

**DIAGNOSTIC
REPAIR
MANUAL**



50 Hz and 60 Hz Air-Cooled Product
with Evolution™ or Nexus™ Control



STANDBY GENERATORS

⚠️ WARNING

Operating, servicing and maintaining this equipment can expose you to chemicals including engine exhaust, carbon monoxide, phthalates, and lead, which are known to the State of California to cause cancer and birth defects or other reproductive harm. To minimize exposure, avoid breathing exhaust, do not idle the engine except as necessary, service your equipment in a well-ventilated area and wear gloves or wash your hands frequently when servicing your equipment.

For more information go to www.P65Warnings.ca.gov.

(000393)

Frequently Asked Questions

Q: Do I have to supply the generator with the 100% loaded BTU rated fuel supply and pipe size?

A: Yes, the generator needs the 100% loaded BTU fuel rating to start, run and handle loads. The fuel pipe must be sized for 100% load, regardless of the load.

Q: What distance does the gas regulator need to be from the generator?

A: Distance is best practices per the regulator manufacturer's instruction to assure proper operation of the regulator and also to meet code.

Q: Can I use a fuel shut off valve that is not "Full Flow Rated"?

A: No, it must be a Full Flow Rated valve and must also match the required fuel pipe ID dimensions.

Q: Do pipe elbows, tees, sediment traps, etc., affect gas pipe size and flow?

A: Yes, they are restrictions to gas flow. You must add 2.5ft. (.76m) per each elbow, tee, etc. to the overall calculated distance from the source to the generator.

Q: Can I leave the unit on the shipping pallet and install it?

A: No, it must be installed per local jurisdiction, code and the instructions as outlined by Generac.

Q: Can the generator be mounted indoors or in a structure?

A: No, it is designed, manufactured and sold for outdoor use only!

Q: Can I run the Main AC and Control Wires in the same conduit?

A: Yes, this wiring can be run in the same conduit if the appropriate rated wire and insulation is used and it meets code.

Q: Can the Transfer Switch be mounted outdoors?

A: Only if it's a NEMA 3R rated transfer switch.

Quick Reference Guide (Evolution Controllers)

Problem	LED	Things to Check	Active Alarm	Solution
Unit running in AUTO but no power in house.	GREEN or Flashing GREEN (2017 Units and newer with Firmware version 1.17 and up.)	Check MLCB.	NONE	Check MLCB. If the MLCB is in the ON position contact the servicing dealer.
Unit shuts down during operation.	RED	Check the LED's/ Screen for alarms.	HIGH TEMPERATURE	Check ventilation around the generator, intake, exhaust and rear of generator. If no obstruction contact servicing dealer.
Unit shuts down during operation.	RED	Check the LED's/ Screen for alarms.	OVERLOAD REMOVE LOAD	Clear alarm and remove household loads from the generator. Put back in AUTO and restart.

Quick Reference Guide (Evolution Controllers)

Problem	LED	Things to Check	Active Alarm	Solution
Unit was running and shuts down, attempts to restart.	RED	Check the LED's/ Screen for alarms.	RPM SENSE LOSS	Clear alarm and remove household loads from the generator. Put back in AUTO and restart. It may be a fuel issue so contact the servicing dealer.
Unit will not start in AUTO with utility loss.	NONE	See if screen says unit not activated.	NOT ACTIVATED	Refer to activation section in owners manual.
Unit will not start in AUTO with utility loss.	GREEN	Check screen for start delay countdown.	None	If the start up delay is greater than expected, contact servicing dealer to adjust from 2 to 1500 seconds.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	LOW OIL PRESSURE	Check Oil Level/Add Oil Per Owners Manual. If oil level is correct contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	RPM SENSE LOSS	Clear alarm. Check the battery using the control panel under the MAIN menu using the BATTERY MENU option. If it states battery is GOOD contact servicing dealer. If it states CHECK BATTERY replace the battery.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	OVERCRANK	Check fuel line shutoff valve is in the ON position. Clear alarm. Attempt to start the unit in MANUAL. If it does not start or starts and runs rough, contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	OVERLOAD REMOVE LOAD	Clear alarm and remove household loads from the generator. Put back in AUTO and restart.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	FUSE PROBLEM	Check the 7.5 Amp fuse. If it is bad replace it with an ATO 7.5 Amp fuse, if not contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	OVERSPEED	Contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	UNDERVOLTAGE	Contact servicing dealer.

Quick Reference Guide (Evolution Controllers)

Problem	LED	Things to Check	Active Alarm	Solution
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	UNDERSPEED	Contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	STEPPER OVERCURRENT	Contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	MISWIRE	Contact servicing dealer.
Unit will not start in AUTO with utility loss.	RED	Check the LED's/ Screen for alarms.	OVERVOLTAGE	Contact servicing dealer.
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	LOW BATTERY	Clear alarm. Check the battery using the control panel under the MAIN menu using the BATTERY MENU option. If it states battery is GOOD contact servicing dealer. If it states CHECK BATTERY replace the battery.
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	BATTERY PROBLEM	Contact servicing dealer.
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	CHARGER WARNING	Contact servicing dealer
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	SERVICE A	Perform SERVICE A maintenance, hit ENTER to clear.
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	SERVICE B	Perform SERVICE B maintenance, hit ENTER to clear.
Yellow LED illuminated in any state.	YELLOW	Check the screen for additional information.	Inspect Battery	Inspect Battery, hit ENTER to clear.

Safety

Throughout this publication and on tags and decals affixed to the generator, DANGER, WARNING, and CAUTION blocks are used to alert personnel to special instructions about a particular operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully. Their definitions are as follows:



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

(000001)



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

(000002)



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

(000003)

NOTE: Notes provide additional information important to a procedure or component.

These safety alerts cannot eliminate the hazards they indicate. Observing safety precautions and strict compliance with the special instructions while performing the action or service are essential to preventing accidents.

Read This Manual Thoroughly

This diagnostic manual has been written and published by Generac to aid qualified Generac dealer 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.

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.

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
QuietTest	WhisperCheck
Nexus/Evolution Controller	Sync 1.0/Sync 2.0 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
Service Rated Switches	
Non-Service Rated Switches	

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Section 1.1 Generator Basics

Introduction

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

This manual has been divided into SECTIONS and each section consists of SUBSECTIONS.

This manual is not intended to provide detailed disassembly and reassembly of the entire Residential product line. This manual is intended to:

- Provide the service technician with an understanding of how the various assemblies and systems work.
- Assist the technician in finding the cause of malfunctions.
- Effect the expeditious repair of the equipment.

Sections

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

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

Section 3 – Transfer Switch – Provides the troubleshooting and diagnostic testing procedure for:

- Pre-packaged 10,12,14,16 circuit EZ Switch™ transfer switches.
- RTSY service and non service entrance rated transfer switches with load management systems.

Section 4 – Engine/DC Control – Provides the troubleshooting and diagnostic testing procedure for engine related problems on the Nexus™ and Evolution™ Controllers.

Section 5 – Disassembly – Provides detailed step-by-step instructions for the replacement of the rotor/stator and engine.

Section 6 – Electrical Data – Illustrates all of the electrical and wiring diagrams for the various kW ranges and transfer switches.

Specifications

Unit	8 kW	9 kW	11 kW	13 kW	14 kW	15 kW	16 kW	17 kW	20 kW	22 kW
Rated Voltage	240									
Rated Max. Continuous Load Current (Amps) 240 Volts (LP/NG)	33.3/29.2	37.5/33.3	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	91.6/86.3
Main Line Circuit Breaker	35 Amp	40 Amp	50 Amp	55 Amp	60 Amp	60 Amp	65 Amp	65 Amp	90 Amp	100 Amp
Main Line Circuit Breaker (2017)	35 Amp	40 Amp	50 Amp	55 Amp	60 Amp	60 Amp	70 Amp	70 Amp	100 Amp	100 Amp
Phase	1									
Rated AC Frequency	60 Hz									
Battery Requirement	Group 26R, 12 Volts and 525 CCA Minimum									
Battery Requirement (2017)	Group 26R, 12 Volts and 525 CCA Minimum or Group 35AGM, 12 Volts and 650 CCA Minimum									
Enclosure, Evolution	Steel	n/a	Steel	Steel	Steel	Steel	Steel	Steel/Aluminum	Aluminum	Aluminum
Enclosure, Evolution (2017)	Aluminum							Steel	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).									

These generators are rated in accordance with UL 2200, Safety Standard for Stationary Engine Generator Assemblies and CSA-C22.2 No. 100-04 Standard for Motors and Generators.

* Natural Gas ratings will depend on specific fuel Btu/joules content. Typical derates are between 10-20% off the LP gas rating.

** 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.

Unit	8 kVA	10 kVA	13 kVA
Rated Voltage	110/220		
Rated Max. Continuous Load Current (Amps) 220 Volts (LP/NG)	36.4/31.8	45.5/45.5	59/59
Main Line Circuit Breaker	35 Amp	50 Amp	65 Amp
Phase	1		
Rated AC Frequency	50 Hz		
Battery Requirement	Group 26R, 12 Volts and 525 CCA Minimum		
Battery Requirement (2017)	Group 26R, 12 Volts and 525 CCA Minimum or Group 35AGM, 12 Volts and 650 CCA Minimum		
Enclosure	Steel	Steel	Steel
Enclosure (2017)	Aluminum	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).		

These generators are rated in accordance with UL 2200, Safety Standard for Stationary Engine Generator Assemblies and CSA-C22.2 No. 100-04 Standard for Motors and Generators.

* Natural Gas ratings will depend on specific fuel Btu/joules content. Typical derates are between 10-20% off the LP gas rating.

** 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.

Generator Size	8/9 kW	11 kW	16-20 kW	22 kW	50 Hz (8/10/13 kVA)
Low Speed Exercise	n/a *	n/a * ~	2400 rpm	1950 rpm	n/a *
Exercise Frequency Options	Options Weekly/Bi-Weekly/Monthly				
Exercise Time Length	12 minutes	12 minutes	5 minutes	5 minutes	5 minutes

* Exercises at 3600 rpm

~ Private label may vary

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-4. 60 Hz – Stator Winding Resistance Values / Rotor Resistance*

	8 kW	9 kW	11 kW	13/14 kW	15 kW	16/17 kW	20 kW	22 kW
Power Windings Across 11 & 22	0.1584-0.1840	0.1580-0.1836	0.1584-0.1840	0.1227-0.1425	0.0758-0.0881	0.0720-0.0837	0.0421-0.0489	0.0361 - 0.0419
Power Windings Across 11&44	0.3168-0.3680	0.3160-0.3672	0.3168-0.3680	0.2454-0.2850	0.1050-0.1220	0.1440-0.1674	0.0824-0.0978	0.0722 - 0.0838
Power Windings Across 33 & 44	0.1584-0.1840	0.1580-0.1836	0.1584-0.1840	0.1227-0.1425	0.0758-0.0881	0.0720-0.0837	0.0421-0.0489	0.0361 - 0.0419
Sensing Windings Across 11 & 44	0.3538-.4112	0.3712-0.4314	0.3538-0.4112	0.2824-0.3280	0.1050-0.1220	0.197-0.229	0.137-0.1594	0.1526 - 0.1772
Excitation Windings Across 2 & 6	0.5517-0.6413	1.0011-1.1634	0.5517-0.6414	0.8506-0.9885	0.7093-0.8243	0.7093-0.8243	0.6121-0.7114	0.6392 - 0.7429
Rotor Resistance	4.96-5.76	6.30-7.32	4.97-5.76	7.22-8.39	8.39-9.72	8.37-9.72	9.54-11.10	10.25 - 11.92

* 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.

Table 1-5. 50 Hz – Stator Winding Resistance Values / Rotor Resistance*

	8 kVA	10 kVA	13 kVA
Power Windings: Across 11 & 22	0.1752 - 0.2036	0.0823 - 0.0957	0.0589 - 0.0685
Power Windings: Across 11&44	0.3504 - 0.4072	0.164 - 0.1914	0.1178 - 0.137
Power Windings: Across 33 & 44	0.1752 - 0.2036	0.0823 - 0.0957	0.0589 - 0.0685
Sensing Windings: Across 11 & 44	0.3504 - 0.4072	0.1646 - 0.1914	0.1178 - 0.1370
Excitation Windings: Across 2 & 6	0.6933 - 0.8057	0.7412 - 0.8614	0.6933 - 0.8057
Rotor Resistance	6.82 - 7.93	8.28 - 9.62	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.

Table 1-6. Engine with Evolution Controller

Model	8 kW	9 kW	11 kW	13/14/15/16/17 kW	16/17kW (2017) 20/22 kW
Type of Engine	GH-410	GH-426	GT-530	GT-992	GT-999
Number of Cylinders	1	1	2	2	2
Displacement	410cc	426cc	530cc	992cc	999cc
Cylinder Block	Aluminum w/Cast Iron Sleeve				
Recommended Spark Plug	RC14YC	RC12YC	BPR6HS / RL87YC	RC14YC	RC12YC
Spark Plug Gap	0.76 mm (0.030 inch)	0.508 mm (0.020 inch)	0.76 mm (0.030 inch)	1.02 mm (0.040 inch)	1.02 mm (0.040 inch)
Valve Clearance	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)
Compression Pressure	190 psi +/- 10-15%	Min 60 psi *	150 psi +/- 10-15%	165 psi +/- 10-15%	160 psi +/- 10-15%
Starter	12 VDC				
Oil Capacity Including Filter	Approx. 1.5 Qt/1.4L	Approx. 1.1 Qt/1.03L	Approx. 1.7 Qt/1.6L	Approx. 1.9 Qt/1.8L	Approx. 1.9 Qt/1.8L
Recommended Oil Filter	Part # 070185F				
Recommended Air Filter	Part # 0E9371A	0E9371A	Part # 0E9371A	Part # 0J8478	Part # 0J8478

Engine power is subject to and limited by such factors as fuel Btu/joules content, ambient temperature and altitude. Engine power decreases about 3.5 percent for each 1000 feet (304.8 meters) above sea level and will decrease about 1 percent for each 6 ° C (10 ° F) above 15 ° C (60 ° F) ambient temperature.

* 426 engine has a decompression system that will not allow full compression pressure while cranking. Can range from 60 to 110 psi.

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-7. Fuel Consumption with Evolution Controller

Unit	Natural Gas*		LP Vapor**	
	1/2 Load	Full Load	1/2 Load	Full Load
7/8 kW	78/2.21	121/3.43	0.87/3.29	1.42/5.37
9 kW (2017)	109 / 3.09	133 / 3.77	1.00 / 3.79	1.50 / 5.66
10/11 kW	124/3.51	195/5.52	1.18/4.45	1.92/7.28
11 kW (2017)	123/3.48	166/5.64	1.19/4.49	2.01/7.62
13/13 kW	157/4.45	255/7.22	1.64/6.2	2.95/11.15
14/14 kW	177/5.01	279/7.9	1.85/6.99	3.07/11.61
15/15 kW	185/5.24	296/8.38	1.83/6.91	3.19/10.82
16/16 kW	193/5.47	296/8.38	1.9/7.2	3.19/12.07
16/16 kW (2017)	193/5.47	312/8.83	1.9/7.2	3.19/12.07
16/17 kW	193/5.47	312/8.83	1.99/7.53	3.57/13.53
17 kW (2017)	193/5.47	312/8.83	2.0/7.57	3.57/13.53
18/20 kW	205/5.8	308/8.72	2.08/7.87	3.85/14.57
20 kW (2017)	205/5.8	308/8.72	2.23/8.45	3.85/14.57
22 kW	184/5.21	281/7.96	2.16/8.16	3.68/13.94
22 kW (2017)	228/6.46	327/9.26	2.53/9.57	3.90/14.77

* Natural gas is in cubic feet per hour/cubic meters per hour

**LP is in gallons per hour/liters per hour

***Values given are approximate

Table 1-8. 60 Hz – Generator with Nexus Controller

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).							

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-9. 60 Hz – Stator Winding Resistance Values / Rotor Resistance*

	8 kW	10 kW	13 kW	14 kW	15 kW	16 kW	17 kW	20 kW
Power Windings 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 Windings 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 Windings Across 11 & 44	0.378-0.4392	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 Windings 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

Table 1-10. Engine with Nexus Controller

Model	8 kW	10 kW	13/14/15/16/17 kW	20 kW
Type of Engine	GT-410	GT-530	GT-992	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 Valve			
Valve Clearance	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)	0.05-0.1mm (0.002-0.004 in)
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 Qt	Approx. 1.7 Qt	Approx. 1.9 Qt	Approx. 1.9 Qt
Recommended Oil Filter	Part # 070185F			
Recommended Air Filter	Part # 0G3332	Part # 0E9581	Part # 0C8127	Part # 0G5894
Operating RPM	3,600			

* 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.

Table 1-11. Fuel Consumption with Nexus Controller

Unit	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
15/15 kW	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.

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-12. 60 Hz – EcoGen™ Generator with Nexus Controller

Unit	6 kW
Rated Voltage	120 V (240V Capable with Conversion)
Rated Max. Continuous Load Current (Amps) 120 Volts (LP only)	50 (25 @ 240 VAC)
Main Line Circuit Breaker	50 Amp (25 after conversion)
Phase	1
Rated AC Frequency	60 Hz
Battery Requirement	Group 26R, 12 Volts and 525 CCA Minimum
Unit Weight - lbs (kg)	387 (175.5)
Enclosure	Steel
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).

Table 1-13. EcoGen™ with Nexus Controller - Stator Winding Resistance Values / Rotor Resistance

Power Windings: Across 11 & 22	0.2124 - 0.2468
Power Windings: Across 33 & 44	0.2124 - 0.2468
Sensing Windings: Across 11 & 44	0.4248 - 0.4936
Excitation Windings: Across 2 & 6	1.59 - 1.84
Rotor Resistance	10.81

Table 1-14. EcoGen™ Engine with Nexus Controller

Model	6 kW
Type of Engine	Generac OHVI
Number of Cylinders	2
Displacement	530cc
Cylinder Block	Aluminum w/Cast Iron Sleeve
Recommended Spark Plug	BPR6HS
Spark Plug Gap	0.76 mm (0.030 inch)
Starter	12 VDC
Oil Capacity Including Filter	Approx. 1.7 Qt/1.6L
Recommended Oil Filter	Part # 070185F
Oil Reservoir Capacity	4.2 Qt./4.0L
Recommended Air Filter	Part # 0E9371A
Operating RPM	2,600

Engine power is subject to and limited by such factors as fuel Btu/joules content, ambient temperature and altitude. Engine power decreases about 3.5 percent for each 1000 feet (304.8 meters) above sea level and will decrease about 1 percent for each 6 ° C (10 ° F) above 15 ° C (60 ° F) ambient temperature.

IMPORTANT NOTE: All unit specifications are subject to change.

Section 1.2 Testing, Cleaning and Drying

Visual Inspection

Perform a thorough visual inspection before testing or troubleshooting an alternator. 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.
- Loose or frayed wiring insulation, including loose or dirty connections.
- All wiring is well clear of rotating and hot parts.
- Generator output voltage rating matches utility voltage.
- Foreign objects, loose nuts, bolts and other fasteners.
- Area around the generator is clean and clear of paper, leaves, snow, and other objects that might blow against the generator and obstruct air flow.

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 contaminants 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.

IMPORTANT NOTE: When testing stators and rotors, set Megohmmeter to 500 volts and apply voltage for a maximum of one second. Follow the Megohmmeter manufacturers instructions carefully. Do not exceed 500 volts or apply voltage longer than 1 second. Megohmmeter HIGH voltages could cause damage to other components on the generator. Take the proper precautions before testing.

Testing Stator Insulation

See [Figure 1-1](#). Isolate all stator leads and connect all the stator leads together.

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

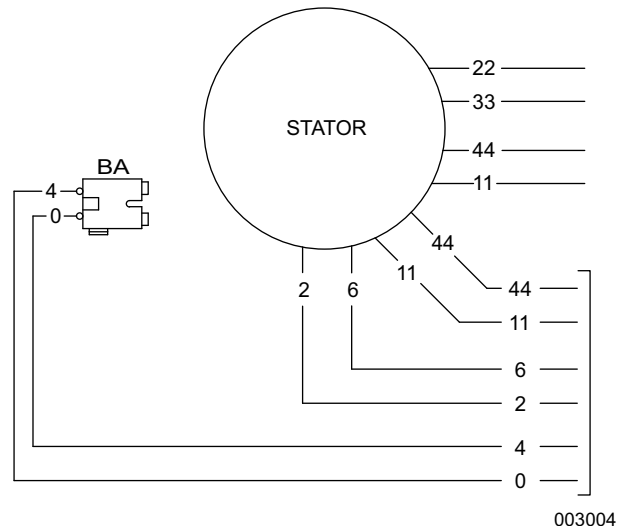


Figure 1-1. Typical Stator Output Leads

To calculate the minimum acceptable Megohmmeter readings use the following formula:

$$\text{Minimum Insulation Resistance (In "Megohms")} = \frac{\text{Generator Rated Volts}}{1000} + 1$$

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

$$\frac{120}{1000} + 1 = 1.2 \text{ megohms}$$

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 Megohmmeter 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 ground (i.e. the rotor shaft).

IMPORTANT NOTE: When testing stators and rotors, set Megohmmeter to 500 volts and apply voltage for a maximum of one second. Follow the Megohmmeter manufacturers instructions carefully. Do not exceed 500 volts or apply voltage longer than 1 second. Megohmmeter HIGH voltages could cause damage to other components on the generator. Take the proper precautions before testing.

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).

IMPORTANT NOTE: Do not use sprayed water to clean the generator. Residual water on generator windings and terminals could cause serious problems.

Drying the Generator

The procedure for drying an alternator is as follows:

1. Open the generator main circuit breaker.

NOTE: Generator should have no electrical loads applied while drying.

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

NOTE: Do not exceed 185 °F (85 °C).

4. 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.

Section 1.3 Evolution Menu System Navigation

Navigation Keys

There are four selection and navigation keys below the display.

Escape

The ESCAPE key will cause the display to move back toward the main menu.

Enter

The ENTER key is used to activate a menu or accept a value when it is changed.

Up and Down

The UP and DOWN triangle keys perform a number of functions depending on which screen of a menu is active.

- Move to the next choice (the menu to be selected will flash on and off).
- Left and right arrows to move between the various editable menus.
- Increase or decrease a value or change a choice in an editable menu (i.e. from Yes to No).

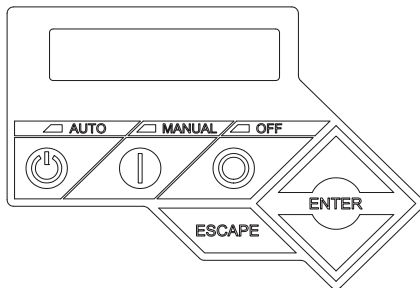


Figure 1-2. Evolution Display and Navigation Buttons

Main Menu

To get to the Main Menu from any other display, press the ESCAPE key one or more times. The Main Menu is shown in Figure 1-3. The menu system diagram is shown in Figure 1-12 and Figure 1-13.

There are four selections in the Main Menu: System, Date/Time, Battery, Sub Menus.

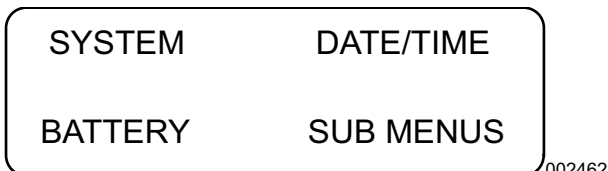


Figure 1-3. Evolution Display Main Menu

System

Selecting SYSTEM returns to the Main Display.

Date/Time

Selecting DATE/TIME displays current date and time.

Battery

Selecting BATTERY displays the battery condition.

Sub Menus

Selecting SUB MENUS displays the Sub Menu screen.

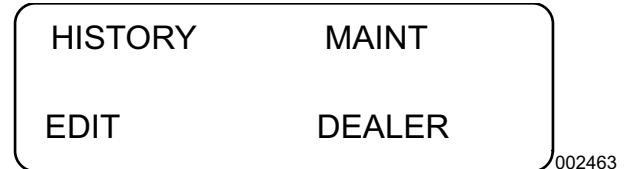


Figure 1-4. Evolution Sub Menu

History

The History Menu displays two history logs:

- **Alarm Log:** displays the last 50 alarm conditions. They are in date and time order, numbered from 1 to 50, with 1 being the most recent. Use the UP and DOWN triangle keys to move from alarm to alarm. Each alarm lists the date, time, and description of the alarm.
- **Run Log:** displays 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.



Figure 1-5. History Menu

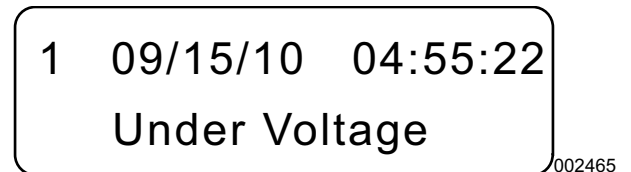


Figure 1-6. Alarm Log Display

Use the UP and DOWN triangle keys to move from the most recent Alarm (1) to the oldest (50).

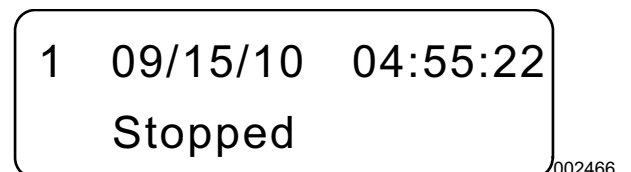


Figure 1-7. Run Log Display.

Use the UP and DOWN triangle keys to move from the most recent Run event (1) to the oldest (50).

Maint

The MAINT Menu displays three selections: Maint Log, Run Hrs, and Scheduled.

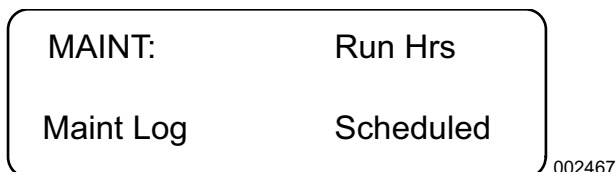


Figure 1-8. Maint Menu

Edit

Selecting the Edit Menu enables editing of the following selections:

- Language
- Fuel Selection
- Cold Smart Start (firmware 1.14 and above)
- Current Date/Time
- Exercise Time
- Exercise Frequency
- Firmware Update

Table 1-15. Cold Smart Start Parameters		
Node	8 - 20 kW	22 kW
Cold Smart Start (2015-02) and Ambient Temp display screen	X	X
Temperature Threshold	50 °F	20 °F
Default Setting	Yes	Yes
Transfer Time Delay	30 sec	30 sec

Run Hrs

View the amount of actual run hours on the unit.

Scheduled

View when the next scheduled maintenance is due.

Maint Log

Review the history of maintenance recorded on the unit.

Evolution Dealer Menu

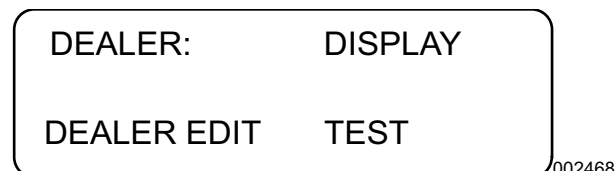


Figure 1-9. Evolution Dealer Menu

Dealer

The Dealer Menu displays three selections:

- Display
- Dealer Edit
- Test

Display

The Display Menu displays these selections:

- Battery Voltage
- Charging Status
- Run Hours
- Output Volts
- Output Frequency (Hz)
- Engine Speed (RPM)
- Utility Input Volts
- Ambient Temperature (°F)
- V Firmware Hardware
- Bootloader EEPROM
- Command
- Node Hz Volts

Use the UP and DOWN triangle keys to move between selections.

Dealer Edit

The Dealer Edit Menu displays these selections:

- Startup Delay
- Run Hours
- Util Volts Low Value
- Util Recovery Volts
- Calibrate Current 1
- Calibrate Current 2
- Calibrate Volts
- 2-Wire Start Select
- Reset Maintenance

These are editable selections within this menu selection.

Test

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

- **INPUTS** displays the status of the 8 input channels monitored by the control panel. See [Table 1-16](#). Each input represents an open or closed set of contacts, and will display either a “0” or “1”. A “0” represents an open contact. A “1” represents a closed contact. This screen also displays Utility Voltage.
- **OUTPUTS** displays the status of the output relays used by the control panel to initiate commands (like

Crank and Run, or Transfer). See [Table 1-16](#). Each channel represents a relay with either a “0” or “1”. A “0” represents a relay that is de-energized (OFF). A “1” represents a relay that is energized (ON). This screen will also display the Generator Output Voltage.

- **Display** provides two flashing bars that test the display LEDs. As the bars flash on and off, bad sectors will not turn on. If a sector does not turn on, those LEDs are not working. The control panel requires replacement to correct a bad display.

NOTE: This will also flash the 3 LED's on the left side of the unit.

- QT-Test is available when enabled on the unit. It provides a way to test the Quiet Test mode of the generator. When tested the generator will run at a lower speed (rpm) during the test. For the unit to perform an actual Quiet Test Exercise, it must be enabled in the Exercise Time editing menu.

NOTE: Utility must be present and the controller must be in AUTO to unlock the Sub Test menu and perform the QT-Test.

Inputs

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

0 indicates an Input is OFF

1 indicates an Input is ON

For example, in [Figure 1-10](#) Inputs 2 and 7 are ON (Low Oil Pressure and the Auto switch). This indicates the unit is shut down and in AUTO.

NOTE: On an Evolution controller, the 1 (ON) in Input 7 is only visible while the AUTO mode is depressed. When the AUTO mode is released Utility 7 reverts to a 0 on the display.

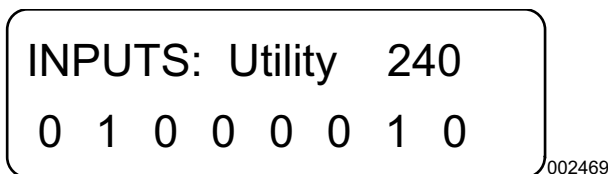


Figure 1-10. Test Inputs Display

Outputs

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

0 indicates the Output is OFF

1 indicates the Output is ON

For example, in [Figure 1-11](#) there are no Outputs ON. This indicates the unit is shut down.



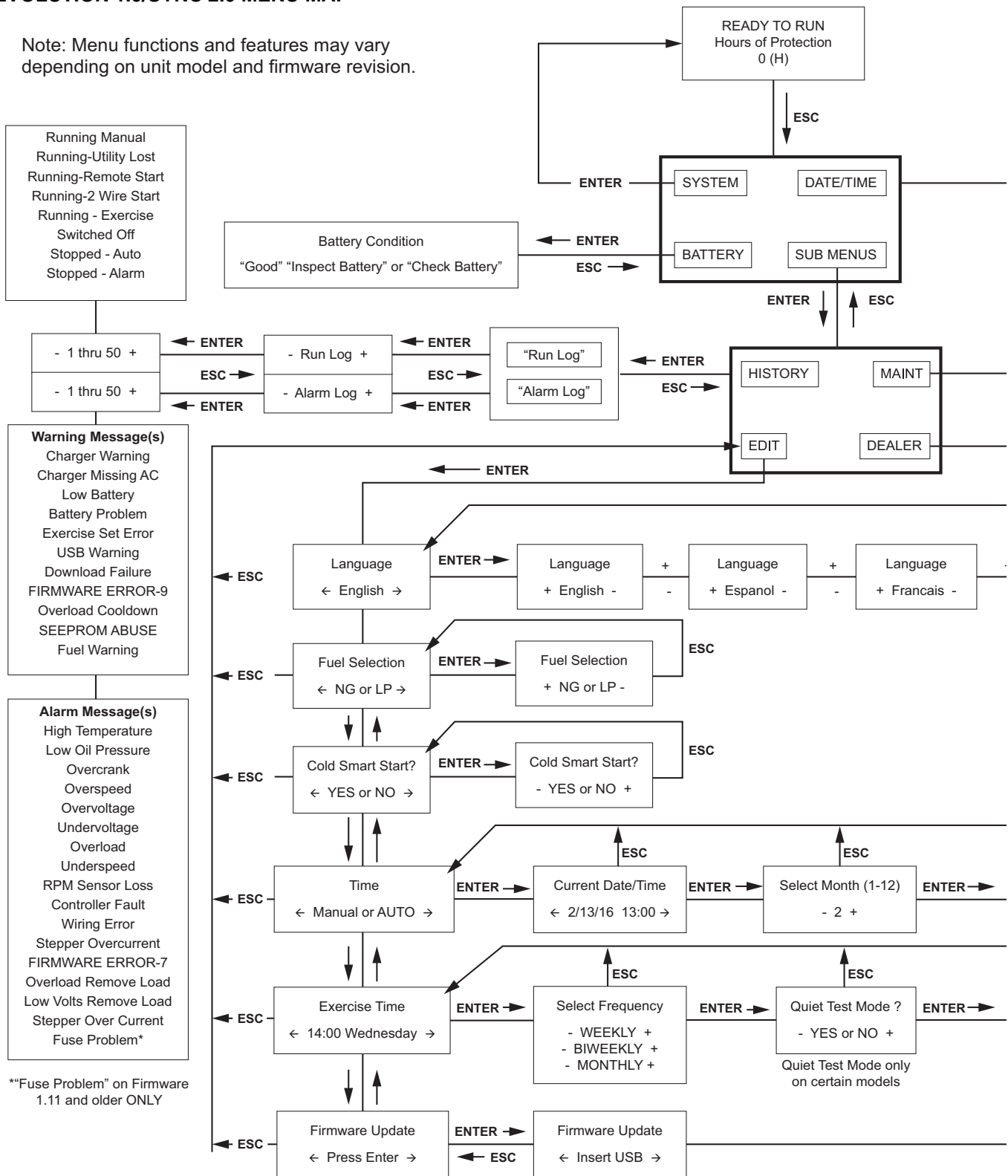
Figure 1-11. Test Outputs Display

Table 1-16. Digital Inputs and Outputs

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

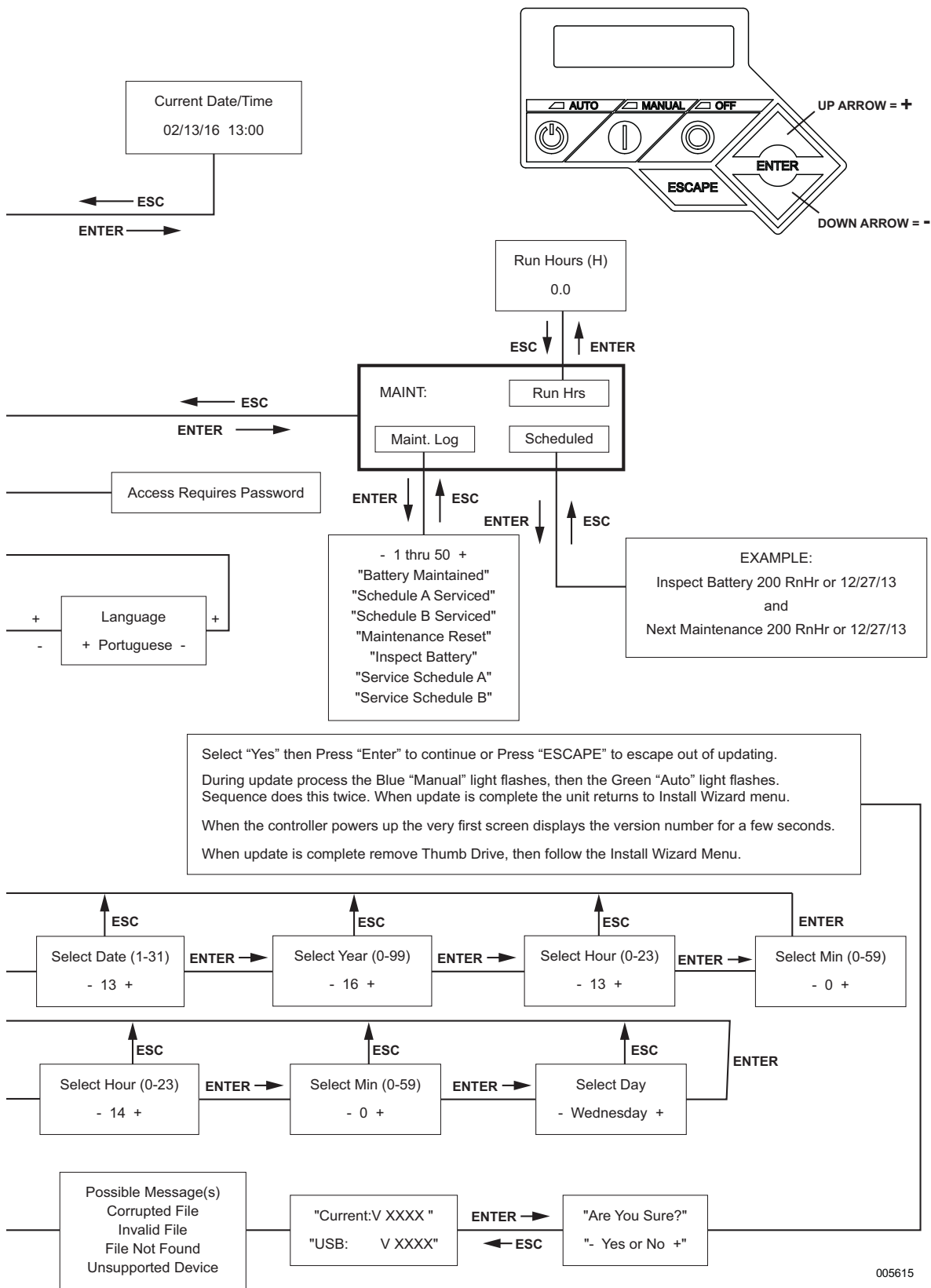
EVOLUTION 1.0/SYNC 2.0 MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.



**"Fuse Problem" on Firmware 1.11 and older ONLY

Figure 1-12. Main Menu Map



005615

Figure 1-13. Main Menu Map

EVOLUTION 1.0/SYNC 2.0 HSB ACTIVATION

Note: Menu functions and features may vary depending on unit model and firmware revision.

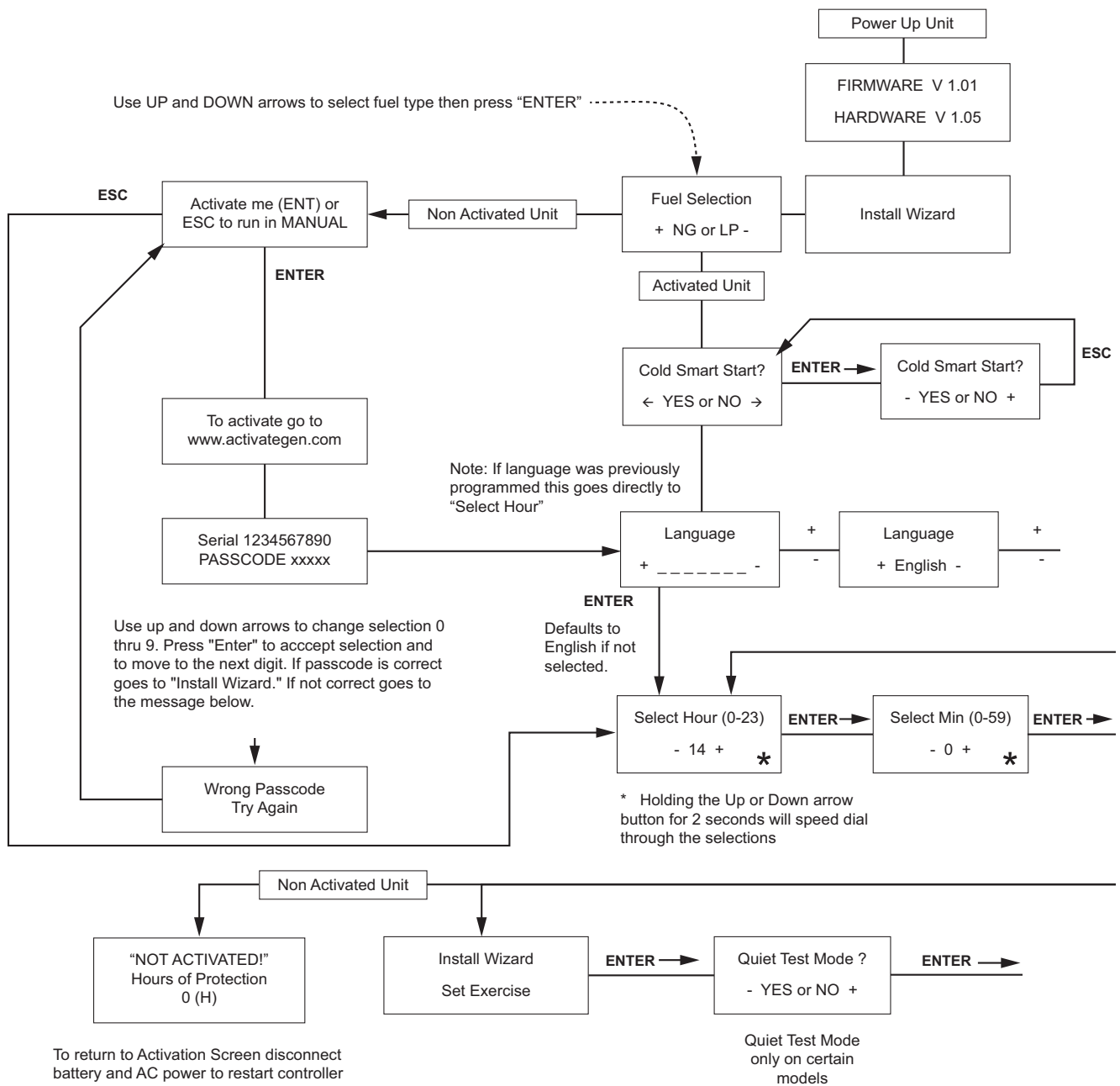
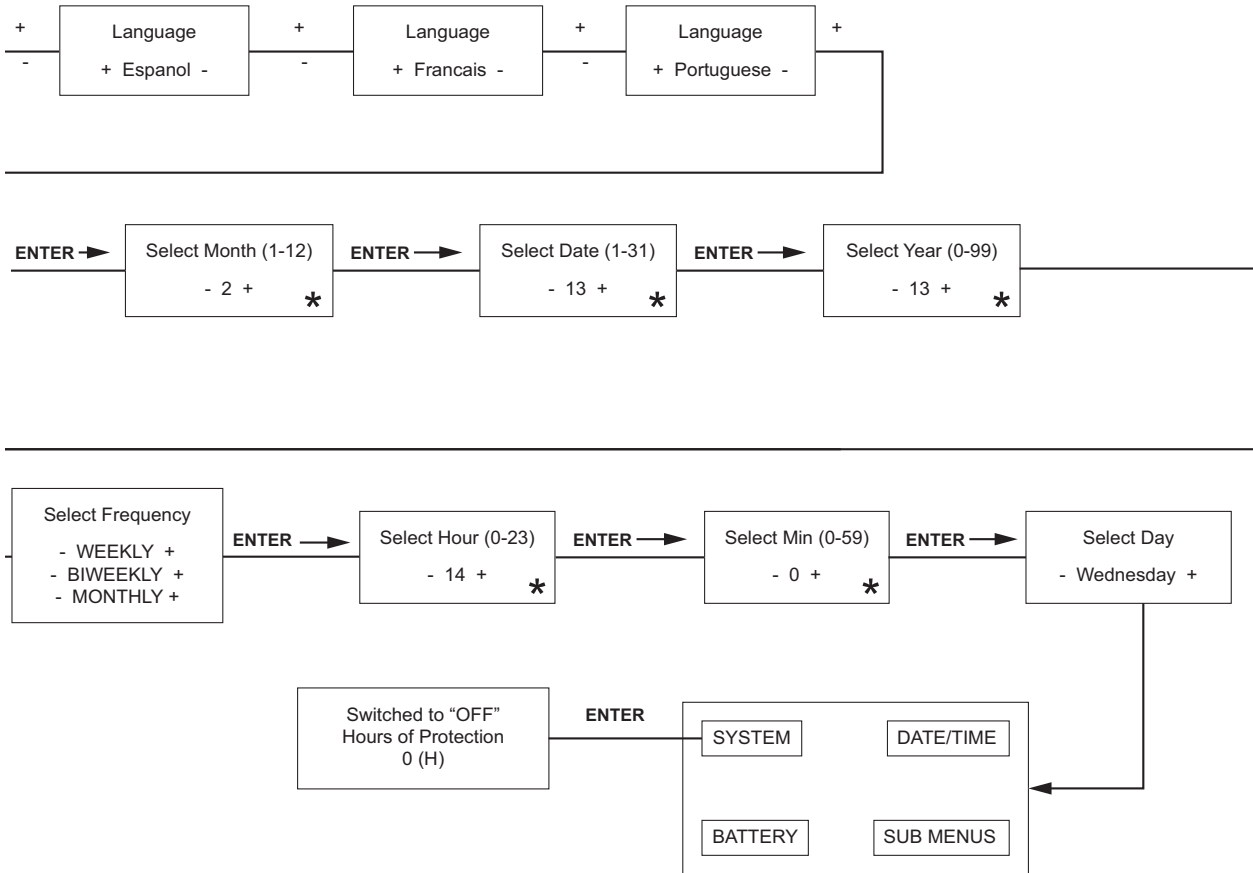
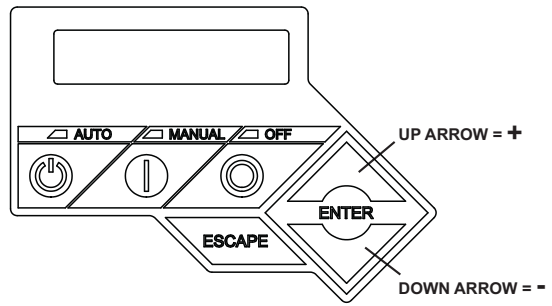


Figure 1-14. Activation and Install Wizard Menu Map



000429

Figure 1-15. Activation and Install Wizard Menu Map

EVOLUTION 1.0/SYNC 2.0 HSB FIRMWARE MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.

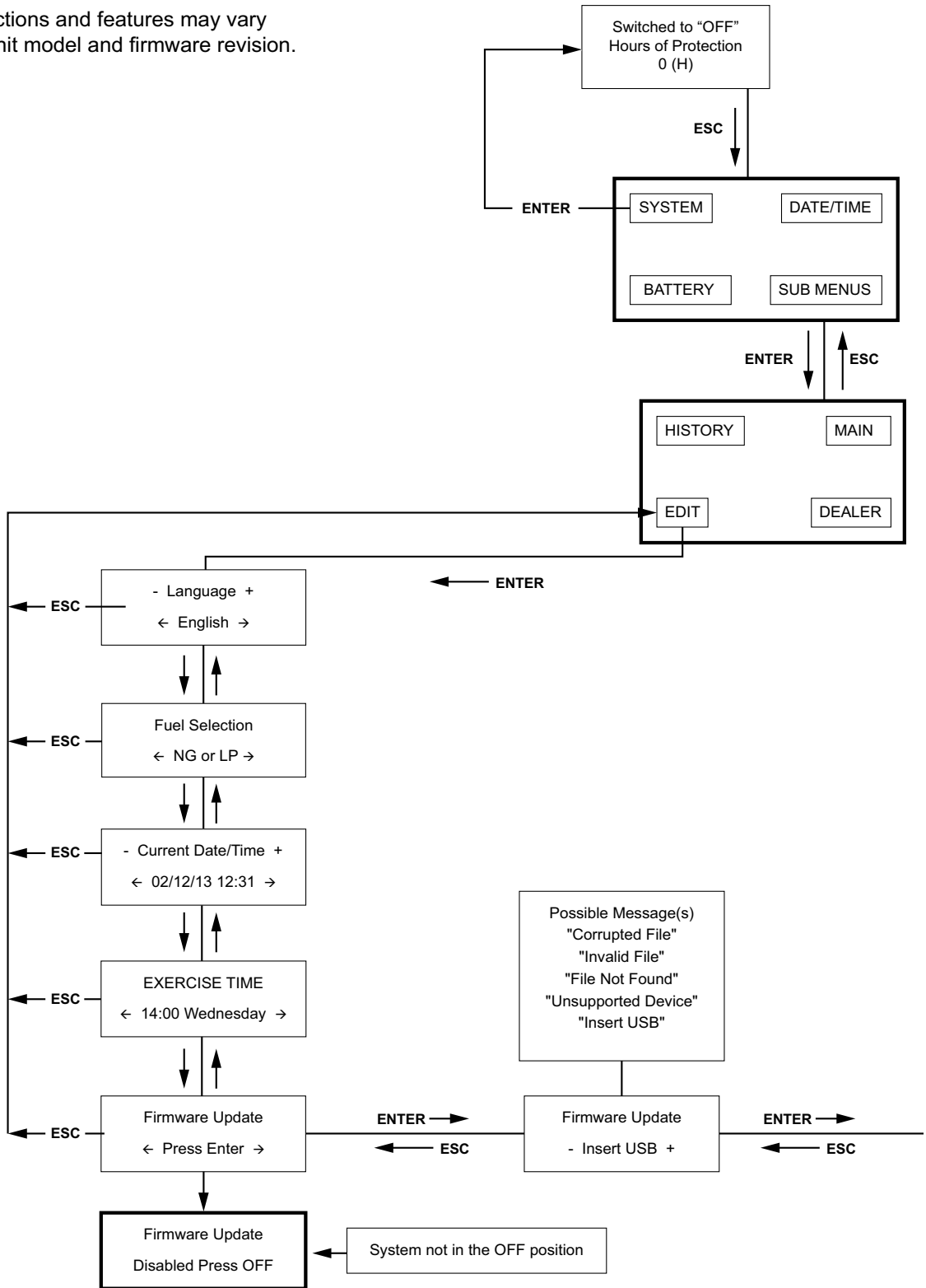
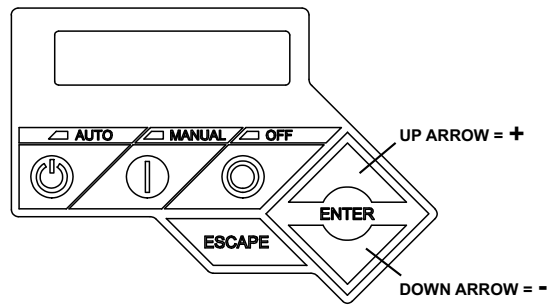
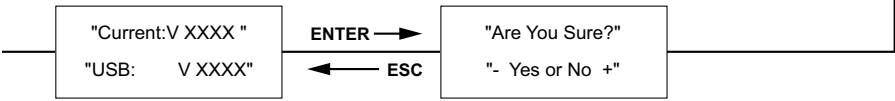


Figure 1-16. Firmware Menu Map



Alternate Firmware Update Method:
 Control unit at main screen and Insert Thumb drive with Firmware
 Power the unit down completely. Disconnect AC power.
 Repower the controller allow unit to complete the update process.
 During update process the Blue "Manual" light flashes, then the Green "Auto" light flashes. Sequence does this twice. When update is complete the unit returns to setup menu.
 When the controller powers up the very first screen displays the version number for a few seconds.
 When unit finishes update remove thumb drive then follow the Install Wizard menu.

Select "Yes" and Press "Enter" to continue or Press "ESCAPE" to escape out of updating.
 During update process the Blue "Manual" light flashes, then the Green "Auto" light flashes. Sequence does this once for firmware (single file) and twice for firmware and hardware (two files)
 When the controller powers up the very first screen displays the version number for a few seconds.
 When update is complete remove Thumb Drive, then follow the Install Wizard Menu.



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Figure 1-17. Firmware Menu Map

EVOLUTION 1.0/SYNC 2.0 DEALER MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.

MAIN DISPLAY

Switched to "OFF"
Hours of Protection
0 (H)

To access Dealer Menu enter Password from MAIN DISPLAY:
Up, Up, ESC, DN, Up, ESC, Up, ENTER

Note: Unit needs to be activated to access the Dealer Menu.

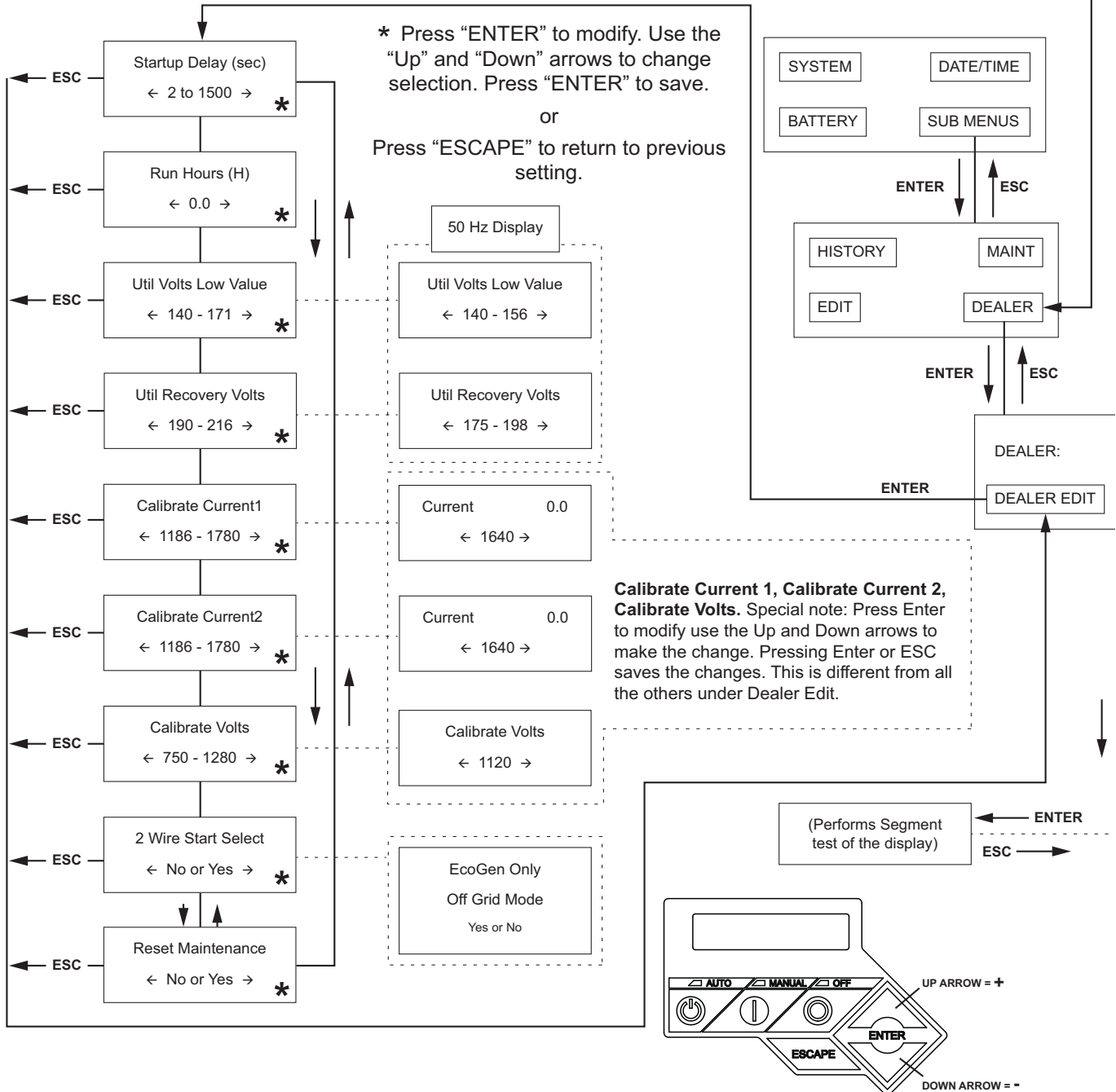
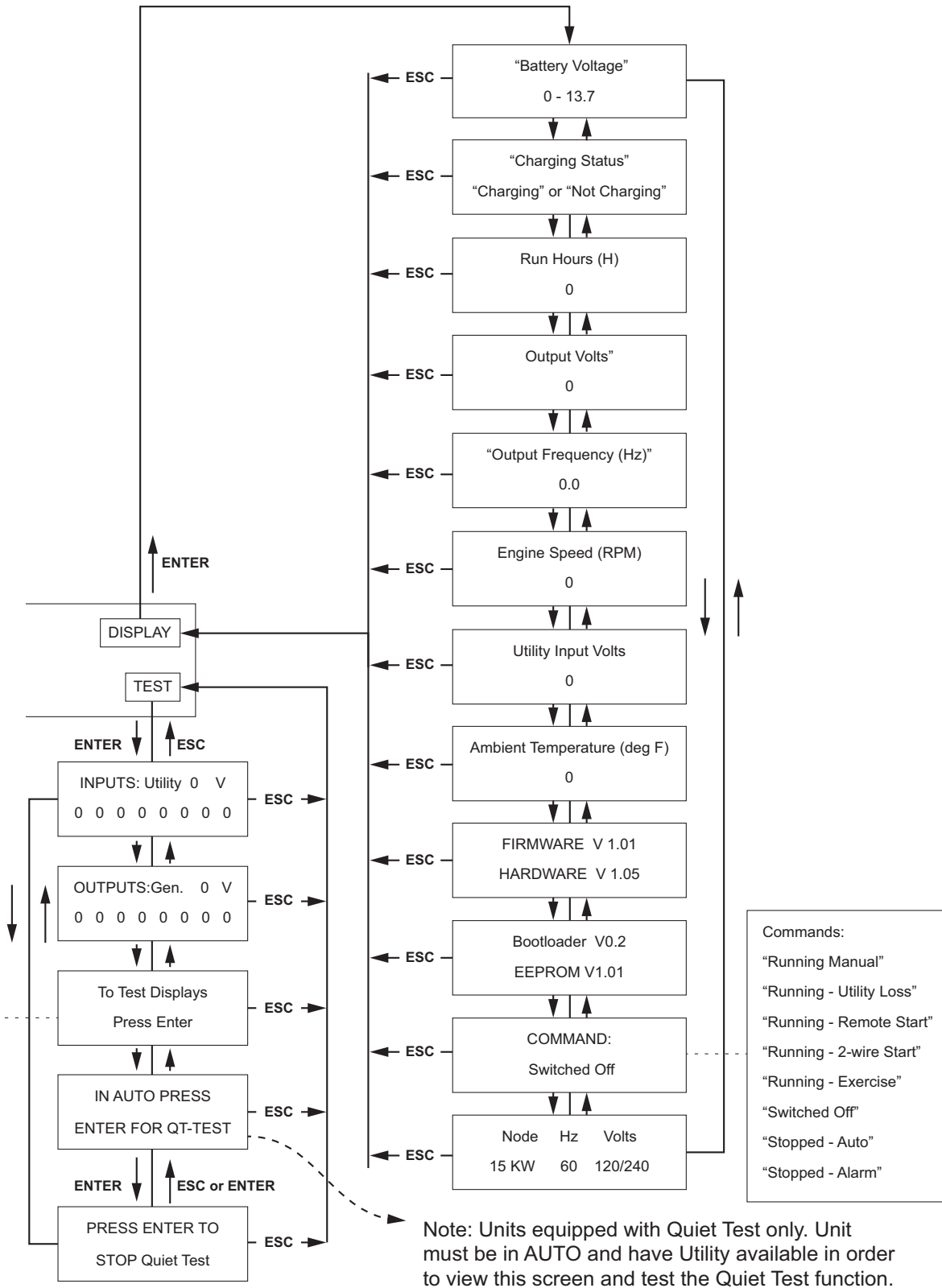


Figure 1-18. Dealer Menu Map



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Figure 1-19. Dealer Menu Map

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Section 1.4 Nexus Menu System Navigation

Navigation Keys

There are four selection and navigation keys below the display.

Escape

The ESCAPE key will cause the display to move back toward the main menu.

Enter

The ENTER key is used to activate a menu or accept a value when it is changed.

Up and Down

The UP and DOWN triangle keys perform a number of functions depending on which screen of a menu is active.

- Move to the next choice (the menu to be selected will flash on and off).
- Left and right arrows to move between the various editable menus.
- Increase or decrease a value or change a choice in an editable menu (i.e. from Yes to No).



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Figure 1-20. Nexus Display and Navigation Buttons

Main Menu

To get to the Main Menu from any other display, press the ESCAPE key one or more times. The Main Menu is shown in Figure 1-21. The menu system diagram is shown in Figure 1-30.

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



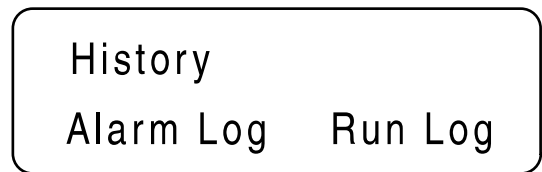
003044

Figure 1-21. Nexus Display Main Menu

History

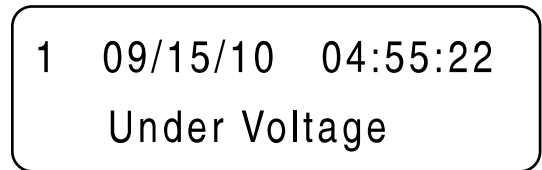
The History Menu displays two history logs:

- **Alarm Log:** displays the last 50 alarm conditions. They are in date and time order, numbered from 1 to 50, with 1 being the most recent. Use the UP and DOWN triangle keys to move from alarm to alarm. Each alarm lists the date, time, and description of the alarm.
- **Run Log:** displays 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.



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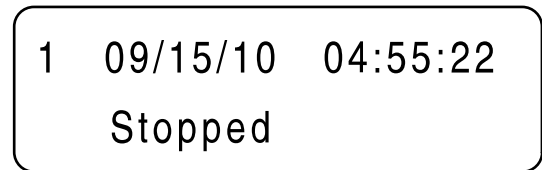
Figure 1-22. History Menu



003047

Figure 1-23. Alarm Log Display

Use the UP and DOWN triangle keys to move from the most recent Alarm (1) to the oldest (50).



003048

Figure 1-24. Run Log Display.

Use the UP and DOWN triangle keys to move from the most recent Run event (1) to the oldest (50).

Status

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

- **State** displays the current state of the panel along with the current date, time and day. See Figure 1-30 for the complete list of possible Status messages which will be displayed.
- **Display** provides up to five generator parameters: Run Hours, RPM, Hz, Battery, and Hours Under Load (if enabled)

- **Run Hours** displays the total number of hours the generator has run (in 0.0 Hours format).
- **RPM** displays the engine speed (in RPM).
- **Hz** displays the generator output frequency (in 0.0 Hz format).
- **Battery** displays the battery voltage (i.e. 12.9).
- **Hours Under Load** displays the total number of hours the unit has actually provided power.
- **Command** displays the current command. See [Figure 1-30](#) for the list of possible commands which will be displayed.
- **Versions** displays the version of Software and Hardware of the panel.

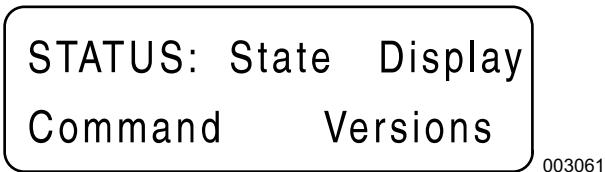


Figure 1-25. Nexus Status Menu

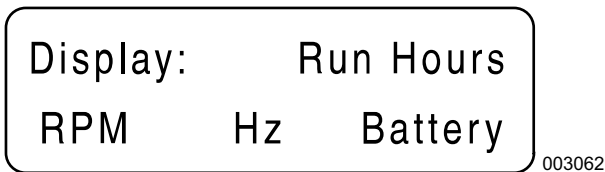


Figure 1-26. Nexus Display Menu

Edit

Selecting the Edit Menu enables editing of the following: Exercise Time, Current Time, Frequency, Language, Startup Delay, and Reset Maintenance. To access the editing screens navigate to the Edit menu and press ENTER. Either the STATUS or DISPLAY menu will appear. Use the UP and DOWN triangle buttons to switch between the menus. When the desired menu is displayed press ENTER. Use the UP and DOWN triangle buttons to change the value, then press ENTER. Press ESCAPE to exit. If no changes are required, press ESCAPE to exit.

- **Exercise Time** displays four selections: Quiet Test Mode (Yes/No), Select Hour, Select Minute, and Select Day. Once programmed the unit will perform a weekly exercise.
- **Current Time** displays five 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 displays 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** displays the status of the 8 input channels that the control panel monitors. See [Table 1-17](#). Each input represents an open or closed set of contacts, and will display either a “0” or “1”. A “0” represents an open contact. A “1” represents a closed contact.

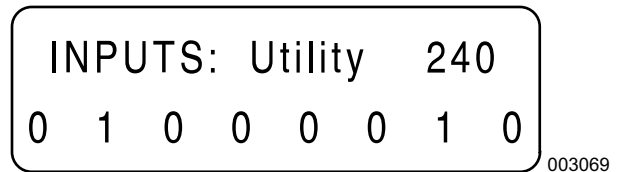


Figure 1-27. Nexus Test Inputs Display

See [Figure 1-27](#). Inputs are numbered from left to right (1-8).

- 0 indicates an Input is OFF
- 1 indicates an Input is ON

In this example Inputs 2 and 7 are ON (Low Oil Pressure and the Auto switch). This indicates the unit is shut down and in Automatic.

- **TEST Output** displays the status of the output relays used by the control panel to initiate commands (like Crank and Run, or Transfer). See [Table 1-17](#). Each channel represents a relay with a either a “0” or “1”. A “0” represents a relay that is de-energized (OFF). A “1” represents a relay that is energized (ON).

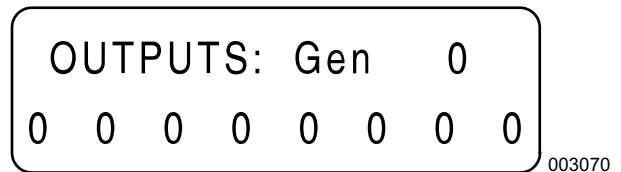


Figure 1-28. Nexus Test Outputs Display

See [Figure 1-28](#). Outputs are numbered from left to right (1-8).

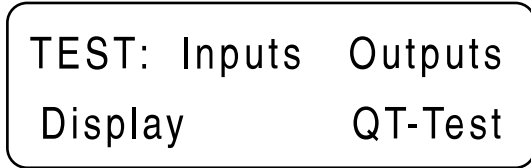
- 0 indicates an Output is OFF
- 1 indicates an Output is ON

In this example there are no Outputs ON which indicates the unit is shut down.

- **TEST Display** provides two flashing bars that test the display LEDs. As the bars flash on and off, bad sectors will not turn on. If a sector does not turn on, those LEDs are not working. The control panel requires replacement to correct a bad display.

- **TEST QT-Test** is only available on 17-20 kW units. It provides a way to test the Quiet Test mode of the generator. When tested the generator will run at a lower speed (rpm) during the test.

NOTE: For the unit to perform an actual weekly Quiet Test Exercise, it must be enabled in the Exercise Time editing menu.

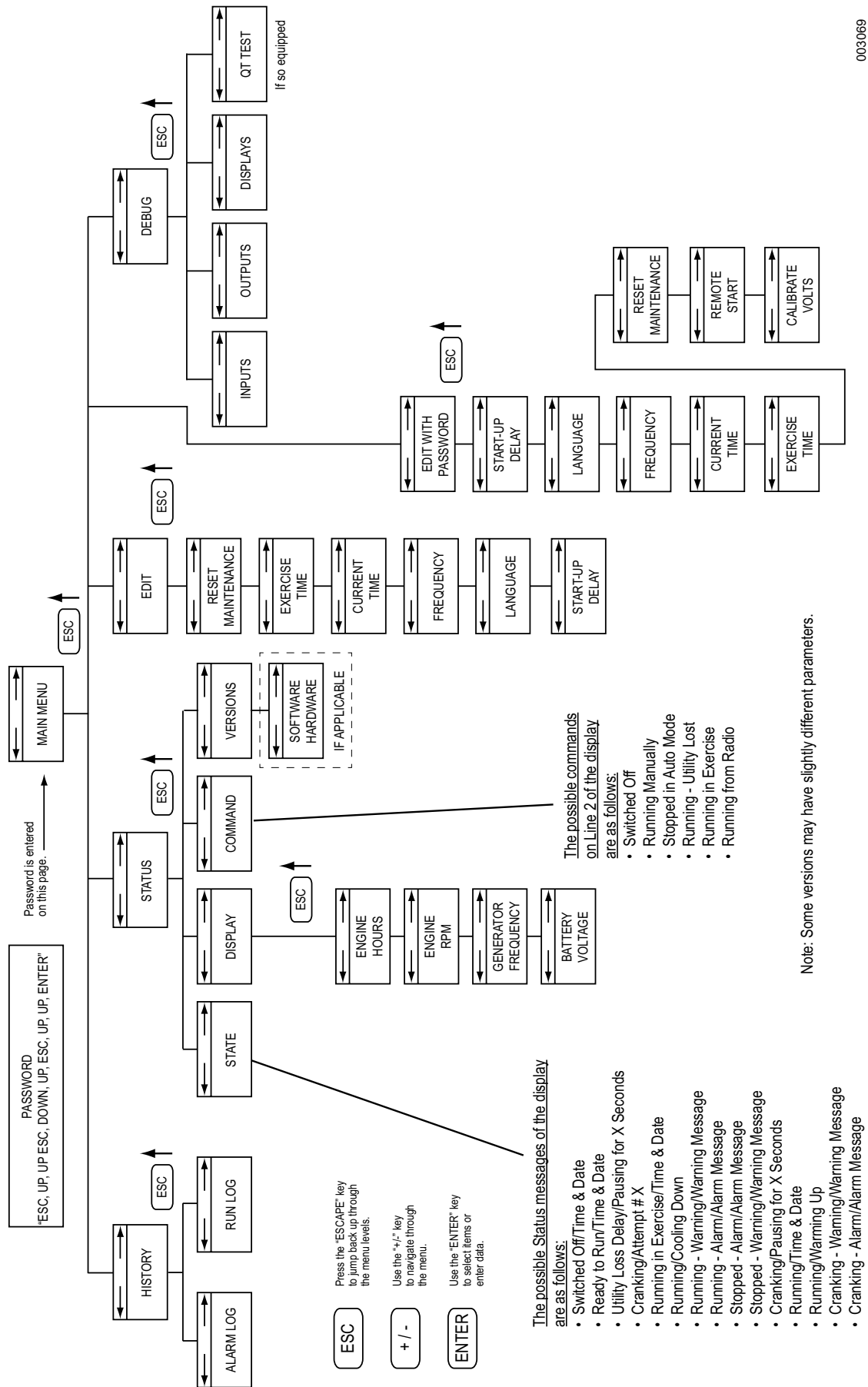


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Figure 1-29. Nexus Status Menu

Table 1-17. 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	Not Used	Battery Charger Relay
5	Wiring Error Detect	Fuel
6	Not Used	Starter
7	Auto	Ignition
8	Manual	Transfer



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Figure 1-30. Main Menu Map

Section 2.1 Operational Analysis

Field Boost

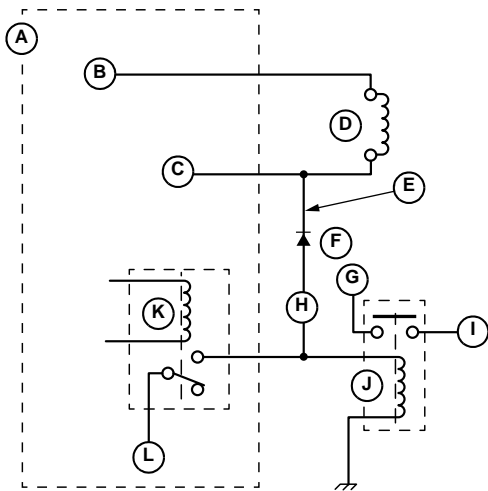
During the engine's crank cycle, the control panel provides battery voltage (12 VDC) on Wire 56 to energize the starter contactor relay (SCR).

See **Figure 2-1**. On a Nexus controller system, Wire 56 also connects to Wire 4 (positive field voltage) through a field boost diode.

See **Figure 2-2**. The Evolution controller has a dedicated field flash output on Wire 4A which flows through the field boost diode to Wire 4.

Nexus Units

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



- A. Nexus Controller
- B. Field Excitation Ground Wire 0
- C. +VDC Gated Variable Wire 4
- D. Rotor
- E. Wire 4
- F. Field Boost Diode
- G. 12 VDC Wire 13
- H. Wire 56
- I. To Starter
- J. Starter Contactor
- K. Crank Relay
- L. 12 VDC

Figure 2-1. Nexus Field Boost Circuit

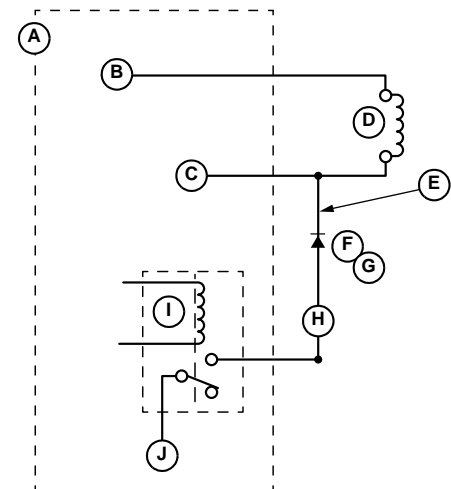
Evolution Units

Evolution units have a dedicated field flash relay with logic that is separate from the start circuit. Depending on the firmware version, the field flash will turn on and off depending on engine speed and system voltage.

Firmware versions up to 1.11 – Field boost turns on at 2200 rpm. Field boost shuts off after 10 seconds, or when voltage is 88 VAC, whichever comes first.

Firmware versions 1.12 and newer – Field boost turns on at 2200 rpm. Field boost shuts off when system voltage reaches 80% of nominal (192 VAC on a 240V generator). This firmware version allows the generator to run up to four additional minutes before shutting down on undervoltage. This will allow sufficient time for the unit to make a positive connection between the brushes and slip rings and build proper system voltage. The firmware also allows for two to four* additional attempts of 15 seconds each following an unsuccessful four minute cycle.

* Number of additional attempts depends on the unit.



- A. Evolution Controller
- B. Field Excitation Ground Wire 0
- C. +VDC Gated Variable Wire 4
- D. Rotor
- E. Wire 4
- F. Field Boost Diode
- G. 12 VDC
- H. Wire 4A
- I. Field Boost Relay
- J. 12 VDC

Figure 2-2. Evolution Field Boost Circuit

Operation

Engine Cranking

See **Figure 2-3**. When the engine is cranking (Evolution 2200 rpm), 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.

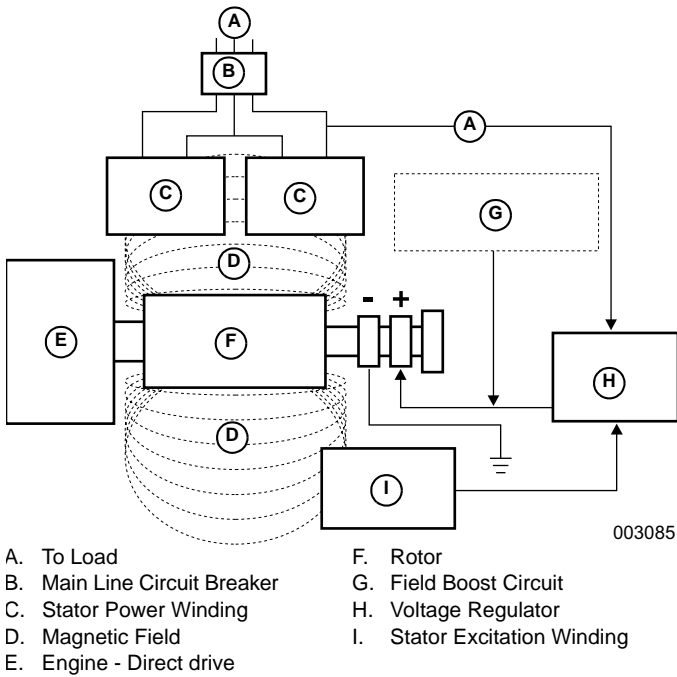


Figure 2-3. Operating Diagram

Field Excitation

AC voltage from the DPE winding provides power to the AVR. The AVR gates and converts AC voltage to DC voltage, and provides regulated variable 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 (11S & 44S for Evolution), which are connected to the main power leads (11 and 44) in the stator windings. 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.

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.

See [Figure 2-4](#) and [Figure 2-5](#). 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.

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.

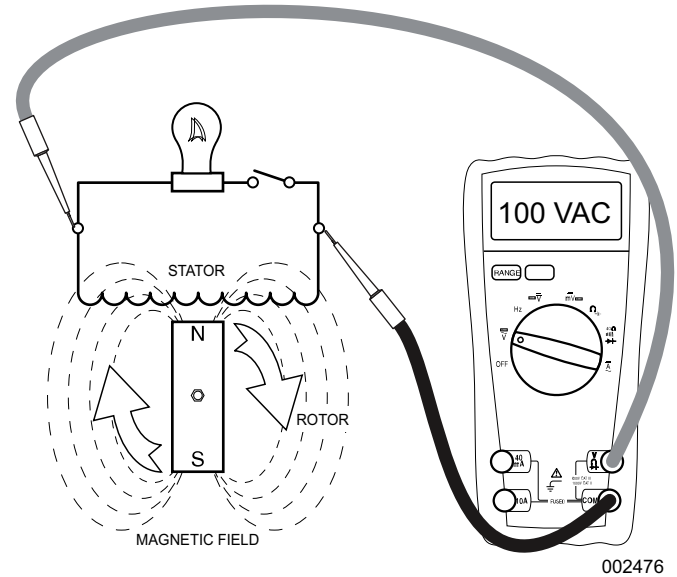


Figure 2-4. Low Field Excitation Voltage = Low Magnetic Lines of Flux = Low AC Output

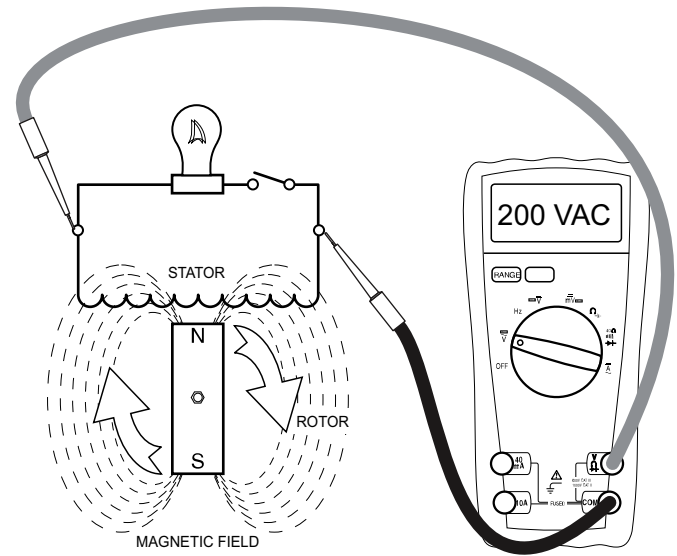


Figure 2-5. Increased Field Excitation Voltage = Increased Magnetic Lines of Flux = Increased AC Output Voltage

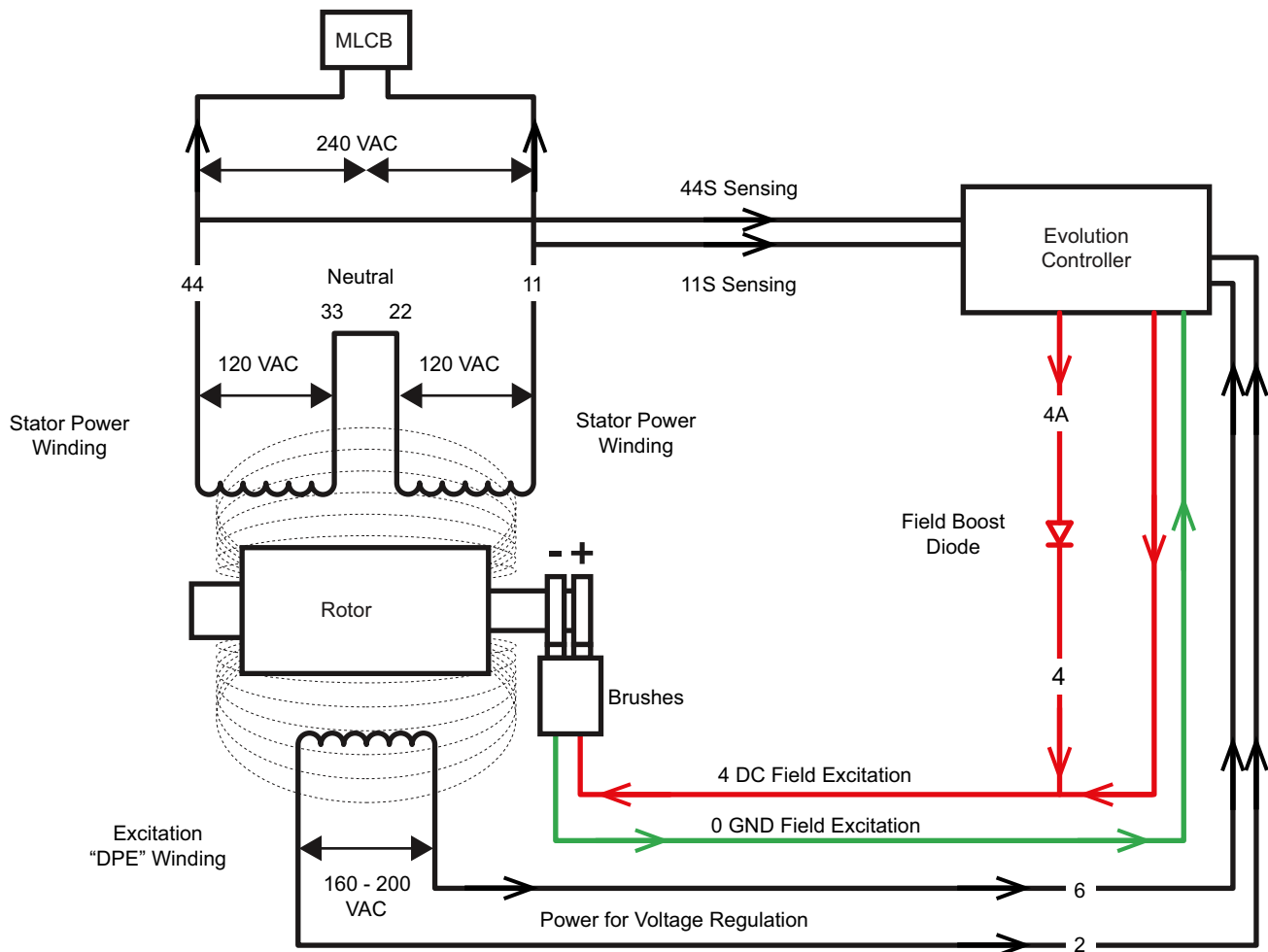
AC Power Winding Output

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

Load changes will result in a corresponding change in voltage. As load demand increases the voltage will decrease. As load demand decreases the voltage will increase. The AVR changes excitation to provide a constant output voltage with minimal increase or decrease during load changes. Frequency is also

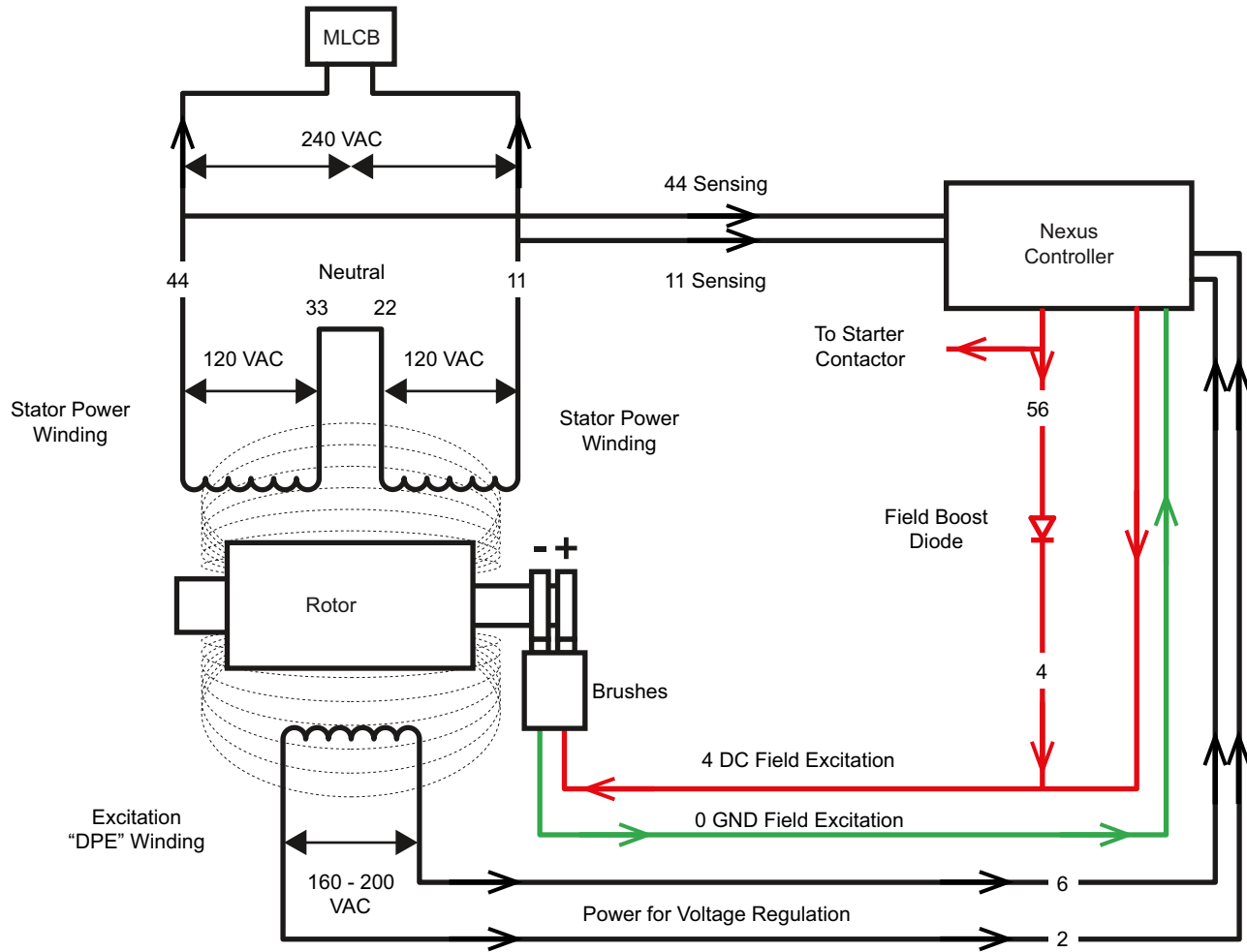
affected during load changes. However, frequency is a function of rotor speed (engine rpm); the engine electronic governor (integral to the control panel) and the AVR will respond to any engine speed changes to maintain a stable, isochronous, frequency output based on the specifications of the unit.

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.



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Figure 2-6. Evolution Voltage Regulator Schematic



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Figure 2-7. Nexus Voltage Regulator Schematic

Section 2.2 Troubleshooting Flow Charts

Evolution™ Controller e-Codes

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Controller Fault	ALARM		No E-code on HSB	Replace Controller
Overcrank	ALARM	1100	Condition - Engine Cranks but will not Start (5 crank attempts) Unit turns over but will not start. Controller is receiving signal on Wire 18.	Problem 17
Overspeed	ALARM	1200	Prolonged (60 Hz on a 50 Hz unit, 72Hz on 60Hz unit) Over specified Hz for 3 seconds. Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1205	Instantaneous (62 Hz on a 50 Hz unit, 75Hz on 60Hz unit) Over specified Hz for 0.1 second (100 milliseconds). Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1207	Monitors zero cross timing of the AVR to determine the alternator frequency which is a speed indicator. Set for 150 milliseconds of 4500 rpm or higher. Used if the normal ignition pulse sequence(s) are not being seen by the controller.	Test 64 and Test 60
Low Oil Pressure	ALARM	1300	Occurred while running The default Extended alarm for low oil pressure. Check oil level and pressure.	Test 61
High Temperature	ALARM	1400	Condition - Air Flow Impeded / Flow Issue Check the inlet/outlet for debris. Check temperature sensor and wiring.	Test 62
RPM Sensor	ALARM	1501	Twin Cylinder+Running Twin Cylinder Running faults to RPM Sensor Loss. Possible Causes: air pocket in fuel line, dirty fuel, missing ignition pulse (loss of one of the primary coils).	Test 50 and Test 64
RPM Sensor	ALARM	1505	Twin Cylinder+Cranking Twin Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor issue, missing ignition pulse (loss of one of the primary coils).	If engine cranks, Test 64. If engine does not crank, Problem 15.
RPM Sensor	ALARM	1511	Single Cylinder+Running Single Cylinder Running RPM sensor loss Possible Causes: air pocket in fuel line, dirty fuel. Loss of ignition pulse.	Test 50 and Test 64
RPM Sensor	ALARM	1515	Single Cylinder+Cranking Single Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor and/or engine issue. Loss of ignition pulse.	If engine cranks, Test 64. If engine does not crank, Problem 15.
Underspeed	ALARM	1600	Condition - Unit is Overloaded (55 Hz for 60 Hz for 30 sec, 40 Hz for 50 Hz unit) Unit is Overloaded slowing engine speed, fuel supply low or throttle control problem.	Problem 3, or Test 50, or Test 12
Underspeed	ALARM	1603	Underspeed The engine never comes up to 3600 RPM.	Check fuel selection and fuel supply
Overvoltage	ALARM	1800	Prolonged Over-Voltage	Problem 2
Undervoltage	ALARM	1900	Prolonged Under-Voltage Undervoltage due to loss of voltage. Below 80% for 10+ seconds)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1901	Instantaneous Undervoltage Undervoltage due to sudden loss of voltage. (Voltage less than 15 sec 2 sec+)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1902	Both Zero Crosses missing Undervoltage due to faulty excitation winding, or zero cross circuit, or circuit in general. Possible cause: loose wiring, field boost hardware failure. (Both zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

Evolution™ Controller e-Codes

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Undervoltage	ALARM	1906	Single Zero Cross missing Undervoltage due to faulty excitation winding, zero cross circuit, or circuit in general. Possible cause: field boost hardware failure. (One zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Wiring Error	ALARM	2099	Mis-wired Customer connection low voltage and high voltage wires are crossed.	Check customer connection in generator
Overload Remove Load	ALARM	2100	Overloaded - Default (Output Current Method) Unit is overloaded. One or both CT(s) detecting an overload condition. Check transfer switch loadshed functionality. (Change load dynamics or utilize loadshed).	Remove Load
Undervoltage Overload	ALARM	2299	Unit was overloaded and attempted to start with a large load connected. The unit can not ramp up the generator voltage to its normal target voltage value if it starts with a large load connected	Remove Load
Stepper Overcurrent	ALARM	2399	Current flow in stepper coil(s) above specification	Test 12
Fuse Problem	ALARM	2400*	Missing / Damaged Fuse The 7.5 amp Controller Fuse is missing or blown (open). *Firmware version 1.11 and older only	Test 44
Aux Shutdown	ALARM	2800	External shut down circuit is open.	Check the continuity of the harness and operation of the switch(es). Repair/replace as needed.
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Test 45
Battery Problem	WARNING		Condition->More than 16 Volts of battery voltage or 600 milliamperes or more of charge current at the end of an 18 hour charge	Test 45
Charger Warning	WARNING		Less than 12.5 volts of battery voltage at the end of a 18 hour charge	Problem 22
Charger Missing AC	WARNING		AC power is missing from the battery charger input	Problem 22
	Service Schedule		Service Schedule A 200hours 2 years Service Schedule B 400 Hours 4 years	Perform Maintenance

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

Additional Codes For 8 and 9 kW Units Only

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Overcrank	ALARM	1101	Engine/Starter Problem Limiting number of cranking cycles to protect the starter motor.	If the engine has tried to crank for 10 times unsuccessfully, this will trigger.
Overload Remove Load	ALARM	2102	Overloaded Unit re-cranks 5 times when load is applied, engine dies (0 RPM) and has low voltage (< 180V)	Check for Overloaded condition on unit. Inspect stepper motor operation.
Overload Remove Load	ALARM	2103	Overloaded Unit has run and attempted to accept load 10 times, could not accept due to overload condition	Check for Overloaded condition on unit

Introduction

Use the “Flow Charts” in conjunction with the detailed instructions in **Section 2.3, Diagnostic Tests**. Test numbers and/or verbiage used in the flow charts correspond to the numbered tests and/or verbiage in Section 2.3.

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.

Preliminary Output Voltage Test (Evolution Only, Non-Synergy, Firmware v1.12 and Above)

General Theory

When an Alarm of the 1900 group (Undervoltage) is displayed on the controller, certain tests need to be performed to determine the actual fault. With firmware v1.12 and above, up to four minutes (in Manual Mode) is now available to measure output voltage before shutting down on “Under Voltage”. Measuring output voltage as described in this test will help determine the next step in troubleshooting. Refer to [Table 2-1](#).

When measuring output voltage, it is important to look at the output voltage displayed on the control panel as well as measuring actual output voltage of the generator.

NOTE: If the unit enters a shutdown during this procedure, acknowledge the alarm by pressing the OFF button and then ENTER. Restart unit if necessary to complete the test.

Procedure

1. Set the Main Line Circuit Breaker (MLCB) to the CLOSED (ON) position.
2. Disconnect and isolate Wire 23 (from ground) in the customer connection area of the generator or the transfer switch to ensure that the generator DOES NOT transfer power to the load (structure) during testing.
3. Navigate to the voltage display using the dealer menu map for the controller.
4. Set the controller to MANUAL. Allow generator to start and stabilize.
5. Visually monitor the output volts displayed on the controller. Record the value indicated.

Voltage Indicated on the Controller: _____

6. Set the digital multimeter (DMM) to measure AC voltage.
7. Connect one meter test lead to Wire 11 and the other meter test lead to Wire 44 at the load side of the MLCB.
8. Measure and record the voltage indicated on the DMM.

Measured Voltage Output at MLCB: _____

9. Shut the unit down by pressing the OFF button on the controller.
10. Connect Wire 23.

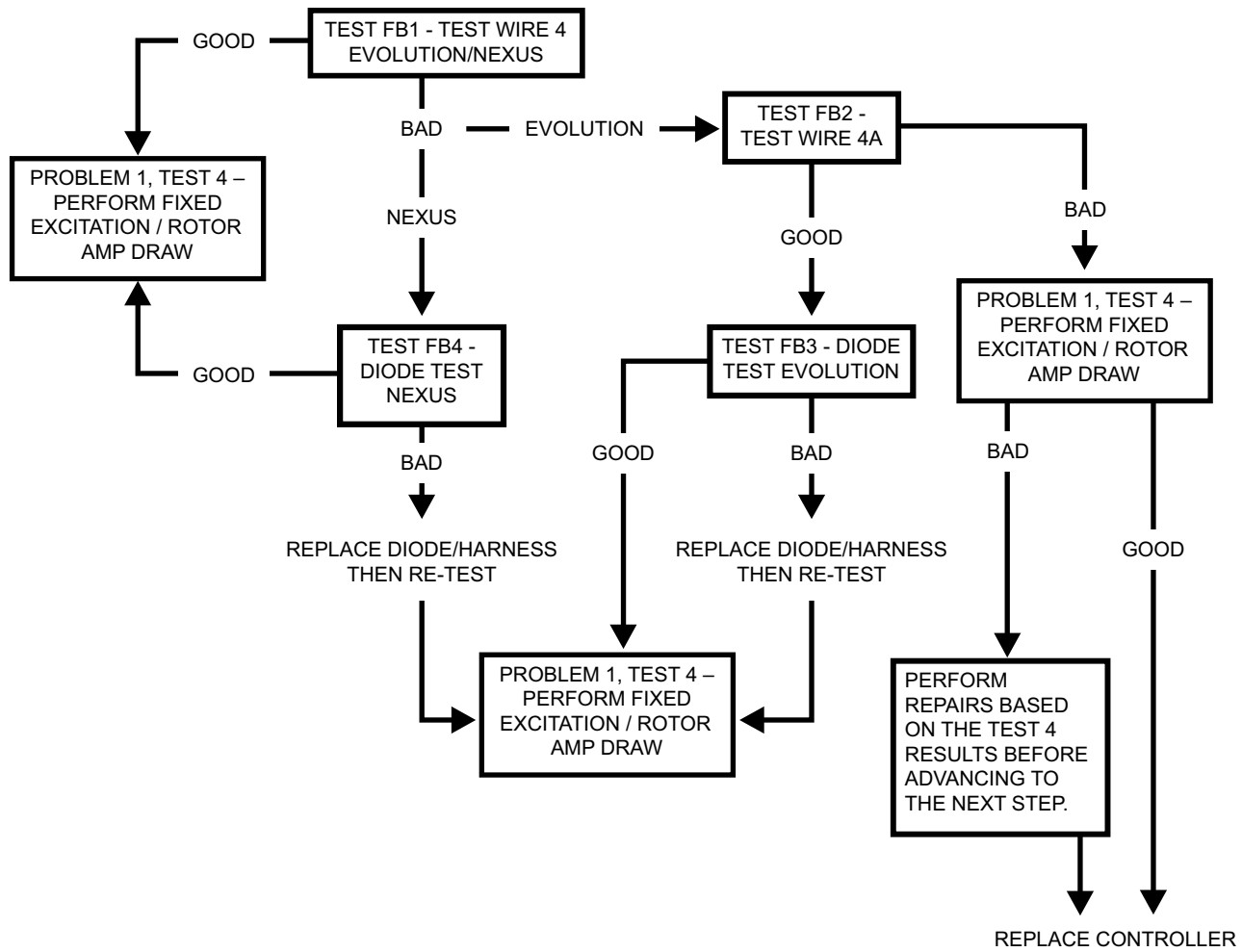
Table 2-1. Preliminary Output Voltage Test Results

Controller Voltage	Measured Voltage	Flow Chart Path Begin:	Perform Test(s):
0 (+10%)	140-180 (+ or - 10%)	C	Test 6 – Test Excitation Winding Circuit 2 and 6
140-180 (+ or - 10%)	140-180 (+ or - 10%)	FB1	Test FB1 – Test Wire 4
0 (+20%)	0 (+20%)	FB2	Test FB2 – Test Wire 4A Evolution if necessary, perform tests as defined in the standard flowchart.
~50% of measured voltage	≥300	B	Test 5 – Test Sensing Circuit Wires 11(S) and 44(S)

Table 2-2. Output Voltage Test Results

Voltage		Voltage		Voltage	
Indicated Controller		Indicated Controller		Indicated Controller	
Measured Output		Measured Output		Measured Output	

Field Boost Circuit Test - Evolution/Nexus



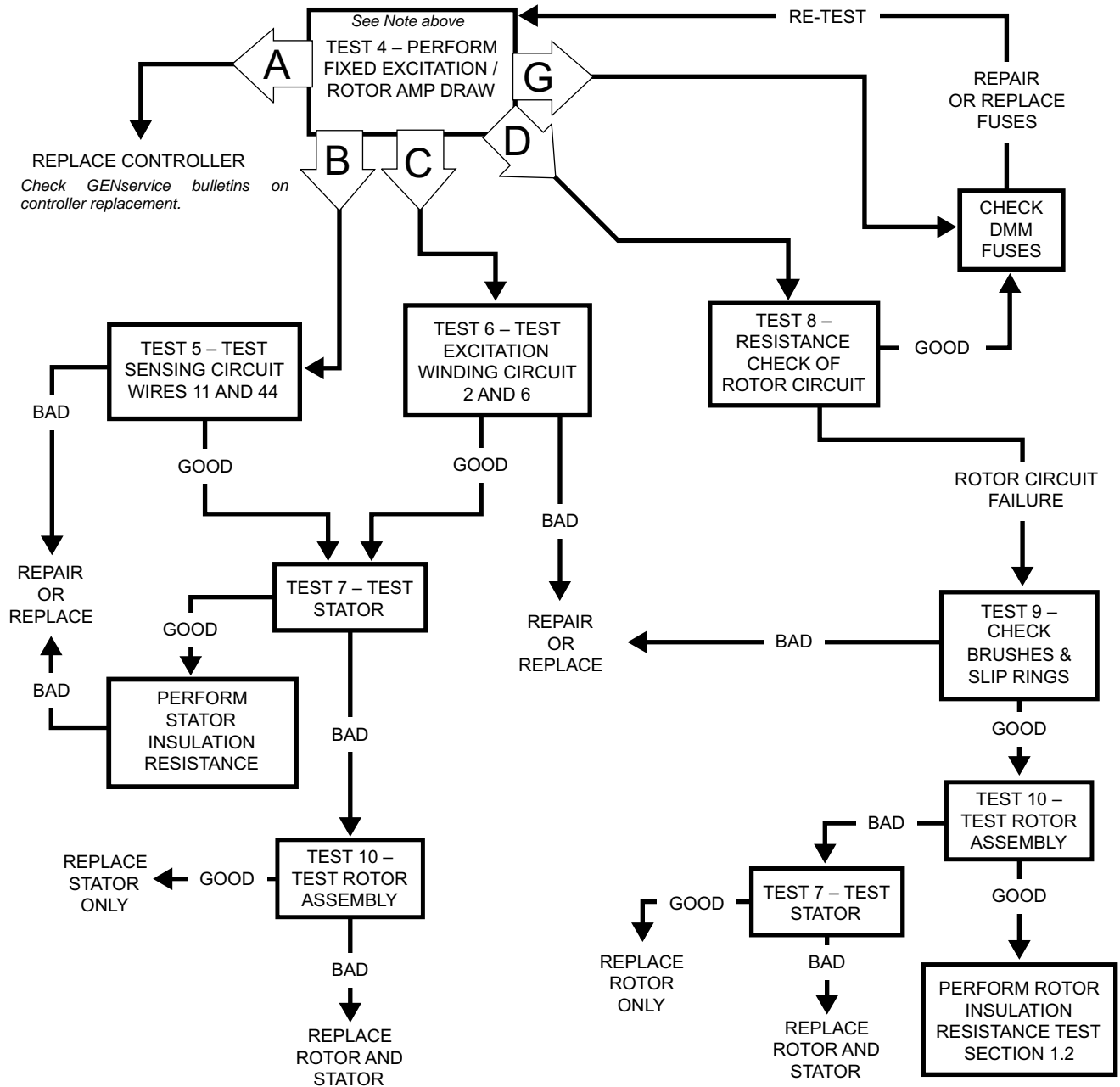
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IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

NOTE: Perform FBCT “Field Boost Circuit Test” PRIOR to performing Test 4. After performing “Field Boost Circuit Test” in it’s entirety, compare the results with the “Test 4 Results Table” to determine letter code result A through H on this page and the next.

Problem 1 – Generator Shuts Down for Under Voltage

NOTE: If the generator is an Evolution (non-Synergy) and has Firmware version v1.12 or higher, perform the Preliminary Output Voltage Test.

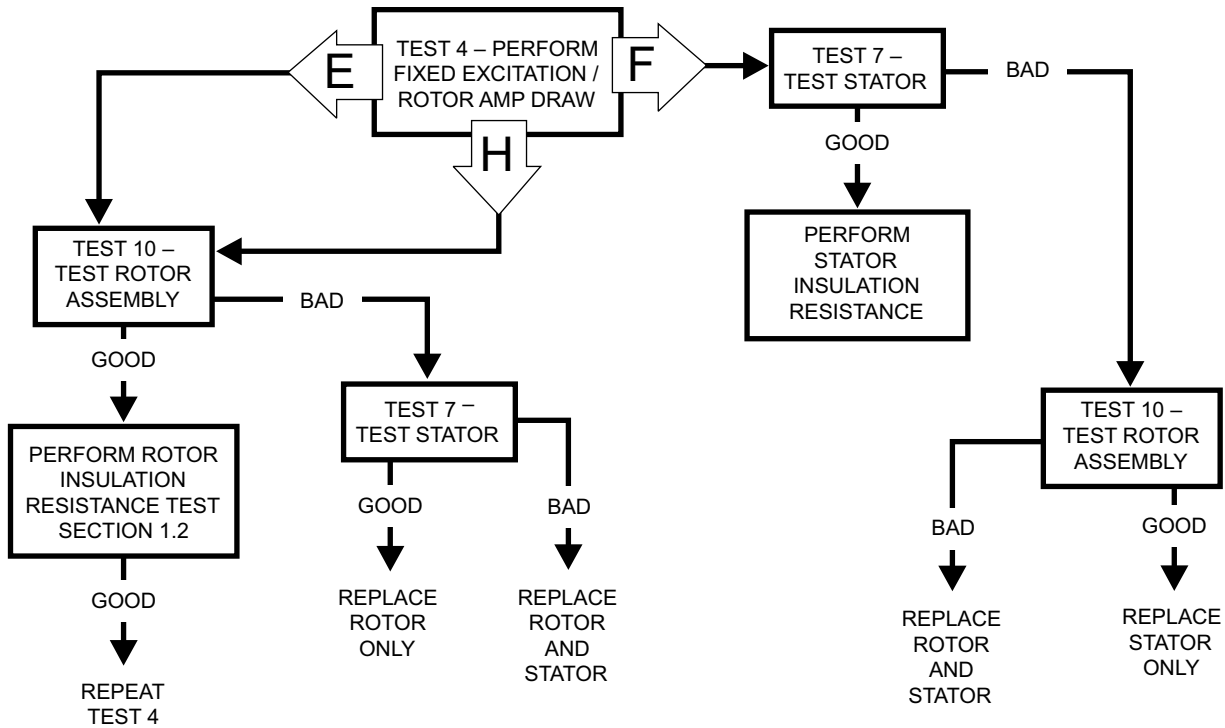


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IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

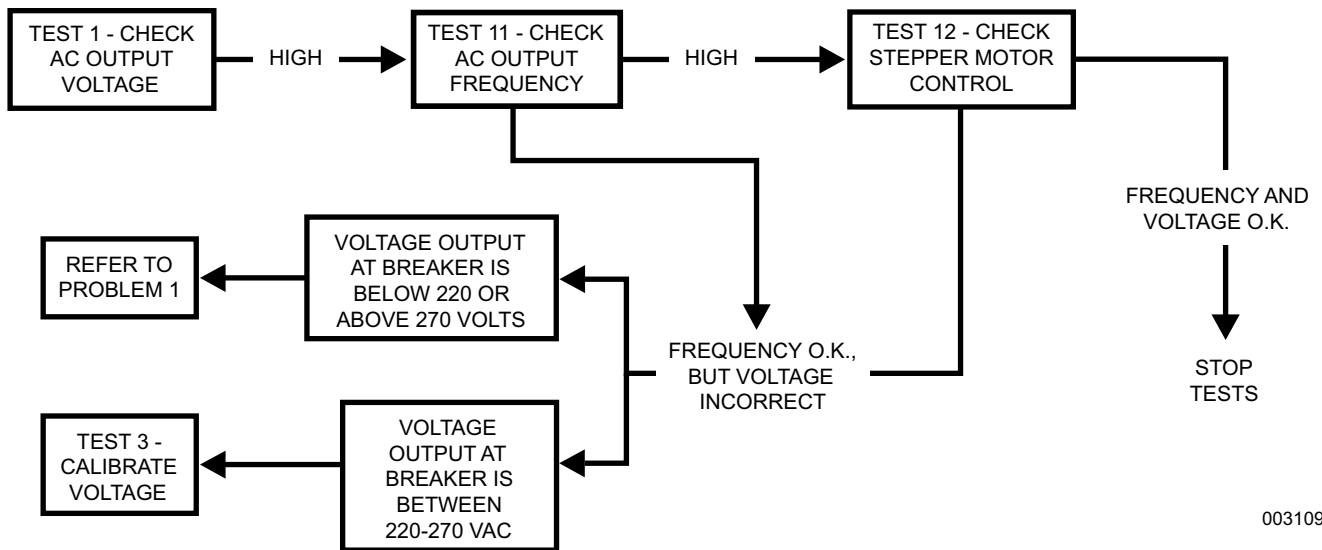
Problem 1 – Generator Shuts Down for Under Voltage (Continued)

NOTE: If the generator is an Evolution (non-Synergy) and has Firmware version v1.12 or higher, perform the Preliminary Output Voltage Test.



003108

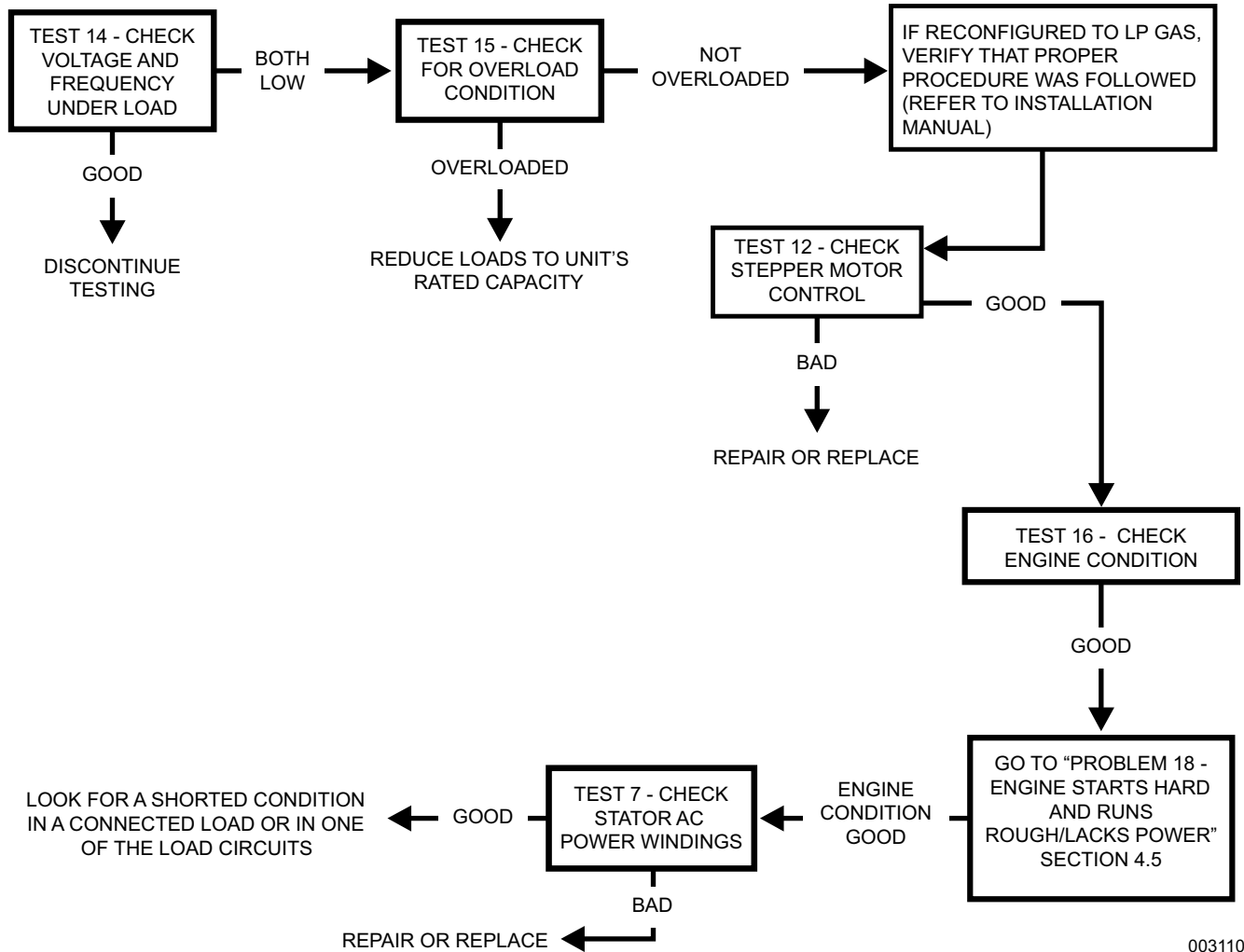
Problem 2 – Generator Produces High Voltage



003109

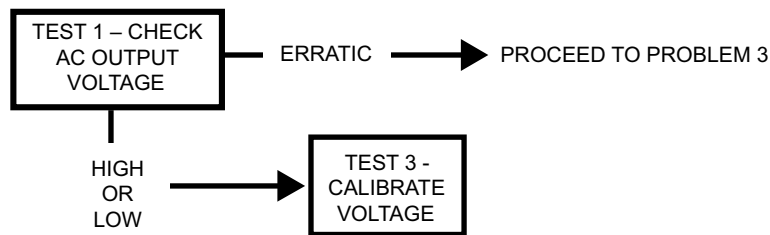
IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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



003110

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



003111

IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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Section 2.3 Diagnostic Tests

Introduction

This section familiarizes the service technician with acceptable procedures for the testing and evaluation of various problems that can occur on standby generators with air-cooled engines. Use this section in conjunction with Section 2.2, **Troubleshooting Flow Charts**. The numbered tests in this section correspond with those of Section 2.2.

Some test procedures in this section require the use of specialized test equipment, meters or tools. Most tests can be performed with a Digital Multimeter (DMM). 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 product's 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 more quickly.

- 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

General Theory

Use a DMM 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

Electrocution. High voltage is present at test terminals. Contact with live terminals will result in death or serious injury.

(000311)

IMPORTANT NOTE: The generator will be running. 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 DMM to measure AC voltage.
2. See [Figure 2-8](#). With the engine shut down, connect the meter test leads across the load terminals of the generator MLCB. This will measure line-to-line voltage.

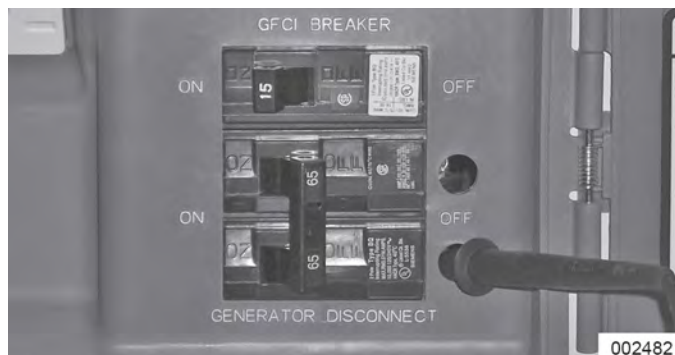


Figure 2-8. MLCB Test Points

3. Set the MLCB to the "Open" position. Verify that all electrical loads are disconnected from the generator.
4. Set the controller to MANUAL.

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 controller to OFF.

Results

1. If the DMM indicated approximately 240-244 VAC, the output voltage is good.
2. If the DMM 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 after the engine reaches 2200 rpm.

Test 3 – Calibrate Voltage

General Theory

When voltage output is too high or too low, it is possible to adjust voltage output of the generator. To access this menu a password will be required to be entered into controller.

NOTE: Replacement controllers must be checked but typically do not require calibration unless output is not within the specifications. (Refer to the unit data decal and to the Specifications section in the front of this manual.)

Procedure

1. Set DMM to measure AC voltage.
2. Open the Main Line Circuit Breaker (MLCB) on the generator.
3. Using appropriate back probes, measure output voltage at the AVR connector (Wires 11S and 44S).
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 appropriate password:

For Evolution:

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

For Nexus:

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

6. After the password has been entered, proceed to the EDIT menu for Nexus controller, or to DEALER EDIT for Evolution controller.
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. The Evolution controller is adjustable from 750-1280. The Nexus controller is adjustable from 700-1300.

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

9. Set controller to MANUAL.

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. A lower value will create a higher voltage at the breaker.
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 of the value displayed in the controller TEST menu (Evolution) or DEBUG menu (Nexus) under OUTPUTS in the TEST section (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, perform the Field Boost Test (FBT) and then refer to “Problem 1 – Test 4 Fixed Excitation / Rotor Amp Draw Test.”

Field Boost Circuit Tests

Test FB1 – Test Wire 4

General Theory

This test is to verify that Wire 4 is receiving field flash voltage during startup of the generator.

NOTE: See [Field Boost](#) in Section 2.1 for analysis of Nexus and Evolution field boost parameters.

Procedure

1. Locate Wire 4 on back of control panel. Disconnect the wire harness connector from the control panel.
2. Insert the Red meter lead adapter into the back of the wire harness on Wire 4 (on Nexus units equipped with the Black AMP style connector, the connector must be disconnected to perform the test).
3. Place Black lead on a good common ground or negative post on the engine battery.
4. Clear all faults and place generator in the manual mode and start engine.
5. Measure and record field flash voltage.

NOTE: See [Field Boost](#) in Section 2.1 for analysis of Nexus and Evolution field boost parameters.

Results

1. If approximately 12 VDC was measured field flash is passing through the field boost diode. Test is good. Go back to flow chart for next test.
2. If 0 volts was measured, test is bad, proceed back to the field boost circuit test flow chart.

Test FB2 – Test Wire 4A Evolution

General Theory

To verify that the field flash is working properly.

Procedure

1. Set DMM to measure DC voltage.
2. Locate Wire 4A on back of control panel. Leave harness connector connected to control panel.
3. Insert Red back probe into connector that contains Wire 4A.
4. Touch Black probe lead to the battery negative post.
5. Clear all faults on the control panel and place into manual mode.
6. Measure and record field flash voltage

NOTE: See [Field Boost](#) in Section 2.1 for analysis of Nexus and Evolution field boost parameters.

7. Record measurements.

Results

1. If approximately 12 VDC (engine battery voltage) was measured during field flash, the control board is good. Refer back to the flow chart.
2. If 0 VDC was measured during field flash, refer back to the flow chart.

Test FB3 – Diode Test Evolution

General Theory

This test is to verify that the field flash diode is working properly.

Procedure

1. Remove 7.5 amp fuse from control panel.
2. Set the DMM to the diode check function (preferred). If the DMM does not have a diode check selection, use the resistance or “Ohms” selection.
3. Locate Wire 4A wire harness connector and disconnect from control panel.
4. With test probe, insert the Black lead into the back of the wire harness on Wire 4A.
5. Locate Wire 4 wire harness connector and disconnect from control panel.
6. With test probe, insert the Red lead into the back of the wire harness on Wire 4.
7. Record reading.

Table 2-3. Test Results

Test Point	Results	
Ohms Test		Ohms
Diode Test		VDC

NOTE: Leave wire harness/harnesses unplugged.

8. Locate Wire 4A.
9. With test probe, insert the Red lead into the BACK of the wire harness on Wire 4A.
10. Locate Wire 4.
11. With test probe, insert the Black lead into the BACK of the wire harness on Wire 4.
12. Record reading.

Table 2-4. Test Results

Test Point	Results	
Ohms Test		Ohms
Diode Test		VDC

Results

1. If a reading of OL for Diode or OHMS test was recorded in Step 7 and approximately 0.5 Volts (in Diode setting) or approximately 2.07M OHMS (in Ohms setting) was recorded in Step 12, the diode is good. Replace 7.5 amp fuse and wire harness/harnesses into proper receptacles. Refer back to flow chart.
2. If readings of INFINITY (OL) on Step 7 and INFINITY on Step 12, Diode or wire is bad (open), wire harness/diode needs to be repaired/replaced.
3. If readings of approximately 0.5 Volts (in Diode setting) or CONTINUITY (Resistance in "Ohms" setting) in Step 7 and Step 12, Diode is bad (shorted), diode needs to be repaired/replaced.

Test FB4 - Diode Test Nexus

General Theory

This test is to verify that the field flash diode is working properly.

Required Tools

DMM and meter lead adapters P/N 0J09460SRV.

Procedure

1. Remove 7.5 amp fuse from control panel.
2. Set the DMM to the diode check function (preferred). If the DMM does not have a diode check selection, use the resistance or "Ohms" selection.

3. Locate Wire 56 at the SCR and disconnect from the SCR. Also disconnect the controller harness connector containing Wire 56.
4. Insert Red test lead probe to Wire 56 disconnected from the SCR.
5. Locate Wire 4 wire harness connector and DISCONNECT from the control panel.
6. With the test probe insert Black lead into Wire 4 connection of harness connector.

NOTE: AMP style connectors must be probed from the front using the proper adapter. WHITE Molex connectors must be back probed using the proper probe adapter.

7. Record reading.

Table 2-5. Test FB4 Results

Test Point	Results	
Ohms Test		Ohms
Diode Test		VDC

NOTE: Leave wire harness/harnesses unplugged.

8. Locate Wire 56 – SCR connection.
9. With test probe connect Black lead into Wire 56 of SCR connection.
10. Locate Wire 4.
11. With the test probe insert Red lead into Wire 4 connection of harness connector.

NOTE: AMP style connectors must be probed from the front using the proper adapter. WHITE Molex connectors must be back probed using the proper probe adapter.

12. Record reading.

Table 2-6. Test FB4 Results

Test Point	Results	
Ohms Test		Ohms
Diode Test		VDC

Results

1. If the reading recorded at Step 7 for Ohms is approximately 1.8M and for the Diode test is 0.5 VDC, and if the reading recorded at Step 12 for Ohms is INFINITY (OL) and Diode test is INFINITY (OL) the diode and wiring is good. Refer back to the flow chart.
2. If both OHMS and Diode readings of INFINITY (OL) on Step 7 and INFINITY (OL) on Step 12, Diode or wire is bad (open), wire harness/diode needs to be repaired or replaced.
3. If readings of approximately 0.5 Volts (in Diode setting) or CONTINUITY (Resistance in "Ohms" setting) in Step 7 and Step 12, the Diode is bad (shorted) and needs to be repaired/replaced.

Test 4 – Fixed Excitation Test/Rotor Amp Draw Test

General Theory

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 Digital Multimeter (DMM), it is possible to capture the maximum output of a particular winding before faulting out on under-voltage.

Under-voltage Alarm – When the controller is set to MANUAL the following logic is used to trigger an under-voltage alarm:

- **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 shutdowns, refer to the Air-cooled Reference Manual (P/N 1000020935).

Table 2-7 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 C “Supplemental Worksheets” at the back of this manual.

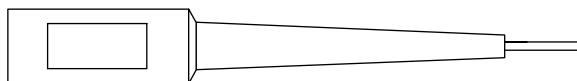
Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11 and 44 Voltage		VAC
Static Rotor Amp Draw		Amps
Running Rotor Amp Draw		Amps
Column Identified		

Required Tools

- A Digital Multimeter (DMM) equipped with a MIN/MAX feature
- Meter test leads 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 manufacturer's approved test lead adapters (P/N 0J09460SRV).

NOTE: These adapters are to be used on the Nexus controller with AMP connectors (front socket test points) and The Nexus/Evolution controllers with white Molex connectors (back-probe only).



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Figure 2-9. Narrow Test Probe

Procedure: Fixed Excitation Test

IMPORTANT NOTE: DO NOT proceed to Step 1 until the Field Boost Circuit Tests (FBCT) have been performed.

1. Remove the 7.5 amp fuse from the controller.
2. Locate and disconnect the appropriate harness connector with Wires 2 and 6 from the controller.

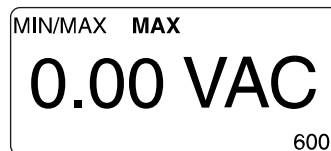
IMPORTANT NOTE: During this procedure, DO NOT reconnect this connector to the controller!

3. Set DMM to measure AC voltage.
4. Using the scale feature of the DMM, set to the first available scale greater than 100 (i.e. “600”).

NOTE: Refer to the manufacturer's owners manual for specific information on using manual scaling.

5. Set meter to MIN/MAX.

NOTE: Refer to the manufacturer's owners manual for specific information on using the MIN/MAX feature.



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Figure 2-10.

6. Using approved meter test probes, connect one meter test lead to the appropriate harness pin for Wire 6 and the other meter test lead to the appropriate harness pin for Wire 2.
7. Install the 7.5 amp fuse.
8. Set the controller to MANUAL.
9. Measure and record the voltage indicated between Wires 2 and 6 as indicated by the DMM.
10. Acknowledge and reset the under-voltage alarm present on the controller.
11. Set the controller to OFF.
12. Re-locate meter test probes to the appropriate harness pin for Wire 11 (11S on Evolution) and the appropriate harness pin for Wire 44 (44S on Evolution).
13. Set the controller to MANUAL.
14. Measure and record the voltage indicated between Wire 11/11S and 44/44S as indicated by the DMM.
15. Acknowledge and reset the under-voltage alarm present on the controller.
16. Set the controller to OFF.

Procedure: Rotor Amp Draw

1. Disengage the MIN/MAX feature and manual scale on the DMM.
2. Set DMM to measure DC amperage.
3. Verify the connector (previously disconnected in the Fixed Excitation Test) is disconnected.

NOTE: Consult the meters documentation for proper setup procedure. See Section 1.4 “Measuring Current” for further information.

4. Connect the Black (negative) meter test lead to the appropriate harness pin for Wire 4 and the Red (positive) test lead to the positive battery terminal.
5. Measure and record the static rotor amp draw.
6. Set the controller to MANUAL.
7. Measure and record the running rotor amp draw.
8. Acknowledge and reset the under-voltage alarm present on the controller.
9. Set the controller to OFF.

Results

1. Using the values recorded in the above procedure, compare the results to **Table 2-9**. Determine the appropriate lettered column to use and refer back to the flow chart. The rotor amp draws are a calculated amp draw and actual amperage readings may vary depending on the resistance of the rotor.

$$12.9 \text{ VDC} / 12.3 \text{ Ohms} = 1.05 \text{ DC Amps}$$

Table 2-8. Example

Model	17 kW
Wires 2 and 6 Voltage	53 VAC
Wires 11 and 44 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”.

Table 2-9. TEST 4 Results – Fixed Excitation Test/Rotor Amp Draw Test (8-20 kW)

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	8 kW	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	
	10 kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05		1.76-2.05	
	11 kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05		1.76-2.05	
	12 kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		1.46-1.70	
	14 kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70		1.46-1.70	
	15 kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54	
	16 kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54	
	17 kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54		1.33-1.54	
Running Rotor Amp Draw	20 kW	1.16-1.36	1.16-1.36	1.16-1.36	Zero Current Draw	Above 2.0A	1.16-1.36	Zero Current Draw	1.16-1.36	
	22 kW	1.00-1.17	1.00-1.17	1.00-1.17		Above 2.0A	1.00-1.17		1.00-1.17	
	8 kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05		Zero Current Draw	Above 2.5A
	10 kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05			
	11 kW	1.76-2.05	1.76-2.05	1.76-2.05		Above 2.5A	1.76-2.05			
	12 kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70			
	14 kW	1.46-1.70	1.46-1.70	1.46-1.70		Above 2.3A	1.46-1.70			
	15 kW	1.33-1.54	1.33-1.54	1.33-1.54		Above 2.3A	1.33-1.54			
16 kW	1.33-1.54	1.33-1.54	1.33-1.54	Above 2.3A	1.33-1.54					
17 kW	1.33-1.54	1.33-1.54	1.33-1.54	Above 2.3A	1.33-1.54					
20 kW	1.16-1.36	1.16-1.36	1.16-1.36	Above 2.0A	1.16-1.36					
22 kW	1.00-1.17	1.00-1.17	1.00-1.17	Above 2.0A	1.00-1.17					

Note: Actual values measured may vary by as much as 0.5 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” →

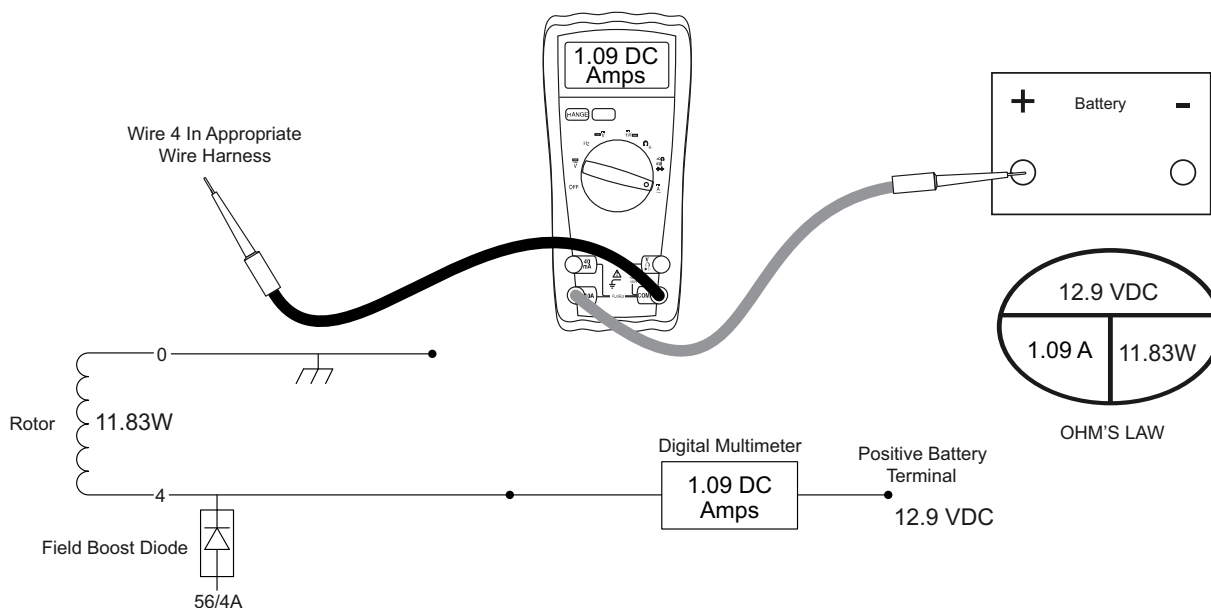


Figure 2-11. Rotor Amp Draw Test

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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 Wires 4 and 0 in the appropriate harness.

Test 5 – Test Sensing Circuit Wires 11(S) and 44(S)

General Theory

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 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 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 2-9](#).

NOTE: It is not recommended to use any testing device other than the manufacturer's 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 appropriate harness connector from the controller.
4. Set the DMM to measure resistance.

NOTE: Stator winding resistance values are very low and some meters will not read such a low resistance, and will simply indicate different ranges of resistance. The manufacturer recommends a high quality digital type meter capable of reading a very low resistance.

5. Connect one meter test lead to the appropriate harness pin for Wire 11 on Nexus, or 11S on Evolution. Connect the other meter test lead to the NEUTRAL connection. Measure and record the resistance.
6. Connect one meter test lead to the appropriate harness pin for Wire 44 on Nexus or 44S on Evolution. Connect 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. See [Figure 2-12](#). Disconnect the lower bulkhead C1 connector (if unit is equipped.)
8. Connect one meter test lead to C1 (if unit is equipped) to the appropriate harness pin with Wire 11. Connect the other meter test lead to the NEUTRAL connection, measure and record the resistance.
9. Connect one meter test lead to C1 (if unit is equipped) to the appropriate harness pin for Wire 44. Connect the other meter test lead to the NEUTRAL connection. Measure and record the resistance.

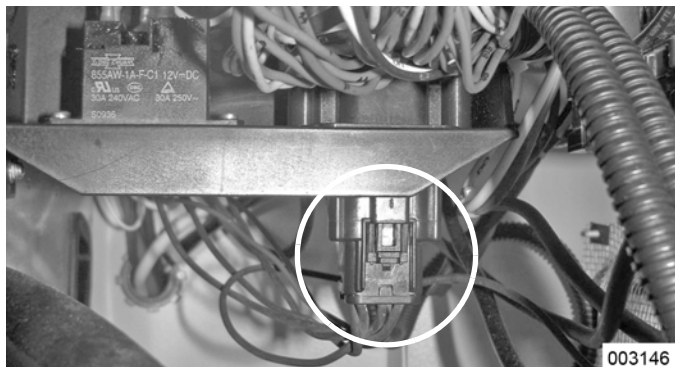


Figure 2-12. C1 Connector (if unit is equipped)

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).
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 (if unit is equipped).
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 (if unit is equipped, see [Figure 2-12](#)).
4. If the meter indicated OPEN in either Step 8 or Step 9, proceed to [Test 7 – Test the Stator with a DMM](#).

Test 6 – Test Excitation Winding Circuit 2 and 6

General Theory

The voltage regulator (internal to the controller) requires unregulated voltage from the stator in order to supply excitation power to the regulator. The regulator supplies DC field excitation current to the rotor. The alternator may be producing this voltage, but if the voltage is not being supplied to the regulator, it will fault out for under-voltage. This test will verify the integrity of the Excitation (DPE) winding inside the stator and connections to the voltage regulator.

Required Tools

- Meter test leads 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 2-9](#).

NOTE: It is not recommended to use any testing device other than the manufacturer's approved test lead adapters.

Procedure

1. Remove the 7.5 amp fuse from the control panel.
2. Expose the controller lower harness connections by removing the controller mounting hardware.
3. Disconnect the harness connector containing Wires 2 and 6 from the controller.
4. Set the DMM to measure resistance.
5. Connect one meter test lead to the harness pin for Wire 2 and the other meter test lead to the harness pin for Wire 6. Measure and record the resistance.
 - a. If the meter indicated a resistance value consistent with the values found in [Section 1.1 Specifications](#), stop testing and refer back to the flow chart (Good).
 - b. If the meter indicated an OPEN, proceed to Step 6.
6. See [Figure 2-13](#) and [Figure 2-14](#). Disconnect the lower bulkhead C1 connector (if unit is equipped). On Evolution units locate the STR connector and disconnect.
7. On the harness connector (disconnected in Step 6) that leads to the stator, connect one meter test lead to Wire 2 and the other meter test lead to Wire 6. Measure and record the resistance.

Results

1. If the meter indicated a resistance value consistent with the values found in the table in the front of the manual, stop testing and refer back to the flow chart (Good).
2. If the meter indicated a resistance value of OPEN in Step 5, but a resistance value consistent with the values found in the table in the front of the manual in Step 7, repair or replace Wire 2 and/or 6 between the controller and the connector (C1 Connector on Nexus, STR Connector on Evolution). Measure Ohms between Wire 2 and 2, or Wire 6 and 6 to confirm which wire is open.
3. If the meter indicated a resistance value of OPEN or a resistance value inconsistent with the values found in the table in the front of the manual in Step 5 and Step 7, replace the stator.

Test 7 – Test the Stator with a DMM

General Theory

This test will use a digital multimeter (DMM) to test the stator windings for the following faults:

- An OPEN circuit condition
- A “short-to-ground” condition
- A short circuit between windings

[Table 2-13](#) has been provided to record the results of the following procedure. These results may be required when requesting factory support.

NOTE: It is the recommendation of the factory to perform this test procedure using piercing probes on the wire side of the connector. Testing inside the connector itself can cause unnecessary 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 stator connector or proper controller connector on the harness (C1 Connector on Nexus, STR Connector on Evolution).

NOTE: The C1 connector is not installed on all generators. Do alternative testing on wire harness using specific wire numbers.

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 DMM 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 2-10](#). Record the results in [Table 2-13](#).

Table 2-10. Resistance 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(S)	Stator Lead 22
C1 Pin 1 Wire 44(S)	Stator Lead 33
C1 Pin 3 Wire 6	C1 Pin 4 Wire 2

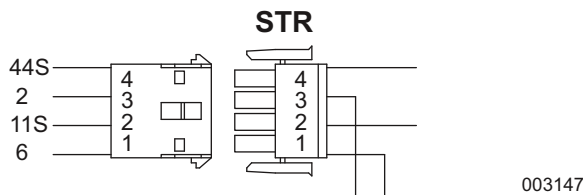


Figure 2-13. Stator Connector (STR) Pin Locations (if unit is equipped)

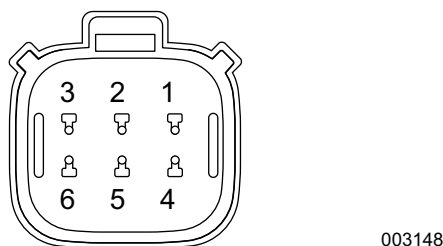


Figure 2-14. C1 Bulkhead Connector Pin Locations (if unit is equipped)

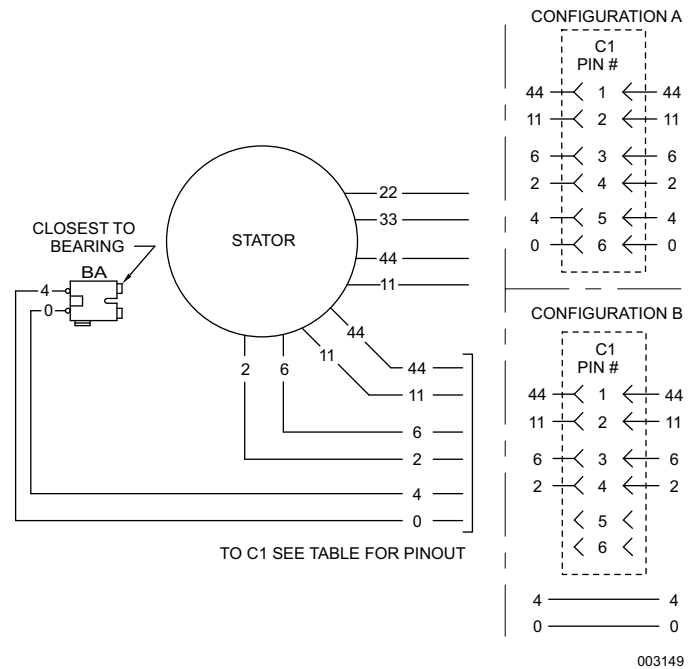


Figure 2-15. Stator Lead Connections

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 2-11](#). Record the results in [Table 2-13](#).

Table 2-11. Short to Ground Test Points

Test Point A	Test Point B
Stator Lead Wire 11	Ground
Stator Lead Wire 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 2-12](#). Record the results in [Table 2-13](#).

Table 2-12. Short Between Windings 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 1 Wire 44
C1 Pin 4 Wire 2	Stator Lead Wire 11
C1 Pin 4 Wire 2	Stator Lead Wire 44
Stator Lead Wire 11	C1 Pin 1 Wire 44
Stator Lead Wire 11	Stator Lead Wire 44

Results

1. **Resistance Test:** If the DMM 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.

Table 2-13. 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 Wire 11	Ground	
Stator Lead Wire 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 1 Wire 44	
C1 Pin 4 Wire 2	Stator Lead Wire 11	
C1 Pin 4 Wire 2	Stator Lead Wire 44	
Stator Lead Wire 11	C1 Pin 1 Wire 44	
Stator Lead Wire 11	Stator Lead Wire 44	

NOTE: Read Section 1.2, *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 Megohmmeter), clean and dry the stator as outlined in Section 1.2 *Testing, Cleaning and Drying*. Then, repeat the insulation resistance test. If the winding fails the second resistance test (after cleaning and drying), replace the stator assembly.

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

NOTE: Stator winding resistance values are very low. Some meters will not read such a low resistance, and will simply indicate CONTINUITY. The manufacturer recommends a high quality digital type meter capable of reading a very low resistance.

Test 8 – Resistance Check of Rotor Circuit

General Theory

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 (if unit is equipped) wiring configuration. Refer to [Figure 2-12](#).
- Configuration A: follow Steps 1-11
- Configuration B: follow Steps 1-6

NOTE: if the unit does not have a C1 connector refer to the appropriate pin at the controller connector.

Procedure

NOTE: For Evolution units perform Steps 1 - 6a.

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 harness connector from the controller
4. Set the DMM to measure resistance.
5. Connect one meter test lead to the appropriate harness pin for Wire 4 and connect the other meter test lead to the appropriate harness pin for Wire 0. Measure and record the resistance.
6. Connect one meter test lead to the appropriate harness pin for Wire 4 and connect the other meter test lead to a ground connection. 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 (if unit is equipped), locate and disconnect the bulkhead C1 connector. If testing C1 Configuration B (if unit is equipped), stop test and refer to Test 8 Results.
8. Connect one meter test lead to C1 (if unit is equipped) to the appropriate harness pin for Wire 4 and connect the other meter test lead to C1 (if unit is equipped) to the appropriate harness pin for Wire 0. Measure and record the resistance. If the meter 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 harness connector from the controller.
11. Connect one meter test lead to the disconnected Wire 56 and connect the other meter test lead to the appropriate harness pin for Wire 4. Measure and record the resistance.

Results

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

1. If the DMM indicated the correct resistance values in Steps 5, 6, 8, and 11, refer back to flowchart (Good).
2. If the DMM indicated INFINITY in Step 8, refer back to flowchart (Rotor Circuit Failure).
3. If the DMM indicated the correct resistance in Step 8 and indicated INFINITY in Step 5, repair or replace Wires 4 and 0 between the C1 (if unit is equipped) and the J5 connector.
4. If the DMM 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 DMM 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

General Theory

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 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 2-12](#) to identify the C1 Connector (if unit is equipped) 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.

IMPORTANT NOTE: 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 (if unit is equipped) disconnect the bulkhead connector C1 inside the control panel. For C1 Configuration B (if unit is equipped) disconnect the harness connector from the controller and isolate Wire 0 from the ground stud.
7. Set the DMM to measure resistance.
8. For C1 Configuration A (if unit is equipped) 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 (if unit is equipped) 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 DMM indicated INFINITY, repair or replace Wire 0 between the negative slip ring and C1 (if unit is equipped) Pin 6 (Configuration A) or the ground stud (Configuration B).
 - If the DMM 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 (if unit is equipped) connect one meter test lead to Wire 4 at the brush assembly and connect the other meter test lead C1 (if unit is equipped) Pin 5. For C1 Configuration B (if unit is equipped) connect one meter test lead to Wire 4 at the brush assembly and connect the other meter test lead to appropriate controller connector.
 - If the DMM indicated INFINITY, repair or replace Wire 4 between the positive slip ring and C1 (if unit is equipped) Pin 6 (Configuration A) or the appropriate controller connector (Configuration B).
 - If the DMM 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 DMM indicated CONTINUITY, repair or replace Wire 4 between the positive slip ring and C1 Pin 6 (Configuration A) or Pin 13 (Configuration B).
 - If the DMM 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 ground connection.
 - If the DMM indicated INFINITY, repair or replace Wire 0 between the positive slip ring and the control panel ground connection.

- If the DMM indicated CONTINUITY, refer back to flow chart.

Results

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

Test 10 – Test Rotor Assembly

General Theory

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 DMM 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 ground connection. Measure and record the resistance.

Results

1. Compare the resistance measured in Step 3 with Section 1.1 [Specifications](#). Replace rotor as required.
2. If the DMM indicated CONTINUITY in Step 4, replace the rotor assembly.

Test 11 – Check AC Output Frequency

General Theory

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.

NOTE: Engine Speed is in direct correlation to frequency (Hertz). The controller monitors Wire 18 to maintain proper frequency.

Tools Required

- A meter that is capable of measuring AC frequency.

Procedure

1. See [Figure 2-8](#). Connect an accurate AC frequency meter across the Wires 11 and 44

Terminals of the generator main line circuit breaker (MLCB).

2. Set the controller to MANUAL.
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 and Single Cylinder

NOTE: For Nexus units follow only Steps 1-3 and 7-10.

1. Remove air cleaner cover to access stepper motor and/or visually see throttle plates.
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 and visually move the throttle to the closed position by pulling the Stepper motor arm towards the idle stop. See [Figure 2-16](#), [Figure 2-17](#), [Figure 2-18](#), and [Figure 2-19](#) for Evolution units. See [Figure 2-20](#), [Figure 2-21](#), and [Figure 2-22](#) for Nexus units.
4. Set the controller to MANUAL.
5. Observe and record the stepper motor movement.
 - a. On Nexus units, it should open.
 - b. On Evolution units the stepper motor will cycle the mixer to a full open throttle position (which opens both venturis), back to a closed position and then to the starting position, which is a slight opening of the throttle in the small venturi.
6. Set the controller to OFF.
7. Physically move the throttle to the open position by pulling the stepper motor arm away from the idle stop.
8. Set the controller to MANUAL.
9. Observe and record the stepper motor movement.
10. Set the controller to OFF.
11. If no movement was seen in Steps 5 or 9 remove the controller and verify the six pin connector on the controller is seated properly. Remove the connector and then connect it and test again. If problems persist, proceed to Step 12.

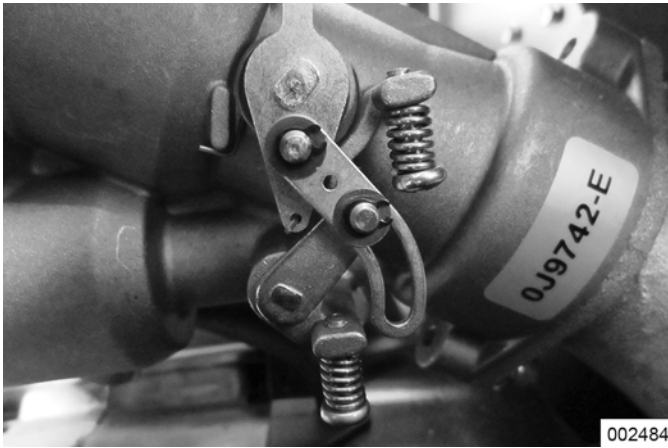


Figure 2-16. Evolution Stepper Motor Starting Position and/or Mid-point

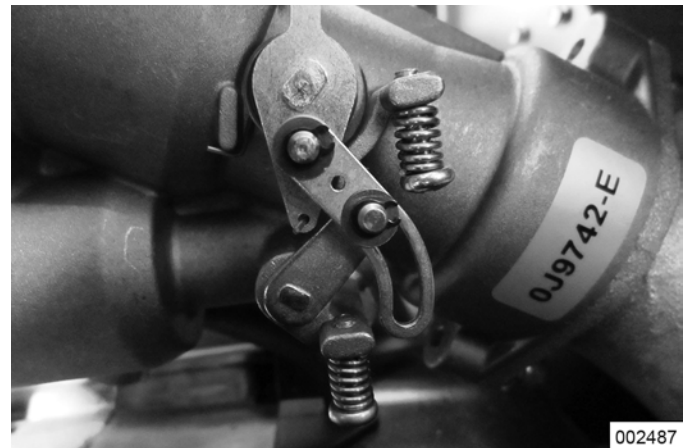


Figure 2-19. Evolution Stepper Motor Mid-point = Starting Point, Smaller Venturi Partially Open

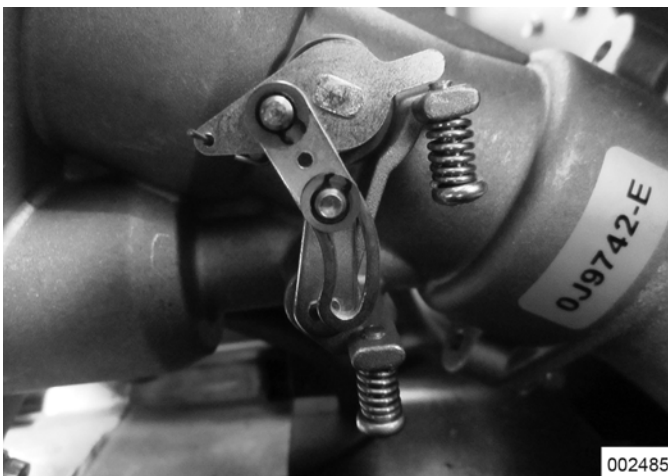


Figure 2-17. Evolution Stepper Motor Wide Open = Opens Both Venturis

NOTE: In [Figure 2-20](#), [Figure 2-21](#), and [Figure 2-22](#) the white arrow indicates the direction to pull the arm to close the throttle.

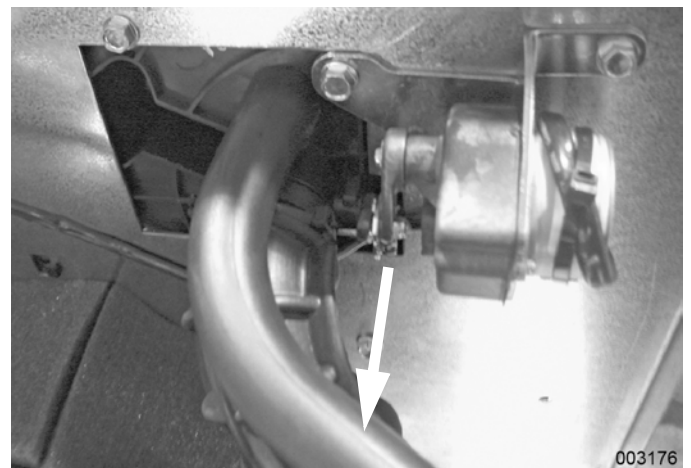


Figure 2-20. Throttle Positions Nexus 8 kW Units

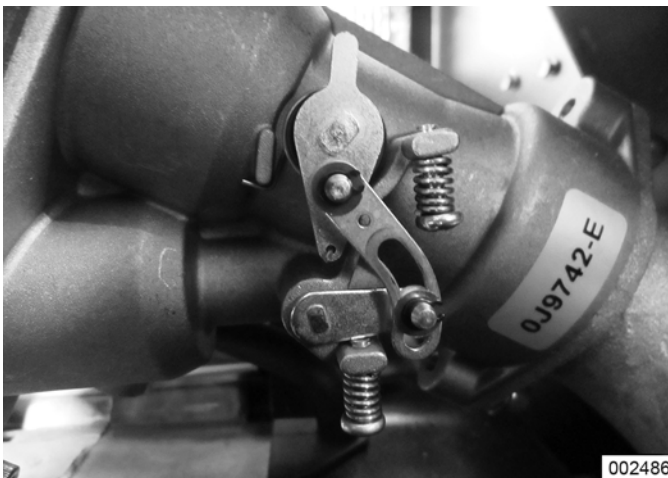


Figure 2-18. Evolution Stepper Motor Closed - Closes Both Venturis

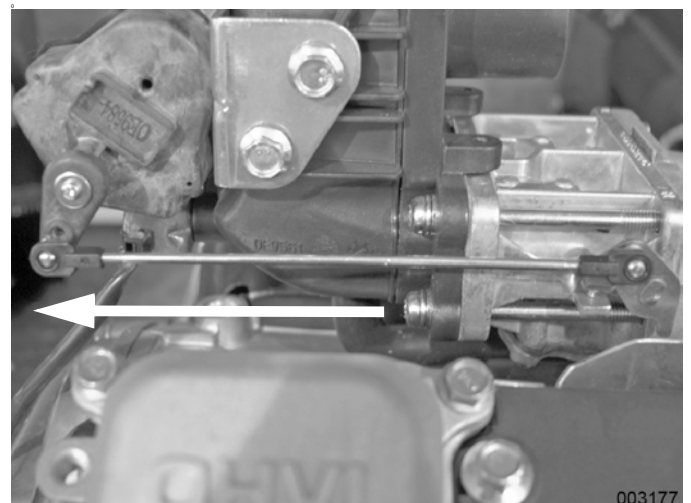


Figure 2-21. Throttle Positions Nexus 9/10 kW Units

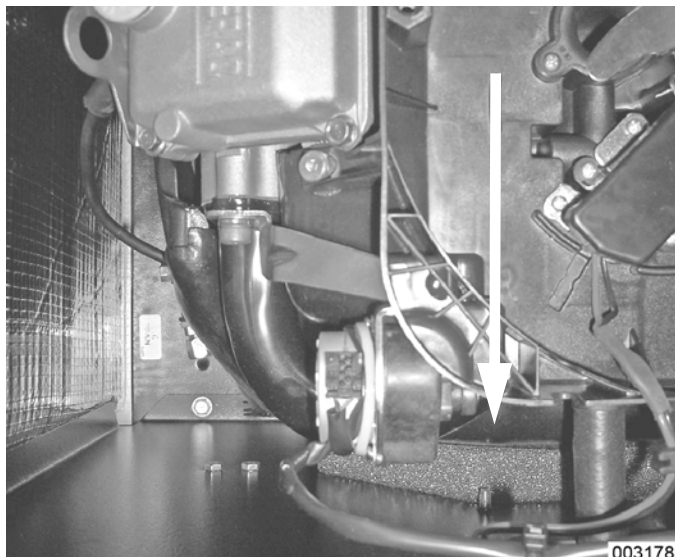


Figure 2-22. Throttle Positions Nexus 12-20 kW Units

12. Set the DMM to measure resistance.

NOTE: Press down with the meter leads on the exposed terminals of the connector. Do not probe into the connector.

13. Connect the meter test leads across points A and B as shown in [Table 2-14](#) and compare to the specified value.

Table 2-14. Stepper Motor Testing

Test Point A	Test Point B	Resistance Value
Red wire	Orange wire	approx. 10-11Ω
Red wire	Yellow wire	approx. 10-11Ω
Red wire	Brown wire	approx. 10-11Ω
Red wire	Black wire	approx. 10-11Ω
Red wire	Ground	INFINITY

Results

1. If the stepper motor moved to the wide-open position in Step 5, and to the closed position in Step 9, and the DMM indicated appropriate 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 moved to the wide-open position in Step 5, and to the closed position in Step 9, and the DMM indicated inappropriate resistance values, replace Stepper motor.

Test 14 – Check Voltage and Frequency Under Load

General Theory

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

Test 15 – Check for an Overload Condition

General Theory

An “overload” condition exists when 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. Refer to the Air-cooled Reference Manual (P/N 1000020935).

Procedure

1. Connect the clamp-on ammeter to the generator according to the ammeter manufacturer’s 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 rated capacity of the unit.
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

General Theory

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 4.6 Diagnostic Tests**. For further engine repair information, refer to the appropriate engine service manual.

Test 17 – Current Calibration

General Theory

An Evolution unit monitors load (current) through two Current Transformers (CT) mounted in the AC connection box area. The CTs provide an AC output signal proportional to the current flowing in the load leads 11 and 44.

CT1 and CT2 have identical functions, diagnostic procedures and calibration process. CT1 wire circuits 398A and 399A monitor the current flow on Wire 11. CT2 wire circuits 398B and 399B monitor the current flow on Wire 44. The CTs are calibrated using the Evolution control panel. A password is required to access the Dealer Edit menu when performing calibrations.

NOTE: Verify Wires 11 and 44 are fed through the side of the CT with the green dot.

Procedure

1. Connect a load bank to the output circuit of the generator. This should be done at the generator's MLCB.
2. Place the Amp meter over the circuit being checked. CT1 "Current Calibration1" – Wire 11 and CT2 "Current Calibration2" – Wire 44.
3. Start the generator and allow it to warm up for 10 seconds.
4. Place a load on the generator that matches the rated output of the generator.
5. Select the correct Current Calibration display menu under the Dealer Edit menu.
6. Press ENTER to view generator output and the calibration value of that CT.
7. Adjust up or down the generator display to match the Amp meter's calibrated reading. (Use the controllers UP and DOWN arrows to make adjustments)
8. Once the display panel reading matches the amp meter, press the ENTER button to save the new calibration. Repeat the process for CT2 Current Calibrations.
9. When both calibration adjustments are correct, remove the load from the generator and allow the

generator and load bank to cool before shutting down.

Results

With loads applied, CT1 - Wires 398A/399A and CT2 - Wires 398B/399B deliver approximately 0 to 1.5 VAC based on percentage of Amps (load). Approximate Values (when back-probed at connector):

25 Amps = 0.380 mVAC
50 Amps = 0.755 mVAC
75 Amps = 1.133 VAC
100 Amps = 1.510 VAC



⚠ DANGER

Electrocution. Lethal voltage may be present at current transformers (CTs). Do not touch CTs while primary current is applied. Doing so will result in death or serious injury. (000310)

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Section 3.1 Description and Major Components

Introduction

The “V-Type” Contactor is available in 100 through 200 Amp ratings at 250 volts maximum with a 2-pole configuration (single phase only).

Automatic transfer operation of the transfer switch is controlled by the generator.

Enclosure

The transfer switch enclosure is either a National Electrical Manufacturer’s Association (NEMA) Type 1 or a Type 3R. 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.

Type 3R Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

Transfer Switch Contactor

The basic 2-pole CONTACTOR consists of a pair of movable LOAD contacts, a pair of stationary UTILITY contacts, and a pair of stationary STANDBY contacts. The LOAD contacts connect to the UTILITY contacts by a utility closing coil or to the STANDBY contacts using the standby closing coil. See [Figure 3-1](#) and [Figure 3-2](#). 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. For example, if the CONTACTOR is in the UTILITY position, the standby closing coil will energize utilizing Standby voltage.

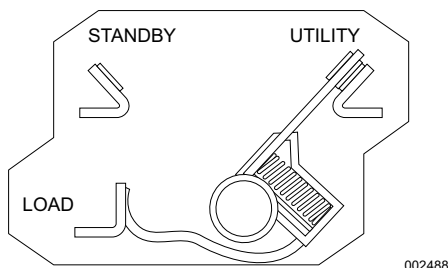


Figure 3-1. Load Connected to Utility Power Source

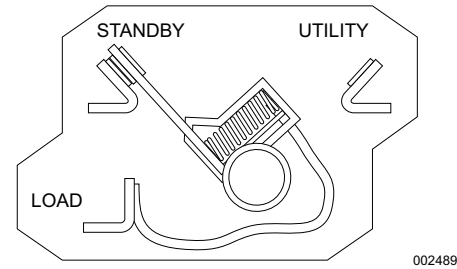
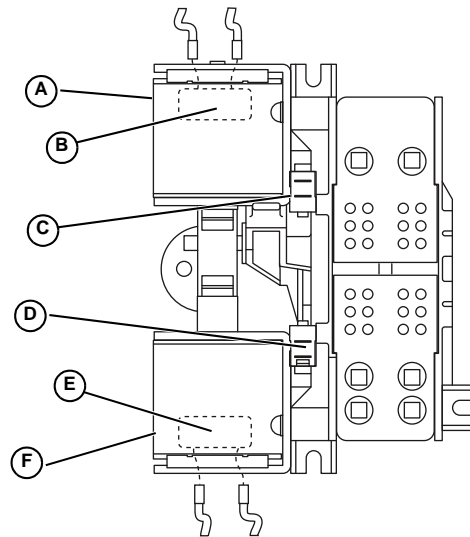


Figure 3-2. Load Connected to Standby Power Source

Utility Closing Coil C1

See [Figure 3-3](#). 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. The coil and the spring force will complete the transfer to UTILITY. A bridge rectifier, which changes the Utility source alternating current (AC) to direct current (DC), is sealed in the coil wrappings. If either coil or bridge rectifier replacement becomes necessary, replace the coil assembly.



- A. Utility Closing Coil C1
- B. Bridge Rectifier
- C. Limit Switch SW2
- C. Limit Switch SW3
- E. Bridge Rectifier
- F. Standby Closing Coil C2

Figure 3-3. The “V-Type” Transfer Mechanism

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. The coil 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.

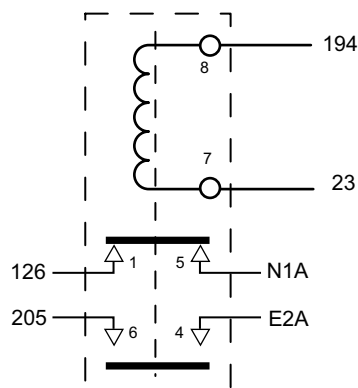
Limit Switches SW2 and SW3

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 re-transfer to UTILITY. An open condition in SW3 will prevent transfer to the STANDBY.

Transfer Relay

Figure 3-4 shows the transfer relay electrical schematic. Transfer relay operation is controlled by the generator controller. The transfer relay operates as follows:

1. Generator battery voltage (12 VDC) is available to the transfer relay coil from the Evolution controller, via Wire 194 to the relay.
 - a. The 12 VDC circuit is completed through the transfer relay coil and back to the controller via Wire 23.
 - b. Controller 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.
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 factory default 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 ten second “Engine Warm-up Timer.”
4. When the “engine warm-up timer” has timed out, controller logic closes the Wire 23 circuit to ground.
 - a. The transfer relay energizes.
 - b. The relay’s normally closed contacts open and the 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.



002491

Figure 3-4. Typical Transfer Relay Schematic

5. When the controller senses that utility source voltage has been restored (nominal for 15 seconds), the Wire 23 circuit will open from ground.
 - a. The transfer relay will de-energize, the normally closed contacts will close and the 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 on a u-shaped bracket. Use the handle to manually move the contactor to the UTILITY or “STANDBY position.

Customer Connections

See **Figure 3-6**. During system installation, the control wires must be properly landed between the generator and transfer switch.

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 drops below the set nominal value for ten seconds (default), controller 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

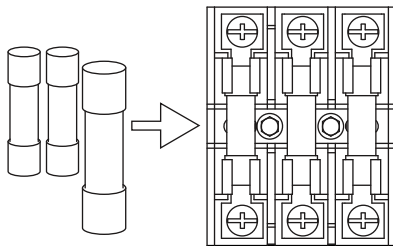
Wire T1, connected to the Load side of the contactor, provides 120 VAC for the battery charging circuit (the battery charger is an integral component of the controller). The charger maintains battery voltage anytime the load terminals have voltage available.

Control 194, 23

Wires 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 controller logic until a utility failure is sensed.

Fuse Holder

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



002509

Figure 3-5. Fuse Holder

Fuses F1, F2

These two fuses protect the N1 and N2 circuit against overload.

Fuse F3

This T1 fuse protects the battery charger against overload.

Fuse F4

This T2 fuse protects the battery charger against overload (50 Hz only).

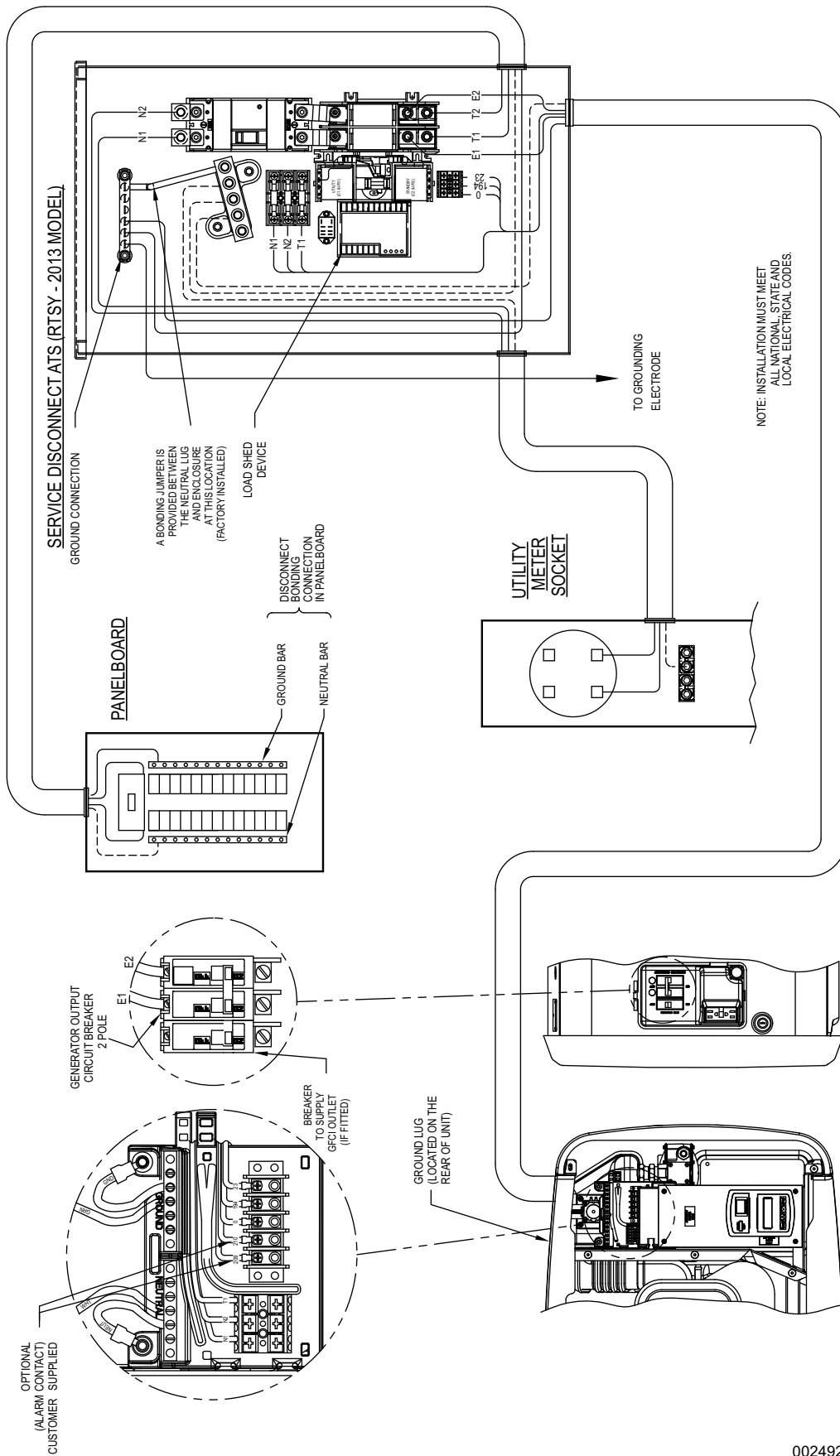


Figure 3-6. A Typical Interconnection Drawing

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Load Shed Module and Operation OPCB LSM 120 Volt Only

The Load Shed Module is designed to prevent an overload on the generator when it is supplying customer loads. Up to six loads can be managed by the load shed module; 2 air conditioner loads and 4 additional loads. The load shed module manages the loads by “shedding” the connected loads in the event of a drop in generator frequency (overload). Loads to be “shed” are grouped in 4 priority levels on the load shed module.

Priority 1 and 2 each have connections for one air conditioner and one contactor. Both an air conditioner and a contactor can be used at the same time if desired. To control an air conditioner, no additional equipment is required. Internal relays interrupt the thermostat 24 VAC control signal to disable the air conditioner load.

Priority 3 and 4 have connections for one contactor only. Four LEDs located on the load shed module will indicate when a load priority level is enabled or disabled.

Any load, including a central air conditioner, can be controlled via a contactor that must be purchased separately. Up to four contactors can be controlled by the load shed module.

The LSM (120 volt only) supplies the 120 VAC to energize each contactor coil.

Wire 194 from the HSB controller supplies 12 VDC to the module. Wire 0 provides the ground for the logic side of the module. Wire 23 is monitored by the module to identify when transfer to standby and back to utility has occurred. T1 and Neutral are used to monitor the frequency of the generator for load control.

Test Button

The load shed modules and the OPCB modules have a TEST button which forces the unit to act as if an overload has occurred. This button operates even when the transfer signal is inactive.



Figure 3-7. LSM TEST Button

Load Shed Operation

NOTE: The following sequence is for the LSM 120 volt module ONLY.

The 4 green status LEDs will indicate when a load priority level is enabled or disabled.

All loads are enabled when the transfer signal is off. (ATS in Utility position).

If the transfer signal is pulled low (Active) all loads are enabled until an overload is detected.

When an overload is detected all loads are disabled.

A generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58 Hz for 3 seconds or <50 Hz for ½ Second (For 60Hz).

- Priority 1 loads are enabled after 5 minutes.
- Priority 2 loads are enabled after 30 seconds.
- Priority 3 load is enabled after another 30 seconds.
- Priority 4 load is enabled after another 30 seconds.

If an overload is detected within 30 seconds of a level being enabled, all loads are disabled again and the sequence repeats. However, the level that caused the overload and all levels higher will not be enabled again for 30 minutes. This process of testing will continue every 30 minutes. The faulting priority and all other higher levels will remain locked out until the overload for that priority is lowered, or system is returned to utility, or reset button is pressed.

Figures 3-8 through 3-17 follow the sequence of operation when an overload condition occurs on Priority Circuit 3. After a 30 minute timer expires, Priority 3 is activated. If the frequency is still OK, Priority 4 is enabled after another 30 second timer expires.

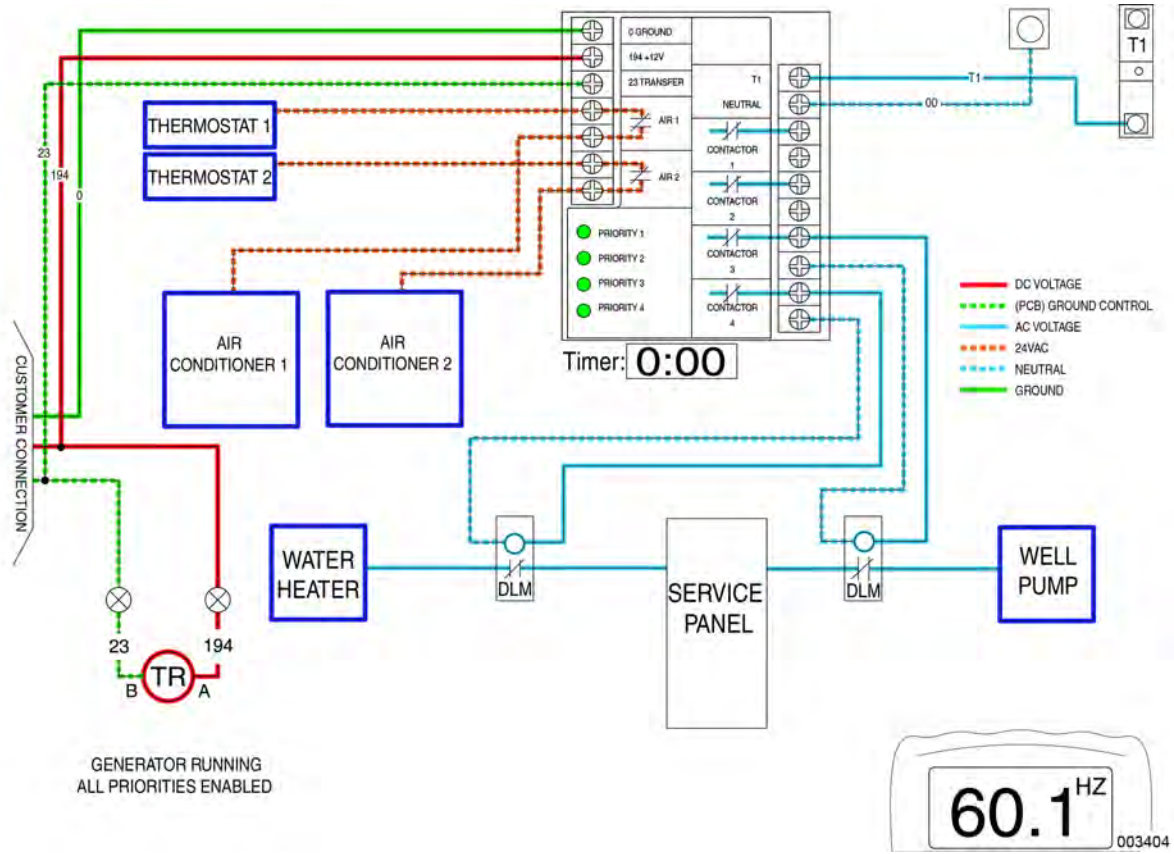


Figure 3-8. Generator Running All Priorities Enabled

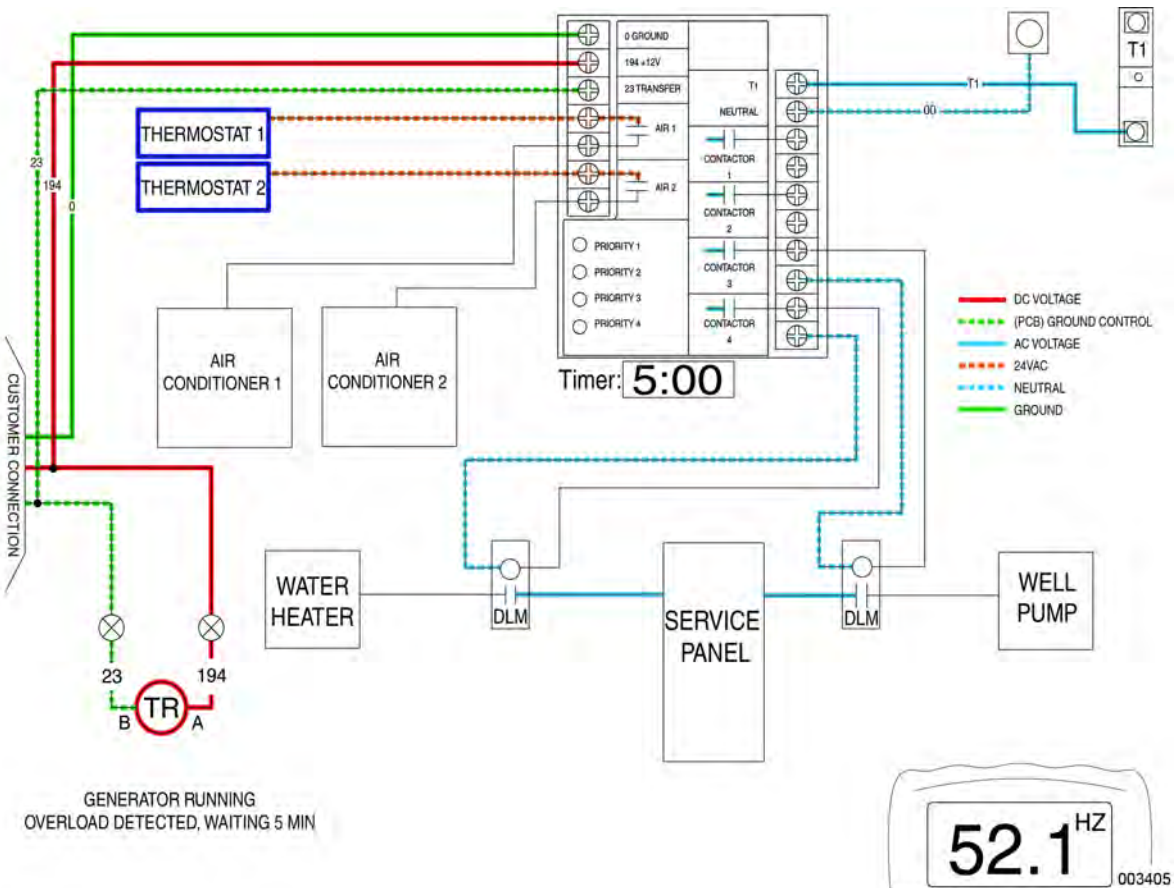


Figure 3-9. Generator Running Overload Detected, Waiting 5 Minutes

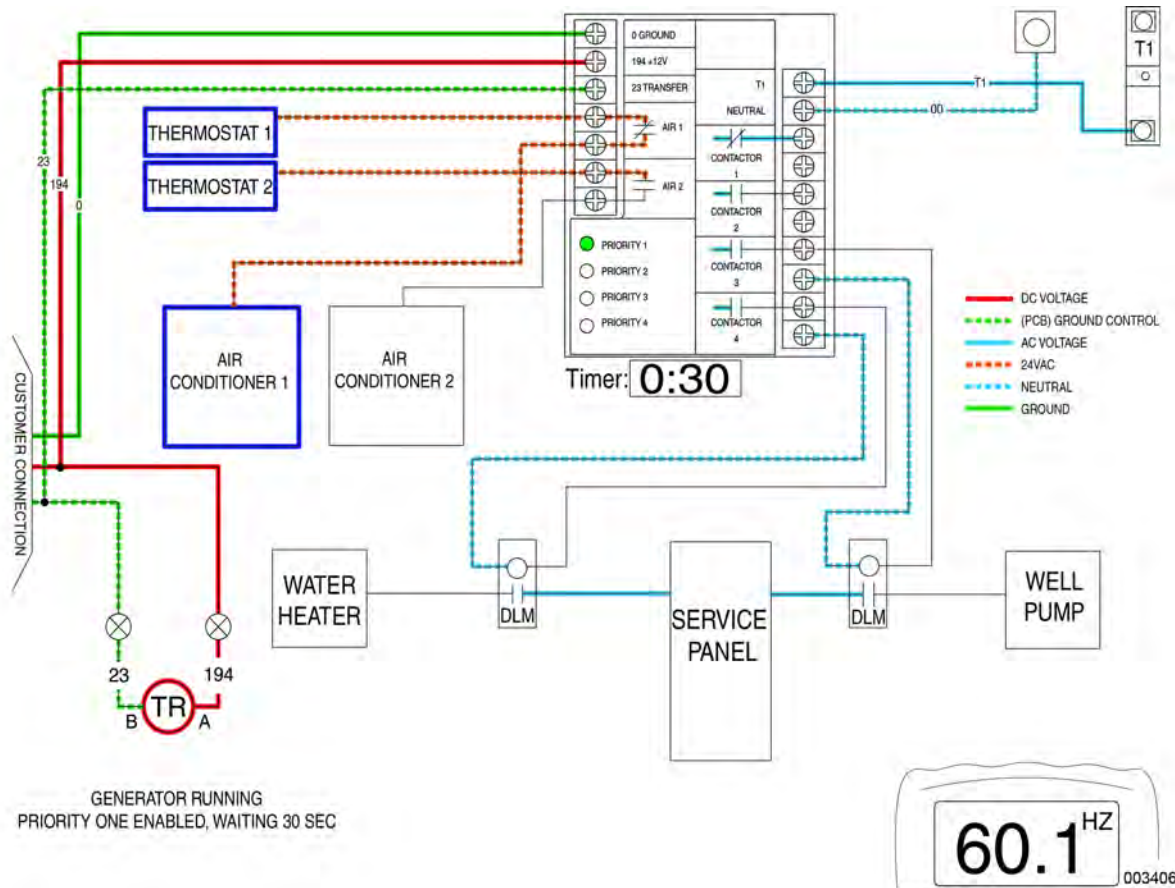


Figure 3-10. LSM 120 Volt Generator Running Priority One Enabled, Waiting 30 Seconds

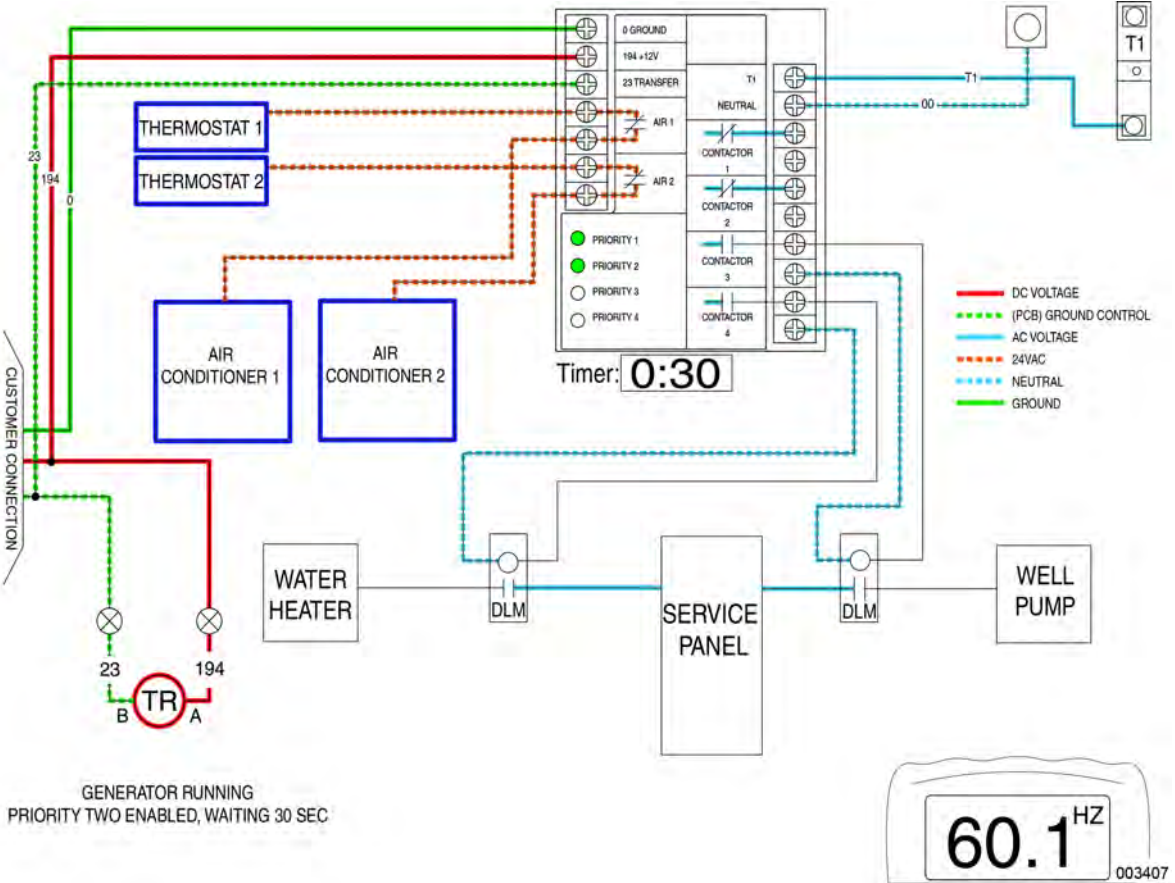


Figure 3-11. LSM 120 Volt Generator Running Priority Two Enabled, Waiting 30 Seconds

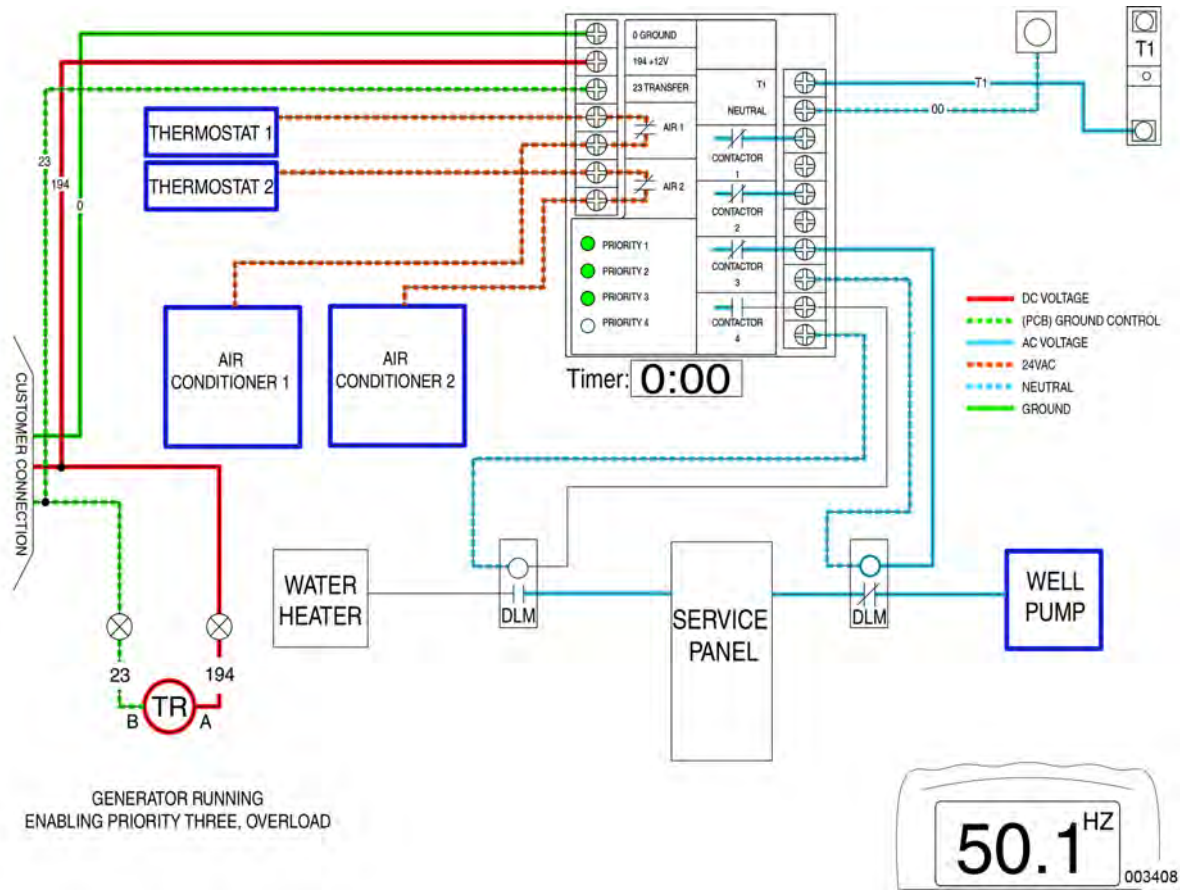


Figure 3-12. LSM 120 Volt Generator Running Enabling Priority Three, Overload

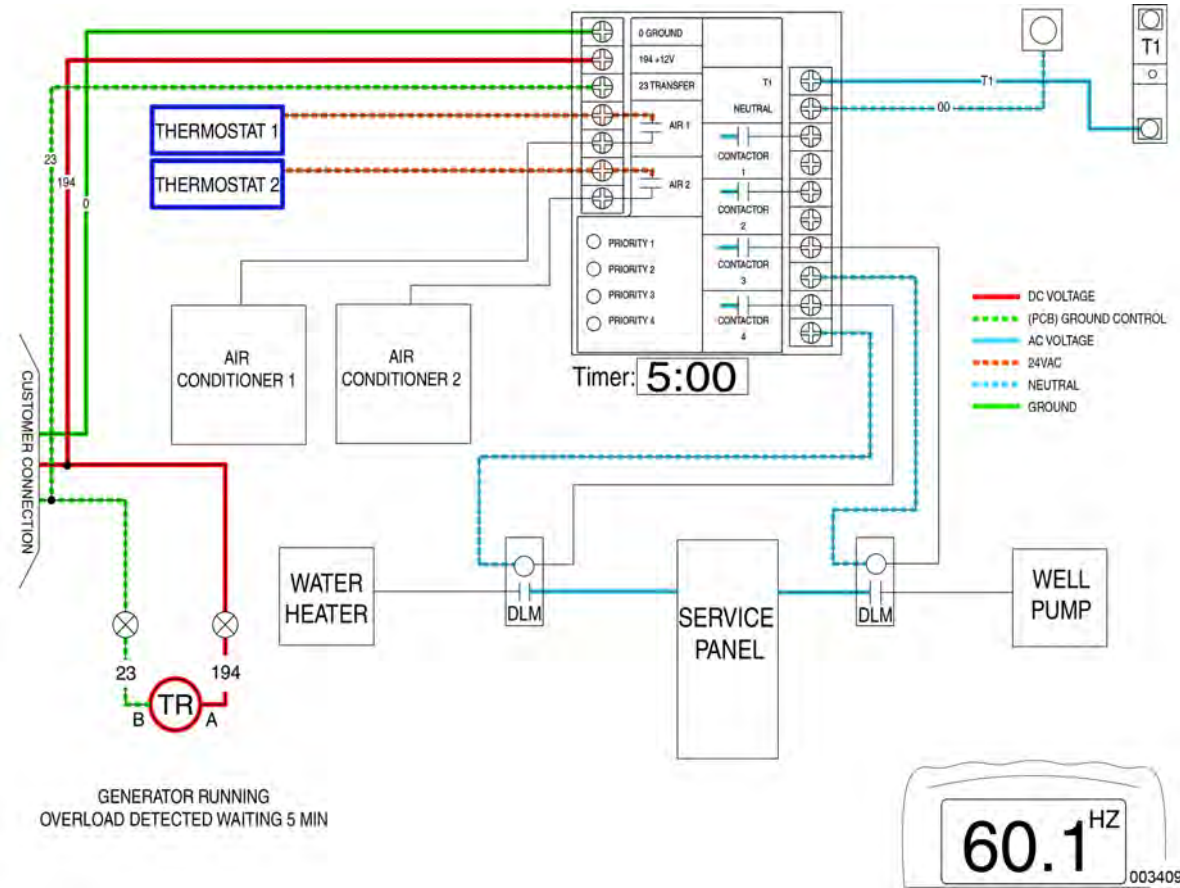


Figure 3-13. LSM 120 Volt Generator Running Overload Detected Waiting 5 Minutes

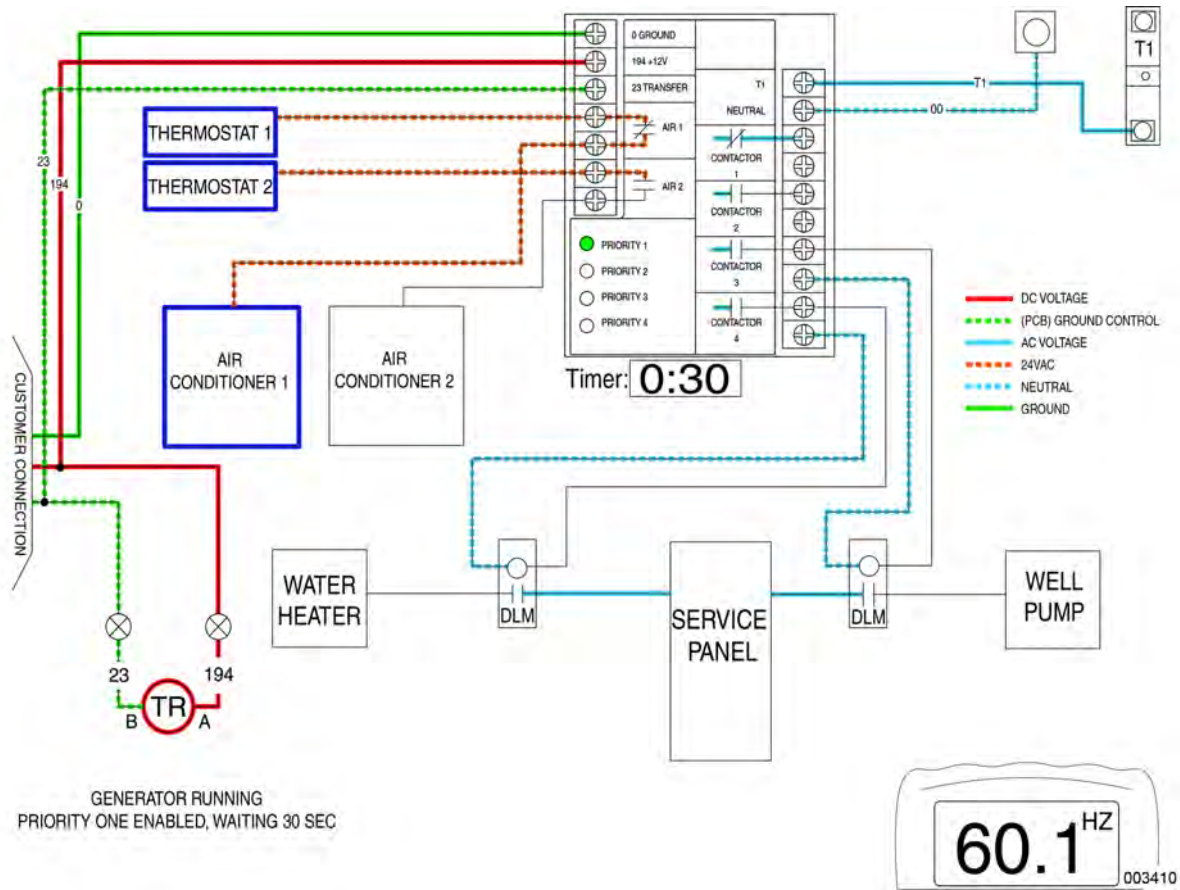


Figure 3-14. LSM 120 Volt Generator Running Priority One Enabled, Waiting 30 Seconds

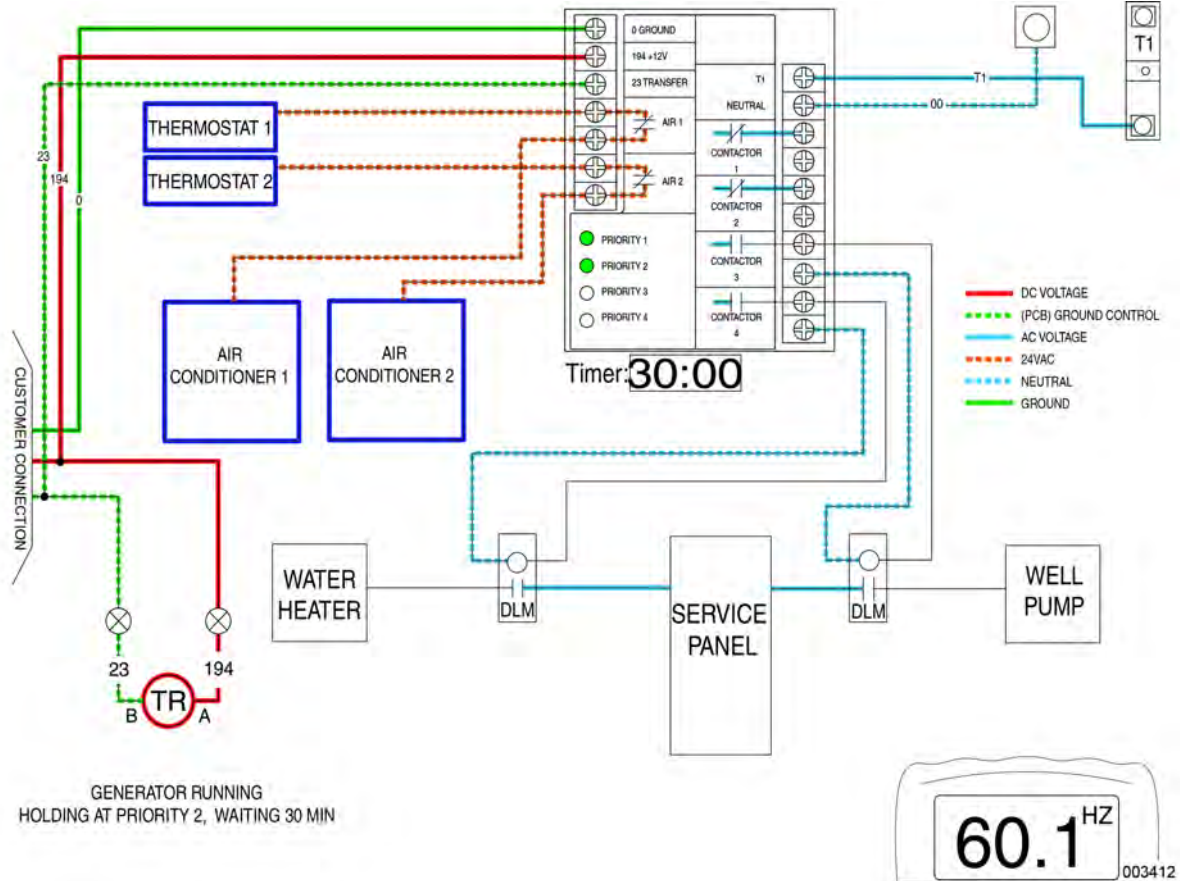


Figure 3-15. LSM 120 Volt Generator Running Holding At Priority 2, Waiting 30 Minutes

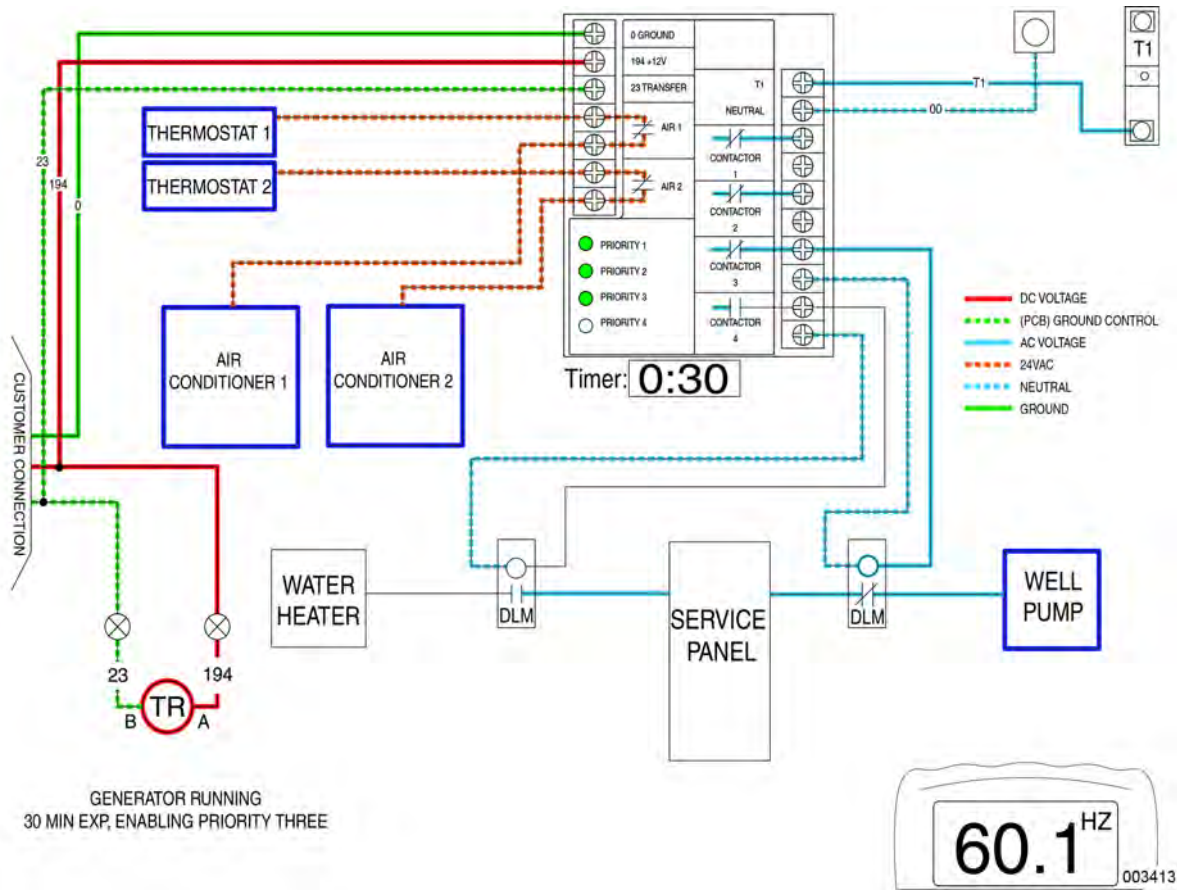


Figure 3-16. LSM 120 Volt Generator Running 30 Min Exp, Enabling Priority Three

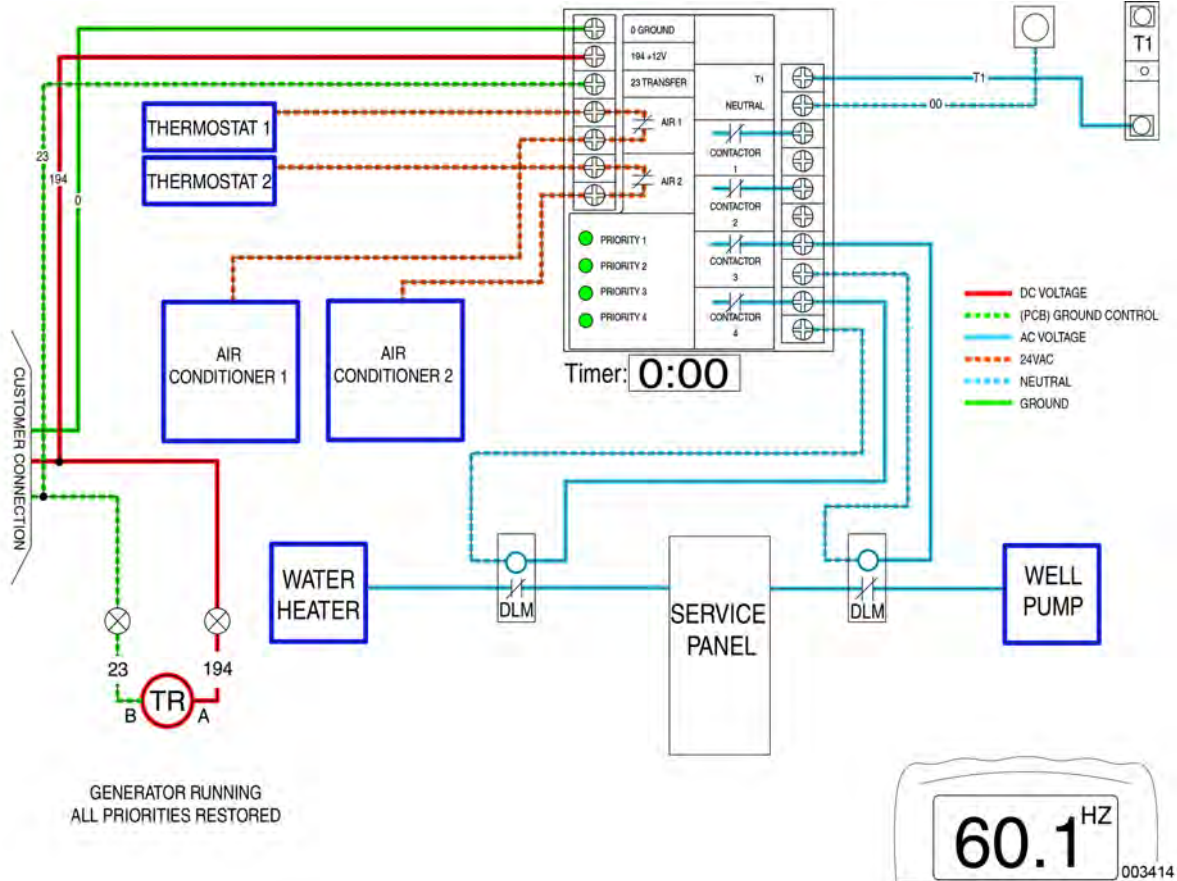


Figure 3-17. LSM 120 Volt Generator Running All Priorities Restored

Load Shed Module Operation OPCB 24/120 Volt Module

The Overload Prevention Control Board (OPCB) can control an air conditioner (24 VAC) directly or a separate contactor (24 VAC or 120 VAC operating coil) which can control any load connected to it.

The OPCB load contacts can be powered from either a 24 VAC or 120 VAC power supply. The 24 VAC supply is from a Class 2 transformer which can be purchased from the manufacturer.

Wire 194 from the HSB controller supplies 12 VDC to the module. Wire 0 provides the ground for the logic side of the module. Wire 23 is monitored by the module to identify when transfer to standby and back to utility has occurred. T1 and Neutral are used to monitor the frequency of the generator for load control.

NOTE: When utilizing the optional 24 VAC configuration, the power supply transformer (Class 2) must have connections to the LOAD and NEUTRAL connection at the OPCB. Limit each output to 1 Amp.

NOTE: 120 volt contactors cannot be used in conjunction with 24 volt contactors. The OPCB must be wired with one or the other.

A generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58 Hz for 3 seconds or <50 Hz for ½ Second (For 60Hz).

Smart A/C Module (SACM)

Up to four air conditioner loads can be managed by the Smart A/C Module (SACM). The SACM manages the loads by “shedding” the connected loads in the event of a drop in generator frequency (overload). Loads to be shed are in 4 priority levels on the module.

Priorities A/C 1-4 have connections for an air conditioner. To control an air conditioner, no additional equipment is required. Internal normally closed relays interrupt the 24 VAC thermostat control signal to disable the air conditioner load.

Four LEDs, located on the SACM, illuminate when a load is connected and powered. The SACM has a test button used to simulate an overload condition. This button operates even when the transfer signal is inactive.

A generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58 Hz for 3 seconds or <50 Hz for ½ Second (For 60Hz).

Test Button

The OPCB/SACM load shed module has a TEST button which forces the unit to act as if an overload has occurred. This button operates even when the transfer signal is inactive.

The TEST button will work when the ATS is in the Utility or the Generator position.

1. Turn on the utility supply to the ATS.
2. Press and hold the TEST button on the OPCB for approximately 1 second.
3. Verify that all of the connected loads to be “shed” become disabled. The method of verification will depend on the type of load.
4. After five (5) minutes verify A/C1 (Priority 1) are energized. Status LED AC 1 and Load 1 is ON.
5. After another 15 seconds, verify A/C2 (Priority 2) are energized. Status LED AC 2 and Load 2 are ON.
6. After another 15 seconds, verify A/C3 (Priority 3) is energized. Status Load 3 is ON.
7. After another 15 seconds, verify A/C4 (Priority 4) is energized. Status Load 4 is ON.



Figure 3-18. OPCB TEST Button

Load Shed Operation

NOTE: The following sequence of operation is the same for the SACM and the OPCB 24/120 modules.

The 4 green status LEDs will indicate when a load priority level is enabled or disabled.

All loads are enabled when the transfer signal is off. (ATS in Utility position).

When utility power is interrupted, T1 is de-activated. The module remains powered via Wire 194 (12 VDC) and Wire 0. Wire 23 is not grounded (high, 12 VDC) at this time.

As the generator starts, runs, and transfers, Wire 23 is pulled to ground (low, 0 VDC). Once the transfer switch goes to the standby position, T1 is powered by the generator.

The module senses that the system is on standby and disables all loads. A 5 minute timer is activated.

- A/C1 (Priority 1) load(s) are enabled after 5 minutes.
- A/C2 (Priority 2) load(s) are enabled after 15 seconds.
- A/C3 (Priority 3) load is enabled after another 15 seconds.
- A/C4 (Priority 4) load is enabled after another 15 seconds.

When an overload is detected all loads are disabled.

Generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58 Hz for 3 seconds or <50 Hz for ½ second (For 60Hz).

If an overload is detected within 15 seconds of a priority being enabled, that load is then locked out. The sequence will continue until all load levels have been checked (temporarily bypassing the faulting level). The level that caused the overload will not be enabled/tested again for 30 minutes. The OPCB/SACM will attempt to enable the load every 30 minutes. During enabling, if the

frequency drops below specifications, the OPCB/SACM will disable again. This will continue until the frequency does not drop when the priority is enabled, the system is returned to utility, or the TEST button is pressed.

When utility voltage returns, Wire 23 is released from ground (back to 12 VDC, high) and the transfer switch returns to the utility position. The OPCB/SACM will disable all loads, time out for 5 minutes and then enable all 4 priorities at the same time.

Figures 3-19 through 3-33 follow the sequence of operation when an overload condition occurs on example Priority Circuit 3. After a 30 minute timer expires, Priority 3 is activated. If the frequency is still OK then all priorities will remain active.

OPCB Module Example

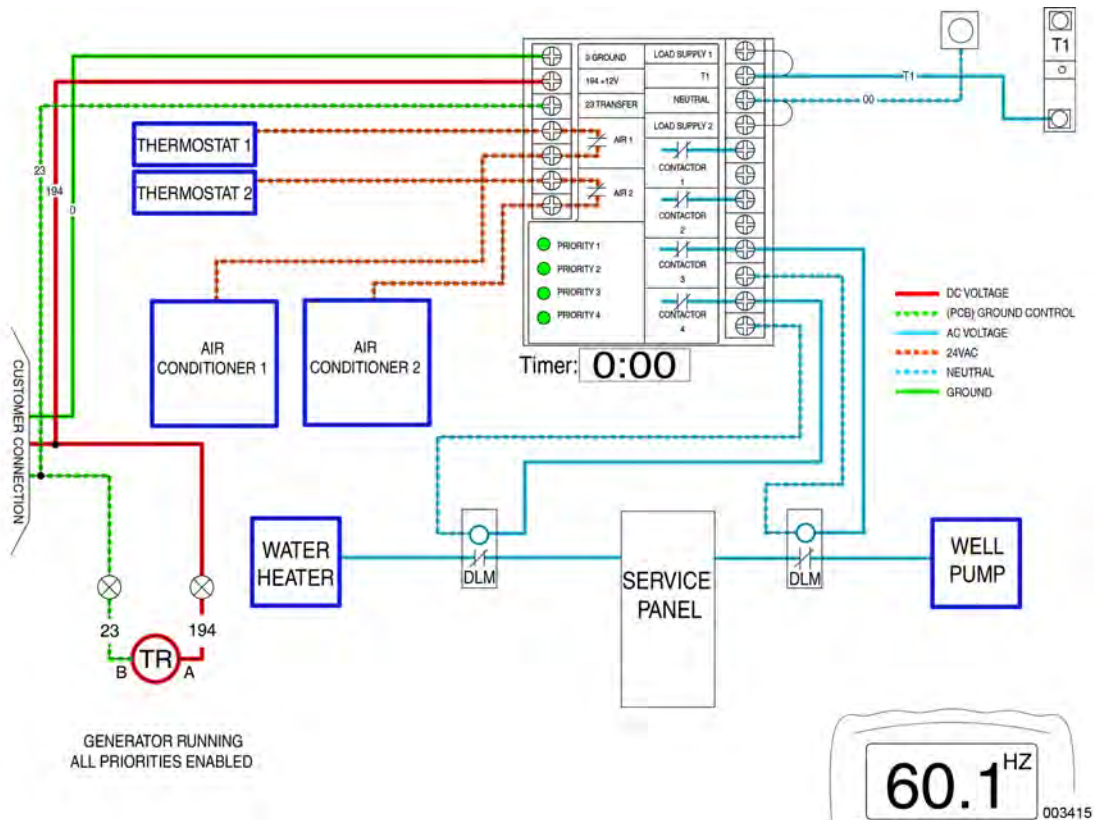


Figure 3-19. Generator Running All Priorities Enabled

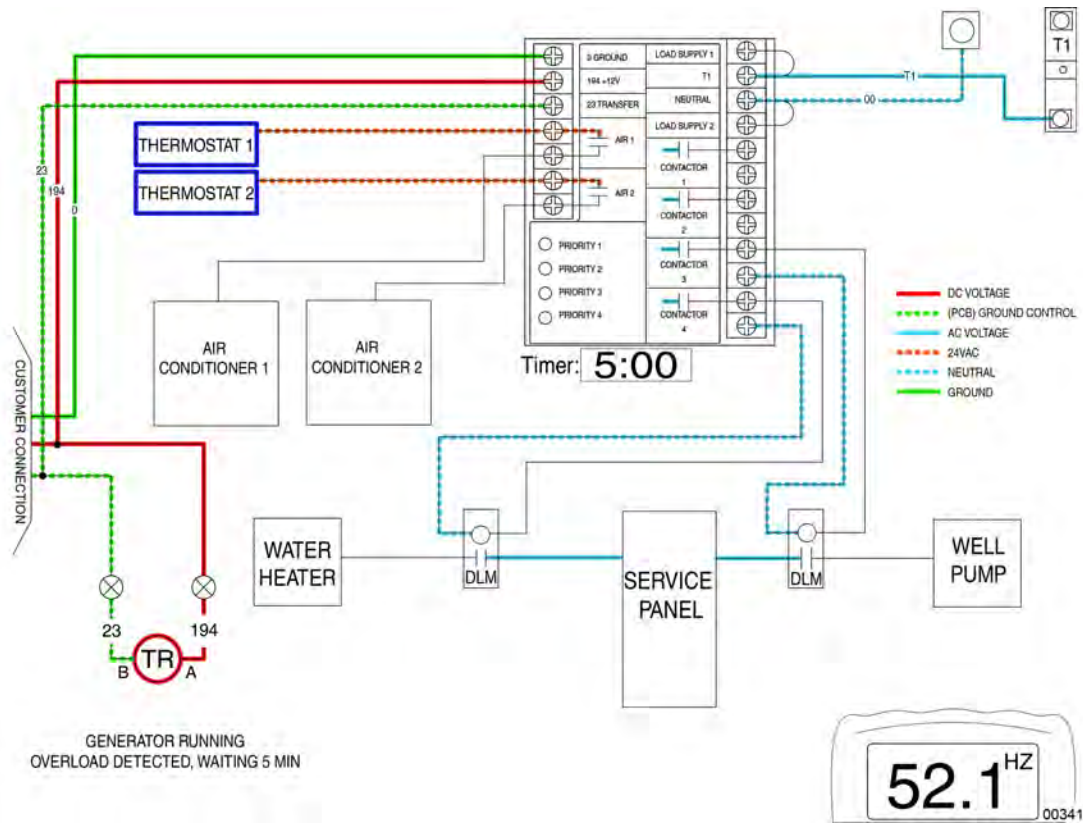


Figure 3-20. Generator Running Overload Detected, Waiting 5 Minutes

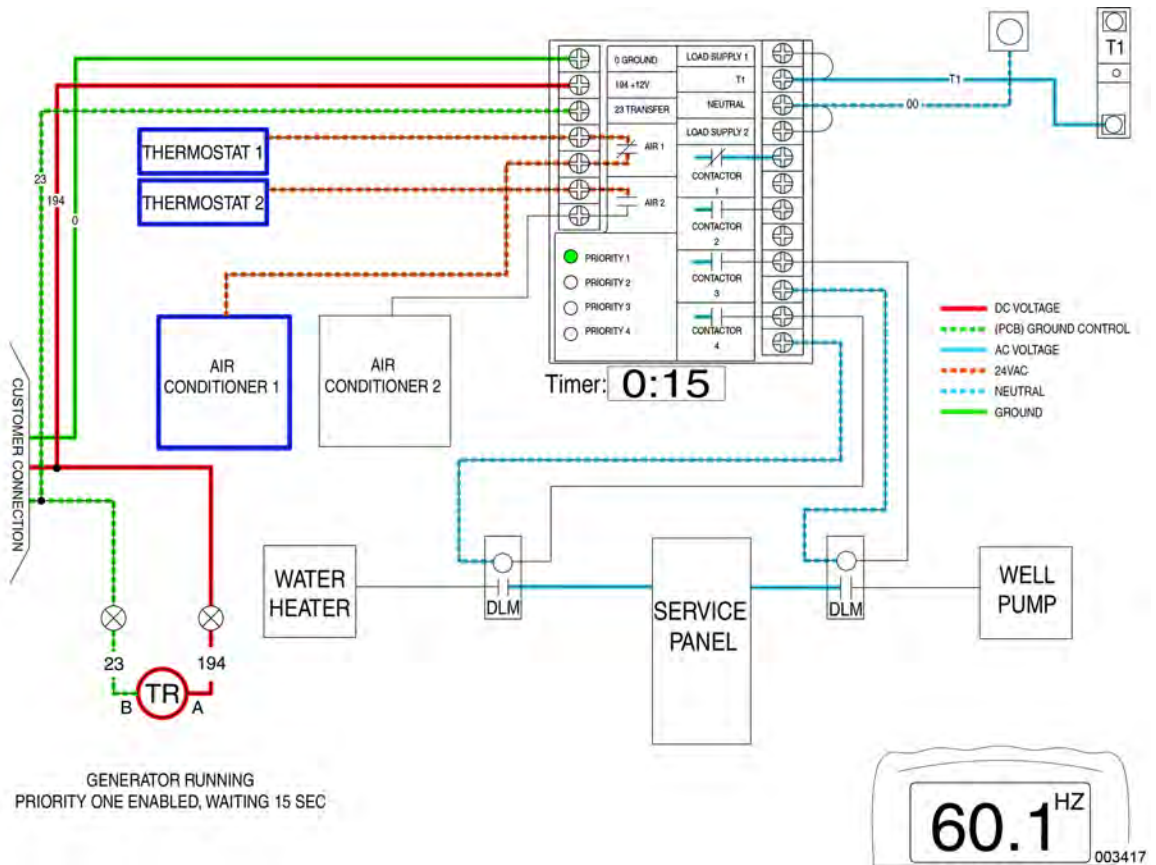
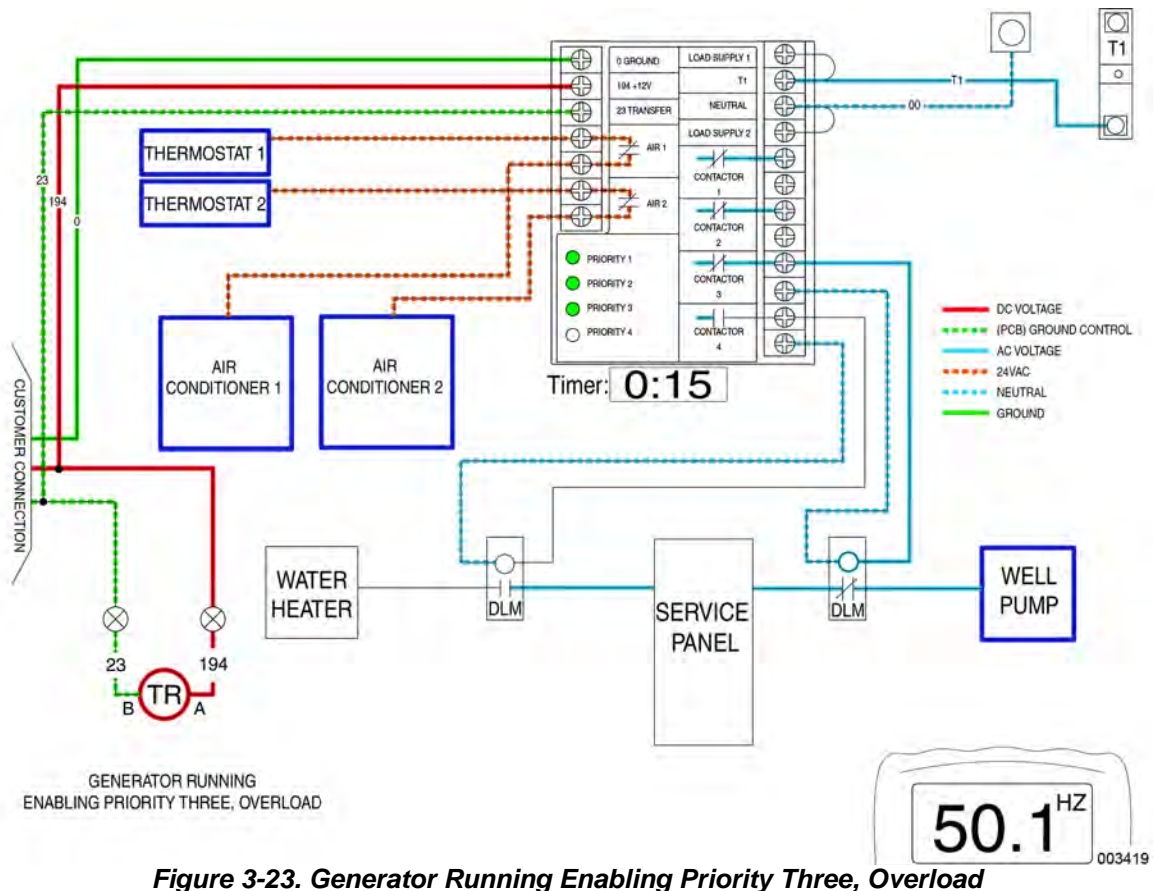
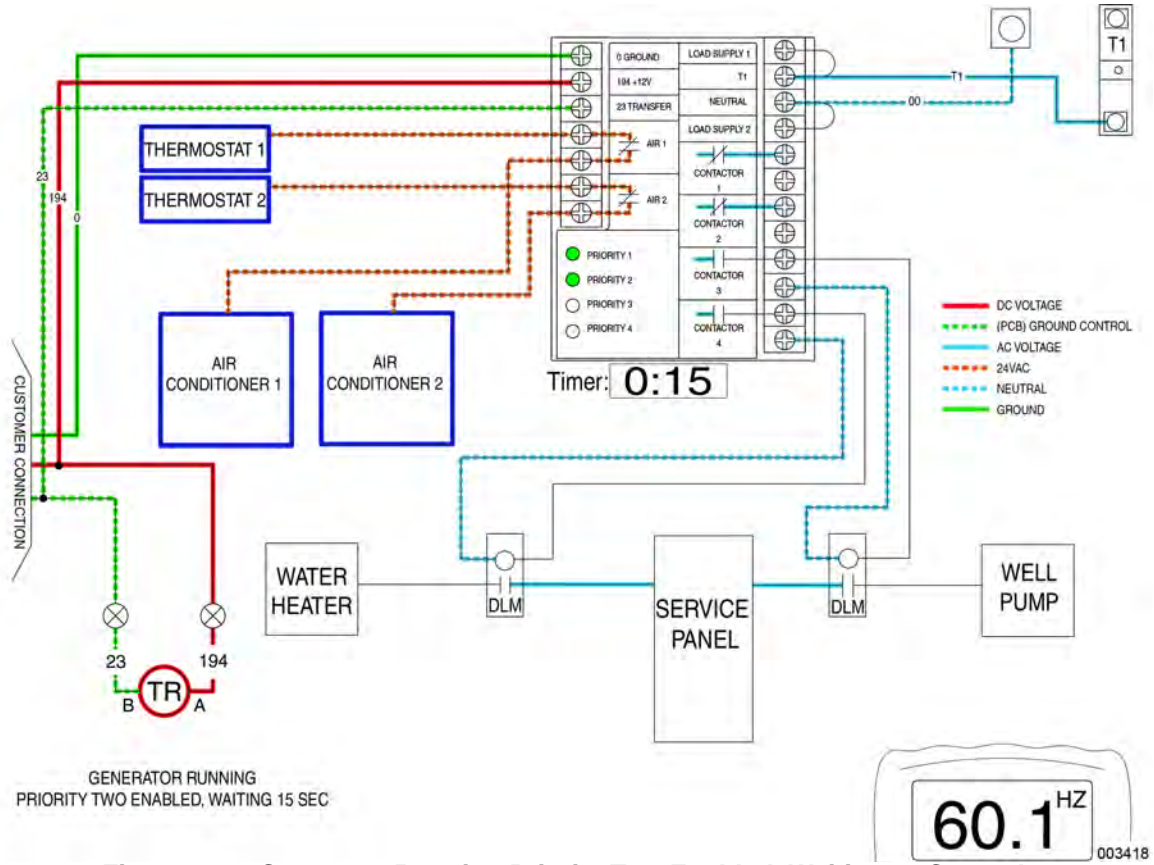
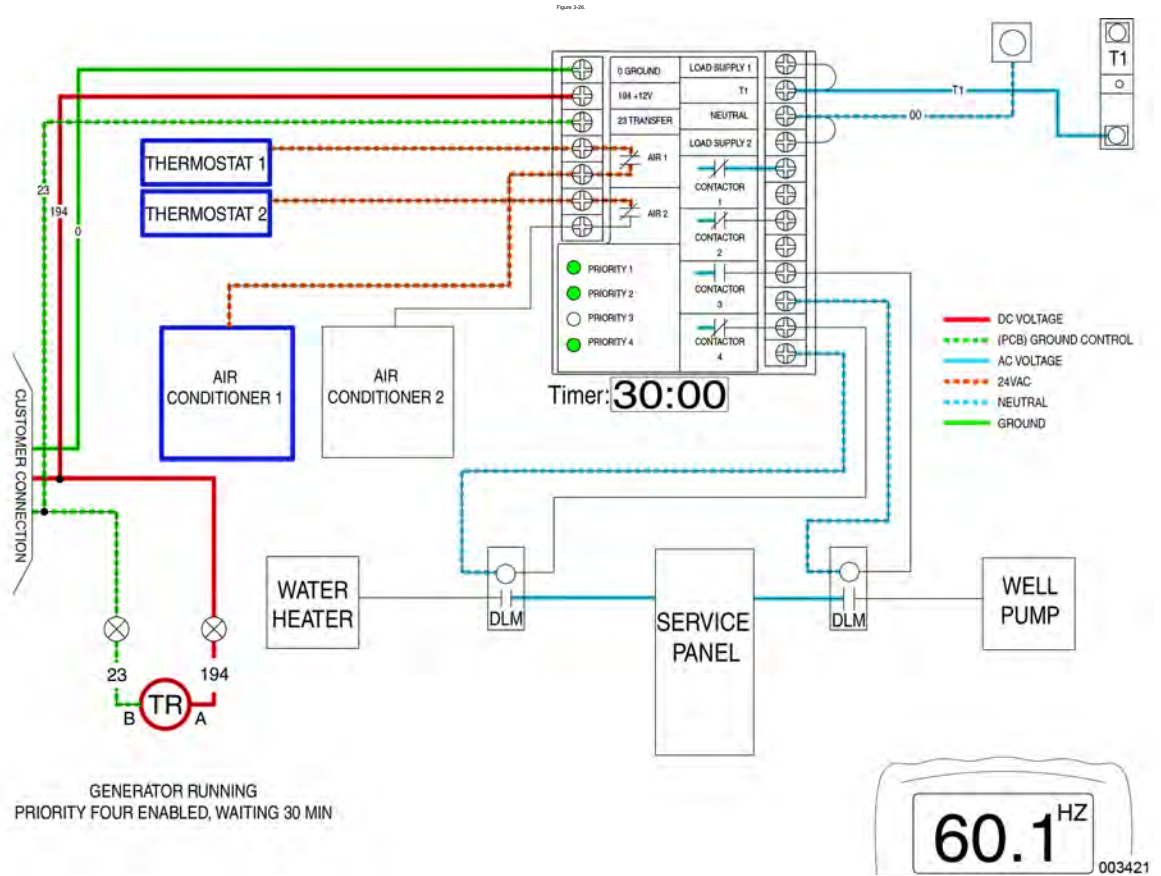
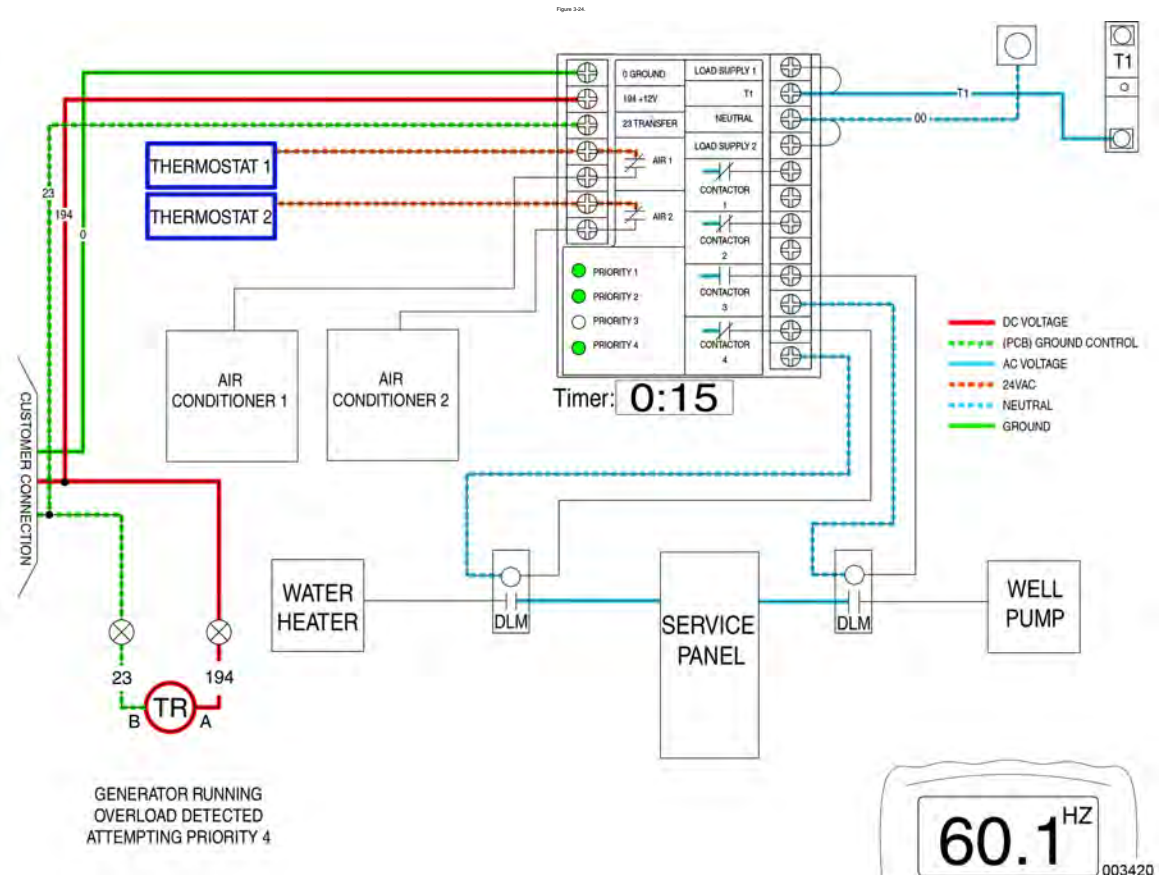


Figure 3-21. Generator Running Priority One Enabled, Waiting 15 Seconds





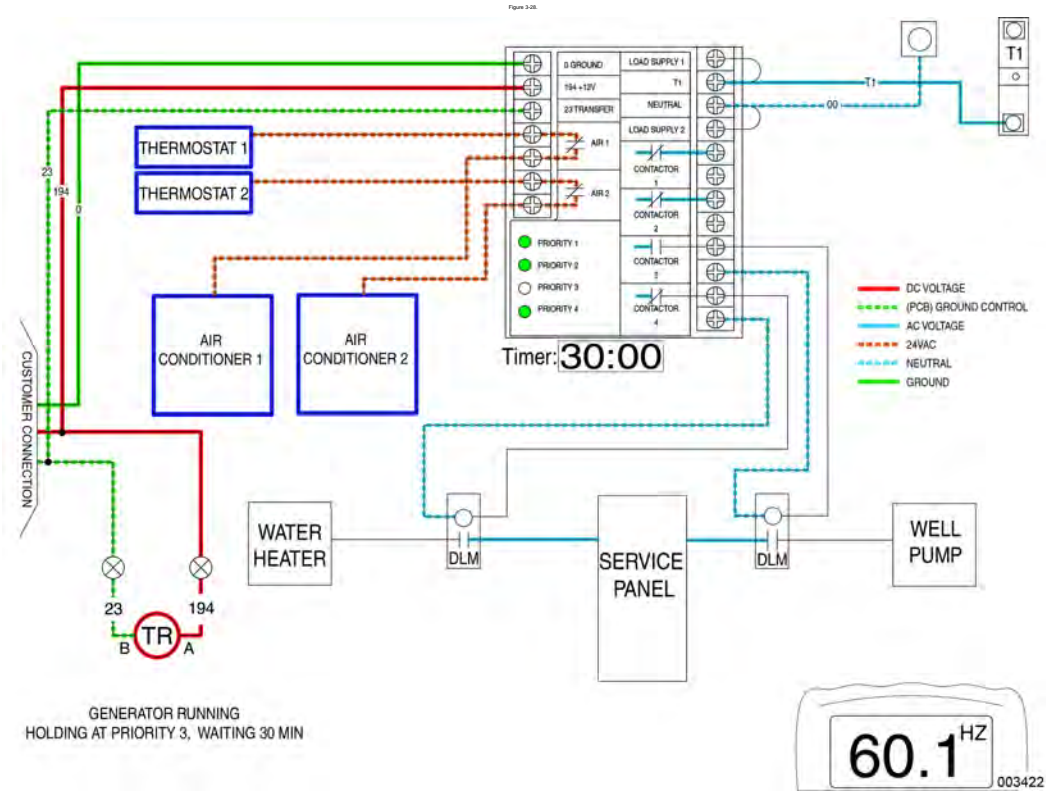


Figure 3-29. Generator Running Holding At Priority 3, Waiting 30 Minutes

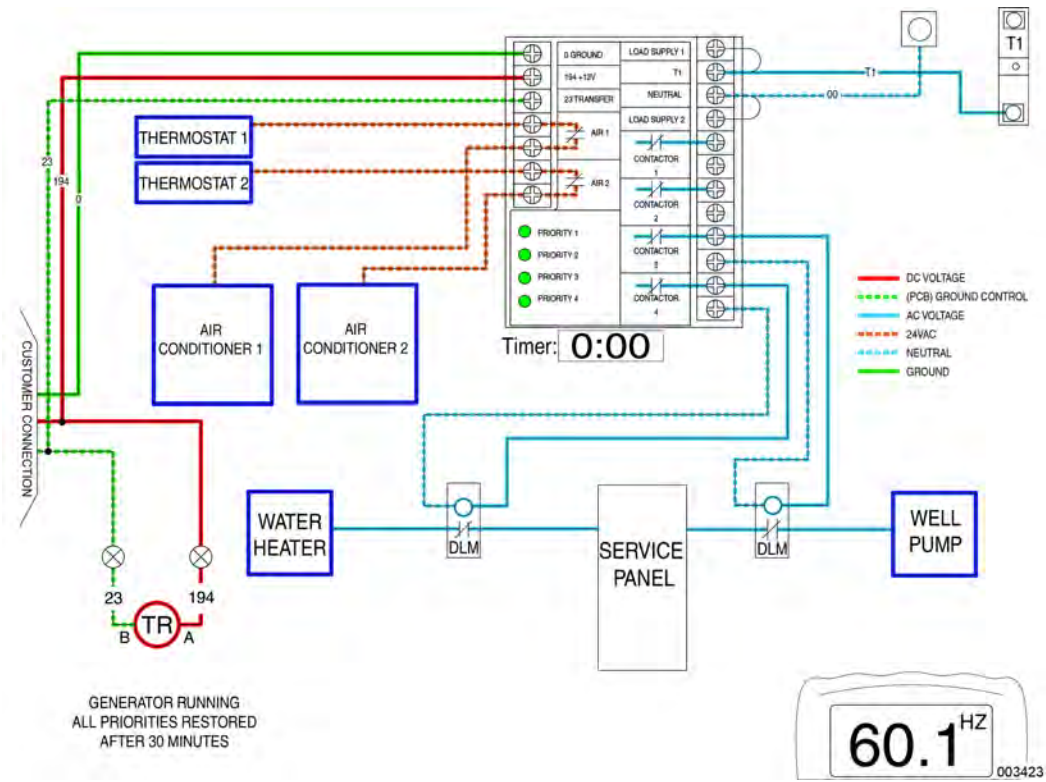


Figure 3-31. Generator Running All Priorities Restored after 30 Minutes

NOTE: After all priorities are enabled and the generator frequency is within limits all priorities will remain on. In this example Priority 3 was the faulty circuit. The controller will lock out the priority for 30 minutes then attempt to enable Priority 3. If not successful, the OPCB module would continue to lock out the faulting priority and continue to attempt to enable it every 30 minutes until utility is restored or until unit is reset. If the unit is reset during generator operation, the testing sequence would begin again.

SACM

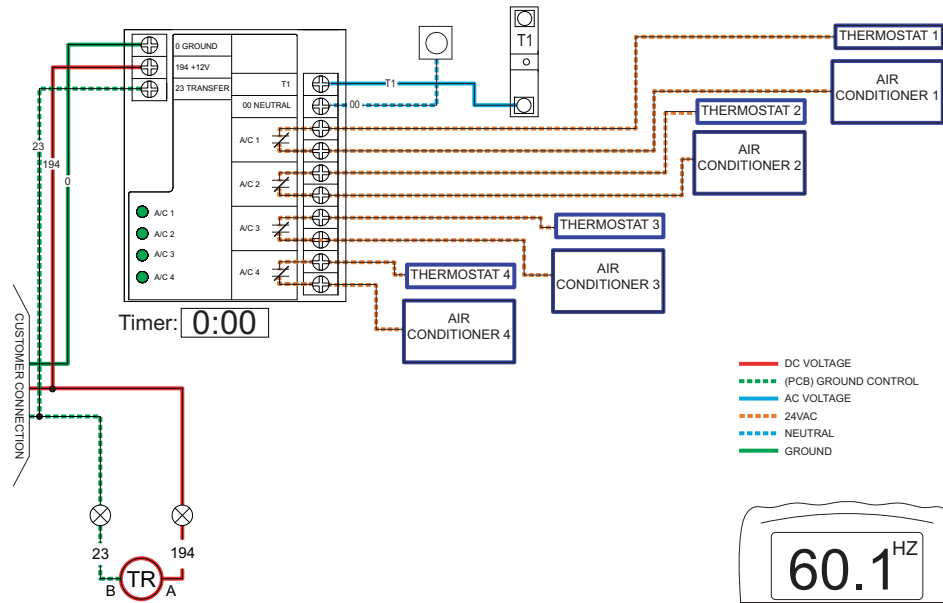


Figure 3-32. SACM

Power Supply Connections for Contactors

The Overload Prevention Control Board (OPCB) can be powered from either a 24 VAC or 120 VAC power supply. The 24 VAC supply is from a class 2 transformer that can be purchased from the manufacturer. Mounting holes are provided in the enclosure subplate for mounting of the transformer. The 120 VAC supply is fused at 5 amps and is factory connected to OPCB terminals labeled “T1” and “Neutral”.

24 VAC Supply

Transformer connections are made as shown in [Figure 3-36](#).

- Blue wire - OPCB “LOAD SUPPLY 1” terminal
- Black wire - OPCB “T1” terminal
- White wire - OPCB “NEUTRAL” terminal
- Yellow wire - OPCB “LOAD SUPPLY 2” terminal

120 VAC Supply

Install the following jumpers on the OPCB as shown in [Figure 3-37](#).

- Load Supply 1 to T1
- Load Supply 2 to Neutral

Control of a Separate Contactor

A separate contactor relay module can be purchased from the manufacturer. If a different relay is used it must have a 120 VAC coil voltage. The LSM supplies fused (5A) 120 VAC to energize the coils of the relay contactors (contactor 1, 2, 3 or 4).

1. Mount the contactor module and connect the load to the main contacts.
2. Connect the contactor coil to the desired LSM (Contactor 1, 2, 3 or 4) terminals on the terminal strip.
3. Connect additional load shedding contactors in a similar fashion.

Power Management Module (PMM)

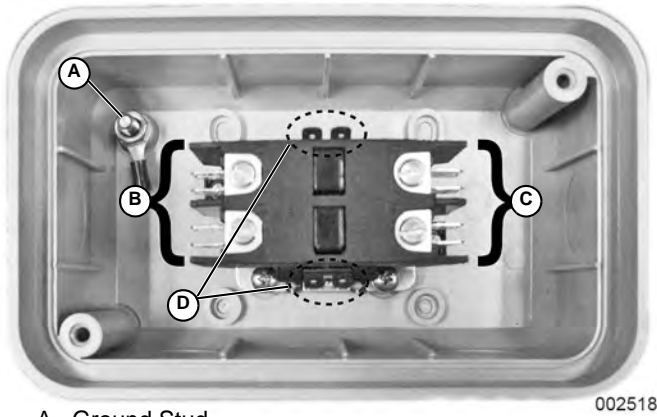
The PMM is for use with the Overload Prevention Control Board (OPCB).

The Power Management Module (PPM) 24 VAC contactor is NOT supplied with the transfer switch. It can be purchased separately from the manufacturer.

The OPCB is mounted in the transfer switch. The OPCB provides 24 VAC to the PMM contactor operating coil via the installed 24 VAC transformer. These PMM contactor coil connections are made at the OPCB terminal strip.



Figure 3-33. Power Management Module

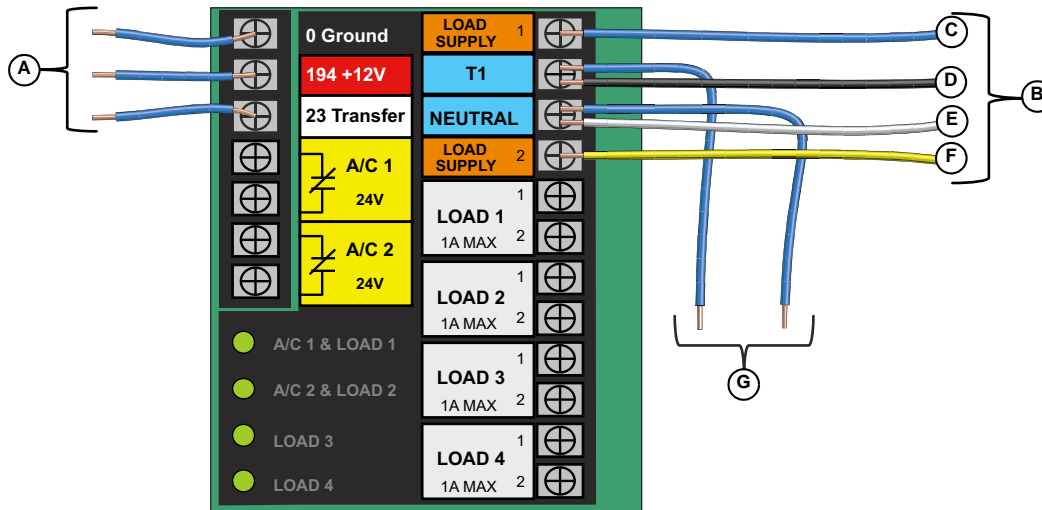


- A. Ground Stud
- B. Line Connections Terminals L1 & L2
- C. Load Connections Terminals T1 & T2
- D. Contactor Control Connections

Figure 3-34. Power Supply Connections

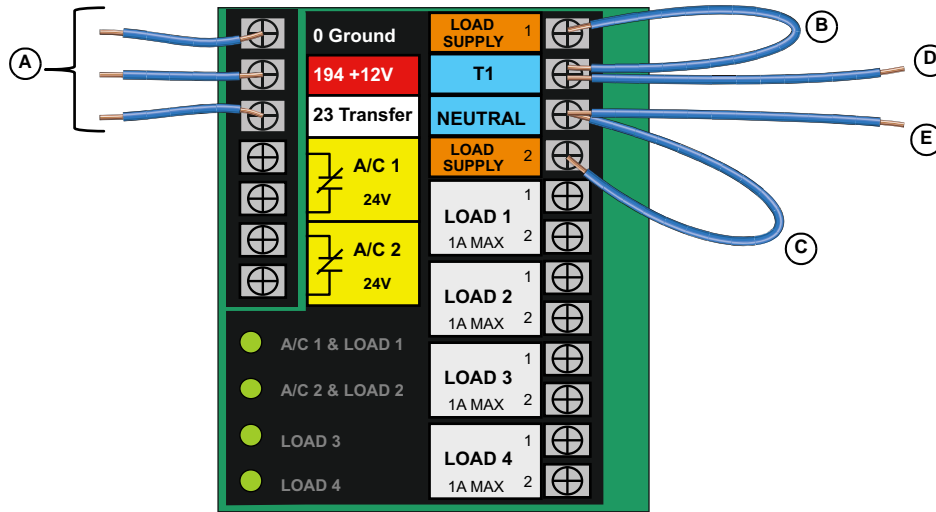


Figure 3-35. PMM Starter Kit



- A. Factory wiring
- B. Transformer leads Field installed
- C. Blue
- D. Black
- E. White
- F. Yellow
- G. Existing wiring

Figure 3-36. 24 VAC Supply Connections



- A. Factory wiring
- B. Jumper Wire T1 to Load Supply 1
- C. Jumper Wire Neutral to Load Supply 2
- D. T1 (Factory)
- E. 00 (Factory)

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Figure 3-37. 120 VAC Supply Connections

Smart Management Module (SMM)

Description

The Smart Power Management System is designed to optimize the performance of a standby generator. The system can consist of up to 8 individual Smart Management Modules (SMM). Unlike other load management systems that depend on another control device, the SMM modules are actually self-aware and operate autonomously.

Frequency is the true measure of generator engine performance and does not need to factor in increased ambient temperatures, elevation changes or generator fuel type. The modules monitor the frequency (Hz) of the power being produced by a standby generator and if it falls below a certain threshold, the module will automatically follow a power management algorithm to ensure that the generator is not overloaded.

Generator overload condition is determined by generator frequency. Loads are shed when the frequency is <58 Hz for 3.5 seconds or <50 Hz for 1 second.

The modules can be set to a load priority between 1 and 8 or be set in a lock out only mode for loads that do not need to run during a power outage, which reduces the necessary size of the generator for a more cost effective solution.

SMM Features and Controls

See [Figure 3-38](#).

Priority Dial (A) – Sets module priority.

NOTE: PRIORITY MUST BE DIFFERENT for each module in an installation. Priority sets the order in which loads recover from a load shed event. Recovery time from a load shed event is five minutes for Priority 1. Each priority after Priority 1 waits an additional 15 seconds after the initial recovery time. See [Table 3-1](#).

Table 3-1. Priority Settings

Priority	Recovery Time
1	5 minutes
2	5 minutes 15 seconds
3	5 minutes 30 seconds
4	5 minutes 45 seconds
5	6 minutes
6	6 minutes 15 seconds
7	6 minutes 30 seconds
8	6 minutes 45 seconds

Lockout Switch (B) – Initial switch to generator power will allow load to operate until an overload condition occurs. If overload happens the load will be locked out until utility returns. See [Table 3-2](#).

NOTE: Early Version: When lockout switch is engaged and running on generator, module will start in load shed mode. After approximately 1 minute of run time the module will enter lockout mode. When utility returns while in lockout mode, the module will delay for 2 minutes before returning to load shed mode. After a 4 minute timer expires the load will be activated.

Test Button (C) – Disables contactor output for a specified time.

LED (D) – Provides module status. See [Table 3-3](#).

Contactor (E) – Controlled by a smart controller in module. Contactor remains CLOSED until generator power is required. Upon generator activation, controller moves to OPEN to handle overload conditions.

NOTE: When the system is on generator power, the contactor is also opened during lockout switch ACTIVE state.

Mounting Holes (F) – Internal enclosure mounting holes provide clean and sturdy mounting.

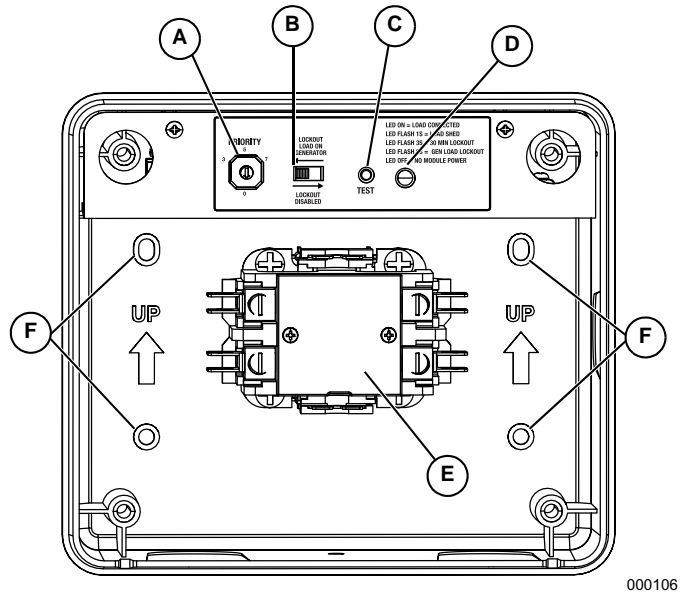


Figure 3-38. SMM Features and Controls

Recovery time is based on priority dial settings. See [Table 3-1](#).

Table 3-2. Lockout Switch Settings

Lockout Switch Position	Mode	Function
ON	GENERATOR	If overloaded, module sheds load until utility returns. Contactor is OPEN. NOTE: Early version goes into lockout mode. Load is never activated until Utility returns.
ON	UTILITY	Power is available on module output (contactor output). Contactor is CLOSED.
OFF	GENERATOR	Module operates with standard load shed logic. Contactor is OPEN or CLOSED per logic.
OFF	UTILITY	Power is available on module output (contactor output). Contactor is CLOSED.

Electrical Specifications

Input Voltage	240 VAC
Current Rating	50A resistive, 40A inductive
Locked Rotor Amp Rating	240A
Motor Rating	3 HP
Contactor Coil Voltage	240 VAC

Enclosure Specifications

UL Rating	Type 3R
Temperature	-30 to 50 deg C (-22 to 122 deg F)

Connections

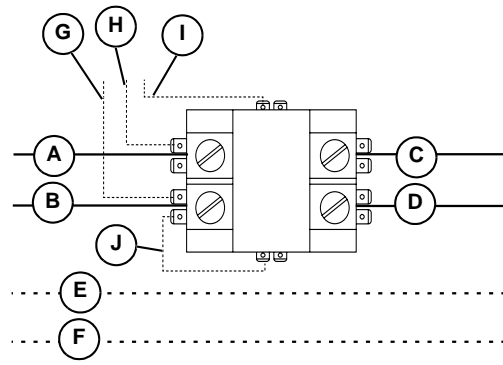


Figure 3-39. Smart Management Module Connections

Legend – Figure 3-39

A	Red (240 VAC - Line)
B	Black (240 VAC - Line)
C	Red (240 VAC - Load)
D	Black (240 VAC - Load)
E	White - Neutral (as required)
F	Green - Ground (as required)
G	Black - Factory (PCB)
H	Red - Factory (PCB)
I	Blue - Factory (PCB)
J	Blue - Factory (Jumper)

Table 3-3. LED States

State	LED State	Mode	Note
Shed	1 second flash (1 On – 1 Off)	Generator	Module detected an overload and shed its load. This state only occurs in generator mode, or during a first time utility power up for five minutes of initial operation.
Lockout (30 minutes)	3 second flash (3 On – 3 Off)	Generator	Module detected an overload while trying to recover from a shed situation. It identified the offending load and disabled operation for 30 minutes to allow other loads to operate. This state only occurs in generator mode.
Lockout Switch Active	6 second flash (6 On – 6 Off)	Generator	Module output is disabled and there is no power to the appliance while in generator mode. Lockout switch must be ON. See Table 2.
Lockout Switch Active	ON	Utility	Lockout Switch operates in generator mode only. It has no function in utility mode. LED is solid, indicating contactor is CLOSED and load is connected. Lockout switch must be ON. See Table 2.
Normal	ON	Generator or Utility	Indicates contactor is CLOSED and appliance has power. This is the default in utility mode. It is the normal operating state in generator mode when an overload is not detected.
Test	1 second flash	Generator or Utility	Test button triggers a typical shed condition and overrides all other states except generator lockout switch ACTIVE state.

Setting Priorities

High priority 240 VAC loads should be set to the highest priorities so those loads recover first, in the event of generator overload.

NOTE: The highest priority, and first load to activate is Priority 1. The last load to activate is Priority 8.

Setting priority determines timing for 3 scenarios:

- Order in which loads recover
- Delay time until power returns during an outage
- Delay time for post load shed recovery

An example configuration is shown in [Table 3-4](#). Configurations will vary depending on customer prioritization of loads.

Table 3-4. Typical SMM Configuration	
Priority 1 - Baseboard heat	Priority 5 - Non-essential circuits
Priority 2 - Air conditioner	Priority 6 - Pool pump or hot tub
Priority 3 - Range	Priority 7 - Other circuits
Priority 4 - Dryer	Priority 8 - Other circuits

1. Set the priority of each SMM module as desired (using the example configuration for reference).

2. Apply priority decal in a suitable location on electrical panel to record chosen priority designations.
3. Record priorities on decal.

Setting Lockout

Most installations will require the lockout switch to be DISABLED. When performing a whole house backup with a generator not sized to manage all household loads, SMM's can be used to disable appliances or circuits during an outage. For non-essential loads that will not be used on generator power, set lockout switch to ENABLED.

Tests

Utility Test

1. Turn utility power ON and enable all module feeding circuits.
2. Verify LED begins to flash at one second intervals.
3. All contactors will close after five minutes. LED will illuminate, and stay ON.
4. Wait 30 seconds after contactor closes, then press TEST button and verify module load shed. LED will flash at one second intervals.
5. Wait five minutes, plus predefined priority set time for module to recover.
6. Contactor will CLOSE and LED will illuminate, and stay ON.

Generator Test

1. Simulate a utility loss by turning main line circuit breaker (MLCB - service disconnect) OFF while generator is in AUTO.
2. All modules will lose power and LEDs will disable.
3. Generator will power on after preset delay.
4. All LEDs will flash when generator transfers.
5. Allow each module to enable output per its priority setting.
6. After predefined priority time elapses, each contactor will CLOSE and LED will illuminate and stay ON.
7. Once LED stays ON, press TEST button and verify load shed occurs.
8. Once load shed occurs, LED will flash at one second intervals.
9. Allow time for each module to enable contactor output per priority setting.
10. After predefined priority set time, each contactor will CLOSE and LED will illuminate and stay ON.

NOTE: Depending on load size, the SMM module may immediately go into load shed mode or lockout during test. In this event, remove one or more higher priority loads to allow testing of each module.

Generator Test with Lockout Switch Enabled (perform if Lockout Switch Enabled on any loads)

1. Simulate a utility loss by turning MLCB (service disconnect) to OFF while generator is in AUTO.
2. All modules will lose power and LEDs will disable.
3. Generator should power on after preset delay.

NOTE: For modules with lockout switch enabled, LEDs will flash at six second intervals and load will remain disabled while in generator power.

Return to Utility Test

1. Return utility power by setting the MLCB (service disconnect) to ON.

NOTE: All modules should begin flashing at one second intervals.

NOTE: All modules will recover in five minutes (including units with lockout switch enabled).

Troubleshooting

See troubleshooting flowcharts.

SMM Functionality Flow Chart

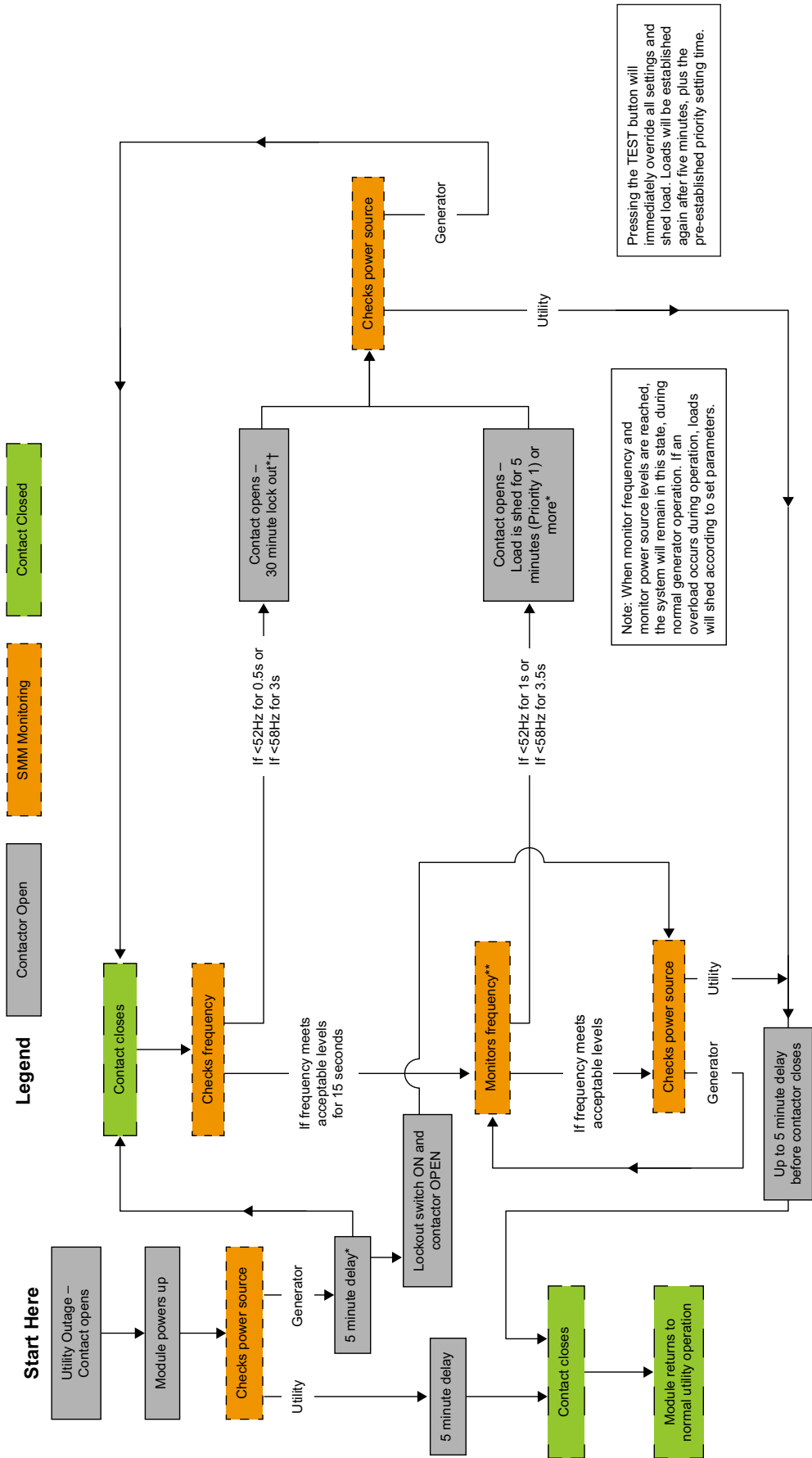


Figure iv-40. SMM Sequence of Operations

000105b

Integrated SACM Module

The integrated SACM module incorporates the following components in one module:

- N1, N2 and T1 6.3 amp mini fuse.
- Transfer relay.
- Load shedding SACM that has the same operating parameters as the non-integrated SACM.

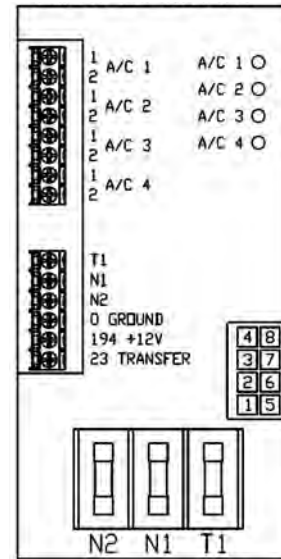
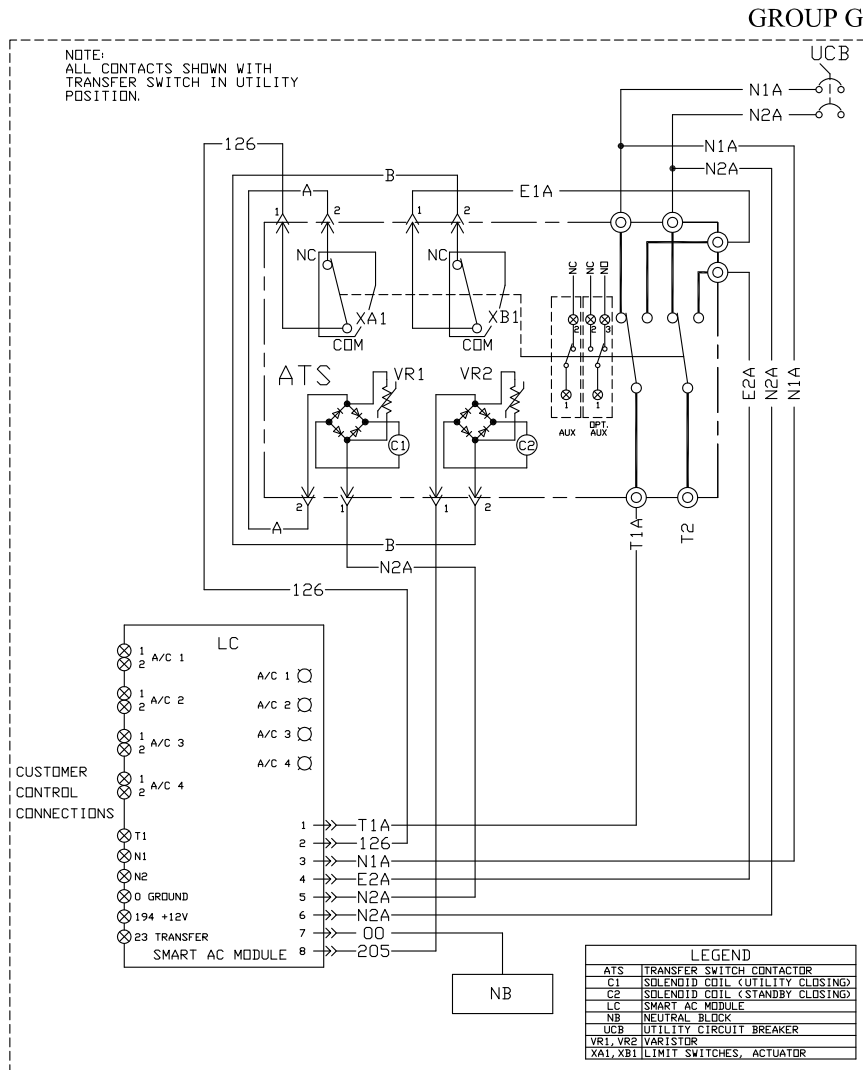


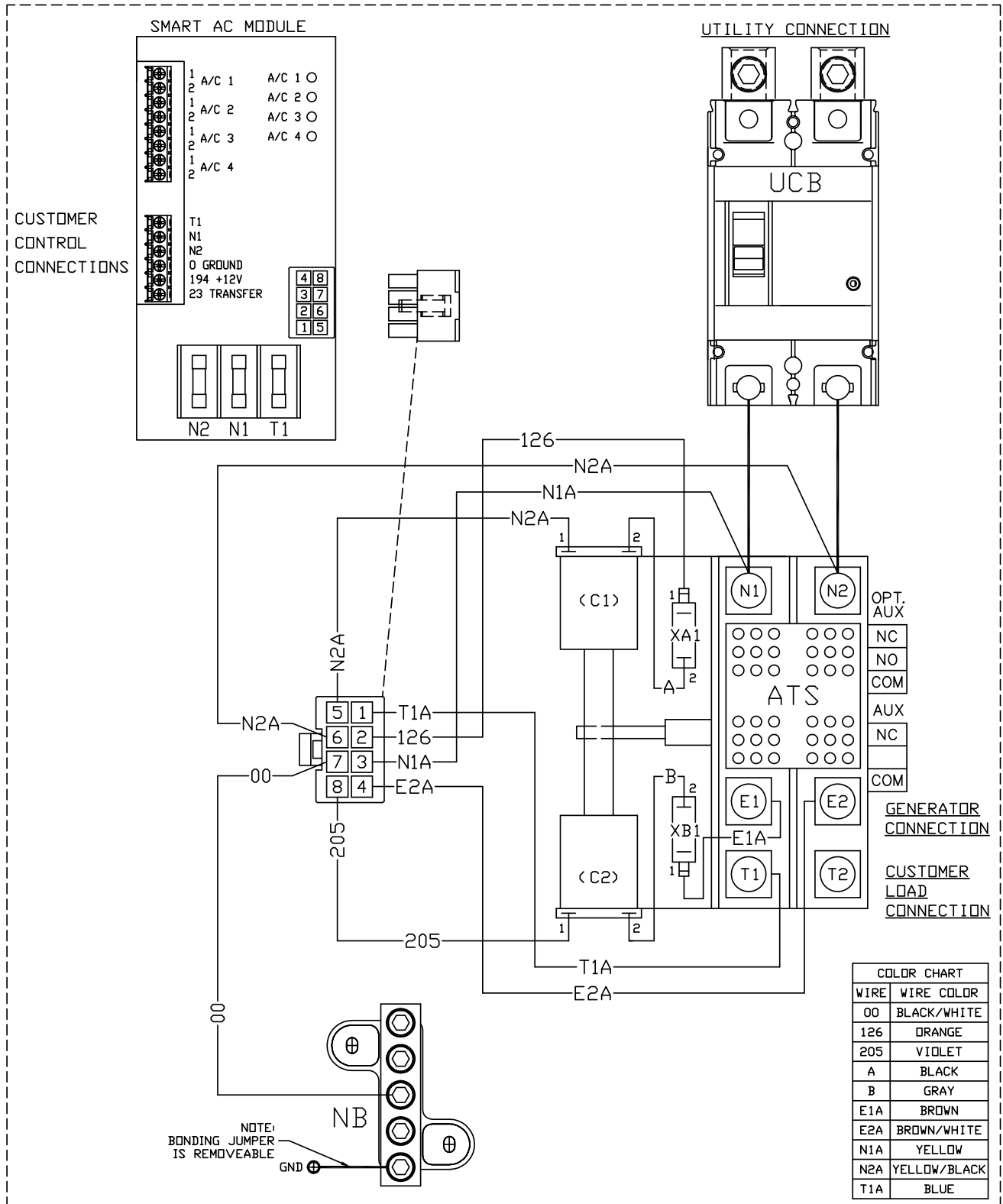
Figure 3-41. Integrated SACM Module



REVISION: -A-
DATE: 2/13/17

SCHEMATIC - DIAGRAM
SE TRANSFER SWITCH 100-200A
DRAWING #: 10000006038

GROUP G



REVISION: -A-
DATE: 4/22/13

WIRING - DIAGRAM
SE TRANSFER SWITCH 100-200A
DRAWING #: 1000006038

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Section 3.2 Operational Analysis

Utility Source Voltage Available

Figure 3-42 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 (XA1) via the normally closed transfer relay contacts (1 and 5) and Wire 126; however, XA1 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).

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

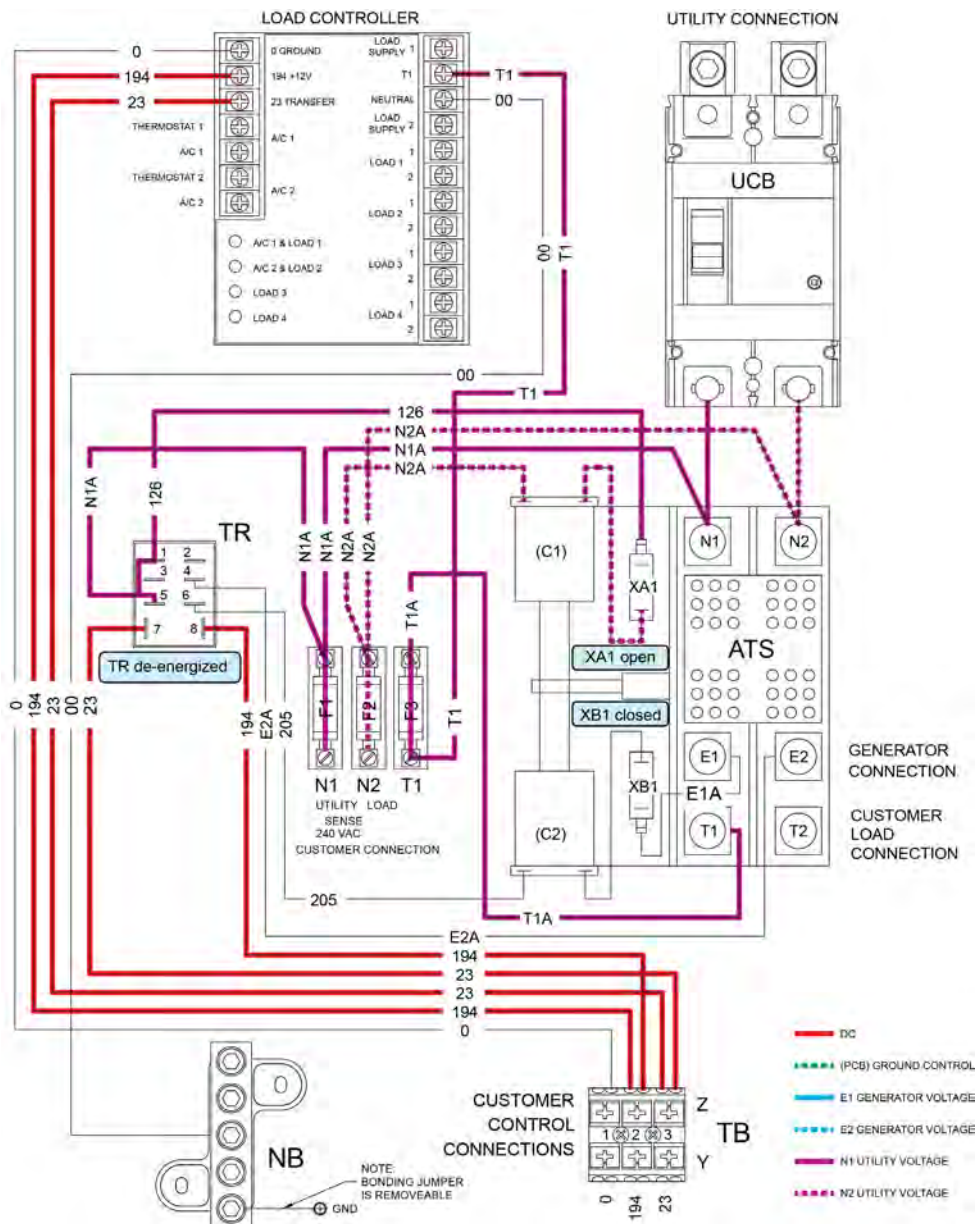


Figure 3-42. Utility Source Voltage Available

Utility Source Voltage Failure

If Utility source voltage drops below 65% of nominal voltage for five (5) seconds, the controller will initiate engine start. After the generator starts, a five (5) second engine warm-up timer is initiated. During this warm-up the generator is running at rated frequency and voltage. **Figure 3-43** is a schematic representation of the transfer switch with the Generator running with voltage available to the transfer switch.

Generator voltage available on contactor terminals E1 and E2.

- Controller 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 (4 & 6) to Wire 205.

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

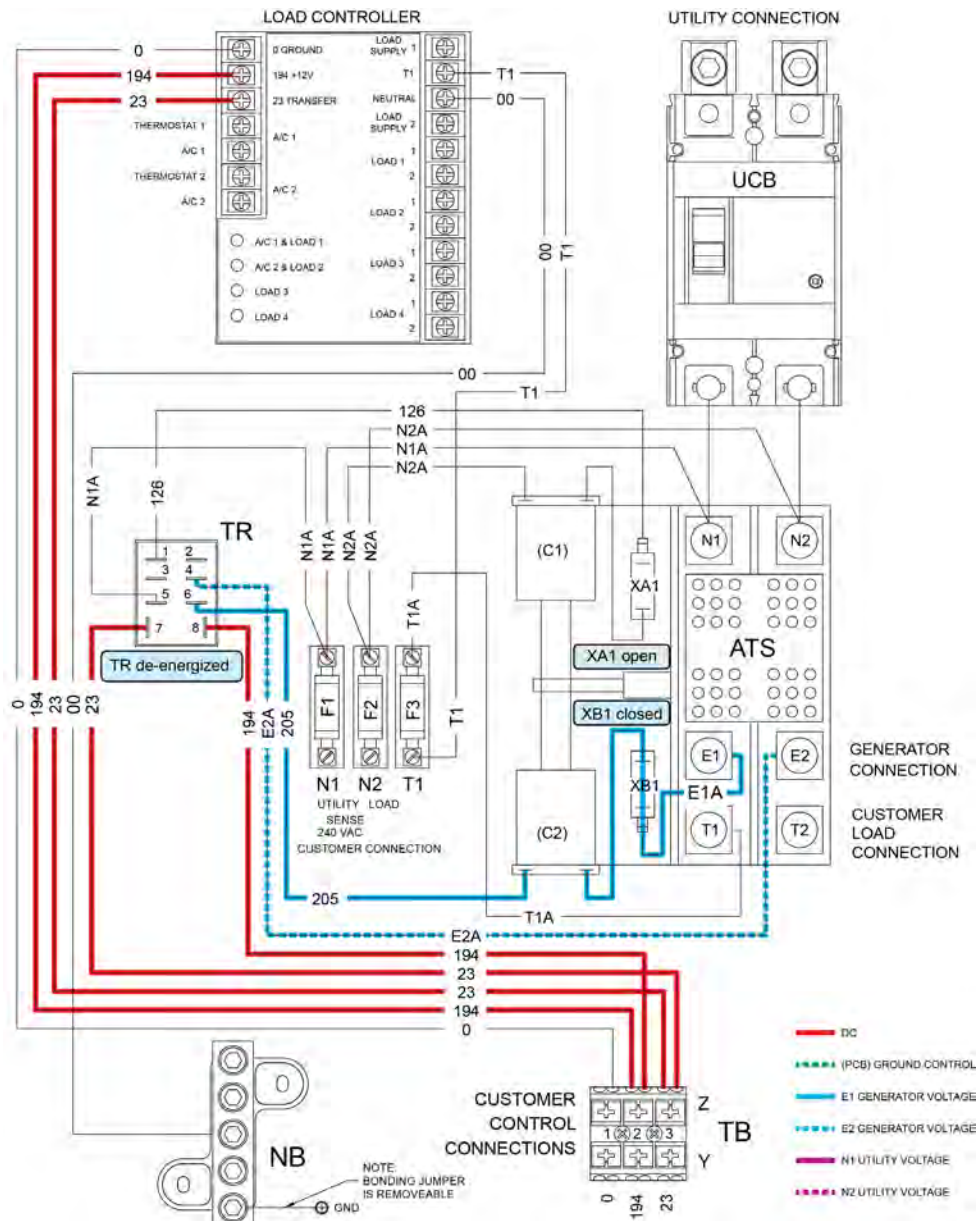


Figure 3-43. Utility Source Voltage Failure

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 through wire 205 at relay connector 6 to E2A relay connector 4. The voltage will go through the N.C. contact of XB1. Voltage from both E1 and E2 will be available at the C2 coil. This voltage will pass through the rectifier in the coil and the coil will energize.

Generator voltage is now delivered to the standby closing coil (C2), via generator voltage E1 and E2, the now closed TR1 contacts, Wire 205, the limit switch (XB1), 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 toward the "Standby" position, limit switch XA1 closes (Utility Coil). When the contacts are in the "Standby" position, a mechanical interlock actuates XB1 to its open 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 and 120 VAC is also supplied to the controller on Wire T1 for the battery charger. (220 VAC on T1 and T2 50 Hz only.)

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams. XA1 and XB1

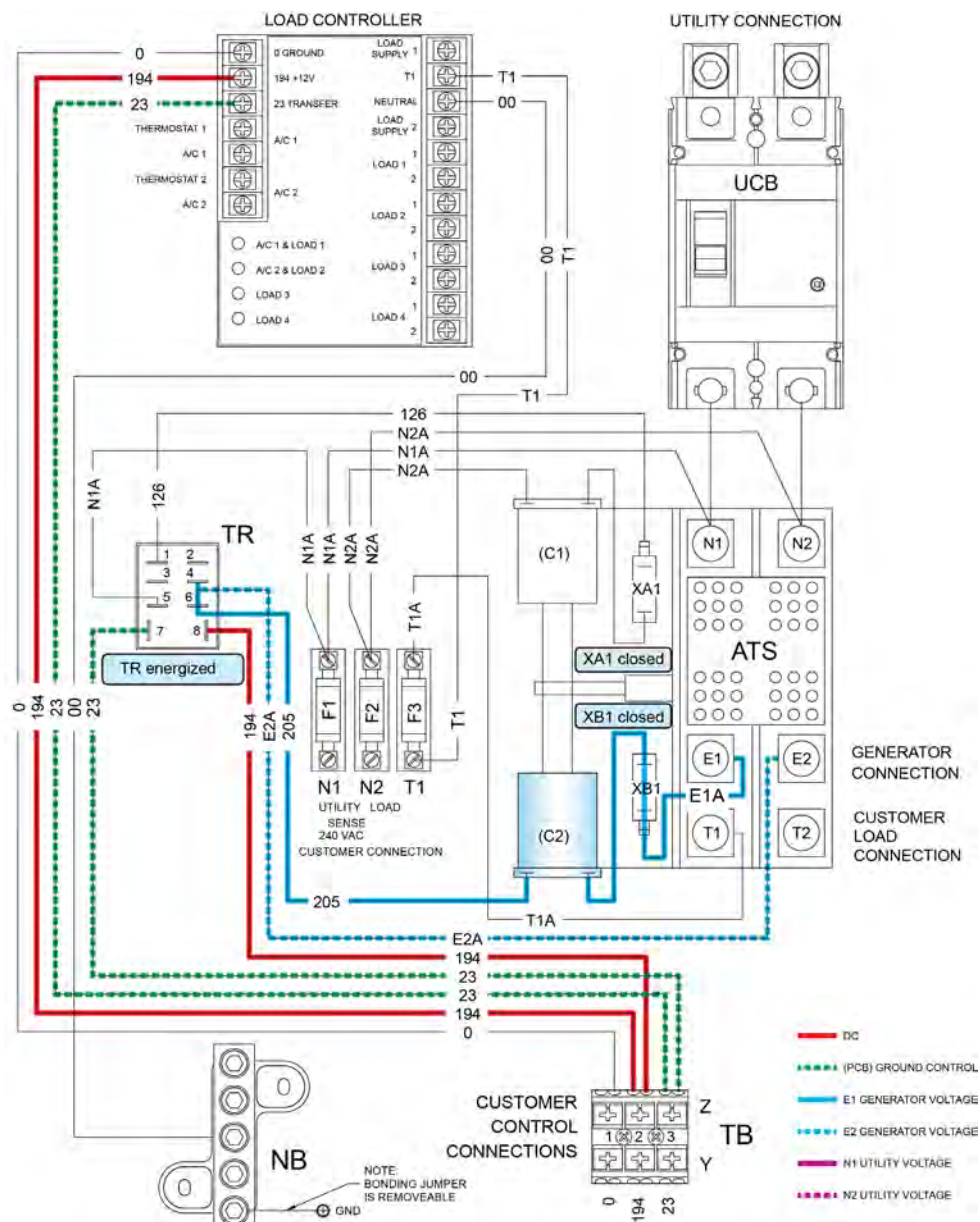


Figure 3-44. Transferring to Standby

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 electronically/mechanically snaps to that position. Upon closure of the main contacts to the STANDBY position limit switches XA1 and XB1 mechanically actuate to “arm” the circuit for re-transfer to the UTILITY position. When XB1 changes, it opens the circuit providing voltage to the standby closing coil (C2). Voltage from the generator, connected through T1 and T2, provides power to customer connected loads.

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

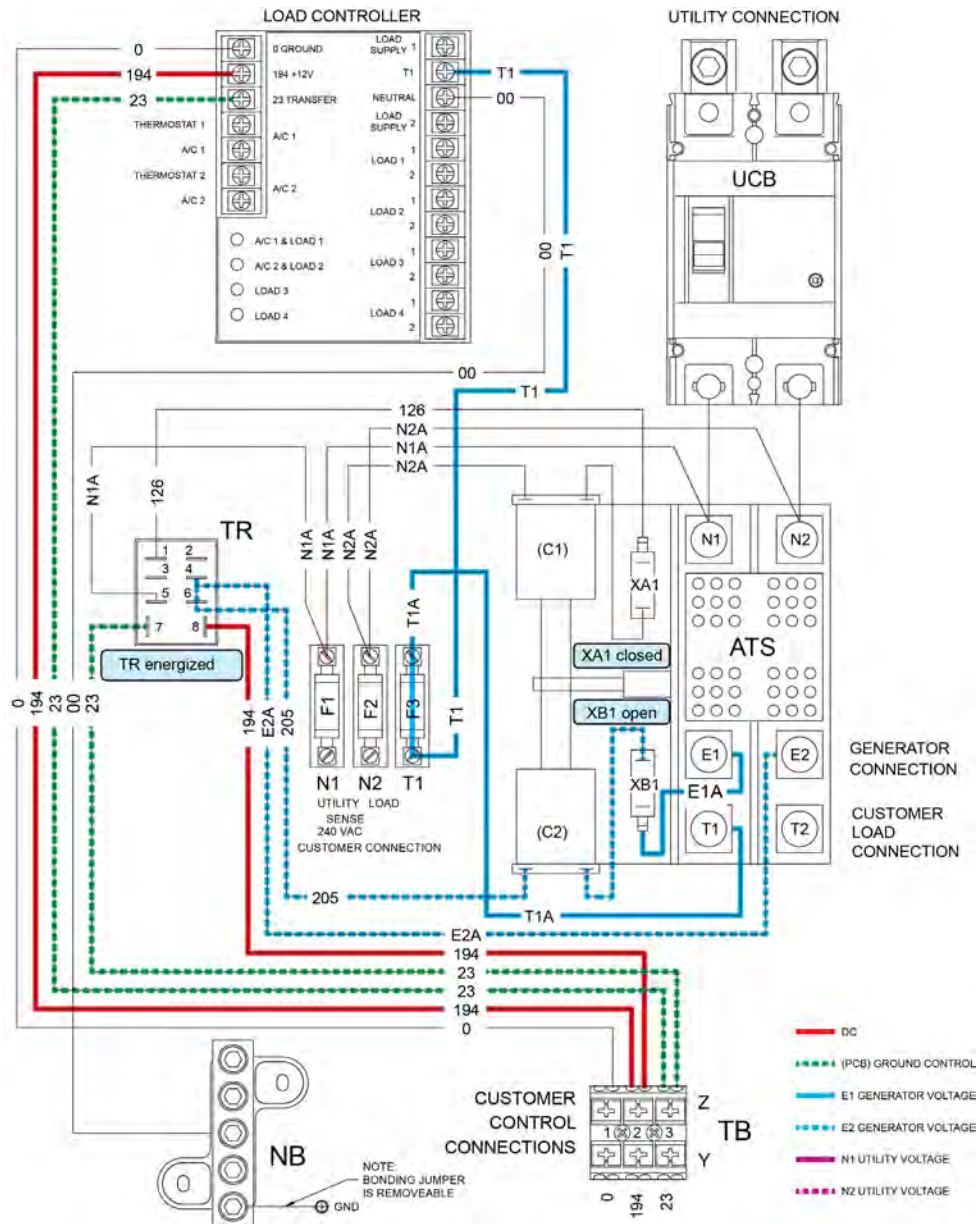


Figure 3-45. Transferred to Standby

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.

NOTE: The TR1 open contacts 1 and 4 keep the switch from immediately transferring to the utility position.

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

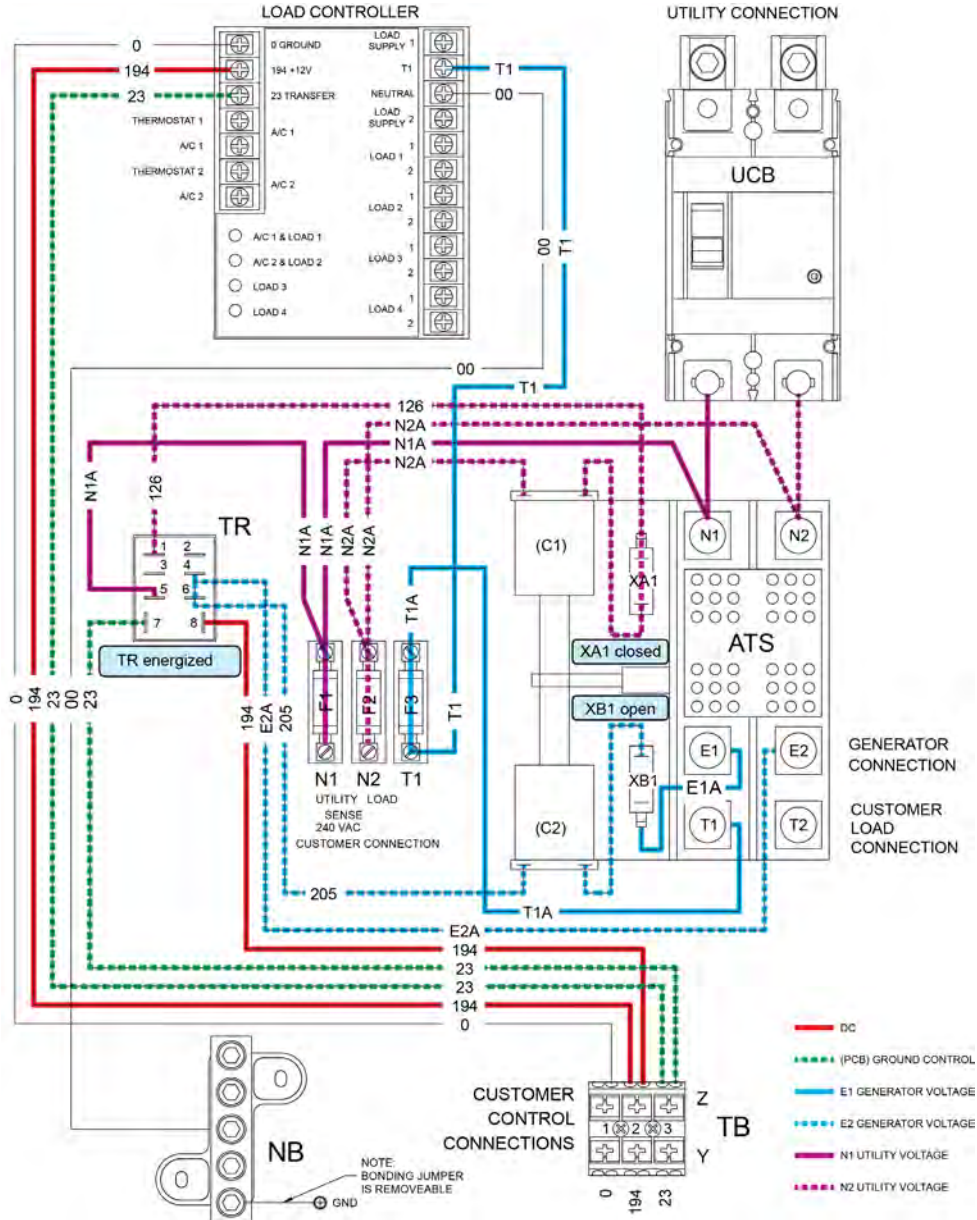


Figure 3-46. Utility Restored

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 5), Wire 126, and limit switch (XA1). With utility voltage applied to both sides of the utility closing coil (C1), the rectifier in the coil causes the coil to energize.

When the TR1 relay de-energizes its utility side contacts close. Utility voltage is then delivered to the utility closing coil (C1), via utility voltage from N1A and N2A, the closed TR1 contacts, Wire 126, limit switch (XA1), 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. XA1 opens and XB1 closes on the Standby source side.

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

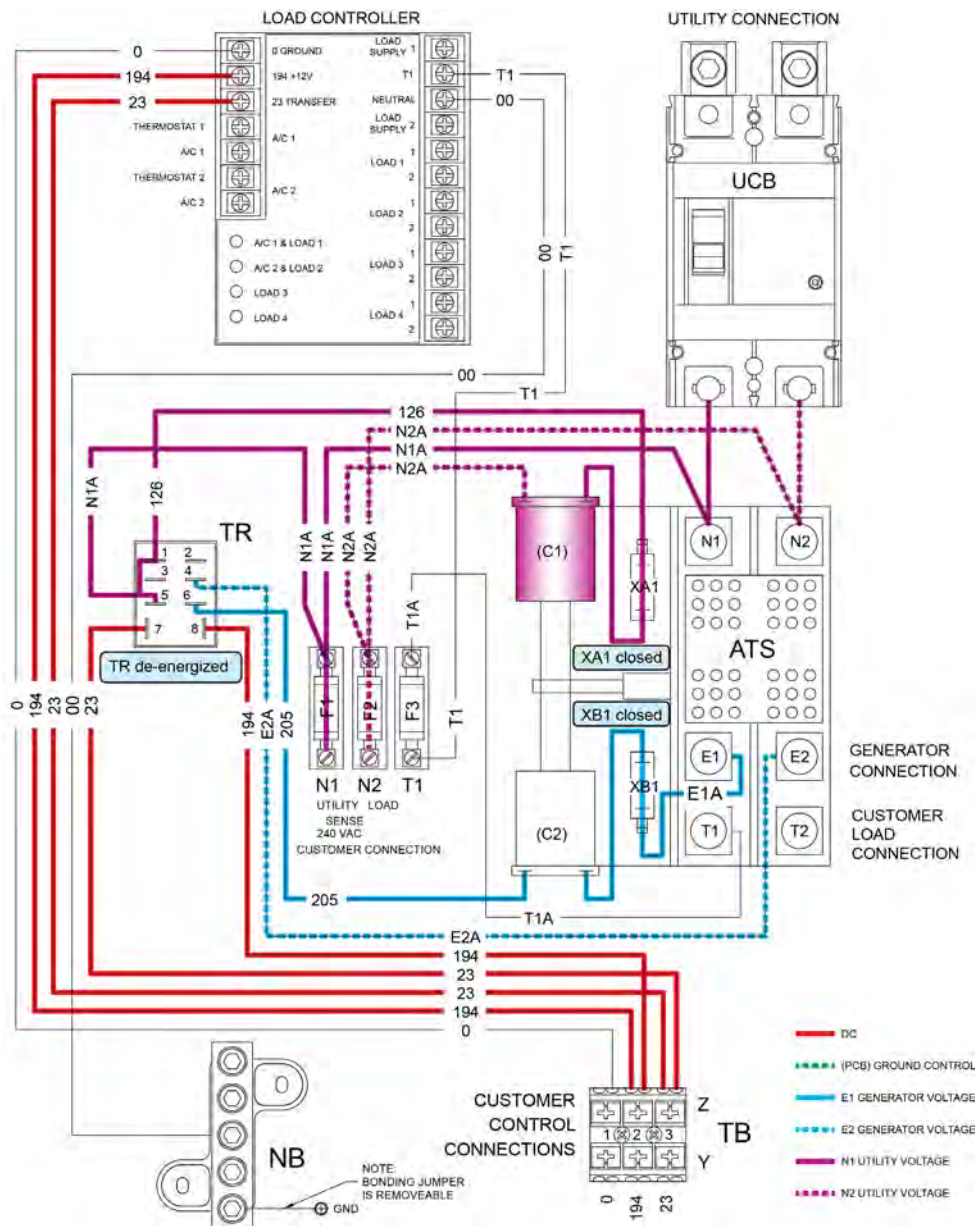


Figure 3-47. Utility Restored, Transferring Back to Utility

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 (XA1 and XB1) mechanically actuate to “arm” the circuit for the next transfer to STANDBY. When switch XA1 changes states, the circuit providing voltage to the utility transfer coil is opened, and the coil de-energizes.

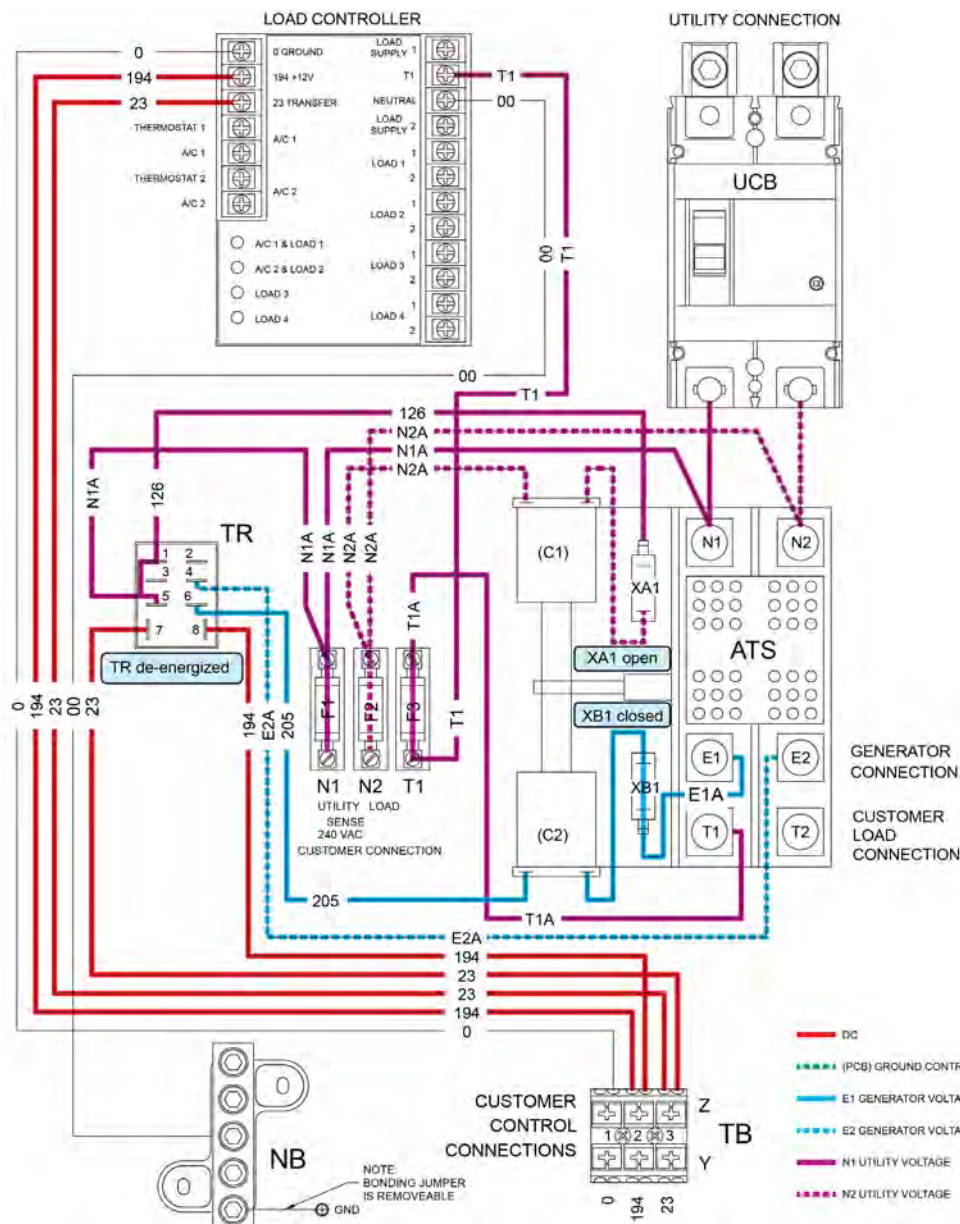


Figure 3-48. Utility Restored, Transferred Back to Utility

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.

NOTE: This is an example of Transfer Switch Operational Analysis. For troubleshooting use the operational analysis with the appropriate wiring/schematic diagrams.

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Section 3.3 Troubleshooting Flowcharts

Evolution™ Controller e-Codes

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Controller Fault	ALARM		No E-code on HSB	Replace Controller
Overcrank	ALARM	1100	Condition - Engine Cranks but will not Start (5 crank attempts) Unit turns over but will not start. Controller is receiving signal on Wire 18.	Problem 17
Overspeed	ALARM	1200	Prolonged (60 Hz on a 50 Hz unit, 72Hz on 60Hz unit) Over specified Hz for 3 seconds. Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1205	Instantaneous (62 Hz on a 50 Hz unit, 75Hz on 60Hz unit) Over specified Hz for 0.1 second (100 milliseconds). Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1207	Monitors zero cross timing of the AVR to determine the alternator frequency which is a speed indicator. Set for 150 milliseconds of 4500 rpm or higher. Used if the normal ignition pulse sequence(s) are not being seen by the controller.	Test 64 and Test 60
Low Oil Pressure	ALARM	1300	Occurred while running The default Extended alarm for low oil pressure. Check oil level and pressure.	Test 61
High Temperature	ALARM	1400	Condition - Air Flow Impeded / Flow Issue Check the inlet/outlet for debris. Check temperature sensor and wiring.	Test 62
RPM Sensor	ALARM	1501	Twin Cylinder+Running Twin Cylinder Running faults to RPM Sensor Loss. Possible Causes: air pocket in fuel line, dirty fuel, missing ignition pulse (loss of one of the primary coils).	Test 50 and Test 64
RPM Sensor	ALARM	1505	Twin Cylinder+Cranking Twin Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor issue, missing ignition pulse (loss of one of the primary coils).	If engine cranks, Test 64. If engine does not crank, Problem 15.
RPM Sensor	ALARM	1511	Single Cylinder+Running Single Cylinder Running RPM sensor loss Possible Causes: air pocket in fuel line, dirty fuel. Loss of ignition pulse.	Test 50 and Test 64
RPM Sensor	ALARM	1515	Single Cylinder+Cranking Single Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor and/or engine issue. Loss of ignition pulse.	If engine cranks, Test 64. If engine does not crank, Problem 15.
Underspeed	ALARM	1600	Condition - Unit is Overloaded (55 Hz for 60 Hz for 30 sec, 40 Hz for 50 Hz unit) Unit is Overloaded slowing engine speed, fuel supply low or throttle control problem.	Problem 3, or Test 50, or Test 12
Underspeed	ALARM	1603	Underspeed The engine never comes up to 3600 RPM.	Check fuel selection and fuel supply
Overvoltage	ALARM	1800	Prolonged Over-Voltage	Problem 2
Undervoltage	ALARM	1900	Prolonged Under-Voltage Undervoltage due to loss of voltage. Below 80% for 10+ seconds)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1901	Instantaneous Undervoltage Undervoltage due to sudden loss of voltage. (Voltage less than 15 sec 2 sec+)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1902	Both Zero Crosses missing Undervoltage due to faulty excitation winding, or zero cross circuit, or circuit in general. Possible cause: loose wiring, field boost hardware failure. (Both zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

Evolution™ Controller e-Codes

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Undervoltage	ALARM	1906	Single Zero Cross missing Undervoltage due to faulty excitation winding, zero cross circuit, or circuit in general. Possible cause: field boost hardware failure. (One zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Wiring Error	ALARM	2099	Mis-wired Customer connection low voltage and high voltage wires are crossed.	Check customer connection in generator
Overload Remove Load	ALARM	2100	Overloaded - Default (Output Current Method) Unit is overloaded. One or both CT(s) detecting an overload condition. Check transfer switch loadshed functionality. (Change load dynamics or utilize loadshed).	Remove Load
Undervoltage Overload	ALARM	2299	Unit was overloaded and attempted to start with a large load connected. The unit can not ramp up the generator voltage to its normal target voltage value if it starts with a large load connected	Remove Load
Stepper Overcurrent	ALARM	2399	Current flow in stepper coil(s) above specification	Test 12
Fuse Problem	ALARM	2400*	Missing / Damaged Fuse The 7.5 amp Controller Fuse is missing or blown (open). *Firmware version 1.11 and older only	Test 44
Aux Shutdown	ALARM	2800	External shut down circuit is open.	Check the continuity of the harness and operation of the switch(es). Repair/replace as needed.
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Test 45
Battery Problem	WARNING		Condition->More than 16 Volts of battery voltage or 600 milliamperes or more of charge current at the end of an 18 hour charge	Test 45
Charger Warning	WARNING		Less than 12.5 volts of battery voltage at the end of a 18 hour charge	Problem 22
Charger Missing AC	WARNING		AC power is missing from the battery charger input	Problem 22
	Service Schedule		Service Schedule A 200hours 2 years Service Schedule B 400 Hours 4 years	Perform Maintenance

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

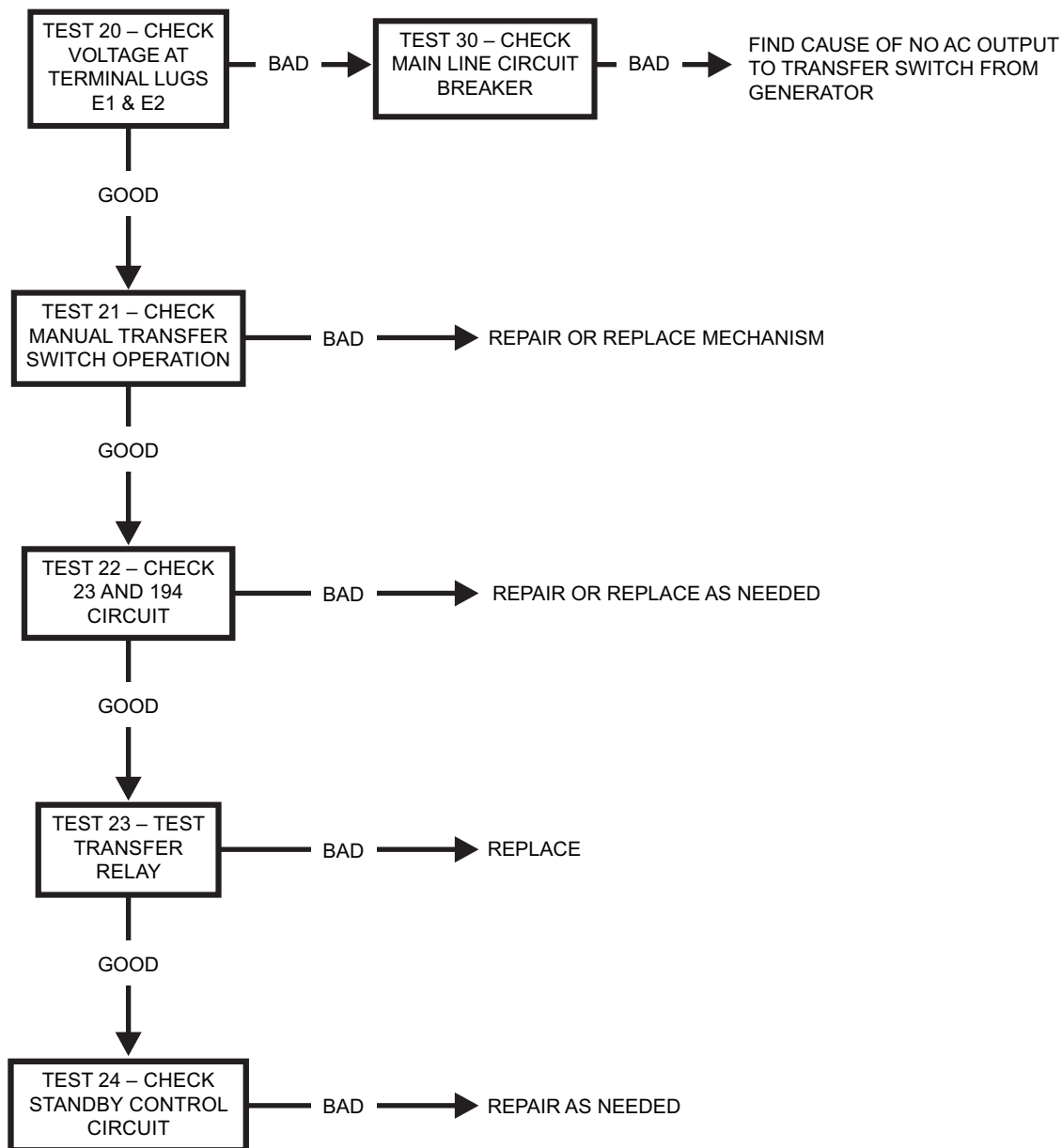
Additional Codes For 8 and 9 kW Units Only

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Overcrank	ALARM	1101	Engine/Starter Problem Limiting number of cranking cycles to protect the starter motor.	If the engine has tried to crank for 10 times unsuccessfully, this will trigger.
Overload Remove Load	ALARM	2102	Overloaded Unit re-cranks 5 times when load is applied, engine dies (0 RPM) and has low voltage (< 180V)	Check for Overloaded condition on unit. Inspect stepper motor operation.
Overload Remove Load	ALARM	2103	Overloaded Unit has run and attempted to accept load 10 times, could not accept due to overload condition	Check for Overloaded condition on unit

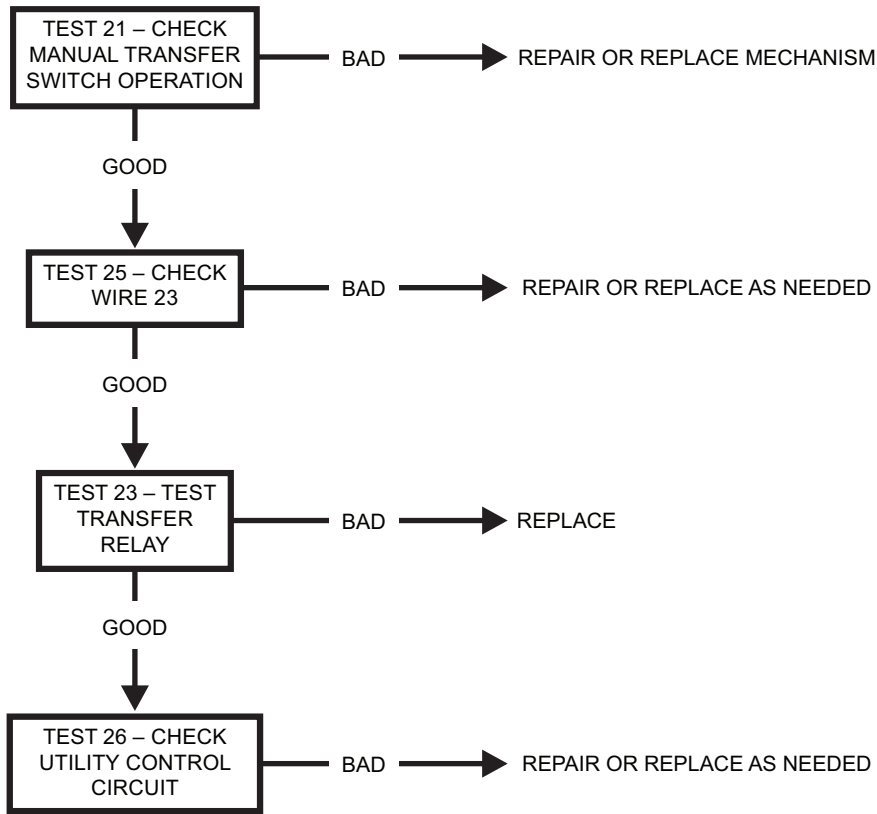
Introduction

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.

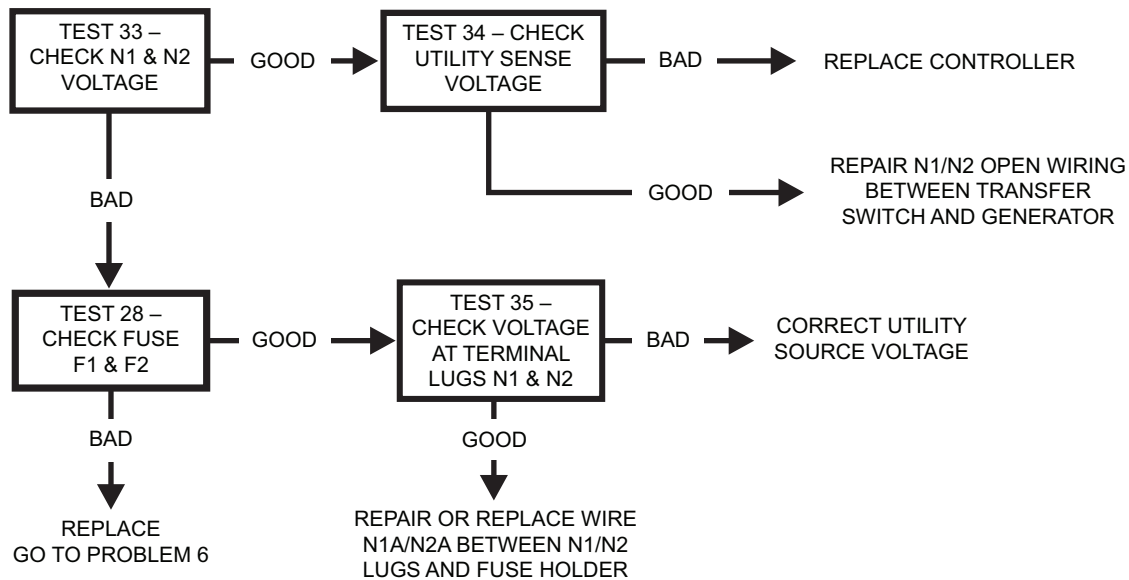
Problem 6 — With Controller in Automatic Mode and Utility Failed, Generator Runs but Transfer to Standby Does Not Occur



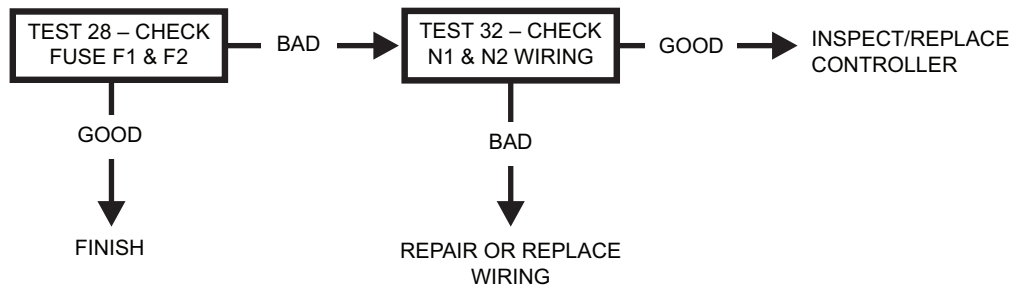
Problem 7 – In Automatic Mode, Generator Starts When Loss of Utility Occurs, Generator Shuts Down When Utility Returns But There is No Re-transfer to Utility Power Or Generator Transfers to Standby During Exercise or in Manual Mode



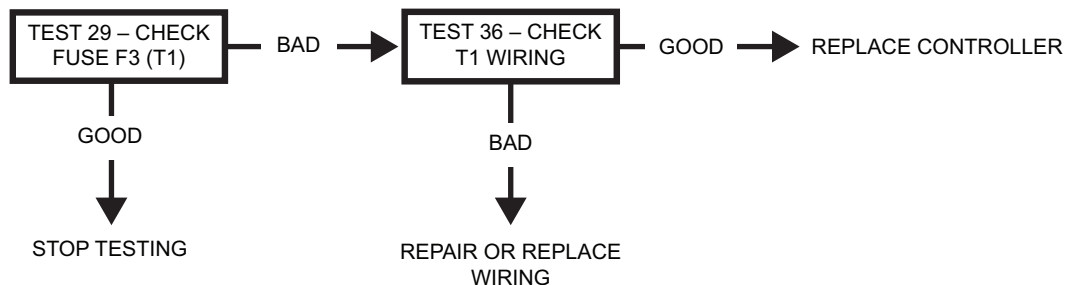
Problem 8 – Unit Starts and May or May Not Transfer When Utility Power is On



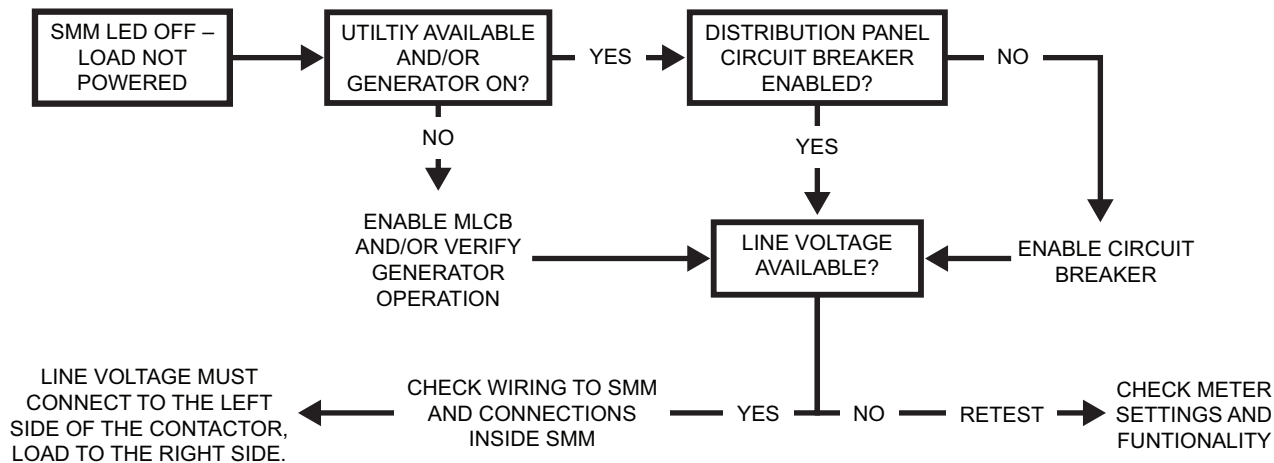
Problem 9 – Blown F1 or F2 Fuse



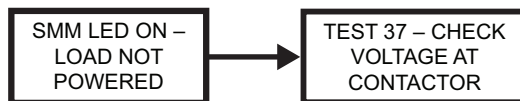
Problem 10 – Blown T1 Fuse



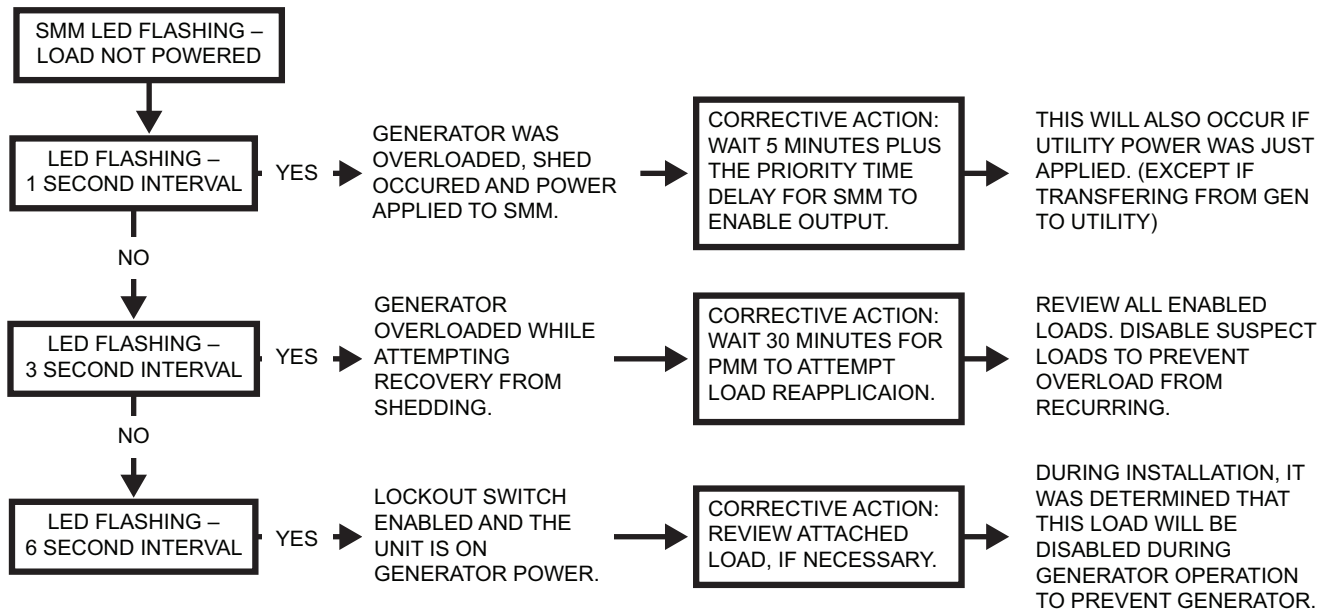
SMM Problem 1 – Load Management Module (SMM) LED is OFF, Load Not Powered



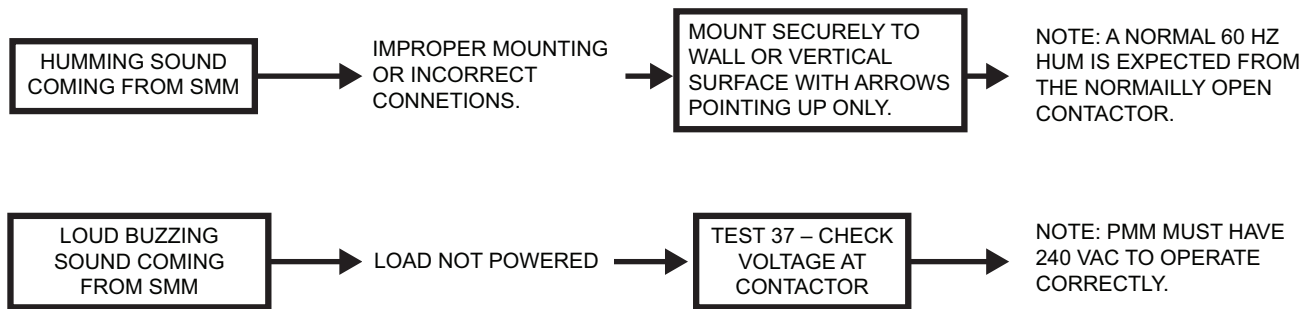
SMM Problem 2 – Load Management Module (SMM) LED is ON, Load Not Powered



SMM Problem 3 – Load Management Module (SMM) LED is Flashing, Load Not Powered



SMM Problem 4 – Load Management Module (SMM) is Humming or Buzzing



Integrated SACM Problem 1 – Generator starts and runs in AUTO with Utility Present

NOTE: Verify the integrity of all wires and connections relative to the function of the Integrated SACM Board. AC Voltage value must equal Generator Output voltage.

NOTE: This procedure will require SD/WD 100000060381.

1. Check for AC Voltage on N1 and N2 at the connection deck on the generator.

AC Voltage Present?	YES	<i>Test 34 – Check Utility Sensing Voltage at the Circuit Board</i>
	NO	Go To Next Step

2. Check for AC Voltage on N1 and N2 at the 6 Pin Customer Control Connector.

AC Voltage Present?	YES	Repair or Replace N1 and N2 interconnect wires
	NO	Go To Next Step

3. Check for AC Voltage at upper end of N1 and N2 Fuses.

AC Voltage Present?	YES	Replace Integrated SACM Board
	NO	Go To Next Step

4. Check for AC Voltage at the lower end of N1 and N2 Fuses

AC Voltage Present?	YES	Replace N1 and N2 fuses
	NO	Go To Next Step

5. Check for AC Voltage at pins 3 and 6 on the white Molex Connector.

AC Voltage Present?	YES	Replace Integrated SACM Board
	NO	Go To Next Step

6. Check for AC Voltage on N1 and N2 at the lugs on the contactor.

AC Voltage Present?	YES	Check N1A and N2A Wires
	NO	Reset Utility Breaker or Check Utility Service

Integrated SACM Problem 2 – Transfer to Standby Does Not Occur in AUTO

NOTE: Verify the integrity of all wires and connections relative to the function of the Integrated SACM Board. AC Voltage value must equal Generator Output voltage. DC Voltage value should be at least 9 VDC.

NOTE: This procedure will require SD/WD 100000060381.

1. Check for AC Voltage on E1 and E2 at the connection deck on the generator.

AC Voltage Present?	YES	Go To Step 3
	NO	Go To Next Step

2. Check for AC Voltage on Wire 11 and Wire 44 at the MLCB (Generator Circuit Breaker).

AC Voltage Present?	YES	Is Breaker Closed? Go To Next Step
	NO	Perform Preliminary Output Voltage Test (Evolution Only, Non-Synergy, Firmware v1.12 and Above)

3. Check for AC Voltage on E1 and E2 at the Transfer Switch Contactor.

AC Voltage Present?	YES	Go To Next Step
	NO	Go to Step 1 in this Test

4. Check for DC Voltage across Wire 23 and Wire 194 at the Customer Control Connection on the Integrated SACM board.

DC Voltage Present?	YES	Go To Next Step
	NO	Go to Test 22 – Check Wire 23 and 194 Circuits

5. Check for AC Voltage at Pin 8 and Pin 4 on the white Molex Connector.

AC Voltage Present?	YES	Go to Step 3 in this Test
	NO	Go To Next Step

6. Check for AC Voltage at Pin 8 of the white Molex Connector and Terminal 2 of the C2 Coil.

AC Voltage Present?	YES	Replace C2 Coil
	NO	Go to Step 1 in this Test

7. Check for AC Voltage on Pin 8 and Terminal 1 of the XB1 Limit Switch.

AC Voltage Present?	YES	Replace XB1 Limit Switch
	NO	Go to Test 23 – Test Transfer Relay

Integrated SACM Problem 3 – Transfer to Utility Does Not Occur after Utility Returns

NOTE: Verify the integrity of all wires and connections relative to the function of the Integrated SACM Board. AC Voltage value must equal Generator Output voltage. DC Voltage value should be at least 9 VDC.

NOTE: This procedure will require SD/WD 10000060381.

1. Check for AC Voltage at the Utility Connection (before Utility Main Circuit Breaker).

AC Voltage Present?	YES	Go To Next Step
	NO	Check Utility Mains for AC Voltage

2. Check for AC Voltage on N1 and N2 (after Utility Main Circuit Breaker).

AC Voltage Present?	YES	Go To Next Step
	NO	Go To Test 30 – Check Main Circuit Breaker

3. Check for DC Voltage across Wire 23 and Wire 194 at the Customer Control Connection on the Integrated SACM board.

DC Voltage Present?	YES	Go To Test 22 – Check Wire 23 and 194 Circuits
	NO	Go To Next Step

4. Check for AC Voltage at Pin 3 (N1A) and Pin 6 (N2A) on the white Molex Connector.

AC Voltage Present?	YES	Go To Next Step
	NO	Go to Step 2 in this Test

5. Check for AC Voltage at Pin 3 (N1A) and Pin 5 (N2A) of the white Molex Connector.

AC Voltage Present?	YES	Go To Next Step
	NO	Replace Integrated SACM board

6. Check for AC Voltage at Pin 3 (N1A) of the white Molex Connector and Terminal 2 of the C1 Coil.

AC Voltage Present?	YES	Go To Next Step
	NO	Replace C1 Utility Coil

7. Check for AC Voltage on Pin 3 (N1A) on the white Molex Connector and Terminal 1 of the XA1 Limit Switch.

AC Voltage Present?	YES	Replace the XA1 Limit Switch
	NO	Go To Next Step

8. Check for AC Voltage on Pin 3 (N1A) and Pin 2 (Wire 126) of the white Molex Connector.

AC Voltage Present?	YES	Go to Test 23 – Test Transfer Relay
	NO	Go Step 3 in this Test

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Section 3.4 Diagnostic Tests

Introduction

This section familiarizes the service technician with acceptable procedures for the testing and evaluation of various problems that can occur on pre-packaged transfer switches. The numbered tests in this section correspond with the flow charts in Section 3.3: [Troubleshooting Flowcharts](#).

Some test procedures in this section may require the use of specialized test equipment, meters or tools. Most tests can be performed with a Digital Multimeter (DMM). 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 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 more quickly.

- 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

General Theory

While in AUTOMATIC mode, the standby closing coil (C2) energizes utilizing generator output to transfer to the STANDBY position. 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 for this test. The first procedure is performed in the event that the generator is already running in a utility failure. The second procedure is performed if the generator has already shutdown. It is not required to complete both procedures.

Be careful! Dangerously high 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 1: Generator Running in Utility Failure, Switch did not Transfer

1. Set multimeter (DMM) 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 transfer switch contactor terminal lugs E1 and E2 with an accurate AC meter. The meter should indicate generator line-to-line voltage.

Procedure 2: Generator Shutdown

1. Set the controller to OFF.
2. Set DMM 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 controller to MANUAL.
7. If transfer to the STANDBY position does not occur, check the voltage across terminal lugs E1 and E2. The DMM should indicate generator line-line voltage.

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 DMM did not indicate voltage across E1 and E2, proceed to **Test 1—Check AC Output Voltage**.
3. If transfer to the STANDBY position did not occur and the DMM indicated proper 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 the generator faulted on under-voltage, refer to **Problem 1 – Generator Shuts Down for Under Voltage**.

Test 21 – Check Manual Transfer Switch Operation

General Theory

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 to evaluate whether any sticking or binding is present in the contactor.

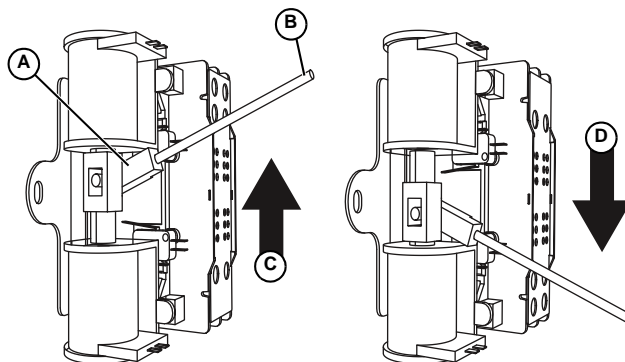
Procedure

1. Set the generator main line circuit breaker (MLCB) to the “Open” position.
2. Set the controller to OFF.
3. Disconnect Utility from the transfer switch.

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. See **Figure 3-49**. Insert the un-insulated end of the handle over the transfer switch-operating lever.
6. Manually actuate the contactor lever up to the UTILITY position.
7. Actuate the operating lever down to the STANDBY position.
8. 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.
9. Actuate the contactor to the UTILITY position.



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- A. Transfer switch-operating lever
 B. Manual transfer handle
 C. Load connected to utility power source

Figure 3-49. Manual Transfer Switch Operation

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 Wire 23 and 194 Circuits

General Theory

An OPEN or improperly grounded circuit in either Wire 23 or Wire 194 will prevent a transfer from occurring. This test assumes that battery voltage is sufficient (at least 12.2 VDC).

NOTE: There are three variations of Transfer Relays (TR1) used in production. See **Table 3-5**, and **Figure 3-50**, **Figure 3-51** and **Figure 3-52** for proper pin identification.

Table 3-5. TR1 Relay Terminal Connections

Relay	Clear Square	Clear Rectangle	Yellow Rectangle
Wire 194	A	7	13
Wire 23	B	8	14
Wire N1A	7	5	9
Wire 126	1	1	1
Wire E1	9	6	12
Wire 205	6	4	8

Procedure/Results

- Check for DC voltage at Wire 194 on the TR1 relay in the transfer switch. 10-12 Volts DC is sufficient.
 - If DC voltage is not present at Wire 194 on the TR1 Relay, check for DC Voltage at the terminal block in the transfer switch and at the terminal block in the generator. If not present at either location, continue to Step 2.
 - If DC voltage is present at Wire 194 on the TR1 relay, proceed to Step 3.
- Disconnect Wire 194 from the transfer switch side of the terminal block in the generator, and then check for DC voltage at this terminal block.
 - If DC voltage is now present but wasn't before, check for a short to ground between generator and transfer switch.
 - If DC voltage is not present at the terminal block, verify the presence of DC Voltage at the controller and for connector/wire/pin integrity. See Appendix A **Controller Identification** for specific pin location. If okay, replace the controller.
- With the generator running (MANUAL or AUTO), connect a jumper wire from ground to Wire 23 located at the terminal block in the transfer switch. Listen and visually watch for the energizing of the TR1 Relay and for the transfer to Standby.
 - If the TR1 Relay visually and audibly energized (clicked) and the contactor transferred to the STANDBY position, proceed to **Test 25 – Check Wire 23**.
 - If the CONTACTOR did not transfer to the STANDBY position and the TR1 Relay DID or DID NOT energize, proceed to **Test 23 – Test Transfer Relay**.

Test 23 – Test Transfer Relay**General Theory**

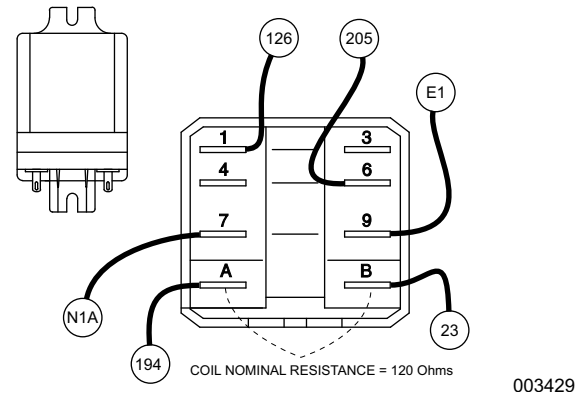
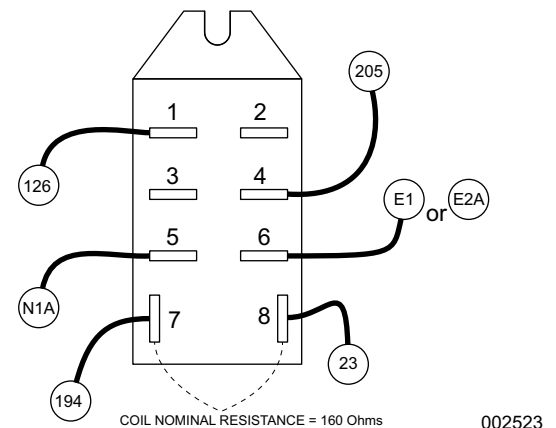
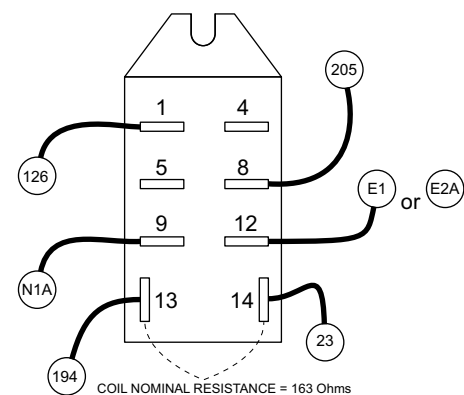
In automatic mode, transfer to standby will not occur until the transfer relay (TR1) energizes. When TR1 relay

energizes, generator source 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.

NOTE: There are three variations of Transfer Relays (TR1) used in production. See the figures in **Test 23 – Test Transfer Relay** for identification.

Procedure

- Disconnect all wires from the TR1 relay to prevent interaction.

**Figure 3-50. Clear Transfer Relay Test Points****Figure 3-51. Clear Transfer Relay Test Points****Figure 3-52. Yellow Transfer Relay Test Points**

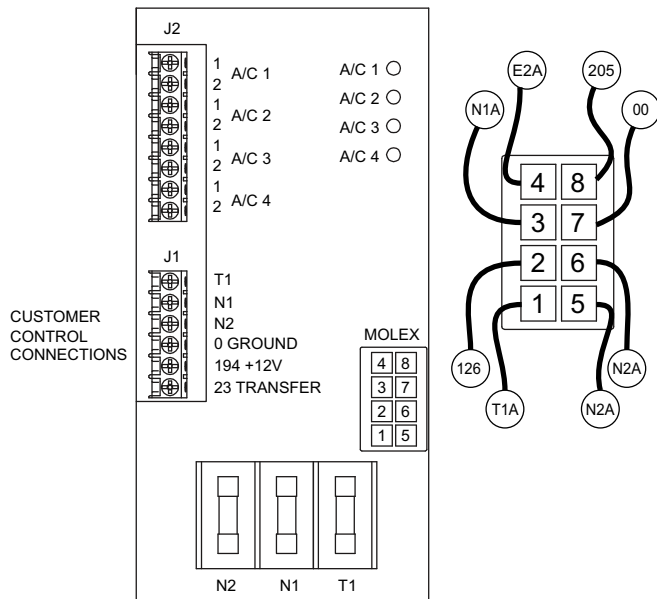


Figure 3-53. Integrated SACM Test Points

2. Set DMM to measure resistance.
3. See appropriate figure. With the wires disconnected, connect the DMM test leads across relay terminals where Wires 194 and 23 were connected. Measure and record the resistance.
4. See appropriate figure. Using jumper wires, connect one fused jumper wire from the positive post of the battery to the relay terminal that had Wire 194 and connect the other jumper wire from the negative post of the battery to the relay terminal that had Wire 23.
5. Connect the DMM test leads across relay Terminals per [Table 3-6](#), [Table 3-7](#), and [Table 3-8](#) based on the TR1 relay being tested. Measure and record the resistance while energized and de-energized.
 - a. Energize the relay. The meter should indicate either INFINITY or CONTINUITY according to the appropriate table.
 - b. De-energize the relay. The DMM should indicate CONTINUITY or INFINITY according to the appropriate table.
6. Repeat Step 5 across relay Terminals 7 and 1.

Table 3-6. Clear Transfer Relay (Ice Cube)		
Connect DMM Test Leads Across:	Desired Meter Reading	
	Energized	De-Energized
Terminals 6 and 9	Continuity	Infinity
Terminals 1 and 7	Infinity	Continuity
Terminals A and B		120 Ohms

Table 3-7. Clear Transfer Relay (small) OMRON®		
Connect DMM Test Leads Across:	Desired Meter Reading	
	Energized	De-Energized
Terminals 4 and 6	Continuity	Infinity
Terminals 1 and 5	Infinity	Continuity
Terminals 7 and 8 (Coil)		160 Ohms

Table 3-8. Yellow Transfer Relay (small) IDEC®		
Connect DMM Test Leads Across:	Desired Meter Reading	
	Energized	De-Energized
Terminals 8 and 12	Continuity	Infinity
Terminals 1 and 9	Infinity	Continuity
Terminals 13 and 14 (Coil)		163 Ohms

Table 3-9. Integrated SACM		
Connect DMM Test Leads Across:	Desired Meter Reading	
	Energized	De-Energized
Pins 4 and 8	Continuity	Infinity
Pins 2 and 3	Infinity	Continuity
Wires 23 and 194		339.5 Ohms

Results

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

Test 24 – Test Standby Control Circuit

General Theory

See [Figure 3-54](#). 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 DMM to measure AC voltage.
2. Measure between the E2 terminal and Terminal 2 of the C2 coil, the DMM should indicate 240 VAC.
 - a. If 240 VAC was not measured, continue testing.
 - b. If 240 VAC was measured, replace the C2 coil.
3. Verify the contactor is in the UTILITY position.

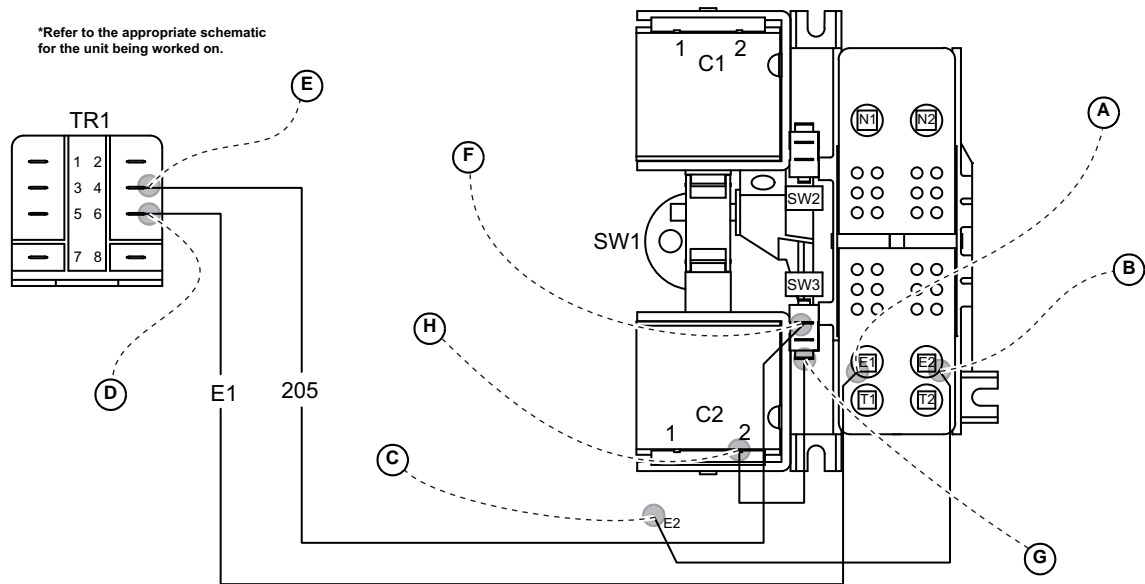


Figure 3-54. Typical Standby Control Circuit Test Points*

4. Remove Wire B from the C2 coil.
5. Set the controller to AUTO mode. Turn off utility power supply to the transfer switch, simulating a utility failure. The generator should start and the transfer relay should energize.
6. Measure across lugs E1 and E2, the DMM 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 7.
7. Measure for the voltage on Wire B from the lug to 1 of the C2 coil (Wire B previously removed from the coil) and B, the DMM 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 8.
8. Measure between the E2 lug and Terminal 9 on the TR1, the DMM 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.
9. Measure between the E2 terminal and terminal 6 of the TR1, the DMM should indicate 240 VAC.
 - a. If 240 VAC was NOT measured, replace transfer relay.
 - b. If 240 VAC was measured, proceed to Step 10.
10. Measure between the E2 terminal and the top terminal of SW3 the DMM 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 11.
11. Measure between the E2 terminal and the bottom terminal of the SW3, the DMM 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 12.
12. Measure between the E2 terminal and terminal 2 of the C2 coil, the DMM 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

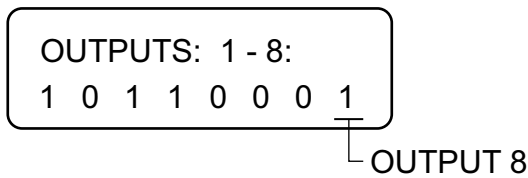
General Theory

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 faulty Wire 23 could be the cause. This test assumes that battery voltage is sufficient (at least 12.2 VDC).

Procedure/Results

1. Set the controller to OFF.
2. Set the DMM to measure DC voltage.
3. See **Figure 3-56** or **Figure 3-57**. Disconnect and isolate Wire 23 from the transfer switch side of the terminal block in the generator. Observe the transfer switch.
 - a. If the transfer relay (TR1) DID NOT de-energize and the Transfer Switch DID NOT return to Utility, proceed to Step 7.

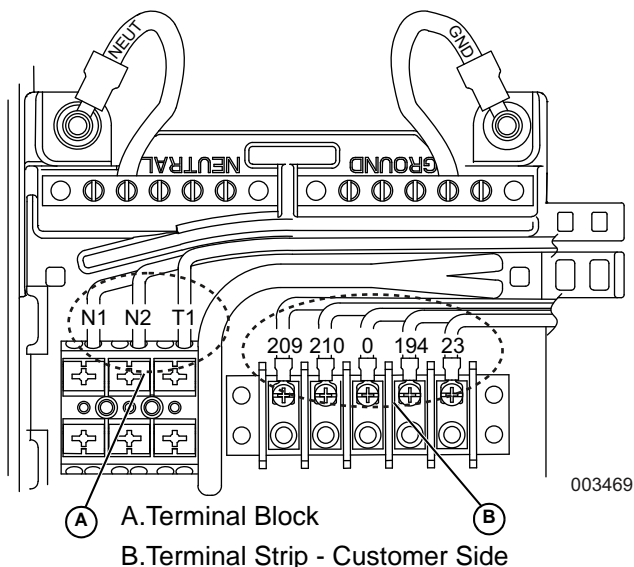
- b. If the transfer relay (TR1) de-energized and the Transfer Switch returned to Utility, proceed to the next step.
- 4. Set the controller to the AUTO mode. Utility Voltage must be present. Verify that Utility is present at N1 and N2 Terminal Block in the generator.
- 5. Using the appropriate menu map, access the OUTPUTS display (Figure 3-55) via the DEALER menu (Evolution) or DEBUG menu (Nexus) on the controller.
- 6. See **Figure 3-55**. Digital Output 8 is the Wire 23 output from the controller (Figure 3-55)
 - a. If Output 8 is displaying a "1", the control board is grounding Wire 23. Replace the controller.
 - b. If Output 8 is displaying a "0", the control board is NOT grounding Wire 23, proceed to the next step.



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Figure 3-55. The Output Screen – Output 8

- 7. See **Figure 3-56** or **Figure 3-57**. Ensure that Wire 23 is disconnected from the transfer switch side of the terminal block on the generator.

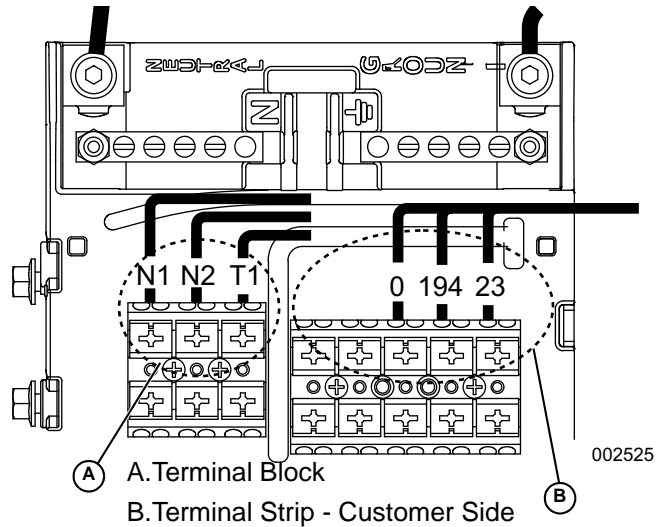


003469

Figure 3-56. Transfer Relay Test Points – Nexus

- 8. Connect the positive meter test lead to Wire 194 at the terminal block in the generator and connect the negative meter test lead to the ground lug. Verify that DC Voltage is present.
 - a. If DC Voltage was not measured, refer back to the flowchart (Test 22).

- 9. If DC Voltage was measured, proceed to the next step.



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Figure 3-57. Transfer Relay Test Points – Evolution

- 10. With Wire 23 removed from the terminal block in the previous step (transfer switch side), check the voltage between Wire 23 previously disconnected and ground.
 - a. If no DC Voltage was measured, an open exists on Wire 23 between the generator and transfer switch.
 - b. If a low DC Voltage was measured, a short to ground exists on Wire 23 between the generator and transfer switch.
 - c. Repair or replace Wire 23 as needed between the generator control panel and transfer switch relay (TR1).

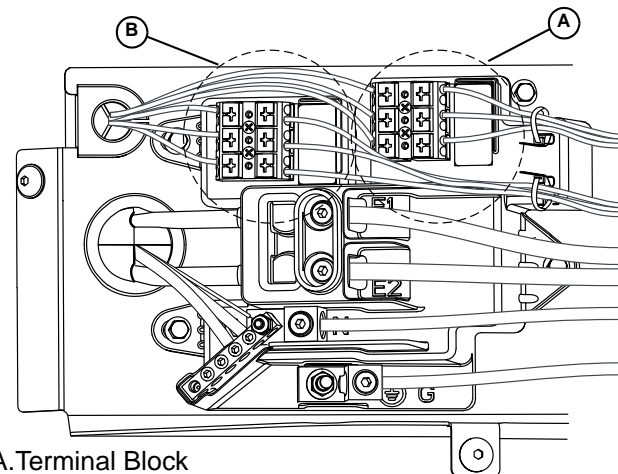


Figure 3-58. Transfer Relay Test Points – Evolution 2017

Figure 3-58. Transfer Relay Test Points – Evolution 2017

Test 26 – Test Utility Control Circuit

General Theory

See [Figure 3-59](#). 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

1. Set the controller to OFF. Disconnect Wire 194 from the transfer switch terminal strip.
2. Set DMM 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](#).
 - b. If transfer to Utility does NOT occur, proceed to Step 7.
6. Remove two wires from the utility coil and check for 240 VAC.
 - a. If 240 VAC is measured check utility coil for continuity.
 - b. If 240 VAC is not measured proceed to Step 9.
 7. Checking coil continuity:
 - a. If continuity is measured proceed to Step 8.
 - b. If there is no continuity, replace the coil.
 8. Measure the voltage across point C (Wire N2A previously removed) and B, the DMM 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 for voltage between the N2 lug and the F1 terminal A. The DMM 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 for voltage from the N2 lug and Terminal 7 of the TR1, the DMM 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 for voltage between the N2 lug and terminal 1 of the TR1, the DMM should indicate 240 VAC.
 - a. If 240 VAC was NOT measured, replace transfer relay.
 - b. If 240 VAC was measured, proceed to Step 12.

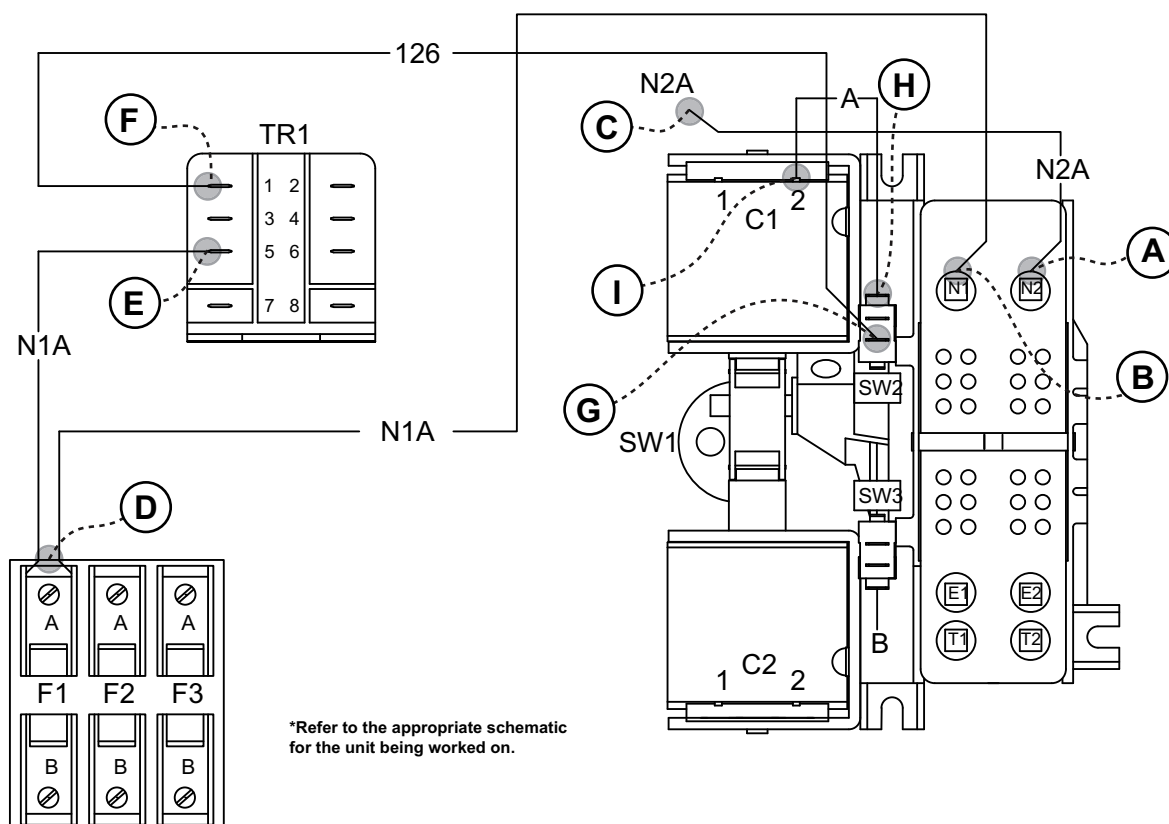


Figure 3-59. Typical Utility Control Circuit Test Points

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12. Measure for voltage between the N2 lug and the bottom terminal of the SW2. The DMM 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 for voltage between the N2 lug and the top terminal of the SW2. The DMM 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 for voltage between the N2 lug and terminal 2 of the C1 coil. The DMM 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

General Theory

Wired to the normally CLOSED contacts, the limit switches provide a means to interrupt the transfer circuits. When the CONTACTOR changes position, the limit switch contacts change state to become OPEN.

Procedure

With the controller set to OFF, 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 DMM to measure resistance.
3. Connect the DMM 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 DMM reading at each switch position.
7. To prevent interaction, disconnect Wire 205 and Wire B from the limit switch (SW3) terminals.
8. Connect the DMM 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 DMM reading at each switch position.

Coil Nominal Resistance: 480-520k ohms

Results

1. If the DMM 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 DMM 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

General Theory

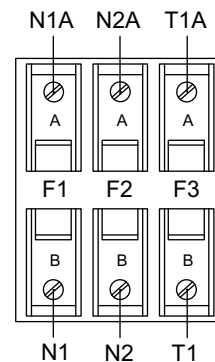
Fuses F1 and F2 are connected in series with the N1 and N2 circuits, respectively. A blown fuse will open the applicable circuit and will result in (a) generator startup and transfer to the “Standby”, or (b) failure to re-transfer back to utility source.

Procedure

1. On the generator panel, set the controller to OFF.
2. Disconnect Utility from the transfer switch.
3. See **Figure 3-60**. Remove fuse F1 and F2 from the fuse holder.
4. Inspect and test fuses for an OPEN condition with a DMM set to measure resistance. CONTINUITY should be measured across the fuse.

Results

1. Replace blown fuse(s) as needed.



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Figure 3-60. Transfer Switch Fuse Block

Test 29 – Check Fuse F3

General Theory

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 controller to OFF.
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 DMM set to measure resistance. CONTINUITY should be measured across the fuse.

Results

1. Replace blown fuse as needed.

Test 30 – Check Main Circuit Breaker

General Theory

Often the most obvious cause of a problem is overlooked. 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.

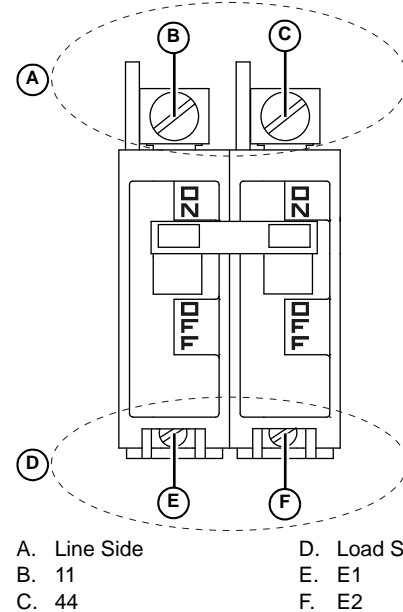
Procedure

The generator main line circuit breaker (MLCB) is located underneath the control panel side cover. If loads are not receiving power, verify the breaker is set to the “Closed” position. If the breaker is suspected to have failed, test it as follows.

1. Set the DMM to measure resistance.
2. With the generator shutdown, disconnect all wires from the MLCB terminals, to prevent interaction.
3. See [Figure 3-61](#). Connect one meter test lead to the Wire 11 terminal on the breaker and the other test lead to the E1 terminal.
4. Set the breaker to its “Closed” position; the DMM should indicate CONTINUITY.
5. Set the breaker to its “Open” position; the DMM should indicate INFINITY.
6. Repeat Step 4 and 5 with the DMM 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.



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Figure 3-61. Main Line Circuit Breaker

Test 32 – Check N1 and N2 Wiring

General Theory

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

Procedure

1. On the generator panel, set the controller 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 connector that supplies the controller T1 located in the control panel.
5. Set DMM 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 repeat test.

Test 33 – Check N1 and N2 Voltage

General Theory

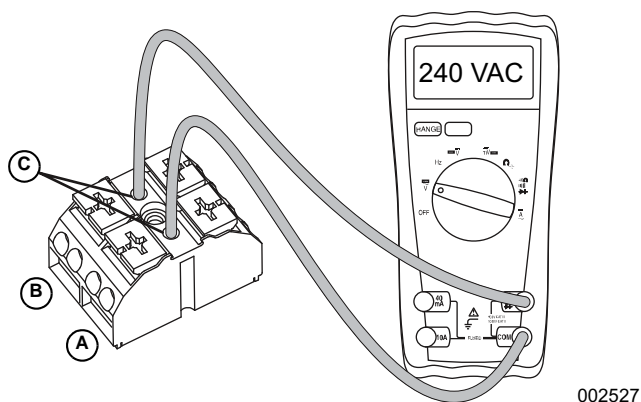
Loss of utility source voltage to the generator will initiate a startup and transfer by the generator. Testing at the control panel terminal block will divide the system in two, thereby reducing troubleshooting time.

Procedure

1. Set the controller to OFF.
2. Set a DMM to measure AC voltage.
3. See [Figure 3-62](#). 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**.



- A. N1
- B. N2
- C. Test Points

Figure 3-62. Terminal Block Test Points

Test 34 – Check Utility Sensing Voltage at the Circuit Board

General Theory

If the generator starts and transfer to STANDBY occurs in 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 controller to OFF.
2. Disconnect the harness connector containing Wires N1 and N2 from the controller.
3. Set a DMM 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.

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

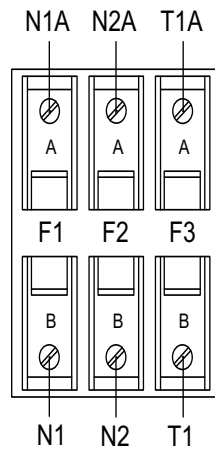
The N1 and N2 terminals in the transfer switch deliver utility voltage “sensing” to a circuit board. If voltage at the terminals is zero or low, standby generator startup and transfer to the “Standby” source will occur automatically as controlled by the circuit board. Zero or low voltage at these terminals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

Procedure

With utility source voltage available to terminal lugs N1 and N2, use a DMM 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.

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**.



002633

Figure 3-63. Transfer Switch Fuse Block

Test 36 – Check T1 Wiring

General Theory

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

Procedure

1. Set the controller to OFF.
2. Remove F1, F2, and F3 from the fuse holder in the transfer switch.
3. Disconnect the proper controller harness connector that has Wire T1 in it from the controller.
4. Set the DMM 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 DMM indicated INFINITY in Steps 4a -4e, replace the controller.
2. If the DMM indicated CONTINUITY, repair or replace the wiring in the appropriate circuit.

Test 37 – Test SMM Contactor Line, Load and Control

General Theory

The SMM Load Shed Module (integral to load shedding) requires line voltage from either the utility or the generator for it to operate. If line voltage is present, but the SMM is still not operating, this test will confirm the proper operation of the contactor.

Required Tools

- Meter test leads that are capable of measuring voltage.
- Phillips screwdriver.

Procedure

1. Remove the four (4) screws securing the cover to the SMM Load Shed Module.
2. Verify the LED is ON, but not flashing.
 - a. If the LED is OFF or flashing in any interval, return to the flowchart.
3. Set the DMM to measure AC volts.
4. Place the meter leads across the line (input) terminals and record the voltage.
5. Place the meter leads across the load (output) terminals and record the voltage.

Results

1. If the meter indicated less than approximately 240 VAC in Step 4, stop testing and check source voltage coming from the circuit breaker.
2. If the meter indicated approximately 240 VAC in Step 4, but not in Step 5, replace the contactor.

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Section 4.1 Description and Major Components

Introduction

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

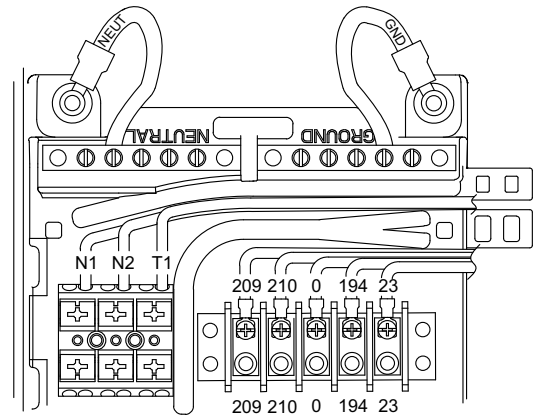
Topics covered in this section are:

- 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

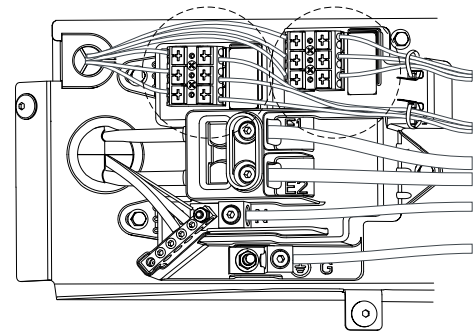
The terminals of this terminal strip connect to identically numbered terminals in the transfer switch. The terminal block provides the electrical connection for the controller at the following connection points:

- UTILITY N1 (Utility Sensing)
- UTILITY N2 (Utility Sensing)
- LOAD T1 (Internal Battery Charger) - 60 Hz Unit
- LOAD T2 (Internal Battery Charger) - 50 Hz Unit
- Wire 194 (Transfer Relay)
- Wire 23 (Transfer Relay)



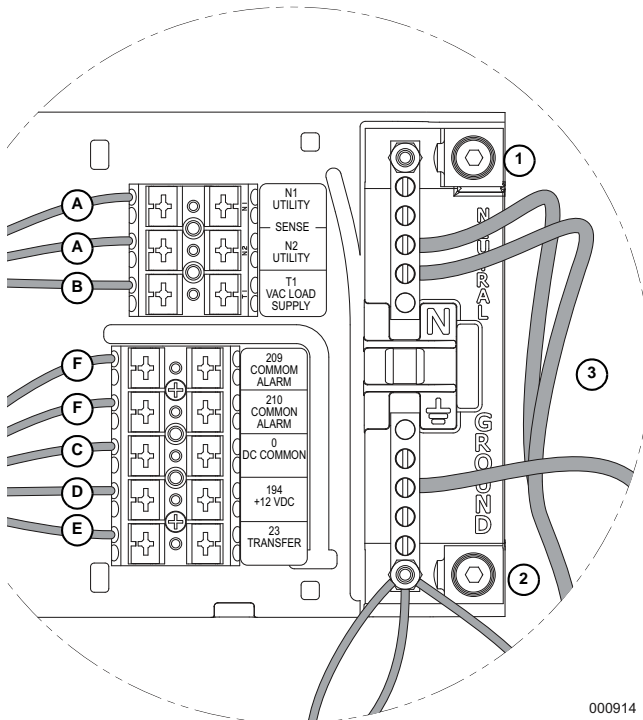
003162

Figure 4-1. Nexus Customer Connections



004920

Figure 4-2. 2017 Evolution Customer Connections



000914

Figure 4-3. Evolution Control Wiring - 60 Hz (found behind control board)

Table 4-1. Control Panel Connections

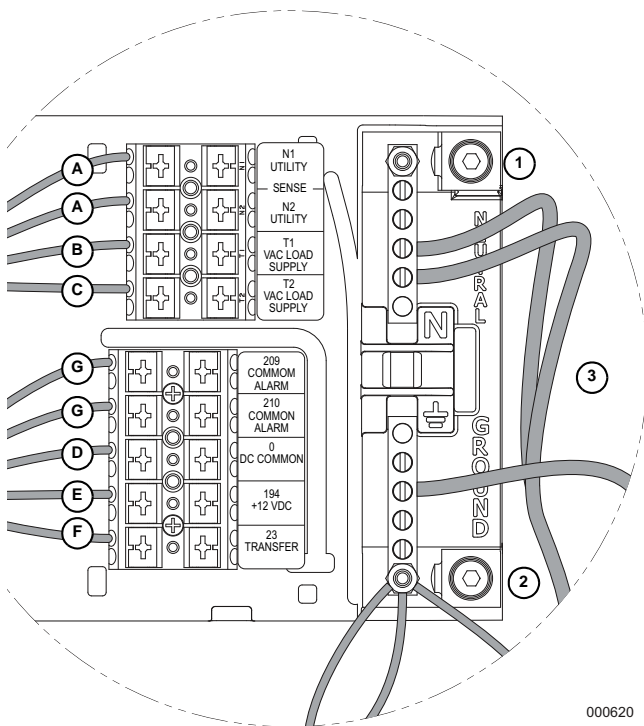
Terminal Numbering Decal	Wire Numbers
A	YELLOW #1 & #2 N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3 T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C	BLACK #3 0 - DC (-) Common Ground Wire
D	RED #4 194 - DC (+) 12 VDC for Transfer Controls
E	WHITE #5 23 - Transfer Control Signal Wire
F	BLUE #1 & #2 Optional Alarm Relay Contacts (Normally Open)

Note: Must be connected to keep battery charged whether unit is running or not.

Table 4-2. Ground and Neutral Connections

1	Large Neutral Lug Torque Spec 2/0 TO 14 AWG 120 in-lb (13.56 N-m)
2	Large Ground Lug Torque Spec 2/0 TO 14 AWG 120 in-lb (13.56 N-m)
3	Ground and Neutral Bus Bar Torque Specs: 4-6 AWG 35 in-lb (3.95 N-m) 8 AWG 25 in-lb (2.82 N-m) 10-14 AWG 20 in-lb (2.26 N-m)

Note: A 25 in-lb (2.82 Nm) torque should be applied to the ground wire and neutral wire connection to the ground/neutral bar.



Terminal Numbering Decal		Wire Numbers
A	YELLOW #1 & #2	N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3	T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C*	WHITE #4	T2 - Fused 120 VAC for Battery Charger (*see NOTE)
D	BLACK #3	0 - DC (-) Common Ground Wire
E	RED #4	194 - DC (+) 12 VDC for Transfer Controls
F	WHITE #5	23 - Transfer Control Signal Wire
G	BLUE #1 & #2	Optional Alarm Relay Contacts (Normally Open)

Note: Must be connected to keep battery charged whether unit is running or not.

1	Large Neutral Lug Torque Spec 2/0 TO 14 AWG 120 in-lb (13.56 N-m)
2	Large Ground Lug Torque Spec 2/0 TO 14 AWG 120 in-lb (13.56 N-m)
3	Ground and Neutral Bus Bar Torque Specs: 4-6 AWG—35 in-lb (3.95 N-m) 8 AWG—25 in-lb (2.82 N-m) 10-14 AWG—20 in-lb (2.26 N-m)

Figure 4-4. Evolution Control Wiring - 50 Hz (found behind control board)

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.
- 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.

The controller harness connectors 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 the appropriate appendix in the back of this diagnostics manual.

To control the generator the controller utilizes digital inputs and outputs. See [Table 4-5](#) for the specific position and function. See [Menu System Navigation](#) to view state of output or input.

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

* Evolution units only with 1.18 firmware and higher.

IMPORTANT NOTE: 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 programmed day and time.

IMPORTANT NOTE: If the controller was OFF during its scheduled exercise time it will immediately attempt to exercise when the unit is set to AUTO.

LED Display

Located next to the right side lock cylinder on the generator, the LED Display provides a visual indication the generators status. The LED Display has three LEDs:

- Red LED- Illuminates during an Alarm condition or when the controller is set to OFF mode.
- 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.

NOTE: On 2017 Evolution units (Firmware 1.17 and above) the Green LED will flash when unit has transferred to standby and is carrying load.

Battery Charger

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

- 13.5 VDC at High Temperature
- 14.1 VDC at Normal Temperature
- 14.6 VDC 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.

NOTE: 50 Hz units use fuses F3 and F4 and a 220 VAC supply to the battery 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 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 dependent 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” (Nexus) or “Charger Warning” (Evolution) 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 40 °F 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 40 °F 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.

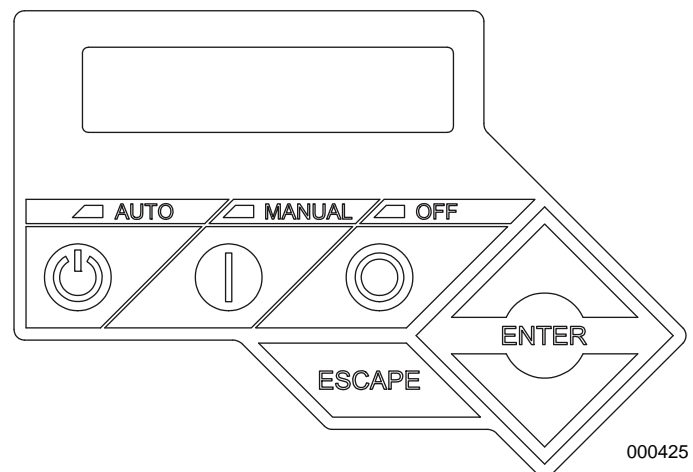
AUTO-OFF-MANUAL

This feature permits the operator to (a) select fully automatic operation, (b) start the generator manually, or (c) stop the engine and prevent the automatic startup. The Nexus controller has a 3-position switch. The Evolution controller has OFF-MANUAL-AUTO Mode buttons. See [Figure 4-5](#) or [Figure 4-6](#) for the location of the switch or push buttons.



003037

Figure 4-5. Nexus Auto-Off-Manual Switch

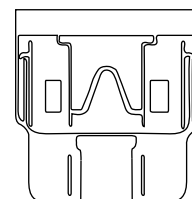


000425

Figure 4-6. Evolution controller Off-Manual-Auto Buttons

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.



002438

Figure 4-7. Typical 7.5 Amp Fuse

Starter Contactor Relay/Solenoid

(V-Twins and units with 426cc Engine)

See **Figure 4-8**. 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.

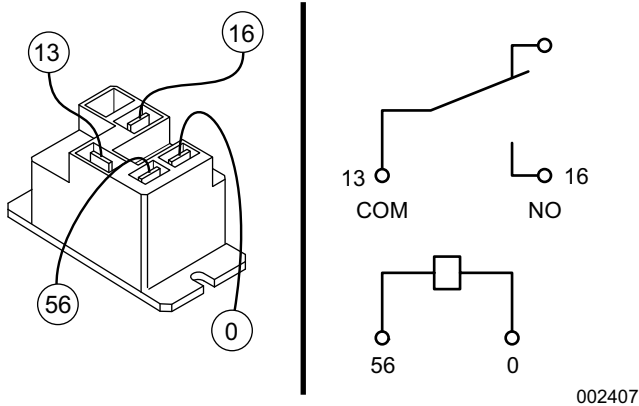


Figure 4-8. Starter Contactor Relay (V-twin Units)

(410cc Single Cylinder Engine Units Only)

See **Figure 4-9**. 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.

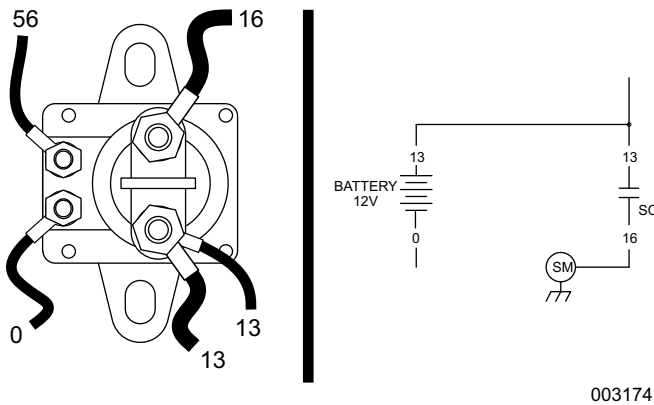


Figure 4-9. The Starter Contactor (Single Cylinder Units)

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.

On Nexus and Evolution (2013), the connections are made to the generator customer connection terminal strip (or WAGO block) at Terminals 1 and 2 (Wires 209 and 210).

On 2017 Evolution units the connections are made to the controller via Wires 209 and 210 by connecting to the dedicated wire connections.

Table 4-6. Specifications

Contact Rating:	200 mA at 12 VDC
-----------------	------------------

NOTE: Contact rating is for resistive load only

Circuit Pin Descriptions

Table 4-7 provides the physical wire identification and circuit functions.

Table 4-7. Circuit Pin Description

Evolution	Nexus	Wire ID	Circuit Function
Y	Y	0	Common Ground (DC) DC Field Excitation Ground
Y	Y	00	Neutral Connection for T1 (battery charger)
Y	Y	2	DPE Winding (AC Excitation power)
Y	Y	4	DC (+) Field Excitation
Y	N	4A	DC (+) Field Excitation (Before Field Boost Diode)
Y	Y	6	DPE Winding (AC Excitation power)
N	Y	11	240 VAC Generator Voltage Sensing
Y	N	11S	240 VAC Generator Voltage Sensing
		13	12 VDC un-fused for the controller
Y	Y	14	12 VDC output for engine run condition. Used for fuel solenoid on all controller units and choke solenoid operation on Nexus controllers only
Y	Y	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
Y	Y	23	Switched to ground (internally) to energize the Transfer Relay
N	Y	44	240 VAC Generator Voltage Sensing
Y	N	44S	240 VAC Generator Voltage Sensing
Y	Y	56	12 VDC output to starter contactor relay/solenoid
Y	Y	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
Y	Y	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
N	Y	90	Switched to ground for choke solenoid operation
Y	Y	178	Two-wire Start Return
Y	Y	183	Two-wire Start Input

Table 4-7. Circuit Pin Description

Evolution	Nexus	Wire ID	Circuit Function
Y	Y	194	Provides 12 VDC to the transfer relay (TR1)
Y	Y	209	Common Alarm Relay Output
Y	Y	210	Common Alarm Relay Output
Y	Y	387	RS-232 Port 1 Rx
Y	Y	387A	RS-232 Port 2 Rx
Y	Y	388	RS-232 Port 1 Tx
Y	Y	388A	RS-232 Port 2 Tx
Y	Y	389	RS-232 Port 1 Gnd
Y	Y	389A	RS-232 Port 2 Gnd
Y	N	398A	Generator Current Sense A2
Y	N	398B	Generator Current Sense B2
Y	N	399A	Generator Current Sense A1
Y	N	399B	Generator Current Sense B1
Y	Y	817	Grounded by the controller to turn on System Ready (Green) LED
Y	Y	818	Grounded by the controller to turn on Alarm (Red) LED
Y	Y	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
Y	Y	820	Positive voltage (5VDC) for status LEDs
N	Y	J1	Model ID Resistor
Y	Y	N1	240 VAC Utility sensing voltage
Y	Y	N2	240 VAC Utility sensing voltage
Y	N	R1	Model ID Resistor
Y	N	R3	Model ID Resistor
Y	Y	T1	120 VAC for Battery Charger
Y	N	T2	240 VAC for Battery Charger
Y	Y	Red	Stepper Power
Y	Y	Orange	Stepper Motor B2 coil
Y	Y	Yellow	Stepper Motor B1 coil
Y	Y	Brown	Stepper Motor A2 coil
Y	Y	Black	Stepper Motor A1 coil

Menu System Navigation

To get to the menu page, press the ESCAPE 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 up and down arrow keys. When the desired menu item is flashing, press ENTER. Depending on the menu selected, a list of choices may be presented. Use the same navigation method to select the desired screen. Refer to Section 1.3 [Evolution Menu System Navigation](#) or Section 1.4 [Nexus 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 up and down arrow 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 up and down arrow 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.

EVOLUTION 1.0/SYNC 2.0 MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.

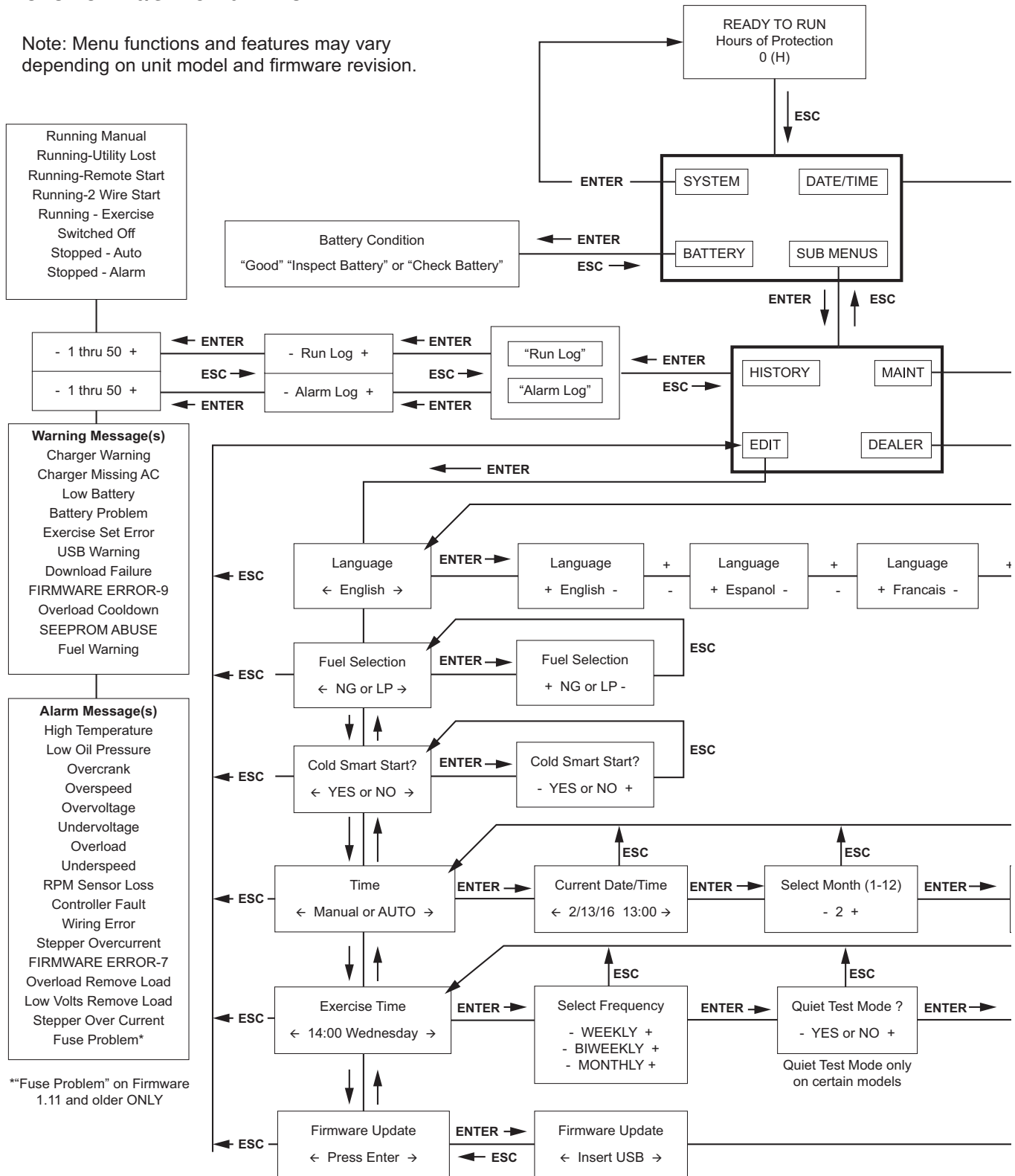
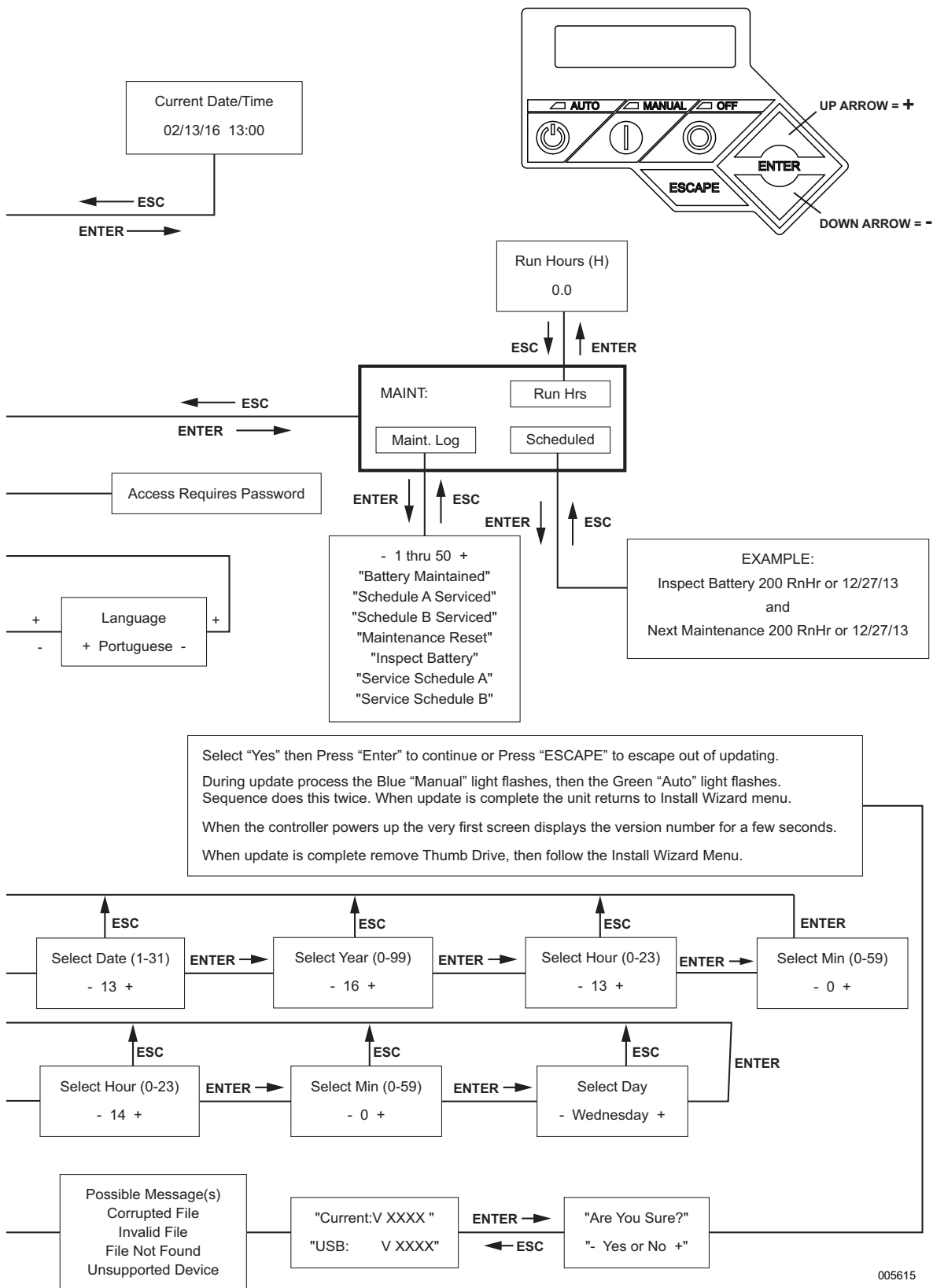
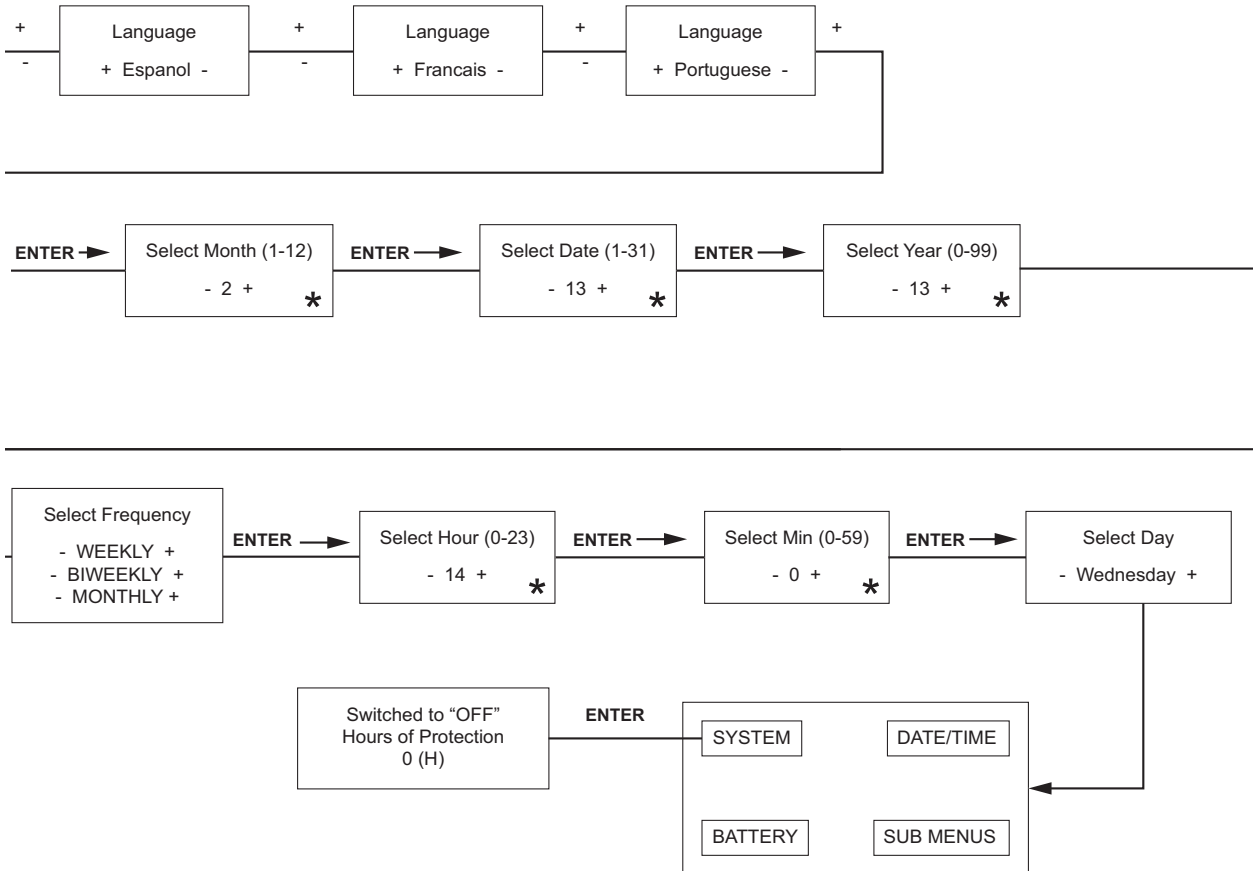
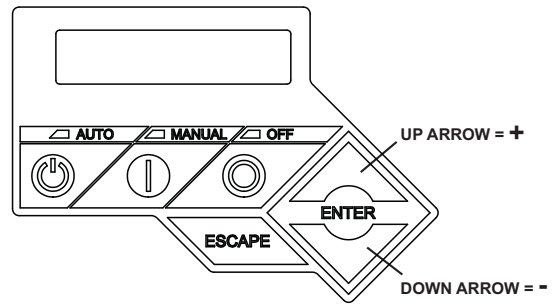


Figure 4-10. Main Menu Map



005615

Figure 4-11. Main Menu Map



000429

Figure 4-13. Activation and Install Wizard Menu Map

EVOLUTION 1.0/SYNC 2.0 HSB FIRMWARE MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.

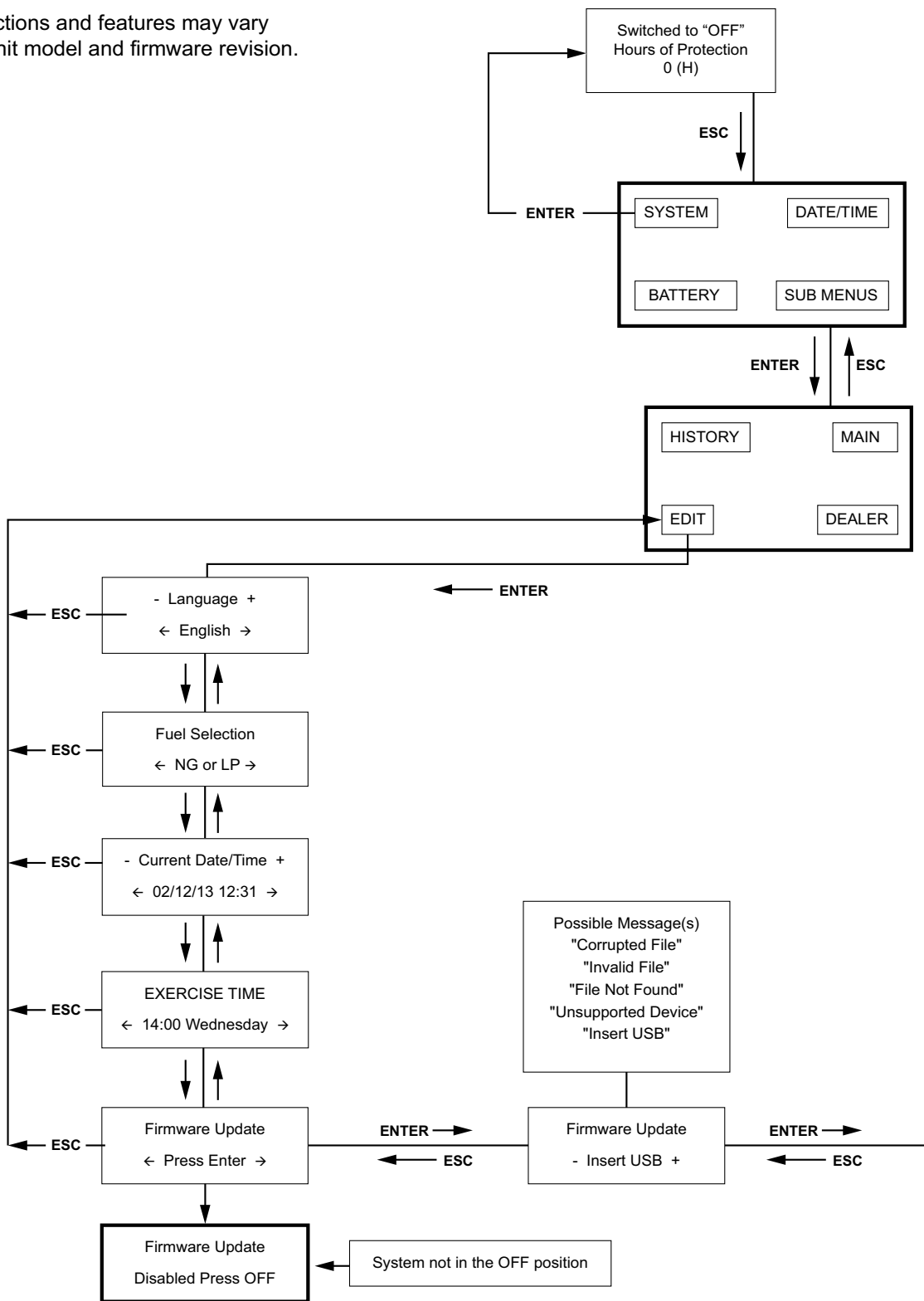
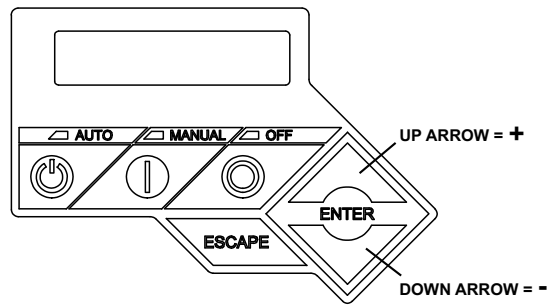
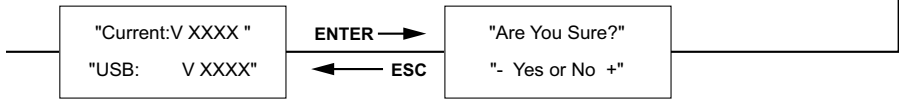


Figure 4-14. Firmware Menu Map



Alternate Firmware Update Method:
 Control unit at main screen and Insert Thumb drive with Firmware
 Power the unit down completely. Disconnect AC power.
 Repower the controller allow unit to complete the update process.
 During update process the Blue "Manual" light flashes, then the Green "Auto" light flashes. Sequence does this twice. When update is complete the unit returns to setup menu.
 When the controller powers up the very first screen displays the version number for a few seconds.
 When unit finishes update remove thumb drive then follow the Install Wizard menu.

Select "Yes" and Press "Enter" to continue or Press "ESCAPE" to escape out of updating.
 During update process the Blue "Manual" light flashes, then the Green "Auto" light flashes. Sequence does this once for firmware (single file) and twice for firmware and hardware (two files)
 When the controller powers up the very first screen displays the version number for a few seconds.
 When update is complete remove Thumb Drive, then follow the Install Wizard Menu.



000430

Figure 4-15. Firmware Menu Map

EVOLUTION 1.0/SYNC 2.0 DEALER MENU MAP

Note: Menu functions and features may vary depending on unit model and firmware revision.

MAIN DISPLAY

Switched to "OFF"
Hours of Protection
0 (H)

To access Dealer Menu enter Password from MAIN DISPLAY:
Up, Up, ESC, DN, Up, ESC, Up, ENTER

Note: Unit needs to be activated to access the Dealer Menu.

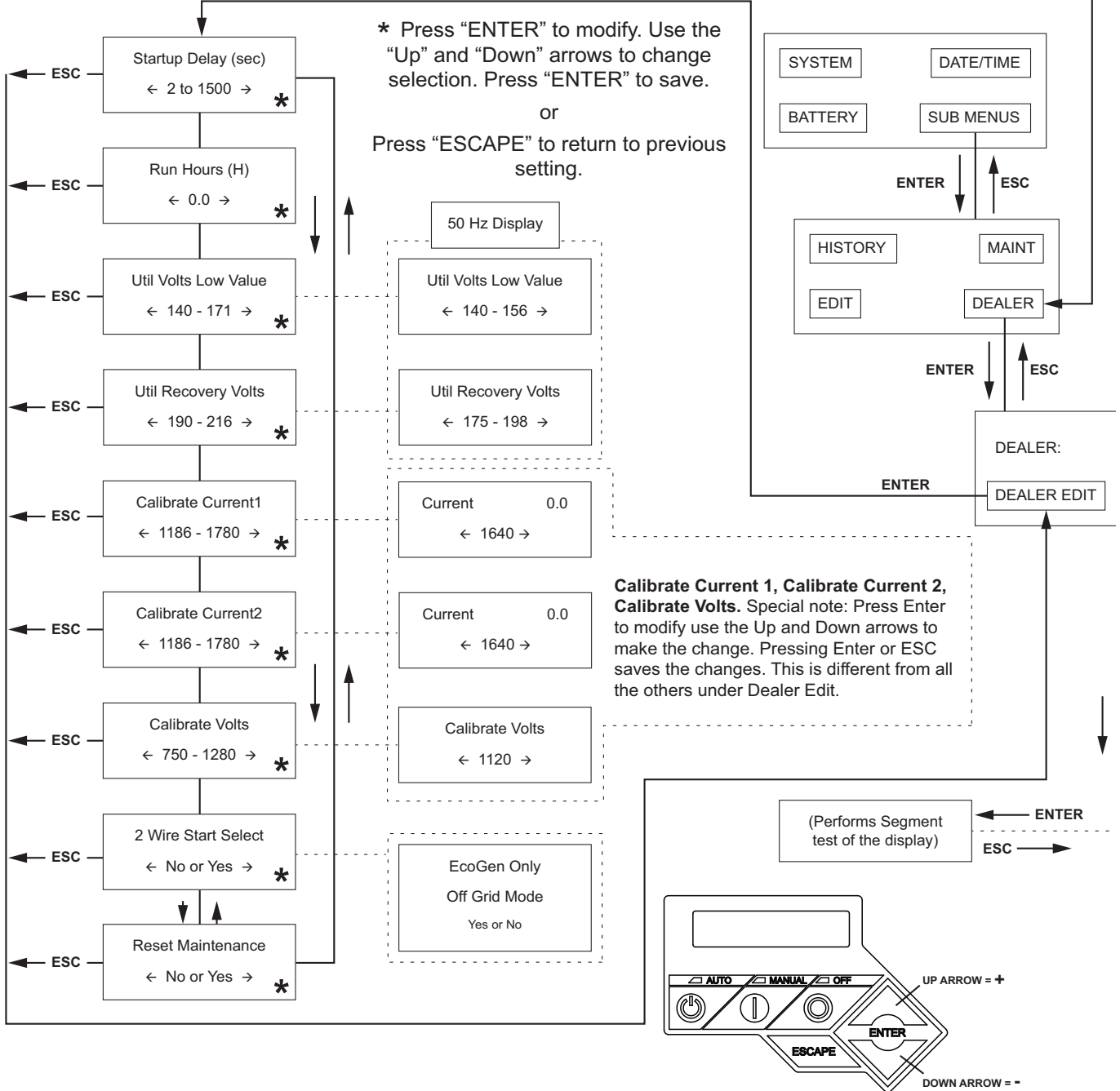
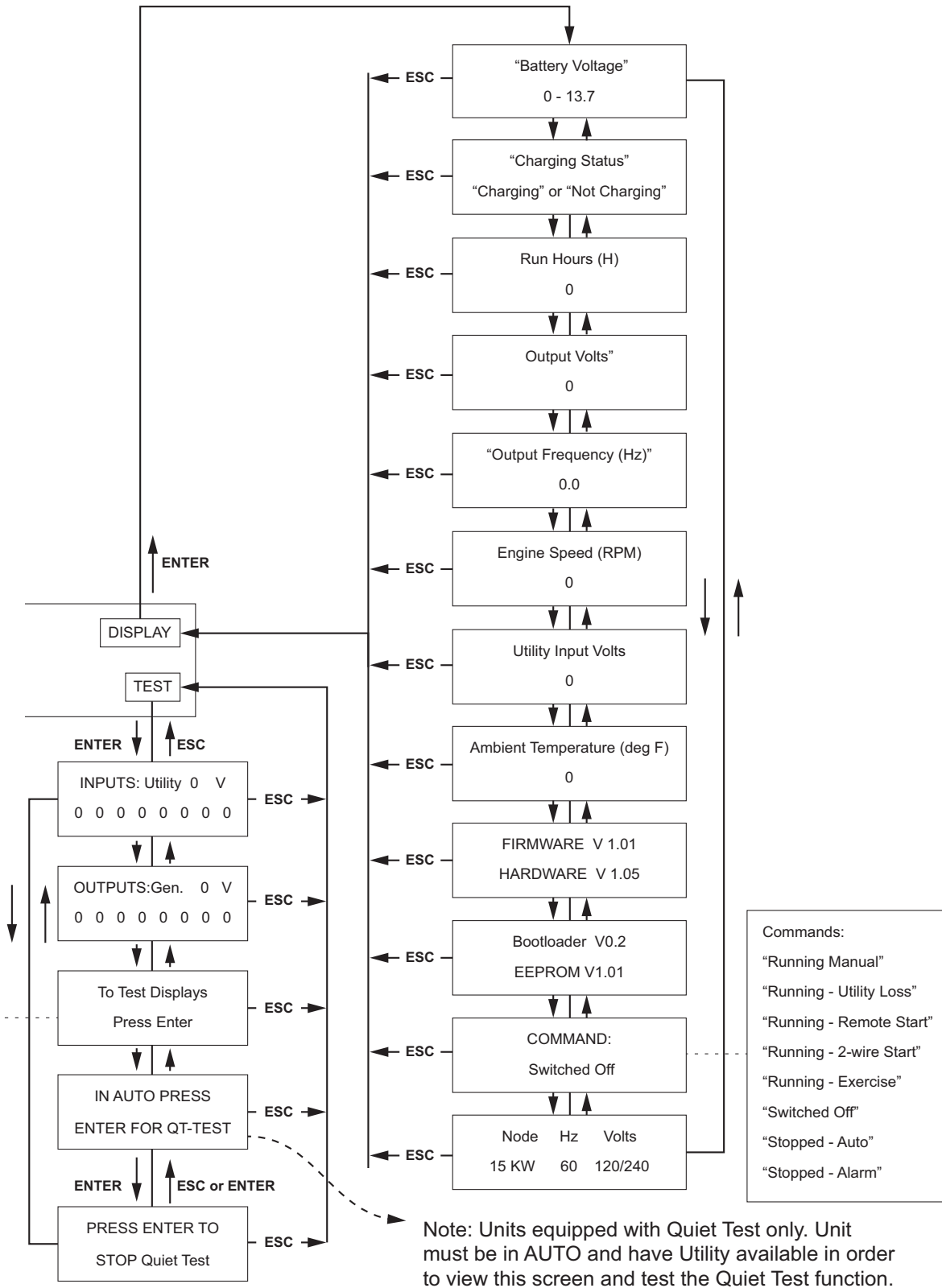
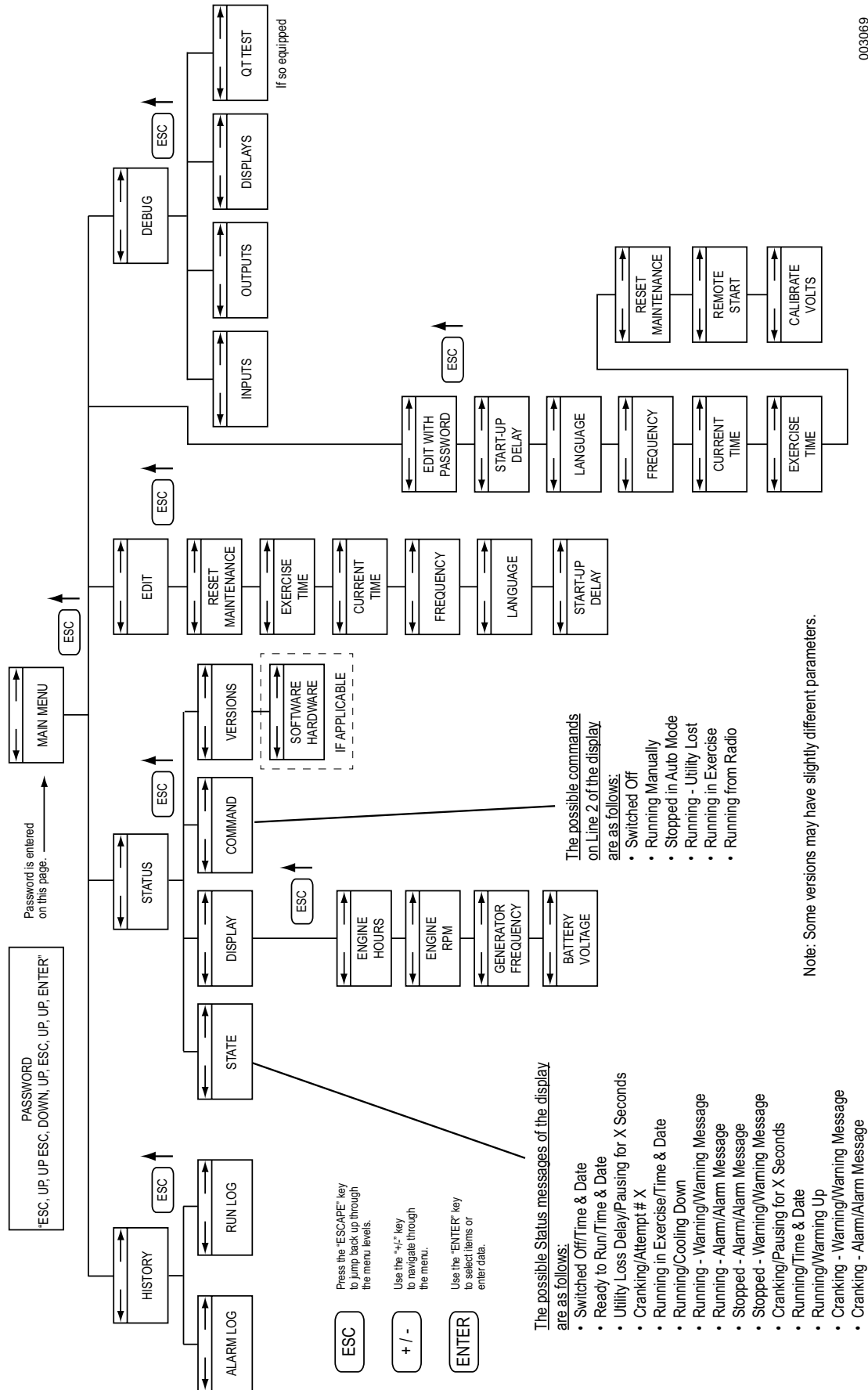


Figure 4-16. Dealer Menu Map



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Figure 4-17. Dealer Menu Map



003069

Figure 4-18. Nexus Main Menu Map

Section 4.2 Engine Protective Devices

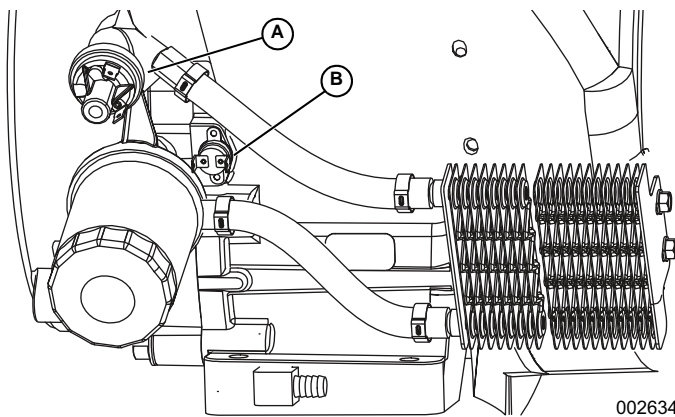
Engine Protective Devices

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. There are alarm codes programmed to display when certain conditions exist. These codes are displayed where they apply in the headings below and elsewhere in this manual.

Low Battery Warning

The controller will continually monitor the battery voltage and display a “Low Battery” message if the battery voltage falls below 12.1 VDC. After a 60 second delay, a warning will be set. The fault will remain until repaired.

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



A.Low Oil Switch B.High Temp Switch
Figure 4-19. Engine Protective Switches

Low Oil Pressure (Evolution e-Code 1300)

All Evolution 2017 and Prior Models

See [Figure 4-19](#). An oil pressure switch is mounted near the oil filter. 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 the 12 VDC run

circuit will be terminated, followed by the grounding of the ignition circuit. This will result in closure of the fuel shutoff solenoid and subsequent loss of engine ignition.

High Temperature Switch (Evolution e-Code 1400)

All Evolution 2017 and Prior Models

See [Figure 4-19](#). The contacts of this switch are normally open and will close if the temperature exceeds 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.

Overspeed

During engine cranking and operation the controller receives AC voltage and frequency signals from the ignition magneto via Wire 18. If engine speed exceeds approximately 72 Hz (4320 rpm), controller 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 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 (Evolution e-Code 1501, 1505, 1511, 1515)

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.”

If the rpm signal is lost for one full second during running, 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 and latch out on “RPM Sensor Loss.”

If an 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 due to a faulty crank circuit, a faulty starter, or a weak battery.

Overcrank (Evolution e-Code 1100)

This feature prevents the generator from damage 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. It will then stop cranking and the LCD screen will indicate an “Overcrank” condition.

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

Cyclic cranking is controlled 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 (Nexus controller only)

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

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.

NOTE: Evolution and Evolution 2.0 units do not utilize a choke mechanism.

Failure to Start

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

1. Not reaching starter dropout speed within the specified crank cycle. Starter dropout speed is defined as four (4) engine cycles at 1,500 rpm (1,800 rpm for 8 kW units).
2. Reaching starter dropout speed, 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 via the magnetos and Wire 18 into the control panel. 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, a rest and 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 controller is in the OFF mode, 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 4-8. Evolution Under-frequency Shutdown Settings

Unit Hertz	Shutdown Frequency
50 Hz	40 Hz
60 Hz	55 Hz

Clearing an Alarm

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

Table 4-9. Nexus 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

Table 4-10. Evolution Warnings and Alarm Parameters

Description	Hold-off Time	Duration Time	Continuous or 2 looks	Upper threshold	Lower threshold	Lockout Type
Low Oil Pressure	5 seconds	8 seconds	2 looks	Digital input	Digital input	Hard Lockout
RPM Sensor Loss	3 seconds 4 sec (8 kW only)	1.1 seconds	Continuous	Timed signal loss	Timed signal loss	2 Re crank, Hard Lockout
Wiring error	0 seconds	7.5% of 100 ms	100 ms sample periods	7.50%	None	Hard Lockout
High temp.	10 seconds	1 second	2 looks	Digital input	Digital input	Auto Reset
Underspeed	5 seconds	30 seconds	Continuous	None	55 Hz/3300 RPM	Hard Lockout
Underspeed 50 Hz	5 seconds	30 seconds	Continuous	None	40 Hz/2400 RPM	Hard Lockout
Overspeed Instant 50 Hz	0 seconds	.1 second	Continuous	62.5 Hz/3750 RPM	None	Hard Lockout
Overspeed Slow 50 Hz	0 seconds	3 seconds	Continuous	60Hz/3600 RPM	None	Hard Lockout
Overspeed Instant	0 seconds	.1 second	Continuous	75 Hz/4500 RPM	None	Hard Lockout
Overspeed Slow	0 seconds	3 seconds	Continuous	72 Hz/4320 RPM	None	Hard Lockout
Undervoltage Fast*	10 seconds	2 seconds	Continuous	None	15 Volts or no zero crosses detected	2 Re crank, Hard Lockout
Undervoltage Slow*	5 seconds	10 seconds	Continuous	None	80% of nominal	2 Re crank, Hard Lockout
Overvoltage fast *	5 seconds	1/5 second	Continuous	130% nominal	None	Hard Lockout
Overvoltage slow *	5 seconds	3 seconds	Continuous	110% nominal	None	Hard Lockout
Stepper Overcurrent	0 seconds	Instant	Continuous	NA	NA	Hard Lockout
Fuse Problem	0 seconds	75% of 100ms	Continuous	NA	NA	Hard Lockout
Overload Alarm	0 seconds	20 seconds	Continuous	102% rated current	NA	Hard Lockout
Overload Undervoltage	5 seconds	10 seconds	Continuous	NA	80% of nominal after Overload Alarm	Hard Lockout
Low Battery	60 seconds	As long as battery is <12.1 VDC	Continuous	NA	12.1 V or less	Warning
Battery Problem	0 seconds	NA	Continuous	> 16V immediate OR > 600mA for 5 sec after 18hr charge cycle		Warning
Charger Warning	0 seconds	NA	Continuous	NA	12.5 V at end of charge cycle	Warning
Charger Missing AC	15 seconds	As long as AC is missing	Continuous except cranking	NA	NA	Warning
Overcrank	0 seconds	5 attempts	NA	NA	NA	Hard Lockout

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Section 4.3 Operational Analysis – Evolution

Introduction

The “Operational Analysis” is intended to familiarize the service technician with the operation of the DC and AC control system. A thorough understanding of how the system works is essential to sound and logical troubleshooting.

Utility Source Voltage Available

The circuit condition with the controller set to AUTO 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.
- Load voltage (120 VAC) is available to the controller via Wire T1 for Battery Charger. (220 VAC on T1 and T2 50 Hz only)
- The controller is shown in the AUTO mode. Battery voltage is available to the circuit board via Wire 13, the 7.5 amp fuse (F1). Wire 194 provides 12 VDC to the transfer relay in the transfer switch.
- Wire 820 supplies 5 VDC to the Tri-Light Annunciator and Wire 817 for the Green System Ready LED is gated to ground.

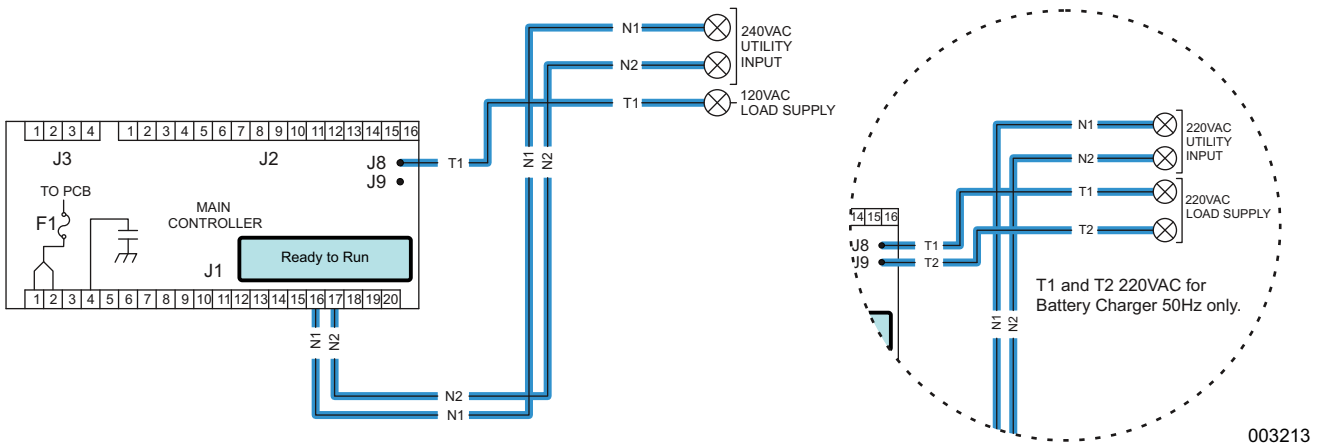


Figure 4-20.

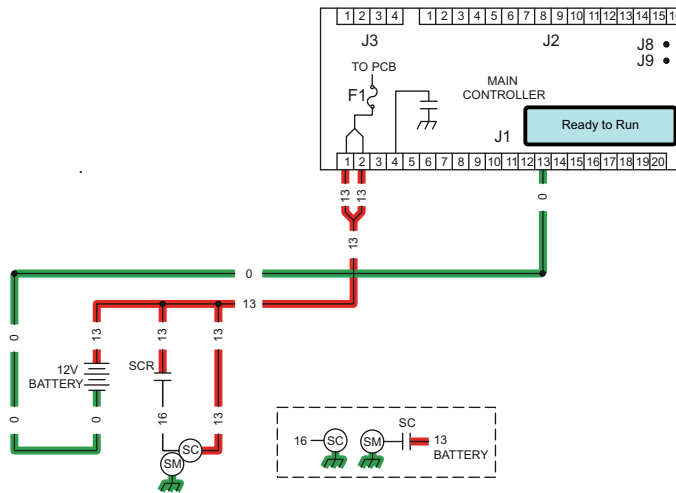
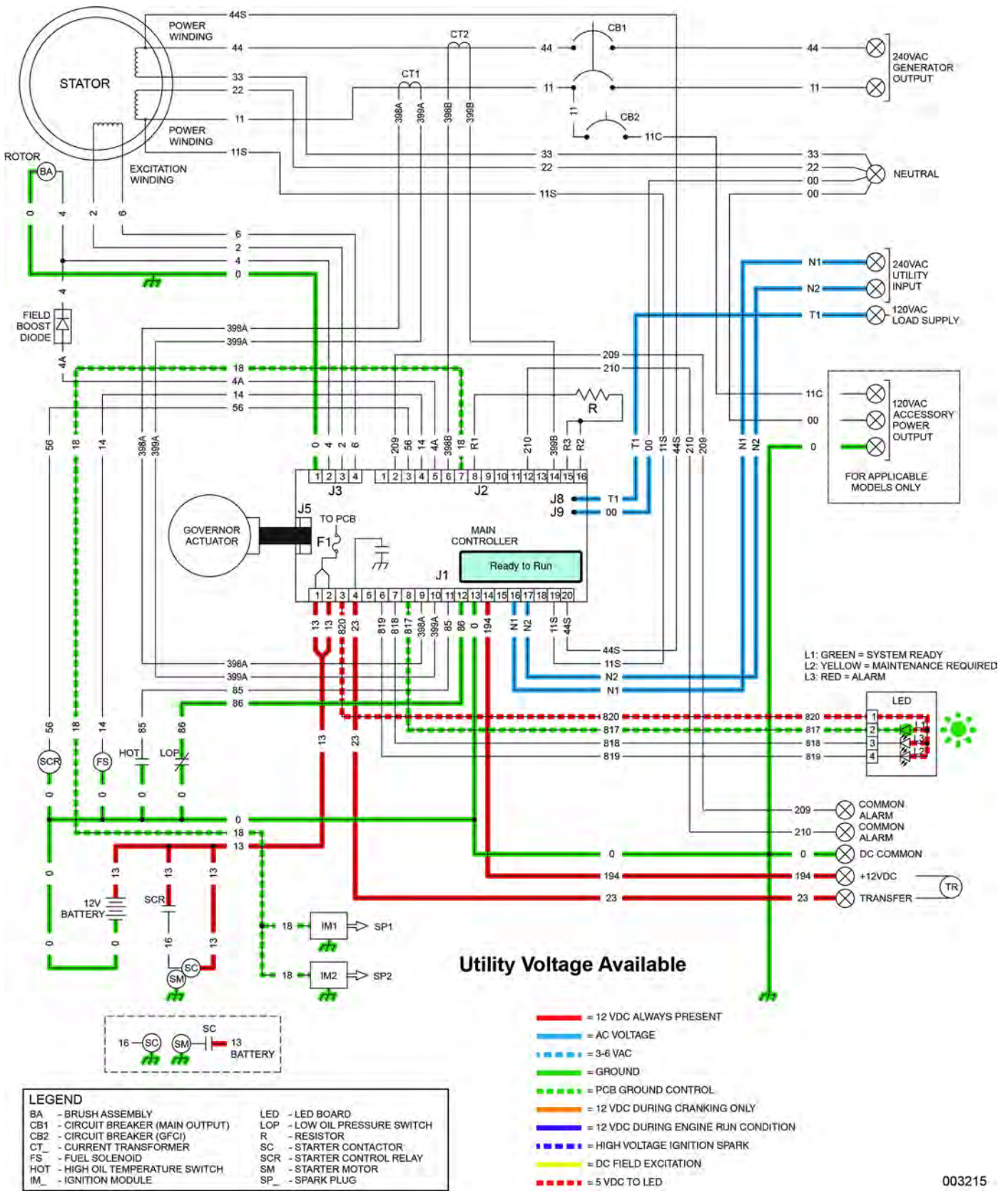


Figure 4-21.



003215

Figure 4-22. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See **Figure 4-24**. 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% (adjustable, see chart) of the nominal source voltage, a programmable timer on the controller will turn on.
- The 5-second timer (factory default, but adjustable from 2-1500 seconds) is still timing and engine cranking has not yet begun.

Utility Dropout	
Factory Default	Adjustable Dropout Voltage
60 Hz = 156 VAC	60 Hz = 140-171 VAC
50 Hz = 142 VAC	50 Hz = 140-156 VAC

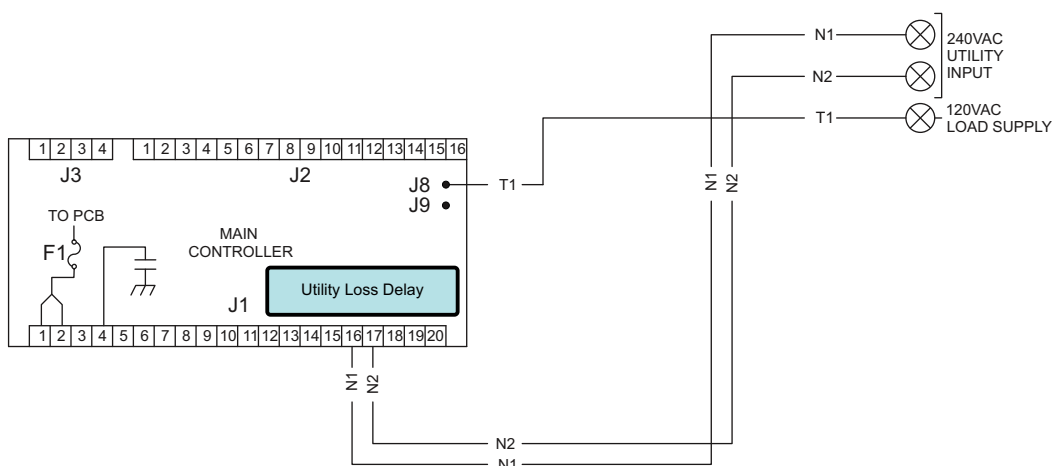


Figure 4-23.

003222

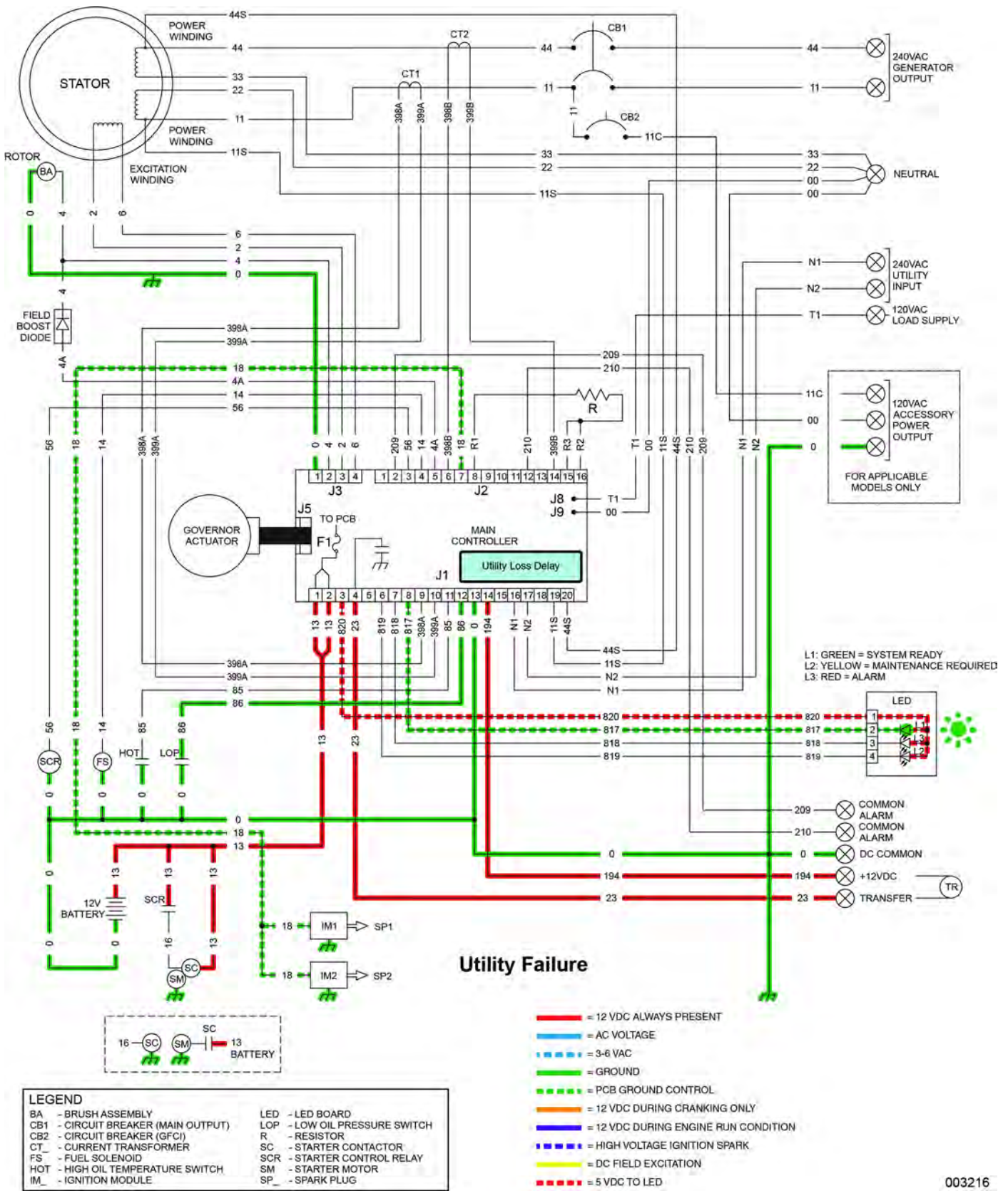


Figure 4-24. Initial Dropout of Utility Source Voltage

003216

Utility Voltage Failure and Engine Cranking

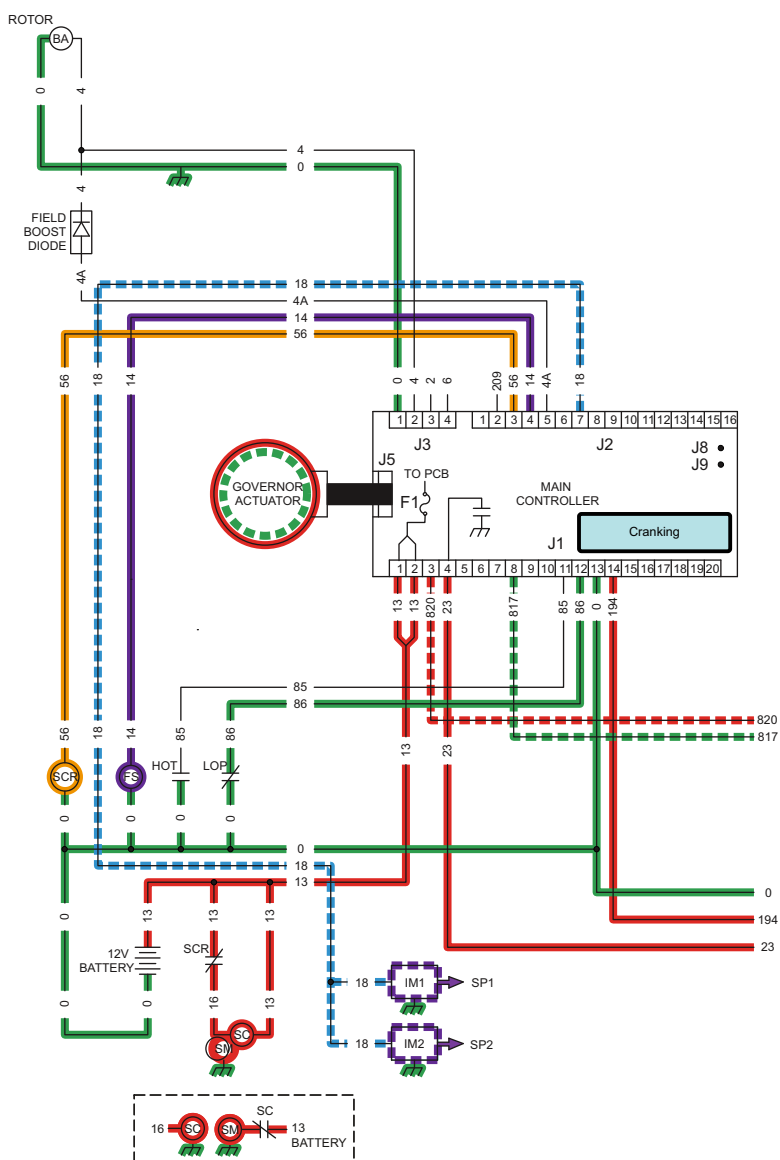
- After the controller's adjustable programmed timer has timed out, if Utility voltage is still below the programmed utility drop out level, the controller's logic will energize the internal crank relay followed by the internal run relay.
- When the internal crank relay energizes, 12 VDC is delivered 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.
- A 12 VDC power supply is delivered to the stepper motor via the Red Wire and the other wires are gated to ground by the controller to open the throttle position.

NOTE: The stepper motor will cycle the mixer to a full open throttle position (which opens both venturis), back to a closed position and then to the starting position, which partially opens the small venturi.

- With the engine cranking, a pulsing AC speed reference signal is generated by the magneto(s) 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 12 VDC on Wire 14. The fuel solenoid energizes (mechanically opens) and fuel is available to the engine.

NOTE: If the controller does not see a RPM signal, it will not energize Wire 14/Fuel Solenoid.

- With ignition and fuel flow available the engine RPM will begin to increase.



003223

Figure 4-25.

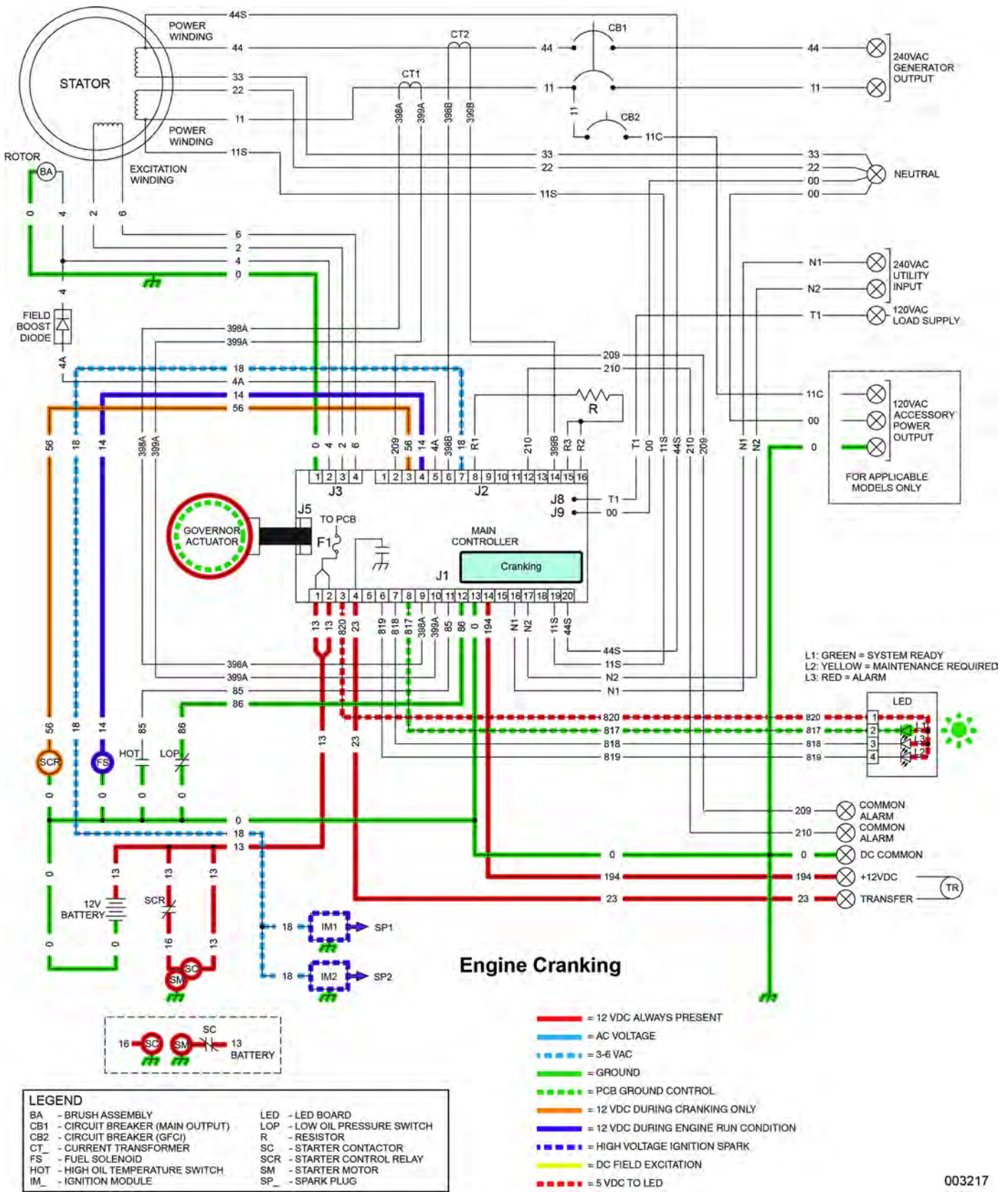


Figure 4-26. Utility Voltage Failure and Engine Cranking

003217

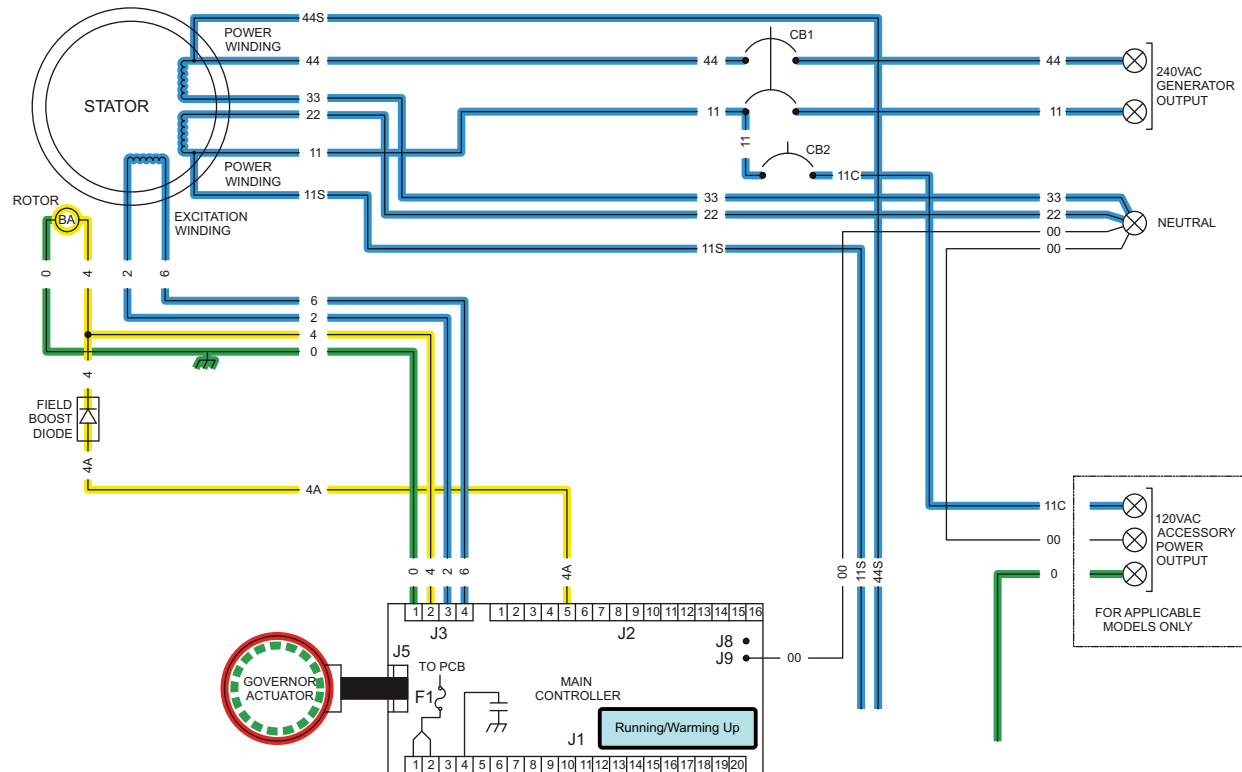
Engine Startup and Running

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

- The ignition magneto(s) 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 by de-energizing Wire 56 at approximately 1500 RPM (V-twin) and 1800 RPM (single cylinder).
 - b. energizes a field flash relay in the controller at 2200 RPM which delivers 12 VDC on Wire 4A through a field boost diode and to the rotor via Wire 4. The field boost will continue for a pre-determined time, or until field boost parameters are achieved, whichever occurs first.

NOTE: See “Field Boost” in Section 2.2 for analysis of Evolution field boost parameters.

- c. also at 2200 RPM the hold off timers activate and the 5 second “warm-up timer” goes active.
- 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 the next series, 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.



003224

Figure 4-27.

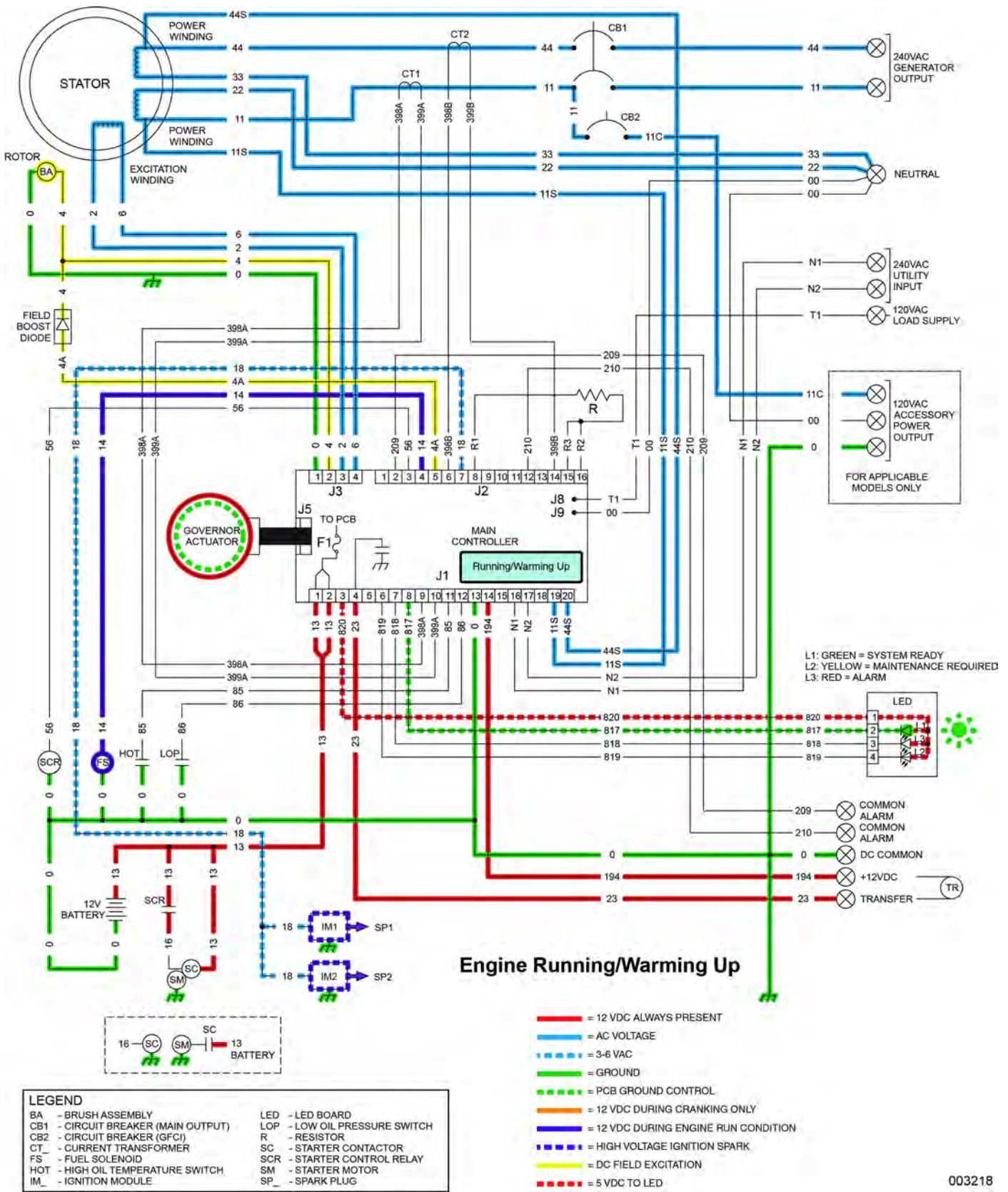


Figure 4-28. Engine Startup and Running

003218

Transfer to Standby

In **Figure 4-30** the Generator is running, the controller's "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).
- While running, the pulsing AC speed reference from the ignition magneto(s) to the controller via Wire 18 will be used for the following functions:
 - a. governor speed control to maintain frequency through different loads
 - b. overspeed
 - c. underspeed
- With no, or a light load, the stepper motor will control the throttle position of the smaller venturi. As the load demand increases and with the smaller venturi nearly wide open, it will start to open the larger venturi as needed for load/fuel demand.
- With loads applied, CT1 - Wires 398A/399A and CT2 - Wires 398B/399B deliver approximately 0- 1.5 VAC based on percentage of Amps (load).


Approximate Values (when back-probed at connector):

25 Amps = 0.380 mVAC

50 Amps = 0.755 mVAC

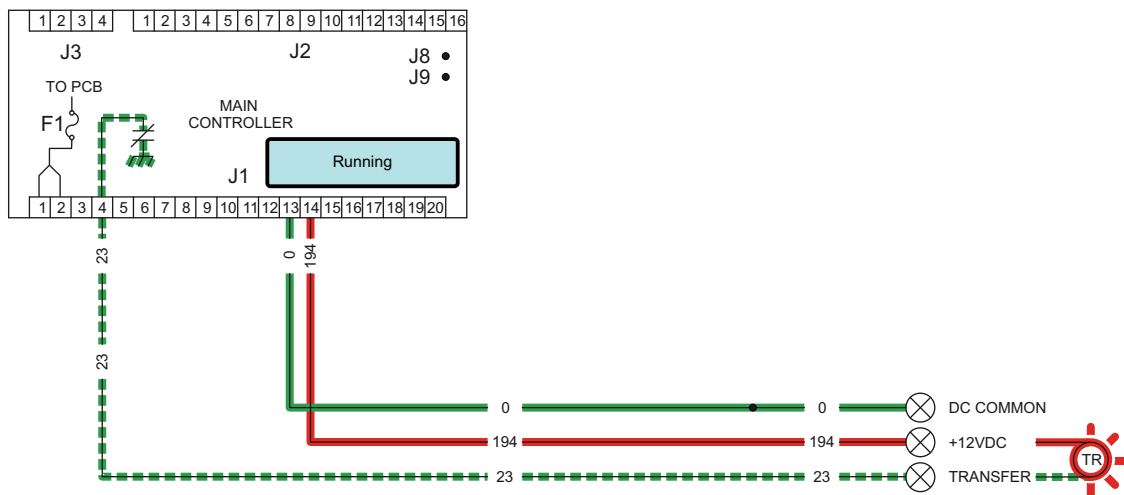
75 Amps = 1.133 VAC

100 Amps = 1.510 VAC



DANGER

Electrocution. Lethal voltage may be present at current transformers (CTs). Do not touch CTs while primary current is applied. Doing so will result in death or serious injury. (000310)



003225

Figure 4-29.

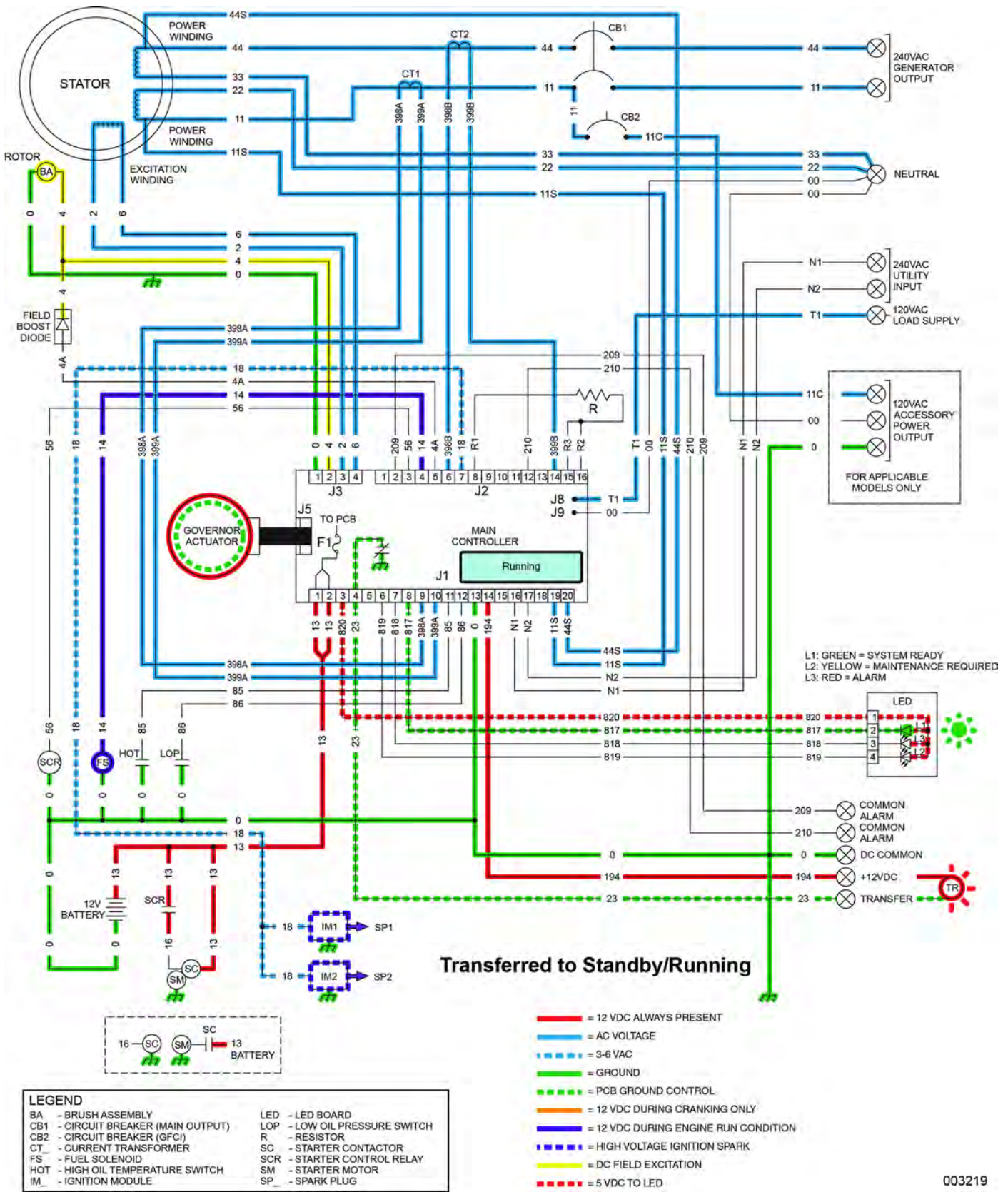


Figure 4-30. Transfer to Standby

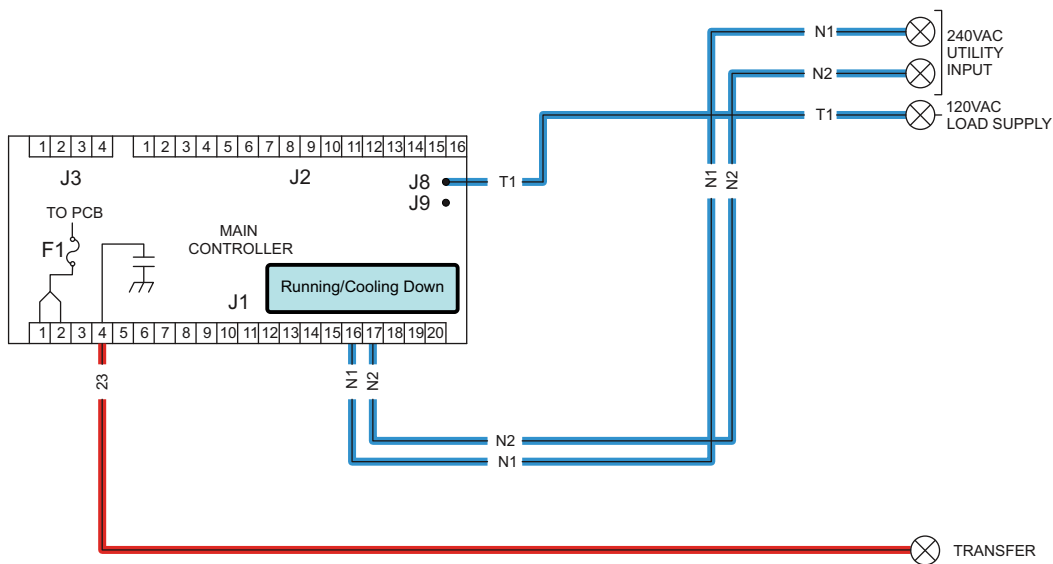
Utility Voltage Restored and Re-transfer to Utility

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

- On restoration of Utility voltage above 75% (programmable, see chart for range) 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.
- The generator continues to run in its cooling down mode.

NOTE: If utility fails during the cool-down timer cycle for 5 seconds, the controller will transfer back to standby.

Utility Pickup	
Factory Default	Adjustable Pickup Voltage
60 Hz = 190 VAC	60 Hz = 190-216 VAC
50 Hz = 175 VAC	50 Hz = 175-198 VAC



003226

Figure 4-31.

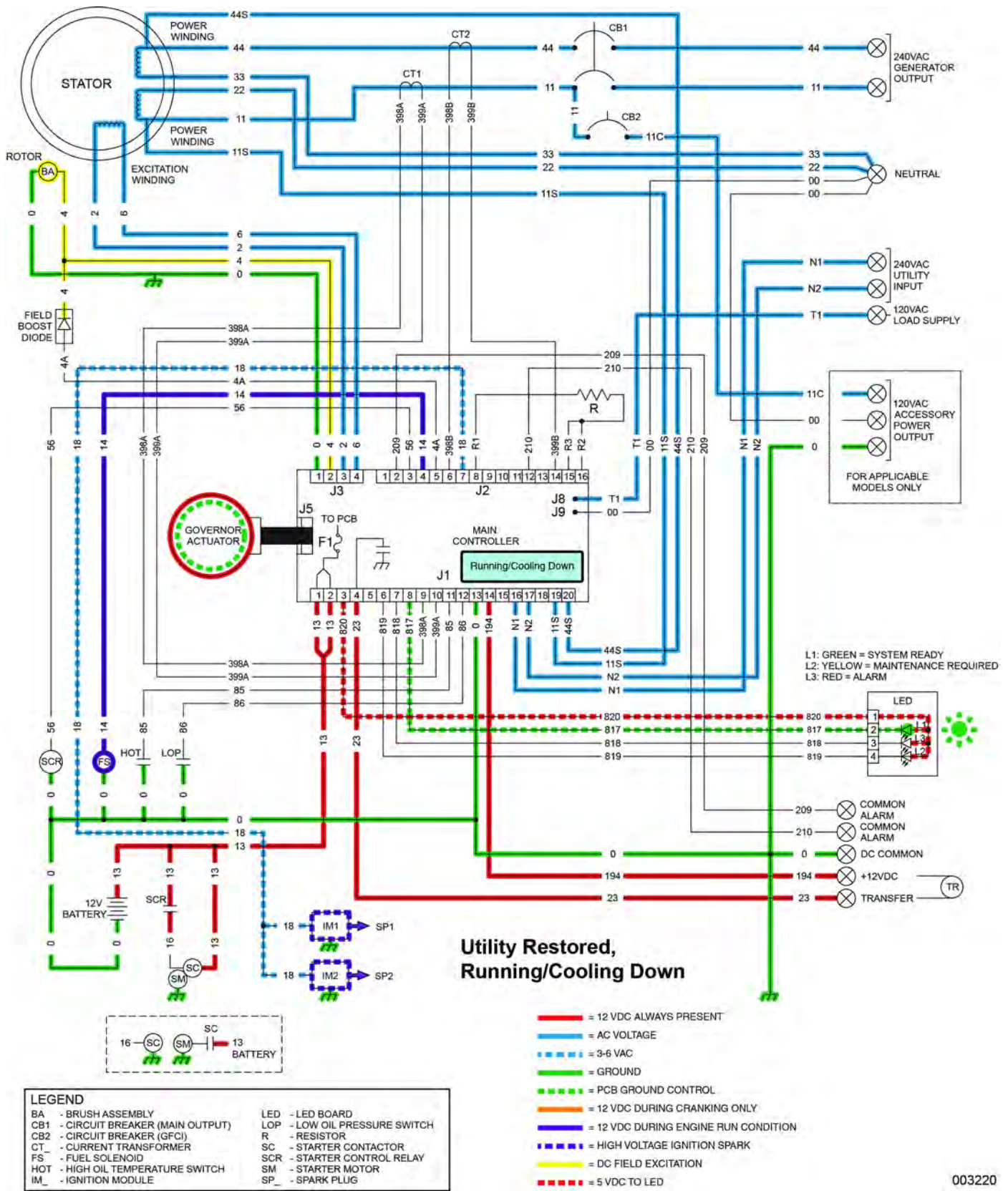


Figure 4-32. Utility Voltage Restored and Re-transfer to Utility

003220

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:

- Wire 14 (run circuit) will de-energize and the fuel solenoid will 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.

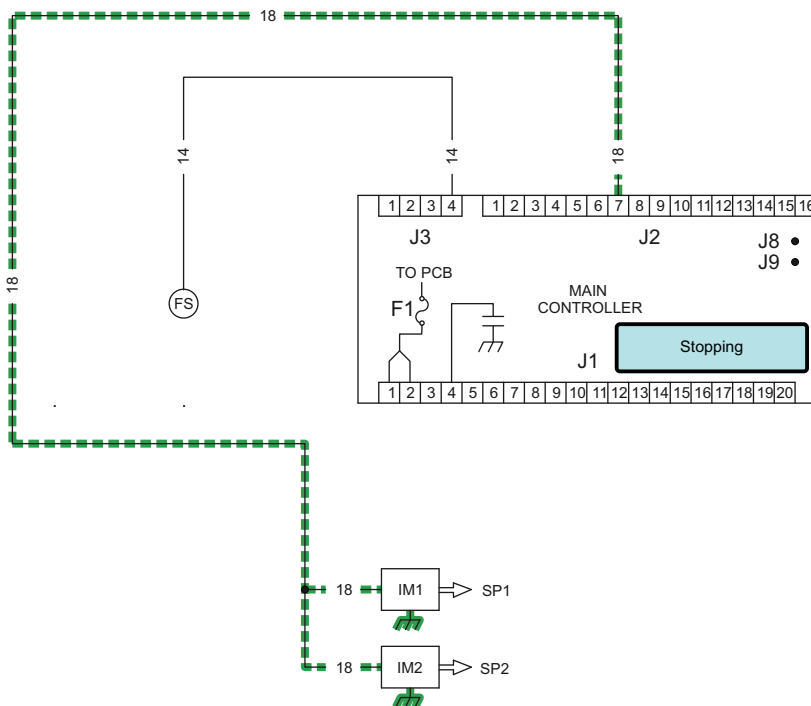


Figure 4-33.

003227

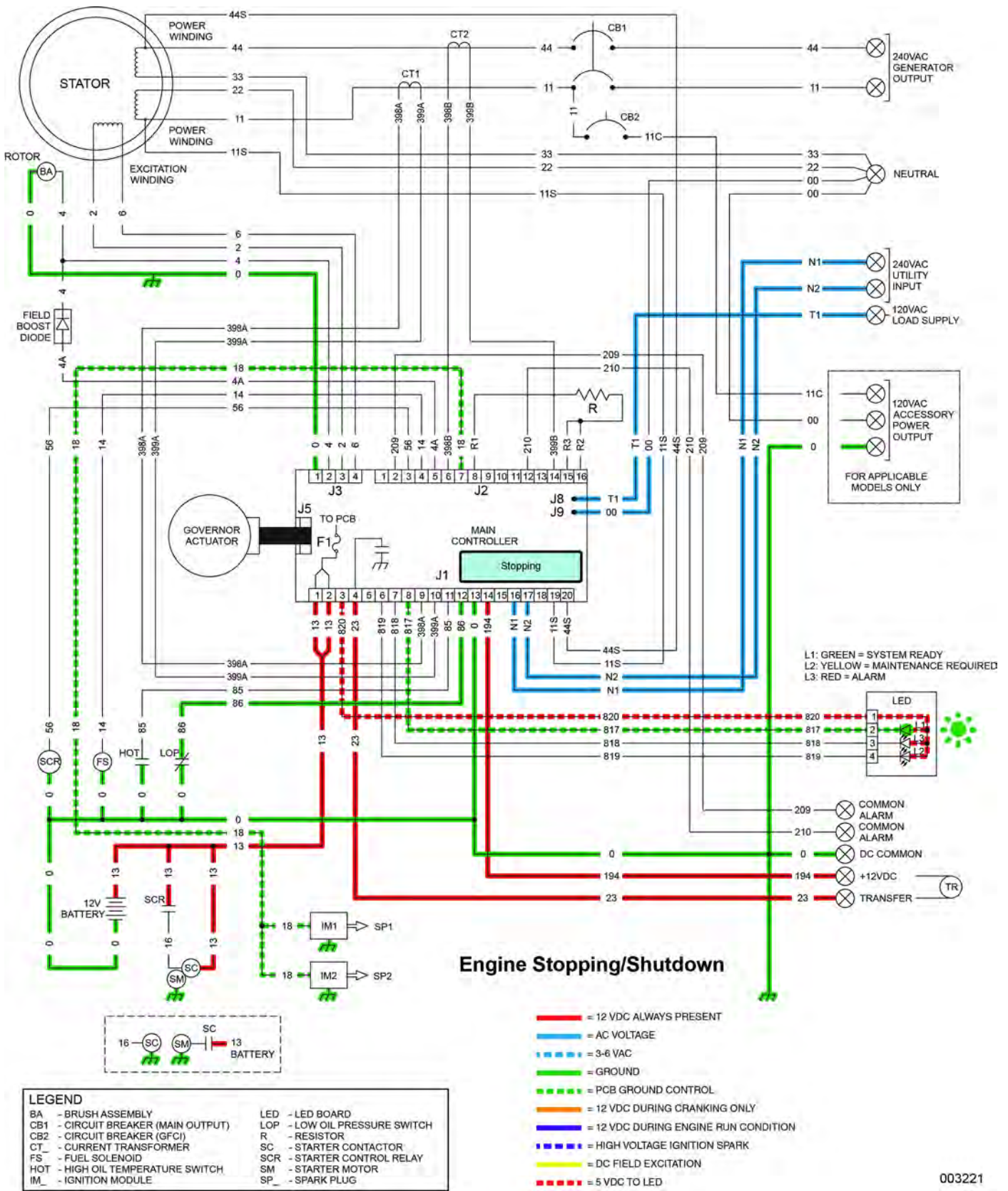


Figure 4-34. Engine Shutdown

003221

Section 4.4 Operational Analysis – Nexus

Introduction

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

Utility Source Voltage Available

The circuit condition with the controller set to the AUTO mode 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.
- Battery voltage is available to the controller via Wire 13 when a Battery is installed.

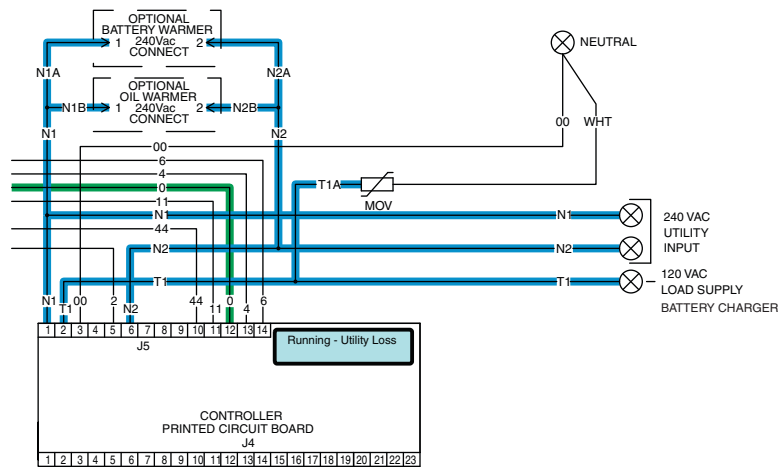


Figure 4-35.

003243

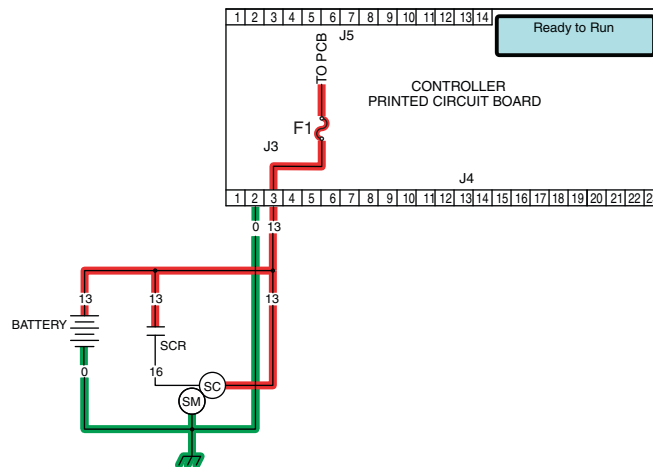
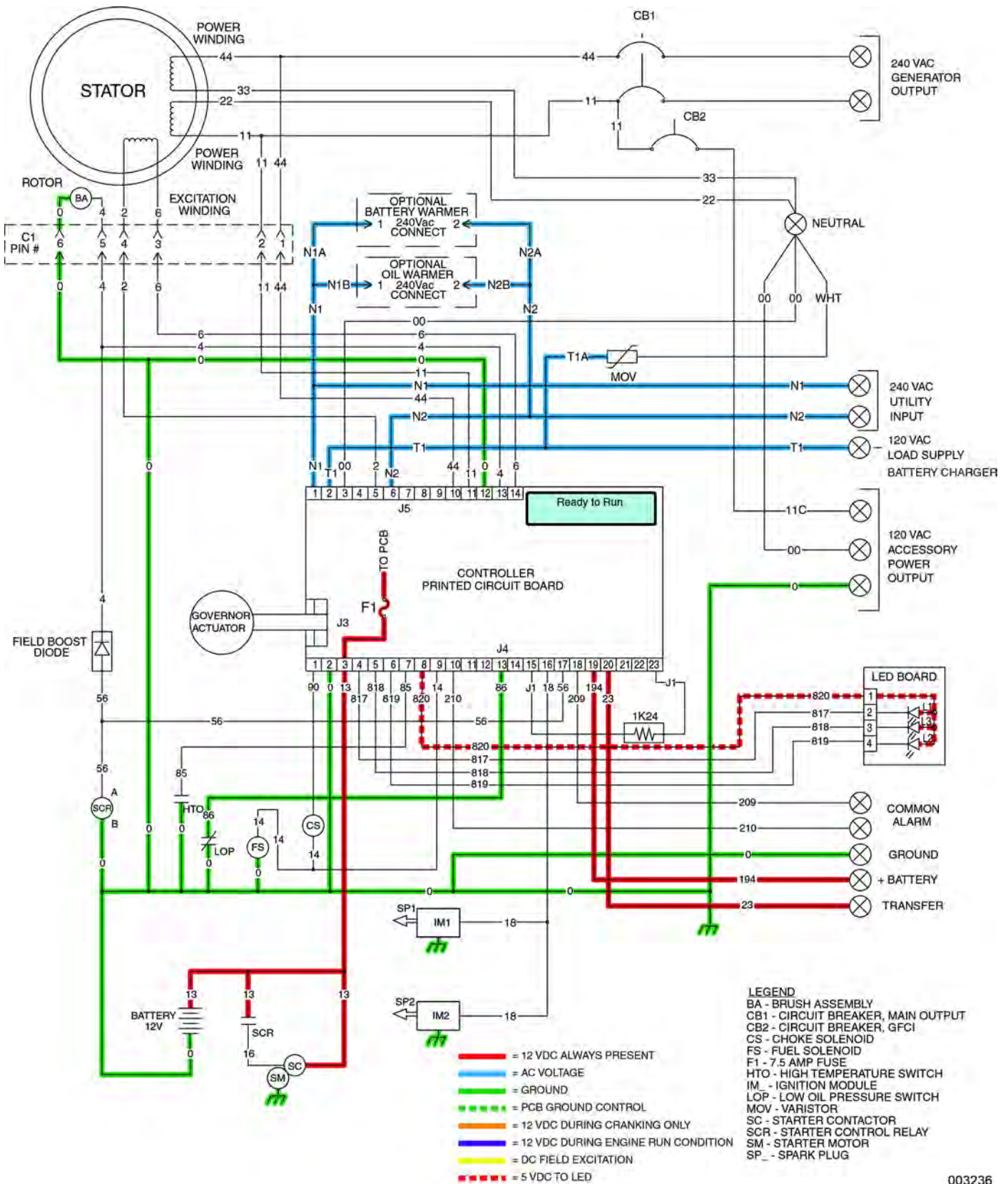


Figure 4-36.

003244



003236

Figure 4-37. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See **Figure 4-39**. 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 4-38**, the 10-second timer is still timing and engine cranking has not yet begun.
- The controller is shown in the AUTO mode. Battery voltage is available to the circuit board via Wire 13, the 7.5 amp fuse (F1). Wire 194 provides 12 VDC to the transfer relay in the transfer switch.

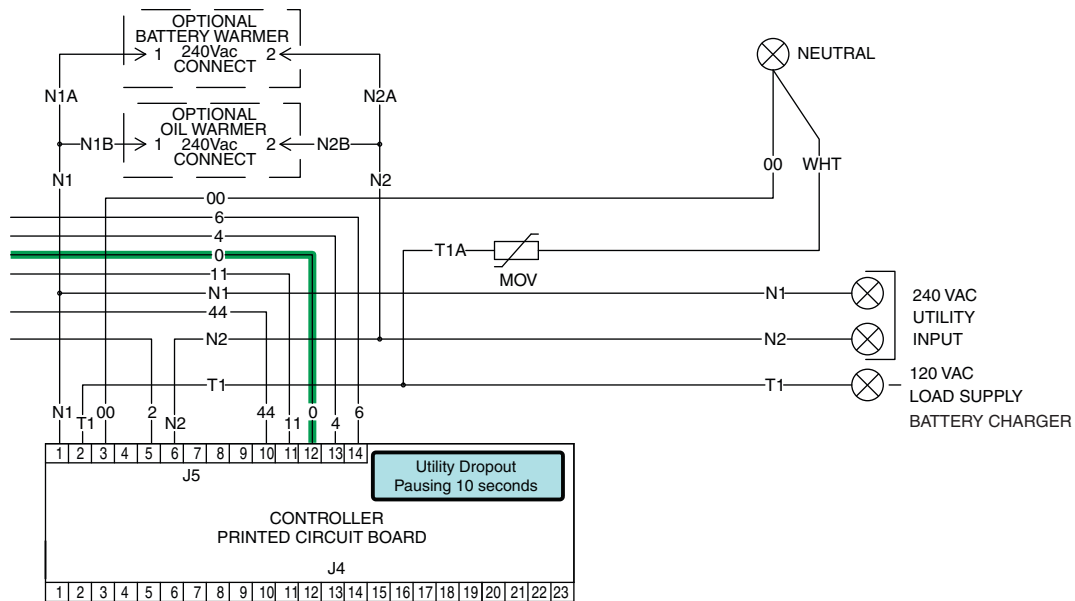
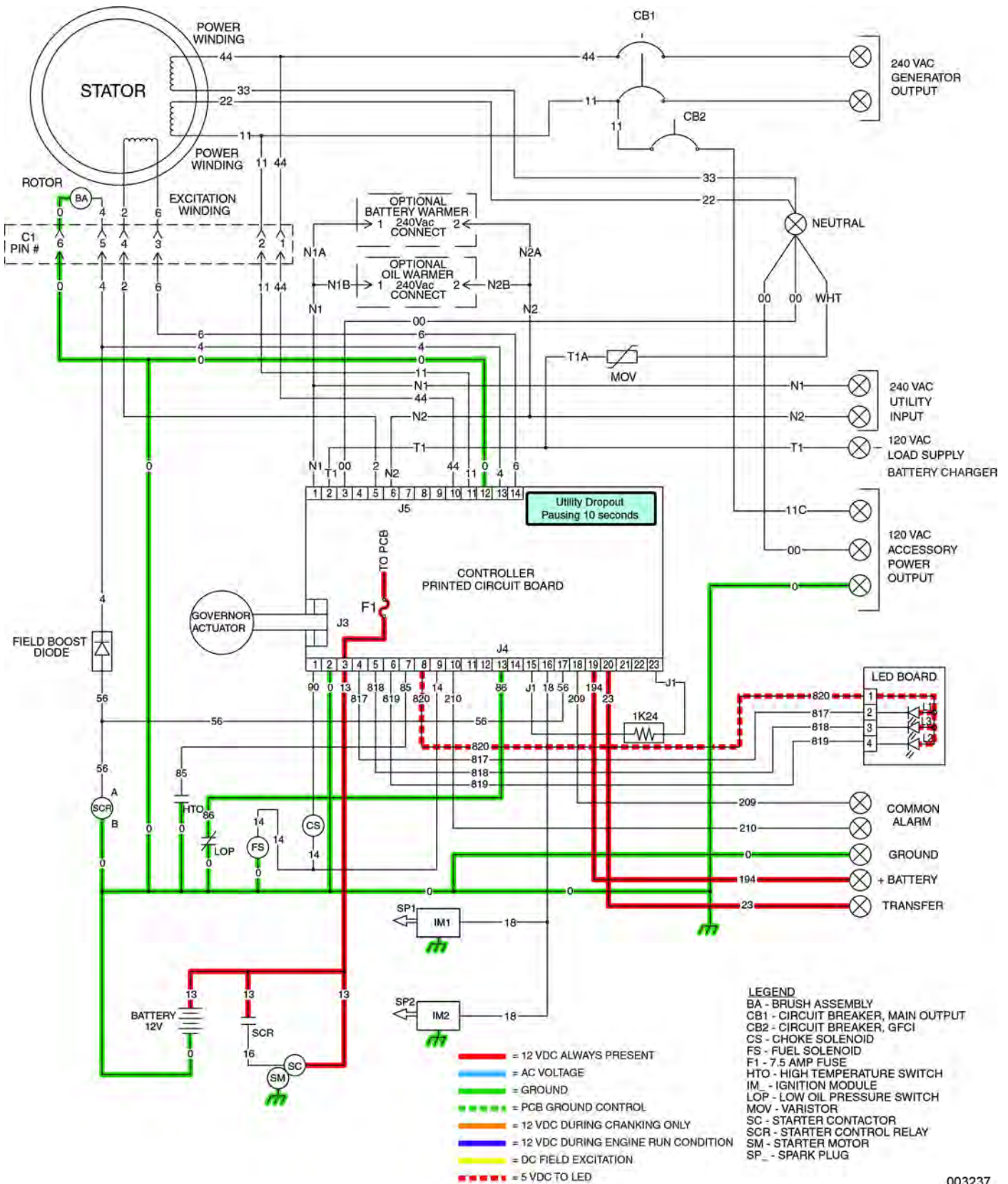


Figure 4-38.

003246



003237

Figure 4-39. 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, controller 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 12 VDC on Wire 14. The fuel solenoid energizes (opens) and fuel is available to the engine. The choke solenoid (CS) (Nexus Only) begins to operate and the controller grounds Wire 90, energizing the choke solenoid cyclically during cranking, and continuously while running.
- During Cranking 3-5 VDC 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.

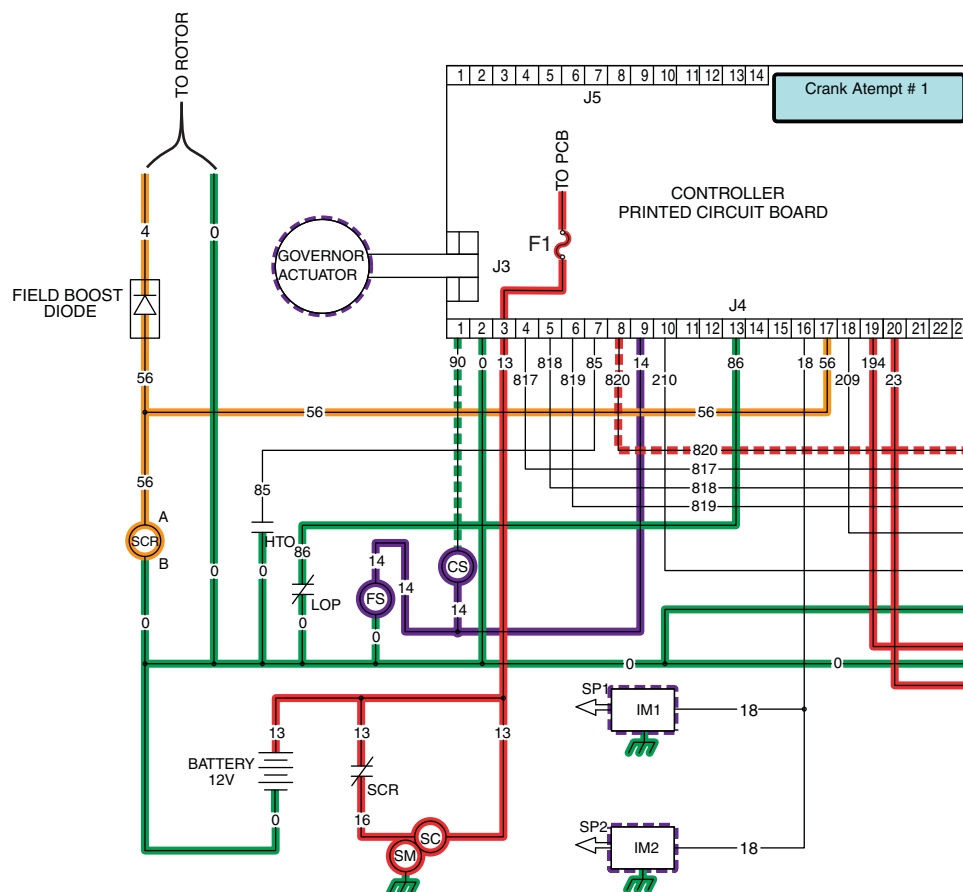
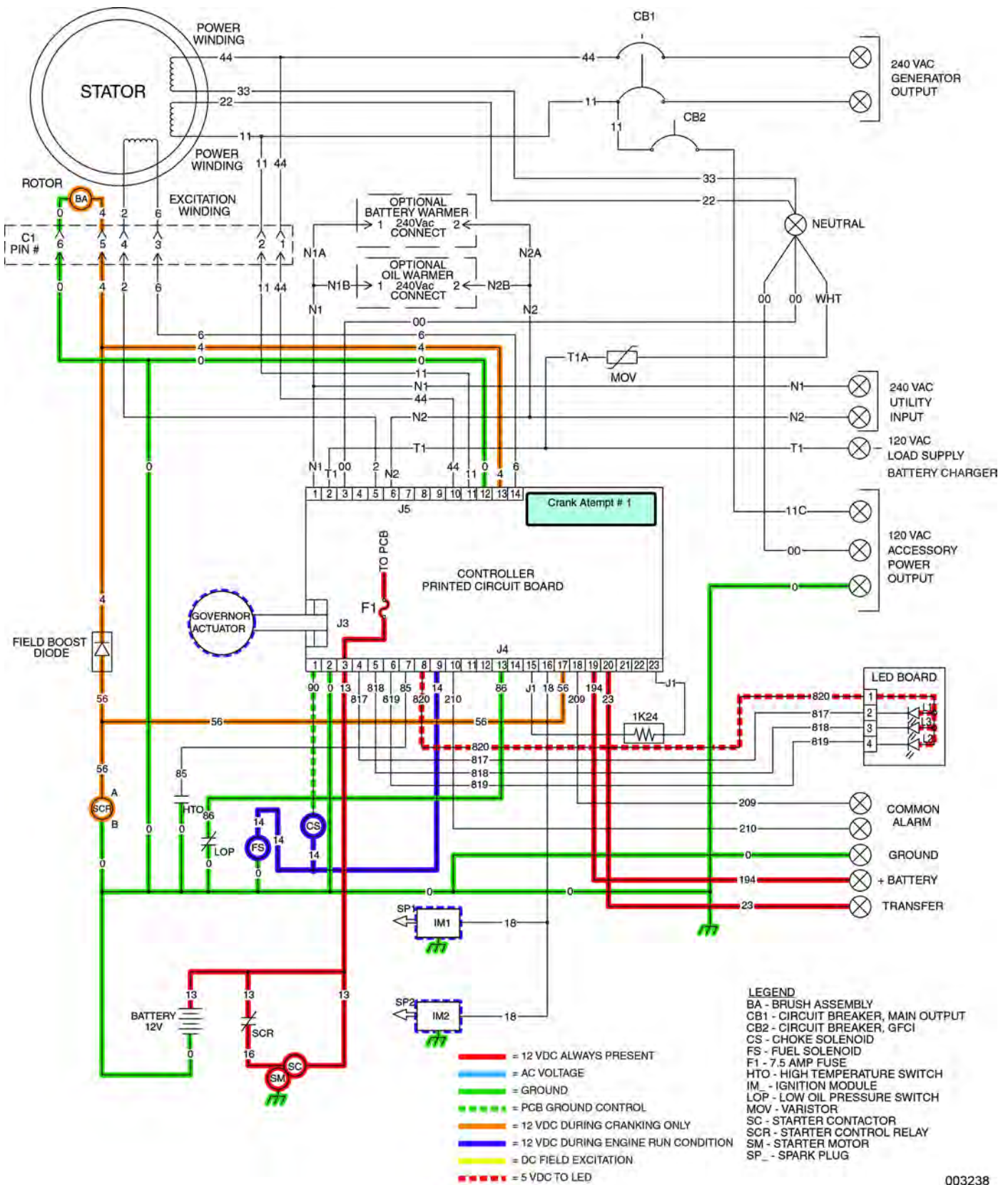


Figure 4-40.

003247



003238

Figure 4-41. 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 8 kW and 10 kW 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 4-43](#), 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.

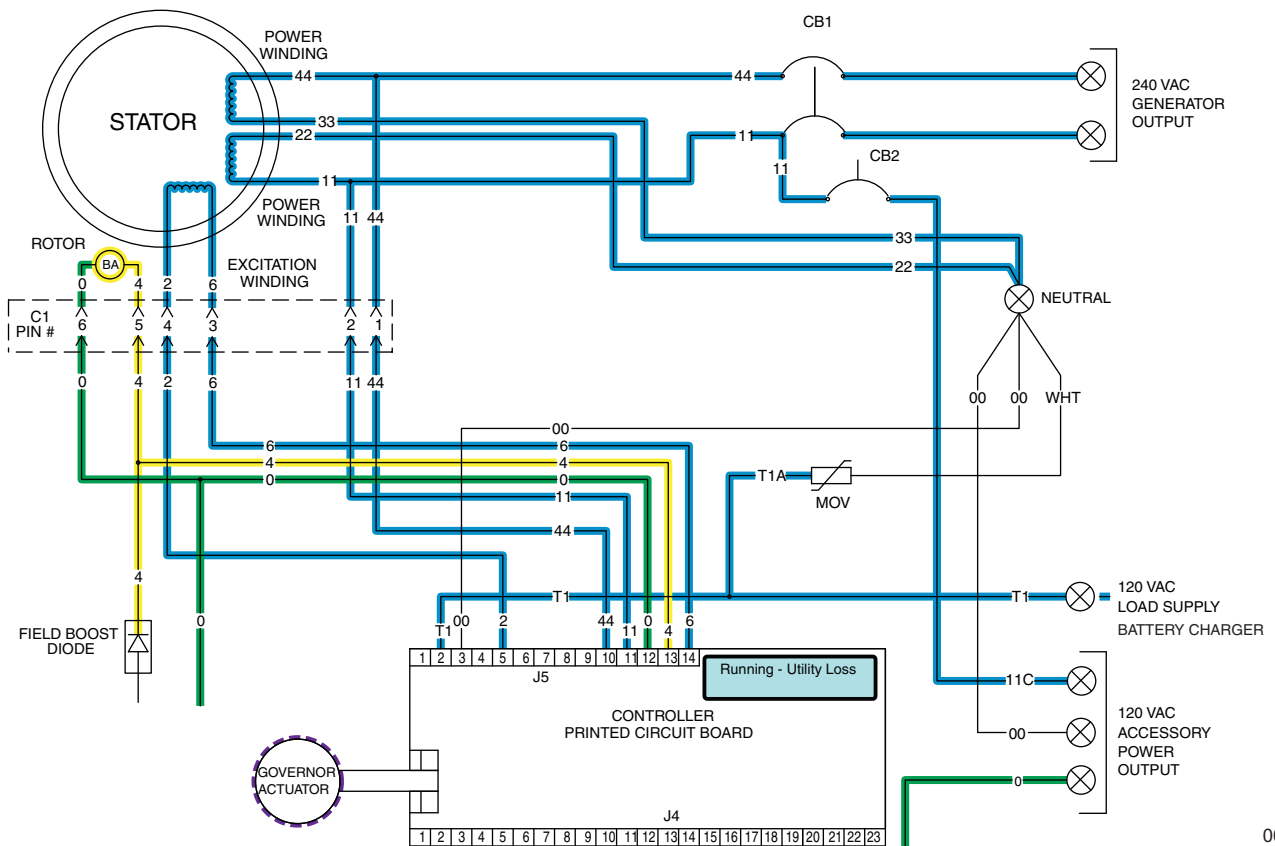
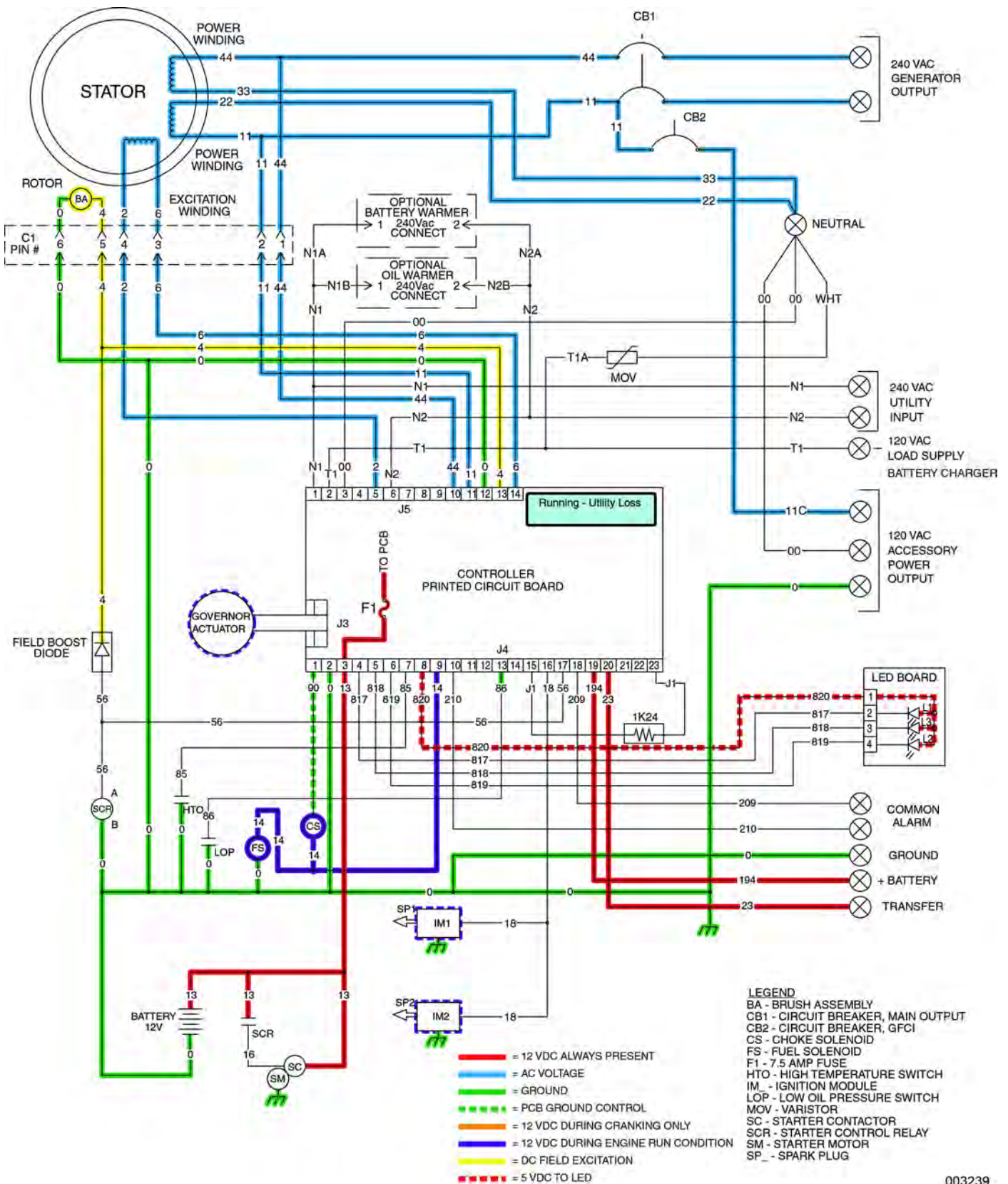


Figure 4-42.

003248



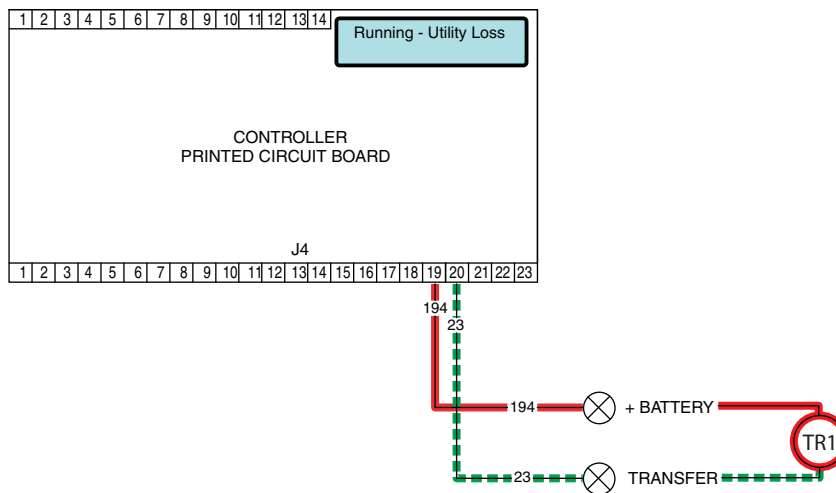
003239

Figure 4-43. Engine Startup and Running

Transfer to Standby

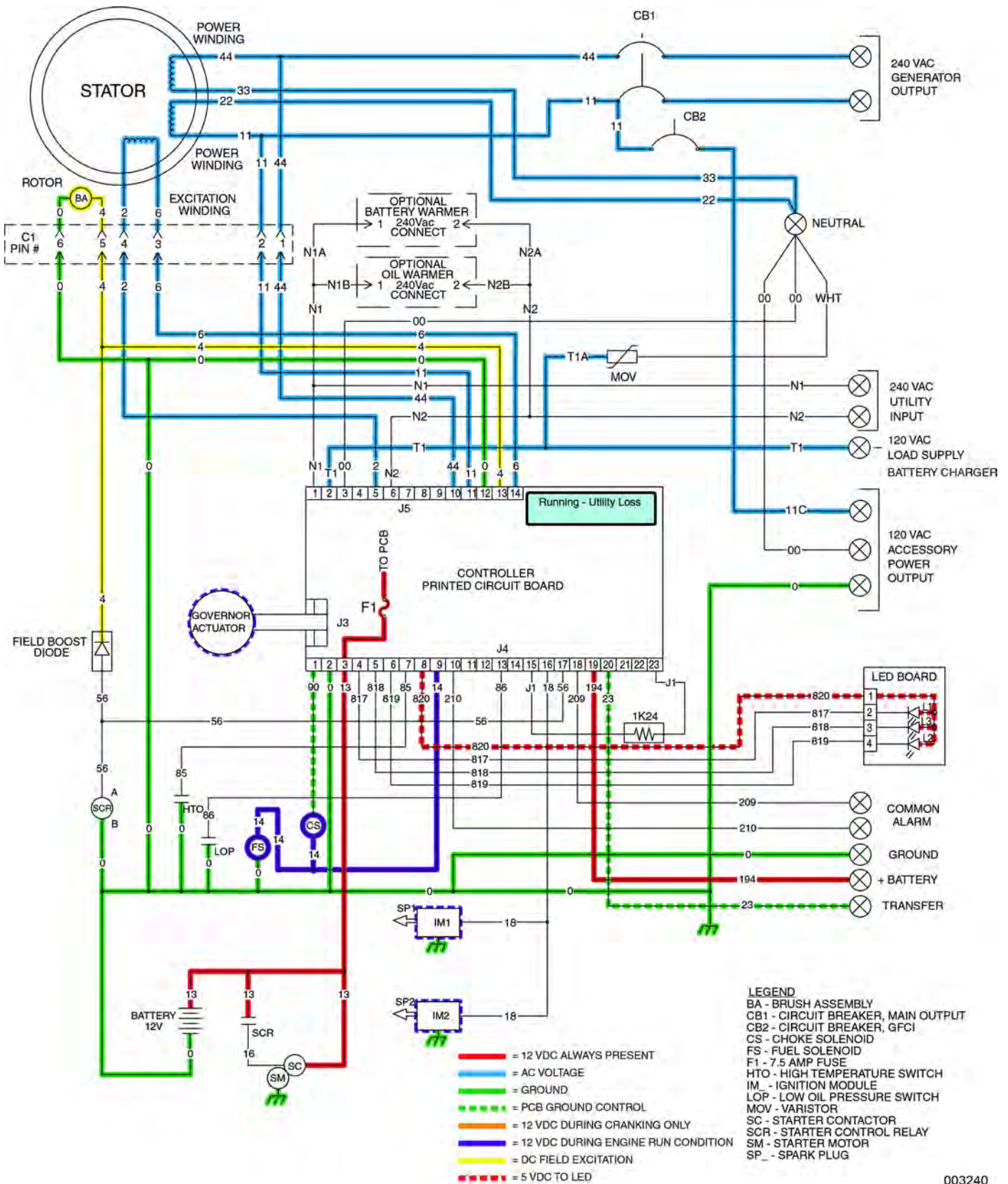
In **Figure 4-45** the Generator is running, the controller's "engine warm-up" timer has expired and generator AC output is available to the transfer switch Terminal Lugs E1 and E2 and to the open contacts on the transfer relay. Transfer to Standby may be briefly described as follows:

- 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.



003249

Figure 4-44.



003240

Figure 4-45. Transfer to 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.

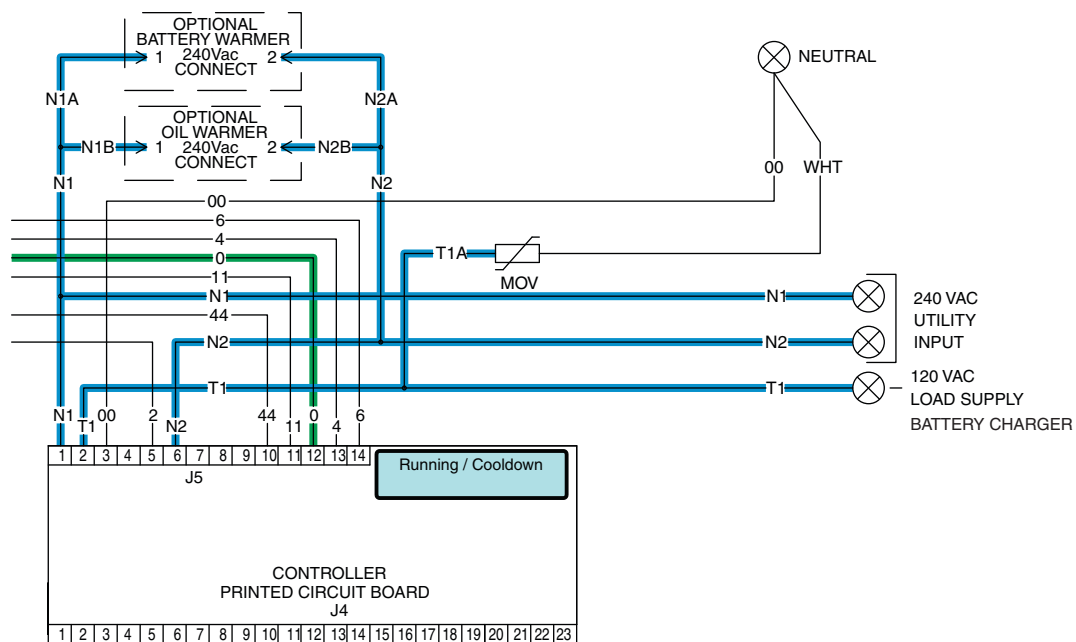
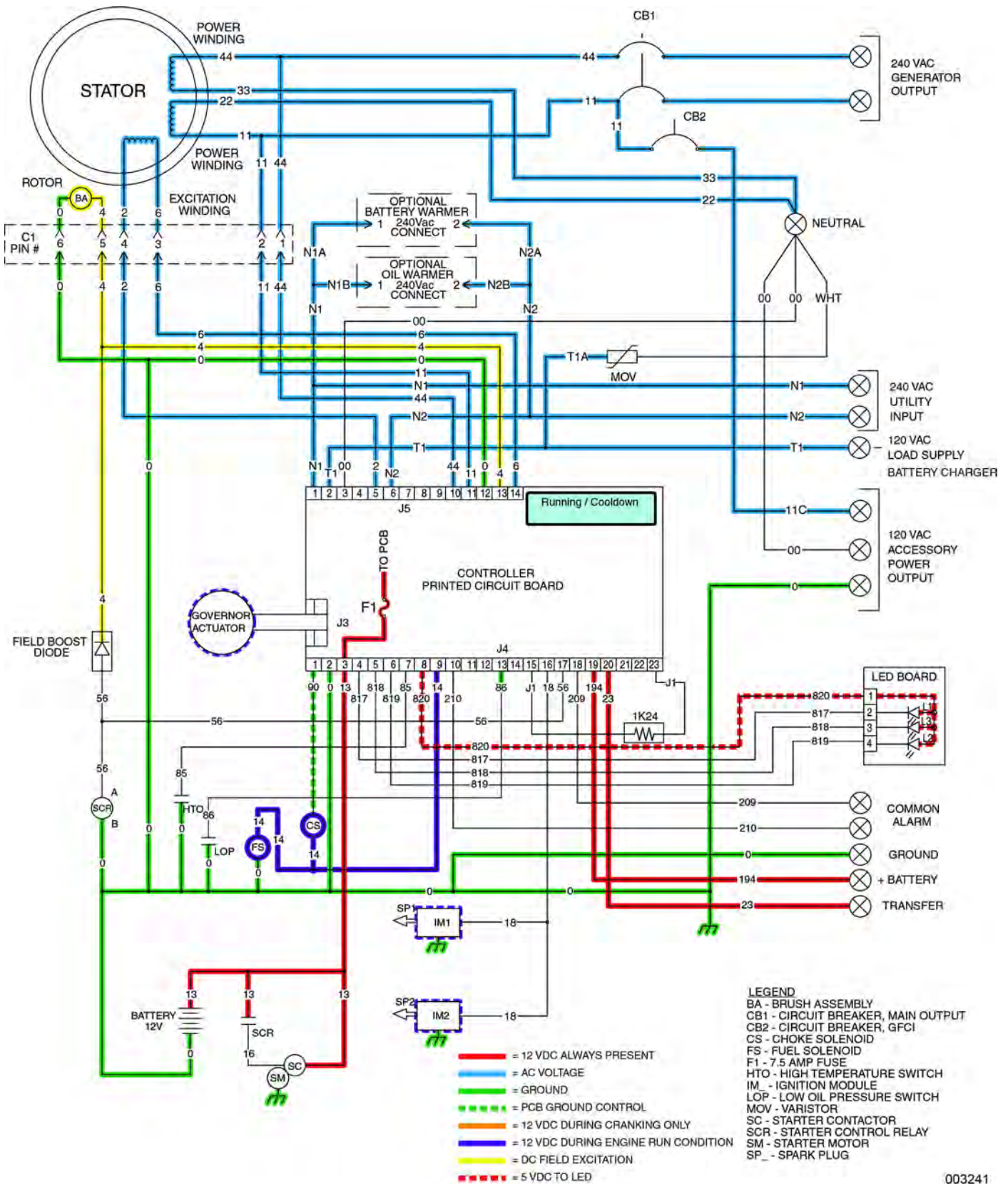


Figure 4-46.

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Figure 4-47. 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.

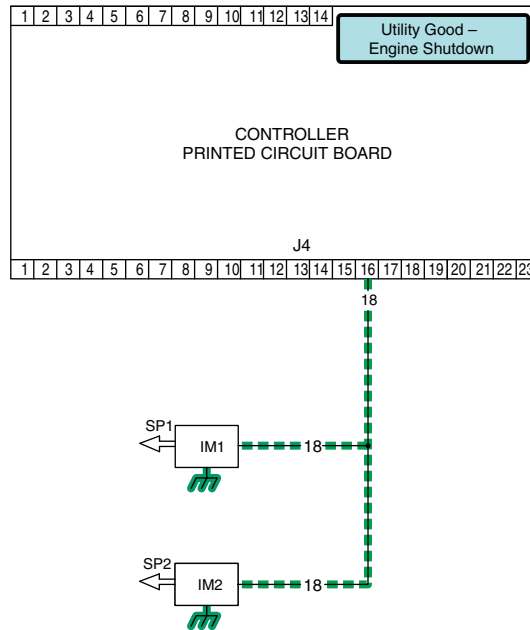
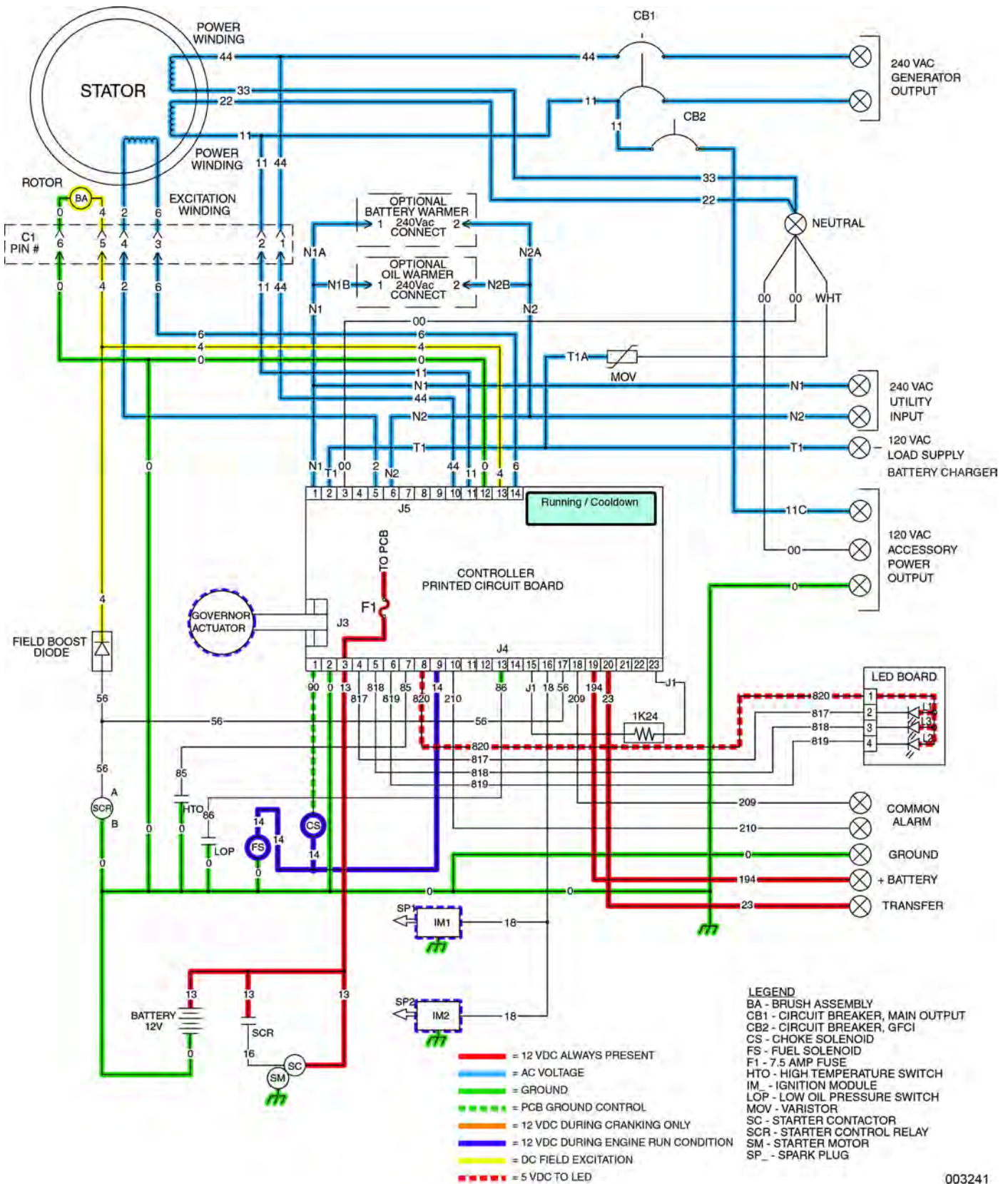


Figure 4-48.

003251



003241

Figure 4-49. Engine Shutdown

Section 4.5 Troubleshooting Flowcharts

Evolution™ Controller e-Codes

Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Controller Fault	ALARM		No E-code on HSB	Replace Controller
Overcrank	ALARM	1100	Condition - Engine Cranks but will not Start (5 crank attempts) Unit turns over but will not start. Controller is receiving signal on Wire 18.	Problem 17
Overspeed	ALARM	1200	Prolonged (60 Hz on a 50 Hz unit, 72Hz on 60Hz unit) Over specified Hz for 3 seconds. Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1205	Instantaneous (62 Hz on a 50 Hz unit, 75Hz on 60Hz unit) Over specified Hz for 0.1 second (100 milliseconds). Possible cause: Stepper motor/mixer body assembly issue.	Test 12
Overspeed	ALARM	1207	Monitors zero cross timing of the AVR to determine the alternator frequency which is a speed indicator. Set for 150 milliseconds of 4500 rpm or higher. Used if the normal ignition pulse sequence(s) are not being seen by the controller.	Test 64 and Test 60
Low Oil Pressure	ALARM	1300	Occurred while running The default Extended alarm for low oil pressure. Check oil level and pressure.	Test 61
High Temperature	ALARM	1400	Condition - Air Flow Impeded / Flow Issue Check the inlet/outlet for debris. Check temperature sensor and wiring.	Test 62
RPM Sensor	ALARM	1501	Twin Cylinder+Running Twin Cylinder Running faults to RPM Sensor Loss. Possible Causes: air pocket in fuel line, dirty fuel, missing ignition pulse (loss of one of the primary coils).	Test 50 and Test 64
RPM Sensor	ALARM	1505	Twin Cylinder+Cranking Twin Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor issue, missing ignition pulse (loss of one of the primary coils).	If engine cranks, Test 64. If engine does not crank, Problem 15.
RPM Sensor	ALARM	1511	Single Cylinder+Running Single Cylinder Running RPM sensor loss Possible Causes: air pocket in fuel line, dirty fuel. Loss of ignition pulse.	Test 50 and Test 64
RPM Sensor	ALARM	1515	Single Cylinder+Cranking Single Cylinder Cranking faults to RPM sensor loss Possible Cause: starter motor and/or engine issue. Loss of ignition pulse.	If engine cranks, Test 64. If engine does not crank, Problem 15.
Underspeed	ALARM	1600	Condition - Unit is Overloaded (55 Hz for 60 Hz for 30 sec, 40 Hz for 50 Hz unit) Unit is Overloaded slowing engine speed, fuel supply low or throttle control problem.	Problem 3, or Test 50, or Test 12
Underspeed	ALARM	1603	Underspeed The engine never comes up to 3600 RPM.	Check fuel selection and fuel supply
Overvoltage	ALARM	1800	Prolonged Over-Voltage	Problem 2
Undervoltage	ALARM	1900	Prolonged Under-Voltage Undervoltage due to loss of voltage. Below 80% for 10+ seconds)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1901	Instantaneous Undervoltage due to sudden loss of voltage. (Voltage less than 15 sec 2 sec+)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Undervoltage	ALARM	1902	Both Zero Crosses missing Undervoltage due to faulty excitation winding, or zero cross circuit, or circuit in general. Possible cause: loose wiring, field boost hardware failure. (Both zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

Evolution™ Controller e-Codes

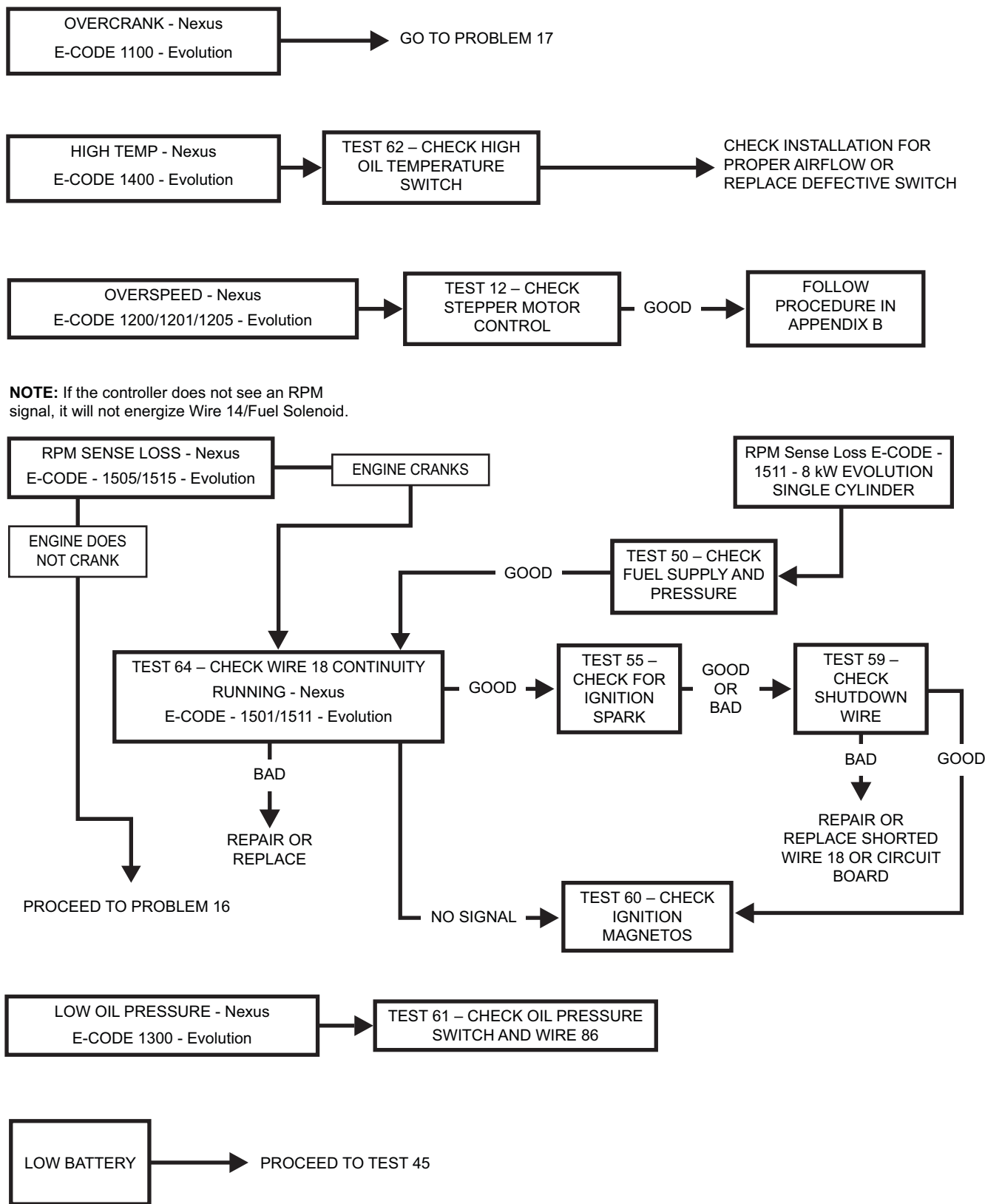
Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Undervoltage	ALARM	1906	Single Zero Cross missing Undervoltage due to faulty excitation winding, zero cross circuit, or circuit in general. Possible cause: field boost hardware failure. (One zero cross missing greater than 1.5 sec)	*Preliminary Output Voltage Test (firmware v1.12 and above). Note: Update controller to latest firmware.
Wiring Error	ALARM	2099	Mis-wired Customer connection low voltage and high voltage wires are crossed.	Check customer connection in generator
Overload Remove Load	ALARM	2100	Overloaded - Default (Output Current Method) Unit is overloaded. One or both CT(s) detecting an overload condition. Check transfer switch loadshed functionality. (Change load dynamics or utilize loadshed).	Remove Load
Undervoltage Overload	ALARM	2299	Unit was overloaded and attempted to start with a large load connected. The unit can not ramp up the generator voltage to its normal target voltage value if it starts with a large load connected	Remove Load
Stepper Overcurrent	ALARM	2399	Current flow in stepper coil(s) above specification	Test 12
Fuse Problem	ALARM	2400*	Missing / Damaged Fuse The 7.5 amp Controller Fuse is missing or blown (open). *Firmware version 1.11 and older only	Test 44
Aux Shutdown	ALARM	2800	External shut down circuit is open.	Check the continuity of the harness and operation of the switch(es). Repair/replace as needed.
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Test 45
Battery Problem	WARNING		Condition->More than 16 Volts of battery voltage or 600 milliamperes or more of charge current at the end of an 18 hour charge	Test 45
Charger Warning	WARNING		Less than 12.5 volts of battery voltage at the end of a 18 hour charge	Problem 22
Charger Missing AC	WARNING		AC power is missing from the battery charger input	Problem 22
	Service Schedule		Service Schedule A 200hours 2 years Service Schedule B 400 Hours 4 years	Perform Maintenance

NOTE: If an alarm code is displayed on the controller, use the diagnostic procedure listed in the action step.

Additional Codes For 8 and 9 kW Units Only

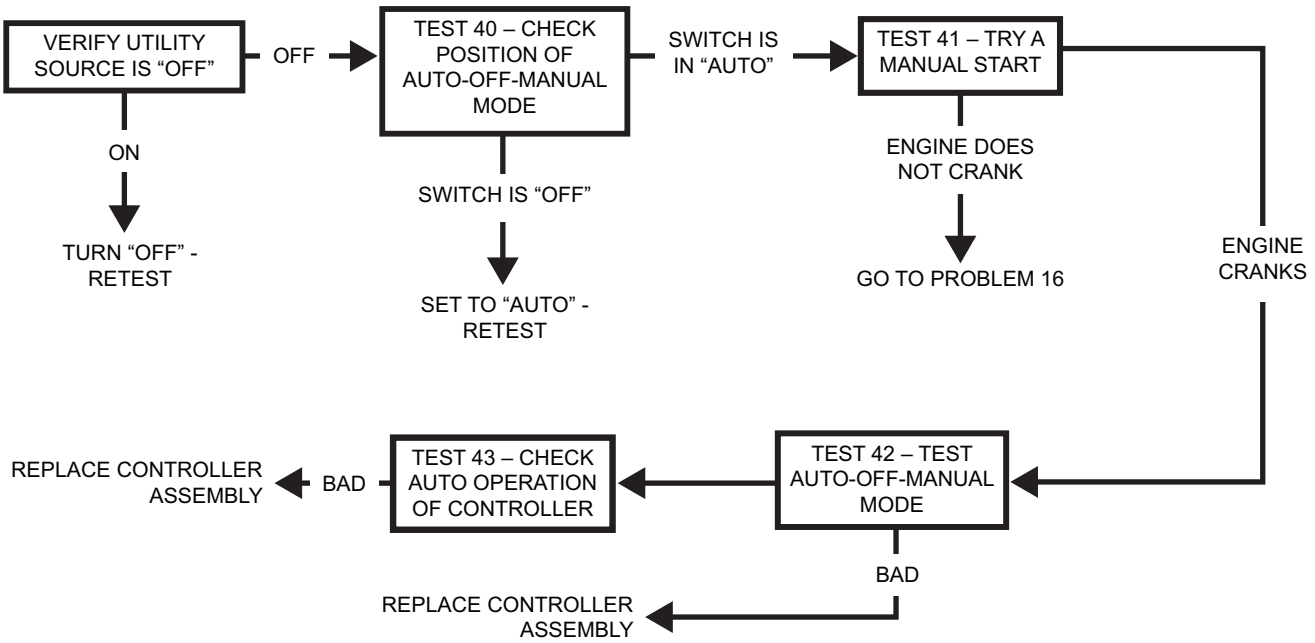
Displayed Alarm	Alarm/Warning	e-Code Breakdown	Description	Action Step
Overcrank	ALARM	1101	Engine/Starter Problem Limiting number of cranking cycles to protect the starter motor.	If the engine has tried to crank for 10 times unsuccessfully, this will trigger.
Overload Remove Load	ALARM	2102	Overloaded Unit re-cranks 5 times when load is applied, engine dies (0 RPM) and has low voltage (< 180V)	Check for Overloaded condition on unit. Inspect stepper motor operation.
Overload Remove Load	ALARM	2103	Overloaded Unit has run and attempted to accept load 10 times, could not accept due to overload condition	Check for Overloaded condition on unit

Problem 14 – Shutdown Alarm/Fault Occurred During Crank Attempt, Start or Run

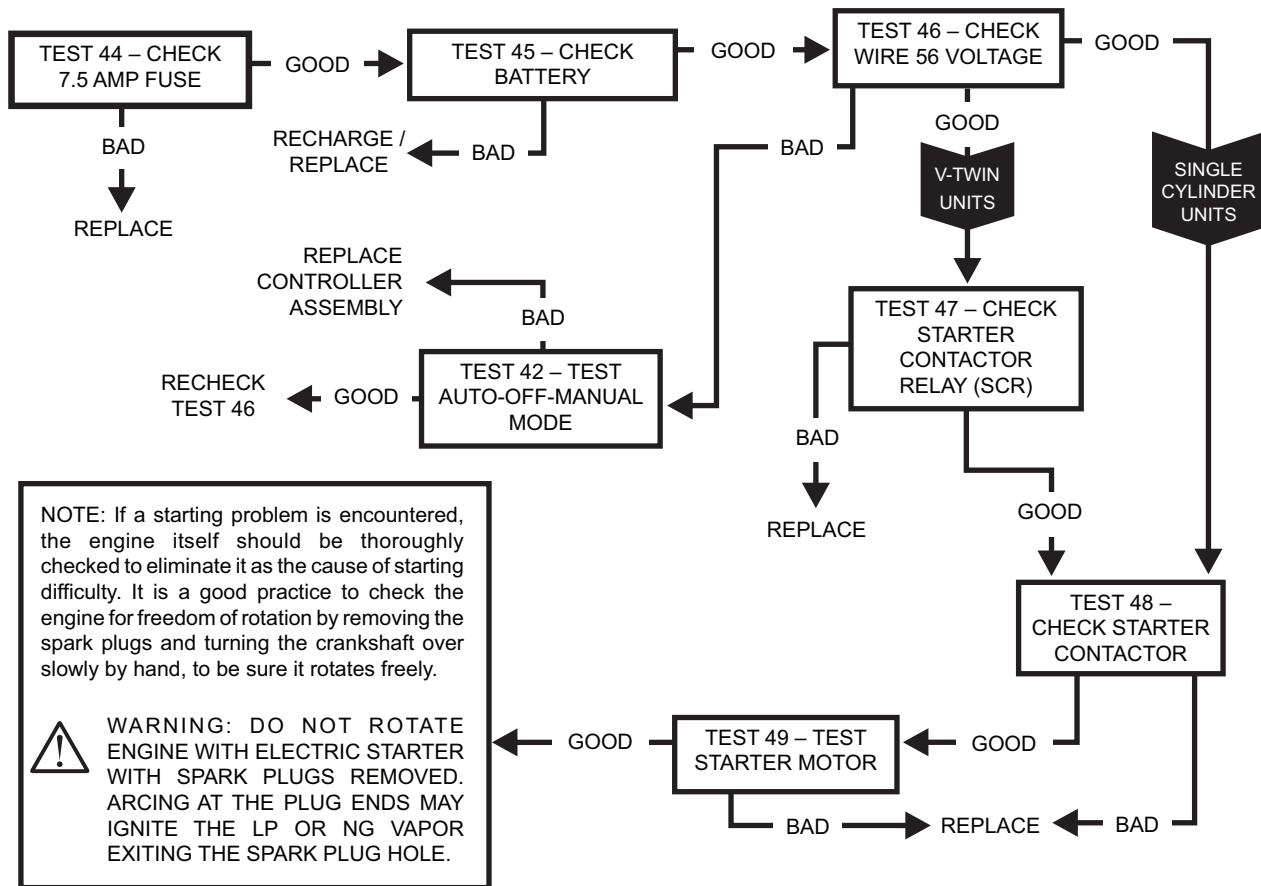


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

Problem 15 – Engine Will Not Crank When Utility Power Source Fails



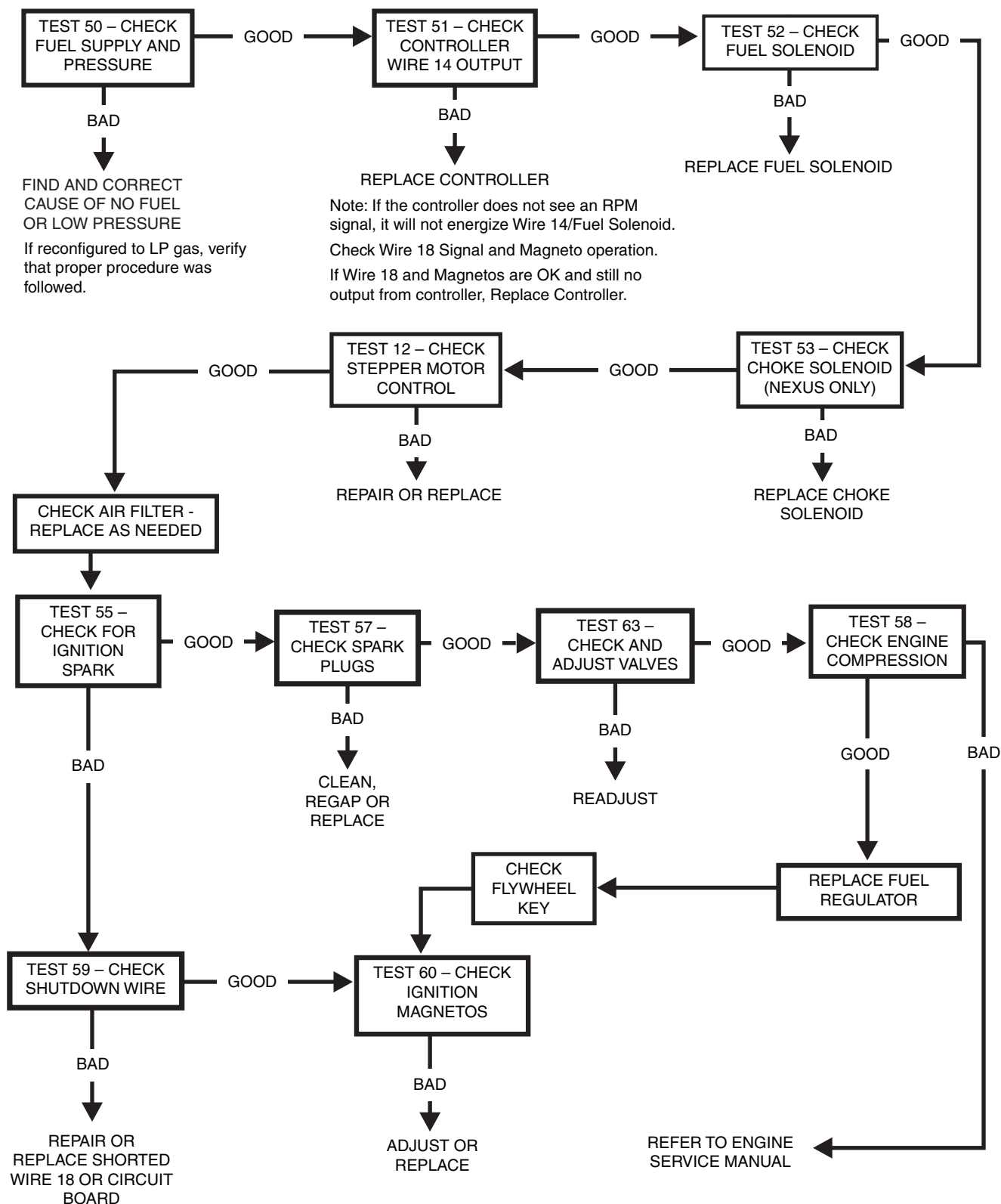
Problem 16 – Engine Will Not Crank When Controller Switch is Set to MANUAL



IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

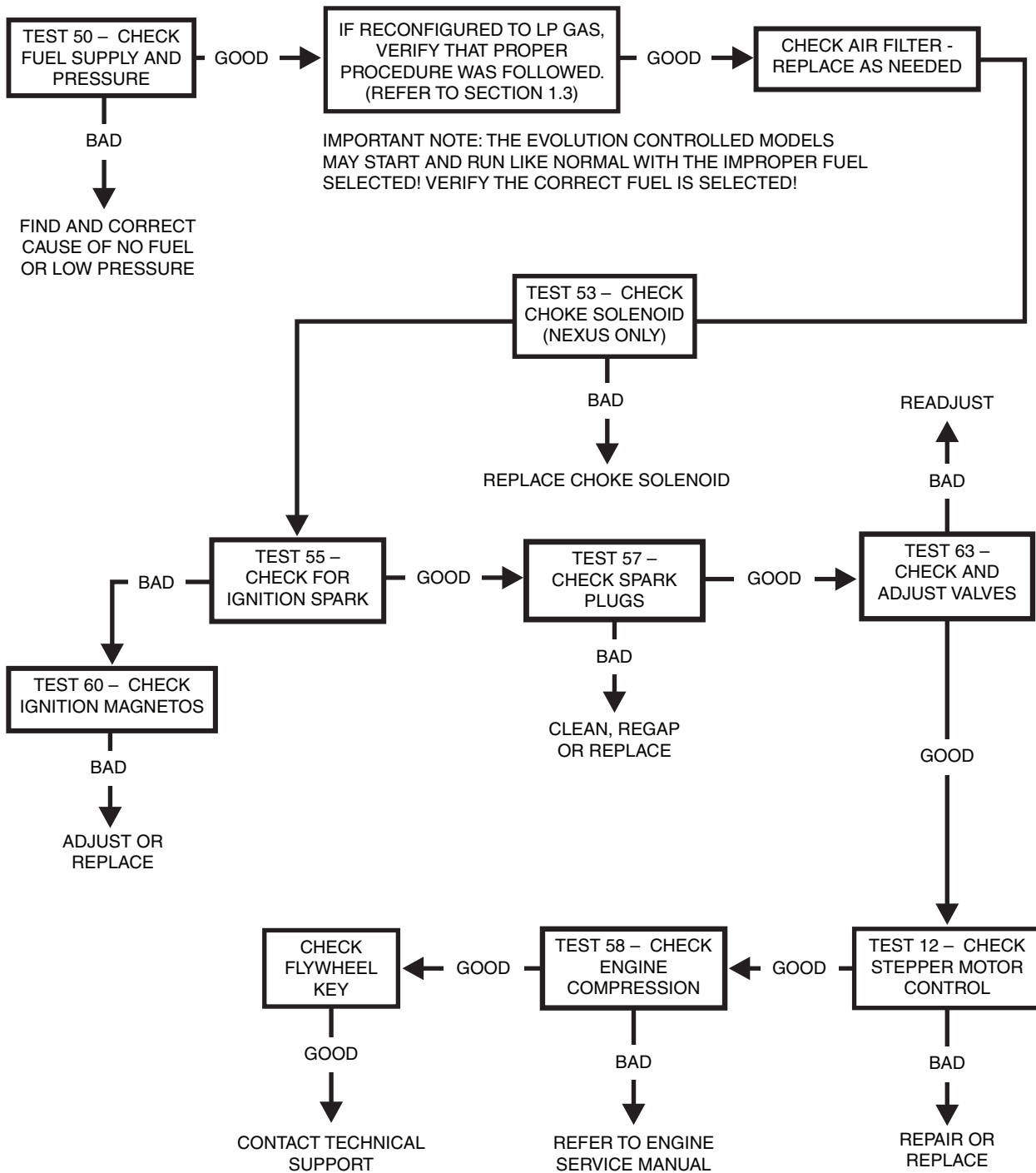
Problem 17 – Engine Cranks but Will Not Start

IMPORTANT NOTE: Verify that the fuel selector is correct for the supplied fuel type.



IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

Problem 18 – Engine Starts Hard and/or Runs Rough / Lacks Power / Backfires / Hunting / Erratic Operation

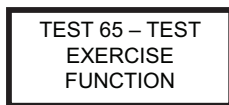


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

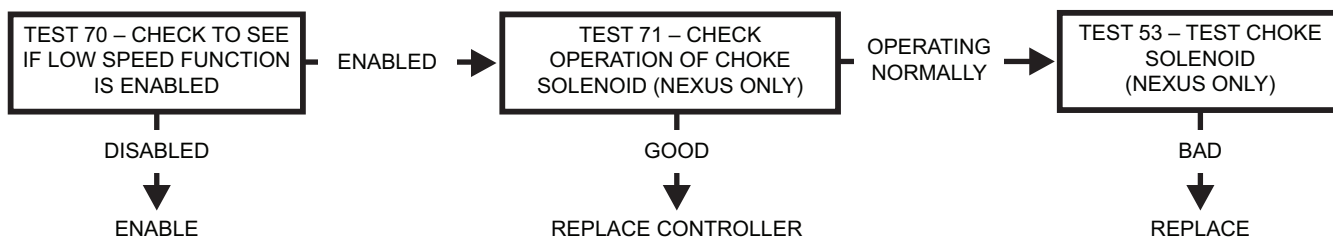
Problem 19 – 7.5 Amp Fuse (F1) Blown (e-Code 2400)



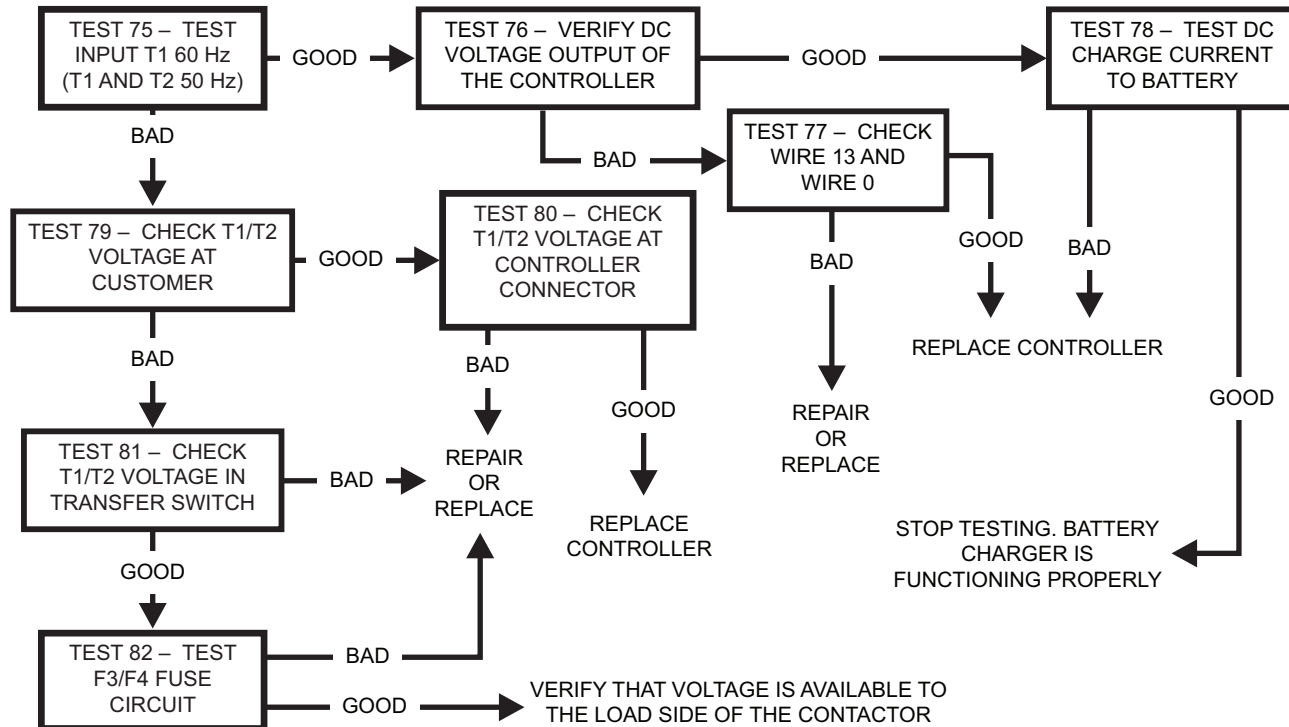
Problem 20 – Generator Will Not Exercise



Problem 21 – No Low Speed Exercise



Problem 22 – Battery is Dead



IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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Section 4.6 Diagnostic Tests

Introduction

This section familiarizes the service technician with acceptable procedures for the testing and evaluation of various problems that can occur on standby generators with air-cooled engines. The numbered tests in this section correspond with the flow charts in **Section 4.5, Troubleshooting Flowcharts**.

Some test procedures in this section require the use of specialized test equipment, meters, or tools. Most tests can be performed with a digital multimeter (DMM). 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 4-50 shows the DMM in two different states. The left DMM indicates an OPEN circuit or INFINITY. The right DMM indicates a dead short or CONTINUITY. Throughout the troubleshooting, refer back to **Figure 4-50** as needed to understand what the meter is indicating about the particular circuit that was tested.

NOTE: CONTINUITY is equal to 0.01 ohms of resistance or a dead short.

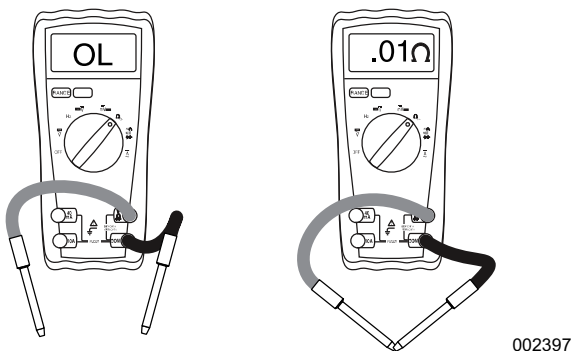


Figure 4-50. INFINITY (Left) and CONTINUITY (Right) Meter Readings

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 more quickly.

- 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 Mode

General Theory

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

Procedure

With the controller set to AUTO, 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.

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

General Theory

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 controller to OFF.
2. Set the main line circuit breaker (MLCB) to the “Open” position.
3. Set the controller set to MANUAL.
 - 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 16**.

Test 42 – Test the Function Of The AUTO-OFF-MANUAL Mode

Procedure

1. See [Figure 4-51](#). Navigate to the Input Screen using the menu system for the controller being worked on.
2. With the Inputs Screen displayed, set the controller to AUTO. If the controller reads the auto input from the switch, Input 7 will change from “0” to “1”. See [Table 4-5](#) in Section 4.1 for a description of the Inputs.

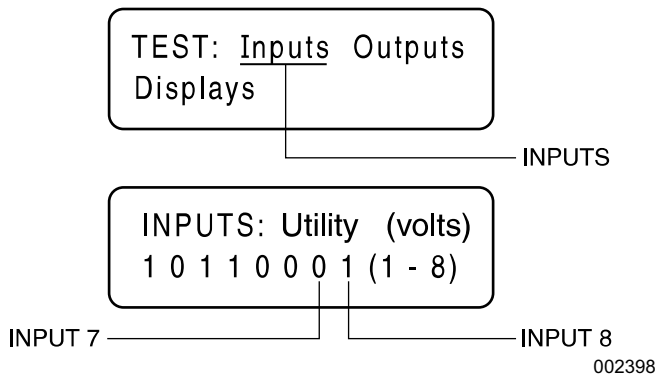


Figure 4-51. The Input Screens

3. With the Inputs Screen displayed place the controller to MANUAL. If the controller reads an input from the Switch, Input 8 will change from “0” to “1”.
4. With the controller set to OFF, both inputs will read zero.

Results

1. If controller failed either Step 2 or Step 3, replace the controller assembly.
2. If the controller passed Step 2 and Step 3, refer back to flow chart.

Test 43 – Test Auto Operations of Controller (Evolution and Nexus)

General Theory

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 10 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 (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. Set the generator controller to AUTO.
2. Simulate a power failure by opening the Utility supply breaker. If the generator cranks and starts and the switch transfers, close the Utility supply breaker to return utility power. Within 15 seconds the unit should transfer back to the Utility position and enter into a cool down mode for one minute, then shut down. If the generator performs this sequence of events the test is good; STOP.
3. If the generator does not perform the sequence of events listed in the above discussion, diagnose based on the symptom or Alarms displayed.

Results

Refer back to the flow chart.

Test 44 – Check 7.5 Amp Fuse (Evolution Alarm Code 2400 Firmware 1.11 and Older)

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.”

General Theory

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 controller 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). Visually inspect the fuse and fuse element. If the fuse element looks good, or if it cannot be visually inspected, test the fuse for an open with a DMM or Continuity Tester.

Results

1. If the fuse is 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 **Problem 19** Flow Chart.

Test 45 – Check Battery and Cables

General Theory

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 is not designed to recharge a dead battery. As well, if there is a loose connection or corrosion associated with a wire (positive or negative), battery voltage may be present, but because of the high resistance, will not allow current to flow. Electrical voltage drop varies according to current flow. Unless the circuit is operated so current flows through it, voltage drop cannot be measured. To properly measure voltage drop, a crank attempt will need to be performed. This test will determine whether the battery, battery cables, or both are at fault.

Procedure A. Perform Starter Circuit Voltage Drop Test

1. Remove the T1 fuse from the transfer switch.
2. Set a DMM to measure DC voltage.
3. Connect the Red meter test lead to the positive battery post and connect the Black meter test lead to the negative battery post.
 - a. If battery voltage is 12.1 VDC or below, or if engine does not crank (turn over), proceed to Procedure C or Procedure D.
 - b. If battery voltage is 12.2 VDC or above, proceed to next step. (For this test, battery voltage should be at least 12.2 VDC)
4. Turn off the fuel source and remove Wire 14 from the fuel solenoid to inhibit any possible startup.
5. Refer to battery post and starter connections in [Figure 4-52](#) and [Figure 4-53](#) and perform a voltage drop test as indicated.

NOTE: Single Cylinder units have a bulkhead mounted starter solenoid.

6. Set the controller to MANUAL. Measure and record the voltage.
7. Record readings from test points V1, V2, V3 and V4 as depicted in [Figure 4-52](#) and [Figure 4-53](#). Although resistance-free connections, wires and cables would be ideal, most of them will contain at least some voltage drop. The maximum voltage readings you should see are as follows:
 - a. 0.00-0.10 VDC across a connection (V4).
 - b. 0.10-0.20 VDC on a ground connection.
 - c. 0.20-0.30 VDC across a wire or cable (V1, V2).
 - d. 0.20-0.30 VDC across a switch or starter contactor (V3).
 - e. 0.40-0.50 VDC across the entire circuit.

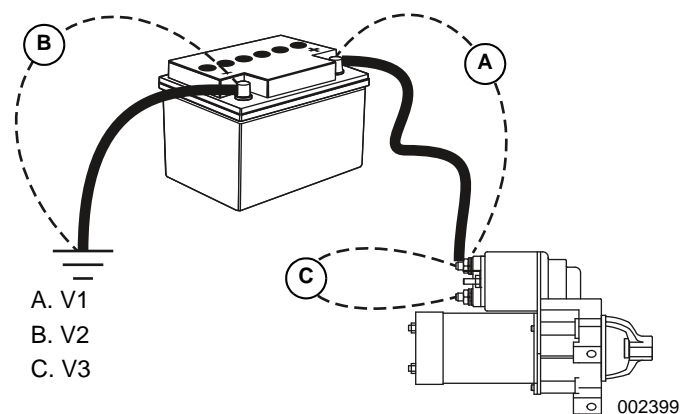


Figure 4-52.

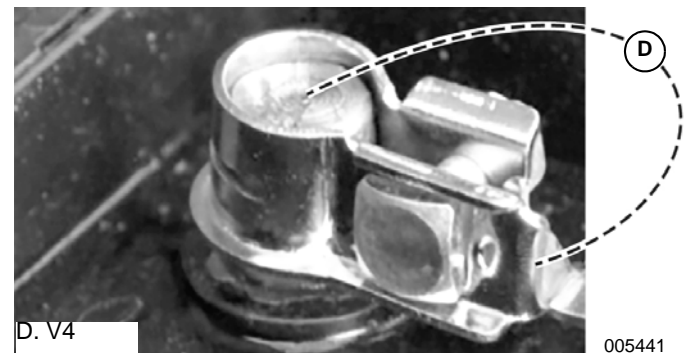


Figure 4-53.

8. If voltage drop is greater than the above, based on the circuit or component, proceed to Procedure B. If voltage drop is within the above, based on the circuit or component, proceed to Procedure C or D.

Procedure B. Inspect Battery Cables, Terminals and Connections

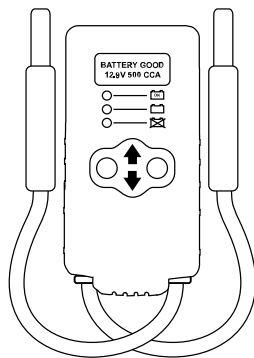
1. Inspect battery cables and battery posts.
2. If cable clamps or terminals are corroded, clean away all corrosion.

NOTE: If corrosion cannot be cleaned or eliminated, replace the component in question.

- Verify 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.

Procedure C. Perform a Conductance Test with a Conductance Type Battery Tester

- Remove 7.5 amp fuse from the controller.
- Remove the T-1 fuse from the Transfer Switch to disable the battery charger.
- Connect the test leads to the positive and negative posts of the battery being tested, and follow the battery tester manufacturer's instructions. Battery Test results should not indicate anything lower than 60% of the battery's rated CCA.



003391

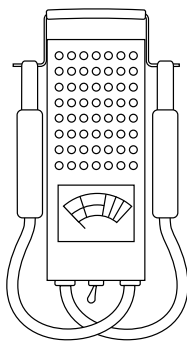
Figure 4-54. A Typical Conductance Type Battery Tester

Procedure D. Perform a load test on the Battery (All Lead-Acid Type Batteries)

- Remove 7.5 amp fuse from the controller.
- Remove the T-1 fuse from the transfer switch.
- Disconnect both negative and positive cables.

NOTE: Disconnect negative cable first.

- Test the load capability of the battery using a lead acid battery load tester.



002409

Figure 4-55. A Typical Battery Load Tester

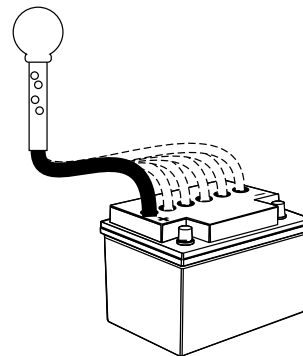
IMPORTANT NOTE: To properly load test a battery, the battery must be fully charged and the load applied must be 1/2 of the battery's CCA Rating. (i.e. $540/2=270$)

- Follow the load tester's manufacturer's instructions carefully.
- Connect both positive and negative cables.

NOTE: Connect positive cable first.

Procedure E. Test Battery State of Charge (Non-Maintenance Free Battery Only)

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



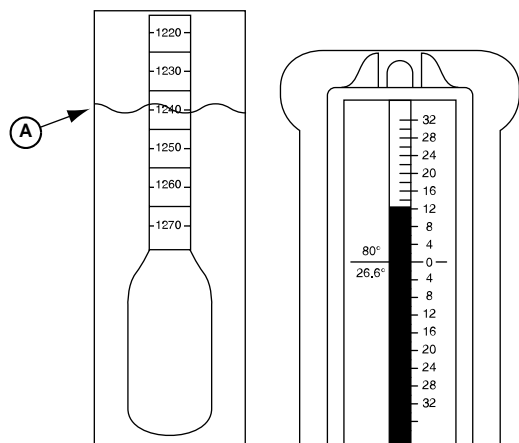
002410

Figure 4-56. Using a Battery Hydrometer

- Test Battery Condition:
 - 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.
 - 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, then repeat the test for condition.

Results from Procedure C, Procedure D, or Procedure E

- If battery CCA is 60% or less in Procedure C, replace battery with new.
- If the DMM indicated less than 10.5 VDC in Procedure D, remove the battery and recharge with an automotive battery charger.
- If battery fails tests in Procedure E, replace with new battery.
- If battery condition is good, refer back to flow chart.



002411

A. Liquid Level

Cell #	Specific Gravity
1	1.255
2	1.260
3	1.235
4	1.250
5	1.240
6	1.225

HIGH READING
 ↑
 35 POINTS DIFFERENCE
 ↓
 LOW READING

Figure 4-57. Reading a Battery Hydrometer

Test 46 – Check Wire 56 Voltage

General Theory

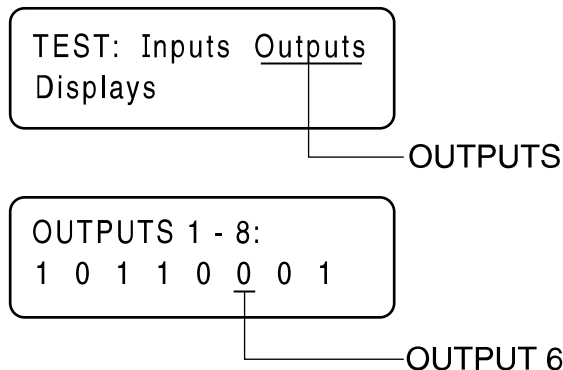
During an automatic start or when starting manually, an internal crank relay energizes. Each time the crank relay energizes, the controller should deliver 12 VDC to a starter contactor relay (SCR), or starter contactor (SC) and the engine should crank. This test will verify (a) that the crank relay on 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 DMM 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 the battery negative terminal.
4. Set the controller to MANUAL. Observe the meter. The DMM 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.

NOTE: If controller is in an Alarm State, digital output will not change. Clear the fault prior to performing Step 5.



002408

Figure 4-58. The Output Screens

5. Navigate to the Digital Output Screen using the menu system for the controller being worked on.
 - a. See **Figure 4-58**. Digital Output 6 is Wire 56 output from the board.
6. Set the controller to MANUAL 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.
 - a. **Nexus Controller** - Move to MANUAL position to view change of state.
 - b. **Evolution Controller** - Press MANUAL button to view change of state.
 - c. If the controller indicated a “1” then proceed to the next step.
7. **Nexus with Amp (black) connectors:** go to step 9.
8. **Evolution and Nexus with Molex (white) connectors:** Set a DMM to measure DC volts. Use one meter lead to back probe Wire 56 at the controller connector, leaving the connector connected to the controller. Connect the other meter lead to ground. Set the controller to MANUAL and measure the voltage.
 - a. If battery voltage is measured go step 8.
 - b. If no voltage is measured replace the controller.
9. Set a DMM to measure resistance.
10. Remove 7.5 amp fuse.
11. Disconnect the harness connector from the controller.
12. Remove Wire 56 from the starter contactor relay (V-twin units) or from the starter contactor (single cylinder units).
13. Connect one meter test lead to disconnected Wire 56 and connect the other meter test lead to the controller side of the harness (Wire 56), measure and record the resistance.

Results

1. If the DMM 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 DMM did NOT indicate CONTINUITY in Step 13, repair or replace Wire 56 between the controller side of the harness and the relay or contactor.
4. If wire did have continuity and the controller indicated "1" in step 6 then replace controller.

Test 47 – Test Starter Contactor Relay (V-Twin Engine)

General Theory

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).

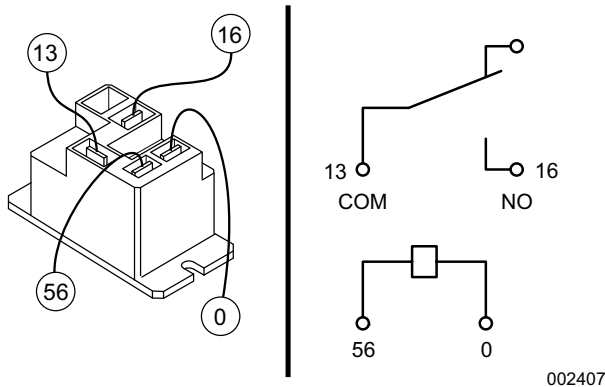


Figure 4-59. Starter Contactor Relay (V-Twin Engine) 002407

Procedure

1. Set a DMM 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 common ground. Measure and record the voltage.
4. Connect Wire 13 to the SCR.
5. Disconnect Wire 16 from the SCR.
6. Connect the positive meter test lead to the **terminal** on the SCR from which Wire 16 was removed and connect the negative meter test lead to a common ground.

IMPORTANT NOTE: Do not test wire.

7. Set the controller to MANUAL. Measure and record the voltage.
 - a. If voltage is measured, stop testing and go to the results of this test procedure.
 - b. If voltage is not measured, continue to the next step.
8. Set the DMM to measure resistance.
9. Remove Wire 56 and Wire 0 from the SCR. Measure and record the resistance at the terminals where Wire 56 and Wire 0 were removed. If resistance was not measured replace the SCR. If resistance was measured go to Step 10.

10. Disconnect Wire 0 from the SCR.
11. Connect one meter test lead to Wire 0 and connect the negative meter test lead to common 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 11, replace the SCR.
3. If CONTINUITY was NOT measured in Step 11, repair or replace Wire 0.
4. If battery voltage was measured in Step 6, refer back to flow chart.

Test 48 – Test Starter Contactor

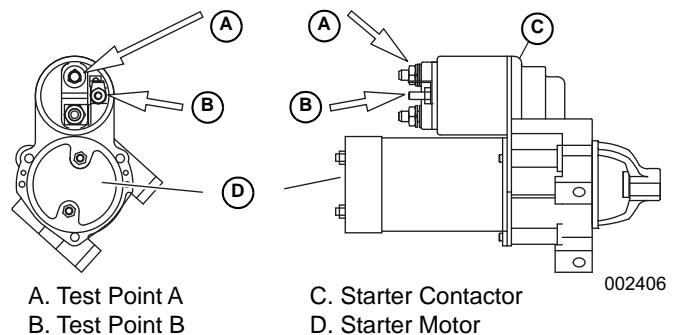
General Theory

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

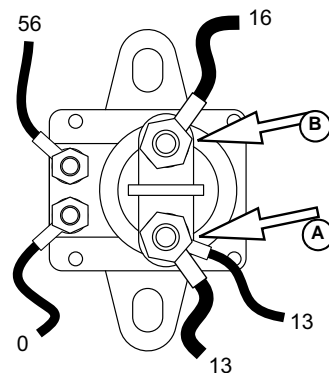
Carefully inspect the starter motor cable that runs from the battery to the starter motor. Cable connections must be clean and tight. If connections are dirty or corroded, remove the cable and clean cable terminals and terminal studs. Replace any cable that is defective or badly corroded.

See [Figure 4-60](#) and [Figure 4-61](#) for Test Points.



A. Test Point A
B. Test Point B
C. Starter Contactor
D. Starter Motor 002406

Figure 4-60. Starter Contactor (V-Twins and units with 426cc Engine)



A. Test Point A
B. Test Point B 003270

Figure 4-61. Starter Contactor (410cc Single Cylinder Engine Units Only)

1. Set DMM 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 DMM should indicate battery voltage. This measurement will be a reference during the testing procedure.
3. Connect the positive meter test lead to Test Point A and connect the negative meter test lead to an engine ground. Measure and record the voltage.
4. Connect the positive meter test lead to Test Point B and connect the negative meter test lead to an engine ground.
5. Set the controller to MANUAL. Measure and record the voltage at Test Point B. The contactor should energize.

Results: V-Twin Engine

1. If the DMM did not indicate battery voltage in Step 5, measure the resistance on Wire 16 between the SCR and the contactor. If no resistance is measured, repair or replace Wire 16 between the SCR and the contactor.

Results: 410cc Single Cylinder Engine Units Only

1. If battery voltage was indicated in Steps 3 and 5, measure the resistance between Test Point B and starter motor. If no resistance is measured, repair or replace Wire 16. If resistance is measured, refer back to the flow chart.
2. If battery voltage was indicated in Step 3, but not in Step 5, replace the starter contactor.

Results: 426cc Single Cylinder Engine Units Only

1. If battery voltage was indicated in Steps 3 and 5, stop testing and refer back to the flowchart.
2. If battery voltage was indicated in Step 3, but not in Step 5, measure the resistance between Test Point B and Controller connection point for Wire 56 (Use Appendix A for pin locations). If no resistance is measured, repair or replace Wire 56. If resistance was measured, refer back to the flow chart.

Test 49 – Test Starter Motor

Conditions Affecting Starter Motor Performance

- A binding or seizing condition in the starter motor bearings.
- A shorted, open or grounded armature.
 - Shorted armature (wire insulation worn and wires touching one another). Indicated by low or no rpm.
 - Open armature (wire broken). Indicated by low or no rpm and excessive current draw.
 - Grounded armature (wire insulation worn and wire touching armature lamination or shaft). Indicated by excessive current draw or no rpm.
- A defective starter motor switch.
- Broken, damaged or weak magnets.

- Starter drive dirty or binding.

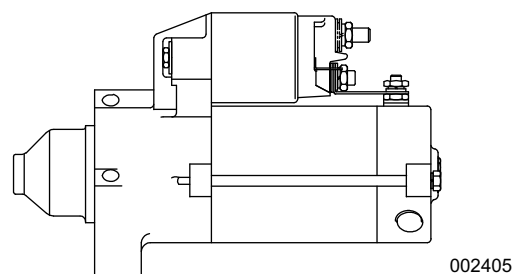


Figure 4-62. Starter Motor (V-Twins and units with 426cc Engine)

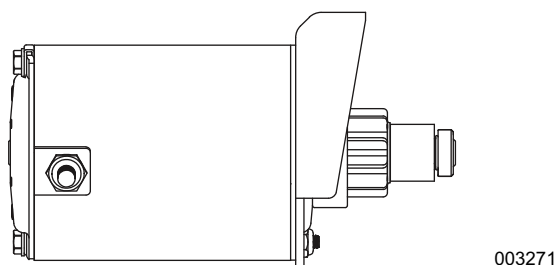


Figure 4-63. Starter Motor (410cc Single Cylinder Engine Units Only)

General Theory

Test 45 verified that the battery is fully charged and that the battery cables and connections are within the voltage drop specifications. 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 itself.

Procedure

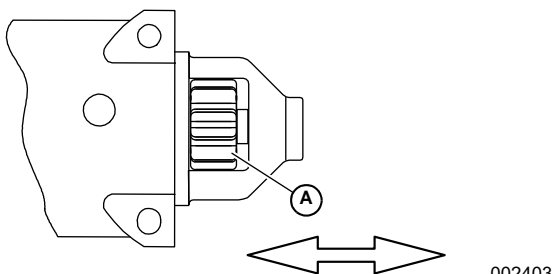
1. Set a DMM to measure DC voltage (12 VDC).
2. Connect the meter positive (+) test lead to the starter contactor stud which has the small jumper wire or plate connected to the starter motor.
3. Connect the common (-) test lead to the starter motor frame.
4. Set the controller to MANUAL and observe the 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.
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.
3. 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.

Checking The Pinion

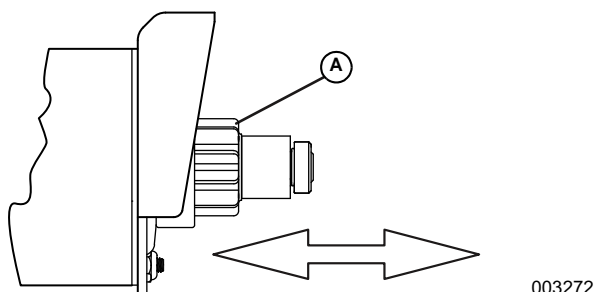
When the starter motor is activated, the pinion gear should move and engage the flywheel ring gear. If the pinion does not move normally, inspect the pinion for binding or sticking.



A. Pinion

002403

Figure 4-64. Check Pinion Gear Operation (V-Twins and units with 426cc Engine)



A. Pinion

003272

Figure 4-65. Check Pinion Gear Operation (410cc Single Cylinder Engine Units Only)

Test 50 – Check Fuel Supply and Pressure

General Theory

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 (Nexus) or 3.5 inches (Evolution) for natural gas (NG) or 10 inches water column for LP gas on Nexus and Evolution.
- 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



Explosion and fire. Fuel and vapors are extremely flammable and explosive. No leakage of fuel is permitted. Keep fire and spark away. Failure to do so will result in death or serious injury.

(000192)

IMPORTANT NOTE: Verify that the fuel selector is properly set for the supplied fuel type.

Procedure

A water manometer or a gauge that is calibrated in “inches of water column” should be used to measure the fuel pressure. Fuel pressure at the inlet side of the fuel solenoid valve should be between 3.5-7 inches (Evolution) or 5-7 inches (Nexus) water column for natural gas (NG), or 10-12 inches water column for LP gas.

1. See [Figure 4-66](#), [Figure 4-67](#), and [Figure 4-68](#) for the gas pressure test point on the fuel regulator. The fuel pressure can be checked at Port 1 (A) on all fuel regulators, and at Port 3 (B) on 12-20 kW 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.

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.

NOTE: The static pressure port (before solenoid) is ALWAYS closest to the solenoid, regardless of the demand regulator/plenum tank configuration.

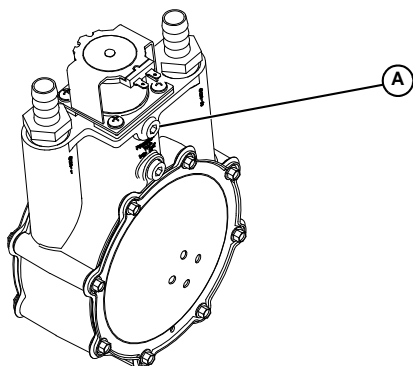
Units with a Plenum Tank Only

The Port 3 (B) 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

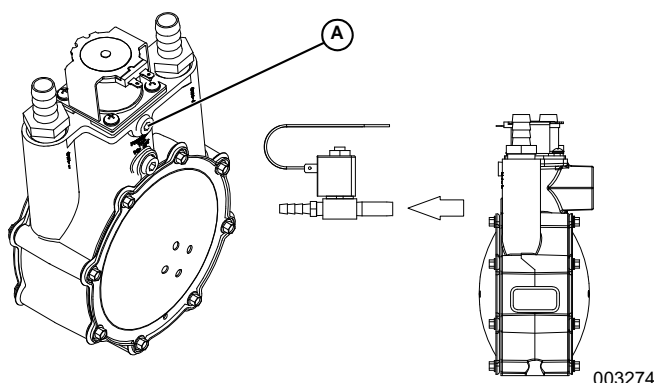
1. If fuel supply and pressure are adequate, but engine will not start refer back to the flow chart.
2. If generator starts but runs rough or lacks power, repeat the above procedure with the generator running and under load. The fuel supply system must be able to maintain between 3.5-7 inches (Evolution) or 5-7 inches (Nexus) water column for natural gas (NG), or 10-12 inches water column for LP gas. If proper fuel supply and pressure is maintained, refer to [Problem 18 – Engine Starts Hard and/or Runs Rough / Lacks Power / Backfires / Hunting / Erratic Operation](#).

NOTE: If pressure is above specifications correct/adjust supply regulator to generator to maintain proper fuel pressure. On Nexus units no more than a 1" drop in fuel pressure from No Load to Full Load operation while staying within specifications.



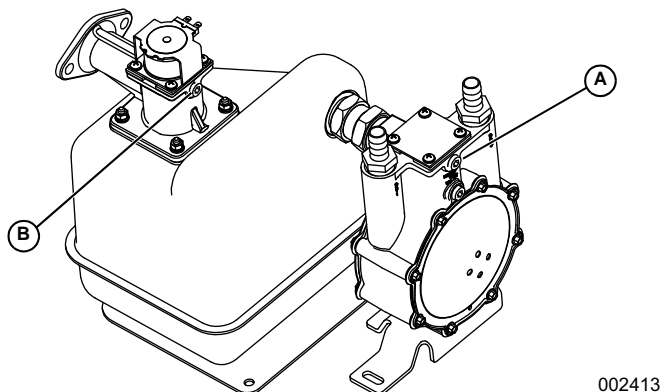
003273

Figure 4-66. Gas Pressure Test points (8 kW)



003274

Figure 4-67. Gas Pressure Test points (10 kW)



002413

Figure 4-68. Gas Pressure Test points (12-20 kW)

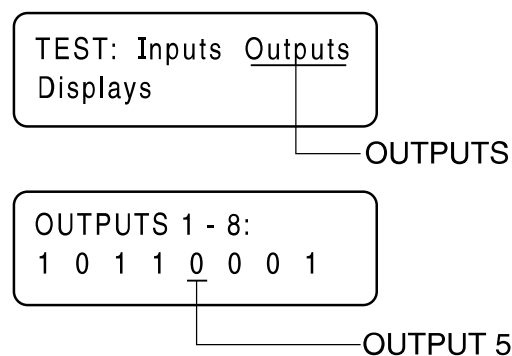
Test 51 – Check Controller Wire 14 Outputs

General Theory

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 controller to OFF.
2. Set a DMM to measure DC voltage.
3. Disconnect Wire 14 from the fuel solenoid (FS).
4. Connect the positive test lead to the disconnected Wire14 from Step 3 and connect the negative test lead to the negative battery post or an engine ground.
5. Set the controller to MANUAL. The meter should indicate battery voltage once the engine rotates. If the engine doesn't crank, refer to appropriate flow chart.
 - 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 using the menu system for the controller.



002414

Figure 4-69. The Output Screens

7. 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 DMM did NOT indicate voltage in Step 5 and output did not change in Step 7, replace the controller.
 - b. If the DMM did NOT indicate voltage in Step 5 and the output in Step 7 changed, proceed to Step 11.
8. Disconnect the 7.5 amp Fuse.
9. Disconnect the appropriate harness connector from the controller.
10. Set a DMM to measure resistance.
11. Connect one meter test lead to Wire 14 (disconnected in Step 3). Connect the other meter test lead to Wire 14 at the controller side of the harness connector (Wire 14). See "Appendix A" for proper wire and connector pin identification.
 - a. If the DMM indicated CONTINUITY repeat Step 5 and then retest.
 - b. If CONTINUITY is not measured, repair or replace Wire 14 between the controller harness connector and the fuel solenoid.

Results

Refer back to flow chart.

Test 52 – Check Fuel Solenoid

General Theory

In Test 51, 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	15-16 ohms
Fuel Solenoid FS2 Nominal Resistance	29 ohms

Procedure: 8 and 12-20 kW Units

1. See [Figure 4-66](#) or [Figure 4-68](#). Install a manometer to Port 2 on the fuel regulator.
2. Set the controller 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: 10 kW Units

1. See [Figure 4-67](#). Remove the hose from fuel solenoid (FS2) and install a manometer to Port 2 on the fuel regulator.
2. Set the controller 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 controller 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 (Nexus Only)

General Theory

12-20 kW: 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. See [Figure 4-70](#). A choke plate (A) is utilized which covers the throttle bores. When the choke solenoid (B) is de-energized the choke is closed.

10 kW: See [Figure 4-72](#). A choke plate (A) located in the choke housing (B) is open when the choke solenoid (C)

is de-energized, and closed when the choke solenoid is energized.

8 kW: See [Figure 4-73](#). A choke solenoid (A), located on the air box, energizes only during cranking to assist starting. When energized the solenoid is closes the choke plate (B).

6 kW EcoGen: A Choke Solenoid is located below the air box and only energizes during cranking to assist starting. When energized, the solenoid is closed.

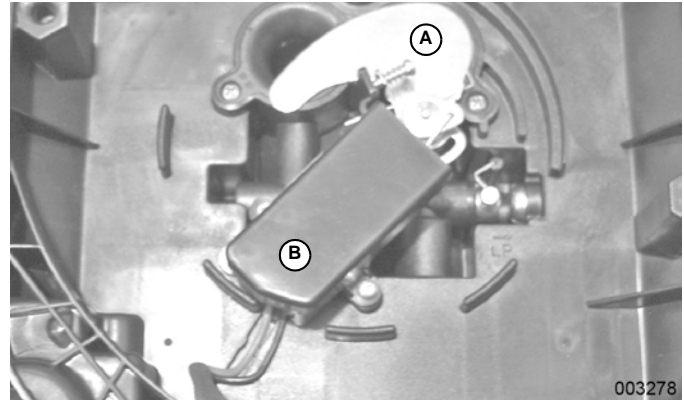


Figure 4-70. Solenoid De-Energized, Choke Closed 12-20 kW Units

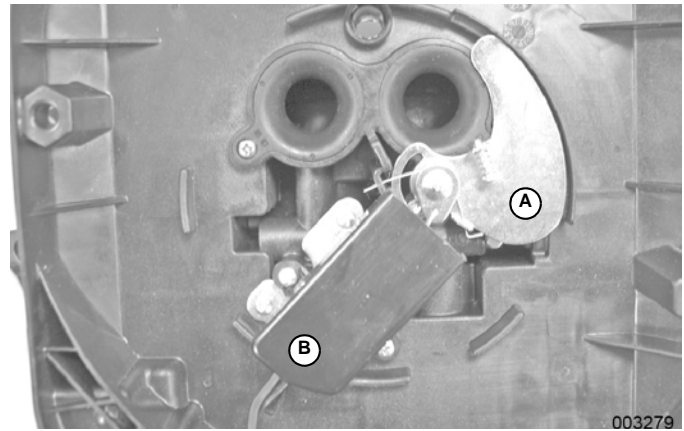
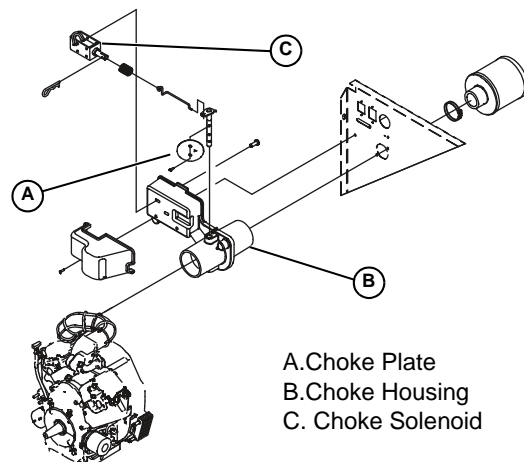


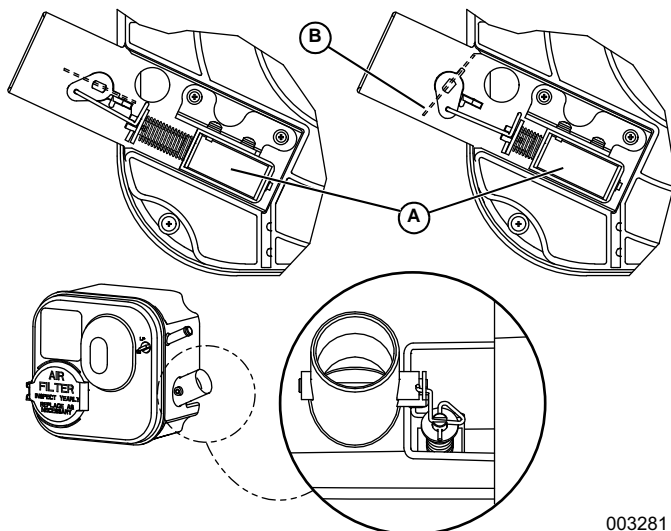
Figure 4-71. Solenoid Energized, Choke Open 12-20 kW Units



A. Choke Plate
B. Choke Housing
C. Choke Solenoid

003280

Figure 4-72. Exploded View Showing Location of Choke Plate - 10 kW Units



003281

Figure 4-73. 8 kW Choke Solenoid

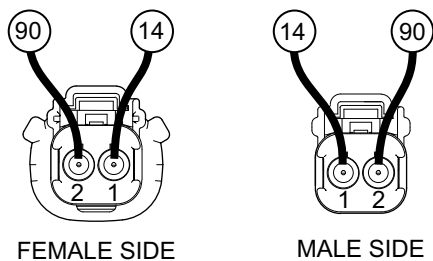
Procedure: 10-20 kW / EcoGen 6 kW

See [Figure 4-72](#) for the 10 kW location. See [Figure 4-70](#) and [Figure 4-71](#) for the 12-20 kW Choke location and operation.

1. Turn off the fuel supply to the generator.
2. Set the controller to MANUAL.

NOTE: 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. See [Table 4-11](#) 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.

3. Disconnect the choke solenoid.
4. Set a DMM to measure DC voltage.
5. See [Figure 4-74](#). Connect the positive meter test lead to Pin 1 (Wire 14) of the female side of the CS connector going to the control panel. Connect the negative meter test lead to Pin 2 (Wire 90).



003285

Figure 4-74. C3 Choke Solenoid Connector

6. Set the controller to MANUAL. While cranking, the DMM should indicate battery voltage cyclically.
 - a. If the DMM did NOT indicate battery voltage, verify CONTINUITY of Wire 90 between the connector and controller side of Wire 90 and verify CONTINUITY of Wire 14 between the connector and controller side of Wire 14. Repair or replace any wiring as needed.

- b. If the DMM indicated a cyclical battery voltage proceed to Step 7.
7. Set a DMM to measure resistance.
8. 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.
9. Connect the choke solenoid.
10. With the generator running at a rated speed of approximately 60 Hz, verify that the choke is energized and holding the choke plate open. (On 10 kW units de-energized is Open)
11. Repeat Step 3; however, once the unit starts, manually hold the choke open while taking the voltage measurement.

Results

1. If the DMM did NOT indicate battery voltage in Step 6 and wire CONTINUITY was good, replace the controller.
2. If the DMM did NOT indicate approximately 3.7 ohms (10 kW units) and 6-7 ohms (EcoGen 6 kW units) in Step 8, replace the choke solenoid.

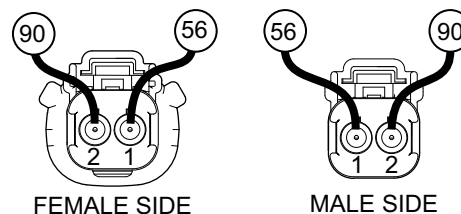
Procedure: 8 kW

See [Figure 4-73](#) for location and function of choke solenoid.

1. Turn off the fuel supply to the generator.
2. Set the controller to MANUAL.

NOTE: 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.

3. Disconnect the choke solenoid.
4. Set a DMM to measure DC voltage.
5. See [Figure 4-75](#). 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).



003288

Figure 4-75. CS Choke Solenoid Connector

6. Set the controller to MANUAL. While cranking, the DMM should indicate battery voltage.
 - a. If the DMM 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 DMM indicated battery voltage proceed to Step 7.
- 7. Set the controller to MANUAL. While cranking, the DMM should indicate battery voltage.
- 8. Set a DMM to measure resistance.
- 9. 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.
- 10. Connect the choke solenoid.

- 11. 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 DMM did NOT indicate battery voltage in Step 6 and wire CONTINUITY was good, replace the controller.
- 2. If the DMM did NOT indicate approximately 3.7 ohms (10 kW units) and 6-7 ohms (EcoGen 6 kW units) in Step 9, replace the choke solenoid.

Table 4-11. 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
10 kW/EcoGen 6 kW	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
12 kW-20 kW	0	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1
Crank Cycle 2	Seconds															
10 kW/EcoGen 6 kW	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1
12 kW-20 kW	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1
Crank Cycle 3	Seconds															
10 kW/EcoGen 6 kW	0	0	0	0	1	1	1									
12 kW-20 kW	0	0	1	1	1	1	1									
Crank Cycle 4	Seconds															
10 kW/EcoGen 6 kW	0	1	1	1	1	1	1									
12 kW-20 kW	0	1	0	0	0	0	0									
Crank Cycle 5	Seconds															
10 kW	0	1	1	1	1	0	0									
12 kW-20 kW	0	0	0	0	1	1	1									

Test 55 – Check for Ignition Spark

General Theory

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.



002415

Figure 4-76. Spark Tester

See [Figure 4-76](#). When using this style spark tester the adjustment screw must be set to the proper distance for the type of ignition system being tested.

NOTE: For the magneto system used on the HSB engines, set the distance of the adjustment screw tip at the 10kV mark. When performing the test monitor the gap for proper spark and color.

The cranking system and engine must be in proper working order to insure accurate results.

Procedure

1. Turn off the fuel supply to the generator.
2. Remove spark plug leads from the spark plugs.
3. See [Figure 4-77](#). Attach the clamp of the spark tester to the engine cylinder head.
4. Attach the spark plug lead to spark tester terminal.
5. Set the controller to MANUAL.
6. While the engine is cranking, observe the spark tester. If spark jumps the tester gap, 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.



002416

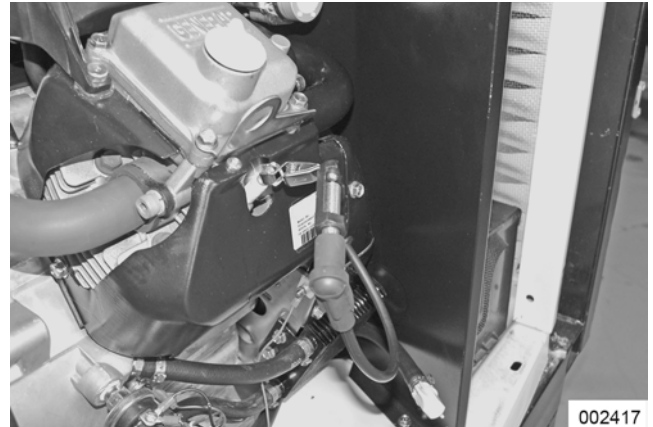
Figure 4-77. Checking Ignition Spark

7. See [Figure 4-78](#). To determine if an engine miss is ignition related, connect the spark tester in series with the spark plug wire and spark plug. 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.

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.



002417

Figure 4-78. Checking Engine Miss

Results

1. If no spark or very weak spark occurs, proceed to [Test 59 – Check Shutdown Wire](#).
2. If spark is present and the engine still will not start, proceed to [Test 57 – Check Condition of Spark Plugs](#).
3. When checking for engine miss, if sparking occurs at regular intervals, but an engine miss continues, proceed to [Test 57 – Check Condition of Spark Plugs](#).
4. When checking for engine miss, if a spark miss is readily apparent, proceed to [Test 60 – Check and Adjust Ignition Magnetos](#).

Test 57 – Check Condition of Spark Plugs

General Theory

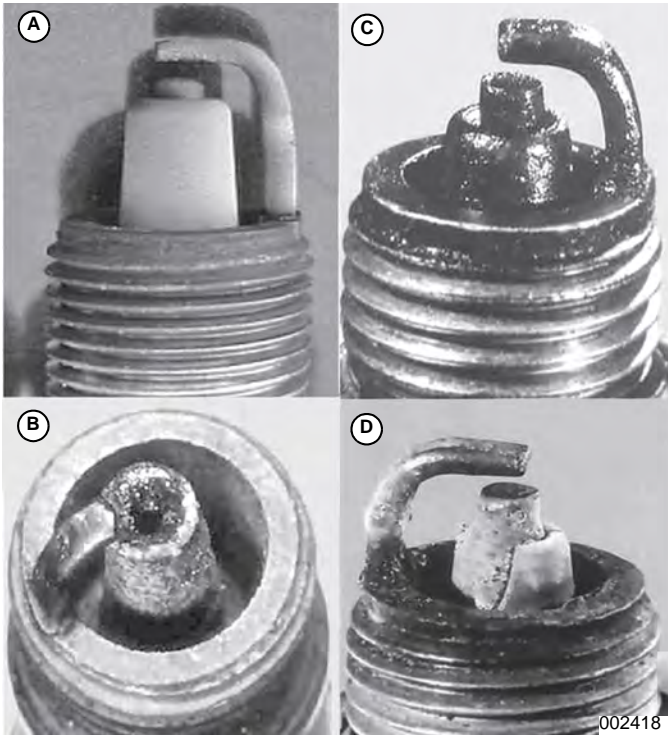
If the engine will not start and Test 55 indicated good ignition spark, a possible cause could be fouled or damaged electrodes. An engine miss may also be caused by defective spark plug(s).

Procedure

See [Figure 4-79](#) for types of engine related spark plug problems.

1. Remove spark plug(s) and inspect for any visible damage.

2. Replace any spark plug having burned electrodes or cracked porcelain.
3. See [Figure 4-80](#). Using a wire feeler gauge set the gap on new or used spark plugs as per [Table 4-12](#).



A. Normal C. Misfires
 B. Pre Ignition D. Detonation

Figure 4-79. Spark Plug Conditions

Results

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

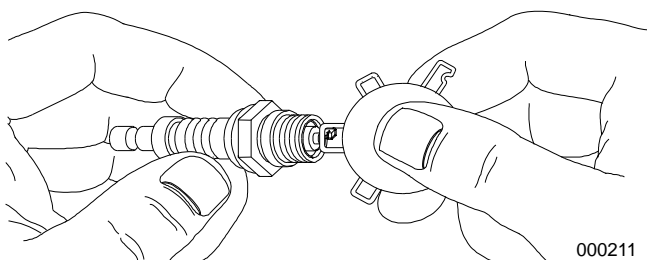


Figure 4-80. Checking Spark Plug Gap

Table 4-12. Spark Plug Gap				
Engine Size	kW Rating	Plug Gap	Recommended Plug	Manufacturer
410 cc	8	0.030 inch	RC12YC	Champion
426 cc	9	0.020 inch	RC12YC	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

NOTE: Always check the specifications of the unit you are working on for correct plug and settings.

Test 58 – Check Engine / Compression Test / Cylinder Leak Down 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

Check Compression

General Theory

Lost or reduced engine compression can result in a failure of the engine to start, or 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 high oil consumption).

For air-cooled engines, the minimum allowable compression pressure for a cold engine is typically 150 PSI. Compression values are based on accurate process and proper procedure. However, testing has proven that an accurate indication of compression in the cylinder can be obtained by using the following procedure.

NOTE: Battery and starting system must be in good condition to get accurate results.

IMPORTANT NOTE: Valve adjustment is critical to proper compression testing. Verify valve adjustment is correct before proceeding with test.

Procedure

1. Shut off the fuel supply to the unit.
2. Remove both spark plugs.
3. Place a jumper wire from the spark plug boot wire terminal to ground, OR ground Wire 18 at the magneto lead connects to harness connection to disable spark.
4. Unplug the stepper motor connector from the controller and open the throttle to wide open.
5. Insert a compression gauge into the cylinder.
6. Crank the engine until there is no further increase in pressure.
7. Record the highest reading obtained.
8. Repeat the procedure for the remaining cylinder if applicable and record the highest reading.

NOTE: See [Specifications](#) in Section 1.1 for acceptable compression values.

Results

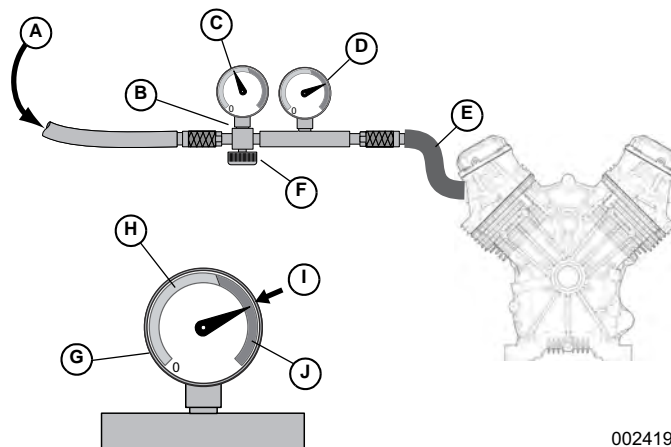
The difference in pressure between the two cylinders should not exceed 25 percent. If the difference in compression is greater than 25 percent, loss of compression in the lowest reading cylinder is indicated.

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.

Cylinder Leak Down Test

General Theory

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 4-81](#) represents a standard tester available on the market.



002419

- A. Compressed air in
- B. Air pressure regulator
- C. Inlet gauge pressure set point
- D. Outlet gauge pressure
- E. To spark plug hole
- F. Regulator adjustment knob
- G. Outlet gauge
- H. Red range indicates unacceptable leakage
- I. Needle indicates minimal air leakage
- J. Green range indicates acceptable leakage

Figure 4-81. Cylinder Leakdown Tester

NOTE: Refer to the Tool Manufacturer's instructions for variations of this procedure.

Procedure

1. Shut off the fuel supply.
2. Remove the spark plug(s) from the cylinder.
3. Gain access to the flywheel or to the generator fan assembly. Remove the valve cover.
4. Rotate the engine crankshaft until the piston reaches top dead center (TDC) of the compression stroke on the cylinder being tested. In this position, both the intake and exhaust valves will be closed. If the

engine is not properly positioned at TDC the results of the test may be inaccurate.

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.

NOTE: Refer to the Tool Manufacturer's instructions for proper setting.

7. Monitor the flywheel/generator fan for rotation from top dead center as you apply air in the next step.
8. Adjust the regulated pressure on the gauge to the manufacturer's setting for the tool that you are using—typically 90 psi. Verify flywheel/fan has not rotated.
9. Read the gauge on the tester for cylinder percent of leakage. A leakage of 20 percent is normally acceptable. Use good judgment, and listen for air escaping at the carburetor (air intake), the exhaust, the side of the head where head and block join, and the crankcase breather. This will help determine where the fault lies.
10. Repeat Steps 1 through 9 on remaining cylinder if applicable.

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 between the cylinder head and block – the head gasket should be replaced and check both gasket surfaces.

Test 59 – Check Shutdown Wire

General Theory

The controller uses Wire 18 for two purposes:

- to measure engine rpm.
- to shutdown the engine. During a shutdown, controller logic 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. Disconnect Wire 18.
 - **Evolution Units and Nexus Single Cylinder Units** – See [Figure 4-82](#), [Figure 4-84](#) and [Figure 4-85](#). Disconnect Wire 18 at the bullet connector.
 - **Nexus V-twin units** – See [Figure 4-83](#). Remove Wire 18 from the stud located above the oil cooler.

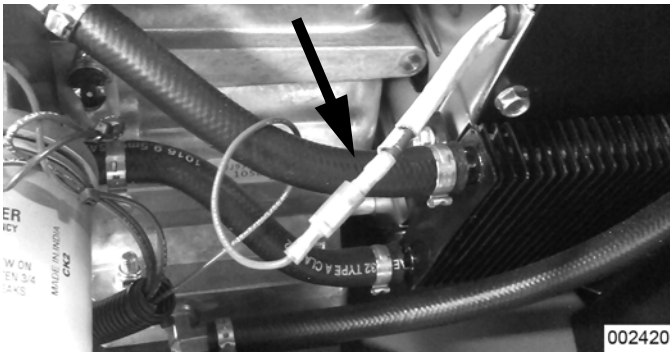


Figure 4-82. Wire 18 Connection – Evolution V-Twin Units

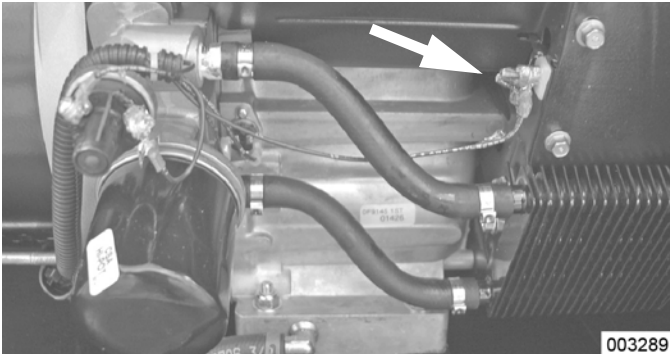


Figure 4-83. Wire 18 Connection – Nexus V-Twin Units

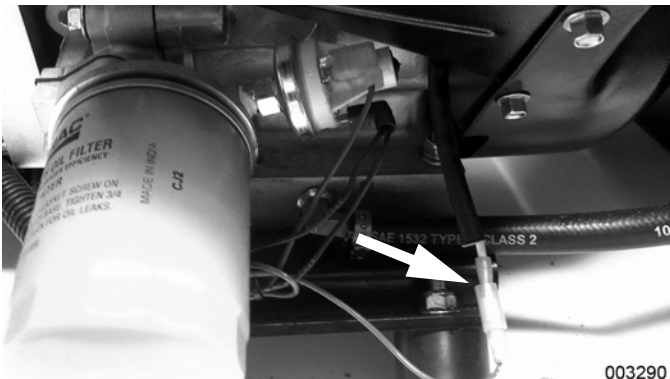


Figure 4-84. Wire 18 Connection – Evolution Single Cylinder Units

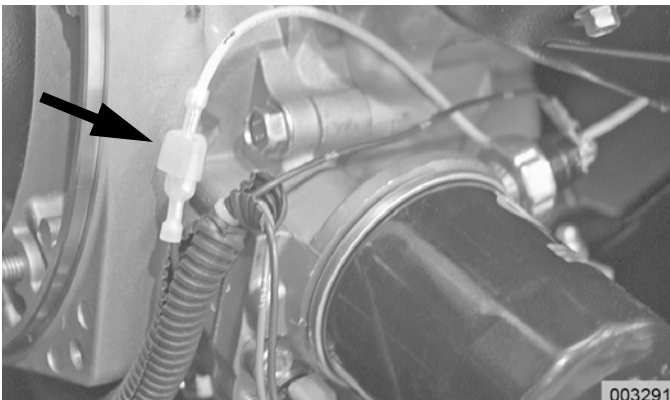


Figure 4-85. Wire 18 Connection – Nexus Single Cylinder Units

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 – Check for Ignition Spark**. Reconnect Wire 56 when done.
3. If spark is now present with Wire 18 removed, proceed to check for a short to ground (Steps 4 through 7).
4. Disconnect the harness connector from the controller.
5. Set the DMM to measure resistance.
6. Connect one meter test lead to Wire 18 (disconnected in Step 1) and connect the other meter test lead to an engine ground. Measure and record the resistance.
7. Connect all disconnected wires and connectors.

Results

1. If the DMM indicated CONTINUITY to ground in Step 6, repair or replace shorted ground Wire 18 between the engine and the controller connector.
2. If the DMM indicated INFINITY 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 – Check and Adjust Ignition Magnets**.

Test 60 – Check and Adjust Ignition Magnets

General Theory

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 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.

NOTE: On V-Twin units a diode is installed in 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. Depending on engine type, do the following:

- **Evolution Units and Nexus Single Cylinder Units** – See [Figure 4-82](#), [Figure 4-84](#) and [Figure 4-85](#). Disconnect Wire 18 at the bullet connector.
 - **Nexus V-twin units** – See [Figure 4-83](#). Remove Wire 18 from the stud located above the oil cooler.
2. Depending on engine type, disconnect spark plug wires from the spark plugs on one or both cylinders.
 3. Set DMM to measure resistance when performing resistance checks and to Diode function when performing the Diode Test.
 4. Follow the chart connections and record readings on DMM to chart.

NOTE: Readings are approximate.

5. **Secondary Resistance Check:** Connect a meter lead to the spark plug wire and connect the other meter lead to battery ground. Record the readings and compare to [Table 4-13](#). Readings are approximate.
6. **Primary Resistance and Diode Check:** Connect the meter lead to the bolt connector or bullet connector where Wire 18 was disconnected in Step 1. Connect the other meter lead to the spark plug wire or to ground following [Table 4-13](#).
7. On V-twin generators, repeat Steps 5 and 6 on Cylinder Two. If readings are not measured, replace the magnetos.

NOTE: On V-twin generators it is recommended to replace magnetos in pairs.

NOTE: Readings can change based on supplier changes. Check GENservice or contact Generac for updates.

NOTE: Resistance values can vary depending on the type and quality of meter being used.

Table 4-13.			
Measurements with Wire 18 disconnected			
Magneto Wire Diagnostics		V-Twins	Single Cyl
POS Test Lead	NEG Test Lead	Ohms	Ohms
To Magneto Wire	To Ground	1.5-2.5 M	.5-1.0
To Ground	To Magneto Wire	OL	3.0
To Magneto Wire	To Plug Wire	1.5-2.5 M	10-11 K
To Plug Wire	To Magneto Wire	OL	10-11 K

Table 4-13.			
Measurements with Wire 18 disconnected			
Magneto Wire Diagnostics		V-Twins	Single Cyl
POS Test Lead	NEG Test Lead	Ohms	Ohms
To Plug Wire	To Ground	7-14 K	9-16 K
Diode Test		V-Twins	Single Cyl
POS Test Lead	NEG Test Lead	VDC	VDC
To Magneto Wire	To Ground	0.5-0.6	N/A
To Ground	To Magneto Wire	OL	N/A
Measurements with Wire 18 connected			
AC Voltage Wire 18 Backprobed		V-Twins	Single Cyl
Cranking		3-5 VAC	1.5-2 VAC
Running @ 3600 rpm		14-20 VAC	7-8.5 VAC
Running @ 3000 rpm		11.5-16.5 VAC	5.8-7 VAC
Frequency		V-Twins	Single Cyl
Cranking		35-45 Hz	13-17 Hz
Running @ 3600 rpm		120 Hz	60 Hz
Running @ 3000 rpm		100 Hz	50 Hz

Procedure: Adjusting Magneto Flywheel Gap

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.

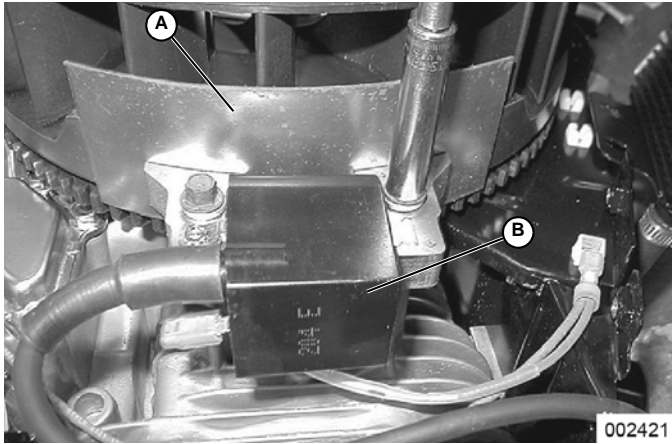
For V-twin engines, proceed as follows:

1. See [Figure 4-86](#). 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) non metallic thickness gauge between the flywheel magnet and the module laminations.

NOTE: A typical 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).



A. 0.008-0.012" Gauge
B. Magneto

Figure 4-86. Setting Ignition Magneto Air Gap

6. Repeat the above procedure for the second magneto.
7. Repeat **Test 55 – Check for Ignition Spark** and check for spark across the spark tester gap.
 - a. A spark test may be conducted with unit disassembled by following this procedure.
 - b. Battery must be connected.
 - c. The harness connector must be connected to the controller.
 - d. Remove Wire 56 from the SCR located beneath the controller.

NOTE: Verify all debris is cleared from the engine compartment and all body parts are clear from flywheel before proceeding.

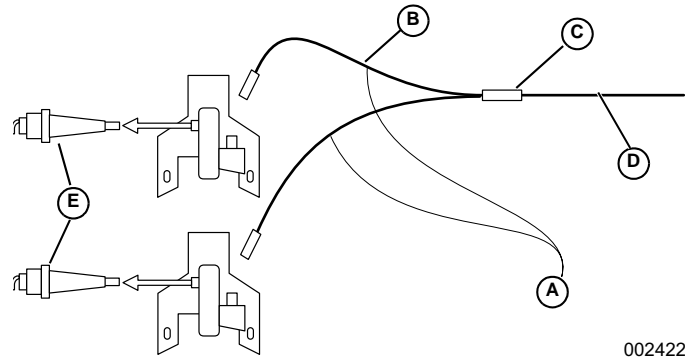
- e. Refer to **Test 55 – Check for Ignition Spark**.
 - f. Connect a jumper wire to the 194 terminal block. Connect the other end to where Wire 56 was disconnected in Step 7d. The engine should crank once the jumper from 194 is connected.
8. If spark was not indicated, replace magnetos.

NOTE: If gap is only adjusted, properly test the magnetos by cranking the engine before reassembly. Spark should be present on both cylinders.

9. If air gap was not out of adjustment, test ground wires.
10. Set a DMM to the measure resistance.
11. See **Figure 4-87**. Disconnect the engine wire harness from the ignition magnetos.

- **Evolution Units and Nexus Single Cylinder Units** – See **Figure 4-82**, **Figure 4-84** and **Figure 4-85**. Disconnect Wire 18 at the bullet connector.
- **Nexus V-twin units** – See **Figure 4-83**. Remove Wire 18 from the stud located above the oil cooler.

12. Connect one meter test lead to one of the wires removed from the ignition magneto(s). Connect the other test lead to an engine ground. INFINITY should be measured. If CONTINUITY is measured, replace the shutdown harness.



A. Remove leads
B. Engine wire harness
C. Stud connector
D. Wire 18 to circuit board
E. Spark plug

Figure 4-87. Engine Ground Harness

13. 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 (19 mm) 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.

NOTE: 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 of how they are connected.

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

3. See **Figure 4-88**. Cylinder one is the back cylinder.
4. See **Figure 4-89**. Cylinder two is the front cylinder.

- See **Figure 4-90**. When installing new magnetos there will be one with a short plug wire and one with a longer plug wire.

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

- Short plug Wire will be installed on back cylinder (Cylinder One).
- Long plug wire (B) will be installed on front cylinder (Cylinder Two).
- 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 **Figure 4-91** and **Figure 4-92**.

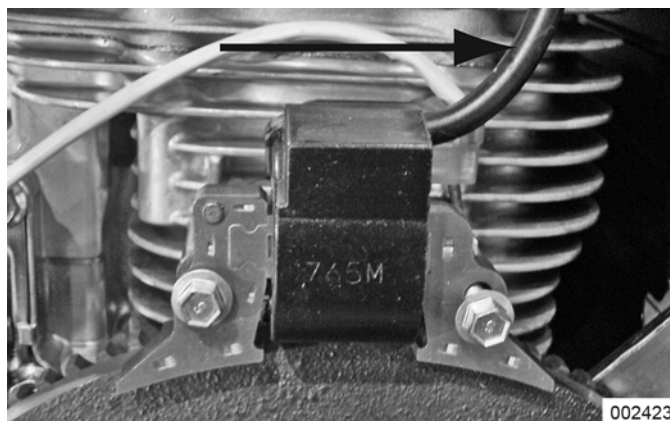


Figure 4-88. Cylinder One (Back, Short)

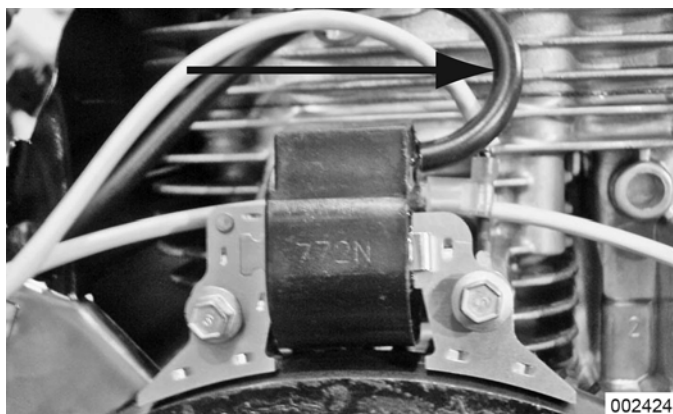
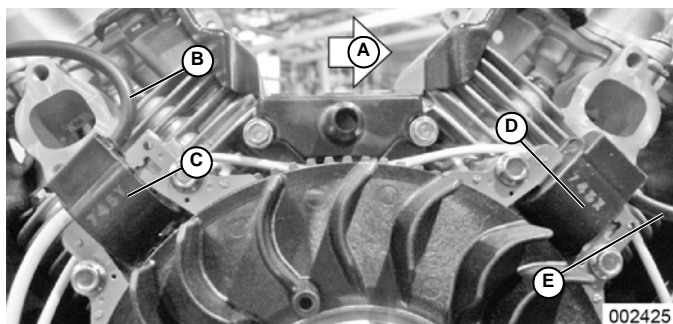


Figure 4-89. Cylinder Two (Front, Long)



- | | |
|-------------------------|--------------------------|
| A. Back Of Enclosure | D. Cylinder One |
| B. Long Spark Plug Wire | E. Short Spark Plug Wire |
| C. Cylinder Two | |

Figure 4-90. Magneto Positions

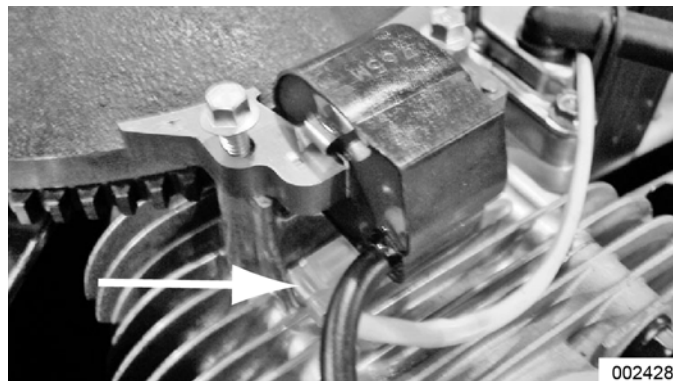


Figure 4-91. Cylinder One Shutdown Wire

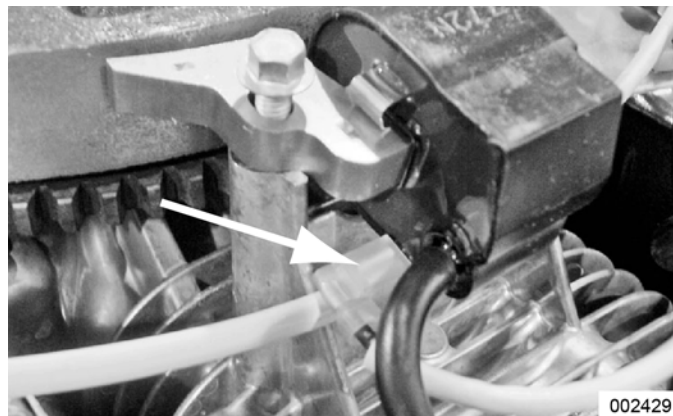


Figure 4-92. Cylinder Two Shutdown Wire

Test 61 – Check Oil Pressure Switch and Wire 86 (Evolution e-Code 1300)

General Theory

If the engine cranks and starts, then shuts down within about 5 (five) to 10 (ten) seconds 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

- Navigate to the Digital inputs display screen of the controller being worked on.
 - See **Figure 4-93**. Digital Input 2 is Wire 86 from the Low Oil Pressure switch to the board.
 - Set the controller to MANUAL.
 - 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.
 - 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.

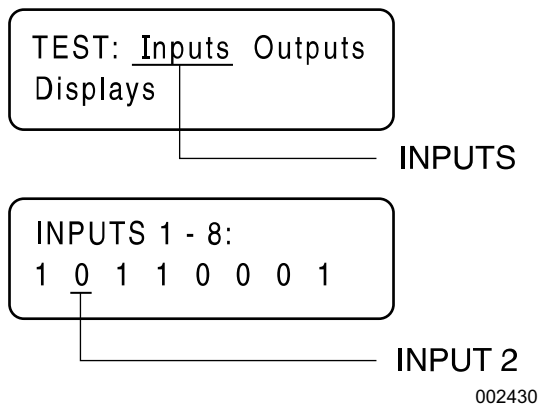


Figure 4-93. The Input Screens

2. Check engine crankcase oil level. 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 5 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: Note: The oil pressure switch is rated at 10 psi for V-twin engines, and 8 psi for single cylinder engines.

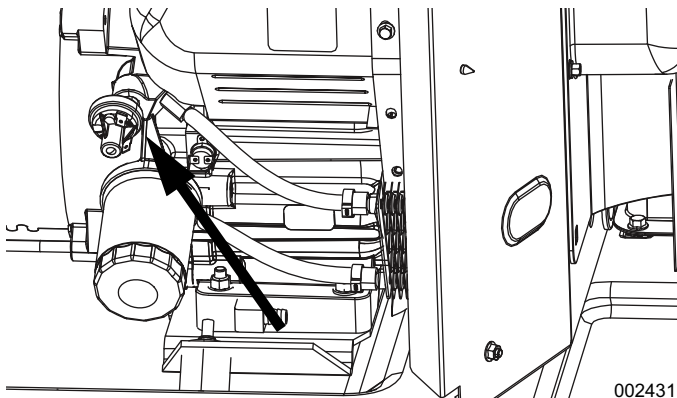


Figure 4-94. Oil Pressure Switch

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 DMM to measure resistance.
 - b. Connect the DMM test lead across the low oil pressure (LOP) switch terminals. With the engine shut down, the DMM should indicate CONTINUITY. If INFINITY was measured, replace the LOP switch.
 - c. With the DMM still connected to the LOP switch, set the AUTO-OFF-MANUAL switch MANUAL. The DMM should indicate INFINITY after the engine has had a chance to build pressure.
6. Set the DMM 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 Step 7 and check continuity on Wire 86 from the LOP switch back to the J4 connector.
 7. Keep the DMM set to measure resistance.
 - a. Disconnect the appropriate harness 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 Wire 86. The DMM should indicate CONTINUITY. If CONTINUITY was not measured repair or replace Wire 86 between the LOP switch and the controller harness connector.
 - c. With Wire 86 still disconnected from the LOP switch and the controller harness connector, connect one meter test lead to disconnected Wire 86 and the other meter test lead to an engine ground. The DMM 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 (e-Code 1400)

General Theory

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

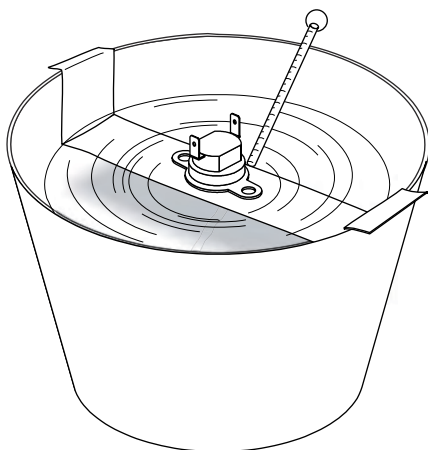
1. Verify that the engine has cooled down (engine block is cool to the touch). This will allow the contacts in the High Oil Temperature Switch to open.
2. Check the installation and area surrounding the generator. There should be at least three feet of clear area around the entire unit. Make sure that 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 DMM to measure resistance. Connect the test leads across the switch terminals. The meter should read INFINITY (OL).
5. If the switch tested good in Step 4, and a true overtemperature condition has not occurred, proceed to step 6.
6. Remove harness connector from the controller.
7. Set the DMM to measure resistance.
8. Connect one test lead to Wire 85 (disconnected from High Oil Temperature Switch). Connect the other test lead to an engine ground. INFINITY should be measured.

Testing High Oil Temperature Switch

9. Remove the High Oil Temperature Switch.
10. See [Figure 4-95](#). Immerse the sensing tip of the switch in oil, along with a suitable thermometer.
11. Set a DMM to measure resistance. Then, connect the DMM test leads across the switch terminal and the switch body. The meter should read INFINITY.
12. Heat the oil in the container. When the thermometer reads approximately 283°-305° F. (139°-151° C.), the DMM should indicate CONTINUITY.

Results

1. If the switch fails Step 4, or Steps 11-12, replace the switch.
2. If INFINITY was not measured in Step 8, repair or replace Wire 85 between the Circuit Board and the High Oil Temperature Switch.



002432

Figure 4-95. Testing the Oil Temperature Switch

Test 63 – Check and Adjust Valves

General Theory

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 procedures for single cylinder and V-twin engines are different and vary according to engine displacement.

Check Valve Clearance

⚠ DANGER

Automatic start-up. Disconnect utility power and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

(000191)

NOTE: The engine should be cool before checking the valve clearance. Adjustment is not needed if valve clearance is within the dimensions provided in Section 1.1 [Specifications](#).

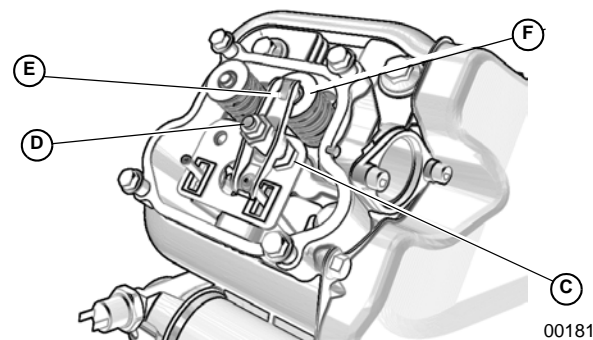
Verify the piston is at Top Dead Center (TDC) of its compression stroke (both valves closed). The cold valve clearance specification is 0.05-0.1mm (0.002-0.004 in).

NOTE: A small non-metallic object, such as a plastic straw, can be inserted through the spark plug opening and rested on the piston. Piston movement will cause the object to move up and down, giving a visual indication of TDC.

Adjust Valve Clearance

See [Figure 4-96](#) or [Figure 4-97](#). Check and adjust the valve to rocker arm clearance as follows:

1. Remove the four screws attaching the valve cover and remove valve cover.
2. Discard valve cover gasket.
3. Loosen the rocker jam nut (C) using a 10 mm wrench (9-11 kW units) or 13 mm wrench (16-22 kW units.)
4. Turn the pivot ball stud (D) using a 14 mm wrench (9 kW units), 8 mm wrench (11 kW units), or 10 mm Allen wrench (16-22 kW units) while checking clearance between the rocker arm (E) and the valve stem (F) with a feeler gauge. Adjust clearance as per Section 1.1 [Specifications](#).



001812

Figure 4-96. Valve Clearance Adjustment (9 kW - 426cc engine)

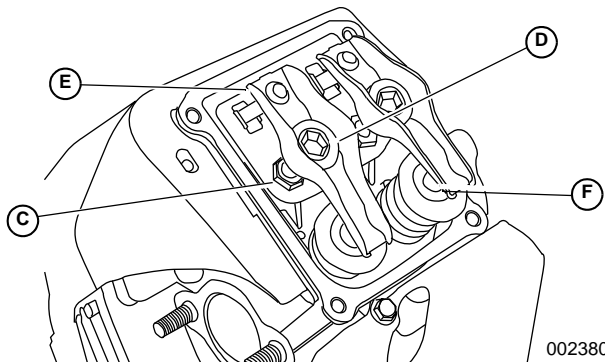


Figure 4-97. Valve Clearance Adjustment (8 kW, 11-22 kW - 530cc through 999cc)

NOTE: Hold the rocker arm jam nut in place as the pivot ball stud is turned.

5. When valve clearance is correct, hold the pivot ball stud (D) in place with a wrench and tighten the rocker arm jam nut. Tighten the jam nut according to the following torque specifications:

7-8 kW	174 in-lbs (19.68 Nm)
9 kW	53 in-lbs (6.0 Nm)
11 kW	72 in-lbs (8.2 Nm)
16-22kW	174 in-lbs (19.68 Nm)

6. After tightening the jam nut, check valve clearance again to verify it did not change.
7. Install new valve cover gasket.
8. Install the valve cover. Tighten fasteners in a cross pattern to:

7-8 kW	48 in-lbs (5.4 Nm)
9 kW	80 in-lbs (9.0 Nm)
11-22kW	60 in-lbs (6.8 Nm)

9. Repeat the process for the other cylinder if unit is a V-Twin.

Test 64 – Check Wire 18 Continuity

General Theory

During cranking and running, the controller receives a pulse from the ignition magneto(s) via Wire 18. During cranking, this signal has an AC voltage of approximately 3-6 Volts on V-twin engines, and approximately 2-3 Volts on single cylinder engines. If the controller does not receive this signal, the unit will shut down due to no rpm sensing.

Procedure

1. Set the DMM to measure AC voltage.
2. See [Figure 4-98](#) and [Figure 4-99](#).
 - On a Nexus V-twin unit, connect one meter test lead to Wire 18 at the stud connector. Connect the other meter test lead to an engine ground.
 - On Evolution V-twin and single cylinder units and the Nexus single cylinder units back probe the harness connector.

3. Set the controller to MANUAL.
4. While unit is cranking measure and record the voltage.
 - a. If the DMM indicated approximately 3-6 VAC for V-twin or 2-3 VAC for single cylinder, proceed to Step 6.
 - b. If the DMM did NOT indicate the appropriate voltage, go to the Step 5.

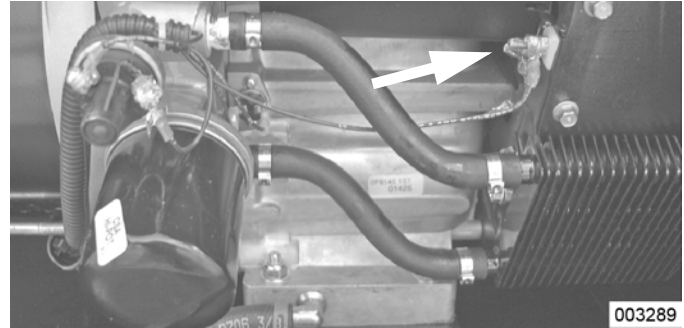


Figure 4-98. Wire 18 Connection – Nexus V-Twin Units

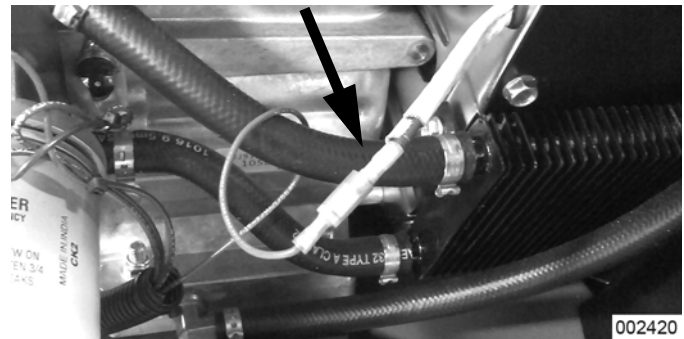


Figure 4-99. Wire 18 Connection Evolution V-Twin and Single Cylinder Units and Nexus Single Cylinder Units

5. Disconnect Wire 18 from the stud on the Nexus V-twin unit. On the Evolution V-twin and single cylinder units, or Nexus single cylinder unit, disconnect Wire 18 from magneto sensing lead.
 - a. Connect one meter test lead to an engine ground and connect the other meter test lead to the magneto lead terminal.
 - b. Set the controller to MANUAL and while unit is cranking measure and record the voltage.
 - c. If the DMM indicated approximately 3-6 VAC for V-Twin and 2-3 VAC for single cylinder, proceed to Step 6.
 - d. If the DMM did NOT indicate the appropriate voltage, go back to the flow chart (Problem 14) and follow “No Signal” (**Test 60**).
6. Set the DMM to measure resistance.
7. Disconnect the harness connector containing Wire 18 from the controller.
8. Connect one meter test lead to an engine ground and connect the other meter test lead to Wire 18.
 - a. If the DMM indicated low resistance (.01), check for a short to ground in the Wire 18 circuit.

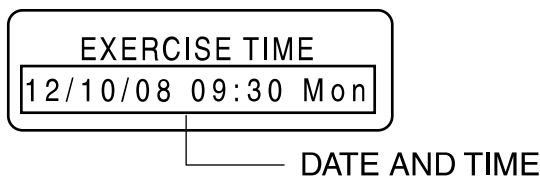
- b. If the DMM indicated 0/L OPEN circuit proceed to Step 9.
9. Connect one meter test lead to harness side of Wire 18 that went to the magneto and connect the other meter test lead to Wire 18 at the controller connector.
 - a. If the DMM indicated CONTINUITY, refer back to the flow chart (Problem 14, RPM Sense Loss).
 - b. If the DMM indicated INFINITY repair or replace Wire 18 between the magneto connector and the controller connector.

Test 65 – Test Exercise Function

General Theory

The following parameters must be met in order for the weekly exercise to occur:

- Exercise Time set in controller.
- Controller set to AUTO.



002434

Figure 4-100. The Exercise Screen

Procedure: 8 kW-14 kW

NOTE: Utility voltage must be present.

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. Navigate to the Exercise settings screen of the controller being worked on.
3. Press “Enter”.
4. Adjust exercise time to 5 minutes ahead of the date and time noted in Step 1.
5. Return to the Main Display where “READY TO RUN” is displayed. The controller must be in AUTO mode for the unit to exercise.
6. Watch the generator display and note the time. When the date and time reaches the time that was programmed for exercise the unit should crank and run. “Running in Exercise” will display if the exercise feature is working properly.

Evolution Procedure: 15-20 kW (11-20 kW Honeywell™)

NOTE: Utility voltage must be present.

1. Set the controller to AUTO.
2. Enter the Dealer Password to enter the Dealer Edit Menu.
3. Select “Test.”

4. Press ENTER.
5. Press arrow key until “IN AUTO PRESS ENTER FOR QT-TEST” is displayed.
6. Press ENTER.
7. The generator should start and run the low speed exercise.
8. To stop test press ENTER.

Nexus Procedure: 17-20 kW

NOTE: Utility voltage must be present.

1. Set the controller to AUTO.
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” begins to flash.
6. Press “Enter.”
7. The generator should start and run its normal exercise period.

Results

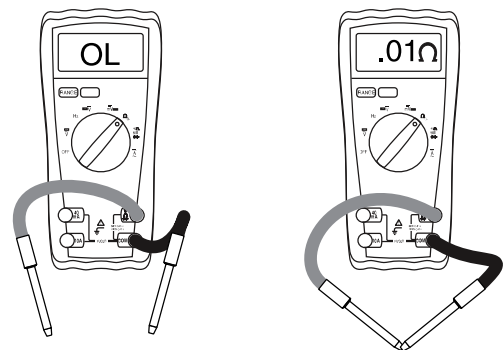
1. In all models, if the unit starts in MANUAL, but fails to exercise without any ALARMS present, replace the controller.

Test 66 – Test Cranking and Running Circuits

General Theory

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 4-14](#) throughout the procedure for the known resistance values of components.

[Figure 4-101](#) shows the DMM in two different states. The left DMM indicates an OPEN circuit or INFINITY. The right DMM indicates a dead short or CONTINUITY. Throughout the troubleshooting, refer to [Figure 4-101](#) as needed to understand what the meter is indicating about the circuit being tested.



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Figure 4-101. INFINITY (Left) and CONTINUITY (Right) Meter Readings

NOTE: CONTINUITY is equal to 0.01 ohms of resistance or a dead short.

Component	Resistance
Starter Contactor	8Ω
Starter Contactor Relay	155 - 158Ω
Fuel Solenoid(s)	15 - 16Ω
Choke Solenoid (Nexus only)	3 - 4Ω

Procedure

1. Set a DMM to measure resistance.
2. Disconnect the harness from the controller.
3. Connect one meter lead to battery negative (ground) and connect the other meter test lead to each of the tests points in [Table 4-15](#). Measure and record the resistance.

Test Point	Pin Location	Circuit	20 kW
1	*	Wire 14	16Ω
2	*	Wire 56	155Ω

* Use Appendix A for pin locations

Results

1. Compare the results of Step 3 with [Table 4-15](#).
 - a. If the DMM indicates less than the value in table 4-16 at Test Point 1 proceed to [Test 67 – Test Run Circuit](#).
 - b. If the DMM indicates less than the value in table 4-16 at Test Point 2 proceed to [Test 68 – Test Crank Circuit](#).
 - c. If the DMM indicated proper resistance values at all Test Points, refer to FB3 (Evolution) or FB4 (Nexus) Diode Test.

Test 67 – Test Run Circuit

General Theory

Wire 14 provides 12 VDC during cranking and running. If the DMM indicated less than 15 Ohms in the previous test, one possible cause could be a faulty harness or solenoid.

Procedure: 8 kW

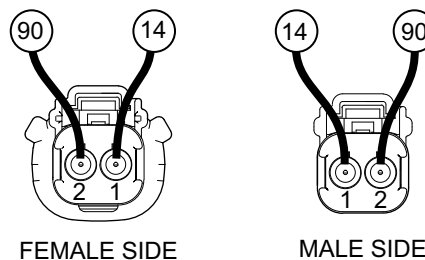
1. Set a DMM to measure resistance.
2. Disconnect Wire 14 from the fuel solenoid (FS).
3. Connect one meter test lead to the FS terminal from which Wire 14 was removed. Connect the other meter test lead to the ground terminal. Measure and record the resistance.

Results

1. If the DMM indicated less than 15 ohms in Step 3, replace the FS solenoid.
2. Refer to [Table 4-15](#) and if the DMM indicated the correct resistance for the component, a short to ground exists on Wire 14. Repair and replace Wire 14 as needed.

Procedure: 10 kW

1. Set a DMM to measure resistance.
2. Disconnect Wire 14 from the fuel solenoid (FS), fuel solenoid 2 (FS2, if equipped), 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. See [Figure 4-102](#). Connect one meter test lead to Pin 1 on the male side of the CS connector. Connect the other meter test lead to Pin 2. Measure and record the resistance.



FEMALE SIDE MALE SIDE
Figure 4-102. C3 Choke Solenoid Connector

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Results

1. If the DMM indicated less than 15 ohms in Step 3, replace the FS solenoid.
2. If the DMM indicated less than 30 ohms in Step 4, replace the FS2 solenoid.
3. If the DMM indicated less than 3 ohms in Step 5, replace the CS solenoid.
4. Refer to [Table 4-15](#) and if the DMM indicated the correct resistance for the component, a short to ground exists on Wire 14. Repair or replace Wire 14 as needed.

Procedure: 12 kW - 20 kW

1. Set a DMM 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.

- See [Figure 4-102](#). Connect one meter test lead to Pin 1 on the male side of the CS connector. Connect the other meter test lead to Pin 2. Measure and record the resistance.

Results

- If the DMM indicated less than 15 ohms in Step 3, replace the FS solenoid.
- If the DMM indicated less than 30 ohms in Step 4, replace the FS2 solenoid.
- Refer to [Table 4-15](#) and if the DMM 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

General Theory

Wire 56 provides 12 VDC during cranking only. If the DMM indicated less than 8 ohms (8 kW) at the starter contactor or less than 155 ohms (10-20 kW) at the starter contactor relay in the previous test, one possible cause could be a faulty relay or solenoid.

Procedure: 8 kW

- Set a DMM to measure resistance.
- Disconnect Wire 56 from the starter contactor (SC) and on Nexus units disconnect the choke solenoid (CS).
- 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.
- See [Figure 4-103](#). Connect one meter test lead to Pin 1 on the male side of the CS connector. Connect the other meter test lead to Pin 2. Measure and record the resistance.

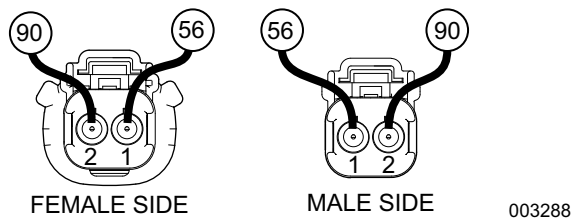


Figure 4-103. CS Choke Solenoid Connector

Results

- If the DMM indicated less than 8 ohms of resistance in Step 3, a short exists. Repair or replace as needed.
- If the DMM indicated less than 3 ohms in step 4 replace the CS solenoid.

Procedure: 10 kW-20 kW

- Set a DMM to measure resistance.

- Disconnect Wire 56 and 0 from the starter contactor relay (SCR).
- 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.
- See [Figure 4-103](#). Connect one meter test lead to Pin 1 on the male side of the CS connector. Connect the other meter test lead to Pin 2. Measure and record the resistance.

Results

- If the DMM indicated less than 155 ohms in Step 3, replace the SCR relay.
- If the DMM indicated less than 3 ohms in step 4 replace the CS solenoid.
- Refer to [Table 4-14](#) and if the DMM indicated the correct resistance for the component, a short to ground exists on Wire 56. Repair and replace Wire 56 as needed.

Test 70 – Check to See If Low Speed Function is Enabled

(Available only on certain models)

General Theory

Some generators are equipped with a low speed exercise function. When enabled, the low speed exercise function allows the generator to exercise at 2400 rpm. When low speed exercise is disabled the generator will exercise at 3600 rpm.

Procedure – Evolution (If equipped)

- From the main display enter the Edit Menu using the menu map.
- Press UP or DOWN Arrow key until “Exercise Time” is displayed.
- Press ENTER.
- “Quiet Test Mode? Yes or No” will be displayed. Press UP or DOWN Arrow key until “Yes” is displayed.
- Press ENTER to save change.
- Return to Main Display.

Procedure – Nexus

- Navigate to the Set Exercise display screen of the controller being worked on and check to see if the exercise function is enabled.

Results

Enable the exercise function if it is not already enabled. Refer back to flow chart.

Test 71 – Check operation of the Choke Solenoid (Nexus Only)

General Theory

The choke solenoid should be closed during low speed exercise.

Procedure

1. Remove the air box cover and air filter from the engine.
2. Refer to [Test 65 – Test Exercise Function](#).
3. When the generator starts and the display indicates that unit 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 – Check Choke Solenoid \(Nexus Only\)](#).

Test 75 – Test 120 Volt Input (T1) 60 Hz 240 Volt Input (T1 - T2) 50 Hz

General Theory

The controller requires 120 VAC (60 HZ Unit) or 240 VAC (50 HZ Unit) 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 (60 Hz) or 240 VAC (50 Hz) input is good.
2. If the controller powered down when the fuse was removed, the controller is not getting the 120 VAC (60 Hz) or 240 VAC (50 HZ) input. Return to the flow chart (Test 79).

Test 76 – Verify DC Voltage Output of the Controller

General Theory

The battery voltage of the unit can be viewed within the “Display” (Evolution) or “Status” (Nexus) menu of the controller. This test procedure will verify battery voltage to the controller.

Procedure

1. Use the Navigation Menu Map for the controller being serviced.

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 11 VDC, check cables and connections, or charge or replace the battery.

Test 77 – Check Wire 13 and Wire 0

General Theory

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 DMM 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 battery negative (ground). Measure and record the voltage.
4. Disconnect the appropriate harness connector from the controller.
5. Connect one meter test lead to harness connector pin for Wire 13 and the other meter test lead to harness connector pin for Wire 0. Measure and record the voltage.

Results

1. If the DMM indicated battery voltage in Steps 3 and 5, replace the controller.
2. If the DMM indicated battery voltage in Step 3, but did NOT indicate battery voltage in Step 5, repair or replace Wire 0 between the harness connector and the ground stud.

Test 78 – Test DC Charge Current to the Battery

General Theory

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: A “Low Battery” or “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 controller to MANUAL and crank the engine for 2 -3 seconds.
2. Set the controller to OFF.
3. Disconnect the negative cable battery.
4. Set the DMM 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.

5. 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.

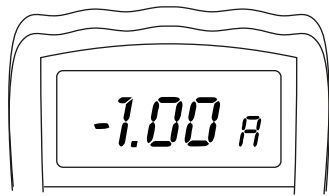
Results

1. If the DMM indicated positive DC amperage between 50 milliamps to 2.5 amps, stop testing. The charger is functioning properly.
2. If the DMM indicated negative DC amperage, replace the controller.



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Figure 4-104. Positive DC Amps



002436

Figure 4-105. Negative DC Amps

Test 79 – Check T1 Voltage at Customer Connections

Procedure

1. Set a DMM 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 DMM indicated 120 VAC, proceed to check voltage at the J5 connector, refer back to flow chart.
2. If the DMM indicated less than 120 VAC or 0, refer back to flow chart.

Test 80 – Check T1 Voltage at Controller Connector

General Theory

If 120 VAC was available on the customer connection block between T1 and neutral for 60 Hz units, or 240 VAC between T1 and T2 for 50 Hz units, the problem may be an open wire or bad connector at the controller harness connection.

Procedure

1. Disconnect the controller connector at the control panel.
2. Set the DMM to measure AC voltage.
 - a. For 60 Hz units check the voltage at the controller harness connector pin between Wire T1 and the neutral connection on 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 controller harness connector.
 - b. For 50 Hz units check the voltage at the controller harness connector pins between T1 and the neutral connection, then between T2 and the neutral connection on the customer connection block. If voltage is not present check the T1/T2 wires from the customer connection block to the controller harness connector. If Voltage is present, replace the controller.
3. For 60 Hz units only, check the voltage between Wire 00 of the controller harness connector pin and T1 at the customer connection block. If voltage is present inspect and repair the connection pins at controller harness connector. If voltage is not available, check the 00 wire from the customer connection block to the controller harness connector.

- If 120 VAC is present between T1 and 00 of the controller harness connector, and the pins are in good condition, then the fault is in the controller. Replace the controller.

Test 81 – Check T1/T2 Voltage in Transfer Switch

General Theory

If voltage was not present in the generator, the most likely cause is a blown T1/T2 fuse or an open wire.

Procedure

- Set the DMM to measure AC voltage.
- Connect one meter test lead to the bottom side of the T1 fuse holder (T1/T2 for 50 Hz units) and the other meter test lead to the NEUTRAL connection. Measure and record the voltage.

Results

- If the DMM indicated proper voltage, repair or replace faulty wire between the generator and the fuse holder.
- If the DMM indicated less than proper voltage or 0, refer back to the flow chart.

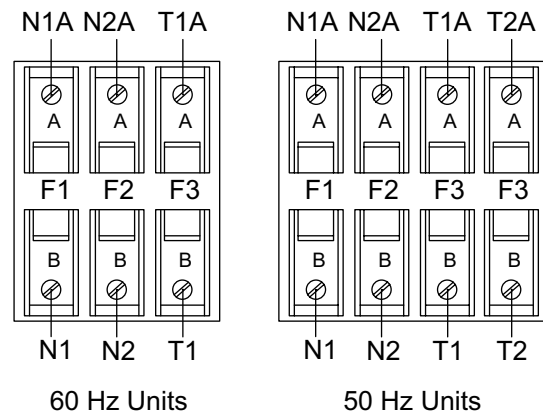
Test 82 – Test F3 Fuse Circuit

Procedure

- Set a DMM to measure AC voltage.
- 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.
 - If the DMM indicated 120 VAC, proceed to Step 3.
 - If the DMM indicated less than 120 VAC or 0, verify that Load voltage is available to the LOAD side of the CONTACTOR.
- Set the controller to OFF.
- Disconnect Utility from the transfer switch.
- See [Figure 4-106](#). Remove fuse F3 from the fuse holder.
- Inspect and test fuses for an OPEN condition with a DMM set to measure resistance. CONTINUITY should be measured across the fuse.

Results

- Replace blown fuse as needed and proceed to Problem 10 “Blown T1 Fuse.”



003304

Figure 4-106. Transfer Switch Fuse Block

Section 5.1 Major Disassembly

2013 Front Engine Access

Safety

1. Set the controller to OFF.
2. See [Figure 5-1](#). Remove the 7.5 amp main fuse.
3. Remove the N1 and N2 fuses from the transfer switch.



Figure 5-1. Remove 7.5 Amp Fuse (Nexus)



Figure 5-2. Remove 7.5 Amp Fuse (Evolution)

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 the front door.
7. Remove battery from the generator.

Front Engine Access

1. **Remove Controls Cover:** See [Figure 5-3](#) or [Figure 5-4](#). Depending on unit, use a Torx T-27 socket or 5/32" (4 mm) Hex Allen socket to remove screws and ground washer from the controls cover. Remove the controls cover.



Figure 5-3.



Figure 5-4.

2. **Remove Nexus Controller:** See [Figure 5-5](#). Use a 10 mm socket to 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.



Figure 5-5.

3. **Remove Evolution Controller:** See [Figure 5-6](#). Use a 1/4" socket to remove the screw that is directly underneath the support bracket and then slide the controller back to line up the tabs on the controller with the openings on the divider wall.



Figure 5-6. Tabs on Controller

4. **Remove Control Harnesses:** See [Figure 5-7](#) or [Figure 5-8](#). Disconnect all connectors and remove the controller.



Figure 5-7. Nexus Controller Connections



Figure 5-8. Evolution Controller Connections

5. **Remove Stator Wires:** See [Figure 5-9](#). Remove all wires from the main circuit breaker, remove the neutral and ground wires from landing lugs.

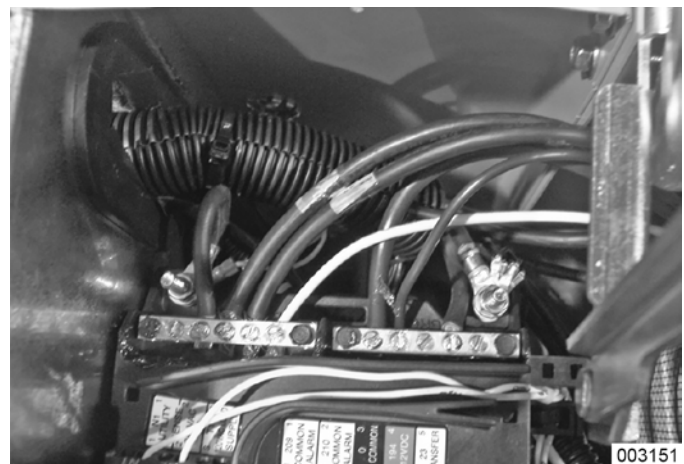


Figure 5-9.

6. **Remove Control Wires:** See [Figure 5-10](#). Remove Wires N1, N2, T1, 0, 194, 23, GFCI Outlet, and unit status lights from the control box.

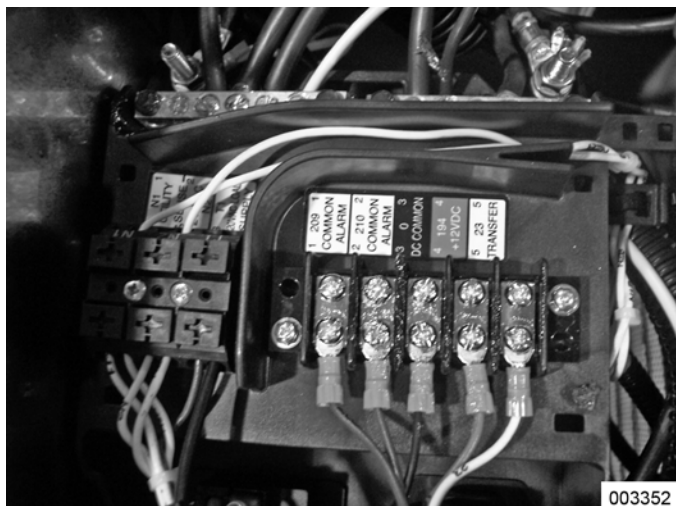


Figure 5-10.

7. **Remove Controller Mounting Box On Nexus Controllers:** See [Figure 5-11](#). On units with Nexus controllers, use an 8 mm socket to remove the two screws from the rear of the controller mounting box. Use a 10 mm socket to remove the two bolts from under the front of the controller mounting box.

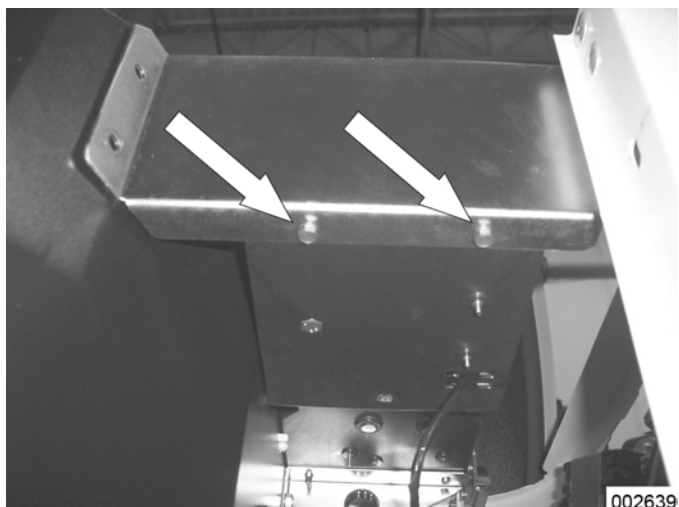


Figure 5-11.

8. **Remove Engine Intake Baffle:** See [Figure 5-11](#). Use a 10 mm socket to remove the two bolts from the engine intake baffle. Pull baffle out carefully, there are tabs holding the backside of the baffle to the divider panel.



Figure 5-12.

9. **Loosen Side Panel:** See [Figure 5-11](#). Using a 10 mm socket remove the two bolts from the base of the enclosure side panel.
10. **Unbolt Enclosure Side Panel Mounting Bracket:** See [Figure 5-11](#). Using a 10 mm socket remove the two bolts from the enclosure side panel mounting bracket.



Figure 5-13.

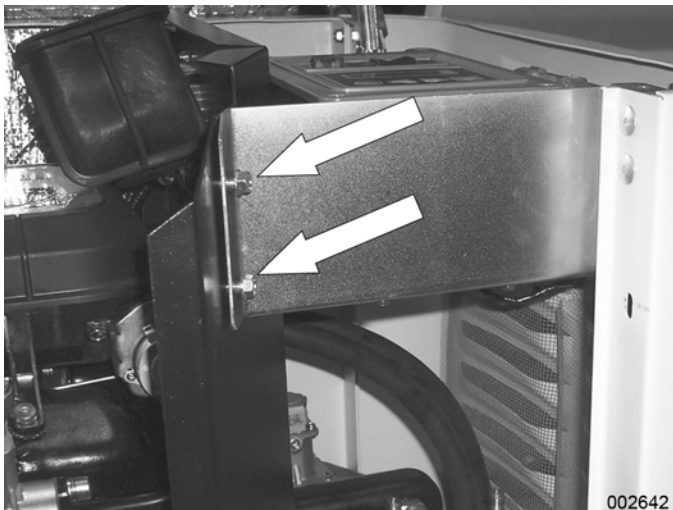


Figure 5-14.

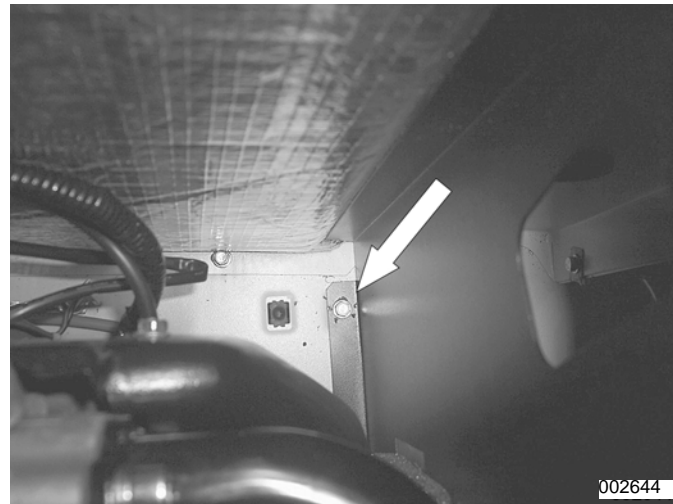


Figure 5-16.

11. **Remove Fuel Regulator:** See [Figure 5-15](#). Remove the two fuel hoses at the top of the regulator. Use a 10 mm socket to remove one 10 mm bolt from the base of the plenum and one 10 mm bolt from the base of the fuel regulator. Flex the enclosure side out to allow for room to remove the regulator assembly.

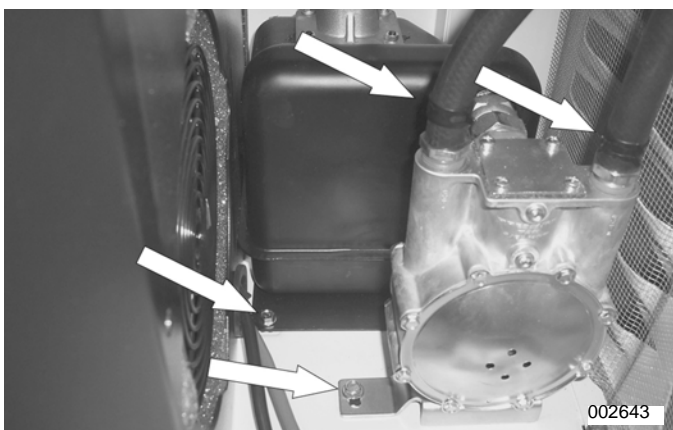


Figure 5-15.

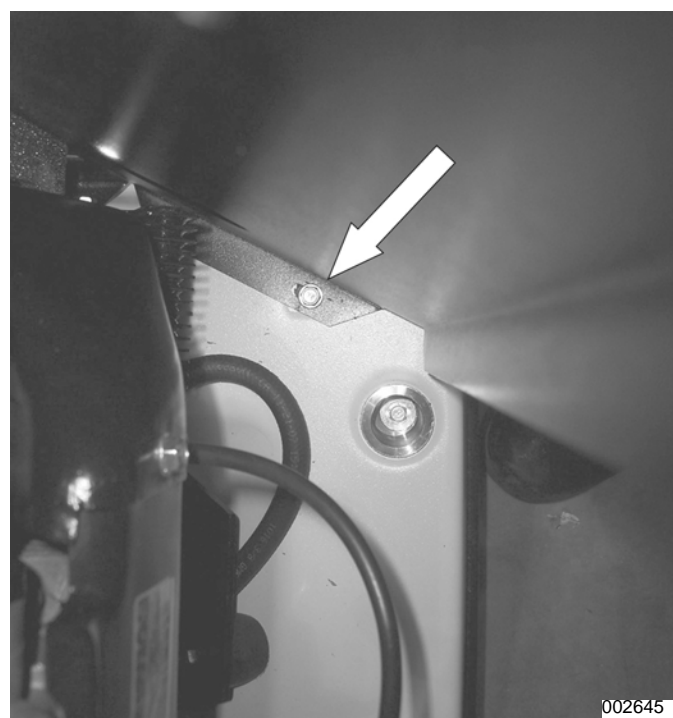


Figure 5-17.

12. **Remove Engine Divider Panel:** See [Figure 5-16](#). Use a 10 mm socket to remove the rear 10 mm bolt from the base of the enclosure. See [Figure 5-17](#). Remove the front 10 mm bolt from the base of the enclosure.

13. **Remove Air Box on Nexus units:** See [Figure 5-18](#). Use a 6 mm Allen wrench to remove the four intake manifold socket head cap screws. See [Figure 5-19](#). Use a 4 mm Allen wrench to remove the four airbox Allen head shoulder bolts. While removing the airbox remove the four rubber washers.



Figure 5-18. Nexus Intake Manifold

003150



Figure 5-21. Evolution Air Box

002647

14. **Unbolt Oil Cooler:** See [Figure 5-22](#). Use a 10 mm socket to remove the two 10 mm bolts from the front of the oil cooler. See [Figure 5-23](#). Remove the two 10 mm bolts from the rear of the oil cooler.



Figure 5-19. Nexus Air Box

003152

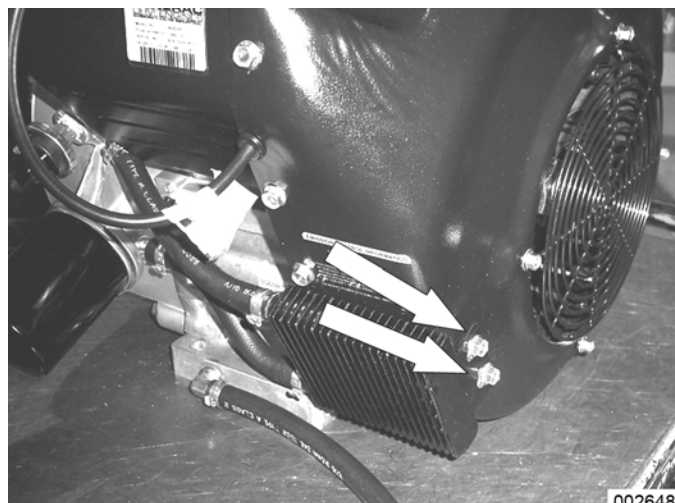


Figure 5-22.

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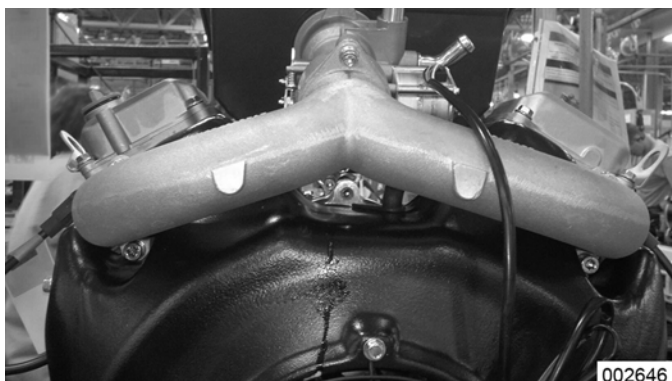


Figure 5-20. Evolution Intake Manifold

002646

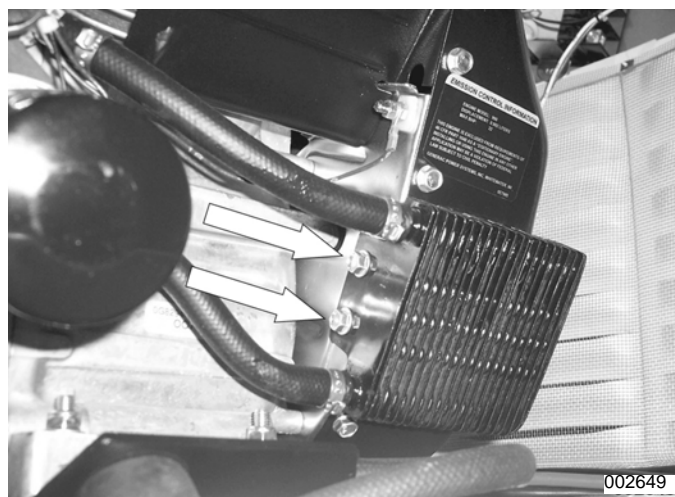


Figure 5-23.

002649

15. **Remove Blower Housing:** See [Figure 5-24](#). Use a 4 mm Allen wrench to remove one button head cap screw from top of blower housing. Use a 10 mm socket to remove one 10 mm bolt from the top of the blower housing.



Figure 5-24.

16. See [Figure 5-25](#) and [Figure 5-26](#). Use a 10 mm socket to remove four 10 mm bolts from the right-side of the blower housing, and four 10 mm bolts from the left-side of the blower housing.
17. Remove blower housing.



Figure 5-25.

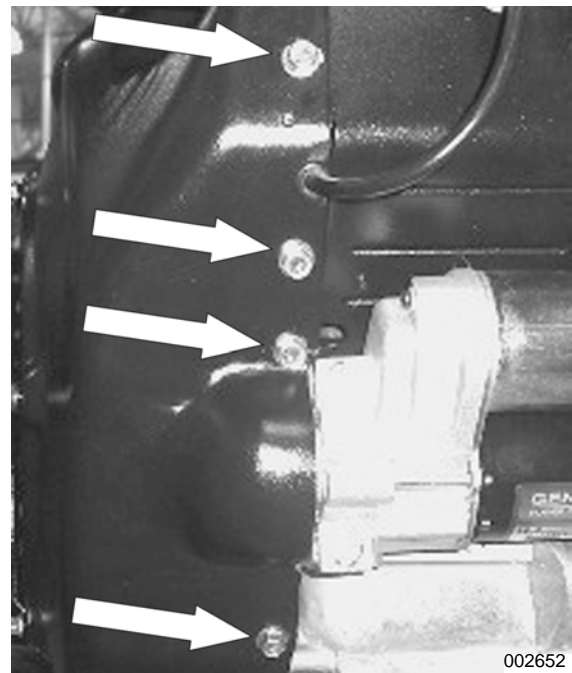


Figure 5-26.

2017 HSB Front Access

1. Set the controller to OFF.
2. Remove the 7.5 amp main fuse.



Figure 5-27.

3. Remove the N1 and N2 fuses from the transfer switch.
4. Turn off fuel supply to the generator.
5. Remove the front door and the right side access panel
6. Remove battery.

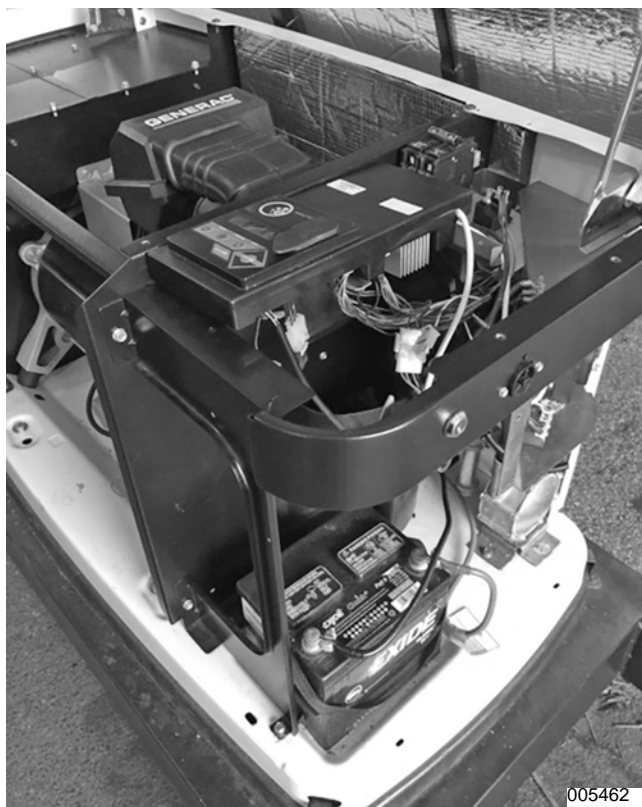


Figure 5-28.

7. **Remove Controls Cover:** Use a 4mm Hex Allen socket to remove the bolts and ground washer from the controls cover.
8. Remove the controls cover.
9. Remove the controller.



Figure 5-29.

10. Remove control harnesses.
11. Disconnect all connectors and remove the controller.

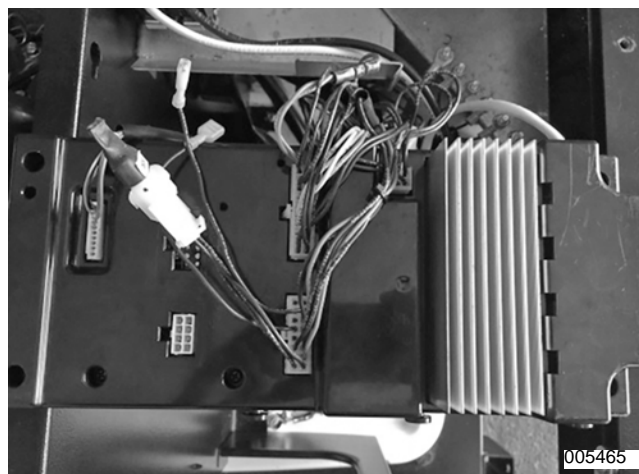


Figure 5-30.

12. Remove right side support panel from divider panel.



Figure 5-31.

- 13. Remove engine intake baffle.
- 14. Use a 10 mm socket to remove the two bolts from the engine intake baffle. Pull baffle out carefully. There are tabs holding the back of the baffle to the divider panel.

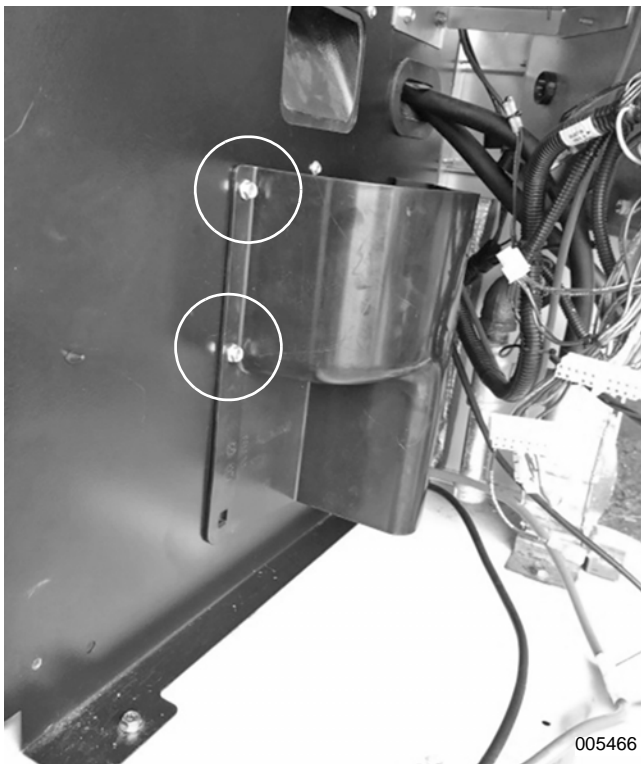


Figure 5-32.

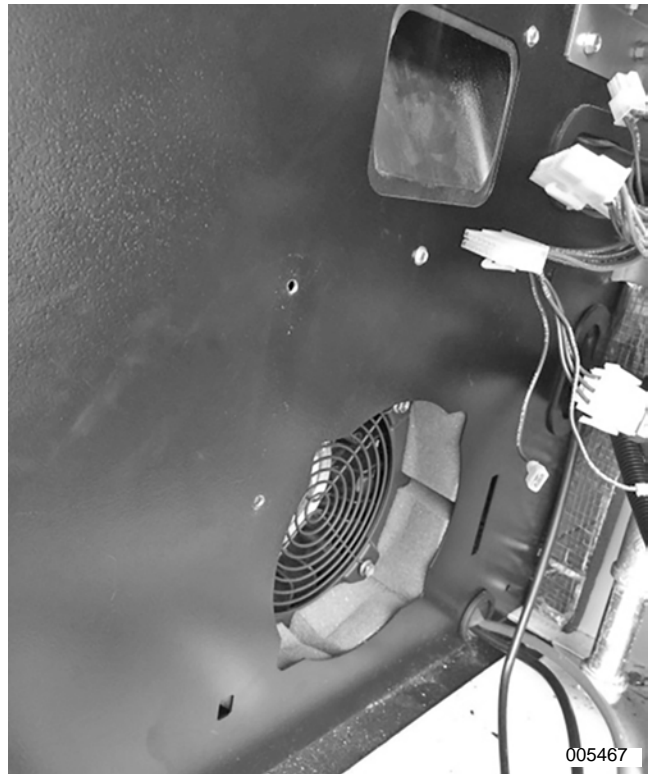


Figure 5-33.

- 15. Remove circuit breaker mounting plate.



Figure 5-34.

- 16. Remove cap screw located above the electrical connection pad in the customer connection area.

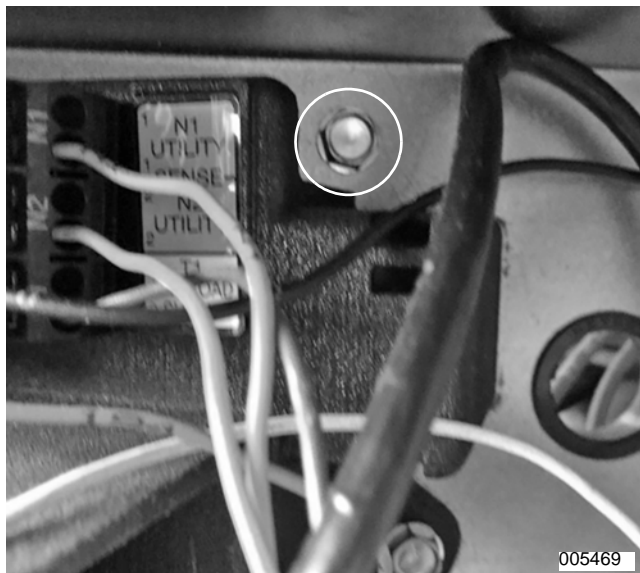


Figure 5-35.

17. Remove the 2 inside cap screws under the breaker tray connecting to the divider panel.

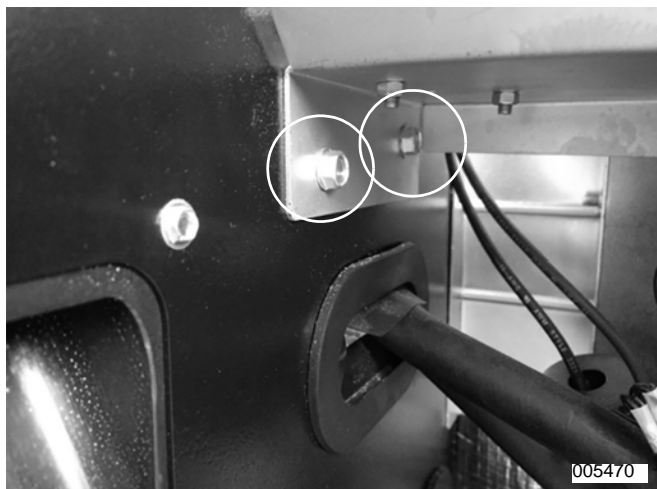


Figure 5-36.

18. Disconnect wires from breaker.



Figure 5-37.

19. Swing breaker with tray out of the way leaving the wires on the outlet side of breaker connected.

20. Remove air cleaner cover and rubber inlet duct.



Figure 5-38.

21. Remove the 2 brass colored mounting screws from the divider panel to the base.



Figure 5-39.

22. Remove two cap screws from the back of the divider panel (located on the engine side).



Figure 5-40.

23. Remove Allen screw back side of divider panel to back panel of generator.



Figure 5-41.

24. Pivot panel out for access to front of engine.

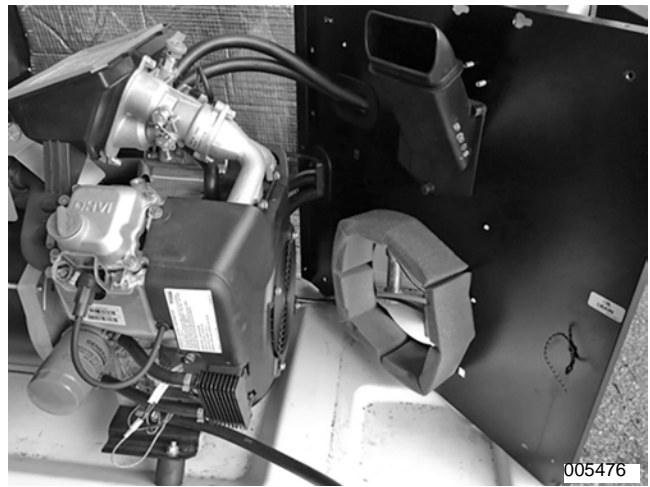


Figure 5-42.

25. Remove the blower housing (front engine cover) per Engine Service manual procedures.

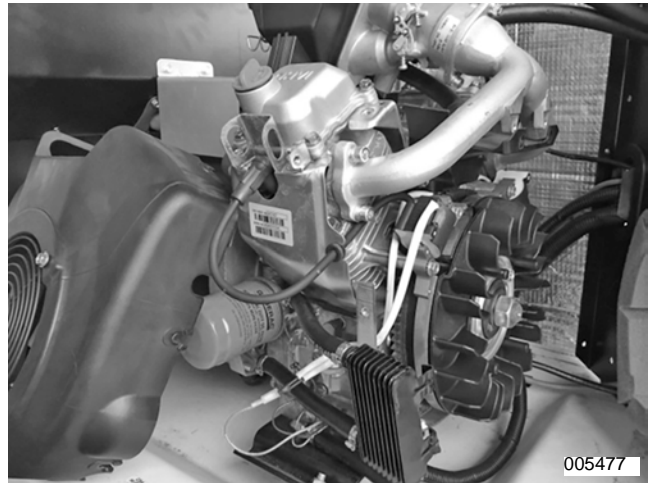


Figure 5-43.

26. Reassemble in reverse order.

Major Disassembly

Safety

1. Set the controller to OFF.
2. See [Figure 5-44](#). Remove the 7.5 amp main fuse.
3. Remove the N1 and N2 fuses from the transfer switch.



Figure 5-44. Remove 7.5 Amp Fuse (Nexus)



Figure 5-45. Remove 7.5 Amp Fuse (Evolution)

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 the front door.
7. Remove battery from the generator.

Stator/Rotor/Engine Removal

1. **Remove Top Exhaust Enclosure Covers:** See [Figure 5-46](#). Use a 10 mm socket to remove the nine bolts from the exhaust top covers. Remove covers.

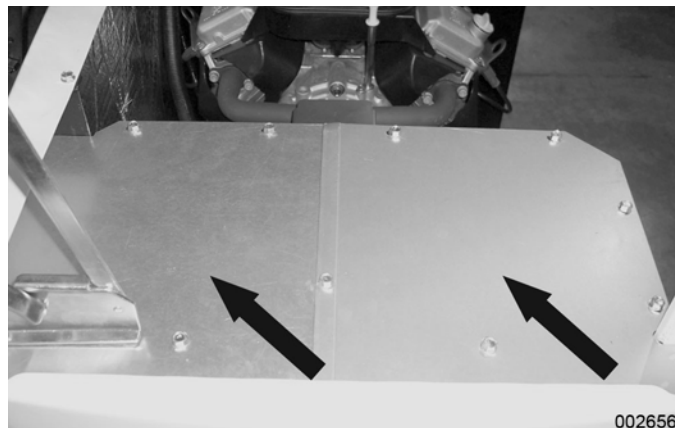


Figure 5-46.

2. **Remove Side Exhaust Enclosure Cover:** See [Figure 5-47](#). Use a 10 mm socket to remove the five bolts from the exhaust side cover. Remove side covers.

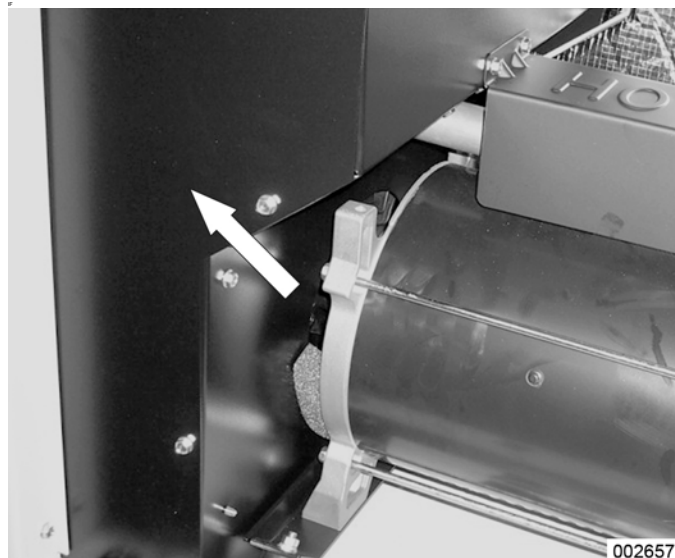


Figure 5-47.

3. **Remove Exhaust Flex Cover:** See [Figure 5-48](#). Use a 10 mm socket to remove the two bolts from the exhaust flex pipe cover. Remove the cover.

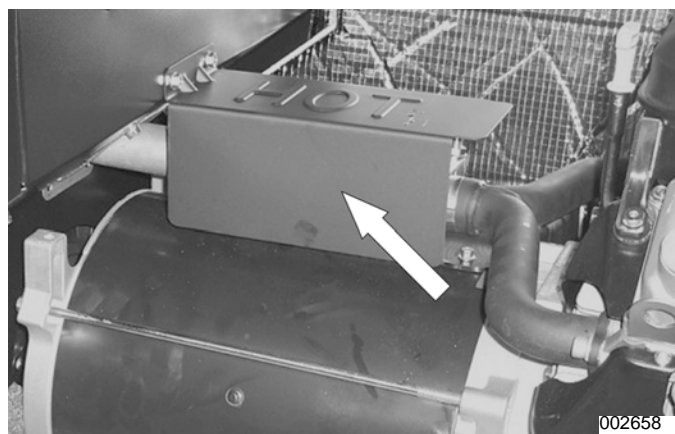


Figure 5-48.

4. **Remove Exhaust Flex Pipe:** See [Figure 5-49](#). Use a ½" socket to remove the front and rear muffler clamp. Slide exhaust flex toward engine to completely expose the muffler flange.

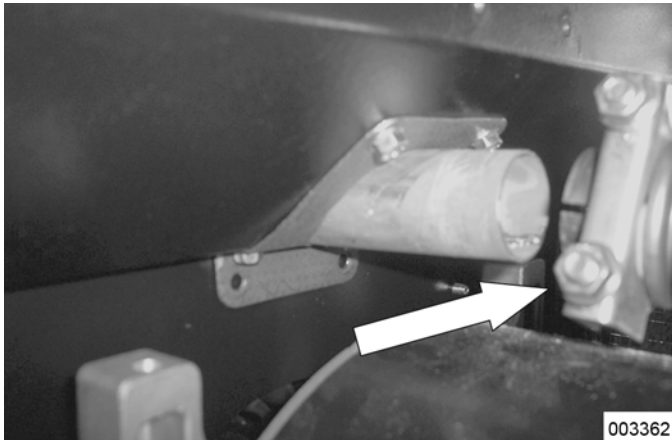


Figure 5-49.

5. **Muffler Assembly:** See [Figure 5-50](#). Depending on the clamp, use a ½" or 10 mm socket to remove the muffler clamp and flex pipe. Leave muffler attached to the divider panel.



Figure 5-50.

6. **Remove Left-side Enclosure:** See [Figure 5-51](#). Use a 10 mm ratchet wrench to remove the horizontal 10 mm bolt that connects the side panel to the back panel.
7. Use a 10 mm socket to remove three bolts from the base of the enclosure.

NOTE: The muffler is shown removed for better view of the bolts.

8. See [Figure 5-52](#). Use a 10 mm socket and wrench to remove the top hinge bolt and loosen the bottom bolt.
9. While holding the roof, remove the bottom hinge bolt.

10. Remove the side panel by sliding it forward then re-install the hinge bolt.

NOTE: The muffler has been removed for better view of the bolts.

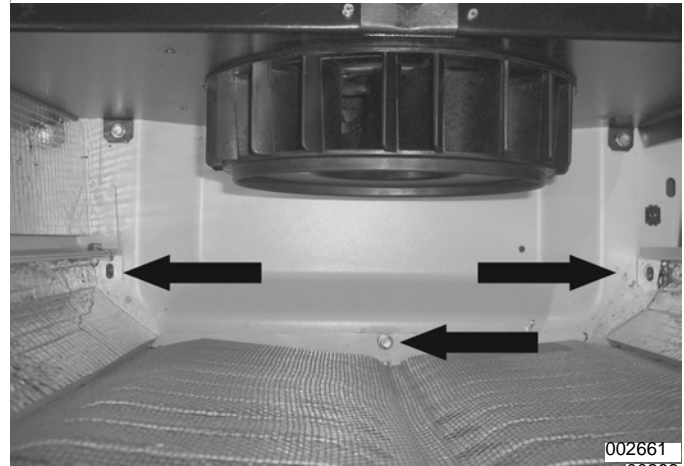


Figure 5-51.



Figure 5-52.

11. **Remove Fan Housing Cover:** See [Figure](#) . Use a 10 mm socket to remove four bolts from the fan housing cover (if equipped).
12. Remove the fan housing cover.

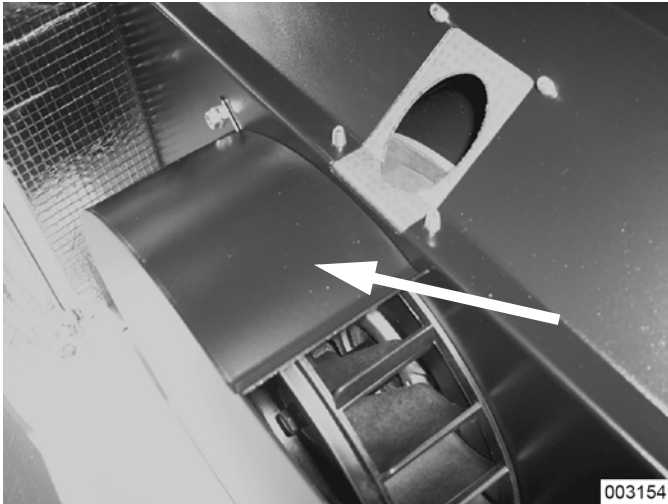


Figure 5-53.

13. **Remove Rotor Bolt:** See [Figure 5-54](#). Use a 9/16" socket to remove rotor bolt.

NOTE: See [Figure 5-55](#). After removing the rotor bolt, install a 12 mm x 1.75 mm cap screw in the end of the rotor shaft. This will be used in conjunction with the puller in the following step.



Figure 5-54.



Figure 5-55.

14. **Remove Rotor Fan:** See [Figure 5-56](#). Attach a vibration dampener or suitable puller to the fan using two M8 x 1.25 bolts.
15. Remove the fan from the rotor.



Figure 5-56.

16. **Remove Alternator Divider Panel:** See [Figure 5-57](#). Depending on the unit, use a 10 mm socket or 4 mm Allen wrench to remove two bottom base bolts.

NOTE: Muffler assembly remains attached to the alternator divider panel during removal.

17. Use a T27 torx driver to remove one top rear bolt.
18. Remove the panel.

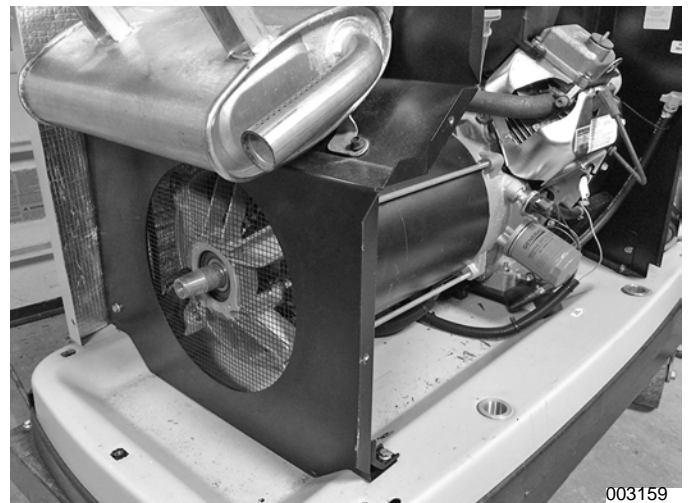


Figure 5-57.

19. **Remove Brushes:** See [Figure 5-58](#) and [Figure 5-59](#). Use a 7 mm socket to remove brushes.

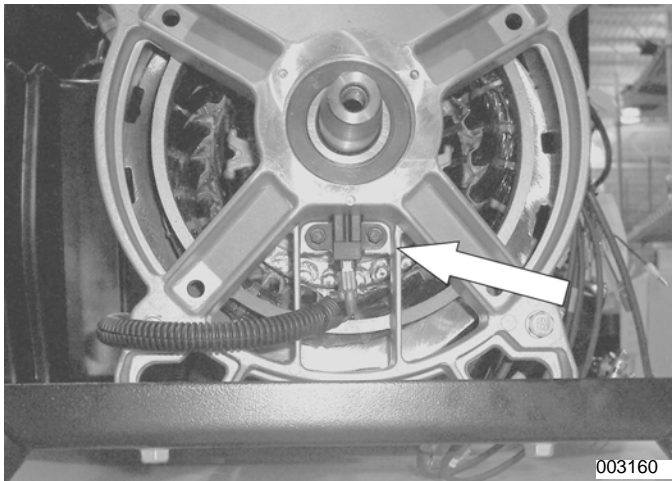


Figure 5-58. Brushes on Nexus Unit

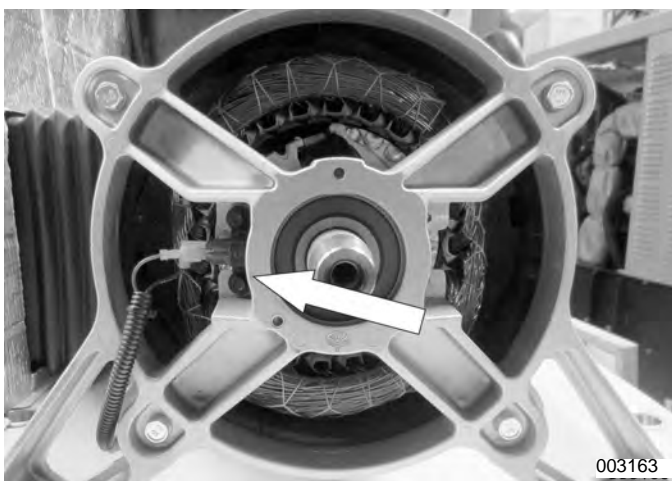


Figure 5-59. Brushes on Evolution Unit

20. **Remove Brush Wires:** See [Figure 5-58](#). Use a side cutters to remove the tie wraps securing the brush wires to the outside of stator.

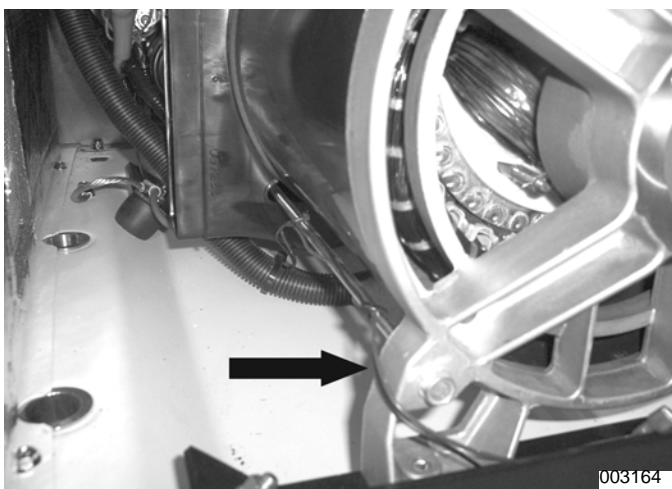


Figure 5-60.

21. **Remove Controls Cover:** See [Figure 5-61](#). Use a Torx T-27 socket or 5/32" Hex Allen socket to

remove two bolts and ground washer from the controls cover. Remove the controls cover.



Figure 5-61.

22. **Remove Stator Wires:** See [Figure 5-62](#). Remove all connectors from the controller, remove all wires the common neutral and ground wires from landing lugs, and remove wires from main breakers.

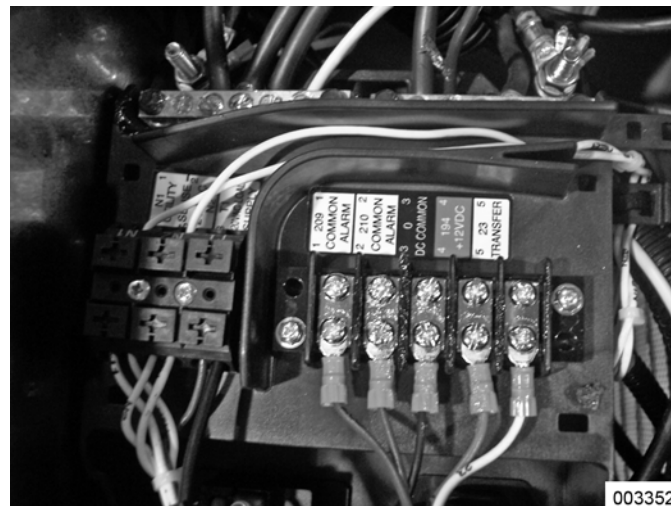


Figure 5-62.

23. **Alternator Air Intake Bellows Removal:** See [Figure 5-63](#). Remove alternator intake bellows.

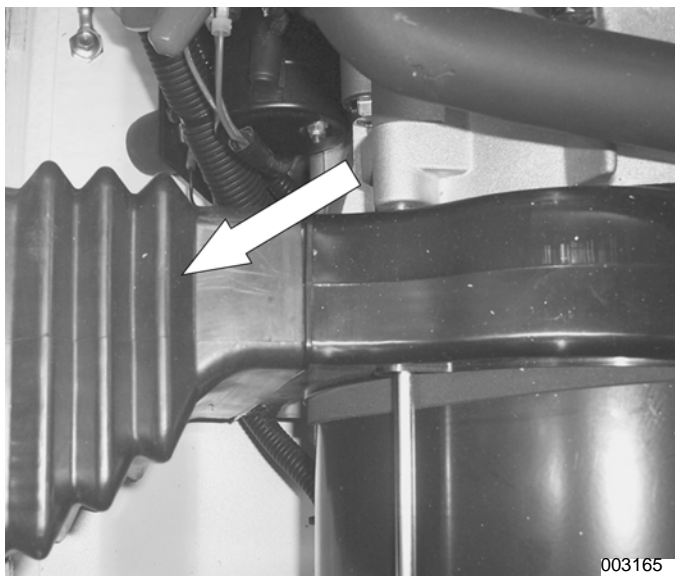


Figure 5-63.

24. **Rear Bearing Carrier Removal:** See [Figure 5-62](#). Use a 13 mm socket to remove the two nuts from the alternator mounting bracket rubber mounts.

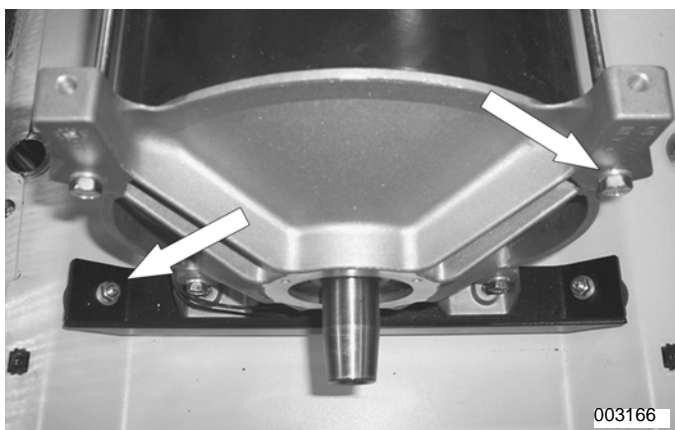


Figure 5-64.

25. See [Figure 5-66](#). Lift the back end of the alternator up and place a 2"x 4" piece of wood under the engine*.

NOTE: *See [Figure 5-65](#). On Evolution product there is a center engine mount and clamping screw. This clamping screw must be loosened before lifting the alternator up to set the wood block in place.

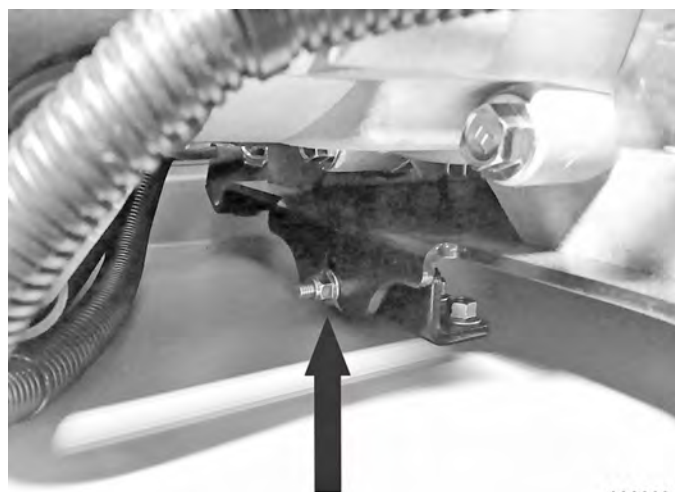


Figure 5-65.

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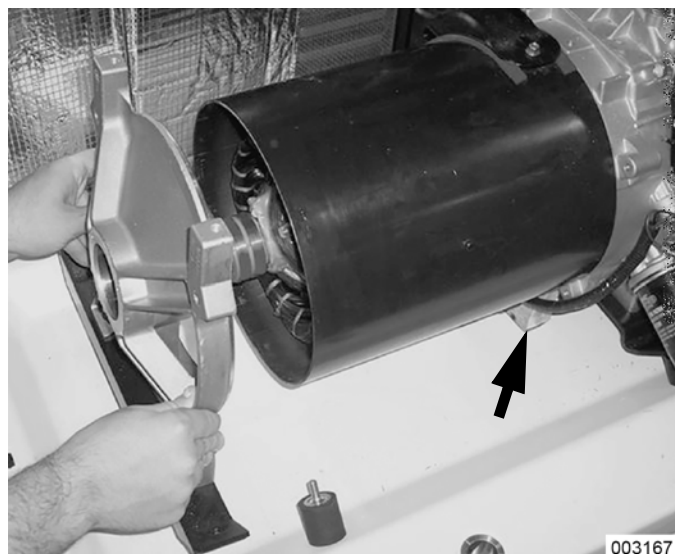


Figure 5-66.

003167

26. Use a 13 mm socket to remove the four stator hold down bolts.
27. Use a small rubber mallet to remove the rear bearing carrier.
28. See [Figure 5-67](#). Remove stator.

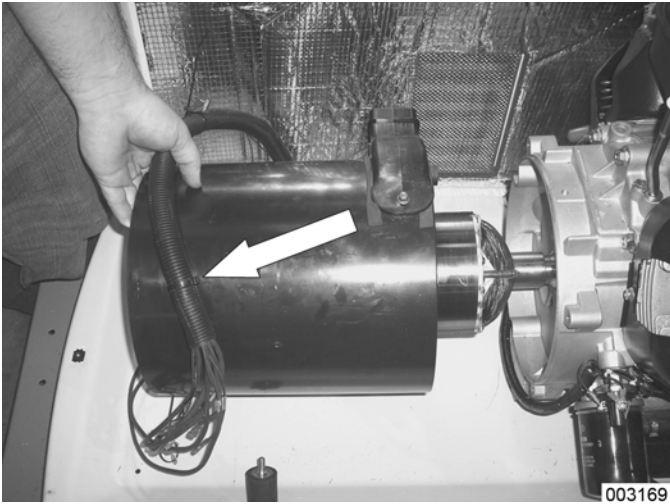


Figure 5-67.

29. Rotor Removal:

NOTE: Each model uses a specific rotor bolt. Verify the correct bolt is being used for the rotor being serviced.

- a. Cut 0.5 inches from the rotor bolt. Slot the end of the bolt to suit a flat blade screwdriver.
- b. Slide the rotor bolt back through the rotor and use a screwdriver to screw it into the crankshaft. Be sure to thread in a minimum of 3/8" to ensure enough threads for puller cap screw.
- c. Screw a 3" M12x1.75 cap screw into rotor.
- d. Apply torque to the 3" M12x1.75 cap screw until taper breaks free from crankshaft.

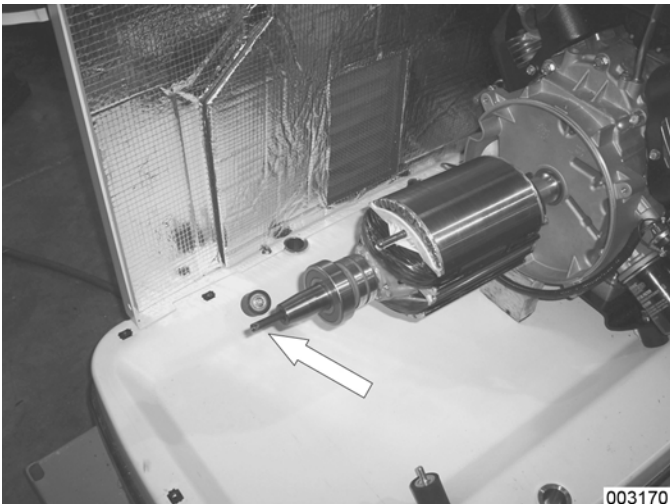


Figure 5-68.

30. **Remove Engine:** See [Figure 5-70](#) . Using a 13 mm socket, remove the two engine mount nuts with ground wires.

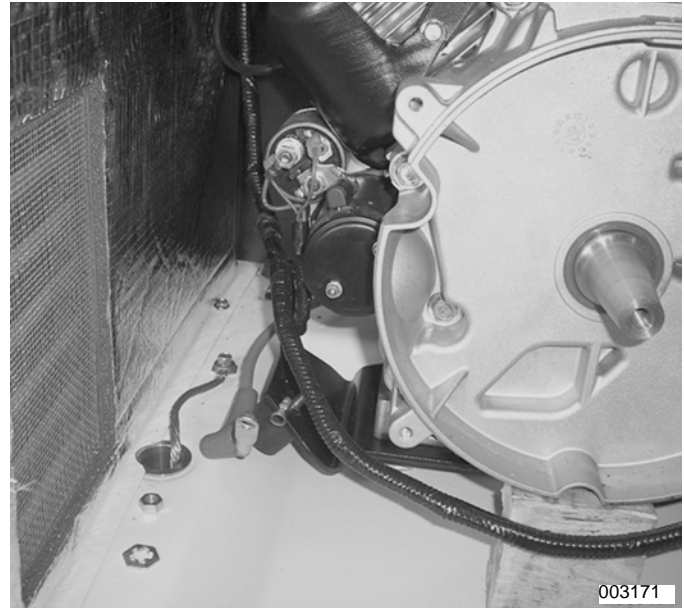


Figure 5-69.

31. See [Figure 5-70](#). Using proper lifting equipment remove the engine.



Figure 5-70.

Torque Specifications

Stator Bolts	6 ft-lbs (+1 / -0)
Rotor Bolt	30 ft-lbs
Engine Adapter	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 values are dynamic, with $\pm 10\%$ tolerance unless otherwise noted.

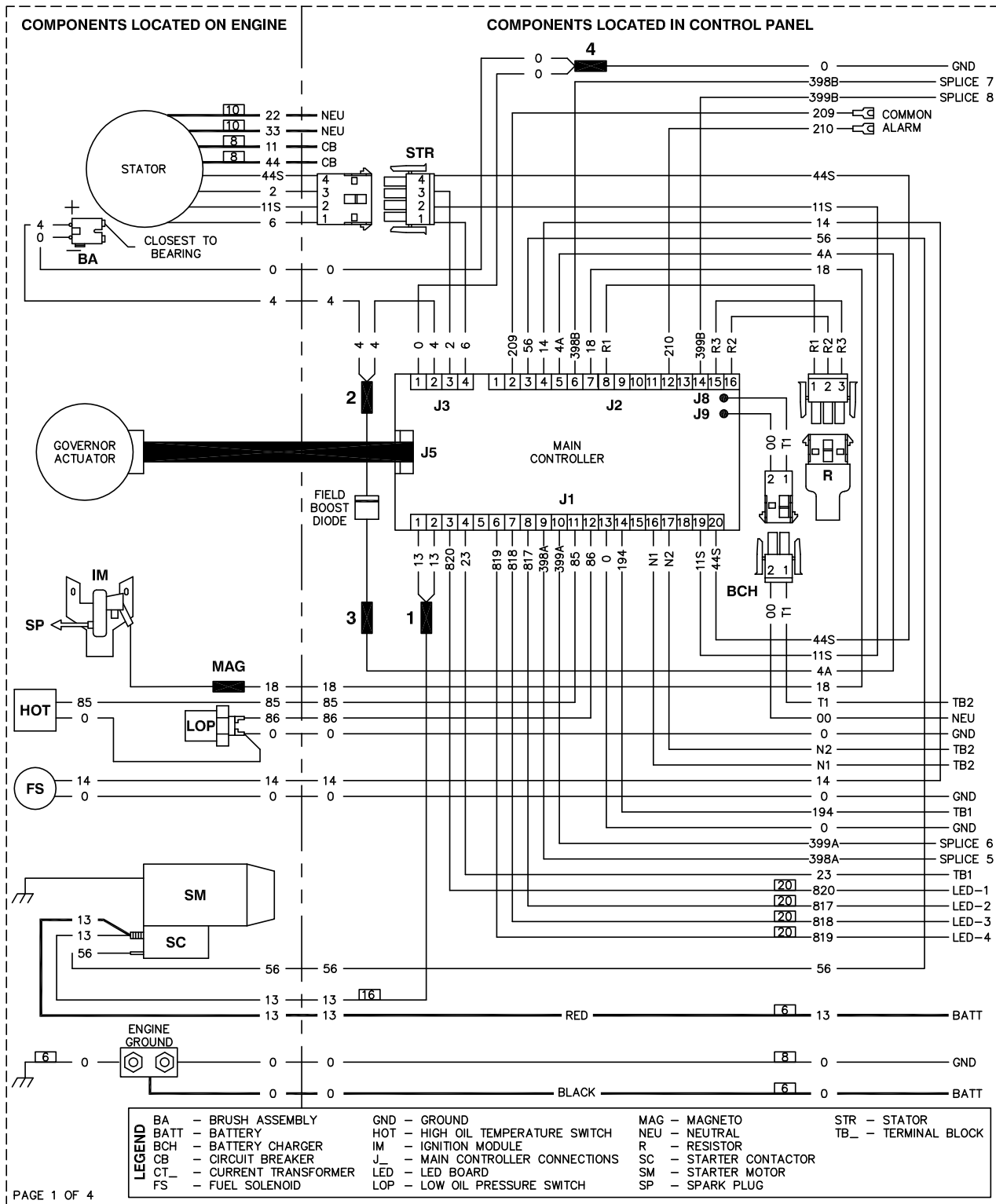
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Section 6.1 *0L6822-B WD/SD Air-cooled 2017 HSB Evolution 9 kW 60 Hz*

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP WD



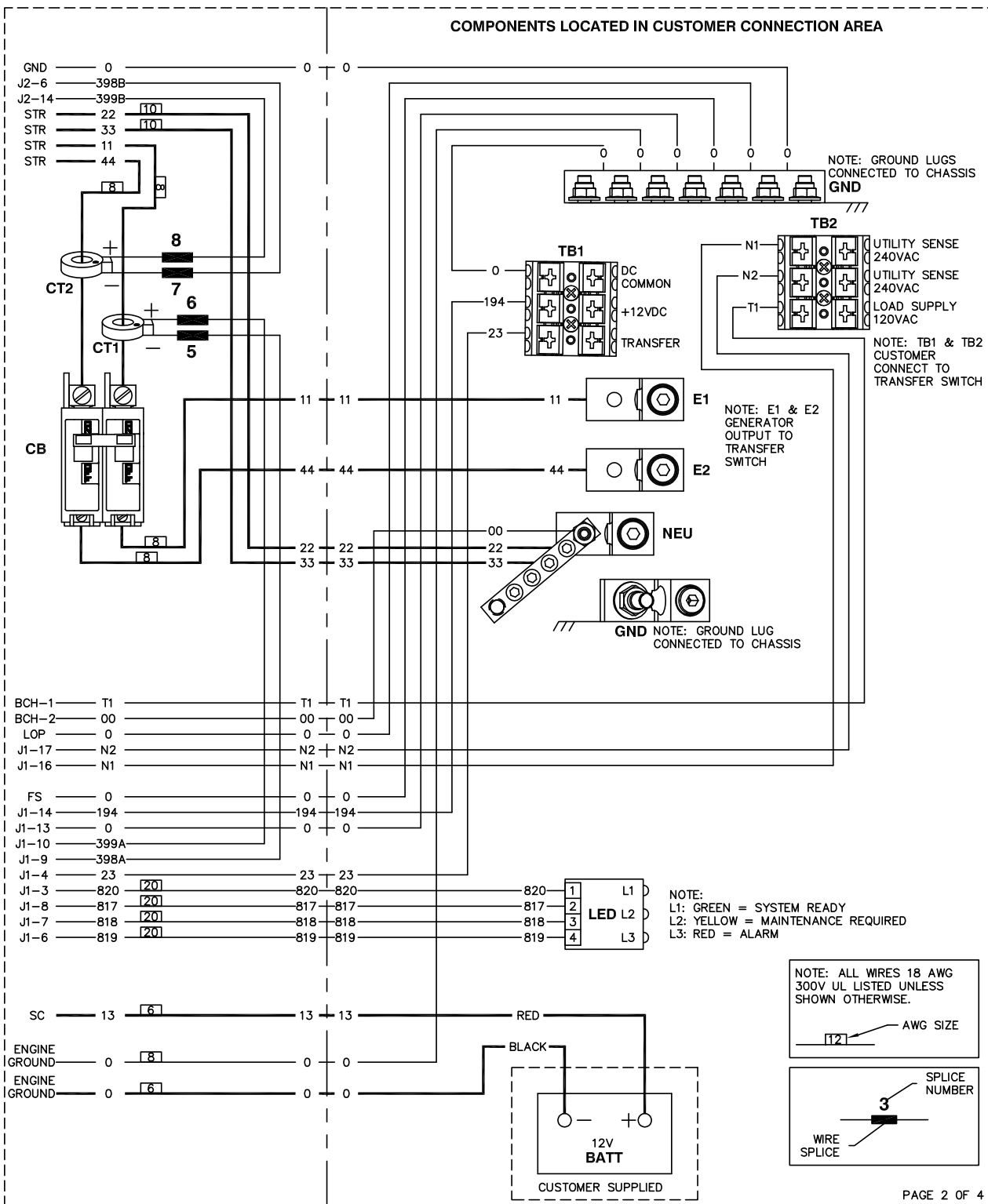
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DATE: 03/08/17

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WIRING - DIAGRAM
AIR COOLED HSB 9KW
DRAWING #: 0L6822

GROUP WD

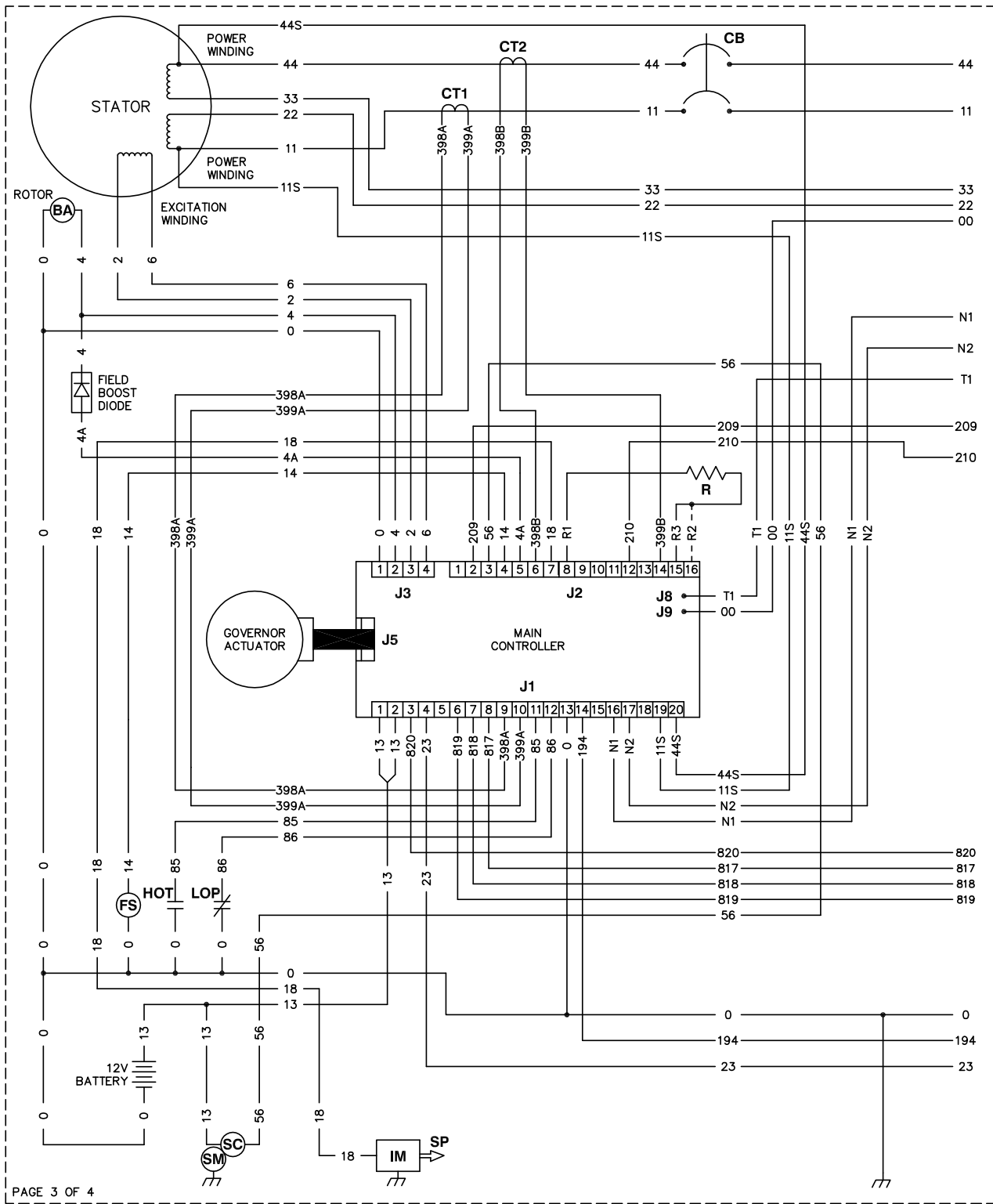


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WIRING - DIAGRAM
AIR COOLED HSB 9KW
DRAWING #: 0L6822

GROUP WD



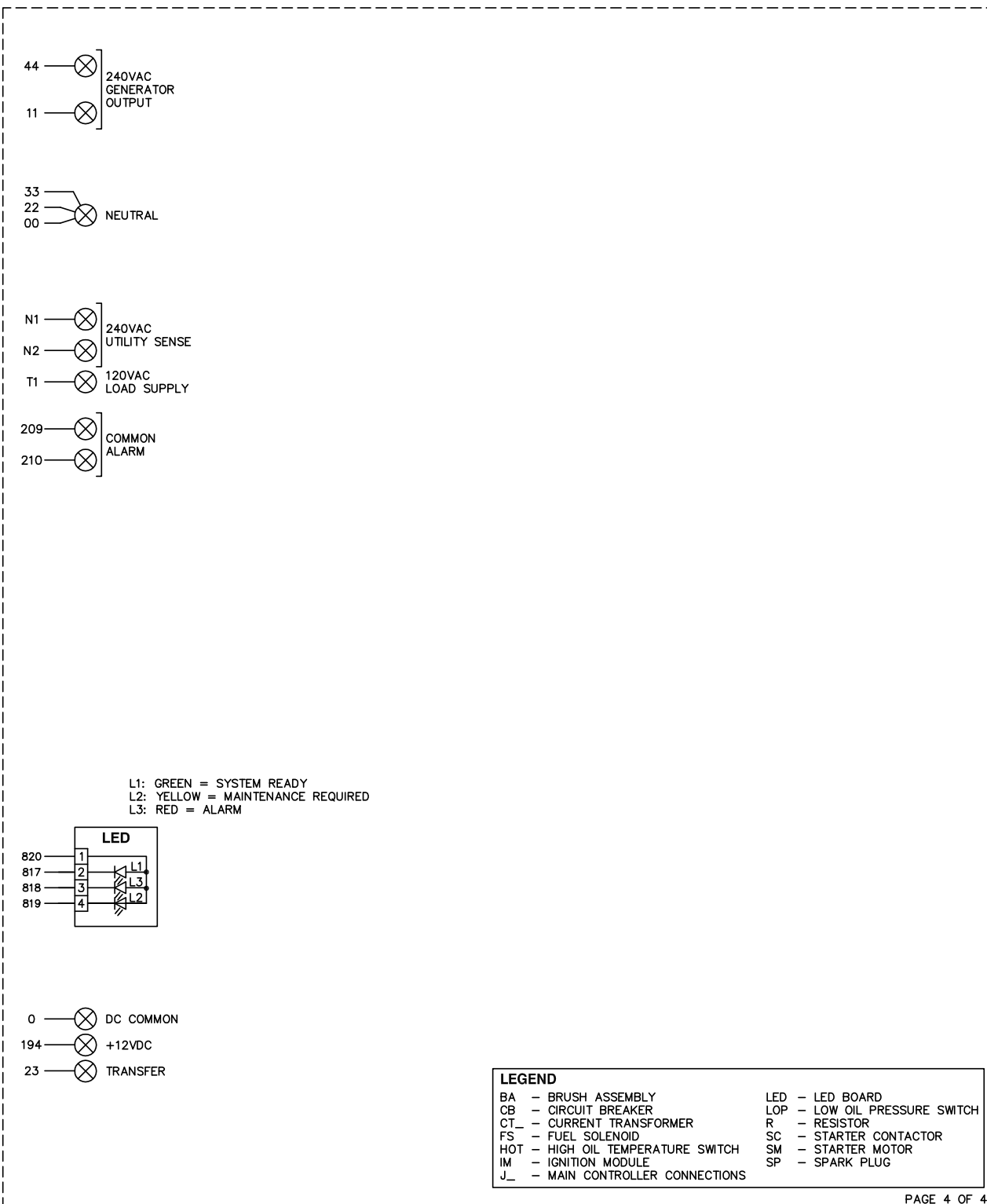
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SCHEMATIC - DIAGRAM
AIR COOLED HSB 9KW
DRAWING #: 0L6822

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SCHMATIC - DIAGRAM
AIR COOLED HSB 9KW
DRAWING #: 0L6822

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DATE: 03/08/17

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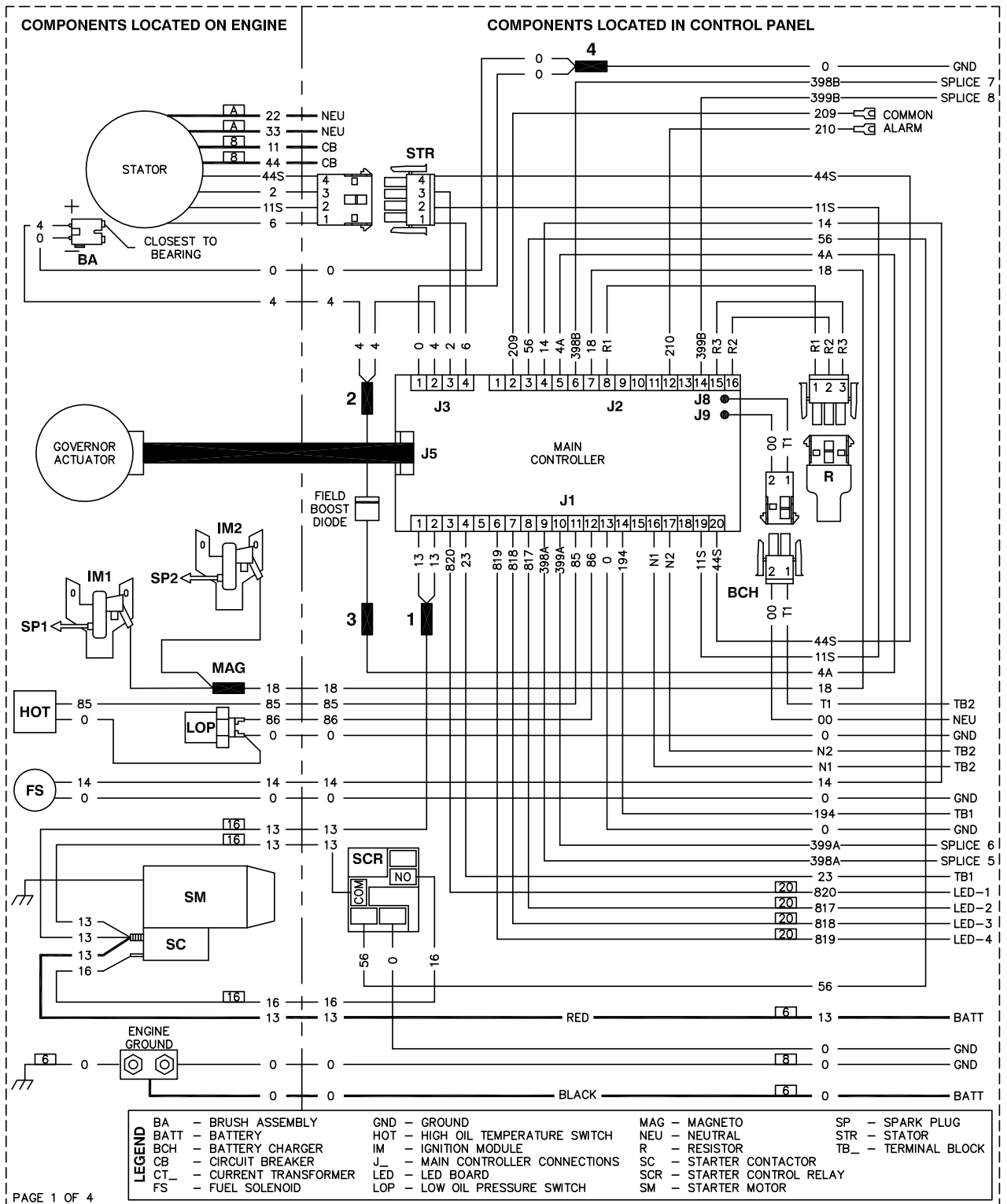
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Section 6.2 *0L6823-B WD/SD Air-cooled 2017 HSB Evolution 60 Hz*

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP WD



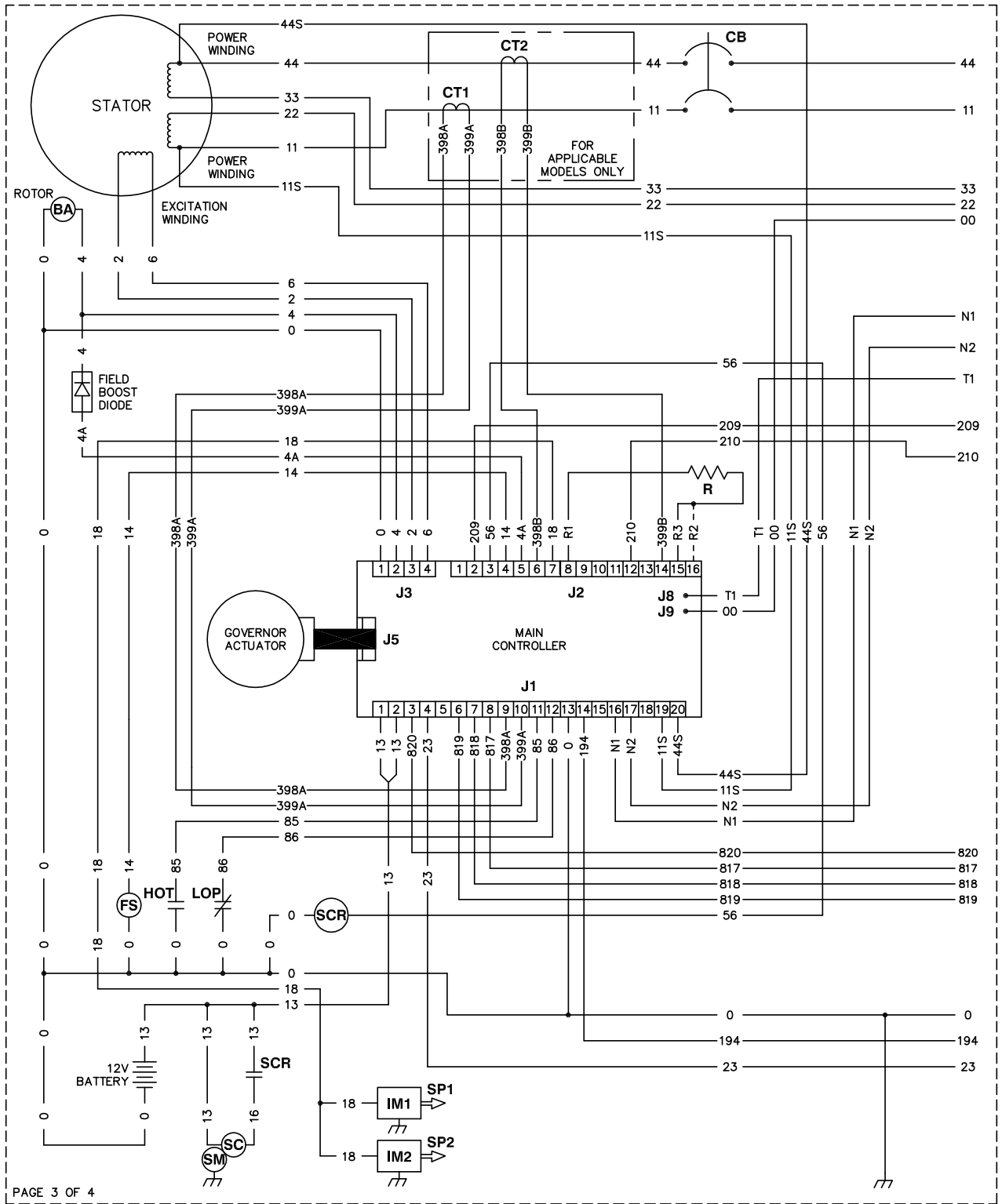
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WIRING - DIAGRAM
AIR COOLED HSB 60HZ
DRAWING #: 0L6823

GROUP WD



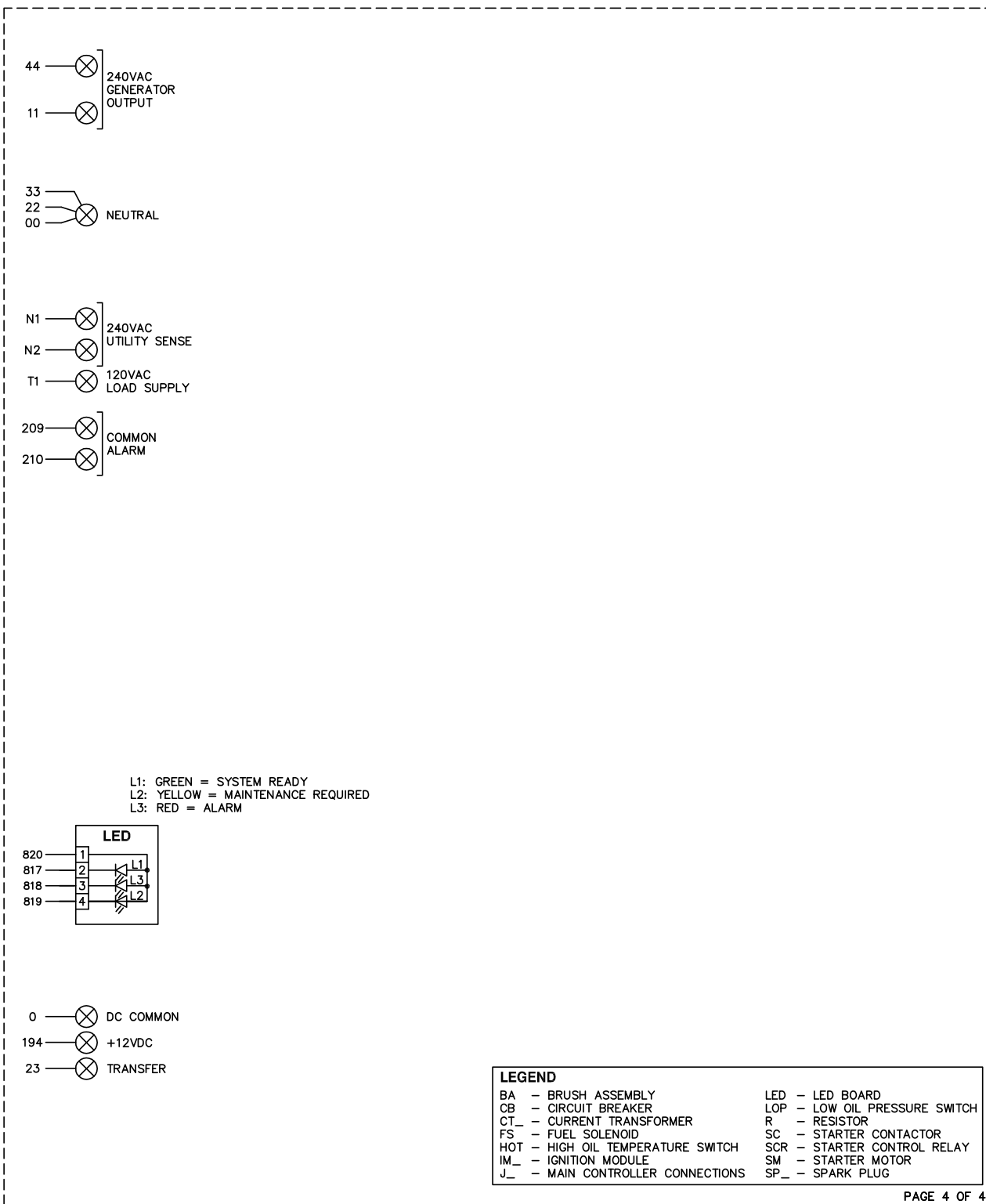
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SCHMATIC - DIAGRAM
AIR COOLED HSB 60HZ
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SCHMATIC - DIAGRAM
AIR COOLED HSB 60HZ
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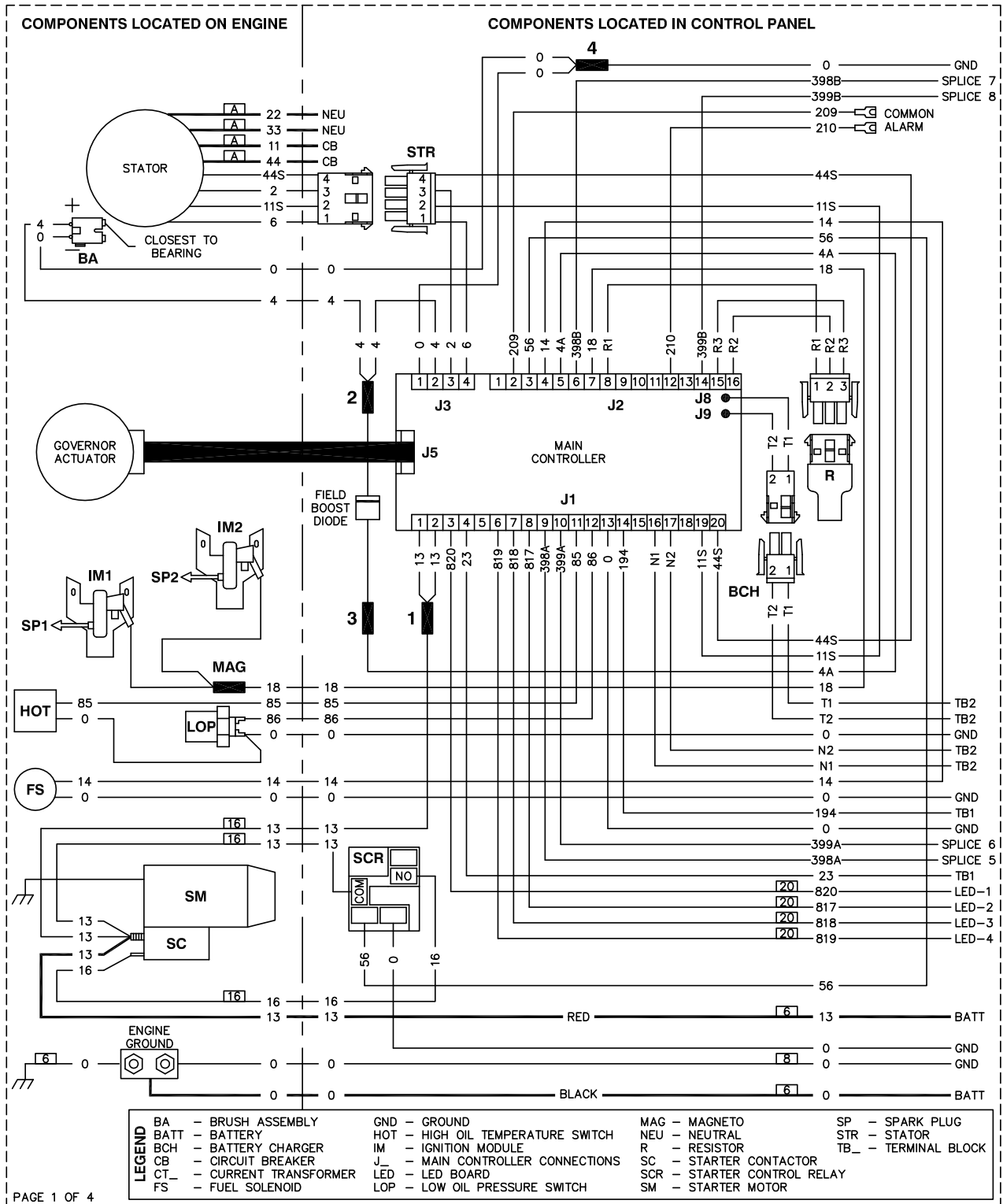
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Section 6.3 0L6824-B WD/SD Air-cooled 2017 HSB Evolution 50 Hz

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP WD



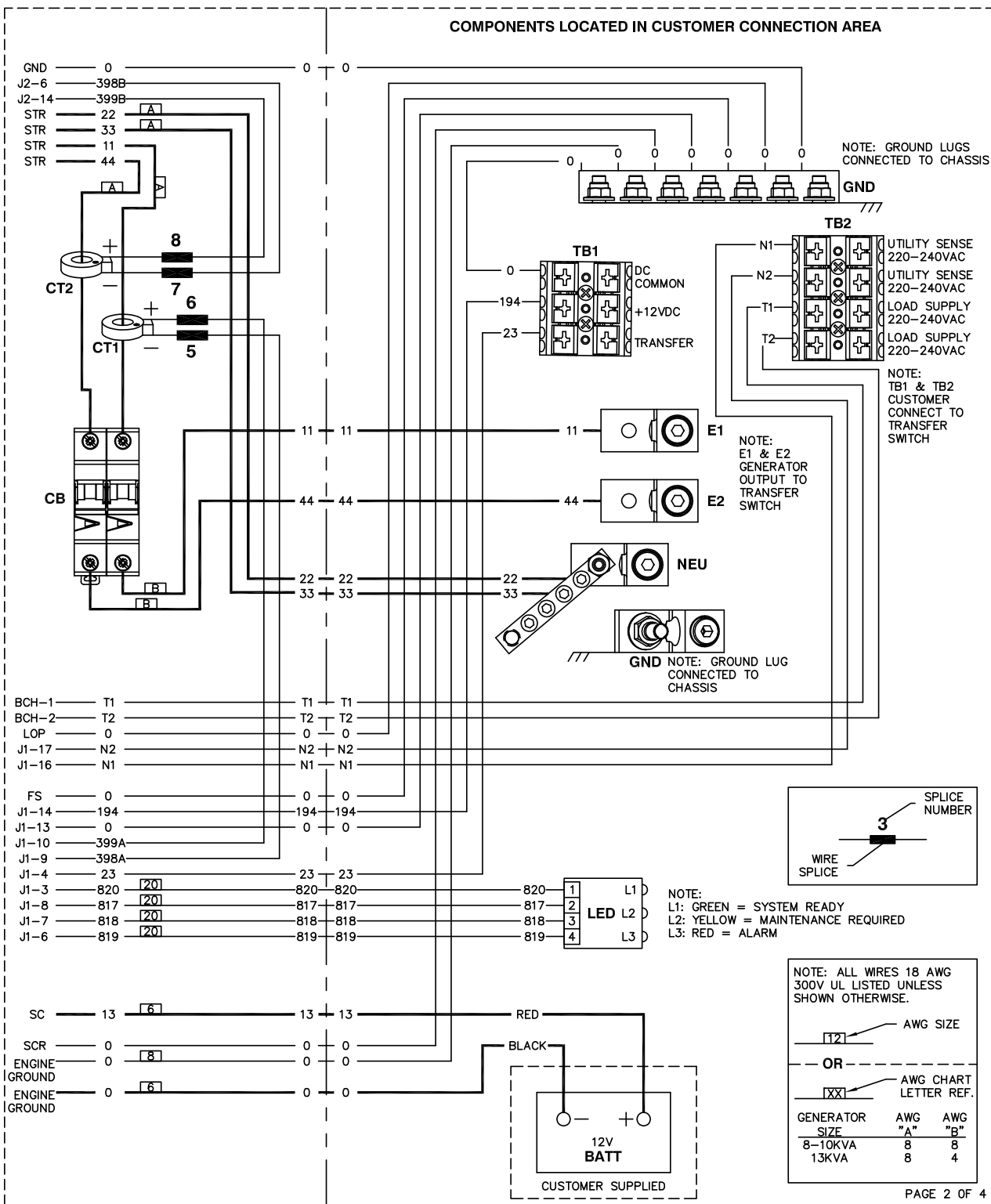
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WIRING - DIAGRAM
AIR COOLED HSB 50HZ
DRAWING #: 0L6824

GROUP WD

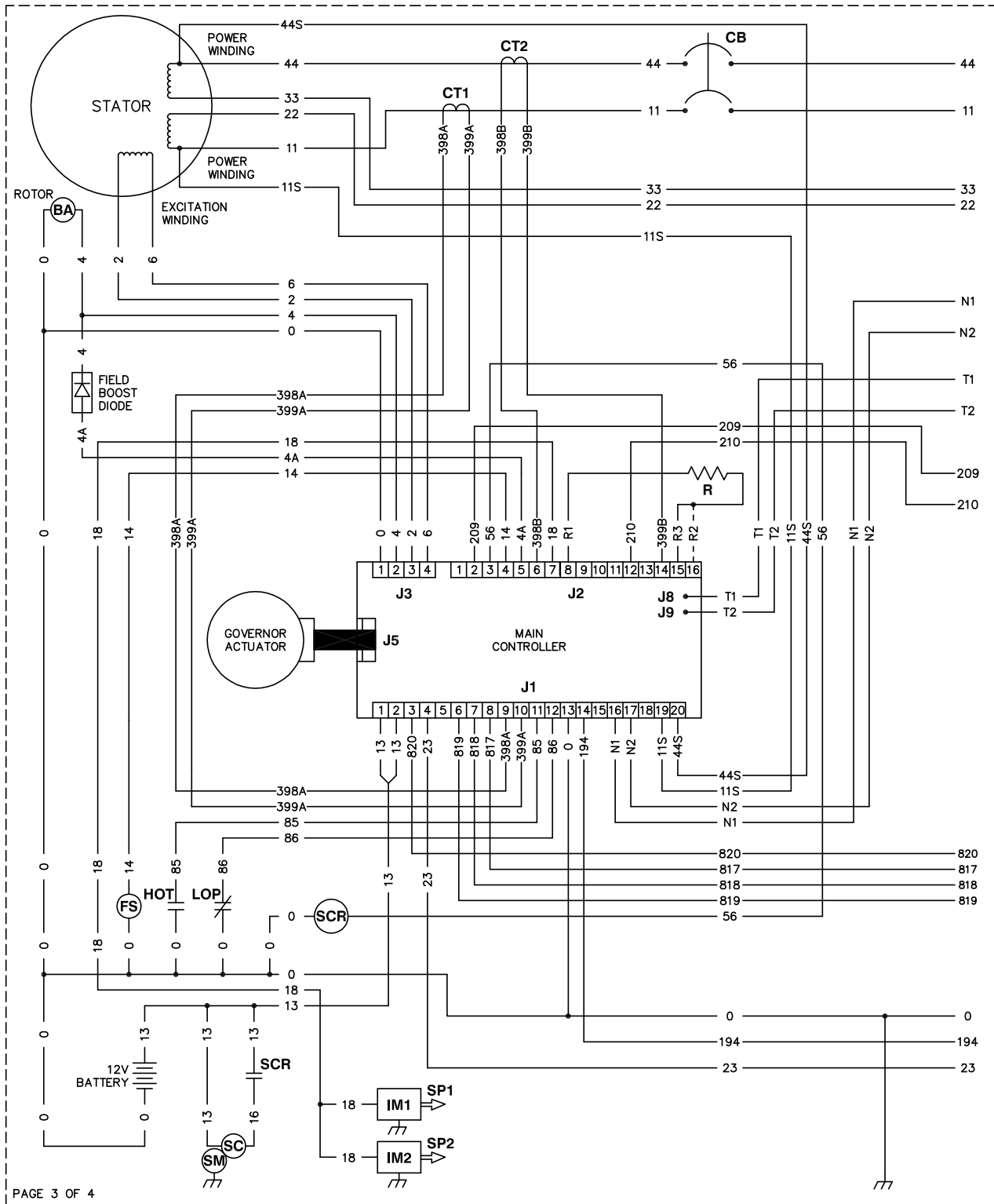


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WIRING - DIAGRAM
AIR COOLED HSB 50HZ
DRAWING #: 0L6824

GROUP WD



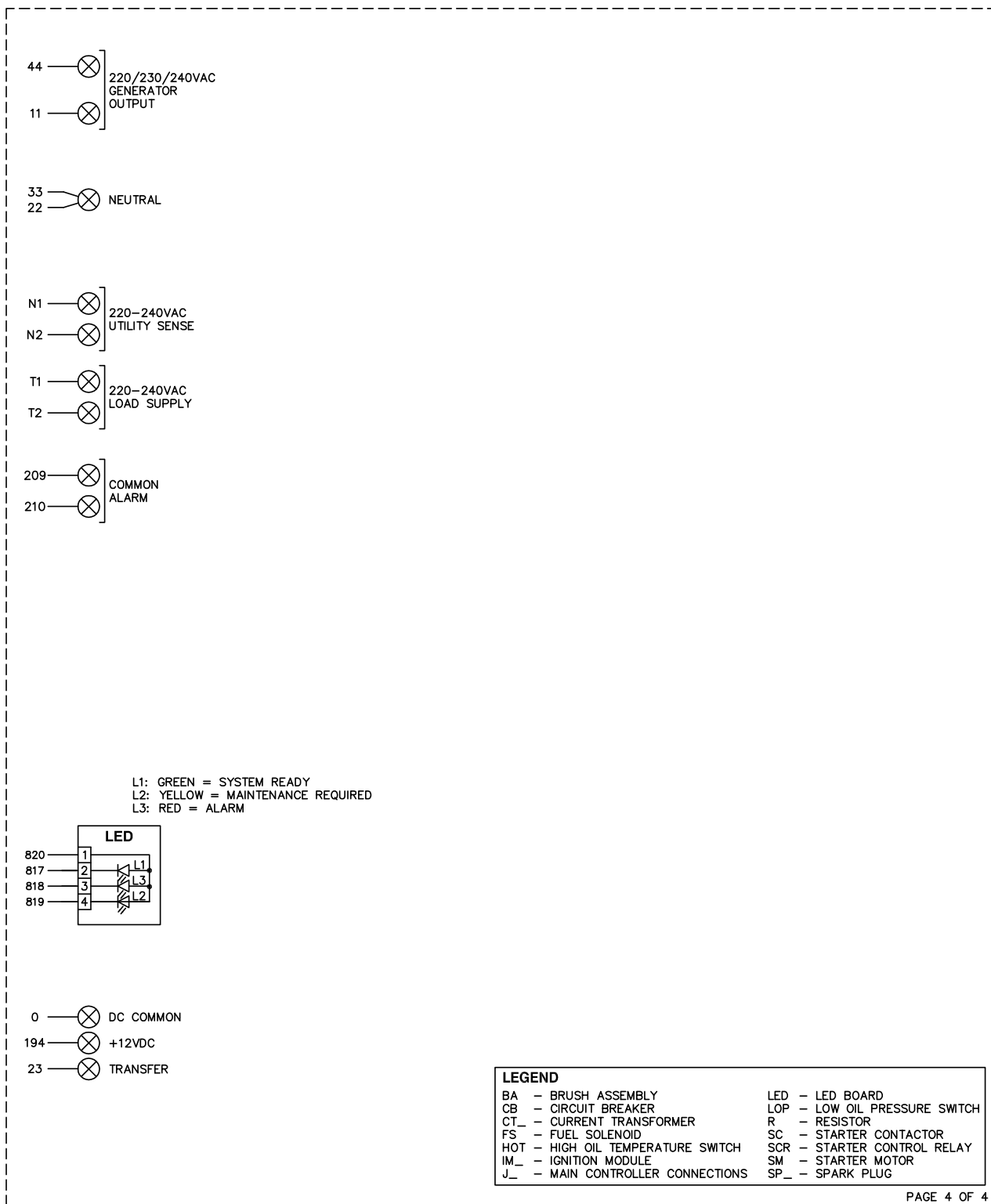
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AIR COOLED HSB 50HZ
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SCHEMATIC - DIAGRAM
 AIR COOLED HSB 50HZ
 DRAWING #: 0L6824

REVISION: B
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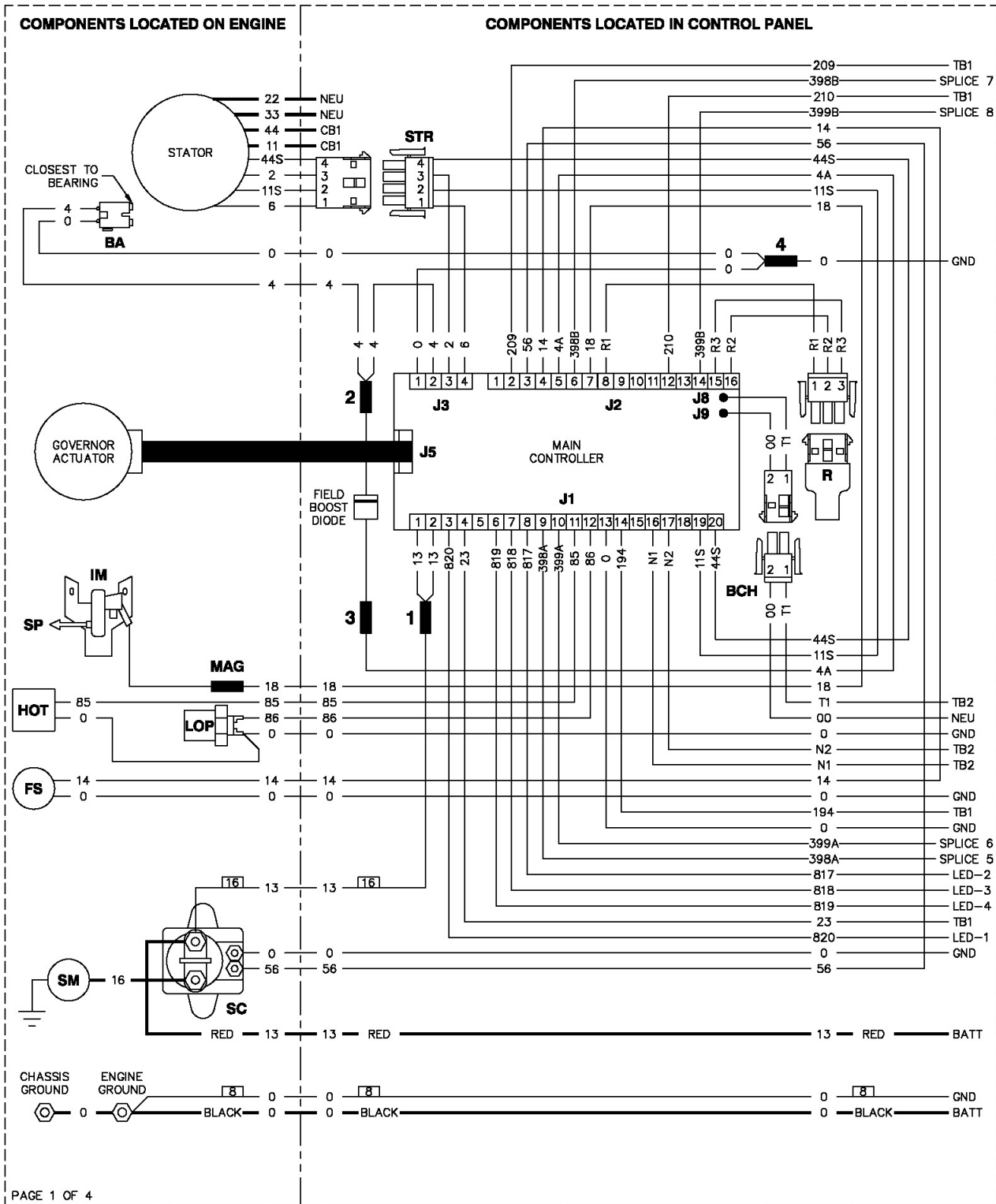
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Section 6.4 *0K2945-E WD/SD Air-cooled Pre 2017 HSB Evolution 8 kW 60 Hz*

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP G

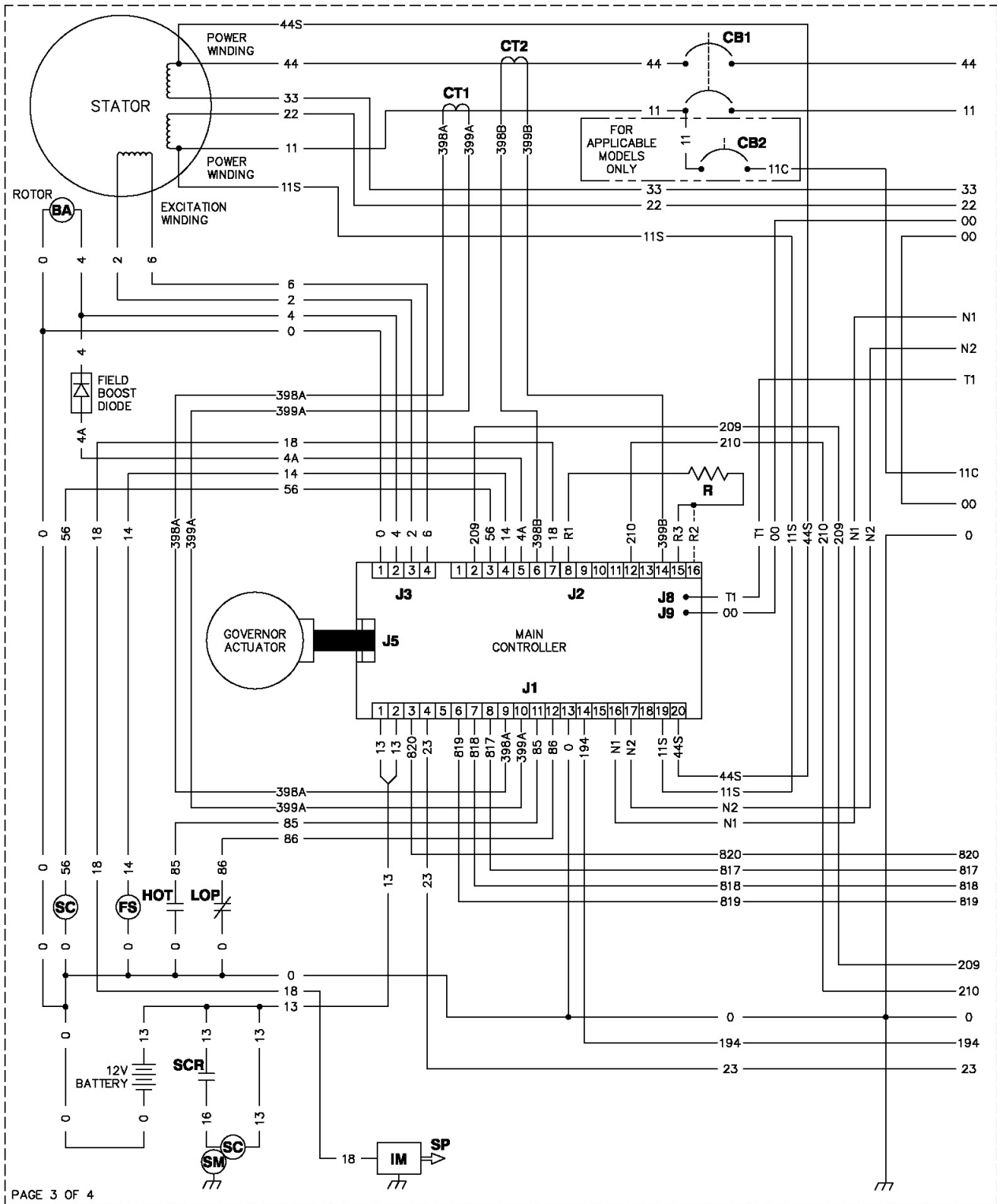


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WIRING - DIAGRAM
8KW 2013 AIR COOLED HSB
DRAWING #: 0K2945

GROUP G



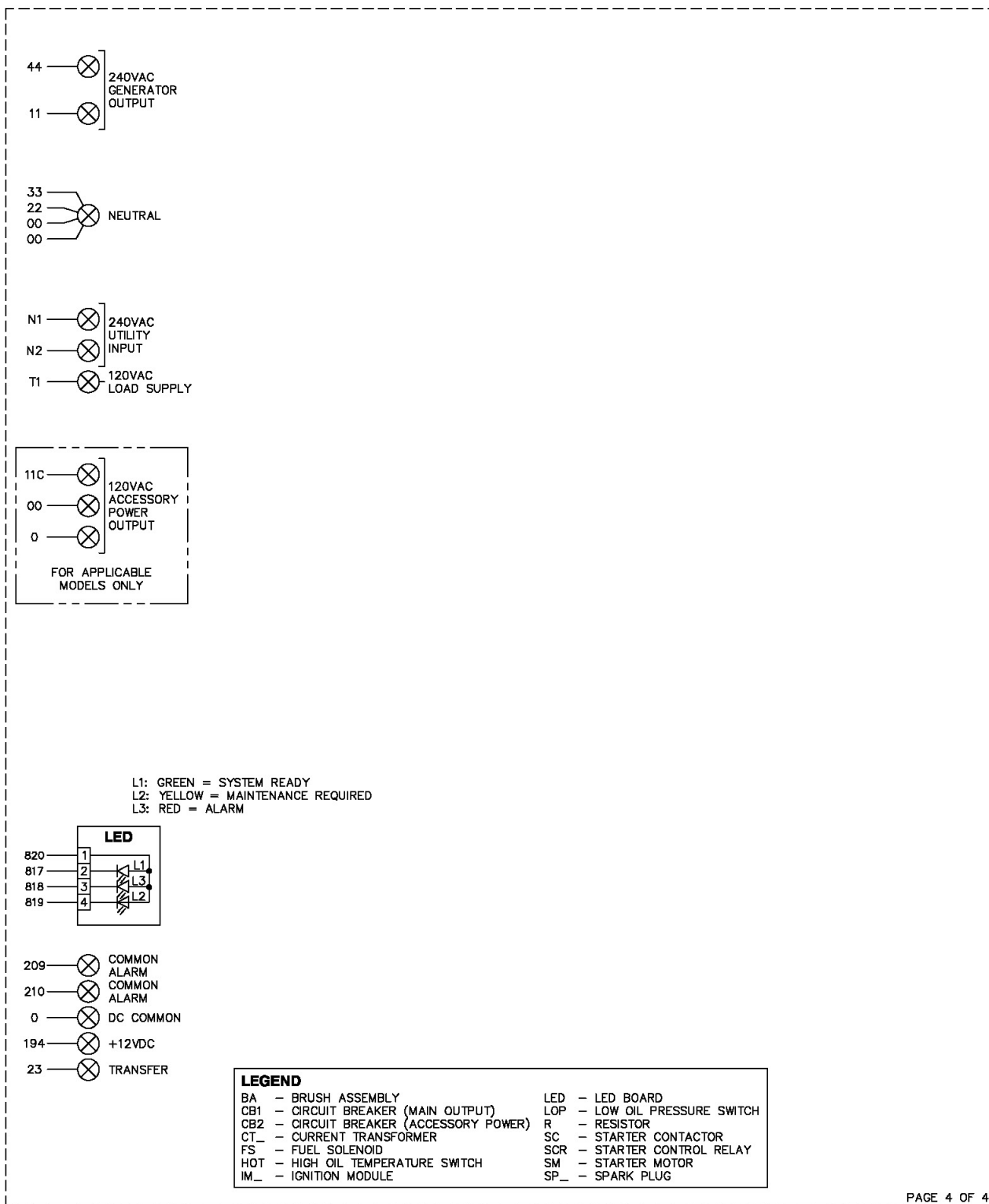
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SCHMATIC - DIAGRAM
8KW 2013 AIR COOLED HSB
DRAWING #: 0K2945

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SCHEMATIC - DIAGRAM
8KW 2013 AIR COOLED HSB
DRAWING #: 0K2945

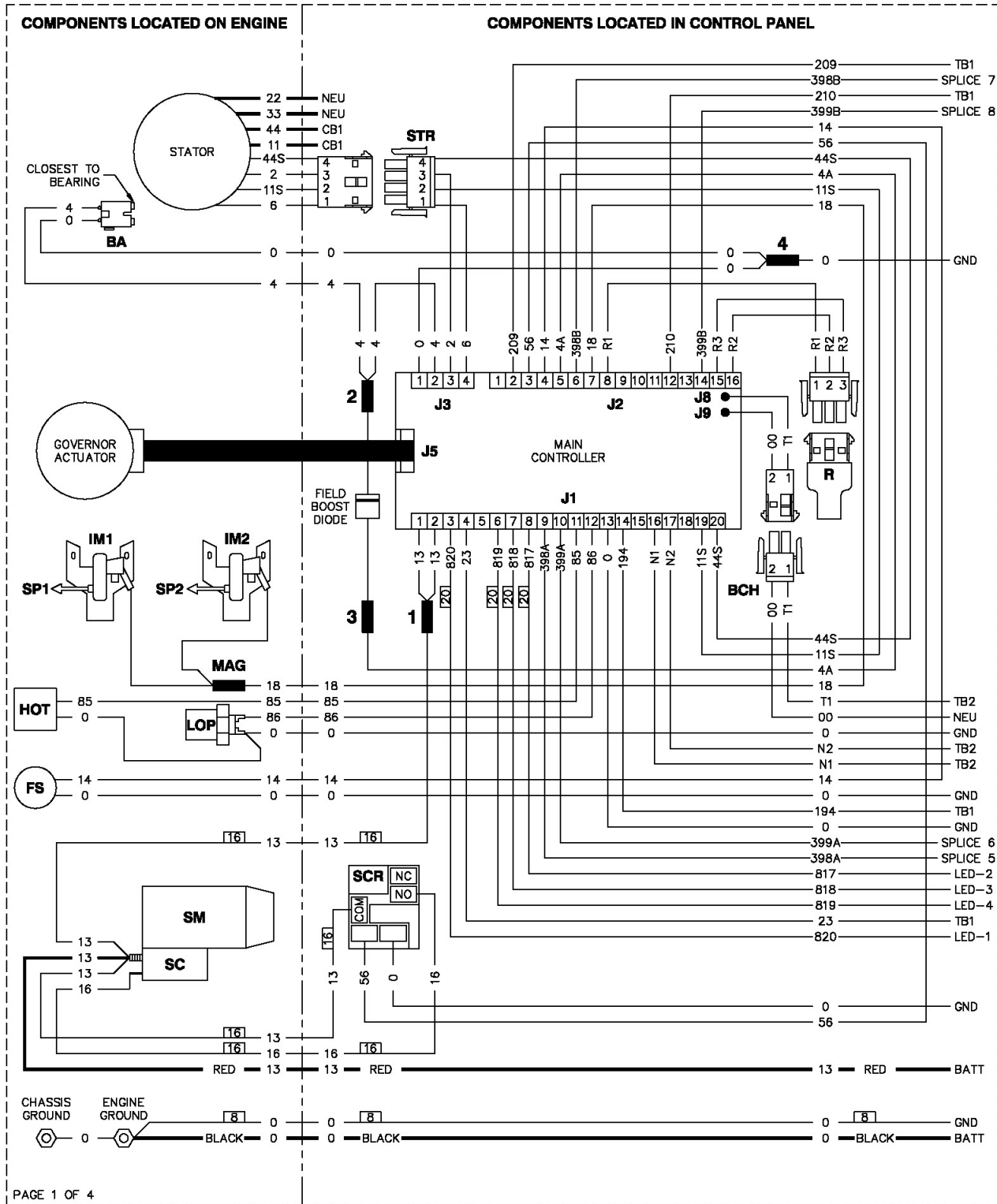
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Section 6.5 *0J9961-D WD/SD Air-cooled Pre 2016 HSB Evolution 11-22 kW 60 Hz*

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

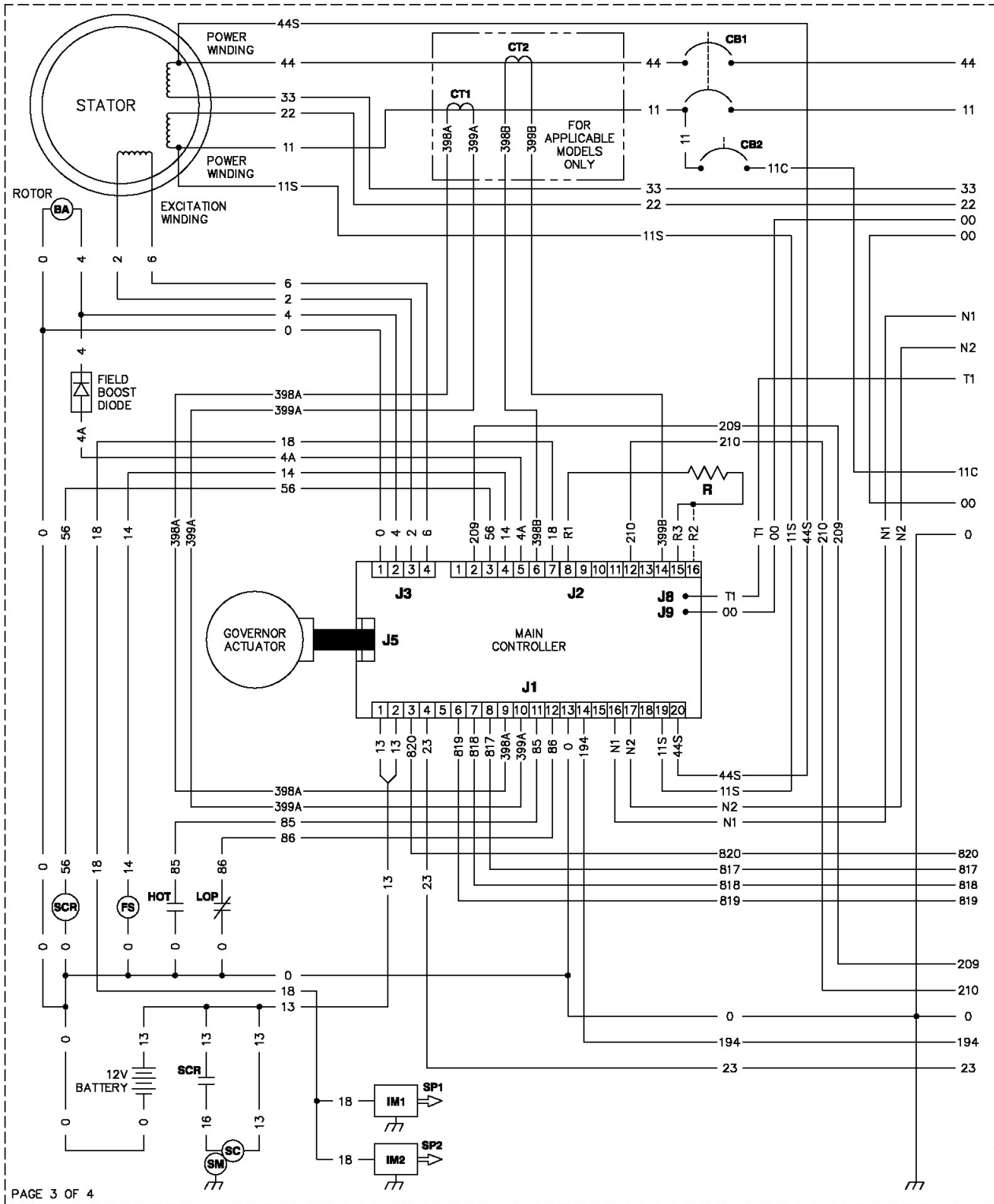
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 DATE: 6/19/13

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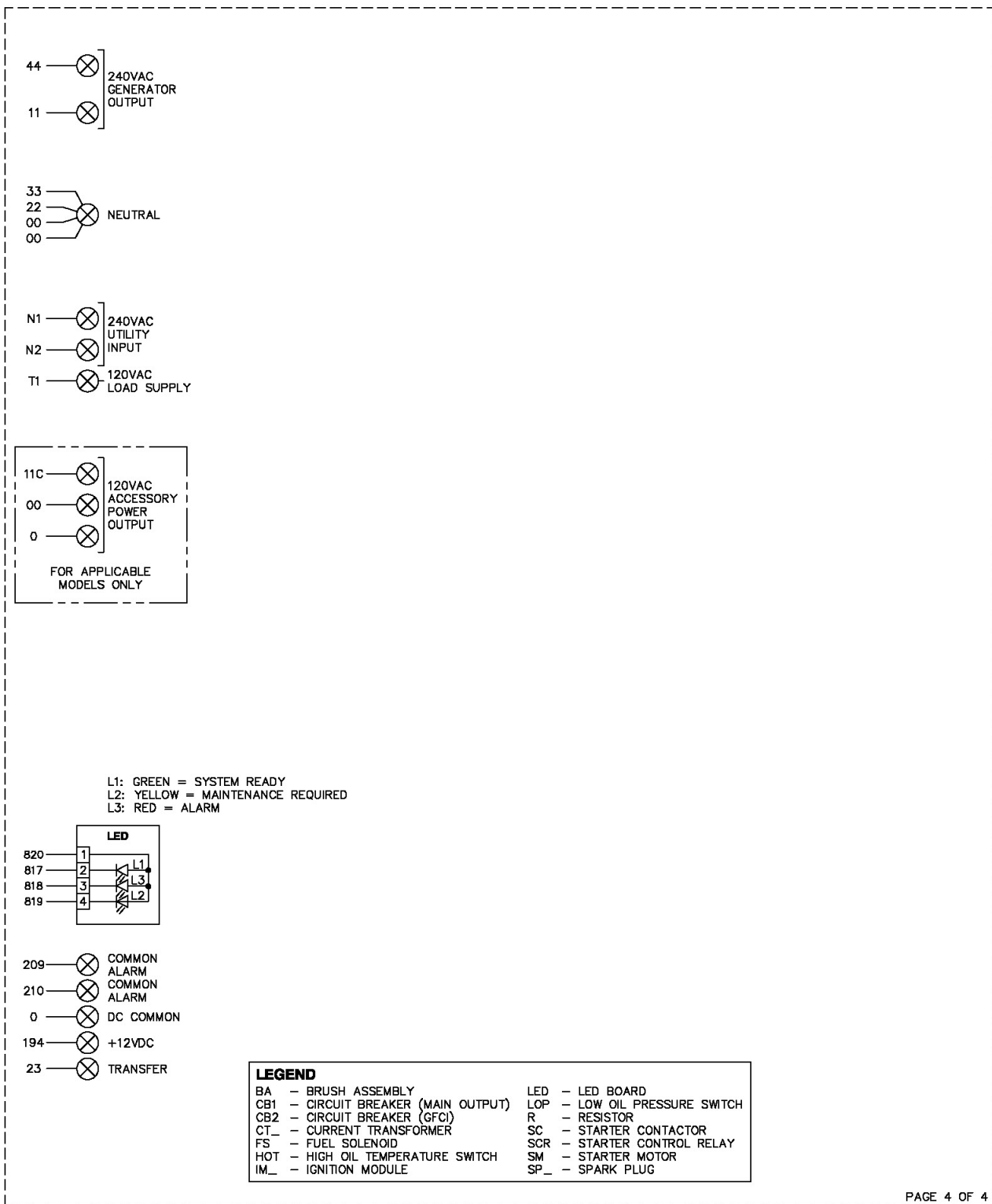
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SCHEMATIC - DIAGRAM
2013 AIR COOLED HSB 60HZ
DRAWING #: 0J9961

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DATE: 6/19/13

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SCHEMATIC - DIAGRAM
2013 AIR COOLED HSB 60HZ
DRAWING #: 0J9961

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Appendix A Controller Identification

Important Note

For *Nexus Menu System Navigation* refer to Section 1.4.

Use wire numbers only and disregard any specific “J” Connector references. Utilize the wire numbers and controller pin out chart in this appendix per specific connector styles!

Probing and Pin Extraction

Use the special tool (P/N 0J09460SRV) to back probe the connector.

NOTE: DO NOT front probe Molex Connectors.

Diagnostic procedures in this manual do not call out the connector or pin number, only the wire number.

This section (Appendix A) is to be used as a resource to identify the correct pin location and connector on the controller being diagnosed.

NOTE: If probing and/or back-probing results in a “BAD” condition, before condemning the controller, remove the pin/plug in question and verify the pin/plug is not distorted, bent and/or not making electrical contact! Repair as needed!



003539

Figure A-1. Special Tool (P/N 0J09460SRV) Back Probe



002450

Figure A-2. Back-Probing Molex Connector



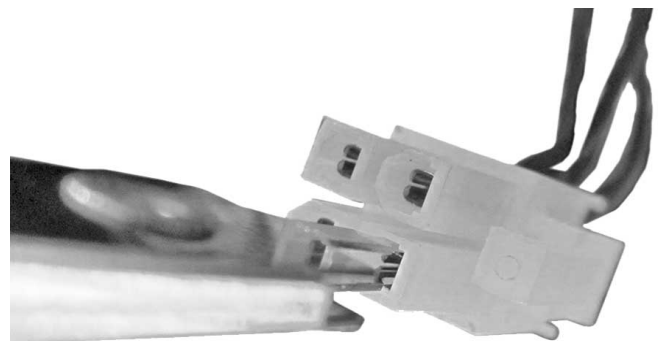
002451

Figure A-3. Probing AMP Connector



002452

Figure A-4. Molex Pin Extractor Tool Part# 0K4445

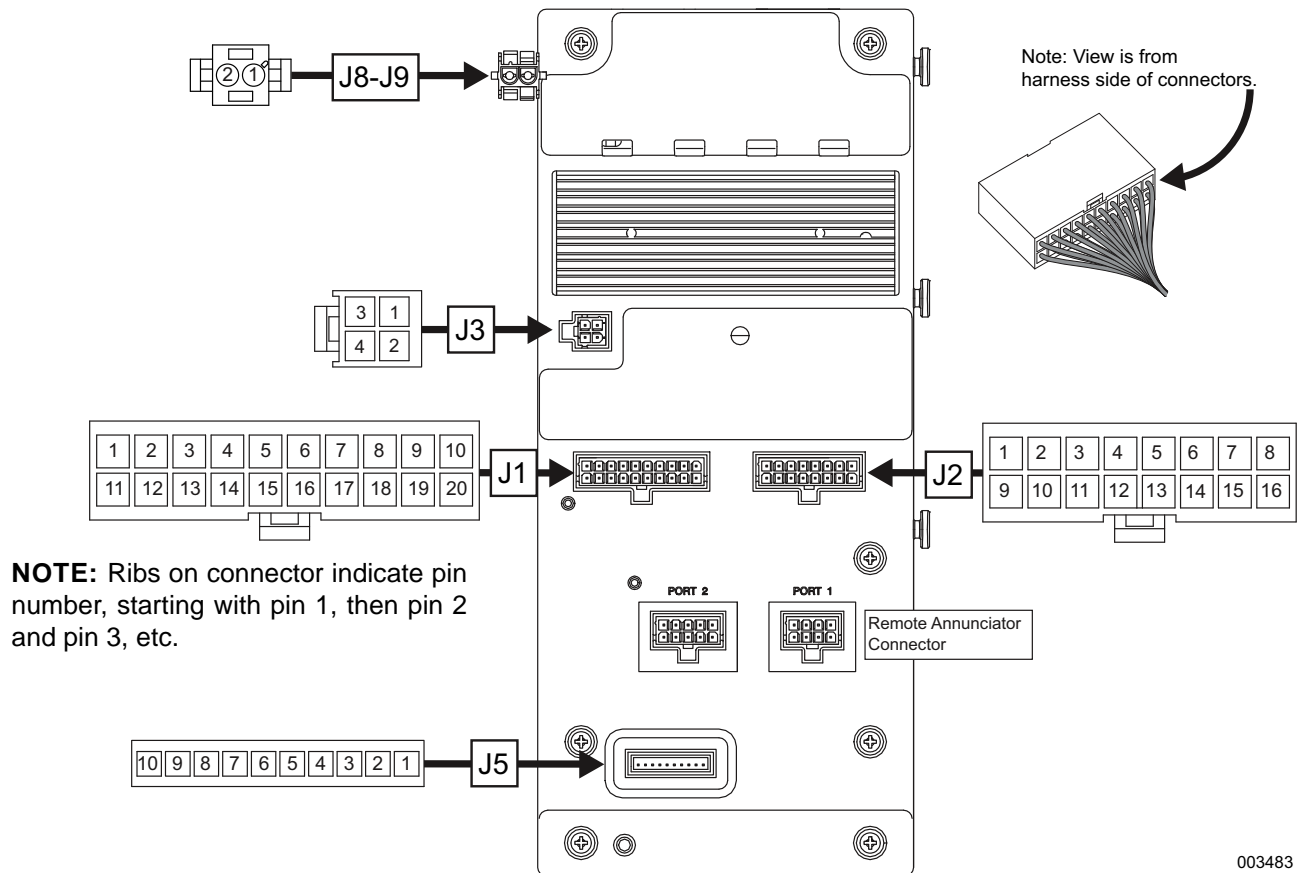


002453

Figure A-5. Using Molex Pin Extractor Tool

Evolution 1.0 Controller

See **Figure A-6** – Evolution 1.0 Air-cooled Panel has 3 Molex style connectors on the back (J1, J2, & J3), one actuator connector (J5), a battery charger connector (J8 & J9), and a connector socket for a remote annunciator (optional accessory).



003483

Figure A-6. Evolution 1.0 Air-cooled Panel and Connectors (Harness End)

J1 Connector		
Pin	Wire	Circuit Function
J1-1	13	12 VDC un-fused for the controller
J1-2	13	12 VDC un-fused for the controller
J1-3	820	Positive voltage (5VDC) for status LEDs
J1-4	23	Switched to ground (internally) to energize the Transfer Relay
J1-5	178	Not Used, Optional - 2-Wire Start (return)
J1-6	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J1-7	818	Grounded by the controller to turn on Alarm (Red) LED
J1-8	817	Grounded by the controller to turn on System Ready (Green) LED
J1-9	398A	Generator Current Sense A2
J1-10	399A	Generator Current Sense A1

J1 Connector		
Pin	Wire	Circuit Function
J1-11	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
J1-12	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
J1-13	0	Common Ground (DC) DC Field Excitation Ground
J1-14	194	Provides 12 VDC to the transfer relay (TR1)
J1-15	-	Not Used - UL Required Spacing
J1-16	N1	240 VAC Utility sensing voltage
J1-17	N2	240 VAC Utility sensing voltage
J1-18	-	Not Used - UL Required Spacing
J1-19	11S	240 VAC Generator Voltage Sensing
J1-20	44S	240 VAC Generator Voltage Sensing

J2 Connector		
Pin	Wire	Circuit Function
J2-1		
J2-2	209	Common Alarm Relay Output
J2-3	56	12 VDC output to starter contactor relay/solenoid
J2-4	14	12 VDC output for engine run condition. Fuel solenoid supply voltage.
J2-5	4A	DC (+) Field Excitation (Before Field Boost Diode)
J2-6	398A	Generator Current Sense B2
J2-7	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
J2-8	R1	Model ID Resistor
J2-9	-	Not Used
J2-10	-	Not Used
J2-11	183	Not Used, Optional - 2-Wire Start
J2-12	210	Common Alarm Relay Output
J2-13	-	Not Used
J2-14	399B	Generator Current Sense B1
J2-15	R3	Model ID Resistor
J2-16	R2	Model ID Resistor

J3 Connector		
Pin	Wire	Circuit Function
J3-1	0	Common Ground (DC) DC Field Excitation Ground
J3-2	4	DC (+) Field Excitation
J3-3	2	DPE Winding (AC Excitation power)
J3-4	6	DPE Winding (AC Excitation power)

J5 Connector		
Pin	Wire	Circuit Function
J5-1	-	Not Used
J5-2	-	Not Used
J5-3	-	Not Used
J5-4	-	Not Used
J5-5	-	Not Used
J5-6	Red	Stepper Power
J5-7	Orange	Stepper Motor B2 Coil
J5-8	Yellow	Stepper Motor B1 Coil
J5-9	Brown	Stepper Motor A2 Coil
J5-10	Black	Stepper Motor A1 Coil

J8-J9 Connector		
Pin	Wire	Circuit Function
1	T1	120 VAC Power for the Battery Charger
2	00	Neutral Connection for T1 (battery charger)

Nexus Controller

There are currently three styles of Nexus Air-cooled control panel. The difference in the styles is how the wires are connected to the panel. The different panel part numbers, connection types, and images of each are shown on the following pages.

See **Figure A-7** – Nexus Air-cooled Panel part number 0H6680 (A) or (B) has two Amp-Seal style connectors on the back (J4 & J5), one actuator connector (J3), and a connector socket for the remote wireless annunciator (optional accessory).

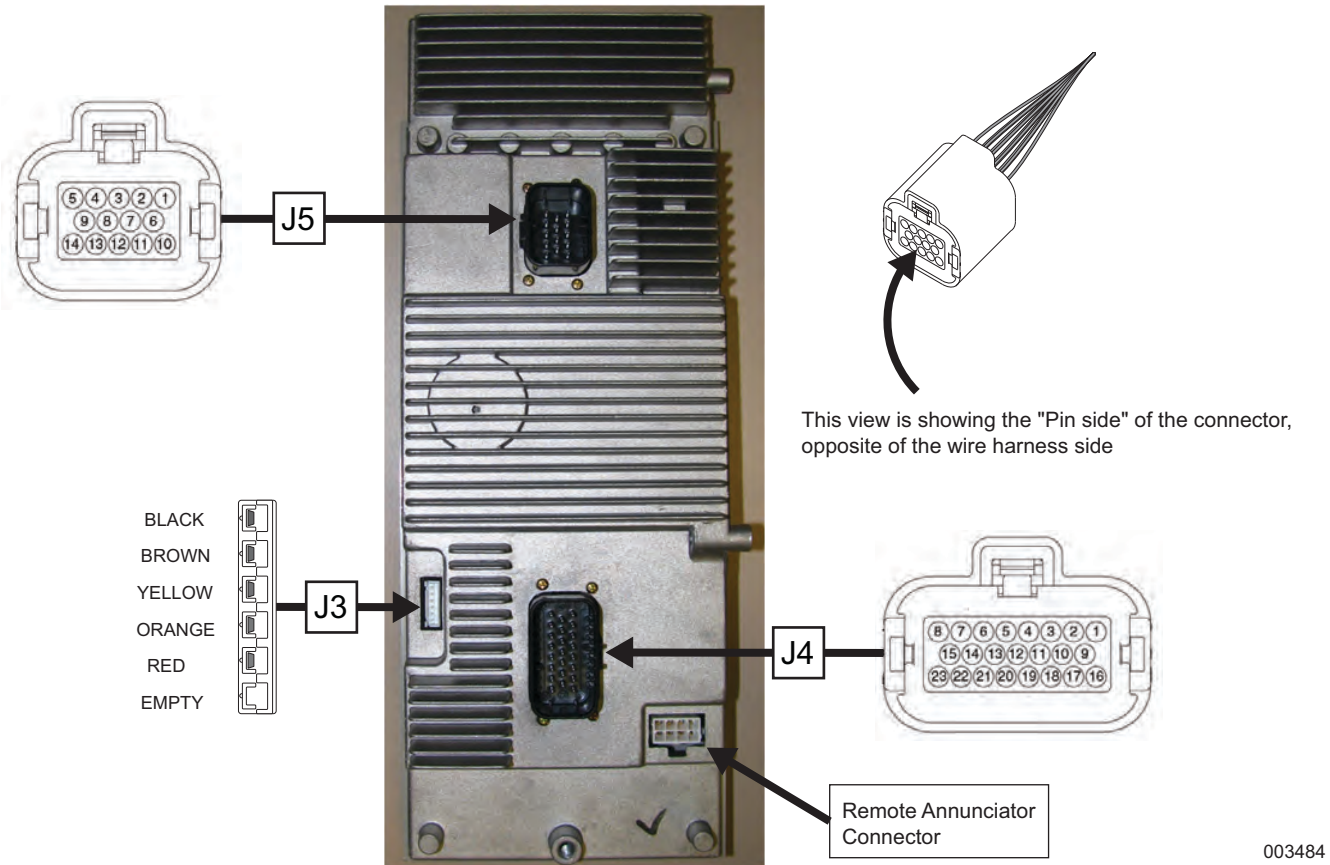


Figure A-7. Nexus Air-cooled Panel Part Number 0H6680 (A) or (B), and Connectors (Harness End)

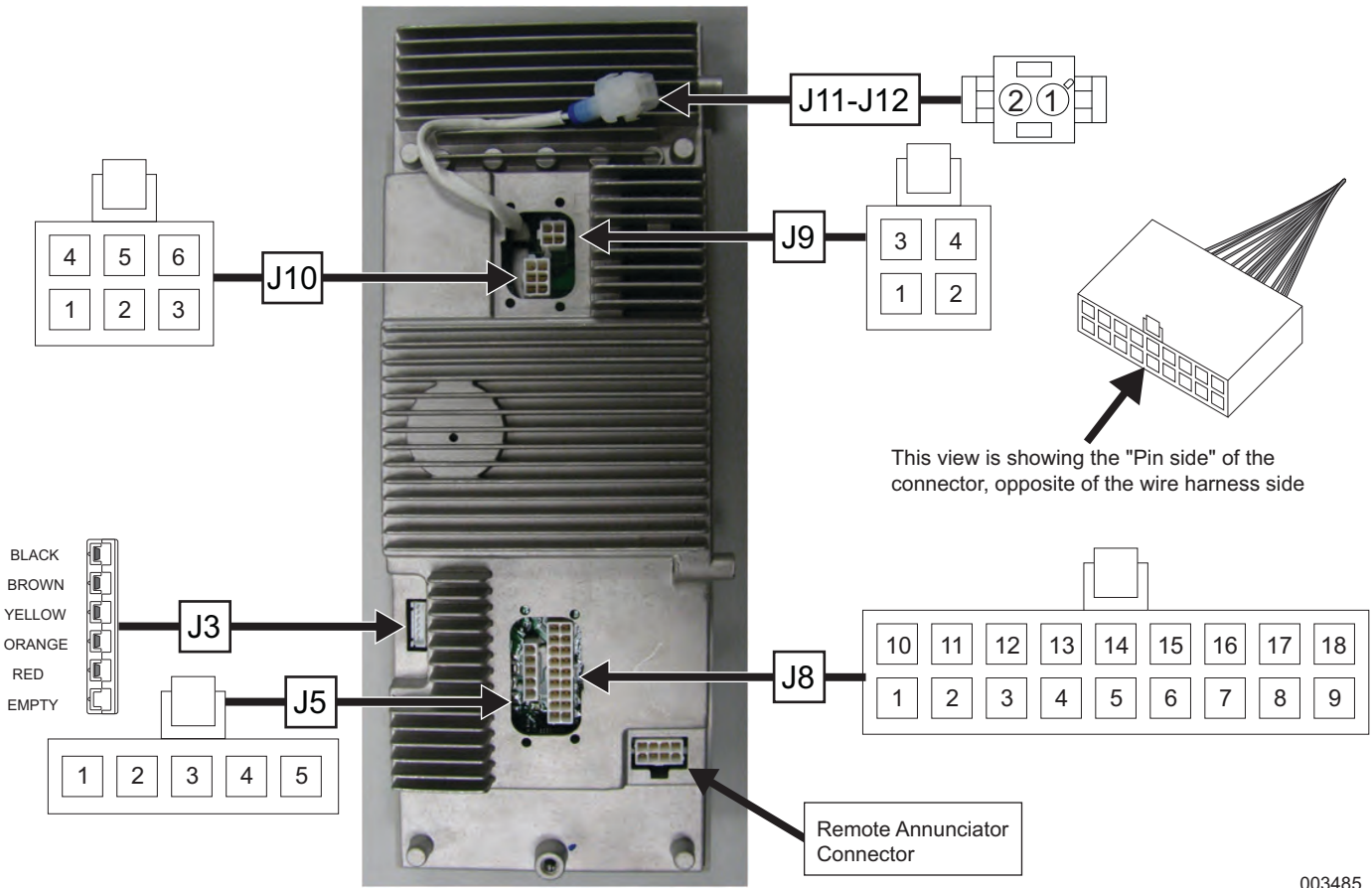
J3 Connector		
Pin	Wire	Circuit Function
J3-1	Black	Stepper Motor A1 Coil
J3-2	Brown	Stepper Motor A2 Coil
J3-3	Yellow	Stepper Motor B1 Coil
J3-4	Orange	Stepper Motor B2 Coil
J3-5	Red	Stepper Power
J3-6	Empty	

J4 Connector		
Pin	Wire	Circuit Function
J4-1	90	Switched to ground for choke solenoid operation
J4-2	0	Common Ground (DC)
J4-3	13	12 VDC un-fused for the controller
J4-4	817	Grounded by the controller to turn on System Ready (Green) LED
J4-5	818	Grounded by the controller to turn on Alarm (Red) LED
J4-6	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J4-7	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
J4-8	820	Positive voltage (5VDC) for status LED's

J4 Connector (Continued)		
Pin	Wire	Circuit Function
J4-9	14	12 VDC output for engine run condition. Used for fuel solenoid and choke solenoid operation on V-Twin Models
J4-10	210	Common Alarm Relay Output
J4-11		Not used
J4-12		Not used
J4-13	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
J4-14		Not used
J4-15	JMP 1	Installed in series with a resistor to identify the kW to the controller
J4-16	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
J4-17	56	12 VDC output to starter contactor relay/solenoid
J4-18	209	Common Alarm Relay Output
J4-19	194	Provides 12 VDC to the transfer relay (TR1)
J4-20	23	Switched to ground (internally) to energize the Transfer Relay
J4-21		Not used
J4-22		Not used
J4-23	JMP 1	Installed in series with a resistor to identify the kW to the controller

J5 Connector		
Pin	Wire	Circuit Function
J5-1	N1	
J5-2	T1	
J5-3	00	
J5-4		Not Used
J5-5	2	DPE Winding (AC excitation power)
J5-6	N2	240VAC Utility sensing voltage
J5-7		Not Used
J5-8		Not Used
J5-9		Not Used
J5-10	44	240VAC Generator voltage sensing
J5-11	11	240VAC Generator voltage sensing
J5-12	0	DC Field excitation ground
J5-13	4	DC (+) Field excitation voltage
J5-14	6	DPE Winding (AC excitation power)

See **Figure A-8** – Nexus Air-cooled Panel part number 0H6680 (D) has 4 Molex/ETC style connectors on the back (J5, J8, J9 & J10), one actuator connector (J3), the battery charger connector (J11 & J12), and a connector socket for the remote wireless annunciator (optional accessory).



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Figure A-8. Nexus Air-cooled Panel Part Number 0H6680 (D), and Connectors (Harness End)

J3 Connector		
Pin	Wire	Circuit Function
J3-1	Black	Stepper Motor A1 Coil
J3-2	Brown	Stepper Motor A2 Coil
J3-3	Yellow	Stepper Motor B1 Coil
J3-4	Orange	Stepper Motor B2 Coil
J3-5	Red	Stepper Power
J3-6	Empty	

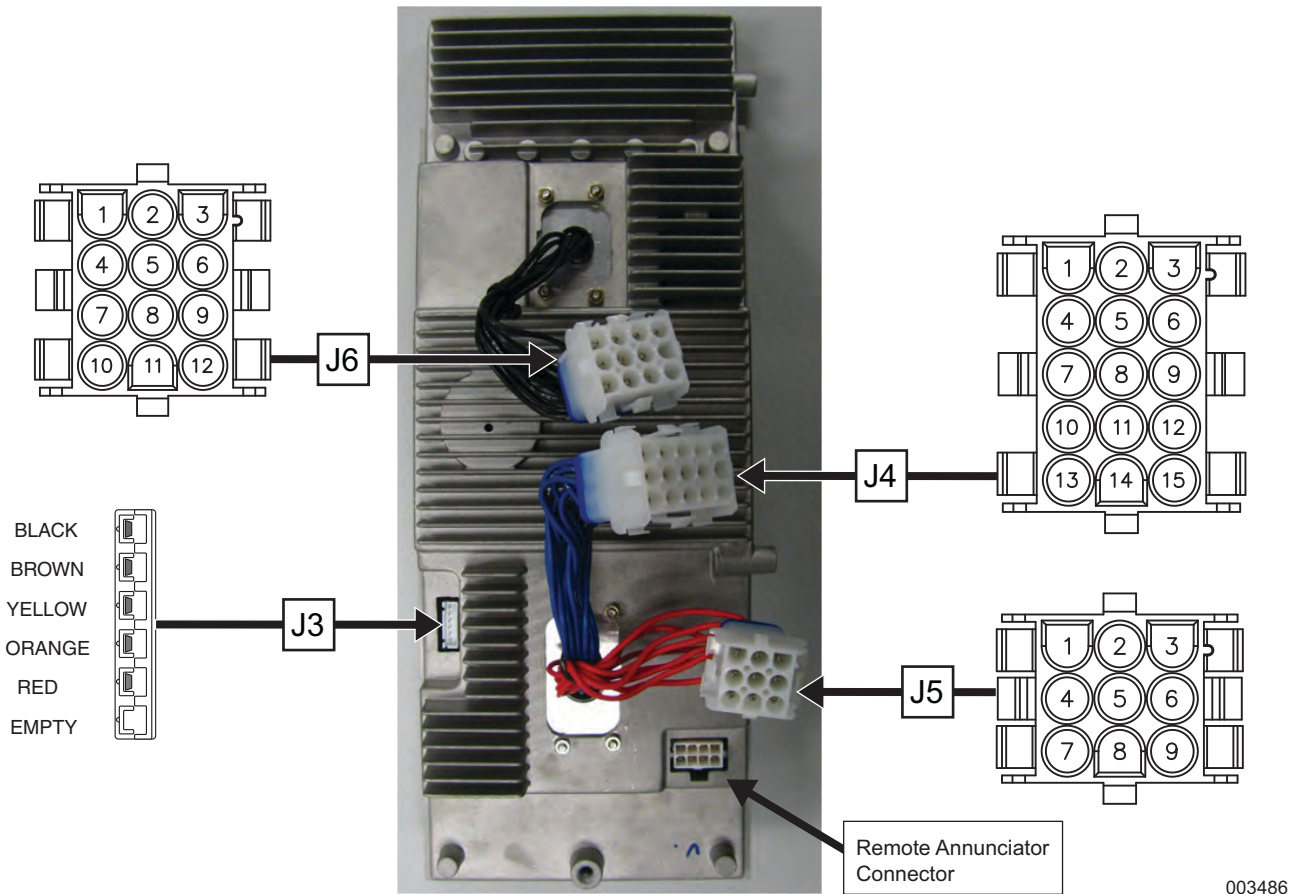
J5 Connector		
Pin	Wire	Circuit Function
J5-1	209	Common Alarm Relay Output
J5-2	194	Provides 12 VDC to the transfer relay (TR1)
J5-3	23	Switched to ground (internally) to energize the Transfer Relay
J5-4		Not used
J5-5		Not used

J8 Connector		
Pin	Wire	Circuit Function
J8-1	820	Positive voltage (5VDC) for status LED's
J8-2	LMP 1	Installed in series with a resistor to identify the kW to the controller
J8-3	85	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
J8-4	0	Common Ground (DC)
J8-5	JMP 1	Installed in series with a resistor to identify the kW to the controller
J8-6	56	12 VDC output to starter contactor relay/solenoid
J8-7	14	12 VDC output for engine run condition. Used for fuel solenoid and choke solenoid operation on V-Twin Models
J8-8	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
J8-9	90	Switched to ground for choke solenoid operation
J8-10	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
J8-11		Not used
J8-12	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J8-13	818	Grounded by the controller to turn on Alarm (Red) LED
J8-14	817	Grounded by the controller to turn on System Ready (Green) LED
J8-15		Not used
J8-16	210	Common Alarm Relay Output
J8-17		Not used
J8-18	13	12 VDC un-fused for the controller

J9 Connector		
Pin	Wire	Circuit Function
J9-1	6	DPE Winding (AC excitation power)
J9-2	11	240 VAC Generator voltage sensing
J9-3	2	DPE Winding (AC excitation power)
J9-4	44	240 VAC Generator voltage sensing

J10 Connector		
Pin	Wire	Circuit Function
J10-1	T1	120 VAC power for the battery charger
J10-2	00	Neutral Connection for T1 (battery charger)

See **Figure A-9** – Nexus Air-cooled Panel part number 0H6680 (T) has 3 Amp/Tyco style connectors on the back (J4, J5 & J6) the actuator connector (J3), and a connector socket for the remote wireless annunciator (optional accessory).



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Figure A-9. Nexus Air-cooled Panel Part Number 0H6680 (T), and Connectors (Harness End)

J3 Connector		
Pin	Wire	Circuit Function
J3-1	Black	Stepper Motor A1 Coil
J3-2	Brown	Stepper Motor A2 Coil
J3-3	Yellow	Stepper Motor B1 Coil
J3-4	Orange	Stepper Motor B2 Coil
J3-5	Red	Stepper Power
J3-6	Empty	

J5 Connector		
Pin	Wire	Circuit Function
J5-1	90	Switched to ground for choke solenoid operation
J5-2	0	Common Ground (DC)
J5-3	13	12 VDC un-fused for the controller
J5-4	817	Grounded by the controller to turn on System Ready (Green) LED
J5-5	818	Grounded by the controller to turn on Alarm (Red) LED

J5 Connector (Continued)		
Pin	Wire	Circuit Function
J5-6	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J5-7	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
J5-8	820	Positive voltage (5VDC) for status LED's
J5-9	14	12 VDC output for engine run condition. Used for fuel solenoid , and choke solenoid operation on V-Twin Models
J5-10	210	Common Alarm Relay Output
J5-11		
J5-12		
J5-13	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
J5-14		
J5-15		

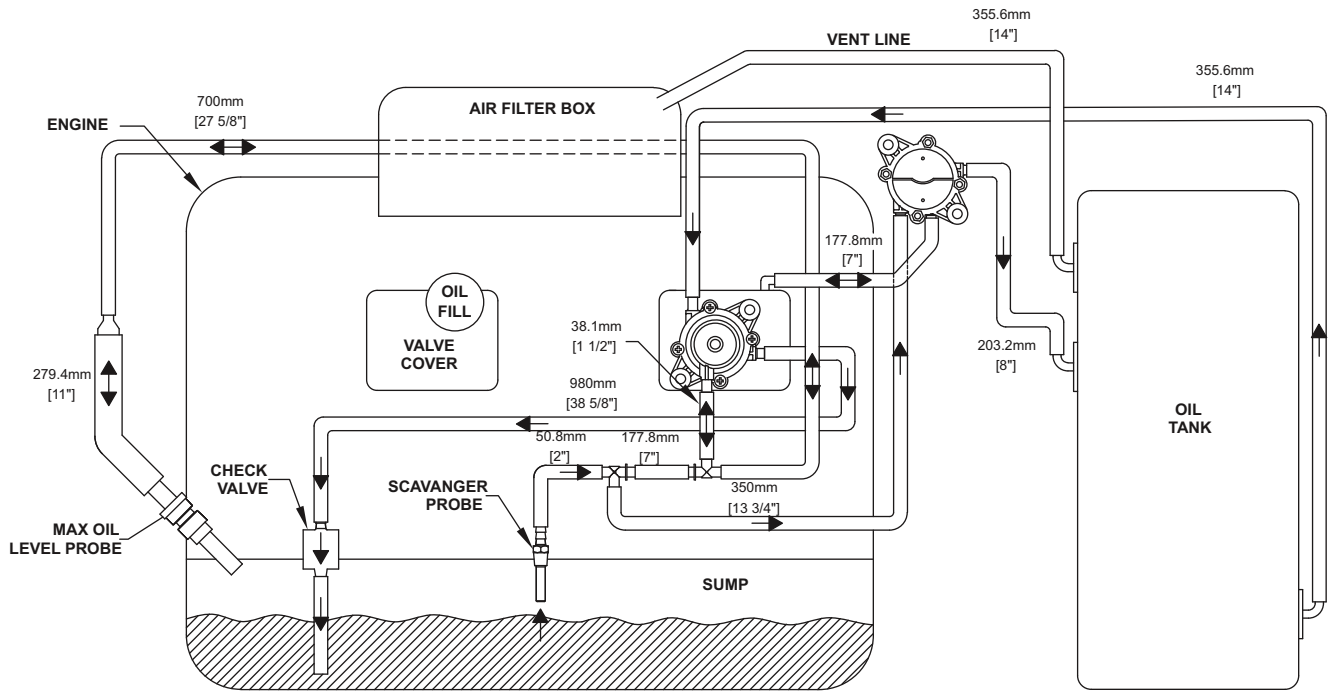
J5 Connector		
Pin	Wire	Circuit Function
J5-1	JMP 1	Installed in series with a resistor to identify the kW to the controller
J5-2	18	Ignition Shutdown: The controller grounds Wire 18 for ignition shutdown and receives a reference signal for speed control while cranking and running
J5-3	56	12 VDC output to starter contactor relay/solenoid
J5-4	209	Common Alarm Relay Output
J5-5	19423	Provides 12 VDC to the transfer relay (TR1)
J5-6	23	Switched to ground (internally) to energize the Transfer Relay
J5-7		
J5-8		
J5-9	JMP 1	Installed in series with a resistor to identify the kW to the controller

J6 Connector		
Pin	Wire	Circuit Function
J6-1	N1	240 VAC Utility sensing voltage
J6-2	T1	120 VAC power for the battery charger
J6-3	00	Neutral Connection for T1 (battery charger)
J6-4	2	DPE Winding (AC excitation power)
J6-5	N2	240 VAC Utility sensing voltage
J6-6	44	240 VAC Generator voltage sensing
J6-7	11	240 VAC Generator voltage sensing
J6-8	0	DC (-) Field excitation voltage
J6-9	4	DC (+) Field excitation voltage
J6-10	6	DPE Winding (AC excitation power)
J6-11		
J6-12		

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Appendix B EcoGen Drawings

Eco Gen Oil Make-Up System (6 kW)



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Figure B-1. Eco Gen Oil Make-Up System

Pump 1



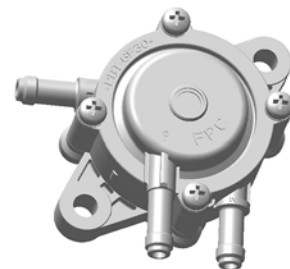
003496

Figure B-2. Pump 1 – 0H7726

- Draws oil from reservoir tank to replenish sump
- Pulse is controlled by the scavenger probe and the max oil probe

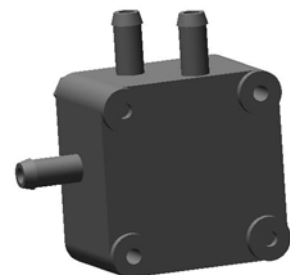
IMPORTANT NOTE: Incorrect routing of the hoses in the oil make-up circuit can cause the crankcase to fill with excessive amounts of oil. Inspect for proper hose routing to the pumps and if necessary, follow the procedures identified in the Service information bulletin (SIB13-09-EcoGen).

Pump 2



003497

Figure B-3. Pump 2 – 0F6263 (New Style)

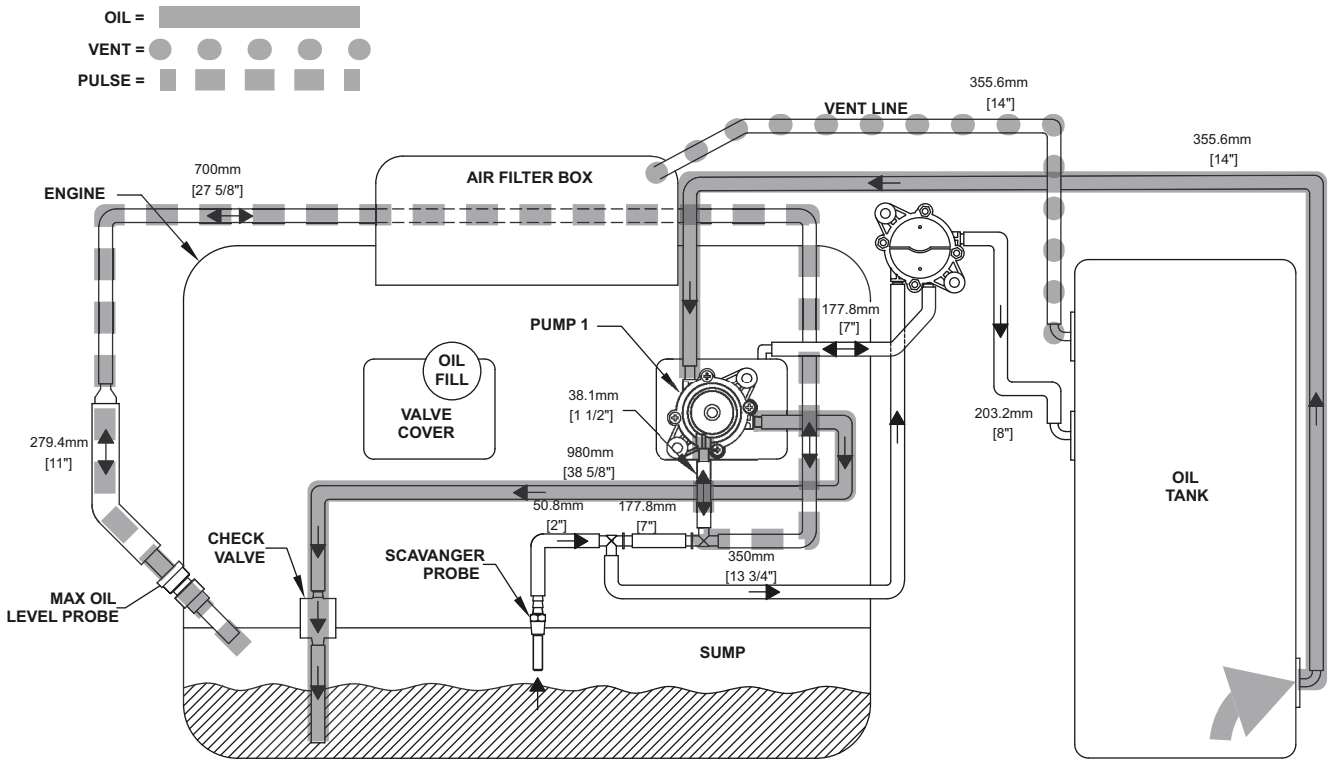


003498

Figure B-4. Pump 2 – 0C4147 (Old Style)

- Draws oil from engine crankcase to the reservoir tank
- Scavenger probe must be submerged to operate properly

Pump 1 Operation

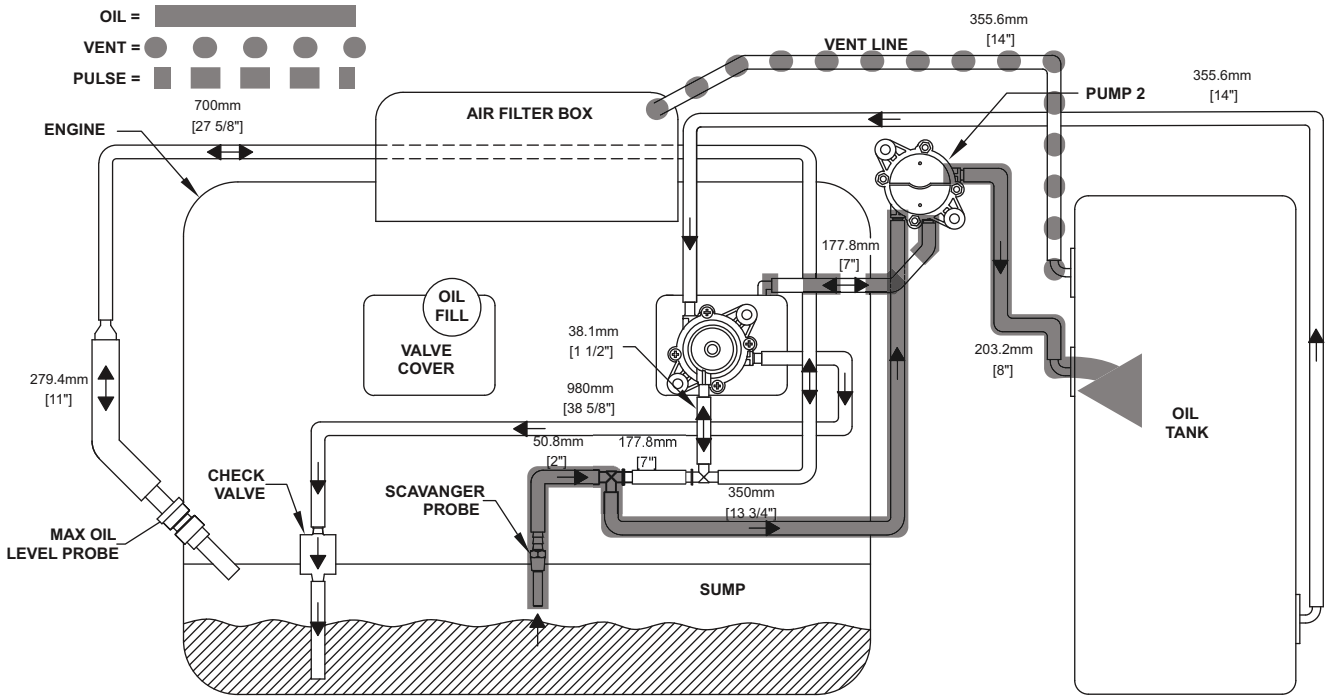


003494

Figure B-5. Eco Gen Oil Make-Up System – Pump 1 Operation

Pump 1 draws oil from reservoir tank to replenish sump with the pulse being controlled by the scavenger probe and the max oil level probe. When the scavenger and max oil probes are submersed in oil, the pulse to pump 1 is stopped.

Pump 2 Operation

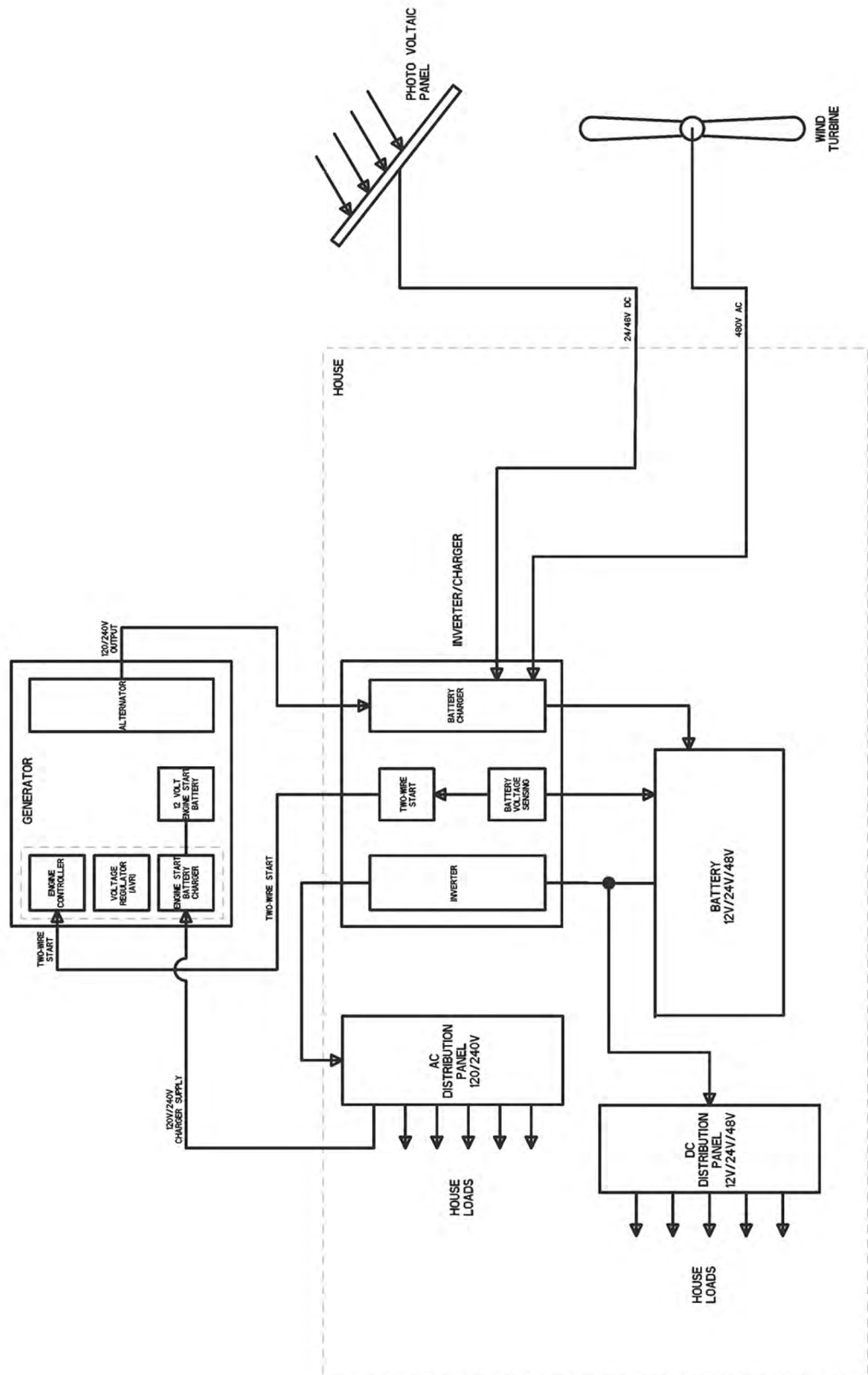


003495

Figure B-6. Eco Gen Oil Make-Up System – Pump 2 Operation

Pump 2 draws oil from engine crankcase to the reservoir tank, essentially keeping the crankcase full. The scavenger probe must be submersed in the crankcase oil for it to pull oil from the crankcase. This stops the flow of oil from the reservoir tank to the engine crankcase.

ECO_GEN - TYPICAL OFF-GRID APPLICATION SYSTEM DIAGRAM



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Figure B-7. Eco Gen Installation Diagram

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Electrical Formulas

To Find	Known Values	1-phase	3-phase
Kilowatts (kW)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73 \times PF}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73}{1000}$
Amperes	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$	$\frac{kW \times 1000}{E \times 1.73 \times PF}$
Watts	Volts, Amps, Power Factor	Volts x Amps	$E \times I \times 1.73 \times PF$
No. of Rotor Poles	Frequency, RPM	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$
Frequency	RPM, No. of Rotor Poles	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{\text{Efficiency}}$	$\frac{HP \times 0.746}{\text{Efficiency}}$
Resistance	Volts, Amperes	$\frac{E}{I}$	$\frac{E}{I}$
Volts	Ohm, Amperes	$I \times R$	$I \times R$
Amperes	Ohms, Volts	$\frac{E}{R}$	$\frac{E}{R}$

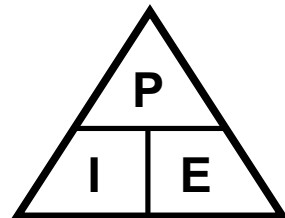
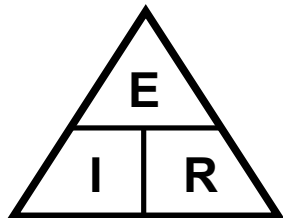
E = Volts

I = Amperes

R = Resistance (Ohms)

PF = Power Factor

Term	Symbol	Measurement
Current	I	Amps
Wattage	P	Watts
Voltage	E	Volts
Resistance	R	Ohms



003003

Constant	Shift		Result	
Voltage E	Resistance Increase	↑	Current Decrease	↓
Voltage E	Resistance Decrease	↓	Current Increase	↑
Resistance R	Voltage Decrease	↓	Current Decrease	↓
Resistance R	Voltage Increase	↑	Current Increase	↑
Current I	Resistance Decrease	↓	Voltage Decrease	↓
Current I	Resistance Increase	↑	Voltage Increase	↑
Power P	Voltage Increase	↑	Power Increase	↑
Power P	Voltage Decrease	↓	Power Decrease	↓
Power P	Current Increase	↑	Power Increase	↑
Power P	Current Decrease	↓	Power Decrease	↓

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