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

Before operating the generator set, read this manual and become familiar with it and the equipment. Safe and efficient operation can be achieved only if the unit 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.

Read and observe each of the following safety precautions.

FUEL AND FUMES ARE FLAMMABLE
Fire, explosion, and personal injury can result from improper practices.

- Do not smoke or allow an open flame or spark-producing equipment near the generator set or fuel tank.
- Inspect the fuel lines and connections daily for leaks per the maintenance schedule.

EXHAUST GASES ARE DEADLY
- Never sleep in the vehicle with the generator set running unless vehicle is equipped with an operating carbon monoxide detector.
- Inspect exhaust system daily for leaks per the maintenance schedule. Do not use engine cooling air to heat a compartment.
- Never operate the generator set inside a building or in an area where exhaust gases could accumulate, such as near a wall or snow bank, or in high grass. When parking, make sure the exhaust outlet is not obstructed. Make sure the generator set is well ventilated.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH
- Disconnect the negative (−) cable at the starting battery before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms on the ground or over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death.
- Tag remote or open switches to avoid accidental closure or starting.
- 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 device and after building main switch is open. Consult an electrician in regard to emergency power use.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH
- Before starting work on the generator set, disconnect negative (−) cable at the battery. This will prevent accidental arcing or starting.
- Keep your hands away from moving parts.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, etc.
- Do not wear loose clothing or jewelry while working on generator sets, because they 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.

GENERAL SAFETY PRECAUTIONS
- Wear safety glasses and protective clothing when servicing batteries. Do NOT SMOKE while servicing batteries. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.
- Have a fire extinguisher rated ABC nearby. Maintain extinguisher properly and become familiar with its use.
- 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.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which presents a potential fire hazard.
- Do not store anything in the generator set compartment such as oil or gas cans, oily rags, chains, wooden blocks, portable propane cylinders, etc. A fire could result or the generator set operation (cooling, noise and vibration) may be adversely affected. Keep the compartment 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.
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ABOUT THIS MANUAL

For servicing purposes, the generator set can be divided into three basic parts: the engine, the generator, and the control. This manual contains troubleshooting and repair information for the generator and the control. Refer to the Engine Service Manual (981-0501) when servicing the engine.

Study this manual carefully and observe all the warnings and cautions throughout the manual. Knowing the generator set, using it properly, and following a regular maintenance schedule can result in longer unit life, better performance and safer operation.

Information for printed circuit board repair is limited because it is more efficient to replace the boards in the field and repair them at the factory. Application of meters or hot soldering irons to printed circuit boards by other than qualified service personnel can cause unnecessary and expensive damage.

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

HOW TO OBTAIN ASSISTANCE

Always give the complete model number and serial number as shown on the Onan nameplate when seeking additional service information or replacement parts.

TEST EQUIPMENT

Most of the test procedures in this manual can be performed with a multimeter such as the Simpson Model 260 VOM or with a digital VOM. Additional instruments used to service generator sets that should be available are:

- AC Voltmeter
- DC Voltmeter
- Frequency Meter
- Jumper Leads
- Load Test Panel
- Megger or Insulation Resistance Meter
- Frequency Meter or Strobolatch
- Variac
- Wheatstone Bridge or Digital Ohmmeter
### TABLE 1-1. HAZARDS AND THEIR SOURCE

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Be prepared if an accident does occur. Numerous agencies such as the Red Cross and local police and fire departments offer basic courses in first aid, CPR, and fire control. Take advantage of these offerings so you are ready to respond when an accident occurs. Learn to be safety conscious and make safe practices a part of your work routine. Do not work when tired or after consuming any alcohol or drug that makes the operation of equipment unsafe.

### SET REMOVAL

Some service procedures will require removing the generator set from a vehicle or boat. Because of the wide variety of generator set installations, it is not possible to specify the exact removal procedures for each generator set. If, after examining the installation, a satisfactory method for removing the set cannot be determined, contact the vehicle or boat manufacturer or the generator set installer to obtain their recommendations.

**WARNING** Generator sets are heavy and they can cause severe personal injury or death if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting the generator set.

**Disconnecting Generator Set Systems**

Some installations may require partial removal of the set to gain access to the battery cable, fuel line, and other connections. Read this entire section before starting set removal. The following steps are a general guideline for set removal.

1. Disconnect the generator set negative (-) battery cable at the battery terminal.
2. Disconnect the generator set positive (+) battery cable from the wire harness.
3. Disconnect the remote control plug wire from the generator set, if applicable.
4. Disconnect the generator load wires and tag for identification when reconnecting.
5. Disconnect the exhaust system and support brackets or hangers to allow set removal.
6. Disconnect the fuel line at the generator set housing. Securely plug the end of the fuel line to prevent fuel leakage or an accumulation of explosive gasoline vapor.
7. Verify that the generator set is adequately supported before loosening any of the mounting bolts or support members.
Leakage of fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Make certain all fuel line openings are plugged to prevent gasoline vapor from accumulating. Before disconnecting the fuel line, be certain there are no ignition sources such as flame, spark, pilot light, cigarette, etc., near the generator set. Keep an ABC type fire extinguisher nearby.

When reinstalling the generator set, be sure all mounting hardware, and electrical, exhaust, and fuel system components are connected exactly as they were before removal. Refer to the appropriate installation manual during reinstallation for important safety precautions.

Check for oil and fuel leaks. Check exhaust system audibly and visually with the generator set running. Repair any leaks immediately. Replace worn, damaged, or corroded exhaust and fuel line components before leaks occur.
Section 2. Marine Engine Control

GENERAL
The marine engine control system includes all the functions that relate to the operation of the engine. This includes starting and stopping, instrumentation, monitoring for fault conditions, and battery charging. This section covers a description of the controls and shows where they are located, describes how the control operates, and provides basic troubleshooting procedures.

CONTROL DESCRIPTION
Gauges/Meters and Switches
Oil Pressure Gauge (Optional): Shows engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa) and is connected to an engine sensor. See Figure 2-1.

Coolant Temperature Gauge (Optional): The water temperature should be in the range of 165°F to 195°F (74°C to 91°C) depending on the load and the ambient temperature.

DC Voltmeter (Optional): Normal battery B+ voltage during operation should be 13.5 to 15 volts on a 12-volt system; 27 to 30 volts on a 24-volt system.

Start/Stop Switch S11: Starts and stops the unit locally. Unit may be operated from an optional remote switch wired to the control panel. Preheat added to stop position on later production sets.

Preheat Switch S12: Activates heater relay K13 to connect battery B+ to the engine glow plugs prior to starting the engine. S12 is not used on later production sets.

Fault Reset: A manual reset breaker that shuts down the engine for low oil pressure, high coolant temperature, high exhaust temperature, and overspeed (option).

Emergency Stop DC Control Breaker: A 15-ampere breaker providing protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

FIGURE 2-1. MDKC/MDKC CONTROL BOX
Control Components
The following describes the basic engine control components and how they function.

**Engine Monitor Circuit Board:** A printed circuit board that monitors engine control system functions. This includes starting, stopping, and fault system operation. A terminal board is included for making remote connections. See Figure 2-1.

Two relays are soldered to the circuit board that are not serviceable. Power Relay K12 connects and maintains battery B+ to the control meters and fuel solenoid during operation. Starter Protection Relay K15 is an AC operated relay. When the start switch is actuated, B+ is connected to the K11 start solenoid through K15 NC contacts until the generator output reaches 90 volts AC. K15 activates and disconnects the starter.

**F1 In-Line Fuse:** A 30-ampere fuse is located in a fuseholder connected to the B+ terminal of the starter. This fuse connects B+ to the control and will open if a short or overload should occur.

**K1 Fuel Solenoid:** Opens the fuel control valve when the start/stop switch is placed in the Start position.

**K11 Start Solenoid:** Located over the engine monitor circuit board. It connects the battery B+ to the starter solenoid B1 during cranking.

**K13 Heater Relay:** Located on the relay mounting tray. It connects the battery B+ to the engine glow plugs prior to and during cranking. It is energized by the Preheat Switch (S12 early production/S11 late production) and the start switch S11 during start sequence.

**K14 Fuel Solenoid Relay:** Located on the relay mounting tray. It is energized only during cranking and connects B+ to the fuel solenoid K1, fuel pump E5, and fault breaker CB12 circuits.

**K15 Start Disconnect Relay:** Located on the relay mounting tray. It is connected through CR11 to the 12-volt battery charging alternator. The relay actuates at 5.5 to 7.5 volts DC. The K16 relay and CR11 diode are not used on later production sets and were disconnected on some sets (refer to Product Support Bulletin 450).

**Engine Sensors**
The following briefly describes the engine mounted sensors and switches, and how they protect the engine from adverse operating conditions.

---

**Figure 2-2. MDKC/MDKD Fault Sensor Location**

Redistribution or publication of this document by any means, is strictly prohibited.
All safety sensors (switches) close to ground if abnormal operating conditions exist and trip the fault breaker CB12 to stop the engine. See Figure 2-2.

Resistance units and switches in the monitoring and shutdown systems are sealed units and are not repairable. When replacing a sensor, do not use a substitute item since resistance units are matched to the gauge they supply. Cutoff switches are close tolerance parts made for a specific application.

**Oil Pressure Monitors**

Refer to Figure 2-2 for the location of the oil pressure sensors.

**Oil Pressure Sender E1 (Optional):** The sender resistance changes with oil pressure and results in a reading on the oil pressure meter. The meter range is 0 to 100 psi (0 to 700 kPa).

**Low Oil Pressure Switch S1:** This switch closes if oil pressure drops to 9 psi (62 kPa), activating the fault breaker and stopping the engine.

**Control Power Latch S6:** This oil pressure switch closes at 5 psi (34 kPa) and provides a latch function for the control circuits. When closed, the switch supplies a ground path for relay K12 on the engine monitor board.

**Overspeed Switch (Optional)**

The mechanical overspeed switch is mounted on the front of the engine crankshaft as shown in Figure 2-3. It is factory adjusted to close and shut down 60 hertz units at 2200 r/min +/- 90 r/min; 50 hertz units at 1900 r/min +/- 90 r/min. An overspeed condition grounds the shutdown circuit on the Engine Monitor Board and trips the fault breaker. After the problem is corrected, starting will not occur until the breaker is reset.

If necessary, the speed trip point can be corrected by turning the adjusting screw, to adjust the magnetic air gap (see Figure 2-3). An accurate tachometer or stroboscope is needed to check the overspeed trip point after adjustment is made. The air gap must not be less than 0.005 inch (0.13 mm).

**Engine Temperature Monitors**

Refer to Figure 2-2 for the location of the engine temperature sensors.

**Coolant Temperature Sender E2 (Optional):** The resistance of the sender unit changes with the engine coolant temperature and causes a reading on the Water Temp Meter. The meter range is 100°F to 250°F (40°C to 121°C).

**High Coolant Temperature Switch S2:** This switch closes if the coolant temperature rises to 222°F (106°C), activating the fault breaker and stopping the engine.

**High Exhaust Temperature Switch S5:** This switch is mounted on the exhaust elbow and it closes on temperature rise above 230°F (110°C), activating the fault breaker and stopping the engine. It will open again when the temperature reaches about 190°F (88°C).

High exhaust elbow temperature is caused by insufficient or lack of sea water flow. Sea water flow at the exhaust outlet should be about 3 gal/min (11 litre/min).

![DIAGRAM](image-url)

**FIGURE 2-3. OPTIONAL OVERSPEED SWITCH**

**CONTROL OPERATION**

Trouble-free operation of the control system should be the major concern of generator set service personnel. Service personnel must thoroughly understand how the controls operate, know how to make the proper adjustments, replacements, or repairs in a reasonable amount of time.

The following section covers the control operation. The schematic diagram shown in Figure 2-4 can be used to help follow the circuit description. Always refer to the specific wiring diagram that corresponds to the model and specification number of the generator set when troubleshooting. Relay contact references normally open (NO) and normally closed (NC) refer to the position of the contacts with the unit at rest (not energized).

Prior to starting the generator set, Check the fuel supply, engine oil level, and battery connections for loose or broken wires. Check the entire exhaust system for worn or corroded parts. Replace defective parts before leaks occur.
Figure 2-4 shows a typical schematic for the circuits described in the following Starting, Start-Disconnect, and Stopping sequences. Relay contact references normally open (NO) and normally closed (NC) refer to position of contacts with the unit at rest (not energized).

**Starting Sequence:** The engine Preheat switch is held for 10 to 30 seconds (depending upon temperature). This energizes the Heater Solenoid K13 and closes a set of NO contacts to connect B+ to the glow plugs. After the preheat time, the start sequence is initiated by pressing the Start button S11.

Switch S11 connects B+ to the coil of K14 and (through the A11-K15 contacts and K16 [early production only] NC contacts) to the Start Solenoid K11. The coil of K11 is grounded through the pull coil of K1 after K1 is completely pulled in and the pull coil is disconnected from B+. K1 must pull in completely before the engine will crank.

The closing of the K11 contacts connects B+ to the glow plugs and to the starter solenoid B1. K14 connects B+ to the fuel solenoid K1, fuel pump E5, CB21 fault breaker and engine monitor circuits only during starting.

**Start-Disconnect Sequence:** As the engine starts, latch switch S6 closes and completes the ground circuit through resistor A11-R1 for the K12 power relay. The closing of K12 dual contacts completes the B+ running circuit to CB12 fault circuit breaker. This was accomplished by K14 during cranking.

The start-disconnect circuit provides starter protection. As the generator gains speed and output voltage, the K15 starter protection relay energizes at about 90 volts AC. The A11-K15 NC contacts open and de-energize the K11 start solenoid; the A11-K15 NO contacts close and provide another ground path for K12 through K11 coil similar to S6.

A backup start-disconnect circuit is initiated by the battery charging alternator G1. When DC output at CR11 reaches approximately 6 volts, K16 energizes and opens B+ to the K11 start solenoid. De-energizing K11 disconnects B+ from the starter solenoid to stop cranking and eliminate glow plug heating. The K16 relay and CR11 diode are not used in later production generator sets.

**Stopping Sequence:** Placing S11 in the Stop position puts B+ on the ground side of K12 power relay. This causes K12 to de-energize and disconnect B+ from CB12, fuel pump E5, and the K1 fuel solenoid. De-energizing K1 shuts off the fuel flow and stops the engine.

**Emergency Shutdown:** Fault breaker CB12 opens to stop the engine any time a fault sensor closes the circuit to ground. The fault sensors, shown in Figure 2-4, are:

- S1 low oil pressure
- S2 high coolant temperature
- S4 overspeed (option)
- S5 high exhaust temperature

CB21 should not be reset for starting until fault is located and corrected.
CONTROL TROUBLESHOOTING
The information in this section is divided into three flow charts. Determine the problem and then refer to the appropriate flow chart (A, B, or C) for the troubleshooting procedures.

A. Engine does not crank.
B. Engine cranks but does not start.
C. Engine starts but stops after running several seconds.

Before starting a troubleshooting procedure, make a few simple checks that could expose the problem and cut down on troubleshooting time.

FLOW CHART A. ENGINE DOES NOT CRANK

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

```
START

Is battery dead?

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<table>
<thead>
<tr>
<th>Is battery dead?</th>
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<tbody>
<tr>
<td>yes</td>
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<td>no</td>
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Is battery dead?

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<tr>
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<tbody>
<tr>
<td>yes</td>
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<tr>
<td>no</td>
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</table>

Check CB11 control breaker and F1 fuse. If okay, jumper battery cable B+ connection to B1 starter solenoid terminal. Does engine crank?

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<table>
<thead>
<tr>
<th>Check CB11 control breaker and F1 fuse. If okay, jumper battery cable B+ connection to B1 starter solenoid terminal. Does engine crank?</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
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<tr>
<td>no</td>
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</table>

With S11 in Start position, is battery voltage present between K11 terminal S and ground?

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<table>
<thead>
<tr>
<th>With S11 in Start position, is battery voltage present between K11 terminal S and ground?</th>
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<tbody>
<tr>
<td>yes</td>
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<tr>
<td>no</td>
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</table>

If K11 does not energize, test per Checkout [H] and replace if bad. Is battery voltage present at B1 solenoid terminal with S11 in Start position.

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<table>
<thead>
<tr>
<th>If K11 does not energize, test per Checkout [H] and replace if bad. Is battery voltage present at B1 solenoid terminal with S11 in Start position.</th>
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<tbody>
<tr>
<td>yes</td>
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<tr>
<td>no</td>
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</table>

Check B+ wiring between K11 and B1 solenoid terminal. Replace if bad. Check K1 plunger travel for freedom to bottom in solenoid which is necessary to open pull coil circuit.

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<table>
<thead>
<tr>
<th>Check B+ wiring between K11 and B1 solenoid terminal. Replace if bad. Check K1 plunger travel for freedom to bottom in solenoid which is necessary to open pull coil circuit.</th>
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<tbody>
<tr>
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<td>no</td>
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Check battery per Checkout [A] and recharge or replace. Check battery charger operation per Checkout [C].

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<table>
<thead>
<tr>
<th>Check battery per Checkout [A] and recharge or replace. Check battery charger operation per Checkout [C].</th>
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<tbody>
<tr>
<td>yes</td>
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<td>no</td>
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</table>

Check battery cables for clean tight connections (ref. Checkout [B]). Check B1 starter solenoid and motor-if bad, repair or replace.

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<tbody>
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<td>no</td>
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Check B+ wiring to S11, and between S11 and K11.

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<table>
<thead>
<tr>
<th>Check B+ wiring to S11, and between S11 and K11.</th>
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<tbody>
<tr>
<td>yes</td>
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<table>
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<tbody>
<tr>
<td>yes</td>
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<tr>
<td>no</td>
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</table>

Engine does not crank. a visual check.

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<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
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</table>

Engine starts but stops after running several seconds.

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<table>
<thead>
<tr>
<th>Engine starts but stops after running several seconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
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</tbody>
</table>

Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

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<table>
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</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
</tr>
</tbody>
</table>

To troubleshoot a problem, start at the upper left corner of the chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced adjustment or test procedures. Refer to Figures 2-1 through 2-4 to locate control components.

Before starting a troubleshooting procedure, make a few simple checks that could expose the problem and cut down on troubleshooting time.
FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is engine getting fuel? Exhaust smoke should be blue-white and fuel flow steady from fuel return line.

Yes → Check fuel system: fuel tank level, shut-off valves, fuel lines and connections, fuel filters, fuel pump and injection pump. Okay?

No → Does K1 fuel solenoid energize when S11 is in Start position?

Yes → Check B+ circuit through S11. Test S11 per Checkout [G]. Test K1 per Checkout [F].

No → Check for closing of S6 power latch switch. If okay, replace engine monitor PC board.

Is battery B+ applied to glow plug heaters when Preheat Switch is closed?


No → Check Preheat switch and heater relay K13 per Checkouts [G] and [E]. Check heater wiring.

FLOW CHART C. ENGINE STARTS BUT STOPS AFTER RUNNING SEVERAL SECONDS

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is a fault condition indicated by fault breaker CS12 on control panel.

Yes → Check for a possible fault condition. If none, check fault monitors S1 through S5 and fault breaker CS12 for improper wiring.

No → Does latching relay K12 energize and contacts close when generator set comes up to operating speed?

Yes → Check all B+ wiring for shorts to ground.

No → Check for closing of S6 power latch switch. If okay, replace engine monitor PC board.
Section 3. Standby Engine Controls

GENERAL
This section contains control information for standby generator sets. Two starting controls are available that differ primarily in the method of starting. An Electric Start Control is used for electric starting and stopping at the generator set only. A Remote Start Control is used for electric starting and stopping with provision for remote operation with optional accessory equipment. Each of the start controls will be covered in a separate section.

ELECTRIC START CONTROL
This control has a key switch for Preheat, Start and Stop on the front panel and cannot be connected for remote operation. Component references are found on separate wiring/schematic diagrams in the Wiring Diagrams section of this manual.

Gauges/Meters and Switches

**DC Voltmeter (Optional):** Normal battery B+ voltage during operation should be 13.5 to 15 volts on a 12-volt system; 27 to 30 volts on a 24-volt system. See Figure 3-1.

**Coolant Temperature Gauge (Optional):** Shows engine coolant temperature. The gauge is wired to a sensor on the engine and has a range of 100°F to 250°F (40°C to 121°C).

**Oil Pressure Gauge (Optional):** Shows engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa) and is connected to an engine sensor.

**Preheat/Stop/Run/Start Switch S11:** This is a key switch that preheats, starts and stops the generator set locally.

**Fault Reset Breaker CB12:** A manual reset breaker that shuts down the engine for low oil pressure, high coolant temperature, and overspeed.

**K1 Fuel Solenoid:** It opens the fuel control valve when the start/stop switch is placed in the Start position.

![Diagram of Electric Start Control Box](image-url)
**F1 Inline Fuse**: A 30-ampere fuse is located in a fuse holder connected to the B+ terminal of the starter. This fuse connects B+ to the control and opens if a short or overload should occur.

Resistance units and switches in the monitoring and shutdown systems are sealed units and are not repairable. When replacing a sensor, do not use a substitute item since resistance units are matched to the gauge they supply. Cutoff switches are close tolerance parts made for a specific application.

**Oil Pressure Monitors**

Refer to Figure 3-2 for the location of the oil pressure sensors.

**Oil Pressure Sender E1 (Optional)**: The sender resistance changes with oil pressure and results in a reading on the oil pressure meter. The meter range is 0 to 100 psi (0 to 700 kPa).

**Low Oil Pressure Switch S1**: This switch closes if oil pressure drops to 9 psi (62 kPa), activating the fault breaker and stopping the engine.

**Engine Temperature Monitors**

Refer to Figure 3-2 for the location of the engine temperature sensors.

**Coolant Temperature Sender E2 (Optional)**: The resistance of the sender unit changes with the engine coolant temperature and causes a reading on the Water Temp meter. The meter range is 100°C to 250°C (40°F to 121°C).

**High Coolant Temperature Switch S2**: This switch closes if the coolant temperature rises to 250°F (121°C), activating the fault breaker CB12 and stopping the engine.

---

![Figure 3-2. DKC/DKD ELECTRIC START FAULT SENSOR LOCATION](image-url)
Overspeed Switch (Optional)
The mechanical overspeed switch is mounted on the front of the engine crankshaft as shown in Figure 3-3. It is factory adjusted to close and shut down 60 hertz units at 2200 +/- 90 r/min; 50 hertz units at 1900 r/min +/- 90 r/min. An overspeed condition grounds the shutdown circuit on the Engine Monitor Board and trips the fault breaker. After the problem is corrected, starting will not occur until the fault breaker is reset.

Prior to starting the generator set, check the fuel supply, engine oil level, and all battery connections for loose or broken wires.

Figure 3-4 shows a schematic diagram for the circuits described in the following Starting, Start-Disconnect and Stopping sequences. Relay contact references normally open (NO) and normally closed (NC) refer to position of contacts with the unit at rest (not energized).

Starting Sequence: When the control key switch S11 is in the Preheat position, contacts 1-2 connect B+ to the glow plug heaters. See Figure 3-4.

In the Start position, S11 contacts 1-2, 3-4 and 5-6 close. Contacts 1-2 energize the glow plugs during cranking; contacts 3-4 connect B+ to CB12 Fault breaker, K1 fuel solenoid, S4 overspeed switch and VR11 battery charging voltage regulator; contacts 5-6 connect B+ to the starter solenoid B1.

In the Run position, S11 contacts 3-4 and 7-8 close. Contacts 3-4 remain closed and maintain B+ to CB12, K1, S4 and VR11. Contacts 7-8 connect B+ to the engine fault sensors S1 and S2. Contacts 1-2 open the glow plug heater circuit, and contacts 5-6 open the starter solenoid circuit.

Start-Disconnect Sequence: This function is completed manually when key switch S11 is released from the Start position opening S11 contacts 5-6 for the starter solenoid B1.

Stopping Sequence: This function is completed manually when key switch S11 is turned to the Stop position. This opens all switch contacts and removes B+ from the fuel solenoid K1. De-energizing K1 shuts off the fuel flow and stops the engine.

Emergency Shutdown: Fault breaker CB12 opens and disconnects B+ from the fuel solenoid K1 anytime a fault sensor closes the circuit to ground. The fault sensors are:

- S1 low oil pressure
- S2 high engine temperature
- S4 overspeed

CB12 should not be reset for starting until fault is located and corrected.

Control Operation
Trouble-free operation of the control system should be the major concern of generator set service personnel. Service personnel must thoroughly understand how the controls operate, know how to make the proper adjustments, replacements, or repairs in a reasonable amount of time.

If necessary, the speed range can be corrected by turning the adjusting screw, thereby changing the magnetic air gap. An accurate tachometer or strobotach is needed to check the overspeed trip point after adjustment is made. The air gap must not be less than 0.005 inch (0.13 mm).

FIGURE 3-3. OPTIONAL OVERSPEED SWITCH
Control Troubleshooting

The information in this section is divided into three flow charts. Determine the problem and then refer to the appropriate flow chart (A, B, or C) for the troubleshooting procedures.

A. Engine does not crank.
B. Engine cranks but does not start.
C. Engine starts but stops after running several seconds.

Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down on troubleshooting time.

- Check all modifications, repairs, and replacements performed since last satisfactory operation of set. A loose wire connection overlooked when installing a replacement part could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced adjustments or test procedures. Refer to Figures 3-1 through 3-4 for locating control components, leads, terminals and other check points.
FLOW CHART A. ENGINE DOES NOT CRANK

WARNING: Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is battery dead?

yes

Check battery per Checkout [A] and recharge or replace. Check battery charger operation per Checkout [C].

no

Check F1 fuse. If okay, jumper battery cable B+ connection to B1 starter solenoid terminal. Does engine crank?

no

Check battery cables for clean tight connections (ref. Checkout [B]). Check B1 starter solenoid and motor-if bad, repair or replace.

yes

Is B+ present at key switch S11?

no

Check wiring and replace if bad.

yes

Test switch S11 per Checkout [G]. Replace if bad.

FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

WARNING: Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is engine getting fuel? Exhaust smoke should be blue-white and fuel flow steady from fuel return line.

no

Check fuel system: fuel tank level, shut-off valves, fuel lines and connections, fuel filters, fuel pump and injection pump. Okay?

yes

Does K1 fuel solenoid energize when S11 is in Start position?

no

Check B+ circuit through S11. Test S11 per Checkout [G]. Test K1 per Checkout [F].

yes

Is battery B+ applied to glow plug heaters when switch S11 is in Preheat and Start positions?

no


yes

Check switch S11 per Checkout [G]. Check heater wiring.
FLOW CHART C. ENGINE STARTS BUT STOPS AFTER RUNNING SEVERAL SECONDS

WARNING Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is a fault condition indicated by fault breaker CB12 on control panel?

Check for a possible fault condition. If none, check fault monitors S1, S2, S4 and fault breaker CB12 for improper wiring.

no

Test key switch S11 per Checkout [G]. Check wiring. Check fuel system.
REMOTE START CONTROL

This control can provide starting and stopping from remote locations when connected to optional accessory equipment. The following text explains control components function, control operation and troubleshooting.

Oil Pressure Gauge (Optional): Shows engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa) and is connected to an engine sensor. See Figures 3-5 and 3-6.

Coolant Temperature Gauge (Optional): The water temperature should be in the range of 165°F to 195°F (74°C to 91°C) depending on the load and ambient temperature.

DC Voltmeter (Optional): Normal battery B+ voltage during operation should be 13.5 to 15 volts on a 12-volt system; 27 to 30 volts on a 24-volt system.

Preheat Switch S12: Activates heater relay K13 to connect battery B+ to the engine glow plugs prior to starting the engine.

Start-Stop Switch: Starts and stops the unit locally. When released, unit may be operated from a remote switch wired to the control panel.

DC Control Breaker CB11: A 15 ampere breaker providing protection to the control box wiring and remote wiring from short circuits or overload. Also serves as an emergency stop switch.

Fault Reset Breaker CB12: A manual reset breaker that shuts down the engine for low oil pressure, high coolant temperature, high exhaust temperature and overspeed.

Battery Charge Breaker CB13 (RV Generator sets): A 15-ampere breaker protecting the DC voltage regulator, alternator and wiring from short circuits or overload.

In-Line Fuse F1 (Land Generator sets): A 30 ampere fuse is located in a fuseholder connected to the B+ terminal of the starter. This fuse connects B+ to the control and opens if a short or overload should occur.

Engine Monitor Circuit Board: A printed circuit board that monitors engine control system functions. This includes starting, stopping, and fault system operations. A terminal board is included for making remote connections. See Figure 3-5.

Two relays are soldered to the circuit board and are not serviceable. Power relay K12 connects and maintains battery B+ to the control meters and fuel solenoid during operation. Starter protection relay, K15 energizes at about 90 volts AC. The A11-K15 NC contacts open and de-energize the K11 start solenoid; the A11-K15 NO contacts close and provide another ground path for K12 through K11 coil similar to S6.

K1 Fuel Solenoid: Opens the fuel control valve when the start/stop switch is placed in the Start position.

K11 Start Solenoid: Located over the engine monitor circuit board. It connects battery B+ to the starter solenoid B1 during cranking.

K13 Heater Relay: Located on the relay mounting tray. It connects battery B+ to the engine glow plugs prior to cranking. It is energized by S12 preheat switch.

K14 Fuel Solenoid Relay: Located on the relay mounting tray. It is energized only during cranking and connects B+ to the fuel solenoid K1, fuel pump E5 and fault breaker CB12 circuits.

K16 Start Disconnect Relay: Located on the relay mounting tray. It is connected through CR11 to the 12-volt battery charging alternator. The relay actuates at about 6 volts DC. The K16 and CR11 diode are not used on later production sets and were disconnected on some sets (refer to Product Support Bulletin 450).
FIGURE 3-5. DKD RV CONTROL BOX COMPONENTS
S11 START-STOP PREHEAT SWITCH
CB11 DC CONTROL BREAKER
CB13 DC CHARGING BREAKER
FAULT RESET BREAKER

FRONT

J2 CONNECTOR
(ENGINE MONITORS)

J1 CONNECTOR
(AC CONTROL BOX)

J3 CONNECTOR (GENSET REMOTE CONTROL)

REAR

K13 RELAY
K14 RELAY

K11 START SOLENOID
A11 ENGINE MONITOR BOARD

CR2 RECTIFIER

FIGURE 3-5a. D KD DC CONTROL BOX
FIGURE 3-5b. DKD AC CONTROL ASSEMBLY
Engine Sensors
The following briefly describes the engine mounted sensors and switches, and how they protect the engine from adverse operating conditions. All safety sensors (switches) close to ground if abnormal operating conditions exist and trip the fault breaker CB12 to stop the engine. See Figure 3-6. Resistance units and switches in the monitoring and shutdown systems are sealed units and are not repairable. When replacing a sensor, do not use a substitute item since resistance units are matched to the gauge they supply. Cutoff switches are close tolerance parts made for a specific application.

Oil Pressure Sender E1 (Optional): The sender resistance changes with oil pressure and results in a reading on the oil pressure meter. The meter range is 0 to 100 psi (0 to 700 kPa).

Low Oil Pressure Switch S1: This switch closes if oil pressure drops to 9 psi (62 kPa). Some early generator sets had switches closing at 14 psi (97 kPa). This activates the fault breaker and stops the engine.

Control Power Latch (S6): This oil pressure switch closes at 5 psi (34 kPa) and provides a latch function for the control circuits. When closed, the switch supplies a ground path for relay K12 on the engine monitor board.

Overspeed Switch (Optional): The mechanical overspeed switch is mounted on the front of the engine crankshaft as shown in Figure 3-7. It is factory adjusted to close and shut down 60 hertz units at 2200 r/min +/- 90 r/min; 50 hertz units at 1900 r/min +/- 90 r/min. An overspeed condition grounds the shutdown circuit on the Engine Monitor Board and trips the fault breaker. After the problem is corrected, starting will not occur until the fault breaker is reset.
If necessary, the speed trip point can be corrected by turning the adjusting screw, thereby changing the magnetic air gap. An accurate tachometer or strobotach is needed to check the overspeed trip point after adjustment is made. The air gap must not be less than 0.005 inch (0.13 mm).

**Coolant Temperature Sender E2 (Optional):** The resistance of the sender unit changes with the engine coolant temperature and causes a reading on the Water Temp meter. The meter range is 100° to 250°F (40° to 121°C).

**High Coolant Temperature Switch S2:** This switch closes if the coolant temperature rises to 222°F (106°C), activating the fault breaker and stopping the engine.

**Control Operation**

Trouble free operation of the control system should be the major concern of generator set service personnel. Service personnel must thoroughly understand how the controls operate, know how to check for troubles, and know how to make the proper adjustments, replacements, or repairs in a reasonable amount of time.

Figure 3-8 shows a typical schematic for the circuits described in the following Starting, Start-Disconnect and Stopping sequences. Relay contact references normally open (NO) and normally closed (NC) refer to position of contacts with the unit at rest (not energized).

**Starting Sequence:** The engine Preheat switch S12 is held for 10 to 30 seconds (depending upon temperature). This energizes the K13 heater solenoid which closes a NO set of contacts to connect B+ to the glow plugs. After preheat time, the start sequence is initiated by pressing the Start button S11.

Switch S11 contacts B+ to the coil of K14 and (through the A11-K15 contacts and K16 NC contacts) to the Start Solenoid K11. The coil of K11 is grounded through the pull coil of K1 after K1 is completely pulled in and the pull coil is disconnected from B+. K1 must pull in completely or the engine will not crank.

The closing of K11 contacts connects B+ to the glow plugs and B1 starter solenoid. K14 connects B+ to K1 fuel solenoid. K5 fuel pump. CB12 fault breaker and engine monitor circuits only during starting.

**Start-Disconnect Sequence:** As the engine starts, latch relay S6 closes and completes the ground circuit through resistor A11-R1 for the K12 power relay. The closing of K12 dual contacts completes the B+ running circuit to CB12 fault circuit breaker.

The start-disconnect circuit provides starter protection. As the generator gains speed and output voltage, the K15 starter protection relay energizes at about 90 volts AC. The A11-K15 NC contacts open and de-energize the K11 start solenoid; the A11-K15 NO contacts close and provide another ground path for K12 through K11 coil similar to S6.
A backup start-disconnect circuit is initiated by the battery charging alternator G1. When DC output at CR11 reaches approximately 6 volts, K16 energizes and opens B+ to the K11 start solenoid. De-energizing K11 disconnects B+ from the starter solenoid to stop cranking and eliminate glow plug heating. The K16 relay and CR11 diode are not used in later production generator sets.

**Stopping Sequence:** Placing S11 in the Stop position puts B+ on the ground side of K12 power relay. This causes K12 to de-energize and disconnect B+ from CB12, fuel pump E5 and the K1 fuel solenoid. De-energizing K1 shuts off the fuel flow and stops the engine.

**Emergency Shutdown:** Fault breaker CB12 opens to stop the engine anytime a fault sensor closes the circuit to ground. The fault sensors as shown in Figure 3-8 are:
- S1 low oil pressure
- S2 high coolant temperature
- S4 overspeed

CB12 should not be reset for starting until fault is located and corrected.

**Control Troubleshooting**

The information in this section is divided into three flow charts. Determine the problem and then refer to the appropriate flow chart (A, B, or C) for the troubleshooting procedures.

A. Engine does not crank.
B. Engine cranks but does not start.
C. Engine starts but stops after running several seconds.

Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down on troubleshooting time.

- Check all modifications, repairs, and replacements performed since the last satisfactory operation of set. A loose wire connection could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.
- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

To troubleshoot a problem, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing reference adjustment or test procedures. Refer to Figures 3-5 through 3-8 for locating control components, leads, terminals and other check points.

**FLOW CHART A. ENGINE DOES NOT CRANK**

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

[Flowchart diagram not shown here]
FLOW CHART B. ENGINE CRANKS BUT DOES NOT START

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is engine getting fuel? Exhaust smoke should be blue-white, and fuel flow steady from fuel return line.

- **yes**
  - Check fuel system: fuel tank level, shut-off valves, fuel lines and connections, fuel filters, fuel pump and injection pump. Okay?
  - **yes**
    - Does K1 fuel solenoid and E5 fuel pump energize when S11 is in Start position?
      - **no**
        - Check B+ circuit to K14 coil. Test relay K14 per Checkout [E]. Test K1 fuel solenoid per Checkout [F].
      - **yes**
        - Check Preheat switch and heater relay K13 per Checkouts [G] and [E]. Check heater wiring.
  - **no**
    - Is battery B+ applied to glow plug heaters when Preheat Switch is closed?
      - **yes**
      - **no**
        - Check Preheat switch and heater relay K13 per Checkouts [G] and [E]. Check heater wiring.

FLOW CHART C. ENGINE STARTS BUT STOPS AFTER RUNNING SEVERAL SECONDS.

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is a fault condition indicated by fault breaker CB12 on control panel.

- **yes**
  - Check for a possible fault condition. If none, check fault monitors S1 through S4 and fault breaker CB12 for improper wiring.
- **no**
  - Does latching relay A1-K12 energize and contacts close when generator set comes up to operating speed?
    - **no**
      - Check for closing of S6 power latch switch. If okay, replace engine monitor PC board.
    - **yes**
      - Does DC control breaker trip after generator set is started?
        - **yes**
          - Check all B+ wiring for shorts to ground.
Section 4. Engine Control Service

GENERAL
The following component checks are referenced in the Control Troubleshooting flow charts. They are an aid to isolating circuit problems caused by faulty engine control components. Disconnect leads before testing components.

⚠️ WARNING ⚠️
Many troubleshooting procedures present hazards that 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 inside cover page.

[A] BATTERY CHECK
⚠️ WARNING ⚠️ Battery electrolyte can cause severe eye damage and burns to the skin. Wear goggles, rubber gloves and a protective apron when working with batteries.

Check charge condition of the battery with a hydrometer. The electrolyte specific gravity should be about 1.260 for a fully charged battery at 80°F (27°C). If not, add distilled water to keep electrolyte at proper level and recharge the battery. If battery will not recharge, replace it.

If battery loses excess water, the charge rate may be too high. If battery state of charge is not maintained, the charge rate may be too low.

[B] BATTERY CABLE CHECK
With the starter motor operating, check the voltage drops (1) from the battery negative post (not the cable clamp) to the cylinder block, (2) from the battery positive post to the battery terminal stud on the solenoid. Normally, each of these should be less than 0.3 volts. 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.

[C] BATTERY CHARGING CHECK
With the engine running, check the DC voltmeter (control option). A 12-volt system should be 13.5 to 15 volts; a 24-volt system should be 27 to 30 volts.

The power source is a belt driven alternator. The charge rate/voltage is determined by voltage regulator VR11. On marine sets VR11 is located on the bottom of the control box saddle and it is located inside the control box on land sets.

Improper output may be caused by a loose drive belt, poor terminal connections, broken wires, bad regulator or alternator. Checkout procedures for the regulator and alternator are found in Section 5 of the engine service manual. The charge circuit on RV series generator sets is protected by a circuit breaker CB13.

If the output voltage is high (over 15 volts), check for loose or corroded voltage regulator leads. If this does not correct the problem, the regulator is probably shorted and should be replaced. With remote start Kubota powered sets, exhibiting overcharging symptoms, refer to Product Support Bulletin 450.

[D] SOLENOID CHECK
1. Apply battery positive (B+) to the terminal marked S.
2. Connect a ground wire to the solenoid mounting bracket. Solenoid should activate.
3. If the contacts are good, battery voltage should be read between terminal 1 and ground. The voltage drop measured across the contacts should never exceed one volt in circuit application.

[E] RELAY CHECK
1. Connect relay coil voltage across relay coil terminals. Relay should activate if coil is okay.
2. Connect voltage source to one side of relay contacts.
3. Connect a voltmeter to other side of relay contact and voltage source. If voltage appears when relay energizes, contact is okay. The voltage reading appears in reverse order when checking normally closed (NC) contacts.
[F] FUEL SOLENOID CHECK
If there is fuel to the injection pump, but no fuel at injection nozzle, the fuel solenoid may be defective.

To check solenoid operation, watch for solenoid actuation when B+ is applied (start switch in start or run position). If there is no actuation when B+ is applied, the fuel solenoid must be replaced. When B+ is removed, the solenoid must de-activate.

1. Apply battery positive (B+) to the terminal marked S.
2. Connect a ground wire to the terminal marked I. Solenoid should activate.
3. Continuity should be read across the two large terminals while solenoid is activated.

[H] SOLENOID CHECK

1. Remove battery B+ cable.
2. Place ohmmeter leads across switch.
3. Open and close switch while observing the ohmmeter. A normally open (NO) switch should indicate infinite resistance when open and continuity when closed. A normally closed (NC) switch should indicate continuity when closed and infinite resistance when open.
4. Replace switch if defective.

[G] SWITCH CHECK

1. Remove battery B+ cable.
2. Place ohmmeter leads across switch.
3. Open and close switch while observing the ohmmeter. A normally open (NO) switch should indicate infinite resistance when open and continuity when closed. A normally closed (NC) switch should indicate continuity when closed and infinite resistance when open.
4. Replace switch if defective.
GENERAL DESCRIPTION

The YD generator (Figure 5-1) is a four-pole, revolving field, brushless exciter design with drip-proof construction. Single and three phase generators are available for both 50 and 60 hertz models.

The generator rotor is directly coupled to the engine flywheel with a flexible drive disc (engine speed determines generator output voltage and frequency). A centrifugal blower on the drive disc circulates generator cooling air which is drawn in through the end bell and discharged through an outlet in the blower end.

A ball bearing in the end bell supports the outer end of the rotor shaft. The end bell is attached with four studs that thread into the generator adapter casting. The brushless exciter stator mounts in the end bell while the exciter rotor and its rotating diode assemblies mount on the generator rotor shaft. Leads F1 (+) and F2 (-) from the exciter stator winding are connected to the output terminals of the voltage regulator.

The composite illustration in Figure 5-2 shows the generator output and control/meter leads for the various voltage options. Voltage reconnection diagrams appear in Section 7, Generator/Regulator Tests, and in Section 8, Wiring Diagrams.
**GENERATOR OPERATION**

Power generation involves the generator components shown in Figure 5-3. These components are italicized in the following text. A permanent magnet embedded in an exciter stator field pole begins the voltage build-up process as the generator set starts. Single-phase AC voltage, taken from a main stator winding, is connected to the voltage regulator as a reference for regulating the generator output voltage. The regulator DC output is coupled to the exciter stator.

The exciter rotor produces three-phase AC voltage that is converted to DC by the full wave rotating rectifier assemblies. The DC voltage excites the rotor main field winding to produce main stator AC for the load.

Generator sets without control panel AC meters are shipped from the factory with the AC output leads separated in the control box. Generator sets with AC meters have the AC output leads wired as specified on the customer’s purchase order to deliver the voltage specified.

---

*Figure 5-3. Excitation Block Diagram*
VOLTAGE REGULATOR

The voltage regulator controls the output of the generator so that a constant voltage is maintained under varying load conditions. There are two types of voltage regulators used on these sets: transformer and electronic (solid state). The description and operation of each type is covered separately.

Transformer Voltage Regulator

The transformer voltage regulator is standard equipment on all single-phase generator sets. It is located inside the generator set control box. A typical transformer and a schematic showing circuit application is shown in Figure 5-4. The transformer provides a feedback loop from the output of the generator to the exciter stator.

The number of primary windings and secondary taps will change for 50 hertz and different model applications. See individual model wiring diagrams in the back of this manual.

The transformer primary is connected in series with the generator output leads making it a current boost winding for the secondary. Separate coils in the primary allows the generator to be reconnected for other voltages without causing an output voltage unbalance.

The transformer secondary is in the exciter circuit and is connected through a diode bridge. The diode bridge converts AC to DC for the exciter. Thus the exciter DC boost current is dependent upon the primary/load current.
**Electronic Voltage Regulator**

Electronic Voltage Regulator is standard equipment on all three phase generator sets, and is optional for single phase sets. Basic components consist of the following items shown in Figure 5-5.

- Regulator Board Assembly
- Voltage Reference Transformer T21
- Commutating Reactor CMR21
- Terminal Board TB21

The electronic regulator provides better voltage regulation than the transformer type. It is recommended when powering non-linear SCR loads (usually associated with solid-state equipment).

Only the basic functions of the regulator are described. Current from one of the generator stator windings is supplied to the primary side (H1 and H2) of voltage reference transformer T21. See Figure 5-6 wiring diagram. AC in the secondary winding (X1 and X2) is supplied as a reference voltage to the regulator circuit board.

A rise or fall in the generator stator output voltage produces a corresponding change in the transformer secondary.

The generator stator is also connected to the commutating reactor CMR21. Reactor L21 is a choke used to produce a uniform AC wave to the circuit board AC input terminal TB1-1.

During operation, the regulator circuit board responds to changes in the reference voltage supplied by transformer T21. These changes raise or lower the DC output voltage produced for field excitation which results in a stable output for the load.
GENERATOR SERVICE

The following sections describe the disassembly and reassembly procedures for the generator.

**WARNING** Generator components are heavy and can cause severe personal injury if dropped during service. Be careful, keep hands and feet clear during service, and use the recommended service procedures.

**Disassembly**

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

2. Remove cover from the control box and disconnect all stator leads. If control has load circuit breakers, disconnect leads at breaker. If lead markings do not clearly identify reconnection, mark leads with tape.

3. Remove end bell cover and remove field leads F1 and F2.

4. Remove load wires and flexible conduit from control box.

5. Remove leads from the plug of the DC voltage regulator mounted on the bottom of saddle.

6. Remove capscrews securing the control box mounting saddle to the stator. The control box and saddle are removed as an assembly.

7. Pull stator leads through opening in bottom of control box and saddle as they are lifted free from stator. Do not disconnect any engine DC control wires in the control box.

8. Set control box and saddle on top of engine.

9. Remove the end bell stud nuts and slide off the end bell and exciter stator. It may be necessary to pry or jar the assembly loose from the main stator assembly.

10. Use a hoist and safe lifting device (stator handling tongs, nylon lifting strap or chain and lift hooks) to support the stator assembly. A support must be placed under the engine before removing stator from the vibration mounts.

11. Remove stator assembly being careful not to touch or drag it on the rotor. Place stator on its side in the horizontal position.

12. Using a hoist and sling to support the rotor, carefully remove the capscrews that attach the drive disc to the engine flywheel (Figure 5-8).

13. Remove the rotor assembly and place upon wood block in the horizontal position. The drive disc and fan should not be resting on anything or distortion may occur.

14. Remove bolts that hold the drive disc and fan to the rotor shaft. Remove bolts holding drive disc to the fan.

15. Use a gear puller to remove the end bearing from the rotor shaft (Figure 5-7).

**CAUTION** The end bearing will be damaged if pulled on the outer race. If reused, the bearing must be pulled on the inner race.

16. Clamp the rotor in a fixed position and remove the exciter rotor lock nut.

17. Remove the generator field leads from the exciter rotor and slide the exciter off the rotor shaft.

**Figure 5-7. End Bearing Removal**
FIGURE 5-8. GENERATOR ASSEMBLY
Reassembly

1. Slide the exciter rotor over the generator shaft and woodruff key. Install the exciter nut and apply torque values shown in Figure 5-9.

2. Connect generator field leads to F1+ and F2- terminals on exciter assembly. Torque to values shown.

3. Press the end bearing onto the rotor shaft.

4. Assemble rotor fan and drive disc to the engine flywheel. Use a hoist and sling to support rotor. Be sure the drive disc is assembled with the chamfer on the flywheel side. Apply torque values shown in Figure 5-9.

5. Install air baffle.

6. Using a hoist and safe lifting device, carefully move the stator into position over the rotor. The leads should be in the top position. Apply a thin film of Molykote grease to mating surfaces of end bearing and hole in the end bell.

7. Install the end bell stud bolts through the stator and into the generator adapter.

8. Install end bell assembly on the stator with the generator lead opening at top position.

9. Torque end bell stud nuts to 20 ft lbs (27 N•m).

10. Using a lead hammer tap the end bell at the horizontal and vertical to relieve stress. Torque end bell stud nuts.

11. Feed stator and control leads through opening in control box and saddle and secure saddle to the generator.

12. Connect all applicable control leads (F1, F2, battery charging, etc.) and verify that all connections are secure.

13. Connect leads to the plug of the DC voltage regulator mounted on the bottom of saddle. Figure 5-10.

14. Install the end bell cover.

15. Connect the stator wires to the load wires.

16. Connect the negative (-) battery cable and test generator operation.

---

**FIGURE 5-9. ROTOR ASSEMBLY AND TORQUE VALUES**

**FIGURE 5-10. DC REGULATOR PLUG CONNECTIONS**
Section 6. Generator/Regulator Troubleshooting

GENERAL

This section contains service information for single and three phase generator sets with transformer or electronic voltage regulators. Make the following visual checks prior to starting the troubleshooting procedures.

- Check any modification or repair that has been performed since the last satisfactory operation of the set to see that they are installed properly.

- Check to see that generator leads are connected correctly. Also check the circuit board connectors. A loose, contaminated, or misplaced wire connection will cause problems that can be detected by close inspection.

- Check for an open circuit breaker. If the breaker is open, check for an overloaded circuit and correct load problems before resetting circuit breaker.

JUMPER TERMINALS 6 & 7 FOR 60 HZ
6, 7, & 8 FOR 50 HZ

TRANSFORMER REGULATION

FIGURE 6-1. ELECTRONIC AND TRANSFORMER REGULATION (TYPICAL SCHEMATICS)
TROUBLESHOOTING PROCEDURES

Determine the type of problem and then refer to the corresponding flow chart (A, B, C, D, E, F, or G) for troubleshooting procedures.

A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM (ELECTRONIC VOLTAGE REGULATOR)
B. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM (TRANSFORMER VOLTAGE REGULATOR)
C. UNSTABLE OUTPUT VOLTAGE, ENGINE SPEED STABLE (ELECTRONIC VOLTAGE REGULATOR)
D. OUTPUT VOLTAGE TOO HIGH OR TOO LOW (ELECTRONIC VOLTAGE REGULATOR)
E. OUTPUT VOLTAGE TOO HIGH, TOO LOW, OR UNSTABLE (TRANSFORMER VOLTAGE REGULATOR)
F. FIELD BREAKER (CB21) TRIPS (ELECTRONIC VOLTAGE REGULATOR)
G. UNBALANCED OUTPUT VOLTAGE (TRANSFORMER OR ELECTRONIC VOLTAGE REGULATOR)

To troubleshoot a problem, start at the upper-left corner of the chart that corresponds to the problem, and answer all questions either YES or NO. Follow the chart until the problem is found. Perform the referenced test or adjustment procedures in the Generator/Regulator Tests section.

Referenced components in the flow charts and test and adjustment procedures can be found on the electrical schematics (Figure 6-1) and on the wiring diagrams.
FLOW CHART A. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM
(ELECTRONIC VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

**START**

Are load circuit breakers closed?

- **no** Close circuit breakers, or replace if bad.
- **yes**

Is control panel field breaker CB21 on?

- **no** Push to reset breaker. Does generator AC output voltage build up?
  - **no** Is residual voltage across terminals 2 and 3 of VR21 5 to 10 VAC or more?
    - **yes** Check reactor CMR21 and transformer T21 per TESTS [B] and [E].
    - **no** Is exciter field voltage across VR21 terminals 4 and 5 5 VDC or more?
      - **yes** Check exciter field wiring harness per TEST [M]. Replace bad wiring.
      - **no** Check exciter field wiring per TEST [H]. Replace if bad.

- **yes** Remove one lead from breaker and check continuity with ohmmeter. Is breaker open?

- **no** If voltage is unstable, high or low, or causes breaker to trip, see Flow Charts B,C,D or E.

- **yes** Replace defective field breaker

- **no** Flash exciter field per TEST [C]. Does generator output voltage build up?

- **no** Disconnect stator leads 1 and 2 from AC terminals of A11. Is residual voltage across the leads 5 to 10 VAC or more now?

- **yes** Check generator stator windings per TEST [K]. Replace if bad.

- **no** Check exciter rotor winding per TEST [L]. Replace if bad.

- **no** Check exciter rotor winding per TEST [J]. Replace if bad.

- **no** Check lead continuity between AC terminals on A11 and terminals 2 and 3 on VR21 per TEST [M].

- **no** Check diodes CR1 through CR6 on rotor per TEST [G]. Replace if bad.

- **no** Replace the regulator PC board per procedure [F] if defective.

**CAUTION** A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.
FLOW CHART B. NO AC OUTPUT VOLTAGE AT RATED ENGINE RPM
(TRANSFORMER VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

**START**

Are load circuit breakers closed?  
- **yes**  
  - Is residual voltage across stator leads S1 and S2 2.5 to 5 VAC or more?  
    - **yes**  
      - Does bridge rectifier CR21 test okay per test [C]?  
        - **yes**  
          - Test transformer T21 per TEST [N]. Replace if bad.  
          - Test exciter stator per TEST [H]. Replace if bad.  
        - **no**  
          - Replace RV21  
      - **no**  
        - Does suppressor assembly RV21 test okay per TEST [C]?  
          - **yes**  
            - Replace CR21.  
          - **no**  
            - Check diodes CR1 through CR6 on rotor per TEST [G]. Replace if bad  
            - Check exciter rotor winding per TEST [J]. Replace if bad  
            - Check generator rotor field winding per TEST [L]. Replace if bad  
            - Check generator stator windings per TEST [K]. Replace if bad.
    - **no**  
      - Flash exciter field per TEST [D]. Does generator output voltage build up?  
        - **yes**  
          - Disconnect stator leads S1 and S2. Is residual voltage across the leads 2.5 to 5 VAC or more now?  
            - **yes**  
              - Does suppressor assembly RV21 test okay per TEST [C]?  
                - **yes**  
                  - Replace CR21.  
                - **no**  
                  - Check diodes CR1 through CR6 on rotor per TEST [G]. Replace if bad  
                  - Check exciter rotor winding per TEST [J]. Replace if bad  
                  - Check generator rotor field winding per TEST [L]. Replace if bad  
                  - Check generator stator windings per TEST [K]. Replace if bad.
        - **no**  
          - Replace RV21  
      - **no**  
        - If voltage is unstable, high or low, or causes breaker to trip. See Flow Charts B.C.D. or E  
          - **yes**  
            - Replace if bad.
FLOW CHART C. UNSTABLE VOLTAGE, ENGINE SPEED STABLE
(ELECTRONIC VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

**FLOW CHART C. UNSTABLE VOLTAGE, ENGINE SPEED STABLE**

**START**

Are there any broken wires or loose connections on voltage regulator assembly?

- yes → Repair as required.

- no → Check wiring harness from regulator assembly to end bell per TEST [M]. Check okay?

  - no → Repair wiring or replace as required.

  - yes → Replace the regulator PC board per procedure [F].

**CAUTION** A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.

FLOW CHART D. OUTPUT VOLTAGE TOO HIGH OR TOO LOW
(ELECTRONIC VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

**FLOW CHART D. OUTPUT VOLTAGE TOO HIGH OR TOO LOW**

**START**

Is engine running at correct RPM?

- yes → Set RPM per instructions in appropriate engine manual.

- no → Does adjustment of Voltage Adjust control on the regulator board result in correct output voltage?

  - yes → Set control per Voltage Adjustment [F]

  - no → Are reference transformer T21 connections correct and secure on TB1?

    - yes → Are generator output leads properly connected? See TEST [Q].

    - no → Replace the regulator PC board per procedure [F].

**CAUTION** A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.
FLOW CHART E. OUTPUT VOLTAGE TOO HIGH, TOO LOW, OR UNSTABLE
(TRANSFORMER VOLTAGE REGULATOR)

WARNING Many troubleshooting procedures present hazards that 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 inside cover page.

START

Is engine running stable and at correct r/min?

- yes
  - Are there broken wires or loose connections to any AC regulator components?
    - yes
      - Repair as required.
    - no
      - Does changing the tap connections on transformer T21 correct high or low voltage condition?
        - yes
          - Adjust for voltage rating on nameplate.
        - no
          - Apply load to generator and then remove. Is voltage across generator leads S1 and S2 60 VAC ±5 percent?
            - yes
              - Test bridge rectifier CR21 and suppressor RV21 per TEST [C]. Replace if bad.
            - no
              - Test transformer T21 per TEST [N]. Replace if bad.

  - no
    - Test exciter stator per TEST [J]. Replace if bad.

- no
  - Test rotor assembly per TEST [J]. Replace if bad.

Set r/min per instructions in appropriate engine manual.
FLOW CHART F. FIELD BREAKER TRIPS
(ELECTRONIC VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START

Does AC output voltage build up to 150% or more of rated voltage before breaker trips? yes → Check for any loose or broken wires or connections on VR21 assembly.

no → Check exciter stator winding per TEST [H]. Replace if bad.

Replace the regulator PC board per procedure [F].

**CAUTION** A new printed circuit board can be damaged by malfunctioning components within the control. Do not install a new PC board until all other problems have been located and corrected.

FLOW CHART G. UNBALANCED GENERATOR OUTPUT VOLTAGE
(TRANSFORMER OR ELECTRONIC VOLTAGE REGULATOR)

**WARNING** Many troubleshooting procedures present hazards that 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 inside cover page.

START


no → Check load for ground faults and correct as necessary.

Correct as necessary.

Replace stator assembly.

Check exciter stator winding per TEST [H]. Replace if bad.

Are generator leads connected and grounded properly? See Test [O].

yes → Check for correct grounding of generator and load.

no → Correct as necessary.

Is generator stator winding continuous per TEST [K]

yes → Replace stator assembly.

no → Check load for ground faults and correct as necessary.
Section 7. Generator/Regulator Tests

GENERAL
The following tests and adjustments can be performed without disassembly of the generator. These procedures should be used for testing the generator components and the regulator in conjunction with the Troubleshooting Flow Charts in the Generator/Regulator Troubleshooting section.

WARNING Many troubleshooting procedures present hazards that 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 inside cover page.

[A] TESTING AC RESIDUAL VOLTAGE
Test for residual AC voltage if there is no AC power output from the generator. Check between generator leads 1 and 2 (electronic regulation controls); between S1 and S2 (transformer regulation controls). See Figure 6-1. Residual voltage should be as follows:

Electronic Regulation 5 to 10 VAC minimum. Transformer Regulation 2.5 to 5 VAC minimum.

[B] TESTING COMMUTATING REACTOR
The commutating reactor is shown in Figure 7-1. It is referenced CMR21 on schematics. Only one winding of the reactor (leads 1 and 2) is used. Remove reactor leads from terminal board for testing.

Resistance across 1 and 2 should be 330 to 390 milli-ohms at 77°F (25°C). Resistance between winding and the reactor frame should be infinity.

[C] TESTING RECTIFIER BRIDGE CR21 AND SUPPRESSOR RV21
The rectifier bridge and suppressor are located within the control box of transformer regulated sets. The bridge contains four diodes as shown in Figure 7-2. They are encapsulated within a hermetically sealed block, and failure of any diode requires replacement of the entire bridge.

Disconnect wires from the bridge prior to testing. Check forward resistance with an ohmmeter on the R x 1 scale; reverse resistance on the R x 10K scale. Forward resistance should be 6 to 50 ohms, and reverse resistance infinity.

If CR21 is defective, the suppressor RV21 should also be replaced. RV21 should have infinite ohmmeter readings in both directions.
[D] FLASHING THE FIELD

If output voltage does not build up it may be necessary to restore residual magnetism by flashing the field. This requires a 12-volt storage battery, 10-amp fuse, momentary-on switch, and diode assembled as shown in Figure 7-3.

**CAUTION** Incorrect flashing procedure can damage the voltage regulator. Do not keep excitation circuitry connected longer than 5 seconds.

Start the generator set and operate at normal speed. Connect the positive lead to the F1 (+) exciter stator lead, and the negative lead to the F2 (-) exciter lead. Close the switch just long enough for the generator output voltage to build up, but not longer than 5 seconds.

Check the output voltage, then shut down the generator set. Restart the generator set and operate at no load. Output voltage must build-up without field flashing. If not, shut down the generator set and perform continuity check of all related wiring.

---

[E] TESTING REFERENCE TRANSFORMER

The reference transformer has four leads; two primary marked H1 and H2 and two secondary leads marked X1 and X2. See Figure 7-4. Resistance readings are made with leads disconnected. The resistance of either coil should be 110 ohms +/-10% at 77°F (25°C). Resistance between leads and transformer frame should be infinity.

---

[F] VOLTAGE REGULATOR VR21 REPLACEMENT

Use the following procedure for replacing the voltage regulator PC board or VR chassis.

1. Stop the generator set and disconnect the starting battery leads, negative (-) lead first.
2. Disconnect (and label if necessary) the wires from voltage regulator. Refer to the AC control wiring diagram.
3. Remove mounting screws from the old voltage regulator, then install new regulator.
4. Reconnect wires removed in Step 2 to the proper terminals.
5. Set voltage as outlined in test [P] Voltage Adjustment.
[G] TESTING ROTATING RECTIFIERS

Two different rectifier assemblies make up the rotating rectifier bridge assembly (Figure 7-5). Using an ohmmeter, test each CR rectifier using negative (-) and positive (+) polarities. Use the following procedure.

1. Disconnect all leads from assembly to be tested.
2. Connect one ohmmeter test lead to F1+ stud and connect the other lead to CR1, CR2 and CR3 in turn; record resistance value of each rectifier.
3. Connect one lead to F2- 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 F1+ to CR1, CR2 and CR3 and F2- 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.

Use 23 to 26 inch lbs (2.6 to 2.9 N·m) torque when replacing nuts of F1+ and F2-, CR1, CR2, CR3, CR4, CR5 and CR6.

[FIGURE 7-5. TESTING ROTATING RECTIFIERS]

[H] TESTING EXCITER STATOR

Test the exciter stator (Figure 7-6) for open or shorted windings and grounds as follows:

Testing for Open or Shorted Windings

Use a Wheatstone Bridge or digital ohmmeter for this test. Disconnect F1+ and F2- exciter field leads from terminal block in generator end bell. The resistance between field leads should be 11.16 to 13.64 ohms at 77°F (25°C).

[FIGURE 7-6. TESTING EXCITER STATOR]

Testing for Grounds

Connect a megger or insulation resistance meter that applies 500 VDC or more between either field lead and the exciter stator lamination. Be sure both exciter leads are disconnected from the terminal block. Reading should be 1,000,000 ohms or greater. If not, the exciter stator is questionable and may require removal for oven drying and retest. A shorted stator must be replaced.
TESTING EXCITER ROTOR

Test the exciter rotor (Figure 7-7) for open or shorted windings or grounds as follows:

**Testing for Open or Shorted Windings**

Use a Wheatstone Bridge or digital ohmmeter for this test. Disconnect main rotor field leads that connect to rotating rectifier assemblies at F1+ and F2-. Disconnect lead wires from diodes CR1, CR2, CR3, CR4, CR5, and CR6. Test between exciter lead pairs T1-T2, T2-T3 and T1-T3. Resistance at 77°F (25°C) should be 486 to 594 milliohms.

**Testing for Grounds**

Test with an insulation resistance meter or Megger that applies at least 500 volts to the test leads. With all generator leads disconnected from rotating rectifiers CR1 through CR6, apply test leads between any CR lead and the rotor laminations. Reading should be 1,000,000 ohms or higher. If not, the exciter rotor is questionable and may require removal for oven drying and retest. A shorted rotor must be replaced.

Use 23 to 26 inch pounds (2.6 to 2.9 N·m) torque when replacing nuts of F1+ and F2- leads, CR1, CR2, CR3, CR4, CR5, and CR6.
TESTING GENERATOR STATOR

Using proper test equipment, check the stator for grounds, opens, and shorts in the windings.

Testing for Grounds

Some generators have ground connections to the frame. Check wiring diagram. All stator leads must be isolated for testing.

Use a megger or insulation resistance meter which applies 500 VDC or more to the test leads (Figure 7-9). Test each stator winding for short to laminations. A reading less than 1,000,000 ohms indicates a questionable stator. Oven dry the stator and retest.

Testing for Open or Shorted Windings

Test for continuity between coil leads shown in Figure 7-8; all pairs should have equal resistance. Use an accurate instrument for this test such as a Wheatstone Bridge. Resistance values at 77°F (25°C) are given in Table 7-1.

If a winding is shorted, open or grounded, replace the stator assembly. Before replacing the assembly, check the leads for broken wires or insulation.

TABLE 7-1. STATOR RESISTANCE VALUES IN MILLIOHMS*

<table>
<thead>
<tr>
<th>kW RATING AND MODEL</th>
<th>60 HZ</th>
<th>50 Hz</th>
<th>60 HZ</th>
<th>50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Hertz</td>
<td>3Ω</td>
<td>3Ω</td>
<td>1Ω</td>
<td>1Ω</td>
</tr>
<tr>
<td>3.5 DKC/MDKC</td>
<td>920</td>
<td>1010</td>
<td>290</td>
<td>380</td>
</tr>
<tr>
<td>4.0 MDKC/MDKC</td>
<td>460</td>
<td>498</td>
<td>190</td>
<td>260</td>
</tr>
<tr>
<td>6.0 DKD</td>
<td>6.5 MDKD</td>
<td>460</td>
<td>498</td>
<td>190</td>
</tr>
</tbody>
</table>

*Resistance in ohms @ 77°F (25°C) ±10%
TESTING GENERATOR ROTOR

For these tests, use a megger or insulation resistance meter which applies 500 VDC or more to the test leads.

Testing for Grounds
Check for grounds between each rotor lead and the rotor shaft, Figure 7-9. Use a Megger or insulation resistance meter which applies 500 VDC or more at the test leads. Perform test as follows:

1. Remove rotor leads F1+ and F2- from the rotating rectifier assemblies.
2. Connect test leads between F1+ and rotor shaft, then between F2- and rotor shaft. Meter should register 1,000,000 ohms or greater.
3. If less than 1,000,000 ohms, rotor is questionable. Oven dry the rotor and retest.
4. Replace a grounded rotor with a new identical part.

Testing for Open or Shorted Windings
Perform this test with an accurate meter such as a digital ohmmeter.

1. Remove rotor leads F1+ and F2- from rotating rectifier assemblies.
2. Using ohmmeter, check resistance between F1 and F2 leads, Figure 7-10.

The resistance values at 77°F (25°C) should be as shown in Table 7-2. If not, replace defective rotor with new, identical part.

<table>
<thead>
<tr>
<th>Model</th>
<th>Ohms Resistance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKC/MDKC</td>
<td>2.50</td>
</tr>
<tr>
<td>DKD/MDKD</td>
<td>2.82</td>
</tr>
</tbody>
</table>

*Resistance in ohms @ 77°F (25°C) ±10%
[M] WIRING HARNESS CHECK

Carefully check wiring harness as follows:

1. Inspect all wires for breaks, loose connections, and reversed connections. Refer to applicable wiring diagram.
2. Remove wires from terminals at each end and with an ohmmeter, check each wire end to end for continuity or opens.
3. Using an ohmmeter, check each wire to other wires and to ground for possible shorts or insulation breaks under areas covered by wrapping material.
4. Reconnect or replace wires/harness according to applicable wiring diagram.

[N] TESTING REGULATING TRANSFORMER T21

Regulating transformer T21 is used only on single phase generators. It consists of a multi-coil primary and a multi-tapped secondary. Figure 7-11 shows a typical transformer. Some transformers may have up to three coils in the primary and six taps on the secondary.

DC resistance of windings at 77°F (25°C) are shown in Table 7-3. Resistance between primary and secondary and the transformer frame should be over 100,000 ohms when measured with a megger or insulation meter.

TABLE 7-3. TRANSFORMER RESISTANCE VALUES IN OHMS

<table>
<thead>
<tr>
<th>WINDING</th>
<th>TRANSFORMER PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>315-0571</td>
</tr>
<tr>
<td>Primary H1-H2</td>
<td>.007 ± .0005</td>
</tr>
<tr>
<td>H3-H4</td>
<td>.007 ± .0005</td>
</tr>
<tr>
<td>H5-H6</td>
<td>N.A.</td>
</tr>
<tr>
<td>Secondary X1-X6</td>
<td>N.A.</td>
</tr>
<tr>
<td>X1-X5</td>
<td>N.A.</td>
</tr>
<tr>
<td>X1-X4</td>
<td>1.29 ± .01</td>
</tr>
<tr>
<td>X1-X3</td>
<td>1.24 ± .01</td>
</tr>
<tr>
<td>X1-X2</td>
<td>.019 ± .01</td>
</tr>
</tbody>
</table>

N.A. (Not applicable)
VOLTAGE ADJUSTMENT

This section supplies information for adjusting the transformer and electronic regulators. When checking output voltage, be sure the generator set has stabilized and is running at the correct speed (frequency). Adjusting the transformer regulator is done with the set stopped. The electronic regulator is adjusted with the set running.

**WARNING** Accidental starting of the set can cause severe personal injury or death. Disconnect both battery cables, negative (-) cable first, when repairs are made to the engine, controls, or generator.

Transformer Voltage Regulator

The transformer regulator circuit supplies a feedback voltage (dependent on load) to the exciter stator. Voltage adjustment is made by changing tap connections on the transformer. When replacement is necessary, install leads to the same terminals on the new transformer. To change voltage, refer to the model wiring diagram or the generator reconnection diagrams in Test [Q].

Electronic Voltage Regulator

**WARNING** Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any part of the body, clothing, tool or jewelry. Do not use non-insulated tools inside the control. Stand on an insulating mat or dry wood platform when the control doors are open.

With the generator set running, set the Voltage Adjust potentiometer on the regulator board assembly for correct voltage. See Figure 7-12.

**CAUTION** Do not adjust the other potentiometer (Volts/Hz Adjust) as it can be impossible to reset for proper operation. It is factory set using special calibration equipment.

![Electronic Voltage Regulator Board](FIGURE 7-12. ELECTRONIC REGULATOR BOARD)

Generator reconnection is dependent upon the nameplate code. Figure 7-13 shows reconnection possibilities. Information is also found on the individual model wiring diagrams in Section 8 of this manual.
Transformer Regulation

To Adjust Output Voltage, Move Taps on T21 According to Following Charts

Electronic Regulation

FIGURE 7-13. GENERATOR RECONNECTION DIAGRAMS 7-9
## Section 8. Wiring Diagrams

The electrical schematics and wiring diagrams that apply to the generator sets covered in this manual are listed below:

<table>
<thead>
<tr>
<th>Wiring Diagram</th>
<th>Drawing No.</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Phase AC Control</td>
<td>612-6184</td>
<td>8-2</td>
</tr>
<tr>
<td>Single and Three Phase AC Control</td>
<td>612-6185</td>
<td>8-3</td>
</tr>
<tr>
<td>MDKC/MDKD DC Control</td>
<td>612-6187</td>
<td>8-4</td>
</tr>
<tr>
<td>DKC/DKD 3-Wire Start Control (&quot;R&quot; Remote Start)</td>
<td>612-6252</td>
<td>8-5</td>
</tr>
<tr>
<td>RV and &quot;AUX&quot; Generator Set Control 3-Wire Start</td>
<td>612-6353</td>
<td>8-6</td>
</tr>
<tr>
<td>DKC/DKD Control (&quot;E&quot; Electric Start Standby Generator sets)</td>
<td>612-6186</td>
<td>8-7</td>
</tr>
<tr>
<td>Electronic AC Voltage Regulator Assembly</td>
<td>305-0091</td>
<td>8-8</td>
</tr>
<tr>
<td>6.5/7.5 DKD DC Control (Spec F RV Gensets)</td>
<td>612-6624</td>
<td>8-9</td>
</tr>
<tr>
<td>Single-phase AC Genset Control (Spec F RV Gensets)</td>
<td>612-6642</td>
<td>8-10</td>
</tr>
<tr>
<td>6.5/7.5 DKD Control Schematic (Extended Oil Fill Version)</td>
<td>612-6631</td>
<td>8-11</td>
</tr>
</tbody>
</table>
AC SCHEMATIC
SINGLE PHASE TRANSFORMER REG

EXCITER

NOTES:
1. Always apply voltage, move tap on T21 according to table.
2. For 1 in all voltage connections, See note 11.
3. Connect to 250 VDC and 120/240 VAC.

EXCITER

NOTED TO ADJUST OVERVOLTAGE. REFER TO TABLES.

H2 AND T4 FOR USE.

SILVER LEAD X3-4 USE.

FOR 110/220V USE H5.

NOTICE:
1. CONNECTIONS SHOWN IN TABLE MUST BE USED.
2. DASHED CONNECTORS ON DASH MODELS may be used.
3. Insulate Leads.

SINGLE PHASE AC CONTROL
SINGLE AND THREE PHASE AC CONTROL

1. CUT LEADS 184 FROM LEIs. THESE LEADS ARE NOT USED.
2. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN DE-ENERGIZED POSITION.
3. DASHED LINES INDICATE CONNECTIONS WHEN USED.
4. ALL CONNECTIONS ON 600-Volt, 3-Phase, 3-Phase Models: 118, 189, 536, 1820 Models Conines Leads 1820 DIRECTLY TO VR21.
5. FOR GENERATOR (26, 2626, 2628) LEADS 1820 WILL NOT BE USED. INSULATE AND LEAVE IN CONTROL BOX.
6. JUMPERS TERMINALS 6, 7 FOR 60 Hz, 1820 DELAYS JUMPERS BETWEEN TERMINALS 7, 8 FOR 50 Hz, 1820 DELAYS.

RECONNECTION DIAGRAM

SEE RECONNECTION DIAGRAM

CONTROL BOX (AC SECTION)
NOTES:
1. CUT CMR21-3 & -4 OFF AT REACTOR.
2. EXTERNAL CONNECTIONS
   CIRCUIT BREAKER
   TB21-3, TBI-1
   GENERATOR
   TBI-2, TBI-3
   FIELD
   FL-TBI-4
   FL-TBI-5
3. TO PREVENT SHORTING AGAINST REGULATOR ASSEMBLY COVER, VERIFY THAT TERMINAL
   TABS (ITEM 10) ARE NOT BENT UP.

<table>
<thead>
<tr>
<th>FROM STATION NO</th>
<th>TO STATION NO</th>
<th>LEAD NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>T21-X1</td>
<td>TBI-9</td>
<td></td>
</tr>
<tr>
<td>T21-X2</td>
<td>TBI-10</td>
<td></td>
</tr>
<tr>
<td>T21-M1</td>
<td>TBI-2</td>
<td></td>
</tr>
<tr>
<td>T21-H2</td>
<td>TBI-3</td>
<td></td>
</tr>
<tr>
<td>CMR21-1</td>
<td>TBI-1</td>
<td></td>
</tr>
<tr>
<td>CMR21-2</td>
<td>TBI-7</td>
<td>12</td>
</tr>
<tr>
<td>TBI-2</td>
<td>TBI-1</td>
<td>13</td>
</tr>
<tr>
<td>TBI-6</td>
<td>TBI-7</td>
<td></td>
</tr>
<tr>
<td>TBI-7</td>
<td>TBI-8</td>
<td>15</td>
</tr>
</tbody>
</table>
CUSTOMER
SUPPLIED FAN (AC)

TO ADJUST OUTPUT VOLTAGE, MOVE TAPS ON T1 ACCORDING TO TABLES.

1. REMOVE ALL VOLTAGE CONNECTIONS LEADS X2 AND X4

2. USE LEAD ON TAPS X2-3, X4-5.

3. UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE SHOWN IN THE OFF-ENERGIZED POSITION.

4. DASHED LINES INDICATE WHEN USED.

5. IF CB22 IS NOT USED, CONNECT LEADS DIRECTLY TO THE LOAD.

SINGLE-PHASE AC GENSET CONTROL (SPEC F RV GENSETS)

Modified

Power Generation

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