DIAGNOSTIC REPAIR MANUAL

GENERAC

Air-Cooled Product with Nexus Control

MODELS:
7 kW NG, 8 kW LP
9 kW NG, 10 kW LP
13 kW NG, 14 kW LP
15 kW NG, 15 kW LP
16 kW NG, 17 kW LP
18 kW NG, 20 kW LP

STANDBY GENERATORS

SAFETY

Throughout this publication, DANGER, WARNING, and CAUTION blocks are used to alert the mechanic to special instructions concerning a particular service or operation that might be hazardous if performed incorrectly or carelessly. Observe them carefully. Their definitions are as follows:

DANGER!

After this heading, read instructions that, if not strictly complied with, will result in serious personal injury, including death.

WARNING!

After this heading, read instructions that, if not strictly complied with, could result in serious personal injury, including death.

CAUTION!

After this heading, read instructions that, if not strictly complied with, might result in minor or moderate injury.

Four commonly used safety symbols accompany the DANGER, WARNING and CAUTION blocks. The type of information each indicates follows:

This symbol points out important safety information that, if not followed, could endanger personal safety and/or property of others.

This symbol points out potential explosion hazard.

This symbol points out potential fire hazard.

This symbol points out potential electrical shock hazard.

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance with these special instructions plus “common sense” are major accident prevention measures.

Some of the terminology used in this manual may appear differently for product manufactured by the factory and branded under another label.

Generac Name	Honeywell Name
TruePower Technology	PrecisionPower Technology
Generac OHVI engine	Generac OHVI Engine
Rhinocoat	Rhinocoat
QuietTest	WhisperCheck
Nexus Controller	Sync Controller
Nexus Smart Switches	Sync Transfer Switches with Load Shedding Capability
Nexus Wireless Remote Monitors	Sync Wireless Remote Monitors
Nexus Smart Switches	Sync Smart Switches

READ THIS MANUAL THOROUGHLY

This SERVICE MANUAL has been written and published by Generac to aid our dealers' technicians and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products manufactured and marketed by Generac, and that they have been trained in the recommended servicing procedures for these products, including the use of common hand tools and any special Generac tools or tools from other suppliers.

Generac could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a procedure or tool not recommended by Generac must first satisfy themselves that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications in this manual are based on the latest product information available at the time of publication.

When working on these products, remember that the electrical system and engine ignition system are capable of violent and damaging short circuits or severe electrical shocks. If you intend to perform work where electrical terminals could be grounded or touched, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings of the engine are exposed during service, they should be covered to prevent accidental entry of foreign material. Entry of such materials will result in extensive damage when the engine Is started.

During any maintenance procedure, replacement fasteners must have the same measurements and strength as the fasteners that were removed. Metric bolts and nuts have numbers that indicate their strength. Customary bolts use radial lines to indicate strength while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can cause damage, malfunction and possible injury.

Note: Special Notes appear in bold type throughout this publication. While not pertaining to safety, they emphasize procedures, circumstances or specifications that require special attention.

REPLACEMENT PARTS

When servicing this equipment, it is extremely important that all components be properly installed and tightened. If improperly installed and tightened, sparks could ignite fuel vapors from fuel system leaks.

GENERATOR								
Unit	**8 kW**	**10 kW**	**13 kW**	**14 kW**	**15 kW**	**16 kW**	**17 kW**	**20 kW**
Rated Max. Continuous Power Capacity (Watts*)	7,000 NG 8,000 LP	9,000 NG 10,000 LP	13,000 NG 13,000 LP	13,000 NG 14,000 LP	15,000 NG 15,000 LP	16,000 NG 16,000 LP	16,000 NG 17,000 LP	18,000 NG 20,000 LP
Rated Voltage	240							
Rated Voltage at No-Load (NG) Older controller P/N 0H6680A Newer controller P/N 0H6680B	250-254 240-244							
Rated Max. Continuous Load Current (Amps) 240 Volts (LP/NG)	33.3/29.2	41.6/37.5	54.2/54.2	58.3/54.2	62.5/62.5	66.6/66.6	70.8/66.6	83.3/75.0
Main Line Circuit Breaker	35 Amp	45 Amp	55 Amp	60 Amp	65 Amp	65 Amp	65 Amp	100 Amp
Circuits*** 50A, 240V	-	-	1	-	1	1	1	-
40A, 240V	-	1	1	1	1	1	1	-
30A, 240V	1	1	-	-	-	-	-	-
20A, 240V	1	-	1	1	1	1	1	-
20A, 120V	3	3	4	6	5	5	5	-
15A, 120V	3	5	4	4	5	5	5	-
Phase	1							
Number of Rotor Poles	2							
Rated AC Frequency	60 Hz							
Power Factor	1							
Battery Requirement	Group 26R, 12 Volts and 525 CCA Minimum							
Weight (unit only in lbs.)	340	387/353	439	439	455/421	439	455/421	450
Enclosure	Steel	Steel/Aluminum	Steel	Steel	Steel/Aluminum	Steel	Steel/Aluminum	Aluminum
Normal Operating Range	This unit is tested in accordance to UL 2200 standards with an operating temperature of 20° F (-29° C) to 122°F. (50° C). For areas where temperatures fall below 32° F (0° C), a cold weather kit is highly recommended. When operated above 77° F (25° C) there may be a decrease in engine power. (Please reference the engine specifications section).							

* Maximum wattage and current are subject to and limited by such factors as fuel Btu content, ambient temperature, altitude, engine power and condition, etc. Maximum power decreases about 3.5 percent for each 1,000 feet above sea level; and also will decrease about 1 percent for each 6 C (10 F) above 16 C (60 F) ambient temperature.

** Load current values shown for 120 volts are maximum TOTAL values for two separate circuits. The maximum current in each circuit must not exceed the value stated for the 240 volts.

*** Circuits to be moved must be protected by same size breaker. For example, a 15 amp circuit in the main panel must be a 15 amp circuit in the transfer switch.

STATOR WINDING RESISTANCE VALUES / ROTOR RESISTANCE*								
	8 kW	**10 kW**	**13 kW**	**14 kW**	**15 kW**	**16 kW**	**17 kW**	**20 kW**
Power Winding: Across 11 & 22	0.1660-0.1930	0.1895-0.2203	0.1003-0.1165	0.1003-0.1165	0.0746-0.0866	0.0746-0.0866	0.0746-0.0866	0.0415-0.0483
Power Winding: Across 33 & 44	0.1660-0.1930	0.1895-0.2203	0.1003-0.1166	0.1003-0.1166	0.0746-0.0866	0.0746-0.0866	0.0746-0.0866	0.0415-0.0483
Sensing Winding: Across 11 & 44	0.378-.4392	0.425-0.4938	0.2484-0.2887	0.2484-0.2888	0.197-0.229	0.197-0.229	0.197-0.229	0.137-0.1594
Excitation Winding: Across 2 & 6	1.0318-0.1930	1.0935-1.2708	0.876-1.017	0.876-1.018	0.780-0.906	0.780-0.906	0.780-0.906	0.7318-0.8504
Rotor Resistance	6.30-7.32	6.30-7.32	7.58-8.80	7.58-8.81	8.37-9.72	8.37-9.72	8.37-9.72	9.54-11.10

* Resistance values shown are based on new windings at 20° C. Actual readings may vary based on type of meter used and any other components or connections included in the circuit being tested.

ENGINE				
Model	**8 kW**	**10 kW**	**13/14/15/16/17 kW**	**20 kW**
Type of Engine	GH-410	GT-530	GT-990	GT-999
Number of Cylinders	1	2	2	2
Rated Horsepower @ 3,600 rpm	14.8	18	32	36
Displacement	407cc	530cc	992cc	999cc
Cylinder Block	Aluminum w/Cast Iron Sleeve			
Valve Arrangement	Overhead Valves			
Ignition System	Solid-state w/Magneto			
Recommended Spark Plug	RC14YC	BPR6HS	RC14YC	RC12YC
Spark Plug Gap	0.76 mm (0.030 inch)	0.76 mm (0.030 inch)	1.02 mm (0.040 inch)	0.76 mm (0.030 inch)
Compression Ratio	8.6:1	9.5:1	9.5:1	9.5:1
Starter	12 VDC			
Oil Capacity Including Filter	Approx. 1.5 Qts	Approx. 1.7 Qts	Approx. 1.9 Qts	Approx. 1.9 Qts
Recommended Oil Filter	Part # 070185F			
Recommended Air Filter	Part # 0G3332	Part # 0E9581	Part # 0C8127	Part # 0G5894
Operating RPM	3,600			

FUEL CONSUMPTION				
Model #	**Natural Gas***		**LP Vapor****	
	1/2 Load	**Full Load**	**1/2 Load**	**Full Load**
7/8 kW	77	140	0.94/34	1.68/62
9/10 kW	102	156	1.25/46	1.93/70
13/13 kW	156	220	1.55/57	2.18/80
13/14 kW	156	220	1.56/58	2.30/84
15/15kW	171	244	1.49/54	2.35/85
16/16 kW	183	261	1.59/58	2.51/91
16/17 kW	183	261	1.61/59	2.57/94
18/20 kW	206	294	1.89/69	2.90/106

* Natural gas is in cubic feet per hour.

**LP is in gallons per hour/cubic feet per hour.

Values given are approximate.

MOUNTING DIMENSIONS

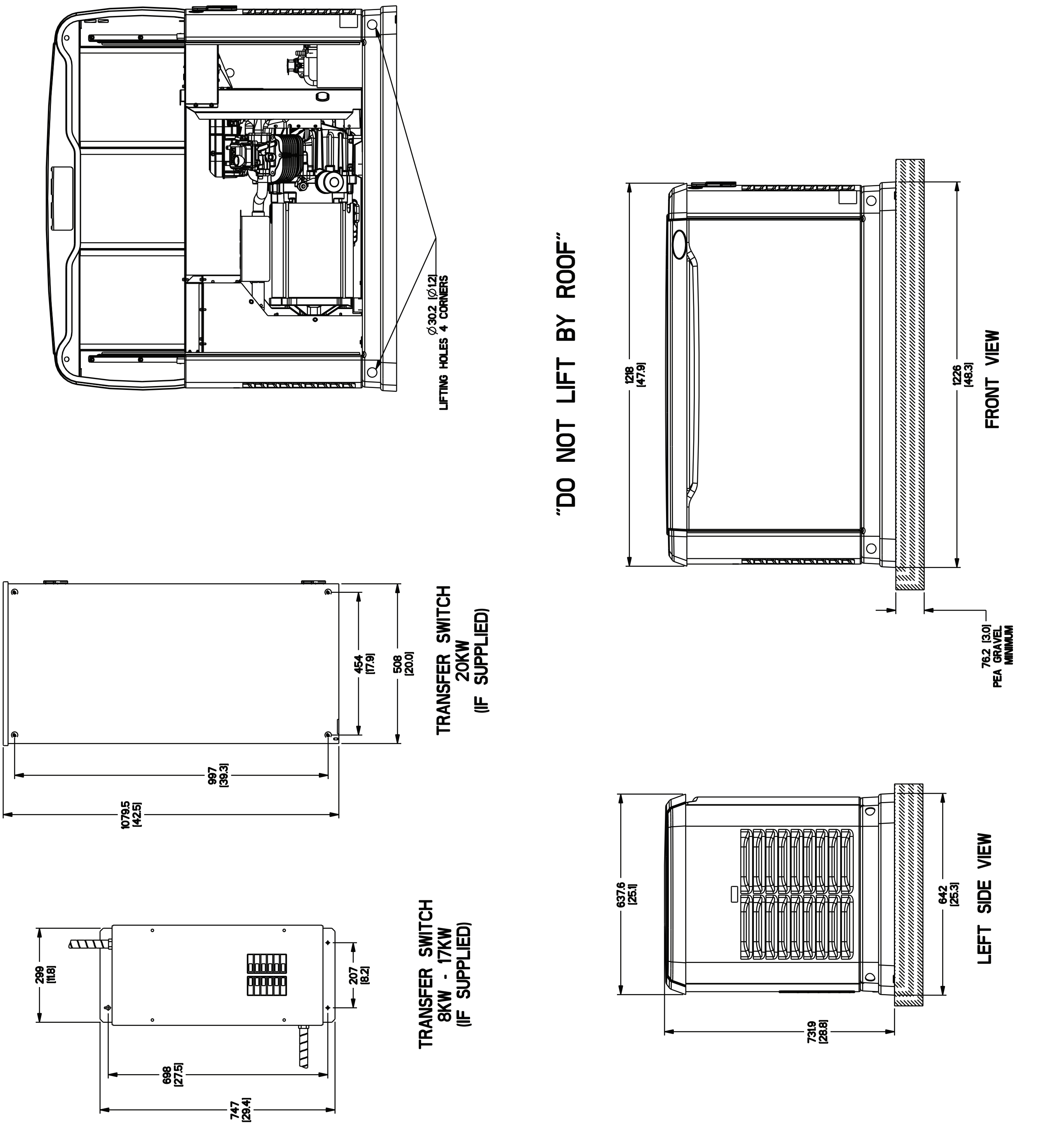
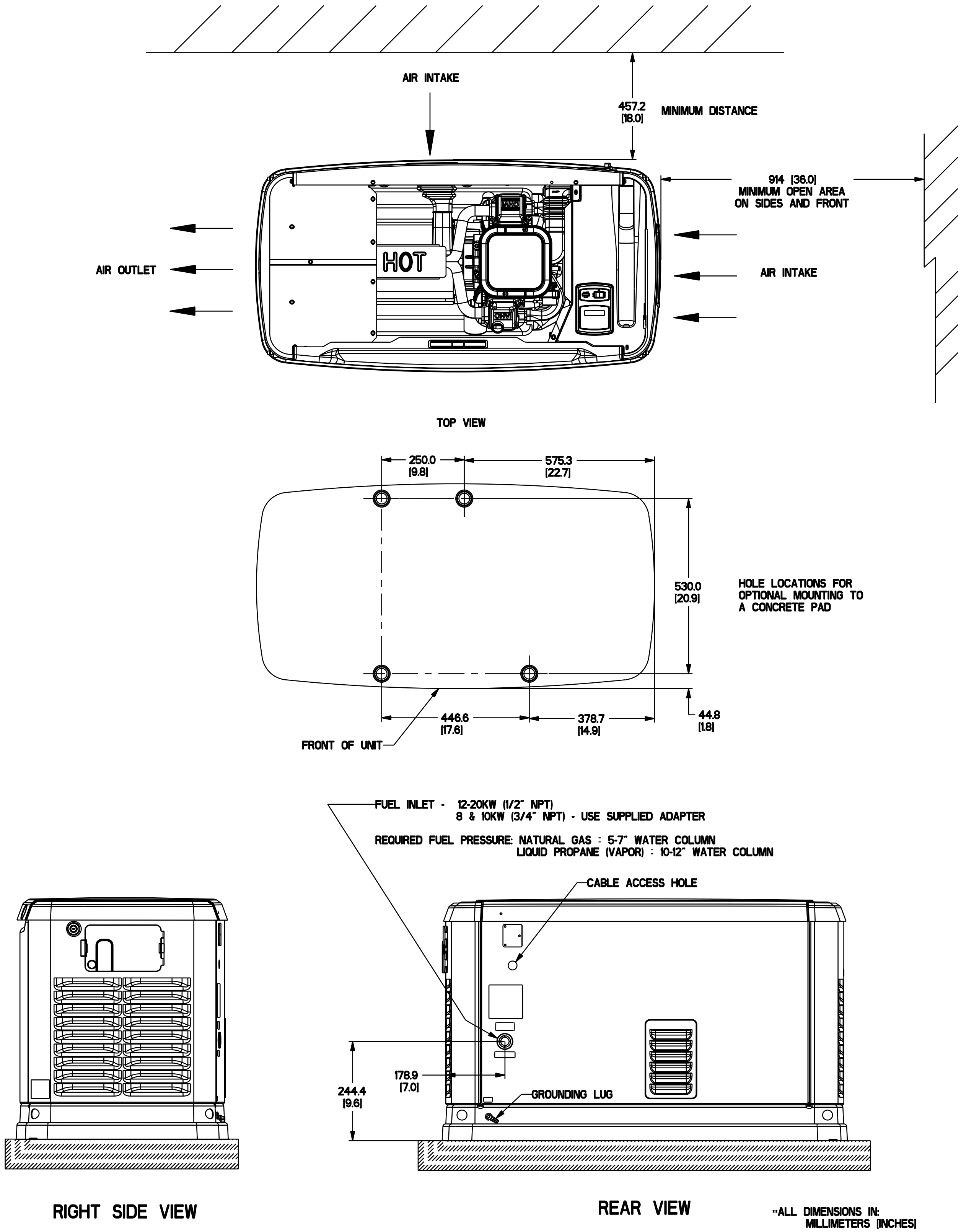


Figure 1.

MOUNTING DIMENSIONS



MAJOR FEATURES

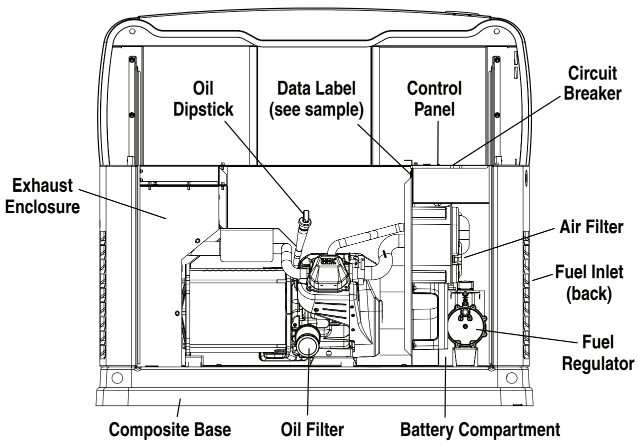


Figure 2. 8kW, Single Cylinder, GH-410 Engine (door removed)

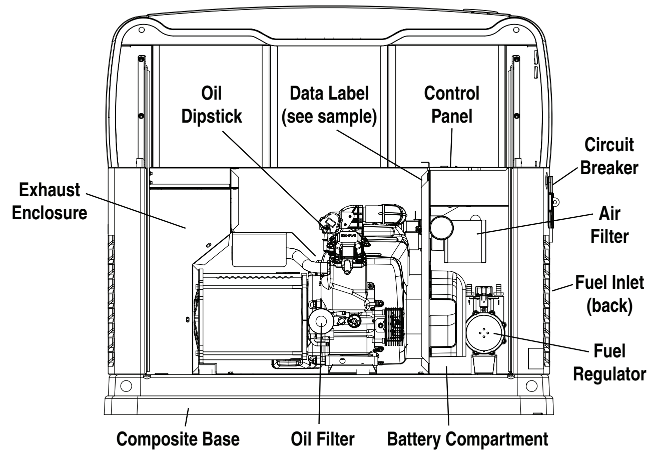


Figure 3. 10kW, V-twin, GT-530 Engine (door removed)

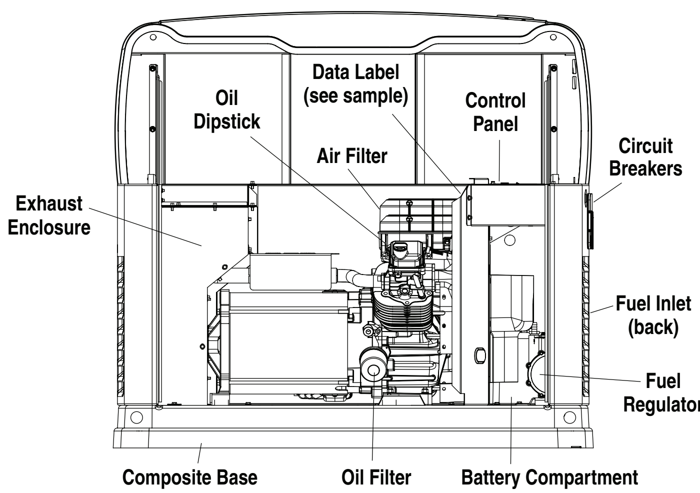


Figure 4. 13, 14, 15, 16, 17 and 20kW, V-twin, GT-990/GT-999 Engine (door removed)

PART 1 GENERAL INFORMATION

Air-cooled, Automatic Standby Generators

TABLE OF CONTENTS

INTRODUCTION

This diagnostic repair manual has been prepared especially for familiarizing service personnel with the testing, troubleshooting and repair of the air-cooled product that utilizes the Nexus controller. Every effort has been expended to ensure that the information and instructions in the manual are both accurate and current. However, the manufacture reserves the right to change, alter or otherwise improve the product at any time without prior notification.

The manual has been divided into several PARTS. Each PART has been divided into SUBSECTIONS and each subsection consists of several sub headings.

It is not the manufactures intent to provide detailed disassembly and reassembly of the entire Residential product line. It is the manufactures intent to (a) provide the service technician with an understanding of how the various assemblies and systems work, (b) assist the technician in finding the cause of malfunctions, and (c) effect the expeditious repair of the equipment.

PARTS

Part 1 – Provides the basic understanding of the generator as well as basic installation information and operating instructions.

Part 2 – Provides the basics of the AC alternator design and the AC troubleshooting portion of the manual.

Part 3 – Provides the troubleshooting and diagnostic testing procedure for the pre-packaged 10,12,14,16 circuit EZ Switch™ transfer switches.

Part 4 – Provides the troubleshooting and diagnostic testing procedure for engine related problems and the Nexus™ Controller.

Part 5 – Provides the basic operational and system function testing to ensure proper operation of the unit.

Part 6 – Provides detailed step-by-step instructions for the replacement of the rotor/stator and engine.

Part 7 – Illustrates all of the electrical and wiring diagrams for the various kW ranges and transfer switches.

Data Plate

The data plate that is affixed to the generator contains important information pertaining to the unit, including its model number, serial number, amperage rating, and voltage rating. The information from this data plate may be required when requesting information, ordering parts, etc.

Item Number

Many home standby generators manufactured are to the unique specifications of the buyer. The Model Number identifies the specific generator set and its unique design specifications

Serial Number

Used for warranty tracking purposes.

GENERATOR IDENTIFICATION

The air-cooled product utilizes four different engines over various kW ranges. It is important to know the size of the engine before attempting a repair because some testing procedures will be different from engine to engine.

410cc Engine 8kW

- Overhead Valve
- Single Cylinder
- Nexus™ Controller

530cc Engine 10kW

- Overhead Valve
- Twin Cylinders
- Nexus™ Controller

990cc Engine 12-17kW

- Overhead Valve
- Twin Cylinders
- Nexus™ Controller

999cc Engine 20kW

- Overhead Valve
- Twin Cylinders
- Nexus™ Controller

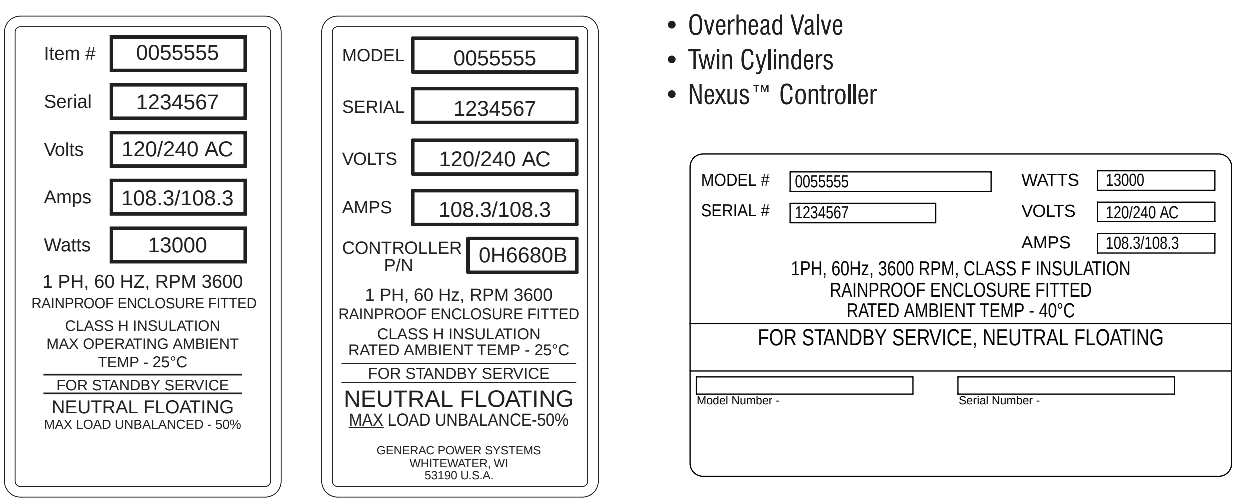


Figure 5. Typical Data Plates

INTRODUCTION

Information is provided in this section to ensure the service technician will have a basic knowledge of installation requirements for home standby systems. Installation problems that arise often relate to poor or unauthorized installation practices.

A typical home standby electric system is shown in Figure 7. Installation of a system includes the following:

- Selecting a location
- Grounding the Generator
- Providing the fuel supply
- Mounting the load center
- Connecting power source and load lines
- Connecting system control wiring
- Post installation tests and adjustments

SELECTING A LOCATION

Install the Generator set as close as possible to the electrical load distribution panel(s) that will be powered by the unit, ensuring that there is proper ventilation for cooling air and exhaust gases. This will reduce wiring and conduit lengths. Wiring and conduit not only add to the cost of the installation, but excessively long wiring runs can result in a voltage drop.

Control system interconnections between the transfer switch and Generator consists of N1, N2, T1, 194, and 23. In addition, a Wire 0 must be connected for use with Nexus Smart Switches. Control system interconnection leads must be run in a conduit that is separate from the AC power leads. Recommended wire gauge size depends on length of the wire:

Max. Cable Length	Recommended Wire Size
35 feet (10.67m)	No. 16 AWG.
60 feet (l8.29m)	No. 14 AWG.
90 feet (27.43m)	No. 12 AWG.

NFPA 37 CODE REQUIREMENTS

The National Fire Protection Association (NFPA) has established standards for the installation and use of stationary combustion engines. This code limits the spacing of an enclosed Generator set from a structure or wall. NFPA 37 states:

NFPA 37, Section 4.1.4, Engines Located Outdoors. Engines, and their weatherproof housings if provided, that are installed outdoors shall be located at least 5 feet from openings in walls and at least 5 feet from structures having combustible walls. A minimum separation shall not be required where the following conditions exist:

1. The adjacent wall of the structure has a fire resistance rating of at least 1 hour.
2. The weatherproof enclosure is constructed of noncombustible materials and it has been demonstrated that a fire within the enclosure will not ignite combustible materials outside the enclosure.

Annex A — Explanatory Material

A4.1.4 (2) Means of demonstrating compliance are by means of full-scale fire test or by calculation procedures.

⚠ WARNING!

Generator exhaust contains DEADLY carbon monoxide gas. This dangerous gas can cause unconsciousness or death. Do not place the unit near windows, doors, fresh air intakes (furnaces, etc) or any openings in the building or structure, including windows and doors of an attached garage.

The air-cooled product line has under gone the required testing, which meets the requirements of exception 2. The criteria for the testing were to determine the worst-case fire scenario within the Generator and to determine the ignitability of items outside the engine enclosure at various distances. The enclosure is constructed of non-combustible materials. The results and conclusion from the independent testing lab indicated that any fire within the Generator enclosure would not pose any ignition risk to nearby combustibles or structures, with or without fire service personnel response.

Based on the required testing, the requirement of NFPA 37, Sect 4.1.4, the guidelines for the 8, 10, 12, 13, 14, 15, 16, 17 and 20kW units changed to 18 inches (457mm) from the back side of the Generator to a stationary wall or building. For adequate maintenance and airflow clearance, the area above the Generator should be at least three (3) feet with a minimum of three (3) feet at the front and ends of the enclosure. This includes, but not limited to trees, shrubs, and vegetation that could obstruct airflow. See Figures 1 and 6 for further details.

GROUNDING THE GENERATOR

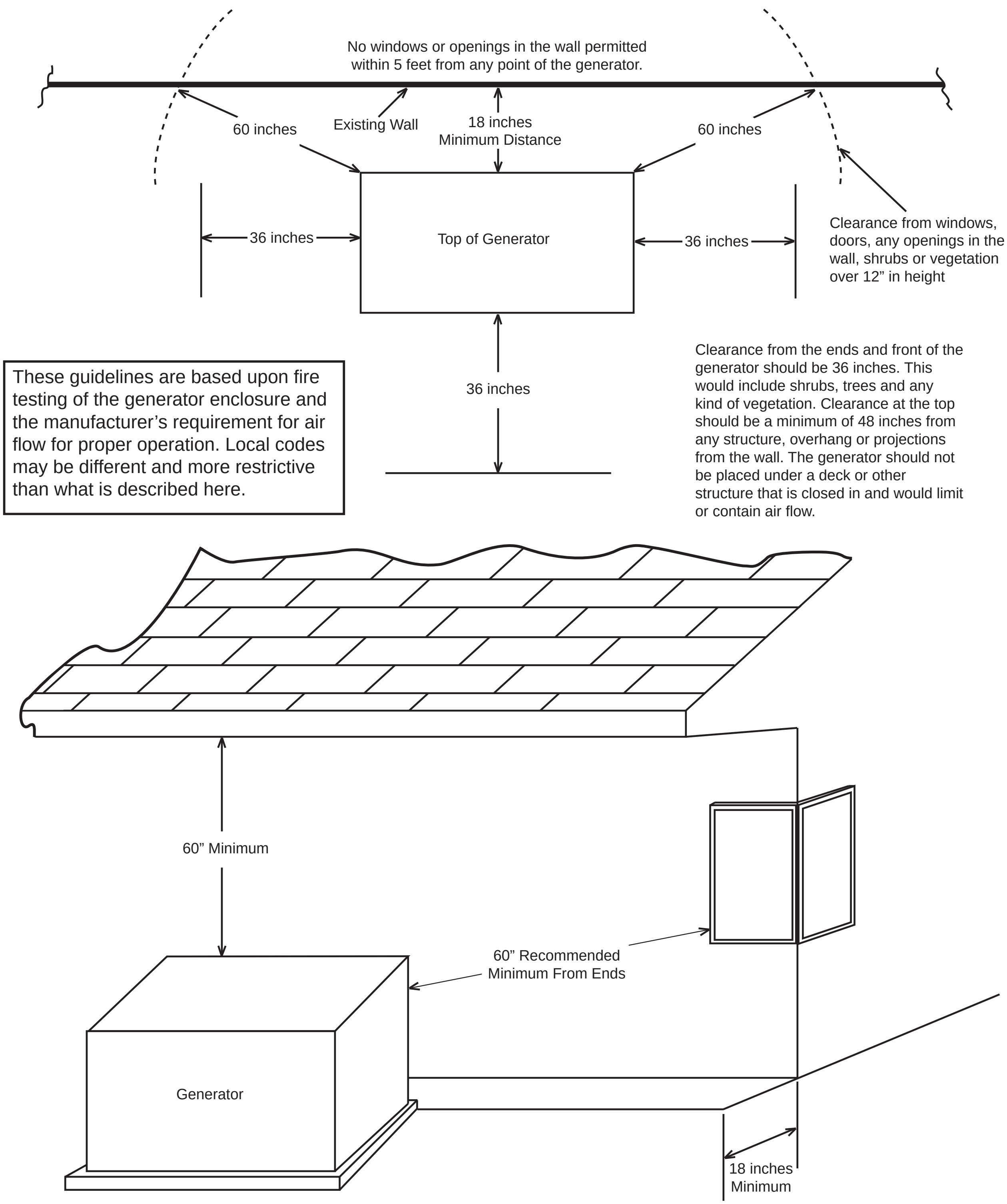
The National Electric Code requires that the frame and external electrically conductive parts of the Generator be properly connected to an approved earth ground. Local electrical codes may also require proper grounding of the unit. For that purpose, a grounding lug is attached to the unit. Grounding may be accomplished by attaching a stranded copper wire of the proper size to the Generator grounding lug and to an earth-driven copper or brass grounding-rod. Consult with local electrician for grounding requirements in the area.

THE FUEL SUPPLY

Natural gas is the primary fuel source utilized for the operating, testing and adjusting of units with air-cooled engine. When it is necessary, it is possible to convert units with air-cooled engines to use liquid propane vapor (LPV). See Section 1.4 “Reconfiguring the Fuel System” for the conversion procedure.

LPV gas is usually supplied as a liquid in high-pressure tanks. The air-cooled product requires a “vapor withdrawal” type of fuel supply system when Liquid Propane (LP) gas is used. The “vapor withdrawal” system utilizes the gaseous fuel vapors that form at the top of the supply tank.

The pressure at which LP is delivered to the Generator may



This drawing supersedes installation instructions in all Generac air-cooled installation and owner’s manuals dated previous to May 26, 2007.

Figure 6. NFPA 37 Code Requirements

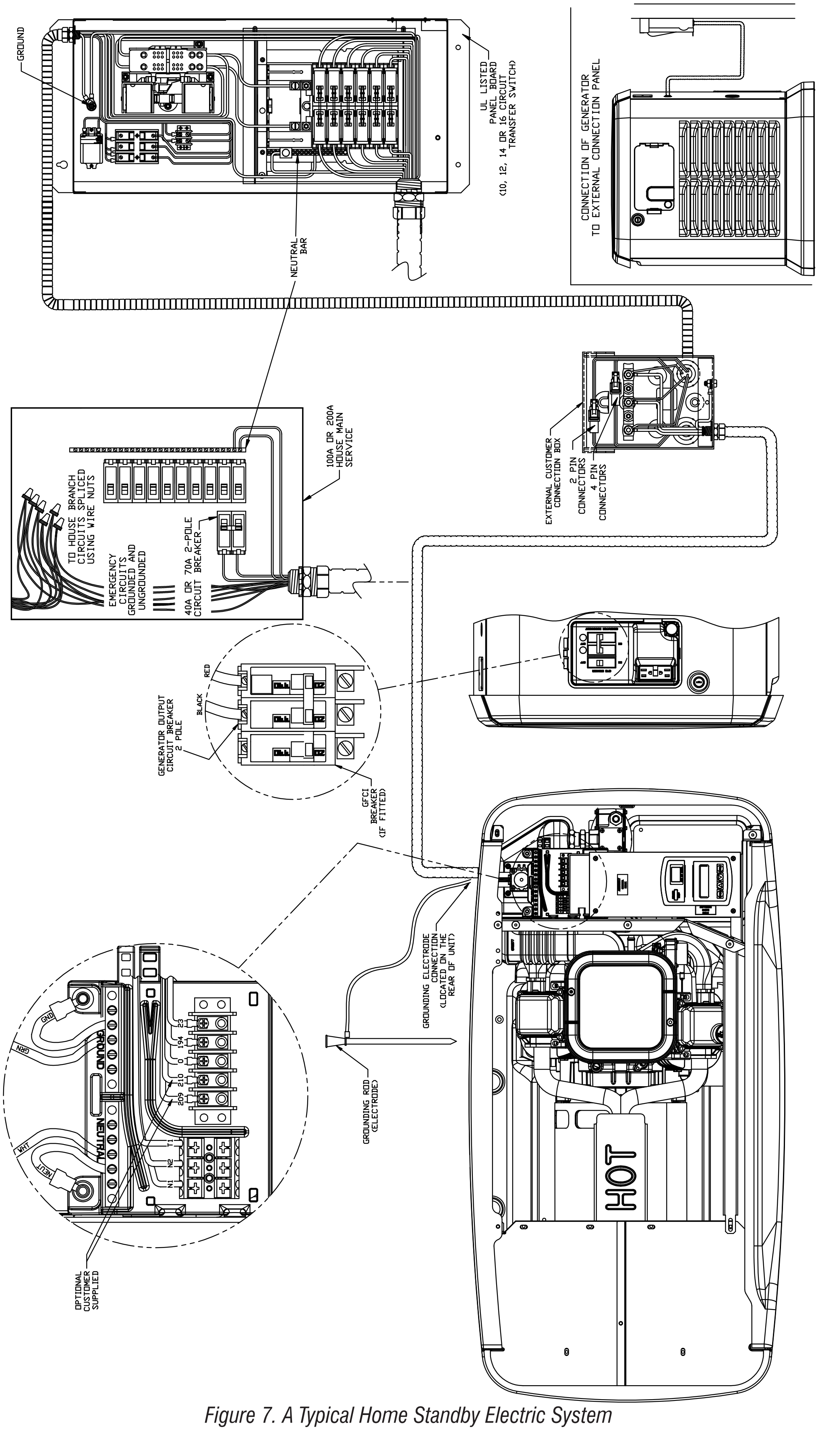


Figure 7. A Typical Home Standby Electric System

vary considerably, depending on ambient temperatures. In cold weather, supply pressures may drop to "zero". In warm weather, extremely high gas pressures may be encountered. A primary regulator is required to maintain correct gas supply pressures.

Required fuel pressure for natural gas is 5 inches to 7 inches water column (0.18 to 0.25 psi); and for liquid propane, 10 inches to 12 inches of water column (0.36 to 0.43 psi).

Note: To maintain proper fuel pressure a primary regulator is required.

DANGER!

LP and Natural Gas are both highly explosive. Gaseous fuel lines must be properly purged and tested for leaks before this equipment is placed into service and periodically thereafter. Procedures used in gaseous fuel leakage tests must comply strictly with applicable fuel gas codes. Do not use flame or any source of heat to test for gas leaks. No gas leakage is permitted. LP gas is heavier than air and tends to settle in low areas. Natural gas is lighter than air and tends to settle in high places. Even the slightest spark can ignite these fuels and cause an explosion.

Use a flexible length of hose between the Generator fuel connection and rigid fuel lines is required. This will help prevent line breakage that might be caused by vibration or if the Generator shifts or settles. The flexible fuel line must be approved for use with gaseous fuels.

Flexible fuel line should be kept as straight as possible between connections. The bend radius for flexible fuel lines is nine (9) inches. Exceeding the bend radius can cause the fittings to crack.

TRANSFER SWITCH / LOAD CENTER

Electrical code requires the use of a transfer switch, to prevent electrical feedback between the Utility and Standby power sources, and to transfer electrical loads from one power supply to another safely. See Section 3.1 for further information.

POWER SOURCE AND LOAD LINES

The Utility supply lines, the Standby supply lines, and electrical Load lines must all be connected to the proper terminal lugs in the transfer switch. In single phase systems only with a 2-pole CONTACTOR the following installation procedure applies. Connect the two Utility source (hot) lines to the CONTACTOR terminal lugs labeled N1 and N2. Connect the Standby source (hot) lines to the CONTACTOR terminal lugs labeled E1 and E2. Connect the Load lines to the CONTACTOR terminal lugs labeled T1 and T2. Connect the Utility, Standby, and Load Neutral lines to the NEUTRAL block in the transfer switch.

NATURAL GAS FUEL INTERCONNECTIONS

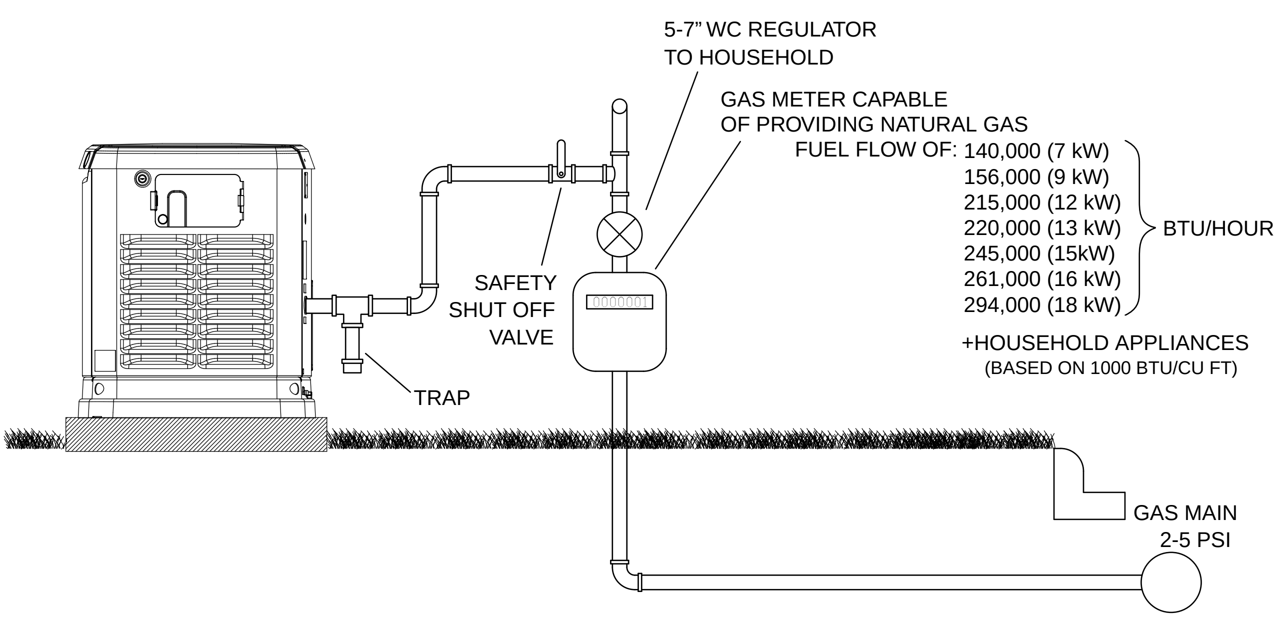


Figure 8. Proper Fuel Installation

SYSTEM CONTROL INTERCONNECTIONS

The system control wiring when properly connected monitors Utility source voltage for drop out below a preset value. When voltage drops below a preset level, the Generator will start in automatic and transfer electrical Loads to the "Standby" position. On restoration of Utility source voltage above a preset value, retransfer of electrical loads from the "Standby" position to the "Utility" position will occur and the Generator will shutdown.

The transfer switch and the Generator will both have a terminal strip labeled "Customer Connections." The connections are as follows:

Table 1. Typical Control Wiring Connections

Wire #	Purpose
194	Provides 12VDC to the transfer relay
23	Switched to ground for transfer relay operation
N1	240VAC sensing for the controller
N2	240VAC sensing for the controller
T1	Provides 120VAC from Load side of the CONTACTOR for battery charging
209	Connects to 210 for an alarm
210	Connects to 209 for an alarm
0	Provides a DC common for Nexus Smart Switches

INTRODUCTION

It is the responsibility of the installer to ensure that the Generator installation was performed properly. A careful inspection must be performed when the installation is complete. All applicable codes, standards, and regulations pertaining to such installations must be strictly complied with. In addition, regulations established by the Occupational Safety and Health Administration (OSHA) must be complied with as well.

Prior to initial startup of the unit, the installer must ensure that the Generator has been properly prepared for use. This includes the following:

- An adequate supply of the correct fuel must be available for Generator operation.
- The engine must be properly serviced with the recommended oil.
- With liquid propane (LP), use only the "vapor withdrawal" system. This type of system uses the vapors formed above the liquid fuel in the storage tank.

The engine has been fitted with a fuel carburetion system that meets the specification of the 1997 California Air Resources Board for tamper-proof dual fuel systems. The unit will run on natural gas or LP, but it has been factory set and tested to run on natural gas. When the change from natural gas to LP is needed, the fuel system needs to be re-configured. See Section 1.4 "Reconfiguring the Fuel System" for further information.

Recommended fuels should have a British Thermal Unit (BTU) content of at least 1,000 BTU's per cubic feet for natural gas; or at least 2,520 BTU's per cubic feet for LP. Ask the fuel supplier for the BTU content of the fuel.

Recommended fuel pressures for natural gas and liquid propane vapor (LPV) are as follows:

	LPV	NG
Minimum Water Column	10 inches	5 inches
Maximum Water Column	12 inches	7 inches

Note: All pipe sizing, construction and layout must comply with NFPA 54 for natural gas applications and NFPA 58 for liquid propane applications. After installation, verify that the fuel pressure NEVER drops below five (5) inches water column for natural gas or ten (10) inches water column for LPV.

Prior to installation of the Generator, the installer should consult local fuel suppliers or the fire marshal to check codes and regulations for proper installation. Local codes will mandate correct routing of gaseous fuel line piping around gardens, shrubs and other landscaping to prevent any damage.

Special considerations should be given when installing the unit where local conditions include flooding, tornados, hurricanes, earthquakes and unstable ground for the flexibility and strength of piping and their connections.

Use an approved pipe sealant or joint compound on all threaded fittings.

Table 2. Fuel Pipe Sizing

Natural Gas							
Table values are maximum pipe run in feet							
KW	0.75"	1"	1.25"	1.5"	2"	2.5"	3"
7-8	55	200	820				
10	20	85	370	800			
13-14	10	50	245	545			
15-17		40	190	425			
20		20	130	305	945		
Liquid Propane Vapor							
Table values are maximum pipe run in feet							
KW	0.75"	1"	1.25"	1.5"	2"	2.5"	3"
7-8	165	570					
10	70	255	1000				
13-14	45	170	690				
15-17	25	130	540				
20	15	115	480				

Notes:
- Pipe sizing is based on 0.5" H20 pressure drop
- Sizing includes a nominal number of elbows and tees
- Please verify adequate service and meter sizing

DANGER!

Gaseous fuels such as natural gas and LPV are highly explosive. Even the slightest spark can ignite such fuels and cause an explosion. No leakage of fuel is permitted. Natural gas, which is lighter than air, tends to collect in high areas. LP gas is heavier than air and tends to settle in low areas.

Note: Code requires a minimum of one approved manual shutoff valve installed in the gaseous fuel supply line. The valve must be easily accessible. Local codes determine the proper location.

Fuel Consumption

The fuel consumption rate for individual kW ranges are listed in the Specifications section at the front of this manual. Table 3 shows standard fuel consumption rates based on 4 different kW ranges.

Table 3. Standard Fuel Consumption Rates

Load (kW)	BTU / Hr	LP Gal / Hr	NG FT3 / Hr	NG Therms / Hr
5	110,000	1.2	110	1.1
10	176,400	2	156	1.6
15	231,800	2.5	220	2.2
20	267,100	2.8	262	2.6

Note: Typical fuel consumption based on a Generator 100% loaded.

RECONFIGURING THE FUEL SYSTEM

8kW, 410cc Engine

To reconfigure the fuel system from NG to LP, follow these steps (Figure 9):

Note: The primary regulator for the propane supply is NOT INCLUDED with the generator. A fuel pressure of 10 to 12 inches of water column (0.36 to 0.43 psi) to the fuel inlet of the generator MUST BE SUPPLIED.

1. Turn off the main gas supply (if connected).
2. Open the roof and remove the door.
3. Remove the battery (if installed).
4. Take the plastic T-handle fuel selector in the poly bag supplied with the generator.
5. Locate the selector knob on the air box cover, behind the yellow air filter door and power bulge. The unit comes from the factory in the NG (Natural Gas) position. Grasping the T-handle, insert the pin end into the hole in the selector knob and pull out to overcome spring pressure and then twist clockwise 90 degrees and allow the selector to return in once aligned with the LP (Liquid Propane) position.
6. Save this tool with the Owner's Manual.
7. Install the battery, door and close the roof.
8. Reverse the procedure to convert back to natural gas.

Figure 9. Fuel Selector

Note: Use an approved pipe sealant or joint compound on all threaded fittings to reduce the possibility of leakage.

10, 13, 14, 15, 16, 17 and 20kw, V-twin Engines

To reconfigure the fuel system from NG to LP, follow these steps:

Note: The primary regulator for the propane supply is NOT INCLUDED with the generator. A fuel pressure of 10 to 12 inches of water column (0.36 to 0.43 psi) to the fuel inlet of the generator MUST BE SUPPLIED.

1. Open the roof.
2. **For 10kW units:** Loosen clamp and slide back the air inlet hose.

- Slide fuel selector on carburetor out towards the back of the enclosure (Figures 10 and 11).
- Return the inlet hose and tighten clamp securely.

For 13, 14, 15, 16, 17 and 20kW units: remove the air cleaner cover.

- Slide the selector lever towards the back of the enclosure (Figures 12 and 13).
- Re-install the air cleaner cover and tighten the two thumb screws.

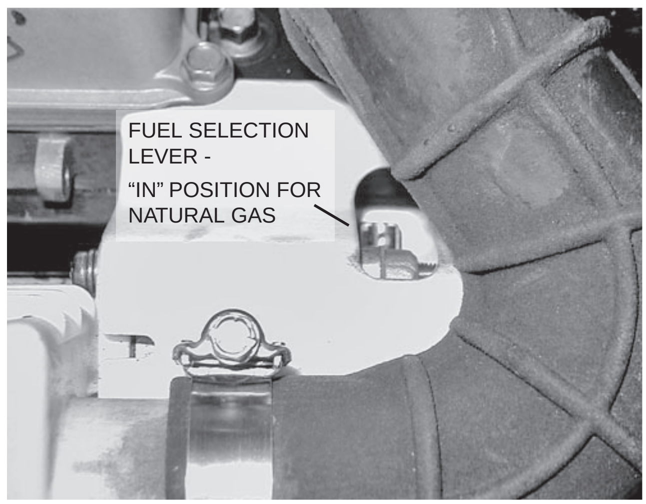


Figure 10. 10kW, GT-530 (Inlet Hose Slid Back)

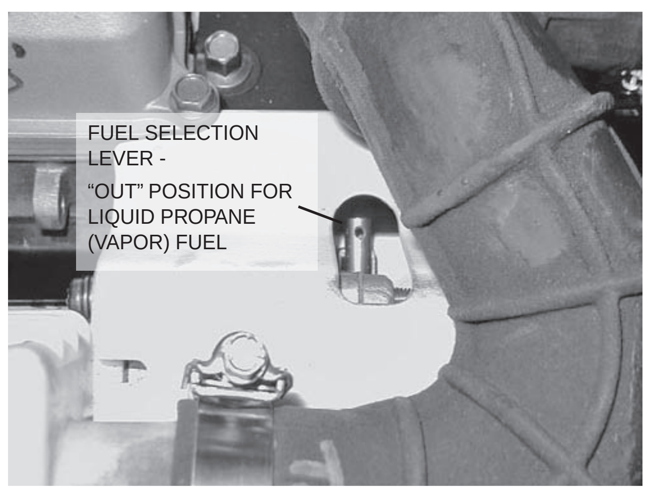


Figure 11. 10kW, GT-530 (Inlet Hose Slid Back)

3. Close the roof.
4. Reverse the procedure to convert back to natural gas.

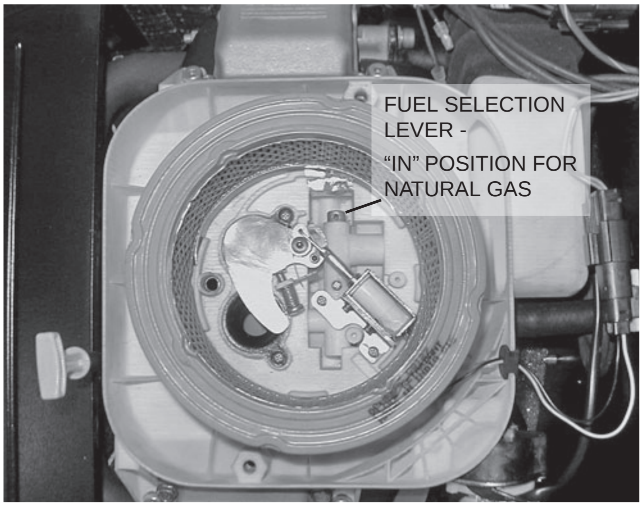


Figure 12. 13, 14, 15, 16, 17, & 20kW, GT-990/GT-999 (Airbox Cover Removed)

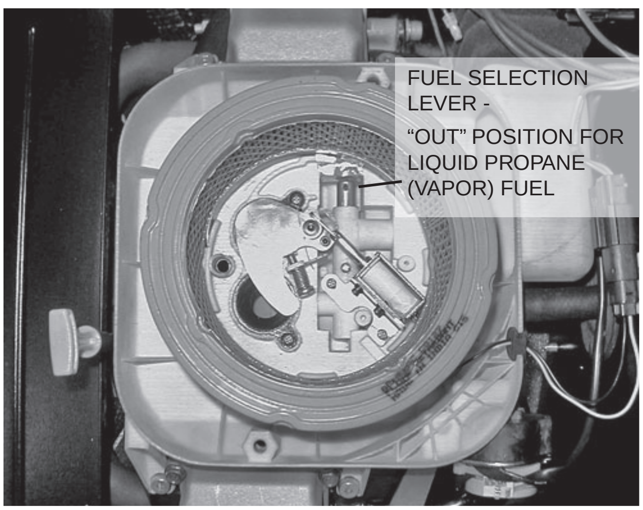


Figure 13. 13, 14, 15, 16, 17, & 20kW, GT-990/GT-999 (Airbox Cover Removed)

METERS

Devices used to measure electrical properties are called meters. Meters are available that allow one to measure (a) AC voltage, (b) DC voltage, (c) AC frequency, and (d) resistance In ohms. The following apply:

- To measure AC voltage, use an AC voltmeter.
- To measure DC voltage, use a DC voltmeter.
- Use a frequency meter to measure AC frequency In "Hertz" or "cycles per second".
- Use an ohmmeter to read circuit resistance, in "ohms".

THE VOM

A meter that will permit both voltage and resistance to be read is the "volt-ohm-milliammeter" or "VOM".

Some VOMs are of the "analog" type (not shown). These meters display the value being measured by physically deflecting a needle across a graduated scale. The scale used must be Interpreted by the user.

"Digital" VOM's (Figure 14) are also available and are generally very accurate. Digital meters display the measured values directly by converting the values to numbers.

Note: Standard AC voltmeters react to the AVERAGE value of alternating current. When working with AC, the effective value is used. For that reason a different scale is used on an AC voltmeter. The scale is marked with the effective or "rms" value even though the meter actually reacts to the average value. That is why the AC voltmeter will give an Incorrect reading if used to measure direct current (DC).

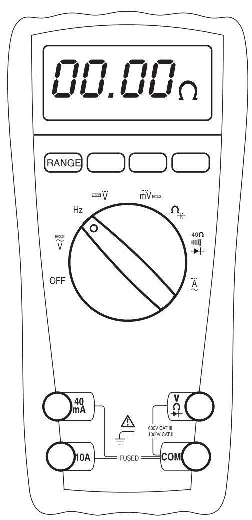


Figure 14. Digital VOM

MEASURING AC VOLTAGE

An accurate AC voltmeter or a VOM may be used to read the generator's AC output voltage. The following guidelines apply:

1. Always read the generator's AC output voltage at the unit's rated operating speed and AC frequency.
2. The generator's rated AC output voltage is 250 to 254 VAC and is not adjustable.
3. Only an AC voltmeter may be used to measure AC voltage. DO NOT USE A DC VOLTMETER FOR THIS PURPOSE.

⚠ DANGER!

Generators produce high and dangerous voltages. Contact with high voltage terminals will result in dangerous and possibly lethal electrical shock.

MEASURING DC VOLTAGE

A DC voltmeter or a VOM may be used to measure DC voltages. Always observe the following rules:

1. Always observe correct DC polarity.
   a. Some VOM's may be equipped with a polarity switch.
   b. On meters that do not have a polarity switch, DC polarity must be reversed by reversing the test leads.
   2. Before reading a DC voltage, always set the meter to a higher voltage scale than the anticipated reading. If in doubt, start at the highest scale and adjust the scale downward until correct readings are obtained.
3. The design of some meters is based on the "current flow" theory while others are based on the "electron flow" theory.
   a. The "current flow" theory assumes that direct current flows from the positive (+) to the negative (-).
   b. The "electron flow" theory assumes that current flows from negative (-) to positive (+).

Note: When testing generators, the "current flow" theory is applied. That is, current is assumed to flow from positive (+) to negative (-).

MEASURING AC FREQUENCY

The generator's AC output frequency is proportional to Rotor speed. Generators equipped with a 2-pole Rotor must operate at 3600 rpm to supply a frequency of 60 Hertz. Units with 4-pole Rotors must run at 1800 rpm to deliver a 60 Hertz output.

MEASURING CURRENT

Clamp-On

To read the current flow, in AMPERES, a clamp-on ammeter may be used. This type of meter indicates current flow through a conductor by measuring the strength of the magnetic field around that conductor. The meter consists essentially of a current transformer with a split core and a rectifier type instrument connected to the secondary. The primary of the current transformer is the conductor through which the current to be measured flows. The split core allows the Instrument to be clamped around the conductor without disconnecting it.

Current flowing through a conductor may be measured safely and easily. A line-splitter can be used to measure current in a cord without separating the conductors.

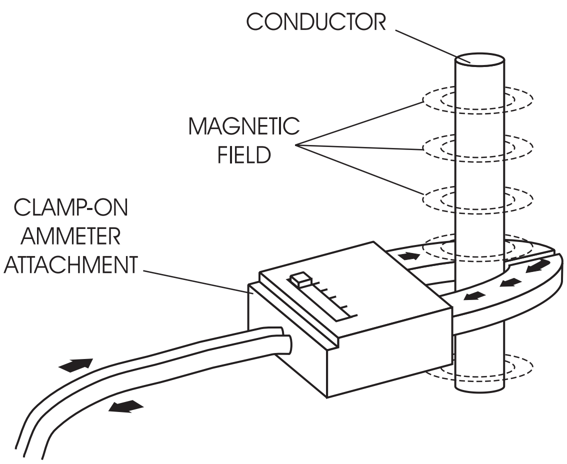


Figure 15. Clamp-On Ammeter

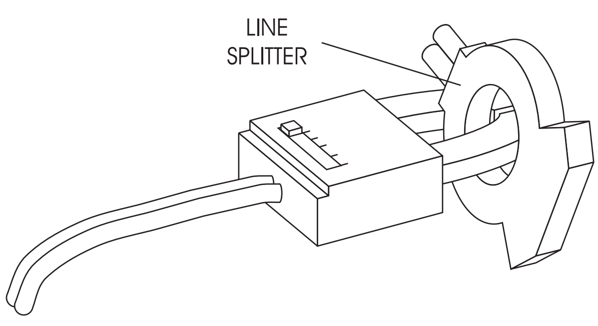


Figure 16. A Line-Splitter

Note: If the physical size of the conductor or ammeter capacity does not permit all lines to be measured simultaneously, measure current flow in each individual line. Then, add the Individual readings.

In-Line

Alternatively, to read the current flow in AMPERES, an in-line ammeter may be used. Most Digital Volt Ohm Meters (VOM) will have the capability to measure amperes.

This usually requires the positive meter test lead to be connected to the correct amperes plug, and the meter to be set to the amperes position. Once the meter is properly set up to measure amperes the circuit being measured must be physically broken. The meter will be in-line or in series with the component being measured.

In Figure 17 the control wire to a relay has been removed. The meter is used to connect and supply voltage to the relay to energize it and measure the amperes going to it.

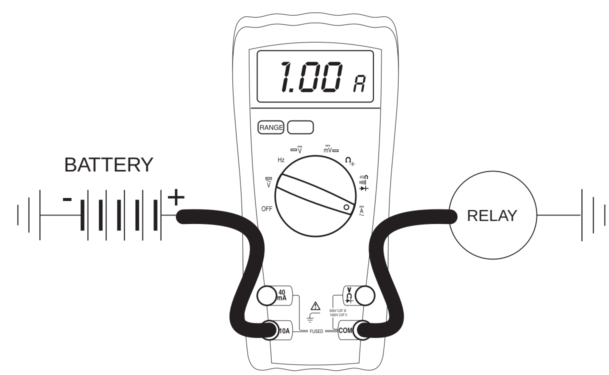


Figure 17. A VOM as an In-line Amp Meter

MEASURING RESISTANCE

The volt-ohm-milliammeter may be used to measure the resistance in a circuit. Resistance values can be very valuable when testing coils or windings, such as the Stator and Rotor windings, or checking a wire for an open or grounded condition.

When testing Stator windings, keep in mind that the resistance of these windings is very low. Some meters are not capable of reading such a low resistance and will simply read CONTINUITY.

If proper procedures are used, the following conditions can be detected using a VOM:

- A "short-to-ground" condition in any Stator or Rotor winding, or a short to ground on a specific control wire.
- Shorting together of any two parallel Stator windings.
- Shorting together of any two isolated Stator windings.
- An open condition in any Stator or Rotor winding, or an open in a control wire.

Component testing may require a specific resistance value or a test for INFINITY or CONTINUITY. Infinity is an OPEN condition between two electrical points, which would read as no resistance, or OL (Open Line) on a VOM. Continuity is a closed condition between two electrical points, which would be indicated as very low resistance (000.000) or “ZERO” on a VOM.

ELECTRICAL UNITS

Ampere

The rate of electron flow in a circuit is represented by the AMPERE. The ampere is the number of electrons flowing past a given point at a given time. One AMPERE is equal to just slightly more than 6.241×10^{18} electrons per second.

With alternating current (AC), the electrons flow first in one direction, then reverse and move in the opposite direction. They will repeat this cycle at regular intervals. A wave diagram, called a “sine wave” shows that current goes from zero to maximum positive value, then reverses and goes from zero to maximum negative value. Two reversals of current flow is called a cycle. The number of cycles per second is called frequency and is usually stated in “Hertz”.

Volt

The VOLT is the unit used to measure electrical PRESSURE, or the difference in electrical potential that causes electrons to flow. Very few electrons will flow when voltage is weak. More electrons will flow as voltage becomes stronger. VOLTAGE may be considered to be a state of unbalance and current flow as an attempt to regain balance. One volt is the amount of Electromotive Force (EMF) that will cause a current of 1 ampere to flow through 1 ohm of resistance.

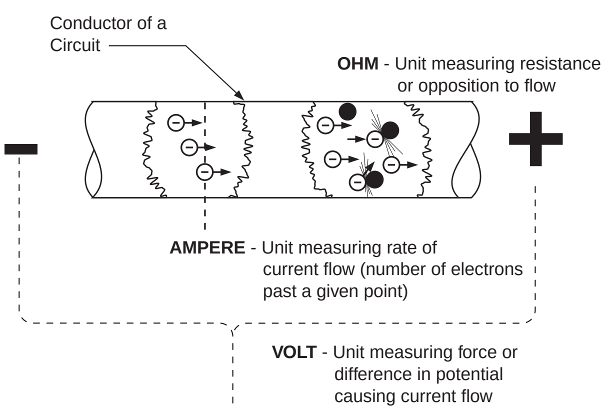


Figure 18. Electrical Units

Ohm

The OHM is the unit of RESISTANCE. In every circuit there is a natural resistance or opposition to the flow of electrons. When an EMF is applied to a complete circuit, the electrons are forced to flow in a single direction rather than their free or orbiting pattern. The resistance of a conductor depends on (a) its physical makeup, (b) its cross-sectional area, (c) its length, and (d) its temperature. As the conductor’s temperature increases, its resistance increases in direct proportion. One (1) ohm of resistance will permit one (1) ampere of current to flow when one (1) volt of EMF is applied.

OHM’S LAW

A definite and exact relationship exists between VOLTS, OHMS and AMPERES. The value of one can be calculated when the value of the other two are known. Ohm’s Law states that in any circuit the current will increase when voltage increases but resistance remains the same, and current will decrease when resistance Increases and voltage remains the same.

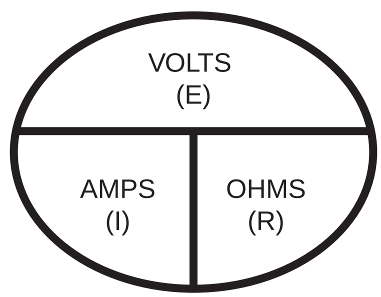


Figure 19. Ohm’s Law

If AMPERES is unknown while VOLTS and OHMS are known, use the following formula:

$$AMPERES = \frac{VOLTS}{OHMS}$$

If VOLTS is unknown while AMPERES and OHMS are known, use the following formula:

$$VOLTS = AMPERES \times OHMS$$

If OHMS is unknown but VOLTS and AMPERES are known, use the following:

$$OHMS = \frac{VOLTS}{AMPERES}$$

VISUAL INSPECTION

When it becomes necessary to test or troubleshoot an alternator, it is a good practice to complete a thorough visual inspection. Remove the access covers and look closely for any obvious problems. Look for the following:

- Burned or broken wires, broken wire connectors, damaged mounting brackets, etc.
- Look for loose or frayed wiring insulation, loose or dirty connections.
- Check that all wiring is well clear of rotating parts.
- Verify that the Generators voltage output matches Utility voltage.
- Look for foreign objects, loose nuts, bolts and other fasteners.
- Clean the area around the Generator. Clear away paper, leaves, snow, and other objects that might blow against the Generator and obstruct its air openings.
- Insulation Resistance

The insulation resistances of stator and rotor windings are a measurement of the integrity of the insulating material that separates the electrical windings from the Generator steel core. This resistance can degrade over time or due to such contaminates as dust, dirt, oil, grease and especially moisture. In most cases, failures of stator and rotor windings are due to a break down in the insulation. In many cases, a low insulation resistance is caused by moisture that collects while the Generator is shut down. When problems are caused by moisture buildup on the windings, this can usually be corrected by drying the windings. Cleaning and drying the windings can usually eliminate dirt and moisture that has built up in the Generator windings.

THE MEGOHMMETER

Introduction

A Megohmmeter often called a “megger”, consists of a meter calibrated in megohms and a power supply. Set the “megger” to a voltage setting of 500 volts when testing stators and rotors.

WARNING!

- DO NOT EXCEED 500 VOLTS
- DO NOT APPLY VOLTAGE LONGER THAN 1 SECOND
- FOLLOW THE “MEGGER” MANUFACTURERS INSTRUCTIONS CAREFULLY

Testing Stator Insulation

WARNING!

Warning: Megger HIGH voltages could cause damage to other components on the Generator. Take the proper precautions before testing.

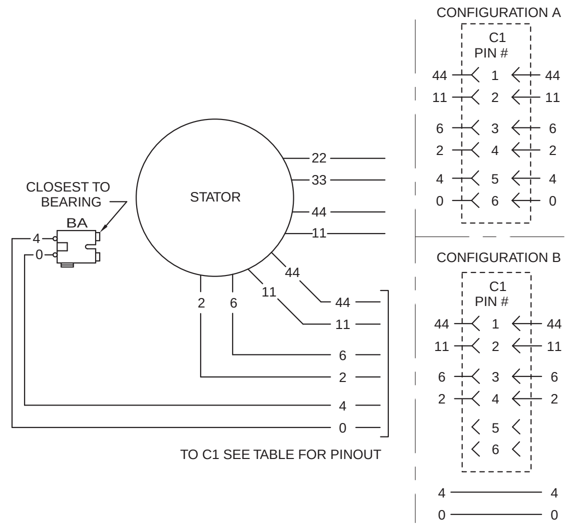


Figure 20. Stator Output Leads

Isolate all stator leads (Figure 20) and connect all the stator leads together.

Use a megger power setting of 500 volts. Connect one megger test lead to the junction of all the stator leads, the other test lead to frame ground on the stator can. Read the number of megohms on the meter.

To calculate the MINIMUM acceptable megger readings use the following formula:

$$\text{MINIMUM INSULATION RESISTANCE (in “Megohms”)} = \frac{\text{GENERATOR RATED VOLTS}}{1000} + 1$$

Example: Generator is rated at 120VAC. Divide “120” by “1000” to obtain “0.12”. Then add “1” to obtain “1.12” megohms. Minimum insulation resistance for a 120VAC stator is 1.12 megohms.

$$\frac{120}{1000} + 1 = 1.12 \text{ megohms}$$

If the stator insulation resistance is less than the calculated minimum resistance, clean and dry the stator. Then, repeat the test. If resistance is still low, replace the stator.

Use the Megger to test for shorts between isolated windings as outlined in “Stator Insulation Tests.”

Testing Rotor Insulation

Apply a voltage of 500 volts across the rotor positive slip ring (nearest the rotor bearing), and a clean frame ground (i.e. the rotor shaft).

WARNING!

- DO NOT EXCEED 500 VOLTS
- DO NOT APPLY VOLTAGE LONGER THAN 1 SECOND
- FOLLOW THE “MEGGER” MANUFACTURERS INSTRUCTIONS CAREFULLY

ROTOR MINIMUM INSULATION RESISTANCE:

1.5 megohms

CLEANING THE GENERATOR

Caked or greasy dirt may be loosened with a soft brush or a damp cloth. A Vacuum system may be used to clean up loosened dirt. Dust and dirt may also be removed using dry, low-pressure air (25 psi maximum).

CAUTION!

Do not use sprayed water to clean the Generator. Some of the water will remain on the Generator windings and terminals and may cause very serious problems.

DRYING THE GENERATOR

The procedure for drying an alternator is as follows:

1. Open the Generator main circuit breaker.

WARNING!

Generator should have no electrical loads applied while drying.

2. Disconnect all wires in a manner that allows the alternator to be completed disconnected.
3. Provide an external source to blow warm, dry air through the Generator interior (around the rotor and stator windings.

CAUTION!

Do not exceed 185º F (85ºC).

4. Re-connect stator lead.
5. Start the Generator and let it run for 2 or 3 hours.
6. Shutdown the Generator and repeat the insulation resistance tests.

CONTROL PANEL

Figure 21. Nexus Controller Panel

WARNING!

With the switch set to AUTO, the engine may crank and start at any time without warning.
Such automatic starting occurs when Utility power source voltage droops below a preset level or during the normal exercise cycle. To prevent possible injury that might be caused by such sudden starts, always set the switch to OFF and remove the fuse before working on or around the Generator or transfer switch. Then, place a "DO NOT OPERATE" tag on the Generator panel and on the transfer switch.

AUTO-OFF-MANUAL Switch

AUTO Position – Selecting this switch activates fully automatic system operation. It also allows the unit to automatically start and exercise the engine every seven days with the setting of the exercise timer (see Section 5.2 "Setting the Exercise Timer").

OFF Position – This switch position shuts down the engine. This position also prevents automatic operation.

MANUAL Position – Set the switch to MANUAL to crank and start the engine. Transfer to standby power will not occur unless there is a Utility failure.

7.5 Amp Fuse

This fuse protects the controller as well as the DC components against overload. If the fuse element has melted open due to an overload, engine cranking or running will not be possible. Should a fuse replacement become necessary, use only an identical 7.5 amp replacement fuse.

USER INTERFACE

Exercise Time

The Generator is equipped with an internal exercise timer. Once set, the Generator will start and exercise every seven days, on the day of the week and the time of day specified. During this exercise period, the unit runs for approximately 12 minutes and then shuts down. Transfer of loads to the Generator output does not occur during the exercise cycle unless Utility is lost. See Section 5.2 for information on setting the exercise time.

Note: The exerciser will only work with the AUTO-OFF-MANUAL switch in the AUTO position.

Activation Wizard

When battery power is applied to the Generator during the installation process, the controller will light up. However, if the Generator is not activated it will NOT automatically run in the event of a power outage. Activating the Generator is a simple one-time process that is guided by the controller screen prompts. Once the product is activated, the controller will not prompt you again, even if the battery is disconnected. See Section 5.2 for the activation wizard procedure.

Installation Wizard

During the initial setup of the controller, an interconnection self-test will load on the screen.

Upon power up, this controller will go through a system self test which will check for the presence of Utility voltage on the DC circuits. If the installer mistakenly connects the AC Utility sense wires onto the DC terminal block the controller may be rendered inoperable. If the self-test failed and detected Utility voltage on the DC circuits, the controller will display a warning message and lock out the Generator, preventing damage to the controller. Power to the controller must be cycled for this warning message to clear. Utility voltage on N1 and N2 must be present inside the Generator control panel for the self-test to begin. Each time power to the controller is cycled the self-test will check for correct wiring.

WARNING!

Damage caused by improper wiring of the control wires is not warrantable!

Time and Date

After the successful completion of the installation wizard, the controller will prompt the user to set the minimum settings to operate. The prompts are as follows: current date, current time, exercise time, and exercise day. These settings may be changed at any time utilizing the "EDIT" menu. See Section 4.1 for "Menu Navigation"

Note: Maintenance interval initialization will take place when the exercise time is set.

If the 12-volt battery or fuse is removed, the Installation Wizard will operate when power has been restored. The only prompts that will follow are the current time and date.

Note: To test the Generator prior to installation, press the

"ENTER" key to avoid setting up the exercise time. This will ensure that when the customer powers up the unit, the controller will prompt the consumer to enter the exercise time.

Low Speed Exercise

On the 17 and 20kW Generators this feature, when enabled, allows the Generator to exercise at 2,400 rpm. Low speed exercise can be disabled from the "EDIT" menu. See Section 4.1 "Menu Navigation".

Display Interface Menus

The LCD display is as detailed below

- The "Home" page is the default page and will display if no keys are pressed for 30 seconds. This page normally shows the current status and the current time and date. It will also display the highest priority active Alarm and/or Warning along with the backlight flashing when one of these events occurs. In the case of multiple Alarms or Warnings, the controller will only display the first message. To clear an Alarm or Warning, see Section 4.2 "Protection Systems."
- The display backlight is normally off. If the user presses any key, the backlight will come on automatically and remain on for 30 seconds after the last key is pressed.
- The "Main Menu" page will allow the user to navigate to all other pages or sub-menus by using the Left/Right and Enter keys. Each press of the Escape key takes you back to the previous menu until the main menu is reached. This page displays the following options: HISTORY, STATUS, EDIT, and DEBUG. See Section 4.1 - "Menu System."

TO SELECT AUTOMATIC OPERATION

The following procedure applies only to those installations which utilize an air-cooled Generator in conjunction with a transfer switch. Residential transfer switches do not have intelligent circuits of their own. PCB logic in the controller controls the automatic operation of the transfer switch and the Generator.

To select automatic operation when a transfer switch is installed along with a home standby Generator, the procedure is as follows:

1. Ensure the CONTACTOR in the transfer switch is in the "Utility" position. If needed, manually actuate the switch contacts to the "Utility" position. See Section 5.1 for specific instructions.
2. Ensure Utility voltage is available to the UTILITY terminals N1 and N2.
3. Actuate the Generator main line circuit breaker (MLCB) to its "Closed" position.
4. Set the Generator AUTO-OFF-MANUAL switch to the AUTO position.

Following the procedure of Steps 1 through 4, a dropout in Utility voltage below a preset level will result in automatic Generator cranking and start-up. Following startup, the transfer switch will actuate to the "Standby" position.

MANUAL OPERATION

Transfer to "Standby" and Manual Startup

To transfer electrical loads to the Generator and to start the Generator manually, the procedure is as follows:

1. On the Generator, set the AUTO-OFF-MANUAL switch to the OFF position.
2. On the Generator, set the main line circuit breaker (MLCB) to the "Open" Position.
3. Locate a means of Utility disconnect and set it to the OFF position.
4. Manually actuate the CONTACTOR to the "Standby" position. See Section 5.1 for specific instructions.
5. On the Generator, set the AUTO-OFF-MANUAL switch to the MANUAL position.

⚠ WARNING!

Engine will crank and start!

6. Let the engine warm up and stabilize for a minute or two at no-load. Set the Generators MLCB to the "Closed" position. Generator voltage is available to the transferred electrical loads.

Retransfer Back to "Utility" and Manual Shutdown

To shutdown the Generator and retransfer electrical loads back to the "Utility" position, the procedure is as follows:

1. Set the Generators MLCB to its "Open" position.
2. Allow the Generator to run at no-load for several minutes to cool.
3. Set the Generators AUTO-OFF-MANUAL switch to the OFF position.
4. Locate a means of Utility disconnect and set it to the OFF position.
5. Manually actuate the CONTACTOR to the "Utility" position.
6. Restore Utility voltage to the transfer switch, by the means that was utilized in Step 4.
7. Set the Generator AUTO-OFF-MANUAL switch to AUTO.

With the Generator in AUTO, a dropout in Utility voltage below a preset level will result in automatic Generator cranking and start-up. Following startup, the transfer switch will actuate to the "Standby" position.

INTRODUCTION

When the Generator is installed in conjunction with a transfer switch, either manual or automatic operation is possible. See Section 5.1 for the manual transfer and engine startup, manual shutdown and re-transfer, and full automatic operation procedure.

UTILITY FAILURE

Initial Conditions

The Generator is in AUTO, ready to run, and the CONTACTOR is in the "Utility" position. When Utility fails (below 65% of nominal), a 10-second line interrupt delay time is started. If the Utility is still not present when the timer expires, the engine will crank and start. Once started a five (5) second engine warm-up timer will start.

When the warm-up timer expires the controller will transfer load to the Generator. If Utility voltage is restored (above 75% of nominal) at any time between the initiation of the engine start and when the Generator is ready to accept load, (five second warm-up time has not elapsed), the controller will complete the start cycle and run the Generator through its normal cool down cycle; however the CONTACTOR will remain in the "Utility" position.

CRANKING

The controller will cyclic crank the engine 5 times as follows: 16 second crank, 7 second rest, 16 second crank, 7 second rest followed by 3 additional cycles of 7 second cranks followed by 7 second rests.

Choke Operation

- The 990/999cc engines have an electric choke in the air box that is controlled automatically via the controller.
- The 530cc engines have an electric choke on the divider panel air inlet hose, control is done automatically via the controller
- The 410cc engines have a choke behind the air box. Control is done automatically via the controller.

Failure to Start

Failure to start is defined as any of the following occurrences during cranking.

1. Not reaching starter dropout within the specified crank cycle.

Note: Starter dropout is defined as 4 cycles at 1,000RPM

2. Reaching starter dropout, but then not reaching 2200 rpm within 15 seconds. After which the controller will go into a rest cycle for 7 seconds, then continue the rest of the crank cycle.

Note: During a rest cycle the start and fuel outputs are de-energized and the magneto output is shorted to ground.

CRANKING CONDITIONS

The following notes apply during the crank cycle.

1. Starter motor will not engage within 5 seconds of the engine shutting down
2. The fuel output will not be energized with the starter
3. The starter and magneto outputs will be energized together
4. Once the starter energizes, the controller will begin looking for engine rotation. If it does not see an RPM signal within 3 seconds it will shut down and latch out on "RPM Sensor loss"
5. Once the controller sees an RPM signal it will energize the fuel solenoid, drive the throttle open, and continue the crank sequence. The fuel solenoid does not activated earlier because if the engine does not crank, this would potentially fill the engine/exhaust up with fuel. It takes at least 3 seconds to detect cranking on the engine with a magneto RPM measurement. This would result in 3 seconds of fuel being delivered, increasing the chances of a backfire.
6. The starter motor will disengage when speed reaches starter dropout
7. If the Generator does not reach 2200 rpm within 15 seconds, re-crank cycle will occur.
8. If the engine stops turning between starter dropout and 2200 RPM the board will go into a rest cycle for 7 seconds then re-crank (if additional crank cycles exist.)
9. Once started the Generator will wait for a hold off period before starting to monitor oil pressure and oil temperature. See Section 4.2 "Engine Protective Devices"
10. During a manual crank attempt, if the AUTO-OFF-MANUAL is switched from MANUAL position to OFF, the crank attempt will abort.
11. During automatic crank attempt, if the Utility returns, the cranking cycle does NOT abort, but continues until complete. Once the engine starts, it will run for one minute then shut down.

LOAD TRANSFER PARAMETERS

The transfer of load when the Generator is running is dependent upon the operating mode as follows:

Manual

- No transfer to Standby when Utility is present.
- Transfer to Standby will occur if Utility fails (below 65% of nominal) for 10 consecutive seconds.
- Transfer back to Utility when Utility returns for 15 consecutive seconds. The engine will continue to run until removed from the Manual mode.

Auto

- Transfer to standby will occur if Utility fails (below 65% of nominal) for 10 consecutive seconds.
- A five (5) second engine warm-up timer will initialize.
- Transfer back to the “Utility” position if Utility subsequently returns.
- Transfer to the “Standby” position if Utility is still not present.
- Transfer back to Utility once Utility returns (above 75% of nominal) for 15 seconds.
- Transfer back to Utility, if present, if the Generator is shut down for any reason (such as the switch turned to the OFF position or a shutdown alarm 0.
- After transferring back to Utility the engine will shut down, after a one (1) minute cool-down timer expires.

Exercise

- Exercise will not function if the Generator is already running in either Auto or Manual mode.
- During exercise, the controller will only transfer if Utility fails during exercise for 10 seconds, and will follow the steps outlined above for Auto operation.

UTILITY RESTORED

The Generator is running, CONTACTOR in “Standby”, running in Utility failure. When the Utility returns (above 75% of nominal), a 15 second return to Utility timer will start. At the completion of this timer, if the Utility supply is still present and acceptable, the control will transfer the load back to the Utility and run the engine through a one (1) minute cool down period and then shut down. If Utility fails for three (3) seconds during this cool down period, the control will transfer load back to the Generator and continue to run while monitoring for Utility to return.

INTRODUCTION

Performing proper maintenance on a Generator will ensure proper function during a Utility failure. Once a Generator has failed, it is already too late. Ensuring the proper oil changes and inspections have been completed at the specified times will help keep the Generator reliable.

MAINTENANCE MESSAGE

When a maintenance period expires, a warning message will be displayed. Pressing the Enter key will cause the alert to reset and will prompt the user to confirm the action. Resetting will clear the alert and reset the maintenance counters for all warnings annunciated. The history log will record the alert. The maintenance counter will not accumulate without battery voltage. Once restored, a prompt will appear for the user to set the time and date. The new date and time will adjust the maintenance counters accordingly.

Only one alert will appear on the display at any one time. With the acknowledgement of the first alert, the next active alert will be displayed

Message Interval

Table 4. Message Intervals

"Inspect Battery"	1 Year
"Change Oil & Filter"	200 hours or 2 years, 100 hours or 2 years on 20kW models
"Inspect Air Filter"	200 Hours or 2 years
"Change Air Filter"	200 Hours Or 2 years
"Inspect Spark Plugs"	200 Hours or 2 years
"Change spark Plugs"	400 hours or 10 years

Resetting Maintenance Intervals

When a complete maintenance inspection has been completed before a specific alert was generated, it is possible to reset the intervals to prevent future alerts from occurring for maintenance that was just performed. To reset the intervals proceed to Section 4.1 "Menu Navigation" for further information

With the resetting of the intervals, all maintenance counters will start from the current time and date of the Generator.

Engine Oil

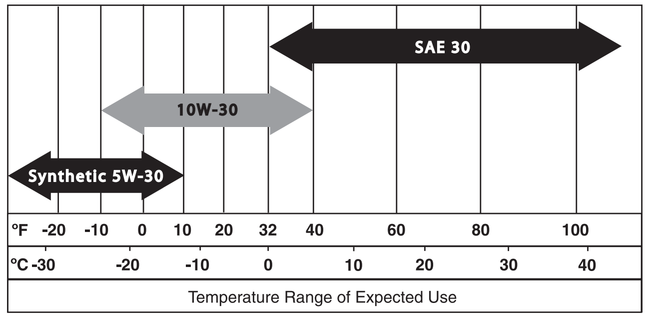
Modern oils play vital functions in protecting the engine. Lubricating oil acts to reduce friction and wear, cool engine parts, seal combustion chambers, clean engine components, and inhibit corrosion. See Table 7 "Service Schedule" for specific inspection items and interval

Engine Oil Recommendations

All oil should meet minimum American Petroleum Institute (API) Service Class SJ, SL or better. Do not use special additives. Select the oil's viscosity grade according to the expected operating temperature. Refer to Table 6.

- SAE 30 ➤ Above 32º F
- 10W-30 ➤ Between 40ºF and -10ºF
- Synthetic 5W-30 ➤ 10ºF and below

Table 6.



⚠ CAUTION!

Any attempt to crank or start the engine without the recommended oil may result in an engine failure.

AIR FILTER

Air is necessary for successful combustion in the engine. Clean air (almost 100% pure) is critical to engine survival and vital to its performance. There are operational signs when an air filter has become completely plugged. The engine begins to lose power, and fuel consumption increases. Black smoke may blow from the exhaust. Continued operation with a plugged air filter may cause severe damage to the engine.

SPARK PLUGS

Good spark is essential to properly maintaining the engine. Although replacement may not be required, inspection of the plugs during routing maintenance is critical. Always verify that spark plugs are gapped according to the specifications. Improperly gaped spark plugs will effect the operation of the engine.

See Test 57 for diagnosing spark plug related problems.

See "Specifications" for specific spark plug gaps.

VISUAL INSPECTION

During all service intervals, a proper visual inspection must be conducted to ensure proper function, airflow, and to prevent fire hazards.

Air inlet and outlet openings in the Generator compartment must be open and unobstructed for continued proper operation. This includes such obstructions as high grass, weeds, brush, leaves, and snow.

WARNING!

The exhaust from this product gets extremely hot and remains hot after shutdown. High grass, weeds, brush and leaves must remain clear of the exhaust. Such materials may ignite and burn from the heat of the exhaust system.

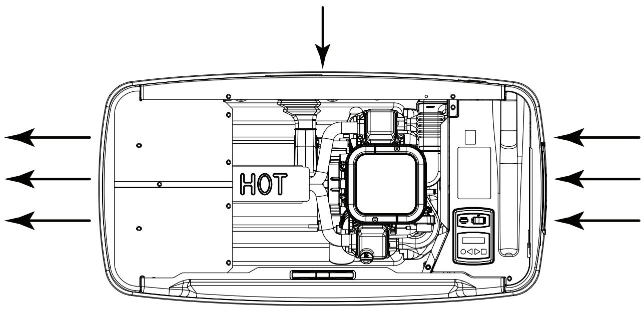


Figure 22. Cooling Vent Locations

CORROSION PROTECTION

Periodically wash and wax the enclosure using automotive type products. Frequent washing is recommended in salt water/ coastal areas. Spray engine linkages with a light oil such as WD-40.

VALVE CLEARANCE

Proper valve clearance is vital to ensuring longevity of the engine. After the first 6 months of operation, check the engine valve clearance and adjust as necessary. Checking of the engine valve clearance thereafter periodically will increase reliability of the Generator. **Refer to Test 63 for Specification and adjustment procedure.**

Some symptoms of an engine with valves in need of adjustment are:

- Hard starting
- Smoke out of the exhaust
- Rough running
- Lack of horse power

BATTERY

Performing proper battery maintenance at the required intervals will allow for proper starting of the Generator during a power outage. Some common things to look for and check during maintenance are:

- Inspect the battery posts and cables for tightness and corrosion. Tighten and clean as necessary.
- Check the battery fluid level of unsealed batteries and, if necessary, fill with Distilled Water only. Do not use tap water in batteries.
- Have the state of charge and conditions checked. This should be done with an automotive-type battery hydrometer.

Note: See Test 45 for further testing the state of a battery.

Table 7. Service Schedule

SYSTEM/COMPONENT	PROCEDURE			FREQUENCY
X = Action R = Replace as Necessary * = Notify Dealer if Repair is Needed.	Inspect	Change	Clean	W = Weekly M = Monthly Y = Yearly
FUEL				
Fuel lines and connections*	X			M
LUBRICATION				
Oil level	X			M or 24 hours of continuous operation.
Oil		X		2Y or 200 hours of operation.**
Oil filter		X		2Y or 200 hours of operation.**
COOLING				
Enclosure louvers	X		X	W
BATTERY				
Remove corrosion, ensure dryness	X		X	M
Clean and tighten battery terminals	X		X	M
Check charge state	X	R		EVERY 6 M
Electrolyte level	X	R		EVERY 6 M
ENGINE AND MOUNTING				
Air cleaner	X	R		2Y or 200 hours
Spark plug(s)	X	R		2Y or 200 hours
GENERAL CONDITION				
Vibration, Noise, Leakage, Temperature*	X			M
COMPLETE TUNE-UP*	TO BE COMPLETED BY A DEALER			2Y or 200 hours

*** Contact the nearest dealer for assistance if necessary.**

**** Change oil and filter after first eight (8) hours of operation and then every 200 hours thereafter, or 2 years, whichever occurs first. Change sooner when operating under a heavy load or in a dusty or dirty environment or in high ambient temperatures.**

WIRELESS MONITOR

A small wireless device (about the size of a credit card) provides a basic approach to wireless monitoring; however, the device only provides three basic alerts.

Figure 23. Nexus™ Wireless Monitor

The green LED (Generator OK) indicates that either:

- The Auto/Off/Manual switch on the generator is set to the Auto position, no alarms are present, and the generator is ready to start and run or is running.

Or:

- The Auto/Off/Manual switch on the generator is set to the Manual position, the engine is running and no alarms are active.

When active, the green LED will flash once every 10 seconds.

The yellow LED (Maintenance Needed) indicates that either a GENERATOR WARNING is present or generator maintenance is required. The generator will not be prevented from running when the yellow LED is on. When active, the yellow LED will flash once every two (2) seconds.

The red LED (Contact Dealer) indicates any one of the following conditions:

- The Auto/Off/Manual switch on the generator is in the Off position.
- The generator has not been registered
- A generator alarm is present.
- The controller has been powered up, but the start up wizard procedure has not been completed.

If a generator alarm is present the generator will not start and run in the event of a utility loss, or will be automatically shut down if the engine is already running. When active, the red LED will flash once every second.

The internal buzzer will sound once every 30 seconds when the red LED is on. The buzzer can be silenced by briefly pressing and releasing the Pair/Reset button; the buzzer will pulse twice to indicate it has been silenced. The buzzer will not reactivate until a new alarm has been detected.

The wireless monitor display unit updates the status of its LED's every 30 to 60 seconds. To conserve power and extend battery life, the LED's are not lit continuously: instead they are briefly flashed as indicated above.

WIRELESS BASIC TROUBLESHOOTING.

Pairing the Generator Transceiver with the Display Unit

1. See figure 11 for the location of the "Pair/Reset" button on the display unit.

   Place the display unit against the generator transceiver as shown in figure 10, then immediately press and hold the "Pair/Reset" button on the display unit
2. Once the yellow LED begins flashing (after about three seconds), indicating the modules are in pairing mode, release the "Pair/Reset" button on the display unit and move the display unit away from the generator transceiver.
3. The Yellow LED will continue to flash during the pairing process.
4. Once the two modules have successfully paired up the yellow LED will stop flashing and the green LED will begin flashing.
5. Press and release the Pair/Reset button to complete the pairing process. At this time the green LED will stop flashing and the display unit will enter its normal mode of operation.

Note: If the Auto/Off/Manual switch is still in the off mode the red LED will begin to flash to indicate the generator is in alarm mode. Do not confuse this flashing red LED with the "failure to pair" described below.

Figure 24. Place the Display Unit Against the Generator Transceiver

NOTE: The magnets in the display unit activate a magnetic reed switch in the generator transceiver in step 21. The relative positioning of the two units needs to be as shown in Figure 10 to activate the magnetic reed switch.

Figure 25. Location of Pair/Reset Button

6. Proceed with the "Re-Assemble the Generator" section
7. If the two modules fail to pair up within 30 seconds, the yellow LED will stop flashing and the red LED will begin to flash. If this happens proceed as follows:

- Press and release the Pair/Reset button to stop the red LED from flashing.
- Check that good non-rechargeable AAA 1.5V batteries are installed.
- Check the wiring to make sure all the plugs are fully inserted.
- Repeat the pairing process from step 21A.

Results

1. If the link is established, discontinue troubleshooting.
2. If the link continues to fail, replace the wireless remote and transmitter.

WIRELESS ADVANCED MODULE

Figure 26. Wireless Advanced Module

The wireless display system consists of two identical radio transceivers, one mounted near the Generator and the other (the one with the display), should be in a convenient viewing location. The system has a "line of sight" range of about 300 feet but this will be reduced if the signal has to go through walls, floors, etc.

NOTE: Some building materials may completely block the passage of the signal. For example: steel beams, metal siding, foil radiant barrier insulation.

The display is intended to show the status of the generator and warn you if the system is in an alarm state. It also provides the following additional functions:

- An independent (of the generator Alarm Log) time/date stamped history of Generator events such as starting and stopping.
- Allows remote starting and stopping of the generator.
- Facility to set an exercise time and day from the display.
- A separate battery backed clock (with date) which is synchronized to the generator clock. If power is removed from the generator, the time and date will automatically be restored from this clock.
- Ability to add extra displays.
- Graphing capability.

WIRELESS ADVANCED FEATURES

One of the most commonly used features on the device is the ability to test the functions of the generator. The "TEST" menu provides the option to remotely start, start and transfer, and stop the generator. This feature only works when the AUTO-OFF-MANUAL switch is set to AUTO and Utility voltage is available.

Note: The remote cannot disable or prevent the Generator from running; the only method to disable the generator is by cycling the AUTO-OFF-MANUAL switch to the OFF position.

Some operational rules apply when using the "TEST" feature and are not due to product failure:

- The Generator can only be shutdown if it was started via the remote. It will not respond to the command if running in a Utility failure.
- When the command has been given for a start and transfer to occur the Generator will stay running until the "STOP" command has been given. The generator will then run for a 1 minute cool down period.

WIRELESS ADVANCED TROUBLESHOOTING.

Resynchronizing the Radio After Battery Disconnection or In the Event of Loss of Communication

If the battery is ever disconnected from the generator, the radio system will stop working and WILL NOT AUTOMATICALLY resynchronize. To resynchronize the system, follow the steps (similar to installation) shown below:

1. Ensure the display unit has working batteries fitted into it.
2. Take the display unit to the generator and turn the display unit off using the slide switch on the side of the unit.
3. Open the generator lid and turn the generator Auto/Off/Manual switch to the "Off" position.

4. Remove the large enclosure panel from the front of the enclosure.
5. Locate the radio connector under the generator display panel. It is the closest one to you as you are facing the generator; it has a white connector with gray cable going to it. It has a locking tab that needs to be squeezed to remove it. Remove the connector by squeezing the tab and pulling the connector down. As the locking mechanism is a tight fit, you may need pliers to help release it.
6. Turn on the display unit and go to the RADIO menu.
7. Select "RESET RADIO" and IMMEDIATELY (within 5 seconds) put the connector back into the controller (that you removed in step 5E).
8. The display unit will start searching for the generator. Up to one minute will pass while the remote unit and generator synchronize. Once the generator is found, the radio link has been re-established and the settings will be remembered.
9. Re-fit the front enclosure panel and close the lid.
10. Turn the Auto/Off/Manual switch to the Auto position.
11. Return the display unit to its original location and re-connect it to the wall transformer. Turn it off and back on again (this is just to get it out of sleep mode which it may have entered on battery power).

Results

1. If the link is established, discontinue troubleshooting.
2. If the link fails to establish, repeat Steps 5-8 using a different channel.
3. If the link continues to fail, replace the wireless remote and transmitter.

To get to the Main Menu from any other display, press the "Esc" key one or more times. The Main Menu is shown in Figure 27. There are four sub-menus, each with its own set of sub-menus. The menu system diagram is shown in Figure 37.

There are four selection and navigation keys below the display. The "Escape" key will cause the display to move back toward the main menu. The "Enter" key is used to activate a menu or accept a value when it is changed. The UP and DOWN triangle keys perform a number of different functions depending on which screen of a menu you are in: with them you can move the flashing curser to the next choice (the menu to be selected will flash on and off); they will act as the left and right arrows to move between the various Edit menus; In an Edit menu they will increase or decrease a value or change the choice (i.e. from Yes to No). See Figure 37 for the Basic Menu System Diagram.

Figure 27. Nexus Display and Navigation Buttons

MAIN MENU

There are 4 selections in the Main Menu: History, Status, Edit, and Debug.

```
History     Status
 Edit       Debug
```

Figure 28. Nexus Display Main Menu

History

The History Menu will display two history logs: Alarm Log and Run Log.

- Alarm Log: displays the last 50 alarm conditions. They are in date time order, numbered from 1 to 50; 1 is the most recent. Use the (up triangle image) and the (down triangle image) to move from alarm to alarm. Each alarm lists the Date, Time of trigger, and the description of the alarm.
- The Run Log will display the last 50 Run events. It will display the date and time as well as a brief description of the event; for instance Running – Utility Lost; Stopped – Auto.

```
History
Alarm Log    Run Log
```

Figure 29. History Menu

```
1   09/15/10   04:55:22
    Under Voltage
```

Figure 30. Alarm Log Display.

Use the up and down keys to move from the most recent Alarm (1) to the oldest (50).

```
1   09/15/10   04:55:22
    Stopped
```

Figure 31. Run Log Display.

Use the up and down keys to move from the most recent Run event (1) to the oldest (50).

Status

The Status Menu will display four choices: State, Display, Command, and Versions. Use the up and down triangle keys to move the

- State will display the current state of the panel along with the current date, time and day. See Figure 37 for the complete list of possible Status messages which will be displayed.
- Command will display the current command. See Figure 37 for the list of possible commands which will be displayed.
- Versions will display the version of Software and Hardware of the panel.
- Display will provide up to five generator parameters: Run Hours, RPM, Hz, Battery, and Hours Under Load (if enabled).
  - Run Hours will display the total number of hours the generator has run (in 0.0 Hours format)
  - RPM will display the Engine Speed (in RPM)
  - Hz will display the generator output frequency (in 0.0 Hz format)
  - Battery will display the battery voltage (i.e. 12.9)
  - Hours Under Load will provide the total number of hours the unit has actually provided power.

Figure 32. Status Menu

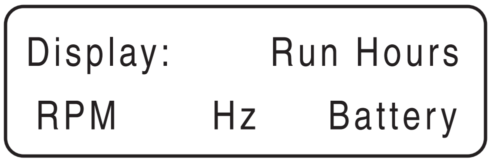


Figure 33. Display Menu

Edit

Provides the means to edit five of the operating parameters of the unit: Exercise Time, Current Time, Frequency, Language, Startup Delay, and Reset Maintenance. To access the editing screens go to the Edit menu and press the “Enter” button. One of the above menus will appear. Use the UP and DOWN triangle buttons to move from menu to menu. When you are in the menu you want to change press the “Enter” button. Then use the UP and DOWN triangle buttons to change the value. When you have reached the value you want press the “Enter” button. If you want to get out of a choice without changing it simply press the “Esc” button.

- Exercise Time will go through 4 selections: Quiet Test Mode (Yes/No), Select Hour, Select Minute, and Select Day. When you are through the unit will be programmed to perform a weekly exercise.
- Current Time will go through 5 selections: Select Hour, Select Minute, Select Month, Select Date, Select Year. The current time must be set to enable the exercise and maintenance functions of the panel.
- Frequency is not enabled at this time.
- Language provides three choices; English, Francais, and Espanol.
- Startup Delay provides a way to change the time delay between when Utility fails and when the Generator starts and transfers. It is adjustable from 10 to 30 seconds.
- Reset Maintenance will reset the Maintenance warning clock.

Debug

Provides four test tools integral to the control panel: Inputs, Outputs, Display, and QT-Test.

- TEST Inputs provides a way to see the status of the 8 input channels that the control panel monitors. See Table 8 for the list of inputs the control panel monitors. Each input represents an open or closed set of contacts, and will display either a 0 or 1 character. The 0 character represents an open contact; a 1 character represents a closed contact. The Inputs screen is a handy way to tell if the control is seeing a valid input from a particular source.
- TEST Output provides a way to see the status or the output relays the control panel uses to make things happen (like crank and run and transfer). See Table 8 for the list of output channels. Each channel represents a relay with a character of either 0 or 1. The 0 character represents a relay that is de-energized (OFF); a 1 represents a relay that is energized (ON). The outputs screen is a handy way to tell if the control is telling the generator to start, or transfer, etc.
- Display provides two flashing bars that test the display LEDs. As the bars flash on and off you can readily tell if the display has a bad area; if an area does not turn on it means those LEDs are not working. The control panel would require replacement to correct a bad display.
- QT-Test is only available on the 17-20kW units. It provides a way to test the Quiet Test mode of the generator. When tested the generator will run at a lower RPM during the test. Note that for the unit to perform an actual weekly Quiet Test Exercise, it must be enabled in the Exercise Time editing menu.

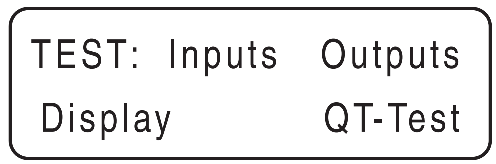


Figure 34. Debug Menu

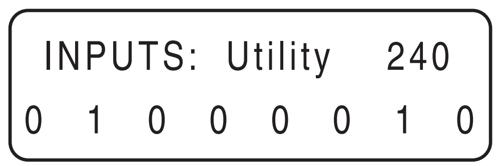


Figure 35. Test Inputs Display

Inputs are numbered from left to right (1-8)

0 indicates an Input is OFF

1 indicates an Input is ON

For instance, in Figure 35 Inputs 2 and 7 are ON (Low Oil Pressure and the Auto switch).

This indicates the unit is shut down and in Automatic.

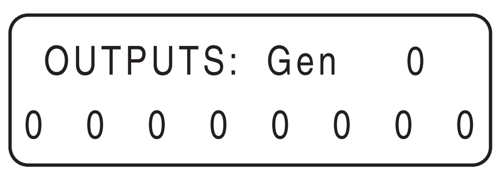


Figure 36. Test Outputs Display

Outputs are numbered from left to right (1-8)

0 indicates the Output is OFF

1 indicates the Output is ON

For instance, in Figure 36 there are no Outputs ON which indicates the unit is shut down.

Table 8. Digital Inputs and Outputs

Position	Digital Inputs	Digital Outputs
1	Not Used	Not Used
2	Low Oil Pressure	Not Used
3	High Temperature	Not Used
4	Low Fuel Pressure	Battery Charger Relay
5	Wiring Error Detect	Ignition
6	Not Used	Starter
7	Auto	Fuel
8	Manual	Transfer

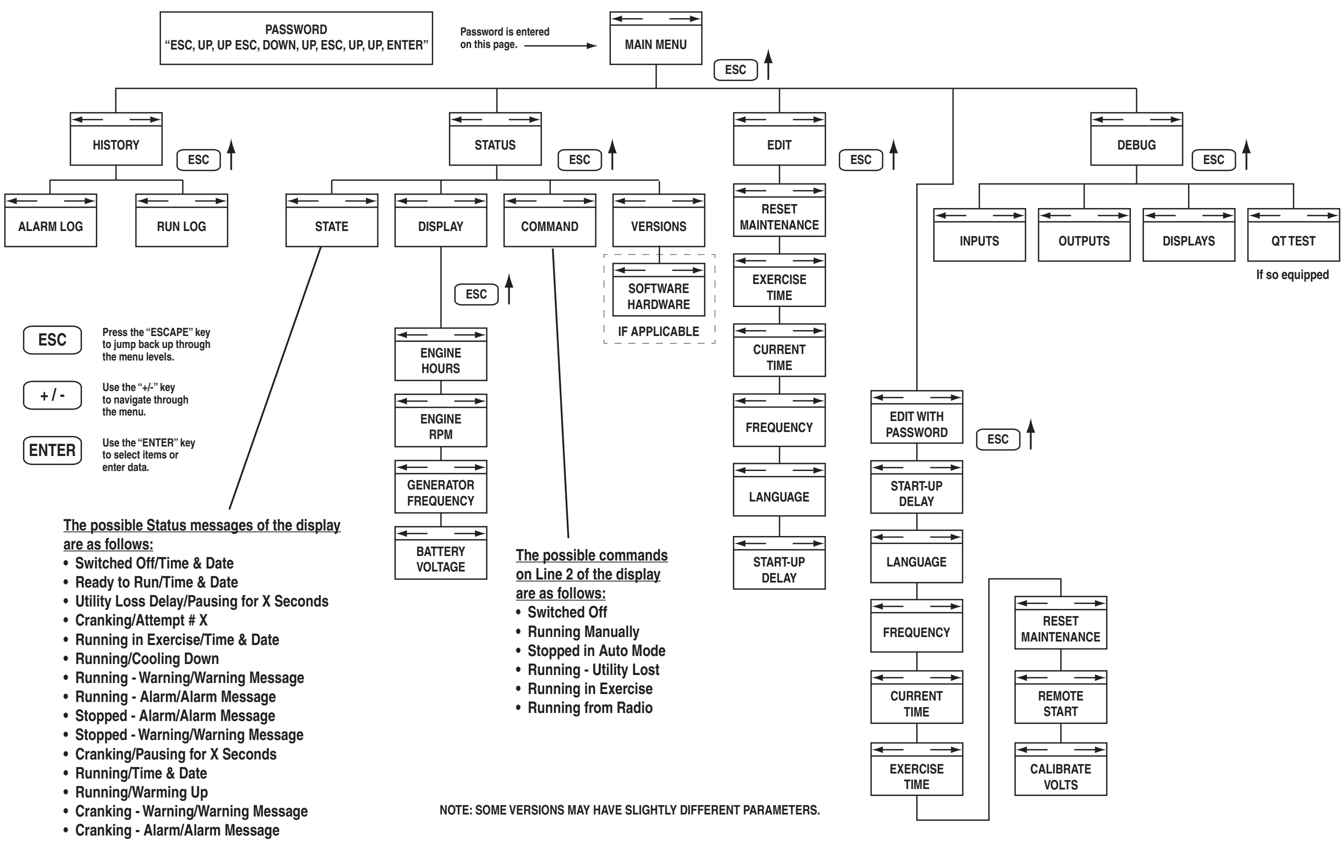


Figure 37. Menu System Diagram

INTRODUCTION

This section familiarizes the service technician with the manufacturer recommended procedures for the testing and evaluation of various problems that can occur on the standby generators with air-cooled engines. It is highly recommended that you read these introductory tips before you attempt to troubleshoot any of the three main generator components: AC Generator, Air Cooled Engine, Transfer Switch. The Troubleshooting Flow Charts provide the simplest, quickest, systematic means to troubleshoot the typical problems that might occur during the lifetime of the unit. If you use the flow charts and perform the indicated tests, you will be able to identify the faulty component, which can then be repaired or replaced as necessary.

The test procedures in each section do require a basic knowledge of electricity and electrical safety, hand tool skills, and use of Volt-Ohm-Meters.

RECOMMENDED TOOLS

In addition to the normal hand tools required, some test procedures may require the use of specialized test equipment. At a minimum you must have a meter that measures AC voltage and frequency, DC voltage and current, and has the ability to record Minimum / Maximum values (digital multi meters [DMM] are recommended); standard meter test leads, a set of piercing probe leads , and a set of pin probe leads for the AMP connector pins. The manufacturer carries a set of acceptable piercing probes (PN 0G7172), or other suppliers piercing probes may be used. Fluke provides a high quality piercing probe, PN AC89, which is highly recommended. The manufacturer also carries a set of flexible pin leads for use with the AMP connector plugs (PN 0J09460SRV).

For engine troubleshooting you will need a good manometer which measures low pressure in Inches of Water Column (IN W.C or IN H20). An ignition spark tester is also a handy tool to have when working with air-cooled engines.

Testing and troubleshooting methods covered in each section are not exhaustive. No attempt has been made to discuss, evaluate and advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Accordingly, anyone who uses a test method not recommended herein must first satisfy himself that the procedure or method he has selected will jeopardize neither his nor the products safety, and will not cause damage to any connectors or components.

TROUBLESHOOTING REMINDERS AND TIPS

The most important step in troubleshooting is identifying the actual problem. Use the History capability of the Nexus panel to help you identify what the panel is seeing. Use the Alarm Log to view the faults that caused the Warning or Alarm Shutdown. The date-time stamp provides the date and time (to the second) that the alarm event occurred. If there are several alarms that all have the same date-time stamps, go to the first in the series of alarms for that time. Some failures can cause a cascading series of faults to occur, one right after the other. Compare the Alarm Log and the Run Log to each other to see the operational sequence of events.

For instance: If the unit shut down on ALARM - Low Oil Pressure, look to see what time it started. If it started at 8/20/10 14:27:30 (2:27 pm), and shut down on low oil pressure on 8/30/10 10:15:22 (10:15 am), then the most likely cause of the loss of oil pressure was low oil level. The unit ran, providing power, for 10 days straight (approximately 234 hours). This would be validated by simply checking the oil level of the unit. These are air-cooled 4 cycle engines and will use oil while running. If run for extended periods of time (several weeks for instance) they will require periodic shut-down to check oil level and do a general inspection. Just think of leaving your lawn mower running at full RPM for several weeks; what would it do?

The next step is to determine the applicable flow chart to use to help diagnose the problem. Use the flow chart index for the part of the generator you are working with. If it is problem with voltage, use Section 2 – AC Generators; for engine problems use Section 4 – Engine/DC Control; for a problem with the transfer switch, use Section 3 – Transfer Switch. The index for each will help you clarify the problem and the flow chart to use. In each flow chart start at the top and use the test indicated to verify whether a component or control item is working properly or not. At the end of each test follow the “good” or “bad” arrows and perform the next test.

It is always good practice to continue to ask questions during the troubleshooting process. When evaluating a problem, these questions may help identify the problem quicker.

- What is it doing? (low voltage; not cranking; not transferring; etc)
- What should it do? (run and start; transfer; shutdown; etc)
- Does the same thing happen each time?
- When is it happening?
- What could or would cause this?
- What type of test will either prove or disprove the cause of the fault?

IMPORTANT NOTE CONCERNING CONNECTORS

A number of the tests require the use of a volt-meter and a set of wire piercing probes. When using the piercing probes make sure you use some liquid tape or silicone to coat the insulation where you pierced it; this will keep moisture out and prevent long term corrosion.

It is very easy to damage the female pins in the connectors on the control panel (AMP connectors) and the C1 connector (Molex connector) which goes to the alternator can.

DO NOT ATTEMPT TO PUSH PROBE TIPS INTO THE FEMALE PINS OF ANY AMP or MOLEX CONNECTORS; doing so will damage the female pin which will create another problem. Use the piercing probes on the correct wire to check for the appropriate voltages ; or use the flexible pin leads, available from the manufacturer (PN 0J09460SRV) to work with the AMP connector plugs.

PART 2
AC GENERATORS

TABLE OF CONTENTS

Air-cooled, Automatic Standby Generators

INTRODUCTION

The alternator contained within the Generator is a revolving field (rotor) type with a stationary armature (stator), and excitation to the field provided through brushes and slip rings (direct excitation). The Generator may be used to supply electrical power for the operation of 120 and/or 240 VAC, 1-phase, 60 Hz, AC loads.

ENGINE-GENERATOR DRIVE SYSTEM

The air-cooled engine is directly coupled to the rotor internally. Both the engine and the rotor operate at 3600 rpm to provide a 60 HZ AC output.

ALTERNATOR ASSEMBLY

The standard alternator consists of three basic components; a rotor, stator, and brush assembly. The rotor assembly provides the magnetic field which will induce a voltage into the stator assembly. The brush assembly provides the electrical connection to the rotor, which allows for excitation voltage and current to create the needed magnetic field.

Rotor

Operating the 2-pole rotor at 3600 rpm will supply a 60 HZ AC frequency. The term "2-pole" means the rotor has a single north magnetic pole and a single south magnetic pole. Held in place with a single through bolt, the tapered rotor shaft mounts to the tapered crankshaft of the engine. As the rotor rotates its lines of magnetic flux cut across the stator assembly windings and induces a voltage into the stator windings. The rotor shaft has a positive and negative slip ring, with the positive slip ring nearest the rear-bearing carrier. The bearing is pressed onto the end of the rotor shaft.

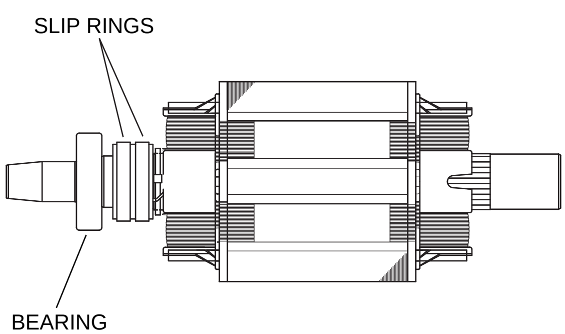


Figure 38. Rotor

Stator

The stator houses a dual power winding and an excitation winding. Coming from the stator there are Eight (8) stator leads as shown in Figure 39.

An adapter molded into the engine block and a rear-bearing carrier support the stator can. Four stator bolts connect the rear bearing carrier and the stator can to the engine.

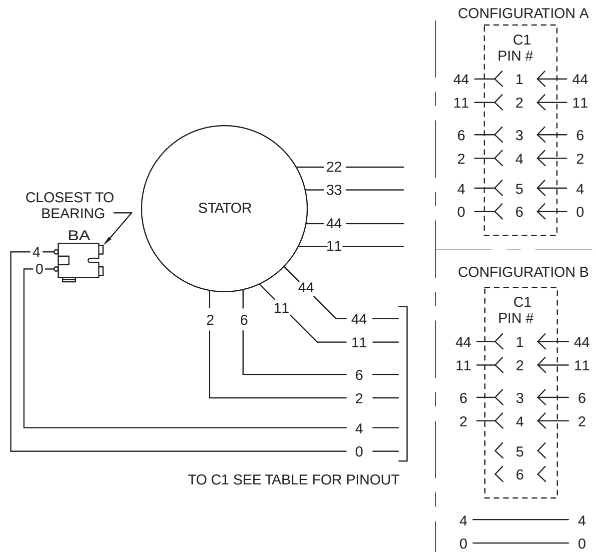


Figure 39. Stator Output Leads

Brush Holder and Brushes

Attached to the rear-bearing carrier, the brush holder and brushes allow for the electrical connection to the rotor. Positive and negative brushes are retained in the brush holder, with the positive brush riding on the slip ring nearest the rotor bearing.

Wire 4 connects to the positive brush and Wire 0 to the negative brush. Wire 0 also connects to the frame ground. The rotor windings receive rectified and regulated excitation current (DC) through Wire 4, as well as current from a field boost circuit. The current flow creates a magnetic field around the rotor having a flux concentration that is proportional to the amount of current flow.

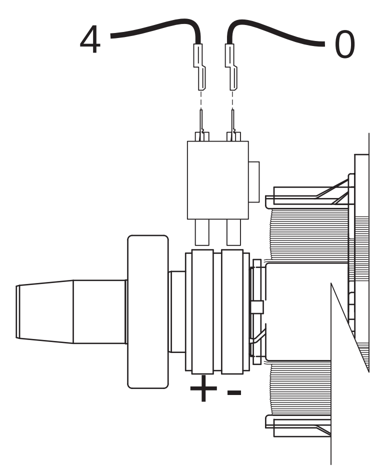


Figure 40. Brush Holder and Brushes

OTHER AC GENERATOR COMPONENTS

Located within the Generator control panel enclosure are the Nexus controller, connection points, SCR, and Main Line Circuit Breaker (MLCB).

Voltage Regulator

The Automatic Voltage Regulator (AVR) is an integral component of the main controller. The AVR receives unregulated AC output voltage from the stator excitation winding (DPE) through Wires 2 and 6. The AVR rectifies the AC voltage, and regulates it based on the sensed voltage output of the stator. The regulated DC excitation voltage (current) is then delivered to the rotor windings through Wires 0 and 4, the brushes and slip rings. The voltage regulator senses the AC output voltage of the alternator through Wires 11 and 44.

The control panel provides both Under-voltage and Over-voltage fault protection. During an over or under-voltage fault condition the control panel will shut the unit down and display the applicable Alarm.

- **Under-voltage (0H6680A Controller)** – If the Generator voltage falls below 60% of rated (144V for a 240V unit) for more than 5 seconds, the generator will shut down and an ALARM will display.
- **Under-voltage (0H6680B Controller through Rev B)** – If the Generator voltage falls below 85% of rated (204V for a 240V unit) for more than 10 seconds, the generator will shut down and an ALARM will display.
- **Under-voltage (0H6680B Controller rev C and greater)** –

  Manual:

  Cranking – If the starter disengages before a voltage has developed in the stator, the controller will initiate a shutdown alarm for "under-voltage."

  Running – If the Generator is running and voltage output has been gone for 10 seconds, the controller will initiate a shutdown alarm for "under-voltage."

  Auto:

  Cranking – If the starter disengages before a voltage has developed in the stator, the controller will shutdown, pause for 15 seconds (countdown displayed), and re-crank 3 additional times. If after three crank attempts and the no voltage output continues, the controller will initiate a shutdown alarm for "under-voltage."

  Running – If the Generator is running and voltage output has been gone for 10 seconds, the controller will initiate a shutdown, pause 10 seconds, and re-crank 3 times additional times. If after three crank attempts and the no voltage output continues, the controller will initiate a shutdown for "under-voltage."

Note: The 3 crank attempts are cumulative. For example, if the unit took two under-voltage re-cranks at startup, it would only allow one additional re-crank for under-voltage.

- **Over-voltage** – If the Generator voltage rises above 110% of rated (264V on a 240V unit) for greater than 3 seconds, or if the Generator voltage rises above 130% of rated (312V on a 240V unit) for greater than 0.2 seconds, the generator will shutdown and an ALARM will display.

Main Line Circuit Breaker

The main line circuit breaker protects the Generator against electrical overload. See the "Specifications" section for specific amperage ratings.

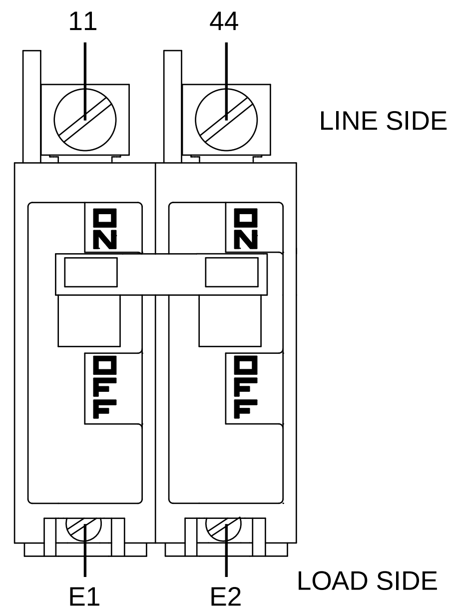


Figure 41. Main Line Circuit Breaker

ROTOR RESIDUAL MAGNETISM

The Generators revolving field (rotor) provides the magnetic flux required to induce voltage into the stator and excitation windings (DPE). Some "residual" magnetism is always present in the rotor. Although residual magnetism is present it is only sufficient to induce a very low AC output, typically 0 to 6 VAC, and not enough to make the excitation winding (DPE) produce enough voltage for the AVR to operate. In order to make the DPE winding produce enough voltage to turn on and allow the AVR to operate, a Field Boost (flash) circuit is used during cranking.

FIELD BOOST

During the engines crank cycle, the control panel provides battery voltage (12 VDC) on Wire 56 to energize the starter contactor relay (SCR). Wire 56 also connects to Wire 4 (positive field voltage) through a field boost diode.

The field boost system is shown schematically in Figure 42. When the controller cranks the engine, battery voltage is applied through Wire 56 and the boost diode to Wire 4. This provides the current necessary to energize the field winding. The diode PREVENTS excitation voltage from feeding into wire 56 while the unit is running during normal operation.

Note: Field boost voltage is available only while the crank relay is energized (i.e. during the engines crank cycle).

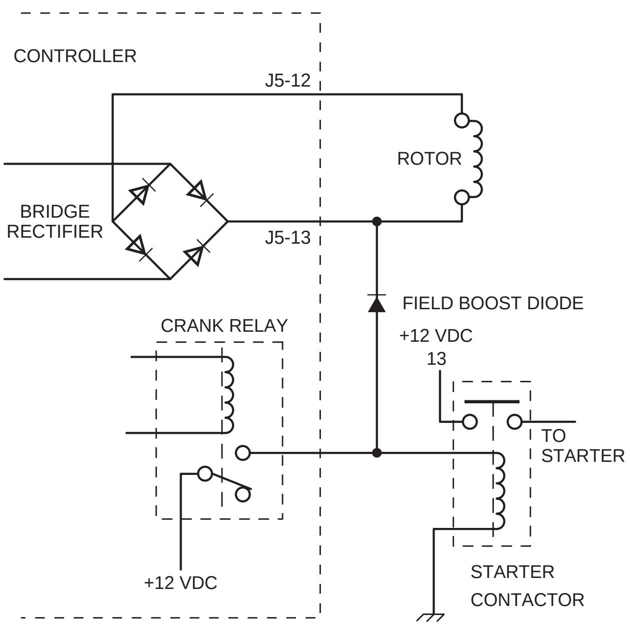


Figure 42. Field Boost Circuit

OPERATION

Engine Cranking

When the engine is cranking, field boost voltage causes the rotor to magnetize. The rotor magnetic field induces a voltage into the stator AC power windings, and the stator excitation (DPE) windings. During cranking, field boost magnetism is capable of creating approximately one-half the unit's rated voltage.

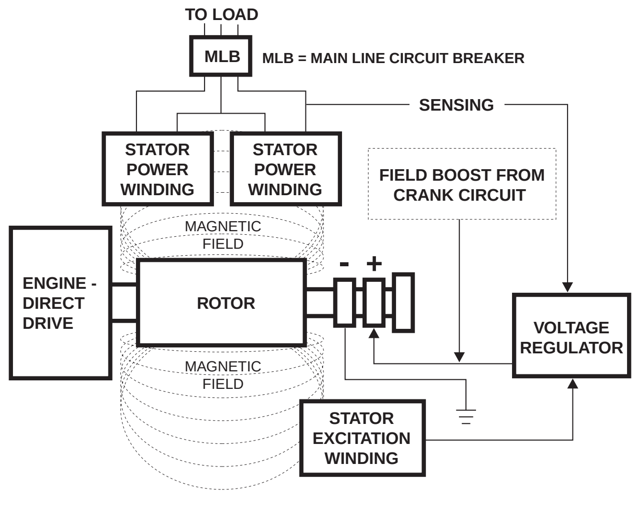


Figure 43. Operating Diagram

Field Excitation

The AC voltage from the DPE winding provides power to the AVR. The AVR rectifies and regulates the AC voltage to DC voltage, and provides the DC voltage to the rotor through Wires 4 and 0. When the starter disengages (cranking stopped), the AVR continues to provide excitation voltage to the rotor.

The AVR senses the AC output voltage through Sensing Wires 11 and 44, which are connected to the main power leads (11 and 44) in the stator can. The AVR will continue to increase excitation voltage to the rotor until the desired AC output voltage is reached. It will continue to "regulate" excitation voltage as necessary to provide a constant AC output voltage to the load.

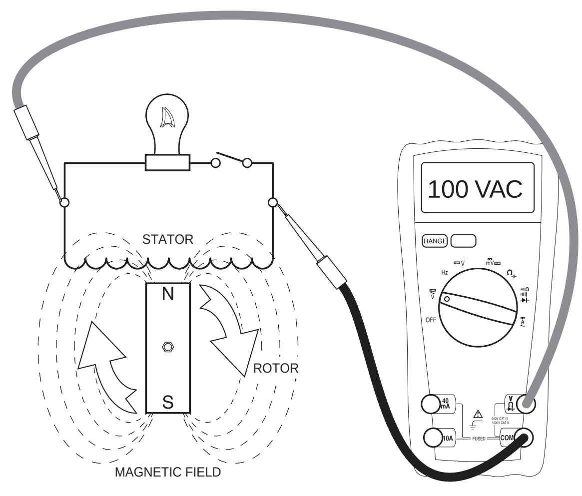


Figure 44. Low Excitation voltage = Low Magnetic lines of Flux = Low AC Output.

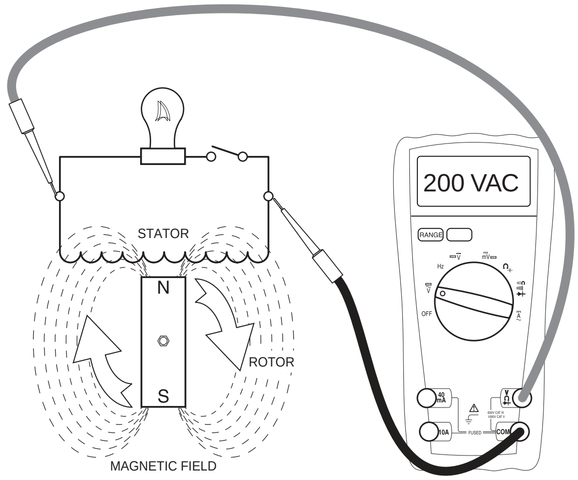


Figure 45. Increased Excitation Voltage = Increased Magnetic Lines of Flux = Increased AC Output Voltage.

The regulated excitation from the regulator is delivered to the rotor windings through Wire 4 and the positive brush and slip ring. This results in current flowing through the field windings to the negative slip ring and brush, and then to ground.

The greater the current flow through the windings the more concentrated the lines of flux around the rotor become. The more concentrated the lines of flux around the rotor, which cut across the stationary stator windings, the greater the voltage induced into the stator. Refer to Figures 44 and 45

Initially, the AC power windings output voltage "sensed" by the AVR is low. The AVR reacts by increasing the excitation voltage (and hence current flow) to the rotor until AC output voltage increases to a preset level. The AVR then maintains the voltage at this level. For example, if voltage exceeds the desired level, the AVR will decrease excitation. Conversely, if voltage drops below the desired level, the AVR responds by increasing excitation.

AC Power Winding Output

When electrical loads are connected across the AC power windings to complete the circuit, current flows through the circuit powering the loads.

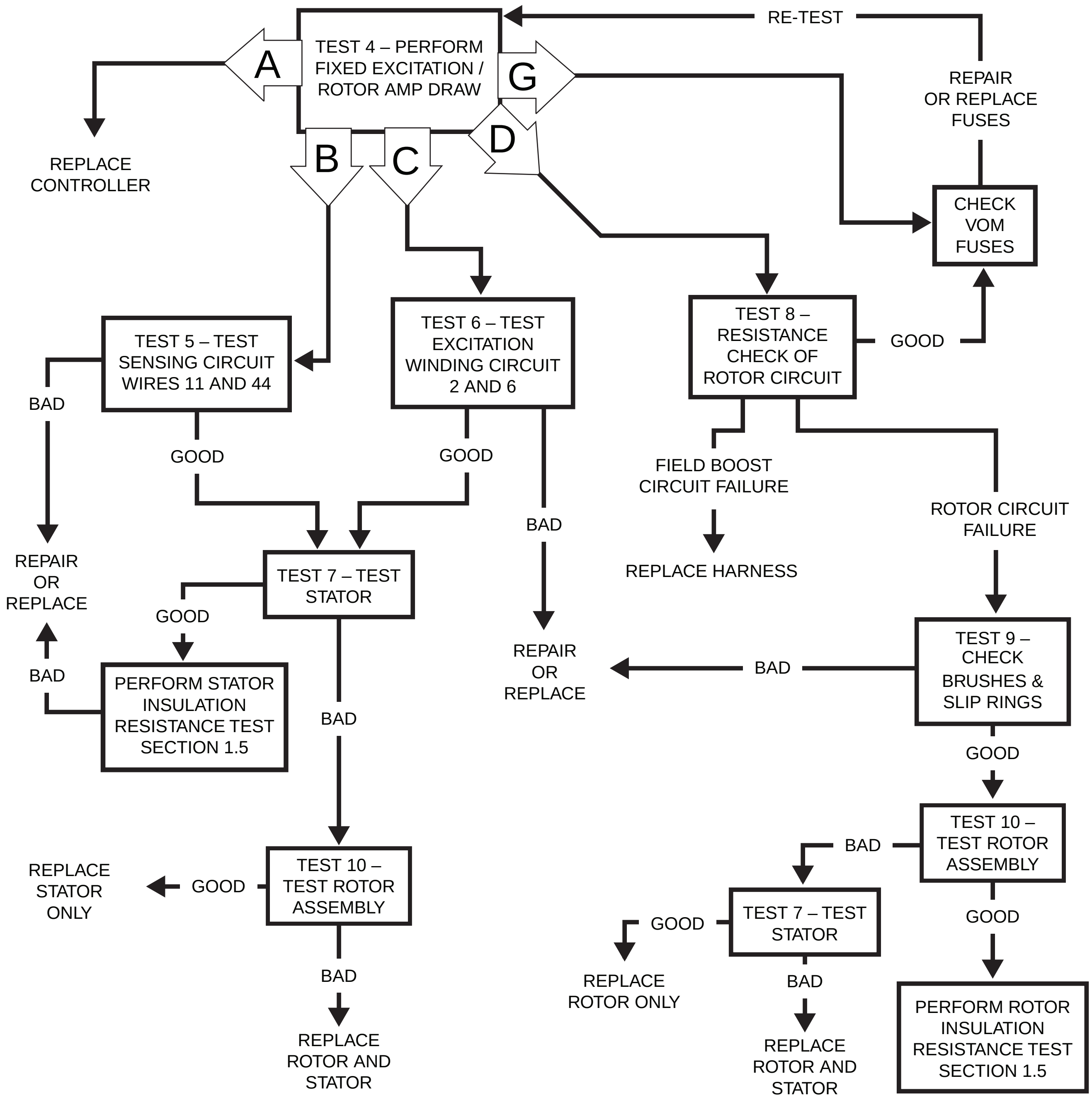
As load changes this will result in a corresponding change in voltage; as load demand increases the voltage will tend to drop; as load demand decreases the voltage will tend to increase. The AVR changes excitation to provide a constant output voltage with minimal increase or decrease during load changes. Frequency is also affected during load changes. However, frequency is a function of rotor speed (engine RPM); the engine electronic governor (integral to the control panel) will respond to any engine speed changes to maintain a stable, isochronous, frequency output of 60Hz.

The Automatic Voltage Regulator and the Electronic Governor work together to provide output voltage regulation of +/- 1% voltage regulation and +/- 0.25% steady state, isochronous, frequency (speed) regulation.

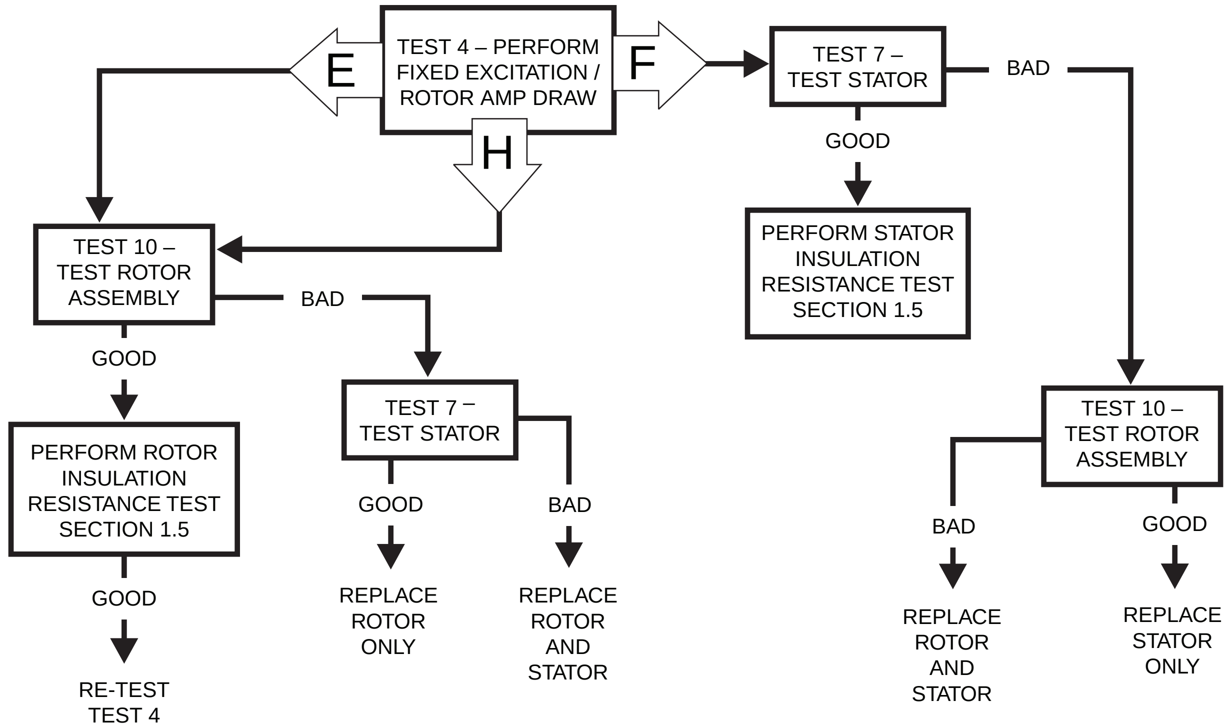
INTRODUCTION

Use the "Flow Charts" in conjunction with the detailed instructions in Section 2.4. Test numbers used in the flow charts correspond to the numbered tests in Section 2.4. The first step in using the flow charts is to identify the correct problem on the following pages. For best results, perform all tests in the exact sequence shown in the flow charts.

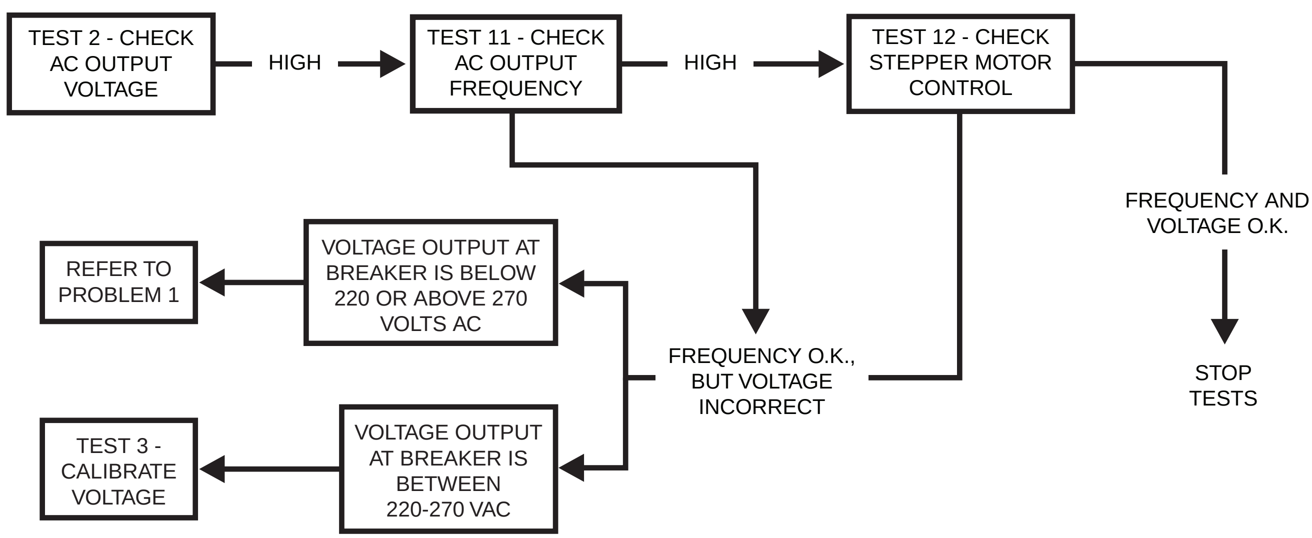
Problem 1 – Generator Shuts Down for Under Voltage



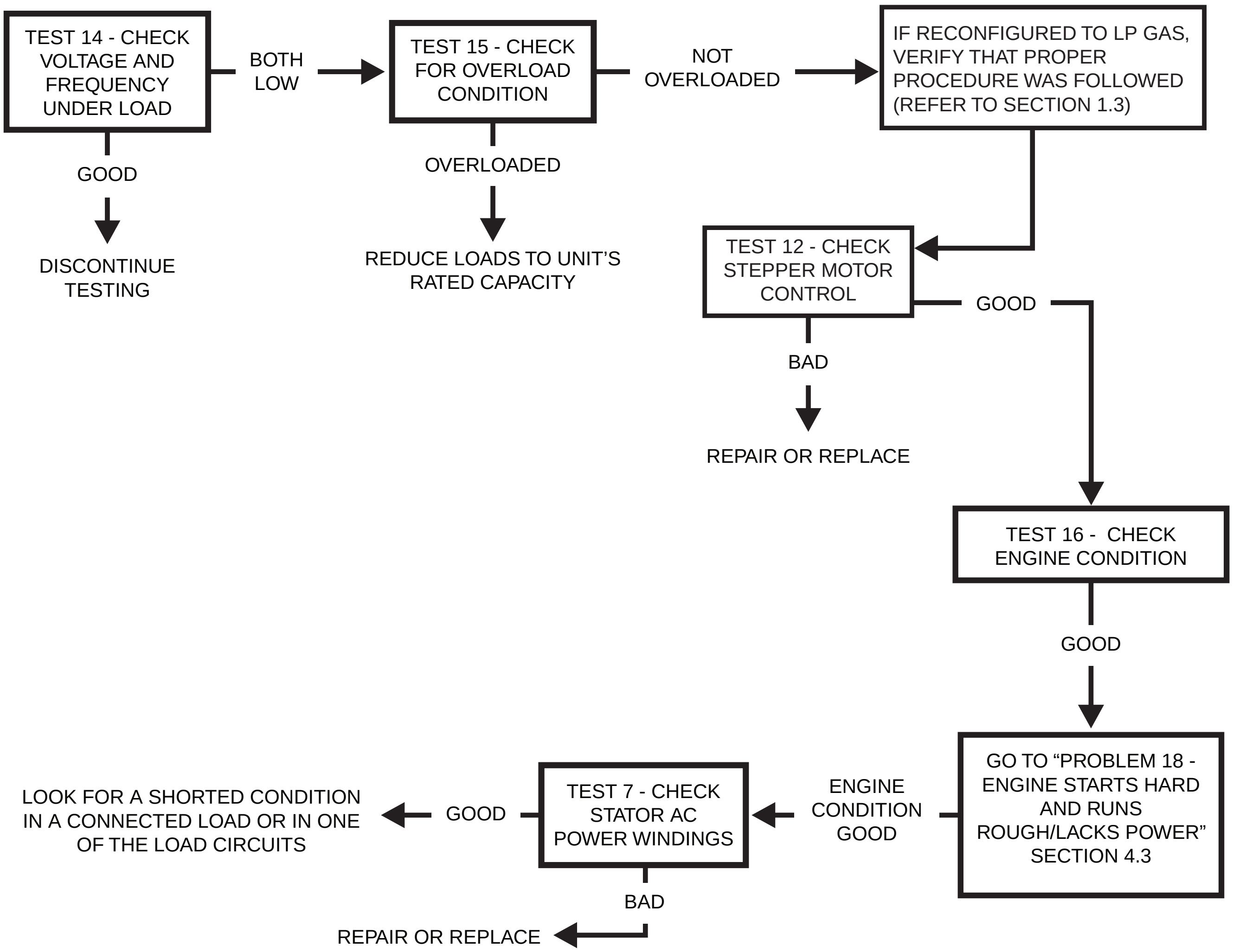
Problem 1 – Generator Shuts Down for Under Voltage (Continued)



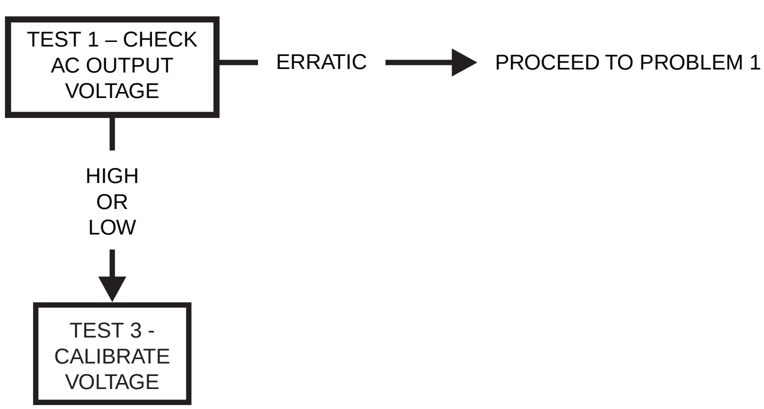
Problem 2 – Generator Produces High Voltage



Problem 3 – Voltage and Frequency Drop Excessively When Loads Are Applied



Problem 4 – Unstable Voltage or Incorrect Output Which is Not Triggering a Shutdown



INTRODUCTION

This section familiarizes the service technician with acceptable procedure for the testing and evaluation of various problems that can occur on the standby generators with air-cooled engines. Use this section in conjunction with Section 2.3, “Troubleshooting Flow Charts.” The numbered tests in this section correspond with those of Section 2.3.

Some test procedures in this section may require the use of specialized test equipment, meters or tools. Most tests can be performed with an inexpensive Volt-Ohm-Milliammeter (VOM). An AC frequency meter is required where frequency readings must be taken. To measure AC loads it is acceptable to use a clamp-on ammeter.

Testing and troubleshooting methods covered in this section are not exhaustive. No attempt has been made to discuss, evaluate and advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Accordingly, anyone who uses a test method not recommended herein must first satisfy himself that the procedure or method he has selected will jeopardize neither his nor the products safety.

SAFETY

Service personnel who work on this equipment should be aware of the dangers of such equipment. Extremely high and dangerous voltages are present that can kill or cause serious injury. Gaseous fuels are highly explosive and can ignite by the slightest spark. Engine exhaust gases contain deadly carbon monoxide gas that can cause unconsciousness or even death. Contact with moving parts can cause serious injury. The list of hazards is seemingly endless.

When working on this equipment, use common sense and remain alert at all times. Never work on this equipment while you are physically or mentally fatigued. If you do not understand a component, device or system, do not work on it.

AC TROUBLESHOOTING

It is always good practice to continue to ask questions during the troubleshooting process. When evaluating the problem asking some of these questions may help identify the problem quicker.

- What is the generator supposed to do?
- What fault (Alarm) is shutting the generator down?
- Is the fault a symptom of another problem?
- Does the generator have the same fault consistently?
- When does the fault occur?
- After the fault occurred what was displayed in the LCD?
- Why would this happen?
- How would this happen?
- What type of test will either prove or disprove the cause of the fault?

TEST 1 – CHECK AC OUTPUT VOLTAGE

Discussion

Use a Volt-Ohm-Milliammeter (VOM) to check the Generators output voltage. Test output voltages at the unit’s main circuit breaker (MLCB) terminals. Refer to the unit’s Data Plate for rated line-to-line and line-to-neutral voltages.

⚠ DANGER!

Use extreme caution during this test. The Generator will be running. High and dangerous voltages will be present at the test terminals. Connect meter test clamps to the high voltage terminals while the Generator is shut down. Stay clear of power terminals during the test. Make sure the meter clamps are securely attached and will not shake loose.

Procedure

1. Set the Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. With the engine shut down, connect the meter test leads across the load terminals of the Generators MLCB. This will measure line-to-line voltage. See Figure 46.

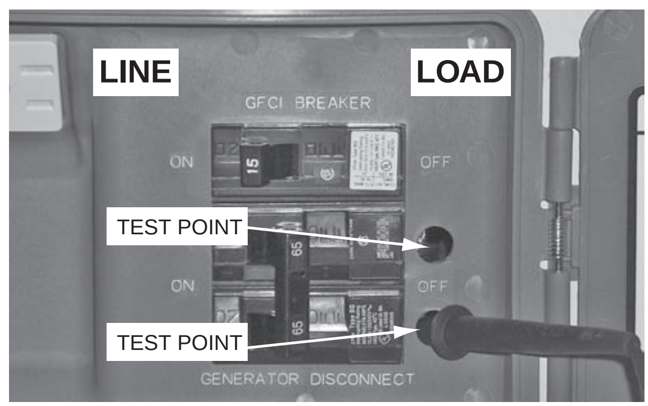


Figure 46. Test 2 Test Points

3. Set the MLCB to the “Open” position. Ensure that all electrical loads are disconnected from the Generator.
4. Set the AUTO-OFF-MANUAL switch to the MANUAL position.

Note: AC under and over-voltage shut downs have a 10 second delay.

5. Set the MLCB to the “Closed” position. Measure and record the voltage.
6. Set the AUTO-OFF-MANUAL switch to the OFF position.

Results

1. If the VOM indicated approximately 240-244 VAC, the output voltage is good.

2. If the VOM indicated any other readings the voltage is BAD. Refer back to the flow chart.

Note: "Residual" voltage may be defined as the voltage produced by rotor residual magnetism alone. The amount of voltage induced into the stator AC power windings by residual voltage alone will be approximately 2 to 16 VAC, depending on the characteristics of the specific Generator. If a unit is supplying residual voltage only, either excitation current is not reaching the rotor or the rotor windings are open and the excitation current cannot pass. On current units with air-cooled engines, "field boost" current flow is available to the rotor only during engine cranking.

TEST 3 – CALIBRATE VOLTAGE

Discussion

When voltage output is too high, it is possible to adjust voltage output of the generator. To access this menu a password will be required to be entered into controller. Replacement controllers do not require calibration unless output is not within the specifications. (Refer to the Specifications section in the front of this manual.)

Procedure

1. Set Volt-Ohm-Meter (VOM) to measure AC voltage.
2. Set up the VOM to measure output voltage on the breaker.
3. Open the Main Line Circuit Breaker (MLCB) on the generator.
4. On the controller, press the ESC key until the main menu is present. (Refer to the Menu Navigation found in Section 1.10)
5. While at this screen proceed to enter the following password:

   UP, UP, ESC, DOWN, UP, ESC, UP, UP

6. After the password has been entered, proceed to the EDIT menu.
7. Press the down arrow key until the screen indicates CALIBRATE VOLTAGE and press ENTER.
8. After pressing enter, a value will appear on the screen.

Note: The default setting from the factory for calibration is 1024.

9. Set AUTO-OFF-MANUAL switch to the MANUAL position.
10. While the unit is running, use the UP or DOWN arrows to adjust the calibration setting. A higher value will create a lower voltage at the breaker and vice versa a lower value will create a higher voltage at the breaker.

⚠ WARNING!

Calibration factor must NOT be adjusted below 990 or above 1040. Adjusting outside of this window could result in damage to the machine.

11. Once a desired output voltage has been achieved, press ENTER to save the new setting.

Note: The Calibration Setting will reset to being a password protected option after the controller is left idle.

Verification

While the unit is running, verify that the output voltage at the breaker is consistent within 5 volts to what the controller displays in the DEBUG menu under OUTPUTS. (Refer to Section 1.10 Menu Navigation).

Results

1. If during the verification process the output voltage at the breaker and the display match and the calibration setting was not adjusted outside of the window, stop testing.
2. If a correct voltage output was not achieved using the window specified, refer to "Problem 1 – Test 4 Fixed Excitation / Rotor Amp draw test."

TEST 4 – FIXED EXCITATION TEST/ROTOR AMP DRAW TEST

Discussion

Supplying a fixed DC current to the rotor will induce a magnetic field in the rotor. With the generator running, this should create a proportional voltage output from the stator windings. With the use of the MIN/MAX feature of a Volt-Ohm-Meter (VOM), it is possible to capture the maximum output of a particular winding before faulting out on under-voltage.

Under-voltage Alarm – When the AUTO-OFF-MANUAL is set in the MANUAL position the following logic is used to trigger the alarm "under-voltage":

- Cranking – If the starter disengages before a voltage has developed in the stator the controller will initiate a shutdown alarm for "under-voltage."

Note: For further information about under-voltage shut-downs, refer to Section 2.1 "Description and Components."

Table 9 has been provided to record the results of the following procedure. These results may be required when requesting factory support. Additional copies of Table 9 can be found in Appendix A "Supplemental Worksheets" at the back of this manual.

Table 9. Test 4 Results Worksheet

Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Required Tools

- A Volt-Ohm-Meter (VOM) equipped with a MIN/MAX feature
- Meter test leads that are capable of measuring voltage inside a connector without damaging the socket. A set of black and red test leads for this application are available from the manufacturer. Contact your nearest servicing dealer for more information.

Note: It is not recommended to use any testing device other than the manufactures approved test lead adapters (P/N 0J09460SRV).

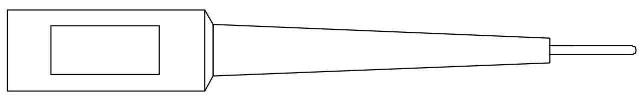


Figure 47. Narrow Test Probe

VOM Setup

Below is an excerpt taken from a Fluke 117 multi-meter owners manual.

MIN/MAX – The MIN MAX AVG recording mode captures the minimum and maximum input values (ignoring overloads), and calculates a running average of all readings. When a new high or low is detected, the Meter beeps.

- Put the Meter in the desired measurement function and range.
- Press [MIN MAX] to enter MIN MAX AVG mode.
  MIN MAX and MAX are displayed and the highest reading detected since entering MIN MAX AVG is displayed.
- Press [MIN MAX] to step through the low (MIN), average (AVG), and present readings.
- To pause MIN MAX AVG recording without erasing stored values, press [HOLD]. HOLD is displayed.
- To resume MIN MAX AVG recording, press [HOLD] again.
- To exit and erase stored readings, press [MIN MAX] for at least one second or turn the rotary switch.

RANGE – When you turn the Meter on, it defaults to Autorange and Auto is displayed.

1. To enter the Manual Range mode, press [RANGE]. Manual is displayed.
2. In the Manual Range mode, press [RANGE] to increment the range. After the highest range, the Meter wraps to the lowest range.

Note: You cannot manually change the range in the MIN MAX AVG or Display HOLD modes.

If you press [RANGE] while in MIN MAX AVG or Display Hold, the Meter beeps twice, indicating an invalid operation, and the range does not change.

3. To exit Manual Range, press [RANGE] for at least 1 second or turn the rotary switch. The Meter returns to Autorange and Auto is displayed.

Procedure: Fixed Excitation Test

1. Remove the 7.5 amp fuse from the controller.
2. Locate and disconnect the J5 connector from the controller.
3. Set VOM to measure AC voltage.
4. Using the scale feature of the VOM, set to the first available scale greater than 100 (i.e. “600”).

Note: Refer to the manufactures owners manual for specific information on using manual scaling

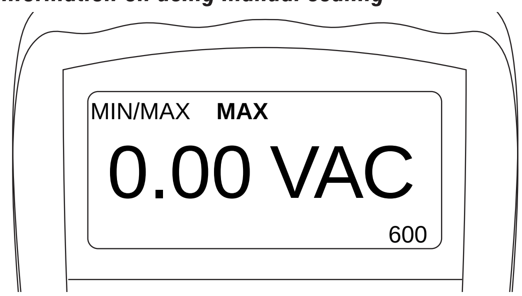


Figure 48.

5. Set meter to MIN/MAX.

Note: Refer to the manufactures owners manual for specific information on using the MIN/MAX feature.

6. Using the approved meter test probes, connect one meter test lead to Pin 14-J5 (Wire 6) and the other meter test lead to Pin 5-J5 (Wire 2).
7. Re-install the 7.5 amp fuse.
8. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
9. Measure and record the voltage indicated between Wires 2 and 6 as indicated by the VOM.
10. Acknowledge and reset the “under-voltage” present on the controller; leave AUTO-OFF-MANUAL switch in the OFF position.
11. Re-locate meter test probes to Pin 11-J5 (Wire 11) and Pin 10-J5 (Wire 44).
12. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
13. Measure and record the voltage indicated between Wire 11 and 44 as indicated by the VOM.
14. Acknowledge and reset the “under-voltage” present on the controller; leave AUTO-OFF-MANUAL switch in the OFF position.

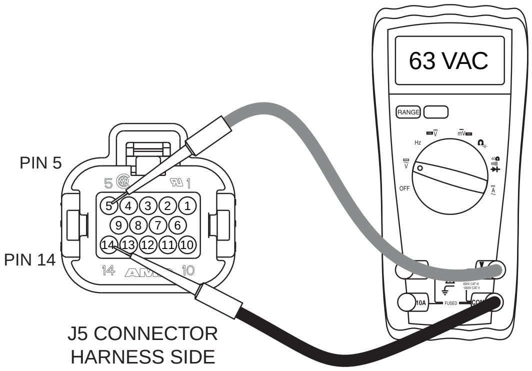


Figure 49. 10-20kW Fixed Excitation Test

Procedure: Rotor Amp Draw

1. Disengage the MIN/MAX feature and manual scale on the VOM.
2. Set VOM to measure DC amperage.

Note: Consult the meters documentation for proper setup procedure. See Section 1.4 "Measuring Current" for further information.

3. Connect the black (negative) meter test lead to Pin 13-J5 and the red (positive) test lead to the positive battery terminal. See Figure 50.
4. Measure and record the static rotor amp draw.
5. Set AUTO-OFF-MANUAL switch to the MANUAL position.
6. Measure and record the running rotor amp draw.
7. Acknowledge and reset the "under-voltage" present on the controller; leave AUTO-OFF-MANUAL switch in the OFF position.

Results

1. Using the values recorded in the above procedure, compare the results to Table 10 "Results – Fixed Excitation Test/Rotor Amp Draw Test". Determine the appropriate lettered column to use and refer back to the flow chart. The rotor amp draws area calculated amp draw and actual amperage readings may vary depending on the resistance of the rotor.

Note: To calculate rotor amp draw take the battery voltage applied, divided by the actual resistance reading of the rotor. Rotor resistance can be measured between Pin 13 J5 and Pin 12 J5.

$$\frac{12.9\text{VDC}}{12.3\text{ Ohms x } 1.05\text{ DC Amps}}$$

Example

Model	17kW
Wires 2 and 6 Voltage	53 VAC
Wires 11 and 22 Voltage	31 VAC
Static Rotor Amp Draw	1.09 Amp
Running Rotor Amp Draw	1.10 Amp

These results match Column B in the chart. Refer back to Problem 1 and follow letter "B"

Figure 50.

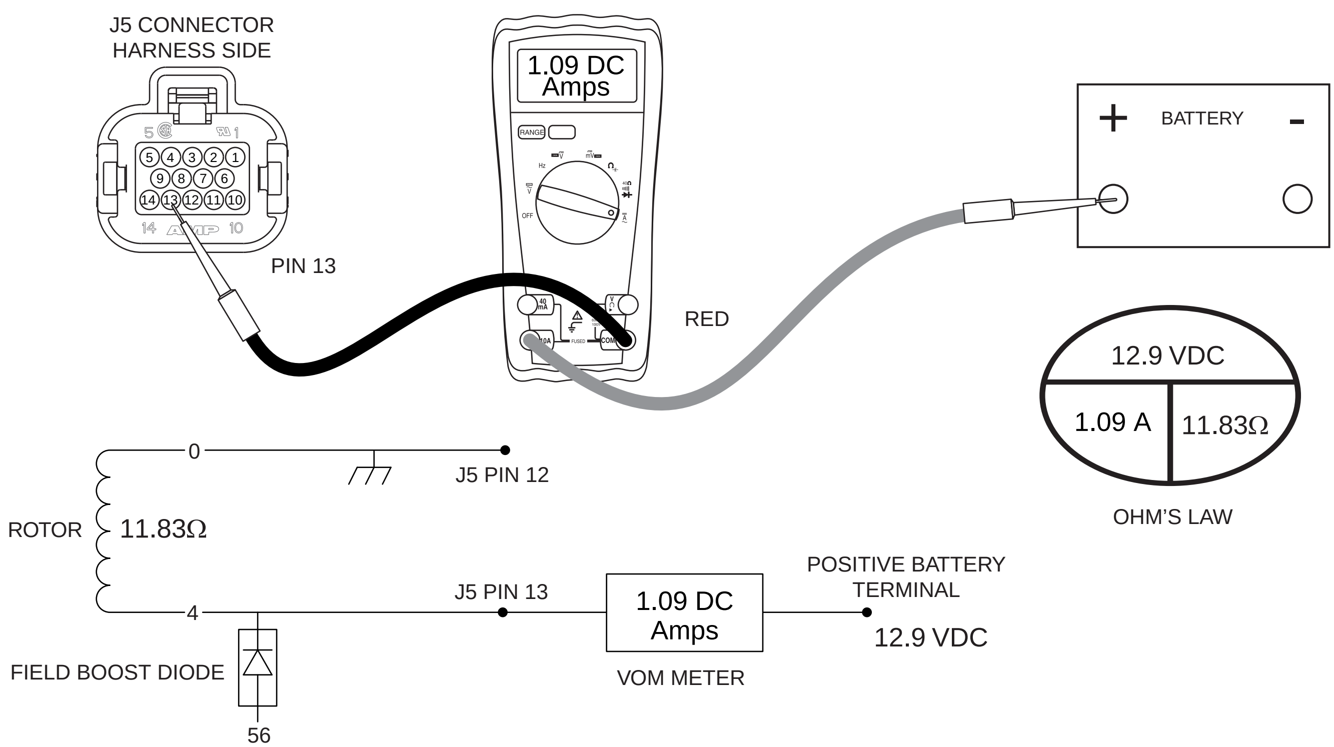


Figure 51. Rotor Amp Draw Test

Table 10. TEST 4 Results – Fixed Excitation Test/Rotor Amp Draw Test (8-20kW)

Results:	Size	A	B	C	D	E	F	G	H
Voltage Results Wire 2 & 6	ALL	Above 50 VAC	Above 50 VAC	Below 50 VAC	Zero or Residual Volts	Below 50 VAC	Below 50 VAC	Above 50 VAC	Below 50 VAC
Voltage Results Wire 11 & 44	ALL	Above 50 VAC	Below 50 VAC	Above 50 VAC	Zero or Residual Volts	Below 50 VAC	Below 50 VAC	Above 50 VAC	Below 50 VAC
Static Rotor Amp Draw	8kW	1.76-2.05	1.76-2.05	1.76-2.05	Zero Current Draw	Above 2.5A	1.76-2.05	Zero Current Draw	1.76-2.05
	10kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05		1.76-2.05
	12kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		1.46-1.70
	14kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		1.46-1.71
	15kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54
	16kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54
	17kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54
	20kW	1.16-1.36	1.16-1.36	1.16-1.36		Above 2.0A	1.16-1.36		1.16-1.36
Running Rotor Amp Draw	8kW	1.76-2.05	1.76-2.05	1.76-2.05	Zero Current Draw	Above 2.5A	1.76-2.05	Zero Current Draw	Above 2.5A
	10kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05		
	12kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		
	14kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		
	15kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		
	16kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		
	17kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		
	20kW	1.16-1.36	1.16-1.36	1.16-1.36		Above 2.0A	1.16-1.36		
Note: Actual values measured may vary by as much as .5 amps; depending on the type and quality of meter used, the condition of the unit, and how good the connection is between the test leads and test points.									
← ***MATCH RESULTS WITH LETTER AND REFER TO FLOW CHART IN SECTION 2.3 "Problem 1"*** →									

TEST 5 – TEST SENSING CIRCUIT WIRES 11 AND 44

Discussion

The voltage regulator (internal to the controller) requires a reference voltage in order to regulate at a specific voltage and to recognize if the alternator is producing voltage. The alternator may be producing a voltage, but if the voltage regulator cannot "sense" the voltage, it will fault out for under-voltage. This test will verify the integrity of the sensing circuit.

Required Tools

- Meter test leads that are capable of measuring voltage inside a connector without damaging the socket. A set of black and red test leads for this application are available from the manufacturer. Contact your nearest servicing dealer for more information. See Figure 47.

Note: It is not recommended to use any testing device other than the manufactures approved test lead adapters.

Procedure

1. Remove the 7.5 amp fuse from the control panel.
2. Remove the controller and the cover to expose the lower harness connections.
3. Disconnect the J5 connector from the controller.
4. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.

Note Stator winding resistance values are very low and some VOM's will not read such a low resistance, and will simply indicate different ranges of resistance. The manufacture recommends a high quality digital type meter capable of reading a very low resistance.

5. Connect one-meter test lead to J5 Pin 11 (Wire 11) and the other meter test lead to the NEUTRAL connection. Measure and record the resistance.
6. Connect one-meter test lead to J5 Pin 10 (Wire 44) and the other meter test lead to the NEUTRAL connection. Measure and record the resistance.
   a. If the meter indicated a resistance value of less than 0.2 ohms in Steps 5 and 6, stop testing and refer back to the flow chart (Good).
   b. If the meter indicated OPEN in Steps 5 or 6, proceed to Step 7.
7. Disconnect the lower bulkhead C1 connector (Figure 52).
8. Connect one-meter test lead to C1 Pin 2 (Wire 11) and the other meter test lead to the NEUTRAL connection, measure and record the resistance.

9. Connect one-meter test lead to C1 Pin 1 (Wire 44) and the other meter test lead to the NEUTRAL connection, measure and record the resistance.

Results

1. If the meter indicated a resistance value of less than 0.2 ohms in Steps 5 through 9, refer back to flow chart (Good).

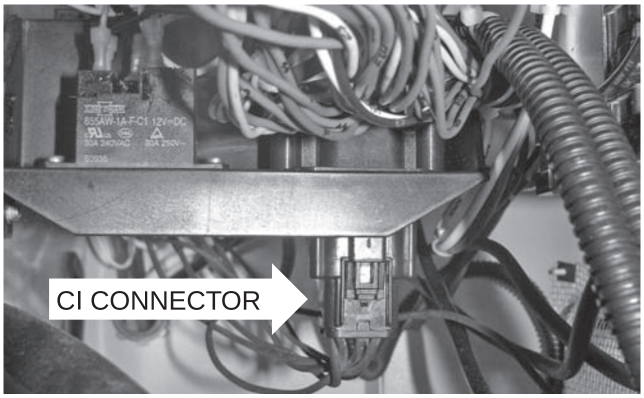


Figure 52. C1 Connector

2. If the meter indicated a resistance value of OPEN in Step 5 and a value less than 0.2 ohms in Step 8, repair or replace Wire 11 between the controller and the C1 connector.
3. If the meter indicated a resistance value of OPEN in Step 6 and a value less than 0.2 ohms in Step 9, repair or replace Wire 44 between the controller and the C1 connector.
4. If the meter indicated OPEN in either Step 8 or Step 9, proceed to Test 7 "Test Stator."

TEST 6 – TEST EXCITATION WINDING CIRCUIT 2 AND 6

Discussion

The voltage regulator (internal to the controller) requires an unregulated voltage in order to regulate DC excitation current to the rotor. The alternator may be producing a voltage, but if the voltage regulator cannot "sense" the voltage, it will fault out for under-voltage. This test will verify the integrity of the Excitation winding inside the stator.

Required Tools

- Meter test leads that are capable of measuring voltage inside a connector without damaging the socket. A set of black and red test leads for this application are available from the manufacturer. Contact your nearest servicing dealer for more information. See Figure 47.

Note: It is not recommended to use any testing device other than the manufactures approved test lead adapters.

Procedure

1. Remove the 7.5 amp fuse from the control panel.
2. Remove the controller and the cover to expose the lower harness connections.
3. Disconnect the J5 connector from the controller.
4. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
5. Connect one-meter test lead to J5 Pin 5 (Wire 2) and the other meter test lead to J5 Pin 14 (Wire 6). Measure and record the resistance.
   a. If the meter indicated a resistance value of less than 0.2 ohms in Step 5, stop testing and refer back to the flow chart (Good).
   b. If the meter indicated OPEN in Step 5, proceed to Step 6.
6. Disconnect the lower bulkhead C1 connector.
7. Connect one-meter test lead to C1 Pin 4 (Wire 2) and the other meter test lead to C1 Pin 3 (Wire 6). Measure and record the resistance.

Results

1. If the meter indicated a resistance value of less than 0.2 ohms in Steps 5 through 9, refer back to the flow chart (Good).
2. If the meter indicated a resistance value of OPEN in Step 5 and a value less than 0.2 ohms in Step 7, repair or replace Wire 2 and 6 between the controller and the C1 connector.
3. If the meter indicated a resistance value of OPEN in Step 7, verify connection, then replace the stator.

TEST 7 – TEST THE STATOR WITH A VOM

Discussion

This test will use a Volt-Ohm-Milliammeter (VOM) to test the stator windings for the following faults:

- An OPEN circuit condition
- A "short-to-ground" condition
- A short circuit between windings

Table 14 (next page) has been provided to record the results of the following procedure. These results may be required when requesting factory support.

Additional copies of Table 14 can be found in Appendix A "Supplemental Worksheets" at the back of this manual.

Note: It is the recommendation of the factory to preform this test procedure using piercing probes on the wire side of the connector. Testing inside the connector itself can cause unneeded damage to the unit resulting in poor or loose connections.

Procedure: Resistance Test

1. Disconnect Wires 11 and 44 from the main line circuit breaker (MLCB).
2. Disconnect Wires 22 and 33 from the NEUTRAL connection and separate the leads.
3. Disconnect the bulkhead C1 connector.
4. Make sure all of the disconnected leads are isolated from each other and are not touching the frame during the test.
5. Set the VOM to measure resistance.
6. Measure and record the resistance values for each set of windings between the A and B test points as shown in Table 11. Record the results in Table 14.

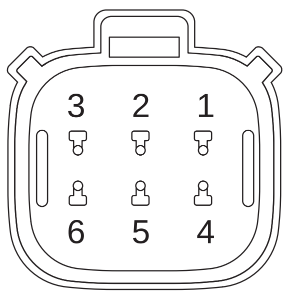


Figure 53. C1 Bulkhead Connector Pin Locations

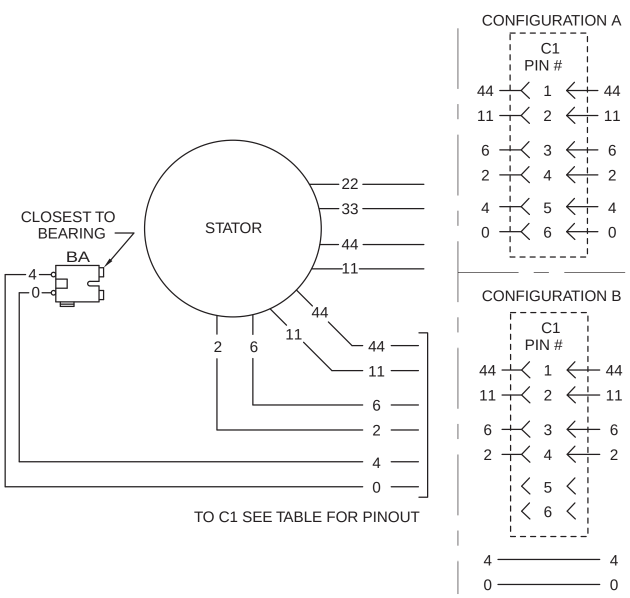


Figure 54. Stator Lead Connections

Table 11. Test Points

Test Point A	Test Point B
Stator Lead Wire 11	Stator Lead 22
Stator Lead Wire 33	Stator Lead 44
C1 Pin 2 Wire 11	Stator Lead 22
C1 Pin 1 Wire 44	Stator Lead 33
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2

Test Windings for a Short to Ground

7. Make sure all stator leads are isolated from each other and are not touching the frame.
8. Measure and record the resistance values for each set of windings between the A and B test points as shown in Table 12. Record the results in Table 14.

Table 12. Test Points

Test Point A	Test Point B
Stator Lead 11	Ground
Stator Lead 44	Ground
C1 Pin 1 Wire 44	Ground
C1 Pin 2 Wire 11	Ground
C1 Pin 4 Wire 2	Ground

Test For A Short Circuit Between Windings

9. Measure and record the resistance values for each set of windings between the A and B test points as shown in Table 13. Record the results in Table 14.

Table 13. Test Points

Test Point A	Test Point B
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44
C1 Pin 4 Wire 2	Stator Lead Wire 11
C1 Pin 4 Wire 2	Stator Lead Wire 44
Stator Lead 11	C1 Pin 1 Wire 44
Stator Lead 11	Stator lead Wire 44

Table 14. Test 7 Stator Results

Test Point A	Test Point B	Results
Resistance Tests		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
C1 Pin 2 Wire 11	Stator Lead 22	
C1 Pin 1 Wire 44	Stator Lead 33	
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2	
Shorts to Ground		
Stator Lead 11	Ground	
Stator Lead 44	Ground	
C1 Pin 1 Wire 44	Ground	
C1 Pin 2 Wire 11	Ground	
C1 Pin 4 Wire 2	Ground	
Shorted Condition		
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11	
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead 11	C1 Pin 1 Wire 44	
Stator Lead 11	Stator lead Wire 44	

Note: These results may be needed when requesting factory support.

Note: Stator winding resistance values are very low and some VOM's will not read such a low resistance, and will simply indicate CONTINUITY. The manufacture recommends a high quality digital type meter capable of reading a very low resistance.

Results

1. Resistance Test: If the VOM indicated a very high resistance or INFINITY, the windings are open or partially open.
2. Grounded Condition: Any resistance value other than INFINITY indicates a grounded winding.
3. Shorted Condition: Any resistance value other than INFINITY indicates a shorted winding.

Note: Read Section 1.5, "Testing, Cleaning and Drying" carefully. If the winding tests good, perform the insulation resistance test. If the winding fails the insulation resistance test (using a meg-ohm-meter), clean and dry the stator as outlined in Section 1.5. Then, repeat the insulation resistance test. If the winding fails the second resistance test (after cleaning and drying), replace the stator assembly.

TEST 8 – RESISTANCE CHECK OF ROTOR CIRCUIT

Discussion

During the rotor amp draw test in Test 4, if the amp draw was zero, then an OPEN circuit should be present on Wires 4 and 0. This test will verify if the readings were accurate and verify the field boost circuit.

Identify C1 Connector wiring configuration. Refer to Figure 54.

Configuration A: follow Steps 1-11

Configuration B: follow Steps 1-6

Procedure

1. Remove the 7.5 amp fuse from the control panel.
2. Remove the cover and controller to expose the lower harness connections.
3. Disconnect the J5 connector from the controller
4. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
5. Connect one-meter test to lead to J5 Pin 13 (Wire 4) and connect the other meter test lead to J5 Pin 12 (Wire 0), measure and record the resistance.
6. Connect one-meter test to lead to J5 Pin 13 (Wire 4) and connect the other meter test lead to a clean frame ground, measure and record the resistance.
   a. If the meter indicated the correct Rotor resistance values as stated in the front of the manual, proceed to Step 9.
   b. If the meter indicated INFINITY, proceed to Step 7.
7. If testing C1 Configuration A, locate and disconnect the bulkhead C1 connector. If testing C1 Configuration B, stop test and refer to Test 8 Results.
8. Connect one-meter test lead to C1 Pin 5 (Wire 4) and connect the other meter test lead to C1 Pin 6 (Wire 0), measure and record the resistance. If the VOM indicated INFINITY, stop testing and refer back to flow chart (Rotor Circuit Failure).
9. Locate the starter contactor relay (SCR) and disconnect Wire 56 (blue wire).
10. Disconnect the J4 connector from the controller.
11. Connect one meter test lead to the disconnected Wire 56 and connect the other meter test lead to J5 Pin 13 (Wire 4). Measure and record the resistance.

Results

Refer to the front of this manual for correct Rotor resistance values.

1. If the VOM indicated the correct resistance values in Steps 5, 6, 8, and 11, refer back to flowchart (Good).
2. If the VOM indicated INFINITY in Step 8, refer back to flowchart (Rotor Circuit Failure).
3. If the VOM indicated the correct resistance in Step 8 and indicated INFINITY in Step 5, repair or replace Wires 4 and 0 between the C1 and the J5 connector.
4. If the VOM indicated the correct resistance in Step 8 and indicated INFINITY in Step 5, but indicated the correct resistance in Step 6, repair or replace Wire 0 between the J5 connector and the ground connection.
5. If the VOM indicated the correct resistance in Step 5 and indicated INFINITY in Step 11, replace the harness (Field Boost Circuit Failure).

TEST 9 – CHECK BRUSHES AND SLIP RINGS

Discussion

The brushes and slip rings function to provide an electrical connection for excitation current from the stationary components to the rotating rotor. Made of a special long lasting material, brushes seldom wear out or fail. However, slip rings can develop a tarnish or film that can inhibit or offer a resistance to the flow of current. Such a non-conducting film usually develops during non-operating periods. Broken or disconnected wiring can also cause loss of excitation current to the rotor.

Refer to Figure 54 to identify the C1 Connector wiring configuration of the unit being tested. Follow steps for Configuration A or Configuration B accordingly.

Procedure

1. Disassemble the Generator until the brushes and slip rings are exposed. Refer to Section 6.1 "Major Disassembly."
2. Inspect the brush wires and verify they are secured and properly connected.
3. Inspect the brush assembly for excessive wear, or damage.
4. Inspect the rotor slip rings. If their appearance is dull or tarnished, polish with a fine grade abrasive material.

WARNING!

Do not use metallic grit to polish slip rings. This may cause irreversible damage to the rotor.

5. Wire 0, located on the negative brush terminal, provides an electrical connection to ground for the rotor and the voltage regulator. To test this wire for an OPEN condition, remove Wire 0 from the brush assembly.
6. For C1 Configuration A disconnect the bulkhead connector C1 inside the control panel. For C1 Configuration B disconnect the J5 connector from the controller and isolate Wire 0 from the ground stud.
7. Set Volt-Ohm-Milliammeter (VOM) to measure resistance.
8. For C1 Configuration A connect one meter test lead to Wire 0 at the brush assembly and connect the other meter test lead to C1 Pin 6. For C1 Configuration B connect one meter test lead to Wire 0 at the brush assembly and connect the other meter test lead to the Wire 0 disconnected in Step 6.

- If the VOM indicated INFINITY, repair or replace Wire 0 between the negative slip ring and C1 Pin 6 (Configuration A) or the ground stud (Configuration B).
- If the VOM indicated CONTINUITY, continue to Step 9.

9. Wire 4, located on the positive brush terminal, provides an electrical connection for excitation current to flow between the rotor and the voltage regulator. To test this wire for an OPEN condition, remove Wire 0 from the brush assembly.
10. For C1 Configuration A connect one meter test lead to Wire 4 at the brush assembly and connect the other meter test lead C1 Pin 5. For C1 Configuration B connect one meter test lead to Wire 4 a the brush assembly and connect the other meter test lead to J5 Pin 13.

- If the VOM indicated INFINITY, repair or replace Wire 4 between the positive slip ring and C1 Pin 6 (Configuration A) or J5 Pin 13 (Configuration B).
- If the VOM indicated CONTINUITY, continue to Step 11.

11. Connect one meter test lead to Wire 4 at the brush assembly and connect the other meter test lead to frame ground.

- If the VOM indicated CONTINUITY, repair or replace Wire 4 between the positive slip ring and C1 Pin 6 (Configuration A) or J5 Pin 13 (Configuration B).
- If the VOM indicated INFINITY, continue to Step 12.

12. Connect one meter test lead to Wire 0 at the brush assembly and connect the other meter test lead to a clean frame ground.

- If the VOM indicated INFINITY , repair or replace Wire 0 between the positive slip ring and the control panel ground connection.
- If the VOM indicated CONTINUITY, refer back to flow chart.

Results

1. Repair, replace, or reconnect wires as necessary.
2. Replace any damage slip rings or brush holder.
3. Clean and polish slip rings as required.

TEST 10 – TEST ROTOR ASSEMBLY

Discussion

A rotor having open windings will cause loss of excitation current flow and as a result generator AC output voltage will drop to "residual" voltage. A "shorted" rotor winding can result in a low voltage condition.

Procedure

1. Remove the brush assembly from the slip rings to prevent interaction.
2. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
3. Connect one meter test lead to the positive slip ring (nearest the rotor bearing) and the common test lead to the negative slip ring, measure and record the resistance.
4. Connect one meter test lead to the positive slip ring and connect the other meter test lead to a clean frame ground, measure and record the resistance.

Results

1. Compare the resistance measured in Step 3 with the "Specifications", replace rotor as required.
2. If the VOM indicated CONTINUITY in Step 4, replace the rotor assembly.

TEST 11 – CHECK AC OUTPUT FREQUENCY

Discussion

The generator AC frequency is proportional to the operating speed of the rotor. The 2-pole rotor will supply a 60 Hertz AC frequency at 3600 RPM.

Tools Required

- A meter that is capable of measuring AC frequency

Procedure

1. See Figure 46, connect an accurate AC frequency meter across the Wires 11 and 44 Terminals of the generator main line circuit breaker (MLCB)
2. Set the AUTO-OFF-MANUAL to the MANUAL position.
3. Let engine stabilize. Measure and record the frequency.

Results

1. If the meter indicated 59-61 Hertz, refer back to flow chart
2. If the meter indicated a value outside the accepted range, refer back to flow chart.

TEST 12 – CHECK STEPPER MOTOR CONTROL

Procedure: V-Twin

1. Remove air cleaner cover to access Stepper motor.
2. Physically move the throttle and verify the Stepper motor, linkage and throttle do not bind in any way, if any binding is felt repair or replace components as needed. The Stepper motor will have resistance as it moves through its travel.
3. Physically move the throttle to the closed position by pulling the Stepper motor arm towards the idle stop. See Figure 55 for 8kW units, Figure 56 for 10kW units, and Figure 57 for 12-20kW units.
4. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
5. Observe record the Stepper motors movement.
6. Set the AUTO-OFF-MANUAL switch to the OFF position.

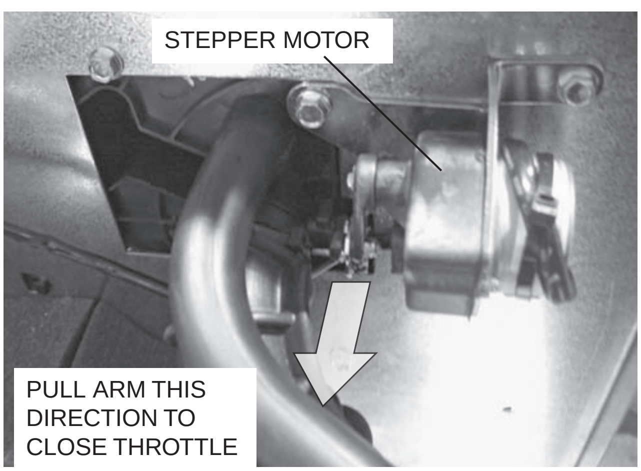


Figure 55. Throttle Positions 8kW Units

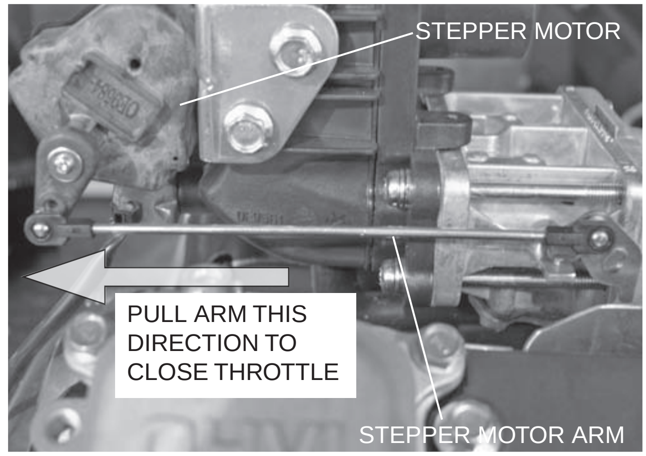


Figure 56. Throttle Positions 9/10kW Units

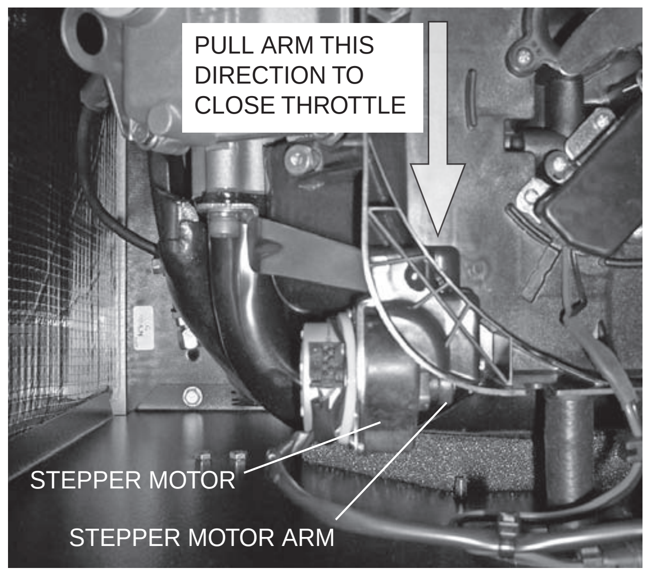


Figure 57. Throttle Positions 12-20kW Units

7. Physically move the throttle to the open position by pulling the Stepper motor arm away from the idle stop.
8. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
9. Observe and record the Stepper motors movement.
10. Set the AUTO-OFF-MANUAL switch to the OFF position.
11. If no movement was seen in Step 5 or 6 remove the controller and verify the six pin connector on the controller is seated properly, remove the connector and then replace it and test again. If problems persist, proceed to Step 12.
12. Set Volt-Ohm-Milliammeter (VOM) to measure resistance.

Note: Press down with the meter leads on the connectors exposed terminals, do not probe into the connector.

13. Connect the meter test leads across points A and B as shown in Table 15 and compare to the specified value. See Figure 58 for pin locations.

Table 15. Stepper Motor Testing

Test Point A	Test Point B	Resistance Value
Red	Orange	10Ω
Red	Yellow	10Ω
Red	Brown	10Ω
Red	Black	10Ω
Red	Ground	INFINITY

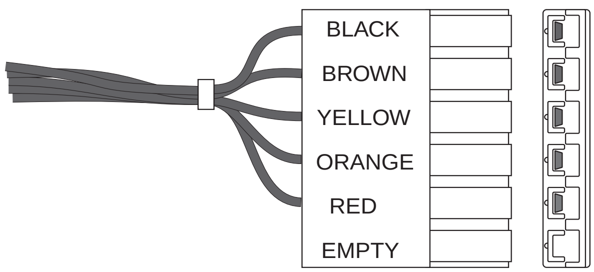


Figure 58. Six Pin Connector Wire Colors

Results

1. If the Stepper motor in Step 5 moved to the wide-open position, the closed position in Step 9, and the VOM indicated CORRECT resistance values, refer back to flow chart.
2. If the Stepper motor failed to change the throttle position in Steps 5 or 9, replace Stepper motor.
3. If the Stepper motor in Step 5 moved to the wide-open position, the closed position in Step 9, and the VOM indicated IN-CORRECT resistance values, replace Stepper motor.

TEST 14 – CHECK VOLTAGE AND FREQUENCY UNDER LOAD

Discussion

It is possible for the Generator AC output frequency and voltage to be good at no-load, but they may drop excessively when electrical loads are applied. This condition, in which voltage and frequency drop excessively when loads are applied can be caused by (a) overloading the Generator, (b) loss of engine power or performance, or (c) a shorted condition in the stator windings or in one or more connected loads.

Procedure

1. Set Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. Connect an accurate AC frequency meter and an AC voltmeter across the stator AC power winding leads.
3. Start the engine, let it stabilize and warm-up.
4. Apply electrical loads to the Generator equal to the rated capacity of the unit. Measure and record the frequency and the voltage.

Results

1. If the VOM indicated 60 Hz and approximately 248 VAC during full load, discontinue testing.
2. If the VOM indicated a frequency and voltage that dropped while under full load, refer back to flow chart.

TEST 15 – CHECK FOR AN OVERLOAD CONDITION

Discussion

An “overload” condition is one in which the Generator rated wattage/amperage capacity has been exceeded. To test for an overload condition on an installed unit, the recommended method is to use an ammeter. See Section 1.4 “Measuring Current.”

Procedure

1. Connect the clamp-on ammeter to the Generator according to the ammeters manufacture specifications.
2. Transfer all normal electrical loads to the Generator, measure and record the amperage.

Results

1. If the ammeter indicated amperage readings that were ABOVE the unit’s specified ratings, reduce loads to the units rated capacity.
2. If the ammeter indicated amperage readings that were BELOW the unit’s specified ratings, but RPM and frequency dropped excessively refer back to flowchart.

TEST 16 – CHECK ENGINE CONDITION

Discussion

If engine speed and frequency drop excessively under load, the engine may be underpowered. An underpowered engine can be the result of a dirty air cleaner, loss of engine compression, faulty fuel settings, or incorrect ignition timing, etc. A decrease in available horsepower will proportionally lead to a decrease in kW.

Procedure

For engine testing, troubleshooting, and repair procedures refer to Section 4.3. For further engine repair information, refer to the appropriate engine service manuals.

PART 3
TRANSFER SWITCH

TABLE OF CONTENTS		
SECTION	TITLE	PAGE
3.1	Description and Components	60
3.2	Operational Analysis	64
3.3	Troubleshooting Flow Charts	73
3.4	Diagnostic Tests	76

Air-cooled, Automatic Standby Generators

INTRODUCTION

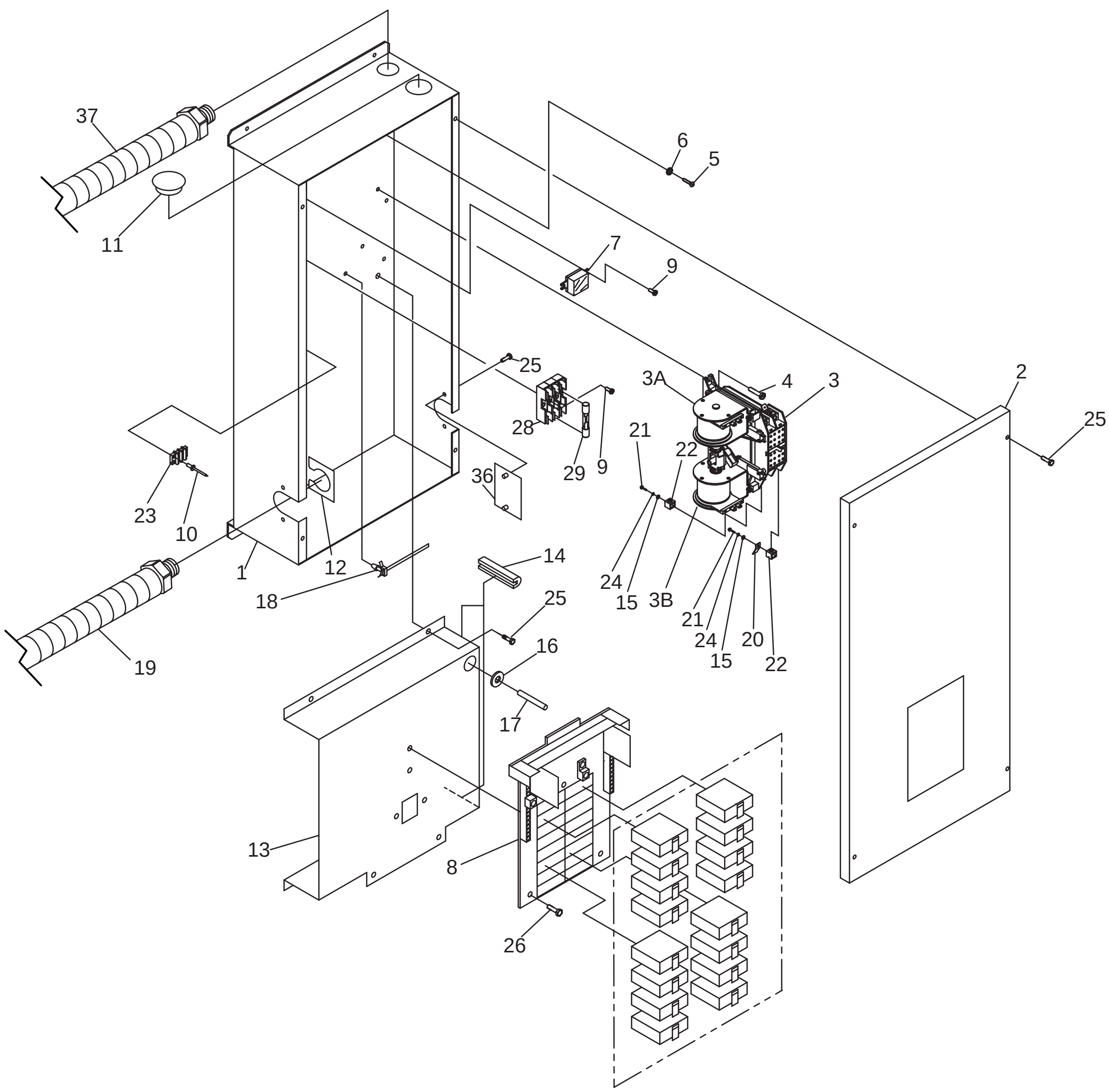
The “V-Type” CONTACTOR is available in 100 and 200 Amp ratings at 250 volts maximum. It is available in 2-pole configuration (single phase only).

The transfer switch does not have any intelligence systems of its own. Instead, the Generator controls automatic operation of the transfer switch.

ENCLOSURE

The transfer switch enclosure is a National Electrical Manufacture’s Association (NEMA) type 1. Based on NEMA Standard 250, the following standard applies

- NEMA 1 – Enclosures constructed for indoor use to provide a degree of protection against incidental contact with the enclosed equipment and to provide a degree of protection against falling dirt.



ITEM	DESCRIPTION
1	GTS LOAD CENTER ENCLOSURE
2	COVER 10 POS.GTS LOAD CTR
3	TRANSFER SWITCH
3A	COIL UTILITY
3B	COIL STANDBY
4	SCREW HHTT M5-0.8 X 10
5	SCREW TAPTITE 1/4-20 X 5/8
6	LOCK WASHER, SPECIAL-1/4”
7	RELAY PANEL 12VDC DPDT 10A@240VAC
8	12CIR L/CENTR 125A/240V (ALSO USED FOR 10 CIRCUIT)
9	SCREW HHTT M4-0.7 X 10
10	RIVET POP .156” X .675”
11	PLUG PLASTIC
12	HARNESS ADAPTER PLATE
13	SUBPLATE GT S LOAD CENTER
14	5.28” U-CHANNEL
15	WASHER FLAT #10 ZINC
16	GROMMET 3/8 X 1/16 X 1/4
17	ARM EXTENDER PIN
18	CABLE TIE SELF MOUNTING 4.3LG
19	HARN GTS-MAIN PNL 10CIR W/NEUT
20	LUG QUICK DISCONNECT NI-S 10X45 DEG BRASS / TIN
21	SCREW PPHM #10-32X3/8
22	LUG SL DLSS 1/0-#14X9/16 AL/CU
23	BLOCK TERM 20A 2 X 6 X 1100V
24	WASHER LOCK #10
25	SCREW SW 1/4"-20 X 5/8” WITH WASHER
26	SCREW HHTT M5-0.8 X 16 (10, 12, 14, 16 CIRCUIT)
27	HARNESS LOAD CT R INT.CONN 10-16 (NOT SHOWN)
28	FUSEBLOCK 30A 600V 3POS W/SQ
29	FUSE 5A
30	CIRCUIT BREAKER 20A 2P 1 1 1
31	CIRCUIT BREAKER 30A 2P 1 1
32	CIRCUIT BREAKER 15A 1P 3 5 4 5
33	CIRCUIT BREAKER 20A 1P 3 3 6 5
34	CIRCUIT BREAKER 40A 2P 1 1 1
35	CIRCUIT BREAKER 50A 2P 1
36	HARNESS ENTRY COVER
37	HARN GTS-EXT CONN BOX 8KW

Figure 59. Exploded View of V-Type Transfer Switch

TRANSFER SWITCH CONTACTOR

The basic 2-pole CONTACTOR consists of a pair of moveable LOAD contacts, a pair of stationary UTILITY contacts, and a pair of stationary STANDBY contacts. The LOAD contacts connect the UTILITY contacts by a utility closing coil or to the STANDBY contacts using the standby closing coil. See Figures 60 and 61. In addition, the LOAD contacts can be moved to either the "Utility" or "Standby" position by means of a manual transfer handle. The closing coils are energized and actuated by the voltage source from the side to which the load is being transferred. I.e. If the CONTACTOR is in the "Utility" position, the standby closing coil will energize utilizing Standby voltage.

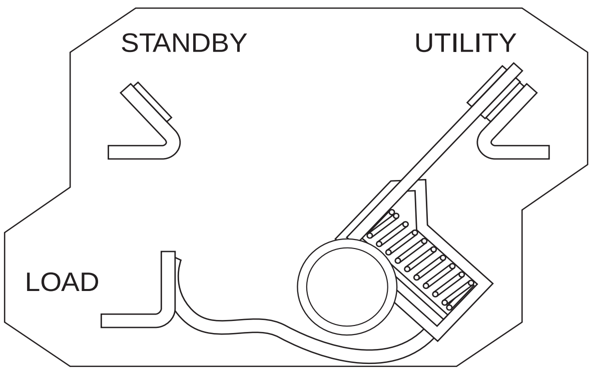


Figure 60. Load Connected to Utility Power Source

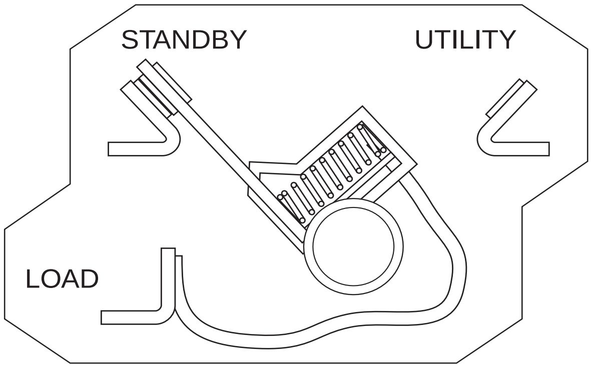


Figure 61. Load Connected to Standby Power Source

Utility Closing Coil C1

See Figure 62. The utility closing coil (C1) utilizes rectified Utility source power to actuate the LOAD contacts to the "Utility" position. When energized, the coil will move the LOAD contacts to an "over center" position. A limit switch opens the circuit and the spring force will complete the transfer to "Standby". The bridge rectifier, which changes the Utility source alternating current (AC) to direct current (DC), is sealed in the coil wrappings. If either the coil or the bridge rectifier replacement becomes necessary replace the coil assembly.

Standby Closing Coil C2

The standby closing coil (C2) utilizes rectified Standby source power to actuate the LOAD contacts to their "Standby" position. Energizing the coil moves the LOAD contacts to an "over center" position. A limit switch opens the circuit and the spring force will complete the transfer to "Standby". If either the coil or the bridge rectifier replacement becomes necessary replace the coil assembly.

Limit Switches SW2 and SW3

The LOAD contacts mechanically actuate the limit switches. When the LOAD contacts connect to the UTILITY contacts, the limit switch (SW2) opens the Utility circuit to C1 and the limit switch (SW3) closes the Standby circuit to standby closing coil (C2). The limit switches "arm" the system for transfer back to the opposite source. An open condition in SW2 will prevent retransfer to "Utility". An open condition in SW3 will prevent transfer to the "Standby."

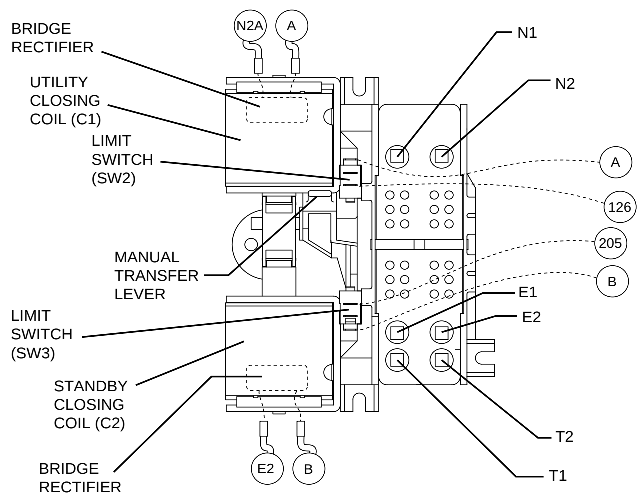


Figure 62. The "V-Type" Transfer Mechanism

TRANSFER RELAY

Transfer relay operation is controlled by the Nexus controller mounted on the generator set. Figure 63 shows the transfer relay electrical schematic. The transfer relay operates as follows:

1. Generator battery voltage (12 volts DC) is available to the transfer relay coil from the Nexus controller, via Wire 194 and Relay Terminal A.
   a. The 12-volt DC circuit is completed through the transfer relay coil and back to the controller via Wire 23.

b. The controller's logic holds the Wire 23 circuit open to ground (Normally Open circuit) and the relay is de-energized.
c. When de-energized, the relay contacts are in their normal condition (one set open, N.O.; and one set closed, N.C.)
d. The normally closed relay contacts deliver Utility source power to the utility closing circuit of the transfer switch.
e. The normally open relay contacts will deliver Standby source power to the transfer switch standby closing circuit only when the Transfer Relay is energized by the control panel.

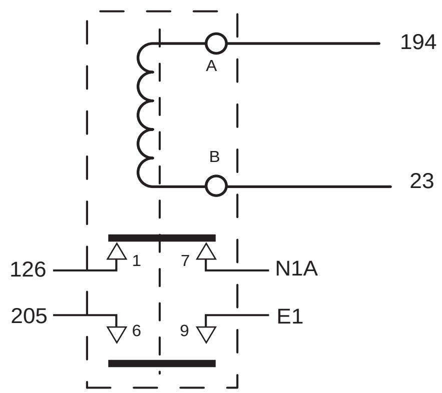


Figure 63. Transfer Relay Schematic

2. During automatic system operation, when the Generator controller "senses" that Utility source voltage has dropped out, the controller will initiate a ten second "Line Interrupt Delay" timer; at the end of the ten second delay the controller will crank and start the engine.
3. When the circuit board "senses" that the engine has started (via wire 18 from the magneto circuit), the controller will initiate a five second "Engine Warm-up Timer."
4. When the "engine warm-up timer" has timed out, the controller's logic closes the Wire 23 circuit to ground.
   a. The transfer relay energizes.
   b. The relays normally closed contacts open and its normally open contacts close.
   c. When the normally open contacts close, Standby source power is delivered to the standby closing coil and transfer to "Standby" occurs.
5. When the controller "senses" that Utility source voltage has been restored (above 75% of nominal for 15 seconds), the Wire 23 circuit will open from ground.
   a. The transfer relay will de-energize, its normally closed contacts will close and its normally open contacts will open.
   b. When the normally closed relay contacts close, utility source voltage is delivered to the utility closing coil to energize that coil.
   c. Transfer back to UTILITY occurs.

NEUTRAL LUG

The Generator is equipped with an UNGROUNDED neutral. The neutral lug in the transfer switch is isolated from the switch enclosure.

MANUAL TRANSFER HANDLE

The manual transfer handle is retained in the transfer switch enclosure by means of a wing nut and stud. Use the handle to manually move the CONTACTOR to the "Utility" or "Standby" position.

Instructions on use of the manual transfer handle are located in Section 5.1 "Operational Tests and Adjustments".

CUSTOMER CONNECTIONS

During system installation, this 3-point terminal block must be properly interconnected with an identically labeled terminal block in the generator customer connections box.

Figure 64 identifies the customer connections located in the transfer switch. The wires are identified as 194, 23, N1, N2, T1.

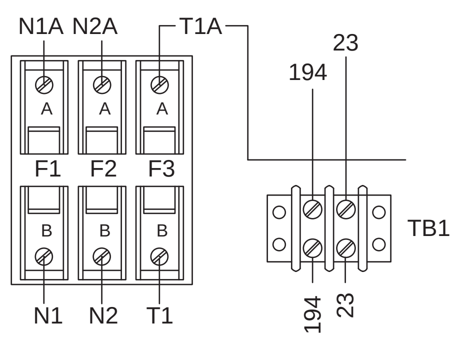


Figure 64. Customer Connections

Utility N1 and N2

N1 and N2 provide the Utility voltage-sensing signal to the controller. The controller utilizes the sensing circuit as follows:

- If Utility source voltage should drop below 65% of nominal for ten seconds, the controller's logic will initiate automatic cranking and startup. The controller will transfer the switch to the Standby position after a five second engine warm-up timer.

Load T1

Wire T1, connected to the Load side of the CONTACTOR, provides 120 VAC for the battery charging circuit (the battery charge is an integral component of the controller). The charger maintains battery voltage anytime the load terminals have voltage available.

Control 194, 23

Wire 194 and 23 provide control of the transfer relay by the controller. Wire 194 provides continuous DC voltage to the transfer switch. Wire 23 is held open from ground by the controller's logic until a Utility failure is "sensed".

FUSE HOLDER

The fuse holder holds three fuses, designated as fuses F1, F2, and F3.

Figure 65. Fuse

Fuses F1, F2

These two fuses protects the N1 and N2 circuit against overload

Fuse F3

This fuse protects the battery charger against overload.

UTILITY SOURCE VOLTAGE AVAILABLE

Figure 66 is a schematic representation of the transfer switch with Utility source power available. The circuit condition is briefly described as follows:

- Utility source voltage is available to terminal lugs N1 and N2 of the CONTACTOR; the transfer switch is in the “Utility” position and Utility voltage is available to T1 and T2, customer load.
- Utility source voltage is available to the limit switch (SW2) via the normally closed transfer relay contacts (1 and 7) and Wire 126; however, SW2 is open and the circuit to the utility closing coil is open.
- Utility voltage “sensing” signals are delivered to controller on the Generator, via Wire N1A, and a 5-amp fuse (F1). The second line of the Utility voltage “sensing” circuit is via Wire N2A, and a 5 amp fuse (F2)

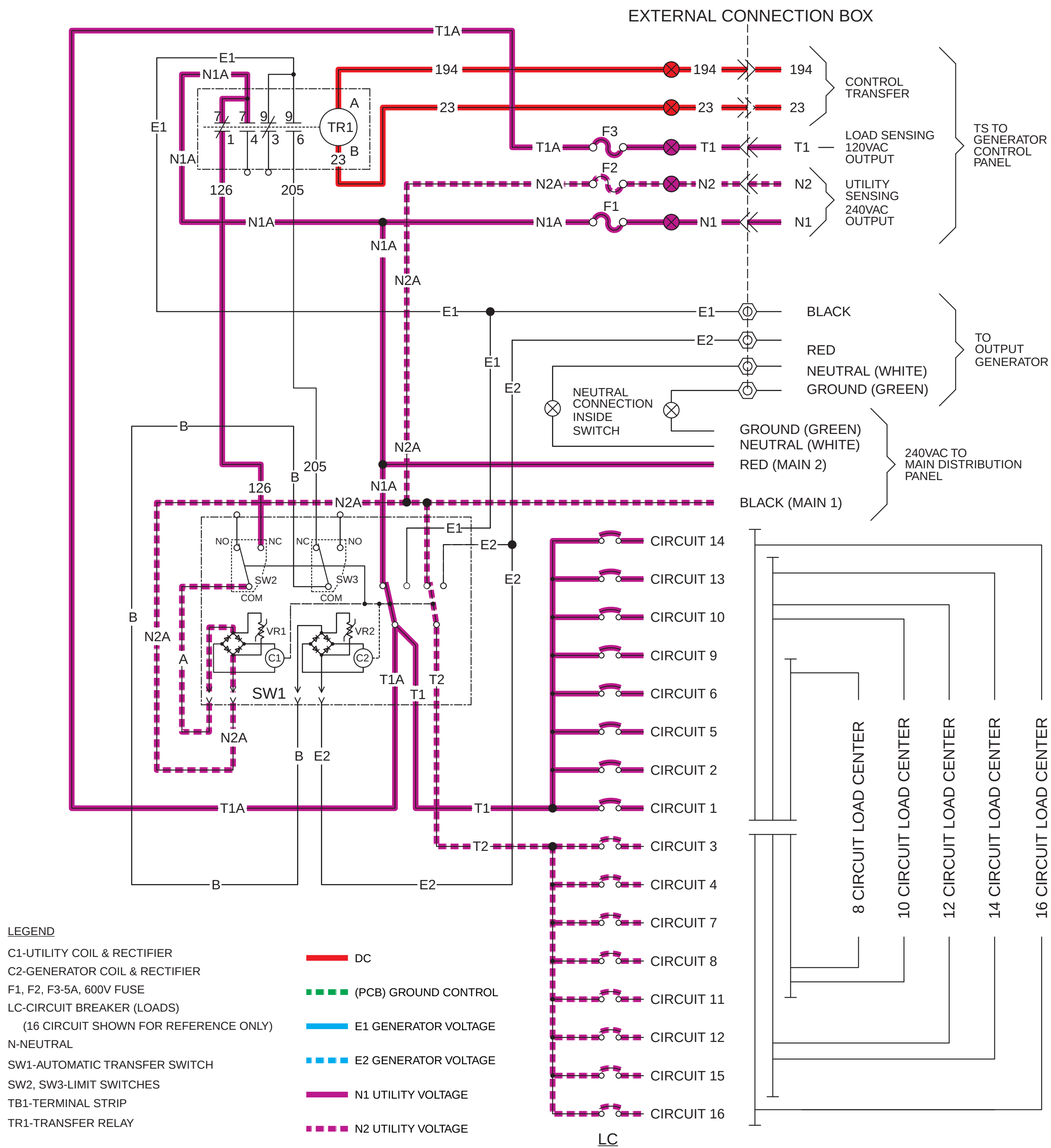


Figure 66. Utility Source Voltage Available

UTILITY SOURCE VOLTAGE FAILURE

If Utility source voltage should drop below 65% of nominal voltage for ten seconds, the controller will initiate engine start. After the generator starts a five second engine warm-up timer is initiated. During this warm-up the generator is running at rated frequency and voltage. Figure 67 is a schematic representation of the transfer switch with the Generator running with voltage available to the transfer switch.

Generator voltage is available on CONTACTOR terminals E1 and E2.

- The controller's logic is holding Wire 23 open from ground.
- Generator voltage from terminal E2 is available at the standby coil (C2); generator voltage from Terminal E1 is available to the transfer relay at Pin 9. The transfer relay is not energized so E1 voltage will not go through the N.O. contact (9 & 6) to Wire 205.

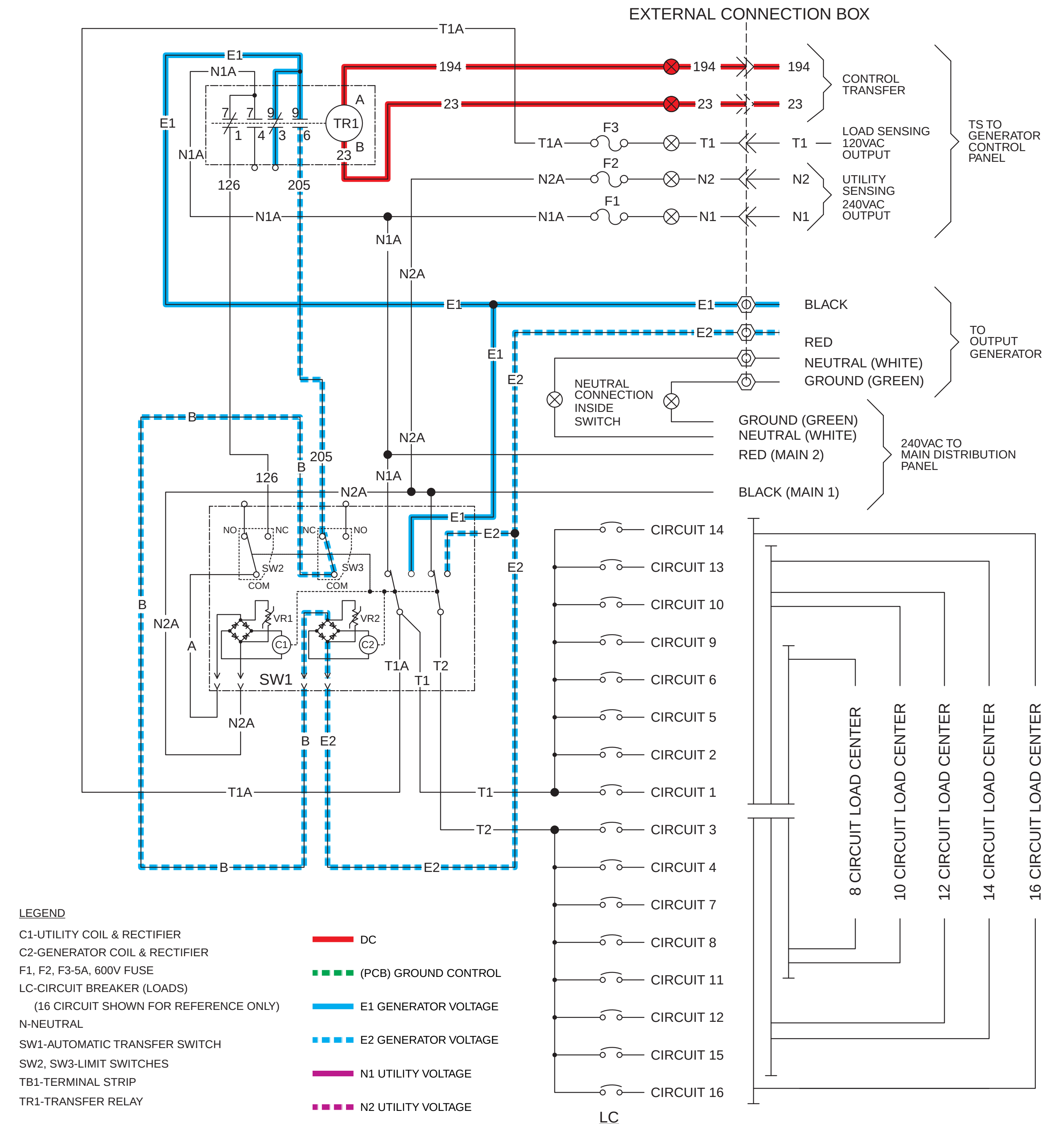


Figure 67. Utility Source Voltage Failure

TRANSFERRING TO STANDBY

12 VDC is delivered to the transfer relay through Wire 194 and back to the controller through Wire 23. When the five second engine warm-up timer expires, the controller will take wire 23 to ground which will energize the Transfer Relay. The N.O. and N.C. relay contacts will change states. This will connect generator voltage from E1 at Pin 9 to Wire 205; the voltage will go through the N.C contact of SW3. Voltage from both E1 and E2 will be available at the C2 coil; this voltage will pass through the rectifier in the coil; the coil will then energize.

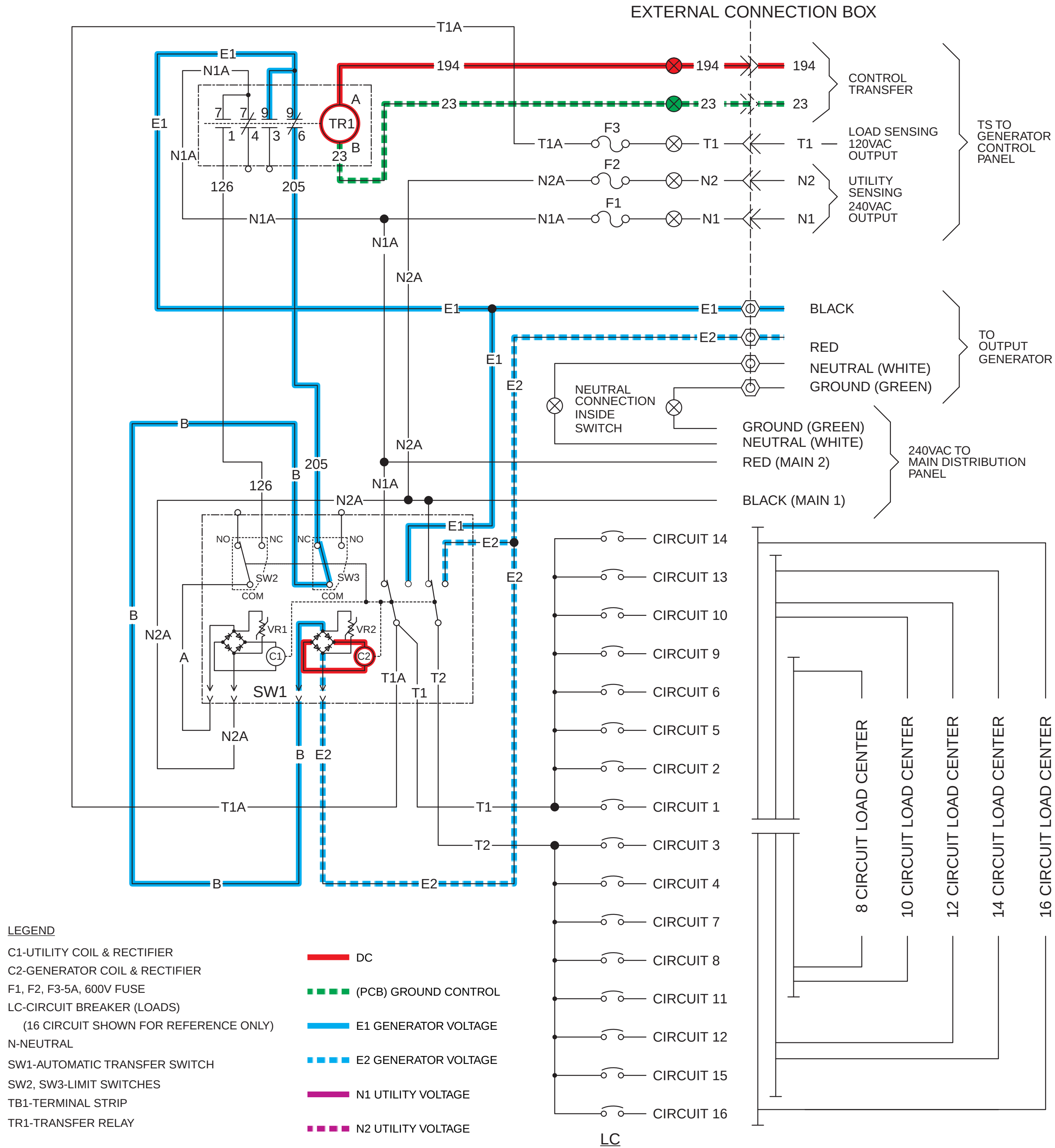


Figure 68. Transferring to Standby

TRANSFERRED TO STANDBY

When the standby coil (C2) energizes it pulls the CONTACTOR to an “over center” position towards the “Standby” position, the transfer switch mechanically snaps to that position. Upon closure of the main contacts to the “Standby” position limit switches SW2 and SW3 mechanically actuate to “arm” the circuit for re-transfer to “Utility” position. When SW3 changes it opens the circuit providing voltage to the Standby closing coil (C2). Voltage from the Generator, connected through T1 and T2, provide power to customer connected loads.

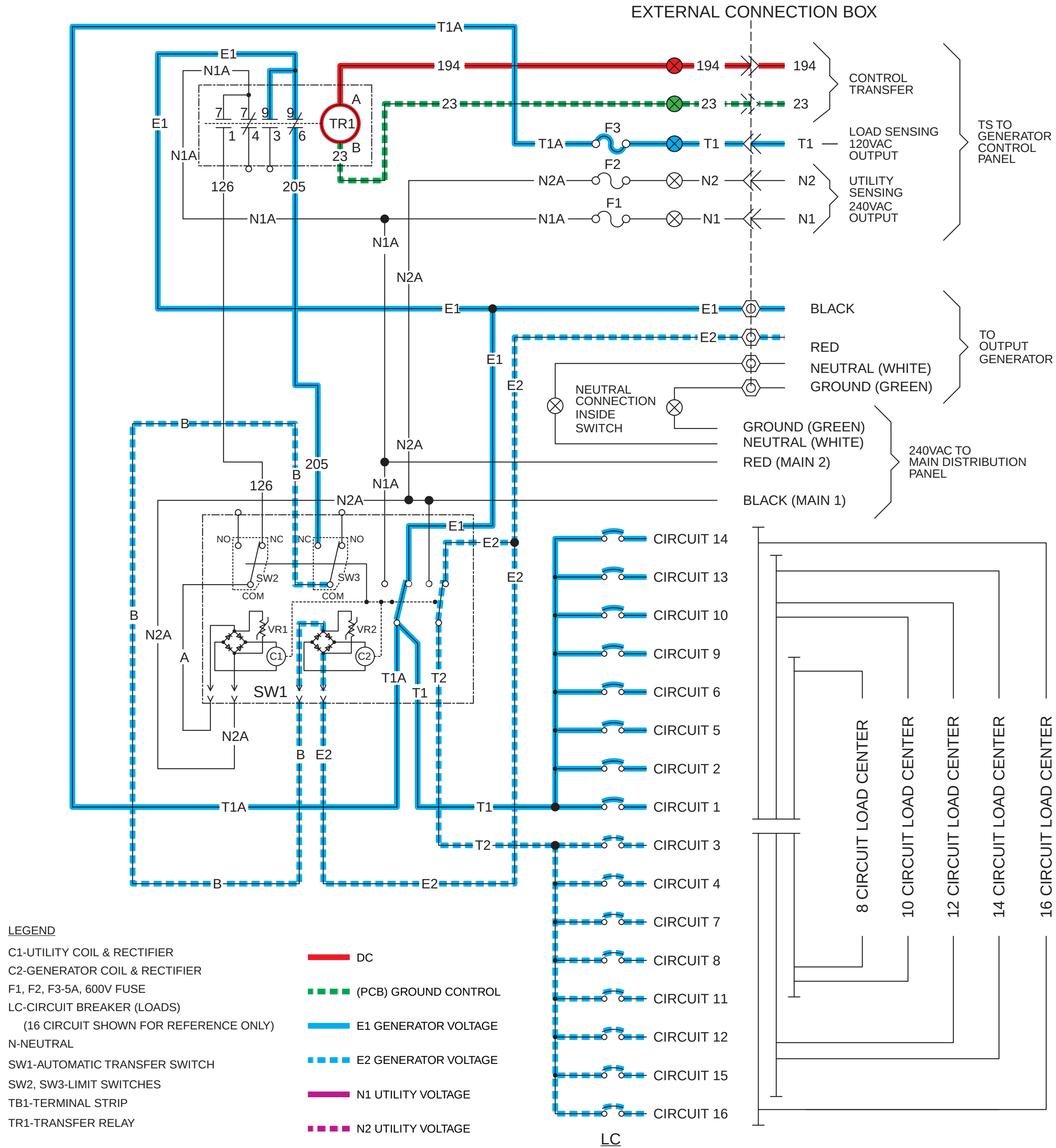


Figure 69. Transferred to Standby

UTILITY RESTORED

Utility voltage is restored and available to terminals N1 and N2. The Utility voltage is "sensed" by the controller and, if it is above 75% of nominal for 15 consecutive seconds, a transfer back to Utility will occur.

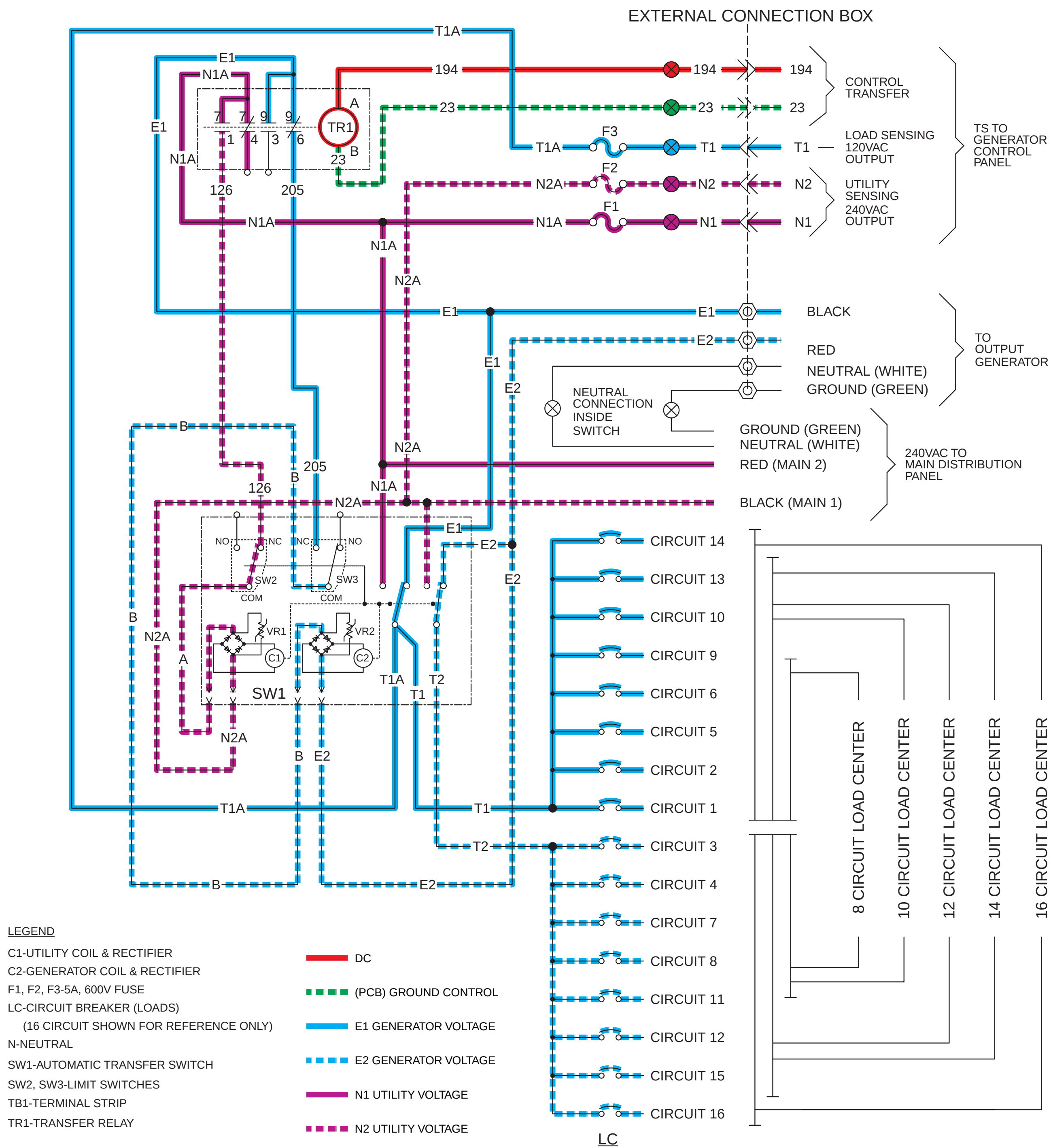


Figure 70. Utility Retored

UTILITY RESTORED, TRANSFERRING BACK TO UTILITY

After the 15 second return to utility delay expires, the controller will open the Wire 23 circuit from ground. The transfer relay (TR1) de-energizes, the N.O. and N.C. contacts change state. Utility voltage is delivered to the utility closing coil (C1) through Wires N1A and N2A, the normally closed contacts (1 and 7) , Wire 126, and limit switch (SW2) . With utility voltage applied to both sides of the utility closing coil (C1), the rectifier in the coil causes the coil to energize.

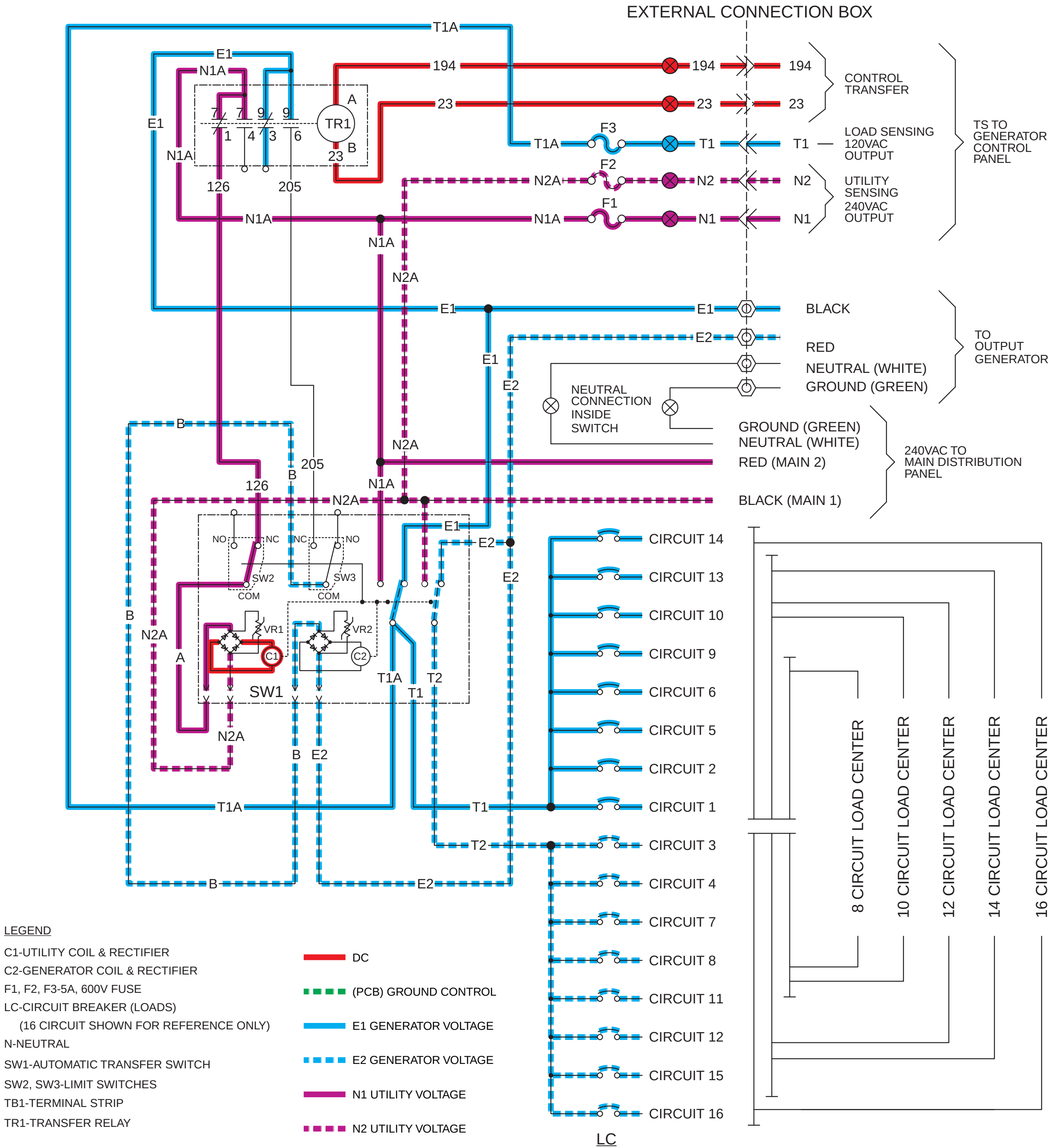


Figure 71. Utility Restored, Transferring back to Utility

UTILITY RESTORED, TRANSFERRED BACK TO UTILITY

As the utility closing coil pulls the transfer switch to an "over center" position, the switch mechanically snaps to the "Utility" position. Upon closure of the contacts to Utility, the limit switches (SW2 and SW3) mechanically actuate to "arm" the circuit for the next transfer to Standby. When switch SW2 changes states, the circuit providing voltage to the utility transfer coil is opened, and the coil de-energizes.

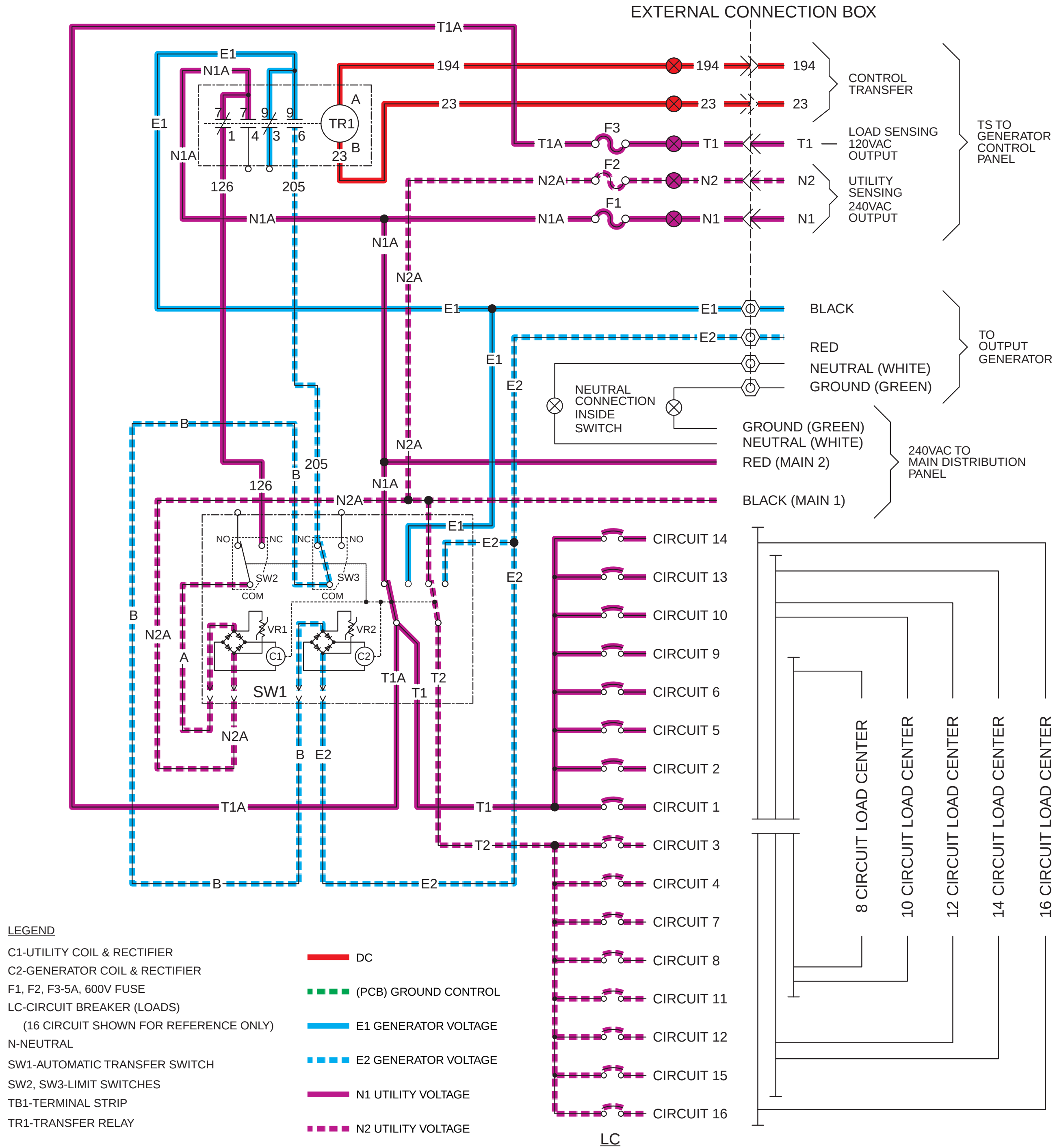


Figure 72. Utility Restored, Transferred back to Utility

TRANSFERRED BACK TO UTILITY, GENERATOR SHUTDOWN

When the transfer switch returns to the "Utility" position the controller will shut the generator down after the one minute engine cool-down timer expires.

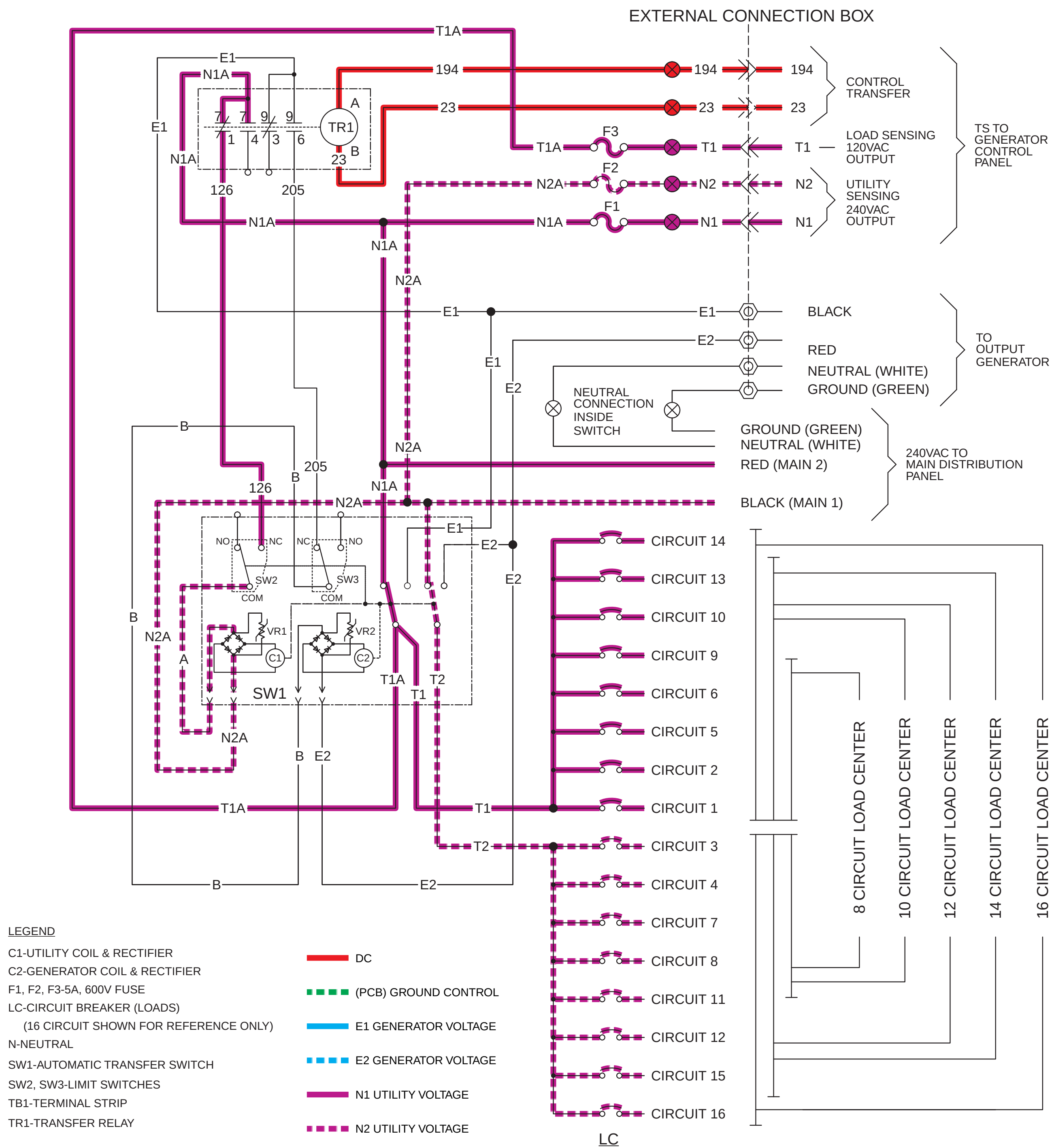
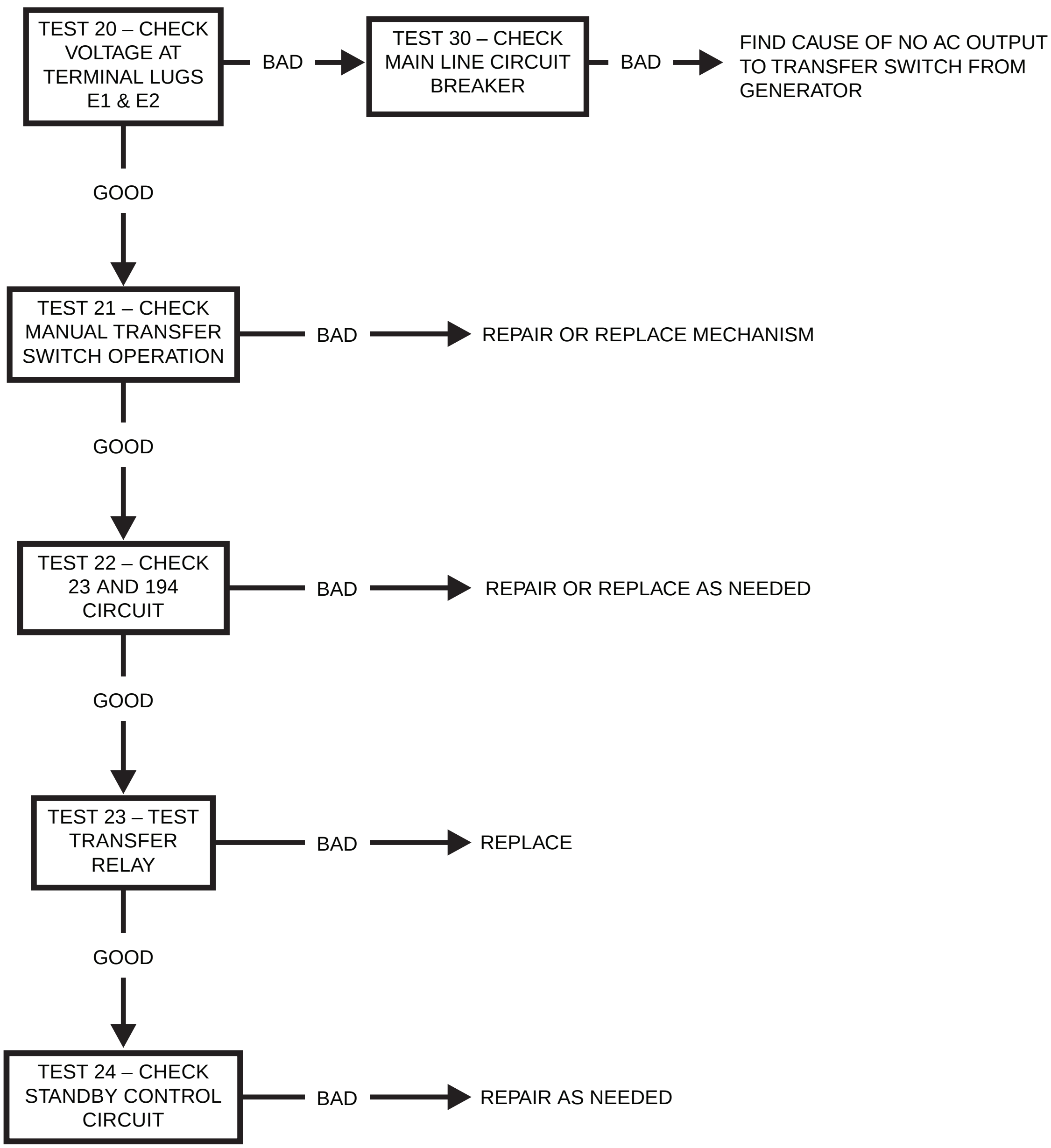


Figure 73. Transferred back to Utility, Generator Shutdown

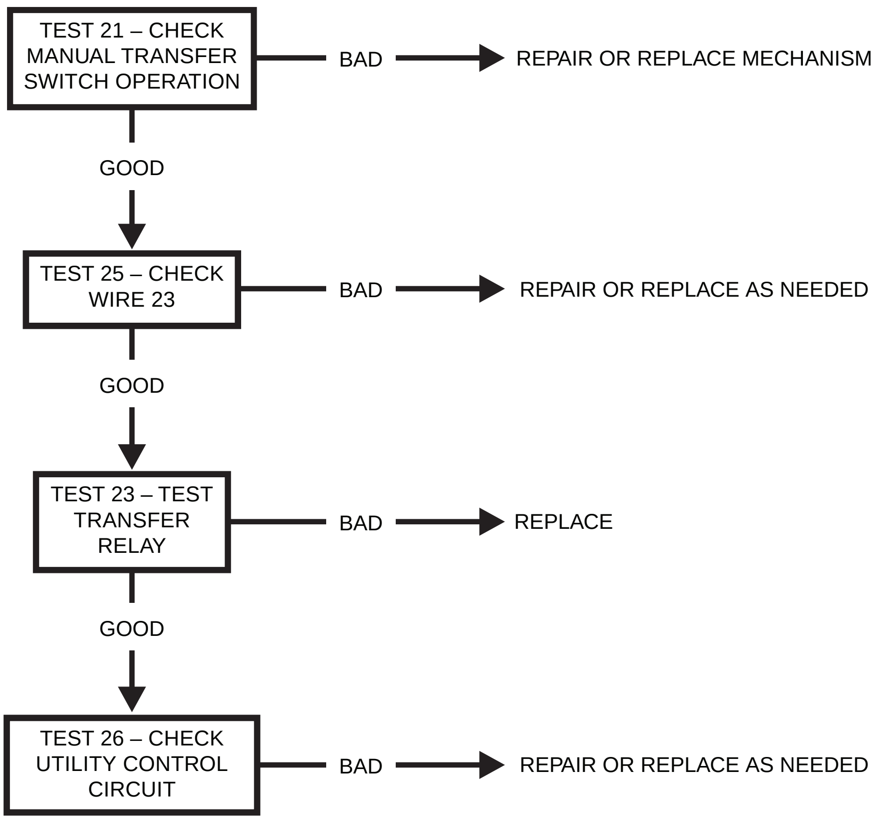
INTRODUCTION

Use the "Flow Charts" in conjunction with the detailed instructions in Section 3.4. Test numbers used in the flow charts correspond to the numbered tests in Section 3.4. The first step in using the flow charts is to identify the correct problem on the following pages. For best results, perform all tests in the exact sequence shown in the flow charts.

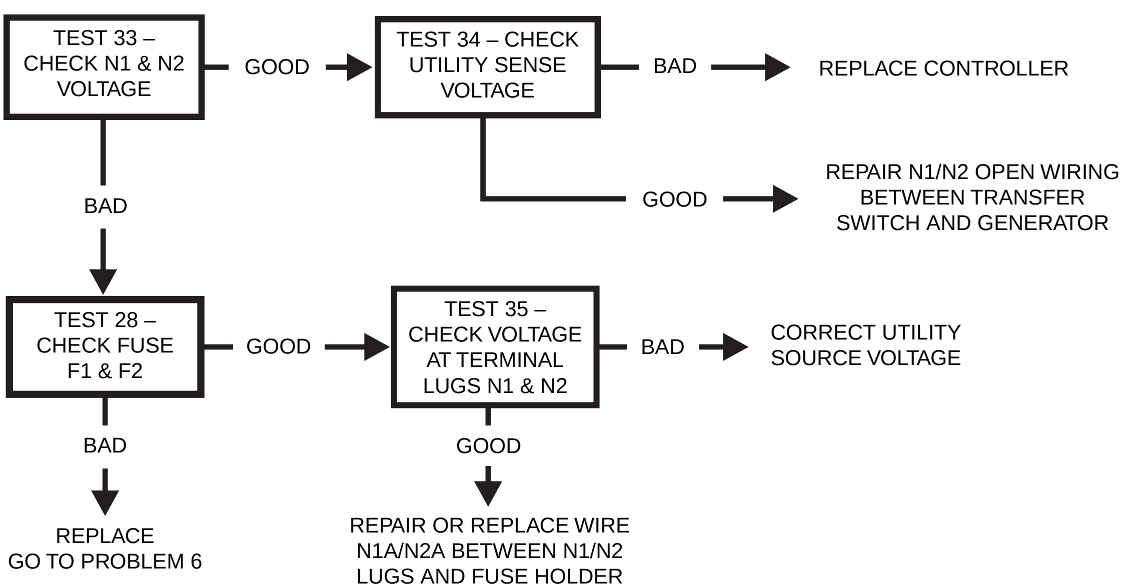
Problem 6 – With Controller in Automatic Mode and Utility Failed, Generator Runs but Transfer to Standby Does Not Occur



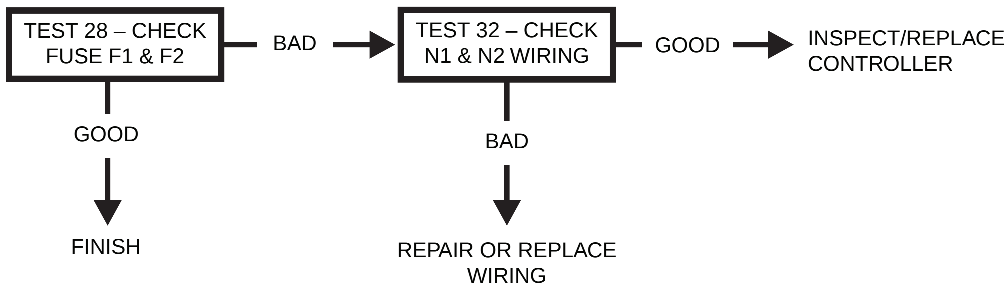
Problem 7 – In Automatic Mode, Generator Starts When Loss of Utility Occurs, Generator Shuts Down When Utility Returns But There Is No Retransfer To Utility Power
OR
Generator Transfers to Standby During Excercise or in Manual Mode



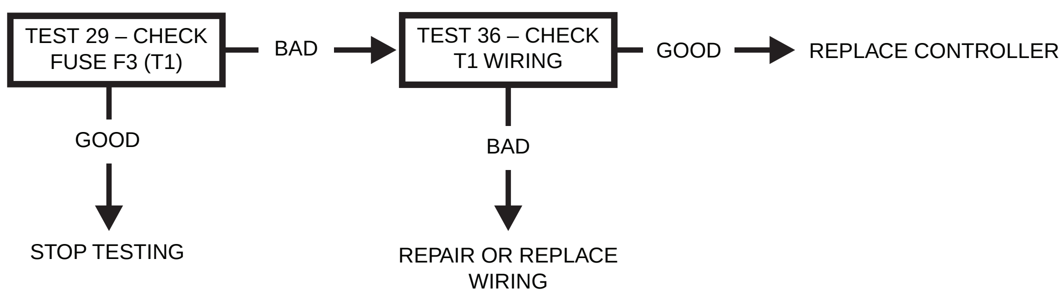
Problem 8 – Unit Starts and Transfer Occurs When Utility Power Is On



Problem 9 – Blown F1 or F2 Fuse



Problem 10 – Blown T1 Fuse



INTRODUCTION

This section familiarizes the service technician with acceptable procedure for the testing and evaluation of various problems that can occur on pre-packaged transfer switches. Use this section in conjunction with Section 3.3, "Troubleshooting Flow Charts." The numbered tests in this section correspond with those of Section 3.3.

Some test procedures in this section may require the use of specialized test equipment, meters or tools. Most tests can be performed with an inexpensive volt-ohm-meter (VOM). An AC frequency meter is required, where frequency readings must be taken. To measure AC loads it is acceptable to use a clamp-on ammeter.

Testing and troubleshooting methods covered in this section are not exhaustive. No attempt has been made to discuss, evaluate and advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Accordingly, anyone who uses a test method not recommended herein must first satisfy himself that the procedure or method he has selected will jeopardize neither his nor the products safety.

SAFETY

Service personnel who work on this equipment should be aware of the dangers of such equipment. Extremely high and dangerous voltages are present that can kill or cause serious injury. Gaseous fuels are highly explosive and can ignite by the slightest spark. Engine exhaust gases contain deadly carbon monoxide gas that can cause unconsciousness or even death. Contact with moving parts can cause serious injury. The list of hazards is seemingly endless.

When working on this equipment, use common sense and remain alert at all times. Never work on this equipment while you are physically or mentally fatigued. If you do not understand a component, device or system, do not work on it.

TRANSFER SWITCH TROUBLESHOOTING

It is always good practice to continue to ask questions during the troubleshooting process. When evaluating the problem asking some of these questions may help identify the problem quicker.

- What is the transfer switch doing?
- What was the transfer switch supposed to do?
- Does the transfer switch have the same fault consistently, and when does it occur?
- Who is controlling it?
- Exactly what is occurring?
- When is it happening?
- Why would this happen?
- How would this happen?
- What type of test will either prove or disprove the cause of the fault?

TEST 20 – CHECK VOLTAGE AT TERMINAL LUGS E1 AND E2

Discussion

In automatic mode to transfer to the "Standby" position, the standby closing coil (C2) energizes utilizing generator output. Transfer to "Standby" cannot occur unless generator voltage is available to the transfer switch.

If the generator is not producing the correct voltage it will shutdown on an under or over-voltage alarm and thus will not be running.

Two procedures have been provided in the event that the generator is already running in a Utility failure. It is not required to complete both procedures.

⚠ DANGER!

Be careful! High and dangerous voltages are present at terminal lugs E1 and E2 when the generator is running. Avoid contact with high voltage terminals or dangerous and possible lethal electrical shock may result. Do not perform this voltage test while standing on wet or damp ground, while barefoot, or while hands or feet are wet.

Procedure: Generator Running in Utility Failure, Switch did not Transfer

1. Set Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. If the Generator engine has started automatically (due to a Utility failure) and is running, check the position of the Generator main line circuit breaker. The circuit breaker must be set to its "Closed" position. After confirming that the Generator main circuit breaker is set to the "Closed" position, verify the voltage at the transfer switch CONTACTOR terminal lugs E1 and E2 with an accurate AC VOM. The meter should indicate generator line-to-line voltage.

Procedure: Generator Shutdown

1. Set the AUTO-OFF-MANUAL switch to the OFF position.
2. Set Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
3. Disconnect Utility voltage from the transfer switch.
4. Verify the CONTACTOR is in the "Utility" position.
5. Verify the Generator main line circuit breaker (MLCB) is in the "Closed Position".
6. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
7. If transfer to the "Standby" position does NOT occur, check the voltage across terminal lugs E1 and E2. The VOM should indicate generator line-line voltage.

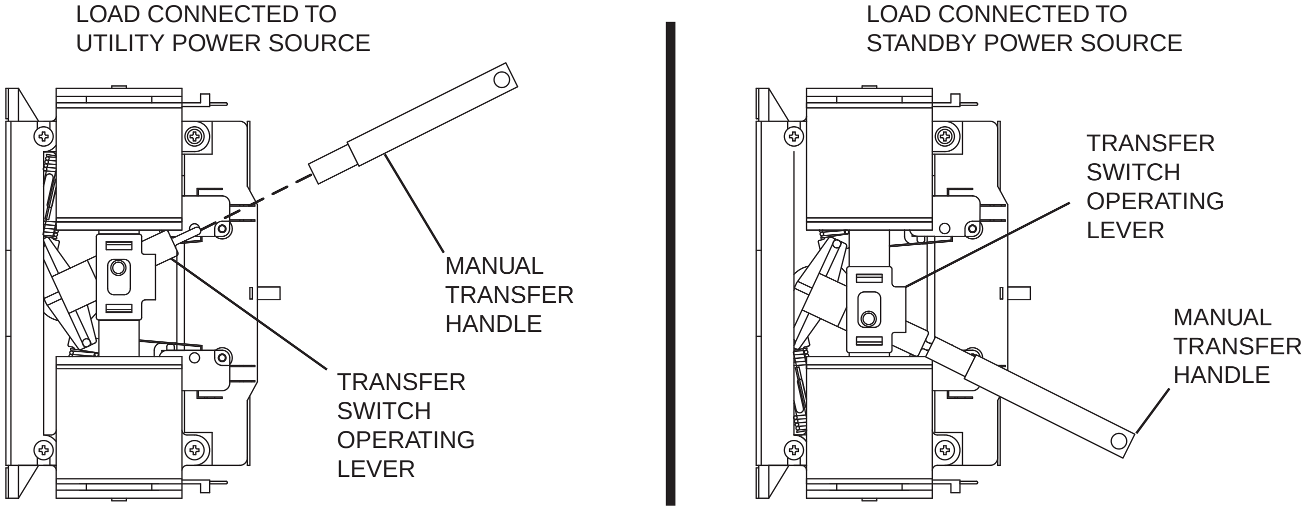


Figure 74. Manual Transfer Switch Operation

Results

1. If normal transfer to the "Standby" position occurs, discontinue testing.
2. If transfer to the "Standby" position did NOT occur but the Generator continued to run for longer than 10 seconds, and the VOM did not indicate voltage across E1 and E2, proceed to Test 1 "Check AC output voltage" and Test 2 "Check Main Line Circuit Breaker."
3. If transfer to the "Standby" position did NOT occur and the VOM indicated voltage across E1 and E2 this test is GOOD; refer to back to flow chart.
4. If transfer to the "Standby" position did NOT occur and Generator faulted on under-voltage, refer to Problem 1 "Generator Shuts Down for Under-voltage."

TEST 21 – CHECK MANUAL TRANSFER SWITCH OPERATION

Discussion

In automatic operating mode, when Utility source voltage drops below a preset level, the engine should crank and start. On engine startup, an "engine warm-up timer" on the Generator should start timing. After the timer has expired (about 15 seconds), the transfer relay (TR1) energizes to deliver generator source voltage to the standby closing coil terminals. If generator voltage is available to the standby closing coil terminals, but transfer to Standby does not occur, the cause of the failure may be (a) a failed standby closing coil and/or bridge rectifier, or (b) a seized or sticking actuating coil or load contact. This test will help you evaluate whether any sticking or binding is present in the CONTACTOR

Procedure

1. Set the generator main line circuit breaker (MLCB) to the "Open" position.
2. Set the AUTO-OFF-MANUAL switch to the OFF position.
3. Disconnect Utility from the transfer switch.

⚠ DANGER!

Do not attempt manual transfer switch operation until all voltage to the switch have been disconnected. Failure to turn off all power voltage supplies may result in extremely hazardous and possibly lethal electrical shock.

4. Locate the manual transfer handle inside the switch enclosure.
5. Insert the un-insulated end of the handle over the transfer switch-operating lever. Refer to Figure 74.
   a. Manual actuate the CONTACTOR lever to the "Utility" position.
   b. Actuate the operating lever down to the "Standby" position.
6. Repeat Step 5 several times. When the CONTACTOR lever is moved slight force should be needed until the lever reaches its center position. As the lever moves past its "over center" position, an over-center spring should snap the movable LOAD contacts against the stationary STANDBY or UTILITY contacts.
7. Actuate the CONTACTOR to the "Utility" position.

Results

1. If there is no evidence of binding, sticking, or excessive force required the test is GOOD; refer back to the flow chart.
2. If evidence of sticking, binding, excessive force is required to move the CONTACTOR, find cause of binding or sticking and repair or replace damaged components.

TEST 22 – CHECK 23 AND 194 CIRCUIT

Discussion

An OPEN circuit in the switch control wiring will prevent a transfer from occurring. Terminal "A" of the transfer relay (TR1) connects to Wire 194 and terminal "B" connects to Wire 23. Wire 194 provides 12 VDC to terminal "A", and the Controller holds Wire 23 open from ground. With Wire 23 open from ground TR1 is de-energized.

Reference: De-energized TR1 relay voltage checks:

- Wire 194 to Ground = 12VDC
- Wire 194 to Wire 23 = 0 VDC
- Wire 23 to Ground =12 VDC

Procedure/Results

1. Disconnect and isolate Wire 23 from the transfer switch terminal strip coming from the Generator. Set the Generators AUTO-OFF-MANUAL to AUTO position; simulate a Utility failure.
2. Once the Generator is running, connect a jumper wire from ground to Wire 23 located at the terminal strip. Listen and visually watch for the energizing of the TR1 relay and for the transfer to Standby.
   a. If the TR1 relay visually and audibly energized and the CONTACTOR transferred to the "Standby" position, stop testing, proceed to Test 25 "Check Wire 23".
   b. If the transfer relay did not energize, continue to Step 3.
   c. If the TR1 relay visually and audibly energized and the CONTACTOR did not transfer to the "Standby" position, proceed to Test 23 "Test Transfer Relay."
3. Set the Generators AUTO-OFF-MANUAL switch to the OFF position.
4. Set Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
5. Connect the negative (-) test lead to ground in the transfer switch. Connect the positive (+) test lead to Wire 194 at the terminal strip located in the transfer switch.
   a. If voltage is present, proceed to Step 6.
   b. If voltage is not present, proceed to Step 17.
6. Connect the positive (+) test lead to Wire 23 at the terminal strip located in the transfer switch. Connect the negative (-) test lead to a ground in the transfer switch.
   a. If voltage is present, proceed to Step 9.
   b. If voltage is not present, proceed to Step 7.
7. Set VOM to measure resistance.
8. Remove Wire 23 and Wire 194 going to the TR1 relay from the terminal strip. Connect the meter test leads across Wire 23 and Wire 194 (going to the relay).
   a. The VOM should indicate TR1 coil resistance of approximately 115 ohms.
   b. If coil resistance is not measured, remove Wire 23 and Wire 194 from the TR1 relay. Measure across terminal A and terminal B of the TR1 relay.
   c. If coil resistance is measured, repair or replace Wire 23 or Wire 194 between the terminal strip and the TR1 relay.
   d. If coil resistance is not measured, replace TR1 relay and retest.

Note: Re-connect wires before proceeding to Step 9.

9. Connect the negative (-) test lead to the ground lug in the Generator control panel. Connect the positive (+) test lead to Wire 23 in the Generator at the customer connection terminal strip.
   a. If voltage is present, proceed to Step 10.
   b. If voltage is not present, repair wiring between transfer switch and Generator control panel.
10. Simulate a power failure (Open Utility Service Breaker) with the AUTO-OFF-MANUAL switch in the AUTO position. Approximately 10 seconds after starting, Navigate to the digital output screen.
11. Press "ESC" three times.
12. Press the right arrow key until "Debug" is flashing.
13. Press "Enter."
14. Press the right arrow key until "Outputs" is flashing.
15. Press "Enter".
16. Digital Output 8 is the Wire 23 output from the controller. Refer to Figure 77.
17. If Output 8 shows a "1" then the control board is grounding Wire 23.
   a. If Output 8 did not change replace the controller.
   b. If Output 8 did not change, proceed to next step.
18. Locate and disconnect the J4 connector from the controller.
19. Set the VOM to measure resistance.
20. Connect one meter test lead to J4 Pin 20 (Wire 23) on the connector. Connect the other meter test lead to J4 Pin 19 (Wire 194). VOM should indicate approximately 115 ohms.
   a. If the VOM indicated approximately 115 ohms, repair or replace the J4 Pin 20 connection.
   b. If the VOM indicated INFINITY, repair or replace Wire 23 between J4 connector and the Generator terminal strip.
   c. If resistance is not within specification, proceed to Test 23 – "Test Transfer Relay."
21. Set VOM to measure DC voltage.

22 Connect the negative (-) test lead to the ground lug in the Generator control panel. Connect the positive (+) test lead to Wire 194 at the terminal strip in the Generator control panel.

a. If voltage is present, repair Wire 194 between the Generator terminal strip and transfer switch terminal strip.
b. If voltage is not present, proceed to Step 20.

23. Locate and disconnect the J4 connector from the controller.
24. Set VOM to measure resistance.
25. Connect one meter test lead to Wire 194 at the Generators customer connection terminal strip. Connect the other meter test lead to J4 Pin 19 (Wire 194) at the connector.
26. Continuity should be measured.
    a. If continuity is not measured, repair pin connection and/ or Wire 194 between the connector and terminal strip.
    b. If continuity is measured, proceed to Step 24.
27. Remove the Generator fuse.
28. Reconnect J4 connector.
29. Re-install the fuse.
30. Disconnect Wire 194 from the Generators terminal strip.
31. Set VOM to measure DC voltage.
32. Connect one meter test lead to Wire 194. Connect the other meter test lead to a clean frame ground, 12 VDC should be measured.
    a. If 12 VDC is not measured, replace the controller.
    b. If 12 VDC is measured, a short exists on Wire 194 or the TR1 relay. Repair or replace as needed

TEST 23 – TEST TRANSFER RELAY

Discussion

In automatic mode, transfer to Standby will not occur until the transfer relay (TR1) energizes. When TR1 relay energizes, Generator voltage is available to operate the standby closing coil. Without Generator source voltage available, the closing coil will remain de-energized and transfer to the “Standby” position will not occur. This test will determine if the TR1 relay is functioning normally.

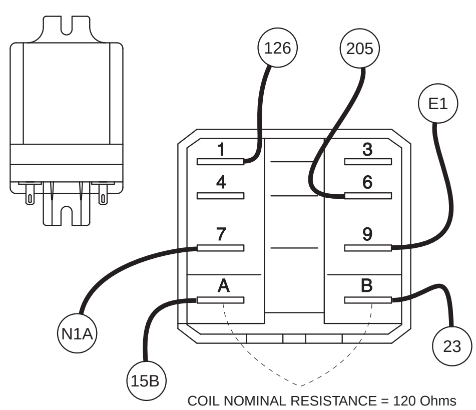


Figure 75. Transfer Relay Test Points

Procedure

1. Disconnect all wires from the TR1 relay to prevent interaction. See Figure 75.
2. Using jumper wires, connect one jumper wire from the positive post of the battery to relay Terminal A and connect the other jumper wire from the negative post of the battery to relay Terminal B.
3. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
4. With the relay de-energized, connect the VOM test leads across relay Terminals “A” and “B”, measure and record the resistance
5. Connect the VOM test leads across relay Terminals 6 and 9, measure and record the resistance.
    a. Energize the relay, the meter should indicate INFINITY.
    b. De-energize the relay ,the VOM should indicate CONTINUITY
6. Repeat Step 5 across relay Terminals 7 and 1.

Table 16.

CONNECT VOM TEST LEADS ACROSS	DESIRED METER READING	
	ENERGIZED	DE-ENERGIZED
Terminals 6 and 9	Continuity	Infinity
Terminals 1 and 7	Infinity	Continuity
Terminal A and B		120 Ohms

Results

1. Compare the results with Table 16. If the relay tests good, refer back to flow chart.
2. Replace relay if found defective.

TEST 24 – TEST STANDBY CONTROL CIRCUIT

Discussion

Refer to Figure 76. The standby coil (C2) requires 240 VAC to energize. When the transfer relay energizes, 240 VAC is applied to the C2 coil. Once energized, the coil will pull the CONTACTOR down to the “Standby” position. Once in the “Standby” position, the limit switch (SW3) will open, removing AC voltage from the C2 coil.

Procedure/Results

1. Set the Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. Verify the CONTACTOR is in the “Utility” position.
3. Remove Wire E2 from the C2 coil.
4. Set the AUTO-OFF-MANUAL switch to AUTO. Turn off Utility power supply to the transfer switch, simulating a utility failure. The Generator should start and the transfer relay should energize.

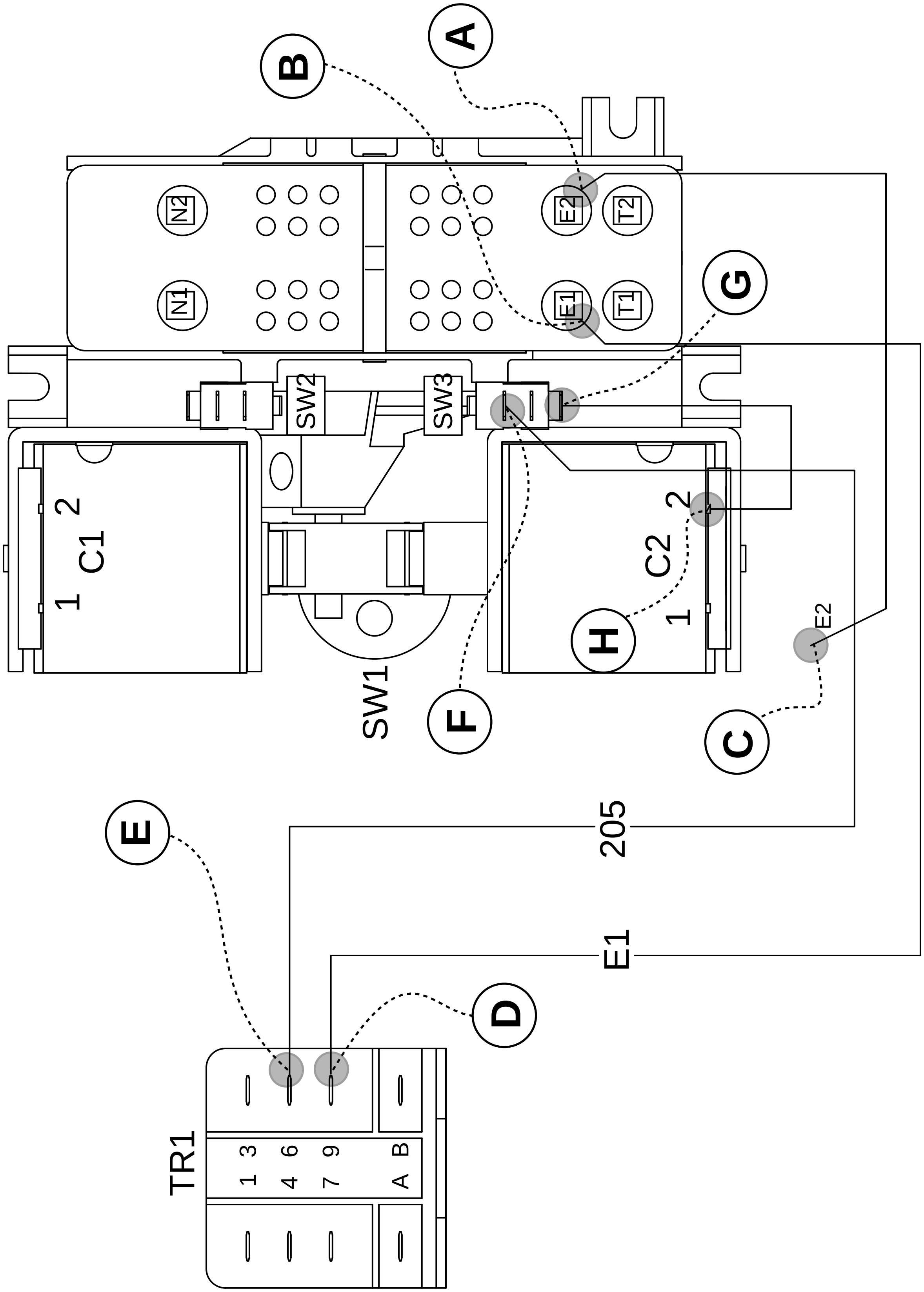


Figure 76. Standby Control Circuit Test Points

5. Measure across points A and B, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, go back to Test 20.
   b. If 240 VAC was measured, proceed to Step 6.
6. Measure across points C (Wire E2 previously removed) and B, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire E2.
   b. If 240 VAC was measured, proceed to Step 7.
7. Measure across points A and D, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire E1.
   b. If 240 VAC was measured, proceed to Step 8.
8. Measure across points A and E, the VOM, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, replace transfer relay.
   b. If 240 VAC was measured, proceed to Step 9
9. Measure across points A and F, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire 205.
   b. If 240 VAC was measured, proceed to Step 10.
10. Measure across points A and G, the VOM should indicate 240 VAC.
    a. If 240 VAC was NOT measured, verify the limit switch (SW3) is wired correctly, proceed to Test 27 – Test Limit Switches.
    b. If 240 VAC was measured, proceed to Step 11.
11. Measure across points A and H, the VOM should indicate 240 VAC.
    a. If 240 VAC was NOT measured, repair or replace Wire B.
    b. If 240 VAC was measured, replace the C2 coil.

TEST 25 – CHECK WIRE 23

Discussion

The controller located in the generator is responsible for grounding Wire 23 in order to initiate a transfer. When Wire 23 closes to ground the transfer relay (TR1) energizes. To initiate a transfer back to Utility the TR1 relay must de-energize. If the TR1 relay is staying energized, a grounded Wire 23 could be the cause.

Procedure/Results

1. Set the Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
2. Set the AUTO-OFF-MANUAL switch to the OFF position.
3. Connect the positive meter test lead to Wire 194 and connect the negative meter test lead to Wire 23 located in the transfer switch.
   a. If 0 VDC was measured, proceed to Step 4.
   b. If 12 VDC was measured, proceed to Step 13.
4. Set the AUTO-OFF-MANUAL switch to the AUTO position.
5. Connect the positive meter test lead to Wire 194 and connect the negative meter test lead to Wire 23 located in the transfer switch.
   a. If 12 VDC was measured, proceed to Step 6.
   b. If 0 VDC was measured, the Wire 23 circuit is good, refer back to flow chart
6. Press “ESC” three times.
7. Press the right arrow key until “Debug” is flashing.
8. Press “Enter”.
9. Press the right arrow key until “Outputs” is flashing.
10. Press “Enter”.

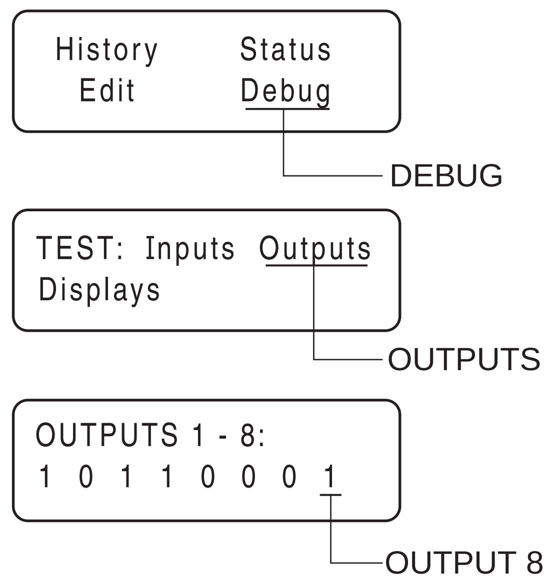


Figure 77. The Home Page, Debug and Output Screens

11. Digital Output 8 is the Wire 23 output from the controller. Refer to Figure 77.
12. If Output 8 shows a “1” then the control board is grounding Wire 23. Replace the controller.
13. Locate the terminal strip in the generator control panel. Disconnect Wire 23 coming in from the transfer switch (customer side, see Figure 79).
14. Connect the positive meter test lead to Wire 194 at the terminal strip in the generator and connect the negative meter test lead to Wire 23 just removed from the terminal strip in Step 13 (Customer Side).
    a. If 0 VDC was measured, proceed to Step 15.
    b. If 12 VDC was measured, a short to ground exists on Wire 23 between the generator and transfer switch. Repair or replace Wire 23 as needed between the generator control panel and transfer switch relay (TR1).

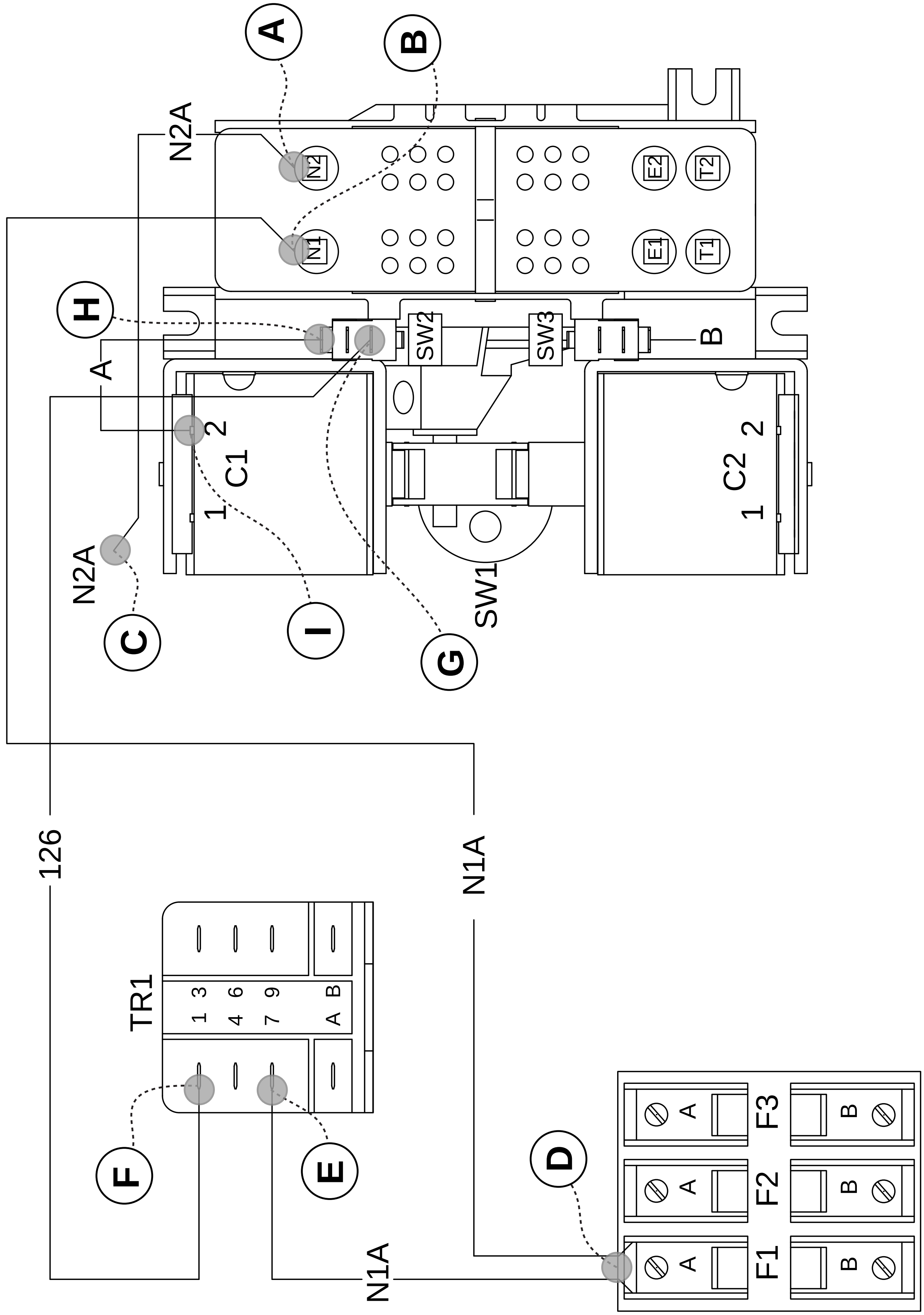


Figure 78. Utility Control Circuit Test Points

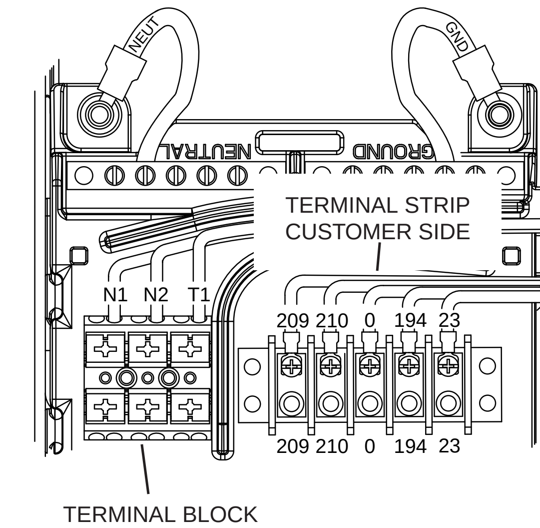


Figure 79. Transfer Relay Test Points

15. Continue to have Wire 23 disconnected on the customer side.
16. Disconnect the J4 connector from the controller.
17. Set VOM to measure resistance.
18. Connect one meter test lead to Wire 23 connected at the terminal strip (see Figure 79) and connect the other meter test lead to a clean frame ground.
   a. If INFINITY or OPEN was measured, replace the controller.
   b. If CONTINUITY was measured, Wire 23 is shorted to ground. Repair or replace Wire 23 between the J4 connector and the Generator terminal strip.

TEST 26 – UTILITY CONTROL CIRCUIT

Discussion

Refer to Figure 78. The utility coil (C1) requires 240 VAC to energize. When the transfer relay (TR1) de-energizes, 240 VAC is applied to the C1 coil. Once energized, the coil will pull the CONTACTOR up to the "Utility" position. Once in the "Utility" position, the limit switch (SW2) will open, removing AC voltage from the C1 coil.

Procedure

Refer to Figure 78.

1. Set the AUTO-OFF-MANUAL switch to the OFF position. Disconnect Wire 194 from the transfer switch terminal strip.
2. Set Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
3. Disconnect Utility supply voltage from the transfer switch.
4. Verify the transfer switch is in the "Standby" position.
5. Turn on Utility supply voltage to the transfer switch.
   a. If transfer to Utility occurs, the transfer relay (TR1) was energized preventing a re-transfer to Utility. Proceed to Test 25 "Check Wire 23 Circuit".
   b. If transfer to Utility does NOT occur, proceed to Step 7.
6. Remove Wire N2A from the utility coil (C1).
7. Measure across points A and B, the VOM should indicate 240 VAC.
   a. If 240 VAC is NOT measured, verify Utility source is ON.
   b. If 240 VAC was measured, proceed to Step 8.
8. Measure across point C (Wire N2A previously remove) and B, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire N2A.
   b. If 240 VAC was measured, proceed to Step 9.
9. Measure across points A and D, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire N1A.
   b. If 240 VAC was measured, proceed to Step 10.
10. Measure across points A and E, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire N1A.
   b. If 240 VAC was measured, proceed to Step 11.
11. Measure across points A and F, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, replace transfer relay.
   b. If 240 VAC was measured, proceed to Step 12.
12. Measure across points A and G, the VOM should indicate 240 VAC.
   a. If 240 VAC was NOT measured, repair or replace Wire 126.
   b. If 240 VAC was measured, proceed to Step 13.
13. Measure across points A and H, the VOM should indicate 240 VAC.
   a. If 240 VAC was not measured, verify the limit switch (SW2) is wired correctly and proceed to Test 27 "Test Limit Switches"
   b. If 240 VAC was measured, proceed to Step 14.
14. Measure across points A and I, the VOM should indicate 240 VAC.
   a. If 240 VAC was not measured, repair or replace Wire A.
   b. If 240 VAC was measured, replace the C1 coil.

TEST 27 – TEST LIMIT SWITCHES

Discussion

Wired to the normally CLOSED contacts, the limit switches provide a means to interrupt the transfer circuits. When the

CONTACTOR changes position, the limit switches contacts change state to become OPEN.

Procedure

With the AUTO-OFF-MANUAL switch in the OFF position, the generator main circuit breaker "Open", and Utility Voltage disconnected from the transfer switch, test limit switches SW2 and SW3 as follows.

1. To prevent interaction, disconnect Wire 126 and Wire A from the limit switch (SW2) terminals.
2. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
3. Connect the VOM meter test leads across the two outer terminals on SW2 from which the wires were disconnected.
4. Manually actuate the CONTACTOR to the "Standby" position, measure and record the resistance.
5. Manually actuate the CONTACTOR to the "Utility" position, measure and record the resistance.
6. Repeat Step 4 and 5 several times and verify the VOM reading at each switch position.
7. To prevent interaction, disconnect Wire 205 and Wire B from the limit switch (SW3) terminals.
8. Connect the VOM meter test leads across the two outer terminals on SW3 from which the wires were disconnected.
9. Manually actuate the CONTACTOR to the "Standby" position, measure and record the resistance.
10. Manually actuate the CONTACTOR to the "Utility" position, measure and record the resistance.
11. Repeat Step 4 and 5 several times and verify the VOM reading at each switch position.

Coil Nominal Resistance is 480-520k ohms

Results

1. If the VOM indicated CONTINUITY in Step 4 and 10 and INFINITY in Step 5 and 9 the limit switches are good, refer back to flowchart
2. If the VOM did NOT indicate CONTINUITY in Step 4 or 10 and INFINITY in Step 5 or 9 the limit switch(es) are bad, repair or replace appropriate switch(es).

TEST 28 – CHECK FUSES F1 AND F2

Discussion

Fuses F1 and F2 are connected in series with the N1 and N2 circuits, respectively. A blown fuse will open the applicable circuit and will result in (a) generator startup and transfer to the "Standby", or (b) failure to re-transfer back to utility source.

Procedure

1. On the generator panel, set the AUTO-OFF-MANUAL switch to the OFF position.
2. Disconnect Utility from the transfer switch.
3. Remove fuse F1 and F2 from the fuse holder. (see Figure 82).
4. Inspect and test fuses for an OPEN condition with a Volt-Ohm-Milliammeter (VOM) set to measure resistance, CONTINUITY should be measured across the fuse.

Results

1. Replace blown fuse(s) as needed.

TEST 29 – CHECK FUSE F3

Discussion

Connected in series with Load Wire T1, F3 provides 120 VAC to the generator to operate the battery charger. A blown fuse will result in a possible dead battery situation.

Procedure

1. On the generator panel, set the AUTO-OFF-MANUAL switch to the OFF position.
2. Disconnect Utility from the transfer switch.
3. Remove fuse F3 from the fuse holder.
4. Inspect and test fuses for an OPEN condition with a Volt-Ohm-Milliammeter (VOM) set to measure resistance, CONTINUITY should be measured across the fuse.

Results

1. Replace blown fuse as needed.

TEST 30 – CHECK MAIN CIRCUIT BREAKER

Discussion

Often the most obvious cause of a problem is over-looked. If the Generator main line circuit breaker (MLCB) is set to "Open", the electrical loads will not receive power. If the connected loads are not receiving voltage a possible cause could be, the MLCB has failed OPEN.

Procedure

The Generator Main Line Circuit Breaker (MLCB) is located underneath the control panel side cover. If loads are not receiving power, make sure the breaker is set to the "Closed" position. If you suspect the beaker has failed, test it as follows.

1. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. With the Generator shutdown, disconnect all wires from the MLCB terminals, to prevent interaction.

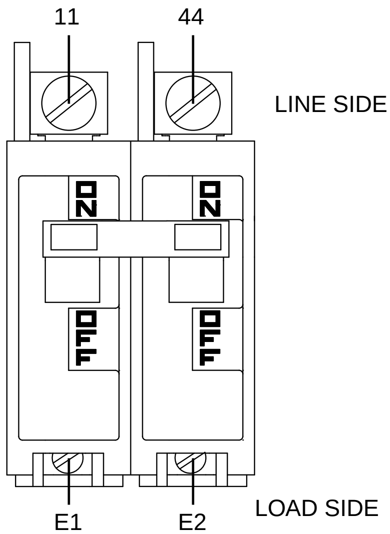


Figure 80. Main Line Circuit Breaker

3. Connect one meter test lead to the Wire 11 terminal on the breaker and the other test lead to the E1 terminal. See Figure 80.
4. Set the breaker to its "Closed" position; the VOM should indicate CONTINUITY.
5. Set the breaker to its "Open" position; the VOM should indicate INFINITY.
6. Repeat Step 4 and 5 with the VOM meter leads connected across the Wire 44 terminal and the E2 terminal.

Results

1. If the circuit breaker tests good, refer back to the flow chart.
2. If the breaker failed Steps 4 or 5, replace the breaker.

TEST 32 – CHECK N1 AND N2 WIRING

Discussion

A shorted Wire N1 or N2 to ground can cause fuse F1 or F2 to blow.

Procedure

1. On the generator panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn off the utility power supply to the transfer switch, using whatever means provided.
3. Remove fuses F1, F2, and F3 from the fuse holder.
4. Remove the generator control panel cover. Disconnect the J5 connector that supplies the controller located in the control panel.
5. Set VOM to measure resistance.
6. Connect the positive meter test lead to Wire N1 at the terminal block in the control panel.
   a. Connect the negative meter lead to the ground lug. INFINITY should be measured.
   b. Connect the negative meter lead to Wire 23 at the terminal strip. INFINITY should be measured.
   c. Connect the negative meter lead to Wire 194 at the terminal strip. INFINITY should be measured.
   d. Connect the negative meter lead to Wire 0 at the terminal strip. INFINITY should be measured.
   e. Connect the negative meter lead to Wire N2 at the terminal block. INFINITY should be measured.
   f. Connect the negative meter lead to the neutral connection. INFINITY should be measured.
7. Connect the positive meter test lead to Wire N2 at the terminal block in the control panel.
   a. Connect the negative meter lead to the ground lug. INFINITY should be measured.
   b. Connect the negative meter lead to Wire 23 at the terminal strip. INFINITY should be measured.
   c. Connect the negative meter lead to Wire 194 at the terminal strip. INFINITY should be measured.
   d. Connect the negative meter lead to Wire 0 at the terminal strip. INFINITY should be measured.
   e. Connect the negative meter lead to the neutral connection. INFINITY should be measured.

Results

If a short is indicated in Step 6 or Step 7, repair wiring and re-test.

TEST 33 – CHECK N1 AND N2 VOLTAGE

Discussion

Loss of utility source voltage to the generator will initiate a startup and transfer by the generator. Testing at the control panel terminal block will divide the system in two, thereby reducing troubleshooting time.

Procedure

1. Set the AUTO-OFF-MANUAL switch to OFF.
2. Set a VOM to measure AC voltage.
3. See Figure 81. Connect one test lead to Wire N1 at the terminal block in the generator control panel. Connect the other test lead to Wire N2. Utility line-to-line voltage should be measured.

Results

Refer to Flow Chart

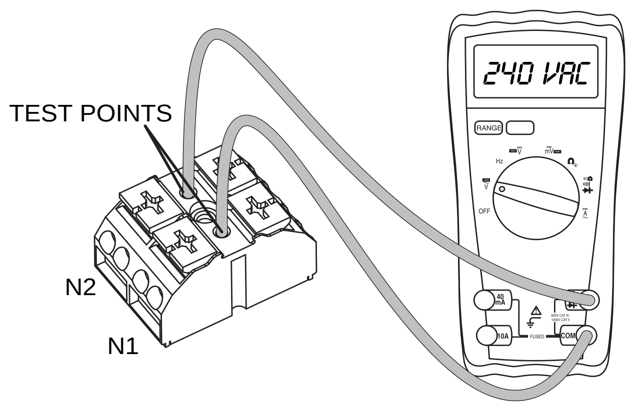


Figure 81. Terminal Block Test Points

TEST 34 – CHECK UTILITY SENSING VOLTAGE AT THE CIRCUIT BOARD

Discussion

If the generator starts and transfer to STANDBY occurs in the automatic mode when acceptable UTILITY source voltage is available at the terminal block, the next step is to determine if sensing voltage is reaching the controller.

Note: The System Ready LED will flash in AUTO or UTILITY LOST will display on the panel.

Procedure

1. Set the AUTO-OFF-MANUAL switch to OFF.
2. Disconnect the J5 connector from the controller.
3. Set a VOM to measure AC voltage.
4. Connect one meter test lead to Wire N1. Connect the other meter test lead to Wire N2. Approximately 240 VAC should be measured. See Figure 82.

Results

1. If voltage was measured in Step 4 and the pin connections are good, replace the circuit board.
2. If voltage was NOT measured in Step 4, repair or replace Wire N1/N2 between connector and terminal block.

TEST 35 – CHECK UTILITY SENSE VOLTAGE

The N1 and N2 terminals in the transfer switch deliver utility voltage "sensing" to a circuit board. If voltage at the terminals is zero or low, standby generator startup and transfer to the "Standby" source will occur automatically as controlled by the circuit board. A zero or low voltage at these terminals will also prevent retransfer back to the "Utility" source.

Procedure

With utility source voltage available to terminal lugs N1 and N2, use a VOM to test for utility source line-to-line voltage across terminal locations N1 and N2 terminals. Normal line-to-line utility source voltage should be indicated.

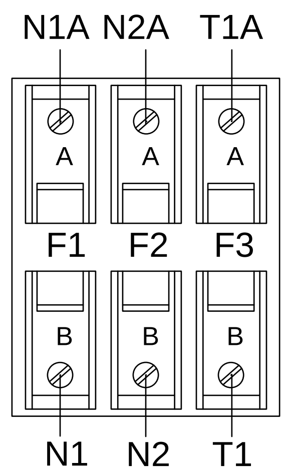


Figure 82. Transfer Switch Fuse Block

Results

1. If voltage reading across the N1 and N2 terminals is zero or low, refer to Flow Chart.
2. If voltage reading is good, refer to Flow Chart.

TEST 36 – CHECK T1 WIRING

Discussion2

If the T1 wiring is shorted to ground can cause the F3 fuse to blow.

Procedure

1. Set the AUTO-OFF-MANUAL to the OFF position.
2. Remove F1, F2, and F3 from the fuse holder in the transfer switch.
3. Disconnect the J5 connector from the controller.
4. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
   a. Connect one meter test lead to T1 on the customer connection in the Generator and the other meter lead to ground. Measure and record the resistance.
   b. Connect one meter test lead to T1 on the customer connection in the Generator and the other meter test lead to Wire 194. Measure and record the resistance.
   c. Connect one meter test lead to T1 on the customer connection in the Generator and the other meter test lead to Wire 23. Measure and record the resistance.

d. Connect one meter test lead to T1 on the customer connection in the Generator and the other meter test lead to Wire N1. Measure and record the resistance.

e. Connect one meter test lead to T1 on the customer connection in the Generator and the other meter test lead to Wire N2. Measure and record the resistance.

Results

1. If the VOM indicated INFINITY in Steps 4a -4e, replace the controller.
2. If the VOM indicated CONTINUITY, repair or replace the wiring in the appropriate circuit.

NOTES

PART 4
ENGINE/DC CONTROL

TABLE OF CONTENTS		
SECTION	TITLE	PAGE
4.1	Description and Components	90
4.2	Engine Protective Devices	94
4.3	Operational Analysis	96
4.4	Troubleshooting Flowcharts	110
4.5	Diagnostic Tests	115

Air-cooled, Automatic Standby Generators

INTRODUCTION

This section will familiarize the reader with the various components that make up the Engine and DC Control systems.

Topics covered in this section are:

- Customer Connections
- Controller
- Menu System Navigation
- LED Display
- Battery Charger
- AUTO-OFF-MANUAL
- 7.5 Amp Fuse
- Starter Contactor Relay
- Common Alarm Relay
- Connector Pin Descriptions

CUSTOMER CONNECTION

The terminals of this terminal strip connect to identically numbered terminals in the transfer switch. The terminal block provides the electrical connection for the controller.

The terminal block provides the following connection points:

- UTILITY N1 (Utility Sensing)
- UTILITY N2 (Utility Sensing)
- LOAD T1 (Internal Battery Charger)
- Wire 194 (Transfer Relay)
- Wire 23 (Transfer Relay)

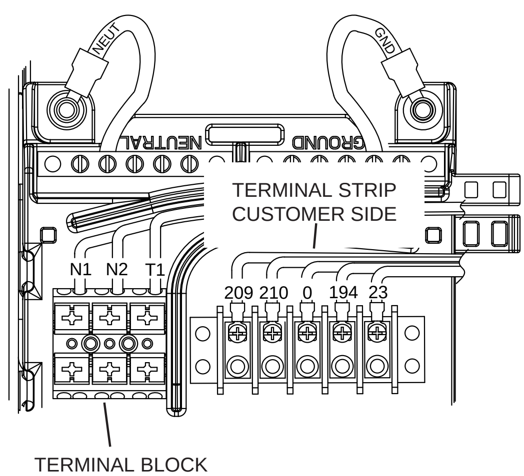


Figure 83. Customer Connections

CONTROLLER

The controller is responsible for all standby electric system operations including (a) engine startup, (b) engine running, (c) automatic transfer, (d) automatic re-transfer, and (e) engine shutdown. In addition, the controller performs the following functions:

- Automatic voltage regulation (See Section 2.1 "Descriptions and Components)
- Starts and exercises the generator once every seven days.
- Automatic engine shutdown in the event of low oil pressure, high oil temperature, over speed, no RPM sense, over crank, or low battery.
- Maintains proper battery charge

A 23-pin and a 14-pin connector are used to interconnect the controller with the various circuits of the DC and AC systems. Connector pin locations, numbers, associated wires and circuit functions are listed in Tables 19 and 20.

To control the Generator the controller utilizes digital inputs and outputs. See Table 17 for the specific position and function. See "Menu Navigation" to view state of output or input.

Table 17. Digital Inputs and Outputs

Position	Digital Inputs	Digital Outputs
1	Not Used	Not Used
2	Low Oil Pressure	Not Used
3	High Temperature	Not Used
4	Low Fuel Pressure	Battery Charger Relay
5	Wiring Error Detect	Ignition
6	Not Used	Starter
7	Auto	Fuel
8	Manual	Transfer

⚠ DANGER!

⚠ **The Generator engine will crank and start when the 7-day exerciser is set. The unit will also crank and start every 7 days thereafter, on the day and at the time the exerciser was set for.**

LED DISPLAY

Located next to the circuit breaker access panel on the generator, the LED Display provides a visually annunciating the Generators status. The LED Display has three LED, a red, a yellow, and a green.

- Red LED- Illuminates during an Alarm condition or when the AUTO-OFF-MANUAL is set to OFF.
- Yellow LED- Illuminates when the controller generates a Maintenance Alert and attention is required.
- Green LED- Illuminates when the system is ready to respond to a Utility failure.

BATTERY CHARGER

The charger operates at one of three battery charging voltage levels depending on ambient temperature.

- 13.5Vdc at High Temperature
- 14.1Vdc at Normal Temperature
- 14.6Vdc at Low Temperature

The battery charger is powered from a 120 VAC Load connection through a fuse (F3) in the transfer switch. This 120 VAC source must be connected to the Generator in order to operate the charger.

During a Utility failure, the charger will momentarily be turned off until the Generator is connected to the Load. During normal operation, the battery charger supplies all the power to the Nexus controller; the Generator battery is not used to supply power.

The battery charger will begin its charge cycle when battery voltage drops below approximately 12.6V. The charger provides current directly to the battery dependant on temperature, and the battery is charged at the appropriate voltage level for 18 hours. At the end of the 18 hour charge period battery charge current is measured when the Generator is off. If battery charge current at the end of the 18 hour charge time is greater than a pre-set level, or the battery open-circuit voltage is less than approximately 12.5V, an “Inspect Battery” warning is raised. If the engine cranks during the 18 hour charge period, then the 18 hour charge timer is restarted.

At the end of the 18 hour charge period the charger does one of two things. If the temperature is less than approximately 40ºF the battery is continuously charged at a voltage of 14.1V (i.e. the charge voltage is changed from 14.6V to 14.1V after 18 hours). If the temperature is above approximately 40ºF then the charger will stop charging the battery after 18 hours.

The battery has a similar role as that found in an automobile application. It sits doing nothing until it either self-discharges below 12.6V or an engine crank occurs (i.e. such as occurs during the weekly exercise cycle). If either condition occurs the battery charge will begin its 18 hour charge cycle.

AUTO-OFF-MANUAL

This 3-position switch permits the operator to (a) select fully automatic operation, (b) start the Generator manually, or (c) stop the engine and prevent the automatic startup. See Figure 84 for the location of the switch.

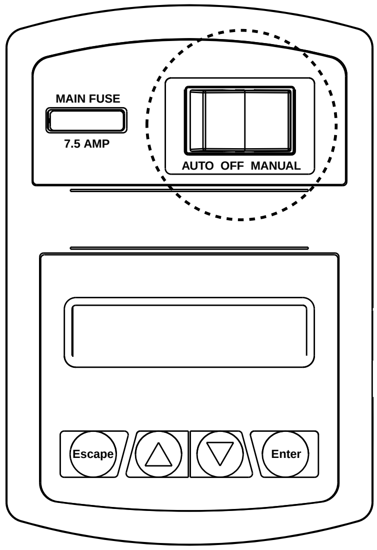


Figure 84. Auto-Off-Manual Switch

7.5 AMP FUSE

The fuse protects the controller against excessive current. If the fuse has blown, engine cranking and operation will not be possible. Should fuse replacement become necessary, use only an equivalent 7.5 amp replacement fuse.

Figure 85. Typical 7.5 Amp Fuse

STARTER CONTACTOR RELAY/SOLENOID

V-Twin Models

The starter contactor relay (SCR) provides a safe and controlled method of energizing the solenoid located on the starter. The controller is responsible for energizing the relay when the start command is given. Refer to Figure 86.

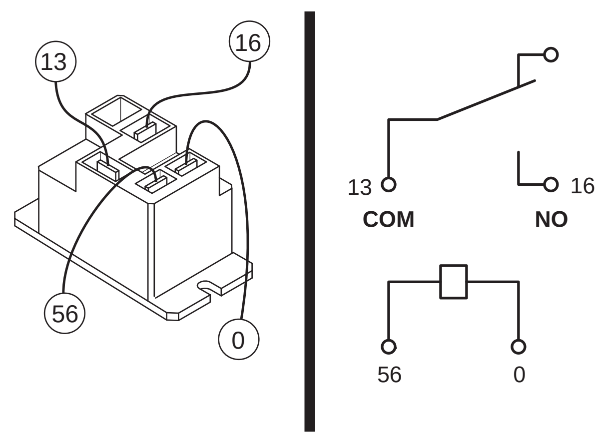


Figure 86. Starter Contactor Relay (V-twin Units)

Single Cylinder Models

The Starter Contactor (SC) is located in the engine compartment and is mounted against the firewall. The SC provides the electrical connection to safely engage the starter. See Figure 87.

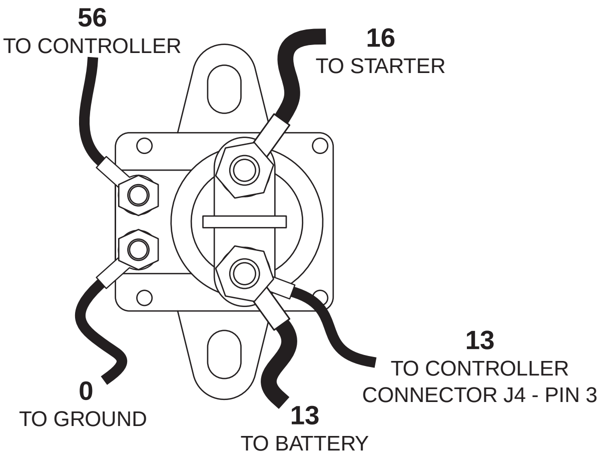


Figure 87. The Starter Contactor (Single Cylinder Units)

COMMON ALARM RELAY

The common alarm relay provides a set of contacts to drive a customer provided external alarm indication. When the control is powered up, if there are no Alarms, the relay contacts will be OPEN. Any ALARM (not warning) will trigger the common alarm relay to operate, closing the contacts. The connections are made to the generator customer connection terminal strip at Terminals 1 and 2 (Wires 209 and 210).

Specifications

Contact Rating:	10A at 250 VAC	5A at 30 VDC

Note: Contact rating is for resistive load only

CONNECTOR PIN DESCRIPTIONS

Figures 88 and 89, and Tables 19 and 20 provide the physical pin connections as well as the Wire and circuit function.

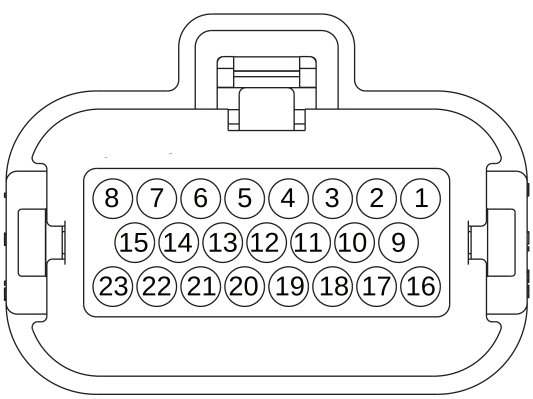


Figure 88. J4 Connector (Harness Side)

Table 19. J4 Connector Pin Descriptions

PIN	WIRE	CIRCUIT FUNCTION
1	90	Switched to ground for choke solenoid operation
2	0	Common Ground (DC)
3	13	12 VDC un-fused for the controller
4	817	Grounded by the controller to turn on System Ready (Green) LED
5	818	Grounded by the controller to turn on Alarm (Red) LED
6	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
7	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
8	820	Positive voltage (5VDC) for status LED's
9	14	12 VDC output for engine run condition. Used for fuel solenoid and choke solenoid operation on V-Twin Models
10	210	Common Alarm Relay Output
11		Not used
12		Not used
13	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
14		Not used
15	JMP 1	Installed in series with a resistor to identify the kW to the controller
16	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
17	56	12 VDC output to starter contactor relay/solenoid
18	209	Common Alarm Relay Output
19	194	Provides 12 VDC to the transfer relay (TR1)
20	23	Switched to ground (internally) to energize the Transfer Relay
21		Not used
22		Not used
23	JMP 1	Installed in series with a resistor to identify the kW to the controller

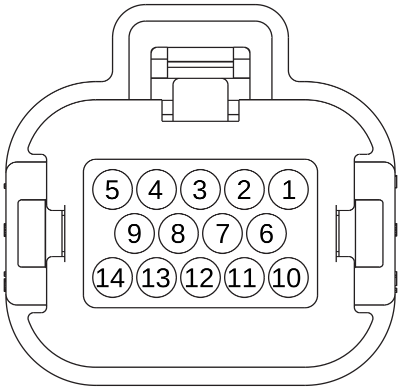


Figure 89. J5 Connector (Harness Side)

Table 20. J5 High Voltage Connector Pin Descriptions

PIN	WIRE	CIRCUIT FUNCTION
1	N1	240 VAC Utility sensing voltage
2	T1	120VAC power for the battery charger
3	00	Neutral Connection for T1 (battery charger)
4		
5	2	DPE Winding (AC Excitation power)
6	N2	240 VAC Utility sensing voltage
7		
8		
9		
10	44	240 VAC Generator Voltage Sensing
11	11	240 VAC Generator Voltage Sensing
12	0	DC Field Excitation Ground
13	4	DC (+) Field Excitation
14	6	DPE Winding (AC Excitation power)

MENU SYSTEM NAVIGATION

To get to the MENU, use the “Esc” key from any page. It may need to be pressed several times before getting to the menu page. The currently selected menu is displayed as a flashing word. Navigate to the desired menu item by using the +/- keys. When the desired menu item is flashing, press the ENTER key. Depending on the menu selected, there may be a list of choices presented. Use the same navigation method to select the desired screen (refer to the Menu System diagram, Figure 90). Refer to Section 1.10 “Nexus Control Panel Menu System Navigation” for additional information.

Changing Settings (Edit Menu)

To change a setting, such as display contrast, go to the EDIT menu and use the +/- keys to navigate to the setting to change. Once this setting is displayed (e.g. Contrast), press the ENTER key to go into the edit mode. Use the +/- keys to change the setting, press the ENTER key to store the new setting.

Note: If the ENTER key is not pressed to save the new setting, it will only be saved temporarily. The next time the battery is disconnected, the setting will revert back to the old setting.

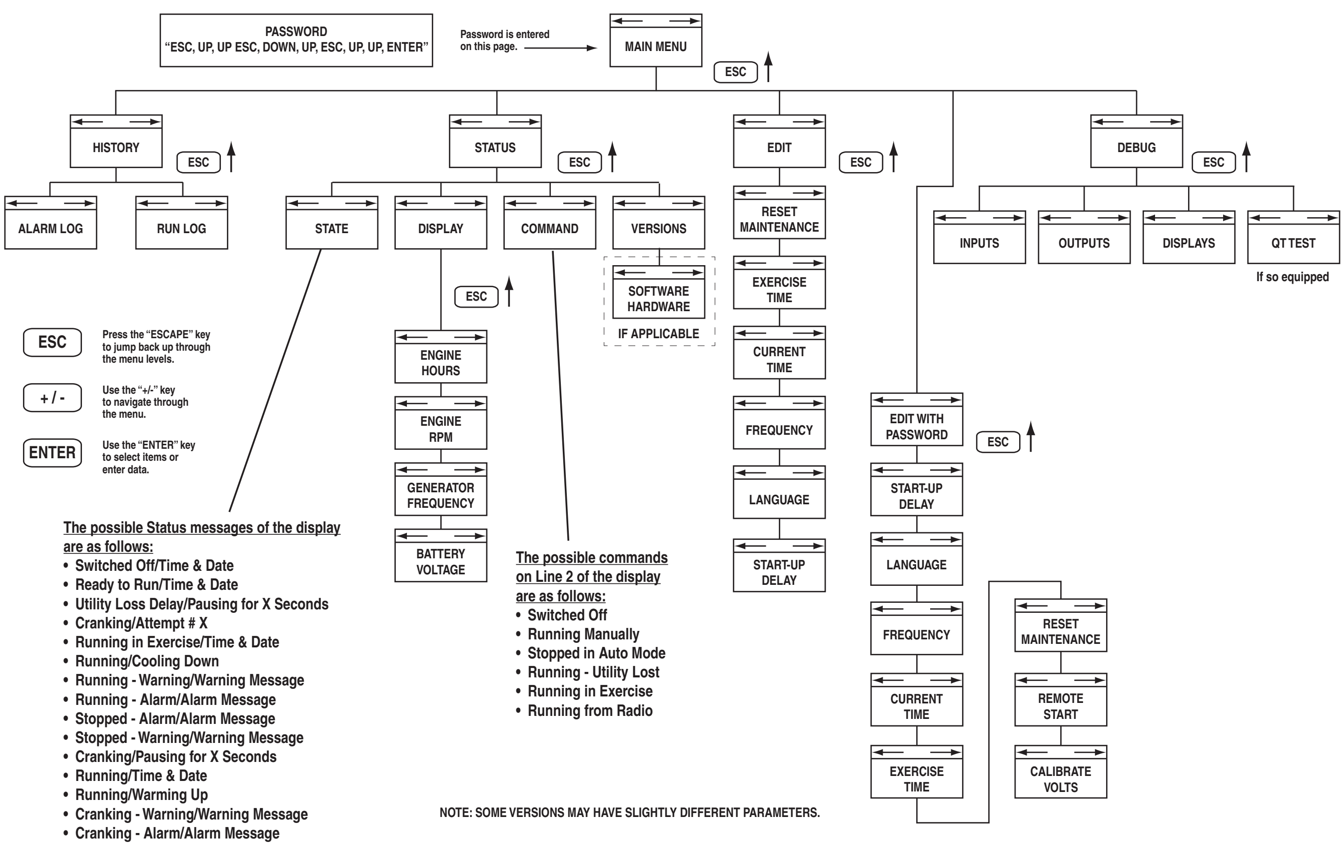


Figure 90. Menu System Diagram

INTRODUCTION

Standby power generators will often run unattended for long periods. Such operating parameters as (a) battery voltage, (b) engine oil pressure, (c) engine temperature, (d) engine operating speed, and (e) engine cranking and startup are not monitored by an operator during automatic operation. Because engine operation will not be monitored, the use of engine protective safety devices is required to prevent engine damage in the event of a problem.

LOW BATTERY WARNING

The controller will continually monitor the battery voltage and display a "Low Battery Voltage" message if the battery voltage falls below 11.9 VDC for 1 minute.

No other action is taken on a low battery condition. The warning will automatically clear if the battery voltage rises above 12.4 VDC.

LOW OIL PRESSURE

See Figure 91. An oil pressure switch is mounted on the oil filter adapter. This switch has normally closed contacts that are held open by engine oil pressure during cranking and startup. Should oil pressure drop below approximately 5 psi, the switch contacts will close. On closure of the switch contacts, the Wire 86 circuit from the controller will be connected to ground. The controller's logic will then de-energize a "run relay" (internal to the controller). The run relay's contacts will then open and then the 12 VDC run circuit will then be terminated. This will result in closure of the fuel shutoff solenoid and loss of engine ignition.

HIGH TEMPERATURE SWITCH

The contacts of this switch (Figure 91) close if the temperature should exceed approximately 293° F (144°C), initiating an engine shutdown. The Generator will automatically restart and the fault on the LCD display will reset once the temperature has returned to a safe operating level.

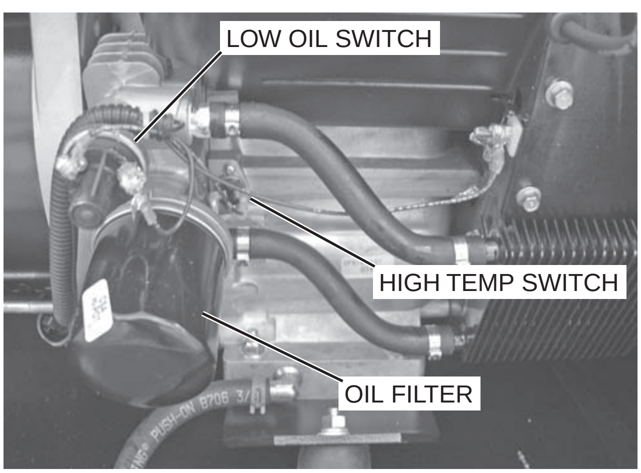


Figure 91. Engine Protective Switches

OVERSPEED

During engine cranking and operation the controller receives AC voltage and frequency signals from the ignition magneto via Wire 18. Should the speed exceed approximately 72 Hz (4320 RPM), the controller's logic will de-energize the "run relay" (internal to the controller). The relay contacts will open terminating engine ignition and closing the fuel shutoff solenoid; the engine will then shut down. This feature protects the engine and alternator against damaging over speeds. During cranking the RPM signal generated by the magnetos is used to terminate engine cranking.

RPM SENSOR FAILURE

During cranking if the board does not see a valid RPM signal within three (3) seconds it will shutdown and latch out on "RPM Sensor Loss."

During running if the RPM signal is lost for one full second the controller will shutdown the engine, wait 15 seconds, then re-crank the engine.

If an RPM signal is not detected within the first three (3) seconds of cranking, the controller will shut down the engine down and latch out on "RPM Sensor Loss."

- If the RPM signal is detected the engine will start and run normally. If the RPM signal is subsequently lost again, the controller will try one re-crank attempt before latching out and the LCD displays "RPM Sensor Loss."

Note: A common cause of RPM Sensor Loss fault is the lack of engine cranking; this could be a faulty crank circuit or a faulty starter.

OVERCRANK

This feature prevents the Generator from damaging itself when it continually attempts to start and another problem, such as no fuel supply, prevents it from starting. The unit will crank and rest for a preset time limit. Then, it will stop cranking and the LCD screen will indicate an "Overcrank" condition. The AUTO-OFF-MANUAL switch will need to be set to OFF and then back to AUTO to reset the generator.

Note: If the fault is not repaired, the overcrank fault will continue to occur.

The system will control the cyclic cranking as follows: 16 second crank, seven (7) second rest, 16 second crank, seven (7) second rest followed by three (3) additional cycles of seven (7) second cranks followed by seven (7) second rests.

Choke Operation

1. The 990/999cc engines have an electric choke in the air box that is automatically controlled by the electronic control board.
2. The 530cc engines have an electric choke on the divider panel air inlet hose that is automatically controlled by the electronic control board.

3. The 410cc engines have a choke behind the air box that is automatically controlled by the electronic control board.

Failure to Start

This is defined as any of the following occurrences during cranking.

1. Not reaching starter dropout within the specified crank cycle. Starter dropout is defined as four (4) cycles at 1,500 RPM (1,800 RPM for 8kW units).
2. Reaching starter dropout, but then not reaching 2200 RPM within 15 seconds. In this case the control board will go into a rest cycle for seven (7) seconds, then continue the rest of the crank cycle.
3. During a rest cycle the start and fuel outputs are de-energized and the magneto output is shorted to ground.

Cranking Conditions

The following notes apply during the cranking cycle.

1. Starter motor will not engage within five (5) seconds of the engine shutting down.
2. The fuel output will not be energized with the starter.
3. The starter and magneto outputs will be energized together.
4. Once the starter is energized the control board will begin looking for engine rotation. If it does not see an RPM signal within three (3) seconds it will shut down and latch out on RPM sensor loss.
5. Once the control board sees an RPM signal it will energize the fuel solenoid, drive the throttle open and continue the crank sequence.
6. Starter motor will disengage when speed reaches starter dropout.
7. If the generator does not reach 2200 RPM within 15 seconds, re-crank cycle will occur.
8. If engine stops turning between starter dropout and 2200 RPM, the board will go into a rest cycle for seven (7) seconds then re-crank (if additional crank cycles exist).
9. Once started, the generator will wait for a hold-off period before starting to monitor oil pressure and oil temperature (refer to the Alarm Messages section for hold-off times).
10. During cranking, if the AUTO-OFF-MANUAL switch is switched to the OFF position, cranking stops immediately.
11. During Auto mode cranking, if the Utility returns, the cranking cycle does NOT abort but continues until complete. Once the engine starts, it will run for one (1) minute, and then shut down.

UNDER-FREQUENCY

After starting, if the generator stays under a set frequency for more than 30 seconds, it will shutdown.

Table 21. Under-frequency Shutdown Settings

Unit Hertz	Shutdown Frequency
50 Hz	40 Hz
60 Hz with 0H6680A Controller	50 Hz
60 Hz with 0H6680B Controller	55 Hz

CLEARING AN ALARM

When the generator is shut down due to a latching alarm, the AUTO-OFF-MANUAL switch must be set to the OFF position and the “Enter” key pressed to unlatch any active fault and clear the corresponding fault alarm message.

INTRODUCTION

The “Operational Analysis” is intended to familiarize the service technician with the operation of the DC and AC control system. A through understanding of how the system works is essential to sound and logical troubleshooting. The control system illustrations on the following pages represent a 17kW unit.

UTILITY SOURCE VOLTAGE AVAILABLE

Refer to Figure 94. The circuit condition with the AUTO-OFF-MANUAL switch set to the AUTO position and with Utility source power available can be briefly described as follows:

- Utility source voltage is available to the transfer switch Terminal Lugs N1 and N2 and the CONTACTOR is in the “Utility” position.
- Utility voltage is available to the controller via Wire N1 and N2 (see to Figure 92).
- Battery voltage is available to the controller via Wire 13 when a Battery is installed (see Figure 93).

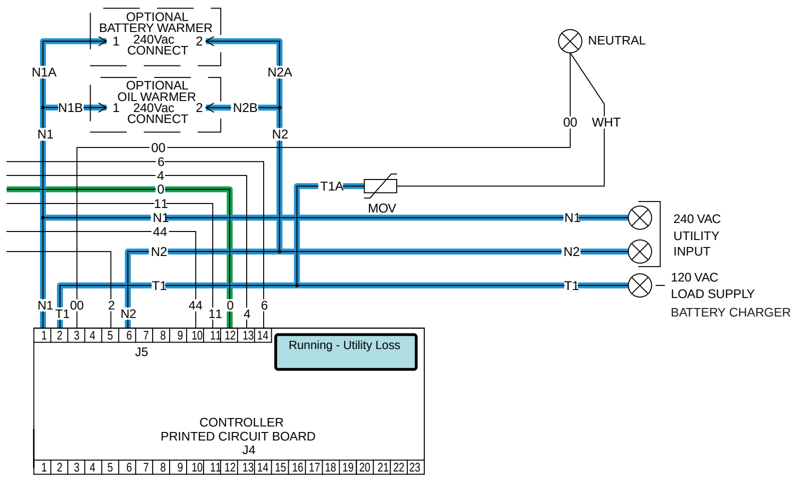


Figure 92.

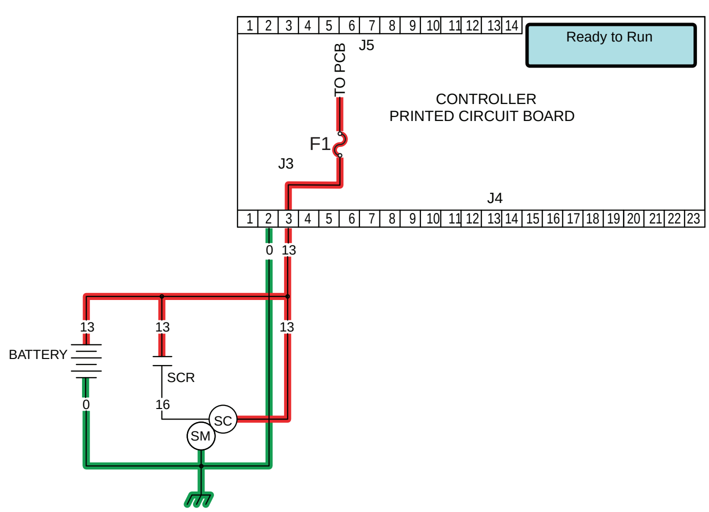


Figure 93.

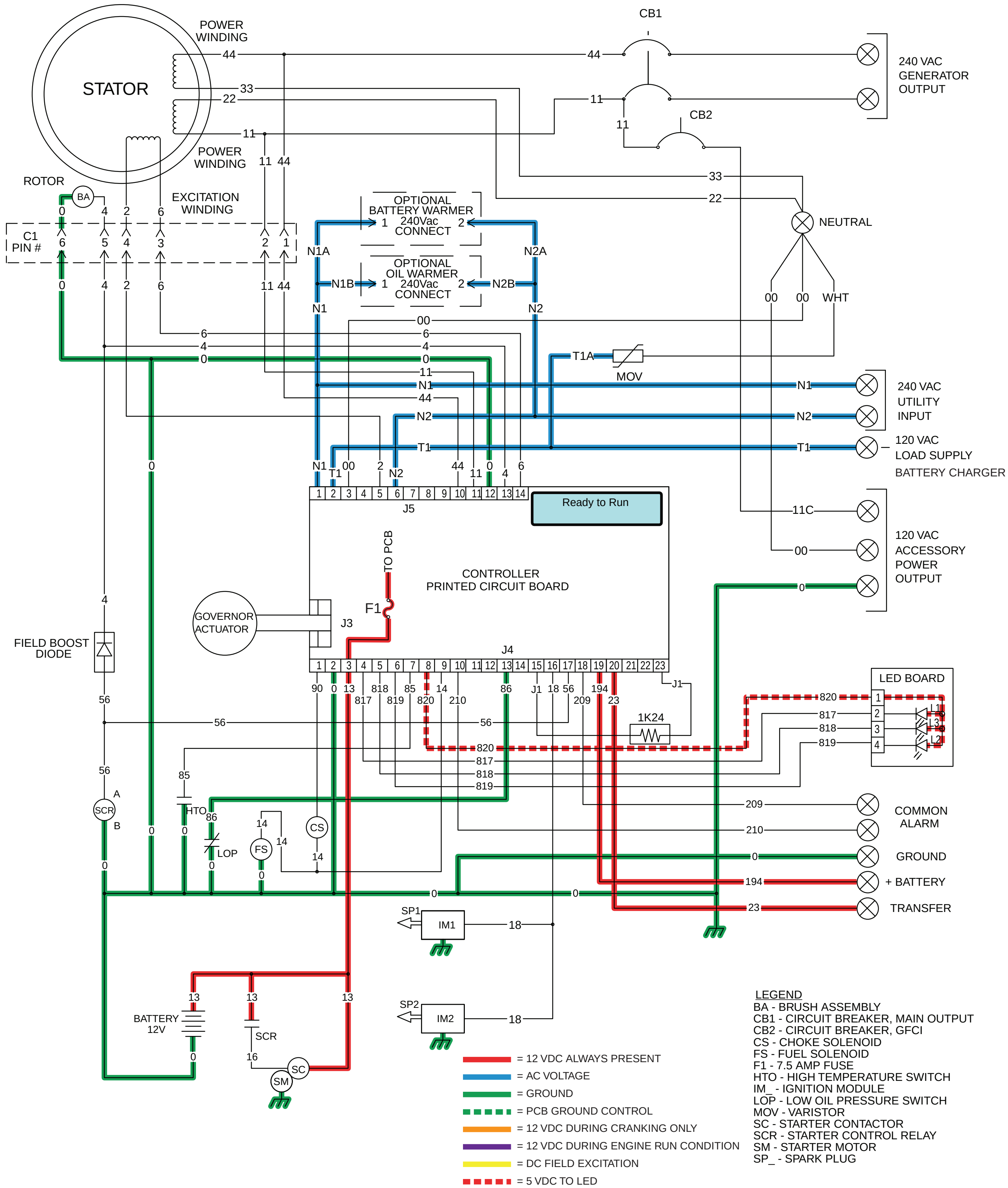


Figure 94. Utility Source Voltage Available

INITIAL DROPOUT OF UTILITY SOURCE VOLTAGE

Refer to Figure 96. Should a Utility power failure occur, circuit condition may be briefly described as follows:

- The controller continually monitors for acceptable Utility voltage via N1 and N2. Should Utility voltage drop below approximately 65% of the nominal source voltage, a programmable timer on the controller will turn on.
- In Figure 95, the 10-second timer is still timing and engine cranking has not yet begun.
- The AUTO-OFF-MANUAL switch is shown in the AUTO position. Battery voltage is available to the circuit board via Wire 13, the 7.5 amp fuse (F1). Wire 194 provides 12VDC to the transfer relay in the transfer switch.

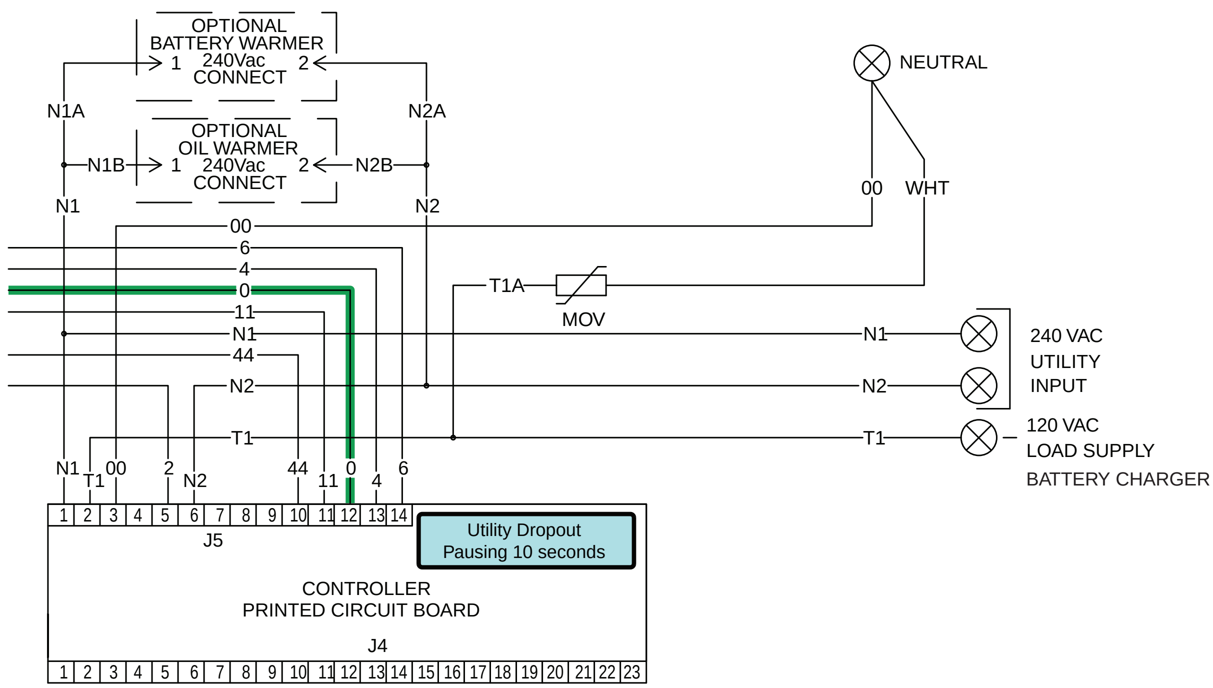


Figure 95.

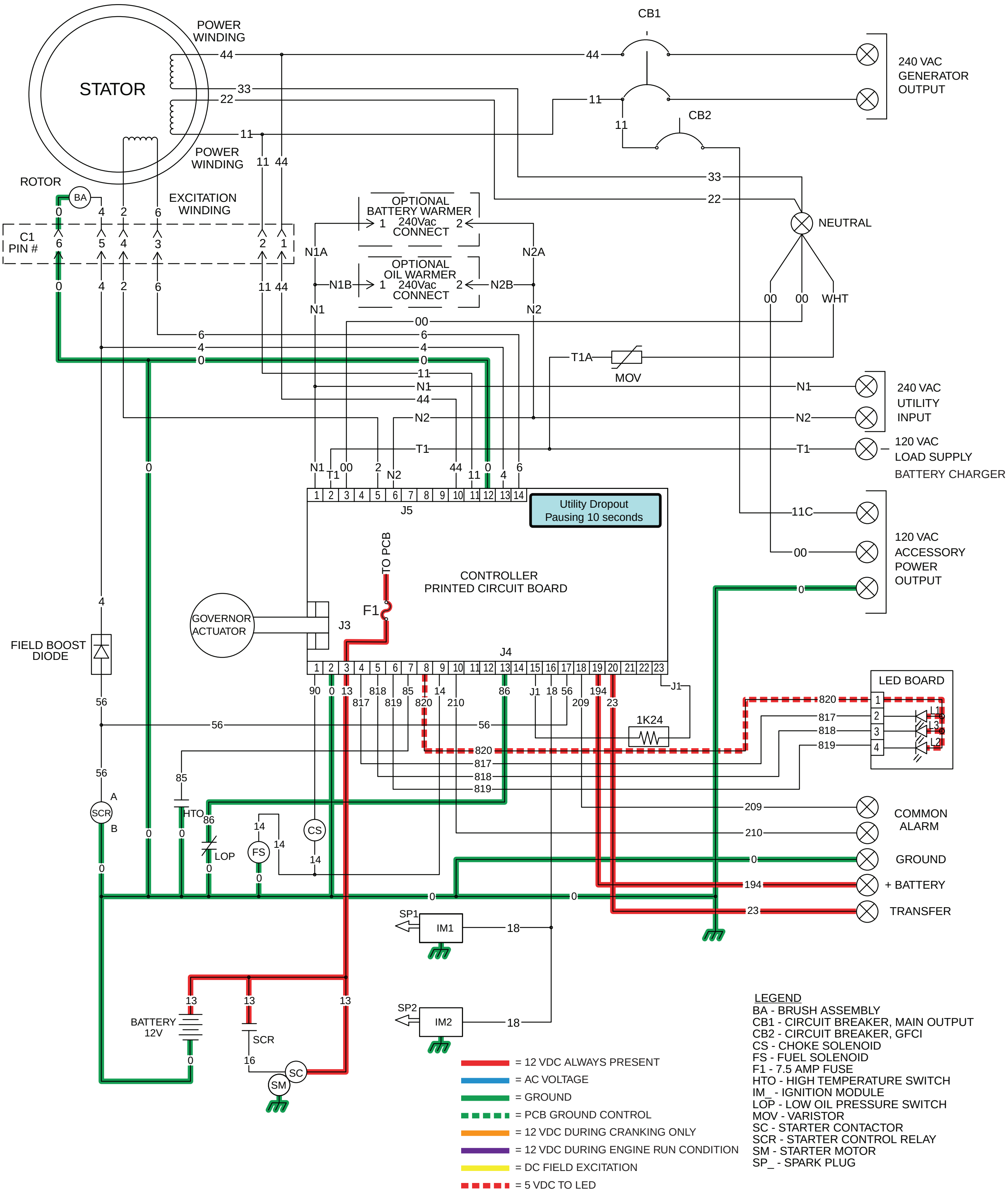


Figure 96. Initial Dropout of Utility Source Voltage

UTILITY VOLTAGE FAILURE AND ENGINE CRANKING

- After the controller's 10-second timer has timed out, if Utility voltage is still below 65% of nominal, the controllers logic will energize the internal crank relay followed by the internal run relay.
- When the internal crank relay energizes 12 VDC is delivered to the starter contactor relay (SCR) via Wire 56. When the SCR energizes its contacts close and battery voltage is delivered to a starter contactor (SC). When the SC energizes its contacts close and battery voltage is delivered to the starter motor (SM); the engine is now cranking.
- With the engine cranking a speed reference signal is generated by the magnetos and is delivered to the controller through Wire 18. If a valid signal is received, the controller will energize the internal run relay and deliver 12VDC on Wire 14. The fuel solenoid energizes (opens) and fuel is available to the engine. The choke solenoid (CS) begins to operate and the controller grounds Wire 90, energizing the choke solenoid cyclically curing cranking, and continuously while running.
- During Cranking 3-5VDC is supplied to the rotor for field flash via a field boost diode connected in parallel with Wire 56.
- With ignition and fuel flow available the engine will start.

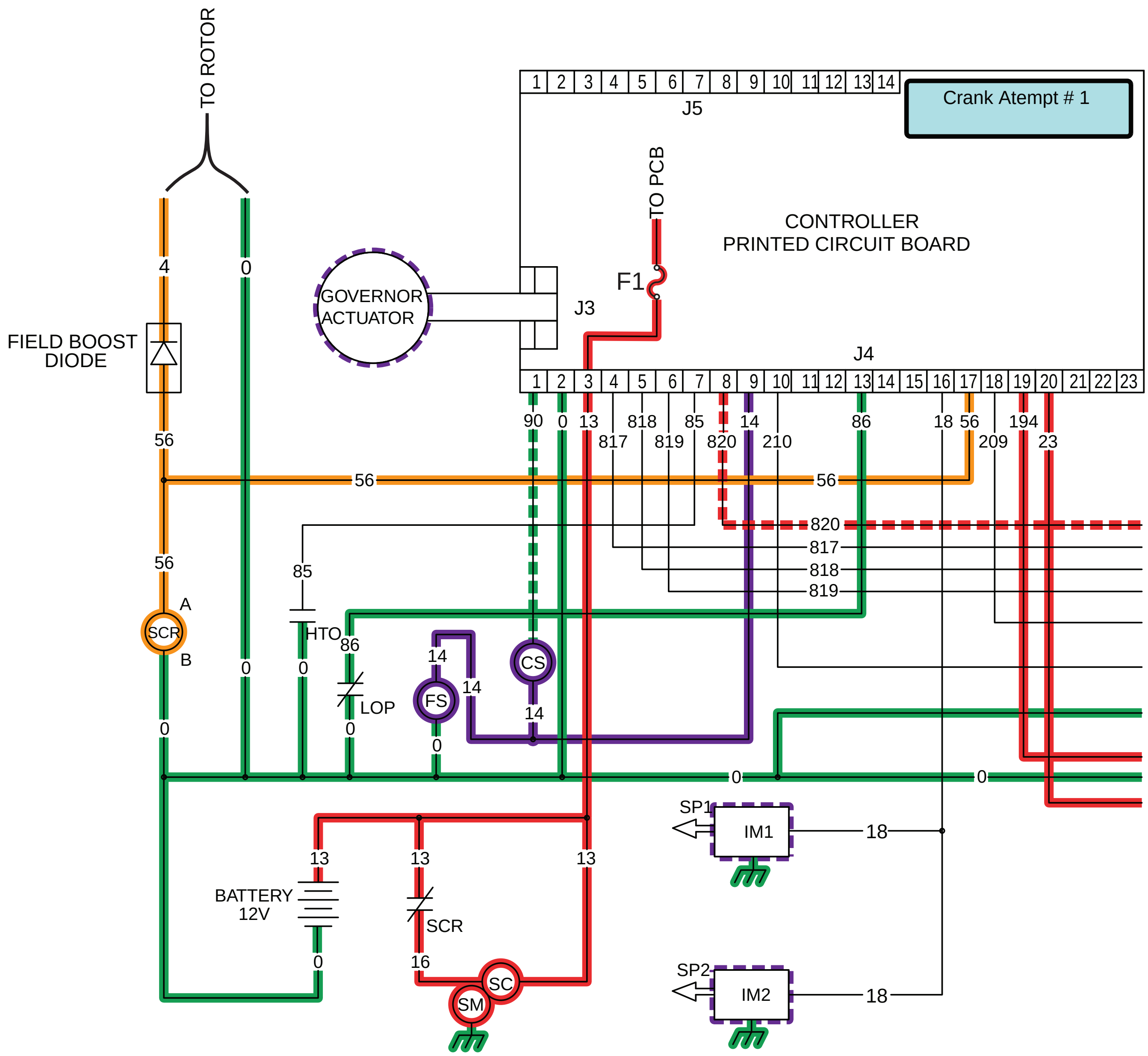
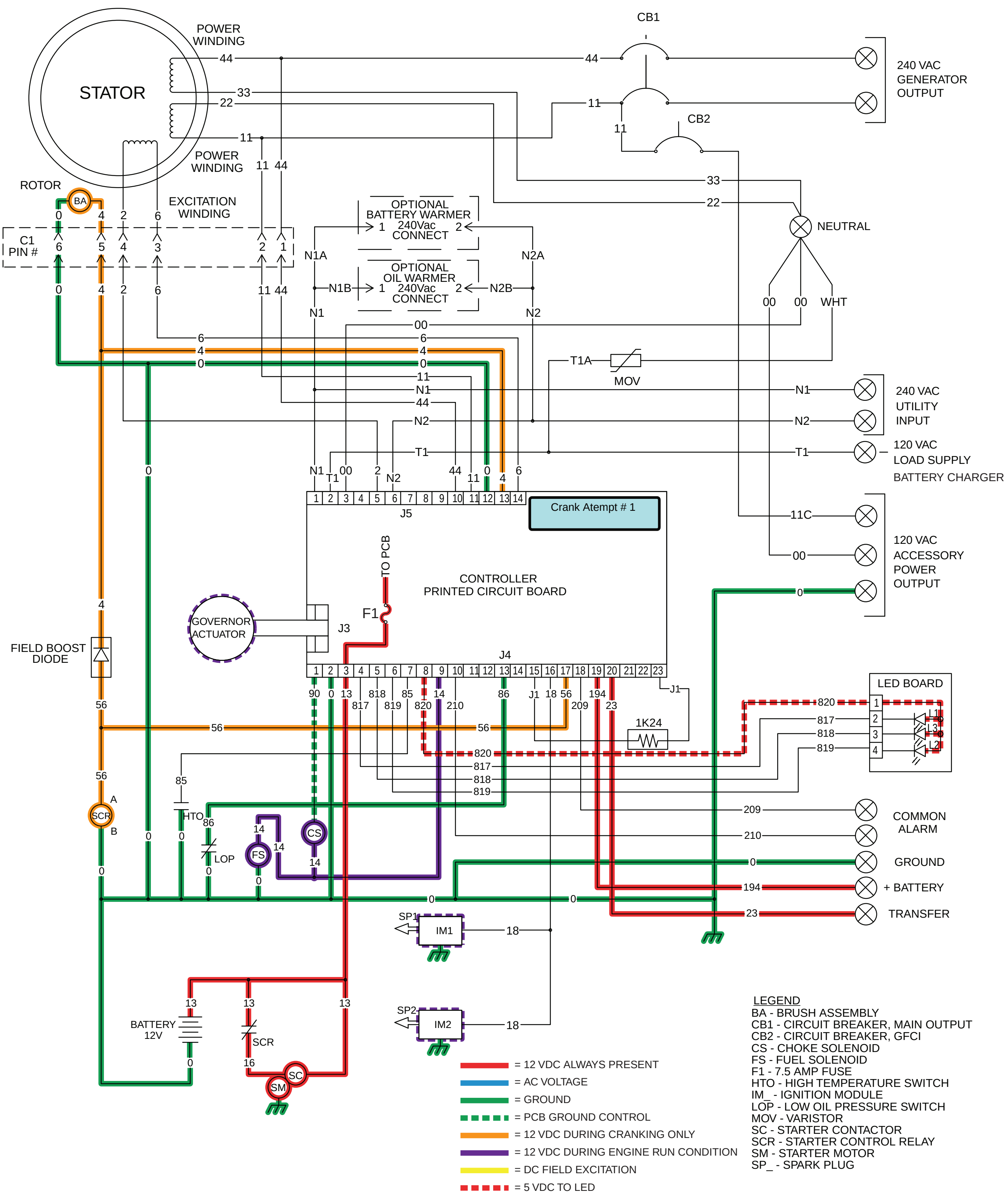


Figure 97.



LEGEND
- BA - BRUSH ASSEMBLY
- CB1 - CIRCUIT BREAKER, MAIN OUTPUT
- CB2 - CIRCUIT BREAKER, GFCI
- CS - CHOKE SOLENOID
- FS - FUEL SOLENOID
- F1 - 7.5 AMP FUSE
- HTO - HIGH TEMPERATURE SWITCH
- IM_ - IGNITION MODULE
- LOP - LOW OIL PRESSURE SWITCH
- MOV - VARISTOR
- SC - STARTER CONTACTOR
- SCR - STARTER CONTROL RELAY
- SM - STARTER MOTOR
- SP_ - SPARK PLUG

Figure 98. Utility Voltage Failure and Engine Cranking

ENGINE STARTUP AND RUNNING

With the fuel solenoid open and ignition occurring, the engine starts. Engine startup and running may be briefly described as follows:

- The ignition magnetos deliver a speed reference signal to the controller via Wire 18. Once the controller determines that the engine is running, the controller (a) terminates cranking, (b) continuously energizes the choke solenoid (open position), and (c) turns on an “engine warm-up timer”.

Note: On 8kW and 10kW units the choke is de-energized to the open position (Wire 90 open from ground).

- The “engine warm-up timer” will run for 5 seconds. When this timer finishes timing the controller’s logic will initiate a transfer to the “Standby” position. As shown in Figure 99, the timer is still running and transfer has not yet occurred.
- Generator AC output is available to the transfer switch Terminal Lugs E1 and E2 and to the normally open contacts of the transfer relay. However, the transfer relay is de-energized and its contacts are open.

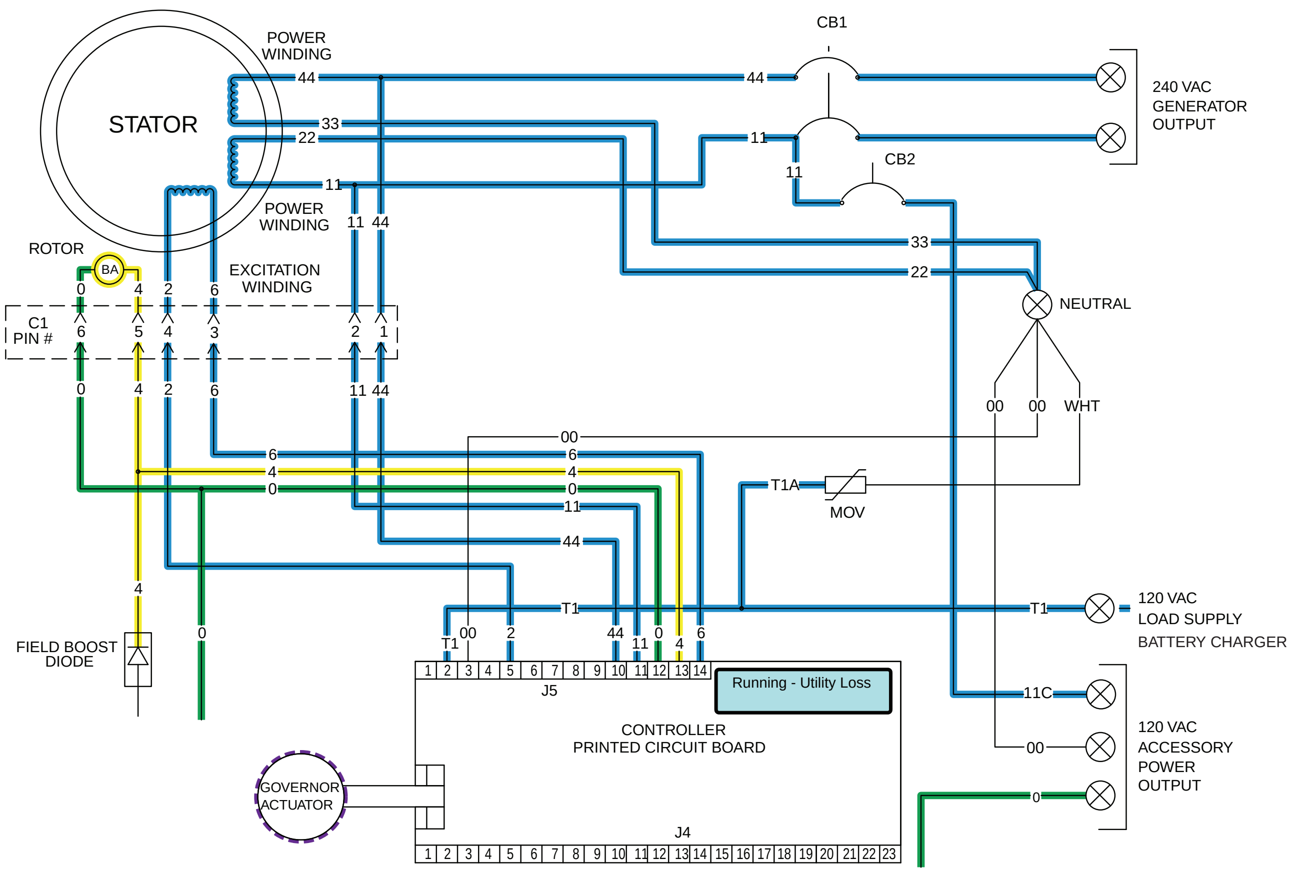


Figure 99.

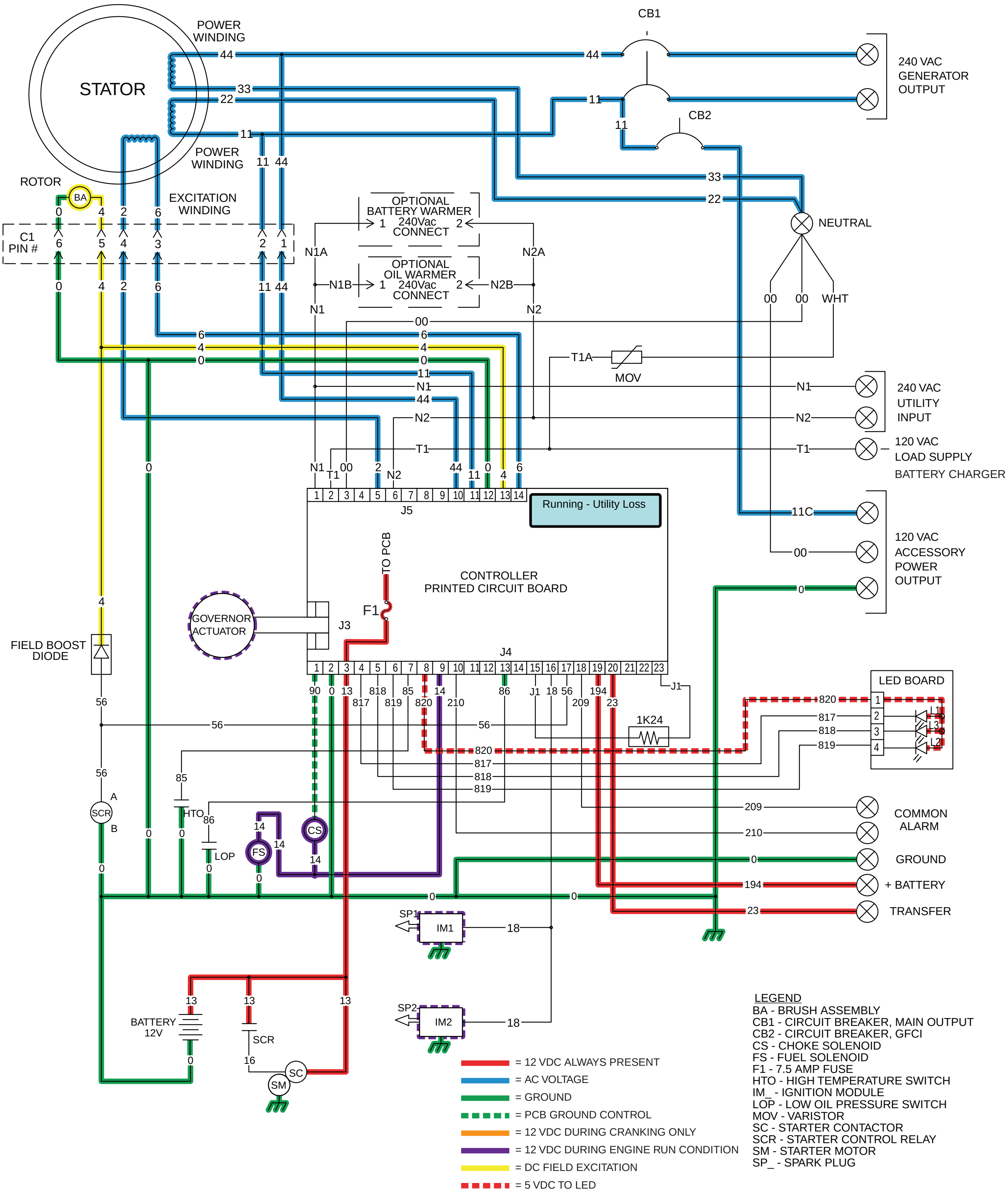


Figure 100. Engine Startup and Running

TRANSFER TO STANDBY

In Figure 102 the Generator is running, the controllers "engine warm-up" timer has expired and generator AC output is available to the transfer switch Terminal Lugs E1 and E2 and to the open contacts on the transfer relay. Transfer to Standby may be briefly described as follows:

- 12 VDC is delivered to the transfer relay coil (TR1 - Terminal A) via Wire 194. The 12 VDC circuit is completed back to the controller via Wire 23 (TR1 - Terminal B). However, the controller's logic holds Wire 23 open from ground and the TR1 relay is de-energized.
- When the "engine warm-up timer" expires, the controller will take Wire 23 to ground. The TR1 relay energizes and its normally open contacts close (standby position).
- Generator voltage is now delivered to the standby closing coil (C2), via Wire E1 and E2, the now closed TR1 contacts, Wire 205, the limit switch (SW3), Wire B, and a bridge rectifier. The standby closing coil energizes and the main current carrying contacts of the transfer switch are actuated to the "Standby" position.
- As the main contacts move to the "Standby" position, a mechanical interlock actuates SW3 to its open position and limit switch (SW2) to the "Utility" position. When SW3 opens the C2 coil de-energizes.
- Generator voltage is now available to the LOAD terminals (T1 and T2) of the transfer switch.

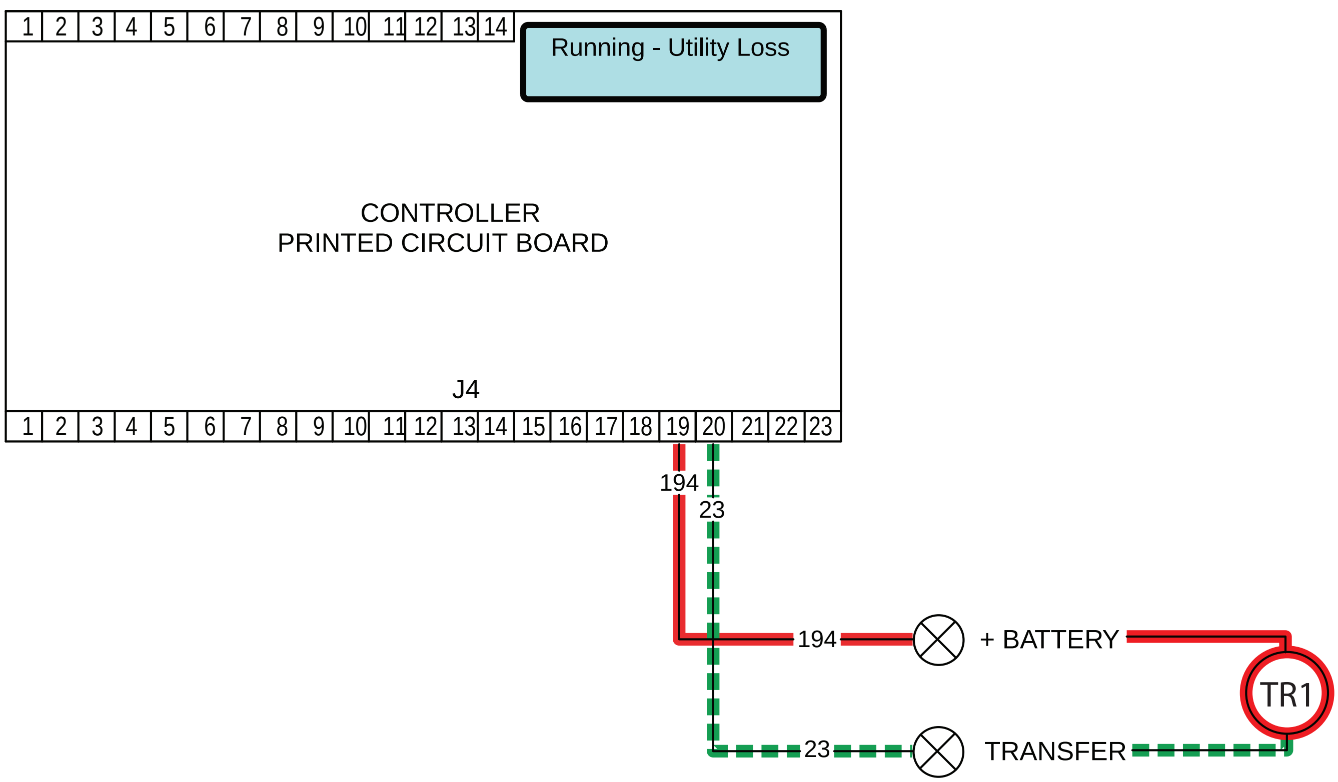


Figure 101.

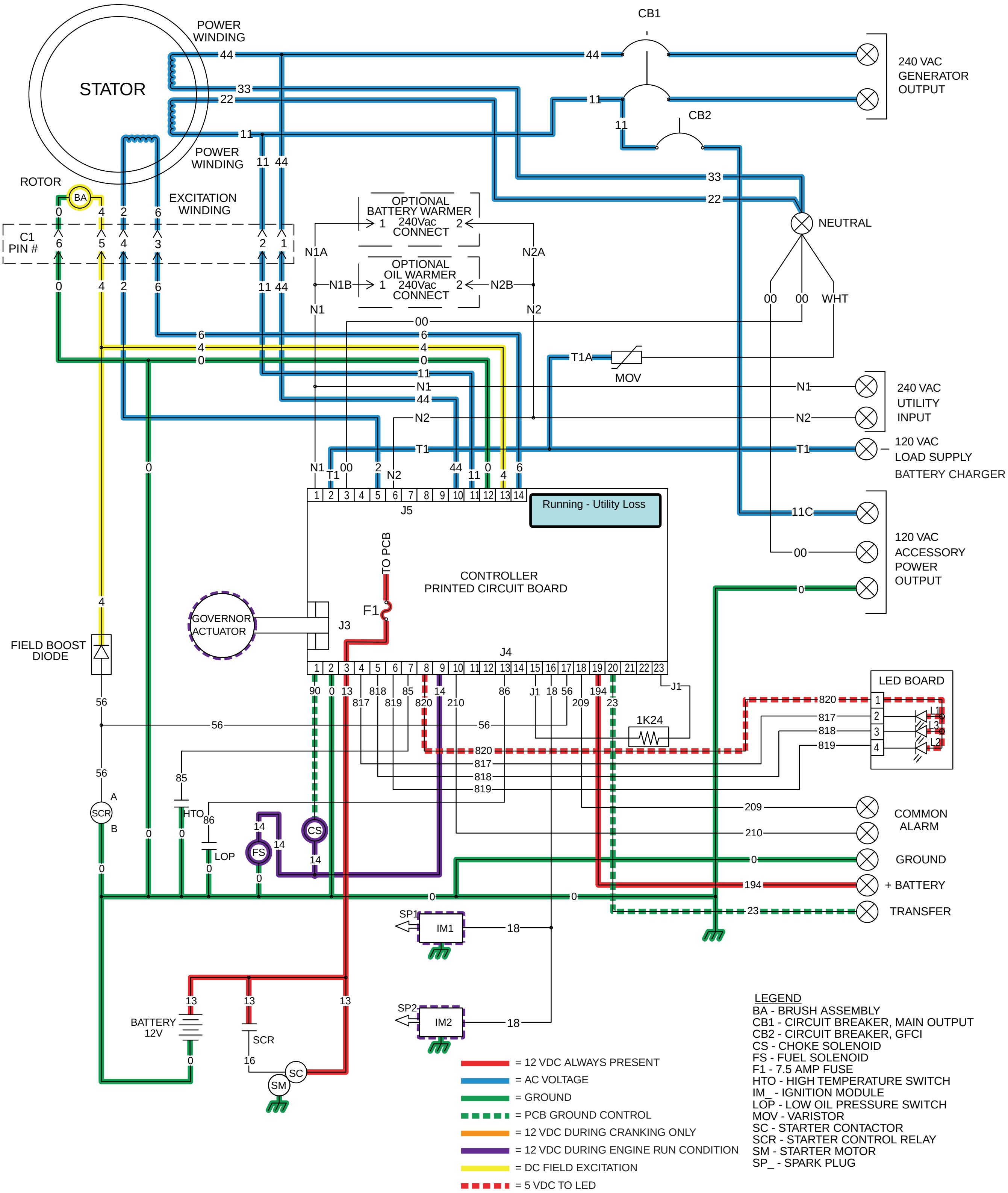


Figure 102. Transfer to the Standby

UTILITY VOLTAGE RESTORED AND RE-TRANSFER TO UTILITY

The Load is powered by Generator voltage. On restoration of Utility voltage, the following events will occur:

- On restoration of Utility voltage above 75% of the nominal rated voltage, a "re-transfer time delay" on the controller starts timing. The timer will run for 15 seconds.
- At the end of the 15 seconds, the "re-transfer time delay" will stop timing. The controller will open the Wire 23 circuit from ground and the transfer relay (TR1) will de-energize.
- When the TR1 relay de-energizes its utility side contacts close. Utility voltage is then delivered to the utility closing coil (C1), via Wire N1A and N2A, the closed TR1 contacts, Wire 126, limit switch (SW2), and a bridge rectifier.
- The C1 coil energizes and moves the main contacts to their "Utility" Position; the LOAD terminals are now powered by Utility.
- Movement of the main contacts to the "Utility" position actuates the limit switches. SW2 opens and SW3 moves to the Standby source side.
- The generator continues to run.

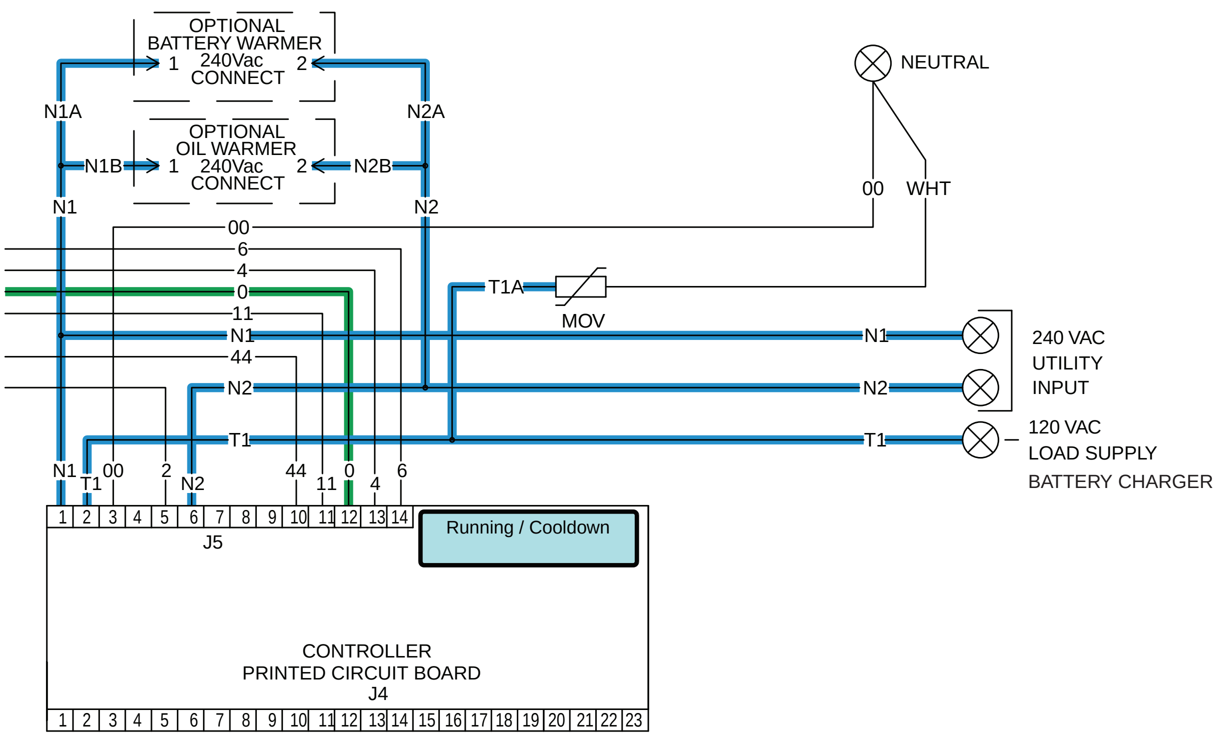


Figure 103.

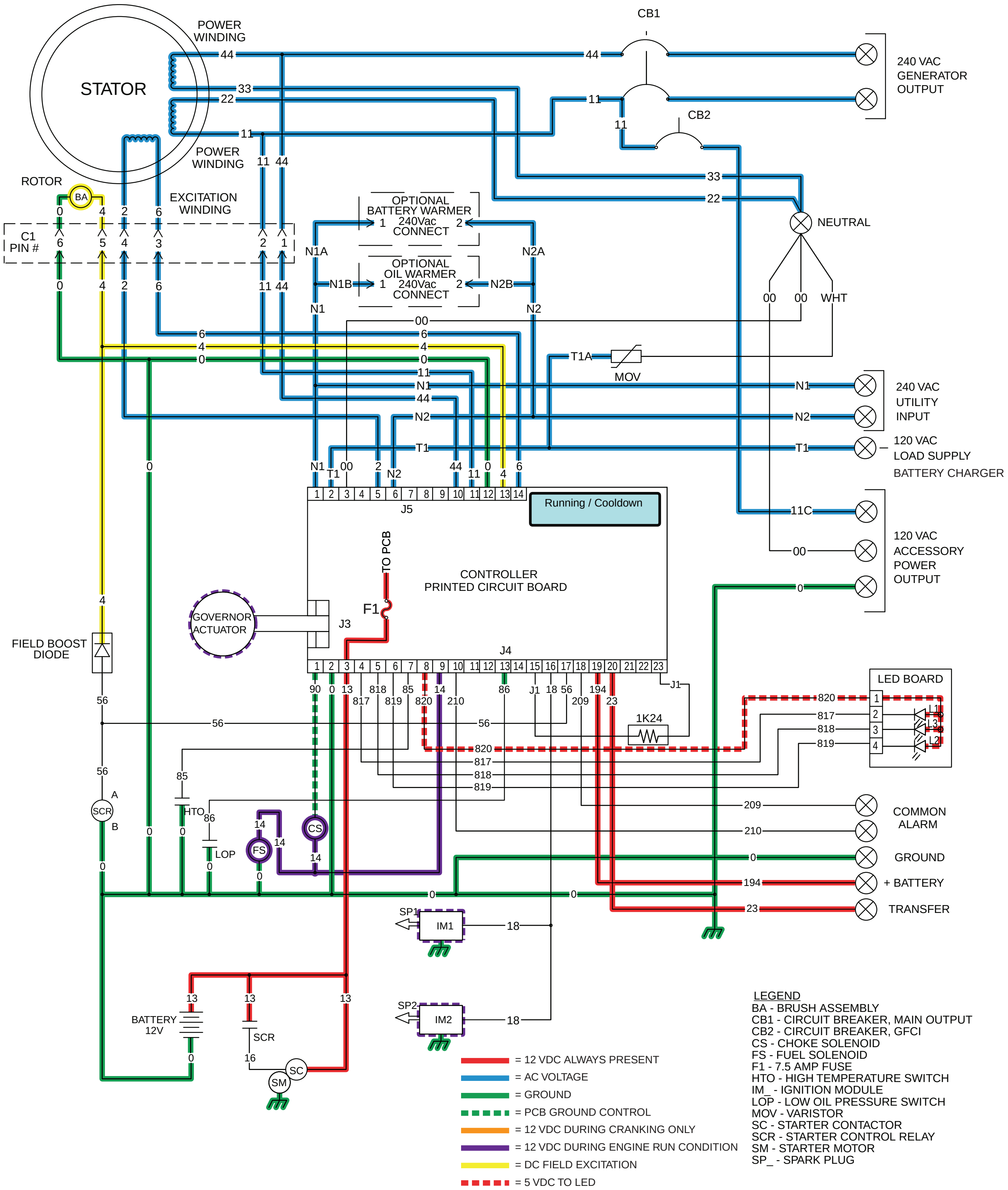


Figure 104. Utility Voltage Restored and Re-transfer to Utility

ENGINE SHUTDOWN

Following re-transfer back to the Utility source an “engine cool-down timer” on the controller starts timing. When the timer has expired (approximately one minute), the controller will de-energize the internal run relay removing fuel from the engine. The following events will occur:

- The DC circuit to Wire 14 and the fuel solenoid will open. The fuel solenoid will de-energize and close to terminate the fuel supply to the engine.
- The controller’s logic will connect the engine’s ignition magnetos to ground via Wire 18. Ignition will terminate.
- Without fuel flow and without ignition the engine will shut down.

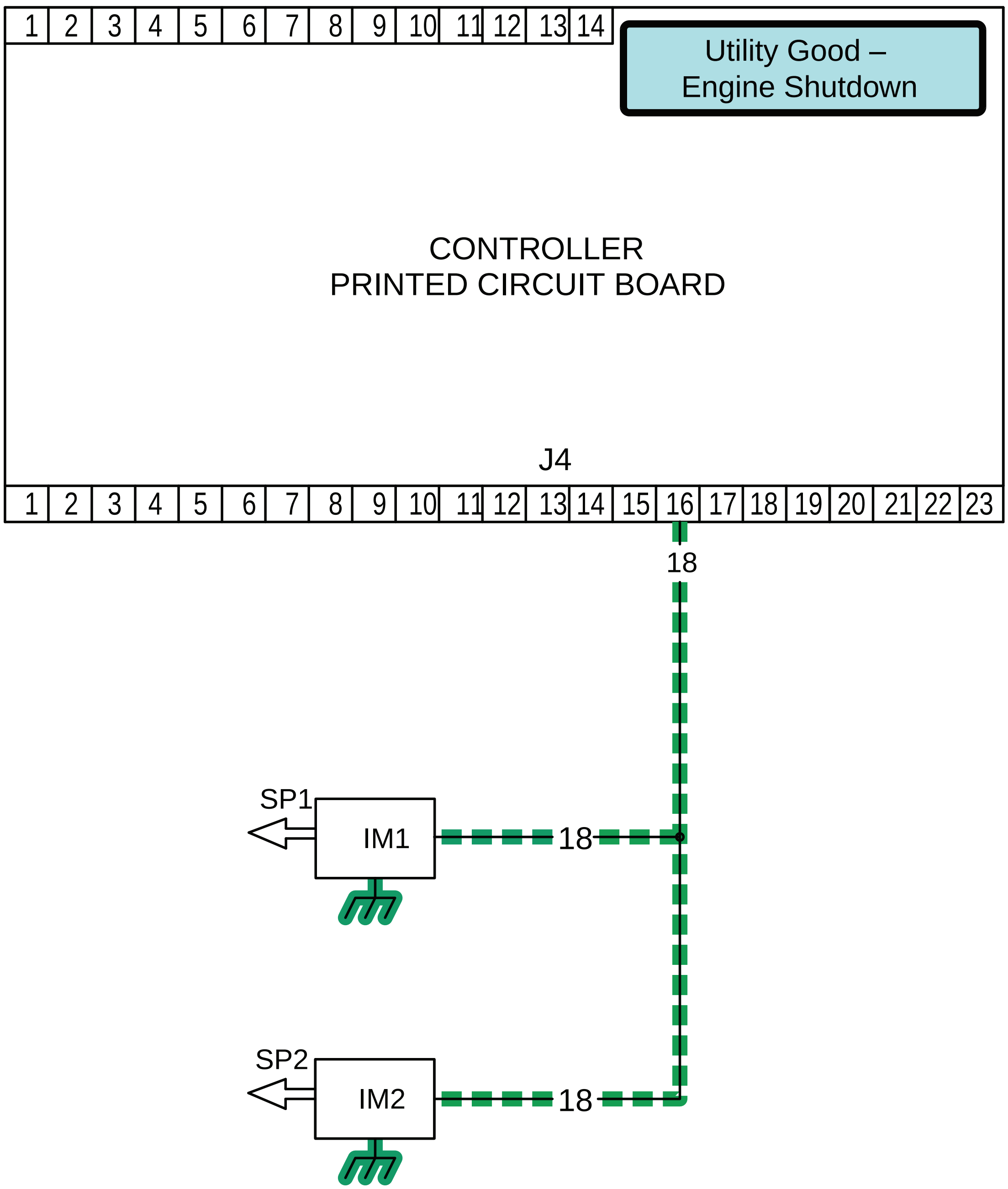


Figure 105.

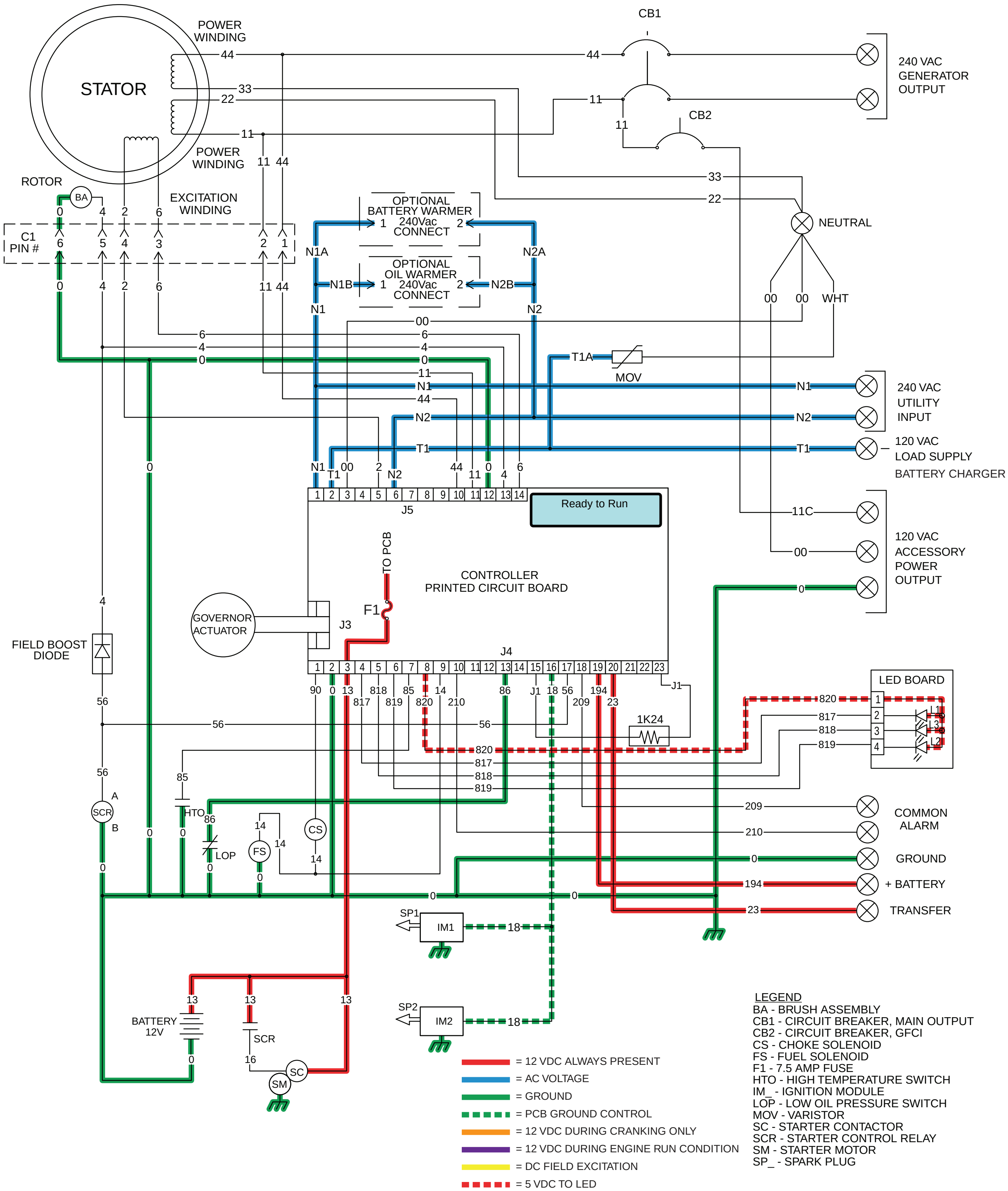
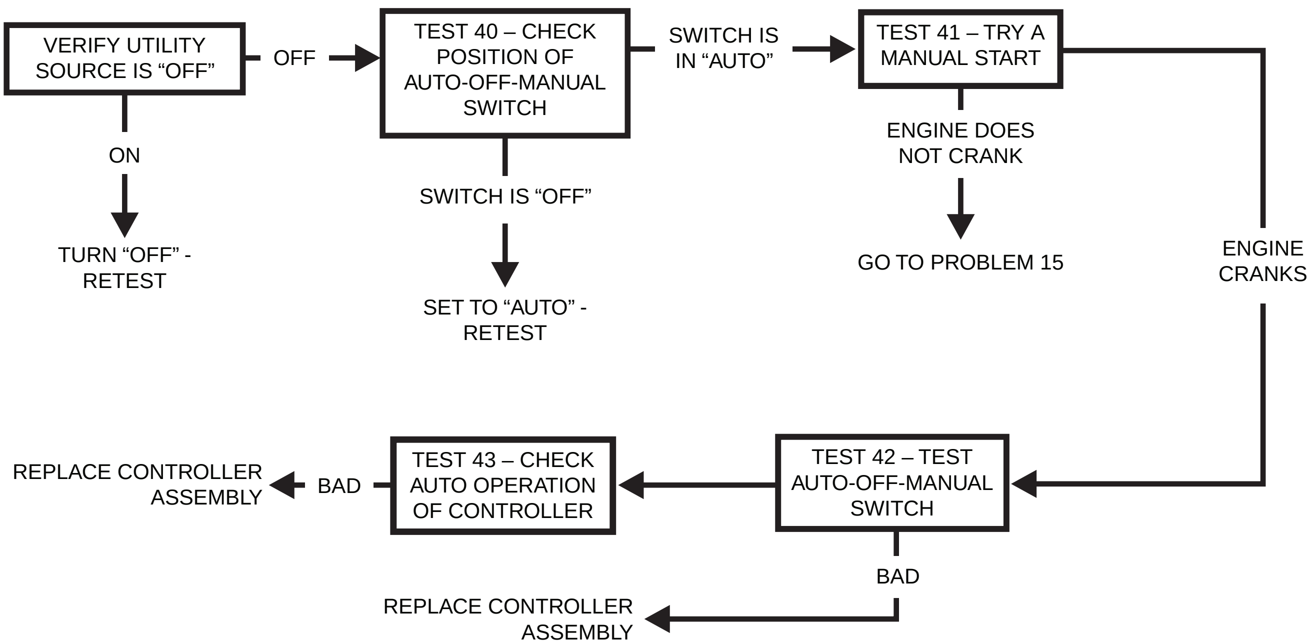
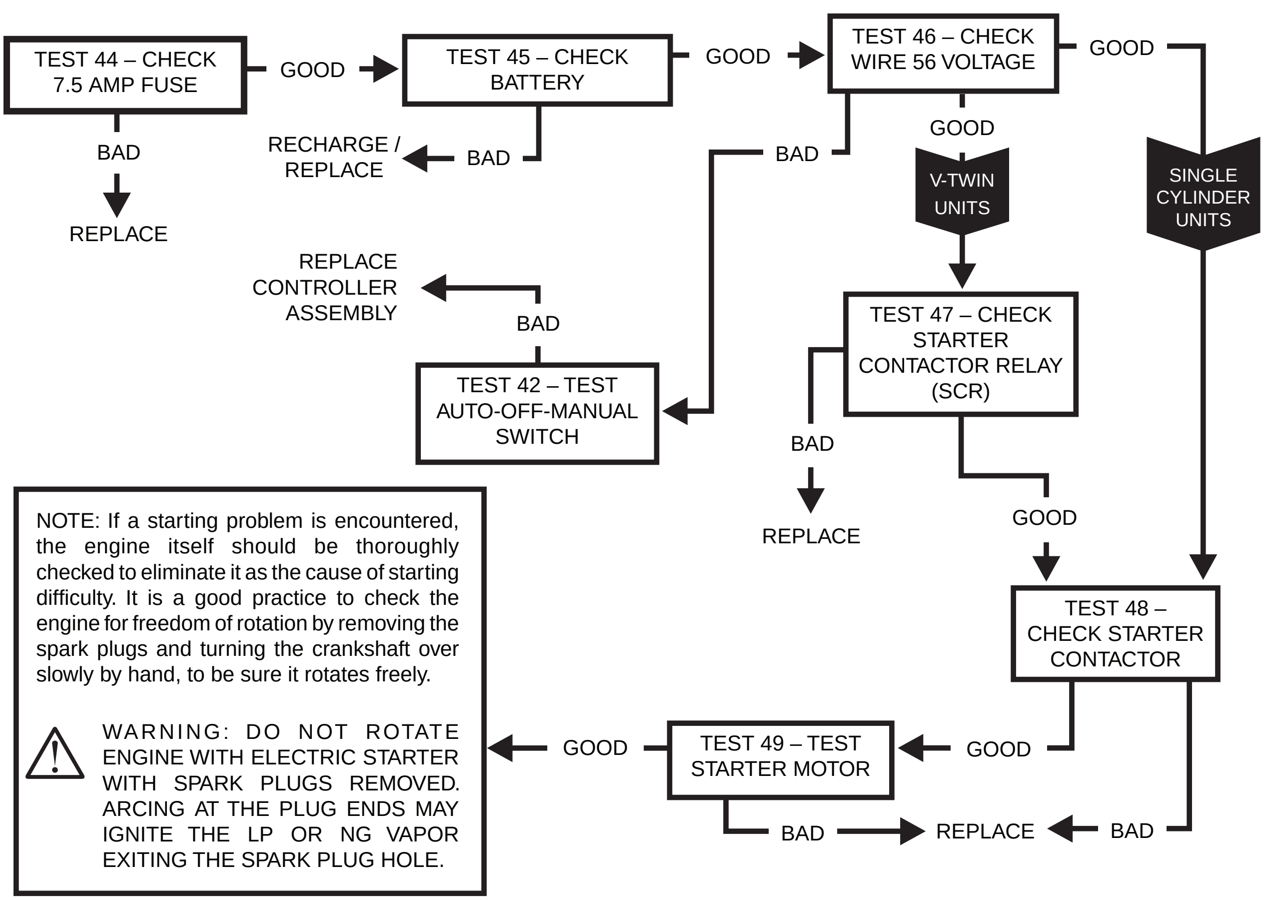


Figure 106. Engine Shutdown

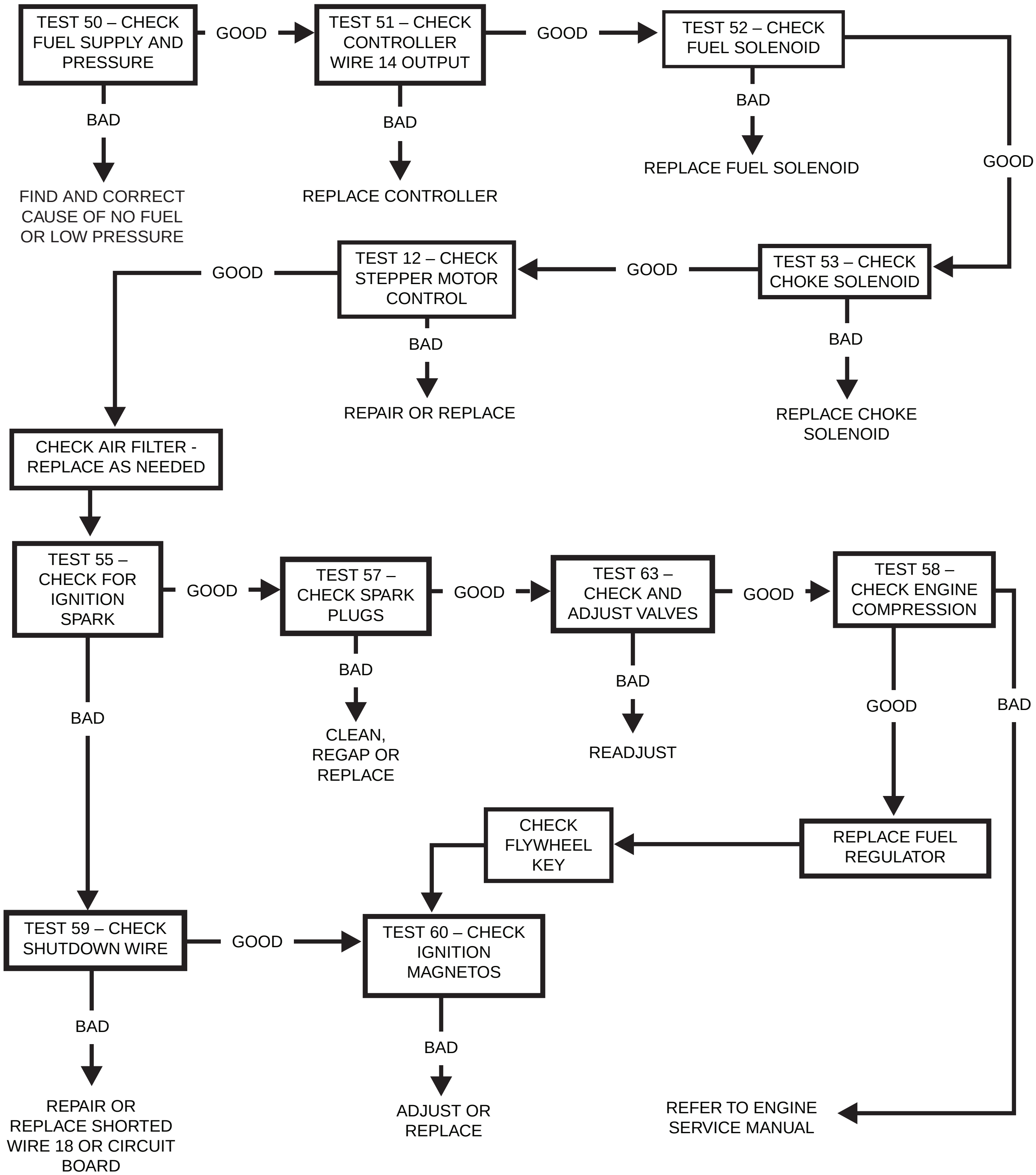
Problem 14 – Engine Will Not Crank When Utility Power Source Fails



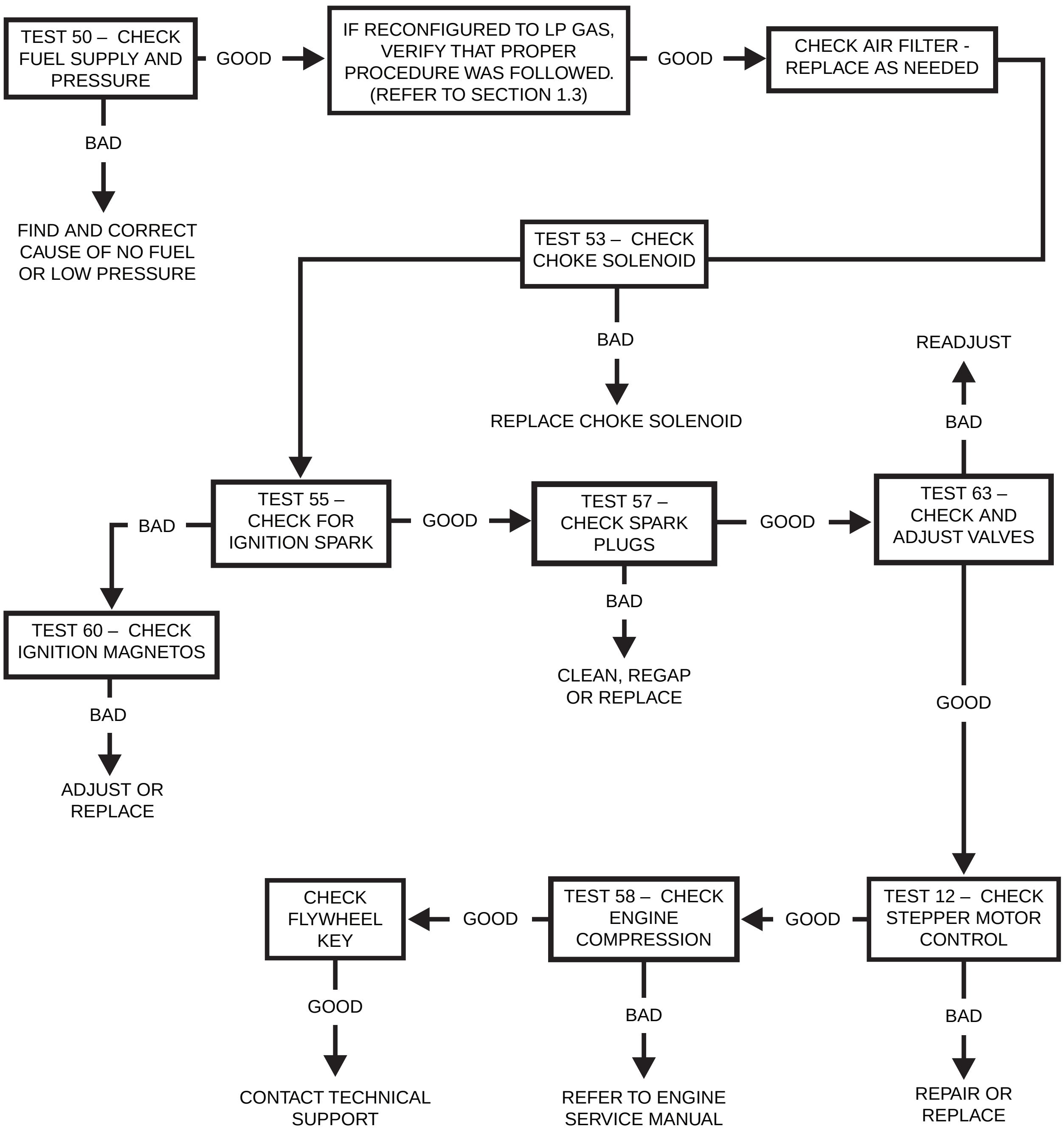
Problem 15 – Engine Will Not Crank When AUTO-OFF-MANUAL Switch is Set to "MANUAL"



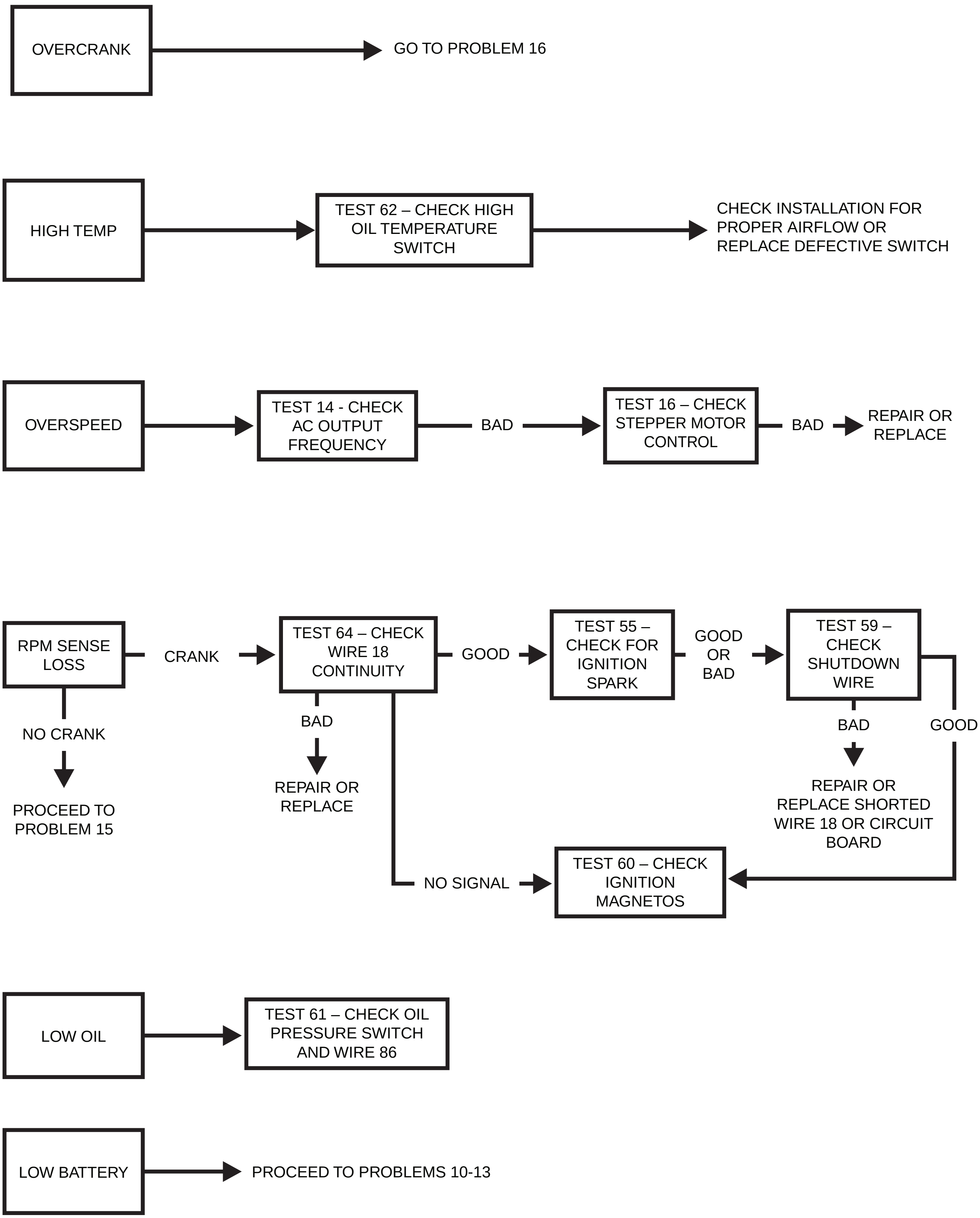
Problem 16 – Engine Cranks but Will Not Start



Problem 17 – Engine Starts Hard and Runs Rough / Lacks Power / Backfires



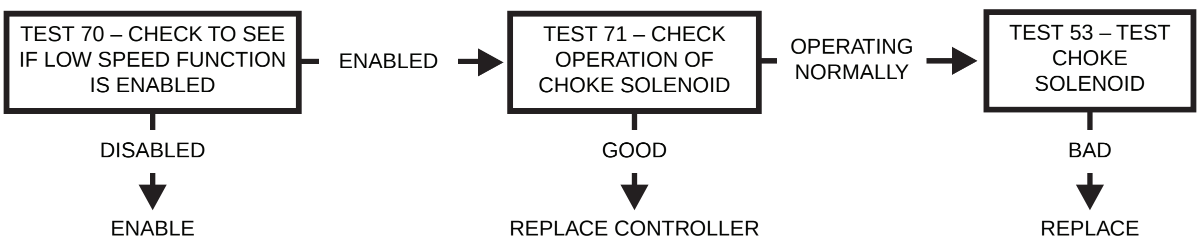
Problem 18 – Shutdown Alarm/Fault Occured



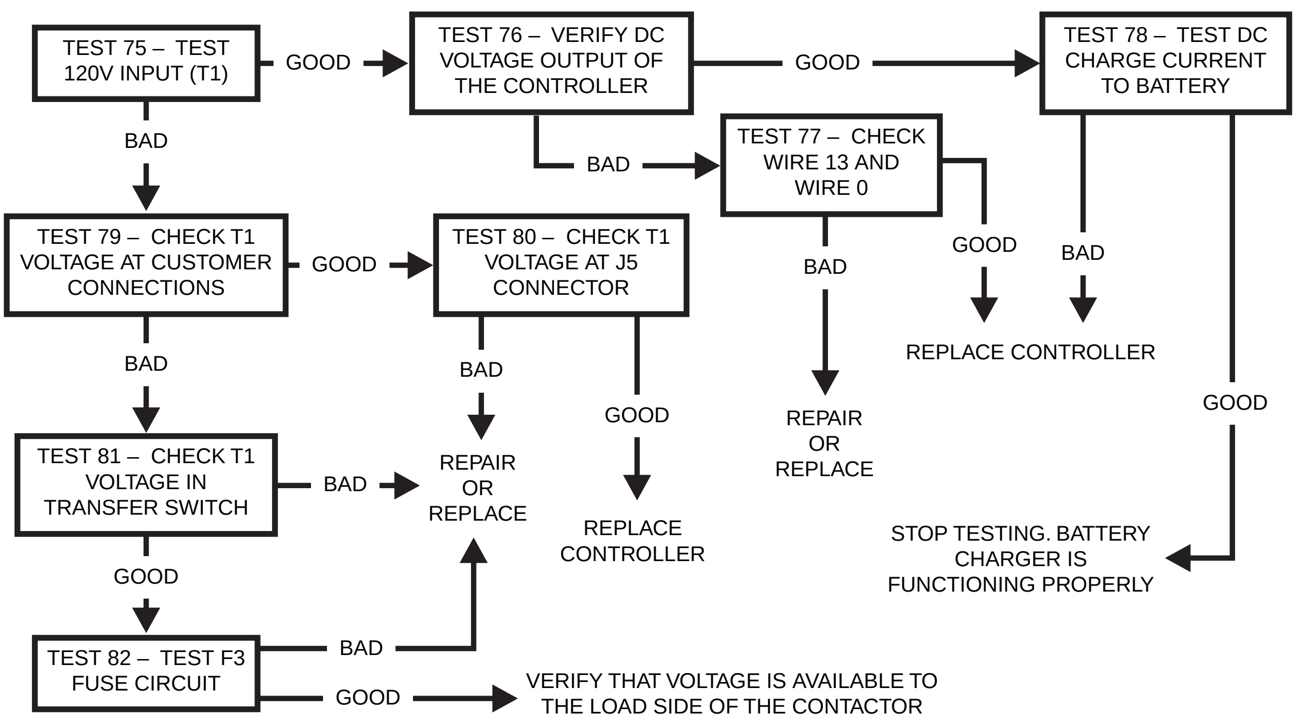
Problem 19 – 7.5 Amp Fuse (F1) Blown

Problem 20 – Generator Will Not Exercise

Problem 21 – No Low Speed Exercise



Problem 22 – Battery is Dead



INTRODUCTION

This section familiarizes the service technician with acceptable procedures for the testing and evaluation of various problems that can occur on the standby generators with air-cooled engines. Use this section in conjunction with Section 4.4, “Troubleshooting Flow Charts.” The numbered tests in this section correspond with those of Section 4.4.

Some test procedures in this section may require the use of specialized test equipment, meters or tools. Most tests can be performed with an inexpensive volt-ohm-meter (VOM). An AC frequency meter is required where frequency readings must be taken.

Testing and troubleshooting methods covered in this section are not exhaustive. No attempt has been made to discuss, evaluate and advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Accordingly, anyone who uses a test method not recommended herein must first satisfy himself that the procedure or method he has selected will jeopardize neither his nor the products safety.

Figure 107 shows the Volt-Ohm-Milliammeter (VOM) in two different states. The left VOM indicates an OPEN circuit or INFINITY. The right VOM indicates a dead short or CONTINUITY. Throughout the troubleshooting, refer back to Figure 107 as needed to understand what the meter is indicating about the particular circuit that was tested.

Note: CONTINUITY is equal to .01 ohms of resistance or a dead short.

OPEN LINE “INFINITY” SHORT "CONTINUITY"

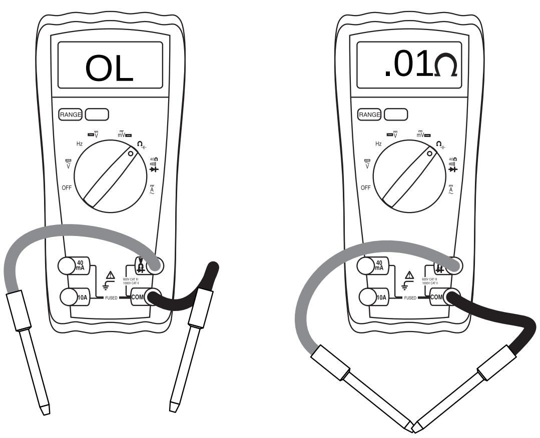


Figure 107.

SAFETY

Service personnel who work on this equipment should be aware of the dangers of such equipment. Extremely high and dangerous voltages are present that can kill or cause serious injury. Gaseous fuels are highly explosive and can ignite by the slightest spark. Engine exhaust gases contain deadly carbon monoxide gas that can cause unconsciousness or even death. Contact with moving parts can cause serious injury. The list of hazards is seemingly endless.

When working on this equipment, use common sense and remain alert at all times. Never work on this equipment while you are physically or mentally fatigued. If you do not understand a component, device or system, do not work on it.

ENGINE/DC TROUBLESHOOTING

It is always good practice to continue to ask questions during the troubleshooting process. When evaluating the problem asking some of these questions may help identify the problem quicker.

- What is the generator doing?
- What is the fault that the generator is shutting down for?
- After the fault occurred, what was the LCD displaying?
- Is there another Alarm in the log just previous to the shutdown?
- Is the fault causing the shutdown a symptom of another problem?
- Does the generator have the same fault consistently, and when does it occur?
- What was the generator supposed to do?
- Who is controlling it?
- Exactly what is occurring?
- When is it happening?
- Why would this happen?
- How would this happen?
- What type of test will either prove or disprove the cause of the fault?

TEST 40 – CHECK POSITION OF AUTO-OFF-MANUAL SWITCH

Discussion

If the system is to operate automatically, the generator AUTO-OFF-MANUAL switch must be set to the AUTO position. The Generator will not crank and start on occurrence of a Utility failure unless the switch is in the AUTO position. In addition, the Generator will not exercise every seven (7) days as programmed unless the switch is in AUTO.

Procedure

With the AUTO-OFF-MANUAL switch set to the AUTO position, test automatic operation. Testing of automatic operation can be accomplished by turning off the Utility power supply to the transfer switch. When the Utility power is turned off the Generator should crank and start. Following startup, transfer to the “Standby” position should occur. Refer to Section 1.7.

Results

1. If normal automatic operation is obtained, discontinue tests.
2. If the engine does not crank when Utility power is turned off refer back to the flow chart.

TEST 41 – TRY A MANUAL START

Discussion

The first step in troubleshooting for an "engine won't crank" condition is to determine if the problem is related to automatic operations only or if the engine will not crank manually either.

Procedure

1. Set the AUTO-OFF-MANUAL switch to the OFF position.
2. Set the main line circuit breaker (MLCB) to the "Open" position.
3. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
   a. The engine should crank cyclically through its "crank-rest" cycles until it starts.
   b. Let the engine stabilize and warm up for a few minutes after it starts.

Results

1. If the engine cranks manually, but does not crank automatically, refer back to flow chart.
2. If the engine does not crank manually proceed to Problem 15.

TEST 42 – TEST THE AUTO-OFF-MANUAL SWITCH

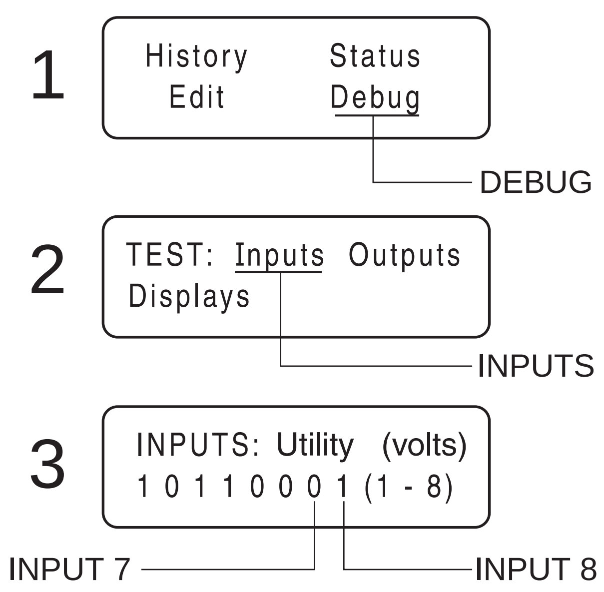


Figure 108. The Home Page, Debug and Input Screens

Procedure

1. Press the "ESC" key on the controller until the home page is reached (Figure 108, Screen 1).
2. Press the right arrow key until "Debug" flashes. Press "Enter" and the following screen will appear. See Figure 108, Screen 2.
3. When "Inputs" flashes, press "Enter".
4. With the Inputs Screen displayed, place the AUTO-OFF-MANUAL switch to the AUTO Position. If the controller reads the auto input from the switch, Input 7 will change from "0" to "1". See Table 17 in Section 4.1 for a description of the Inputs.
5. With the Inputs Screen displayed place the AUTO-OFF-MANUAL switch to the MANUAL position. If the controller reads an input from the Switch, Input 8 will change from "0" to "1".
6. With the AUTO-OFF-MANUAL Switch in the OFF position, both inputs will read zero.

Results

1. If controller failed either Step 4 or Step 5, replace the controller assembly.
2. If the controller passed Step 4 and Step 5, refer back to flow chart.

TEST 43 – TEST AUTO OPERATIONS OF CONTROLLER

Discussion

Initial Conditions: The Generator is in AUTO, ready to run, and voltage is being supplied by Utility. When Utility fails (below 65% of nominal), a 10 second (optionally programmable) line interrupt delay time is started. If the Utility is still gone when the timer expires, the engine will crank and start. Once started a five (5) second "engine warm-up timer" will be initiated. When the warm-up timer expires, the controller will transfer the load to the Generator. If Utility voltage is restored (above 75% of nominal) at any time from the initiation of the engine start until the Generator is ready to accept a load (5 second warm-up time has not elapsed), the controller will complete the start cycle and run the Generator through its normal cool down cycle; however, the voltage will remain on the Utility source.

Procedure

1. Place the generator Auto-Off-Manual switch in the Auto position.
2. Simulate a power failure by opening Utility supply breaker. If the generator cranks and starts and the switch transfers, the test is good; STOP.
3. If the Generator does not perform the sequence of events listed in the above discussion, replace the controller.

Results

Refer back to the flow chart

TEST 44 – CHECK 7.5 AMP FUSE

Note: Use the Alarm Log in the control panel to help troubleshoot various problems. For instance, if the unit does not crank the control panel will display "Stopped-Alarm RPM Sensor Loss." If the Fuse is bad and the unit attempts to crank the alarm log will display "Inspect Battery" first, and then "Stopped-Alarm RPM Sense Loss."

Discussion

The 7.5 amp fuse is located on the generator control console. A blown fuse will prevent battery power from reaching the circuit board with the same result as setting the AUTO-OFF-MANUAL switch to OFF ; the display and menus will remain active but the unit will not be able to crank or run.

Procedure

Remove and inspect the 7.5 amp fuse (F1) by pulling the fuse and visually checking the fuse element (hold the fuse up to some light and look through it).

Results

1. If the fuse if good, refer back to the Flow Chart.
2. If the fuse is bad, it should be replaced. Use only an identical 7.5 amp replacement fuse.
3. If fuse continues to blow, proceed to the Problem 19 Flow Chart.

TEST 45 – CHECK BATTERY

Discussion

Battery power is used to (a) crank the engine and (b) to power the circuit board. Low or no battery voltage can result in failure of the engine to crank, either manually or during automatic operation. The battery charger in the control panel will not recharge a dead battery.

Procedure

A. Inspect Battery Cables:

1. Visually inspect battery cables and battery posts.
2. If cable clamps or terminals are corroded, clean away all corrosion.
3. Install battery cables, making sure all cable clamps are tight. The red battery cable from the starter contactor (SC) must be securely attached to the positive (+) battery post; the black cable from the frame ground stud must be tightly attached to the negative (-) battery post.
4. Disconnect both negative and positive cables.

Note: Disconnect negative battery cable first.

5. Set a Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
6. Connect the red meter test lead to the positive battery post and connect the black meter test lead to the negative battery post.
7. Set the AUTO-OFF-MANUAL switch to the MANUAL position; measure and record the voltage.

B. Perform a load test on the Battery: (Maintenance Free Battery)

1. Using a lead acid battery load tester test the load capability of the battery.
2. Follow the load tester's manufacturer's instructions carefully.

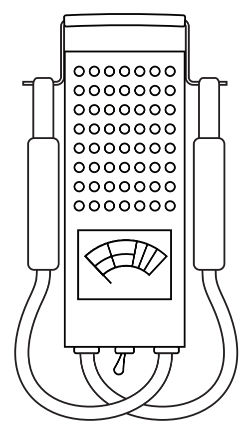
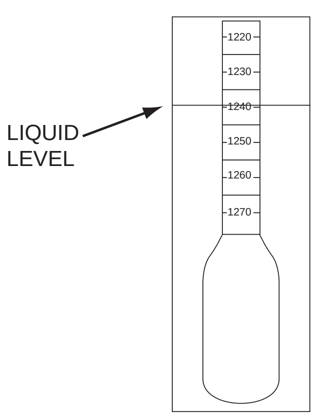


Figure 109. A Typical Battery Load Tester



Cell #	Specific Gravity	
1	1.255	
2	1.260	HIGH READING
3	1.235	
4	1.250	35 POINTS DIFFERENCE
5	1.240	LOW READING
6	1.225	

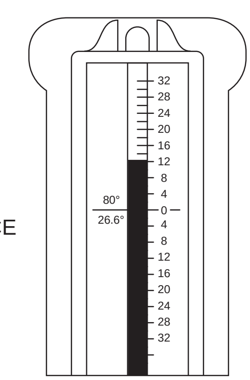


Figure 110. Reading a Battery Hydrometer

C. Test Battery State of Charge: (Non-Maintenance Free Battery)

1. Use an automotive type battery hydrometer to test battery state of charge.
2. Follow the hydrometer manufacturer's instructions carefully. Read the specific gravity of the electrolyte fluid in all battery cells.
3. If cells are low, distilled water can be added to refill cell compartment.
4. If the hydrometer does not have a "percentage of charge" scale, compare the reading obtained to the following:
   a. An average reading of 1.260 indicates the battery is 100% charged.
   b. An average reading of 1.230 means the battery is 75% charged.
   c. An average reading of 1.200 means the battery is 50% charged.
   d. An average reading of 1.170 indicates the battery is 25% charged.

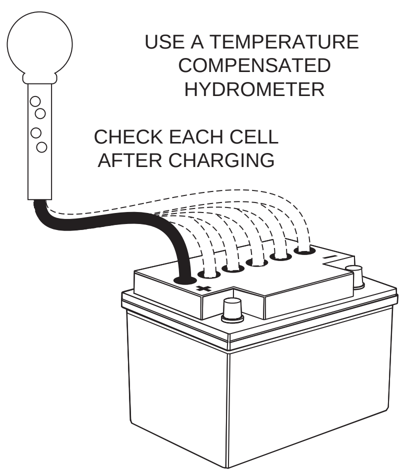


Figure 111. Using a Battery Hydrometer

5. Test Battery Condition:
   a. If the difference between the highest and lowest reading cells is greater than 0.050 (50 points), battery condition has deteriorated and the battery should be replaced.
   b. However, if the highest reading cell has a specific gravity of less than 1.230, the test for condition is questionable. Recharge the battery to a 100 percent state of charge, and then repeat the test for condition.

Results

1. Remove the battery and recharge with an automotive battery charger, if necessary.
2. If battery condition is bad, replace with a new battery.
3. If the VOM indicated less than 10.5 VDC during Step 7, replace or recharge battery.
4. If battery condition is good, refer back to flow chart.

TEST 46 – CHECK WIRE 56 VOLTAGE

Discussion

During an automatic start or when starting manually, an internal crank relay energizes. Each time the crank relay energizes, the controller should deliver 12 VDC to a start contactor relay (SCR), or starter contactor (SC) and the engine should crank. This test will verify (a) that the crank relay on the controller is energizing, and (b) that the controller is delivering 12 VDC to the SCR relay or the SC.

Note: If the unit does not crank the Alarm Log will display, "Stopped-Alarm RPM Sense Loss."

Procedure

1. Set the Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
2. Locate and disconnect Wire 56 from the SCR on V-Twin units and the SC on single cylinder units.
3. Connect one meter test lead to Wire 56 and the other meter test lead to a clean frame ground.
4. Set the AUTO-OFF-MANUAL switch to MANUAL. Observe the meter, the VOM should indicate battery voltage. If battery voltage was measured, stop testing and refer back to the flow chart. If voltage was NOT measured, proceed to Step 5.
5. Navigate to the Digital output display screen.
   a. Press "ESC" until the main menu is reached.
   b. Press the right arrow key until "Debug" is flashing.
   c. Press "Enter".
   d. Press the right arrow key until "Outputs" is flashing.
   e. Press "Enter".
   f. Digital Output 6 is Wire 56 output from the board. Refer to Figure 112.
6. Set the AUTO-OFF-MANUAL switch to the MANUAL position and observe digital output Number 6. If the controller is working correctly output Number 6 will change from a "0" to a "1", observe and record the change in state.
7. Set a VOM to measure resistance.
8. Remove 7.5 amp fuse.
9. Disconnect the J4 connector from the controller.
10. Remove Wire 56 from the starter contactor relay (V-twin units) or from the starter contactor (single cylinder units).
11. Connect one meter test lead to disconnected Wire 56 and connect the other test lead to J4 Pin 17 (Wire 56), measure and record the resistance.

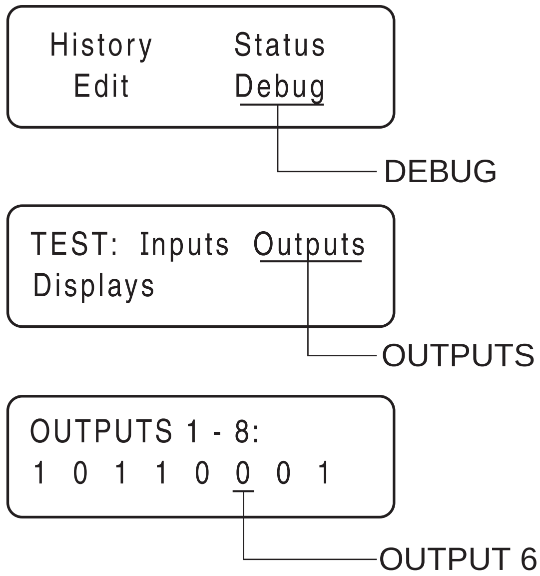


Figure 112. The Home Page, Debug and Output Screens

Results

1. If the VOM indicated battery voltage in Step 4, refer back to the flow chart.
2. If the Digital Output in Step 5 did not change, replace the controller.
3. If the VOM did NOT indicate CONTINUITY in Step 11, repair or replace Wire 56 between the J4 connector and the relay or contactor.

TEST 47 – TEST STARTER CONTACTOR RELAY (V-TWIN ONLY)

Discussion

The starter contactor relay (SCR) located in the control panel must energize for cranking to occur. Once energized the normally open contacts of the SCR will close and battery voltage will be available to Wire 16 and to the starter contactor (SC).

Procedure

1. Set a Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
2. Disconnect Wire 13 from the SCR located in the control panel.
3. Connect the positive meter test lead to Wire 13 and connect the negative meter test lead to a clean frame ground, measure and record the voltage.
4. Reconnect Wire 13 to the SCR
5. Disconnect Wire 16 from the SCR.

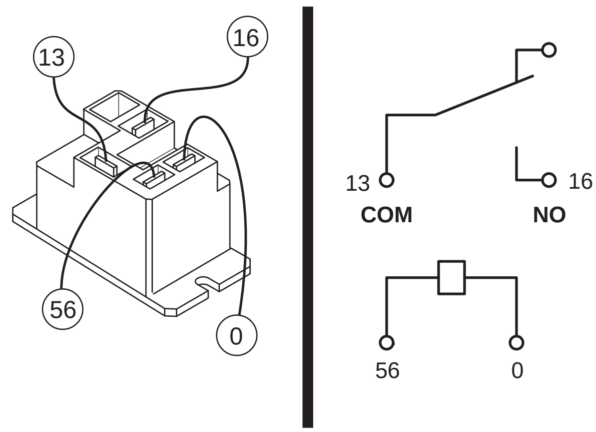


Figure 113. Starter Contactor Relay (V-twin Units)

6. Connect the positive meter test lead to the SCR terminal from which Wire 16 was removed and connect the negative meter test lead to a clean frame ground.
7. Set the AUTO-OFF-MANUAL switch to the MANUAL position, measure and record the voltage.
8. Set the VOM to measure resistance.
9. Disconnect Wire 0 from the SCR.
10. Connect one meter test lead to Wire 0 and connect the negative meter test lead to clean frame ground, measure and record the resistance.

Results

1. If battery voltage was NOT measured in Step 3, repair or replace Wire 13 between the SCR and the SC.
2. If battery voltage was NOT measured in Step 7 and CONTINUITY was measured in Step 10, replace the SCR.
3. If CONTINUITY was NOT measured in Step 10, repair or replace Wire 0.
4. If battery voltage was measured in Step 6 and CONTINUITY was measured in Step 10, refer back to flow chart.

TEST 48 – TEST STARTER CONTACTOR

Discussion

The coil in the starter contactor (SC) must energize and its normally open contacts close or the engine will not crank. This test will determine if the SC is working.

Procedure

Carefully inspect the starter motor cable that runs from the battery to the starter motor. Cable connections must be clean and tight. If connections are dirty or corroded, remove the cable and clean cable terminals and terminal studs. Replace any cable that is defective or badly corroded.

Refer to Figure 114 and 115 for Test Points

1. Set Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
2. Connect the positive meter test lead to the positive post of the battery and connect the negative meter test lead to the negative post of the battery. The VOM should indicate battery voltage. This measure will be a reference during the testing procedure.
3. Connect the positive meter test lead to Test Point 1 and connect the negative meter test lead to a clean frame ground, measure and record the voltage.
4. Connect the positive meter test lead to Test Point 2 and connect the negative meter test lead to a clean frame ground.
5. Set the AUTO-OFF-MANUAL switch to the MANUAL position; measure and record the voltage at Test Point 2 (Wire 16). The contactor should energize.

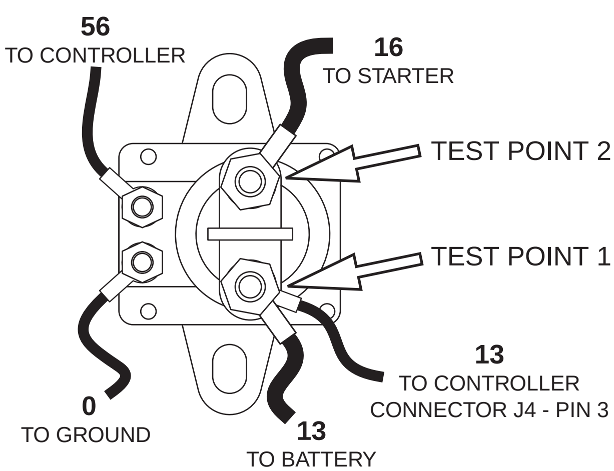


Figure 114. The Starter Contactor (Single Cylinder Units)

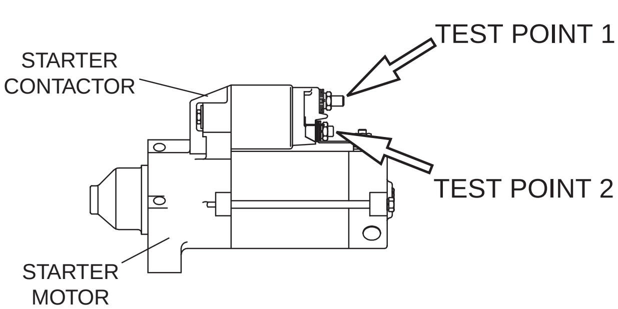


Figure 115. The Starter Contactor (V-twin Units)

Results

1. If battery voltage was indicated in Steps 3 and 4, refer back to the flow chart.
2. If battery voltage was indicated in Step 3, but not in Step 4, replace the starter contactor.

V-Twin Only

3. If the VOM did not indicate battery voltage in Step 4 (on Wire 16), repair or replace Wire 16 between the SCR and the contactor.

TEST 49 – TEST STARTER MOTOR

Conditions Affecting Starter Motor Performance

1. A binding or seizing condition in the starter motor bearings.
2. A shorted, open or grounded armature.
   a. Shorted armature (wire insulation worn and wires touching one another). Will be indicated by low or no RPM.
   b. Open armature (wire broken) will be indicated by low or no RPM and excessive current draw.
   c. Grounded armature (wire insulation worn and wire touching armature lamination or shaft). Will be indicated by excessive current draw or no RPM.
3. A defective starter motor switch.
4. Broken, damaged or weak magnets.
5. Starter drive dirty or binding.

Discussion

Test 46 verified that the circuit board is delivering DC voltage to the starter contactor relay (SCR). Test 47 verified the operation of the SCR. Test 48 verified the operation of the starter contactor (SC). Another possible cause of an “engine won’t crank” problem is a failure of the starter motor.

Procedure

The battery should have been checked prior to this test and should be fully charged.

Set a VOM to measure DC voltage (12 VDC). Connect the meter positive (+) test lead to the starter contactor stud which has the small jumper wire connected to the starter. Connect the common (-) test lead to the starter motor frame.

Set the AUTO-OFF MANUAL Switch to its “MANUAL” position and observe the meter. Meter should indicate battery voltage, starter motor should operate and engine should crank.

Results

1. If battery voltage is indicated on the meter but starter motor did NOT operate, remove and bench test the starter motor (see following test).
2. If battery voltage was indicated and the starter motor tried to engage (pinion engaged), but engine did NOT crank, check for mechanical binding of the engine or rotor.

If engine turns over slightly, go to Test 63 "Check and Adjust Valves." If valve clearance is too loose the valves will not fully open which could slow down cranking of the engine.

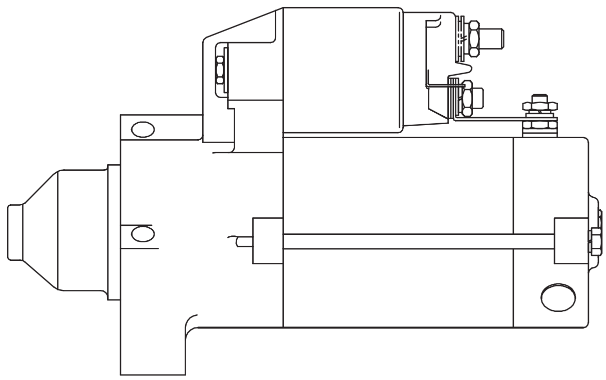


Figure 116. Starter Motor (V-Twin Engines)

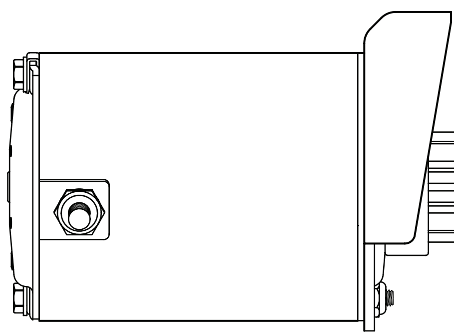


Figure 117. Starter Motor (Single Cylinder Engines)

Checking The Pinion

When the starter motor is activated, the pinion gear should move and engage the flywheel ring gear. If the pinion does not move normally, inspect the pinion for binding or sticking.

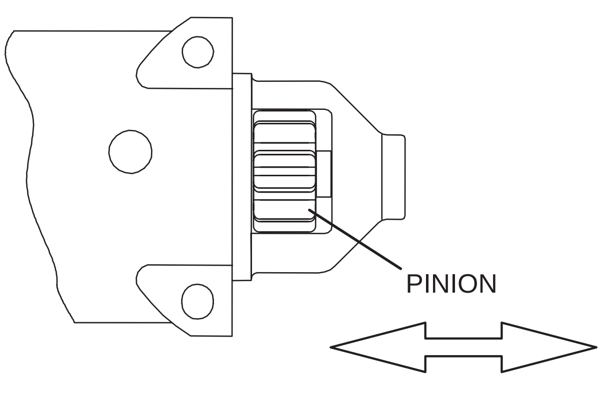


Figure 118. Check Pinion Gear Operation (V-Twin)

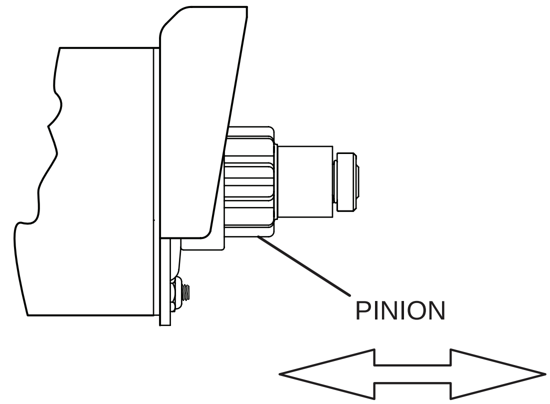


Figure 119. Check Pinion Gear Operation (Single Cylinder)

Tools For Starter Performance Test:

The following equipment may be used to complete a performance test of the starter motor:

- A clamp-on ammeter.
- A tachometer capable of reading up to 10,000 rpm.
- A fully charged 12 volt battery.

Measuring Current:

To read the current flow, in AMPERES, a clamp-on ammeter may be used. This type of meter indicates current flow through a conductor by measuring the strength of the magnetic field around that conductor.

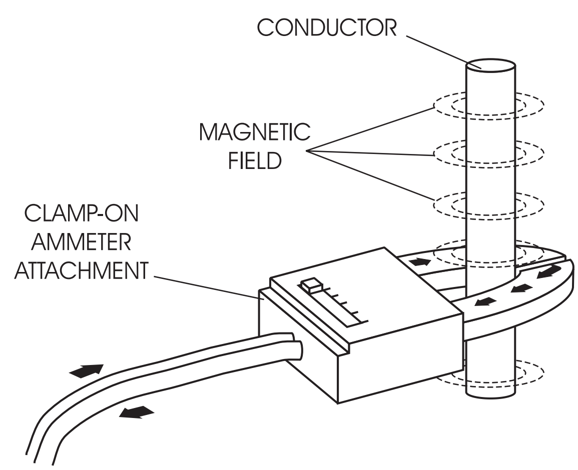


Figure 120. Clamp-On Ammeter

Tachometer:

A tachometer is available from your parts source. The tachometer measures from 800 to 50,000 rpm, (see Figure 121).

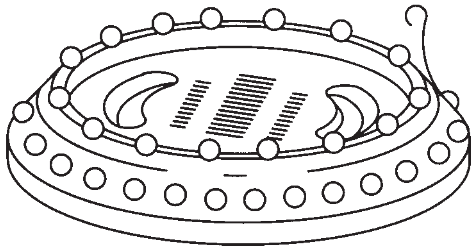


Figure 121. Tachometer

Test Bracket:

A starter motor test bracket may be made as shown in Figure 122. A growler or armature tester is available from an automobile diagnostic service supplier.

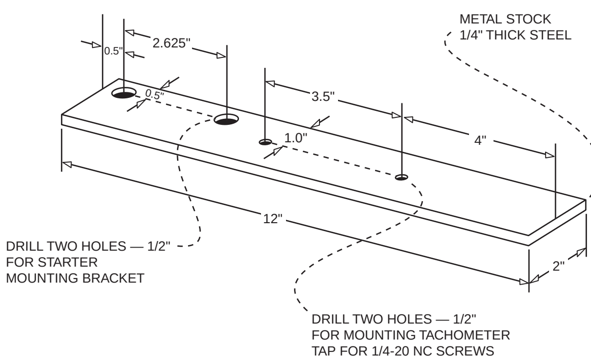


Figure 122. Test Bracket

Remove Starter Motor:

It is recommended that the starter motor be removed from the engine when testing starter motor performance. Assemble starter to test bracket and clamp test bracket in vise, Figure 123.

Testing Starter Motor:

1. A fully charged 12 volt battery is required.
2. Connect jumper cables and clamp-on ammeter as shown in Figure 123.
3. With the starter motor activated (jump the terminal on the starter contactor to battery voltage), note the reading on the clamp-on ammeter and on the tachometer (rpm).

Note: Take the reading after the ammeter and tachometer are stabilized, approximately 2-4 seconds.

4. A starter motor in good condition will be within the following specifications:

	V-twin	Single Cylinder
Minimum rpm	3250	4500
Maximum Amps	62	9

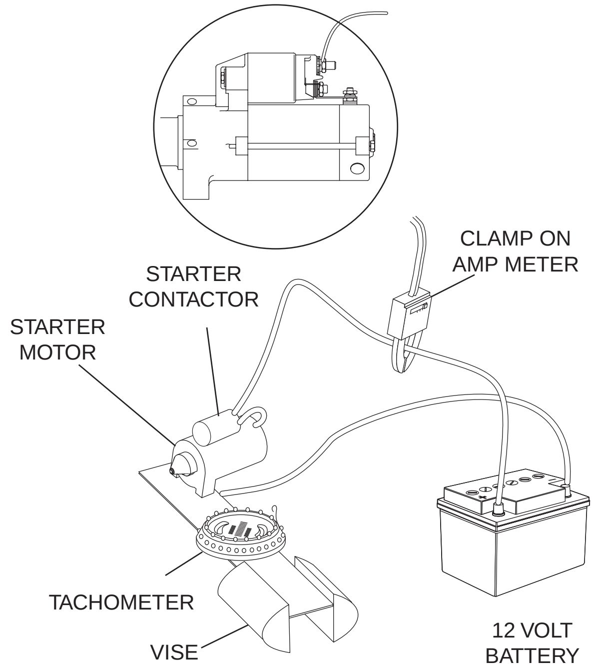


Figure 123. Testing Starter Motor Performance

TEST 50 – CHECK FUEL SUPPLY AND PRESSURE

Discussion

The air-cooled generator was factory tested and adjusted using natural gas as a fuel. If desired, LP (propane) gas may be used. However, when converting to propane, some minor adjustments are required. The following conditions apply for a unit to operate correctly:

- An adequate gas supply and sufficient fuel pressure must be available or the engine will not start.
- Minimum recommended gaseous fuel pressure at the generator fuel inlet connection is 5 inches water column for natural gas (NG) or 10 inches water column for LP gas.
- Maximum gaseous fuel pressure at the generator fuel inlet connection is 7 inches water column for natural gas or 12 inches water column for LP gas.
- When propane gas is used, only a “vapor withdrawal” system may be used. This type of system utilizes the gas that forms above the liquid fuel. The vapor pressure must be high enough to ensure engine operation.
- The gaseous fuel system must be properly tested for leaks following installation and periodically thereafter. No leakage is permitted. Leak test methods must comply strictly with gas codes.

⚠ DANGER!

Gaseous fuels are highly explosive. Do not use flame or heat to test the fuel system for leaks. Natural gas is lighter than air, and tends to settle in high places. LP

(propane) gas is heavier than air, and tends to settle in low areas. Even the slightest spark can ignite these gases and cause an explosion.

Procedure

A water manometer or a gauge that is calibrated in "ounces per square inch" may be used to measure the fuel pressure. Fuel pressure at the inlet side of the fuel solenoid valve should be between 5-7 inches water column for natural gas (NG) or 10-12 inches water column for LP gas.

1. See Figures 124, 125 or 126 for the gas pressure test point on the fuel regulator. The fuel pressure can be checked at Port 1 on all fuel regulators, and at Port 3 on 12-20kW units.
2. With the manometer connected properly, crank the engine. Nominal fuel pressure should be measured. If pressure is not measured while cranking refer back to flow chart.

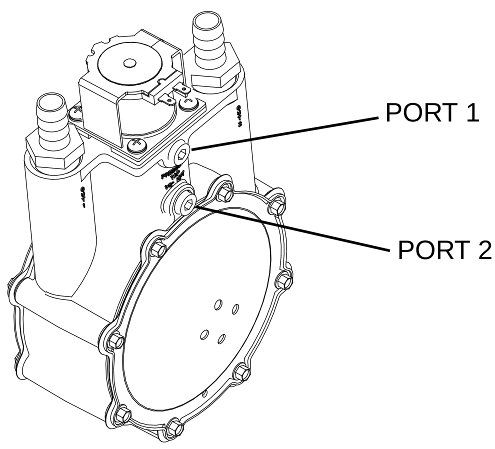


Figure 124. (8kW) Gas Pressure Test point

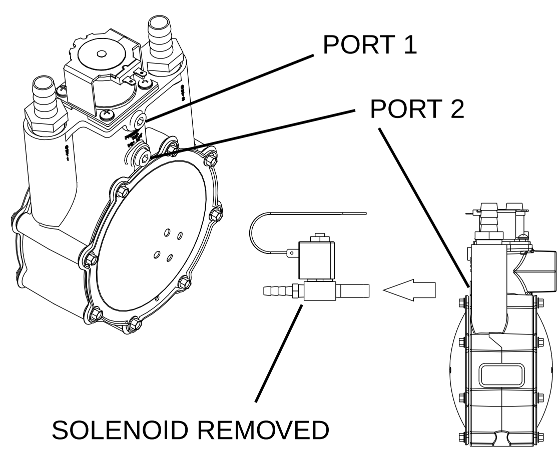


Figure 125. (10kW) Gas Pressure Test point

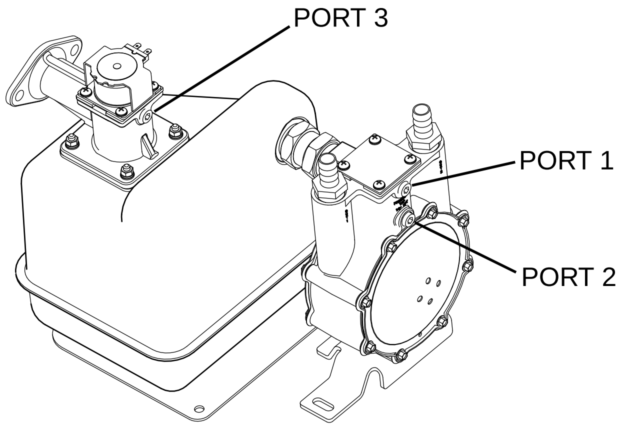


Figure 126. (12-20kW) Gas Pressure Test point

Note: Where a primary regulator is used to establish fuel inlet pressure, adjustment of that regulator is usually the responsibility of the fuel supplier or the fuel supply system installer.

12-20kW Units Only

Note: The test port (Port 3) below the fuel solenoid may be used to take a fuel pressure reading before the fuel solenoid. Consistent pressure should be measured at this port both while the generator is running and when the generator is off.

Results

1. If fuel supply and pressure are adequate, but engine will not start refer back to the flow chart.
2. If generator starts but runs rough or lacks power, repeat the above procedure with the generator running and under load. The fuel system must be able to maintain 10-12 inches water column at all load requirements for propane, and 5-7 inches water column for natural gas. If proper fuel supply and pressure is maintained, refer to Problem 17 Flow Chart.

TEST 51 – CHECK CONTROLLER WIRE 14 OUTPUTS

Discussion

During any crank attempt, the controllers crank relay and run relays both are energized. When the run relay energizes, its contacts close and 12 VDC is delivered to the Wire 14 circuit and to the fuel solenoid. The solenoid energizes open to allow fuel flow to the engine. This test will determine if the controller is working properly.

Procedure

1. Set the AUTO-OFF-MANUAL switch to OFF.
2. Set a Volt-Ohm-Milliammeter (VOM) to measure DC voltage.

3. Disconnect Wire 14 from the fuel solenoid (FS).
4. Connect the positive test lead to the disconnected Wire 14 from Step 3 and connect the negative test lead to a clean frame ground.
5. Set AUTO-OFF-MANUAL switch to the MANUAL position. The meter should indicate battery voltage.
   a. If battery voltage is indicated, refer back to flow chart.
   b. If battery voltage is not measured, proceed to Step 6
6. Navigate to the Digital Output display.
7. Press “ESC” until the display screen is present.
8. Press the right arrow key until “Debug” is flashing. Press “Enter”.
9. Press the right arrow key until “Outputs” is flashing. Press “Enter”.

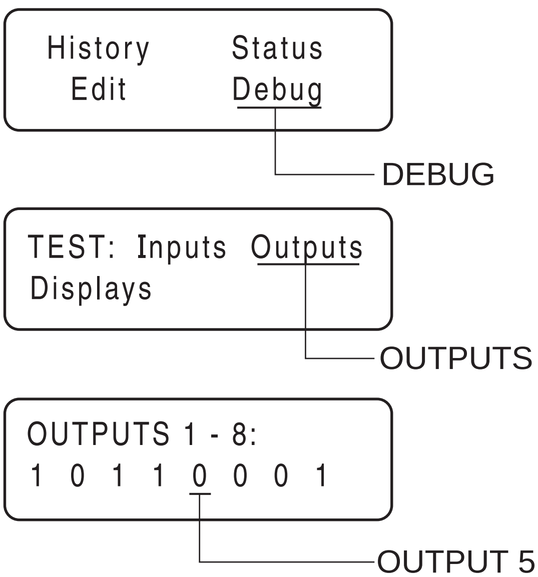


Figure 127. The Home Page, Debug and Output Screens

10. Output 5 is Wire 14 out from the controller. If the controller is functioning properly, Output 5 will change from a “0” to a “1” while the unit is cranking.
    a. If the VOM did NOT indicate voltage in Step 5 and output did not change in Step 10, replace the controller.
    b. If the VOM did NOT indicate voltage in Step 5 and the output in Step 10 changed, proceed to Step 11.
11. Disconnect the 7.5 amp Fuse
12. Disconnect the J4 connector from the controller.
13. Set a VOM to measure resistance.
14. Connect one meter test lead to Wire 14 that was disconnected in Step 3 and connect the other meter test lead to Wire 14 at Pin 9 J4 (Wire 14). See Section 4.1 “Connector Pin Descriptions”.
    a. If the VOM indicated CONTINUITY repeat Step 5 and then retest.
    b. If CONTINUITY is not measured, repair or replace Wire 14 between the J4 Connector and the fuel solenoid.

Results

Refer back to flow chart

TEST 52 – CHECK FUEL SOLENOID

Discussion

In Test 67, if battery voltage was delivered to Wire 14, the fuel solenoid should have energized open. This test will verify whether or not the fuel solenoid is operating.

Fuel Solenoid FS1 Nominal Resistance	27-33 ohms.
Fuel Solenoid FS2 Nominal Resistance	29 ohms.

Procedure: 8 and 12-20kW Units

1. Install a manometer to Port 2 on the fuel regulator. See Figure 124 or Figure 126.
2. Set the AUTO-OFF-MANUAL Switch to MANUAL.
3. Proper gas pressure should be measured during cranking. If gas pressure is measured, the fuel solenoid is operating. If gas pressure is not measured, repair or replace the fuel solenoid.

Procedure: 10kW Units

1. Remove the hose from fuel solenoid (FS2) and install a manometer to Port 2 on the fuel regulator. See Figure 125.
2. Set the AUTO-OFF-MANUAL Switch to MANUAL.
3. Proper gas pressure should be measured during cranking. If gas pressure is measured, both fuel solenoids are operating. Discontinue testing.
4. If gas pressure was not measured in Step 3, remove fuel solenoid FS2 and install a manometer to the bottom port of the fuel regulator.
5. Set the AUTO-OFF-MANUAL Switch to MANUAL.
6. Proper gas pressure should be measured during cranking. If gas pressure is measured, fuel solenoid FS1 is operating. Replace fuel solenoid FS2. If gas pressure is not measured, repair or replace fuel solenoid FS1.

Results

If fuel pressure was measured in any of the preceding tests it indicates that the fuel solenoid is operating properly. Refer back to the flow chart for the next test.

TEST 53 – CHECK CHOKE SOLENOID

Discussion

12-20kW: The automatic choke cycles open and closed during cranking and stays energized (choke open) during running. For low speed exercise the choke will remain closed. A plate is utilized which covers the throttle bores. When de-energized the choke is closed.

10kW: Utilize a throttle plate located in the choke housing. The choke is open when the solenoid is de-energized and closed when it is energized. Refer to Figure 131 for assembly and location.

8kW: A choke solenoid (CS), located on the air box, energizes only during cranking to assist starting. When energized the solenoid is closed.

Procedure: 10-20kW

1. Refer to Figure 131 for the 10kw location and Figures 128 and 129 for the 12-20kW Choke location and operation. Turn off the fuel supply to the generator. Set the AUTO-OFF-MANUAL switch to the MANUAL position. While cranking, the choke solenoid should pull the choke plate open cyclically. The duration of the cycle will vary depending on its position in the crank cycle sequence. Refer to Table 22 for crank durations. If the choke solenoid does not pull in, verify that the choke can be manually opened. There should be no binding or interference.

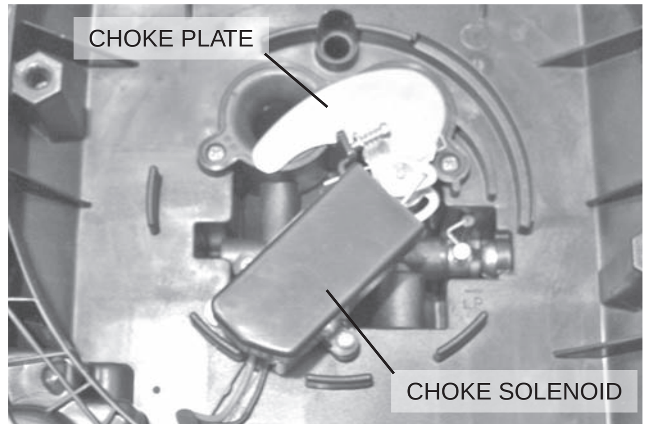


Figure 128. Solenoid De-Energized, Choke Closed 12-20kW Units

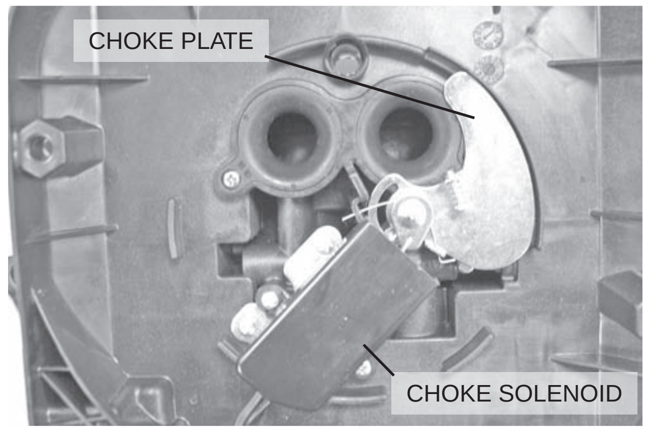


Figure 129. Solenoid Energized, Choke Open 12-20kW Units

Table 22. Crank Cycle Sequence

1=CHOKED 0=OPEN	***Note: The first second of each crank cycle is equal to two (2) revolutions of the engine.***															
	Seconds															
Crank Cycle 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
10kW	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
12 kW-20kW	0	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1
Crank Cycle 2	Seconds															
10kW	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
12 kW-20kW	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1
Crank Cycle 3	Seconds															
10kW	0	1	1	1	1	0	0									
12 kW-20kW	0	0	1	1	1	1	1									
Crank Cycle 4	Seconds															
10kW	0	1	0	0	0	0	0									
12 kW-20kW	0	1	0	0	0	0	0									
Crank Cycle 5	Seconds															
10kW	0	1	1	1	1	0	0									
12 kW-20kW	0	1	0	0	0	0	1									

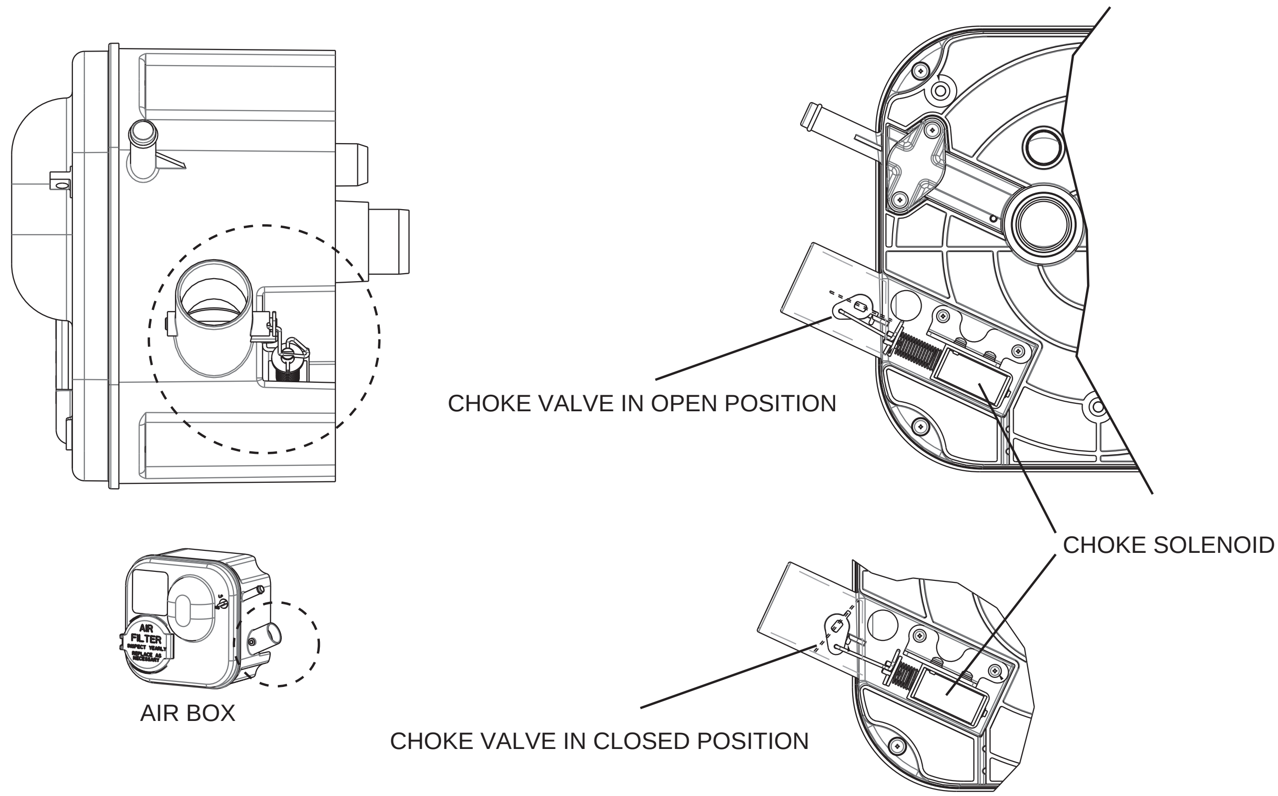


Figure 130. 8kW Choke Solenoid

2. Disconnect the choke solenoid.
3. Set a Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
4. Refer to Figure 132. Connect the positive meter test lead to Pin 1 (Wire 14) of the female side of the CS connector going to the control panel and connect the negative meter test lead to Pin 2 (Wire 90).

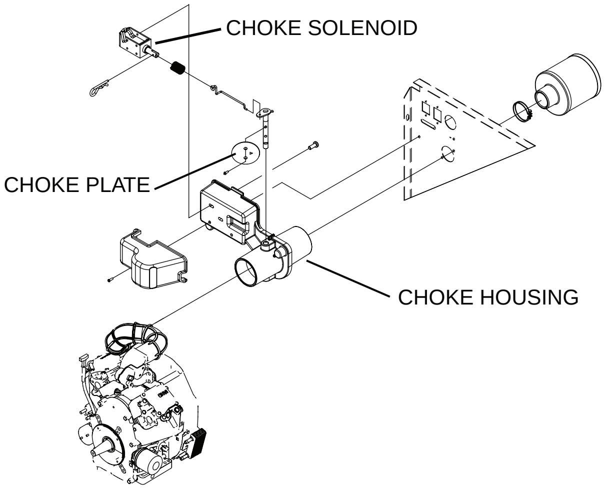


Figure 131. Exploded View Showing Location of Choke Plate - 10kW Units

5. Set the AUTO-OFF-MANUAL switch to MANUAL. While cranking, the VOM should indicate battery voltage cyclically.
   a. If the VOM did NOT indicate battery voltage, verify CONTINUITY of Wire 90 between the connector Pin 1 J4 (Wire 90) and verify CONTINUITY of Wire 14 between the connector Pin 9 J4 (Wire 14). Repair or replace any wiring as needed.
   b. If the VOM indicated a cyclical battery voltage proceed to Step 6.

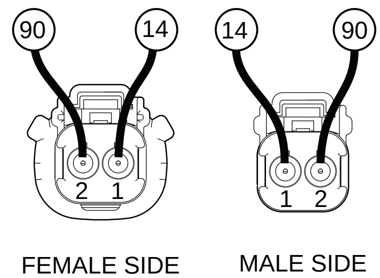


Figure 132. C3 Choke Solenoid Connector

6. Set a VOM to measure resistance.
7. Connect one meter test lead to Pin 1(Wire 14) on the male side of the CS connector and the other meter test lead to Pin 2 (Wire 90), measure and record the resistance.
8. Reconnect the choke solenoid.

9. With the generator running at a rated speed of approximately 60 Hz, verify that the choke is energized and holding the choke plate open.
10. Repeat Step 2; however, once the unit starts, manually hold the choke open while taking the voltage measurement.

Results

1. If the VOM did NOT indicate battery voltage in Step 5 and wire CONTINUITY was good, replace the controller.
2. If the VOM did NOT indicate approximately 3.7 ohms in Step 7, replace the choke solenoid.

Procedure: 8kW

1. Refer to Figure 130 for location and function of choke solenoid. Turn off the fuel supply to the generator. Set the AUTO-OFF-MANUAL switch to the MANUAL position. While cranking, the choke solenoid should pull the choke plate closed. If the choke solenoid does not pull in, verify that the choke can be manually opened. There should be no binding or interference.
2. Disconnect the choke solenoid.
3. Set a Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
4. Refer to Figure 133. Connect the positive meter test lead to Pin 1 (Wire 56) of the female side of the CS connector going to the control panel and connect the negative meter test lead to Pin 2 (Wire 90).

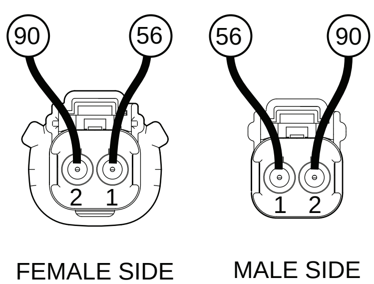


Figure 133. CS Choke Solenoid Connector

5. Set the AUTO-OFF-MANUAL switch to MANUAL. While cranking, the VOM should indicate battery voltage.
   a. If the VOM did NOT indicate battery voltage, verify CONTINUITY of Wire 90 between the connector Pin 1 J4 (Wire 90) and verify CONTINUITY of Wire 14 between the connector Pin 9 J4 (Wire 56). Repair or replace any wiring as needed.
   b. If the VOM indicated battery voltage, proceed to Step 6.
6. Set a VOM to measure resistance.
7. Connect one meter test lead to Pin 1(Wire 56) on the male side of the CS connector and the other meter test lead to Pin 2 (Wire 90), measure and record the resistance.
8. Reconnect the choke solenoid.
9. With the generator running at a rated speed of approximately 60 Hz, verify that the choke is de-energized and the choke plate is open.

Results

1. If the VOM did NOT indicate battery voltage in Step 5 and wire CONTINUITY was good, replace the controller.
2. If the VOM did NOT indicate approximately 3.7 ohms in Step 7, replace the choke solenoid.

TEST 55 – CHECK FOR IGNITION SPARK

Discussion

If the engine cranks but will not start, one cause might be that an ignition system failure has occurred. A special spark tester can be used to check for ignition spark.

Figure 134. Spark Tester

Procedure

1. Turn off the fuel supply to the generator.
2. Remove spark plug leads from the spark plugs.
3. Attach the clamp of the spark tester to the engine cylinder head. Refer to Figure 135.
4. Attach the spark plug lead to spark tester terminal.
5. Set the AUTO-OFF-MANUAL switch to the MANUAL.
6. While the engine is cranking, observe the spark tester. If spark jumps the tester gap, you may assume the engine ignition system is operating satisfactorily.

Note: The engine flywheel must rotate at 350 RPM (or higher) to obtain a good test of the solid-state ignition system.

7. To determine if an engine miss is ignition related, connect the spark tester in series with the spark plug wire and spark plug (Figure 136). Then, crank and start the engine. A spark miss will be readily apparent. If spark jumps the spark tester gap regularly, but the engine miss continues, the problem is in the spark plug or in the fuel

system.

Figure 135. Checking Ignition Spark

V-Twin Only

8. Repeat Step 1 through 7 on the second cylinder.

Note: A sheared flywheel key may change ignition timing but sparking will still occur across the spark tester gap.

Figure 136. Checking Engine Miss

Results

1. If no spark or very weak spark occurs, proceed to Test 59.
2. If spark is present and the engine still will not start, proceed to Test 57.
3. When checking for engine miss, if sparking occurs at regular intervals, but an engine miss continues, proceed to Test 57.
4. When checking for engine miss, if a spark miss is readily apparent, proceed to Test 60.

TEST 57 – CHECK CONDITION OF SPARK PLUGS

Discussion

If the engine will not start and Test 55 indicated good ignition spark, some possible causes could be fouled or damaged electrodes. An engine miss may also be caused by defective spark plug(s).

Procedure

1. Remove spark plug(s) and inspect for any visible damage, refer to Figure 137 for types of engine related spark plug problems.
2. Replace any spark plug having burned electrodes or cracked porcelain.
3. Refer to Figure 138. Using a wire feeler gauge set the gap on new or used spark plugs as per Table 23.

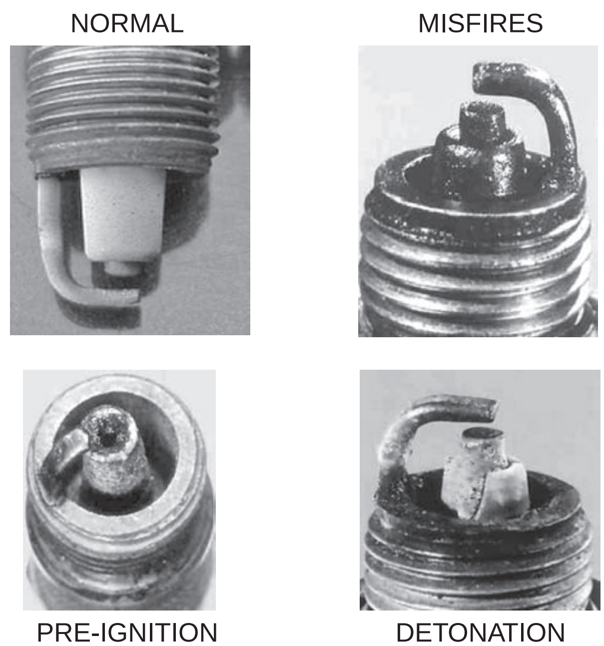


Figure 137. Spark Plug Conditions

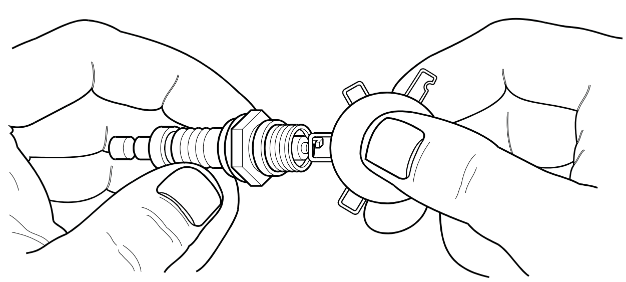


Figure 138. Checking Spark Plug Gap

Results

1. Clean, re-gap or replace plugs as necessary, re-test.
2. If spark plugs are good, refer back to flow chart.

Table 23.

Engine Size	kW Rating	Plug Gap	Recommended Plug	Manufacture
410 cc	8	0.030 inch	RC14YC	Champion
530 cc	10	0.030 inch	BPR6HS	NGK
990 cc	12-17	0.040 inch	RC14YC	Champion
999 cc	20	0.030 inch	RC12YC	Champion

TEST 58 – CHECK ENGINE / CYLINDER LEAK DOWN TEST / COMPRESSION TEST

Introduction

Performing the following test procedures will accurately diagnose some of the most common problems:

- Will not start
- Lack of power
- Runs Rough
- Vibration
- Overheating
- High Oil Consumption

CYLINDER LEAK DOWN TEST

Discussion

The Cylinder Leak Down Tester checks the sealing (compression) ability of the engine by measuring air leakage from the combustion chamber. Compression loss can present many different symptoms. This test is designed to detect the section of the engine where the fault lies before disassembling the engine. Figure 139 represents a standard Tester available on the market.

Note: Refer to Manufactures instructions for variations of this procedure.

Procedure

1. Remove the spark plug from the front cylinder.
2. Gain access to the flywheel. Remove the valve cover.
3. Rotate the engine crankshaft until the piston reaches top dead center (TDC). In this position, both the intake and exhaust valves will be closed. If the engine is not properly position at TDC the results of the test may be inaccurate at diagnosing a problem.

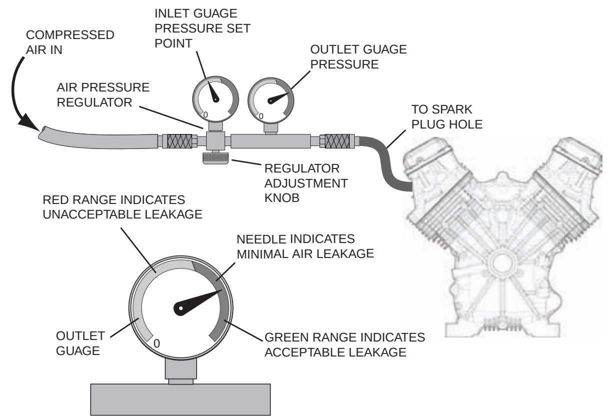


Figure 139. Cylinder Leakdown Tester

4. Lock the flywheel at top dead center.
5. Attach cylinder leak down tester adapter to spark plug hole.
6. Connect an air source of 90 PSI to the cylinder leak down tester.
7. Adjust the regulated pressure on the gauge to 80 PSI.
8. Read the right hand gauge on the tester for cylinder pressure. A leakage of 20 percent is normally acceptable. Use good judgment, and listen for air escaping at the carburetor (air intake), the exhaust, and the crankcase breather. This will determine where the fault lies.
9. Repeat Step 1 through 8 on remaining cylinder.

Results

- Air escapes at the carburetor (air intake)– check intake valve
- Air escapes through the exhaust – check exhaust valve
- Air escapes through the breather – check piston rings
- Air escapes from the cylinder head – the head gasket should be replaced.

CHECK COMPRESSION

Discussion

Lost or reduced engine compression can result in a failure of the engine to start, or a rough operation. One or more of the following will usually cause loss of compression:

- Blown or leaking cylinder head gasket
- Improperly seated or sticking-valves
- Worn piston rings or cylinder. (This will also result in a high oil consumption)

For single cylinder engines, the minimum allowable compression pressure for a cold engine is 60 PSI. Compression values are difficult to obtain accurately without special equipment. For this reason, compression values are not published for the larger engines. However, testing has proven that an accurate indication of compression in the cylinder can be obtained by using the following procedure.

Note: Refer to Manufactures instructions for variations of this procedure.

Procedure

1. Remove both spark plugs.
2. Insert a compression gauge into either cylinder.
3. Crank the engine until there is no further increase in pressure.
4. Record the highest reading obtained.
5. Repeat the procedure for the remaining cylinder and record the highest reading.

Results

The difference in pressure between the two cylinders should not exceed 25 percent. If the difference in compression is greater that 25 percent, loss of compression in the lowest reading cylinder is indicated.

Example 1: *If the pressure reading of cylinder #1 is 165 PSI and of cylinder #2 is 160 PSI. The difference is 5 PSI. Divide "5" by the highest reading (165) to obtain the percentage of 3.0 percent.*

Example 2: *If the pressure reading of cylinder #1 is 160 PSI and of cylinder #2 is 100 PSI. The difference is 60 PSI. Divide "60" by the highest reading (160) to obtain the percentage of 37.5 percent. Loss of compression in No. 2 cylinder is indicated.*

If compression is poor, look for one or more of the following causes:

- Loose cylinder head bolts
- Failed cylinder head gasket
- Burned valves or valve seats
- Insufficient valve clearance
- Warped cylinder head
- Warped valve stem
- Worn or broken piston ring(s)
- Worn or damaged cylinder bore
- Broken connecting rod
- Worn valve seats or valves
- Worn valve guides

TEST 59 – CHECK SHUTDOWN WIRE

Discussion

The controller uses Wire 18 for two purposes: first, to measure engine RPM; second to shutdown the engine. The controller's logic during a shutdown will apply a ground to Wire 18. Wire 18 is connected to the Ignition Magneto(s). The grounded magneto will not be able to produce spark.

Procedure

1. On V-twin generators, (refer to Figure 140) remove Wire 18 from the stud located above the oil cooler. On single cylinder generators, (refer to Figure 141) disconnect Wire 18 at the bullet connector.

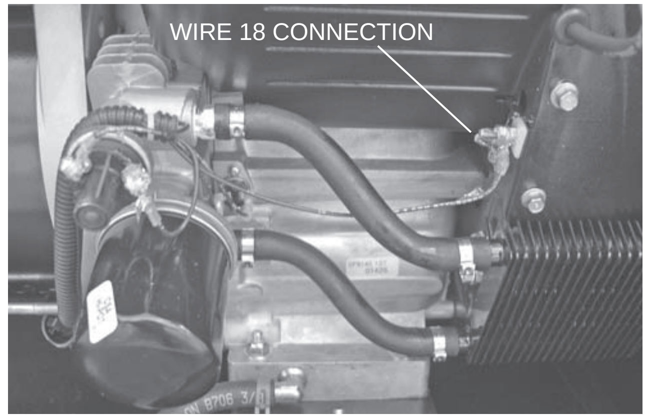


Figure 140. Wire 18 Connection 10-20kW Units

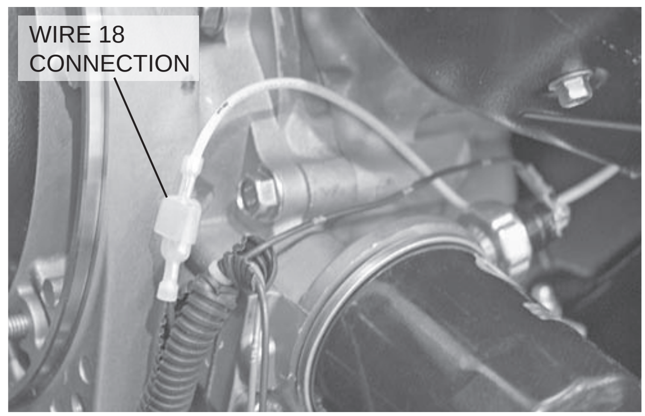


Figure 141. Wire 18 Connection 8kW Units

2. Depending on engine type, do the following:
   a. On V-twin units, remove Wire 56 from the starter contactor relay (SCR). Utilizing a jumper wire, jump 12 VDC from the positive battery terminal to the terminal on the SCR from which Wire 56 was removed. The generator will start cranking. As it is cranking, repeat Test 55 – "Check for Ignition Spark." Reconnect Wire 56 when done.
   b. On single cylinder units, connect a jumper wire from the stud to which Wire 56 is connected on the starter contactor (SC) and 12 VDC from the positive battery terminal. The generator will start cranking. As it is cranking, repeat Test 55.
3. With Wire 18 removed, if spark is now present, proceed to check for a short to ground (Steps 4 through 7).
4. Disconnect the J4 connector from the controller.
5. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
6. Connect one meter test lead to Wire 18 (disconnected in Step 1) and connect the other meter test lead to a clean frame ground, measure and record the resistance.
7. Reconnect disconnected wires and connectors.

Results

1. If the VOM indicated CONTINUITY to ground in Step 6, repair or replace shorted ground Wire 18 between the engine and the J4 connector.
2. If the VOM did NOT indicate CONTINUITY to ground in Step 6, replace the control board and re-test for spark.
3. If ignition (spark) was not present in Step 2 with Wire 18 disconnected, proceed to Test 60.

TEST 60 – CHECK AND ADJUST IGNITION MAGNETOS

Discussion

In Test 55, a spark tester was used to check for engine ignition. If sparking or weak spark occurred, one possible cause might be the ignition magneto(s). This test consists of checking ohm values across the primary and secondary windings of the magneto and adjusting the air gap between the ignition magneto(s) and the flywheel. The flywheel and flywheel key will also be checked during this test. A diode is installed before the primary winding inside the coil. This is done to inhibit a spark occurring on both magnetos at the same time.

Procedure: Testing Magnetos

1. On V-twin generators, (refer to Figure 140) remove Wire 18 from the stud located above the oil cooler. On single cylinder generators, (refer to Figure 141) disconnect Wire 18 at the bullet connector.
2. Disconnect spark plug wires from the spark plugs on cylinder one and two.
3. Set VOM to measure resistance.
4. Connect the positive (red) meter lead to the bolt connector where Wire 18 was disconnected in Step 1. Connect the negative (black) meter lead to a clean frame ground. A resistance of approximately 300K ±10K Ohms should be measured. This reading is the primary winding of both coils in parallel.
5. Connect the positive meter lead to the spark plug wire and connect the negative meter lead to a clean frame ground. Approximately 14K ±3 Ohms should be measured. This reading is the secondary winding of both coils in parallel. If INFINITY, or a low or high ohm reading is measured, replace the magnetos.
6. Connect the negative (black) meter lead to the bolt connector where Wire 18 was disconnected in Step 1. Connect the positive (red) meter lead to the spark plug wire on cylinder number two. The meter should indicate INFINITY (open). This step is testing the diodes in both magnetos to ensure they are still functioning.
7. Repeat Step 6 on cylinder two. If INFINITY (open) is not measured, replace the magnetos.

Note: It is recommended to replace Magnetos in pairs.

Procedure: Adjusting Magneto Flywheel Gap

Note: The air gap between the ignition magneto and the flywheel on single cylinder engines is not adjustable. Proceed directly to Step 10 for single cylinder engines. For V-twin engines, proceed as follows.

1. See Figure 142. Rotate the flywheel (by hand) until the magnet is under the module (armature) laminations.
2. Place a 0.008-0.012 inch (0.20-0.30mm) thickness gauge between the flywheel magnet and the module laminations.

Note: A business card is approximately 0.010 inch thick.

3. Loosen the mounting screws and let the magnet pull the magneto down against the thickness gauge.
4. Tighten both mounting screws.
5. To remove the thickness gauge, rotate the flywheel (manually).
6. Repeat the above procedure for the second magneto.

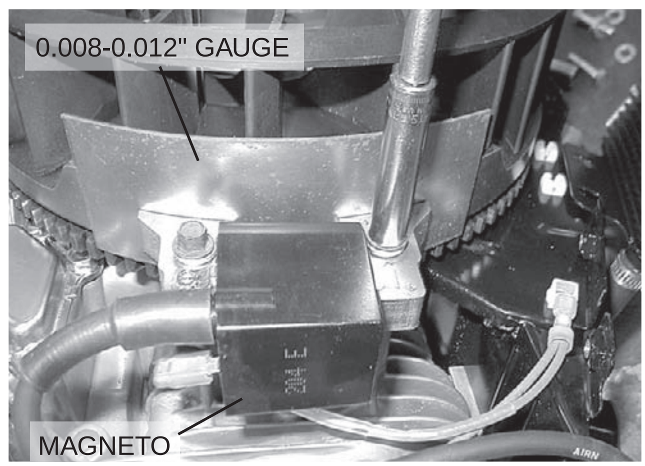


Figure 142. Setting Ignition Magneto (Armature) Air Gap

7. Repeat Test 55 and check for spark across the spark tester gap.
   a. A spark test may be conducted with unit dissembled by following this procedure.
   b. Battery must be connected.
   c. J4 Connector must be connected to the controller.
   d. Remove Wire 56 from the SCR located beneath the controller.

⚠ WARNING!

Make sure all debris is cleared from the engine compartment and all body parts are clear from flywheel before proceeding.

   e. Refer to Test 55 to check for spark.
   f. Utilizing a jumper wire, connect a wire to the 194 terminal block. Connect the other end to where Wire 56

was disconnected in Step 7d. The engine should crank once the jumper from 194 is connected.

8. If spark was not indicated, replace magnetos.

Note: If gap is only adjusted, ensure to properly test the magnetos by cranking the engine over before reassembly occurs. Spark should be present on both cylinders before reassembly should be completed.

9. If air gap was not out of adjustment, test ground wires.
10. Set a VOM to the measure resistance.
11. Disconnect the engine wire harness from the ignition magnetos (Figure 143).
    a. On V-twin generators, remove Wire 18 from the stud located above the oil cooler. See Figure 140.
    b. On single cylinder generators, disconnect Wire 18 at the bullet connector. See Figure 141.

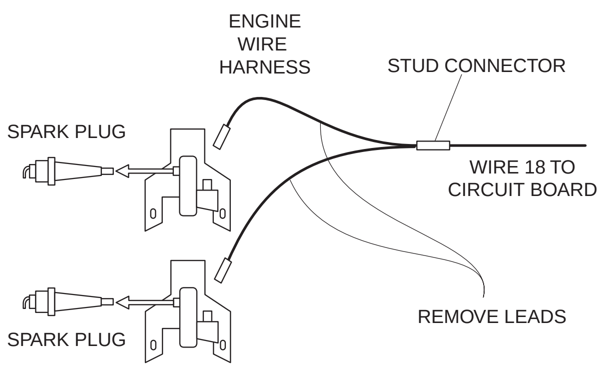


Figure 143. Engine Ground Harness

12. Connect one meter test lead to one of the wires removed from the ignition magneto(s). Connect the other test lead to frame ground. INFINITY should be measured. If CONTINUITY is measured, replace the shutdown harness.
13. Now check the flywheel magnet by holding a screwdriver at the extreme end of its handle and with its point down. When the tip of the screwdriver is moved to within 3/4 inch (19mm) of the magnet, the blade should be pulled in against the magnet.
14. For rough running or hard starting engines check the flywheel key. The flywheel's taper is locked on the crankshaft taper by the torque of the flywheel nut. A keyway is provided for alignment only and theoretically carries no load.

Note: If the flywheel key becomes sheared or even partially sheared, ignition timing can change. Incorrect timing can result in hard starting or failure to start.

15. As stated earlier, the armature air gap is fixed for single cylinder engine models and is not adjustable. Visually inspect the armature air gap and hold down bolts.

Results

If sparking still does not occur after adjusting the armature air gap, testing the ground wires and performing the basic flywheel test, replace the ignition magneto(s).

Procedure, Replacing Magnetos:

1. Follow all steps of the Major Disassembly procedures that are located in Section 6.
2. Once the magnetos are visible, make note to how they are connected.

Note: Each magneto has its own part number. Verify the part number prior to installation.

3. Cylinder one is the back cylinder (Figure 144) and cylinder two is the front cylinder (Figure 145).

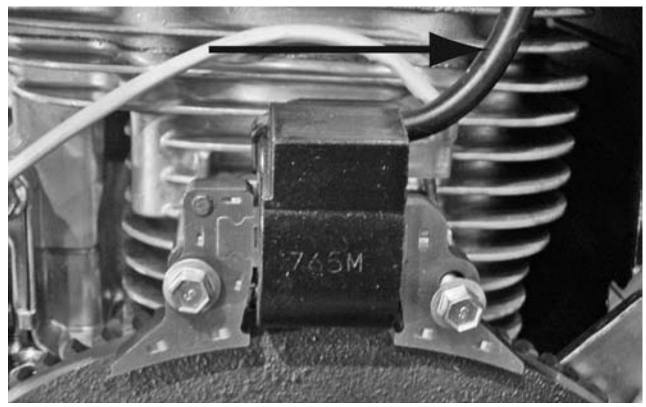


Figure 144. Cylinder One (Back, Short)

4. When installing new magnetos there will be one with a short plug wire and one with a longer plug wire (Figure 146).

Note: Magneto gap to flywheel needs to be 0.010 inch.

5. Long plug wire (B) will be installed on front cylinder (number two).
6. Short plug Wire (A) will be installed on back cylinder (number one).
7. Verify installation of magnetos correctly by ensuring both spark plug wires point to the back of the enclosure and shutdown terminals are nearest cylinder head as shown in Figures 147 and 148.

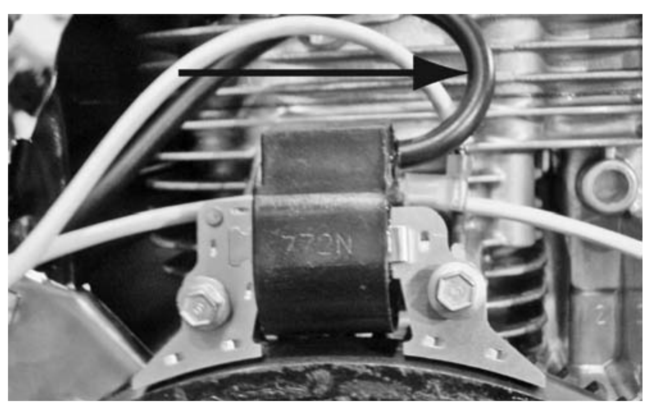


Figure 145. Cylinder Two (Front, Long)

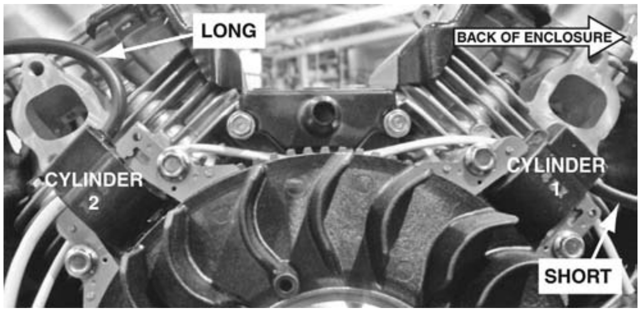


Figure 146.

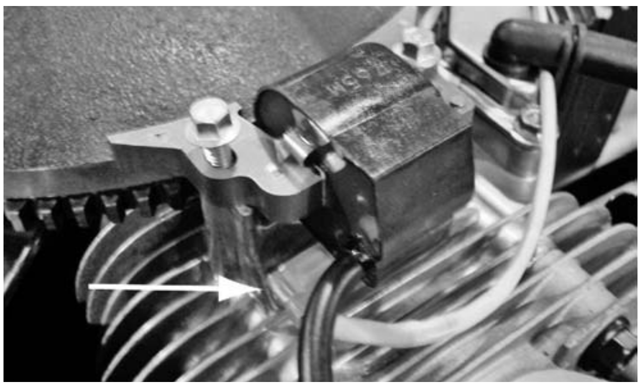


Figure 147.

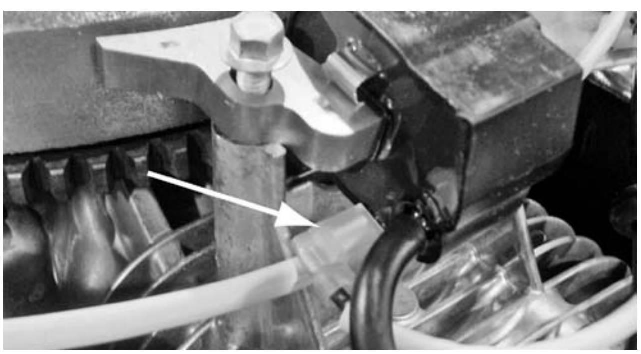


Figure 148.

TEST 61 – CHECK OIL PRESSURE SWITCH AND WIRE 86

Discussion

If the oil pressure switch contacts have failed in their closed position, the engine will crank and start, however shutdown will occur within about 5 (five) seconds. If the engine cranks and starts, then shuts down almost immediately with a Shutdown-Alarm Low Oil Pressure, the cause may be one or more of the following:

- Low engine oil level.
- Low oil pressure.
- A defective oil pressure switch.

Procedure

1. Navigate to the Digital inputs display screen.
   a. Press "ESC" until the main menu is reached.
   b. Press the right arrow key until "Debug" is flashing.
   c. Press "Enter".
   d. Press the right arrow key until "Inputs" is flashing.
   e. Press "Enter".

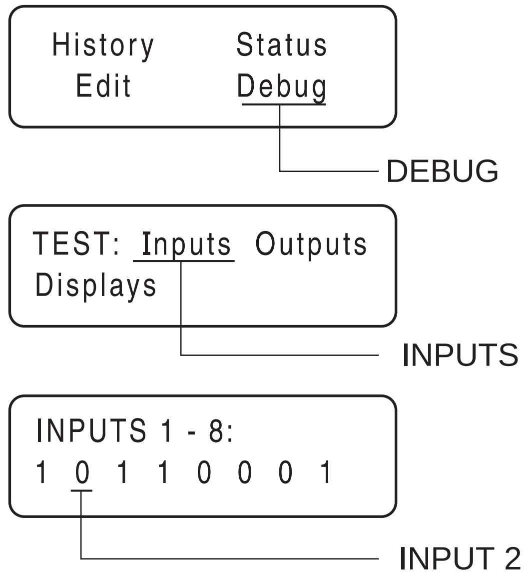


Figure 149. The Home Page, Debug and Input Screens

   f. Digital Input 2 is Wire 86 from the Low Oil Pressure switch to the board. Refer to Figure 149.
   g. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
   h. Observe Input 2 for a change from "1" to "0". A change from "1" to "0" indicates that the control board sensed the LOP switch change states. If the generator still shuts down, replace controller.
   i. If the input did change states, the oil pressure switch is good. An intermittent oil pressure problem may still be present and should be checked with a mechanical gauge as in Step 4.
2. Check engine crankcase oil level.
   a. Check engine oil level.
   b. If necessary, add the recommended oil to the dipstick FULL mark. DO NOT OVERFILL ABOVE THE FULL MARK.
3. With oil level correct, try starting the engine.
   a. If engine still cranks and starts, but then shuts down, go to Step 4.
   b. If engine cranks and runs normally, discontinue tests.
4. Do the following:
   a. Disconnect Wire 86 and Wire 0 from the oil pressure switch terminals. Remove the switch and install an oil pressure gauge in its place.

b. Start the engine while observing the oil pressure reading on the gauge.

c. Note the oil pressure.

(1) Normal oil pressure is approximately 35-40 psi with engine running. If normal oil pressure is indicated, go to Step 4 of this test.

(2) If oil pressure is below about 4.5 psi, shut engine down immediately. A problem exists in the engine lubrication system.

Note: The oil pressure switch is rated at 10 psi for V-twin engines, and 8 psi for single cylinder engines.

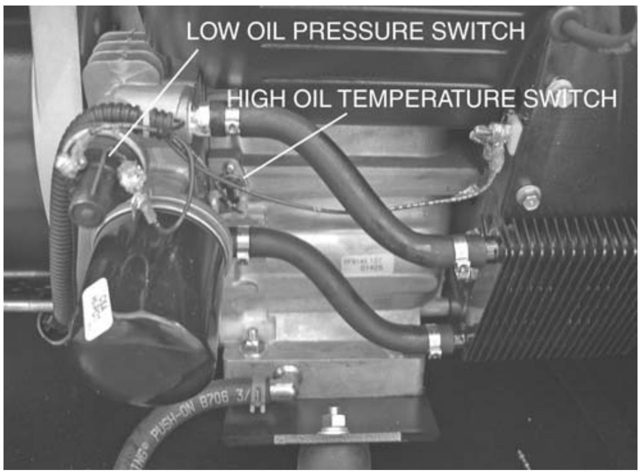


Figure 150. Oil Pressure Switch

5. Remove the oil pressure gauge and reinstall the oil pressure switch. Do NOT connect Wire 86 or Wire 0 to the switch terminals.

a. Set a VOM to measure resistance.

b. Connect the VOM test lead across the low oil pressure (LOP) switch terminals. With the engine shut down, the VOM should indicate CONTINUITY. If INFINITY was measured, replace the LOP switch.

c. With the VOM still connected to the LOP switch, set the AUTO-OFF-MANUAL switch to the MANUAL position. The VOM should indicate INFINITY once the engine has had a chance to build pressure.

6. Set the VOM to measure DC voltage.

a. Disconnect Wire 86 at the low oil pressure switch.

b. Connect the black meter test lead to a good ground, and the red meter test lead to Wire 86. Approximately 3.3 VDC should be measured.

If 3.3 VDC is not measured, go to Test 6 and check continuity on Wire 86 from the LOP switch back to the J4 connector.

7. Keep the VOM set to measure resistance.

a. Disconnect the J4 Connector from the controller and disconnect Wire 86 and Wire 0 from the LOP switch.

b. Connect one meter test lead to the disconnected Wire 86 and connect the other meter test lead to J4 Pin 13 (Wire 86). The VOM should indicate CONTINUITY. If CONTINUITY was not measured repair or replace Wire 86 between the LOP switch and the J5 connector.

c. With Wire 86 still disconnected from the LOP switch and the J4 connector, connect one meter test lead to disconnected Wire 86 and the other meter test lead to a clean frame ground. The VOM should indicate INFINITY. If CONTINUITY was measured a short to ground exists on Wire 86. Repair or replace as needed.

Results

1. If the switch operated properly and proper oil pressure was measured, and Wires 86 and 0 tested good, and/or the Input would not change on the controller, replace the controller.

TEST 62 – CHECK HIGH OIL TEMPERATURE SWITCH

Discussion

If the temperature switch contacts have failed in a closed position, the engine will fault out on "OVERTEMP". If the unit is in an overheated condition, the switch contacts will close at 293° F. This will normally occur from inadequate airflow through the generator.

Procedure

1. Verify that the engine has cooled down (engine block is cool to the touch). This will allow the contacts in the High Oil Temperature Switch to open.

2. Check the installation and area surrounding the generator. There should be at least three feet of clear area around the entire unit. Make sure that there are no obstructions preventing cooling air from entering or exiting the enclosure.

3. Disconnect Wire 85 and Wire 0 from the High Oil Temperature Switch.

4. Set a VOM to measure resistance. Connect the test leads across the switch terminals. The meter should read INFINITY (0L).

5. If the switch tested good in Step 4, and a true overtemperature condition has not occurred, check Wire 85 for a short to ground. Remove J1 Connector from the circuit board. Set the VOM to measure resistance. Connect one test lead to Wire 85 (disconnected from High Oil Temperature Switch). Connect the other test lead to a clean frame ground. INFINITY should be measured.

Testing High Oil Temperature Switch

6. Remove the High Oil Temperature Switch.

7. Immerse the sensing tip of the switch in oil as shown in Figure 151, along with a suitable thermometer.

8. Set a VOM to measure resistance. Then, connect the VOM

test leads across the switch terminal and the switch body. The meter should read INFINITY.

9. Heat the oil in the container. When the thermometer reads approximately 283°-305° F. (139°-151° C.), the VOM should indicate CONTINUITY.

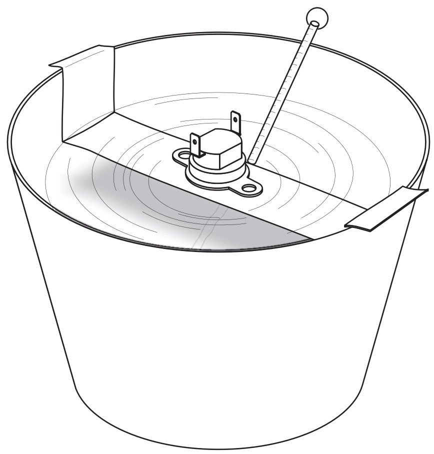


Figure 151. Testing the Oil Temperature Switch

Results

1. If the switch fails Step 4, or Steps 8-9, replace the switch.
2. If INFINITY was NOT measured in Step 5, repair or replace Wire 85 between the Circuit Board and the High Oil Temperature Switch.

TEST 63 – CHECK AND ADJUST VALVES

Discussion

Improperly adjusted valves can cause various engine related problems including, but not limited to, hard starting, rough running and lack of power. The valve adjustment procedure for both the single cylinder and the V-twin engines is the same.

Procedure: Intake and Exhaust

Make sure that the piston is at Top Dead Center (TDC) of it's compression stroke (both valves closed). The valve clearance should be 0.05-0.1mm (0.002-0.004 in.) cold.

Check and adjust the valve to rocker arm clearance as follows:

1. Remove the four (4) screws from the rocker cover.
2. Remove the rocker cover and rocker cover gasket.
3. Loosen the rocker arm jam nut. Use a 10mm allen wrench to turn the pivot ball stud and check the clearance between the rocker arm and the valve stem with a flat feeler gauge (see Figure 152).
4. When the valve clearance is correct, hold the pivot ball stud with the allen wrench and tighten the rocker arm jam nut. Torque the jam nut to 174 inch pounds. After tightening the jam nut, recheck the valve clearance to make sure it did not change.
5. Re-install the rocker cover gasket, rocker cover and the four (4) screws.

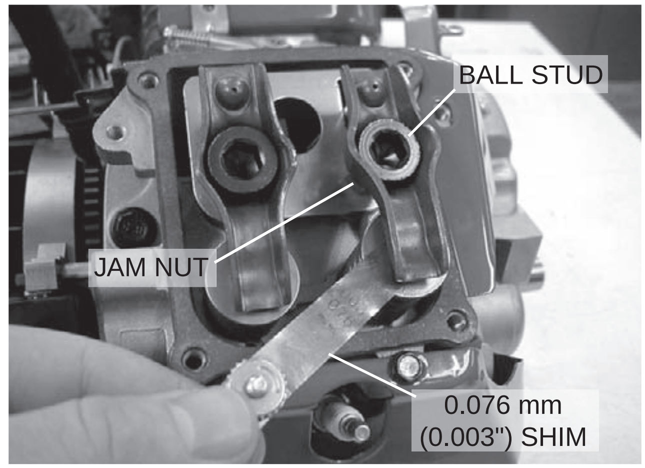


Figure 152.

Results

Adjust valve clearance as necessary, then retest.

TEST 64 – CHECK WIRE 18 CONTINUITY

Discussion

During cranking and running, the controller receives a pulse from the ignition magnetos via Wire 18. This signal has an AC voltage of 4-6 Volts on V-twin engines only. If the controller does not receive this signal, the unit will shut down due to no RPM sensing.

Procedure: V-Twin Engine

1. Set the Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. Connect one meter test lead to Wire 18 at the stud connector shown in Figure 140 and connect the other meter test lead to a clean frame ground.
3. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
4. Once the Generator has reached its rated speed, measure and record the voltage.
   a. If the VOM indicated approximately 4 to 12VAC, proceed to Step 5
   b. If the VOM did NOT indicate the appropriate voltage, refer back to flow chart.
5. Set the VOM to measure resistance.

6. Disconnect the J4 connector from the controller.
7. Connect one meter test lead to a clean frame ground and connect the other meter test lead to J4 Pin 16 (Wire 18).
   a. If the VOM indicated a low resistance (.01), check for a short to ground in the Wire 18 circuit.
   b. If the VOM indicated approximately 275K-325k ohms of resistance proceed to Step 8.
8. Disconnect Wire 18 from the stud connector. Leave the J4 connector disconnected.
9. Connect one meter test lead to Wire 18 removed from the stud connector and the other meter test lead to a clean frame ground, measure and record the resistance.
   a. If the VOM indicated CONTINUITY, repair or replace Wire 18 between the stud connector and the J4 connector.
   b. If the VOM indicated INFINITY, refer back to the flow chart.

Procedure: Single Cylinder Engine

1. Set the Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 18 from the bullet connector (Refer to Figure 141).
3. Disconnect the J4 connector from the controller.
4. Connect one meter test lead to Wire 18 removed from the bullet connector (female side) and connect the other meter test lead to J4 Pin 16 (Wire 18).
   a. If the VOM indicated CONTINUITY, repair or replace Wire 18 between the stud connector and the J4 connector.
   b. If the VOM indicated INFINITY, refer back to the flow chart.

TEST 65 – TEST EXERCISE FUNCTION

Discussion

The following parameters must be met in order for the weekly exercise to occur:

- Exercise Time set in controller and AUTO-OFF-MANUAL switch set to AUTO

Procedure: 8kW-14kW

Note: Make a record of the date and time the generator is set to exercise.

1. Record the current date and time of the unit.
2. Press the "ESC" key until the main menu is displayed.
3. Press the right arrow key until "EDIT" starts to flash.
4. Press "Enter".
5. Press the right arrow key until "EXERCISE TIME/DAY" is displayed.
6. Press "Enter".
7. Adjust exercise time to 5 minutes ahead of the date and time noted in Step 1.
8. Press "ESC" until "READY TO RUN" is displayed. The AUTO-OFF-MANUAL switch must be in AUTO for the unit to exercise.
9. Watch the generator display and note the time. When the date and time reaches the time that was programmed for exercise, the unit will display "Running in Exercise" if the exercise feature is working properly.

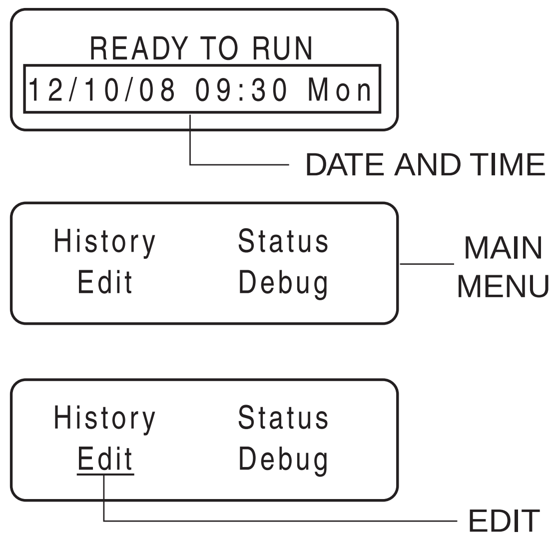


Figure 153. The Date and Time, and Main Menu Screens

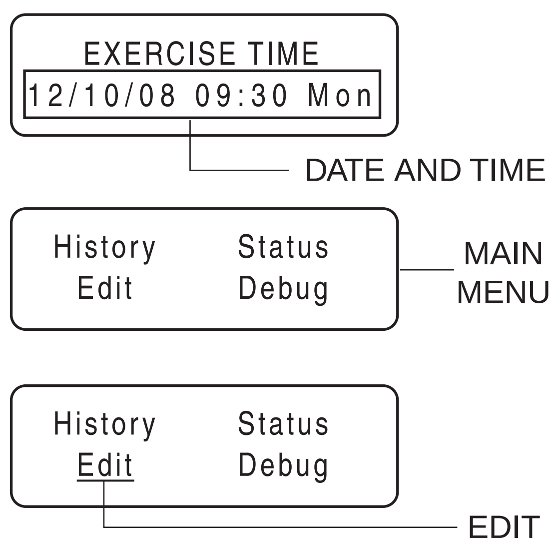


Figure 154. The Date and Time, and Main Menu Screens

Procedure: 17kW-20kW

1. Set the AUTO-OFF-MANUAL switch to the MANUAL position.
2. Press the "ESC" key until the main menu is displayed.

3. Press the right arrow key until "Debug" begins to flash.
4. Press "Enter."
5. Press the right arrow key until "QT Test" beings to flash.
6. Press "Enter."
7. The generator should start and run its normal exercise period.

Results

1. In all models, if the unit starts in MANUAL, but fails to exercise without any ALARMS present, replace the controller.

TEST 66 – TEST CRANKING AND RUNNING CIRCUITS

Discussion

This test will check all of the circuits that are "Hot" with battery voltage and which could cause the Main Fuse to blow. Refer to Table 24 throughout the procedure for the known resistance values of components.

Figure 155 shows the Volt-Ohm-Milliammeter (VOM) in two different states. The left VOM indicates an OPEN circuit or INFINITY. The right VOM indicates a dead short or CONTINUITY. Throughout the troubleshooting, refer back to Figure 155 as needed to understand what the meter is indicating about the particular circuit that was tested.

Note: CONTINUITY is equal to .01 ohms of resistance or a dead short.

Table 24. Components Resistance Values

Starter Contactor	8Ω
Starter Contactor Relay	155Ω
Main Fuel Solenoid	16Ω
10kW Fuel Solenoid 2	7Ω
Transfer Relay	90Ω
Choke Solenoid	4Ω

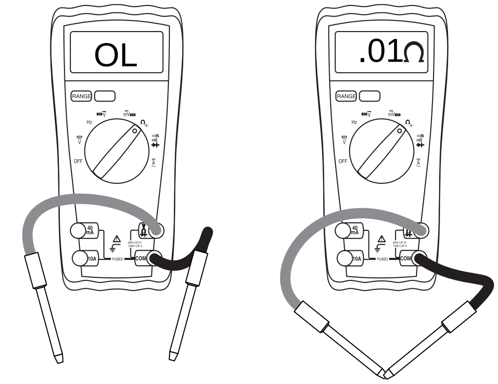


Figure 155.

Procedure

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect the J4 connector from the controller.
3. Connect one meter lead to a clean frame ground and connect the other meter test lead to each of the following tests points in Table 25, measure and record the resistance.

Table 26 has been provided to record the results of this test. Additional copies of this table can be found in Appendix A "Supplemental Worksheets" at the back of this manual.

Table 25. Resistance Measurements

Test Point	Pin Location	Circuit	8kW	10kW-20kW
1	J4 Pin 9	Wire 14	16Ω	16Ω
2	J4 Pin 17	Wire 56	4Ω	155Ω
3	J4 Pin 19	Wire 194	OPEN	OPEN

Results

1. Compare the results of Step 3 with Table 25 according to the different kW range.
   a. If the VOM indicated CONTINUITY at Test Point 1 proceed to Test 67
   b. If the VOM indicated CONTINUITY at Test Point 2 proceed to Test 68
   c. If the VOM indicated CONTINUITY at Test Point 3 proceed to Test 69
   d. If the VOM indicated proper resistance values at all Test Points, replace the controller

Table 26. Test 66 Results

Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

TEST 67 – TEST RUN CIRCUIT

Discussion

Wire 14 provides 12 VDC during cranking and running. If the VOM indicated CONTINUITY in the previous test, one of the possible causes could be a faulty relay or solenoid.

Procedure: 8kW

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 14 from the fuel solenoid (FS)
3. Connect one meter test lead to the FS terminal from which Wire 14 was removed. Connect the other meter

test lead to the ground terminal, measure and record the resistance.

Results

1. If the VOM indicated 16 ohms of resistance in Step 3, a short to ground exists on Wire 14 between the FS and the J4 connector. Repair and replace as needed.
2. If the VOM indicated CONTINUITY in Step 3, replace the FS

Procedure: 10kW

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 14 from the fuel solenoid (FS), fuel solenoid 2 (FS2), and the choke solenoid (CS).
3. Connect one meter test lead to the FS terminal from which Wire 14 was removed. Connect the other meter test lead to the ground terminal, measure and record the resistance.
4. Connect one meter test lead to the FS2 terminal from which Wire 14 was removed. Connect the other meter test lead to the ground terminal, measure and record the resistance.
5. Refer to Figure 156 in reference to the CS connector. Connect one meter test lead to Pin 1 and the other meter test lead to Pin 2, measure and record the resistance.

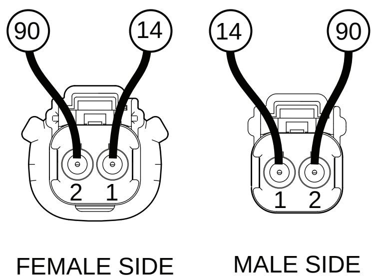


Figure 156. C3 Choke Solenoid Connector

Results

1. If the VOM indicated CONTINUITY in Step 3, replace the FS solenoid.
2. If the VOM indicated CONTINUITY in Step 4, replace the FS2 solenoid
3. If the VOM indicated CONTINUITY in Step 5, replace the CS solenoid.
4. Refer to Table 24 and if the VOM indicated the correct resistance for the component, a short to ground exists on Wire 14. Repair or replace Wire 14 as needed.

Procedure: 12kW-20kW

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 14 from the fuel solenoid (FS) and the choke solenoid (CS).
3. Connect one meter test lead to the FS terminal from which Wire 14 was removed. Connect the other meter test lead to the ground terminal, measure and record the resistance.
4. Refer to Figure 156 in reference to the CS connector. Connect one meter test lead to Pin 1 and the other meter test lead to Pin 2, measure and record the resistance.

Results

1. If the VOM indicated CONTINUITY in Step 3, replace the FS solenoid.
2. If the VOM indicated CONTINUITY in Step 4, replace the CS solenoid.
3. Refer to Table 24 and if the VOM indicated the correct resistance for the component, a short to ground exists on Wire 14. Repair and replace Wire 14 as needed.

TEST 68 – TEST CRANK CIRCUIT

Discussion

Wire 56 provides 12 VDC during cranking only. If the VOM indicated CONTINUITY in the previous test, one of the possible causes could be a faulty relay or solenoid.

Procedure: 8kW

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 56 from the starter contactor (SC) and disconnect the choke solenoid (CS)
3. Connect one meter test lead to the SC terminal from which Wire 56 was removed. Connect the other meter test lead to the ground terminal, measure and record the resistance.
4. Refer to Figure 157 in reference to the CS connector. Connect one meter test lead to Pin 1 and the other meter test lead to Pin 2, measure and record the resistance.

Results

1. If the VOM indicated 4 ohms of resistance in Step 3, a short to ground exists on Wire 56 between the SC and the J4 connector. Repair or replace as needed.
2. If the VOM indicated CONTINUITY in Step 3, replace the SC

Procedure: 10kW-20kW

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.

2. Disconnect Wire 56 and 0 from the starter contactor relay (SCR).
3. Connect one meter test lead to the SCR terminal from which Wire 56 was removed. Connect the other meter test lead to the terminal from which Wire 0 was removed, measure and record the resistance.
4. Refer to Figure 157 in reference to the CS connector. Connect one meter test lead to Pin 1 and the other meter test lead to Pin 2, measure and record the resistance.

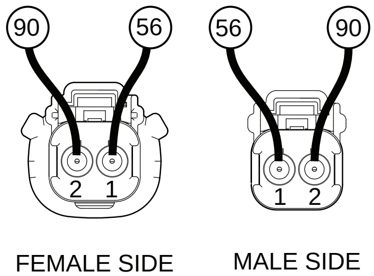


Figure 157. CS Choke Solenoid Connector

Results

1. If the VOM indicated CONTINUITY in Step 3, replace the SCR relay.
2. If the VOM indicated CONTINUITY in Step 4, replace the CS solenoid.
3. Refer to Table 24. If the VOM indicated the correct resistance for the component, a short to ground exists on Wire 56. Repair and replace Wire 56 as needed.

TEST 69 – TEST TRANSFER RELAY CIRCUIT

Discussion

Wire 194 provides 12 VDC for the transfer relay (TR1). If the VOM indicated CONTINUITY in the previous test, one of the possible causes could be a faulty relay.

Procedure

1. Set a Volt-Ohm-Milliammeter (VOM) to measure resistance.
2. Disconnect Wire 194 and 23 from TR1 relay located inside the transfer switch.
3. Connect one meter test lead to terminal “A” on the relay and connect the other meter test lead to terminal “B”, measure and record the resistance.

Results

1. If the VOM did not indicate 120 ohms of resistance in Step 3, a short to ground exists on Wire 194 between the TR1 relay and the J4 connector. Repair and replace as needed.
2. If the VOM indicated CONTINUITY in Step 3, replace the TR1 relay.

TEST 70 – CHECK TO SEE IF LOW SPEED FUNCTION IS ENABLED

Discussion

The Low speed exercise function when it is enabled allows the generator to exercise at 2400 rpm. If it is disabled it will exercise at its 3600 rpm during exercise.

Procedure

1. Press the “ESC” key till the main menu is reached.
2. Press the right arrow key until “Edit” is flashing.
3. Press “Enter”
4. Press the right arrow key until “Exercise Time” appears on the controller.
5. Press “Enter”.
6. Press the right arrow key until the Low speed exercise option is displayed.
7. Ensure that it is enabled.

Results

Refer back to flow chart.

TEST 71 – CHECK OPERATION OF THE CHOKE SOLENOID

Discussion

The choke solenoid should be closed when it is in low speed exercise.

Procedure

1. Remove the air box cover and filter from the engine.
2. Refer to test 65 for Test Exercise Function.
3. When the generator starts and the display reflects that it is exercising, confirm that the choke solenoid is fully closed over one port.

Results

1. If the solenoid did not close, confirm that utility voltage is present. If the generator believes that there is a power outage it will run at full speed until utility is returned.
2. If the solenoid did not close during low speed (quiet test) exercise, and Utility power was available, refer back to Test 53.

TEST 75 – TEST 120 VOLT INPUT (T1)

Discussion

The controller requires 120 VAC supplied from the LOAD side of the CONTACTOR in the transfer switch to function properly. When the circuit is supplied to the controller it will allow the controller to remain ON, but in a disabled mode where it will not crank or function properly.

Procedure

Note: "Inspect Battery" alarm may appear while performing this test procedure. Ignore this alarm, it is a symptom of the test procedure.

1. Locate the 7.5 amp fuse on the controller.
2. Remove the fuse and observe the LCD screen.

Results

1. If the controller remained illuminated or continued to show its status after the fuse was removed, the 120 VAC input is good.
2. If the controller powered down when the fuse was removed, the controller is not getting the 120 VAC input. Return to the flow chart (Test 79).

TEST 76 – VERIFY DC VOLTAGE OUTPUT OF THE CONTROLLER

Discussion

The battery voltage of the unit can be viewed within the "Status" menu of the controller. This test procedure will verify battery voltage connections to the controller.

Procedure

1. Navigate to the "Battery Voltage" menu in the controller.
   a. Press "ESC" until the main menu screen is present
   b. Press the right arrow key until "Status" is flashing. Press Enter.
   c. Press the right arrow key until "Display" is flashing. Press Enter.
   d. Press the right arrow key until "Battery Voltage" displays. Press Enter.
2. Record the displayed voltage.

Results

1. If the battery voltage indicated on the display is greater than 12 VDC, the connections to the controller from the battery are good. Refer back to flow chart.
2. If the battery voltage indicated on the display is 0 VDC, the connections to the controller are bad. Refer back to flow chart.
3. If the battery voltage indicated on the display is between 1 VDC to 11VDC, charge or replace the battery.

TEST 77 – CHECK WIRE 13 AND WIRE 0

Discussion

The previous test indicated that battery voltage was not available to the controller and it was operating only off of the 120 VAC input from T1.

Procedure

1. Set Volt-Ohm-Milliammeter (VOM) to measure DC voltage.
2. Remove the 7.5 Amp fuse from the controller.
3. Connect one meter lead to the left side of the fuse holder where the fuse was previously connected. Connect the other meter test lead to a clean frame ground. Measure and record the voltage.
4. Disconnect the J4 connector from the controller.
5. Connect one meter test lead to J4 Pin 3 (Wire 13) and the other meter test lead to J4 Pin 2 (Wire 0). Measure and record the voltage.

Results

1. If the VOM indicated battery voltage in Steps 3 and 5, replace the controller.
2. If the VOM indicated battery voltage in Step 3, but did NOT indicate battery voltage in Step 5, replace or replace Wire 0 between the J4 connector and the ground stud.

TEST 78 – TEST DC CHARGE CURRENT TO THE BATTERY

Discussion

Previous testing has verified the 120 VAC input connection and the battery connection. This test procedure will determine if there is a negative draw on the battery or a positive one, which will indicate successful operation of the charger.

Procedure

Note: An "Inspect Battery" alert may be generated during this test procedure. It will not effect the results of the test and can be acknowledged when testing is complete.

1. Set the AUTO-OFF-MANUAL switch to the MANUAL position and crank the engine for 2 -3 seconds.
2. Disconnect the negative cable battery.
3. Set the Volt-Ohm-Milliammeter (VOM) to measure DC amperage.

Note: Consult the meters owner's manual to ensure proper setup of meter and that the internal fuse is good before proceeding.

3. Connect the positive (red) meter test lead to the negative battery post and connect the negative (black) meter test lead to disconnected negative battery cable. Measure and record the amperage.

Results

1. If the VOM indicated positive DC amperage between 50 milliamps to 2.5 amps, stop testing. The charger is functioning properly.
2. If the VOM indicated negative DC amperage, replace the controller.

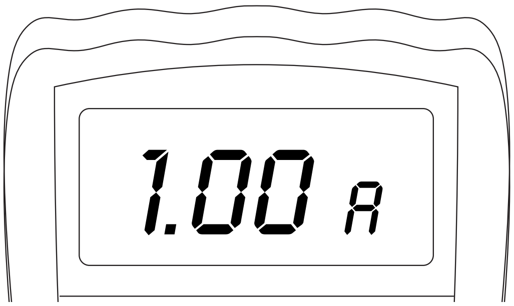


Figure 158. Positive DC Amps

Figure 159. Negative DC Amps

TEST 79 – CHECK T1 VOLTAGE AT CUSTOMER CONNECTIONS

Procedure

1. Set a Volt-Ohm-Milliammeter (VOM) to measure AC Voltage.
2. Connect one meter test lead to the T1 Terminal block at the customer connections in the generator. Connect the other meter test lead to the NEUTRAL connection. Measure and record the voltage.

Results

1. If the VOM indicated 120 VAC, proceed to check voltage at the J5 connector, refer back to flow chart.
2. If the VOM indicated less than 120 VAC or 0, refer back to flow chart.

TEST 80 – CHECK T1 VOLTAGE AT J5 CONNECTOR

If 120 VAC was available at T1 and neutral of the customer connection block, the problem may be an open wire or bad connector at the J5 connection.

Procedure

1. Disconnect the J5 connector at the control panel.
2. With the VOM set for AC voltage, check the voltage at the J5 connector between Pin 2 (T1) and the neutral connection of the customer connection block. If Voltage is present, proceed to Step 3. If voltage is not present check the T1 wire from the customer connection block to the J5 connector.
3. Check the voltage between Pin 3 (00) of the J5 connector and the T1 at the customer connection block. If voltage is present inspect and repair the connection pins at Pins 2 and 3 of the J5 connector. If voltage is not available, check the 00 wire from the customer connection block to the J5 connector.
4. If 120VAC is present between Pins 2 and 3 of the J5 connector, and the pins are in good condition, then the fault lies in the controller itself. Replace the controller.

TEST 81 – CHECK T1 VOLTAGE IN TRANSFER SWITCH

Discussion

If 120 VAC was not present in the Generator; the most likely cause is a blown T1 fuse or an open wire.

Procedure

1. Set the VOM to measure AC voltage.
2. Connect one meter test lead to the bottom side of the T1 fuse holder and the other meter test lead to the NEUTRAL connection. Measure and record the voltage.

Results

1. If the VOM indicated 120 VAC, repair or replace Wire T1 between the Generator and the Transfer Switch.
2. If the VOM indicated less than 120 VAC or 0, refer back to the flow chart.

TEST 82 – TEST F3 FUSE CIRCUIT

Procedure

1. Set a Volt-Ohm-Milliammeter (VOM) to measure AC voltage.
2. Connect one meter test lead to the top side of the T1 fuse holder and connect the other test lead to the NEUTRAL connection. Measure and record the voltage.
   a. If the VOM indicated 120 VAC, proceed to Step 3.
   b. If the VOM indicated less than 120 VAC or 0, verify that Load voltage is available to the LOAD side of the CONTACTOR.
3. On the generator panel, set the AUTO-OFF-MANUAL switch to the OFF position.
4. Disconnect Utility from the transfer switch.
5. Remove fuse F3 from the fuse holder. (see Figure 160).
6. Inspect and test fuses for an OPEN condition with a Volt-Ohm-Milliammeter (VOM) set to measure resistance, CONTINUITY should be measured across the fuse.

Results

1. Replace blown fuse as needed and proceed to Problem 10 "Blown T1 Fuse"

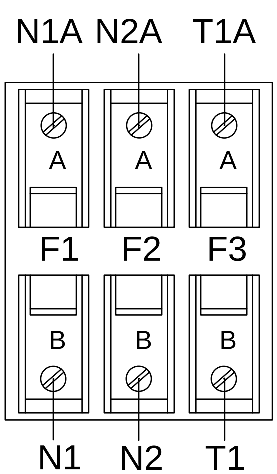


Figure 160. Transfer Switch Fuse Block

PART 5
OPERATIONAL TESTS

TABLE OF CONTENTS		
SECTION	TITLE	PAGE
5.1	System Functional Tests	144
5.2	Setup Procedures	147

Air-cooled, Automatic Standby Generators

INTRODUCTION

Following home standby electric system installation and periodically thereafter, the system should be tested. Functional tests of the system include the following:

- Manual transfer switch operation.
- System voltage tests.
- Generator Tests Under Load.
- Testing automatic operation.

Before proceeding with functional tests, read instructions and information on tags or decals affixed to the generator and transfer switch. Perform all tests in the exact order given in this section.

MANUAL TRANSFER SWITCH OPERATION

"W/V-Type" Transfer Switches

1. On the generator panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn OFF the utility power supply to the transfer switch using whatever means provided (such as a "Utility" main line circuit breaker).
3. Set the generator main line circuit breaker to OFF (or open).

⚠ DANGER!

Be sure to turn off all power voltage supplies to the transfer switch before attempting manual operation. Failure to turn off power voltage supplies to the transfer switch may result in dangerous and possibly lethal electrical shock.

4. Remove the manual transfer handle from the enclosure.
5. Place open end of the manual transfer handle over transfer switch operating lever.
6. To connect LOAD terminal lugs to the utility power source, move, the handle upward.
7. To connect LOAD terminals to the standby power source, move the handle downward.
8. Actuate the switch to UTILITY and to MANUAL several times. Make sure no evidence of binding or interference is felt.
9. When satisfied that manual transfer switch operation is correct, actuate the main contacts to their UTILITY position (Load connected to the utility power supply).

ELECTRICAL CHECKS

Complete electrical checks as follows:

1. Set the generator main circuit breaker to its OFF (or open) position.
2. Set the generator AUTO-OFF-MANUAL switch to the OFF position.
3. Turn off all loads connected to the transfer switch Terminals T1 and T2.
4. Turn on the utility power supply to the transfer switch using the means provided (such as a utility main line circuit breaker).

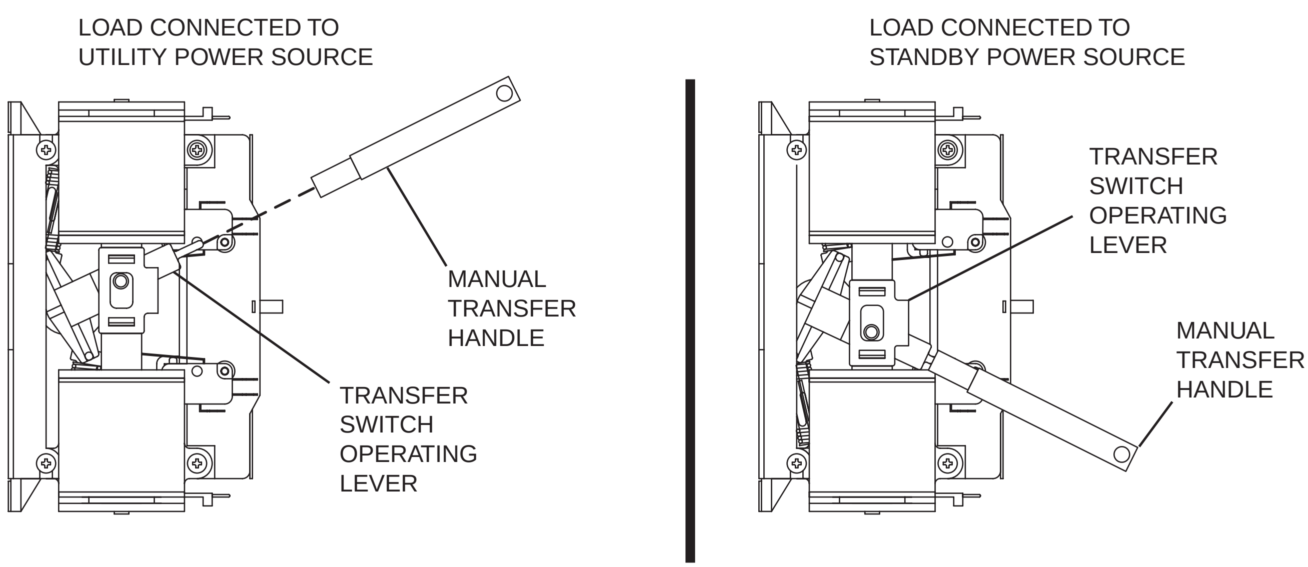


Figure 161. Manual Operation "V-Type" Switch

DANGER!

The transfer switch is now electrically "hot", contact with "hot" parts will result in extremely hazardous and possibly fatal electrical shock. Proceed with caution.

5. Use an accurate AC voltmeter to check utility power source voltage across transfer switch Terminals N1 and N2. Nominal line-to-line voltage should be 240 volts AC.
6. Check utility power source voltage across Terminals N1 and the transfer switch neutral lug; then across Terminal N2 and neutral. Nominal line-to-neutral voltage should be 120 volts AC.
7. When certain that utility supply voltage is compatible with transfer switch and load circuit ratings, turn off the utility power supply to the transfer switch.
8. On the generator panel, set the AUTO-OFF-MANUAL switch to MANUAL. The engine should crank and start.
9. Let the engine warm up for about five minutes to allow internal temperatures to stabilize. Then, set the generator main circuit breaker to its "ON" (or closed) position.

DANGER!

Proceed with caution! Generator power voltage is now supplied to the transfer switch. Contact with live transfer switch parts will result in dangerous and possibly fatal electrical shock.

10. Connect an accurate AC voltmeter and a frequency meter across transfer switch Terminal Lugs E1 and E2. Voltage should be 240-254 volts; frequency should read about 60 Hertz.
11. Connect the AC voltmeter test leads across Terminal Lug E1 and neutral; then across E2 and neutral. In both cases, voltage reading should be 121-126 volts AC.
12. Set the generator main circuit breaker to its OFF (or open) position. Let the engine run at no-load for a few minutes to stabilize internal engine generator temperatures.
13. Set the generator AUTO-OFF-MANUAL switch to OFF. The engine should shut down.

Note: It is important that you do not proceed until you are certain that generator AC voltage and frequency are correct and within the stated limits. Generally, if both AC frequency and voltage are high or low, the engine governor requires adjustment. If frequency is correct, but voltage is high or low, the generator voltage regulator requires adjustment.

GENERATOR TESTS UNDER LOAD

To test the generator set with electrical loads applied, proceed as follows:

1. Set generator main circuit breaker to its OFF (or open) position.
2. Turn OFF all loads connected to the Transfer Switch Terminals T1 and T2.
3. Set the generator AUTO-OFF-MANUAL switch to OFF.
4. Turn off the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).

WARNING!

Do not attempt manual transfer switch operation until all power voltage supplies to the transfer switch have been positively turned off. Failure to turn off all power voltage supplies will result in extremely hazardous and possibly fatal electrical shock.

5. Manually set the transfer switch to the STANDBY position, i.e., load terminals connected to the generator E1/E2 terminals. The transfer switch operating lever should be down.
6. Set the generator AUTO-OFF-MANUAL switch to MANUAL. The engine should crank and start immediately.
7. Let the engine stabilize and warm up for a few minutes.
8. Set the generator main circuit breaker to its ON (or closed) position. Loads are now powered by the standby generator.
9. Turn ON electrical loads connected to transfer switch T1 and T2. Apply an electrical load equal to the full rated wattage/amperage capacity of the installed generator.
10. Connect an accurate AC voltmeter and a frequency meter across Terminal Lugs E1 and E2. Voltage should be greater than 240 volts and frequency should be 60 Hz.
11. Let the generator run at full rated load for 20-30 minutes. Listen for unusual noises, vibration or other indications of abnormal operation. Check for oil leaks, evidence of overheating, etc.
12. When testing under load is complete, turn off electrical loads.
13. Set the generator main circuit breaker to its OFF (or open) position.
14. Let the engine run at no-load for a few minutes.
15. Set the AUTO-OFF-MANUAL switch to OFF. The engine should shut down.

CHECKING AUTOMATIC OPERATION

To check the system for proper automatic operation, proceed as follows:

1. Set generator main circuit breaker to its OFF (or open) position.
2. Check that the AUTO-OFF-MANUAL switch is set to OFF.
3. Turn off the utility power supply to the transfer switch, using whatever means provided (such as a utility main line circuit breaker).
4. Manually set the transfer switch to the UTILITY position, i.e., load terminals connected to the utility power source side.
5. Turn on the utility power supply to the transfer switch, using the means provided (such as a utility main line circuit breaker).
6. Set the AUTO-OFF-MANUAL switch to AUTO. The system is now ready for automatic operation.
7. Turn off the utility power supply to the transfer switch.

With the AUTO-OFF-MANUAL switch at AUTO, the engine should crank and start when the utility source power is turned off. After starting, the transfer switch should connect load circuits to the standby side. Let the system go through its entire automatic sequence of operation.

With the generator running and loads powered by generator AC output, turn ON the utility power supply to the transfer switch. The following should occur:

- After about fifteen seconds, the switch should transfer loads back to the utility power source.
- About one minute after retransfer, the engine should shut down.

SETTING THE EXERCISE TIME

This Generator is equipped with an exercise timer. Once it is set, the Generator will start and exercise every seven days, on the day of the week and at the time of day specified. During this exercise period, the unit runs for approximately 12 minutes and then shuts down. Transfer of load to the Generator output does not occur during the exercise cycle unless Utility power is lost.

After the Activation process has been completed, an installation wizard will prompt the user to set the minimum settings to operate. These settings are simple: “Current Time/Date” and “Exercise Day/Time”.

The exercise settings can be changed at any time via the “EDIT” menu (See Section 4.1 “Menu Navigation”). If the 12 volt battery is disconnect or the fuse removed, the Installation Assistant will operate upon power restoration. The only difference being that the display will only prompt the customer for the current time and date.

If the installer tests the Generator prior to installation, press the “ENTER” key to avoid setting the exercise time. This will ensure that the customer will still be prompted to enter an exercise time when the unit is first powered up.

The exerciser will only work in the AUTO mode and will not work unless this procedure is performed. The current date/time will need to be reset every time the 12 volt battery is disconnected and then reconnected, and/or when the fuse is removed.

ACTIVATION PROCESS

When battery power is applied to the Generator during the installation process, the controller will light up. However, the Generator still needs to be activated before it will automatically run in the event of a power outage.

Activating the Generator is a simple, one time process that is guided by the controller screen prompts. Once the product is activated, the controller screen will not prompt you again, even if you disconnect the Generator battery.

The five digit activation code can be obtained by two methods. The first is via the internet at www.activategen.com. The second is by dialing 1-888-9ACTIVATE (922-8482). In both cases, a passcode is issued to enter in the controller. See Figure 162 (next page) for detailed instructions of the process.

Activation Chart

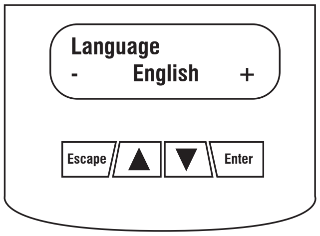
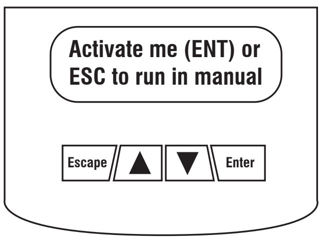
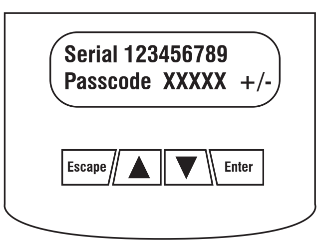
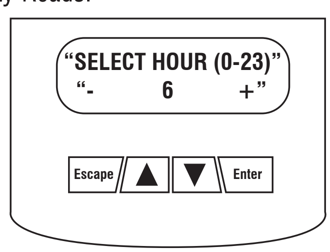
CHOOSE LANGUAGE		**TROUBLESHOOTING**
Display Reads: 	Use ARROW keys to scroll to desired language. Press ENTER to select.	If the wrong language is chosen, it can be changed later using the "edit" menu.
Display Reads: 	Press ENTER to begin the activation process.	If ESCAPE is pressed instead of ENTER, your generator will only run in manual mode (for test purposes) and NOT ACTIVATED will be displayed. You will need to reconnect the battery and begin with Step 1.
Display Reads: 	If you do not have your activation code, go to www.activategen.com or call 1-888-9ACTIVATE (922-8482). If you already have your activation code, wait 3-5 seconds for the next display.	
ENTER ACTIVATION CODE (Passcode)		**TROUBLESHOOTING**
Display Reads: 	Use ARROW keys to scroll and find the first number of your Activation Code. Press ENTER to select. Repeat this step until all digits have been entered. Use ESCAPE to correct previous digits.	
Display Reads: 	Activation is complete when all digits are entered above and your screen shows this display. Follow the controller prompts to continue setting the time function. Refer to your Owner's Manual with questions.	What happens if "Wrong Passcode Try Again" appears? Reenter the activation code. If a second attempt is unsuccessful, check the number against the code given on activategen.com. If it is correct and the generator will not accept it, contact 1-888-9ACTIVATE (922-8482).

Figure 162. Activation Process

PART 6
DISASSEMBLY

TABLE OF CONTENTS		
SECTION	TITLE	PAGE
6.1	Major Disassembly	150

Air-cooled, Automatic Standby Generators

FRONT ENGINE ACCESS

Safety

1. Set the AUTO-OFF-MANUAL switch to OFF.
2. Remove the 7.5 amp main fuse. See Figure 163.
3. Remove the N1 and N2 fuse from the transfer switch.

Figure 163. Remove 7.5 Amp Fuse

4. Turn off fuel supply to the generator and remove the flex-line from the fuel regulator.
5. Remove Utility power from the Generator.
6. Remove front door.
7. Remove battery from the generator.

Front Engine Access

1. **Remove Controls Cover:** Using a Torx T-27 socket or 5/32” Hex Allen socket remove two bolts and ground washer from the controls cover. Remove the controls cover. See Figure 164.

Figure 164.

2. **Remove controller:** Using a 10mm socket remove the three bolts holding the control panel in place. There are two bolts on the side of the divider panel and the third directly underneath the support bracket. See Figure 165.

Figure 165.

3. **Remove control harnesses:** Disconnect all connectors and remove the controller. See Figure 166.

Figure 166.

4. **Remove Stator Wires:** Remove all wires from the main circuit breaker, remove the neutral and ground wires from landing lugs. See Figure 167.
5. **Remove Control Wires:** Remove Wires N1, N2, T1, 0, 194, 23, GFCI Outlet, and unit status lights from the control box. See Figure 168.

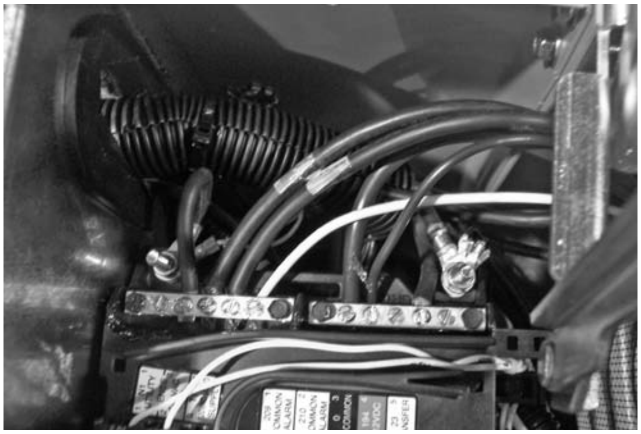


Figure 167.

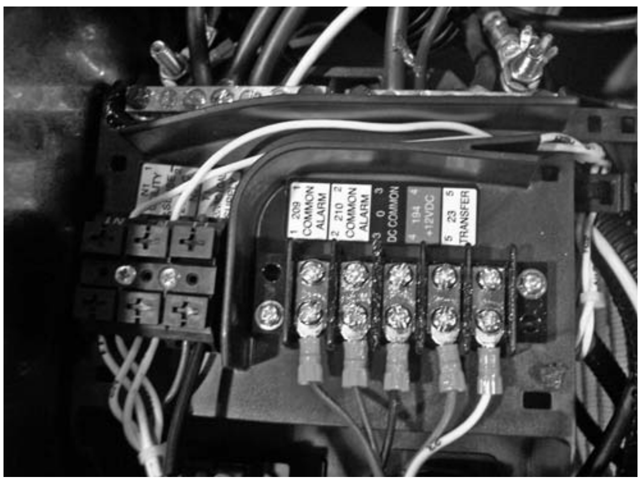


Figure 168.

6. **Remove controller mounting box:** Using an 8mm socket remove the two screws from the rear of the controller mounting box. Using a 10mm socket remove the two bolts from under the front of the controller mounting box. See Figure 169.

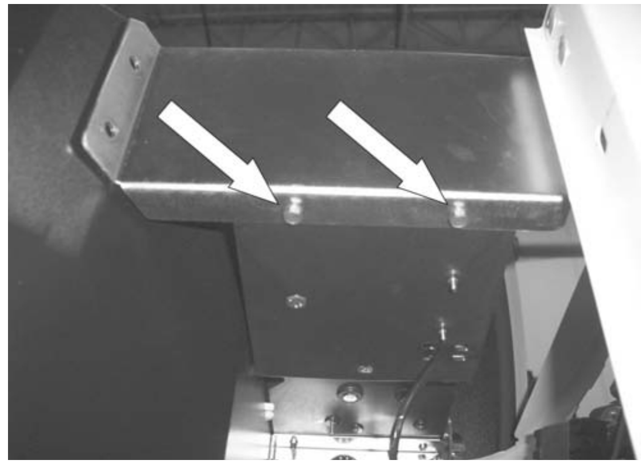


Figure 169.

7. **Remove engine intake baffle:** Using a 10mm socket remove the two bolts from the engine intake baffle. Pull baffle toward you carefully, there are tabs holding the backside of the baffle to the divider panel. See Figure 170.

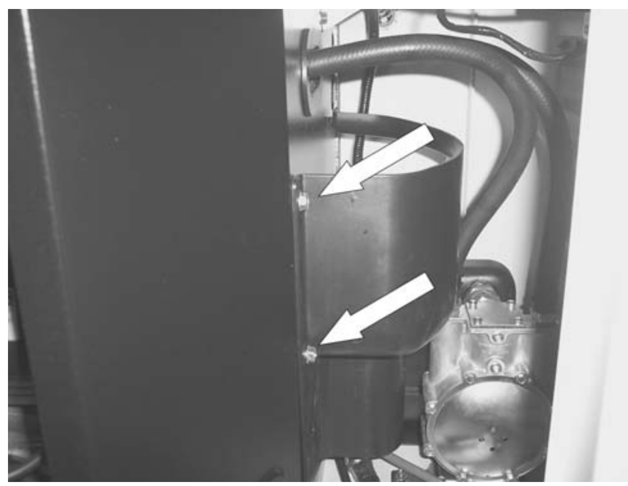


Figure 170.

8. **Loosen side panel:** Using a 10mm socket remove the two bolts from the base of the enclosure side panel. See Figure 171.

9. **Unbolt enclosure side panel mounting bracket:** Using a 10mm socket remove the two bolts from the enclosure side panel mounting bracket. See Figure 172.

Figure 171.

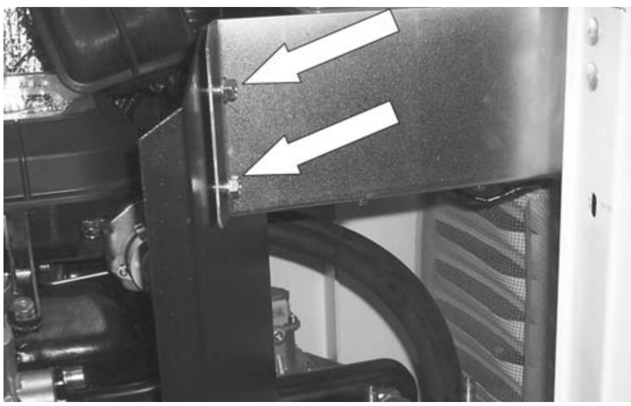


Figure 172.

10. **Remove fuel regulator:** Remove the two fuel hoses at the top of the regulator. Using a 10mm socket remove one 10mm bolt from the base of the plenum and one 10mm bolt from the base of the fuel regulator. Flex the enclosure side out to allow for room to remove the regulator assembly. See Figure 173.

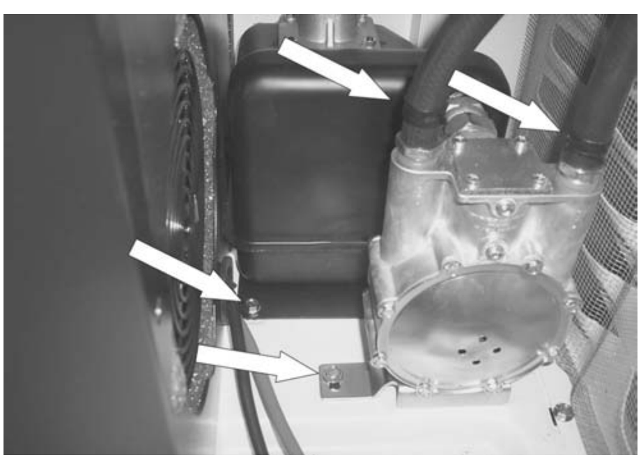


Figure 173.

11. **Remove engine divider panel:** Using a 10mm socket remove the rear 10mm bolt from the base of the enclosure. See Figure 174. Remove the front 10mm bolt from the base of the enclosure. See Figure 175.

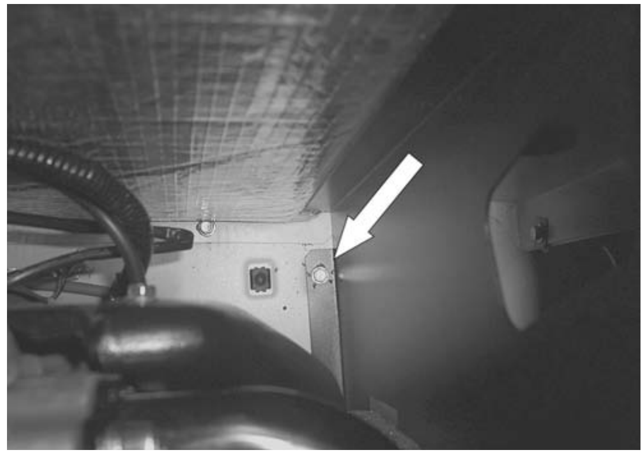


Figure 174.

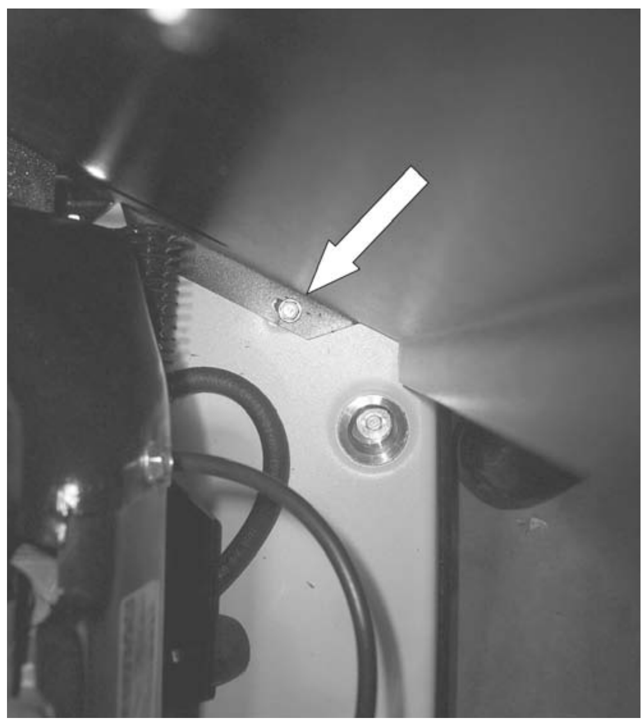


Figure 175.

12. **Remove Air Box:** Using a 6mm allen wrench remove the four intake manifold socket head cap screws. See Figure 176. Using a 4mm allen wrench, remove the four airbox allen head shoulder bolts. While removing the airbox remove the four rubber washers. See Figure 177.

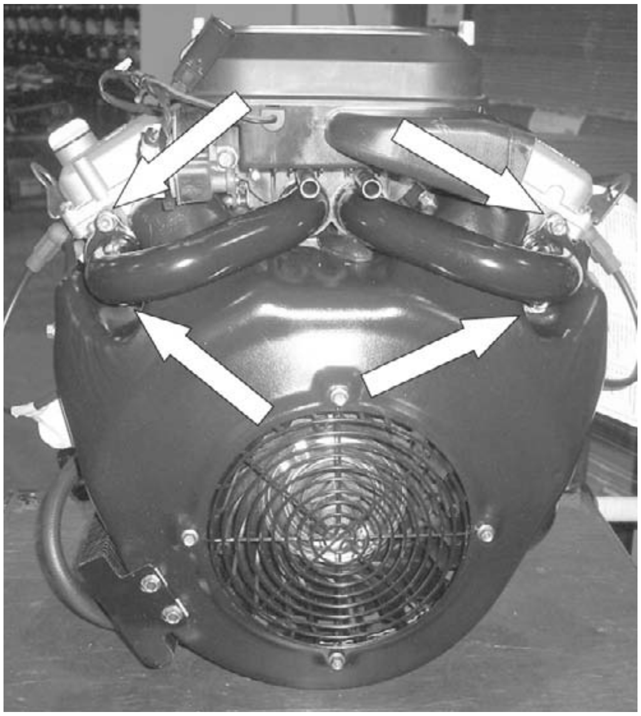


Figure 176.

Figure 177.

13. **Unbolt Oil Cooler:** Using a 10mm socket remove the two 10mm bolts from the front of the oil cooler. See Figure 178. Remove the two 10mm bolts from the rear of the oil cooler. See Figure 190.

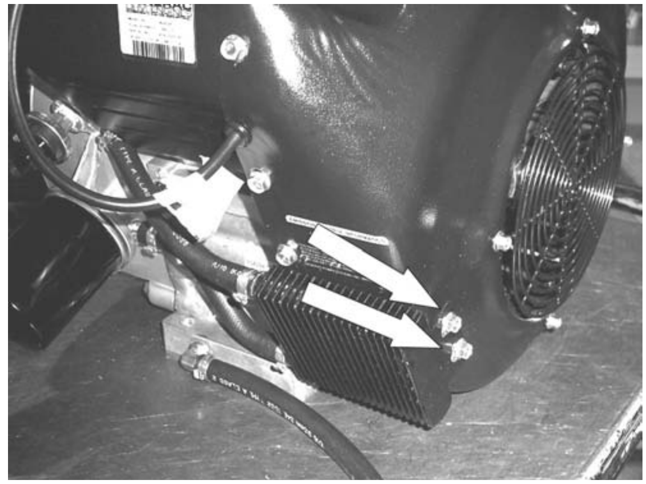


Figure 178.

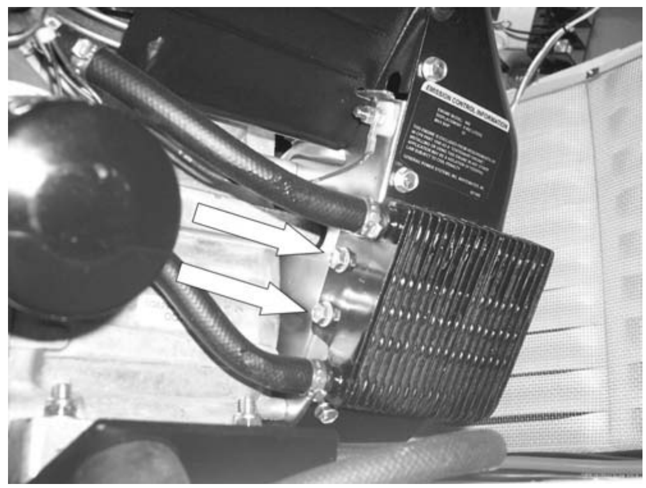


Figure 179.

14. **Remove Blower Housing:** Using a 4mm allen wrench remove one button head cap screw from top of blower housing. Using a 10mm socket remove one 10mm bolt from the top of the blower housing. See Figure 180. Using a 10mm socket remove four 10mm bolts from the right-side of the blower housing, (see Figure 181) and four 10mm bolts from the left-side of the blower housing. See Figure 182. Remove blower housing.

Figure 180.

Figure 181.

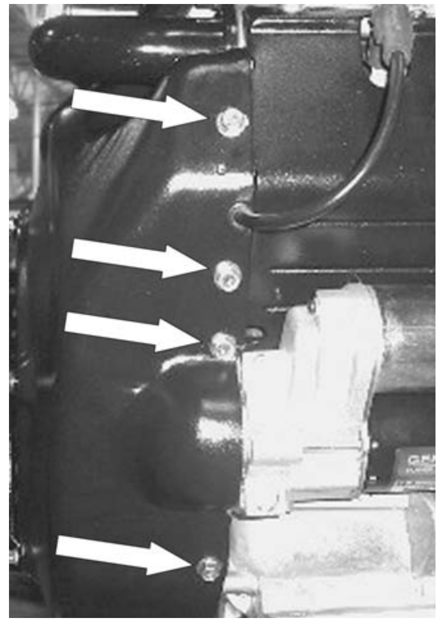


Figure 182.

MAJOR DISASSEMBLY

Safety:

1. Set the AUTO-OFF-MANUAL switch to OFF.
2. Remove the 7.5 amp main fuse. See Figure 183.
3. Remove the N1 and N2 fuses from the transfer switch.

Figure 183. Remove 7.5 Amp Fuse

4. Turn off fuel supply to the generator and remove the flex-line from the fuel regulator.
5. Remove Utility power from the Generator.
6. Remove front door.
7. Remove battery from the generator.

Stator/Rotor/Engine Removal:

1. **Remove Top Exhaust Enclosure Covers:** Using a 10mm socket, remove the nine bolts from the exhaust top covers. Remove covers. See Figure 184.

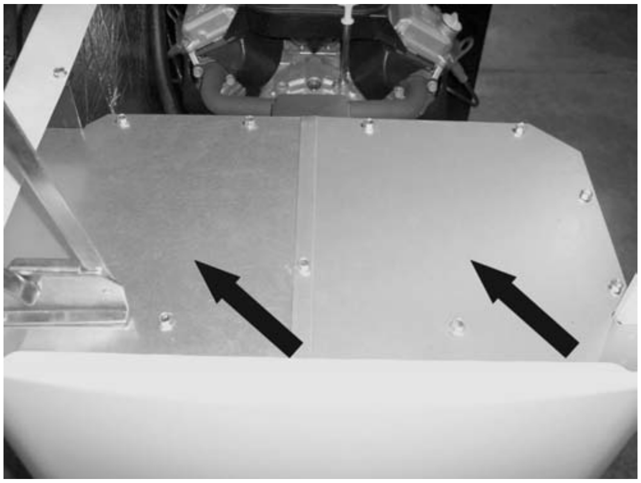


Figure 184.

2. **Remove Side Exhaust Enclosure Cover:** Using a 10mm socket, remove the five bolts from the exhaust side cover. Remove side covers. See Figure 185.

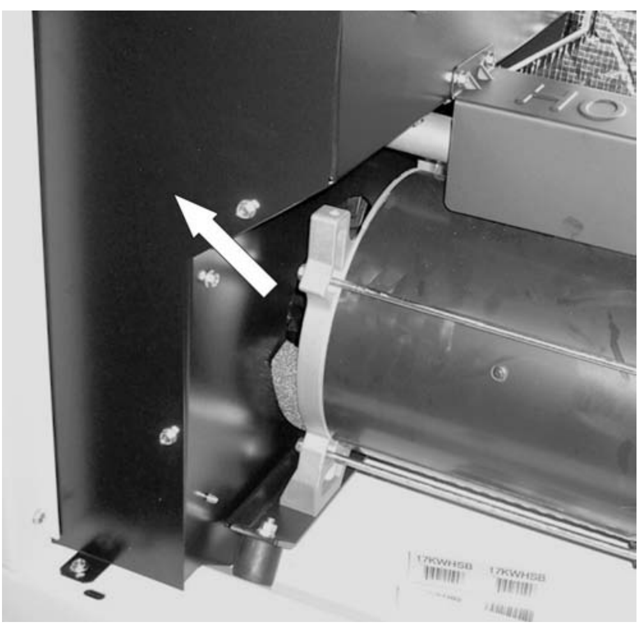


Figure 185.

3. **Remove Exhaust Flex Cover:** Using a 10mm socket, remove the two bolts from the exhaust flex pipe cover. Remove the cover. See Figure 186.

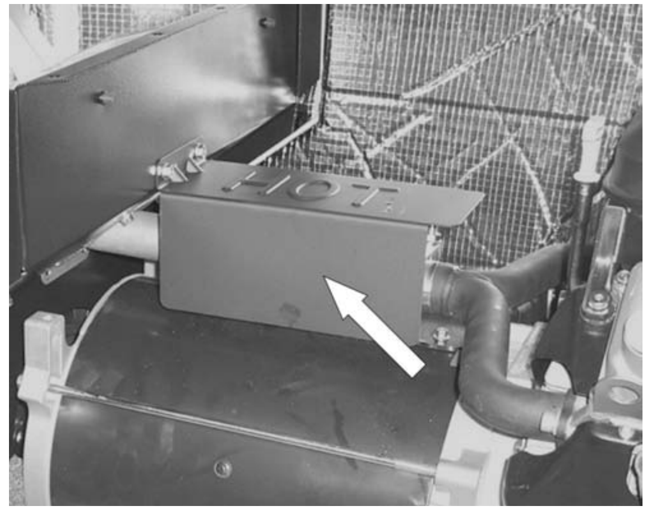


Figure 186.

4. **Remove Exhaust Flex Pipe:** Using a ½" socket remove the front and rear muffler clamp. Slide exhaust flex toward engine completely exposing the muffler flange. See Figure 187.

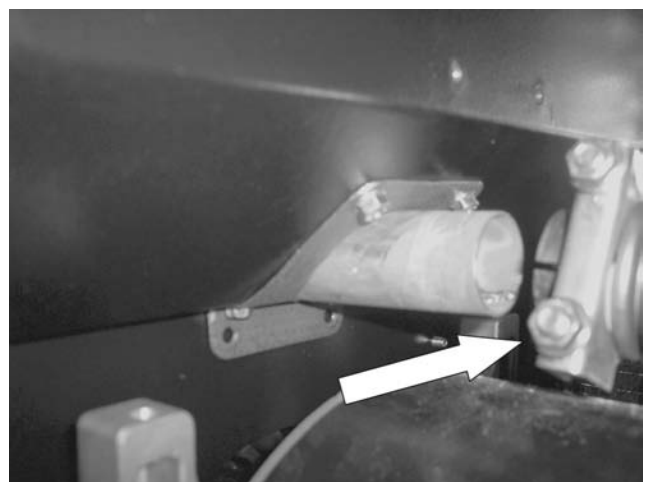


Figure 187.

5. **Remove Muffler and Tail Pipe:** Using a ½" socket remove the muffler clamp and tail pipe. Using a 10mm socket, remove the four bolts from the muffler mounts and remove muffler. See Figure 188.

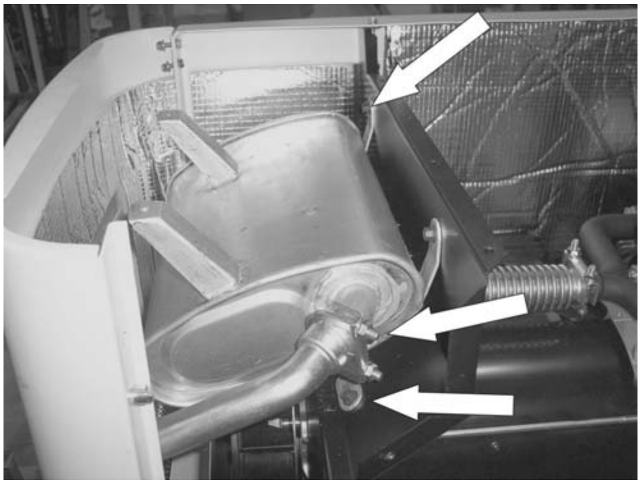


Figure 188.

6. **Remove Left-side enclosure:** Using a 10mm ratchet wrench remove the horizontal 10mm bolt that connects the side panel to the back panel. Using a 10mm socket, remove three bolts from the base of the enclosure. See Figure 189. Using a 10mm socket and wrench remove the top hinge bolt and loosen the bottom bolt. See Figure 190. Holding the roof, remove the bottom hinge bolt, remove the side panel by sliding it forward then re-install the hinge bolt.

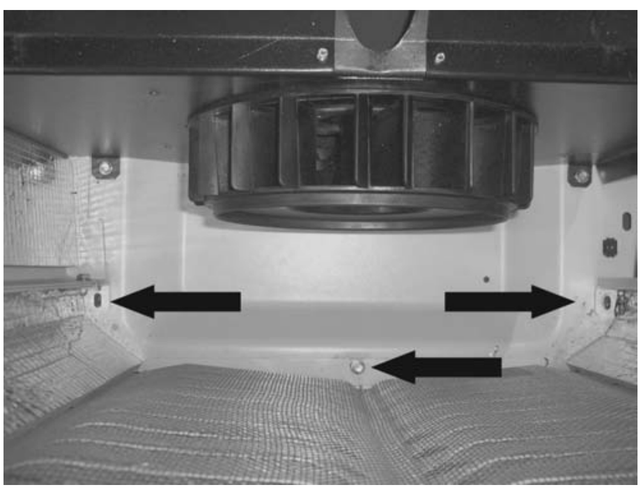


Figure 189.

Figure 190.

7. **Remove Fan Housing Cover:** Using a 10mm socket remove four bolts from the fan housing cover. Remove the fan housing cover. See Figure 191.

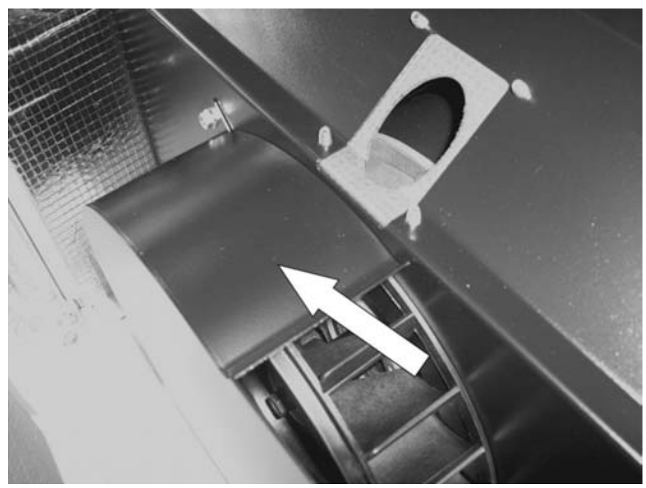


Figure 191.

8. **Remove Rotor Bolt:** Using a 9/16" socket, remove rotor bolt. Figure 192.

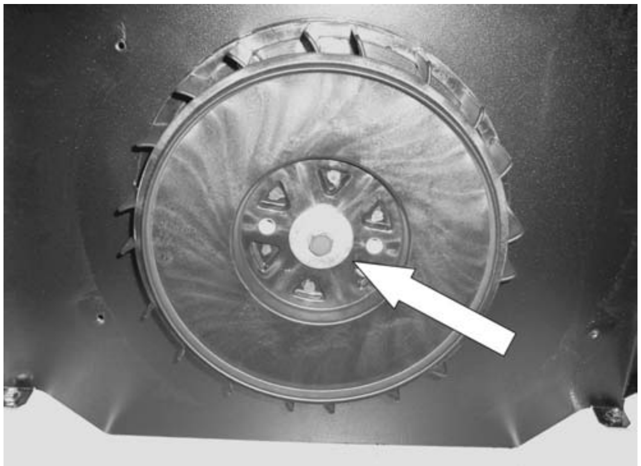


Figure 192.

9. **Remove Fan:** Attach a steering wheel puller to the fan using two M8 x 1.25 bolts. Remove the fan from the rotor. Figure 193.

Figure 193.

10. **Remove Brushes:** Using a 7mm socket remove brushes. See Figure 194.

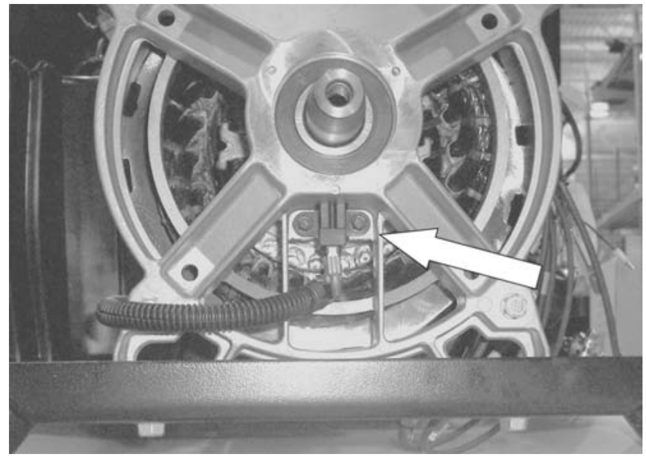


Figure 194.

11. **Remove Alternator Divider Panel:** Using a 10mm socket remove two bottom base bolts. Using a T27 torx driver remove one top rear bolt. Remove the panel. See Figure 195.

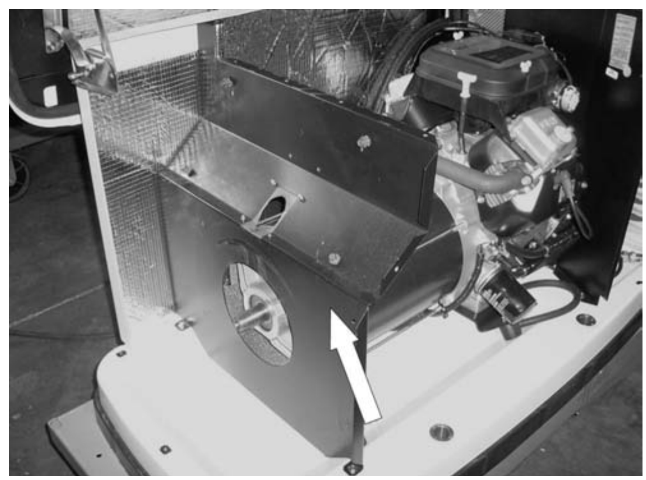


Figure 195.

12. **Remove Brush Wires:** Using a side cutters remove the tie wraps securing the brush wires to the outside of stator. See Figure 196.

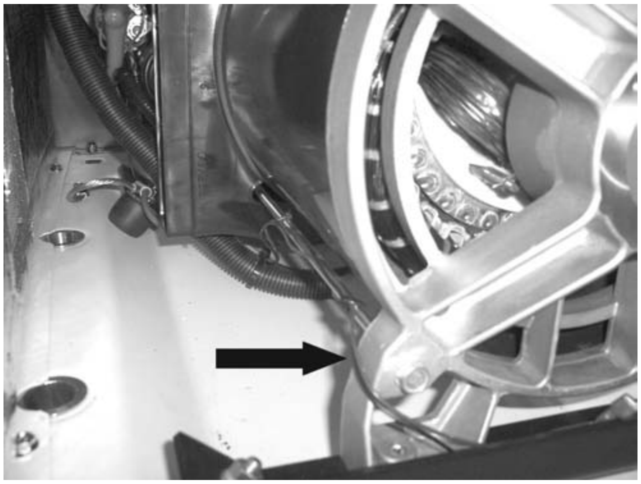


Figure 196.

13. **Remove Controls Cover:** Using a Torx T-27 socket or 5/32” Hex Allen socket remove two bolts and ground washer from the controls cover. Remove the controls cover. See Figure 197.

Figure 197.

14. **Remove Stator Wires:** Remove all connectors from the controller, remove all wires the common neutral and ground wires from landing lugs, and remove wires from main beakers. See Figure 198.

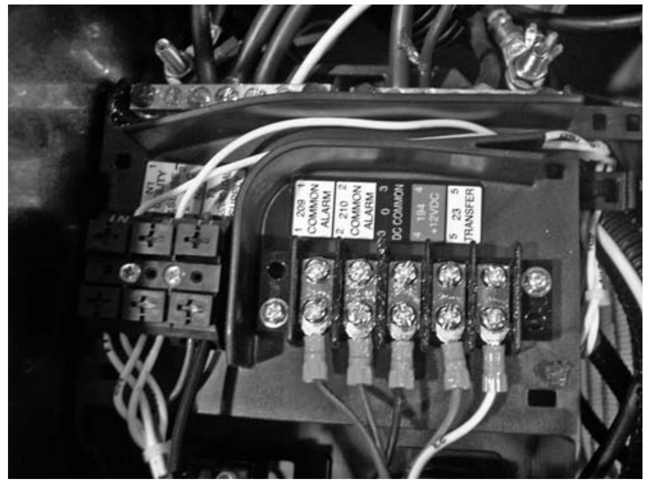


Figure 198.

15. **Alternator Air Intake Bellows Removal:** Remove alternator intake bellows. See Figure 199.

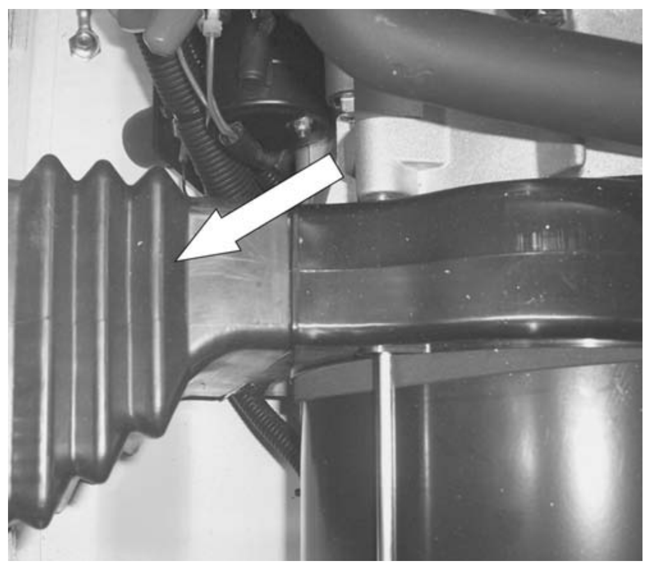


Figure 199.

16. **Rear Bearing Carrier Removal:** Using a 13mm socket, remove the two nuts from the alternator mounting bracket rubber mounts. Lift the back end of the alternator up and place a 2”x 4” piece of wood under the engine. See Figure 201. Using a 13mm socket, remove the four stator hold down bolts. See Figure 201. Using a small rubber mallet remove the rear bearing carrier. See Figure 201. Remove stator. See Figure 202.

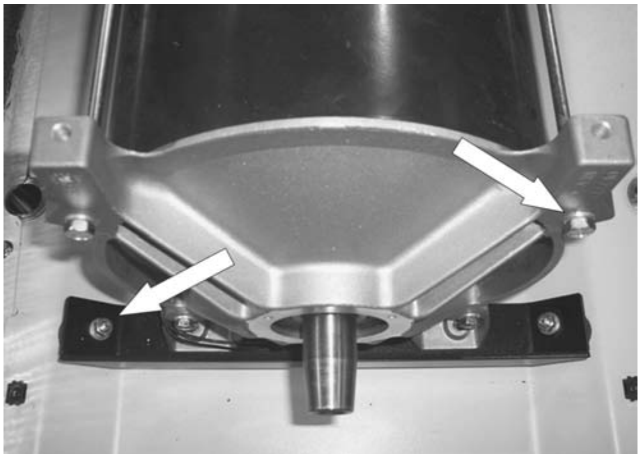


Figure 200.

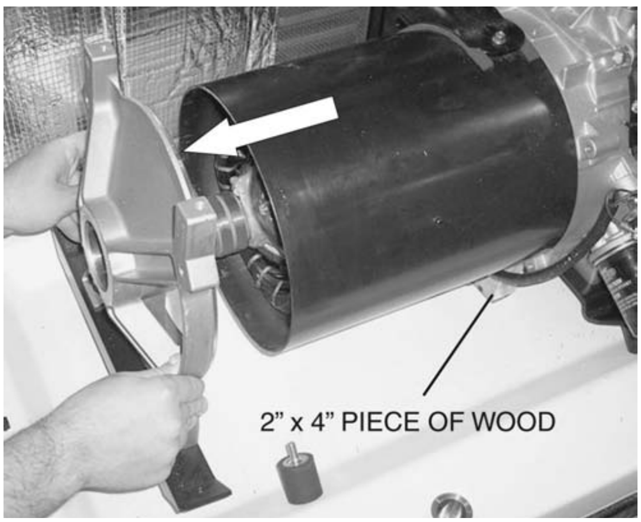


Figure 201.

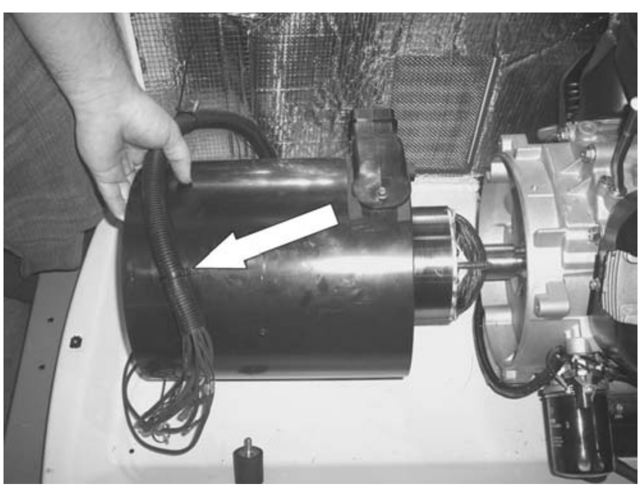


Figure 202.

17. **Rotor Removal:** Cut 2.5 inches from the rotor bolt. Slot the end of the bolt to suit a flat blade screwdriver. Slide the rotor bolt back through the rotor and use a screwdriver to screw it into the crankshaft. Use a 3" M12x1.75 bolt to screw into rotor. Apply torque to the 3" M12x1.75 bolt until taper breaks. See Figure 203.

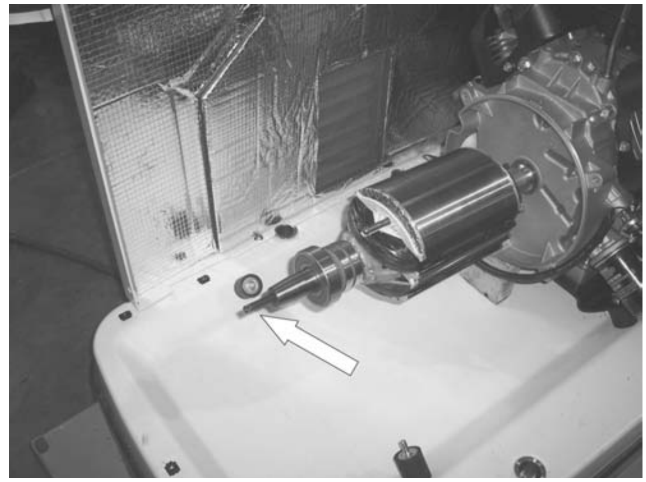


Figure 203.

18. **Remove Engine:** Using a 13mm socket, remove the two engine mount nuts with ground wires. See Figure 204.

Figure 204.

19. **Remove Engine:** Using proper lifting equipment remove the engine. See Figure 206.

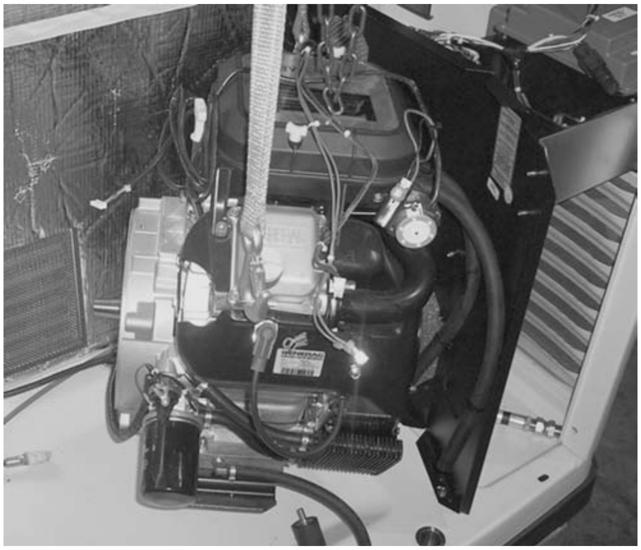


Figure 205.

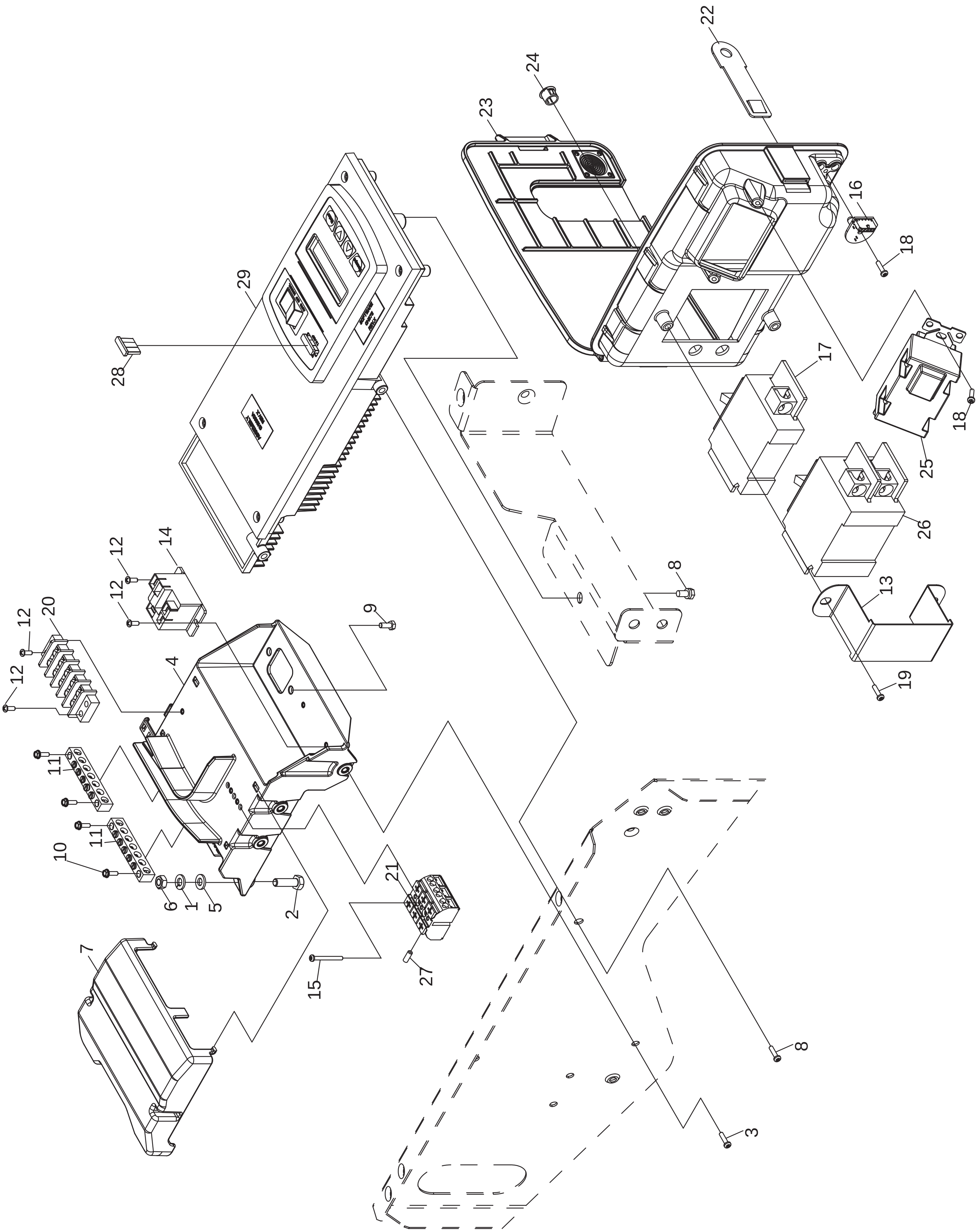
TORQUE REQUIREMENTS (UNLESS OTHERWISE SPECIFIED)

STATOR BOLTS .... 6 ft-lbs (+1 / -0)
ROTOR BOLT .... 30 ft-lbs
ENGINE ADAPTOR .... 25 ft-lbs
EXHAUST MANIFOLD .... 18 ft-lbs
M5-0.8 TAPTITE SCREW INTO ALUMINUM .... 25-50 in-lbs
M5-0.8 TAPTITE SCREW INTO PIERCED HOLE ... 25-50 in-lbs
M6-1.0 TAPTITE SCREW INTO ALUMINUM .... 50-96 in-lbs
M6-1.0 TAPTITE SCREW INTO PIERCED HOLE ... 50-96 in-lbs
M6-1.0 TAPTITE SCREW INTO WELDNUT .... 50-96 in-lbs
M8-1.25 TAPTITE SCREW INTO ALUMINUM .... 12-18 ft-lbs
M8-1.25 TAPTITE SCREW INTO PIERCED HOLE ... 12-18 ft-lbs
M6-1.0 NYLOK NUT ONTO WELD STUD .... 16-65 in-lbs
M6-1.0 NYLOK NUT ONTO HINGE STUD .... 30-36 in-lbs

Note: torques are dynamic values with ±10% tolerance unless otherwise noted.

NOTES

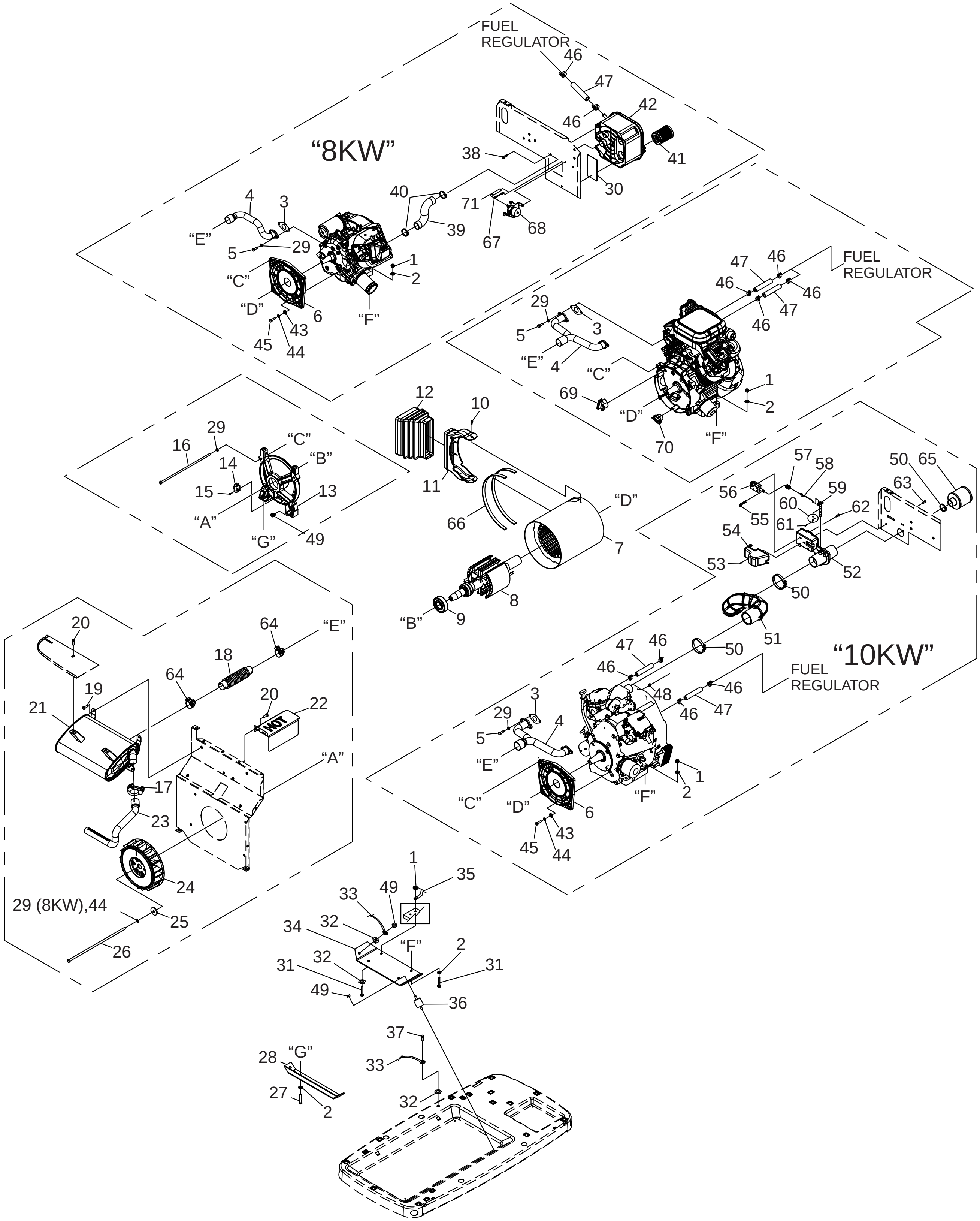
Control Panel



ITEM	QTY.	DESCRIPTION
1	2	WASHER LOCK M6-1/4
2	2	SCREW HHC M6-1.0 X 30 C8.8
3	3	SCREW HHFC M5-0.8X12 W/PATCH
4	1	BRACKET CUSTOMER CONNECT
5	2	WASHER FLAT M6
6	2	NUT HEX M6 X 1.0 G8 YEL CHR
7	1	COVER CUSTOMER CONNECT
8	3	SCREW HHFC M6-1X12 8.8 W/PATCH
9	2	SCREW HHSP #10X3/8 HI-LO
10	4	SCREW HHC M4-0.7 X 25 SEMS
11	2	GROUND BAR
12	2	SCREW PPHM M3-0.5 X 12 SEMS (8kW)
	4	SCREW PPHM M3-0.5 X 12 SEMS (10kW, 13kW, 14kW, 16kW, 17kW, & 20kW)
13	1	CB BRACKET CONTROL BOX
14	1	RELAY 12V 25A SPST (10kW, 13kW, 14kW, 16kW, 17kW, & 20kW)
15	2	SCREW PPHM M3-0.5 X 30
16	1	ASSY PCB TRIP LED DISPLAY
17	1	CB 0015A 1P 120V S BQ1 LB (16kW, 17kW & 20kW)
18	3	SCREW HH HI-LO M4X10MM (16kW, 17kW & 20kW)
	1	SCREW HH HI-LO M4X10MM (8kW, 10kW, 13kW, & 14kW)

ITEM	QTY.	DESCRIPTION
19	2	SCREW REDUCED HH HI-LO M6X10MM
20	1	BLOCK TERM 5POS 20A
21	1	TERM BLOCK 3P UL 12-20AWG
22	1	EYE HASP CNTRL PANEL
23	1	ASSY CONTROL BOX (8kW, 10kW, 13kW, & 14kW)
24	2	PLUG PLASTIC DOME 7/16"
25	1	OUTLET, 15A GFCI DUPLEX WHITE (16kW, 17kW & 20kW)
26	1	CB 0035A 2P 240V S BQ2 LB (8kW)
	1	CB 0045A 2P 240V S BQ2 LB (10kW)
	1	CB 0055A 2P 240V S BQ2 LB (13kW)
	1	CB 0060A 2P 240V S BQ2 LB (14kW)
	1	CB 0065A 2P 240V S BQ2 LB (17kW)
	1	CB 0100A 2P 240V S BQ2 LB (20kW)
27	1	CAP LOCKOUT
28	REF	FUSE, ATO TYPE 7.5AMP (BROWN)
29	1	ASSY CNTR PROGRAMMED
30	1	HARNESS (NOT SHOWN)

Generator


"8KW"
"10KW"
FUEL
REGULATOR
FUEL
REGULATOR
FUEL
REGULATOR
HOT
"A"
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"G"
29 (8KW),44
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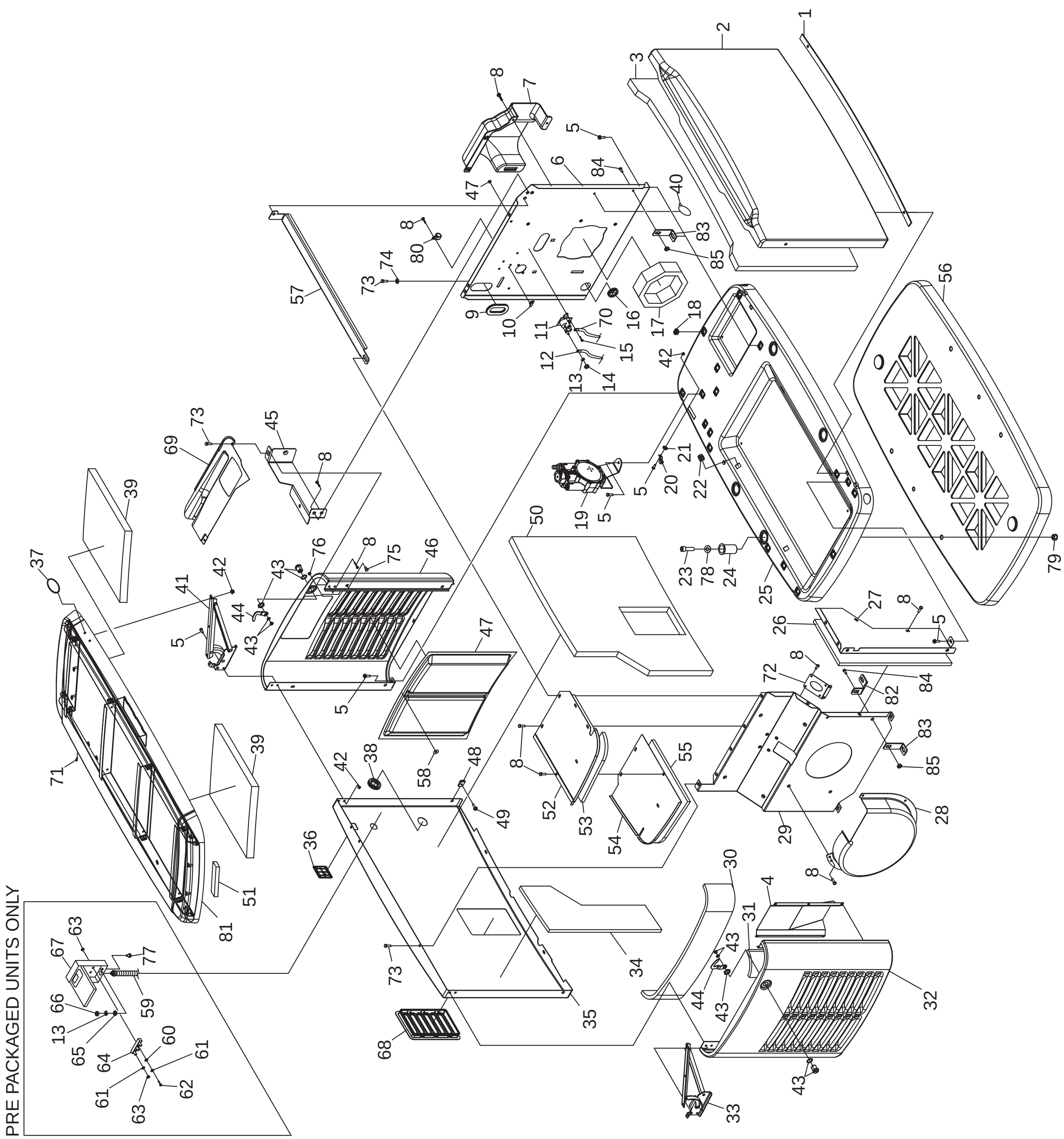
ITEM	QTY.	DESCRIPTION
1	4	NUT LOCK HEX M8-1.25 NYLON INSERT
2	8	WASHER FLAT M8-5/16
3	1	GASKET, EXHAUST (8KW)
	2	GASKET, EXHAUST (10KW)
	2	GASKET, EXHAUST
4	1	MANIFOLD, EXHAUST
5	AR	SCREW SHC M8-1.25 X 20
6	1	ENGINE ADAPTOR (8KW & 10KW)
7	1	STATOR
8	1	ROTOR
9	1	BEARING
10	2	SCREW HHTT M6-1.0 X 10
11	1	ALTERNATOR AIR IN DUCT
12	1	ALTERNATOR AIR IN BELLOWS
13	1	BEARING CARRIER
14	1	ASSEMBLY BRUSH HOLDER
15	2	SCREW HHTT M5-0.8 X 16
16	4	BOLT, IHHCS M8-1.25
17	1	U-BOLT 5/16” X 1.62” WITH SADDLE
18	1	FLEX PIPE
19	4	SCREW HHTT M8-1.2 X 12
20	4	SCREW TAPTITE M6-1.0 X 12
21	1	MUFFLER
22	1	FLEX COVER
23	1	TAIL PIPE
24	1	FAN, CURVED BLADE
25	1	WASHER FLAT .406 ID X 1.62 OD
26	1	BOLT IHHC
27	2	SCREW HHC 5/16-18 X 1-1/4” G5
28	1	BRACKET, ALTERNATOR MOUNTING
29	AR	WASHER LOCK M8-5/16
30	1	GASKET, AIR CLEANER (8KW ONLY)
31	4	SCREW HHC M8-1.25
32	3	5/16 SPECIAL LOCK WASHER
33	1	EARTH STRAP 3/8 X 3/8
34	1	BRACKET ENGINE MOUNTING
35	1	CABLE, #6 30” BLACK BATTERY
36	4	RUBBER MOUNT
37	1	SCREW HHTT M8-1.25 X 16

ITEM	QTY.	DESCRIPTION
38	4	SCREW PLASTITE 1/4-15 X 3/4” (8KW ONLY)
39	1	AIR IN SNORKEL (8KW ONLY)
40	2	BAND HOSE CLAMP n35.05 (8KW ONLY)
41	1	AIR FILTER (8KW ONLY)
42	1	AIR BOX (8KW ONLY)
43	4	WASHER FLAT 3/8 (8KW & 10KW)
44	AR	WASHER LOCK 3/8
45	4	BOLT HHC 3/8-16 X 1.25” (8KW & 10KW)
46	AR	HOSE CLAMP 3/4” ID
47	1	HOSE RES 1/2 LP GAS
48	1	CLAMP HOSE .38-.87
49	6	NUT FLANGE 5/16-18 NYLOK
50	3	CLAMP HOSE #24 B1.06-2.00 (10KW ONLY)
51	1	HOSE, INTAKE (10KW ONLY)
52	1	CHOKE HOUSING (10KW ONLY)
53	2	SCREW PPPH HI-LO #6/1/2 W/ #5HD (10KW ONLY)
54	1	BOOT, CHOKE SOLENOID (10KW ONLY)
55	1	COTTER PIN (10KW ONLY)
56	1	SOLENOID, 6 VOLTS DC (10KW ONLY)
57	1	SPRING-CHOKE RETURN (10KW ONLY)
58	1	LINKAGE, CHOKE (10KW ONLY)
59	1	ASSEMBLY, CHOKE SHAFT (10KW ONLY)
60	1	VALVE, CHOKE (10KW ONLY)
61	2	SCREW PFHM M3-0.5 X (10KW ONLY)
62	2	SCREW PPHM #4-40 X 3/8 SEMS (10KW ONLY)
63	3	SCREW PPPH HI-LO #14-15 X 1/2 (10KW ONLY)
64	2	BAND CLAMP DIA 36-39MM
65	1	AIR CLEANER (10KW ONLY)
66	2.6 FT	TAPE ELEC UL FOAM 1/8 X 1/2
67	1	THROTTLE ROD (8KW ONLY)
68	1	ASSY STEPPER MOTOR (8KW ONLY)
69	1	PLUG, GEAR COVER (13KW – 20KW)
70	1	PLUG, GEAR COVER – SMALL (13KW – 20KW)
71	1	SPRING, ANTI-LASH (8KW ONLY)

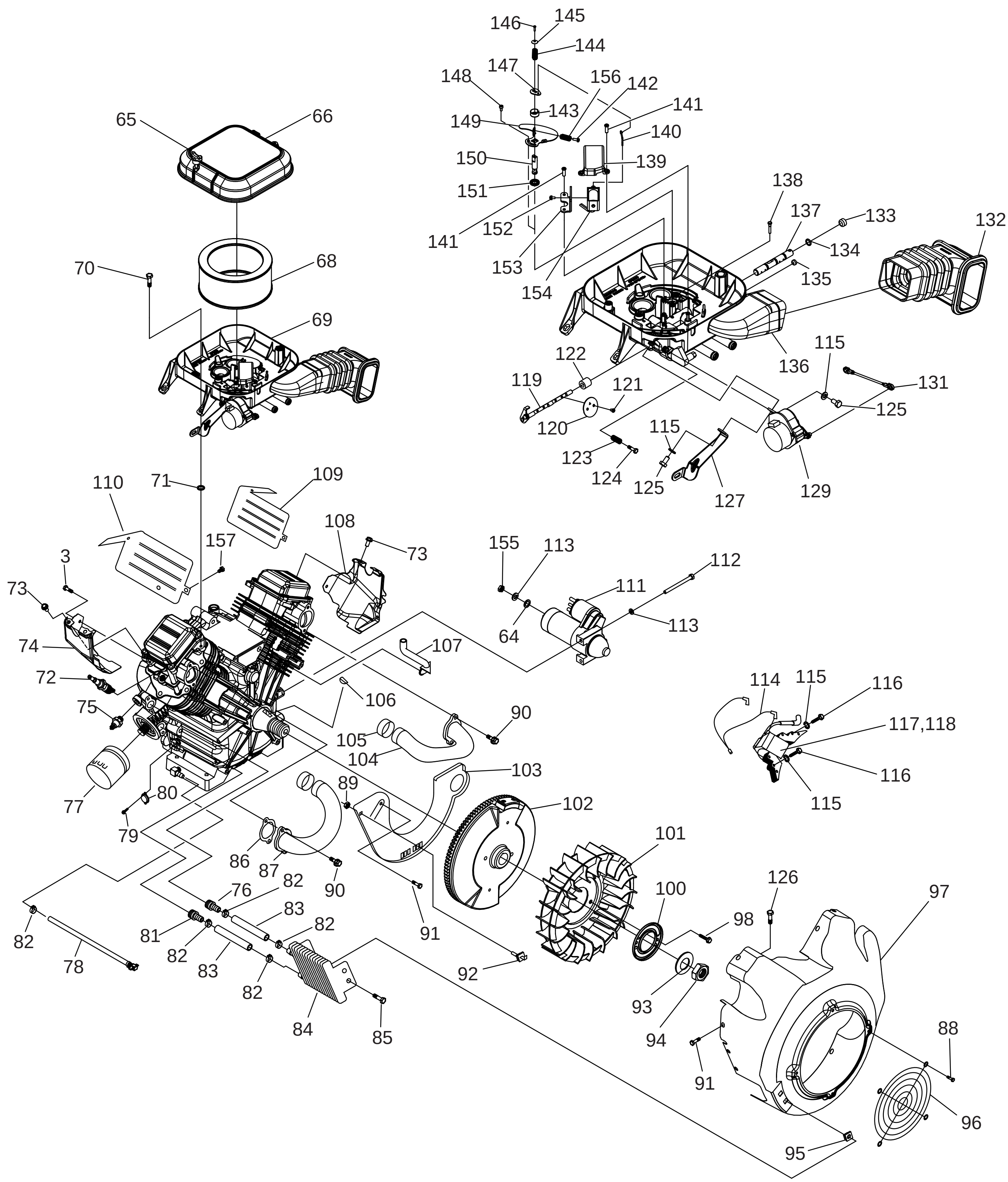
Enclosure



ITEM	QTY.	DESCRIPTION
1	1	GASKET, DOOR SEAL
2	1	ENCLOSURE FRONT PANEL
3	1	FOAM, FRONT PANEL ENCLOSURE
4	1	EXHAUST BAFFLE (13KW-20KW)
5	AR	SCREW HHFC M6-1.0 X 20 (8KW, 10KW)
6	1	PANEL, ENGINE DIVIDER
7	1	BAFFLE, INTAKE
8	AR	SCREW TAPTITE M6-1.0X12
9	AR	GROMMET OVAL 31.75 X 50.8
10	1	MOUNTING CLIP
11	1	CONTACTOR, STARTER (8KW)
12	1	CABLE, #6 RED BATTERY 38.5”
13	AR	WASHER, LOCK M6-1/4”
14	1	NUT HEX 1/4-20 (8KW ONLY)
15	2	SCREW HHC, M6-1.0 X 12 (8KW)
16	1	GROMMET, n38.1 CROSS SLIT
17	1	GASKET, ENGINE DIVIDER
18	17	PANEL CLIP, M6-1.00
19	1	REGULATOR ASSEMBLY
20	1	LUG SLDLSS #2-#8 X 17/64 CU
21	1	LOCK WASHER, SPECIAL 1/4
22	4	PANEL CLIP, 5/16-18
23	4	SCREW, SHC-3/8-16 WITH LOCKING PATCH
24	4	BUSHING
25	1	ENCLOSURE, BASE
26	1	FOAM, FRONT EXHAUST SHIELD
27	1	FRONT EXHAUST SHIELD
28	1	SCROLL, FAN (8KW, 10KW)
29	1	PANEL, EXHAUST DIVIDER
30	1	FOAM, EXHAUST END PANEL
31	2	FOAM, EXHAUST END PANEL SIDES
32	1	ENCLOSURE, EXHAUST SIDE PANEL
33	1	HINGE ASSEMBLY – LEFT SIDE
34	1	FOAM, BACK EXHAUST COMPARTMENT
35	1	ENCLOSURE, BACK PANEL
36	1	RF COVER PLATE, PLASTIC
37	1	BADGE HOLDER - OVAL
38	1	GROMMET, n38.1 CROSS SLIT WITH HOLE
39	3	1.00” THICK FOAM, ENCLOSURE ROOF
40	1	PUSHBUTTON WIRE TIE
41	1	HINGE ASSEMBLY – RIGHT SIDE
42	AR	NUT, LOCKING FLANGE M6-1.00
43	2	1/4 TURN LOCKING HATCH
44	2	LATCH PAWL

ITEM	QTY.	DESCRIPTION
45	1	BRACKET, CONTROL PNL FRONT
46	1	ENCLOSURE END PANEL
47	2	SCREEN
48	2	U-CLIP, M6-1.00
49	2	SCREW HHFC M6-1.0 X 14
50	1	FOAM, ENCLOSURE BACK PANEL
51	11 FT	GASKET, EXTRUDED TRIM
52	1	COVER, FRONT TOP EXHAUST
53	1	FOAM, FRONT TOP EXHAUST COVER
54	1	COVER, BACK TOP EXHAUST
55	1	FOAM, BACK TOP EXHAUST COVER
56	1	MOUNTING PAD
57	1	CROSS SUPPORT
58	12	WASHER, SELF LOCKING
59	1	HARNESS GENERATOR TO EXTERNAL CONNECTION BOX
60	2	WASHER FLAT M5
61	5	WASHER LOCK #10
62	2	SCREW PPHM#10-32 X 1
63	5	NUT HEX #10-32
64	1	POWER BLOCK
65	1	WASHER SHAKEPROOF EXT 1/4 STEEL
66	1	NUT HEX M6-1.0
67	1	EXTERNAL CONNECTION BOX
68	1	LOUVER, SNAP IN
69	1	CONTROL PANEL FASCIA
70	1	WIRE ASSY, CNTRL TO STARTER (8KW ONLY)
71	1	PLUG 6.35 BLACK
72	1	GASKET, EXHAUST DIVIDER
73	AR	SCREW SWT 1/4-20 X 5/8
74	1	1/4 SHAKEPROOF WASHER
75	2	THREADED SPACER M6-1.0
76	2	NUT TOP LOCK FLANGE M6-1.0
77	1	SCREW HHC, M6-1.0 X 16
78	4	WASHER FLAT 3/8
79	4	NUT, HEX 3/8-16
80	1	CLAMP STL/VNL (8KW)
81	1	ENCLOSURE ROOF ASSY, GALV.
82	2	BRACKET, EXHAUST (20KW ONLY)
83	AR	BRACKET, L
84	4	SCREW HHFC M6-1.0 X 12 (16kW, 17kW ALUM, 20kW)
85	4	NUT HEX FL WHIZ M6-1.0 (16kW, 17kW ALUM, 20kW)

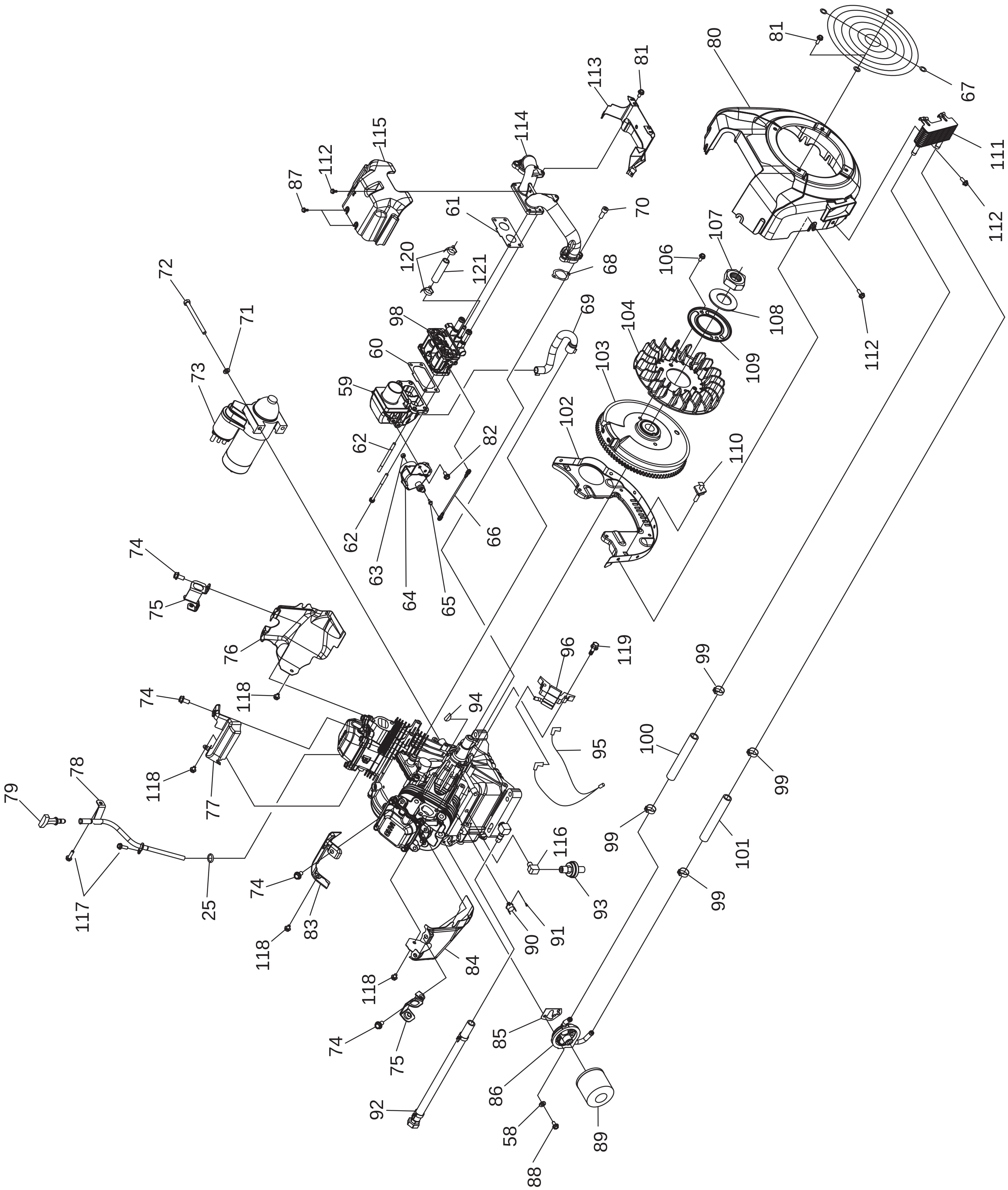
Engine, GN990/999



ITEM	QTY.	DESCRIPTION
64	1	WASHER FLAT M8 – 5/16
65	2	KNOB, AIR CLEANER ORG
66	1	COVER, AIRBOX NG/LP
68	1	ELEMENT, AIR CLEANER
69	1	ASSY, MIXER / AIRBOX 990
70	4	SCREW SHLDR(8MM) M6-1.0 X 21
71	4	WASHER,RUBBER 1/4" X 1/8" THICK
72	2	SPARKPLUG
73	2	SCREW TAPTITE M5 – 0.8 X 8
74	1	WRAPPER, LOWER CYLINDER 2 ZINC
75	1	SWITCH, OIL PRESS
76	1	EXTENDED BARBED STR ¼ NPT X 3/8
77	1	OIL FILTER, 90mm
78	1	ASSY, OIL DRAIN HOSE ORG
79	2	SCREW M3 – 0.5 X 6 SEMS
80	1	SWITCH, THERMAL 293F
81	1	BARBED STRAIGHT 1/4NPT X 3/8
82	5	CLAMP, HOSE OETIKER STEPLESS 18.5mm
83	2	HOSE 3/8" 300PSI 6" LG OIL
84	1	COOLER, OIL
85	4	SCREW PLASTITE 1/4-15 X 3/4
86	2	GASKET, MANIFOLD / PORT
87	1	MANIFOLD CYLINDER 2
88	4	SCREW, HHTT M6-1 x 10 LONG
89	1	NUT, HEX LOCK M5-0.8 ZINC
90	4	SCREW SHC M8 – 1.25 X 20 SEMS
91	13	SCREW TAPTITE M6–1X12 CLEAR ZINC
92	1	ASSY,GROUND WIRE CONNECTOR
93	1	WASHER, 25MM I.D.
94	1	NUT, HEX M24
95	4	NUT, GROMMET 1/4 PLUG
96	1	GUARD, FAN
97	1	HOUSING, BLOWER NG COOLER
98	2	SCREW HHFCS M8 – 1.25 X 10 G8.8
99		
100	1	PLATE, FAN
101	1	FAN, NYLON
102	1	ASSY, FLYWHEEL
103	1	PLATE, BACKING WITH CUT OUT
104	1	MANIFOLD CYLINDER 1
105	2	SLEEVE, RUBBER
106	1	KEY, WOODRUFF 4 X 19D
107	1	HOSE BREATHER
108	1	WRAPPER, LOWER CYLINDER 1 ZINC
109	1	WRAPPER, UPPER CYLINDER 1 ZINC
110	1	WRAPPER, UPPER CYLINDER 2 ZINC

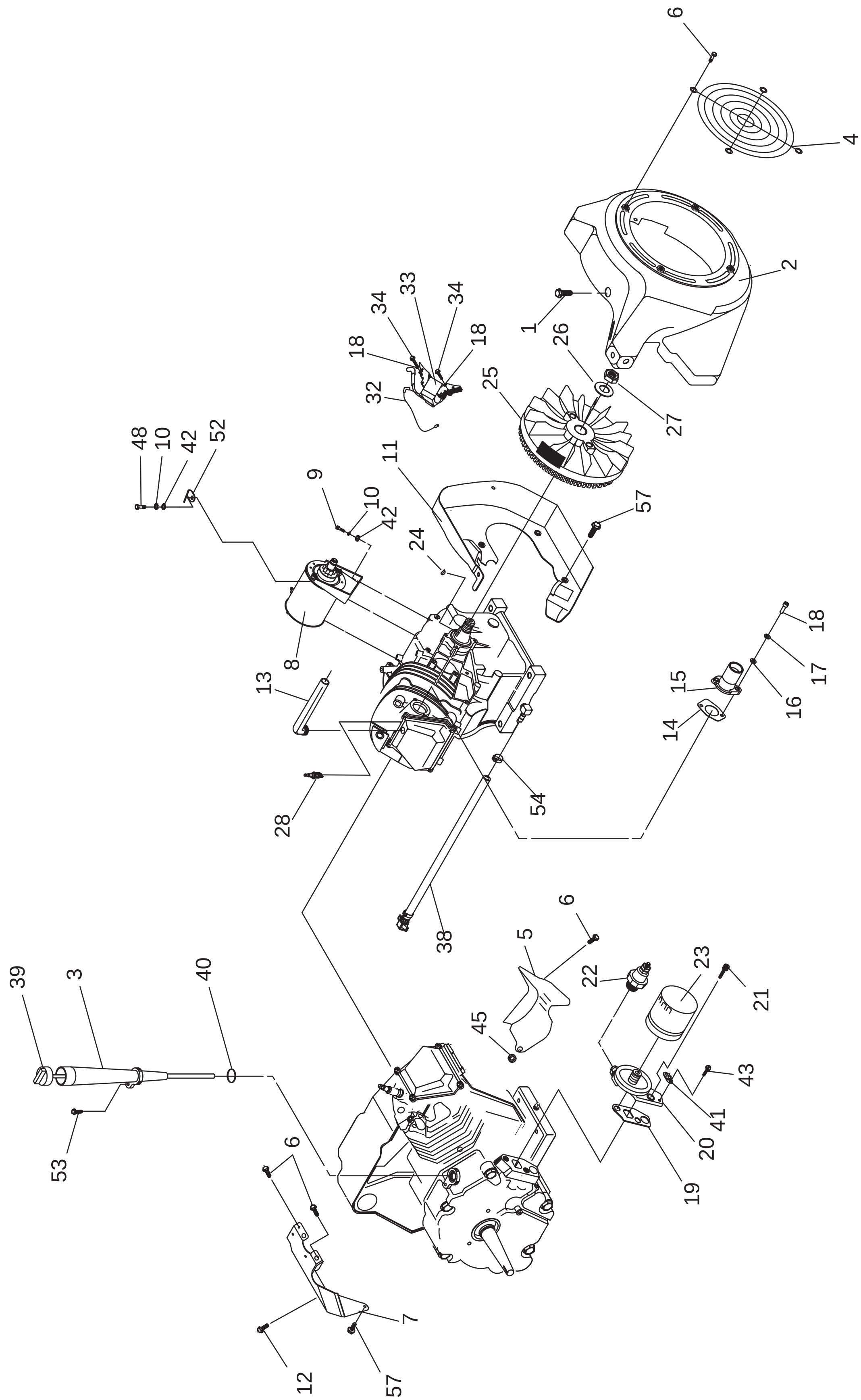
ITEM	QTY.	DESCRIPTION
111	1	STARTER MOTOR HEAR REDUCED 1KW
112	2	SCREW HHC M8 – 1.25 X 85 G8.8
113	3	WASHER LOCK M8 – 5/16
114	1	ASSEMBLY, GROUND WIRE
115	2	WASHER LOCK M6 – 1/4
116	4	SCREW TAPTITE M6 – 1.0 X 20 ZINC
117	1	ASSY, IGN COIL W/DIODE, CYLINDER 1
118	1	ASSY, IGN COIL W/DIODE, CYLINDER 2
119	1	ASSY, THROTTLE SHAFT
120	2	THROTTLE VALVE
121	4	SCREW PPHM M3 – 0.5 X 5
122	1	COVER, DUST, MIX/AIRBOX
123	1	SPRING, IDLE ADJUST
124	1	SCREW PPHM M5 – 0.58 X 20
125	2	SCREW HHC M6 – 1.0 X 12
126	1	SCREW BHSC M6-1.0 X 12 SS
127	1	BRACKET, STEPPER MOTOR
129	1	ASSY,CONTROLLER GTH990 HSB
131	1	ASSY, THROTTLE ROD
132	1	BELLOWS, INTAKE
133	1	EXPANSION PLUG
134	3	#10 O-RING
135	1	PLUG, MANIFOLD
136	1	ASSY, AIR BOX BASE
137	1	PIN, FUEL SELECTOR
138	1	PIN, FUEL SEL STOP
139	1	SOLENOID COVER
140	1	LINKAGE, CHOKE
141	4	SCREW PPPH HI-LO #6 X 1/2
142	1	SCREW PHTT M3 – 0.5 X 8
143	1	RETAINER, CHOKE RETURN SPRING
144	1	SPRING, CHOKE RETURN
145	1	WASHER, BELLEVILLE SPRING
146	1	SCREW PPHM M2 – 0.4 X 8
147	1	CHOKE ARM
148	1	SCREW SHOULDER M3 – 0.5 X 6
149	1	VALVE, CHOKE
150	1	SHAFT, CHOKE
151	1	SEAL, GOVERNOR ARM
152	2	SCREW PHM #4 – 40 X 1/4
153	1	BRACKET, SOLENOID
154	1	SOLENOID, 6VDC
155	1	NUT HEX M8 – 1.25 YELLOW ZINC
156	1	SPRING, CHOKE VALVE ADJUST
157	1	SCREW, BHSC M6-1.0 x 12

Engine, GN530



ITEM	QTY.	DESCRIPTION
58	3	WASHER LOCK M6-1/4
59	1	INTAKE ADAPTER
60	1	GASKET, AIRBOX TO CARB/MIXER
61	1	GASKET, MANIFOLD TO CARB/MIXER
62	4	BOLT, CARB MOUNT M6 – 1.0 X 85
63	1	NUT HEX LOCK M3 – 0.5
64	1	ASSY, CONTROLLER
65	1	BALL STUD, 10 MM
66	1	ASSY, THROTTLE ROD
67	1	GUARD, FAN
68	2	GASKET INTAKE
69	1	BREATHER HOSE
70	4	SCREW SHC M8 – 1.25 X 20 G12.9
71	2	WASHER LOCK M8 – 5/16
72	2	SCREW HHC M8 – 1.25 X 85
73	1	STARTER MOTOR
74	6	SCREW HHFC M8 – 1.25 X 14
75	2	LIFTING HOOK
76	1	WRAPPER OUTER CYLINDER 1 CLEAR ZINC
77	1	WRAPPER INNER CYLINDER 1 CLEAR ZINC
78	1	TUBE, DIPSTICK GTH 530
79	1	ASSY, DIPSTICK /TEXT ORG
80	1	BLOWER HOUSING
81	6	SCREW HHFC M6-1.0 X 10 G8.8
82	3	SCREW HHFC M6-1.0 X 8 G8.8
83	1	WRAPPER INNER CYLINDER 2 CLEAR ZINC
84	1	WRAPPER OUTER CYLINDER 2 CLEAR ZINC
85	1	GASKET, OIL FILTER ADAPTER
86	1	ASSY, DIRECT OIL COOLER ADAPTER
87	2	SCREW PLASTITE HI-LOW #10X3/8
88	3	SCREW HHC M6 – 1.0 X 25
89	1	OIL FILTER
90	1	THERMAL SWITCH
91	2	SCREW PPHM M3-0.5 X 6 SEMS
92	1	ASSY OIL DRAIN HOSE ORG
93	1	OIL PRESSURE SWITCH HOBBS 5PSI
94	1	KEY, WOODRUFF 4 X 19D
95	1	ASSY, GROUNDING WIRE
96	1	ASSY IGNITION COIL CYLINDER 1
	1	ASSY IGNITION COIL CYLINDER 2
97		
98	1	ASSY, MIXER DUAL FUEL
99	4	CLAMP, HOSE OETIKER STEPLESS 18.5mm
100	1	HOSE 3/8”ID X 6” SAE J30R9
101	1	HOSE 3/8”ID X 7.25 SAE J30R9
102	1	BACKING PLATE, GT-530 ZINC
103	1	ASSY, FLYWHEEL & RING GEAR
104	1	FAN, FLYWHEEL, 20 FIN, 218.8 OD
106	2	SCREW HHFCS M8 – 1.25 X 12 C8.8
107	1	NUT HEX M20 – 1.5
108	1	WASHER BELV – 20 X 2.2
109	1	PLATE, FAN
110	1	ASSY, GROUND WIRE CONNECTOR
111	1	OIL COOLER
112	13	SCREW HHFC M6 – 1.0 X 14
113	1	CENTER BAFFLE
114	1	INTAKE MANIFOLD
115	1	FRONT COVER
116	1	ELBOW - 1/8” NPT
117	2	SCREW, HHFC M6-1.0 x 12
118	4	SCREW, HHFCS M6-1 x 12 CLEAR ZINC
119	4	SCREW, HHC M6-1 x 25 SEMS
120	1	CLAMP HOSE .38-.87
121	1.5	HOSE 1/4 ID LPG 350PSI UL21

Engine, GN410



ITEM	QTY.	DESCRIPTION
1	7	SCREW, TAPTITE M6-1.0X8 YELLOW CHROME
2	1	HOUSING, BLOWER GH410 BLACK
3	1	TUBE 410GH OIL FILL/CHECK
4	1	GUARD, F AN
5	1	WRAPPER, BOTT OM
6	6	SCREW, TAPTITE M6-1X10 YELLOW CHROME
7	1	WRAPPER, TOP
8	1	ASSY, START ER
9	2	SCREW SHC M 8-1.25 X 40 C8.8
10	3	WASHER, LOCK M8-5/16
11	1	BACKPLATE, L/F D/F
12	1	SCREW, HHTT 5/16”-18 X ½” SEMI-GIMLET
13	1	BREATHER HOSE
14	1	GASKET, INTAKE ADAPTER
15	1	ASSY THROTTLE BODY
16	2	WASHER, F LAT M6
17	4	WASHER, LOCK M6-1/4
18	4	SCREW, SHC M6-1.0 X 20 G12.9
19	1	GASKET,OIL F ILTR ADAPTER
20	1	ADAPTER, OIL FILTER
21	2	SCREW, SHC M8-1.25 X 30 G12.9

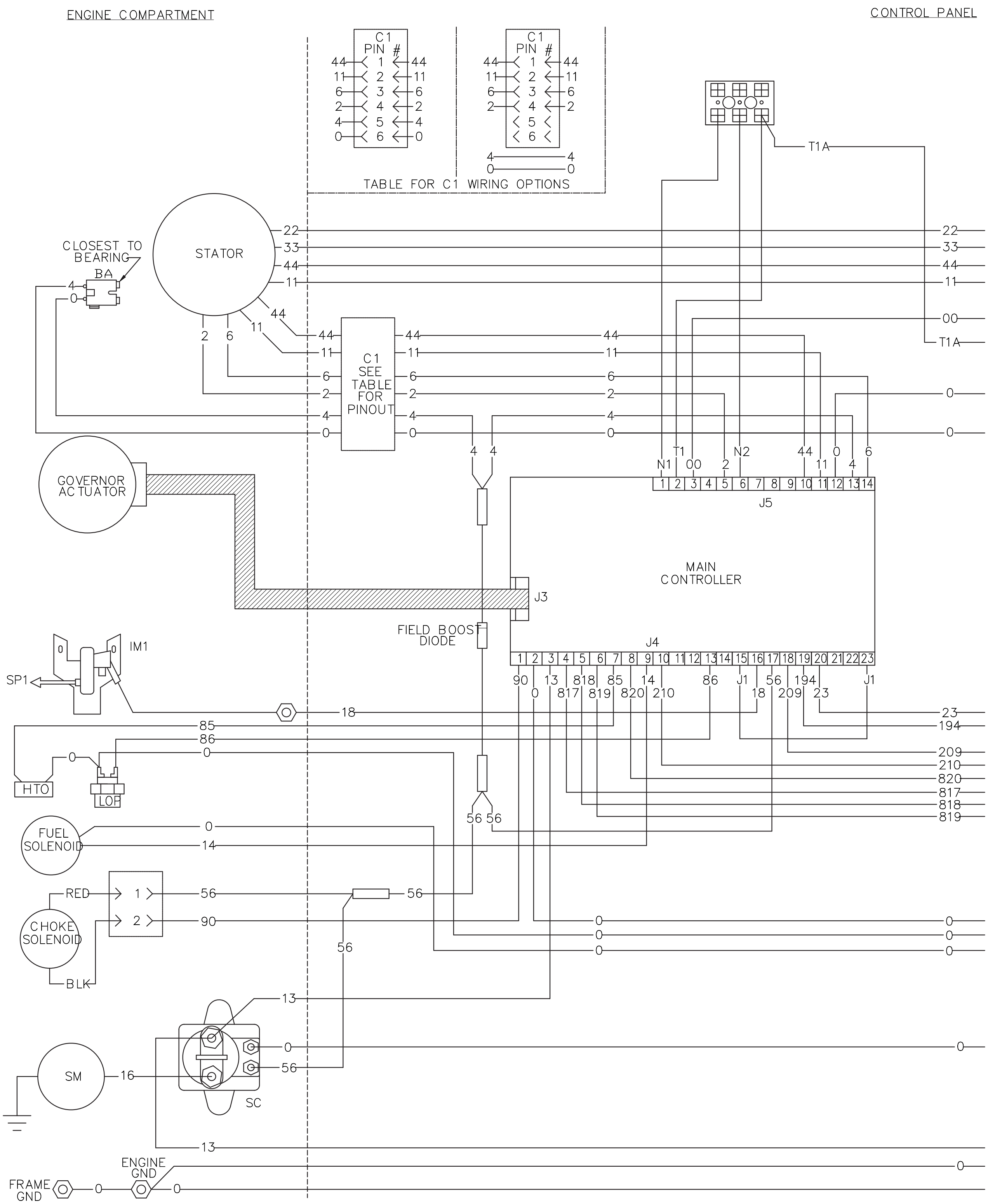
ITEM	QTY.	DESCRIPTION
22	1	SWITCH, OIL 5 PSI
23	1	OIL FILTER
24	1	KEY, WOODRFF 4 X 19D
25	1	FLYWHEEL WITH RING GEAR 27 DEGREE
26	1	WASHER,BELV-20 X 2.2
27	1	NUT , HEX - FLYWHEEL
28	1	SPARKPLUG
32	1	ASSEMBLY, WIRE
33	1	ASSEMBLY, IGNIT ION COIL ADVANCE W/ DIODE
34	2	SCREW HHFC M6-1.0 X 25 FTH G8
38	1	ASSY OIL DRAIN HOSE
39	1	DIPSTICK, GT H410
40	1	O-RING 9/16 X 3/4 X 3/32
41	1	SWITCH, THERMAL 293F
42	3	WASHER FLAT 5/16 - M8
43	2	SCREW, M3-0.5 X 6 SEMS
45	1	GOMMET
48	1	SCREW HHC M8-1.25 x 20
52	1	ENGINE LIF T HOOK
53	1	SCREW HHFCS M6-1.0X10 G8.8
54	1	CLAMP,HOSE OETIKER STEPLESS 17
57	5	SCREW HHFC M6-1.0 X 12

PART 7
ELECTRICAL DATA

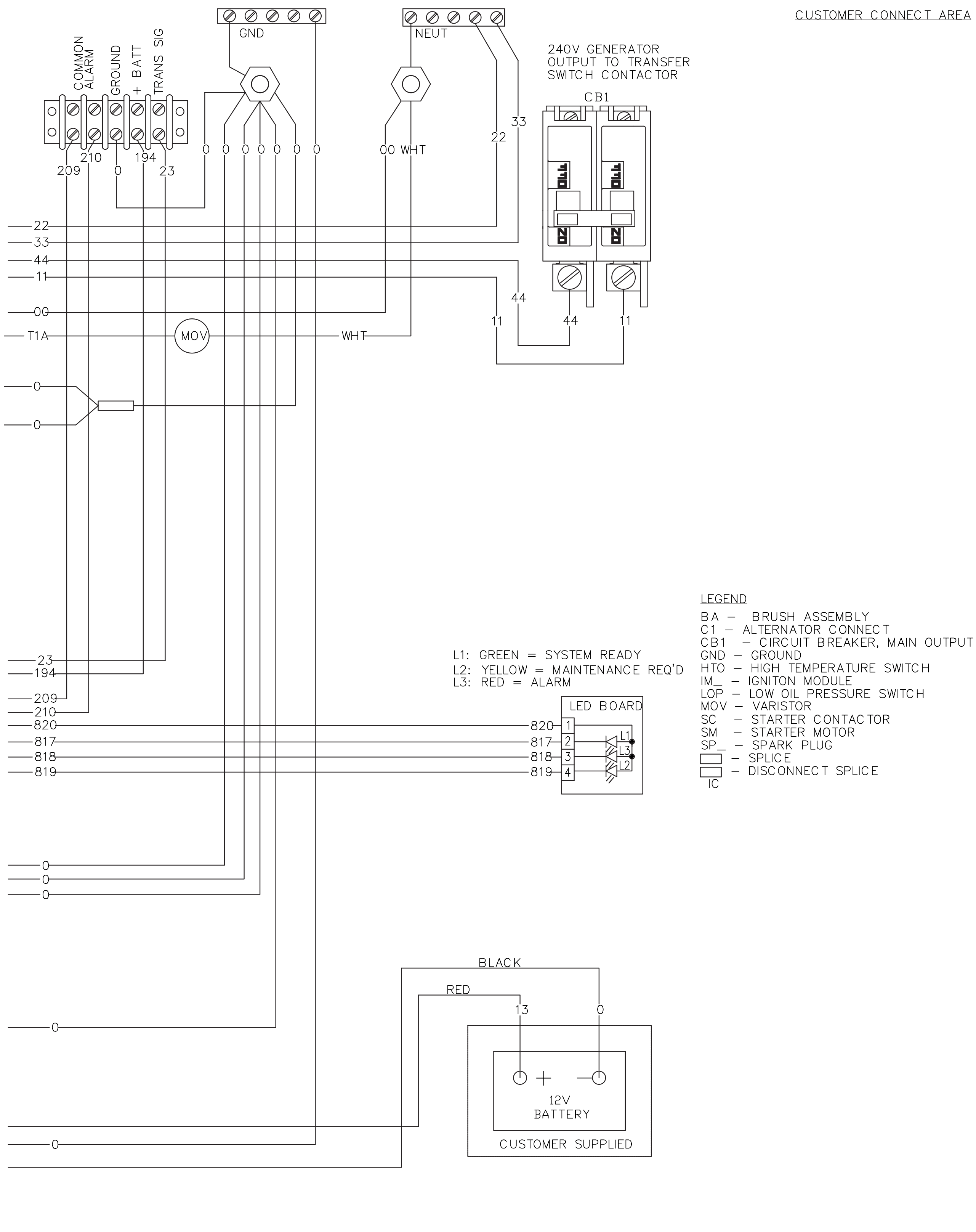
Air-cooled, Automatic Standby Generators

TABLE OF CONTENTS

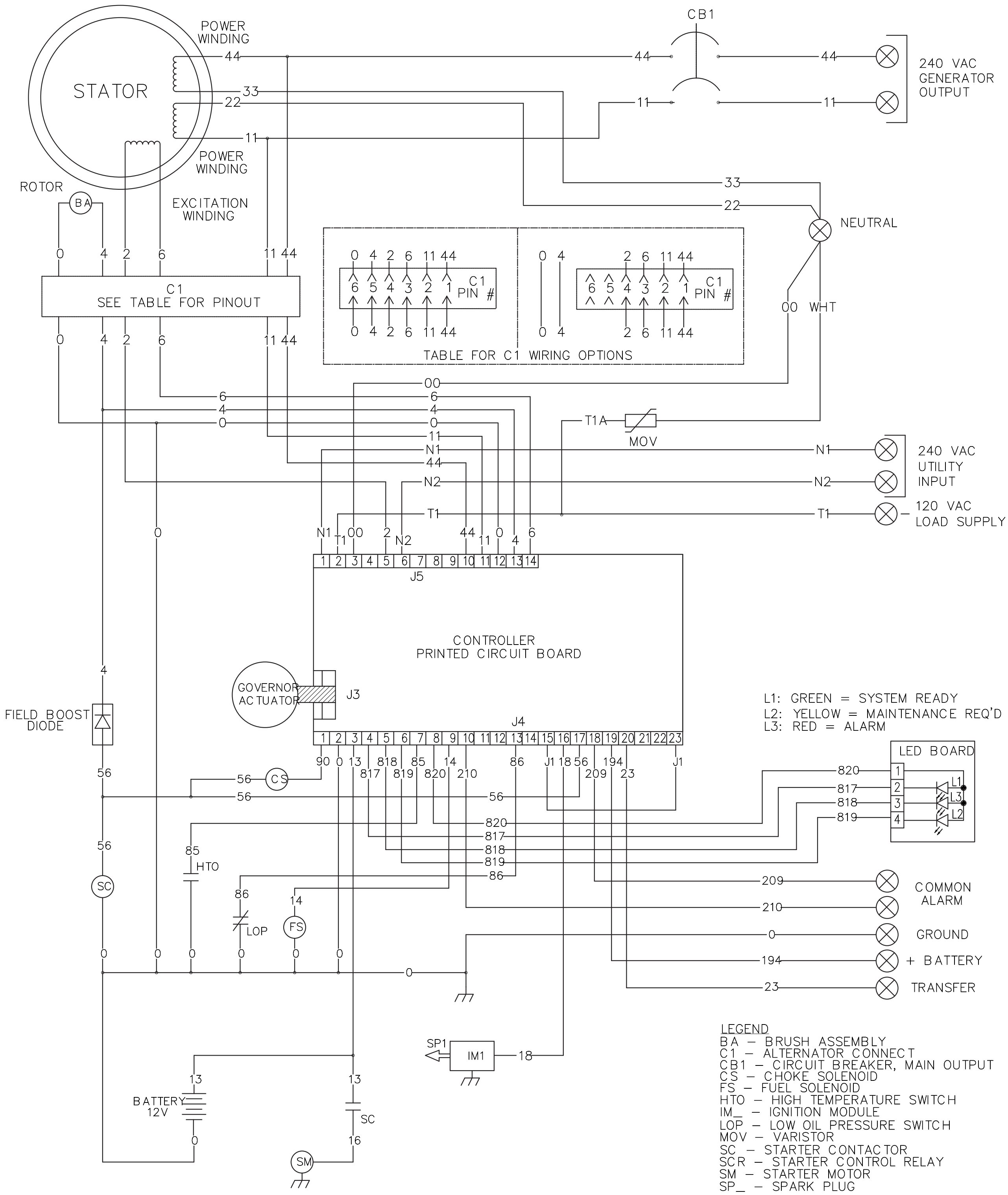
Wiring Diagram – Drawing 0H6912-B



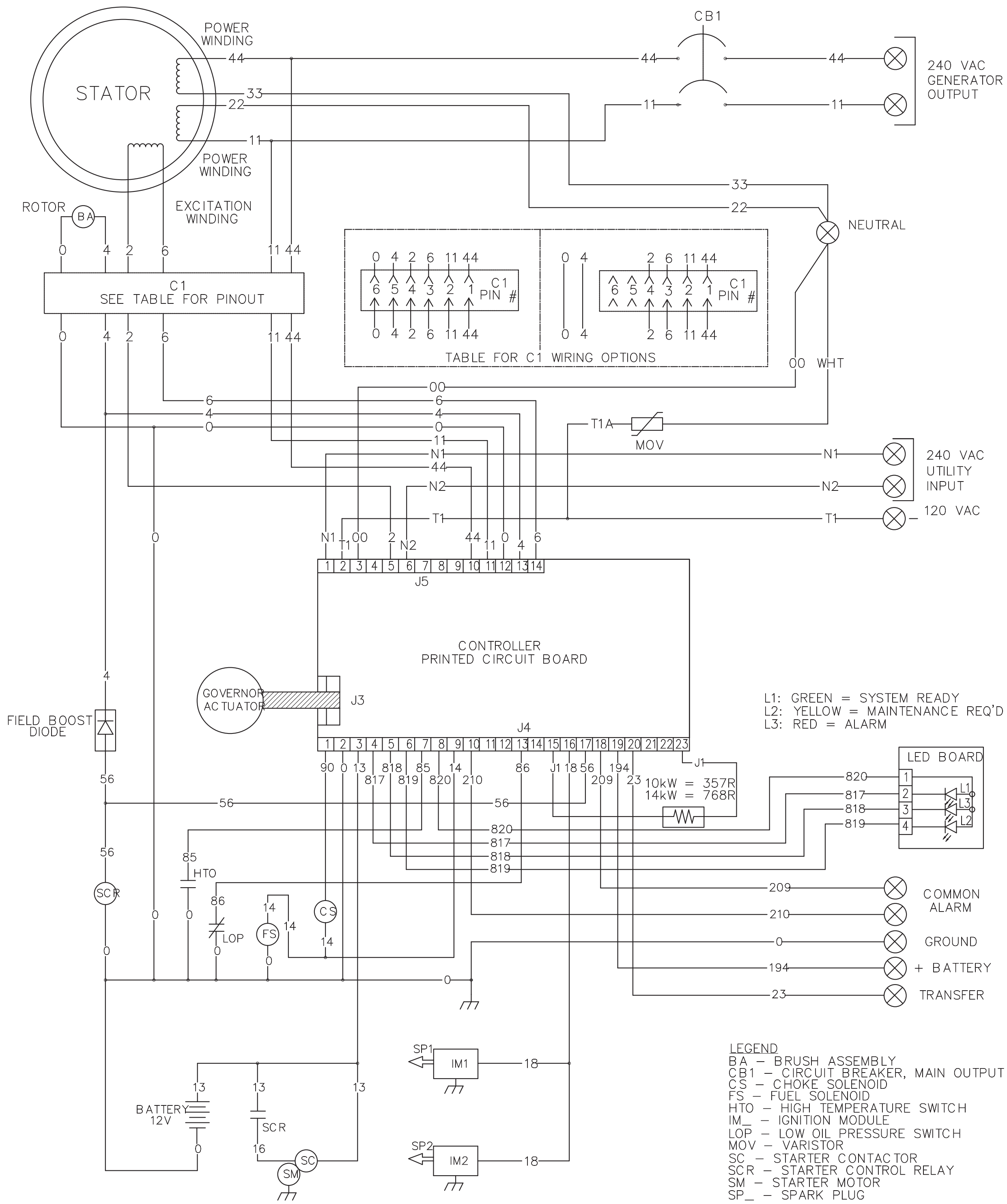
Wiring Diagram – Drawing 0H6912-B



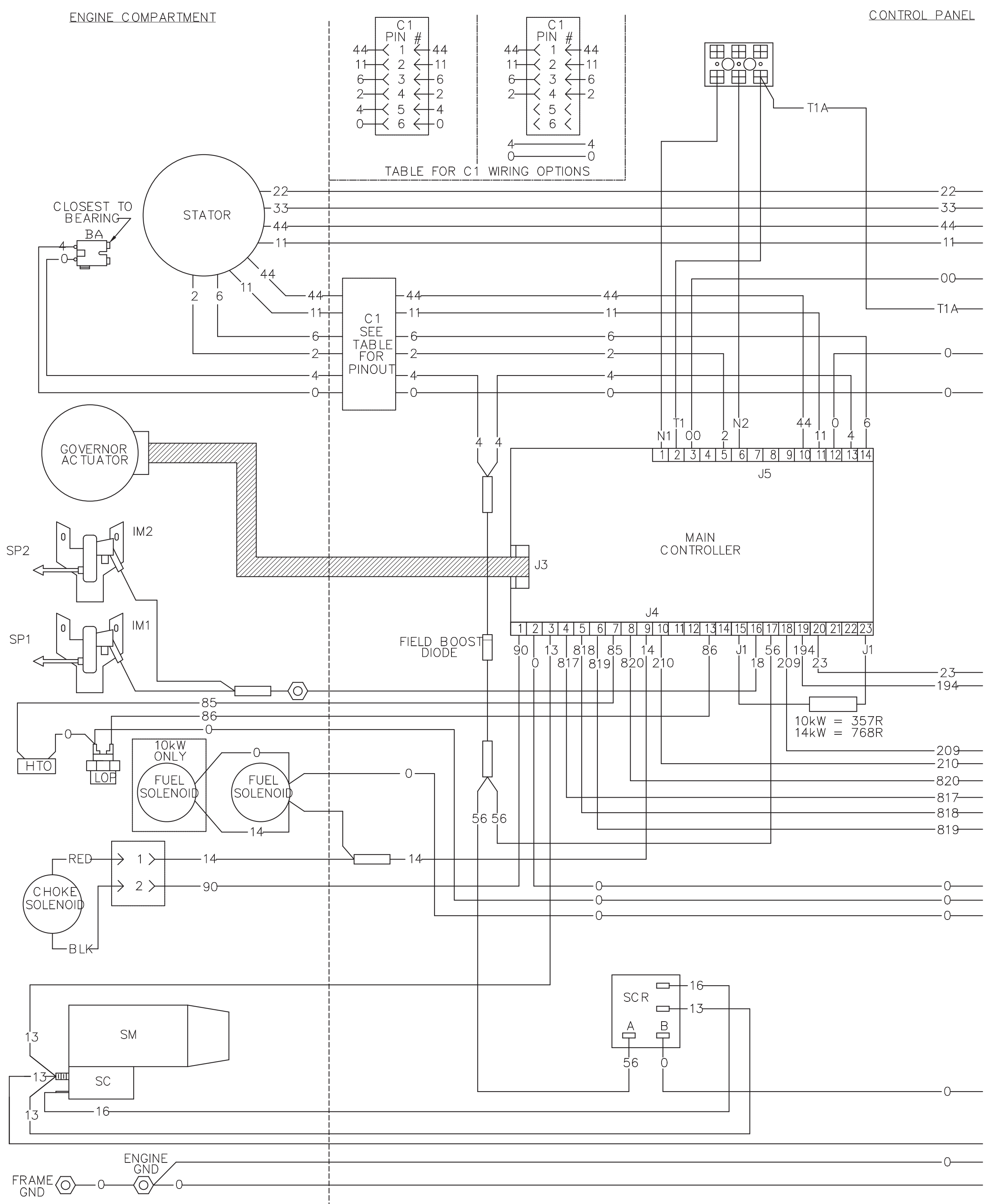
Electrical Schematic – 0H6912-B



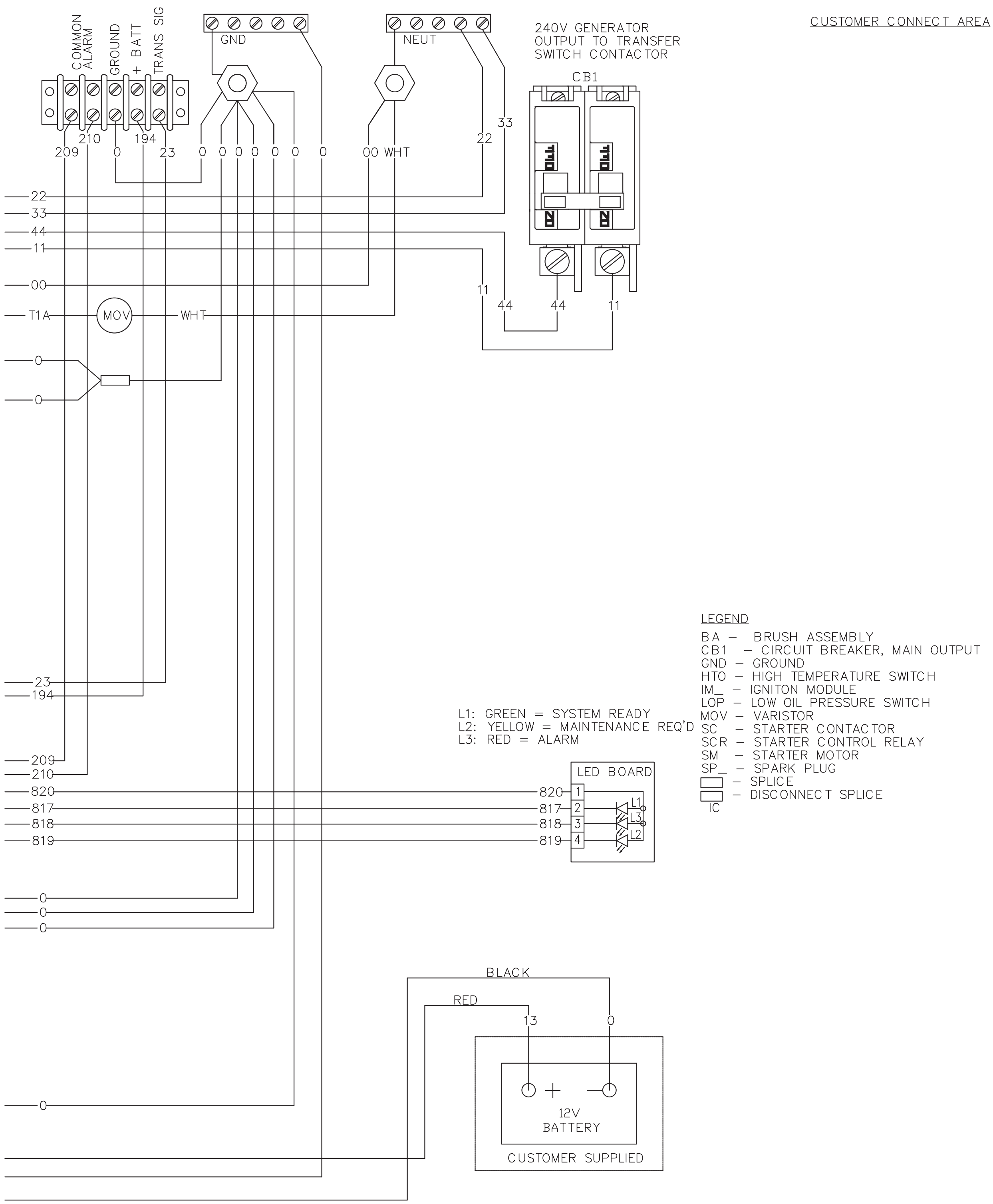
Wiring Diagram – Drawing 0H7358-B



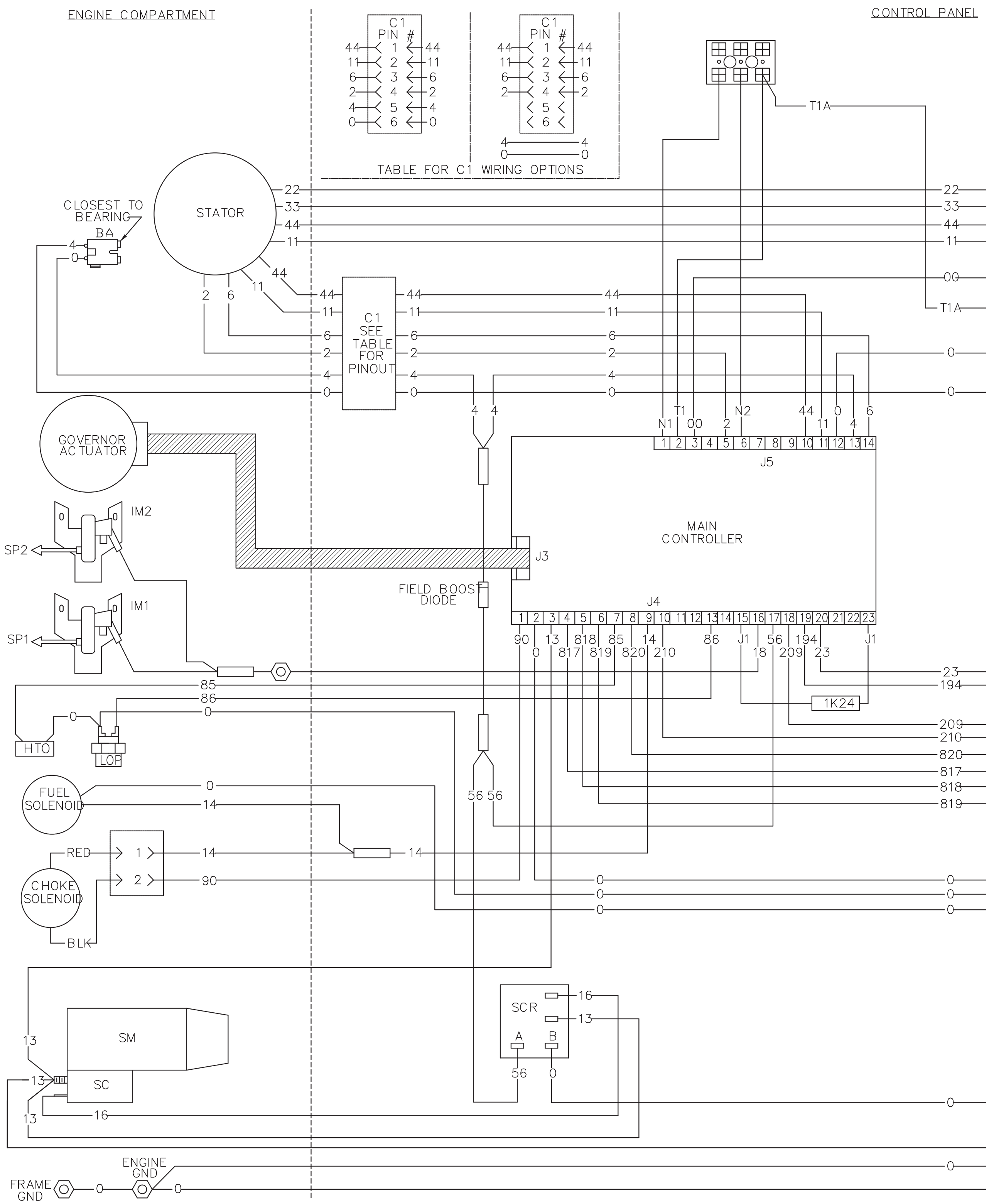
Electrical Schematic – Drawing 0H7358-B



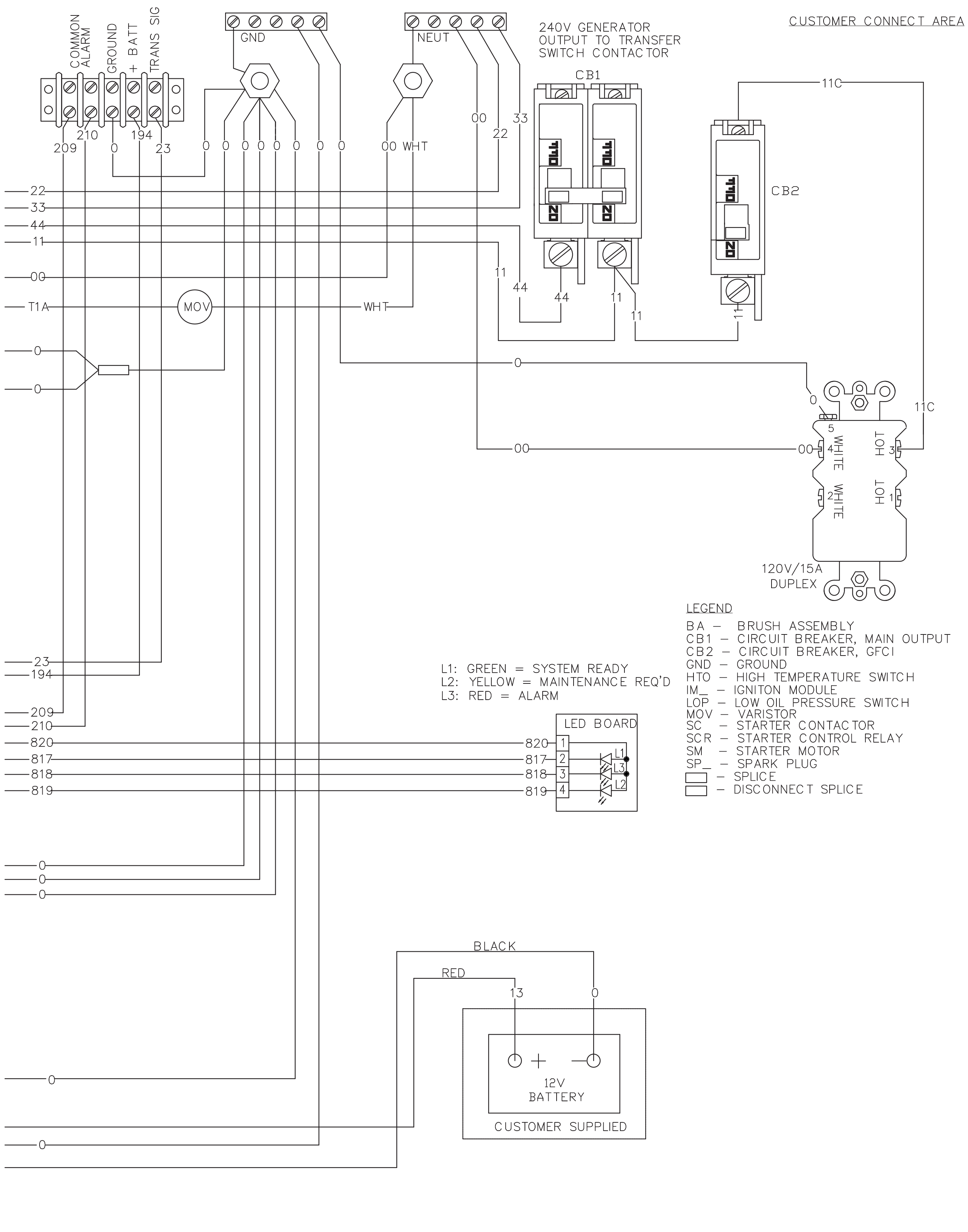
Electrical Schematic – Drawing 0H7358-B



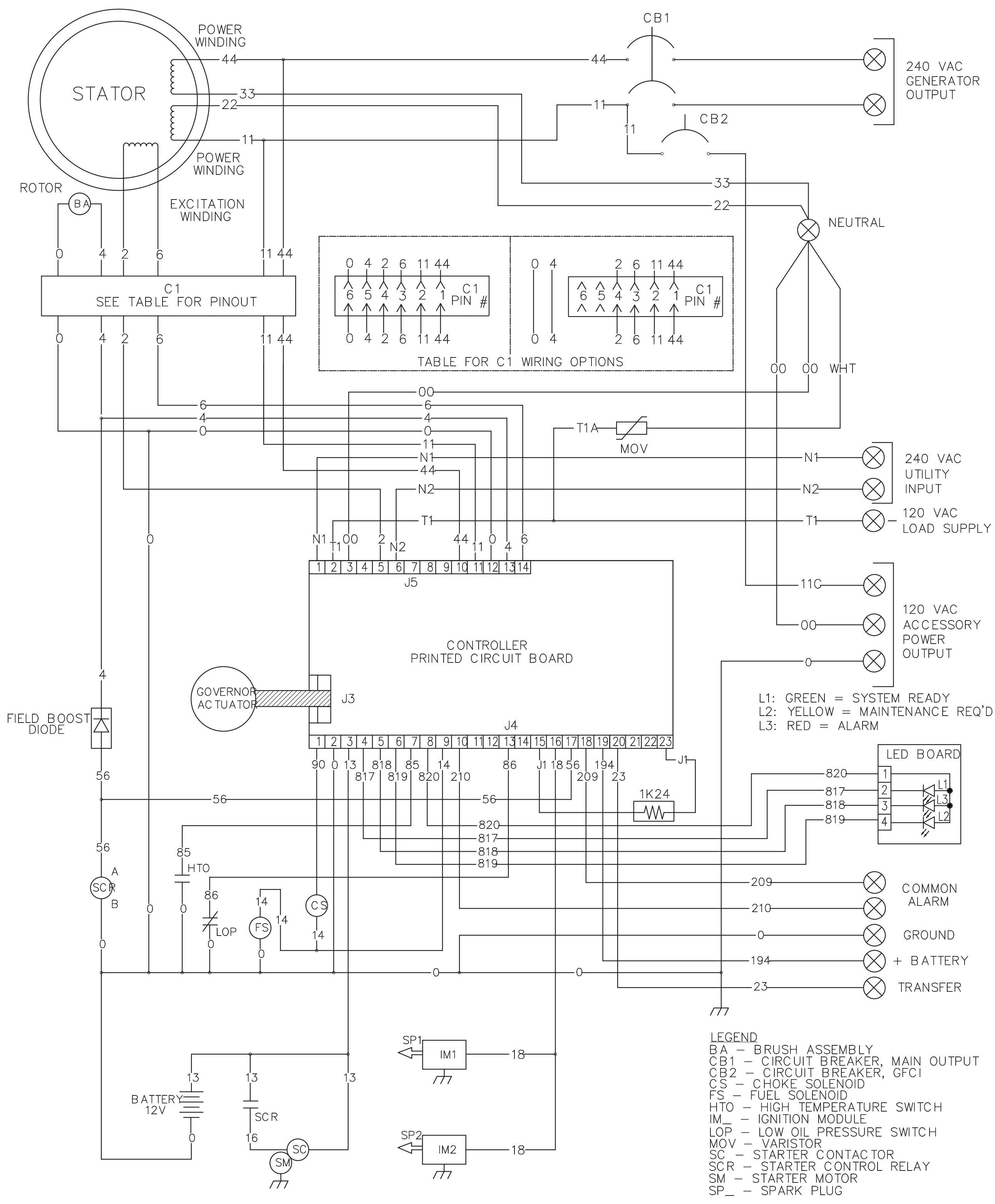
Electrical Schematic – Drawing 0H6198-C



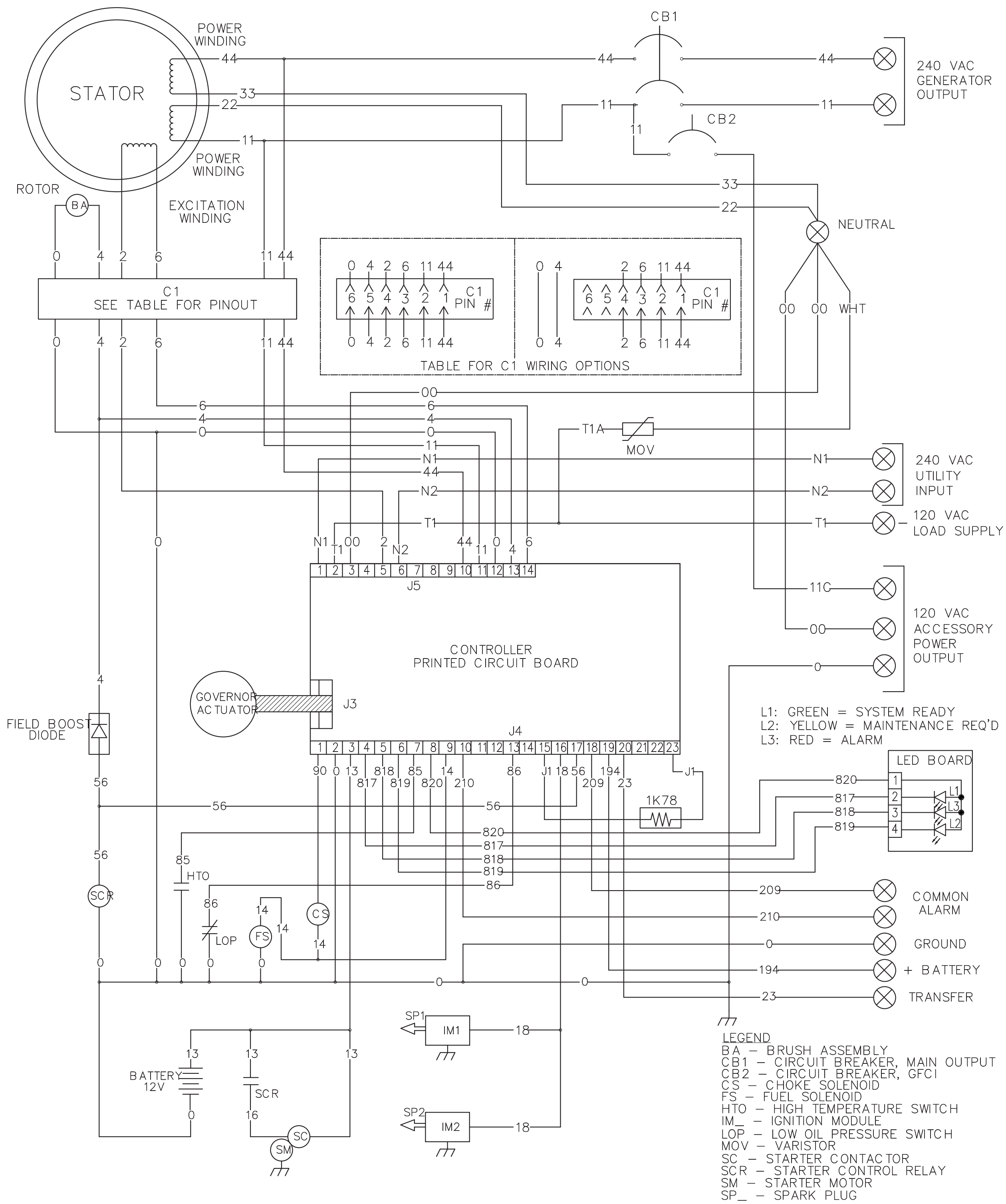
Electrical Schematic – Drawing 0H6198-C



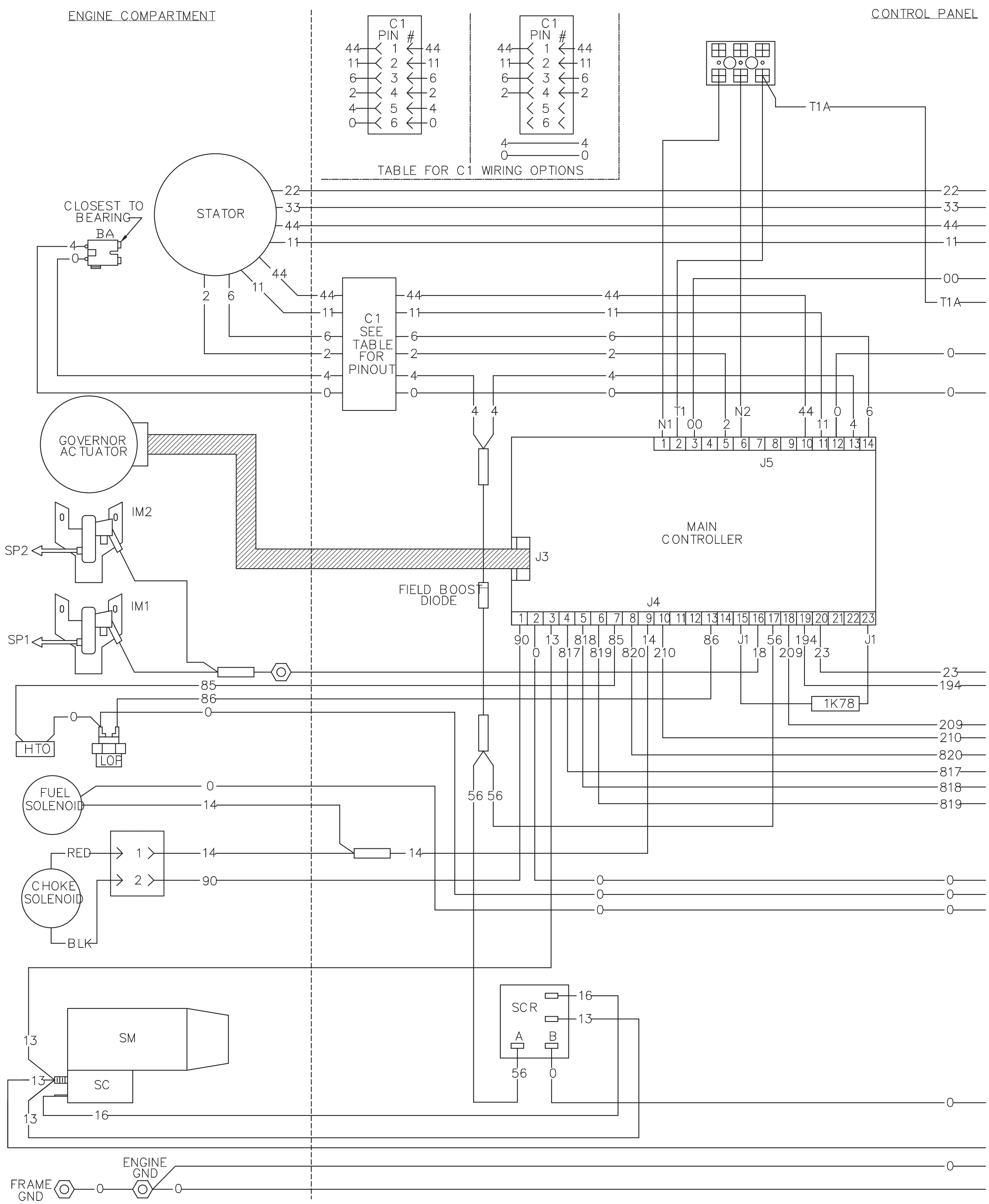
Wiring Diagram – Drawing 0H6198-C



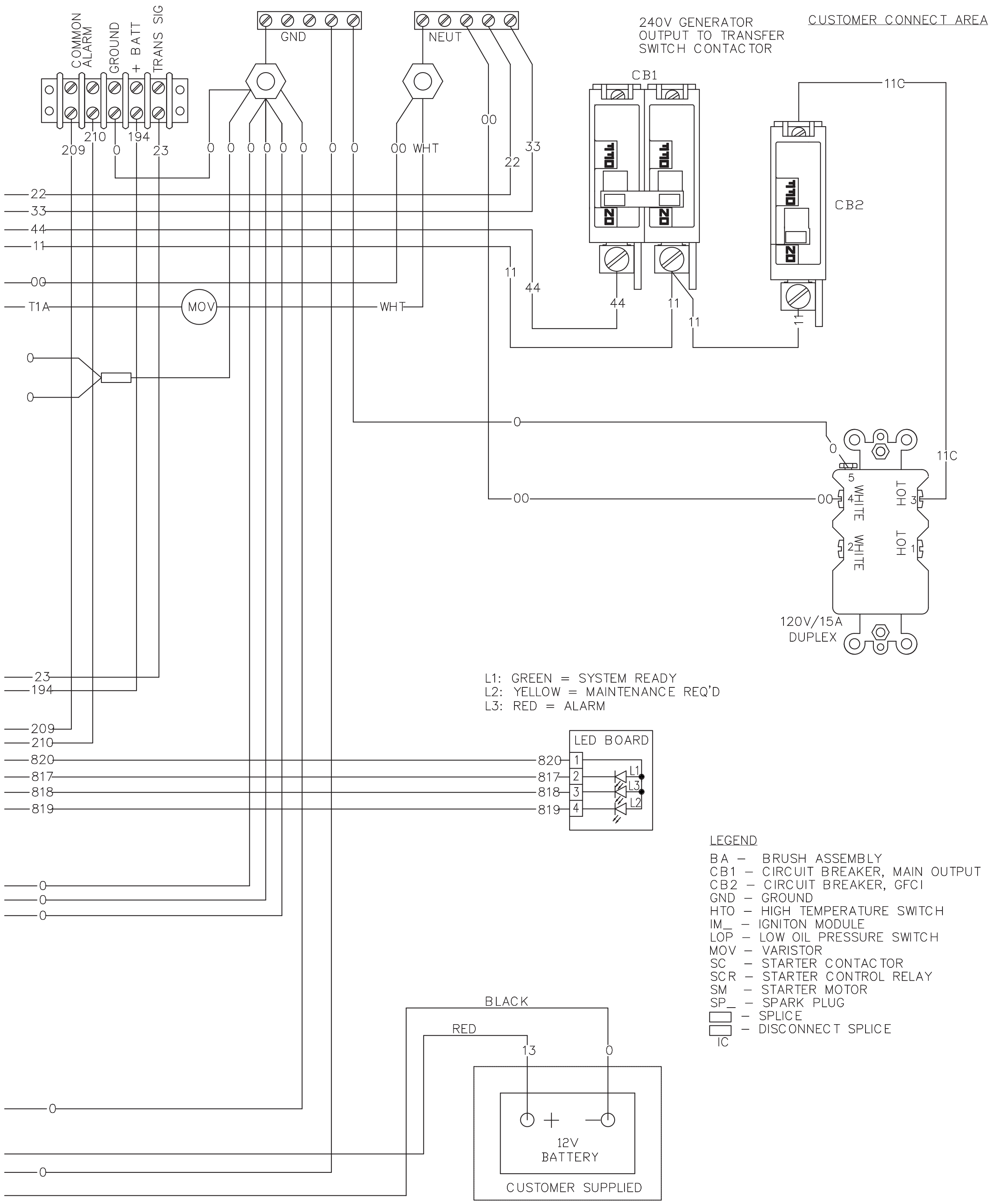
Wiring Diagram – Drawing 0H7570-B



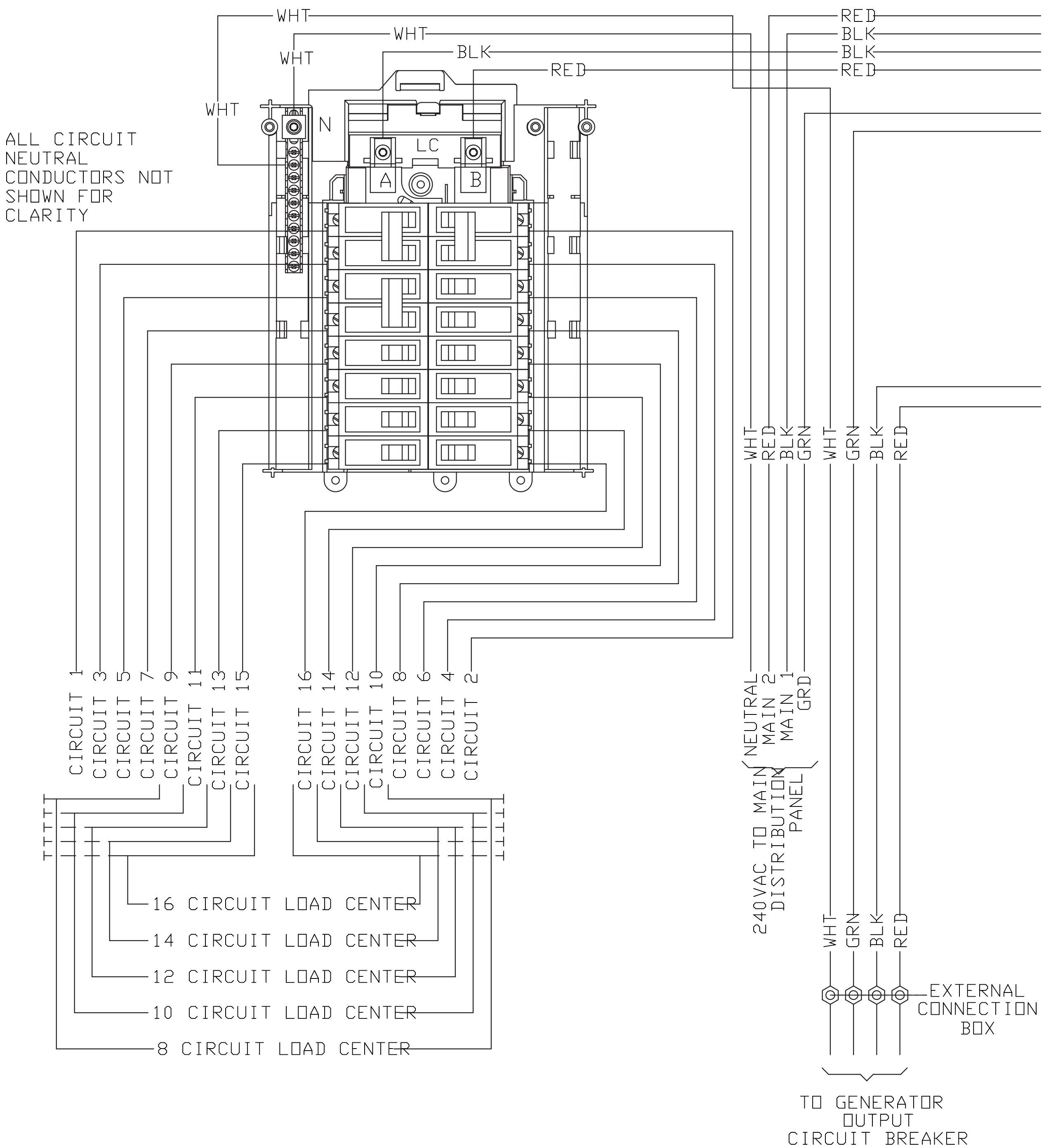
Electrical Schematic – Drawing 0H7570-B



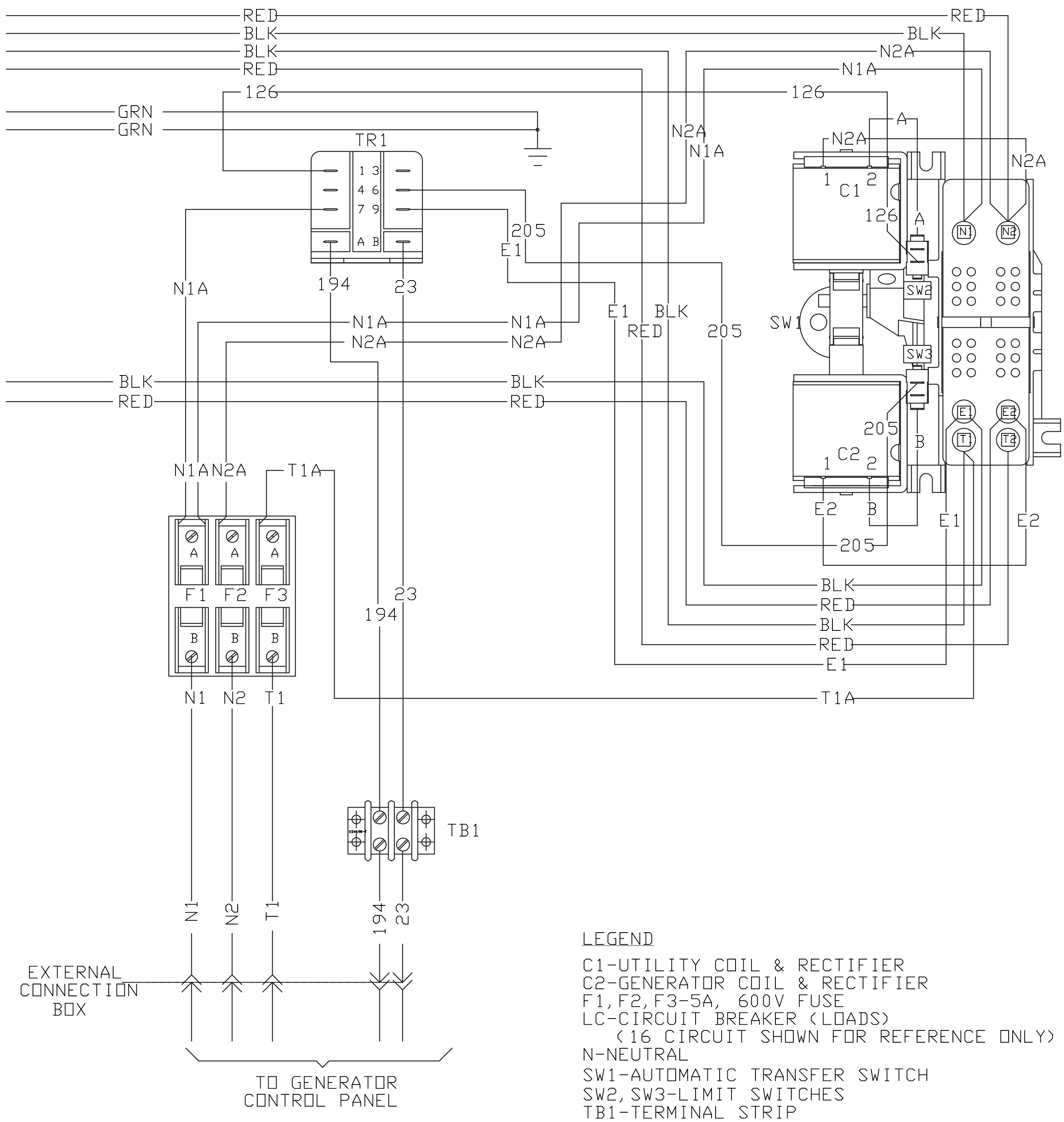
Electrical Schematic – Drawing 0H7570-B



Electrical Schematic – Drawing 0H6385-A



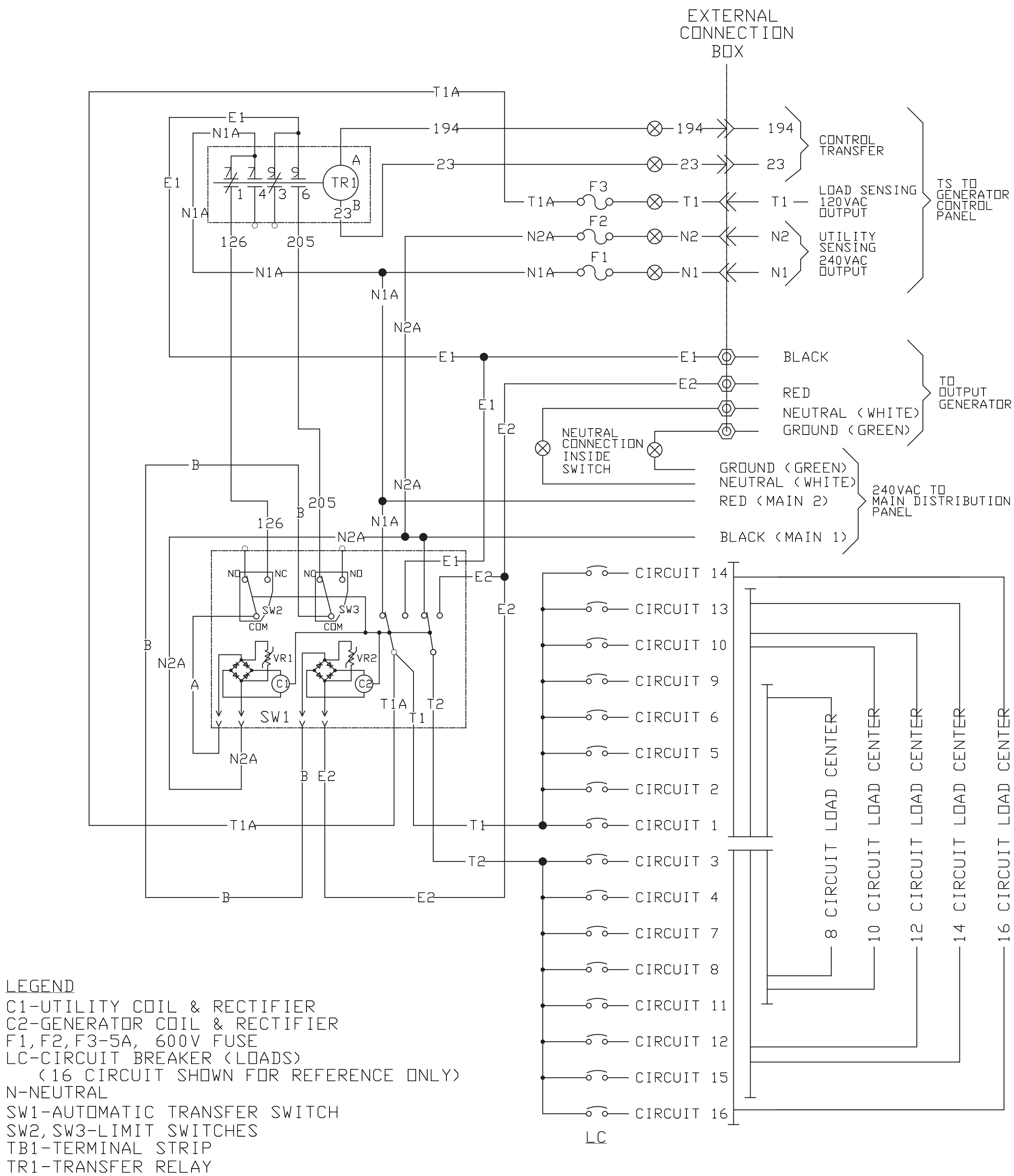
Electrical Schematic – Drawing 0H6385-A



LEGEND

C1-UTILITY COIL & RECTIFIER
C2-GENERATOR COIL & RECTIFIER
F1,F2,F3-5A, 600V FUSE
LC-CIRCUIT BREAKER (LOADS)
(16 CIRCUIT SHOWN FOR REFERENCE ONLY)
N-NEUTRAL
SW1-AUTOMATIC TRANSFER SWITCH
SW2,SW3-LIMIT SWITCHES
TB1-TERMINAL STRIP
TR1-TRANSFER RELAY

Electrical Schematic – Drawing 0H6386-B



Electrical Formulas

TO FIND	KNOWN VALUES	1-PHASE
KILOWATTS (kW)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$
AMPERES	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$
WATTS	Volts, Amps, Power Factor	Volts x Amps
NO. OF ROTOR POLES	Frequency, RPM	$\frac{2 \times 60 \times Frequency}{RPM}$
FREQUENCY	RPM, No. of Rotor Poles	$\frac{RPM \times Poles}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times Frequency}{Rotor\ Poles}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{Efficiency}$
RESISTANCE	Volts, Amperes	$\frac{E}{I}$
VOLTS	Ohm, Amperes	I x R
AMPERES	Ohms, Volts	$\frac{E}{R}$

E = VOLTS I = AMPERES R = RESISTANCE (OHMS) PF = POWER FACTOR

APPENDIX A SUPPLEMENTAL WORKSHEETS

TABLE OF CONTENTS

Air-cooled, Automatic Standby Generators

Table 9
Test 4 Results

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Test 4 Results, Serial #________		
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Table 14
Test 7 Stator Results

Test 7 Stator Results, Serial #______________________		
Test Point A	Test Point B	Results
Resistance Tests		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
C1 Pin 2 Wire 11	Stator Lead 22	
C1 Pin 1 Wire 44	Stator Lead 33	
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2	
Shorts to Ground		
Stator Lead 11	Ground	
Stator Lead 44	Ground	
C1 Pin 1 Wire 44	Ground	
C1 Pin 2 Wire 11	Ground	
C1 Pin 4 Wire 2	Ground	
Shorted Condition		
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11	
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead 11	C1 Pin 1 Wire 44	
Stator Lead 11	Stator lead Wire 44	

Test 7 Stator Results, Serial #______________________		
Test Point A	Test Point B	Results
Resistance Tests		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
C1 Pin 2 Wire 11	Stator Lead 22	
C1 Pin 1 Wire 44	Stator Lead 33	
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2	
Shorts to Ground		
Stator Lead 11	Ground	
Stator Lead 44	Ground	
C1 Pin 1 Wire 44	Ground	
C1 Pin 2 Wire 11	Ground	
C1 Pin 4 Wire 2	Ground	
Shorted Condition		
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11	
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead 11	C1 Pin 1 Wire 44	
Stator Lead 11	Stator lead Wire 44	

Test 7 Stator Results, Serial #______________________		
Test Point A	Test Point B	Results
Resistance Tests		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
C1 Pin 2 Wire 11	Stator Lead 22	
C1 Pin 1 Wire 44	Stator Lead 33	
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2	
Shorts to Ground		
Stator Lead 11	Ground	
Stator Lead 44	Ground	
C1 Pin 1 Wire 44	Ground	
C1 Pin 2 Wire 11	Ground	
C1 Pin 4 Wire 2	Ground	
Shorted Condition		
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11	
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead 11	C1 Pin 1 Wire 44	
Stator Lead 11	Stator lead Wire 44	

Test 7 Stator Results, Serial #______________________		
Test Point A	Test Point B	Results
Resistance Tests		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
C1 Pin 2 Wire 11	Stator Lead 22	
C1 Pin 1 Wire 44	Stator Lead 33	
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2	
Shorts to Ground		
Stator Lead 11	Ground	
Stator Lead 44	Ground	
C1 Pin 1 Wire 44	Ground	
C1 Pin 2 Wire 11	Ground	
C1 Pin 4 Wire 2	Ground	
Shorted Condition		
C1 Pin 4 Wire 2	C1 Pin 2 Wire 11	
C1 Pin 4 Wire 2	C1 Pin 2 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead 11	C1 Pin 1 Wire 44	
Stator Lead 11	Stator lead Wire 44	

Table 26
Test 66 Results

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Test 66 Results, Serial #________			
Test Point	Pin Location	Circuit	Result
1	J4 Pin 9	Wire 14	
2	J4 Pin 17	Wire 56	
3	J4 Pin 19	Wire 194	

Date: ______________________________

Serial #: ______________________________

Failed Part #: ______________________________

Describe the symptoms of the fault:

____

____

____

____

Fill in the test number performed during troubleshooting and indicate if it passed or failed. If it failed the test, describe what part of the test failed.

Problem # ____________________

1.) Test #	**2.) Test #**	**3.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
4.) Test #	**5.) Test #**	**6.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
7.) Test #	**8.) Test #**	**9.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:

Summary of why generator failed or which part was no longer operational.

Date: ______________________________

Serial #: ______________________________

Failed Part #: ______________________________

Describe the symptoms of the fault:

____

____

____

____

Fill in the test number performed during troubleshooting and indicate if it passed or failed. If it failed the test, describe what part of the test failed.

Problem # ____________________

1.) Test #	**2.) Test #**	**3.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
4.) Test #	**5.) Test #**	**6.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
7.) Test #	**8.) Test #**	**9.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:

Summary of why generator failed or which part was no longer operational.

Date: ______________________________

Serial #: ______________________________

Failed Part #: ______________________________

Describe the symptoms of the fault:

____

____

____

____

Fill in the test number performed during troubleshooting and indicate if it passed or failed. If it failed the test, describe what part of the test failed.

Problem # ____________________

1.) Test #	**2.) Test #**	**3.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
4.) Test #	**5.) Test #**	**6.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
7.) Test #	**8.) Test #**	**9.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
Summary of why generator failed or which part was no longer operational.		

Date: ______________________________

Serial #: ____________________________

Failed Part #: _________________________

Describe the symptoms of the fault:

____

____

____

____

Fill in the test number performed during troubleshooting and indicate if it passed or failed. If it failed the test, describe what part of the test failed.

Problem # ____________________

1.) Test #	**2.) Test #**	**3.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
4.) Test #	**5.) Test #**	**6.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
7.) Test #	**8.) Test #**	**9.) Test #**
Pass ❑ Fail ❑	Pass ❑ Fail ❑	Pass ❑ Fail ❑
Reason:	Reason:	Reason:
Summary of why generator failed or which part was no longer operational.		

Date: ______________________________

Serial #: ______________________________

Failed Part #: ______________________________

Describe the symptoms of the fault:

____

____

____

____

Fill in the test number performed during troubleshooting and indicate if it passed or failed. If it failed the test, describe what part of the test failed.

Problem # ____________________

1.) Test #	**2.) Test #**	**3.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
4.) Test #	**5.) Test #**	**6.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
7.) Test #	**8.) Test #**	**9.) Test #**
Pass ❏ Fail ❏	Pass ❏ Fail ❏	Pass ❏ Fail ❏
Reason:	Reason:	Reason:
Summary of why generator failed or which part was no longer operational.		

APPENDIX B INDEX OF FIGURES AND TABLES

Air-cooled, Automatic Standby Generators

TABLE OF CONTENTS

Index of Figures

Index of Tables

NOTES

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Part No. 0H9172 Printed in USA Rev. C 04/07/11

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