Onan

Service Manual

GenSet Models:

DFAA
DFAB
DFAC

DFBC NT4
DFBD NT4
DFBE NT5
DFBF NT6
DFCB NTA2
DFCC NTA3

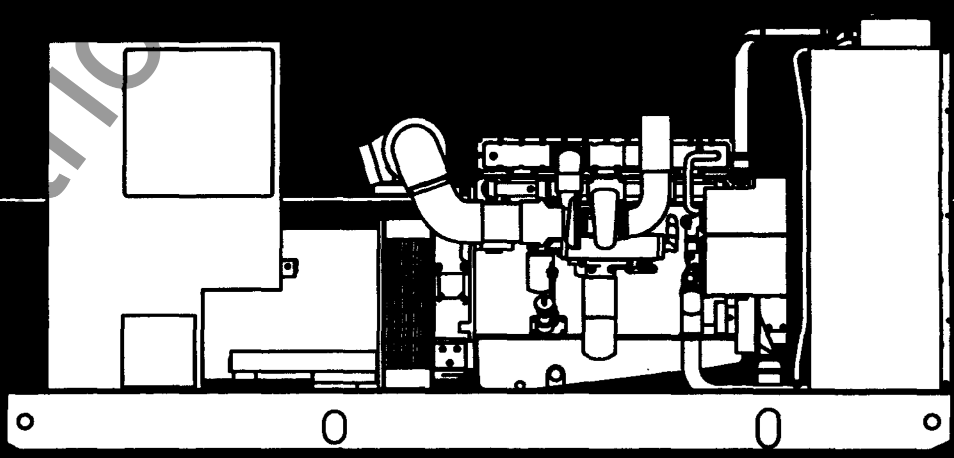
DFEB KTA12
DFEC
DFFA KTT11
DFFB KTT12

DFGA VTA1
DFGB VTA2
DFGC VTA3

DFJA KTA31
DFJB KTA32
DFJC KTA33
DFJD

DFLA KTA51
DFLB KTA52
DFLC KTA53
DFLD KTA54
DFMA KTT51
DFMB KTT52

GENERATOR AND CONTROL



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Contents

Safety Precautions

Before operating the generator set, 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.
- Be sure all fuel supplies have a positive shutoff valve.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

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. Ensure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

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 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 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.

HIGH VOLTAGE GENERATOR SETS (1.9kV to 15kV)

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

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- 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.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- 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.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

Section 1. Introduction

ABOUT THIS MANUAL

This manual provides troubleshooting and repair information regarding the controls and generators used on the following generator sets.

GENERATOR SET			
MODEL DESIGNATIONS		KW RATING	
		50 Hz	60 Hz
DFAA		175	200
DFAB		200	230
DFAC		220	250
DFBC	NT4	175	200
DFBD	NT4	175	200
DFBD	NT4	200	230
DFBE	NT5	220	250
DFBF	NT6	250	275
DFCB	NTA2	275	300
DFCC	NTA3	310	350
DFEB	KTA12	330	400
DFEC		400	450
DFFA	KTT11	400	450
DFFB	KTT12	450	500
DFGA	VTA1	440	500
DFGB	VTA2		600
DFGC	VTA3	550	
DFJA	KTA31	620	750
DFJB	KTA32	660	800
DFJC	KTA33	800	900
DFJD		900	1000
DFLA	KTA51	900	1000
DFLB	KTA52		1100
DFLC	KTA53	1120	1250
DFLD	KTA54	1200	
DFMA	KTT51	1100	1250
DFMB	KTT52	1280	1500

For further operation, service, and troubleshooting information regarding engine components, refer to support manuals specific to your generator set.

Study this manual carefully and observe all warnings and cautions. Be sure to review *Safety Precautions*, on pages ii and iii. Using the generator set properly and following a regular maintenance schedule is important to obtain longer unit life, better performance, and safer operation.

For proper replacement parts identification, refer to appropriate Parts Manual supplied with unit.

Repair of printed circuit board components other than fuses requires well-trained, qualified personnel with the proper equipment; repair of the printed circuit boards is not recommended except by the factory. Application of meters or hot soldering irons to printed circuit boards by other than qualified personnel can cause unnecessary and expensive damage.

⚠CAUTION ***High voltage testing or high potential (or Megger) testing of generator windings can cause damage to solid state components. Isolate these components before testing.***

For any operation, maintenance, or troubleshooting information beyond the scope of this manual, refer to other manuals received with unit, or contact your distributor.

TEST EQUIPMENT

Most of the test procedures in this manual can be performed with an AC-DC multimeter such as a Simpson Model 260 VOM or a digital VOM. Some other instruments to have available are:

- Battery Hydrometer
- Tachometer or Frequency Meter
- Jumper Leads
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter

HOW TO OBTAIN SERVICE

Always give the complete Model 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 qualified to perform electrical and mechanical service. Read and follow Safety Precautions, on pages ii and iii.***

CONTROLS AND GENERATORS OVERVIEW

General

Depending on customer order, the control options and generator type may differ. Read through this manual to identify the control options, and generator type. A more in-depth description of the control and generator components follow in the *Controls* and *Generator* sections. Read this information well and understand the function of each component.

Also, periodically review this manual and the unit Operator's Manual when no fault condition is present. You will want to become familiar with the generator set component locations, their proper operation and interaction with other components in order to be effective troubleshooting a fault condition, if one occurs.

Control Panel

The control panel is mounted inside the front portion of the generator output box with vibration isolators on both top and bottom. The controls are separated into a DC panel for monitoring the engine and an AC panel for monitoring the generator. See Figure 1-1 and Section 2.

Generator

The generators fitted to this series of generator sets are a Permanent Magnet Generator (PMG) type.

The generators are controlled by an Automatic Voltage Regulator (AVR). The AVR is mounted on the inside, back wall of the control panel. See Figure 1-1 and Section 3.

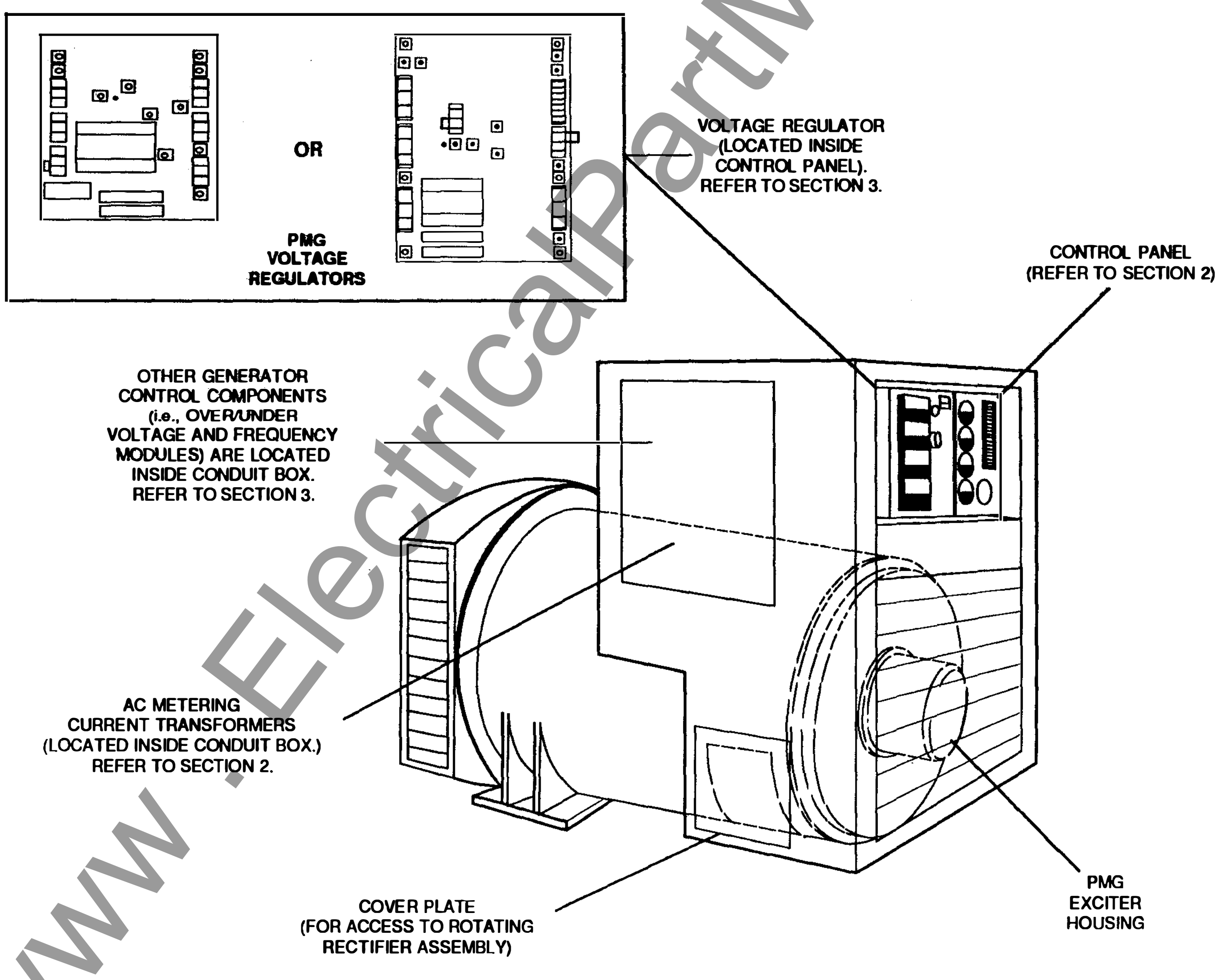


FIGURE 1-1. TYPICAL PMG GENERATOR AND CONTROLS

Section 2. Controls

GENERAL

Depending on customer order, the control configuration and options may differ. This section identifies the control configurations used; Detector-7 and Detector-12 (NFPA) DC Panel, and AC Panel options.

The control panels are separated into an AC panel for monitoring the generator (if equipped with meter options), and a DC panel for monitoring the engine. Review Figure 2-1 to identify the control configuration and options, and refer to Control Descriptions that follow for further information.

CONTROL DESCRIPTIONS

AC Panel

The following describes the function and operation of the optional AC panel for monitoring the generator. Review the following component descriptions and Figure 2-1.

AC Voltmeter (Optional): Dual range instrument indicating generator AC voltage. Measurement range in use shown on indicator lamps.

AC Ammeter (Optional): Dual range instrument indicates AC generator line current. Measurement range in use shown on indicator lamps.

Frequency/RPM Meter (Optional): Indicates generator output frequency in hertz and engine speed in revolutions-per-minute (RPM).

Wattmeter (Optional): Continuously gives reading of the generator output in kilowatts.

Voltage Adjust (Optional): Rheostat providing approximately plus or minus five percent adjustment of the rated output voltage.

Upper and Lower Scale Indicator Lamps (Optional): Indicates which scale to use on the AC voltmeter and AC ammeter.

Phase Selector Switch (Optional): Selects phases of generator output to be measured by AC voltmeter and AC ammeter.

Field Breaker: Provides generator exciter and regulator protection from overheating in the event of an overvoltage fault condition.

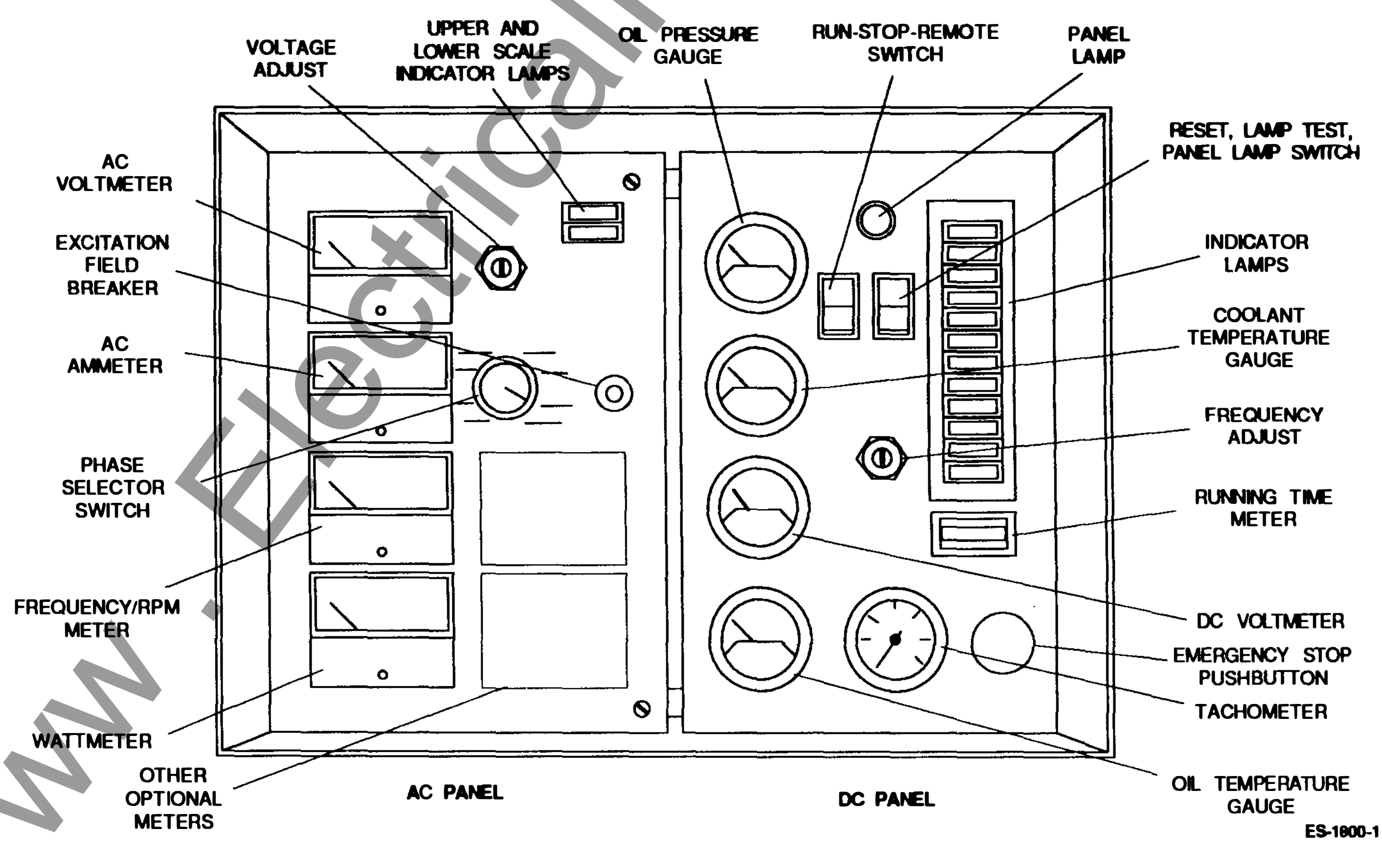


FIGURE 2-1. CONTROLS (DETECTOR-12 AND AC METER OPTIONS SHOWN)

DC Panel

The following describes the function and operation of the DC panel components. The Detector-7 panel is standard, and Detector-12 panel includes options to more effectively monitor the generator set and ancillary equipment during operation. Both controls include pre-alarm monitoring to inform the operator that a shutdown might occur if attention is not given to an aspect of engine operation soon. Review the following component descriptions and Figure 2-1.

Panel Lamp: Illuminates control panel.

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

Water Temperature Gauge: Indicates temperature of circulating coolant in engine (wired to a sensor unit located on the engine).

DC Voltmeter: Indicates the battery condition. Proper reading should be approximately 26 to 28 volts when set is running.

Tachometer (Optional): Provides constant monitoring of engine r/min.

Oil Temperature Gauge (Optional): Indicates temperature of lubricating oil in engine (wired to a sensor unit located on the engine).

Run-Stop-Remote Switch: Starts and stops the unit locally, or from a remote location that is wired to the control engine monitor board.

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

Frequency Adjust (Optional): Potentiometer providing engine speed adjustment to achieve proper AC frequency.

Running Time Meter: Registers the total number of hours the unit has run. Use it to keep a record of periodic servicing. Time is cumulative; meter cannot be reset.

Emergency Stop Pushbutton (Optional): Stops the generator set immediately when depressed. Must be reset (pulled out) before restarting generator set.

Indicator Lamps

Detector-7 Control (Standard): The standard control panel has seven monitor system indicator lamps.

- RUN (green)
- PRE LO OIL PRES (yellow)
- PRE HI ENG TEMP (yellow)
- LO OIL PRES (red)
- HI ENG TEMP (red)
- OVERCRANK (red)
- OVERSPEED (red)

The green Run lamp comes on as soon as both primary and secondary starter circuits are opened after unit starts. The yellow pre-alarm lamps indicate that engine oil pressure is marginally low, or coolant temperature is marginally high, and should be attended to when the generator set is shut down. The red fault lamps indicate a shutdown of the generator set for low oil pressure, high engine temperature, overspeed, or overcrank fault condition.

Detector-12 Control (Optional): The optional control panel has a 12 lamp monitoring system. The following describes each lamp function.

- RUN (green) lamp comes on when both starter circuits are opened after unit starts.
- PRE LO OIL PRES (yellow) indicates engine oil pressure is marginally low.
- PRE HI ENG TEMP (yellow) indicates engine temperature is marginally high.
- LO OIL PRES (red) indicates engine has shut down because of critically low oil pressure.
- HI ENG TEMP (red) indicates engine has shut down because of critically high temperature.
- OVERSPEED (red) indicates engine has shut down because of excessive speed.
- OVERCRANK (red) indicates the starter has been locked out because of excessive cranking time.
- FAULT 1 (red) an undedicated fault. May be programmed as a timed or non-timed shutdown or fault light only (normally factory set for timed shutdown).
- FAULT 2 (red) same features as Fault 1 (normally factory set for non-timed shutdown).
- LOW ENG TEMP (yellow) engine temperature is marginally low for starting. Indicates possible inoperative coolant heater. Lamp lights when engine water jacket temperature is 70° F (21° C) or lower. The lamp may stay on during initial generator set operation, but should go out after the engine warms up.
- LO FUEL (yellow) indicates fuel supply is marginally low (if equipped).
- SWITCH OFF (flashing red) indicates generator set is not in automatic start operation mode.

CONTROL PANEL INTERIOR

Refer to Figure 2-2 for component locations inside control panel. Review the following component descriptions to better understand the operation of the generator set should a fault condition occur. Also refer to Section 5, *Component Tests and Adjustments*, for more in-depth information about these components.

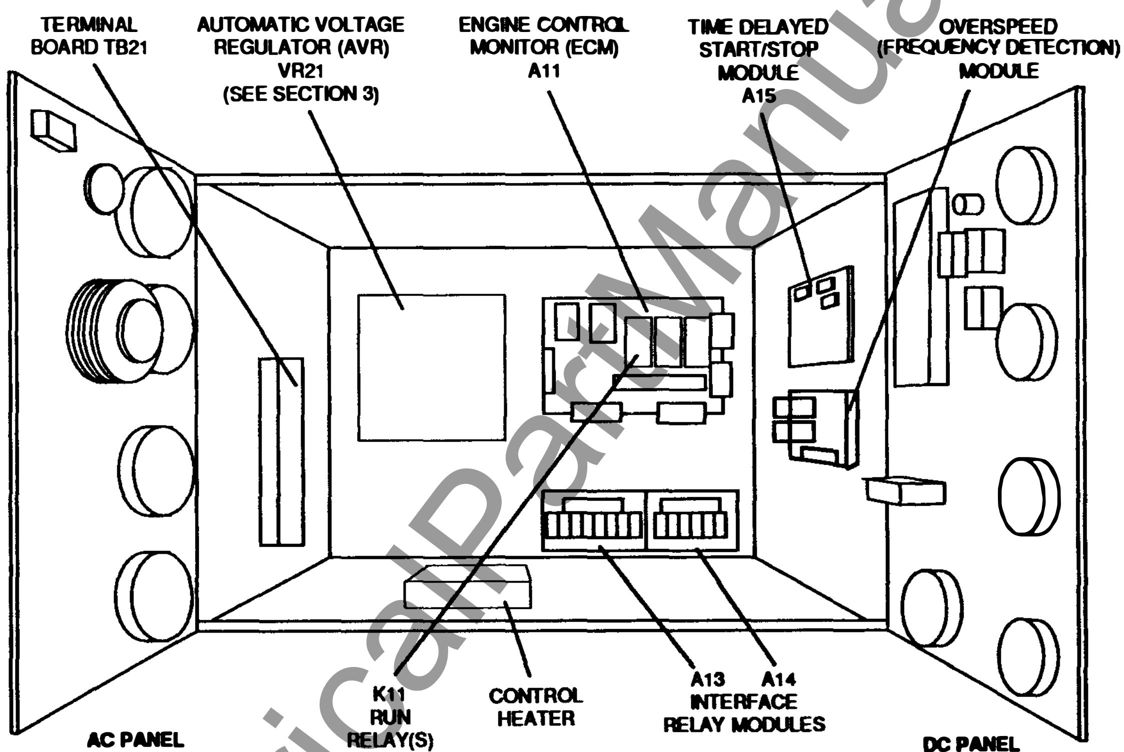


FIGURE 2-2. CONTROL PANEL INTERIOR

Engine Control Monitor

This circuit board assembly contains the basic components for normal engine start-up and shutdown, terminals for remote control interconnection, plug-in connectors for option modules and engine sensor inputs. The ECM provides the following functions of unit protection:

- Overcrank - Limits engine cranking to 75 seconds. If engine fails to start, the module lights a fault lamp and opens the cranking circuit. This cycle cranking circuit allows three 15-second cranking cycles with two 15-second rest periods.

- Overspeed - Shuts down the engine immediately if an overspeed condition occurs and lights a fault lamp. The generator sets are equipped with an overspeed (frequency detection) module, inside the control panel. The module is factory set to shut down the generator set at approximately 2100 r/min (60 Hz units), or 1850 r/min (50 Hz units). Refer to *Component Tests and Adjustments* section for further information.

- Low Oil Pressure - Shuts down the engine immediately if oil pressure drops below 14 psi (97 kPa) and lights a fault lamp. The fault is inhibited during cranking and time delayed about 10 seconds following starter disconnect. The delay allows oil pressure to rise to normal before the electronic control module monitors this system.

  The pre-low oil pressure sensor and lamp provides an alarm that oil pressure is marginally low, 20 psi (138 kPa) or less. The cause should be found and corrected as soon as possible.

- High Engine Temperature - Shuts down the engine immediately if coolant temperature rises above 215° F (102° C) and lights a fault lamp. The fault is inhibited during cranking and time delayed about 10 seconds following starter disconnect. This delay allows coolant in a hot engine time to circulate and return the water jacket to normal before the electronic control module resumes monitoring this system.

  The pre-high engine temperature sensor and lamp provides an alarm that engine temperature is marginally high, 205° F (97° C) or higher. The cause should be found and corrected as soon as possible.

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

- Low Coolant Level Shutdown (Optional) - A solid-state sensor installed into the radiator provides engine shutdown if coolant level falls too low. It also lights the high engine temperature fault lamp.

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 guage circuits, 5 amps.

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

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

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

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

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

W6 Jumper Position:

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

W7 Jumper Position:

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

W8 Jumper Position:

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

W8 Jumper Position:

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

The ECM also has solder links and rectifiers that can be repositioned to provide other functions such as: negative signal mode, 105 second cycle cranking, 75 second noncycle cranking and 60 second non-cycle cranking.

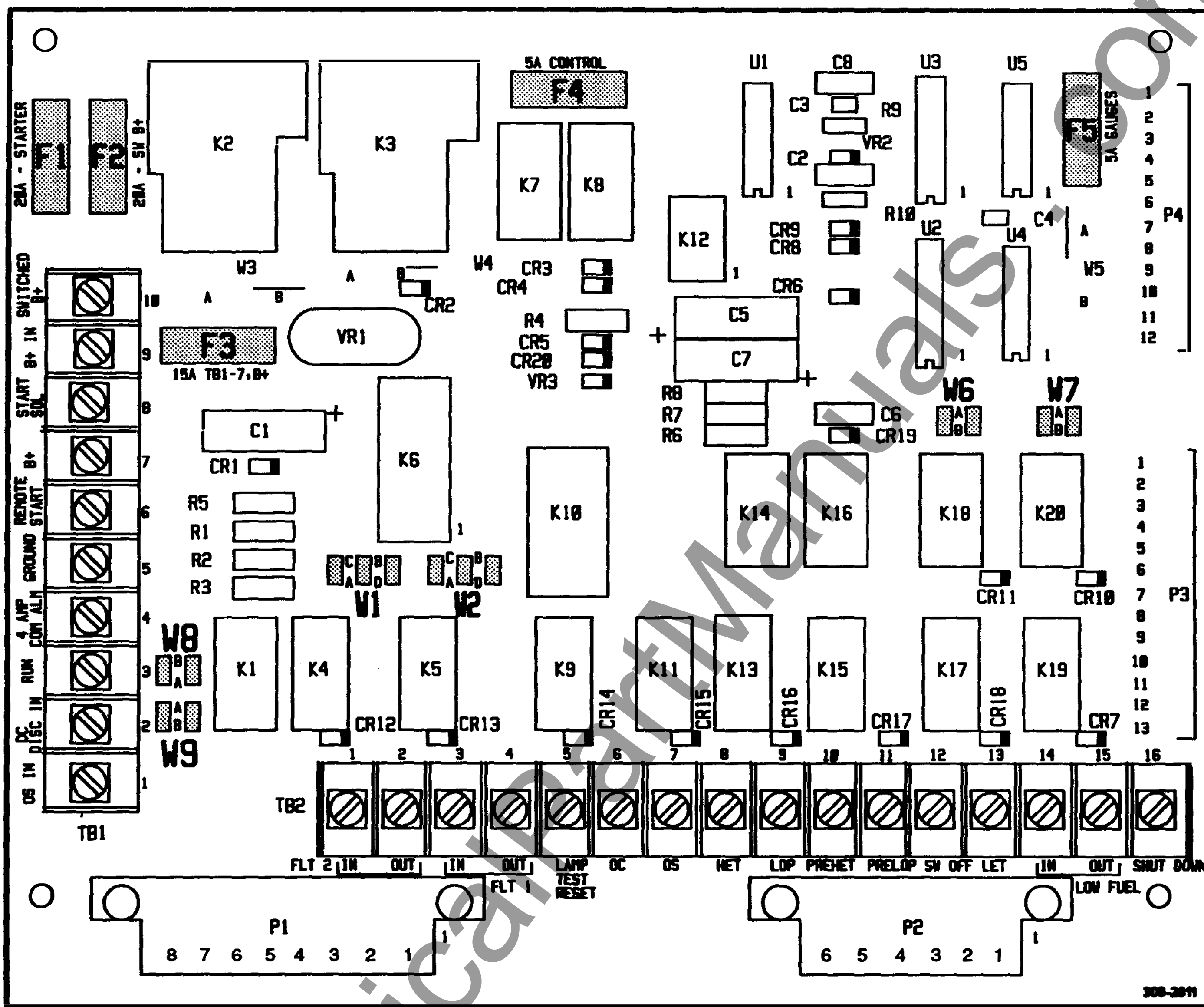


FIGURE 2-3. ENGINE CONTROL MONITOR (DETECTOR 12 ECM SHOWN)

Run Relay(s) (K11)

This relay (may be up to three) provides wiring connections for external functions of the site installation that are to be controlled by the starting and/or stopping of the generator set such as ventilation air louvers, blowers, etc. The sets of contacts in the relay base provide for either closing a circuit or opening a circuit upon energizing and de-energizing the relay (depending on the desired function wires to the base connections). The relay is energized when the generator set run circuitry is energized (i.e., fuel solenoid) when connected to the ECM at TB1-10 (switched B+ connection).

Interface Relay Modules (A13, A14)

These relay modules are used in conjunction with the Detector ECM's to provide external monitoring of the engine-generator at customers control panel. As add-on circuit boards, they interface with the remote annunciator signals from the ECM and allow the use of either AC or DC for alarm drives. The relays are configured for low side switching by the control and supply sets of contacts for external alarm connections.

Current Transformers (Not shown)

All units equipped with AC meters have current transformers installed inside the conduit box through which the customer can route the load leads.

Automatic Voltage Regulator (VR21)

Refer to section 3 for more information.

Overspeed (Frequency Detection) Module

This module derives a speed (Hz) signal from the PMG, but is powered from the generator set battery. A small time delay, typically one second, is incorporated in the overspeed function to allow for engine overshoot. The module contains two adjustable potentiometers, Overspeed and Cranking (the cranking potentiometer is not used however). Refer to Section 5 for more information.

Time Delayed Start/Stop Module (A15)

This module provides time delays for starting and stopping the generator set as follows:

Delayed Starting: The time delay start function is to preclude automatic start-up of the generator set for a determined amount of time (adjustable from 1 to 15 seconds) for installations that might experience power interruptions of short duration, and therefore not want the generator set starting.

Delayed Stopping: The time delay stop function is adjustable from 1 to 15 minutes to provide for automatic cool-down running of the engine for prescribed amount of time (approximately 3 to 5 minutes is recommended).

Control Cabinet Heater

A control cabinet heater provides a means of humidity/temperature control of the control box interior to protect the components and assist their effectiveness when the generator set is subjected to varying ambient conditions during extended periods of non-use. The element is controlled by an adjustable thermostat.

GENSET OPERATION

Because of varying control option combinations, the following operating descriptions will encompass a Detector-12 controller with full options. Read the information through to Emergency Shutdown to gain a full understanding of the options and how they interact with the engine control monitor (ECM).

Regardless of the controller model you have, the ECM includes the shutdown fault commands. Controllers with options provide delineation and pre-alarm of the shutdown faults, time delayed starting and stopping, and additional monitoring/control, but all engine operation commands through these options are still controlled through the ECM.

If you are reviewing this operation information for troubleshooting purposes, make sure you have eliminated all other malfunction checks external of the controls prior to troubleshooting the printed circuit board type components of the controller. Also review the *Generator* section for generator related control components and *Component Tests and Adjustments* section for more in-depth information. Refer to appropriate DC Schematic – Ladder Diagram in *Wiring Diagrams* section when reviewing the following information.

Starting Sequence

Manual: The starting sequence is initiated by placing the Run/Stop/Remote switch (S12) in the Run position.

Placing switch S12 in the Run position energizes the ECM Run Relay (K7). By energizing K7, B+ is supplied through the electrical circuits of the ECM to energize the engine run circuits (i.e., fuel solenoid) and front panel gauges and the starter solenoid (through K3).

The engine cranking period is determined by the Overcrank Timer and Cycle Crank Driver (U1), and the Cycle Crank Relay (K12), which control energizing and de-energizing the Power Relays K2 and K3 that supply current to the on-set starter and fuel solenoids.

Automatic: With the Run/Stop/Remote switch (S12) in Remote position, a remote start command (closure of on-site, dry contacts) to the generator set controller (B+ to remote) activates the Time Delayed Start/Stop Module (A15), which initiates its time delay start period.

Upon completion of the time delay start period, the ECM initiates engine cranking and start-up by energizing Run Relay (K7) as described in manual start-up.

When engine successfully cranks and starter disconnects, input signals from either start disconnect system of the ECM will activate the Start Disconnect Relay of module A15 (K1) which enables the module for Time Delayed Stop mode.

During generator set operation, all safety systems function to protect and monitor set operation. At end of the generator set duty cycle, when generator output is disconnected from load and the remote run signal is discontinued, the time delayed stop function of module A15 will continue the engine-generator run time for the prescribed engine cool-down period of 3 to 5 minutes before deactivating the run circuits of the ECM.

Starter-Disconnect Parameters

This type of control uses two means of starter-disconnect in order to protect the starter in the case one means should fail. The first uses a DC relay (K14); a B+ signal taken from the battery charging alternator in most cases energizes the relay to disconnect the starter. The second method uses an AC relay (K10); voltage from the generator energizes this relay to provide a back-up to the DC relay. The control uses this method to provide uninterrupted generator set operation even if only one means of start disconnect is operational. However, the local Run lamp does not light unless both start disconnect relays operate. If the generator set is equipped with a remote Run lamp, the operator can then determine which means of start disconnect has failed for such an occurrence. If the remote Run lamp lights (and the local Run lamp does not), the DC relay is not functioning.

High Engine Temperature (HET) and Low Oil Pressure (LOP) faults are time delayed about 10 seconds following starter disconnect and inhibited during cranking. This allows the coolant in a hot engine some time to circulate and return the water jacket to normal temperature before the ECM begins to monitor this parameter. It also allows the oil pressure to build to normal before monitoring this system. Following this delay, these faults become immediate shutdowns for engine protection.

If conditions are correct, the engine will start and the starter will disconnect. If not, an overcrank fault occurs by U1 having cycled/timed out through drive transistor U4 to energize Fault Relay K6, which opens the start circuit of the ECM. The Reset switch (S11) must be pushed to clear the fault before attempting to restart.

Start-Disconnect Sequence

When the generator set starts, output voltage from the DC alternator energizes Start-Disconnect relay K14. Energizing K14 then closes its N.O. contacts which lights the control panel Run lamp. Also, when the generator set starts, output voltage from the generator stator energizes Starter-Disconnect relay K10. Energizing K10 then closes its N.O. contacts and lights a Remote Run lamp (if equipped).

After the starter disconnects, the LOP and HET fault shutdowns will remain inhibited for another 10 seconds to allow oil pressure and engine temperature to stabilize within the operating range.

Normal Operating Parameters

After a successful engine start-up, with all conditions satisfied, the engine will gain in speed to governor controlled operation. Should the engine go into an overspeed condition, either an Over/Under Frequency Sensor, an Overspeed Module, or a mechanical overspeed switch (depending on generator type and options ordered) will ground the overspeed input circuit to the ECM to cause a shutdown and light the Overspeed fault lamp. After the problem is corrected, starting will not occur until the Reset switch is pressed.

Continuous operation of the generator set also depends on the proper oil pressure and engine temperature being maintained, and also any customer required fault conditions connected to the ECM.

Stopping Sequence

Placing the Run/Stop/Remote switch to the Stop position de-energizes Run Relay (K7) which opens the current supply through the ECM (K2) to de-energize the generator set mounted fuel solenoid (stops fuel flow which stops the engine).

Emergency Shutdown

The K6 fault relay is energized when fault sensors respond to one of the following fault conditions: overcrank, low oil pressure, high engine temperature, overspeed, and over/under voltage/frequency (if equipped). Energizing the K6 fault relay opens its N.C. contacts and closes its N.O. contacts. Opening the N.C. contacts disconnects B+ from the Power Relays K3 and K2. This stops cranking if the engine is being cranked and shuts off the fuel flow. Closing one of the N.O. contacts of K6 activates the K8 relay which breaks power to the fault interface relays so that only the indicator associated with the fault will activate. Closing the other N.O. contacts of K6 connects B+ to the remote alarm terminal.

Section 3. Generator

GENERATOR DESCRIPTIONS

The AC generators are brushless, rotating field type, controlled by an automatic voltage regulator (AVR). Permanent magnet exciter (PMG) types are used in these series of generator sets. The AVR of these generator sets is powered by the permanent magnet pilot exciter which provides a source of constant excitation power, independent of load changes or load current distortions.

An exciter/rotating rectifier assembly is mounted internally to the non-drive-end bearing, while the permanent magnet exciter is overhung from the non-drive-end bearing.

Removable access covers are provided at each end of the generators and on each side of the conduit box for cleaning and inspection, and easy access to the output terminals and other ancillary equipment. See Figures 3-1 and 3-2.

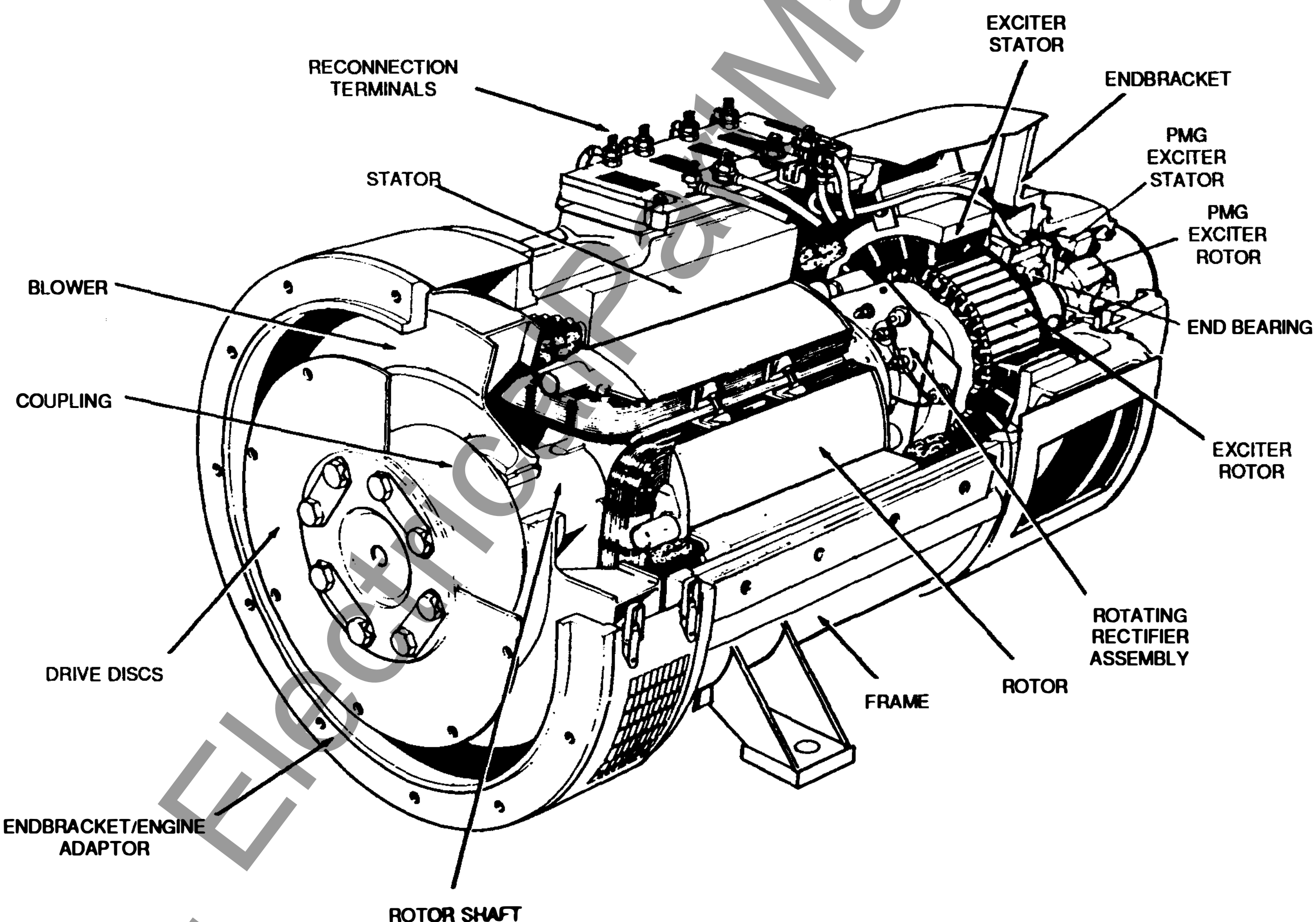


FIGURE 3-1. TYPICAL PMG GENERATOR

GENERATOR CONTROL COMPONENTS

The following briefly describes generator related control components that affect the proper operation or shutdown of the generator set. See Figure 3-2 for component locations.

Automatic Voltage Regulator (AVR)

The AVR is mounted on the inside back wall of the control box. Refer to Generator Operation following for further AVR operation information, and to *Component Tests and Adjustments* section for further description and adjustment procedure of the AVR.

Over/Under Voltage Sensor Module

This is an adjustable voltage-sensitive relay typically connected to the Engine Control Monitor (ECM) Fault 1 circuit to shut down the generator set when the output voltage is over or under the nominal voltage by the preselected amount (typically 10 percent). The module includes an adjustable time delay relay to prevent nuisance tripping (typically set at 25 percent, or approximately 2.5 seconds). The module and time delay relay are mounted on a bracket in the generator conduit box.

Over/Under Frequency Sensor Module

This is an adjustable frequency-sensitive relay typically connected to the Engine Control Monitor (ECM) Fault 2 circuit if the Over/Under Voltage module is also installed, or Fault 1 for overfrequency and Fault 2 for underfrequency if installed alone, to shut down the generator set when the output frequency is over or under the nominal frequency by the preselected amount. (Also, Fault 2 must be converted for timed shutdown.) The module is mounted on a bracket in the generator conduit box.

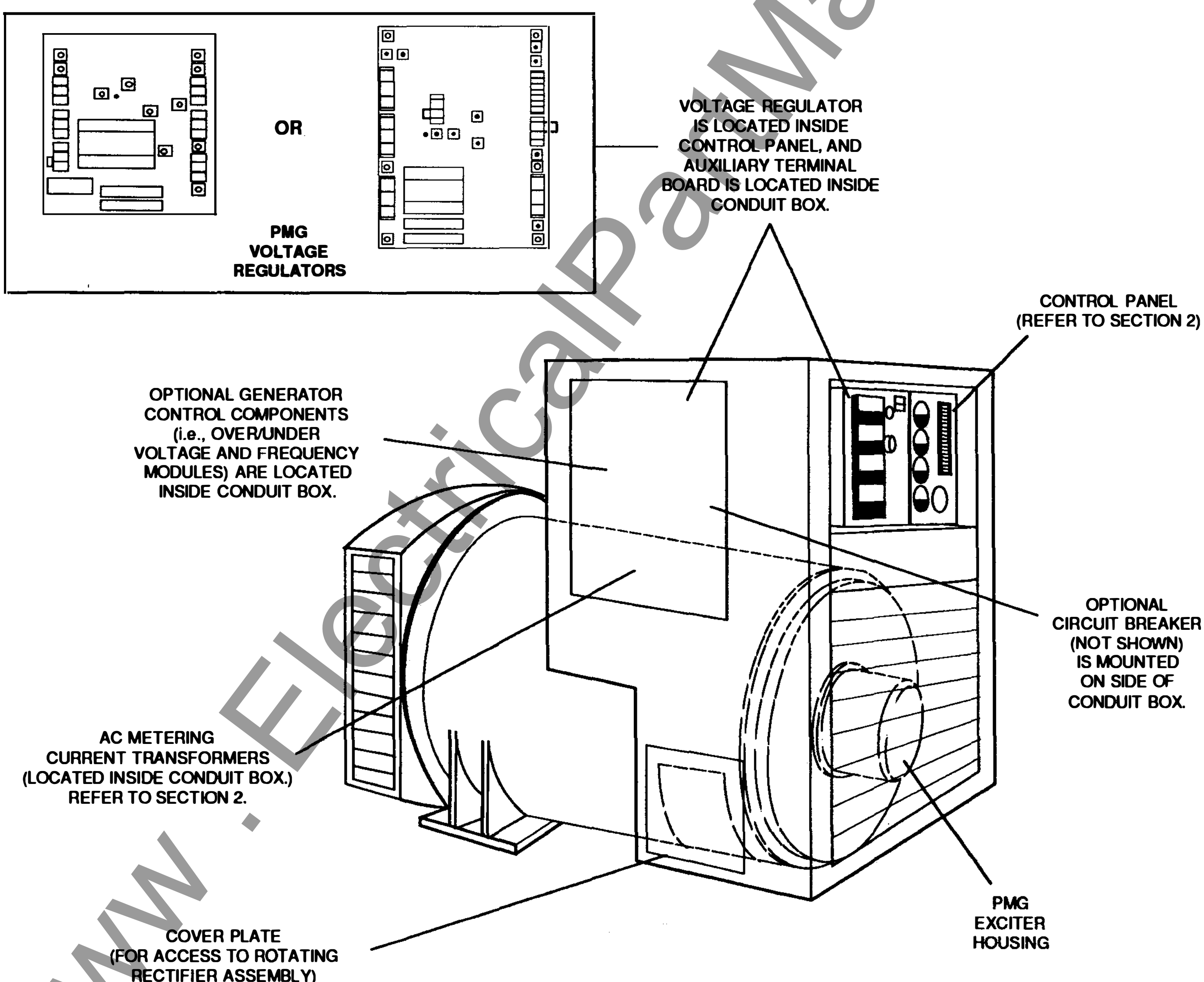


FIGURE 3-2. GENERATOR CONTROL COMPONENT LOCATIONS

GENERATOR OPERATION

A permanent magnet generator exciter (PMG), mounted to the end of the main rotor shaft, provides power by way of the AVR to the main exciter stator. Excitation power is therefore independent of output voltage, resulting in positive voltage build-up, without reliance on residual magnetism. The main exciter stator mounts in the end bell, the main exciter rotor and its rotating rectifier assembly mount on the rotor shaft. Within the end bell, leads X (+, positive) and XX (–, negative) from the exciter stator winding, connect to the output terminals of the voltage regulator (at auxillary terminal block). The AVR compares the main stator output with a reference value and feeds a controlled excitation current to the main exciter stator. The AC output of the main exciter rotor is converted to DC by the rectifier assembly, comprised of six diodes mounted on two heatsinks to form positive and negative plates. The diodes are protected against harmful over–voltages (caused for example, by switching circuits or out–of–phase paralleling) by a metal–oxide varistor (MOV). The DC output of the rectifier assembly provides the excitation onto the main rotor.

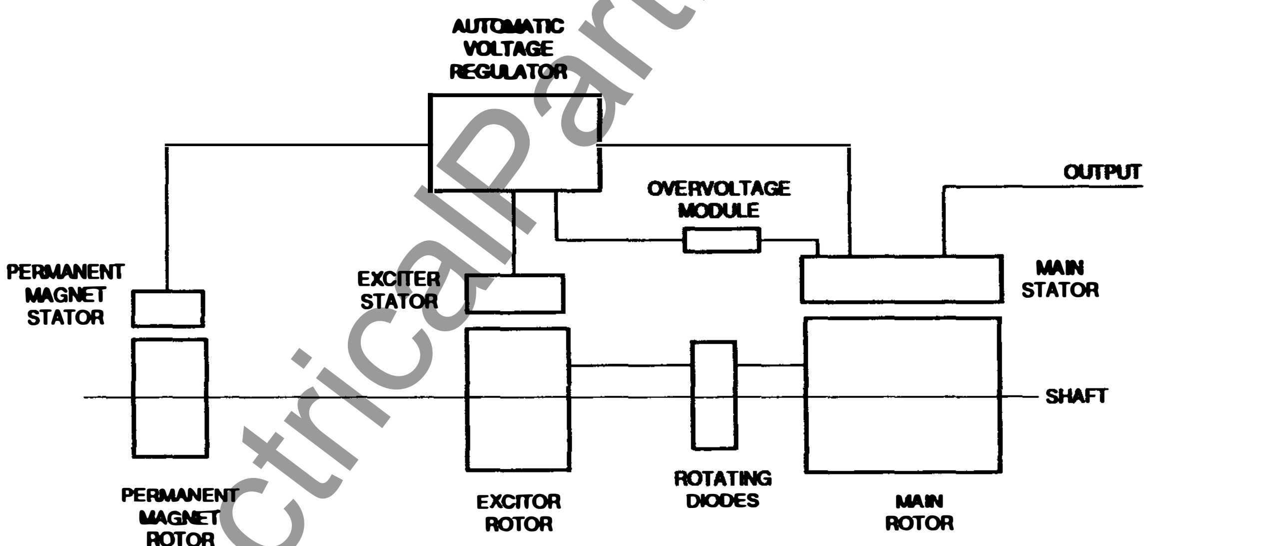


FIGURE 3-3. GENERATOR OPERATION DIAGRAM

OPTIONAL CIRCUIT BREAKER

Depending on site specifications and applicable code requirements, an optional circuit breaker may be mounted in the generator AC output box.

Description

All supplied breakers are thermal and magnetic trip type. Depending on customer requirements, the breaker may also include shunt trip and remote alarm connections. Review the following functions/requirements and Figure 3-4.

- Generator set output is connected to the load through the circuit breaker.
- When an overload or short circuit occurs on any one conductor, a common trip bar will disconnect all three conductors.
- The thermal trip action of the breaker is accomplished by bimetal strips. A sustained overcurrent condition will cause a thermal reaction of the bimetal and trip the breaker. Response of the bimetal is proportional to current; high current–fast response, low current–slow response. This action provides a time delay for normal inrush current and temporary overload conditions such as motor starting.
- The magnetic trip action of the breaker is caused by an electromagnet, which partially surrounds the internal bimetal strips. If a short circuit occurs, the high current through the electromagnet will attract the bimetal armature and trip the breaker. Some breaker models provide front adjustment of the magnetic trip action. These adjustments are normally set at the factory at the high position, but provide for individual conductor settings to suit customer needs.
- The shunt trip mechanism (if equipped) consists of a solenoid tripping device mounted in the breaker with external lead connections for remote signaling. A momentary signal to the solenoid coil will cause the breaker to trip.

  This feature is available in AC or DC voltages, and is normally installed at the factory to meet customer needs. The shunt trip mechanism is most often connected to a common fault shutdown circuit of the generator set. This quickly disconnects the set from the load on shutdown and avoids a reverse power condition.
- Auxiliary contacts (if equipped) are used for local or remote annunciation of the breaker status. They usually have one normally-open and one normally-closed contact (1 form C contacts) to comply with the annunciator requirement.
- The trip actuator (if applicable) is for periodic exercise of the breaker to clean and maintain its proper operation. Rotating this actuator mechanically simulates over-current tripping through actuation of linkages not operated by the *On/Off* handle. See Section 5, *Component Tests and Adjustments,* for further information.
- Operation of the circuit breaker is determined by site-established procedures. In emergency standby installations, the breaker is often placed to the On position, and is intended for safety trip actuation in the event of a fault condition. If the breaker trips open, investigate the cause and perform remedial steps per the troubleshooting procedures. To close the breaker, the handle must be placed to the Reset position and then to On. Refer to Section 4 for troubleshooting and safety procedures.

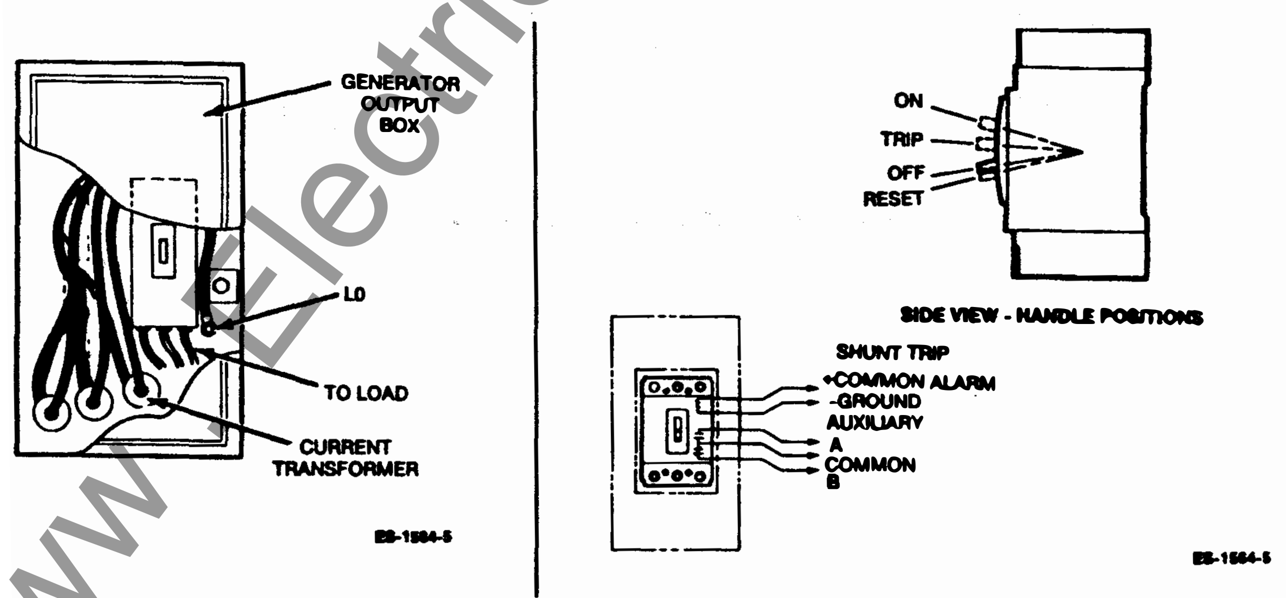


FIGURE 3-4. TYPICAL GENERATOR-MOUNTED CIRCUIT BREAKER

Section 4. Troubleshooting

GENERAL

This section contains troubleshooting information for engine-generator control systems. Be sure to review the troubleshooting information as outlined in the unit Operator's Manual before performing the procedures in this section. Refer to *Component Tests and Adjustments* section for further engine-generator component information and appropriate engine service manuals for additional information specific to the engine.

Because this section contains information about various control options, read through this section before a fault occurs to identify what is or is not applicable to your genset. This will save troubleshooting time when the actual need arises.

Before starting a troubleshooting procedure, make a few simple checks that might expose the problem. Check all modifications, repairs, or parts replacements performed since the last satisfactory operation of the generator set. A loose or otherwise incorrect wire connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

When troubleshooting a problem, remember to keep your problem solving a methodical and most of all safe process. Hasty decisions can be costly, harmful to your health, dangerous to others, and may not solve the problem.

Regardless of the controller model a generator set has, the basics of problem analysis are fundamentally the same. Identify the fault condition then get specific about the corrective action to take. However, the Detector-7 controller does not have all the lamp indicators that the Detector-12 has; to aid in identifying other customer required fault conditions (i.e., low fuel, fault 1 and 2) that may have caused the shutdown. Your initial problem analysis before reviewing the tables in this section should be to ask yourself the following questions:

1. Was the engine running when it shut down? If it was, shutdown is not due to overcrank.
2. Did shutdown occur within one minute after start-up? If it did, the shutdown is probably due to low oil pressure.
3. Was engine operation noticeably erratic or faster than usual? If it was, the shutdown was probably due to overspeed.
4. If the engine starts and runs, observe the oil pressure, engine temperature and frequency meter or tachometer until shutdown occurs, to determine the cause.

This section is divided into engine-related troubleshooting tables and generator-related troubleshooting flow charts to aid you. They are:

Table 4-1. Engine does not crank.
Table 4-2. Engine cranks, but does not start.
Table 4-3. Engine starts, but stops after running short time.
Table 4-4. Engine-generator is in operation, then a fault shutdown occurs.

Flow Chart 4-1. No AC output voltage at rated engine speed.
Flow Chart 4-2. Unstable output voltage, engine speed stable at rated speed.
Flow Chart 4-3. Output voltage too high or low.
Flow Chart 4-4. Exciter field breaker trips (if equipped).
Flow Chart 4-5. Unbalanced generator output voltage.
Flow Chart 4-6. No AC output through set-mounted circuit breaker.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

TABLE 4-1. ENGINE DOES NOT CRANK

SYMPTOM	CAUSE	CORRECTIVE ACTION ◆
1. SWITCH OFF indictor lamp flashing.	Run/Stop/Remote switch in Stop position.	Press to desired, Run or Remote position.
2. Other fault indicator lamps iluminated, but no fault exists.	Lamp Reset switch not actuated after a previous fault was remedied.	Press Lamp Reset switch to de-energize fault lamp relays of ECM, after Run/Stop/Remote switch is pressed to Stop position.
3. No indication.	Fuses blown on ECM board A11.	Check fuses F1 and F4. Replace if necessary with proper fuse: F1 - 20 Ampere F4 - 5 Ampere
	Emergency stop button pushed in.	To reset, pull switch out and move the RUN/STOP/REMOTE switch to STOP position. Then push test switch to RESET/Lamp position.
	Starter solenoid will not energize.	Inspect starter solenoid per proper test procedure.
	Possible defective ECM board A11.	Check A11 board TB1-9 for B+ voltage in. With S12 switch in Run position, check for voltage out to starter solenoid at TB1-8 of board A11.
	Broken wiring or poor connections between board A11 TB1-8 and starter solenoid.	Check and repair as necessary.
	Faulty ECM board A11.	If there is no voltage between TB1-8 and ground stud when the panel switch is in the Run position, the ECM is faulty. Replace.
4. Time delay start is initiated, but starter solenoid does not energize after desired time delay period.	Possible defective Time Delayed Start/ Stop Module A15.	Check A15 board TB1-4 for constant B+ voltage in. Check A15 board TB1-5 for Run Signal In voltage. Voltage at A15 board TB1-6 should be at B+ at end of start delay period. Check wiring and connections from A15 TB1-6 to A11 TB1-6.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

TABLE 4-2. ENGINE CRANKS BUT DOES NOT START

SYMPTOM	CAUSE	CORRECTIVE ACTION
1. Overcrank lamp lit.		
Low Fuel lamp also lit.	Insufficient fuel in supply tank.	Fill with correct fuel.
Fuel solenoid does not energize.	Fuse blown on ECM board A11.	Check fuse F2. Replace if necessary. F2 - 20 Ampere.
	Possible defective ECM board A11.	Check for voltage out at TB1-10 when engine is cranking.
	Broken wiring or poor connections between board A11 TB1-10 and fuel solenoid.	Check and rectify as necessary.
Fuel solenoid energizes, but no fuel flows.	Blockage of fuel supply system.	Check fuel supply system (fuel supply tank, shutoff valves, lines and connections, filters and transfer pump, etc.).
Engine hard to start due to cold ambient air temperature.	Heater system not keeping engine warm.	Check heater system power supply, controls, etc., and correct as necessary.
2. Fault shutdown occurs, but no fault lamp indication.	Lamp burned out.	Place Run/Stop/Remote switch to Stop position, then depress Lamp Test switch to Test position to check fault lamps.
3. Short cranking period. Note: The ECM board A11 P.C. board controls are to provide cycle cranking, but generator set stops before 15 ±3 seconds.	Defective ECM board A11.	Replace ECM (A11).

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

TABLE 4-3. ENGINE STARTS, BUT STOPS AFTER RUNNING SHORT TIME

SYMPTOM	CAUSE	CORRECTIVE ACTION
1. Overspeed lamp lit.	Overspeed Module initialized shutdown.	Refer to *Tests and Adjustments* section. Perform necessary adjustments of O.S. module. Perform start-up and monitor engine speed to overspeed shutdown. If shutdown occurs before desired setpoint, readjust O.S. module. If adjustment does not correct fault condition, replace O.S. module.
Unstable engine operation.	Engine governor faulty or out of adjustment.	Refer to *Tests and Adjustments* section. Perform appropriate tests.
2. Low Oil Pressure lamp lit.	Low oil level in engine.	Replenish as necessary.
	LOP switch faulty.	Check oil level, perform restart, and monitor oil pressure gauge. If gauge reading is within normal range, switch S1 is faulty. Replace.
3. High Engine Temperature lamp lit.	Low coolant level in engine.	Replenish as necessary.
	HET switch is faulty.	Check coolant level, perform restart, and monitor engine temperature gauge. If gauge reading is within normal range, switch S2 is faulty. Replace.
	Thermostat defective.	Replace thermostat.
	Fan belt slipping.	Tighten fan belt.
4. No fault condition.	Intermittent control wiring connections.	Check condition of all control wiring to make sure connections are correct and secure.

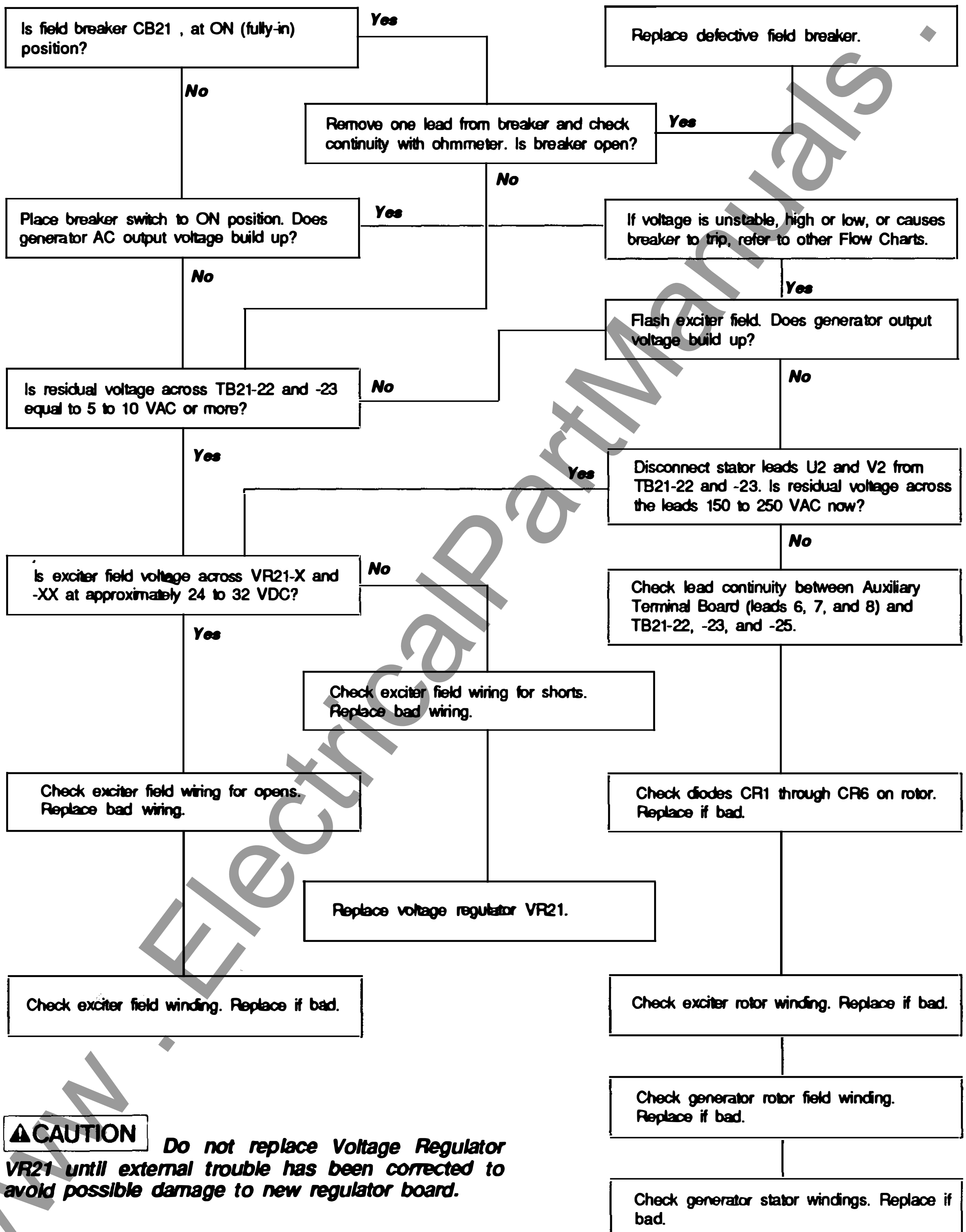
⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

TABLE 4-4. ENGINE-GENERATOR IS IN OPERATION, THEN A FAULT SHUTDOWN OCCURS

SYMPTOM	CAUSE	CORRECTIVE ACTION
1. LOP, HET, Overspeed lamp lit.	As indicated.	Refer to Table 4-3.
2. Fault 1 or Fault 2 lamp lit.	Over/Under Voltage or Frequency, as dedicated by customer.	Refer to *Tests and Adjustments* section, and perform necessary adjustments. Restart unit and monitor gauges. If shutdown was due to over/under voltage, the voltage regulator may require adjustment or is faulty. Refer to *Tests and Adjustments* section for adjustments, replace if faulty. If shutdown was due to over/under frequency, the engine governor may require adjustment or is faulty. Refer to *Tests and Adjustments* section for adjustments, replace if faulty. Refer also to generator-related Flow Charts that follow.
3. No fault lamp lit.	Possible defective ECM board A11.	Check fuses F4 and F2 of ECM board A11. F4 (Main) - 5 Ampere F2 (Fuel solenoid or ignition) - 20 Ampere Perform restart and check for B+ voltage in at TB1-9 and voltage out at TB1-10 to fuel solenoid. If there is voltage out at TB1-10, check fuel supply solenoid, shutoff valves, etc. If there is no voltage out at TB1-10, ECM board A11 is defective. Replace.
	Other customer required shutdown command.	Refer to installation reference material, or contact your service representative for assistance.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

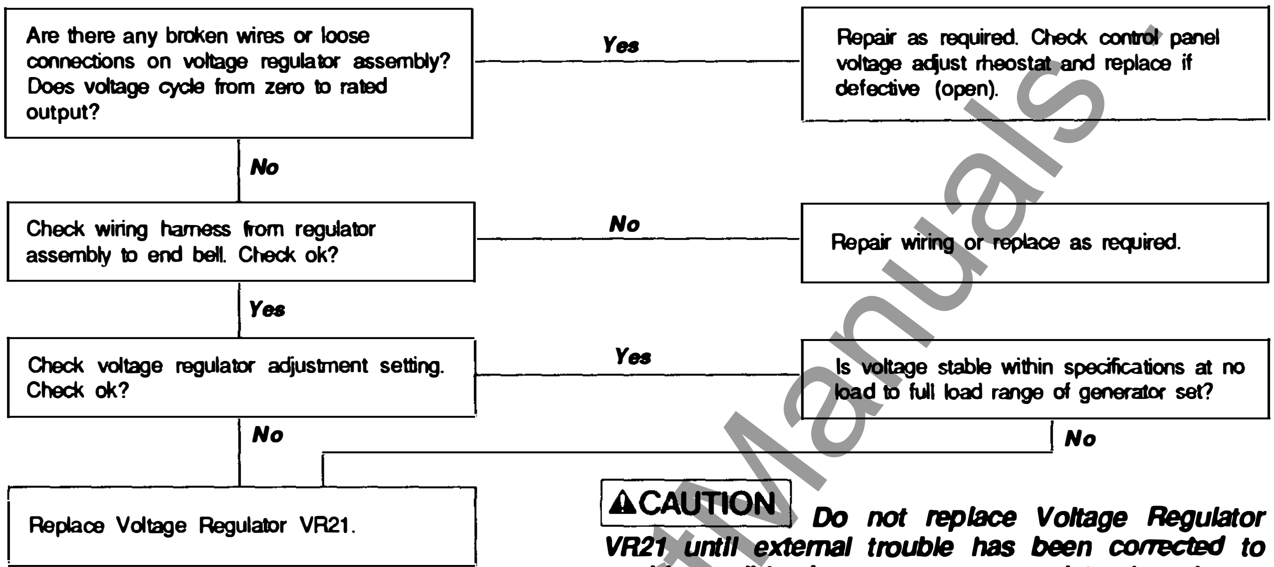
FLOW CHART 4-1. NO AC OUTPUT VOLTAGE AT RATED SPEED



⚠CAUTION ***Do not replace Voltage Regulator VR21 until external trouble has been corrected to avoid possible damage to new regulator board.***

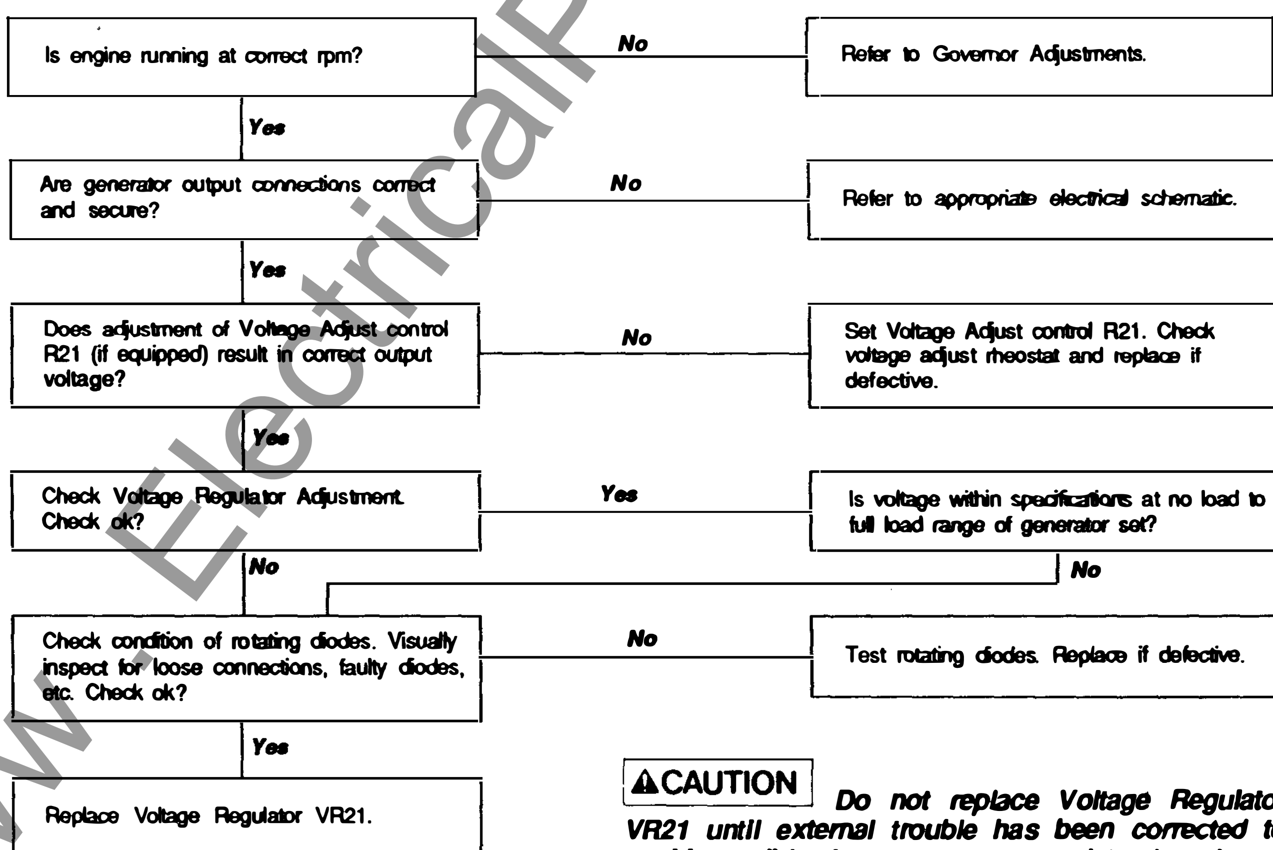
WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

FLOW CHART 4-2. UNSTABLE VOLTAGE, ENGINE SPEED STABLE AT RATED SPEED



CAUTION ***Do not replace Voltage Regulator VR21 until external trouble has been corrected to avoid possible damage to new regulator board.***

FLOW CHART 4-3. OUTPUT VOLTAGE TOO HIGH OR LOW



CAUTION ***Do not replace Voltage Regulator VR21 until external trouble has been corrected to avoid possible damage to new regulator board.***

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

FLOW CHART 4-4. EXCITER FIELD BREAKER TRIPS

Does AC output voltage build up to 150% or more of rated voltage before breaker trips?

No

Check diodes in rotor assembly. Replace if bad.

Check exciter stator winding. Replace if bad.

Check exciter rotor winding. Replace if bad.

Check generator rotor field winding. Replace if bad.

Check generator stator windings. Replace if bad.

Replace Voltage Regulator VR21.

Yes

Check for any loose or broken wires or connections to VR21 assembly.

Check Voltage Regulator adjustments and connections.

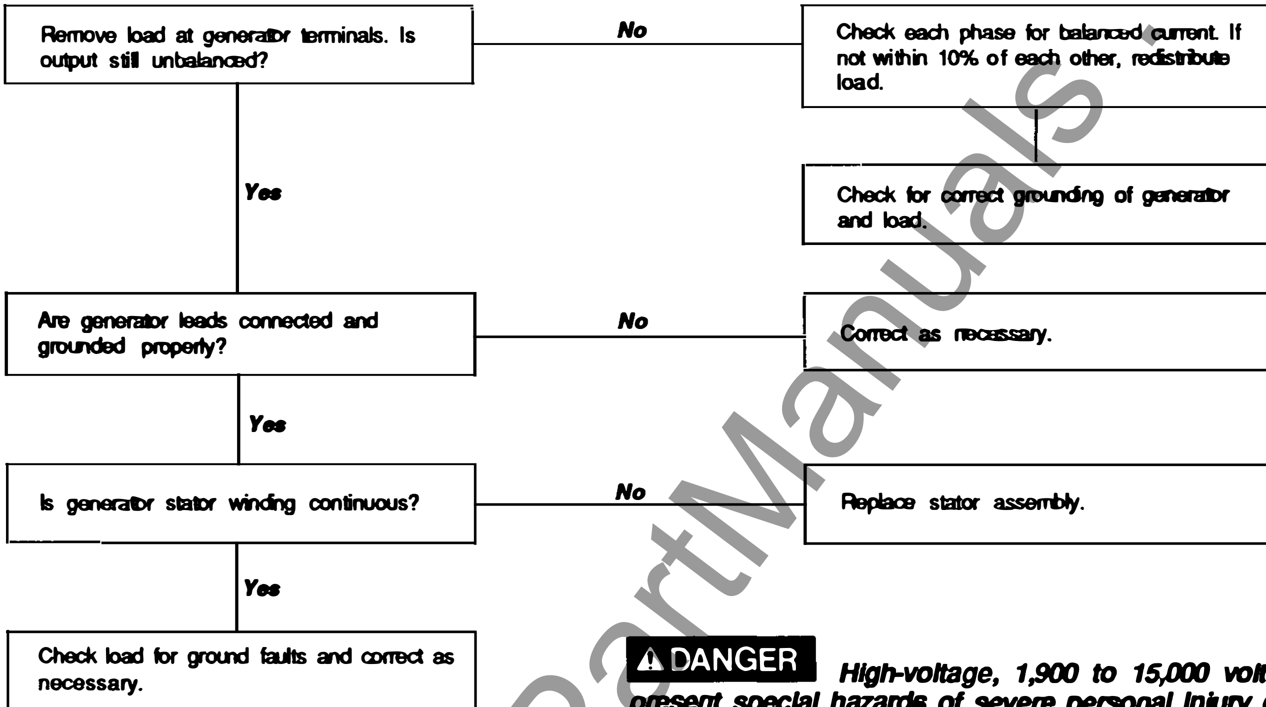
Check generator stator leads for proper, and secure connection. Refer to appropriate electrical schematic.

⚠DANGER ***High-voltage, 1,900 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages.***

⚠CAUTION ***Do not replace Voltage Regulator VR21 until external trouble has been corrected to avoid possible damage to new regulator board.***

WARNING *Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.*

FLOW CHART 4-5. UNBALANCED GENERATOR OUTPUT VOLTAGE



DANGER *High-voltage, 1,900 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages.*

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions, on pages ii and iii.***

FLOW CHART 4-6. NO AC OUTPUT THROUGH SET MOUNTED CIRCUIT BREAKER

Is set-mounted circuit breaker at Tripped position?

- ***No*** → Is set-mounted circuit breaker at OFF position?
  - ***Yes*** → Confirm that no maintenance is being performed, or other purpose for breaker at OFF position, and that set is available for use.
  - → If set is operating and available for use, reset circuit breaker to ON position.

- ***Yes*** → Determine cause of breaker trip. If not immediately known, stop generator set and investigate cause.
  - Circuit overload (per site-established procedures).
  - Short circuit (per site-established procedures).
  - Shunt trip (check for generator set fault shutdown, or other signal source).
  - → Review Testing AC Load Circuit Breaker in *Tests and Adjustments* section.
  - → Correct fault condition and reset circuit breaker to ON position.

Section 5. Component Tests and Adjustments

GENERAL

This section contains test and adjustment information for the GenSet control, generator, and engine components. Refer to the figures included with this information and also the *Wiring Diagrams* section when instructed.

DANGER ***High-voltage, 1,900 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages.***

CAUTION ***In-depth information is provided for some components such as the ECM's. Only qualified personnel with proper equipment should use this information to attempt repair of printed circuit board assemblies. Contacting your distributor for replacement parts is recommended.***

ENGINE CONTROL MONITOR (ECM)

Sequence of Operation — Detector-7 ECM

Refer to schematic diagram in *Wiring Diagrams* section when reviewing this information.

Starting is initiated by applying B+ or ground to P4-7 depending on the position of links W3 and W4.

- Position A — Ground signal to run
- Position B — B+ signal to run

This energizes run relay K7, which closes its N.O. contacts (9,14) connecting B+ to starter relay K3, switched B+ relay K2 fault circuits, overcrank/cycle crank timer U1, and HET/LOP time delay timer U5 through N.C. fault relay K8 (16,9). This also opens N.C. K7 (9,16), disconnecting B+ to the reset circuit (K6).

K2 energizes, closing its N.O. contacts (5,3) connecting B+ to terminal TB1-10 through fuse F2 and to P4-9 through fuse F5.

K3 energizes, closing its N.O. contacts (5,3) connecting B+ to terminal TB1-8 through fuse F1. K3 is controlled by timer U1 through cycle crank relay K12. U1 can be programmed to give 3 crank periods by combining diodes across U1 pins 10, and 12; CR6 to pin 12 with CR8 to pin 10 = 3 cranks.

U1 will energize and de-energize K12 depending on the number of cranks programmed, K12 N.C. contacts (10,7) open and close to energize and de-energize K3, K3 N.O. contacts (5,3) open and close connecting and removing B+ from TB1-8.

If the set fails to start after the pre-set number of cranks, U1 pins 10, 11, and 12 go high and trigger the drive transistor U4 pins 6 and 11 which grounds K6 fault relay, stopping the starting sequence by opening its N.C. contacts (9,8) de-energizing K3 and K2. U1 pins 10, 11, and 12 going high also triggers U4 pins 12 and 5 which energizes overcrank lamp drive relay K9. K9 N.O. contacts (9,13 and 4,8) close putting a ground on TB2-6 for a remote indication and also the DS18 lamp.

If the set starts, voltage builds up on the DC (K14) and AC (K10) start disconnect relays. K14 energizes at approximately 14 VDC. K10 energizes at approximately 100 VAC. Regardless of which one energizes first, either relay will break the ground path to starter relay K3, K3 de-energizes opening its N.O. contacts (5,3) removing B+ from TB1-8. Both K10 and K14 must be energized to operate the run lamp DS12. Either relay will also inhibit the overcrank timer U1 by making U1 pin 2 go high. This is achieved by removing the ground path from U1 pin 2 through U3 pins 6-11, N.C. K14 contacts (16,9) and N.C. K10 contacts (3,5). A positive is then allowed through the K3 coil, N.C. K6 contacts (3,7), N.C. K12 contacts (10, 7), U3 pins 6-11 to pin 2 on U1 or via R5, U3 pins 6-11 to U1 pin 2 if K6 fault relay has operated. By making pin 2 high the timer is reset and put into a standby mode.

Either K10 or K14 will initiate U5 - LOP/HET time delay timer. This is achieved by removing the ground from U4 pin 3 and allowing a positive there. This triggers U4 pin 14 to ground U5 pin 2. After a 10 second delay U5 pin 14 energizes K1 through U4 pins 1 and 16. K1 N.O. (1,8) contacts (9,14) close, latching in fault circuits. K1 N.C. contacts open to latch U5 into an inactive state during run, made by removing B+ from pin 5 and grounding it through R8 and U2 pins 2 and 15. (K1 N.O. contacts (2,8) also close providing timing shutdown path to K6 fault relay.)

If a fault should occur a ground is placed on the following plug points.

- P2-2, for Pre-Low Oil Pressure (PLOP)
- P2-3, for Pre-High Engine Temperature (PHET)
- P2-4, for Low Oil Pressure (LOP)
- P2-5, for High Engine Temperature (HET)
- P2-6 or terminal TB1-1, for Overspeed (OS)

Pre-LOP and pre-HET only activate a warning lamp and do not stop the set.

LOP, HET, and OS activate a lamp and also shut down the set.

Fault relay K6 is in series with the K13 (HET), K15 (LOP), K11 (OS), K4 (Fault 1) and K5 (Fault 2) fault relays. Therefore, when a ground is placed on the respective plug input it will cause both the K6 relay and the associated fault relay to energize. K6 N.C. contacts (9,8) open to de-energize K2 relay, stopping the set. K6 N.O. contacts (11,10) close to energize K8 relay. K8 opens its N.C. contacts (16,9) to remove B+ from the operational parts of the circuit. The associated fault relay will bring up an indicating lamp and also connect a ground to one of the following terminals for a remote indication:

- TB2-11, for PLOP
- TB2-10, for PHET
- TB2-9, for LOP
- TB2-8, for HET
- TB2-7, for Overspeed
- TB2-6, for Overcrank

To reset a fault the run signal must be removed from P4-7 to de-energize K7, closing its N.C. contacts (9,16) to connect B+ to the fault reset circuit. A ground is placed on P4-11 which grounds all of the latchable fault relays reset coils as follows:

- K6 - Fault Relay
- K9 - Overcrank
- K11 - Overspeed
- K13 - HET
- K15 - LOP
- K17 - PHET
- K19 - PLOP

This resets K6 fault relay and any fault relays that are latched in an active state.

To stop the set normally, the run signal is removed from P4-7 which de-energizes K7. K7 N.O. contacts (9,14) open to remove B+ from K2 relay. K2 de-energizes opening its N.O. contacts (5,3) removing B+ from TB1-10, stopping the set.

Sequence of Operation — Detector-12 ECM

Refer to schematic diagram in *Wiring Diagrams* section when reviewing this information.

Starting is initiated by applying B+ or ground to P4-7 depending on the position of links W3 and W4.

- Position A — Ground signal to run
- Position B — B+ signal to run

This energizes run relay K7, which closes its N.O. contacts (9,14) connecting B+ to starter relay K3, switched B+ relay K2 fault circuits, overcrank/cycle crank timer U1, and HET/LOP time delay timer U5 through N.C. fault relay K8 (16,9). This also opens N.C. K7 (9,16), disconnecting B+ to the reset circuit (K6).

K2 energizes, closing its N.O. contacts (5,3) connecting B+ to terminal TB1-10 through fuse F2 and to P4-9 through fuse F5.

K3 energizes, closing its N.O. contacts (5,3) connecting B+ to terminal TB1-8 through fuse F1. K3 is controlled by timer U1 through cycle crank relay K12 through N.C. fault relay K6 contacts (2,3). U1 is set to provide 3 cranking periods through CR6 and Cr8. The timing is set to 15 seconds on, and 15 seconds off through oscillator circuit comprising C3, and resistors U3 (3,6), (15,2), and (16,1). The total crank time is 75 seconds.

U1 will energize and de-energize K12 through U4 (7,10). K12 N.C. contacts (10,7) open and close to energize and de-energize K3, K3 N.O. contacts (5,3) open and close connecting and removing B+ from TB1-8.

If the set fails to start after the three cranks, U1 pins 10, and 12 go high and trigger the drive transistor U4 pins 6 and 11 which grounds K6 fault relay, stopping the starting sequence by opening its N.C. contacts (9,8) de-energizing K3 and K2. U1 pins 10, 11, and 12 going high also triggers U4 pins 12 and 5 which energizes overcrank lamp drive relay K9. K9 N.O. contacts (9,13 and 4,8) close putting a ground on TB2-6 for a remote indication and a reound on P3-8 to light the DS18 lamp.

If the set starts, voltage builds up on the DC (K14) and AC (K10) start disconnect relays. K14 energizes at approximately 14 VDC. K10 energizes at approximately 100 VAC. Regardless of which one energizes first, either relay will break the ground path to starter relay K3, K3 de-energizes opening its N.O. contacts (5,3) removing B+ from TB1-8. Both K10 and K14 must be energized to operate the run lamp DS12. Either relay will also inhibit the overcrank timer U1 by making U1 pin 2 go high. This is achieved by removing the ground path from U1 pin 2 through U3 pins 6-11, N.C. K14 contacts (16,9) and N.C. K10 contacts (3,5). A positive is then allowed through the K3 coil, N.C. K6 contacts (3,7), N.C. K12 contacts (10, 7), U3 pins 6-11 to pin 2 on U1 or via R6, U3 pins 6-11 to U1 pin 2 if K6 fault relay has operated. By making pin 2 high the timer is reset and put into a standby mode.

Either K10 or K14 will initiate U5 - LOP/HET time delay timer. This is achieved by removing the ground from U4 pin 3 and allow a positive there. This triggers U4 pin 14 to ground U5 pin 2. After a 10 second delay U5 pin 14 energizes K1 through U4 pins 1 and 16. K1 N.O. contacts (9,15) close, connecting B+ to the fault circuits. K1 N.C. (1,8) contacts open to latch U5 into an inactive state during run, made by removing B+ from pin 5 and grounding it through R8 and U2 pins 2 and 15. (K1 N.O. contacts (2,8) also close providing timing shutdown path to K6 fault relay from appropriate fault circuit.)

If a fault should occur a ground is placed on the following plug points:

- P2-1, for Low Engine Temperature (LET)
- P2-2, for Pre-Low Oil Pressure (PLOP)
- P2-3, for Pre-High Engine Temperature (PHET)
- P2-4, for Low Oil Pressure (LOP)
- P2-5, for High Engine Temperature (HET)
- P2-6 or terminal TB1-1, for Overspeed (OS)
- TB2-14, for Low Fuel
- TB2-1, for Fault 2
- TB2-3, for Fault 1
- TB2-16, for shutdown of customers requirements

Low fuel, pre-LOP, pre-HET, and LET only activate a warning lamp and do not stop the set.

LOP, HET, OS, Fault 1, Fault 2 and Remote shutdown (TB2-16) activate a lamp and also shuts down the set.

Fault relay K6 is separately in series with the K13 (HET), K15 (LOP), K11 (OS), K4 (Fault 2) and K5 (Fault 1) fault relays. Therefore, when a ground is placed on the respective plug input it will cause both the K6 relay and the associated fault relay to energize. K6 N.C. contacts (9,8) open to de-energize K2 relay, stopping the set. K6 N.O. contacts (11,10) close to energize K8 relay. K8 opens its N.C. contacts (16,9) to remove B+ from the operational parts of the circuit. The associated fault relay will bring up an indicating lamp and also connect a ground to one of the following terminals for a remote indication:

- TB2-2, for Fault 2
- TB2-4, for Fault 1
- TB2-6, for Overcrank
- TB2-7, for Overspeed
- TB2-8, for HET
- TB2-9, for LOP
- TB2-10, for PHET
- TB2-11, for PLOP

To reset a fault the run signal must be removed from P4-7 to de-energize K7, closing its N.C. contacts (9,16) to connect B+ to the fault reset circuit. A ground is placed on P4-11 which grounds all of the latchable fault relays reset coils as follows:

- K6 - Fault Relay
- K4 - Fault 2
- K5 - Fault 1
- K9 - Overcrank
- K11 - Overspeed
- K13 - HET
- K15 - LOP
- K17 - PHET
- K19 - PLOP

This resets K6 fault relay and any fault relays that are latched in an active state.

To stop the set normally, the run signal is removed from P4-7 which de-energizes K7. K7 N.O. contacts (9,14) open to remove B+ from K2 relay. K2 de-energizes opening its N.O. contacts (5,3) removing B+ from TB1-10, stopping the set.

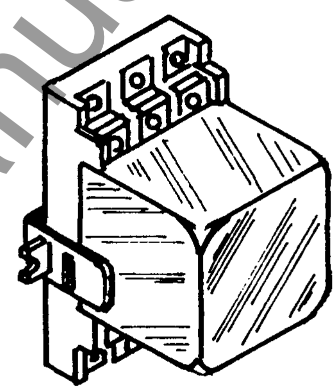
RUN RELAY (IF EQUIPPED)

Checking Relay Coil

Connect B+ across relay coil terminals. Relay should activate if coil is okay.

Checking Relay Contacts

Connect B+ to one side of relay contacts. Connect a voltmeter to other side of relay contact. If B+ is present when relay is energized, contact is okay. The B+ reading is present in reverse order when checking normally closed (N.C.) contacts. Typical wiring diagram is shown in Figure 5-1.



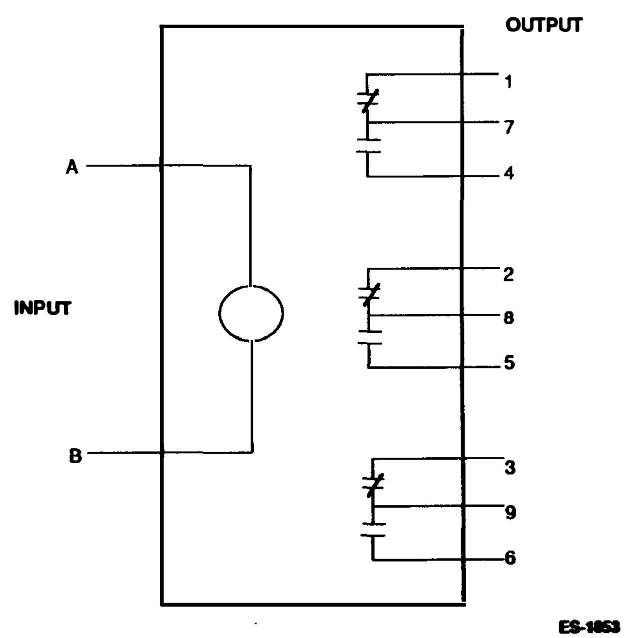
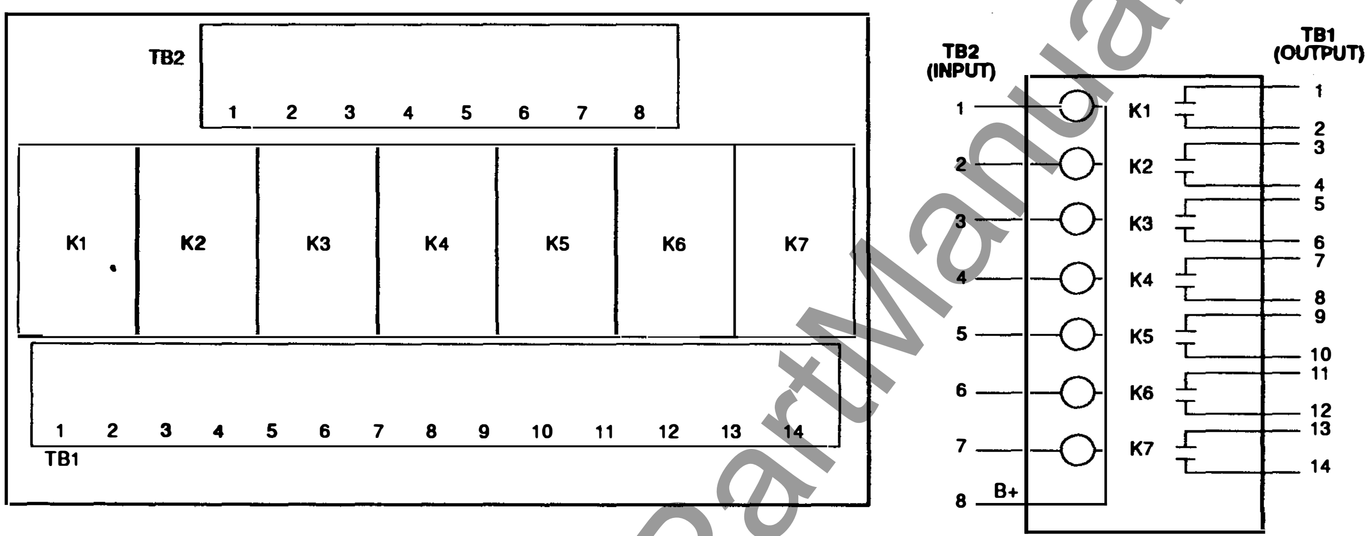


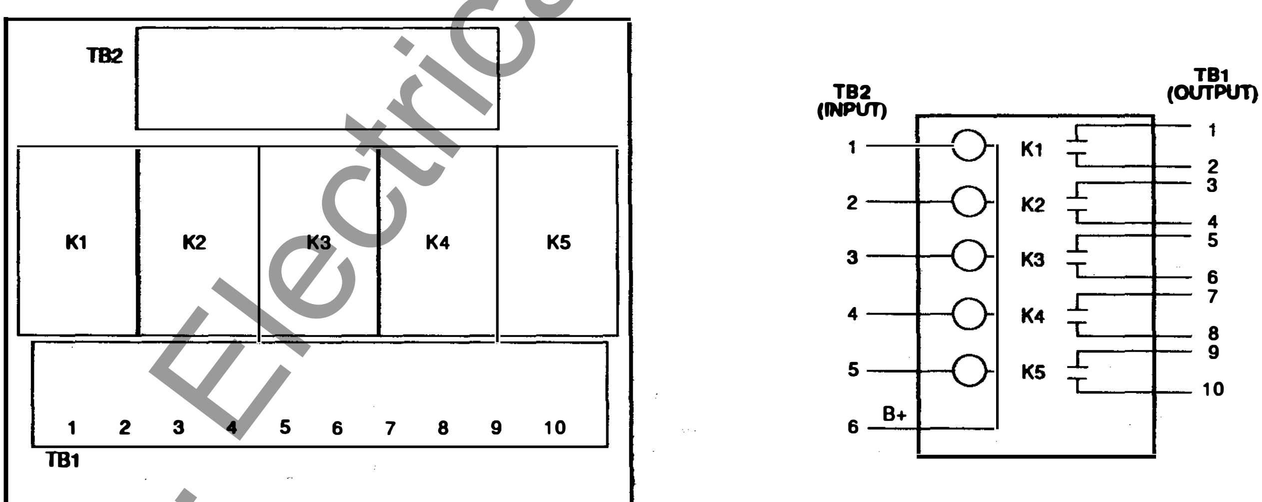
FIGURE 5-1. RUN RELAY

INTERFACE RELAY MODULES (IF EQUIPPED)

When the customer provides a remote control panel having alarm circuits powered by a separate AC or DC source, Module A13 (7 relays) and Module A14 (5 relays) can be provided to interface with the ECM (A11) circuits. Typical wiring diagrams are shown in Figure 5-2.



A13



A14

ES-1854

FIGURE 5-2. INTERFACE RELAY MODULES

TIME DELAYED START/STOP MODULE (IF EQUIPPED)

This module contains adjustable potentiometers for time delayed start (1 to 15 seconds), and time delayed stop (1 to 15 minutes). Time delay adjustment is made by turning the appropriate potentiometer clockwise to increase or counterclockwise to decrease the time delay. Set the time delay start per site requirements, and the time delay stop for approximately 3 to 5 minutes. Typical wiring diagram is shown in Figure 5-3. Refer to *Wiring Diagrams* section for further information.

AC METERS AND CURRENT TRANSFORMERS

If a meter malfunctions, the problem might be a loose wiring connection, the meter itself, the phase selector switch, or the current transformer for that meter. If more than one meter is malfunctioning, you may have to check for proper and secure generator tap connections. Check appropriate AC wiring diagram/schematic for wire lead and terminal connections. Checking continuity of the wiring and components should identify the problem. Repair or replace any faulty wiring, replace faulty meter, current transformer, switch, etc. Refer to appropriate wiring diagram/schematic in *Wiring Diagram* section.

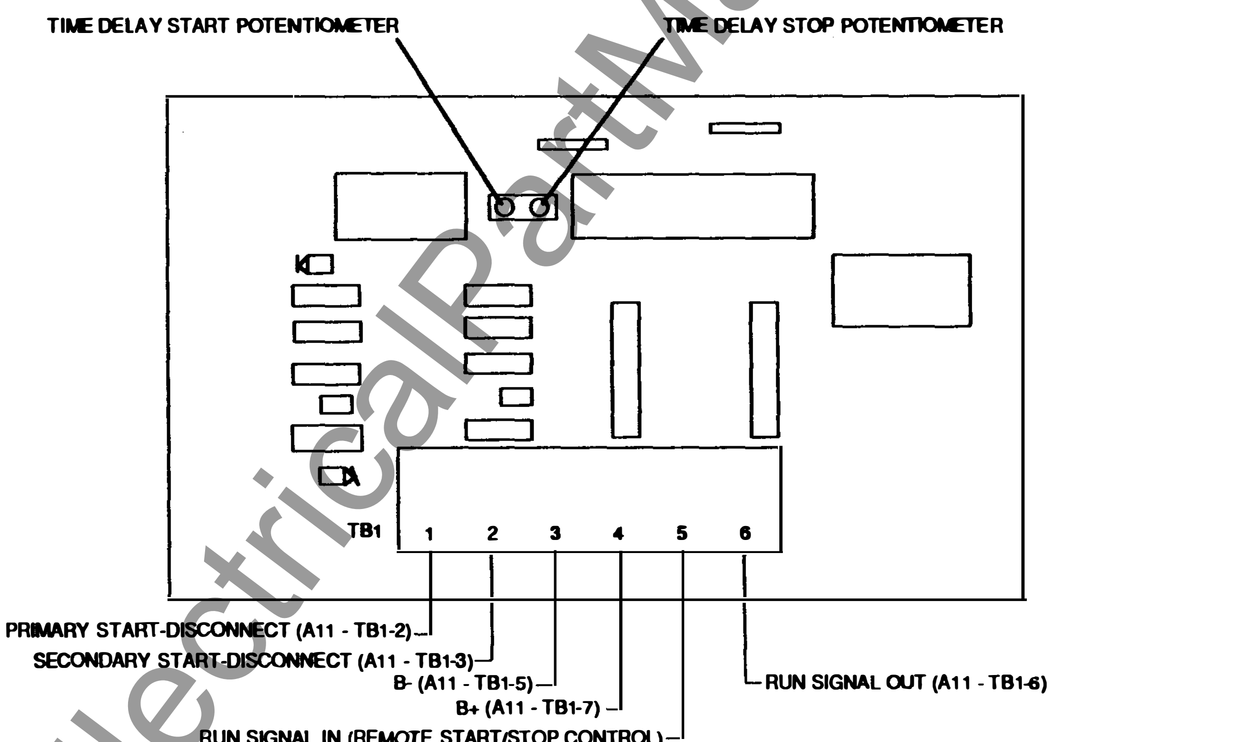


FIGURE 5-3. TIME DELAYED START/STOP MODULE

AUTOMATIC VOLTAGE REGULATOR

The automatic voltage regulator (AVR) is a three-phase full wave power output type device, which forms part of the excitation system for the generator.

In addition to regulating the generator voltage, the AVR circuitry includes a number of protective features which provide safe reliable control of the generator. Excitation power is derived from a permanent magnet generator (PMG), providing low Radio Frequency Interference (RFI) and immunity from thyristor type loads.

The AVR is interlinked with the main stator windings, exciter field and PMG to provide closed loop control of the output voltage with load regulation at approximately ±0.5% RMS.

The AVR senses the output voltage from the main stator windings and in response to this controls the power fed to the exciter field, and the main field, in such a way as to maintain the machine output voltage within the specified limits, compensating for load, speed, temperature and power factor of the generator.

Soft start circuitry is included to provide a smooth controlled build up of generator output voltage.

Sustained overvoltage situations caused by open circuit sensing terminals or short circuit power device are avoided by overvoltage detection circuitry which provides internal shutdown and circuit breaker trip signals for circuit isolation if required.

A frequency measuring circuit continually monitors the shaft speed of the generator and provides underspeed protection of the excitation system by reducing the generator output voltage proportionally with speed below a preset value. A further enhancement of this feature provides greater voltage roll off in response to rate of falling speed (dHz/dt), to improve frequency recovery time on turbocharged engines.

Current limiting circuitry (optional) provides control over the amount of short circuit current flowing during three-phase and single-phase shorts on the generator output.

Over excitation situations left uncontrolled are limited to a safe duration by internal shutdown of the AVR output device. This condition remains latched until the generator has been stopped.

Basic Operation

The internal block diagram of the AVR board is shown in Figure 5-4. The main functions of the AVR are as follows.

Sensing Resistors: Take a portion of the generator output voltage and attenuate it to a suitable lower level. This input chain of resistors includes the hand trimmer adjustment.

Quadrature Droop Circuit (Optional): Converts the current input from a CT into a voltage which is phase mixed with sensing voltage. The result is a net increase in the output from the sensing network as the power factor lags, causing a reduction in excitation.

RMS Converter: Is a square law precision rectifier circuit that converts the AC signals from the sensing networks into a composite DC signal representing the mean squared value of the waveform.

The output of the RMS converter includes a variable potential divider which forms the voltage range control for the AVR.

Current Converter: Is a three-phase precision rectifier and amplifier that converts the inputs from current transformers into a DC signal representing the mean value of the current waveform.

Offset Control: Provides an interface between the AVR and accessories and allows the generator's excitation to be controlled by adding or subtracting the accessory DC output voltage to the AVR rectified sensing voltage.

Power Supply: Components consist of zener diodes, dropper resistors and smoothing to provide the required voltages for the integrated circuits.

Precision Voltage Reference: Is a highly stable temperature compensated zener diode used for DC comparison.

Soft Start Circuitry: Overrides the precision voltage reference during run up to provide a linear rising voltage.

Main Comparator/Amplifier: Compares the conditioned sensing voltages with the precision reference voltage and amplifies the difference (error) to provide a controlling signal for the power device in such a way as to supply the exciter with the required amount of power to maintain the generator voltage within the specified limits.

Stability Circuit: Provides adjustable negative AC feedback to prevent voltage hunting and ensure good steady state and transient performance of the control system.

Power Control Driver: Provides the means to infinitely control the conduction period of the output device. This is achieved by pedestal and ramp control followed by a level detector and driver stage.

Power Control Devices and Rectifier: Are configured as a three phase 4 diode bridge, power mosfet and freewheel diode to vary the amount of exciter field current in response to the error signals produced by the main comparator.

Sync: Circuit provides a short pulse near the zero point of one of the phases on the PMG and is used to synchronize the Under Frequency Roll-Off (UFRO) and power control circuits to the generator cycle period.

Under Frequency Roll-Off: Circuit measures the period of each electrical cycle and causes the reference voltage to be reduced approximately linear with speed below a presettable threshold. A light emitting diode (LED) gives indication of underspeed running.

Block Relief: Circuit measures the rate of falling speed of the generator (dHz/dt) and causes greater voltage roll off (makes the V/Hz slope steeper) to aid engine speed recovery after application of a "block" load.

Over Voltage Monitor: Continuously monitors the voltage at the generator terminals and provides signals to shut down the output device and trip an optional circuit breaker, to isolate power from the exciter and AVR in event of sustained overvoltages. A one second timer is included in the circuit to prevent operation during transient overvoltages, which are normal after load removal.

Overload Detector: Continuously monitors the level of excitation and provides signals to shut down the output device in event of sustained overloads lasting greater than ten seconds. Both the overload and overvoltage conditions are latched faults requiring the generator to be stopped for reset.

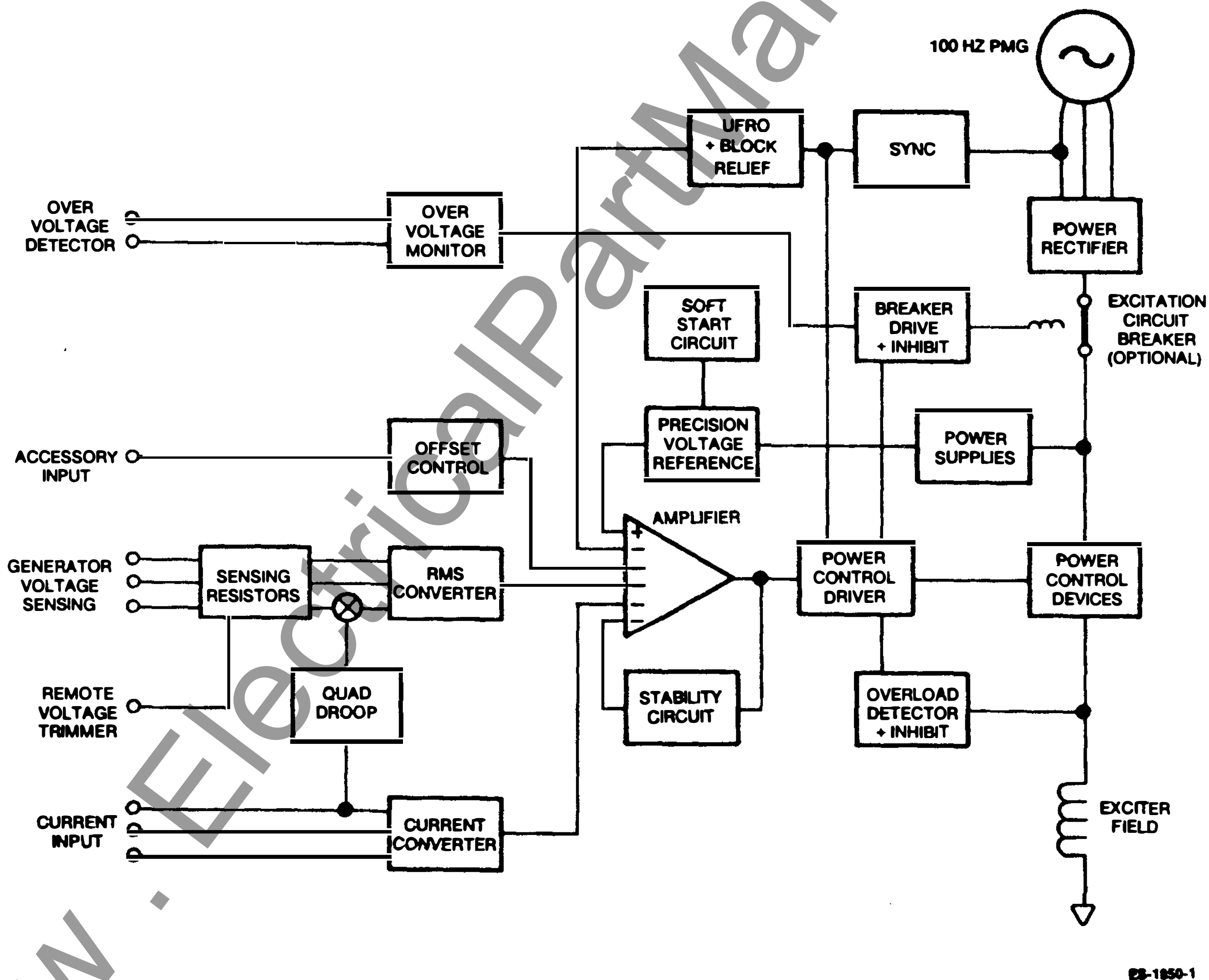


FIGURE 5-4. PMG VOLTAGE REGULATOR BLOCK DIAGRAM

GENERATOR OPERATION REVIEW

The PMG provides power via the AVR to the main exciter stator, see Figure 5-5. Excitation power is therefore independent of output voltage, resulting in positive voltage build-up, without reliance on residual magnetism. The AVR compares the main stator output with a reference value and feeds a controlled excitation current to the main exciter stator. The AC output of the main exciter rotor is converted to DC by the rectifier assembly, comprised of six diodes mounted on two heatsinks to form positive and negative plates. The diodes are protected against harmful overvoltges (caused for example, by switching circuits or out-of-phase paralleling) by a metal-oxide varistor (MOV). The DC output of the rectifier assembly provides the excitation onto the main rotor.

AVR Sensing and Power Supply

3-Phase Sensing: With rated output voltage on the main terminals, the reference supply to this unit should be between 170 and 250 volts AC across 6-7, 7-8 and 8-6. This supply can be by way of a quadrature droop burden resistor and/or dropper transformer. These should be checked for continuity.

Power Supply (PMG): Power supply is derived from the permanent magnet exciter. Its output leads are connected at AVR terminals P2, P3 and P4. These must first be disconnected. With the machine at rated speed the output voltage between leads P2-P3, P3-P4, and P4-P2 should be balanced at approximately 165 volts for 50 Hz (1500 rpm) units or 200 volts for 60 Hz (1800 rpm) units.

Voltage Regulator Adjustment

Generator voltage is controlled by the optional voltage control rheostat (R21) located on the control front panel and the solid-state voltage regulator located inside control panel (see Figure 5-6).

Two, similar PMG voltage regulators have been used in permanent magnet exciter generator sets. One is a four position mount, and the newer of the two has six mounting holes (of which only four are used). Adjustment procedures are the same for both, even though the potentiometers are located differently. Refer to Figure 5-6 to identify which PMG AVR the unit is equipped.

The generator voltage may be adjusted within ±3 percent of the rated nameplate voltage via the optional control-panel mounted voltage control rheostat (R21). If the adjustment cannot be made with R21, or if R21 is not installed, adjust the voltage regulator as follows:

1. Adjust voltage control rheostat R21 (if available) to the mid position.
   - Loosen the locking nut. With a screwdriver, turn rheostat R21 fully counterclockwise, then fully clockwise, then to mid position.
2. Open the control panel doors to gain access to the voltage regulator.
3. With the generator set operating, and the voltage being monitored (either by meters on the set or with remote metering), adjust voltage regulator board Volts potentiometer to the desired generator voltage.
4. Perform fine voltage adjustment (±3 percent) by adjusting rheostat R21, retighten locking nut.
5. Stop and restart generator set to confirm proper operation.
6. If adjusting the Volts potentiometer of the voltage regulator board does not allow the generator voltage to come within desired range, refer to wiring diagram included with unit and check for proper connections. Repeat the adjustment procedure. If proper adjustment is still not possible, review the following regard-

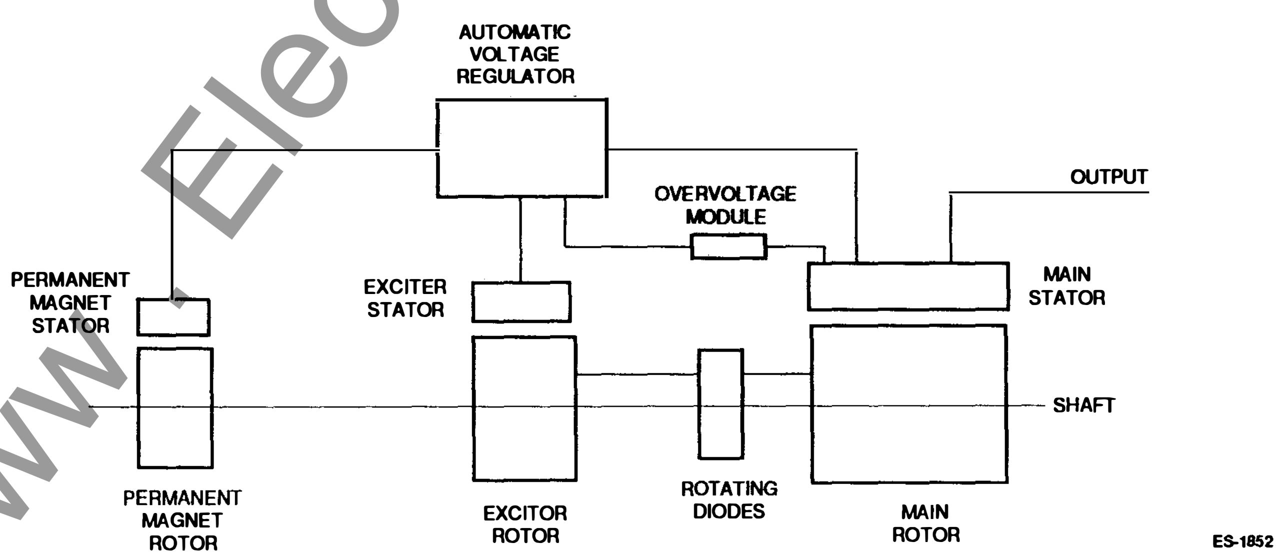


FIGURE 5-5. PERMANENT MAGNET GENERATOR (PMG) EXCITATION SYSTEM (BLOCK DIAGRAMS)

ing other potentiometers on the AVR (note that a non-PMG regulator does not have all the same potentiometers as a PMG regulator). Replace voltage regulator board, or contact your service representative for assistance.

⚠CAUTION ***Sealed voltage regulator potentiometers are factory-calibrated for operation with this generator set. Any adjustment of other components could cause generator set voltage instability or overheating. Further adjustments should only be made by a qualified service representative.***

Stability: If the voltage is unstable after a block load reduction, turn the Stability control clockwise. Optimum setting should be found around midpoint. Any stability adjustment affects the generator output voltage. Reset the output voltage after any stability adjustment.

Under Frequency Roll Off (UFRO) Knee Point: This control is set at 58 to 59 Hz (60 Hz units) or 48 to 49 Hz (50 Hz units). The LED (light emitting diode) adjacent the UFRO potentiometer will be lit when the voltage regulator is in the under frequency mode, off is the standard operating mode. To check, reduce generator frequency from rated to where the LED just begins to illuminate. Note set point frequency. Turning the UFRO potentiometer clockwise reduces the knee point frequency, and the LED will extinguish. Return set to rated frequency.

DIP (Voltage Dip Limit): This control is preset at approximately 30 percent of the operating voltage. Turning the control clockwise increases the voltage dip on large load pickup. This will make it easier for the engine to pick up load. Turning the control counterclockwise reduces the voltage dip (makes the AVR "stiffer"). The engine may not be able to pick up the load if the Voltage Dip Limit is set too far counterclockwise.

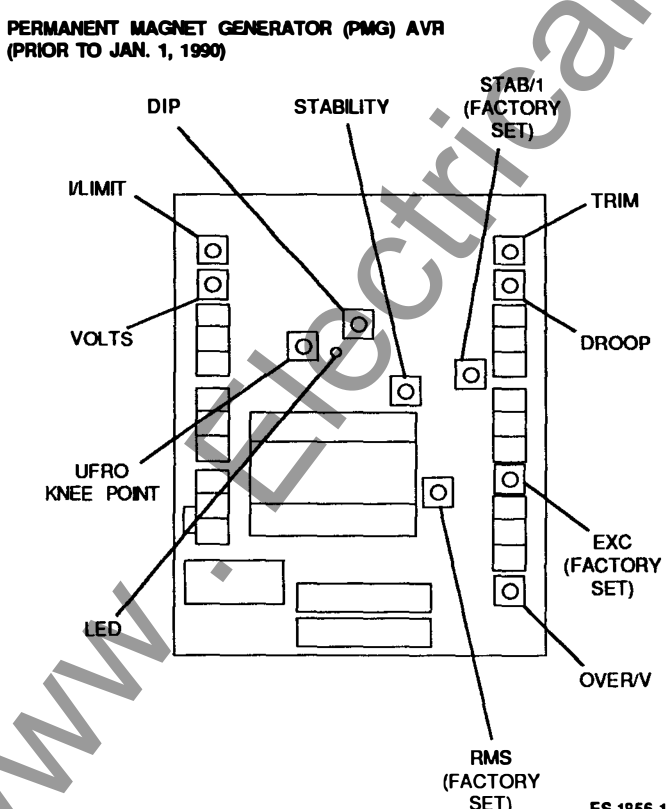
Droop: To set generator droop to 5% at full load, 0 PF. Turning this control clockwise increases the droop (the I/Limit may also need to be adjusted if there is too much droop.)

Trim: To match AVR input to accessory output. Turning this control clockwise allows accessories, like a VAR/PF controller, more control over the AVR.

Over/V: To set the overvoltage protection cutoff level. Turning this control clockwise increases the overvoltage cutoff level.

I/Limit: To set the maximum short circuit current. Turning this control clockwise increases the short circuit current.

Stab/1, EXC, and RMS: Are set at factory, and should not require any adjustment. Replace AVR.



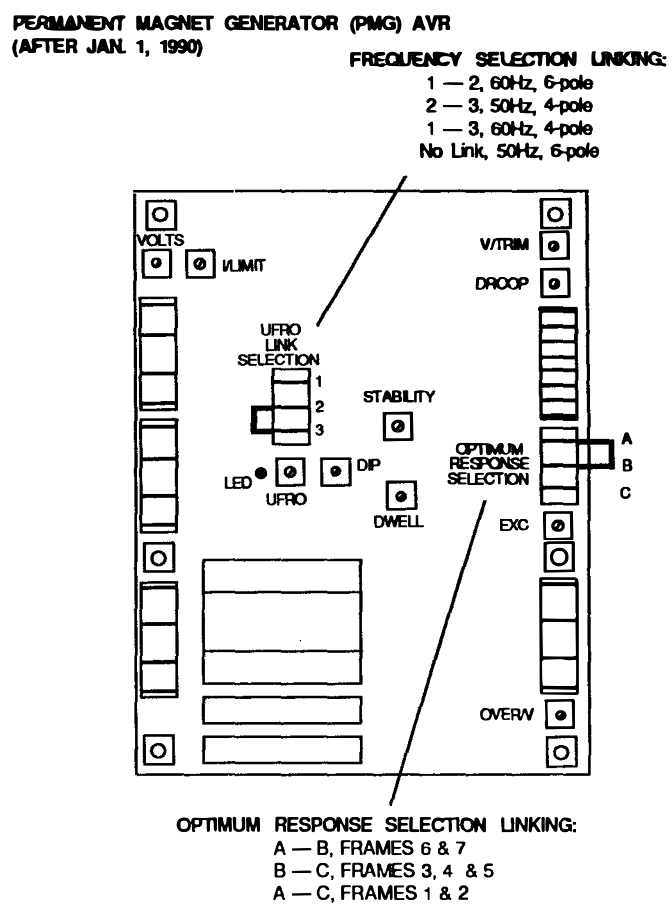


FIGURE 5-6. PMG VOLTAGE REGULATORS

OVER/UNDER VOLTAGE SENSOR MODULE (IF EQUIPPED)

Rotate the appropriate arrow indicator to adjust the module, the recommended approximate settings are:

Under % Volts Set	90
% Volts Reset	5
Over % Volts Set	110
% Volts Reset	5

The module includes an adjustable time delay relay to prevent nuisance tripping (typically set at 25 percent, or approximately 2.5 seconds). See typical wiring diagram in Figure 5-7.

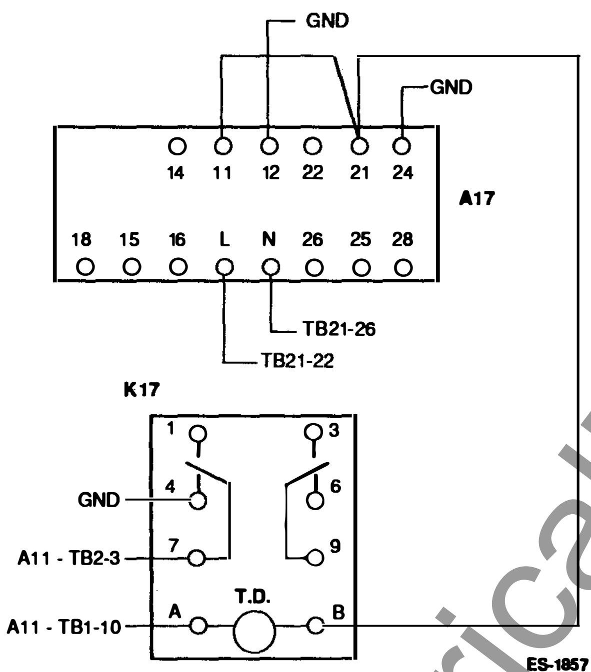


FIGURE 5-7. OVER/UNDER VOLTAGE SENSOR MODULE

OVER/UNDER FREQUENCY SENSOR MODULE (IF EQUIPPED)

Rotate the appropriate arrow indicator to adjust the module, the recommended settings are:

Nominal Hz	50	60
Under Hz Set	45	55
Reset	47	57
Over Hz Set	55	65
Reset	53	63

See typical wiring diagram in Figure 5-8.

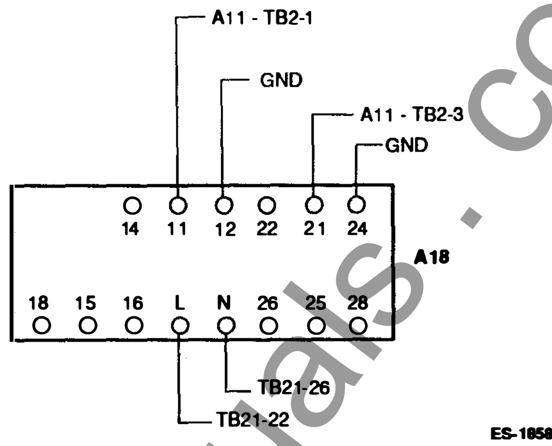


FIGURE 5-8. OVER/UNDER FREQUENCY SENSOR MODULE

OVERSPEED (FREQUENCY DETECTION) MODULE

This module derives a speed (Hz) signal from the PMG but is powered from the generator set battery. A small time delay, typically one second, is incorporated in the overspeed function to allow for engine overshoot. The module contains two adjustable potentiometers, Overspeed and Cranking (the cranking potentiometer is not used however).

The Overspeed potentiometer is adjustable from 1500 to 2500 RPM. Adjust the Overspeed potentiometer to achieve overspeed at approximately 1800 to 1900 RPM for 50 Hz units and 2100 to 2200 RPM for 60 Hz units. See typical wiring diagram in Figure 5-9.

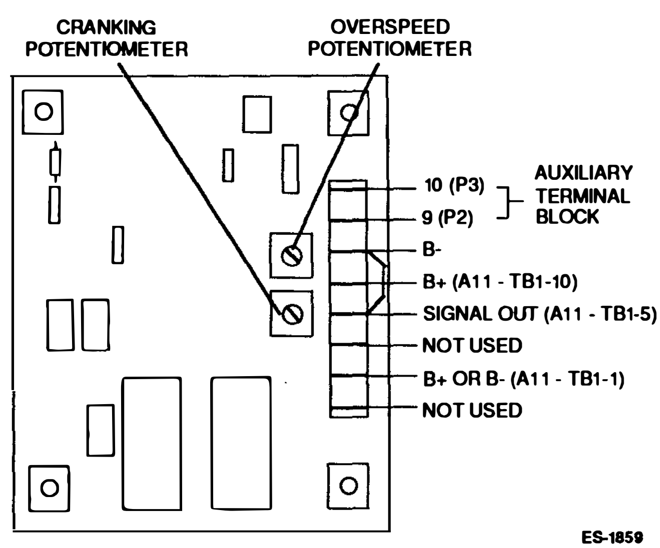


FIGURE 5-9. OVERSPEED (FREQUENCY DETECTION) MODULE

ROTATING RECTIFIER ASSEMBLY

The rectifier assembly, Figure 5-10, is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative based diodes, and the positive plate carries positive based diodes. The correct polarity diodes must be fitted to their respective plate.

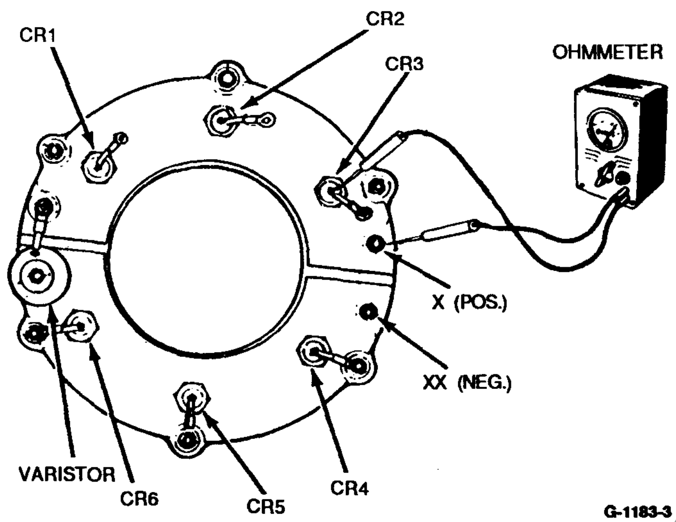


FIGURE 5-10. TESTING ROTATING RECTIFIER ASSEMBLY

Surge Suppressor

The surge suppressor (varistor) connected across the two rectifier plates prevents high transient reverse voltages in the field winding from damaging the diodes. This device is not polarized and will show an infinite reading in both directions with an ohmmeter. If defective, signs of burning will probably be apparent and it will give a full deflection (short-circuit) reading. Replace if defective.

Rectifier Diodes

Using an accurate ohmmeter, test each CR using negative and positive polarities. Test rectifiers (diodes) as follows:

1. Disconnect all leads from assembly to be tested.
2. Connect one lead to the positive (X) stud and connect other lead to CR1, CR2, and CR3 in turn; record resistance value of each rectifier.
3. Connect one lead to the negative (XX) stud and connect other lead to CR4, CR5, and CR6 in turn; record resistance value of each rectifier.
4. Reverse ohmmeter leads from Steps 2 and 3 and record resistance value of each rectifier; positive stud (X) to CR1, CR2, and CR3; and negative stud (XX) to CR4, CR5, and CR6.
5. All the resistance readings should be high in one test and low in the other test. If any reading is high or low in both tests, rectifier assembly is defective.
6. Replace defective rectifier assembly with new, identical part.

⚠CAUTION ***Excessive dust or dirt on diodes and other components will cause overheating and eventual failure. Keep these assemblies clean!***

Use 24 in-lbs. (2.7 N•m) torque when replacing nuts of positive (X) and negative (XX) studs, and CR1 to CR6.

Replacing Rectifiers

To replace rectifiers use the following procedure:

1. Disconnect diode lead wire from stud terminal.
2. Use proper size wrench to unscrew diode from rectifier assembly base.
3. Apply heatsink compound to underside of new diode. DO NOT apply this compound to diode stud threads.
4. Insert new diode into mounting hole. Torque diodes on rotating rectifier assembly to 36-42 in-lbs. (4-4.8 N•m).
5. Reconnect diode lead wire to stud terminal. Use 24 in-lbs. (2.7 N•m) torque when replacing nuts.

PERMANENT MAGNET EXCITER

The permanent magnet exciter is the main power supply for a PMG AVR and is isolated from all other windings. For this reason the output from the exciter must be tested independently across its terminals, which are connected to auxiliary terminal board (exciter leads P2, P3, and P4). With the machine run up to full speed, the output voltage across the leads P2, P3, and P4 should be balanced at approximately 165 volts for 1500 rpm (50 Hz) or 200 volts for 1800 rpm (60 Hz) between terminals. The permanent magnet exciter will produce an output voltage completely independent from the rest of the machine, and has no effect on the separate excitation tests that follow. Refer to appropriate wiring diagram/schematic in Section 7.

The permanent magnet exciter stator resistance is 4.4 ohms line-to-line.

EXCITER ROTOR

Testing for Grounds

Connect leads of ohmmeter between each CR lead and exciter rotor laminations. Use an ohmmeter set at the highest resistance range. An ohmmeter reading less than one megohm (1,000,000 ohms) indicates defective ground insulation. See Figure 5-11.

Testing for Open or Shorted Windings

Use a Wheatstone Bridge for this test. Disconnect main rotor field leads which connect to rotating rectifier assemblies at the positive and negative studs. Disconnect lead wires from diodes CR1, CR2, CR3, CR4, CR5, and CR6. Test between exciter lead pairs U6-V6, V6-W6 and U6-W6. Refer to Table 5-1 for resistance values.

Be sure to identify the genset model, kW rating and generator frame size from the generator set nameplate before reviewing Table 5-1.

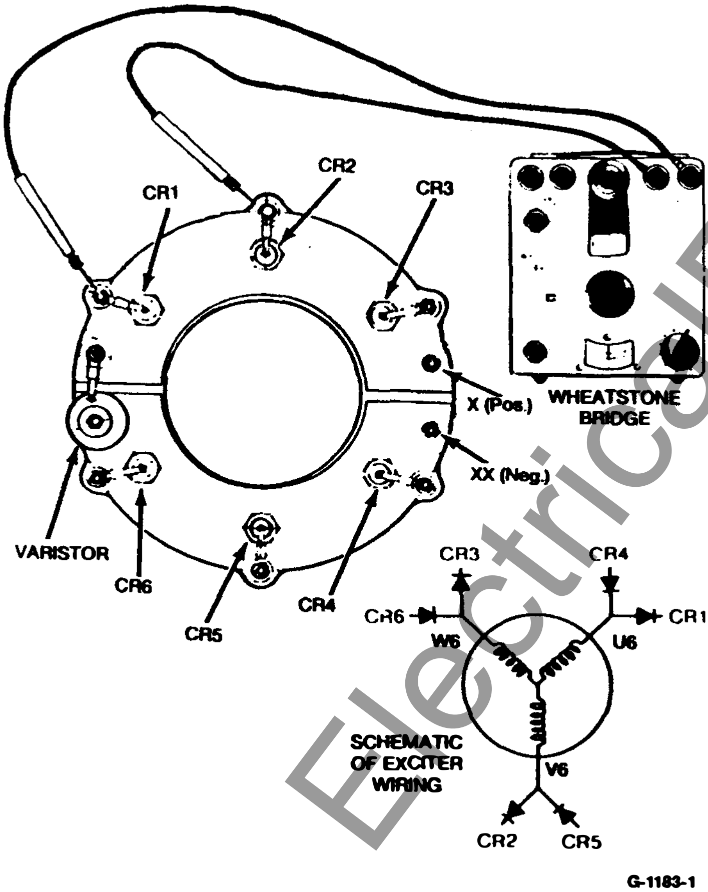


FIGURE 5-11. TESTING EXCITER ROTOR

EXCITER STATOR

Testing for Grounds

Using an ohmmeter, R x 100 scale, measure the insulation resistance between either lead X or XX and the laminations, Figure 5-12. A reading of less than infinity indicates a ground.

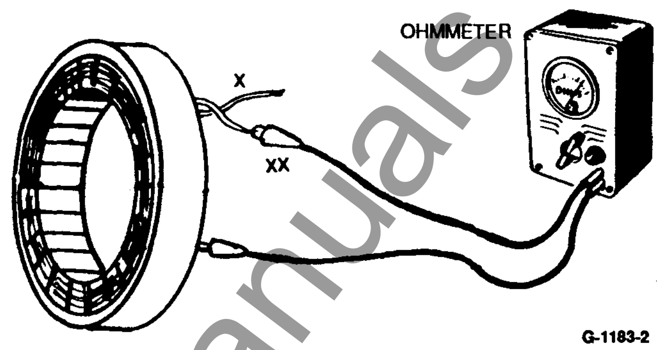


FIGURE 5-12. TESTING EXCITER STATOR FOR GROUNDS

Testing Winding Resistance

Measure coil resistance between leads X and XX with an ohmmeter, scale R x 1. See Figure 5-13. Refer to Table 5-1 for resistance values.

Be sure to identify the genset model, kW rating and generator frame size from the generator set nameplate before reviewing Table 5-1.

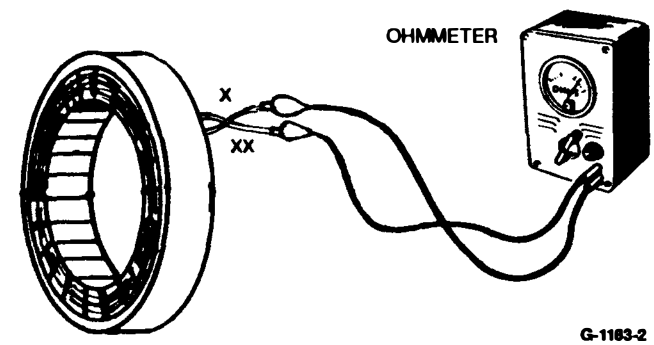


FIGURE 5-13. TESTING EXCITER STATOR FOR OPEN CIRCUIT

GENERATOR ROTOR

Testing for Grounds

Use an ohmmeter, (R x 100 scale) and measure as follows:

1. Disconnect rotor leads from the rotating diodes.
2. Measure between either lead and the rotor shaft, Figure 5-14.
3. A reading of less than infinity indicates a ground.

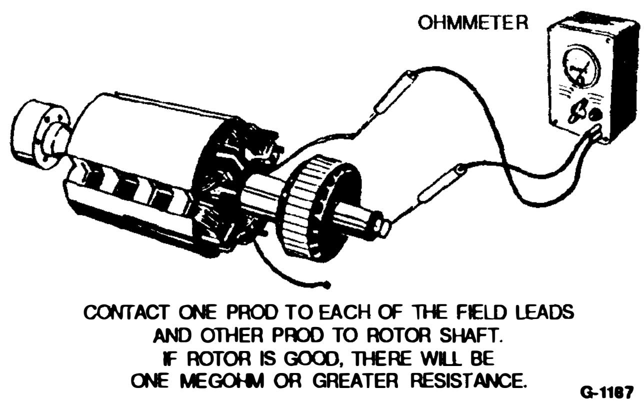


FIGURE 5-14. TESTING GENERATOR ROTOR FOR GROUNDS

Testing for an Open Circuit

1. Disconnect and test between rotor leads, Figure 5-15.
2. Replace the rotor if it is grounded or has an open or short. Refer to Table 5-1 for resistance values.

Be sure to identify the genset model, kW rating and generator frame size from the generator set nameplate before reviewing Table 5-1.

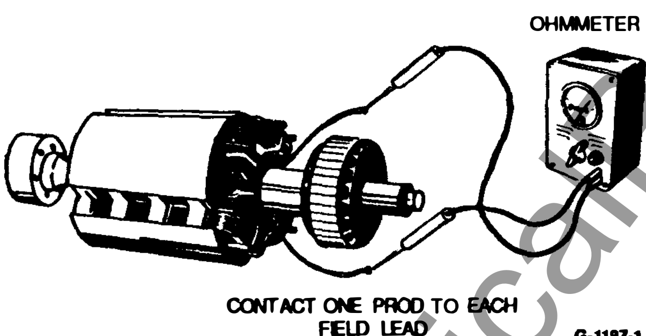


FIGURE 5-15. TESTING GENERATOR ROTOR FOR OPEN CIRCUIT

GENERATOR STATOR

⚠ DANGER ***High-voltage, 1,900 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages.***

Testing for Grounds

Before testing stator, disconnect all external load and control wires. Isolate from ground and each other.

Connect all (U, V, and W) stator output leads together. Use an ohmmeter set on the R x 100 scale and measure the insulation resistance between these windings and the stator frame. A reading of less than infinity indicates a ground. Field circuit breaker can be either open or closed for this test.

Testing for Shorts

To check for shorts between individual windings, first refer to electrical schematic to determine individual coil lead wires (U5-U6, U1-U2, etc.). Be sure to disconnect the instrumentation leads and stator leads U1, U2, U5, V2, and W2. Connect an ohmmeter, R x 100 scale to one lead of a stator winding (leaving the other end of coil winding being tested open), and the other ohmmeter lead to all other stator leads connected together.

Example:

- Ohmmeter lead to: U6 coil winding lead.
- Ohmmeter lead to: U1, 2, V1, 2, 5, 6, W1, 2, 5, and 6 connected together.
- Coil winding lead U5, open.

A reading of less than infinity indicates a short. Repeat test for all six coils.

Measure resistance of windings using a Kelvin Bridge meter. Refer to Figure 5-16. If any windings are shorted, open, or grounded, first check the leads for broken wires or damaged insulation. If winding leads show no damage, and it is determined that windings are damaged internally, replace the stator assembly. Refer to Table 5-1 for resistance values.

Be sure to identify the genset model, kW rating and generator frame size from the generator set nameplate before reviewing Table 5-1.

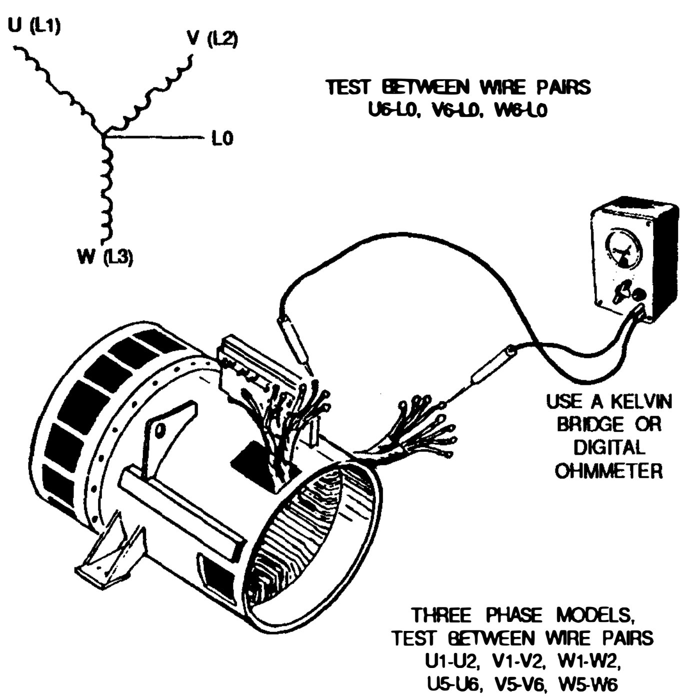


FIGURE 5-16. TESTING GENERATOR STATOR WINDINGS

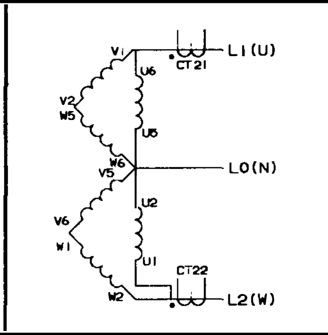
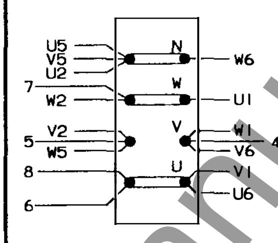
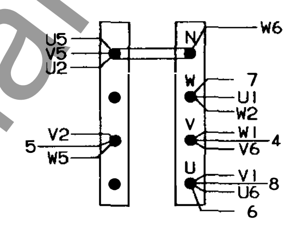
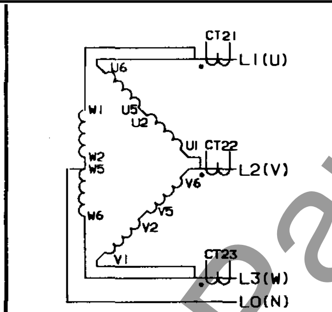
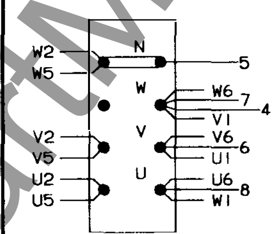
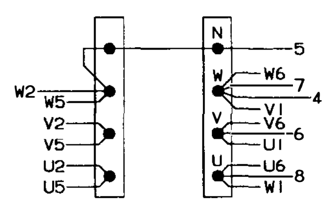
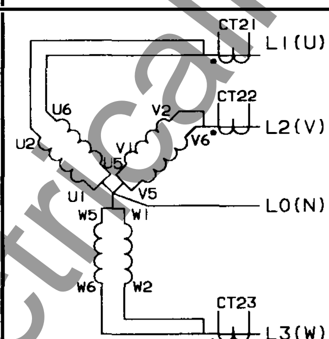
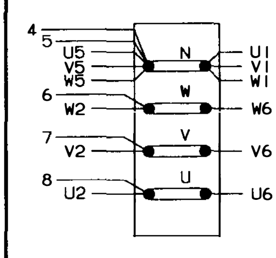
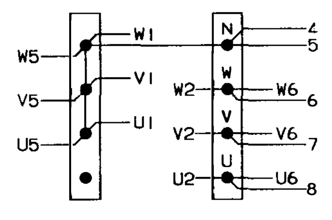
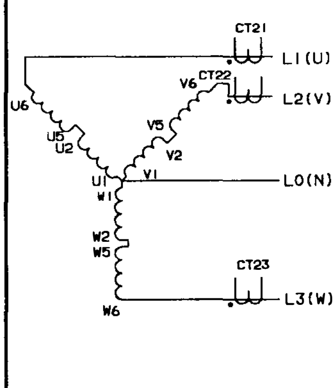
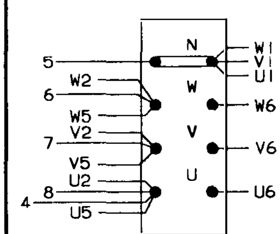
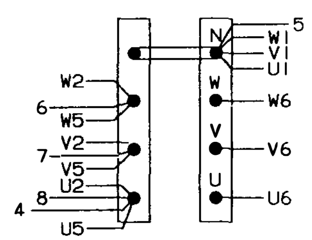
TABLE 5-1. WINDING RESISTANCE VALUES*

GENSET MODEL DESIGNATIONS		KW RATING 50 Hz	KW RATING 60 Hz	GEN. FRAME SIZE	EXCITER STATOR	EXCITER ROTOR	STATOR (Per Phase: Wye or Series Wye)	ROTOR
DFAA		175	200	4C	25	0.14	0.017-0.023	0.91
DFBC	NT4	175	200	4C	25	0.14	0.017-0.023	0.91
DFBD	NT4	175	200	4C	25	0.14	0.017-0.023	0.91
DFAB		200	230	4D	25	0.14	0.014-0.020	1.04
DFBD	NT4	200	230	4D	25	0.14	0.014-0.020	1.04
DFBE	NT5	220	250	4D	25	0.14	0.014-0.020	1.04
DFAC		220	250	4D	25	0.14	0.014-0.020	1.04
DFBE	NT5	220		4E	25	0.14	0.010-0.015	1.17
DFBF	NT6	250	275	4E	25	0.14	0.010-0.015	1.17
DFCB	NTA2		300	4E	25	0.14	0.010-0.015	1.17
DFCB	NTA2	275		4F	25	0.14	0.0097-0.010	1.35
DFCC	NTA3	310	350	5C	25	0.17	0.068-0.0090	1.55
DFEB	KTA12	330	400	5C	25	0.17	0.0068-0.0090	1.55
DFFA	KTT11	400	450	5D	25	0.17	0.0058-0.0080	1.77
DFEC		400	450	5D	25	0.17	0.0058-0.0080	1.77
DFFB	KTT12	450	500	5E	25	0.17	0.0043-0.0069	1.96
DFGA	VTA1	440	500	5E	25	0.17	0.0043-0.0069	1.96
DFGB	VTA2		600	5F	25	0.17	0.0031-0.0042	2.16
DFGC	VTA3	550		6A	17**	0.16	0.0037-0.0053	1.37
DFJA	KTA31	620	750	6B	17**	0.16	0.0030-0.0033	1.47
DFJB	KTA32	660	800	6B	17**	0.16	0.0030-0.0033	1.47
DFJC	KTA33	800	900	6C	17**	0.16	0.0023-0.0028	1.66
DFJD		900	1000	6C	17**	0.16	0.0023-0.0028	1.66
DFLA	KTA51	900	1000	6D	17**	0.16	0.0018-0.0023	1.89
DFLB	KTA52		1100	6D	17**	0.16	0.0018-0.0023	1.89
DFLC	KTA53	1120	1250	7B	17**	0.20	0.0012-0.0018	2.29
DFLD	KTA54	1200		7G	17**	0.20	0.0012-0.0018	2.29
DFMA	KTT51	1100	1250	7G	17**	0.20	0.0012-0.0018	2.29
DFMB	KTT52	1280	1500	7G	17**	0.20	0.0012-0.0018	2.29

* Resistance figures are approximates, at 68°F (20°C) ±10%.
** Units built prior to November, 1989, were 28 ohms.

RECONNECTION

Figure 5-17 shows the general reconnection possibilities for the generators. When reconnecting for a different voltage, refer to AC Reconnect Wiring Diagram in Section 7 and AC diagrams that came with unit.

CURRENT TRANS. CONN.	VOLTAGE CODE	VOLTAGE	PHASES	HERTZ	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM — PHASE SEQUENCE U.V.W. WHEN ROTATING CLOCKWISE VIEWED AT THE DRIVE END: FRAME 4	FRAME 5, 6, 7
1 AND 3	L	120/240	1	60	DOUBLE DELTA			
	Z	115/230	1	50				
		110/220	1	50				
1 AND 3	L	120/240	3	60	SERIES DELTA			
	Z	110/220	3	50				
		115/230	3	50				
1 AND 3	L	120/208	3	60	PARALLEL WYE			
		127/220	3	60				
		139/240	3	60				
	Z	110/190	3	50				
		115/200	3	50				
		120/208	3	50				
		127/220	3	50				
1 AND 2	L	220/380	3	60	SERIES WYE			
		240/416	3	60				
		254/440	3	60				
		277/480	3	60				
	Z	220/380	3	50				
		230/400	3	50				
		240/416	3	50				
		254/440	3	50				
	H	347/600	3	60				

ES1866c

FIGURE 5-17. RECONNECTION DIAGRAM

ELECTRONIC GOVERNOR

Generator frequency is in direct ratio to engine speed which is controlled by the governor. The governor control has four potentiometers for making adjustments. See Figure 5-18. Use a frequency meter or tachometer to monitor the unit during adjustment procedure.

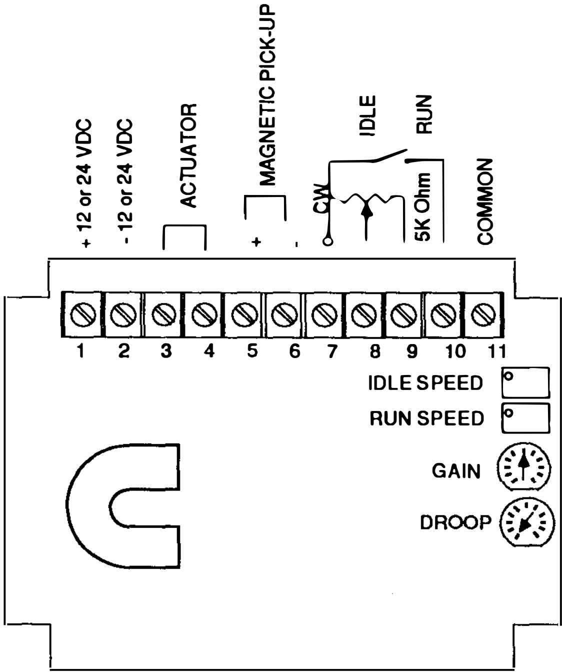


FIGURE 5-18. ELECTRONIC GOVERNOR

Gain: The Gain control is a one-turn potentiometer. It is used to adjust the sensitivity of the governor. A clockwise rotation of the potentiometer will shorten the response time to load changes.

Droop: The Droop control is a one-turn potentiometer. It is adjustable for zero % (isochronous) to more than 5% speed droop. Fully counterclockwise rotation is 0% speed droop.

Idle Speed: The Idle Speed control is a 20-turn potentiometer for adjusting the idle speed. A clockwise rotation will increase the idle speed.

Run Speed: The Run Speed control is a 20-turn potentiometer for setting the desired no-load governed speed. A clockwise rotation will increase the run speed.

Refer to the following adjustment procedures.

Adjustments

Preliminary Adjustments:

1. Frequency Adjust (engine speed) potentiometer on control panel (if equipped).
   A. Loosen the locking nut.
   B. With a screwdriver, turn the potentiometer fully counterclockwise, then fully clockwise, then to mid position.
   C. Hold mid position setting with screwdriver, and tighten locking nut.
2. **Idle Speed** potentiometer.
   A. Turn the screw counterclockwise 20 turns.
   B. Turn the screw clockwise 10 turns.
   C. This will set the idle speed potentiometer to its mid position.
3. **Run Speed** potentiometer.
   A. Turn the screw counterclockwise 20 turns.
   B. Turn the screw clockwise 10 turns.
   C. This will set the run speed potentiometer to its mid position.
4. **Gain** potentiometer.
   A. Set the Gain adjustment at the third division from zero.
5. **Droop** potentiometer.
   A. For isochronous operation, the droop potentiometer must be turned fully counterclockwise and will not require any further adjustment.
   B. Turn the screw to approximately 40 for 3 percent droop.
   C. Turn the screw to approximately 80 for 5 percent droop.

Calibration Checks:

1. Start the generator set.
2. For proper full-load generator set operation the engine no-load speed must first be adjusted to the desired allowable speed droop. (For example: isochronous operation set to 60.0 Hz/1800 r/min (50.0 Hz/1500 r/min), for 3% speed droop set to 61.8 Hz/1854 r/min (51.5 Hz/1545 r/min), for 5% speed droop set to 63.0 Hz/1890 r/min (52.5 Hz/1575 r/min.)

   With the generator set warmed up to proper operating temperature, adjust the Run Speed potentiometer until the engine is operating at the desired frequency or r/min.
3. With no load connected to the generator set, turn the GAIN adjustment clockwise slowly until the actuator lever oscillates. Reduce the GAIN adjustment slowly counterclockwise until the lever is stable. Upset the lever by hand. If the lever oscillates up to 3 deminishing oscillations and stops, the setting is correct.
4. Apply and remove loads to check generator set response. If generator set operation is satisfactory, the governor is now calibrated. If generator set response is not satisfactory, review Step 3. If electric governor cannot be properly calibrated, contact your service representative for assistance.

Fine Speed Adjustment: After the GAIN adjustment is made, the full load governed Run Speed may require a minor adjustment to equal the desired speed (i.e., 60 Hz, 1800 r/min or 50 Hz, 1500 r/min). Use the SPEED ADJUST potentiometer (when supplied) on the engine instrument panel for fine speed adjustments of less than ±100 r/min.

Electric Fuel Control (EFC) Governor System Description

The EFC governor system contains a magnetic pickup, electronic control, and the fuel pump actuator. See Figure 5-19.

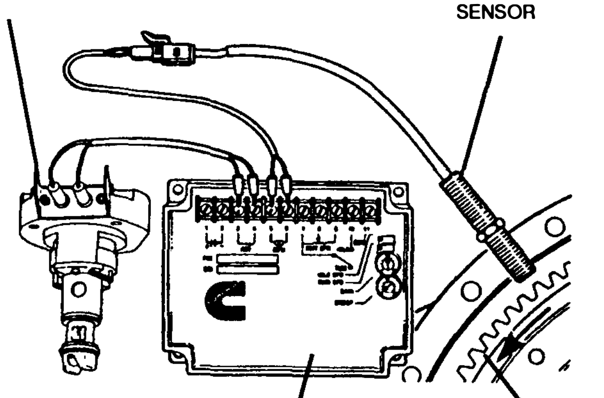


FIGURE 5-19. EFC GOVERNOR SYSTEM

The magnetic pickup senses engine speed at the flywheel ring gear and sends an alternating current (AC) electrical signal to the governor control.

The governor control compares the electrical signal from the magnetic pickup with a preset reference point. If there is a difference in the two signals, the control will change the current to the actuator (located on the engine side of the fuel pump).

The change in current in the actuator coil will make the actuator shaft rotate. The fuel flow, and engine speed or power will change when the actuator shaft rotates.

Performance Checks

If the generator set operation is rough or surges, review the following:

1. Start the generator set and check voltage readings at governor control terminals for; magnetic pickup (1.5 VAC minimum at cranking, to 30 VAC maximum at genset operating speed), battery B+ (24 VDC), fuel pump actuator (19-20 VDC).
2. Stop generator set, disconnect the leads to the actuator (see Figure 5-20), and connect battery B+ voltage directly to the actuator studs. An audible click in the actuator should be heard when B+ is applied and removed. This check only shows that the actuator is operating (rotating to open and closed position), but not if its binding, futher disassembly of fuel pump may be required to inspect/ repair O-rings, pump, etc.

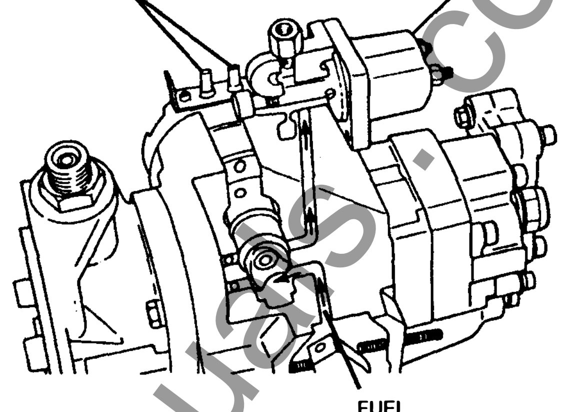


FIGURE 5-20. FUEL PUMP ASSEMBLY

3. If further tests and repair is required, contact your Cummins/Onan distributor for further information, or request a copy of Electric Fuel Control Governor brochure (bulletin no. 3379231-03).

BATTERIES

Check that connections are clean and tight. A light coating of non-conductive grease will help retard corrosion at terminals.

Check the charge condition of the starting batteries with a hydrometer. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity and re-charge if below 1.260.

If the generator set is operated in an area where the ambient temperature is consistently above 95° F (35° C), a specific gravity of 1.225 is recommended to reduce electrolyte loss.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. Do not smoke while servicing batteries. Wear protective apron and goggles when checking specific gravity and adding distilled water.***

If the battery loses excess water, the alternator charge may be too high. Likewise, if battery state of charge is not maintained, the charge rate may be too low. Refer to Alternator, this section. Also, if the battery will not re-charge, replace it.

BATTERY CABLES

With the starter motor operating, check the voltage drops (1) from the battery negative post (not the cable clamp) to the grounding stud, (2) from the battery positive post to the battery terminal stud on the solenoid. Normally, each of these should be less than 0.3 volt. If extra long battery cables are used, slightly higher voltage drops may result. Thoroughly clean all connections in any part of the circuit showing excessive voltage drop.

ALTERNATOR

With the engine running, check the battery condition DC voltmeter. If the alternator is operating properly, the voltmeter reading should be between 26 and 28 volts. If the voltmeter reading is constantly more or less than this, stop the generator set and check for a loose or slipping drive belt, poor terminal connections, or broken lead wires. Repair or replace as required. Also check the condition of the batteries and battery cables.

If everything checks out okay, use a separate voltmeter to determine the alternator output voltage, and to verify accuracy of panel mounted DC voltmeter. Connect the positive (+) lead to the output terminal, and connect the negative (-) lead to ground. Start the generator set and run for a few minutes to allow the voltage to stabilize. A proper operating system will have nominal output voltage of 26 to 28 volts.

If the output voltage is high (over 28 volts), the regulator is probably shorted and should be replaced.

If the output voltage is low (equals battery voltage), the problem could be worn or broken brushes, an open regulator, or an open field diode. If further tests and repair is required, contact your Cummins/Onan distributor, or replace alternator.

STARTER SOLENOID

Apply B+ to the terminal marked **"S"**. Jumper a ground wire to the solenoid mounting bracket. Solenoid should activate.

If the contacts are good, B+ should be present between terminal marked **"I"** and ground. The voltage drop measured across the contacts should never exceed one volt in circuit application.

FUEL SOLENOID

If there is fuel to the injection pump, but no fuel at injection nozzle, the fuel solenoid might be defective.

To check fuel solenoid operation, remove the B+ lead connection from the solenoid, and jumper a separate B+ connection to this terminal. The injection pump should click. If no click is heard, the fuel solenoid must be replaced.

CONTROL SWITCH

Remove battery B+ cable. Place ohmmeter leads across switch. Open and close switch while observing the ohmmeter. A normally open switch should indicate infinite resistance when open and continuity when closed. A normally closed switch should indicate continuity when closed and infinite resistance when open. Replace switch if defective.

TESTING AC LOAD CIRCUIT BREAKER

General

The AC circuit breaker does not require any special maintenance other than periodic exercise and a check of conductor mounting. Circuit breaker options vary by customer requirements. Review the Optional Circuit Breaker Description in Section 6. Generator/Voltage Regulator and perform checks and adjustment applicable to the breaker. A typical breaker diagram is shown in Figure 5-21 for reference. When performing tests and adjustments, avoid accidental start-up by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

⚠WARNING ***Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.***

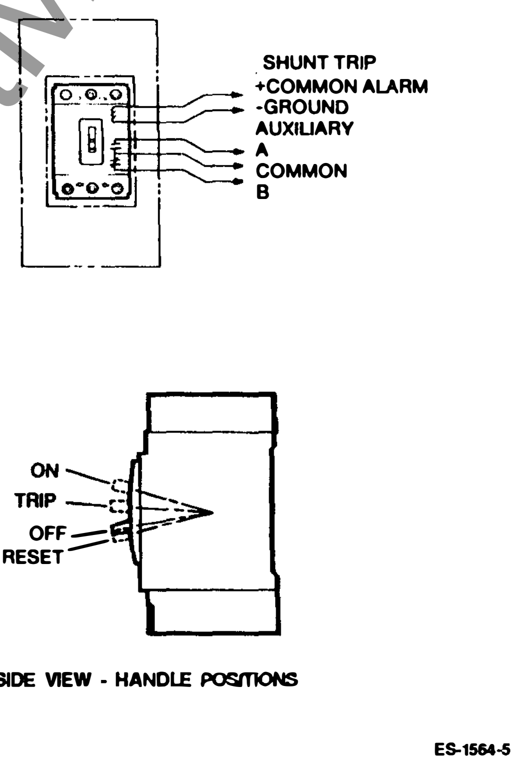


FIGURE 5-21. OPTIONAL CIRCUIT BREAKER DIAGRAM

Exercising Breaker: Actuate the breaker handle to the On and Off positions several times. If the breaker is equipped with a Trip Test button, the breaker should be tripped, reset and actuated to On several times. This will remove any dust from the mechanism and latch surfaces.

Checking Insulation Resistance: Disconnect the load and line conductors from the breaker, and place the breaker in the On position. Use an insulation resistance meter that will apply at least 500 volts to the test leads. Measure the insulation resistance between each pole, and to ground. Also test between the line and load terminals with the breaker in the Off position. A resistance reading less than 100,000 ohms indicates a ground. Investigate for possible contamination on the breaker case surfaces, clean if necessary and retest.

Checking Contact Resistance: Extensive operation of the breaker under load may eventually cause contacts to deteriorate. Test by a Resistance Check, or by a Voltage Drop Check across the breaker poles. Except when generator set operation is required for testing, avoid accidental start-up by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

⚠WARNING ***Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.***

Resistance Check:

1. Disconnect the line and load wires from the circuit breaker.
2. Move the breaker handle to the On position and check the resistance across each pole (line to load).
3. Resistance should be very low (near zero) and relatively equal across all poles.

Voltage Drop Check: This test is done with the conductors connected, generator set operating, and load applied. As a precaution against electrical shock, place an insulating mat or a dry wood platform on the floor to stand on when taking measurements.

⚠WARNING ***Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any body part, clothing, tool or jewelry. Stand on an insulating mat or dry wood platform when taking measurements.***

1. Operate the generator set with the breaker in the On position and load applied.
2. Take voltage readings at the line connections, then the load connections.
3. There should only be slight variation in the voltage dropped across each pole of the breaker. Unequal or excessive millivolt drops across the complete breaker, or one pole, indicates contaminated contacts or loose connections.
4. Stop the generator set by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

⚠WARNING ***Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.***

Checking Shunt-Trip Operation: The shunt-trip feature is available in varying AC or DC voltages. The circuit breaker model is selected and installed at the factory to meet customer requirements. Check the shunt-trip function as follows:

1. Refer to the original equipment order, installation wiring diagrams, and unit wire routing to identify and confirm proper AC or DC signal source connections.

3. Apply the appropriate signal voltage (12 VDC; 240, 480-VAC). The shunt-trip solenoid should energize and trip the breaker open.

4. If the breaker did not trip open, remove the signal source. Perform continuity check of interconnect wiring and shunt-trip solenoid lead wires. Replace interconnect wiring if defective.

Checking Auxiliary Contacts: If equipped, the breaker will have three leads for wiring to an internal single-pole, double-throw switch. The switch allows connection of a remote annunciator (see installation wiring diagrams). Perform continuity checks of the switch with the breaker in On and Off positions to confirm operation.

Adjusting Magnetic Trip Operation: If equipped with front-adjustable magnetic trip controls, the short circuit protection feature for each pole of the breaker can be adjusted equally or individually as required. Surge current above the trip settings will actuate the trip mechanism. These adjustors are set equally to the high position at the factory. Consult on-site requirements and adjust to proper position.

Section 6. Generator Disassembly/Reassembly

GENERATOR DISASSEMBLY

The following procedures provide information for removal and reassembly of the generator PMG exciter, control housing, and stator/rotor assemblies. Be sure to read through this section first, before performing procedures listed, to determine the steps most appropriate for the service attention required.

⚠DANGER ***High-voltage, 1,900 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages.***

Permanent Magnet Exciter Removal

1. Disconnect the negative (-) battery cable to prevent accidental starting of the generator set while servicing.

   ⚠WARNING ***Accidental starting of the generator set during this procedure presents the hazard of severe personal injury or death. Make sure to disconnect the negative (-) battery cable before beginning.***

2. Remove the generator air inlet panel and access covers from control housing (see Figure 6-1).
3. Remove the three M5x12mm capscrews and lockwashers from the PMG exciter assembly cover, and remove cover.
4. Disconnect the PMG wiring harness connector.
5. Remove the four bolts and clamps retaining the exciter stator housing to the endbracket.
6. Tap the stator housing out of its spigot, and carefully remove from generator endbracket.

   The highly magnetic rotor will attract the stator core, care must be taken to avoid any contact which may damage the windings.

7. Remove the hex head through-bolt from the rotor shaft and firmly pull the complete rotor assembly from its location. Keep the rotor clean by avoiding contact with metal dust or particles.

   ⚠CAUTION ***The rotor assembly should under no circumstances be dismantled, or the magnetic properties will be destroyed.***

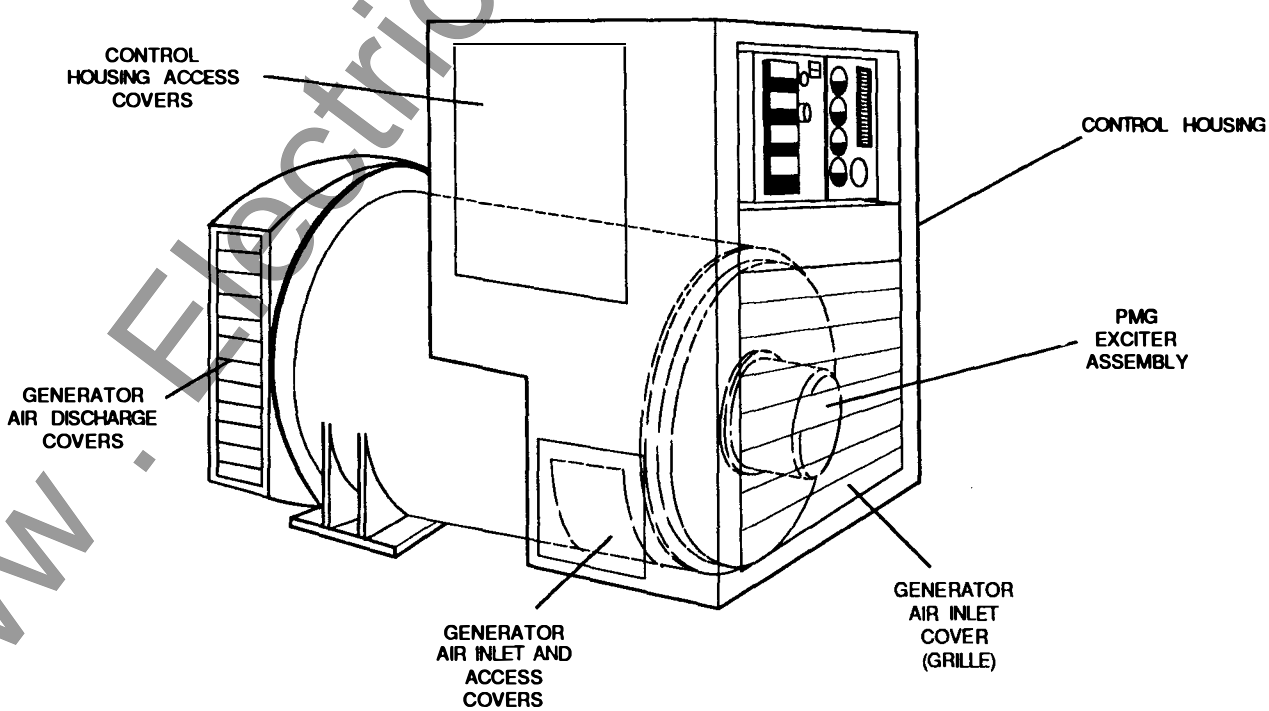


FIGURE 6-1. GENERATOR AND CONTROL HOUSING ASSEMBLY

Main Stator and Rotor Removal

1. Remove the air inlet and discharge panels and access covers from control housing and generator (see Figure 6-1).

2. Crank or bar the engine/generator to position the rotor such that a full pole face is at the bottom of the main stator core. Proper positioning can be viewed through the generator access openings. Refer to engine service manual for proper cranking or barring procedure.

3. Disconnect the negative (-) battery cable to prevent accidental starting of the generator set while servicing.

⚠WARNING ***Accidental starting of the generator set during this procedure presents the hazard of severe personal injury or death. Make sure to disconnect the negative (-) battery cable before beginning.***

4. Disconnect all load wires from the reconnection terminal block assembly (see Figure 6-2). If equipped with the circuit breaker option, disconnect load wires from circuit breaker. Check that all leads are labeled to ease reassembly.

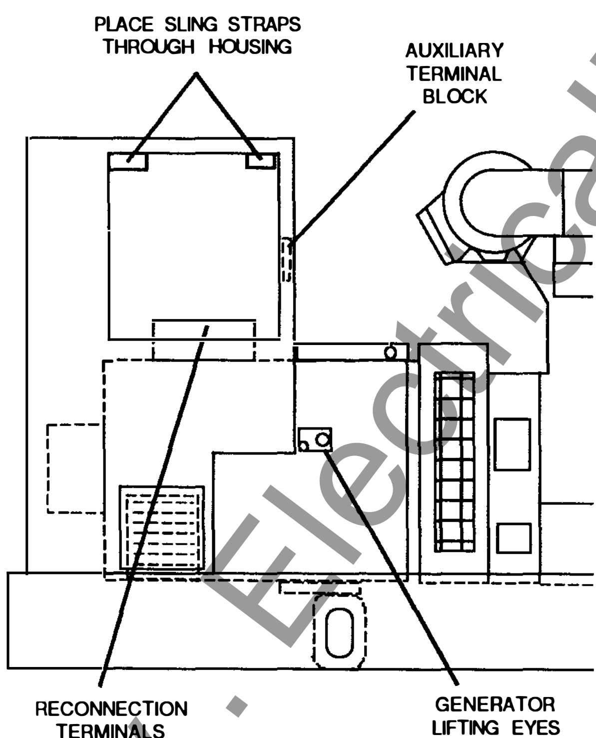


FIGURE 6-2. REMOVING CONTROL HOUSING

5. Disconnect all wire leads from the auxiliary terminal block, inside conduit box (see Figure 6-2), that would interfere with control housing removal. (Example: exciter stator leads X and XX.) Before disconnecting, check wire markings for legibility to ease reassembly.

6. Refer to the proper wiring diagram/schematic in *Wiring Diagrams* section and on-site specifics for remote control/monitoring. Open control box doors, and check wire markings for legibility to ease reassembly. Disconnect all engine, generator, and on-site control wire leads from inside control box and conduit box such as:

   DC Wiring
   - A11/TB1-8,-10, and terminals -1 through -7 and TB2 as required.
   - Unplug A11/J1 and J2.

   AC Wiring
   - VR21-X and -XX.
   - TB21-22 to -30.

   Arrange leads so they can be easily withdrawn from the control box.

7. Use a hoist or similar lifting device to support the control housing assembly (see Figure 6-2).

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

8. Loosen the fasteners that secure the control housing side and bottom panels to generator. Make sure that hoisting device is controlling weight of control housing assembly.

9. Remove control housing fasteners, and remove the control housing assembly from the generator. Replace panel fasteners to their respectibe positions for safe keeping, and tighten finger-tight.

10. Remove control housing mounting brackets from both sides of generator, and assemble lifting eyes to generator.

11. Remove as necessary, air intake components to engine that may interfere with disassembly and reassembly of generator.

To remove the stator and rotor at the same time, refer to Generator Assembly Removal, later this section. To remove the stator and rotor individually, continue with step 12.

12. Remove the four bolts retaining the bearing cartridge housing in the endbracket (outer four bolts).

13. Remove the eight bolts holding the endbracket to the generator housing.

14. Insert two bolts (M10) in the two holes provided for "jacking" purposes, on the endbracket center line. Screw bolts in until endbracket spigot is clear of locating recess.

15. Carefully tap the whole assembly off the bearing

cartridge housing, ensuring the endbracket is supported to prevent the exciter stator from damaging the windings on the exciter rotor.

WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

16. The exciter stator is now accessible for inspection and removal from endbracket/engine adaptor.

17. The end bearing can now be removed if required. Refer to Bearing Removal.

18. Remove the fasteners from the two generator mounting feet brackets.

19. Using an adequate lifting device, lift the generator (at lifting eyes provided, and main stator housing) until the mounting feet brackets are clear of the frame member (see Figures 6-3 and 6-4).

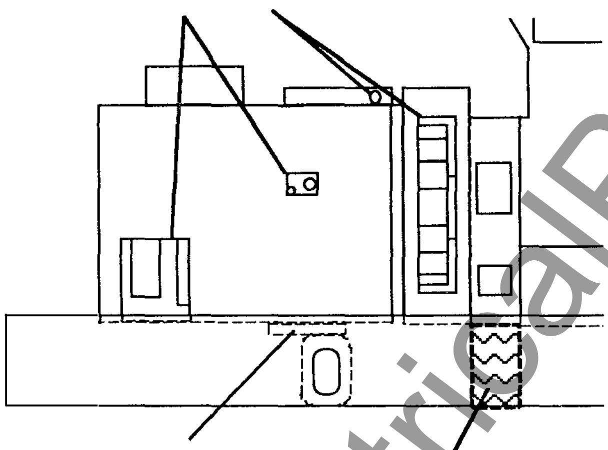


FIGURE 6-3. GENERATOR LIFTING POSITIONS

20. If generator set does not have chassis mounts at generator end (N855 and K19), block the rear of the engine in place by supporting the flywheel housing. A length of steel channel and wooden blocking is required to support the rear of the engine. Place the channel and blocking under the flywheel housing. Lower the generator until most of the set weight is supported by the blocking (see Figure 6-3).

21. Disconnect the grounding strap from the flywheel housing.

22. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly. See Figure 6-4.

23. Verify that the stator is adequately supported and then carefully remove the capscrews from the stator attachment ring.

WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

CAUTION ***Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/straped to maintain level control of stator assembly while lifting and moving.***

24. Being careful not to drag the windings on the rotor, move the stator assembly sufficiently away from engine to sling and support the rotor assembly. Do not allow rotor assembly to hang on engine flywheel.

CAUTION ***Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.***

25. Reposition or add hoist and sling support for the main rotor, and remove the forklift. See Figure 6-5, Rotor Lift detail.

WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

26. Remove the stator assembly, being careful not to drag the windings on the rotor. Place stator assembly away from the chassis in the horizontal position.

27. Using the hoist and sling to support the rotor, carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

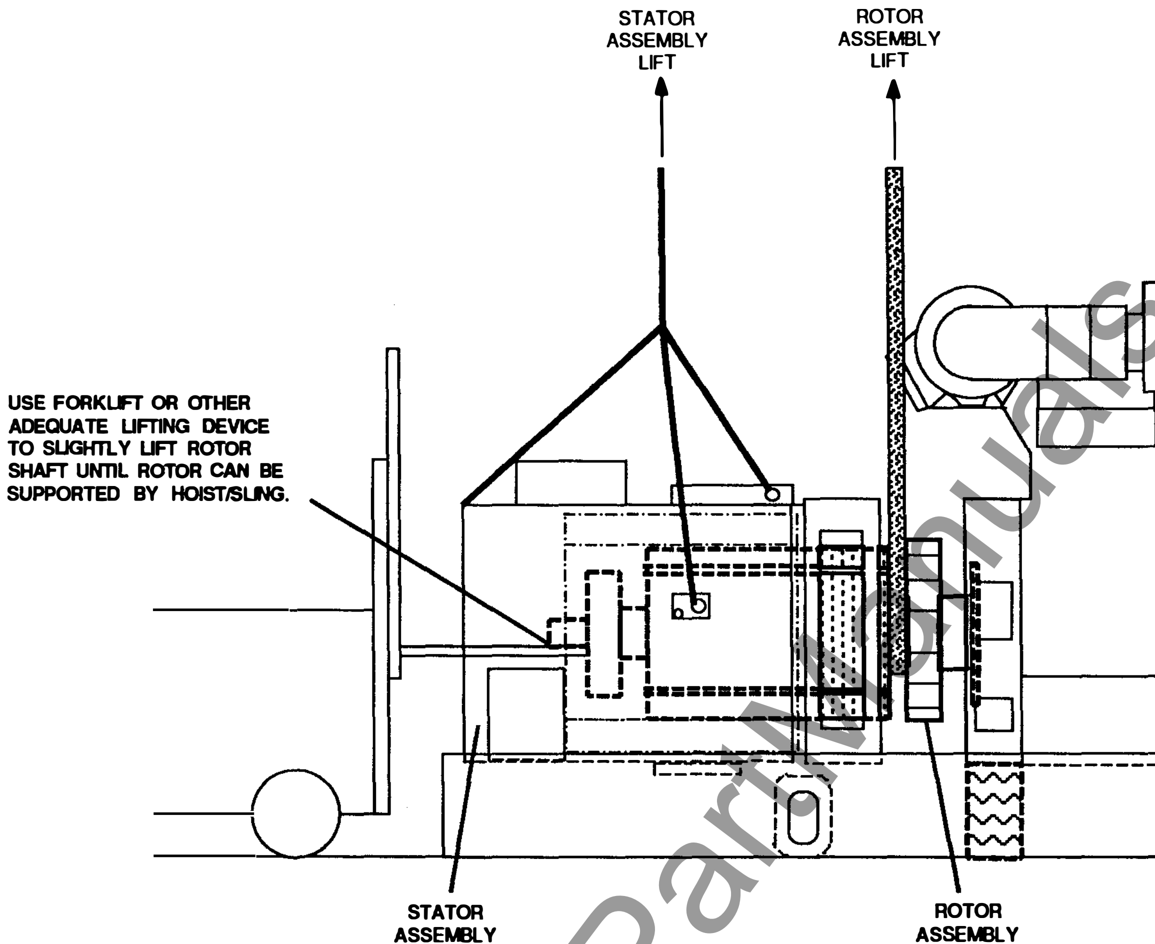


FIGURE 6-4. REMOVING STATOR ASSEMBLY

28. Remove the rotor assembly and place it on wood blocks in the horizontal position. To avoid possible distortion, do not allow the drive discs and fan to rest on anything.

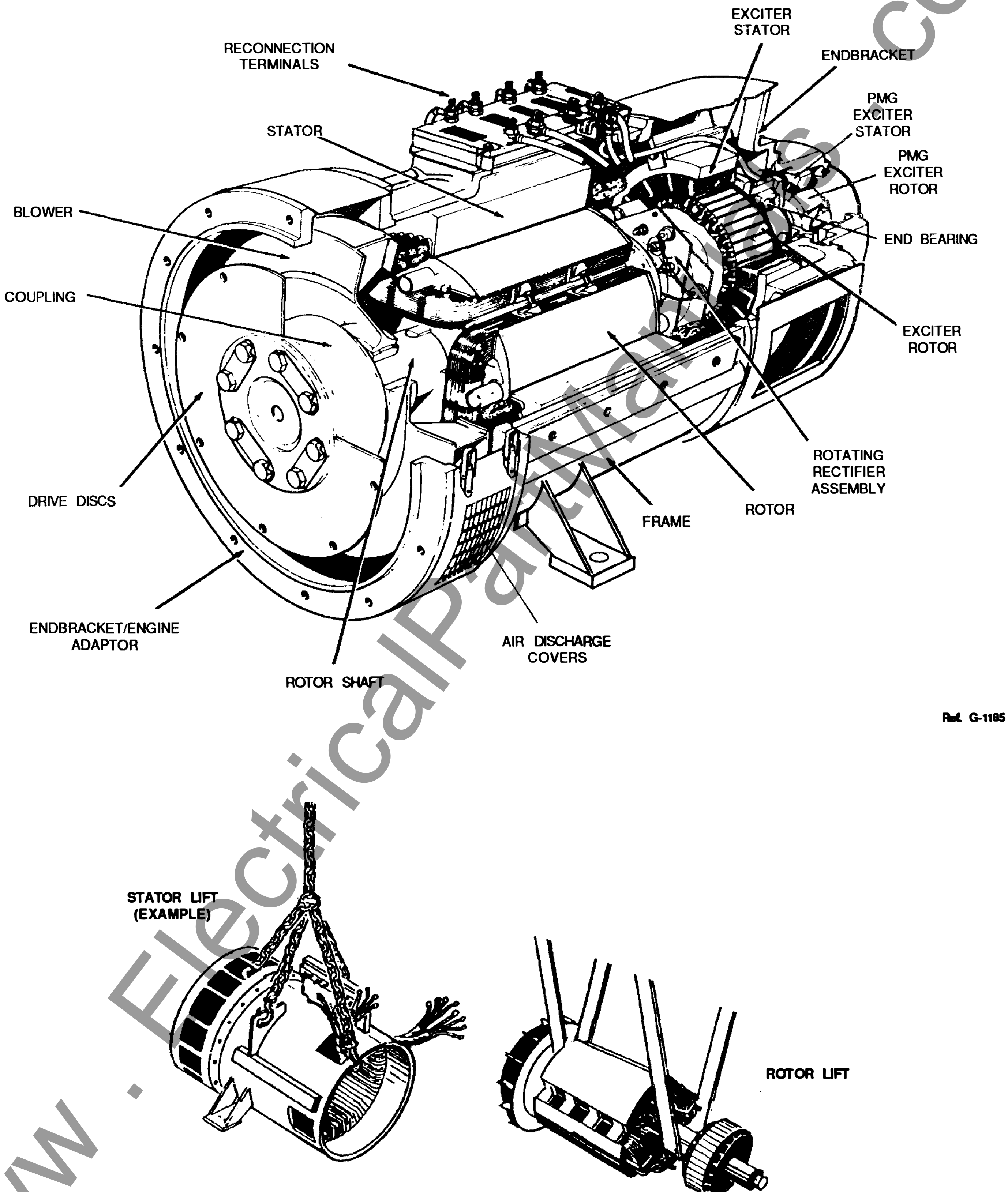


FIGURE 6-5. TYPICAL GENERATOR ASSEMBLY

Generator Assembly Removal

29. Remove the fasteners from the two generator mounting feet brackets.

30. Using an adequate lifting device, lift the generator (at lifting eyes provided, and main stator housing) until the mounting feet brackets are clear of the frame member (see Figures 6-5 and 6-6).

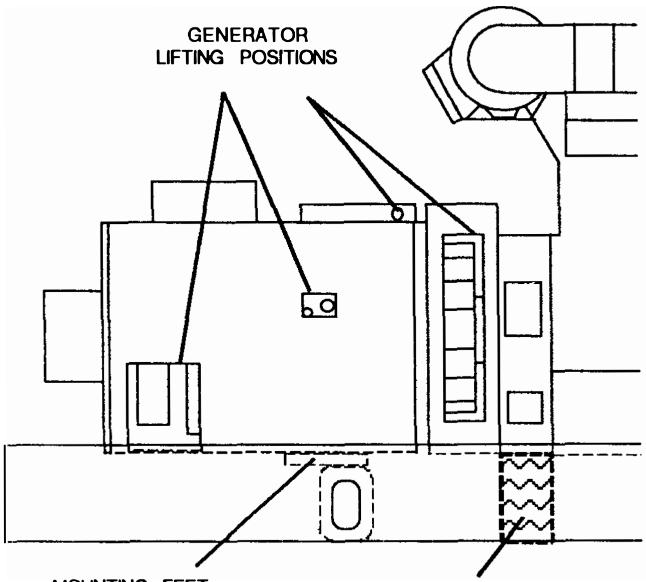


FIGURE 6-6. GENERATOR LIFTING POSITIONS

31. If generator set does not have chassis mounts at generator end (N855 and K19), block the rear of the engine in place by supporting the flywheel housing. A length of steel channel and wooden blocking is required to support the rear of the engine. Place the channel and blocking under the flywheel housing. Lower the generator until most of the set weight is supported by the blocking (see Figure 6-3).

32. Disconnect the grounding strap from the flywheel housing.

33. Carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

34. Verify that the generator assembly is adequately supported. Carefully remove the capscrews securingthe engine adaptor endbracket to the engine flywheel housing.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

⚠CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/ straped to maintain level control of assembly while lifting and moving.***

35. Remove the generator assembly away from engine. Place generator assembly on floor with a piece of wood beneath the stator housing (toward PMG end) to allow for endbracket removal, if desired.

Bearing Removal

The end bearing is enclosed in a pre-packed cartridge housing and must only be dismantled as necessary for relubrication, replacement, or when a major overhaul is carried out on the generator set.

Removal of the bearing can only be accomplished after removal of the endbracket, as follows:

1. Remove the four screws holding bearing cap.

2. Remove cap.

3. Remove circlip.

4. Remove bearing cartridge housing complete with bearing.

When replacing bearing onto rotor shaft, be sure to apply pressing force to the inner face of the bearing only.

Bearing Lubrication: When re-lubricating or replacing the bearing, review the following.

- Recommended Lubricant: Lithium based grease, Mobilux No. 2 or Shell Alvania R3.
- Temperature Range: -22°F to +248°F (-30°C to +120°C).
- Quantity: 2.74 oz. (81 ml). About a third of the grease should be inserted in the bearing, the bearing cap cavity, and the bearing cartridge cavity.

GENERATOR REASSEMBLY

Generator reassembly is the reverse of disassembly procedure.

To assemble the stator and rotor at the same time, continue with step 1. To assemble the stator and rotor individually, skip to step 16.

1. Using an adequate lifting device, locate the generator assembly into position near the engine flywheel housing. Align the holes of the rotor drive discs with the holes of the engine flywheel. Install the capscrews and flat washers that secure the drive discs to the engine flywheel, hand tighten.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

⚠CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/straped to maintain level control of assembly while lifting and moving.***

2. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Tighten to 45-55 ft-lbs. (61-74 N•m) torque.
3. Secure the rotor assembly to the flywheel. Tighten capscrews to 190-200 ft-lbs. (257-271 N•m) torque.
4. Lift the generator slightly and remove any blocking from under the flywheel housing. Lower the generator (see Figure 6-3).
5. Connect the grounding strap to the flywheel housing using a capscrew and EIT locking washer; and tighten securely.
6. Install the mounting feet bracket fasteners; and tighten securely.

If endbracket has been removed, continue with step 7, otherwise skip to step 15.

7. Lift slightly on end of rotor shaft and install wooden shims to hold rotor on center with stator.
8. Press bearing onto rotor shaft, applying force to the inner face of the bearing. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.
9. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.
10. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.
11. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.
12. Lift slightly on endbracket and remove wooden whims holding rotor on center with stator.
13. Securely tighten the endbracket fasteners.
14. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.
15. Install the PMG exciter assembly, if removed. Refer to Permanent Magnet Exciter Installation, later this section.

Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to the following steps.

To assemble the control housing, skip to step 34.

16. If removed, replace exciter rotor and rotating rectifier assembly to main rotor shaft. Reconnect main rotor wire leads to positive and negative terminals of rectifier assembly.
17. If removed, install the drive disc spacer, drive disc, and pressure plate on the rotor shaft. Install the eight capscrews and flat washers and tighten to 352 ft-lbs. (476 N•m) on frame sizes 4 to 6, 607 ft-lbs. (822 N•m) on frame 7. Note: 1500 kW, frame 7 uses 12 capscrews.
18. Using a hoist and sling to support the rotor, align the holes in the drive disc with the corresponding holes in the flywheel.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

19. Secure the rotor assembly to the flywheel using appropriate capscrews and flat washers. Tighten to 190-200 ft-lbs. (257-271 N•m) torque. Do not allow rotor assembly to hang on engine flywheel. (Refer to Figure 6-4.)

⚠CAUTION ***Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.***

20. Reassemble engine adaptor endbracket to stator frame if removed. Using an adequate lifting device, carefully move the stator into position over the rotor assembly, being careful not to drag the windings on the rotor.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

⚠CAUTION ***Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/straped to maintain level control of stator assembly while lifting and moving.***

21. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly. See Figure 6-4.

22. Remove the hoist/sling support of the rotor assembly. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Tighten to 45-55 ft-lbs. (61-74 N•m) torque.

23. Using an adequate lifting device, slightly raise the generator so that the wooden blocking and steel channel can be removed from under the flywheel housing; then lower the generator so the full weight is resting on the generator mounting feet brackets.

Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to Step 24.

24. Reassemble the covers over the generator air discharge openings and fasten securely.

25. Connect the grounding strap to the flywheel housing using a capscrew and EIT locking washer; and tighten securely.

26. Install the mounting feet bracket fasteners; and tighten securely.

27. Press bearing onto rotor shaft, applying force to the inner face of the bearing. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.

28. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.

29. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.

30. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.

31. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.

32. Securely tighten the endbracket fasteners.

33. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.

34. Remove generator lifting eyes. Reassemble control housing mounting brackets to sides of generator and fasten securely.

35. Use an adequate lifting device to lift the control housing in position for mounting to the stator frame. Replace the capscrews and lock washers and tighten to 20 ft-lbs. (27 N•m) torque.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

36. Reassemble any engine air intake components removed during generator disassembly.

37. Connect all control wires and generator leads using the proper generator set AC and DC wiring diagram/schematic.

38. Refer to Permanent Magnet Exciter Installation.

39. If equipped with the circuit breaker option, reconnect load wires to circuit breaker. Reconnect all lead wires to the terminal block assembly using proper reconnection diagram in Section 7.

40. Verify that all connections are proper and secure and then install the air inlet panel and access covers to control housing (see Figure 6-1).

41. Connect the negative (-) battery cable and test the generator set for operation.

Permanent Magnet Exciter Installation

1. Install the complete exciter rotor assembly to the end of the main rotor shaft using the hex head through-bolt. Keep the rotor clean by avoiding contact with metal dust or particles.

2. Carefully locate the exciter stator housing to position on the generator endbracket. Fasten in place using the 4 bolts and clamps, and tighten securely.

   The highly magnetic rotor will attract the stator core, care must be taken to avoid any contact which may damage the windings.

3. Connect the PMG wiring harness connector.

4. Install the PMG exciter assembly cover using the three M5x12mm capscrews and lockwashers, and tighten securely.

Aligning Generator with Engine

Proper alignment of the generator and engine assemblies is necessary to avoid premature wear and improper operation of the genset. Review the following alignment conditions and procedures for aligning the generator assembly to engine flywheel housing.

Angular Alignment: Is the result of the generator bearing center axis not aligning with axis of the engine crankshaft. This condition creates an angle between the generator shaft axis and the crankshaft axis. The cause of this type of misalignment is usually shimming error.

Axial Misalignment: Is the result of the generator shaft axis not aligning with engine crankshaft axis. The tolerances in the bolted flywheel and drive disc connection may add up to displace the generator axially relative to the crankshaft axis.

Misalignment Symptoms: If the assembly is allowed to run under these conditions, the discs must flex in alternate directions twice for each engine revolution. It is important to minimize the amount of disc flexing since, if it is excessive, the drive disc will crack. Although perfect bearing alignment is desirable, it is more important to keep disc deflection to the minimum possible. This procedure assumes that the pilot bore of the drive discs are in the exact center and the flywheel counterbore (pilot) has no practical runout. Under these conditions, perfect Angular alignment will be attained when no deflection of the disks is measured.

Excessive Axial misalignment will cause more generator vibration than Angular misalignment.

Axial misalignment should be checked only when an objectionable vibration is present.

Either type off misalignment may be present in a generator set assembly, with angular misalignment being the most common problem. Angular alignment may also be effected by set installation conditions and/or mishandling during shipping of the genset.

Angular Alignment Procedure (V28 and larger engine gensets):

⚠WARNING ***Accidental starting of the generator set during this procedure presents the hazard of severe personal injury or death. Make sure to disconnect the negative (-) battery cable(s) before beginning.***

Fasten a dial indicator to either the generator shaft or the cooling fan with the sensing point resting on the capscrew head or the flat surface of the drive disc at the bolt circle diameter, see Figure 6-7. Bar the engine over in a

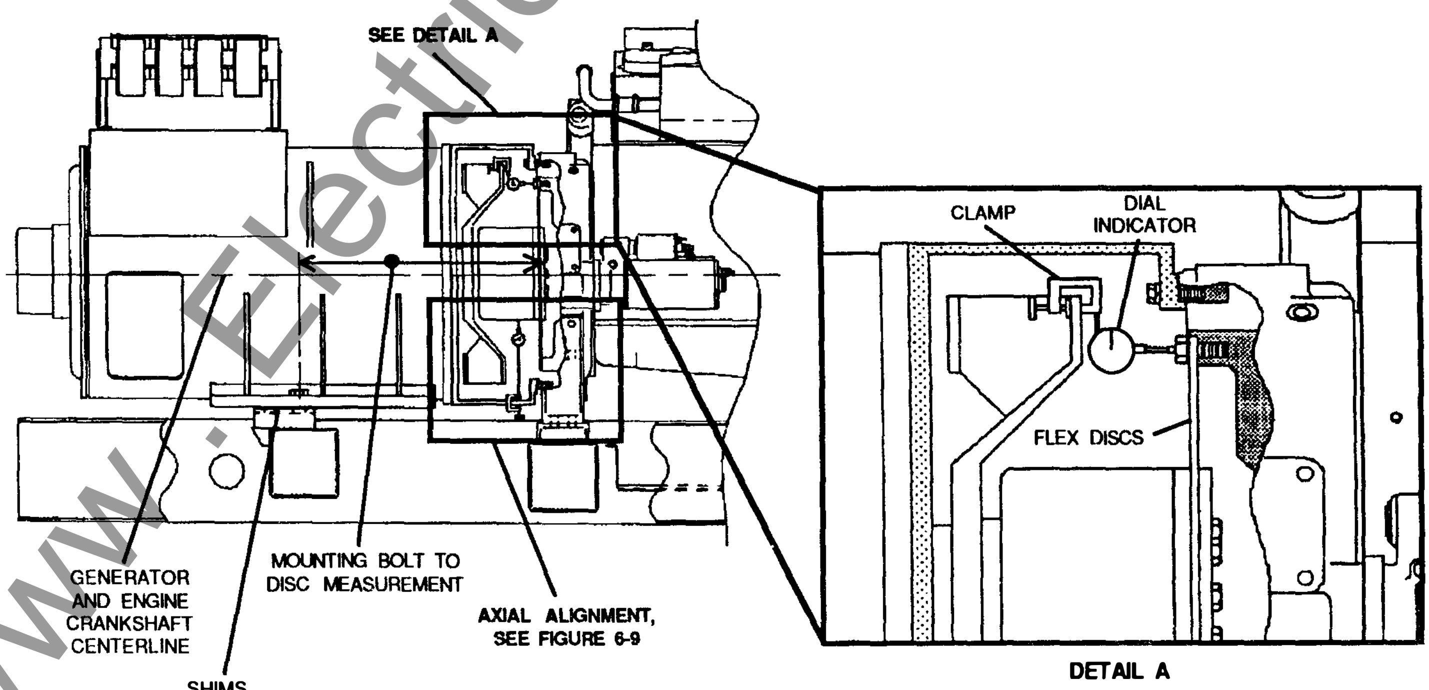


FIGURE 6-7. ANGULAR ALIGNMENT MEASUREMENT

clockwise rotation as viewed from engine flywheel. Do not allow it to roll back on compression at the end of the travel of each reading. It is unnecessary to zero the indicator since the total indicator reading (T.I.R.) of the deflection measurement to the bolt heads is what is required. T.I.R. will be the sum of the maximum positive and negative dial indicator readings as the engine completes one revolution.

Sample Generator Runout Readings: When taking the deflection readings described, make a diagram similar to the example shown in Figure 6-8, where a total indicator reading of .025". (The highest positive value of +.010 and the largest negative value of -.015".) The indicator is closer to the top and further away at the bottom. This example indicates that the generator bearing is high. Since the side readings are equal, the generator is centered side to side. To lower the generator, remove equal shims from under both generator mounting feet. To approximate the amount of shims to remove or add:

1. Measure the distance between the center of the generator shaft to the point the indicator is measuring at. (For example; a SAE 18 Disc coupling distance is 10.7").

2. Measure the distance from the generator side of the flex discs to the center of the generator mounting bolt, refer to Figure 6-7. (For example; a HC6 Frame's distance is 28.4".)

3. Compare the distance measured in steps 1 and 2. (28.4" vs 10.7" or a 2.65 to 1 ratio.) Multiply this ratio times one half the T.I.R. (In our example, .025" divided by 2 is .0125". This, times 2.65 equals .033". Therefore, remove .033" of shims from under both mounting feet.)

In general, the T.I.R. should not be more than .001" for each inch of radius (center of shaft to indicator axis). If we use our example of 10.7", then the maximum T.I.R. would be .011". This would only require a correction of .014" from the T.I.R. of .025". (A reading of +.002 at the top and -.009 at the bottom would fall within the satisfactory range.)

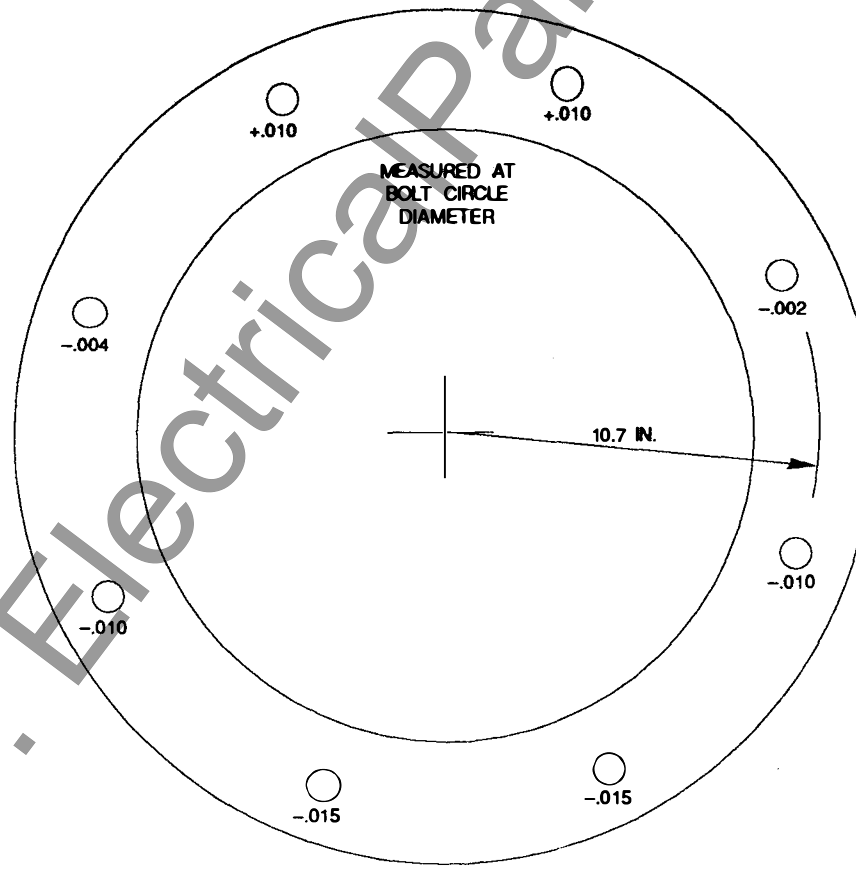


FIGURE 6-8. ANGULAR ALIGNMENT MEASUREMENT READINGS (Example)

Axial Alignment Procedure (all gensets):

Axial misalignment should be checked only when an objectionable vibration is present.

If excessive vibration remains after the angular alignment, check for concentric alignment of the generator shaft/ engine crankshaft axes.

Fasten dial indicator holding device to skid base, engine block, or generator shell with a magnetic base or clamp and position so the sensor point of indicator rests on the generator shaft hub, see Figure 6-9. Bar the engine over in a clockwise rotation as viewed from engine flywheel, through a couple of rotations. Record indicator readings in eight equally spaced points around the shaft diameter. This will provide a T.I.R. for Axial shaft misalignment.

The maximum allowable T.I.R. runout is subjective, the optimal T.I.R. for runout would be .000", however that may not be attainable. The recommendation of this procedure will be to reduce the measured T.I.R. runout by one half.

Specific out-of-tolerance runout levels are difficult to establish due to the varying surface quality of the generator shaft's drive disc mounting hub.

The goal of the Axial realignment is to reduce the vibration level of the genset while it is operating. A small improvement in the T.I.R. runout may have dramatic effects in the mechanically measured or physically observed vibration levels.

To correct for an out of tolerance T.I.R. indication, remove the capscrews connecting drive discs and flywheel. Mark the drive discs and flywheel with respect to each other. Rotate either the engine or generator so that drive discs holes are repositioned 180 degrees from their original location. Put the drive discs capscrews back in and retorque. Recheck shaft alignment as before. If shaft T.I.R. runout remains unchanged then the discs should be rotated to either 30, 60, or 90 degrees from original location to correct the out of tolerance condition. If the T.I.R. does not improve after repositioning, a closer inspection of the flywheel pilot and drive disc runouts is required. This will help determine the cause of the Axial misalignment.

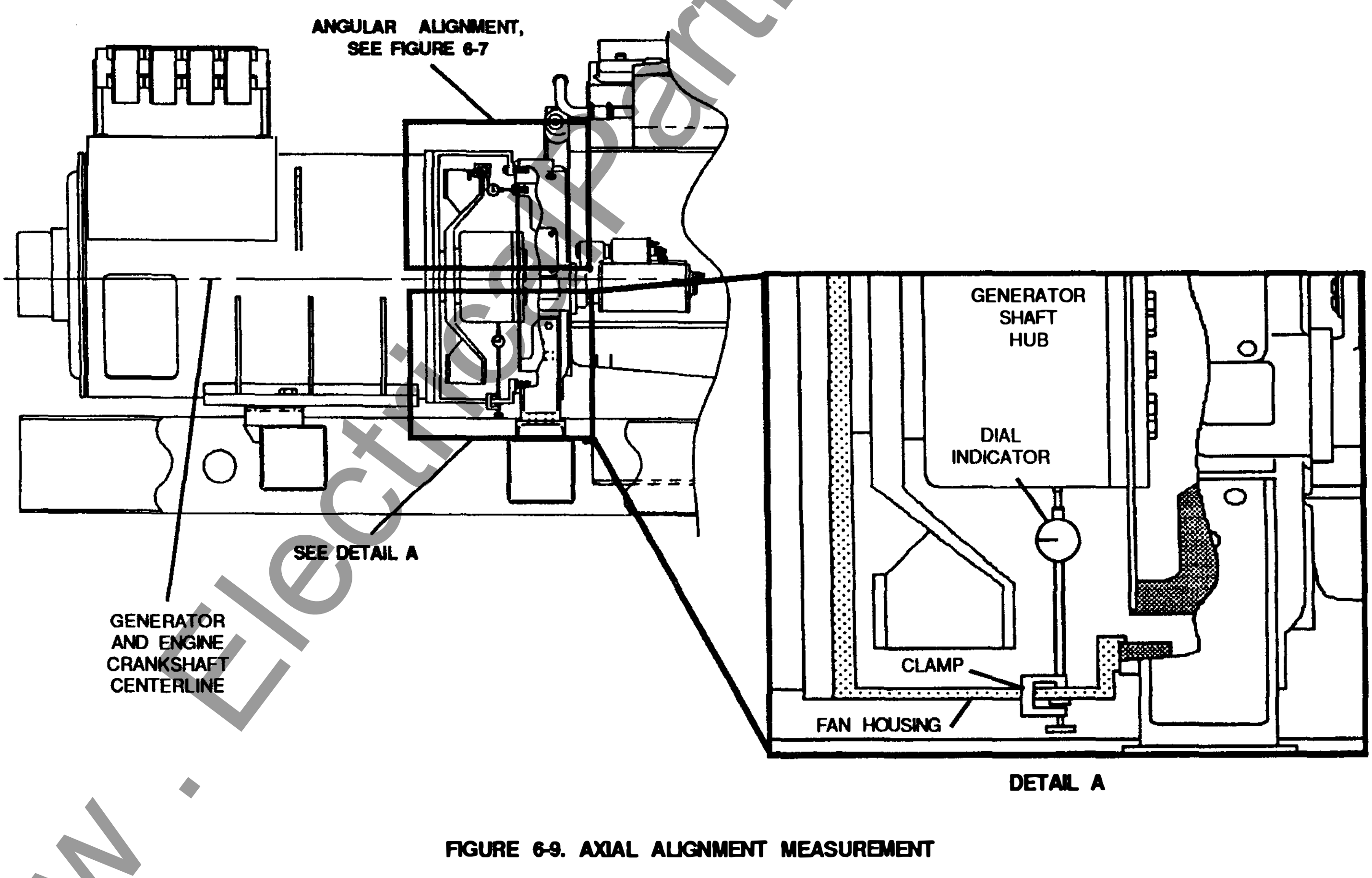


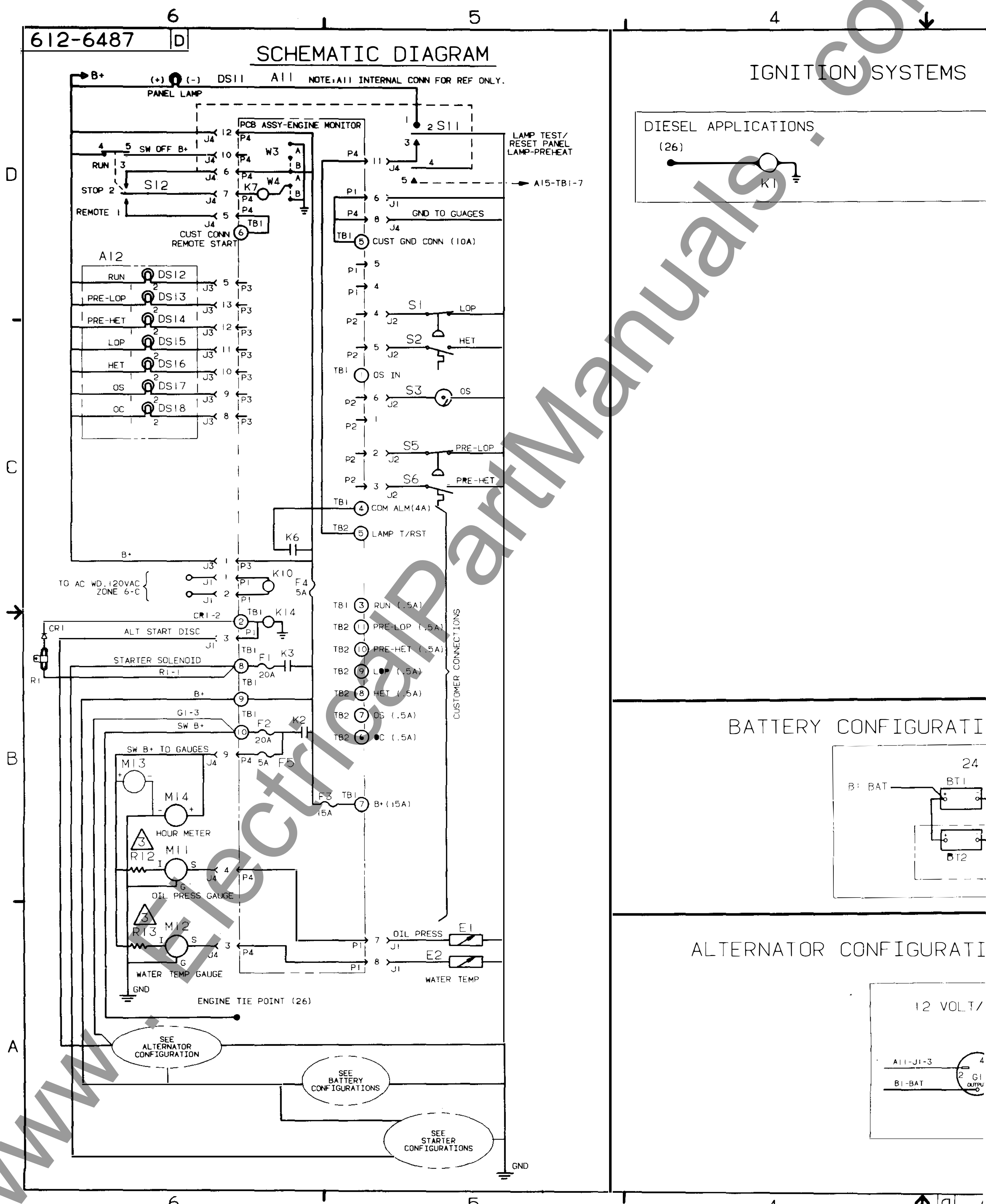
FIGURE 6-9. AXIAL ALIGNMENT MEASUREMENT

Section 7. Wiring Diagrams Control/Generator

This section contains the following AC and DC Wiring Diagrams/Schematics:

⚠CAUTION

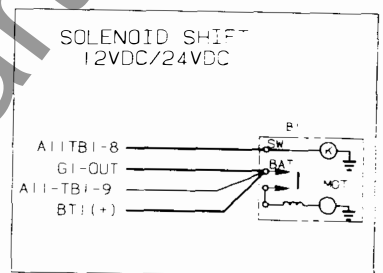
Repair of printed circuit board components other than fuses requires well-trained, qualified personnel with the proper equipment; repair of the printed circuit boards is not recommended except by the factory. Application of meters or hot soldering irons to printed circuit boards by other than qualified personnel can cause unnecessary and expensive damage.



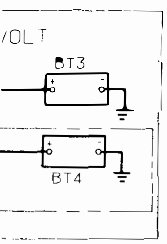
DC WIRING DIAGRAM/SCHEMATIC (7-LIGHT)

STARTER
CONFIGURATIONS

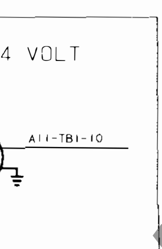
ER NO	LTR	NO	REVISION	ZONE	DR	CHKD	APPROVED	DATE
29865	A	1	PRODUCTION RELEASE	-	JC	VB	PE	07-01-8
30817	B	1	REVISED PER ER	-	JP	VB	PE	11-17-87
32870	D	2	REVISED PER ER	-	JC	VB	PE	09-15-8
33259	E	2	REVISED PER ER	-	MI	VB	P.A.H.	[illegible]



ONS



ONS



CADAM SYSTEM DWG

DO NOT SCALE PRINT	TOLERANCES UNLESS OTHERWISE SPECIFIED	SIM TO	REF DES	ITEM	PART NO	*BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL
	MM / INCH; MACHINED HOLES ≤ .5 IN (13MM) +0.15 -0.05 / +.006 -.002; ANGLES: ± --; DRAWN TO SCALE OF	COPIED FROM; THIRD ANGLE PROJECTION							

	NAME	DATE
DR	J.CASALENDA	06-25-87
CHKR	M. REED	07-02-87
APPROVED	P. ERICKSON	07-01-87

FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ANSI Y14.5M-1982

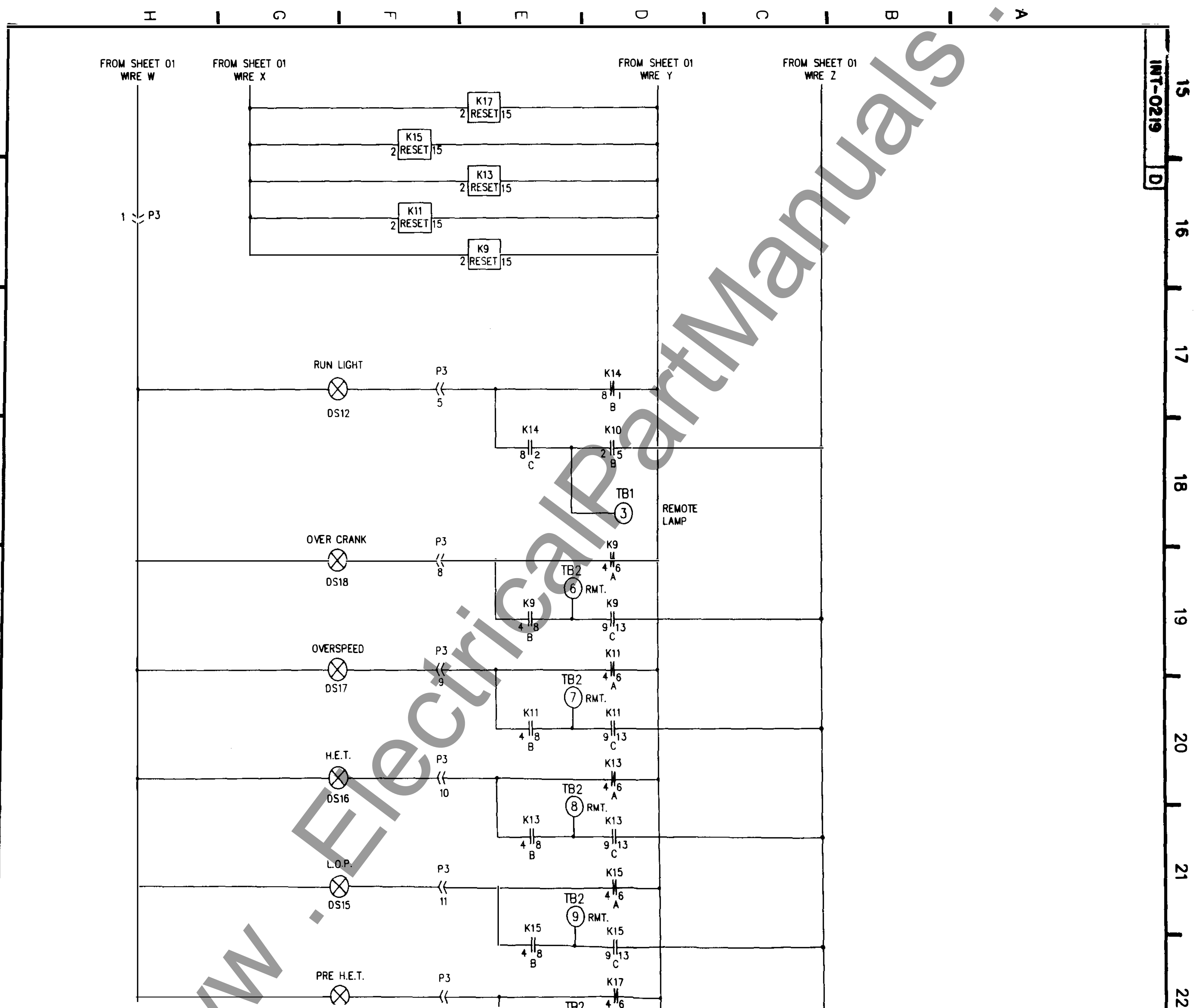
MODEL FIRST USED ON

TITLE: WD-GEN SET DC CONT (7LT)

DWG NO 612-6487 | SHEET 2 OF 2 | DWG SIZE D

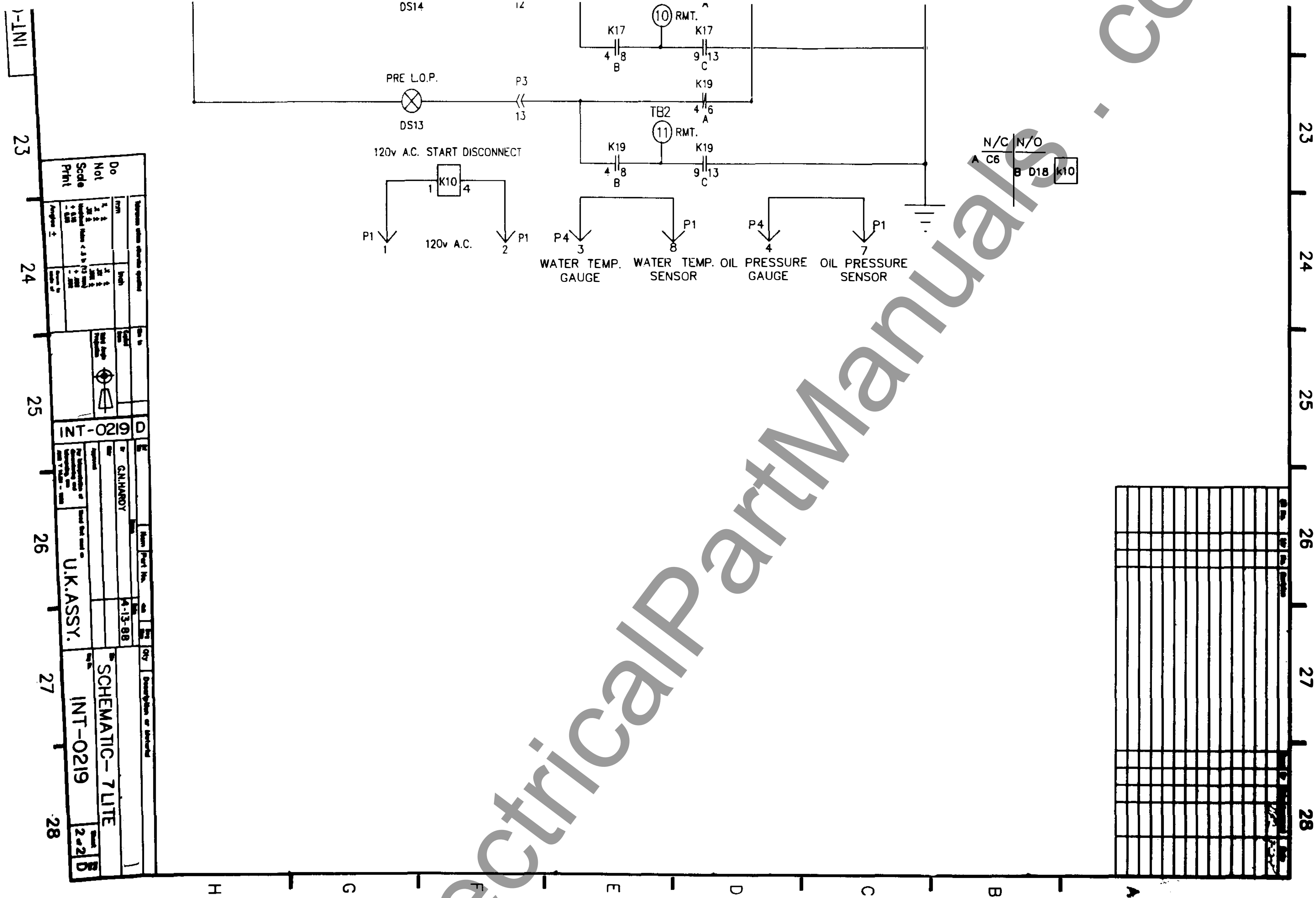
612-6487 D

2 O/C

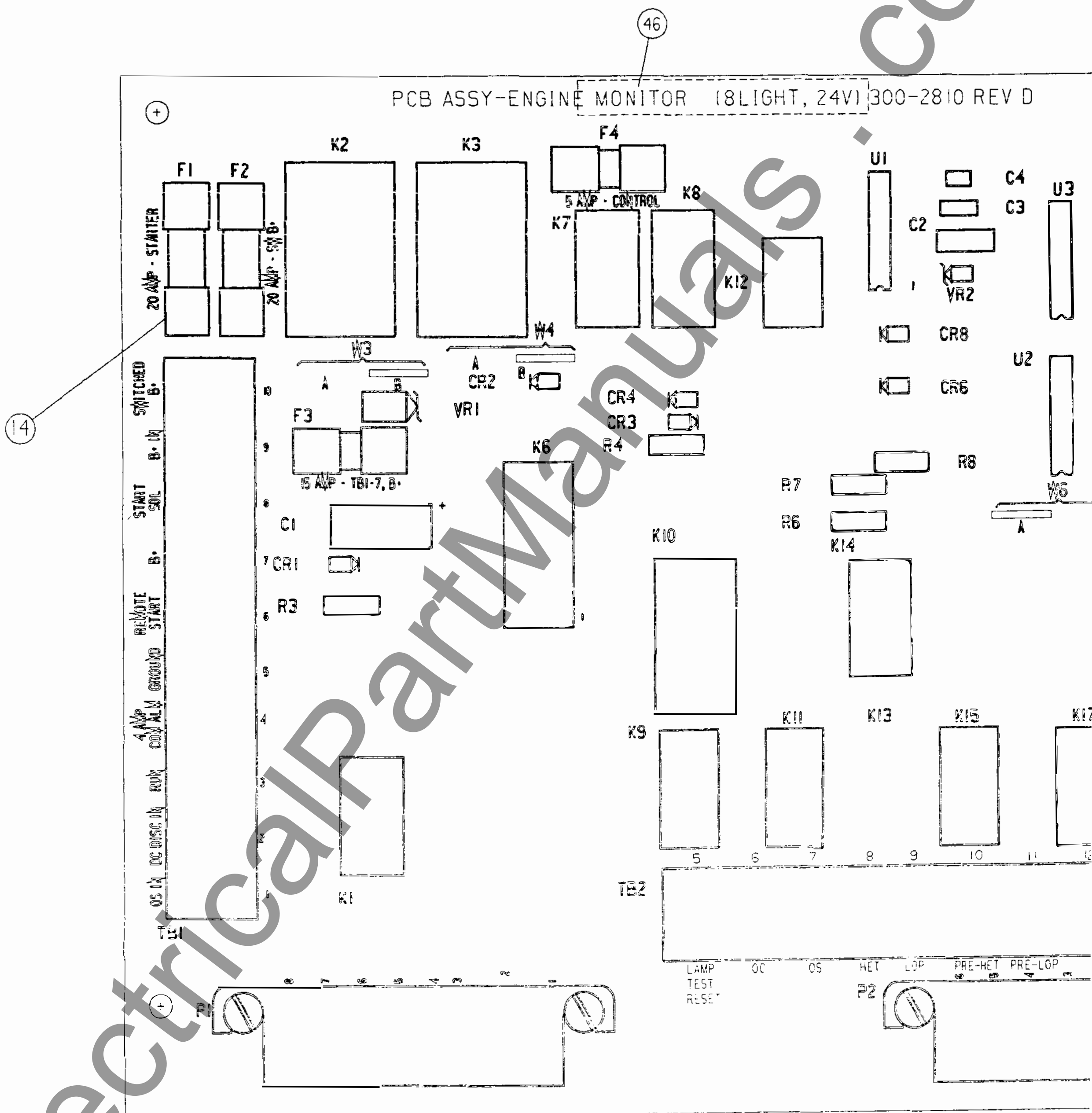


DC SCHEMATIC – LADDER DIAGRAM (7-LIGHT)

7-5


DS14
12
10 RMT.
K17
K17
4 8 B
9 13 C
PRE L.O.P.
P3
K19
DS13
13
TB2
4 6 A
11 RMT.
K19
K19
4 8 B
9 13 C
120v A.C. START DISCONNECT
K10
1
4
P1 1
120v A.C.
P1 2
P4 3
WATER TEMP. GAUGE
P1 8
WATER TEMP. SENSOR
P4 4
OIL PRESSURE GAUGE
P1 7
OIL PRESSURE SENSOR
N/C N/O
A C6
B D18
K10
Do Not Scale Print
INT-0219 D
G.N.HARDY
4-13-88
U.K.ASSY.
SCHEMATIC- 7LITE
INT-0219
2 of 2 D
23
24
25
26
27
28
H
G
F
E
D
C
B
A

300-2810 SHT 2 OF 2 D



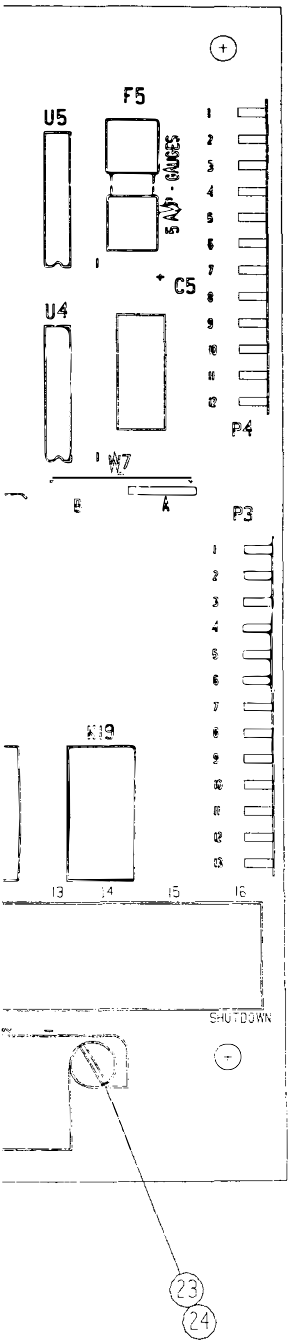
NOTES:

1. CIRCUIT BOARD SHALL BE SOLDERED WITH ITEM •3 AT MAXIMUM SOLDER TEMPERATURE OF 500° AND MAXIMUM TIME OF 6 SECONDS.
2. SOLDER JOINTS AND/OR COMPONENT LEADS (EXCEPT TERMINAL BLOCK LEADS) SHALL NOT PROJECT MORE THAN 1/8" BEYOND SURFACE OF BD.
3. CONFORMAL COAT BOTH SIDES OF COMPLETED BOARD WITH ITEM •4 EXCEPT ITEM •11-14, 23-28, 35 AND 36. COATING BUILDUP SHALL NOT BE LESS THAN .002" OR GREATER THAN .1"

(B6) 4. TEST PRINTED CIRCUIT BOARD PER ITEM •5.

7. CLEAN BOARD WITH SUITABLE CLEANER PRIOR TO CONFORMAL COATING.

(B8) 8. DESIGN OF THIS ASSEMBLY IS CONTROLLED BY ITEM •42
9. PLACE ITEM 46 ON COMPONENT SIDE OF BOARD, AS SHOWN, BEFORE CONFORMAL COATING.



ER NO.	LTR.	NO.	REVISION	ZONE	DR	CHKR	APPROVED	DATE
23,312	A	1	PRODUCTION RELEASE		MM	MM	SLS	2-24-84
24,078	B	1	P1 (ITEM 25) WAS 332-2678 (A)	2-B	MD	MM	SLS	4-2-84
		2	P2 (ITEM 26) WAS 332-2668 (A)	2-B	MD	MM	SLS	4-2-84
		3	P3 (ITEM 27) WAS 332-2671 (A)	2-B	MD	MM	SLS	4-2-84
		4	P4 (ITEM 28) WAS 332-2670 (A)	2-B	MD	MM	SLS	4-2-84
		5	ADDED ITEM #5	2-A	MD	MM	SLS	4-2-84
		6	REMOVED TS# FROM NOTE #4	2-C	MD	MM	SLS	4-2-84
		7	ADDED ITEM #42	2-C	MD	MM	SLS	4-2-84
		8	REMOVED DS# FROM NOTE 8	2-C	MD	MM	SLS	4-2-84
26,690	C	1	ITEM 43 WAS 359-0063	2-C	DO	GH	SLS	8-6-85
35,580	D	2	NOTES AND PARTS LIST REVISED PER ER	-	DFO	YB	[illegible]	10-04-89

REF DES	ITEM	PART NO. * BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL
	50				
	49				
	48				
	47				
SEE NOTE 9	46	98-5926	B	1	LABEL-BARCODE
W3-4,6,7	45	337-0341	A	4	JUMPER-PC BD
VR2	44	359-0036	A	1	DIODE-ZENER
VR1	43	359-0070	A	1	SUPPRESSOR-VOLTAGE
	42	DS 98010	S	-	PRODUCT DESIGN SPEC
U4	41	367-0064	B	1	IC-DRIVER ARRAY (1413)
U3	40	367-0086	B	1	IC-100K RES NETWORK (8 RES)
U2	39	367-0189	B	1	IC-RESISTOR (10K, 1/8W, 2%)
U1,5	38	367-0160	C	2	IC-24 STAGE FREQ DIV (4521)
	37				
TB2	36	332-2310	A	1	TERMINAL BLOCK-PC BD (12 PL)
TB1	35	332-2706	A	1	TERMINAL BLOCK-PC (10PL)
	34				
	33				
R4,6,8	32	350-0394	-	3	RESISTOR (2K, 1/2W, 5%)
R3	31	350-0363	-	1	RESISTOR (100 OHM, 1/2W, 5%)
R7	30	350-0384	-	1	RESISTOR (750 OHM, 1/2W, 5%)
	29				
P4	28	323-1307	A	1	CONNECTOR-PCB (12 PIN)
P3	27	323-1309	A	1	CONNECTOR-PCB (13 PIN)
P2	26	323-1303	A	1	CONNECTOR-PCB (6 PIN)
P1	25	323-1305	A	1	CONNECTOR-PCB (8 PIN)
	24	870-0183	-	4	NUT-H W/ET (#6-32)
	23	812-0061	-	4	SCREW-RHM (#6-32 X 3/8)
	22				
K12	21	307-2342	A	1	RELAY (12V, SPDT)
K10	20	307-2329	A	1	RELAY (SPST, 115VAC)
K7,8	19	307-2128	A	2	RELAY (SPDT, 24V)
K6	18	307-2103	A	1	RELAY-LATCHING (12V)
K9,11,13,15,17,19	17	307-2339	A	6	RELAY (12V, DPDT)
K2,3	16	307-2334	A	2	RELAY-POWER (SPST, 24V)
K1,14	15	307-2131	A	2	RELAY (DPDT, 24V)
	14	321-0163	P	10	CLIP-FUSE
F4,F5	13	321-0094	P	2	FUSE-CARTRIDGE (5A)
F3	12	321-0231	P	1	FUSE-CARTRIDGE (15A)
F1,F2	11	321-0270	P	2	FUSE-CARTRIDGE (20A)
CR1-4,6,8	10	357-0004	A	6	RECTIFIER (1A, 800V)
C4	9	355-0120	A	1	CAPACITOR (10PF, 100V)
C3	8	355-0121	A	1	CAPACITOR (.001MFD, 100V)
C2	7	355-0122	A	1	CAPACITOR (1 MFD, 50V)
C1,5	6	356-0115	A	2	CAPACITOR (22MFD, 35V)
	5	TS 98024	S	-	PERFORMANCE TEST SPEC
	4	*524-0115	P	.01GAL	RESIN-POLYURETHANE
	3	*880-0003	-	.1 OZ	SOLDER-BAR
	2	98-5045	C	1	SILKSCREEN-PCB (7LIGHT, 24V)
	1	332-2667	D	1	PCB-ENGINE MONITOR (12&24V)

CADD SYSTEM DWG

DO NOT SCALE PRINT	TOLERANCES UNLESS OTHERWISE SPECIFIED	
	mm	INCH
	X. ± / .X ± / .XX ±	.X ± / .XX ± / .XXX ±
	MACHINED HOLES ≥ .5 In (13 mm) +0.15 -0.05	+.006 -.002
	ANGLES ±	DRAWN TO SCALE OF 2-1

SIM TO 300-2809 D

COPIED FROM

THIRD ANGLE PROJECTION

300-2810 D

	NAME	DATE
DR	MAUREEN MANN	2-22-84
CHKR	L. L. NELSON	2-24-84
APPROVED	S. L. SWENSON	2-24-84

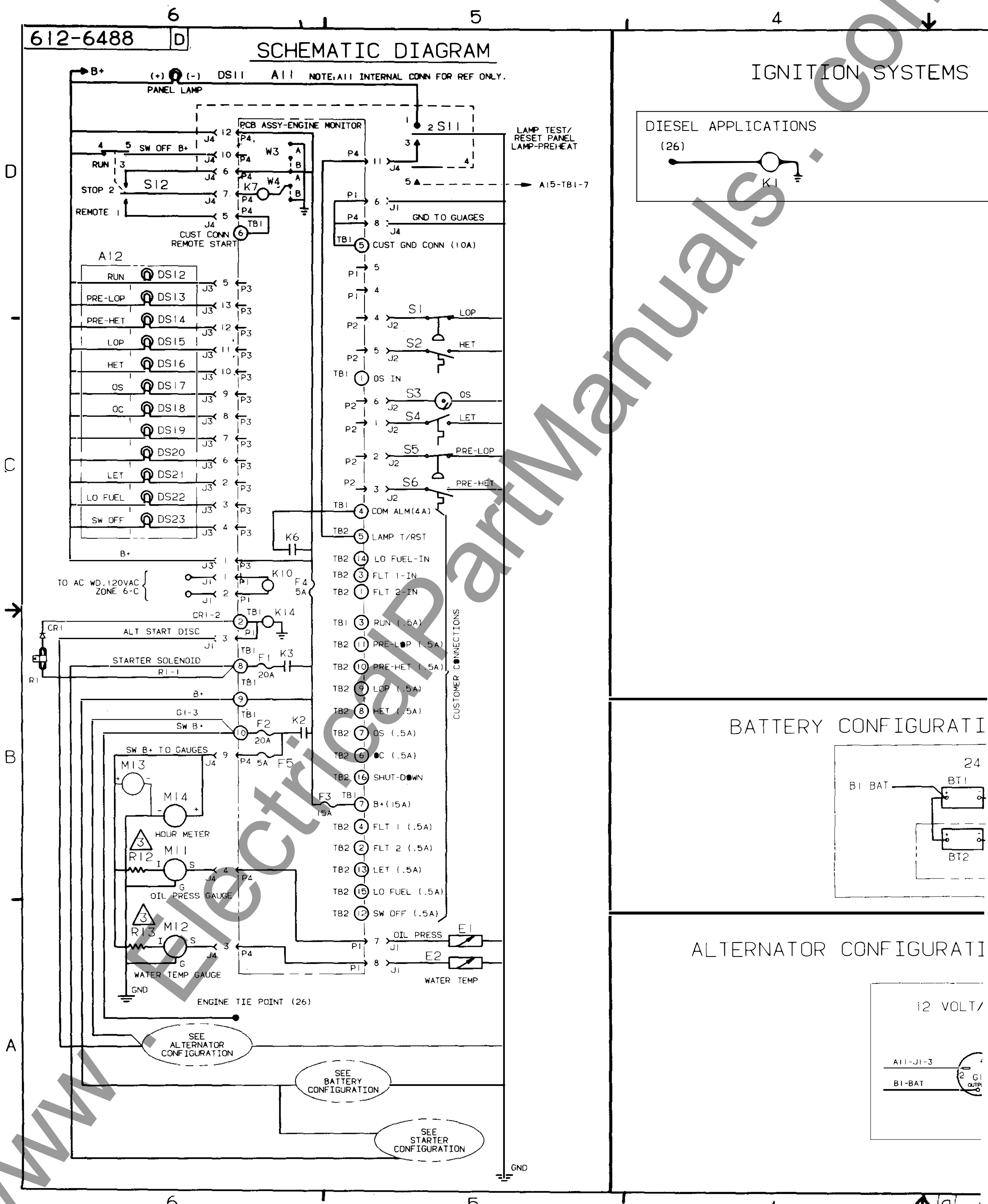
FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ANSI Y14.5-1973

MODEL FIRST USED ON: GENERAL

Onan — ONAN CORPORATION, MINNEAPOLIS, MINNESOTA

TITLE: PCB ASSY-ENGINE MONITOR (7 LIGHT, 24V)

DWG NO. 300-2810 — SHEET 2 OF 2 — DWG SIZE D

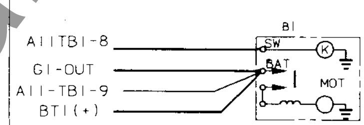


DC WIRING DIAGRAM/SCHEMATIC (12-LIGHT)

ER NO	LTR	NO	REVISION	ZONE	DR	CKHR	APPROVED	DATE
29865	A	1	PRODUCTION RELEASE	-	JC	VB	PE	07-01-87
30817	B	1	REVISED PER ER	-	JP	JC	SLS	12-08-87
32870	D	2	REVISED PER ER	-	JC	VB	PE	09-15-88
33259	E	2	REVISED PER ER	-	MI	VB	B.A.N.	11-18-88

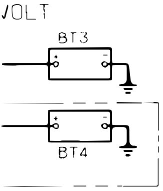
STARTER CONFIGURATIONS

SOLENOID SHIFT
12VDC/24VDC



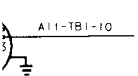
ONS

VOLT



ONS

4 VOLT



CADAM SYSTEM DWG

TOLERANCES UNLESS OTHERWISE SPECIFIED | SIM TO | COPIED FROM | THIRD ANGLE PROJECTION

DO NOT SCALE PRINT

MACHINED HOLES ≤ .5 IN (13MM) +0.15 -0.05 / +.006 -.002

ANGLES: ---

DRAWN TO SCALE OF

612-6488 D

ITEM	PART NO	BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL

	NAME	DATE
DR	J. CASALENDA	06-25-87
CHKR	M. REED	07-01-87
APPROVED	P. ERICKSON	07-01-87

FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ANSI Y14.5M-1982

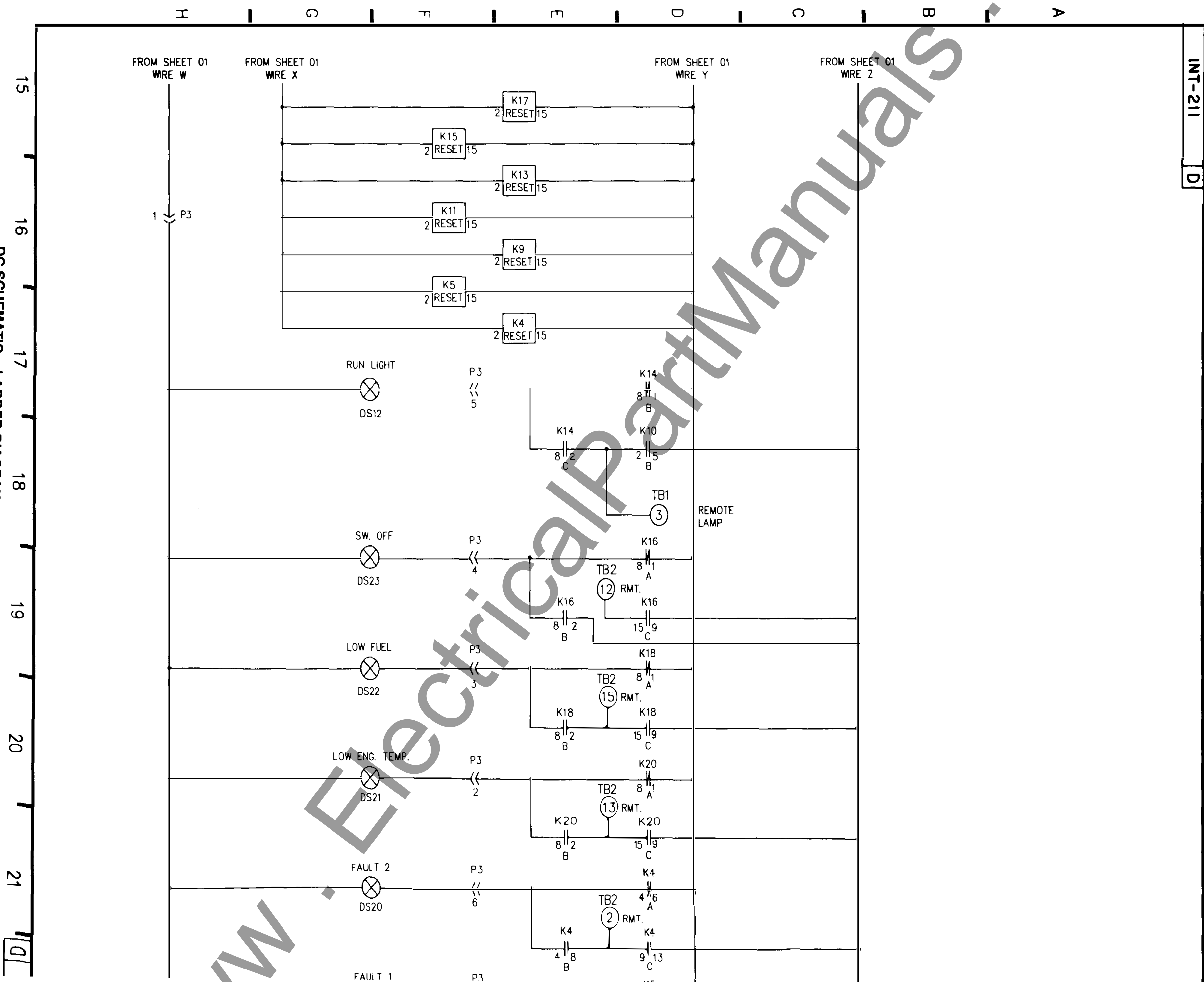
MODEL FIRST USED ON

TITLE WD-GEN SET DC CONT 12 LT

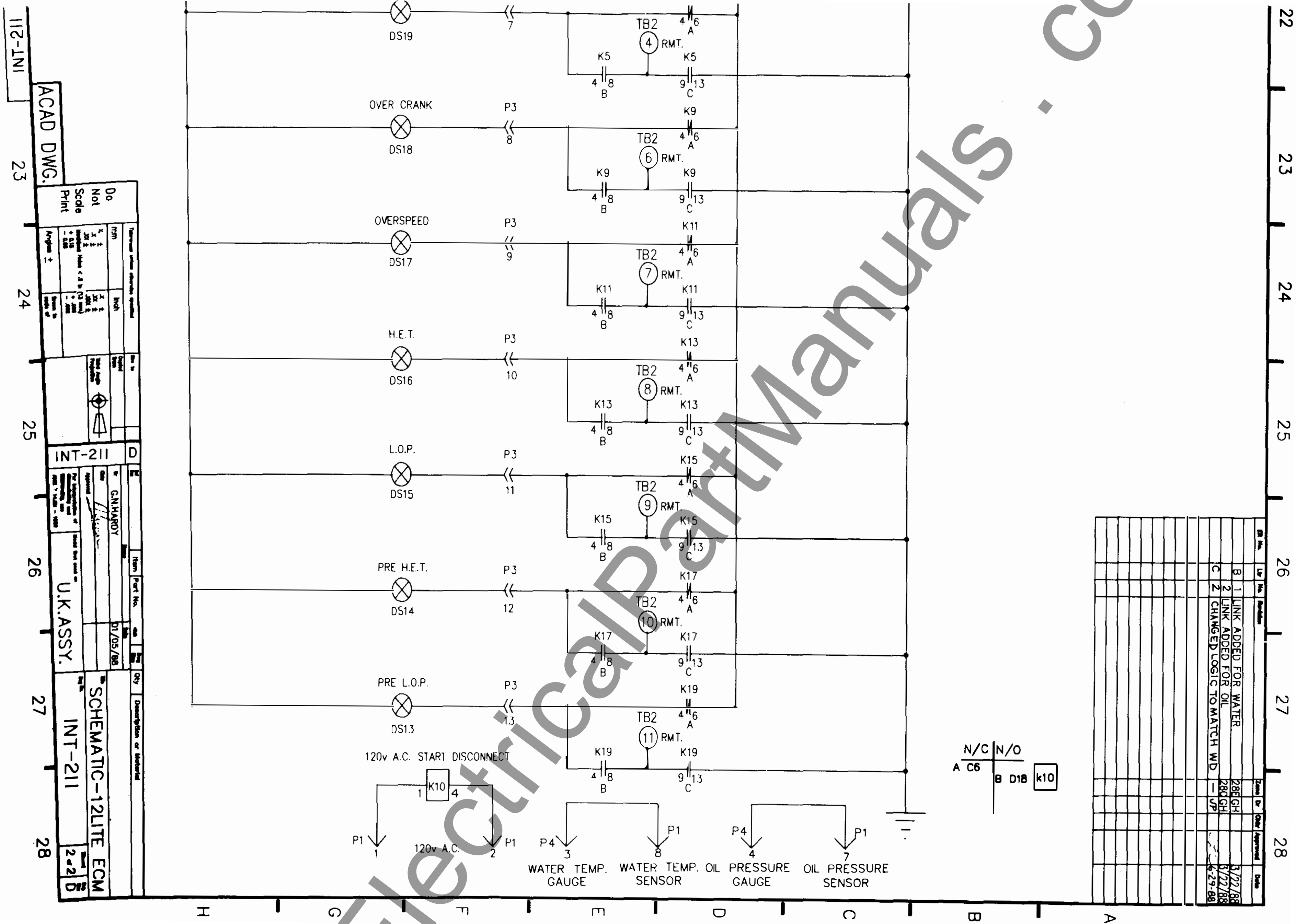
DWG NO 612-6488 SHEET 2 of 2 DWG SIZE D

0/C

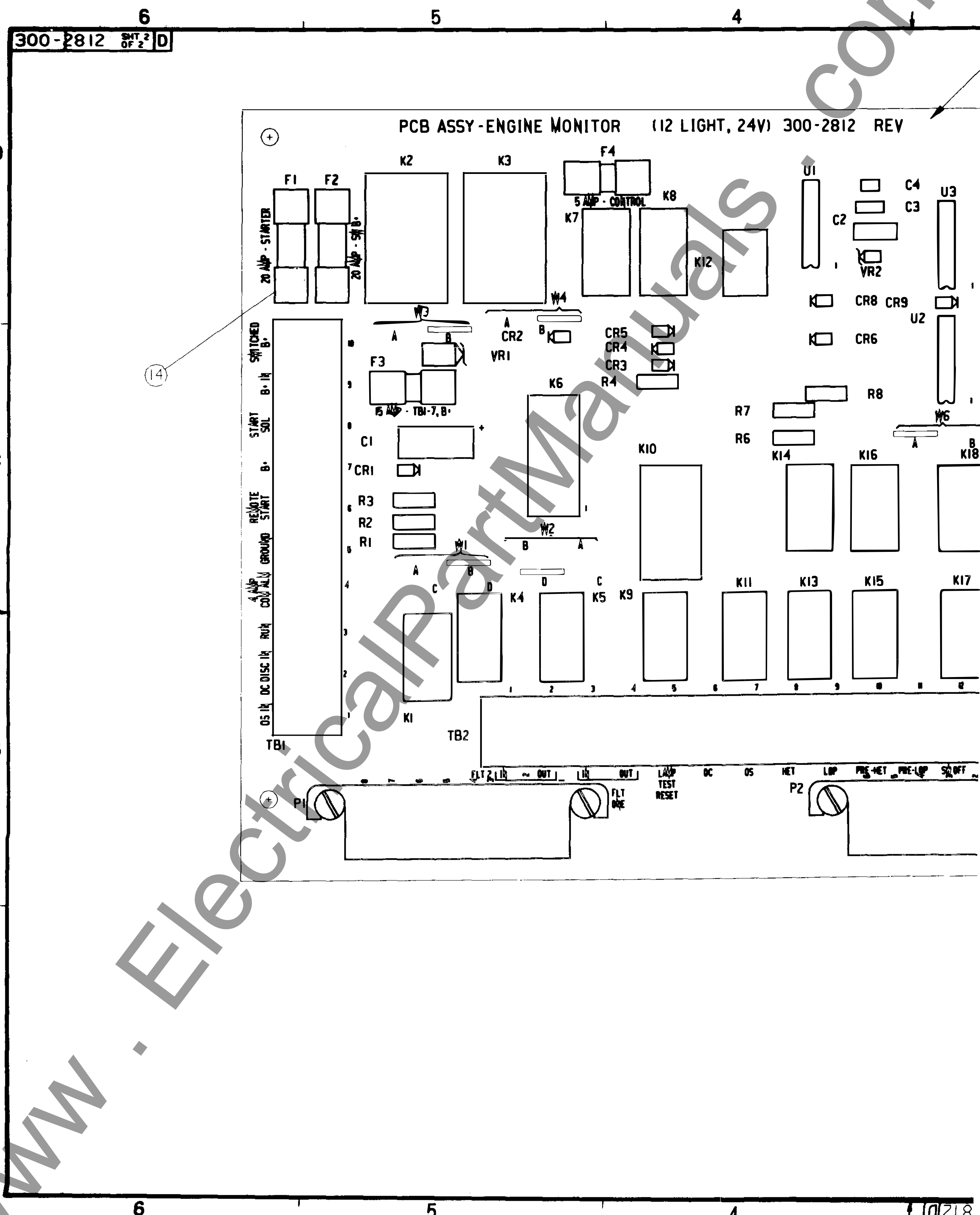
612-648



DC SCHEMATIC – LADDER DIAGRAM (12-LIGHT)

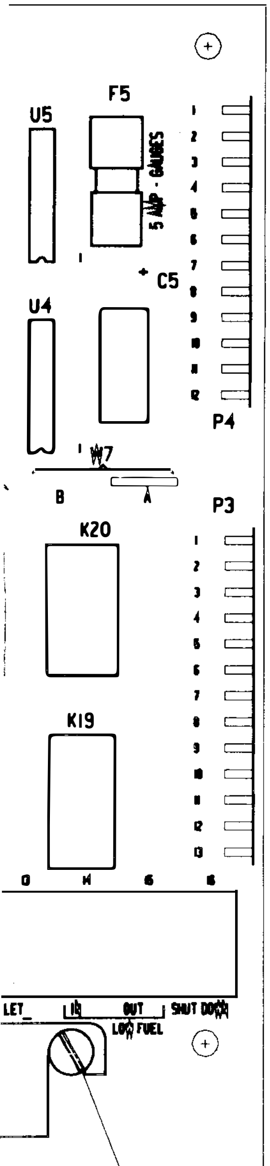


DS19
7
TB2
4 RMT.
K5
K5
OVER CRANK
DS18
P3
8
K9
6 RMT.
OVERSPEED
DS17
9
K11
7 RMT.
H.E.T.
DS16
10
K13
8 RMT.
L.O.P.
DS15
11
K15
9 RMT.
PRE H.E.T.
DS14
12
K17
10 RMT.
PRE L.O.P.
DS13
13
K19
11 RMT.
120v A.C. START DISCONNECT
K10
120v A.C.
P1
P4
WATER TEMP. GAUGE
WATER TEMP. SENSOR
OIL PRESSURE GAUGE
OIL PRESSURE SENSOR
N/C
N/O
A C6
B D18
K10
LINK ADDED FOR WATER
LINK ADDED FOR OIL
CHANGED LOGIC TO MATCH WD
3/22/88
3/22/88
6-29-88
ACAD DWG.
INT-211
Do Not Scale Print
G.N.HARDY
01/05/88
U.K.ASSY.
SCHEMATIC-12LITE ECM
INT-211
2-2
D


300-2812 SHT 2 OF 2 D
PCB ASSY-ENGINE MONITOR (12 LIGHT, 24V) 300-2812 REV
F1
F2
20 AMP - STARTER
20 AMP - SW B+
K2
K3
F4
5 AMP - CONTROL
K7
K8
K12
U1
C4
C3
C2
U3
VR2
CR8
CR9
U2
CR6
W3
W4
CR2
VR1
CR5
CR4
CR3
R4
F3
15 AMP - TB1-7, B+
K6
R8
R7
R6
W6
C1
CR1
R3
R2
R1
K10
K14
K16
K18
W2
W1
K4
K5
K9
K11
K13
K15
K17
K1
TB1
TB2
SWITCHED B+
B+ IN
START SOL
B+
REMOTE START
GROUND
4 AMP CONV ALM
RUN
DC DISC IN
OS IN
LAMP TEST RESET
FLT GRE
P1
P2
(14)

MFGR TO STAMP LATEST REVISION LETTER FROM THIS DWG HERE. (SEE NOTE 6)

ER NO.	LTR.	NO.	REVISION	ZONE	BY	CHKD	APPROVED	DATE
23,312	A	1	PRODUCTION RELEASE		MM			2-24-84
24,078	B	1	P1 (ITEM 26) WAS 332-2678 (A)	2-B	MD	MM	SLS	4-2-84
		2	P2 (ITEM 27) WAS 332-2668 (A)	2-B	MD	MM	SLS	4-2-84
		3	P3 (ITEM 28) WAS 332-2671 (A)	2-B	MD	MM	SLS	4-2-84
		4	P4 (ITEM 29) WAS 332-2670 (A)	2-B	MD	MM	SLS	4-2-84
		5	ADDED ITEM #5 TS98024	2-A	MD	MM	SLS	4-2-84
		6	REMOVE TS # FROM NOTE 4	2-C	MD	MM	SLS	4-2-84
		7	ADDED ITEM #42	2-C	MD	MM	SLS	4-2-84
		8	REMOVED DS # FROM NOTE #8	2-C	MD	MM	SLS	4-2-84
26,690	C	1	ITEM 43 WAS 359-0063	2-C	00	MM	SLS	8-5-85



NOTES:

1. CIRCUIT BOARD SHALL BE SOLDERED WITH ITEM #3 AT MAX SOLDER TEMP OF 500° AND MAX TIME OF 6 SECONDS.
2. SOLDER JOINTS AND/OR COMPONENT LEADS (EXCEPT POTENTIOMETER LEADS) SHALL NOT PROJECT MORE THAN 1/8" BEYOND SURFACE OF BD.
3. CONFORMAL COAT BOTH SIDES OF COMPLETED BOARD WITH ITEM #4 EXCEPT ITEM #11-14, 24-29, 35 AND 36. COATING BUILDUP SHALL NOT BE LESS THAN .002" OR GREATER THAN .1"
4. (B6) TEST PRINTED CIRCUIT BOARD PER ITEM NO.5
5. FOR INSPECTION PROCEDURE SEE DWG #539-0393 (C).
6. STAMP REVISION LETTER PRIOR TO CONFORMAL COATING.
7. CLEAN BOARD WITH SUITABLE CLEANER BEFORE CONFORMAL COATING.
8. (B8) DESIGN OF THIS ASSY IS CONTROLLED BY ITEM #42.

REF DES	ITEM	PART NO.	BULK SIZE	QTY	DESCRIPTION OR MATERIAL
W1-4,6,7	45	337-0341	A	6	JUMPER-PC BD
(C1) VR2	44	359-0036	A	1	DIODE-ZENER
VR1	43	359-0070	A	1	SUPPRESSOR-VOLTAGE
(B7)	42	DS 98009	S	-	PRODUCT DESIGN SPEC
U4	41	367-0064	B	1	IC-DRIVER ARRAY (1413)
U3	40	367-0086	B	1	IC-100K RES NETWORK (8 RES)
U2	39	367-0189	B	1	IC-RESISTOR (10K, 1/8W, 2%)
U1,5	38	367-0160	C	2	IC-24 STAGE FREQ DIV (4521)
	37				
TB2	36	332-2551	A	1	TERMINAL BLOCK-PC BD (16PL
TB1	35	332-2706	A	1	TERMINAL BLOCK-(PC)10PL
	34				
R4,6,8	33	350-0394	-	3	RESISTOR 12K, 1/2W, 5%)
R3	32	350-0363	-	1	RESISTOR 1100 OHM, 1/2W, 5%)
R1,2,7	31	350-0384	-	3	RESISTOR 1750 OHM, 1/2W, 5%)
	30				
(B4) P4	29	323-1307	A	1	CONNECTOR-PCB (12 PIN)
(B3) P3	28	323-1309	A	1	CONNECTOR-PCB (13 PIN)
(B2) P2	27	323-1303	A	1	CONNECTOR-PCB (6 PIN)
(B1) P1	26	323-1305	A	1	CONNECTOR-PCB (8 PIN)
	25	870-0183	-	4	NUT-H W/ET (#6-32)
	24	812-0061	-	4	SCREW-RHM (#6-32 X 3/8)
	23				
K12	22	307-2342	A	1	RELAY (12V, SPDT)
K10	21	307-2329	A	1	RELAY (SPST,115VAC)
K7,8	20	307-2128	A	2	RELAY (SPDT, 24V)
K6	19	307-2103	A	1	RELAY-LATCHING (12V)
K4,5,9,11,13, 15,17,19	18	307-2339	A	8	RELAY (12V,DPDT)
	17				
K2,3	16	307-2334	A	2	RELAY-POWER (SPST,24V)
K1,14,16,18,20	15	307-2131	A	5	RELAY (DPDT, 24V)
	14	321-0163	P	10	CLIP-FUSE
F4,F5	13	321-0094	P	2	FUSE-CARTRIDGE (5A)
F3	12	321-0231	P	1	FUSE-CARTRIDGE (15 A)
F1,F2	11	321-0270	P	2	FUSE-CARTRIDGE (20A)
CR1-6,8,9	10	357-0062	P	8	RECTIFIER (1A, 200V) IN5614
C4	9	355-0120	A	1	CAPACITOR (10PF, 100V)
C3	8	355-0121	A	1	CAPACITOR (.001MFD, 100V)
C2	7	355-0122	A	1	CAPACITOR (1 MFD, 50V)
C1,5	6	356-0115	A	2	CAPACITOR (22MFD, 35V)
(B5)	5	TS 98024	S	-	PERFORMANCE TEST SPEC
	4	*524-0115	P	0IGAL	RESIN-POLYURETHANE
	3	*880-0003	-	.1 OZ	SOLDER-BAR
	2	98-5047	C	1	SILKSCREEN-PCB (12LIGHT,24V)
	1	332-2667	D	1	PCB-ENGINE MONITOR (12&24V)

CADD SYSTEM DWG

TOLERANCES UNLESS OTHERWISE SPECIFIED	mm	INCH
DO NOT SCALE PRINT	X. ± / .X ± / .XX ±	.X ± / .XX ± / .XXX ±
MACHINED HOLES ≥ .5 In (13 mm)	+0.15 / -0.05	+.006 / -.002
ANGLES ±	DRAWN TO SCALE OF 2-1	

SIM TO 300-2811 D

COPIED FROM

THIRD ANGLE PROJECTION

	NAME	DATE
DR	MAUREEN MANN	9-30-83
CHKR	L. L. NELSON	2-24-84
APPROVED	S. L. SWENSON	2-24-84

MODEL FIRST USED ON: GENERAL

TITLE: PCB ASSY-ENGINE MONITOR (12 LIGHT 24V)

DWG NO. 300-2812 SHEET 2 of 2 SIZE D

300-2812

O. P. E. 1

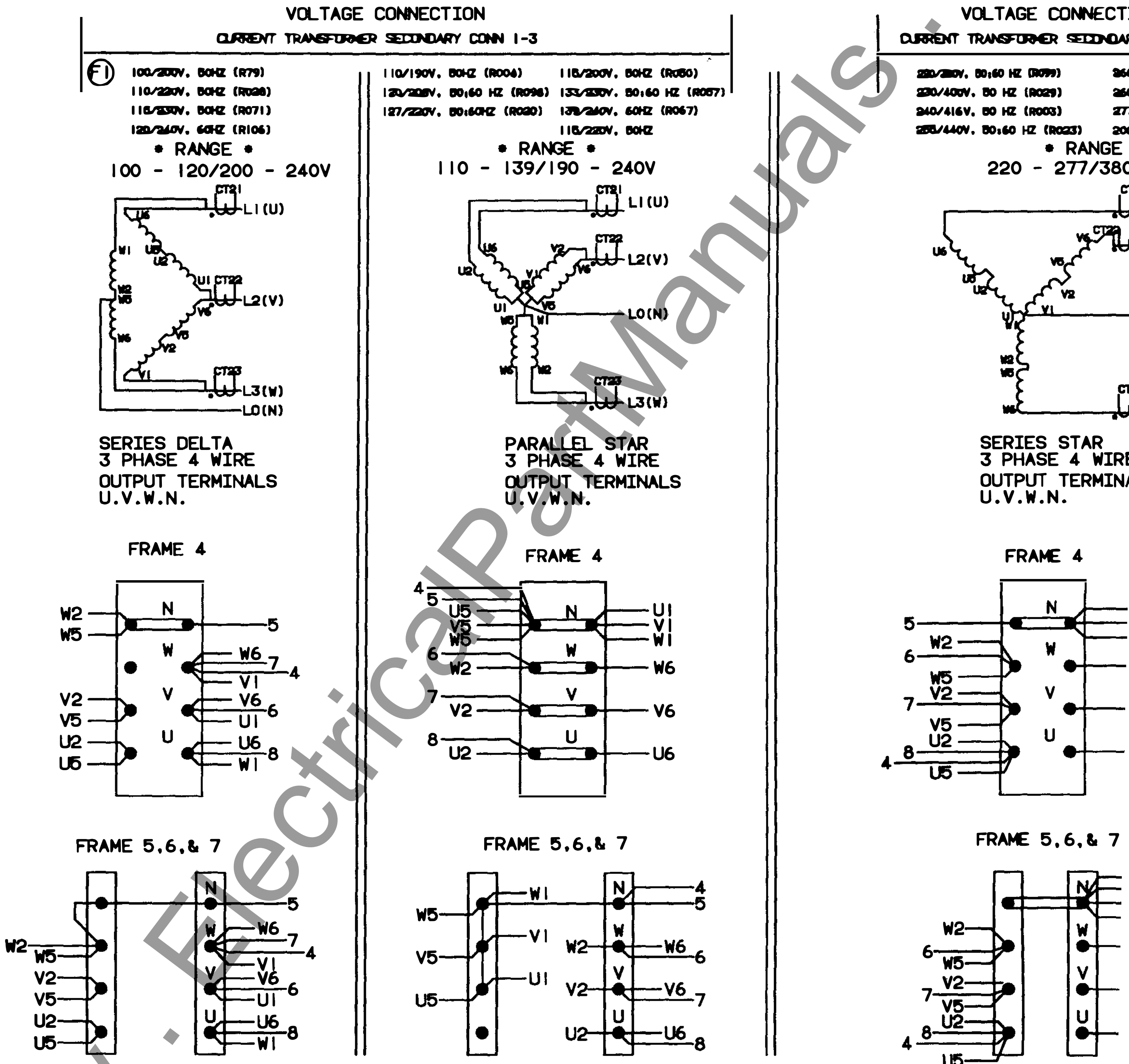
MICROFILMED

SHT 2 OF

300-003

SC, CC, HC GENERA

3 PHASE RECONNECTABLE



E1

CONTROL INPUT					
12 LEAD					
CONTROL INPUT TB21	AUX TERM CON	SERIES DELTA	PARALLEL STAR	SERIES STAR	DOUBLE DELTA
22	8	8	8	8	8
23	7	7	7	7	7
[illegible]	—	4	4	4	4
[illegible]	6	6	6	6	6
[illegible]	—	[illegible]	[illegible]	[illegible]	6
JUMPER	—	—	—	—	—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	D	1	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	E	1	[illegible]	(A)	[illegible]	[illegible]	[illegible]	[illegible]
		2	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	F	1	[illegible]	(A)	JC			

TORS

ON
CONN 1-2

460V, 60 HZ (R027)
450V, 50/60 HZ (R109)
480V, 60 HZ (R002)
346V, 50 HZ (R068)

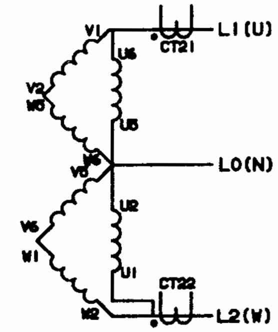
- 480V

1 PHASE RECONNECTABLE

VOLTAGE CONNECTION
CUR XFMR SEC CONN 1-3

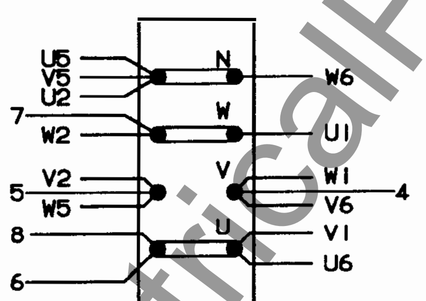
100/200V, 50 HZ (R054)
110/220V, 50 HZ (R046)
115/230V, 60 HZ (R041)
120/240V, 60 HZ (R104)

* RANGE *
100 - 120/200 - 240V

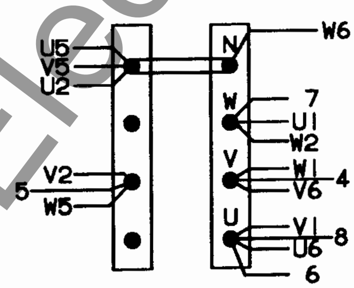


DOUBLE DELTA
1 PHASE 3 WIRE
OUTPUT TERMINALS
U.W. CENTER TAP N.

FRAME 4

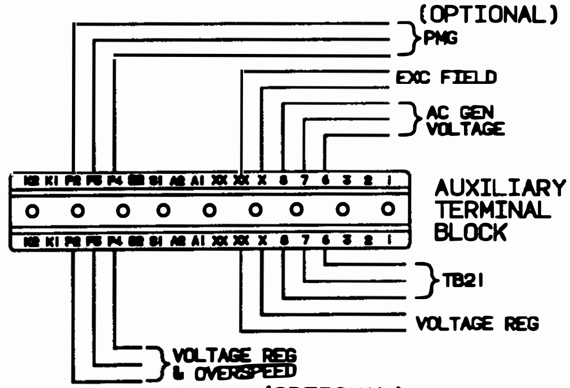


FRAME 5

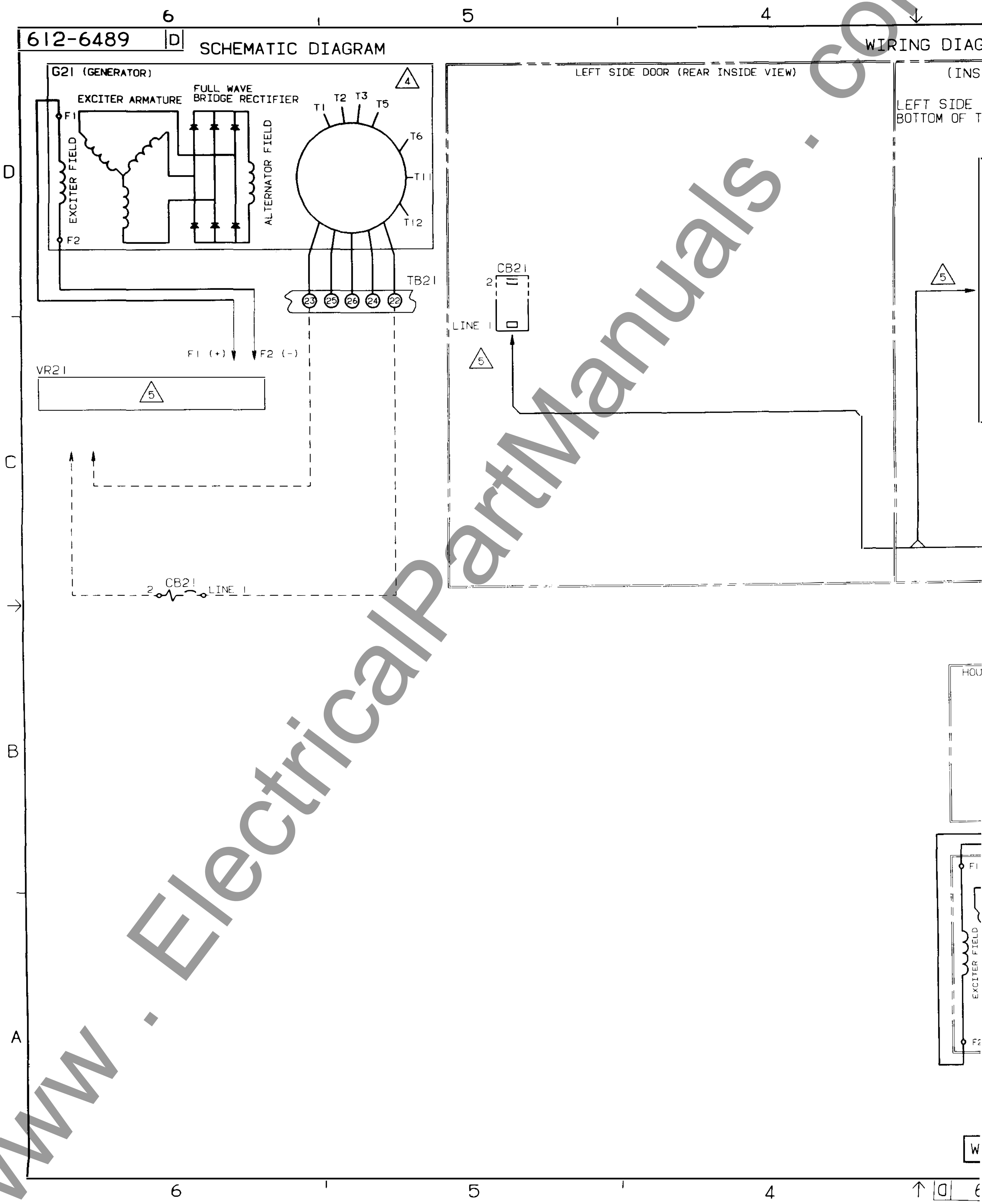


NOTES:

1. UVW PHASE SEQUENCE WITH C.W. ROTATION FACING DRIVE END.

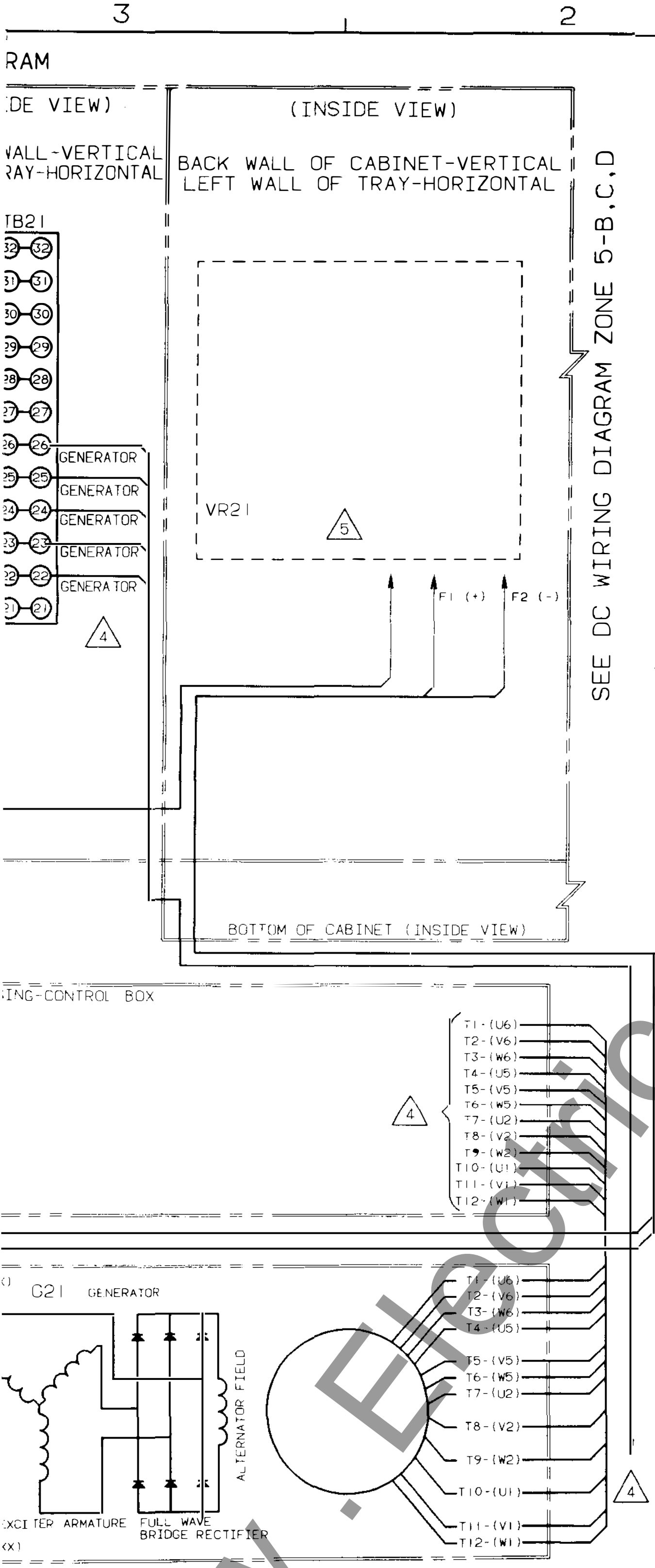


625-2165c 1of2



AC WIRING DIAGRAM/SCHEMATIC (W/O METERS)

ER NO	LTR	NO	REVISION	ZONE	DR	CKHR	APPROVED	DATE
29865	A	1	PRODUCTION RELEASE	-	JC	MR	PE	06-25-87
30817	B	1	REVISED PER ER	-	JP	JC	SLS	12-08-87
32870	C	1	REVISED PER ER	-	JC	VB	PE	09-15-88



NOTES:

1. ALL COMPONENTS SHOWN IN DE-ENERGIZED POSITION.
2. ILLUSTRATION NUMBERS REFER TO DWG. NO. 539-0741 VERT. (D) ILLUS-STD CONTROL AND 539-0997 (D) HORIZ.
3. LOCATE ONE (1) DANGER LABEL ON EXTERIOR AND ONE (1) ON INTERIOR OF LEFT SIDE DOOR IN ANY READILY VISIBLE AREA AVAILABLE.
4. SEE GENERATOR CONNECTION DIAGRAM FOR INPUT CONNECTIONS.
5. SEE VOLTAGE REGULATOR INSTALLATION FOR CONNECTIONS TO VR21, CB21 AND TB21.

ILLUS NO	REF DES	PART NO.	DWG SIZE	QTY	DESCRIPTION	DASH #
		098-5387	B	2	LABEL-DANGER (3)	-01
	G21	REF	-	1	GENERATOR	-
43	VR21	REF	-	1	INSTL-VOLTAGE REGULATOR	-
42		812-0065	-	2	SCREW-RHM (#6-32 X 5/8)	ALL
41		332-2723	A	1	MARKER STRIP	ALL
29	CB21	REF	-	1	CIRCUIT BREAKER-MAG (FIELD)	-
25	TB21	332-0607	A	1	BLOCK-TERMINAL (12 PL)	ALL
24		319-0416	D	1	TRAY ASSY-CONTROL	-02
23		98-5897-02	D	1	SILKSCREEN-PNL REAR (AC,HORIZ)	-02
23		98-5299	D	1	SILKSCREEN-PNL REAR (AC,VERT)	-01
22		98-5896-02	D	1	SILKSCREEN-PNL FR (AC,HORIZ)	-02
22		98-5316	D	1	SILKSCREEN-PNL FR (AC,VERT)	-01
21		319-0417	D	1	DOOR ASSY-CONTROL (LH) HORIZ	-02
21		301-9054-03	C	1	DOOR WELDT-CONTROL (LH) VERT	-01
20		821-0004	-	3	SCREW-LKH (#10-32 X 5/16)	-01
17		856-0008	-	1	WASHER -EIT LK (5/16)	ALL
16		862-0015	-	1	NUT-HEX (5/16-18)	-02
15		800-0024	-	1	SCREW-HHC (5/16-18 X 1/2)	-01
14		337-0049	A	1	BOND-STRAP	ALL
13		853-0013	-	1	WASHER-ET LK (1/4")	ALL
12		871-0015	A	1	NUT-HEX (1/4-20)	ALL
11		870-0131	-	3	NUT-H W/ET (#10-32)	ALL
10		332-0052	P	1	CLIP-WIRE (5/8")	-01
9		406-0334	A	2	WASHER-STUD RTNR	-01
8		406-0333	A	2	STUD-FASTENER	-01
7		406-0332	A	2	RECEPTACLE-FASTENER	-01
6		508-0051	A	1	GROMMET (2")	ALL
5		508-0001	P	1	GROMMET (3/4")	-01
4		850-0045	-	4	WASHER-LK (5/16)	-01
3		800-0045	-	4	SCREW-HHC (5/16-18 X 3/8)	-01
2		402-0527	B	4	ISOLATOR-VIBRATION	ALL
1		319-0413	D	1	COVER ASSY-CONTROL (HORIZ)	-02
1		301-8065	C	1	BOX WLDMT-CONTROL (VERT)	-01

TABULATION	
VERT	-01
HORIZ	-02

THOUT METERS

CADAM SYSTEM DWG

SIM TO 612-6268 D

612-6489

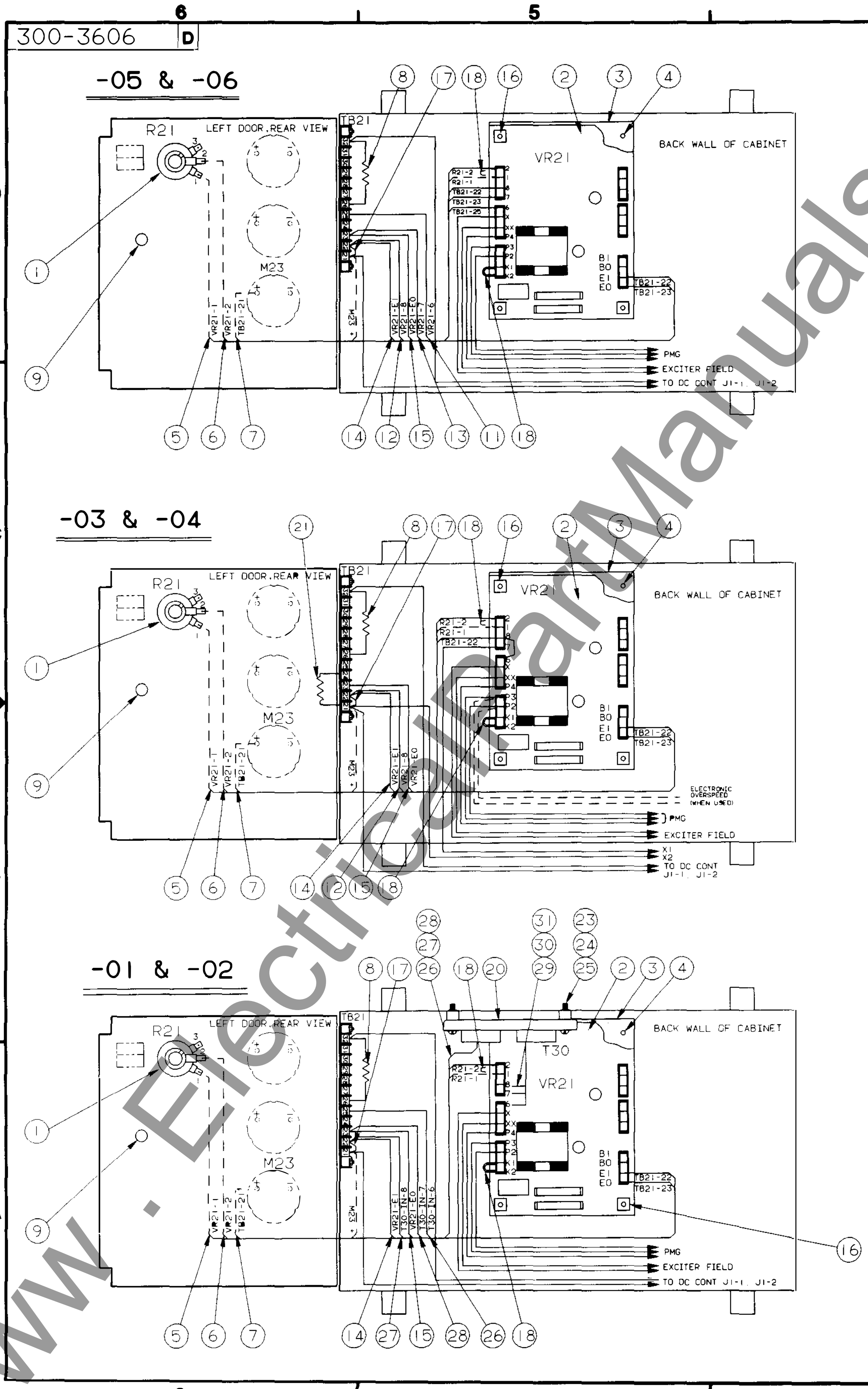
	NAME	DATE
DR	J. CASALENDA	6-10-87
CHKR	V. BECKMAN	6-10-87
APPROVED	P. ERICKSON	7-01-87

MODEL FIRST USED ON

TITLE WD-GEN SET AC CONT (BASIC)

DWG NO 612-6489 SHEET 1 OF 1 DWG SIZE D

O/C



DASH NO.	WITH PNL VOLTAGE ADJUST	W/OUT PNL VOLTAGE ADJUST	QTY ITE 1
-01	-	X	-
-02	X	-	1
* -03	-	X	-
* -04	X	-	1
-05	-	X	-
-06	X	-	1

* -03 &
REGULA

NOTES

1. DAS
2. REF
3. TIE
4. FO
A)
B)

PMG VOLTAGE REGULATOR INSTALLATION WIRING DIAGRAM

3 | 2 | 1

ER NO	LTR	NO	REVISION	ZONE	DR	CKHR	APPROVED	DATE
32172	A	1	PRODUCTION RELEASE	-	JC	DH	DG	10-11-88
33713	B	1	ITEM 8 REMOVED "TAB" ADD QTY 1	2A	JC	VB	PE	01-16-89
	B	2	ADDED ITEM 17 TO PARTS LIST	2B	JC	VB	PE	01-16-89
34164	C	1	ITEM 16 WAS 815-•218 (6-32 X 1)	2A	JC	JGP	PE	01-29-89
		2	DELETED ITEM 10, 226-3939-•2	2A	JC	JGP	PE	01-29-89
		3	ITEM 6 WAS 226-3939-09	2A	JC	JGP	PE	01-29-89
34566	D	1	ADDED ITEM 18	2B	JC	VB	PE	05-08-89
61508	E	1	REVISED PER ER	-	DS	DS	JAD	06-17-91
62171	F	1	REVISED PER ER	-	JC	VB	PE	12-09-91
62569	G	1	REVISED PER ER	-	JC	JC	PE	01-29-92
63249	H	1	REVISED PER ER	-	JC			5-15-92

D

TABULATION

QTY. ITEM 5	QTY. ITEM 6	QTY. ITEM 7	QTY. ITEM 11	QTY. ITEM 12	QTY. ITEM 13	QTY. ITEM 18	QTY. ITEM 20	QTY. ITEM 21	QTY. ITEM 22	QTY. ITEM 23	QTY. ITEM 24	QTY. ITEM 25	QTY. ITEM 26	QTY. ITEM 27	QTY. ITEM 28	QTY. ITEM 29	QTY. ITEM 30	QTY. ITEM 31
-	-	-	-	-	-	2	1	-	-	4	4	4	1	1	1	1	1	1
1	1	1	-	-	-	1	1	-	-	4	4	4	1	1	1	1	1	1
-	-	-	-	1	-	2	-	1	1	-	-	-	-	-	-	-	-	-
1	1	1	-	1	-	1	-	1	1	-	-	-	-	-	-	-	-	-
-	-	-	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-

C

•4 ARE QUIET SITE I & II WITH RECONNECT PANEL.
OR IS CONNECTED FOR 2 PHASE SENSING.

HED LEADS INDICATE WHEN USED

ER TO ILLUSTRATION DRAWING 539-0741

EXTRA WIRE INTO HARNESS

2 PHASE GENERATOR OPERATION:
DISCONNECT LEAD FROM TB21-25 TO VR21-6.
CONNECT JUMPER LEAD FROM VR21-8 TO VR21-6.

G1 D B2 C1 C2 B1 C3

MX321

ILLUS NO	ITEM	PART NO	DWG SIZE	*BULK QTY	DESCRIPTION OR MATERIAL
	31	226-4458-06	A	TAB	LEAD (T30-OUT-6; VR21-6)
	30	226-4458-05	A	TAB	LEAD (T30-OUT-7; VR21-7)
	29	226-4458-04	A	TAB	LEAD (T30-OUT-8; VR21-8)
	28	226-4458-03	A	TAB	LEAD (T30-IN-7; TB21-23)
	27	226-4458-02	A	TAB	LEAD (T30-IN-8; TB21-22)
	26	226-4458-01	A	TAB	LEAD (T30-IN-6; TB21-25)
	25	850-0030	-	TAB	LOCKWASHER #10
	24	526-0008	-	TAB	WASHER-FLAT #10
	23	813-0108	P	TAB	SCREW-RHSM (10-32 X 1-1/2)
	22	332-1571	P	TAB	TERMINAL - TAB ADAPTOR
	21	350-1224	B	TAB	RESISTOR ASSY
	20	305-0868	C	TAB	TRANSFORMER PCB-ISLN
	19				
	18	226-3942-07	B	TAB	LEAD (VR21-1; VR21-2)
	17	332-1043	C	1	JUMPER
	16	812-0084	-	4	SCREW-RHM (8-32X1)
	15	226-3942-05	B	1	LEAD (VR21-E0; TB21-23)
	14	226-3942-04	B	1	LEAD (VR21-E1; TB21-22)
	13	226-3942-03	B	TAB	LEAD (VR21-7; TB21-23)
	12	226-3942-02	B	TAB	LEAD (VR21-8; TB21-22)
	11	226-3942-01	B	TAB	LEAD (VR21-6; TB21-25)
	10				
	9	517-0131	A	1	PLUG-HOLE
	8	350-1222	A	1	RESISTOR ASSY
	7	226-3939-08	B	TAB	LEAD (TB21-21; M23 +)
	6	226-3942-06	B	TAB	LEAD (R21-2; VR21-2)
	5	226-3939-01	B	TAB	LEAD (VR21-1; R21-1)
18	4	815-0544	-	6	SCREW-LKH (6-32X1/2)
	3	319-0652	C	1	PLATE-VOLT RGLTR MTG
43	2	305-0823	D	1	VOLTAGE REGULATOR
38	1	303-0285	A	TAB	POTENTIOMETER

B

A

CADAM SYSTEM DWG

TOLERANCES UNLESS OTHERWISE SPECIFIED: MM / INCH; X ±, XX ±, XXX ±; MACHINED HOLES ≤ 5 IN (13MM) +0.15 -0.05 / +.006 -.002; ANGLES ±

DO NOT SCALE PRINT

DRAWN TO SCALE OF .75

SIM TO / COPIED FROM / THIRD ANGLE PROJECTION

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FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ANSI Y14.5M-1982

300-3606 D

	NAME	DATE
DR	J. CASALENDA	09-06-88
CHKR	M.F. REED	10-06-88
APPROVED	P. ERICKSON	10-06-88

MODEL FIRST USED ON: DF SERIES

Onan — ONAN CORPORATION, MINNEAPOLIS, MINNESOTA

TITLE: INSTL-VOLTAGE RGLTR

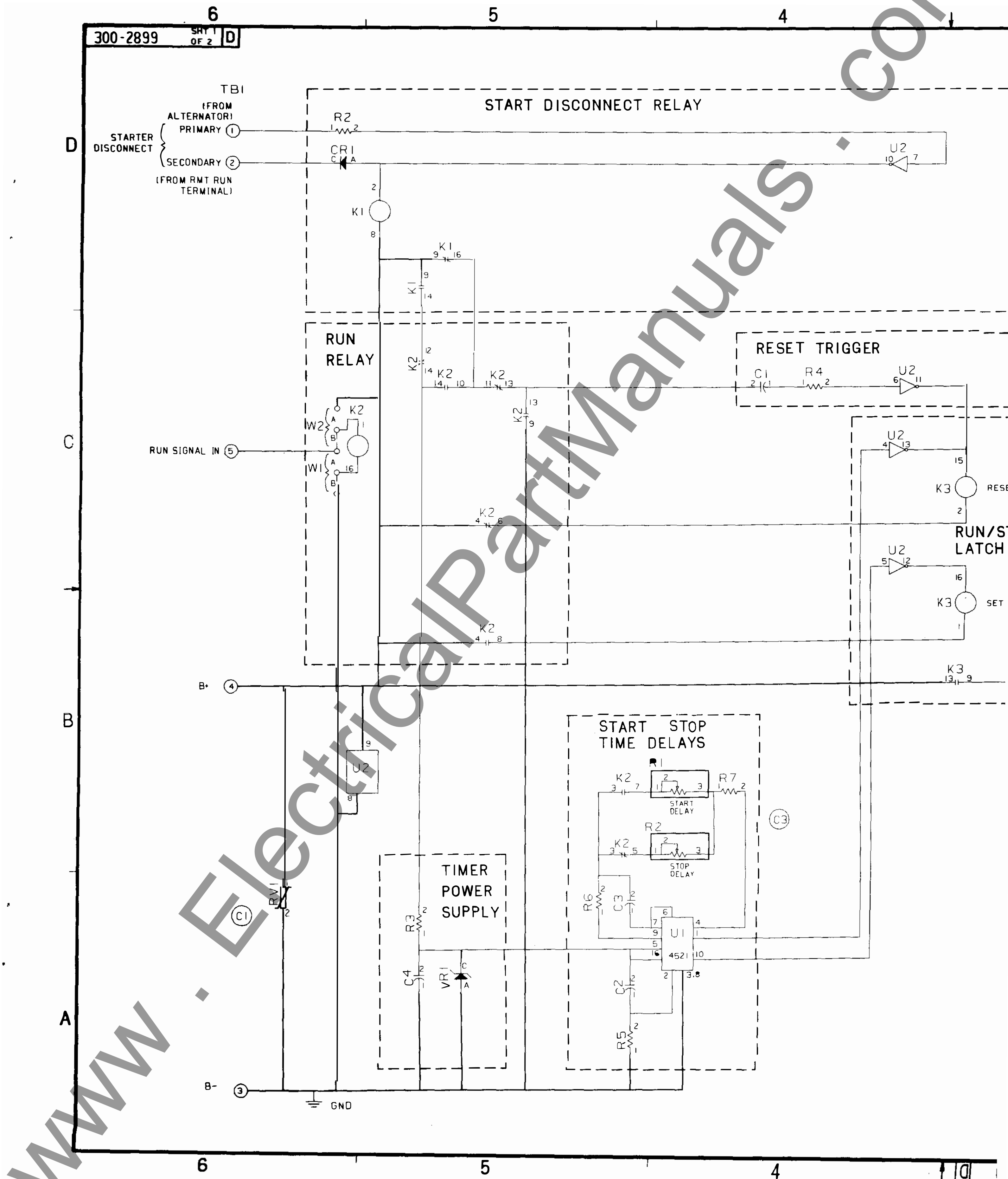
DWG NO: 300-3606 — SHEET 1 OF 1 — DWG SIZE D

MICROFILMED

D/C

1 | 2 | 3

300-36



TIME DELAYED START/STOP MODULE

ER NO.	LTR.	NO.	REVISION	ZONE	DR	CHKR	APPROVED	DATE
24,103	A	1	PROD RLSE	-	MM	LLN	SLS	3-21-84
29,706	B	1	SPEC 4.2 WAS 30 SEC TO 15 MIN	2-B	MRO	LLN	SLS	4-8-87
		2	SEE SHT 2	-	MRO	LLN	SLS	4-8-87
30,592	C	1	ADDED RV1	6-A	DO	JC	SLS	9-23-87
		2	SEE SHEET 2 OF 2	-	DO	JC	SLS	9-23-87
		3	SPLIT R1 POT TO R1, R2 AND REVERSED CONNECTIONS	4-B	DO	JC	SLS	9-23-87
		4	CORRECETED SPELLING NOTE 1.1.2	2-C	DO	JC	SLS	9-23-87
		5	SPEC 4.4.2 WAS 30 SEC TO 15 MIN 5%	2-B	DO	JC	SLS	9-23-87

OP

(6) RUN SIGNAL OUT

SPECIFICATIONS

1. GENERAL
   - 1.1 POWER SUPPLY VOLTAGE (TERMINAL #4)
     - 1.1.1 CRANKING MODE — 12 TO 30 VDC
     - 1.1.2 NON-CRANKING MODE — 21.2 TO 30 VDC
   - (C4) 1.2 MAXIMUM POWER CONSUMPTION — 1.5 WATTS
   - 1.3 OPERATING TEMPERATURE RANGE — -40 TO +70 °C
   - 1.4 STORAGE TEMPERATURE RANGE — -55 °C TO +100 °C

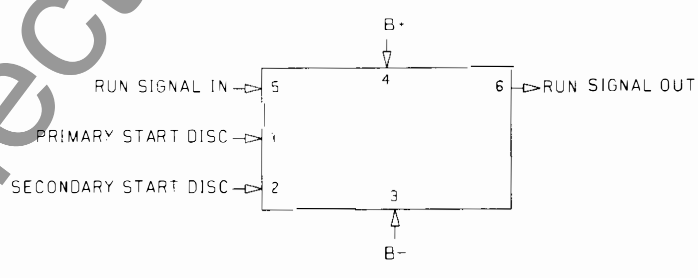
2. INPUTS
   - 2.1 VMAX LOW STATE — 2.4 VDC
   - 2.2 VMIN HIGH STATE — 21.2 VDC
   - 2.3 TERMINAL #1 GOES HIGH FOR PRIMARY START DISCONNECT
   - 2.4 TERMINAL #2 GOES LOW FOR SECONDARY START DISCONNECT
   - 2.5 TERMINAL #5 IS SIGNAL MODE SELECTABLE AS FOLLOWS

W1 & W2 POSITION	RUN SIGNAL IN MODE
A	GND TO RUN
B	B+ TO RUN

3. OUTPUTS
   - 3.1 MAXIMUM SOURCE CURRENNT (TERMINAL #6) — 2 AMPS

4. TIME DELAYS
   - 4.1 TIME DELAY START — .5 TO 15 SECONDS ±35%
   - (C5)(B1) 4.2 TIME DELAY STOP PERIOD — 30 SEC TO 30 MIN ±35%

BLOCK DIAGRAM



CADD SYSTEM DWG			
DO NOT SCALE PRINT	TOLERANCES UNLESS OTHERWISE SPECIFIED	SIM TO	
	mm: .X ± / .XX ±	INCH: .XX ± / .XXX ±	COPIED FROM
	MACHINED HOLES ≥ .5 In (13 mm): +0.15 -0.05	+.006 -.002	THIRD ANGLE PROJECTION
	ANGLES ±	DRAWN TO SCALE OF	

REF DES	ITEM	PART NO.	◆ BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL

	NAME	DATE
DR	MAUREEN MANN	3-21-84
CHKR	L. L. NELSON	3-29-84
APPROVED	S. L. SWENSON	3-29-84

FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ANSI Y14.5-1973

MODEL FIRST USED ON: CLASS B SETS

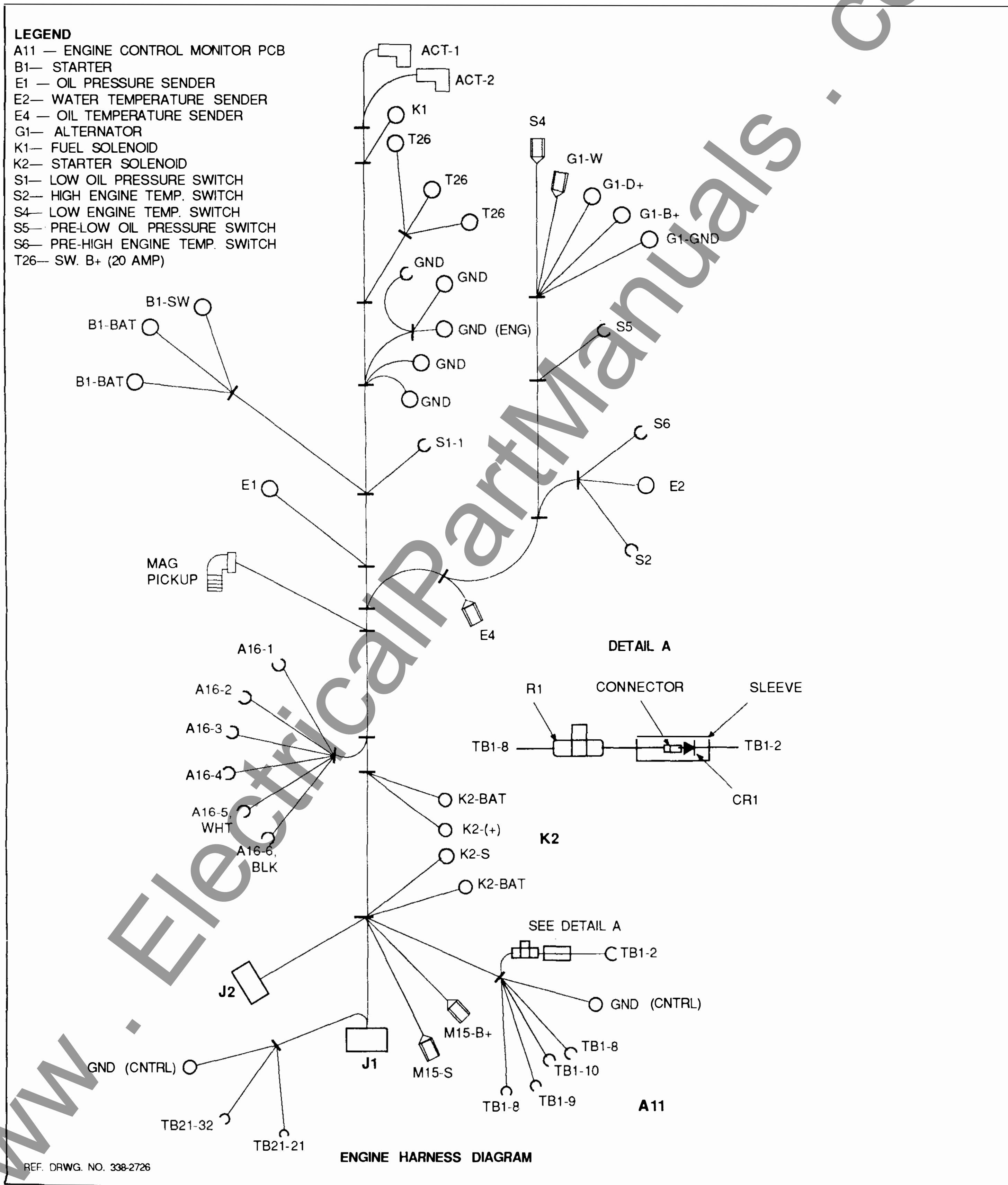
TITLE: PCB ASSY - TD START/STOP (24V)

DWG NO. 300-2899 | SHEET 1 OF 2 | SIZE D

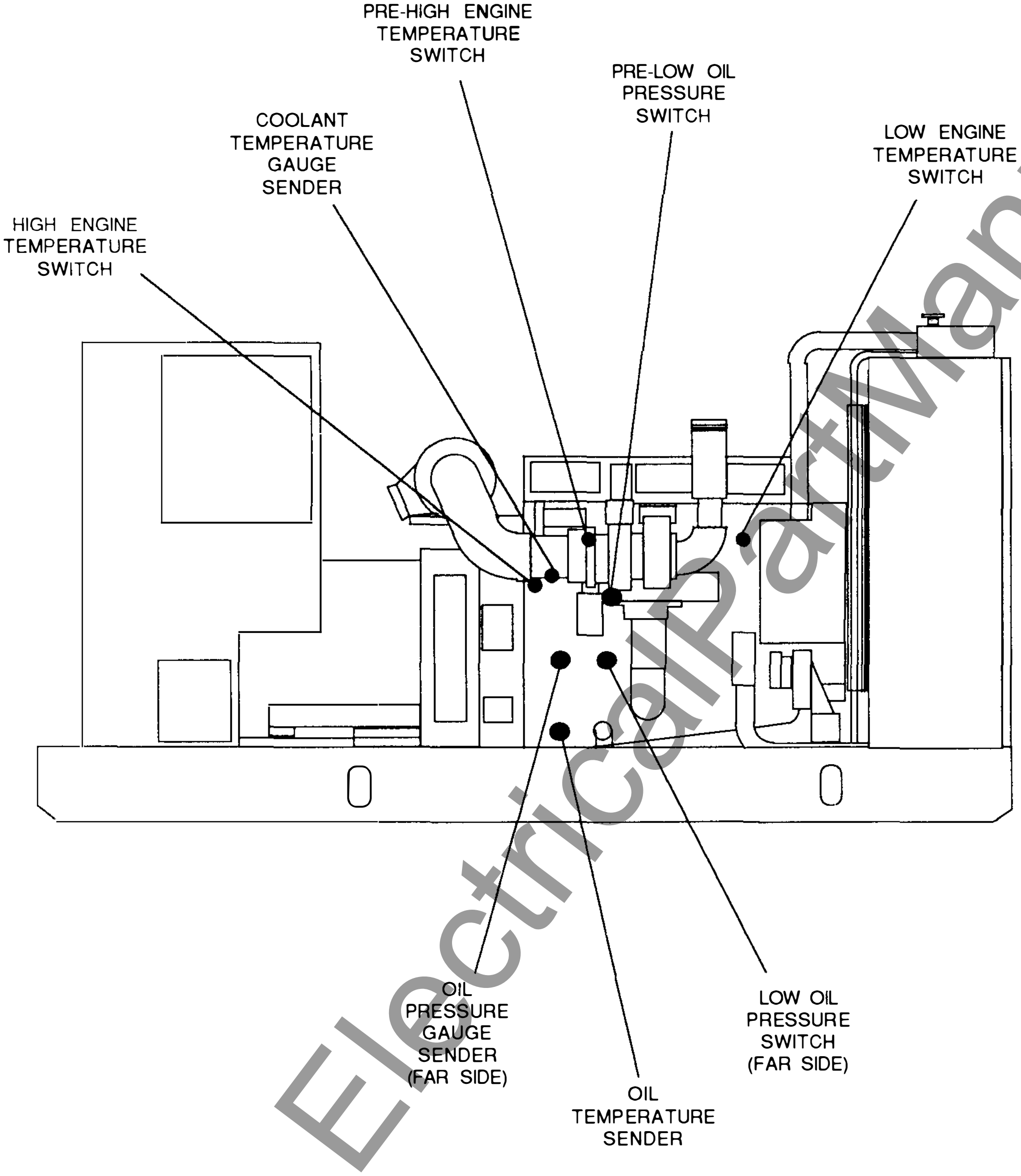
300-2899

SHT 1 OF

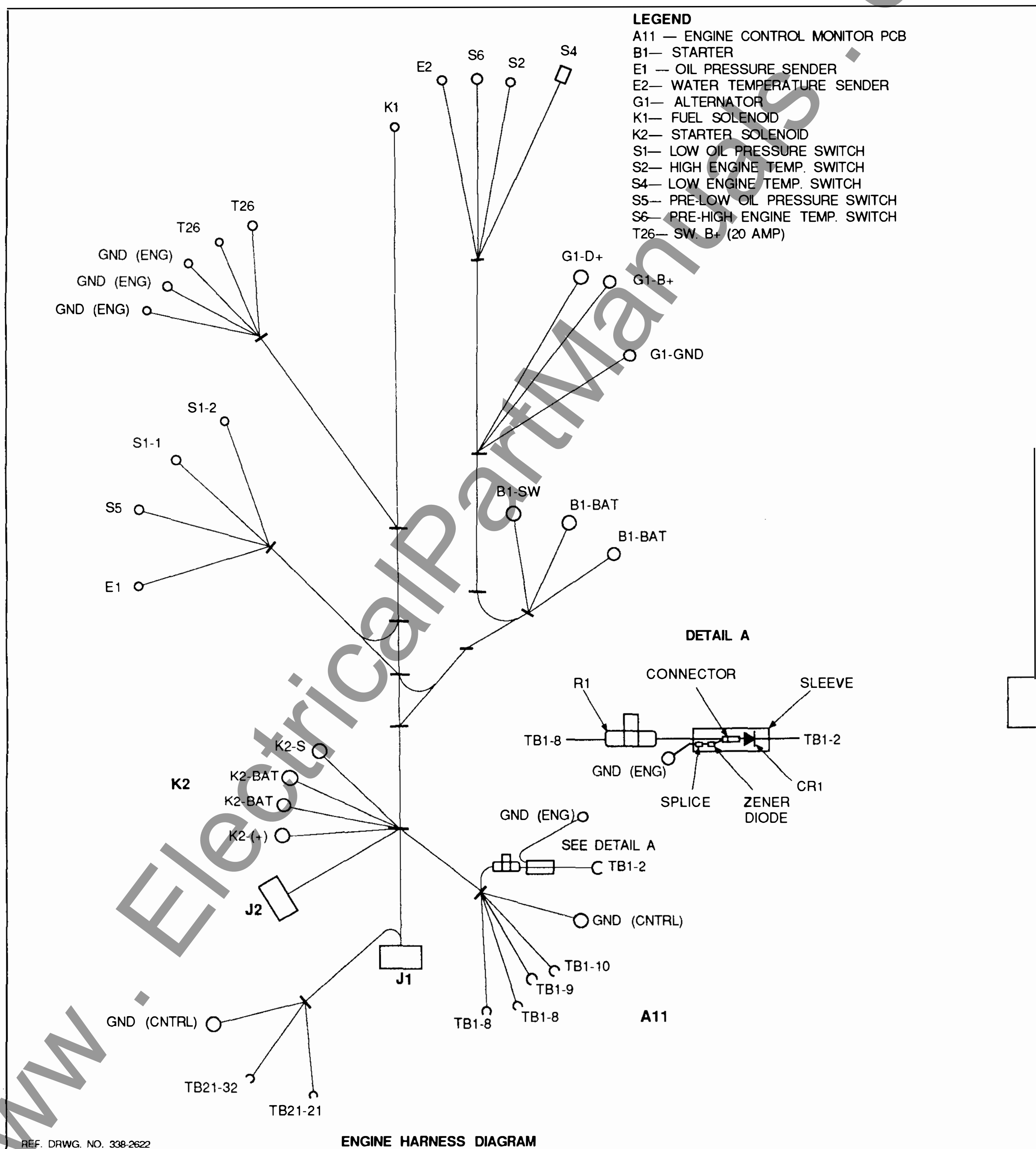
300-289



ENGINE SENSOR LOCATIONS (L10 SERIES)

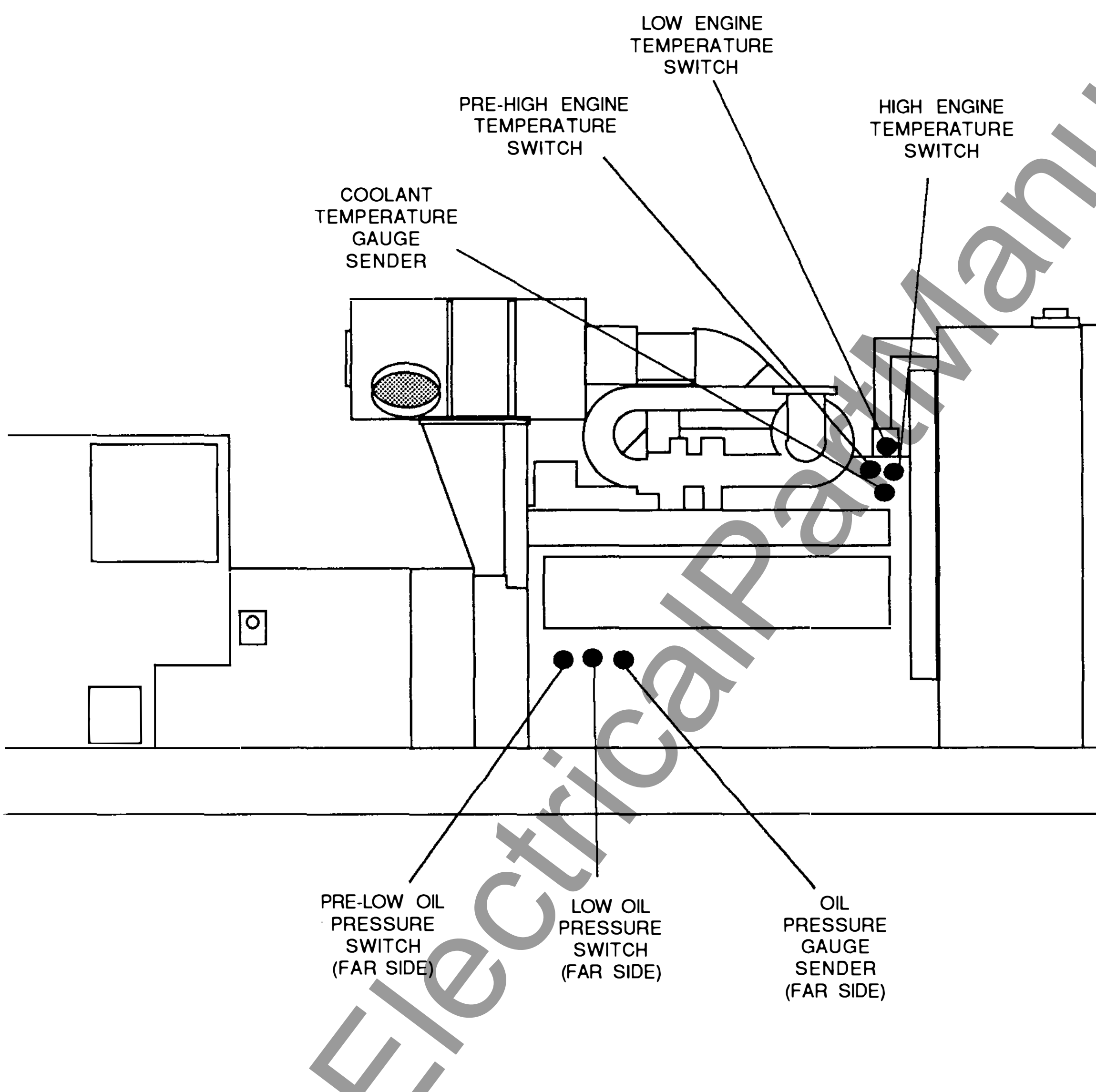


REFERENCE DRAWINGS:
GENSET OUTLINE – 500-2781
ENGINE ACC. – 100-3075

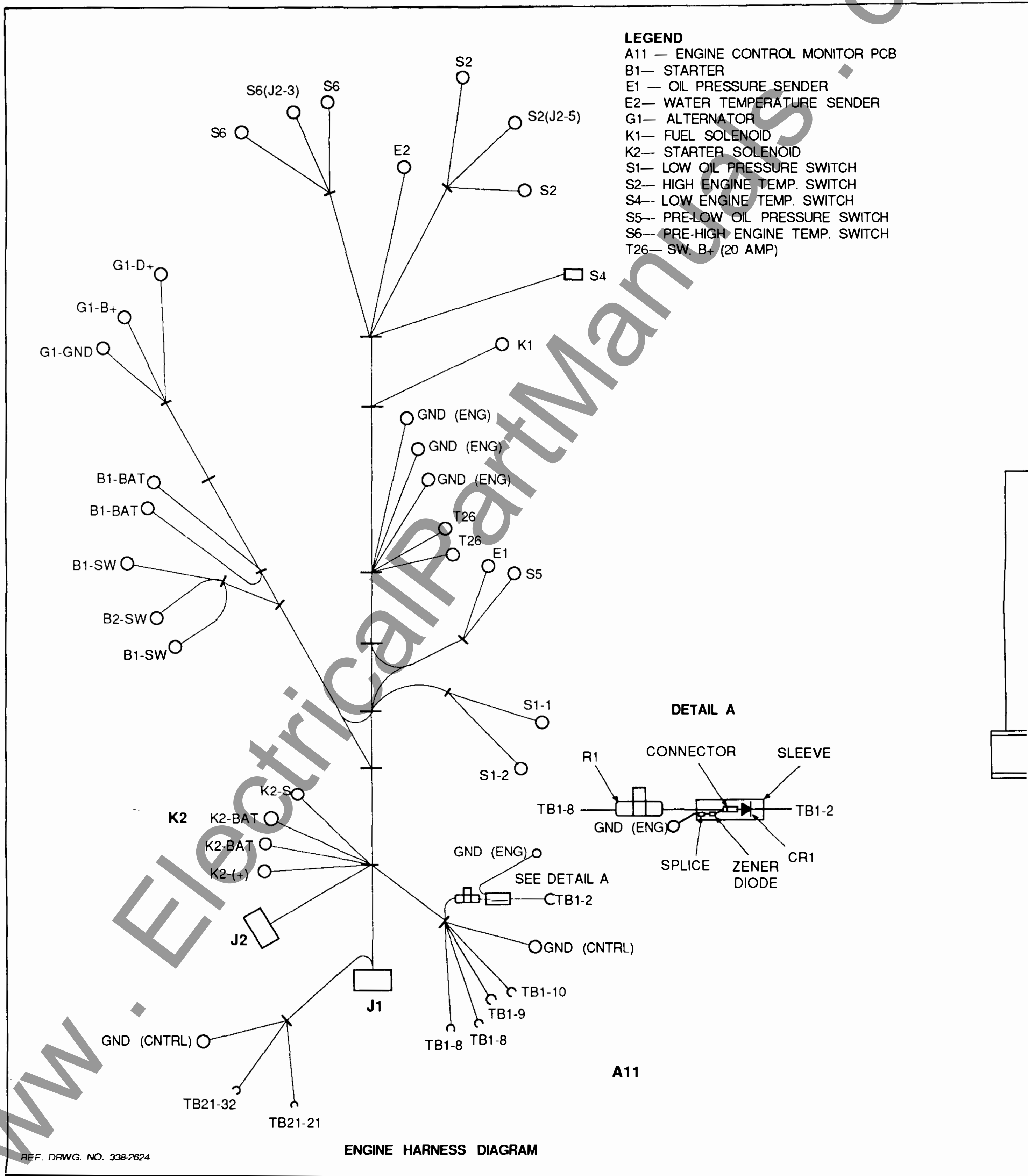


ENGINE HARNESS DIAGRAM

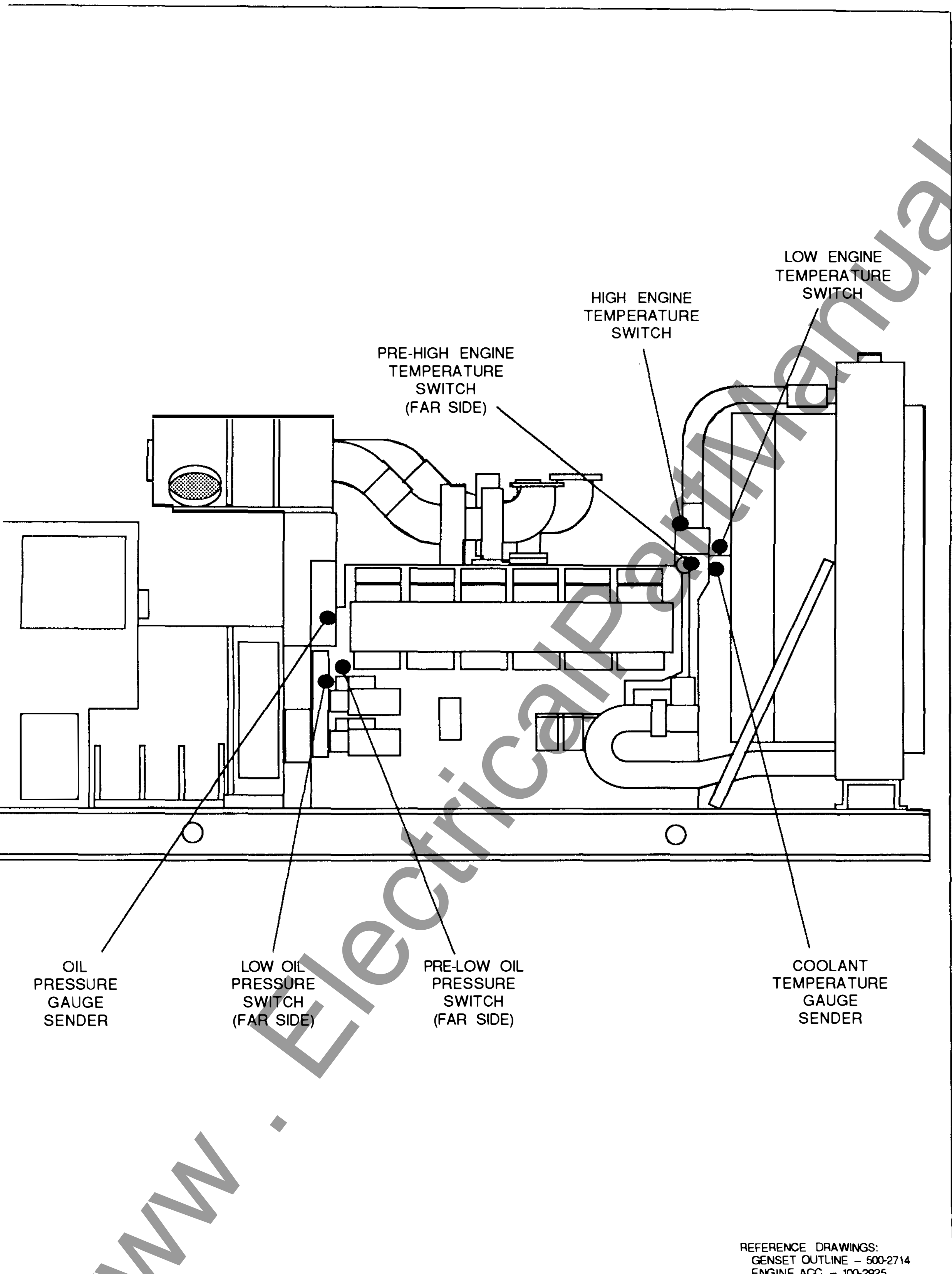
ENGINE SENSOR LOCATIONS (KT19 SERIES)



REFERENCE DRAWINGS:
GENSET OUTLINE – 500-2619 & 500-2649
ENGINE ACC. – 100-2886



ENGINE SENSOR LOCATIONS (KT38 SERIES)


LOW ENGINE TEMPERATURE SWITCH
HIGH ENGINE TEMPERATURE SWITCH
PRE-HIGH ENGINE TEMPERATURE SWITCH (FAR SIDE)
OIL PRESSURE GAUGE SENDER
LOW OIL PRESSURE SWITCH (FAR SIDE)
PRE-LOW OIL PRESSURE SWITCH (FAR SIDE)
COOLANT TEMPERATURE GAUGE SENDER
REFERENCE DRAWINGS:
GENSET OUTLINE – 500-2714
ENGINE ACC. – 100-2925

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