6741 sh 4 of 7
Rev. C
Modified 12-02

DC WIRING DIAGRAM (BEGIN SPEC D)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

DESIGNATION	
B1	STARTER MOTOR
CB1	CIRCUIT BREAKER
CR1,2	RECTIFIER
F1	FUSE
G1	GENERATOR
K1	FUEL SOLENOID
K11	RELAY-SHUNT TRIP
K12	RELAY-STARTER
K13	RELAY-DISCONNECT
K13F	RELAY (IGN HARNESS)
K14	RELAY-SW B+
K15	RELAY-PRE HEAT
K21	RELAY-AC DISCONNECT
S1	SWITCH-OIL PRESSURE
S2	SWITCH-HI TEMP
S3	IGNITION MODULE
S6	OVERSPEED
S7	LOW COOLANT LEVEL
S8	LOW FUEL PRESSURE
S9	BASIN FAULT
S11	LOW FUEL PRESSURE
S12	SWITCH-ON-OFF
S15	SWITCH-PRE HEAT
TB1	TERMINAL BLOCK
TD	RELAY-TIME DELAY
VR21	VOLTAGE REGULATION
VR1	VOLTAGE REGULATION



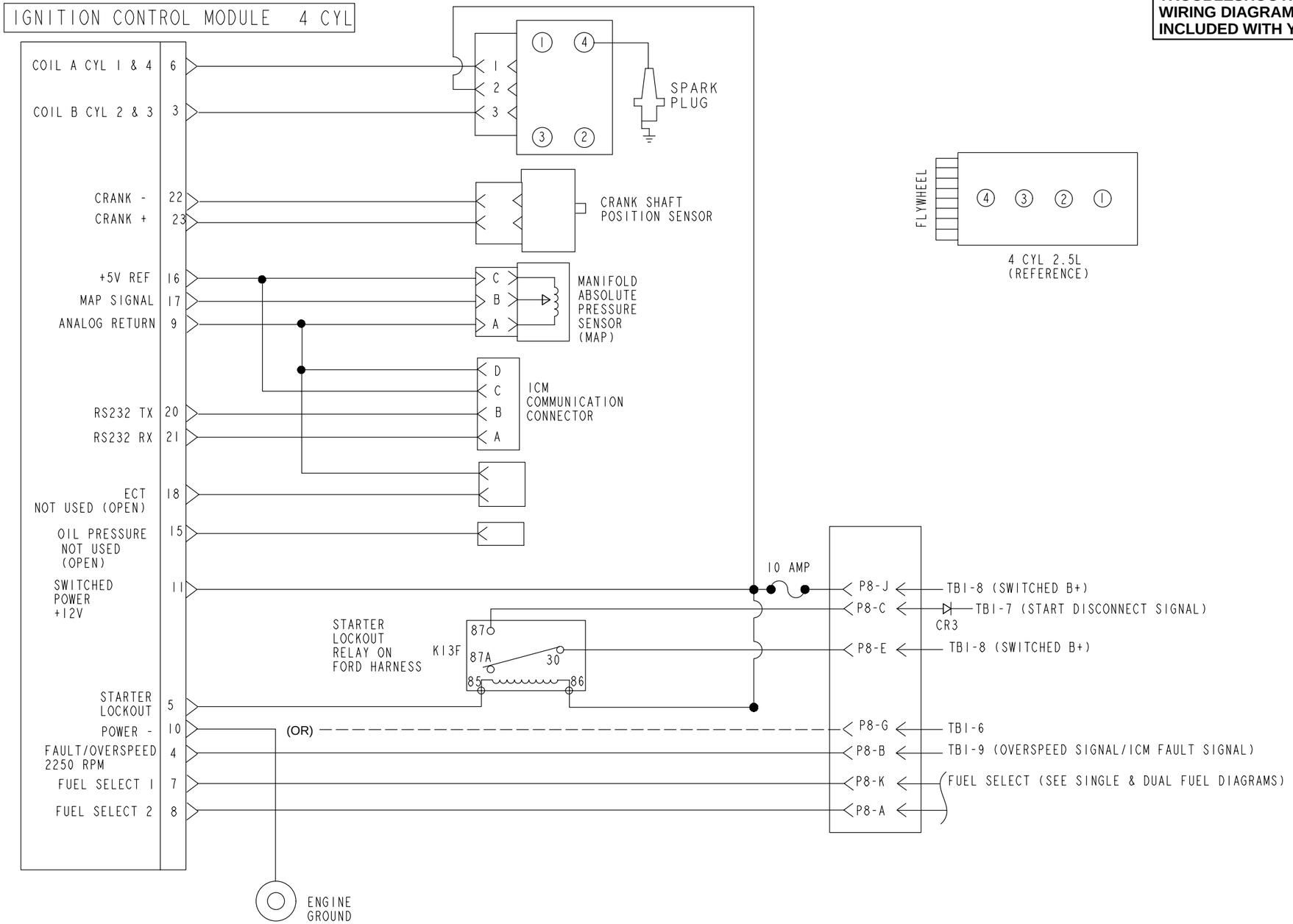
No. 612-6741 sh 5 of 7
Rev. C
Modified 12-02

DC WIRING DIAGRAM (BEGIN SPEC D)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

GGDB SPEC D

IGNITION CONTROL MODULE 4 CYL



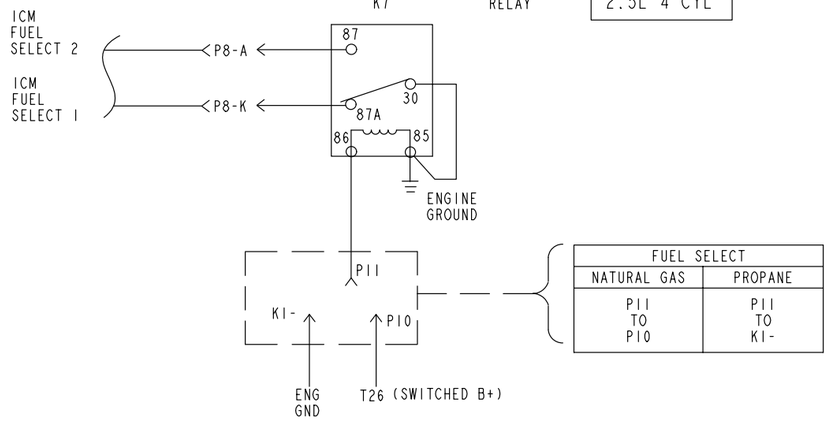
No. 612-6741 sh 6 of 7
Rev. C
Modified 12-02

DC WIRING DIAGRAM (BEGIN SPEC D)

GGDB SPEC D

FUEL SELECT RELAY

SINGLE FUEL
2.5L 4 CYL



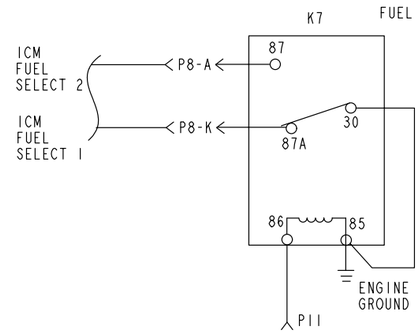
FUEL SELECT	
NATURAL GAS	PROPANE
P11 TO P10	P11 TO K1-

REF: HARNESS 0338-3667

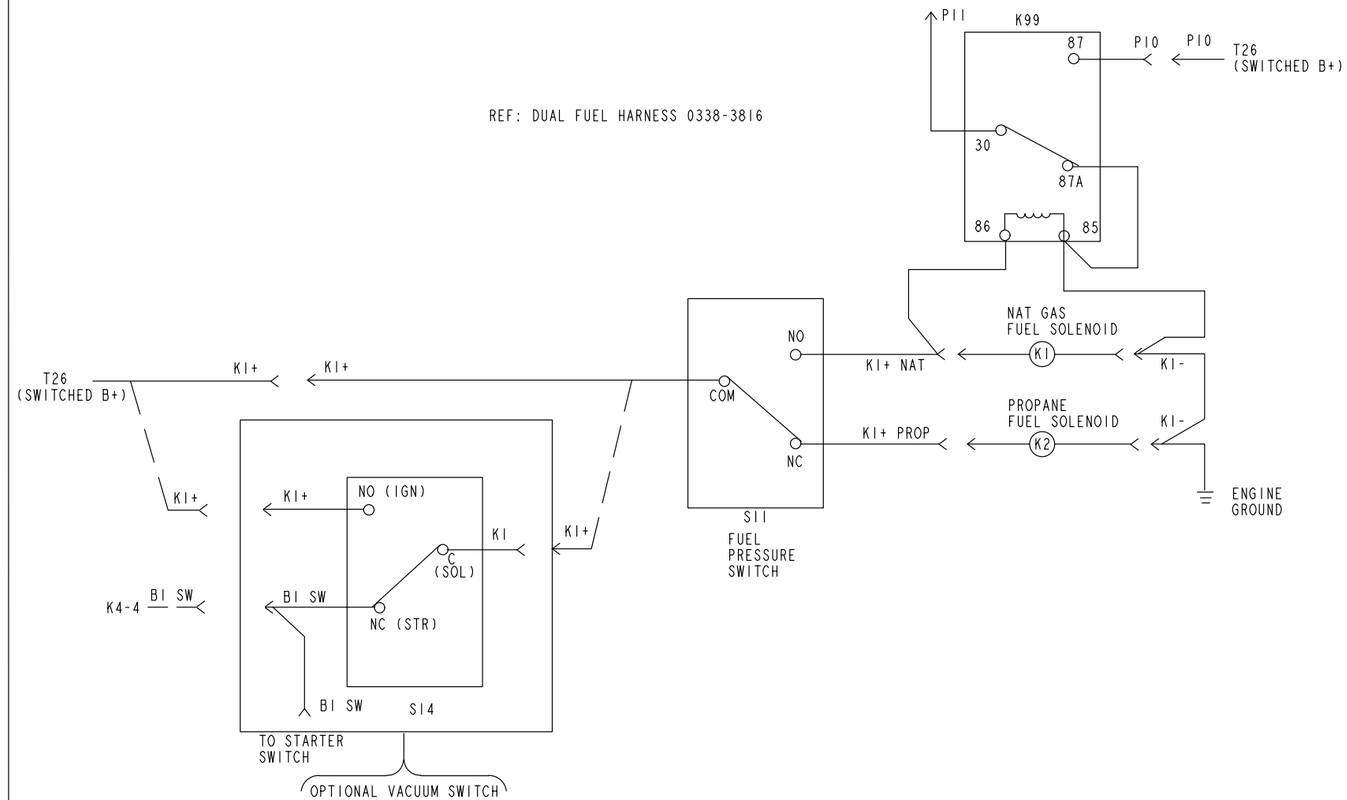
GGDB SPEC D

DUAL FUEL
2.5L 4 CYL

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



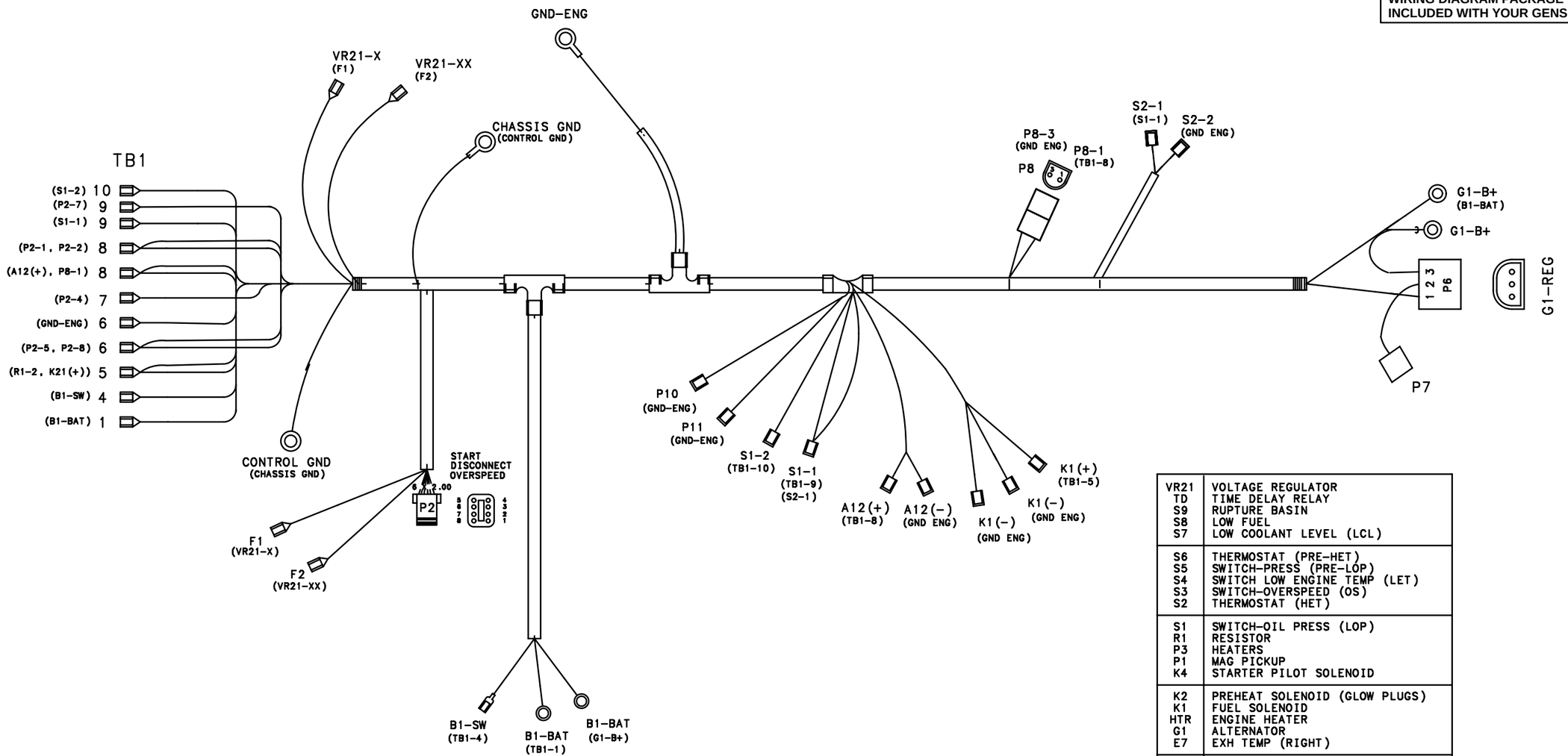
REF: DUAL FUEL HARNESS 0338-3816



REF: HARNESS 0338-3667

No. 612-6741 sh 7 of 7
Rev. C
Modified 12-02

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

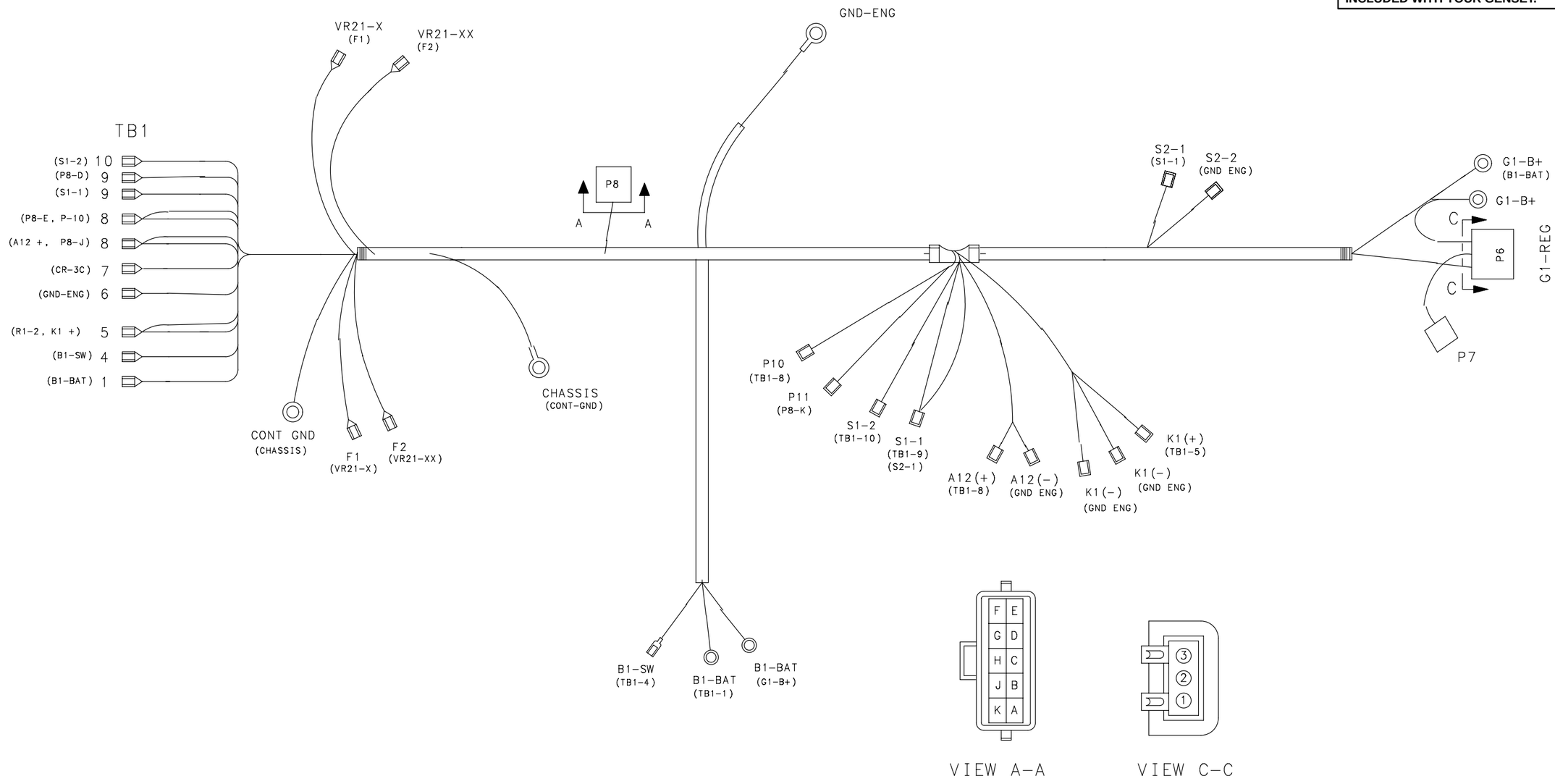


VR21	VOLTAGE REGULATOR
TD	TIME DELAY RELAY
S9	RUPTURE BASIN
S8	LOW FUEL
S7	LOW COOLANT LEVEL (LCL)
S6	THERMOSTAT (PRE-HET)
S5	SWITCH-PRESS (PRE-LOP)
S4	SWITCH LOW ENGINE TEMP (LET)
S3	SWITCH-OVERSPEED (OS)
S2	THERMOSTAT (HET)
S1	SWITCH-OIL PRESS (LOP)
R1	RESISTOR
P3	HEATERS
P1	MAG PICKUP
K4	STARTER PILOT SOLENOID
K2	PREHEAT SOLENOID (GLOW PLUGS)
K1	FUEL SOLENOID
HTR	ENGINE HEATER
G1	ALTERNATOR
E7	EXH TEMP (RIGHT)
E6	EXH TEMP (LEFT)
E5	TACHOMETER
E4	SENDER-OIL TEMP
E3	SENDER-WATER TEMP (RIGHT)
E2	SENDER-WATER TEMP (LEFT)
E1	SENDER-OIL PRESSURE
BT1	BATTERY-STORAGE
B1	STARTER & SOLENOID
A12	GOVERNOR

No. 338-3669 sh 2 of 2
Rev. B Sys: Revisio
Modified 11/97

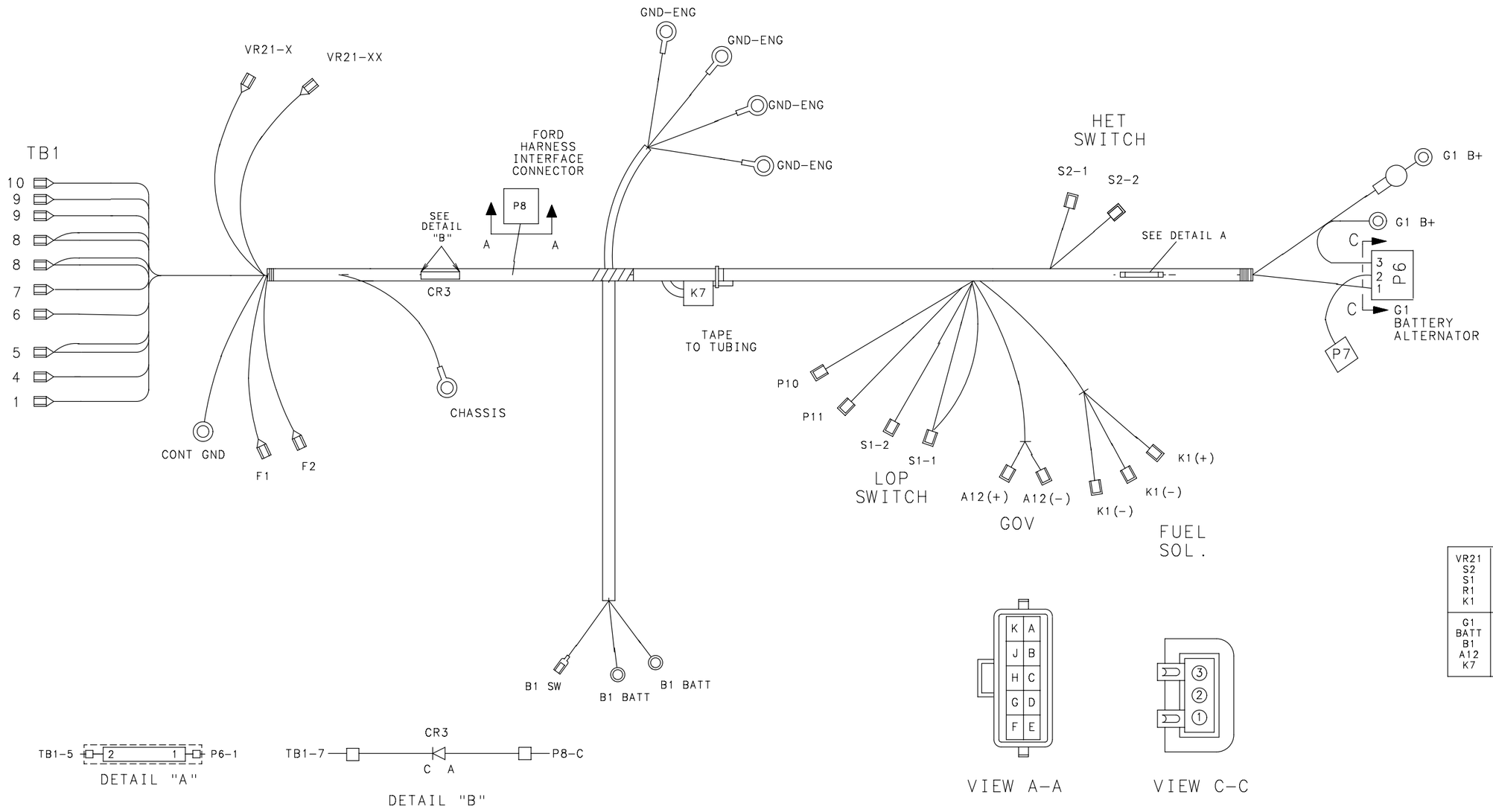
ENGINE HARNESS (SPEC A & B)

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



No. 338-3795 sh 2 of 2
Rev. C Sys: Revisio
Modified 12/99

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.



LEAD TABULATION	
FROM	TO
TB1-1	B1 BATT
TB1-4	B1 SW
TB1-5	R1-2
	K1 (+)
K7-87A	P8-K
K7-87	P8-A
TB1-7	CR3-C
TB1-8	P8-E
	P10
TB1-8	A12 (+)
	P8-J
TB1-9	S1-1
S2-1	
TB1-10	S1-2
VR21-X	F1
VR21-XX	F2
TB1-6	GND-ENG
S2-2	GND-ENG
A12 (-)	
P8-G	GND-ENG
K1 (-)	
K1 (-)	GND-ENG
K7-85	
	K7-30
R1-1	P6-1
P7	P6-2
G1 B+	P6-3
G1 B+	B1 BATT
TB1-9	P8-B
CONT-GND	CHASSIS
CR3-A	P8-C
K7-86	P11

VR21	VOLTAGE REGULATOR
S2	THERMOSTAT (HET)
S1	SWITCH-OIL PRESS (LOP)
R1	RESISTOR
K1	FUEL SOLENOID
G1	ALTERNATOR
BATT	BATTERY-STORAGE
B1	STARTER & SOLENOID
A12	GOVERNOR
K7	FUEL SELECT RELAY

No. 338-4299 sh 2 of 2
Rev. A
Modified 11-02

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
1-800-888-6626
763-574-5000 International Use
Fax: 763-528-7229

Power Generation

Power Generation