Section 5 – Electrical Data

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

Section 4 – Disassembly – Provides detailed step-by-step instructions for the replacement of the rotor/stator and engine.

Section 5 – Electrical Data – Illustrates all of the electrical and wiring diagrams for the various kW ranges and transfer switches.

Specifications

For rated power capacity, rated voltages, maximum load, harmonic distortion, main line circuit breaker sizes, number of phases, number of rotor poles, rated frequency, power factor, battery requirement, unit weight, dimensions, sound output, exercise duration, engine type, number of cylinders, displacement, cylinder block design, valve arrangement, ignition system, governor system, compression ratio, starter system, oil capacity, operating rpm, and fuel consumption, please refer to the specific unit's spec sheet located at www.generac.com.

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-1. Stator Winding Resistance Values / Rotor Resistance*

	Power Windings Across 11 & 22	Power Windings Across 11&44	Power Windings Across 33 & 44	Sensing Windings Across 11s & 44s	Excitation Windings Across 2 & 6	Rotor Resistance
8 kW	0.16 - 0.18	0.32 - 0.37	0.16 - 0.18	0.35 - 0.41	0.55 - 0.64	4.96 - 5.76
9 kW	0.16 - 0.18	0.32 - 0.37	0.16 - 0.18	0.37 - 0.43	1 - 1.16	6.30 - 7.32
10 kW (2019)	0.13 - 0.16	0.26 - 0.32	0.13 - 0.16	0.31 - 0.38	0.9 - 1.05	6.82 - 7.93
11 kW	0.16 - 0.18	0.32 - 0.37	0.16 - 0.18	0.35 - 0.41	0.55 - 0.64	4.97 - 5.76
13 kW (2019)	0.13 - 0.15	0.26 - 0.31	0.13 - 0.15	0.3 - 0.35	0.84 - 0.98	7.09 - 8.23
13/14 kW	0.12 - 0.14	0.25 - 0.29	0.12 - 0.14	0.28 - 0.33	0.85 - 0.99	7.22 - 8.39
15 kW	0.08 - 0.09	0.11 - 0.12	0.08 - 0.09	0.11 - 0.12	0.71 - 0.82	8.39 - 9.72
16 kW (2019)	0.07 - 0.08	0.14 - 0.17	0.07 - 0.08	0.2 - 0.23	0.71 - 0.82	8.37 - 9.72
16/17 kW	0.07 - 0.08	0.14 - 0.17	0.07 - 0.08	0.2 - 0.23	0.71 - 0.82	8.37 - 9.72
20 kW	0.04 - 0.05	0.08 - 0.1	0.04 - 0.05	0.14 - 0.16	0.61 - 0.71	9.54 - 11.10
22 kW	0.04 - 0.04	0.07 - 0.08	0.04 - 0.04	0.15 - 0.18	0.64 - 0.74	10.25 - 11.92
24 kW	0.04 - 0.04	0.09 - 0.11	0.05 - 0.05	0.09 - 0.11	0.71 - 0.82	9.99 - 11.61
8 kVA (50 Hz)	0.18 - 0.2	0.35 - 0.41	0.18 - 0.2	0.35 - 0.41	0.69 - 0.81	6.82 - 7.93
10 kVA (50 Hz)	0.08 - 0.1	0.16 - 0.19	0.08 - 0.1	0.16 - 0.19	0.74 - 0.86	8.28 - 9.62
13 kVA (50 Hz)	0.06 - 0.07	0.12 - 0.14	0.06 - 0.07	0.12 - 0.14	0.69 - 0.81	9.54 - 11.1

* Resistance values shown are based on new windings at 68 °F (20 °C) with neutrals connected. Actual readings may vary based on type of meter used and any other components or connections included in the circuit being tested.

Table 1-2. Fuel Consumption with Evolution and Evolution 2.0 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 and newer)	90/2.55	120/3.40	0.87/3.29	1.37/5.20
10/11 kW	124/3.51	195/5.52	1.18/4.45	1.92/7.28
10 kW (2019)	101/2.86	127/3.60	0.97/3.66	1.48/5.62
11 kW (2017 and newer)	107/3.03	159/4.50	1.22/4.62	1.97/7.45
13/13 kW	157/4.45	255/7.22	1.64/6.2	2.95/11.15
13 kW (2019)	154/4.36	225/6.37	1.54/5.83	2.45/9.28
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 and newer)	218/6.17	309/8.75	2.03/7.70	2.94/11.11
16 kW (2019)	182/5.15	245/6.94	1.70/6.45	2.99/11.32
16/17 kW	193/5.47	312/8.83	1.99/7.53	3.57/13.53
17 kW (2017 and newer)	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 and newer)	204/5.78	301/8.52	2.37/8.99	3.56/13.48
22 kW	184/5.21	281/7.96	2.16/8.16	3.68/13.94
22 kW (2017 and newer)	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

IMPORTANT NOTE: All unit specifications are subject to change.

Table 1-3. Engine with Evolution and Evolution 2.0 Controller							
Displacement	**Model**	**No. of Cylinders**	**Oil Capacity (w/Filter)**	**Recommended Spark Plug**	**Spark Plug Gap**	**Valve Clearance**	**Compression Pressure**
410cc	8 kW	1	Approx. 1.5 Qt/ 1.4L	RC12YC Generac P/N 0G0767A	0.508 mm (0.020 inch)	0.05-0.1mm (0.002-0.004 in)	190 psi +/- 10-15%
426cc	9 kW	1	Approx. 1.1 Qt/ 1.0L	RC12YC Generac P/N 0G0767A	0.508 mm (0.020 inch)	0.05-0.1mm (0.002-0.004 in)	80–120 psi *
460cc	10 kW	1	Approx. 1.1 Qt/ 1.0L	RC12YC Generac P/N 0G0767A	0.508 mm (0.020 inch)	0.05-0.1mm (0.002-0.004 in)	80–120 psi *
530cc	11 kW	2	Approx. 1.7 Qt/ 1.6L	BPR6HS/RL87YC Generac P/N 0E9368	0.76 mm (0.030 inch)	0.05-0.1mm (0.002-0.004 in)	170 psi +/- 10-15%
816cc	13/16 kW (2019) 14/18 kW (2020)	2	Approx. 2.2 Qt/ 2.1L	RC12YC Generac P/N 0G0767A	0.508 mm (0.020 inch)	Hydraulic lifters—Not adjustable	180–220 psi
992cc	13/14/15/16/17 kW	2	Approx. 1.9 Qt/ 1.8L	RC14YC Generac P/N 0E7585	1.02 mm (0.040 inch)	0.05-0.1mm (0.002-0.004 in)	185 psi +/- 10-15%
999cc	16/17kW (2017) 20/22/24 kW	2	Approx. 1.9 Qt/ 1.8L	RC12YC Generac P/N 0G0767A	1.02 mm (0.040 inch)	0.05-0.1mm (0.002-0.004 in)	185 psi +/- 10-15%

* The 426 cc and the 460 cc engine have an Automatic Compression Release (ACR) system that will not allow full compression while cranking. Full compression resumes at 650 RPM when ACR disengages.

Component Locator

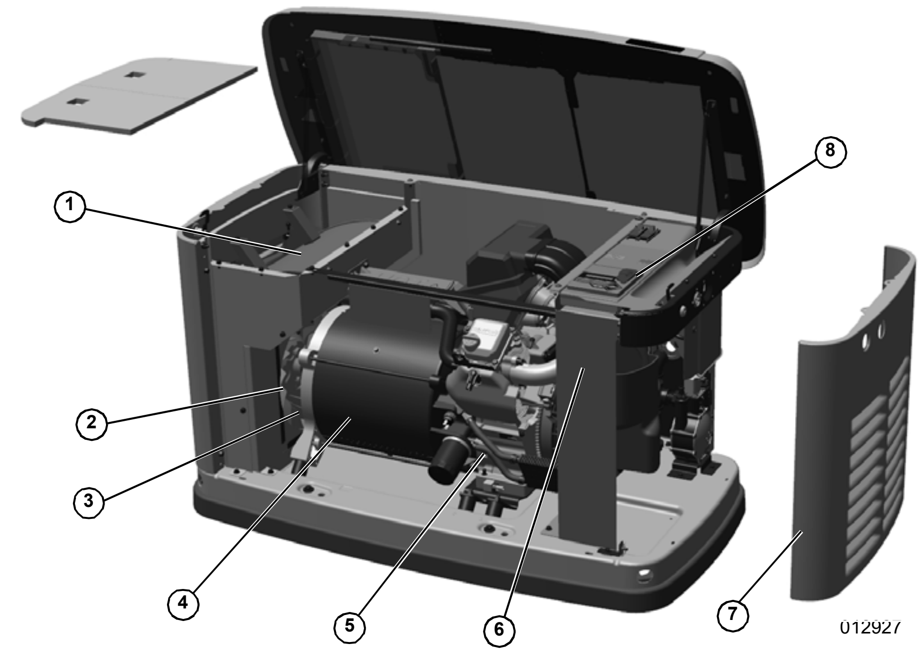

Figure 1-1.

1. Exhaust
2. Generator Fan
3. Brush Assembly (mounted to bearing carrier)
4. Alternator
5. Engine
6. Data Plate
7. Access Panel
8. Evolution Controller

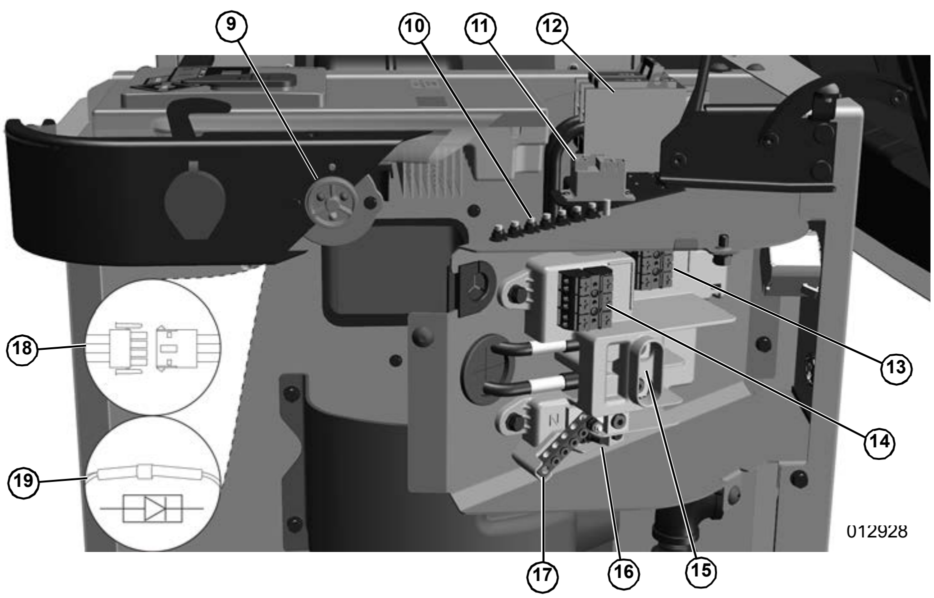

Figure 1-2.

9. LED Status
10. Chassis ground lugs
11. Starter Contactor Relay (SCR)
12. Main Line Circuit Breaker (MLCB)
13. AC Wago Block
14. DC Wago Block
15. E1 and E2 Lugs
16. Ground Lug
17. Neutral Lug
18. Stator Connector (STR) (in harness)
19. Field Boost Diode (in harness)

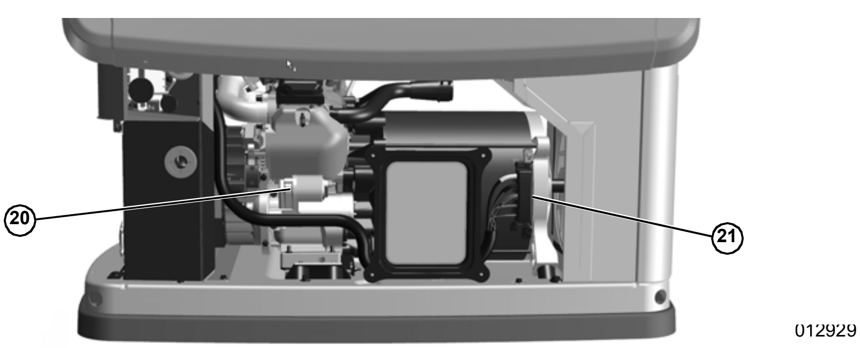

Figure 1-3.

20. Starter Contactor (SC)
21. Stator Terminal Block (STB) (if equipped)

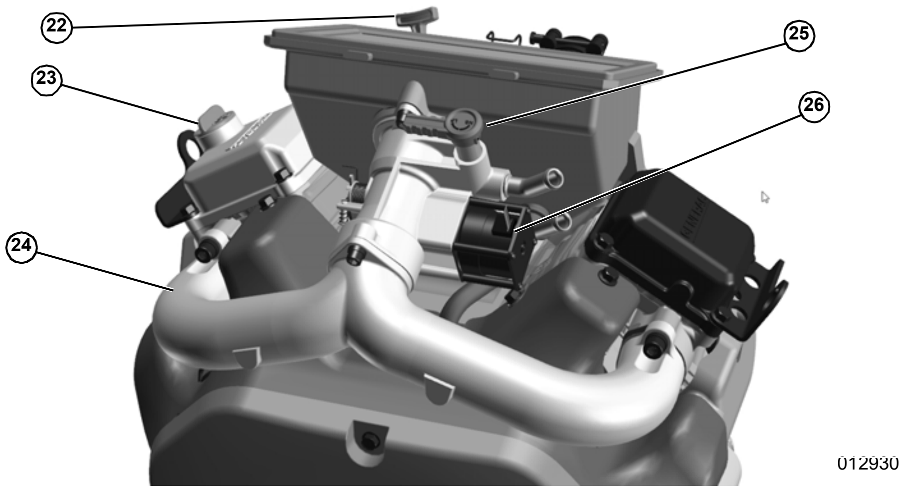

Figure 1-4.

22. Oil Dipstick
23. Oil Fill
24. Intake Manifold
25. Fuel Select
26. Stepper Motor

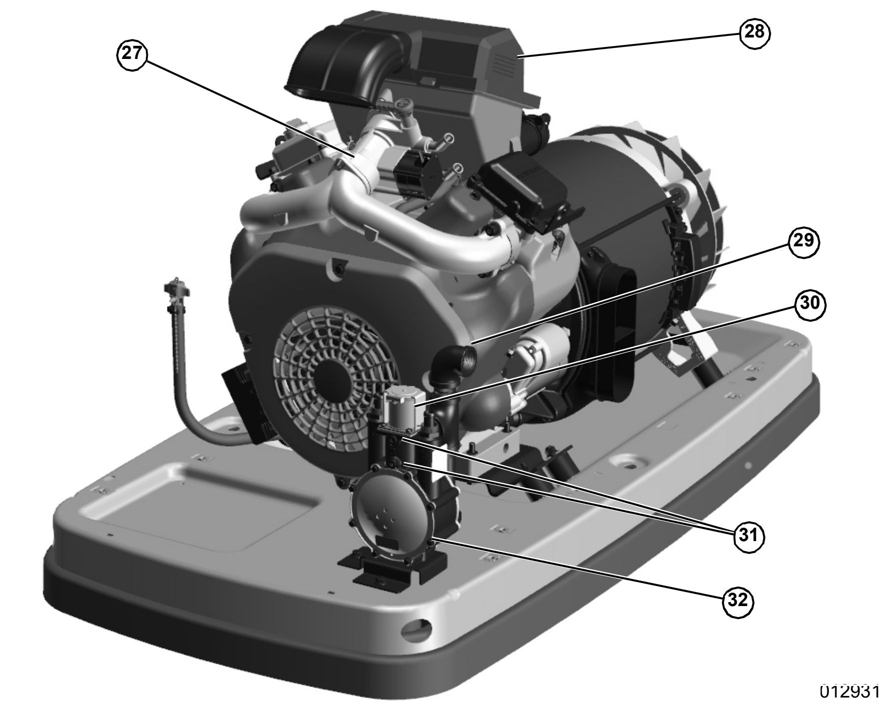

Figure 1-5.

27. Venturi Mixer
28. Air Filter
29. Fuel Supply
30. Fuel Solenoid
31. Test Ports
32. Demand Regulator

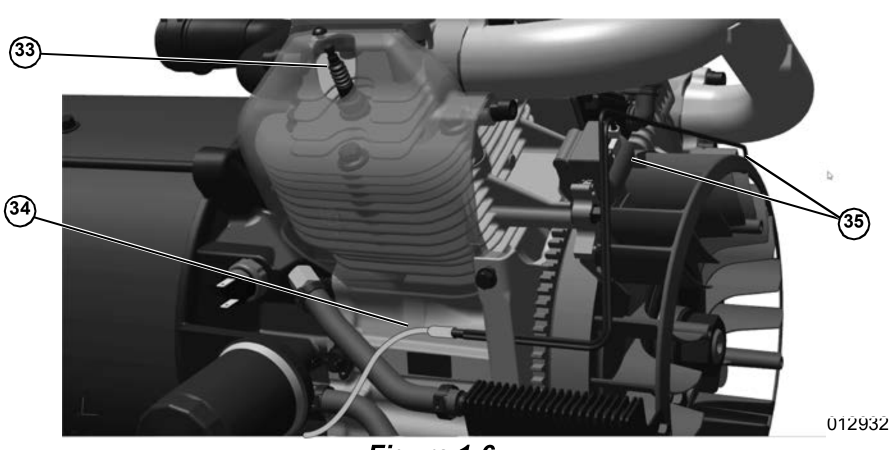

Figure 1-6.

33. Spark Plug
34. Wire 18
35. Ignition Magnetos

Table 1-4. Symptom Related Diagnostic Guide

Problem - Symptom	Go To…
Aux Shutdown - E2800	Check harness/switches
Battery is Dead	Section 4.5, Problem 22
Charger Missing AC	Problem 22
Charger Warning	Problem 22
Controller displays “Model Ident Problem Fix Harness Resistor”	Section 4.5, Problem 23
Controller Fuse (7.5 Amp - F1) Blown (open)	Section 4.5, Problem 19
Controller Goes Dark and Reboots when Starting	Section 4.5, Problem 16
Controller Displays “Warming Up” longer than 5 seconds	Preliminary Output Voltage Test (POVT)
Engine Backfires and/or Hunts or Erratic Operation	Section 4.5, Problem 18
Engine Cranks but Will Not Start	Section 4.5, Problem 17
Engine Starts Hard and/or Runs Rough or Lacks Power	Section 4.5, Problem 18
Engine Will Not Crank When Controller Set to AUTO or MANUAL	Section 4.5, Problem 16
Engine Will Not Crank When Utility Power Source Fails	Section 4.5, Problem 15
Generator Produces High Voltage	Section 2.2, P.O.V.T.
Generator Shuts Down for Under Voltage	Section 2.2, P.O.V.T.
Generator Will Not Exercise	Section 4.5, Problem 20
High Temperature - E1400	Test 62
Incorrect Voltage Output, but does not Trigger a Shutdown	Section 2.2, Problem 4
Low Battery	Test 45
Low Oil Pressure - E1300	Test 61
Model Ident Problem - Fix Harness Resistor	Problem 23
No Low-Speed Exercise	Section 4.5, Problem 21
Over Crank - E1100	Section 4.5, Problem 17
Overload Remove Load - E2100	Test 15
Overspeed - E1200, E1205	Test 53 (was Test 12)
Overspeed - E1207	Test 64 and Test 60
Overvoltage - E1800	Section 2.2, Problem 2
RPM Sense Failure - E1501, E1511	Test 50 and Test 64
RPM Sense Failure (Engine Cranks) - E1505, E1515	Test 64
RPM Sense Failure (Engine Does Not Crank) - E1505, E1515	Problem 15
Shutdown Fault Occurred During Crank Attempt, Start or Run	Section 4.5, Problem 14
Under Speed - E1600, E1603	Problem 3, Test 50, Test 53
Undervoltage - E1900, E1901, E1902, E1906	Section 2.2, P.O.V.T.
Undervoltage Overload - E2299	Test 15
Unstable Voltage, but does not Trigger a Shutdown	Section 2.2, Problem 4
Voltage and Frequency Drop Excessively When Loads Are Applied	Section 2.2, Problem 3
Wiring Error - E2099	Check Wiring Interconnection

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 contaminates as dust, dirt, oil, grease and especially moisture. In most cases, failures of stator and rotor windings are due to a break down in the insulation. In many cases, a low insulation resistance is caused by moisture that collects while the generator is shut down. When problems are caused by moisture buildup on the windings, this can usually be corrected by drying the windings. Cleaning and drying the windings can usually eliminate dirt and moisture that has built up in the generator windings.

The Megohmmeter

Introduction

A Megohmmeter (often called a megger), consists of a meter calibrated in megohms and a power supply.

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 1-7***. 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.

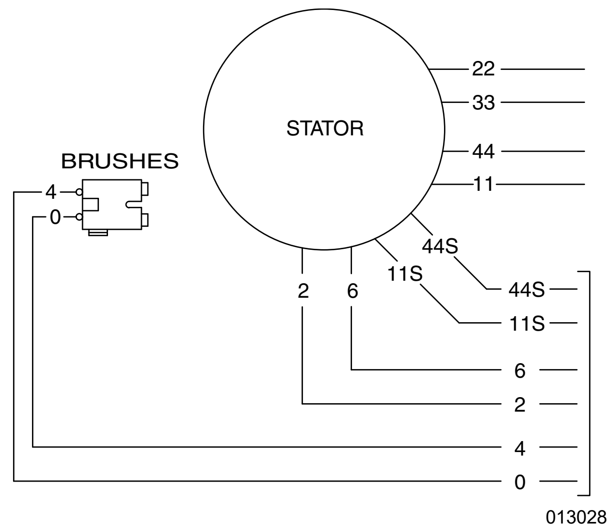

Figure 1-7. Typical Stator Output Leads

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 ºF (85 ºC).

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.

Navigation Keys

See ***Figure 1-8***. There are four selection and navigation keys below the display.

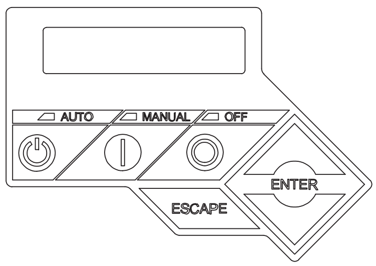

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Figure 1-8. Evolution Display and Navigation Buttons

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).
- Move left and right between various editable menus.
- Increase or decrease a value or change a choice in an editable menu (i.e. from Yes to No).

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 1-9*** and ***Figure 1-10***. The menu system diagram is shown in ***Figure 1-20*** and ***Figure 1-28***.

There are four selections in the Main Menu: System, Date/Time, Battery (Evolution 1.0), WIFI or Setup WIFI* (Evolution 2.0), Sub Menus.

SYSTEM	DATE/TIME
BATTERY	SUB MENUS

002462

Figure 1-9. Evolution 1.0 Display Main Menu

SYSTEM	DATE/TIME
WIFI*	SUB MENUS

009017

Figure 1-10. Evolution 2.0 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.

HISTORY	MAINT
EDIT	DEALER

002463

Figure 1-11. 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.

History
Alarm Log Run Log

002464

Figure 1-12. History Menu

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

002465

Figure 1-13. Alarm Log Display

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

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

002466

Figure 1-14. Run Log Display.

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

Maint (Evolution 1.0)

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

MAINT:	Run Hrs
Maint Log	Scheduled

002467

Figure 1-15. Maint Menu (Evolution 1.0)

Battery (Evolution 2.0)

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

Battery	Run Hrs
Maint Log	Scheduled

009018

Figure 1-16. Battery Menu (Evolution 2.0)

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 1-5. Cold Smart Start Parameters

Node	**8 - 20 kW**	**22 - 24 kW**
Cold Smart Start (2015-02) and Ambient Temp display screen	X	X
Temperature Threshold	50 ºF	20 ºF
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

Dealer

The Dealer Menu displays three selections:

- Display
- Dealer Edit
- Test

DEALER:	DISPLAY
DEALER EDIT	TEST

002468

Figure 1-17. Evolution Dealer Menu

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 (ºF)
- 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
- Set Output Voltage (Evolution 2.0)
- Calibrate Current 1
- Calibrate Current 2
- Calibrate Volts
- 2-Wire Start Select
- Wi-Fi Options (Evolution 2.0)
- Go To Wizard (Evolution 2.0)
- Reset Maintenance
- Factory Reset (Evolution 2.0)

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 1-6***. 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 1-6***. 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). 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 1-18*** 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.

INPUTS: Utility 240
0 1 0 0 0 0 1 0

002469

Figure 1-18. 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 1-19*** there are no Outputs ON. This indicates the unit is shut down.

OUTPUTS: Gen 0
0 0 0 0 0 0 0 0

002470

Figure 1-19. Test Outputs Display

Table 1-6. 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

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.

Evolution 2.0/Sync 3.0 HSB Menu Map—EDIT

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

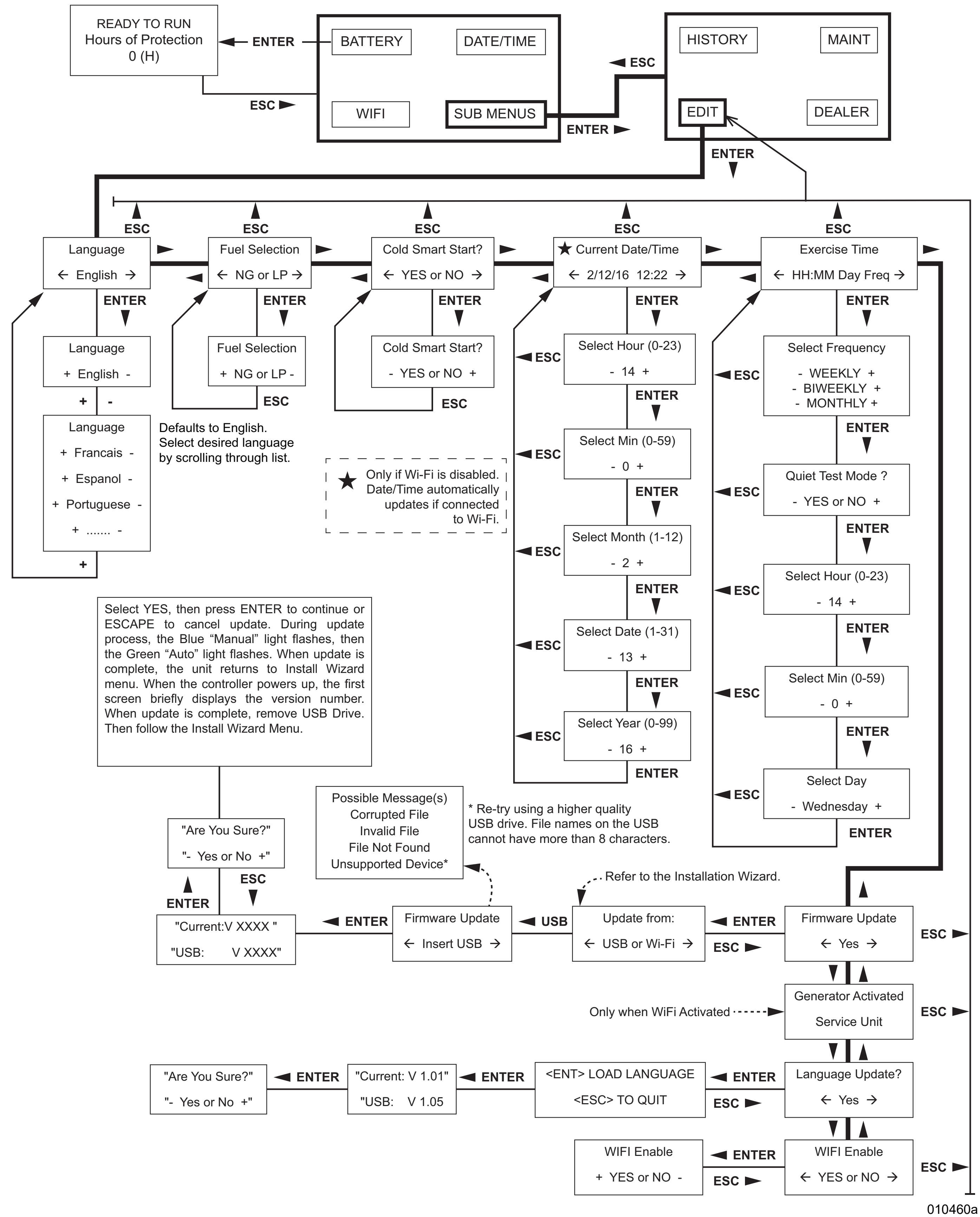


Figure 1-20. Evolution 2.0/Sync 3.0 HSB Menu Map—EDIT

Evolution 2.0/Sync 3.0 HSB Menu Map—HISTORY, MAINT

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

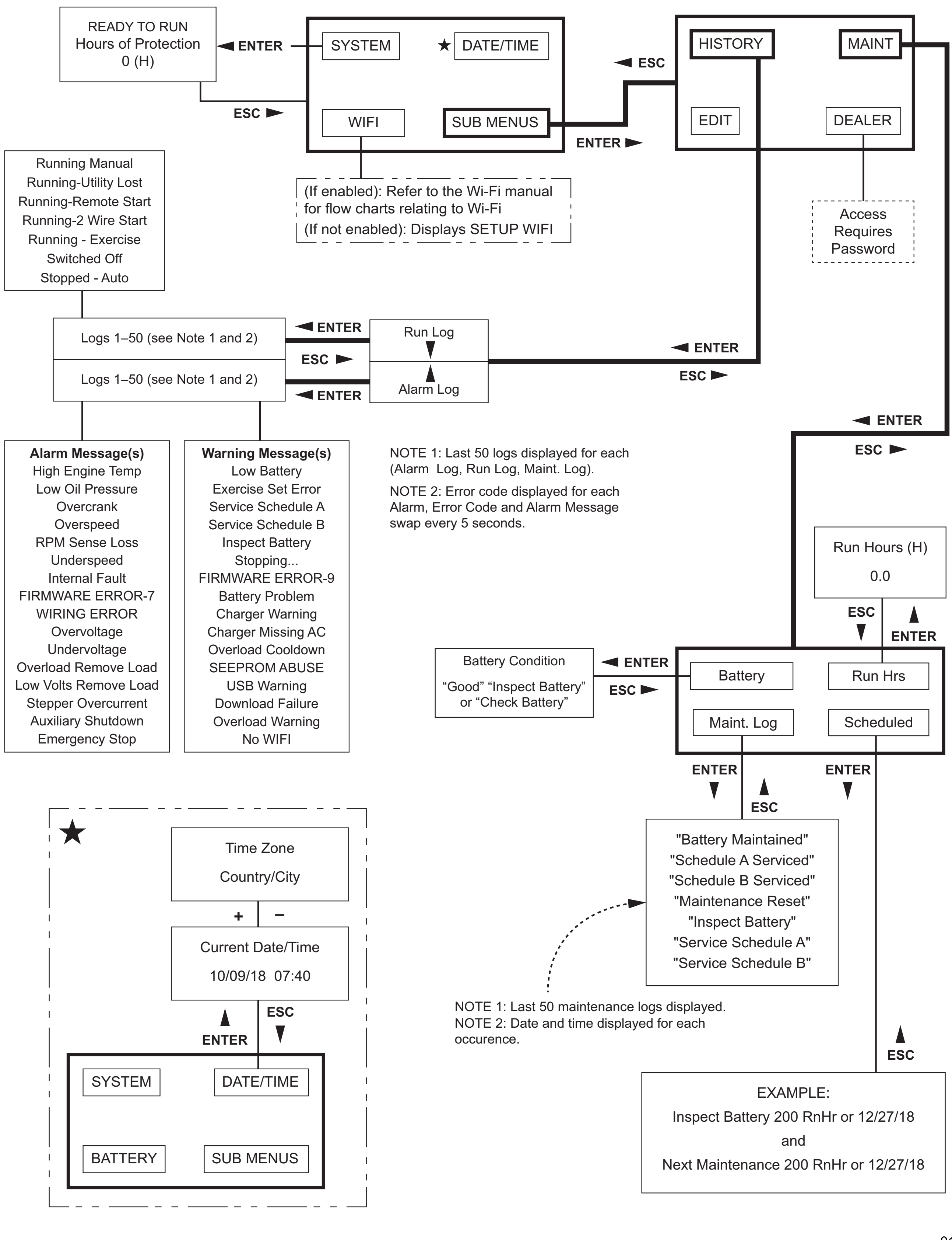


Figure 1-21. Evolution 2.0/Sync 3.0 HSB Menu Map—HISTORY, MAINT

Evolution 2.0/Sync 3.0 HSB Menu Map—SYSTEM

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

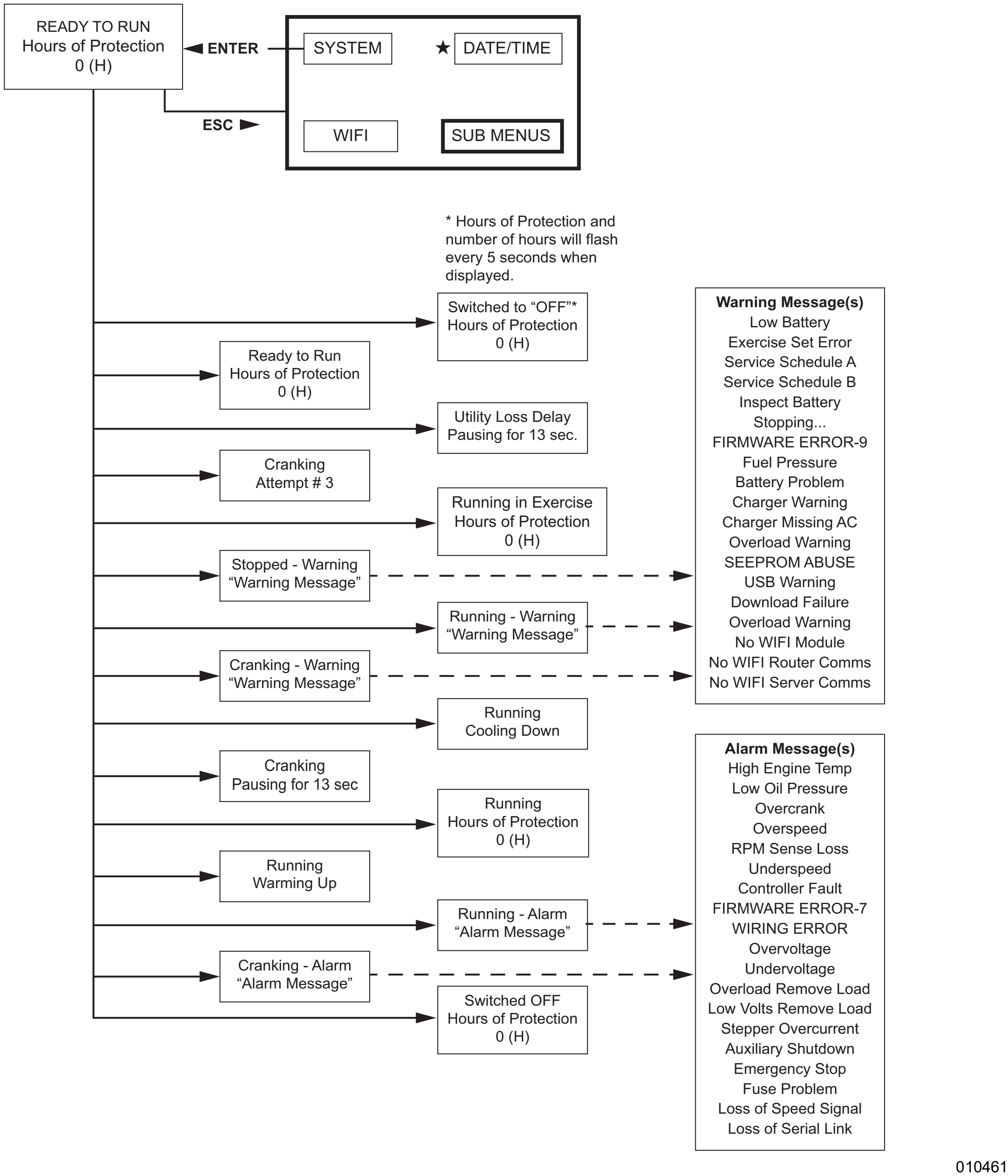


Figure 1-22. Evolution 2.0/Sync 3.0 HSB Menu Map—SYSTEM

Evolution 2.0/Sync 3.0 HSB Menu Map—ACTIVATION

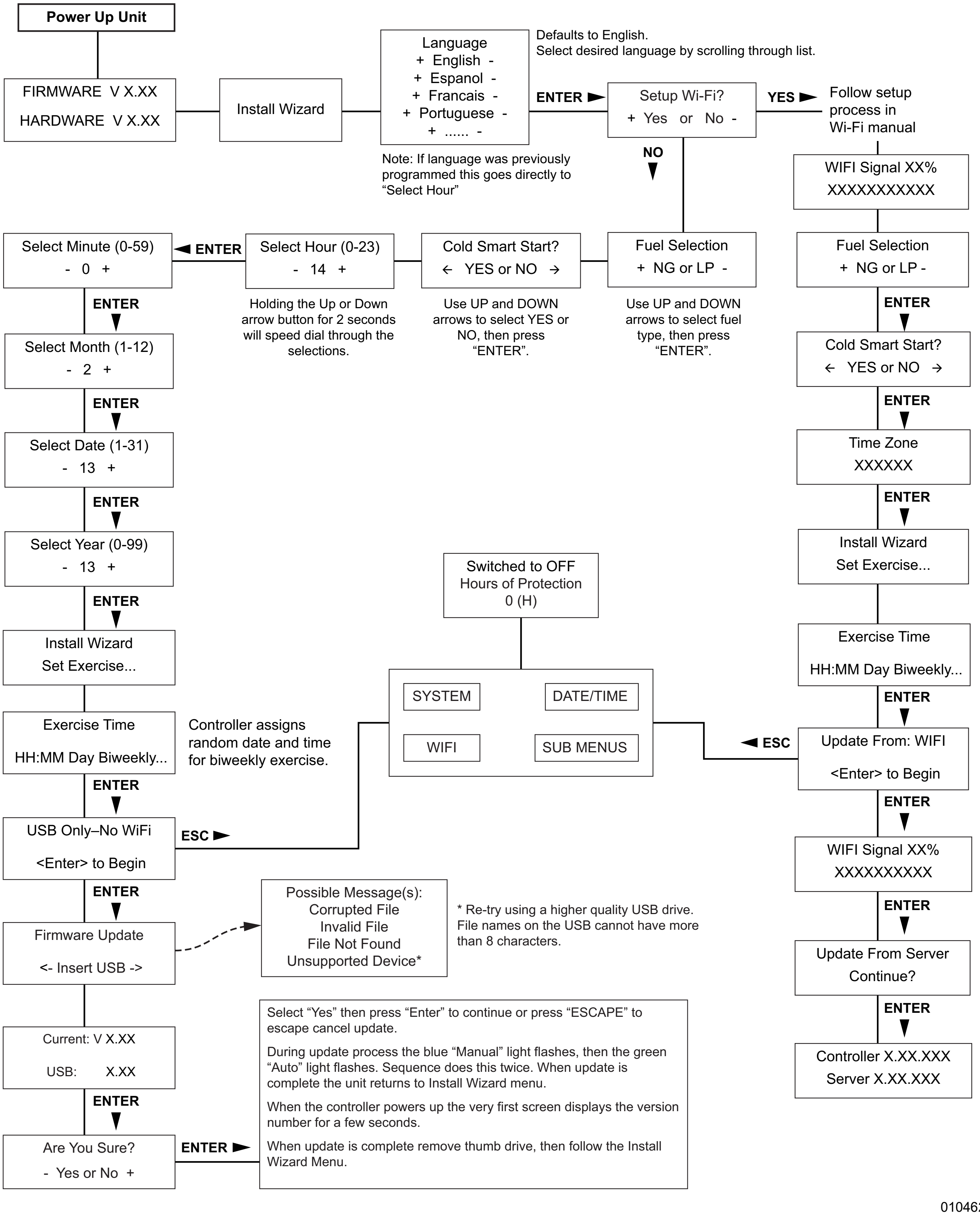


Figure 1-23. Evolution 2.0/Sync 3.0 HSB Menu Map—ACTIVATION

Evolution 2.0/Sync 3.0 HSB Menu Map—FIRMWARE

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

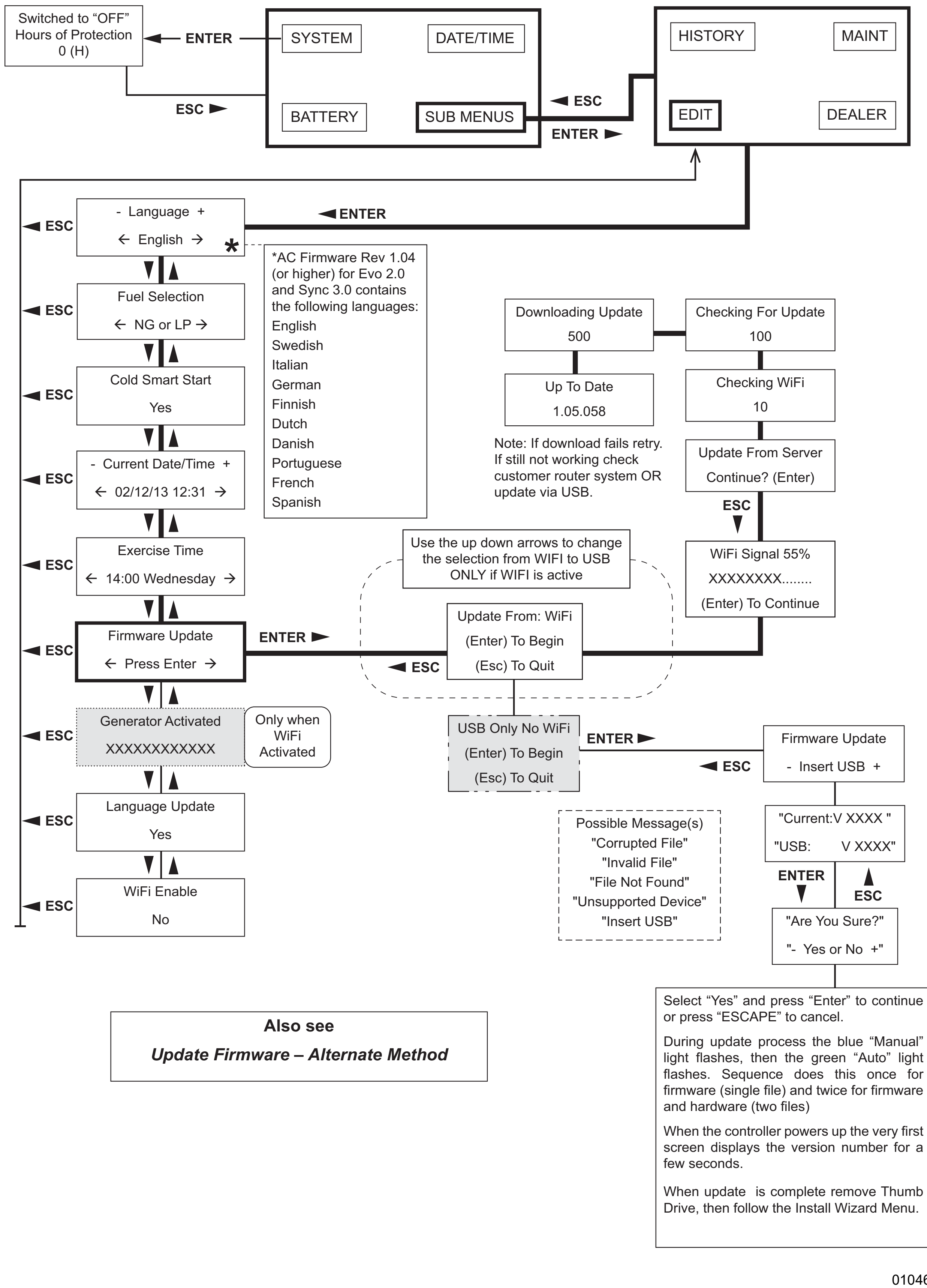


Figure 1-24. Evolution 2.0/Sync 3.0 HSB Menu Map—FIRMWARE

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER EDIT

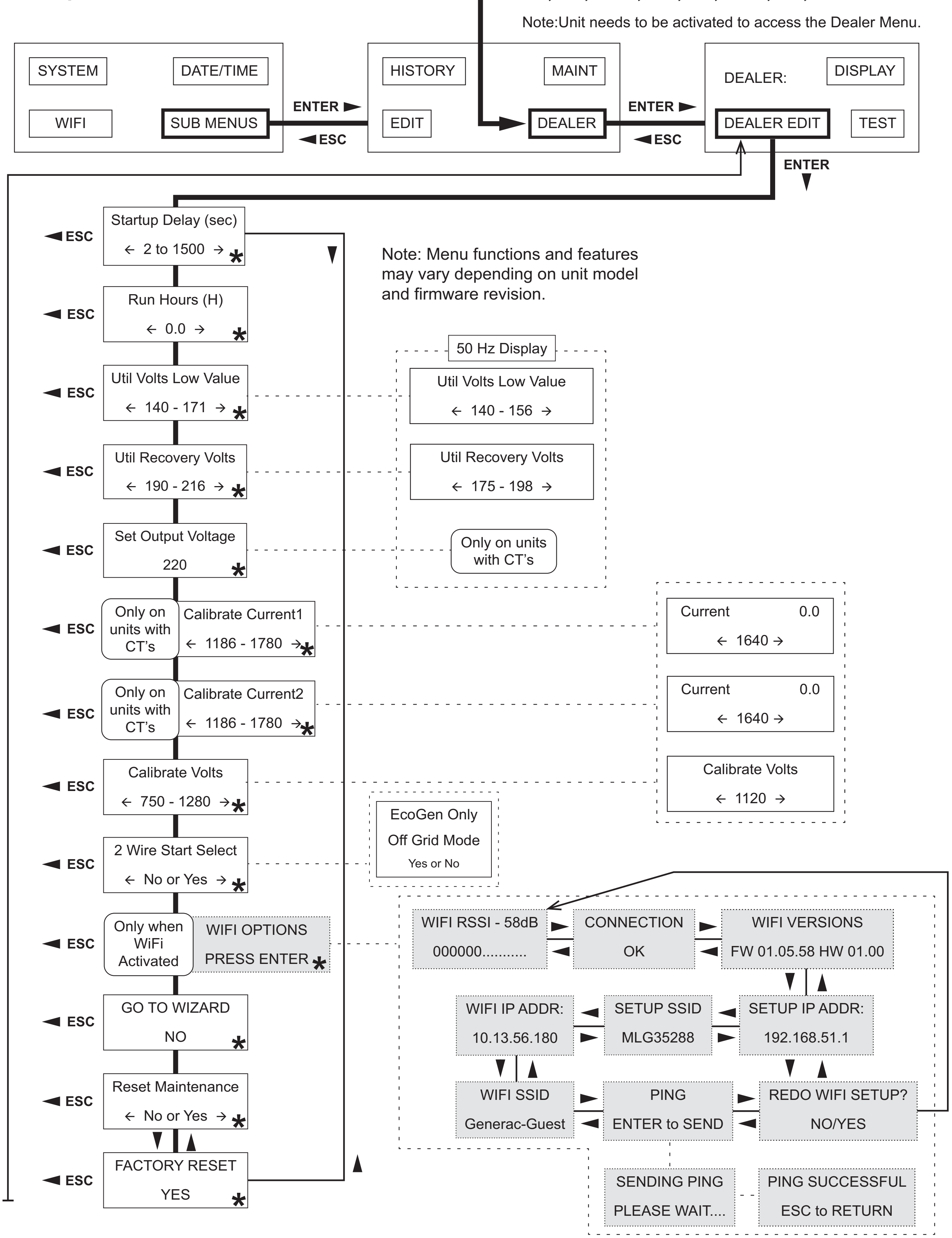


Figure 1-25. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER EDIT

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER TEST

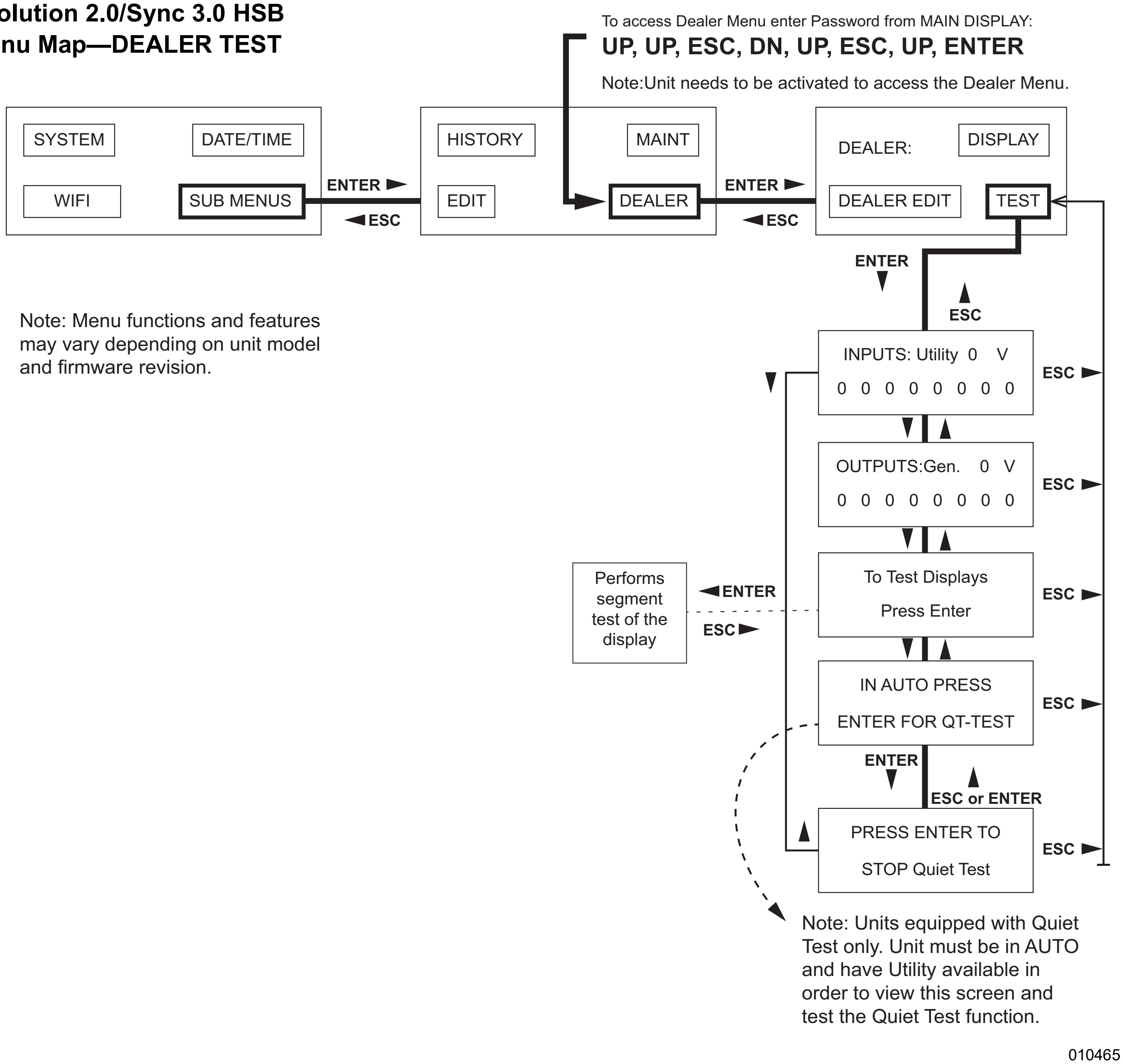


Figure 1-26. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER TEST

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER DISPLAY

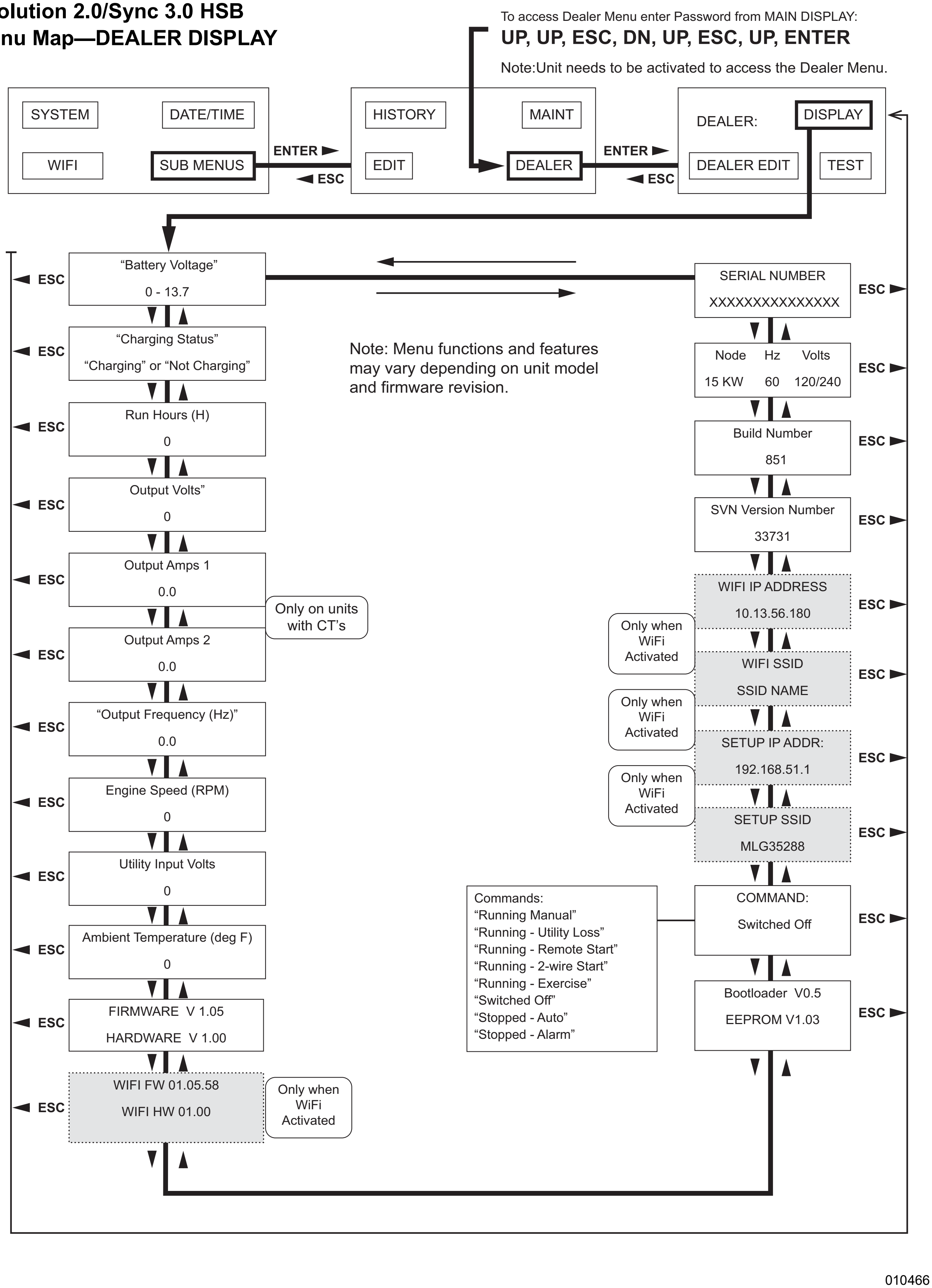


Figure 1-27. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER DISPLAY

Evolution 1.0/Sync 2.0 HSB Menu Map—EDIT

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

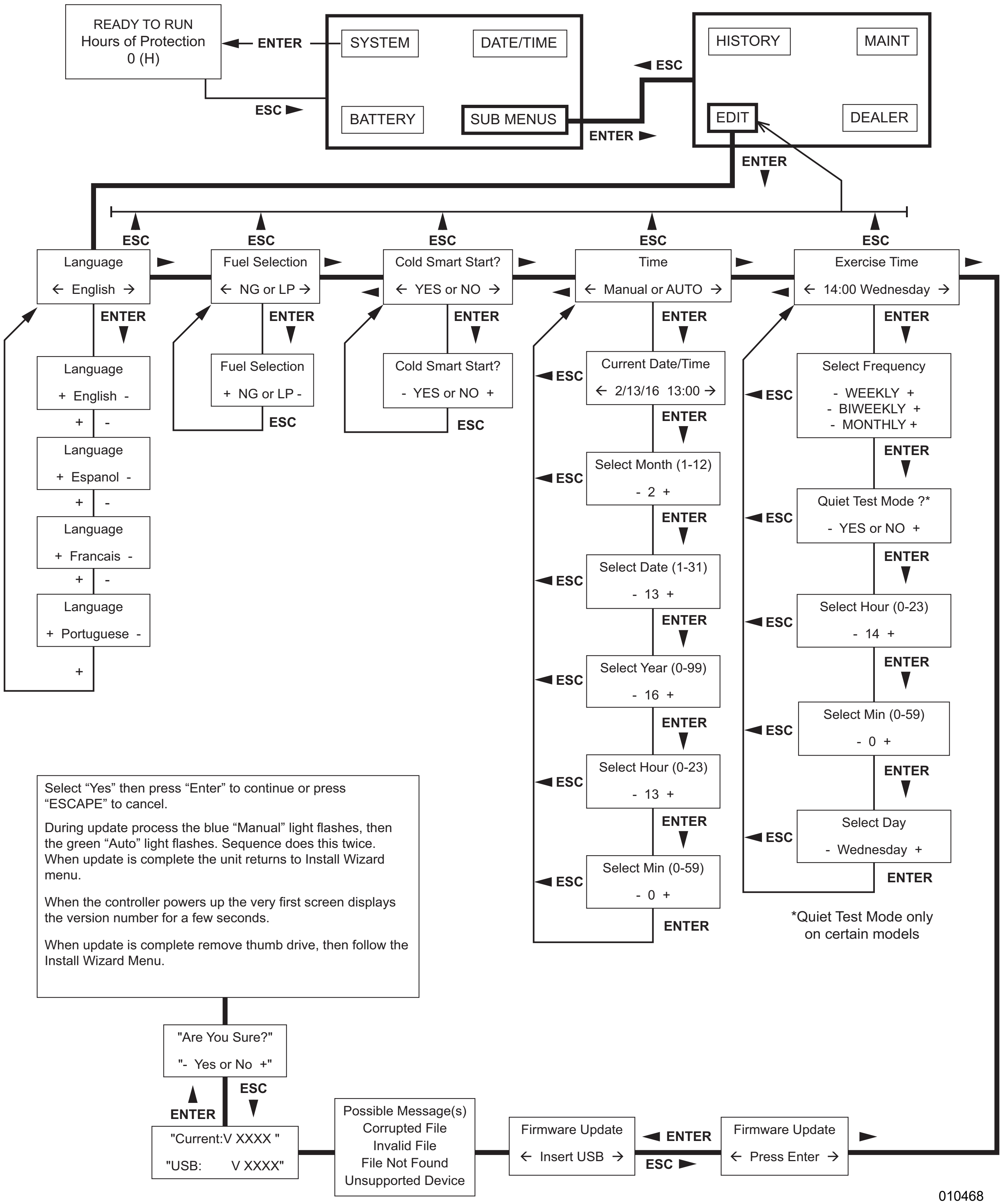
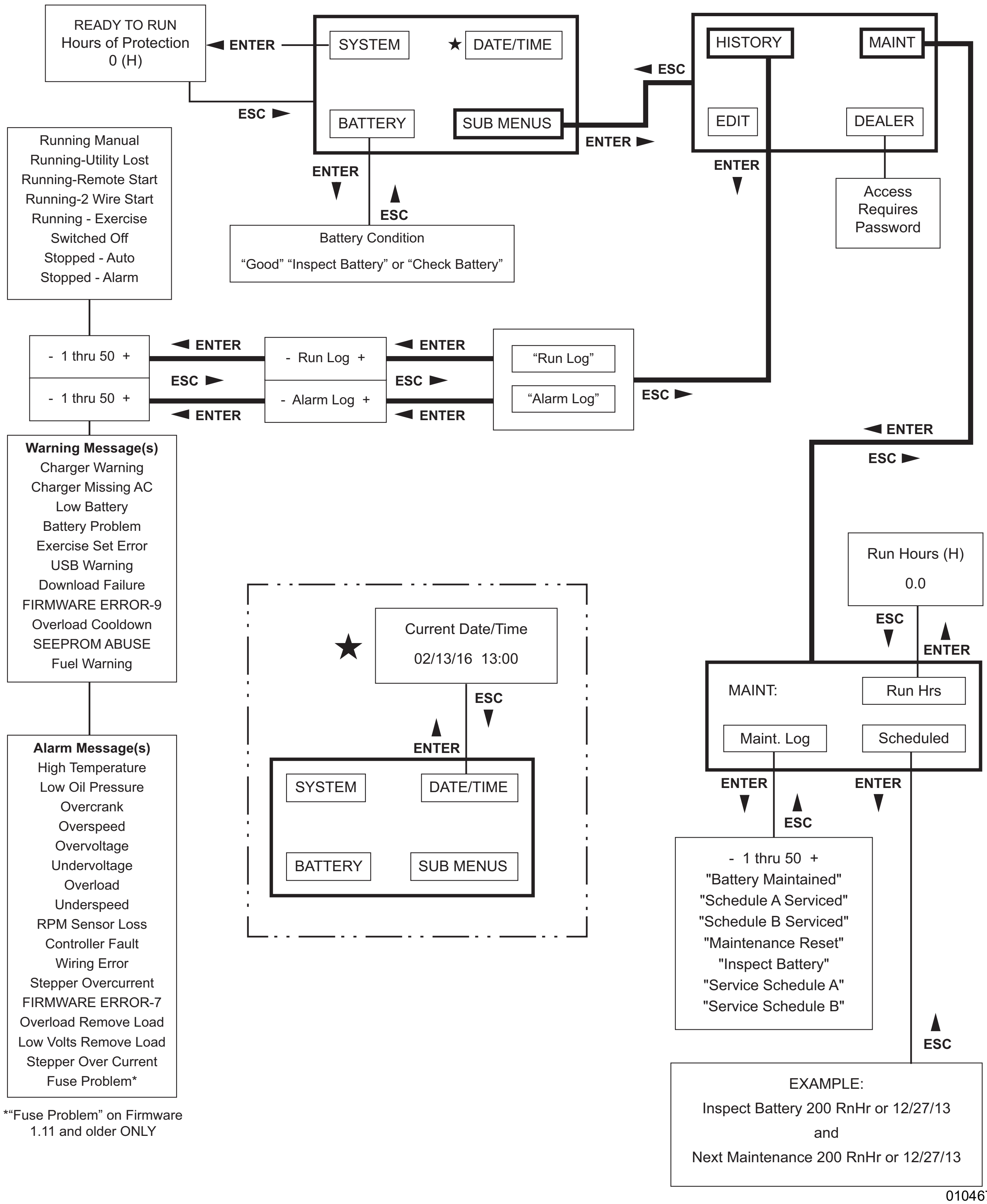


Figure 1-28. Evolution 1.0/Sync 2.0 HSB Menu Map—EDIT

Evolution 1.0/Sync 2.0 HSB Menu Map—HISTORY, MAINT

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



*"Fuse Problem" on Firmware 1.11 and older ONLY

Figure 1-29. Evolution 1.0/Sync 2.0 HSB Menu Map—HISTORY, MAINT

Evolution 1.0/Sync 2.0 HSB Menu Map—ACTIVATION

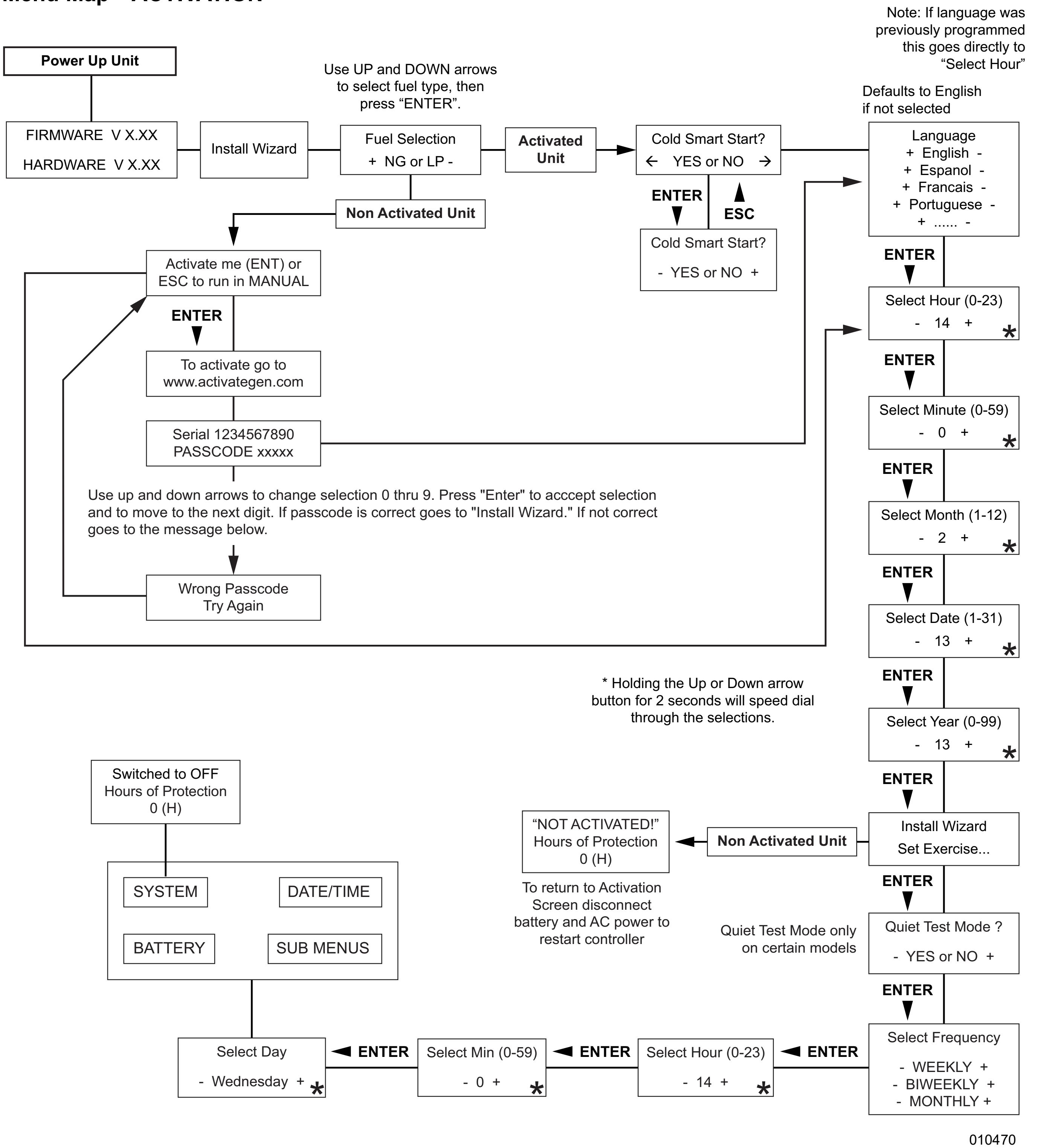
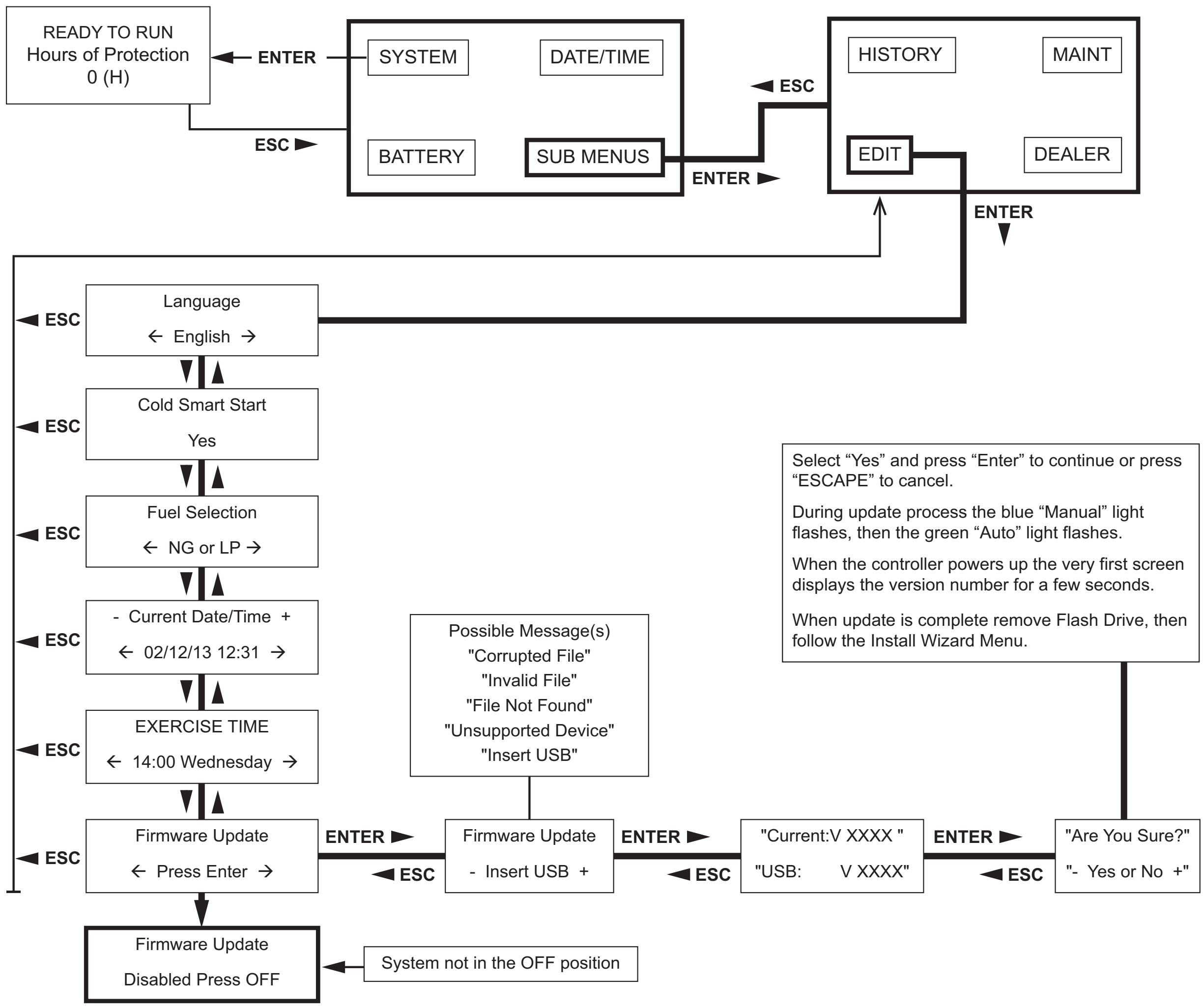


Figure 1-30. Evolution 1.0/Sync 2.0 HSB Menu Map—ACTIVATION

Evolution 1.0/Sync 2.0 HSB Menu Map—FIRMWARE

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



Also see

Update Firmware – Alternate Method

010471a

Figure 1-31. Evolution 1.0/Sync 2.0 HSB Menu Map—FIRMWARE

Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER EDIT

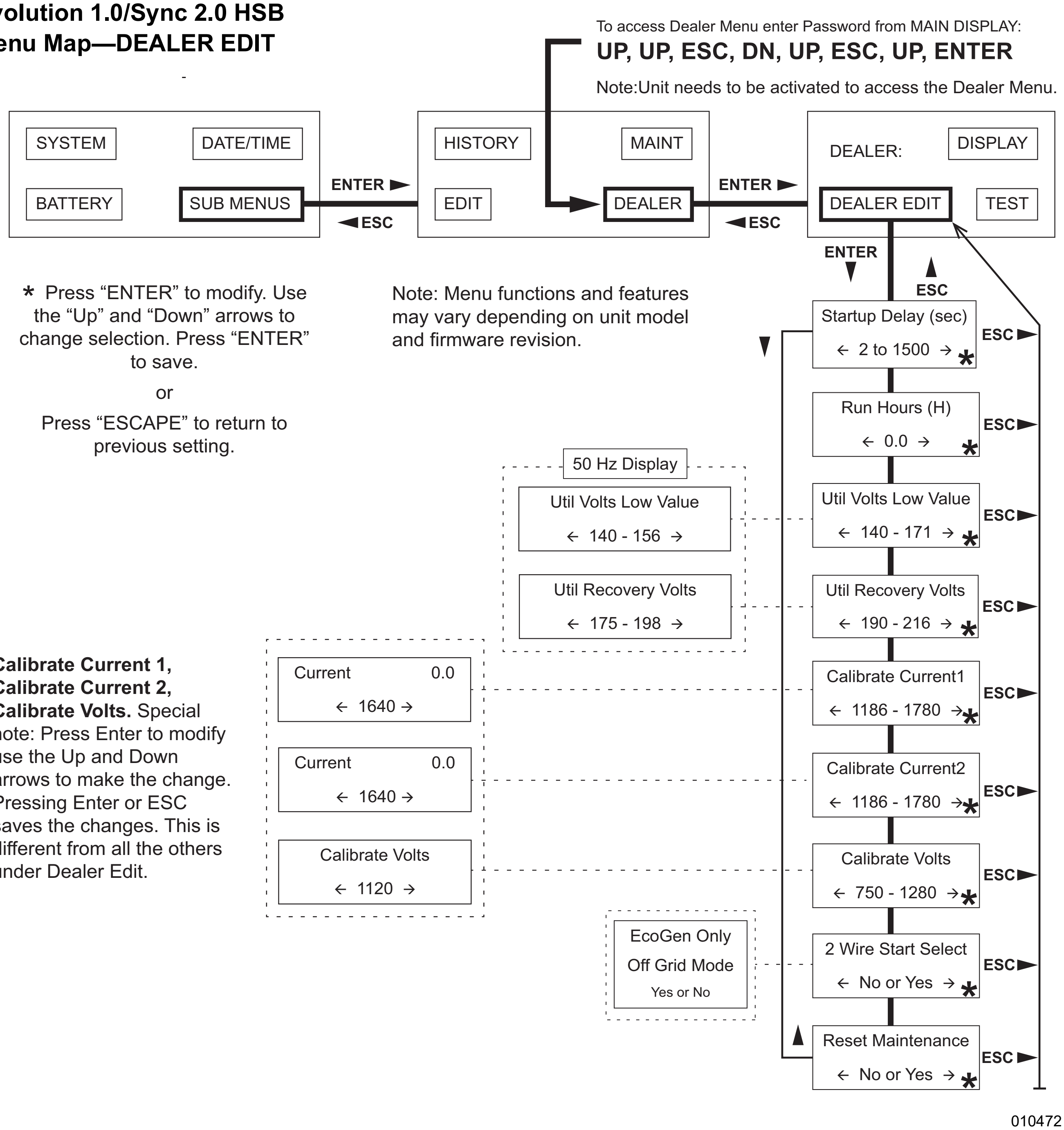


Figure 1-32. Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER EDIT

Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER TEST

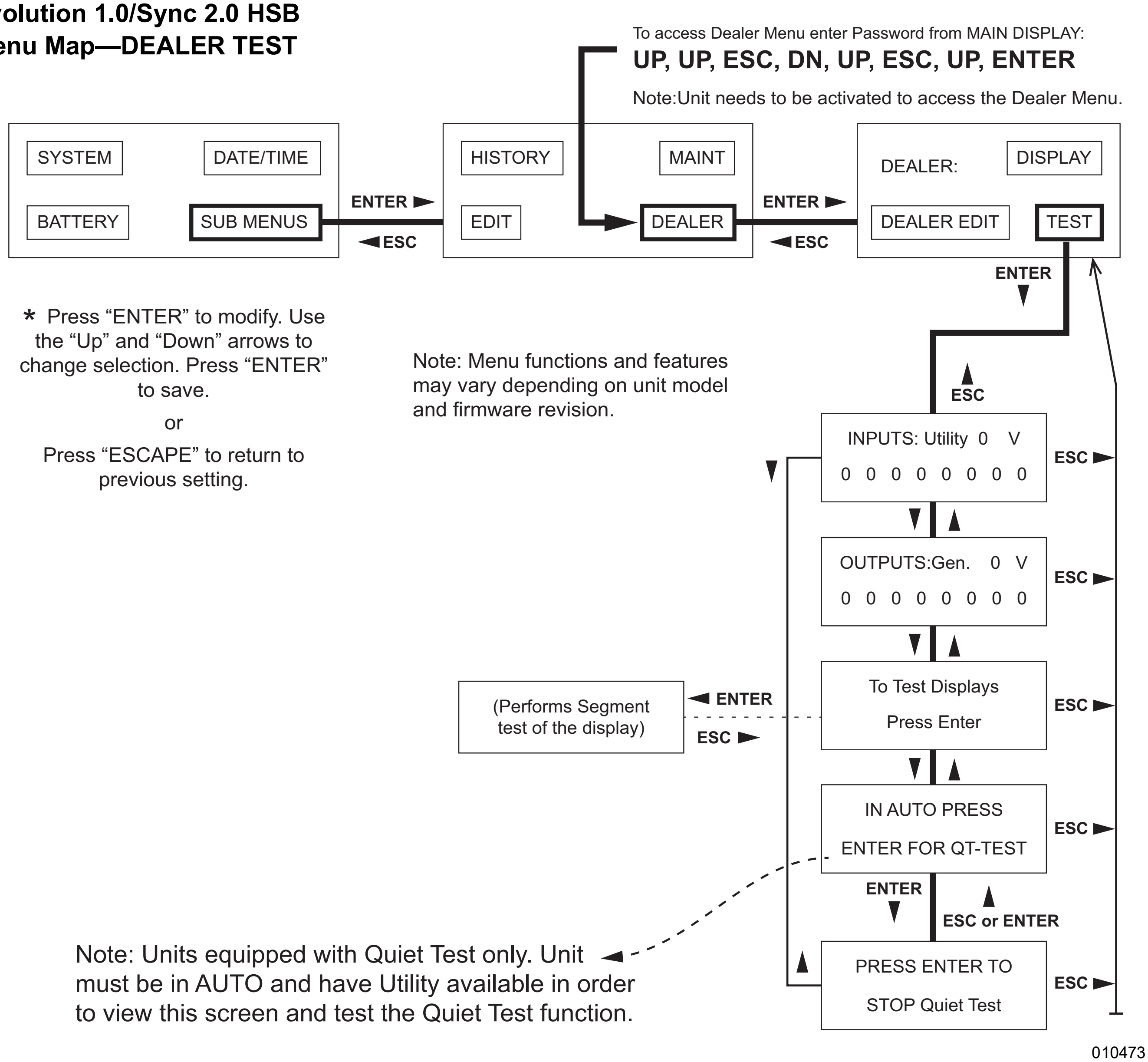


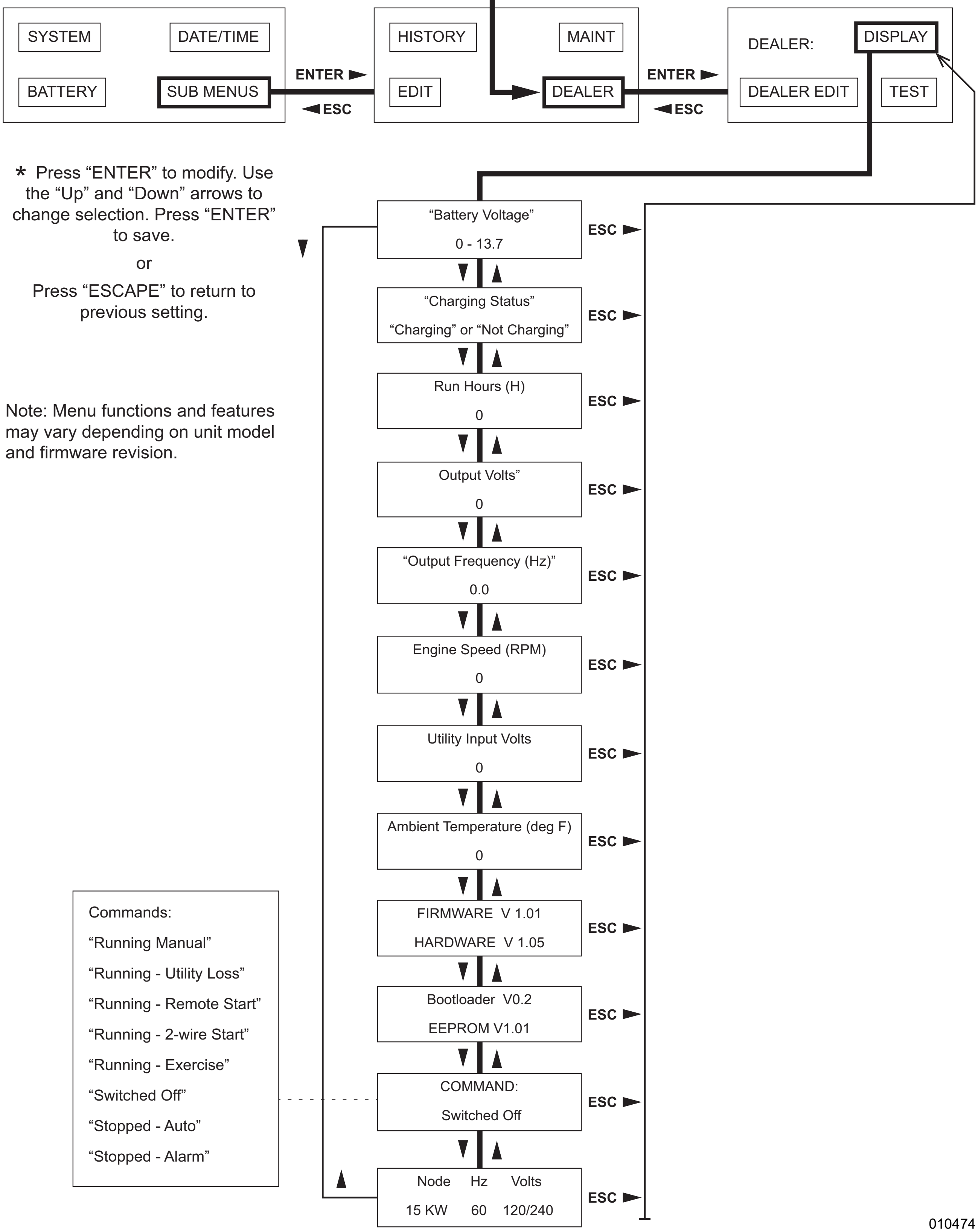
Figure 1-33. Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER TEST

Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER DISPLAY

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.



Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER DISPLAY

Update Firmware – Alternate Method

With the unit controller at MAIN screen, insert the flash drive with the latest firmware.

Power the unit down completely by performing the following:

1. Remove the 7.5 Amp fuse.
2. See ***Figure 1-34***. Disconnect AC power at the T1 connection (A).

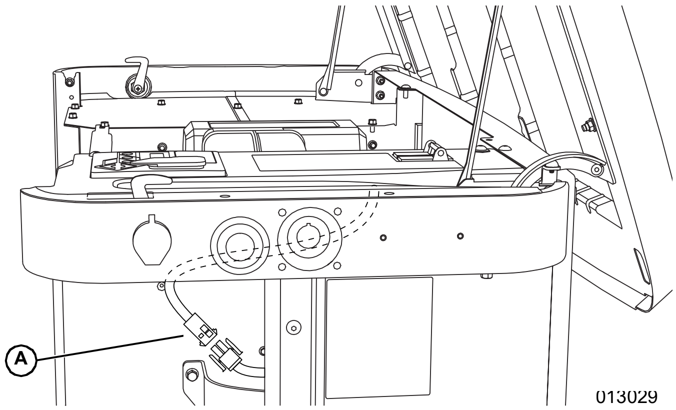


Figure 1-34. T1 Connection

Re-power the controller by performing the following:

1. Insert the 7.5 Amp fuse.
2. See ***Figure 1-34***. Connect AC power at the T1 connection.

Allow controller to boot up and complete the update process.

During the update process the blue “Manual” light flashes, then the green “Auto” light flashes. When the controller powers up, the first screen briefly displays the version number and when complete, returns to the “INSTALL WIZARD” screen.

When unit finishes its update, remove Flash Drive then follow the Install Wizard menu.

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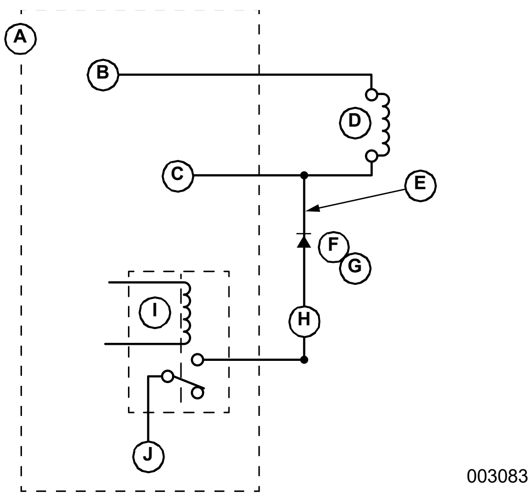
Field Boost

See *Figure 2-1*. The Evolution controller has a dedicated field flash output on Wire 4A which flows through the field boost diode to Wire 4.



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 2-1. Evolution Field Boost Circuit

The dedicated field flash relay with logic is separate from and does not involve the start circuit. Depending on the firmware version, the field flash will turn on and off depending on engine speed and system voltage.

Evolution 1.0 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.

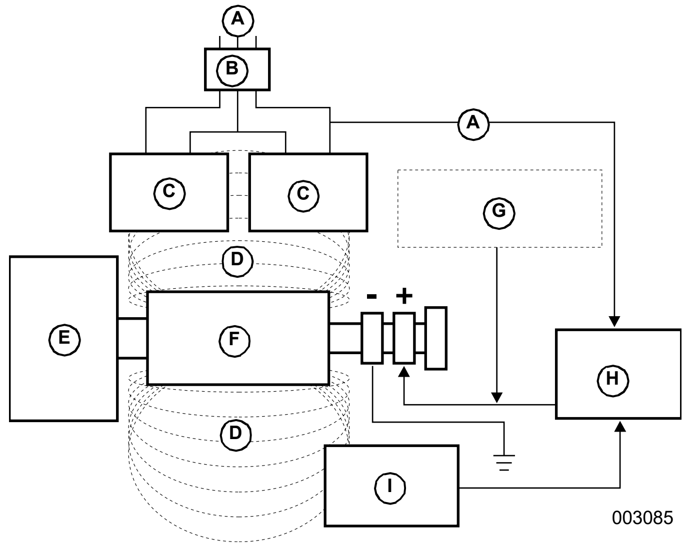
Evolution 1.0 Firmware (v1.12 and above) and Evolution 2.0 (all firmware) – Field boost turns on at 2200 rpm. Field boost shuts off when system voltage reaches 80% of nominal (192 VAC on a 240V generator). This firmware version allows the generator to run up to four additional minutes before shutting 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.

Operation

Engine Cranking

See *Figure 2-2*. Once the engine is running at 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.



A. To Load
B. Main Line Circuit Breaker
C. Stator Power Winding
D. Magnetic Field
E. Engine - Direct drive
F. Rotor
G. Field Boost Circuit
H. Voltage Regulator
I. Stator Excitation Winding

Figure 2-2. 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 field flash relay disengages (above 80% of nominal output voltage), the AVR then provides excitation voltage to the rotor.

The AVR senses the AC output voltage through Sensing Wires 11S and 44S, 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 2-3* and *Figure 2-4***. 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.

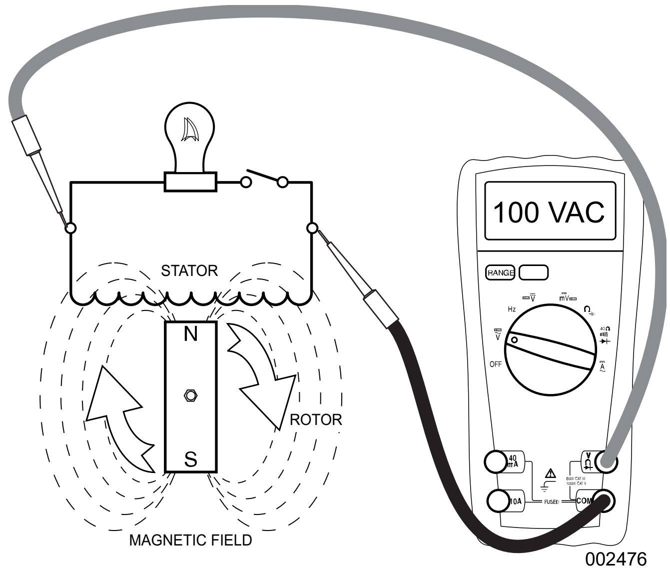


Figure 2-3. Low Field Excitation Voltage = Low Magnetic Lines of Flux = Low AC Output

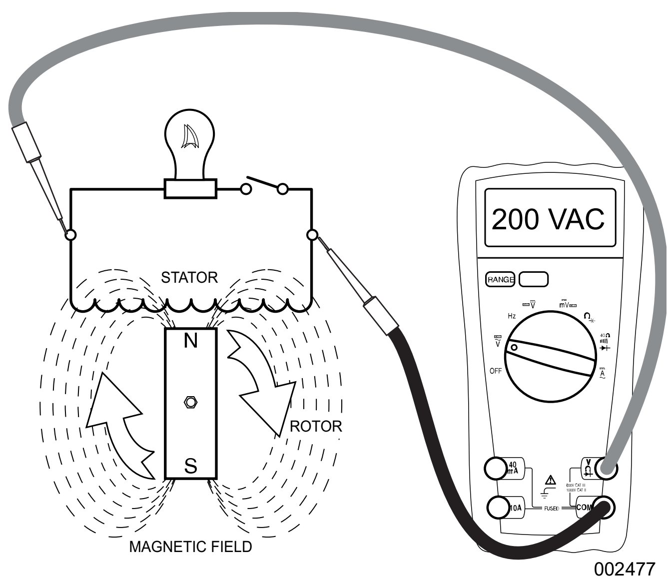


Figure 2-4. Increased Field Excitation Voltage = Increased Magnetic Lines of Flux = Increased AC Output Voltage

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.

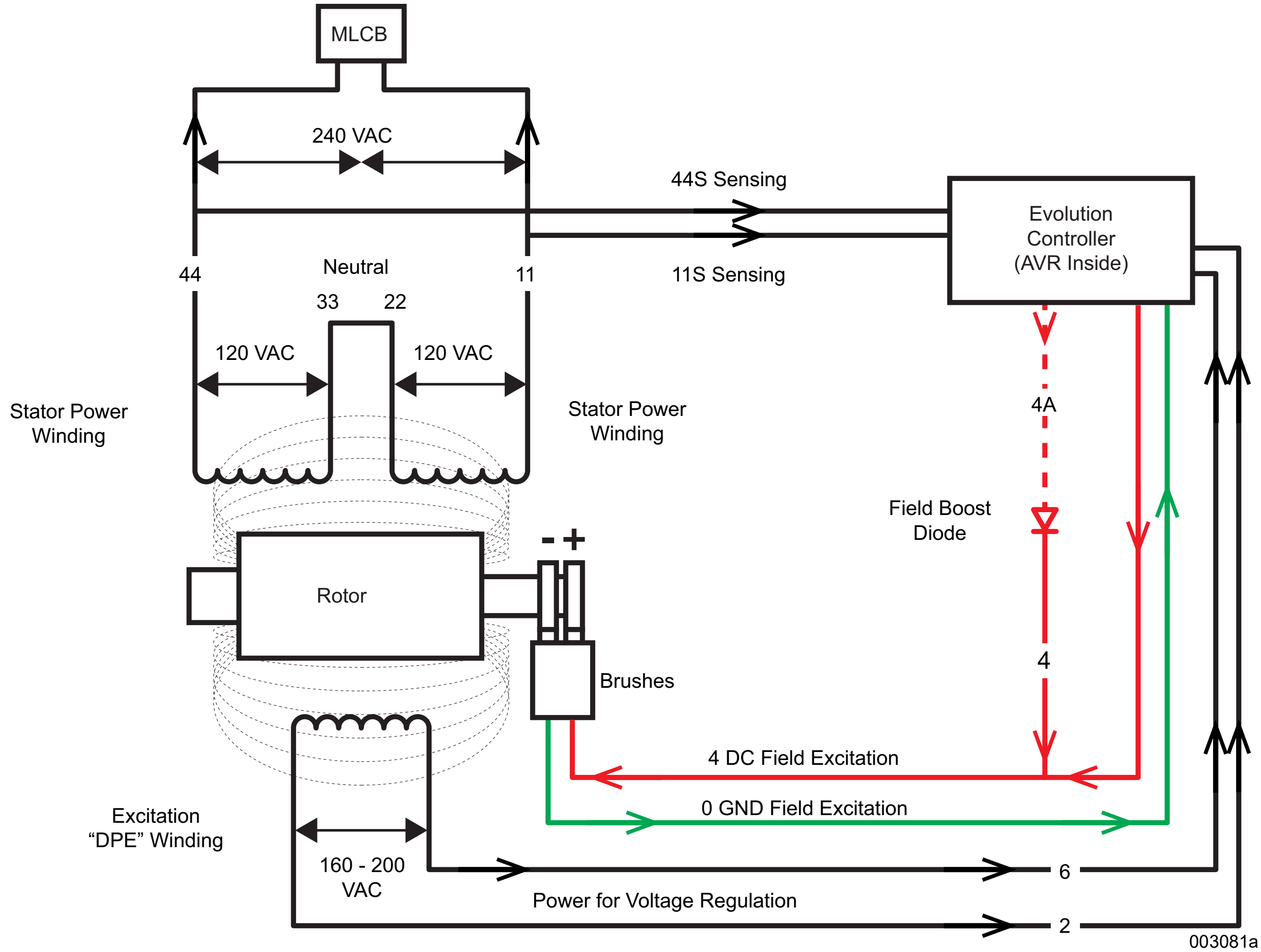


Figure 2-5. Evolution (All) Voltage Regulator Schematic

AVR = Automatic Voltage Regulator
DPE = Displaced Phase Excitation
MLCB = Main Line Circuit Breaker
VAC = Volts Alternating Current

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Evolution™ Controller E-Codes

NOTE: For any Displayed Alarm on the controller, use the Action Step as a starting point.

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 54
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 54
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 54
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) Controller will display "WARMING UP" for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.
Undervoltage	ALARM	1901	**Instantaneous** **Undervoltage due to sudden loss of voltage.** (Voltage less than 15 sec 2 sec+) Controller will display "WARMING UP" for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has 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) Controller will display "WARMING UP" for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.
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) Controller will display "WARMING UP" for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.

Evolution™ Controller E-Codes

NOTE: For any Displayed Alarm on the controller, use the Action Step as a starting point.

Displayed Alarm	Alarm/ Warning	E-Code Breakdown	Description	Action Step
Wiring Error	ALARM	2098	**Mis-wired Customer connection** Insufficient DC voltage on transfer power output.	Check for shorted 194 to ground. Refer to RTS Diagnostic Manual A0001176044.
Wiring Error	ALARM	2099	**Mis-wired** Customer connection low voltage and high voltage wires are crossed.	Check for AC voltage on Wire 194 at 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 load shed functionality. (Change load dynamics or utilize load shed).	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 54 Note: Verify controller has latest firmware.
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 Note: Verify controller has latest firmware.
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
Model Ident Problem - Fix Harness Resistor			Controller was powered up before the resistor plug was connected.	Problem 23 - Controller displays “Model Ident Problem Fix Harness Resistor” fault
	Service Schedule		Service Schedule A 200hours 2 years Service Schedule B 400 Hours 4 years	Perform Maintenance

Additional Codes For 8 and 9 kW Units (Evolution 1.0 Controller 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

Begin troubleshooting by performing the ***Preliminary Output Voltage Test*** . Then 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.

For best results, perform all tests in the exact sequence shown in the flow charts.

Preliminary Output Voltage Test

NOTE: This test is for Evolution 1.0 firmware (v1.12 and above) and Evolution 2.0 (all firmware) and does not apply to VSCF Synergy.

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 the latest firmware, up to four minutes (in Manual Mode) is 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. Gain access to the main line circuit breaker (MLCB) on the generator.
   a. On Evolution 1.0 (2016 and prior), access is obtained from back side of breaker.
   b. On Evolution 1.0 (2017 and later) and all 2.0, access is obtained by removing the controller fascia.
2. Set the MLCB to the OPEN (OFF) position to avoid any possible output voltage to the home.
3. Navigate to Dealer>Display>Voltage using the dealer password for the controller.
4. Set a digital multimeter (DMM) to measure AC voltage.
5. Connect one meter test lead to Wire 11 and the other meter test lead to Wire 44 at the alternator side of the MLCB.
6. Set the controller to MANUAL. Allow generator to start and stabilize.
7. Measure and record the voltage indicated on the DMM.
8. Visually monitor the output volts displayed on the controller.
9. Record the value indicated.

   Voltage Indicated on the Controller: _________

   Measured Voltage Output at MLCB: __________

10. Shut the unit down by pressing the OFF button on the controller.
11. Use ***Table 2-1*** to determine which test to perform.

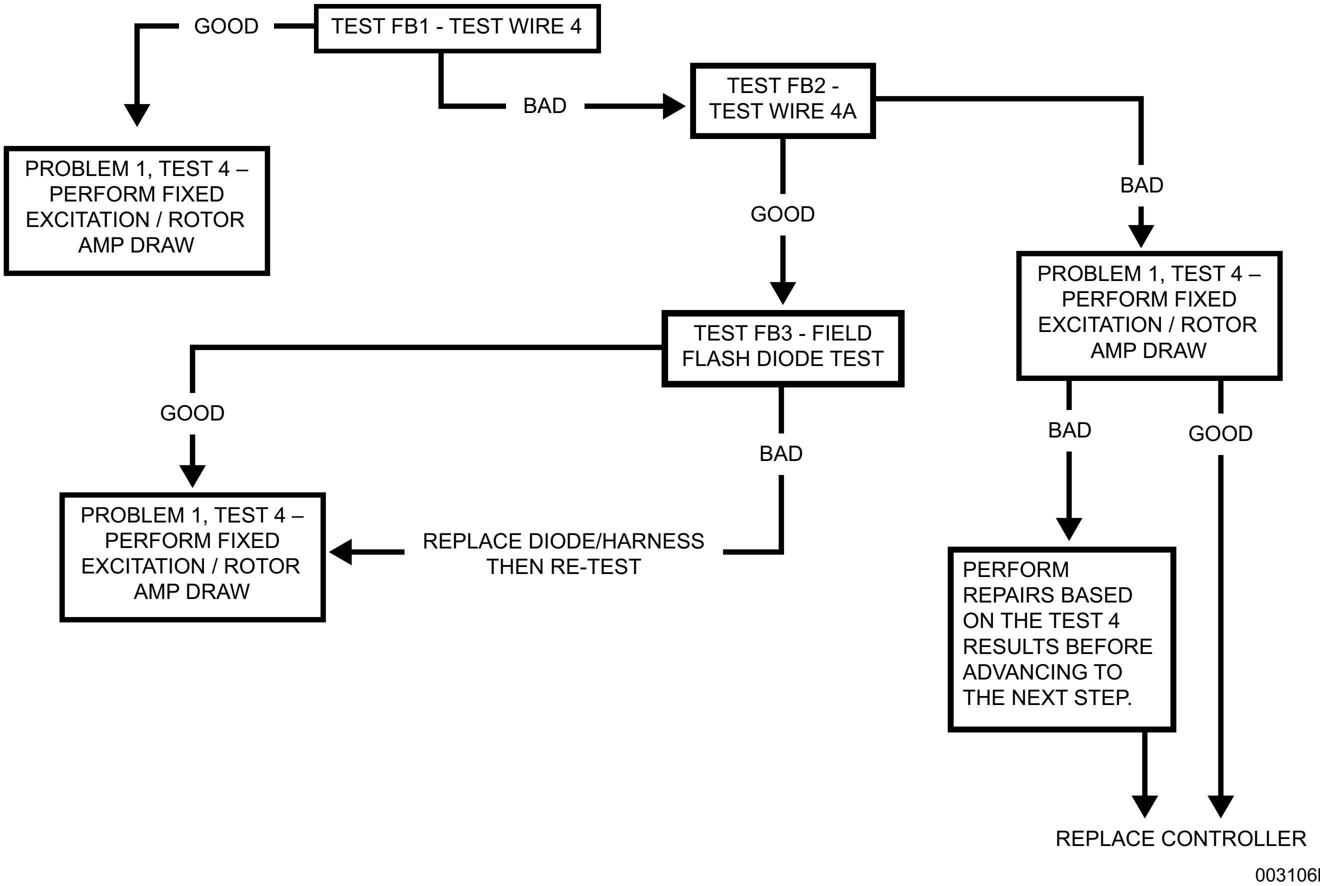
Table 2-1. Preliminary Output Voltage Test Results

Controller Voltage	MLCB Voltage	Perform Test(s):	Flow Chart Path Begin:
0 (+10%)	140–180 (+ or – 10%)	***Test 6 – Test Excitation Winding***	Test 4, Path C
140–185 (+ or – 10%)	140–185 (+ or – 10%)	***Test FB1 – Wire 4 Test***	FBCT
0 (Residual voltage may be present)	0 (Residual voltage may be present)	***Test FB2 – Wire 4A Test*** if necessary, perform tests as defined in the ***Field Boost Circuit Test (FBCT)*** flowchart.	FBCT
~50% of measured voltage	≥300	***Test 5 – Test Sensing Circuit Wires 11S and 44S***	Test 4, Path B
240 (approximately)	240 (approximately)	***Test 14 – Check Voltage and Frequency Under Load*** and/or ***Test 16 – Check Engine Condition***	Problem 18

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 (FBCT)

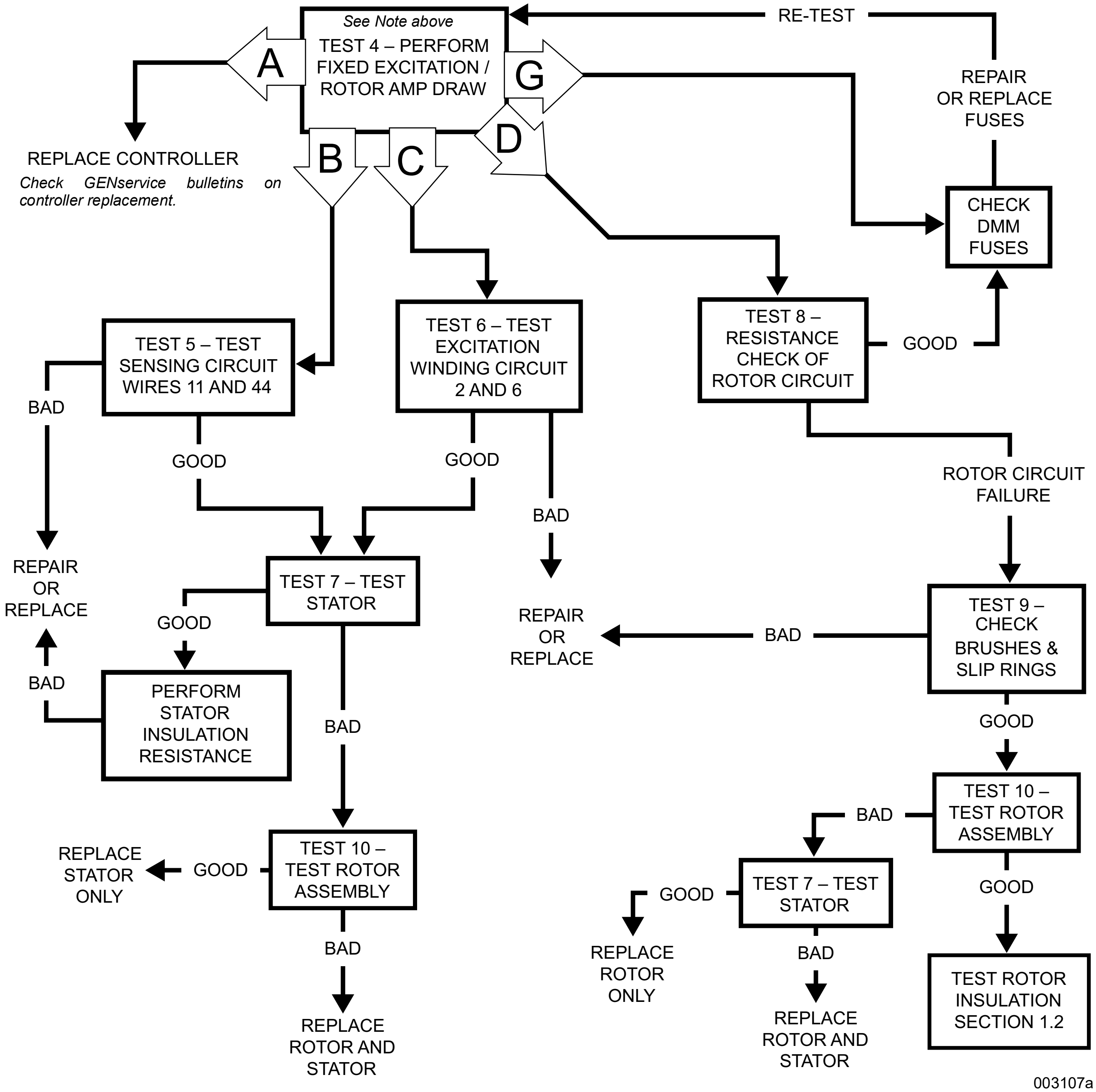


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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

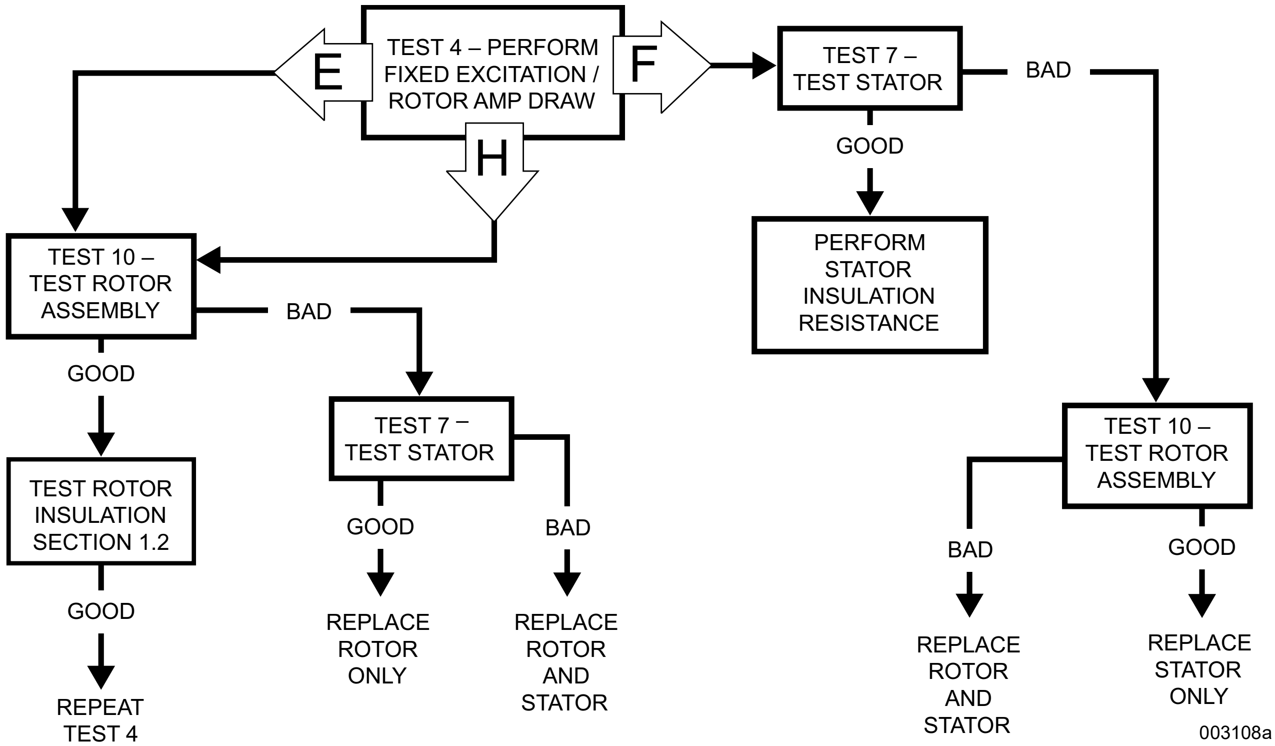
NOTE: Evolution 1.0 (non-Synergy) Firmware (v1.12 and above) and Evolution 2.0 (all firmware), perform the Preliminary Output Voltage Test.



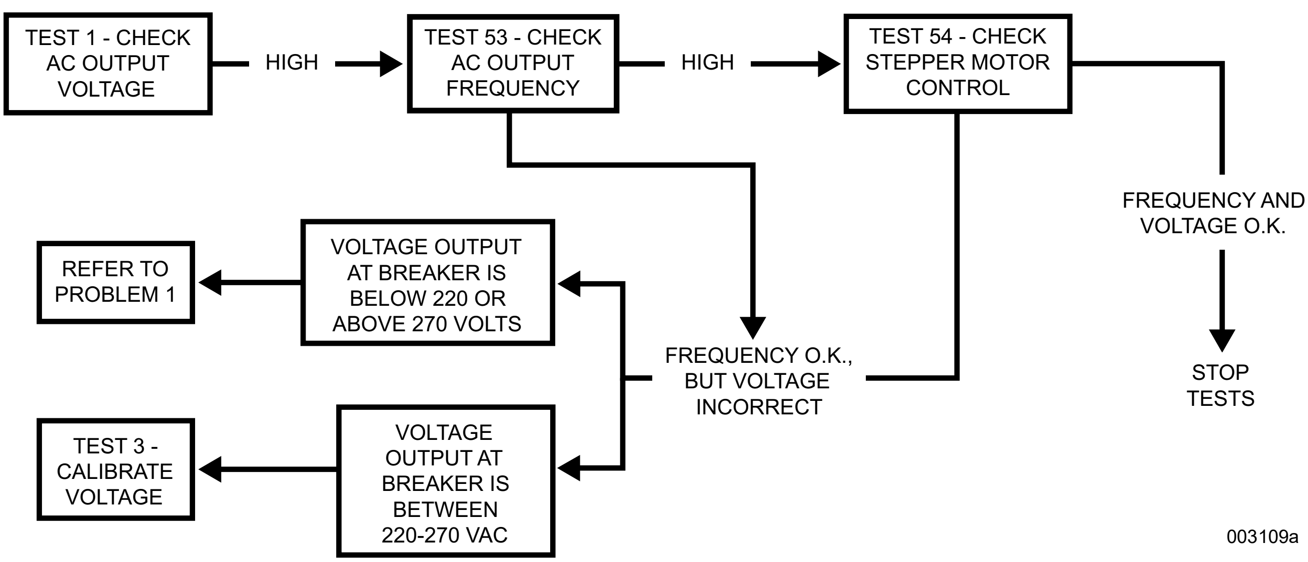
IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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

NOTE: Evolution 1.0 (non-Synergy) Firmware (v1.12 and above) and Evolution 2.0 (all firmware), perform the Preliminary Output Voltage Test.

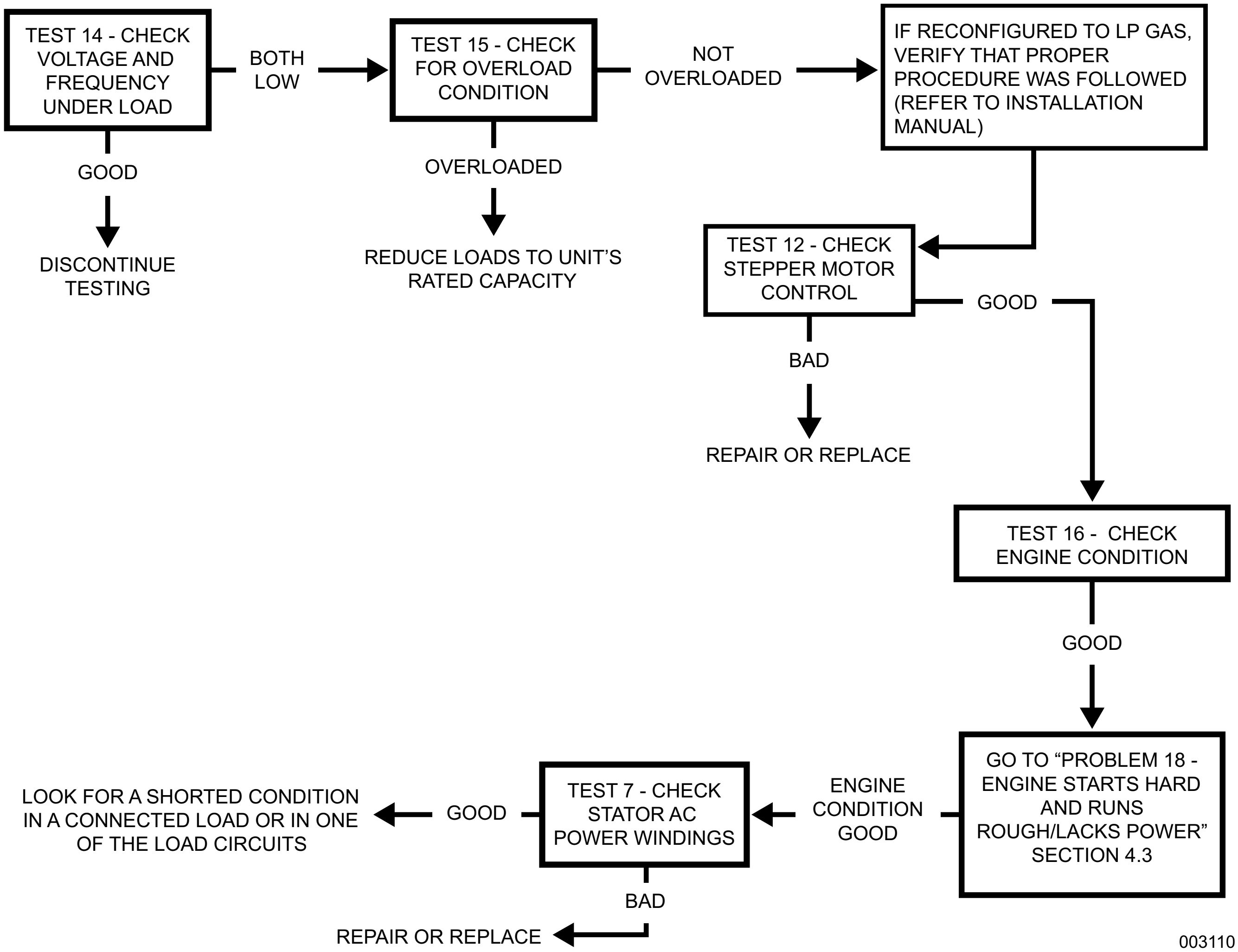


Problem 2 – Generator Produces High Voltage

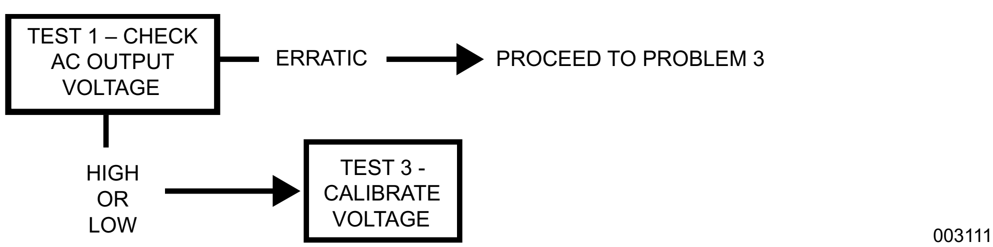


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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



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



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

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Introduction

This section provides 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 physically or mentally fatigued. If you do not understand a component, device or system, do not work on it.

AC Troubleshooting

Continue to ask questions during the troubleshooting process. 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 same fault happen consistently?
- When does the fault occur?
- After the fault occurred what was displayed on 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. Verify the meter clamps are securely attached and will not shake loose.

Procedure

1. Set the DMM to measure AC voltage.
2. See ***Figure 2-6***. 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.

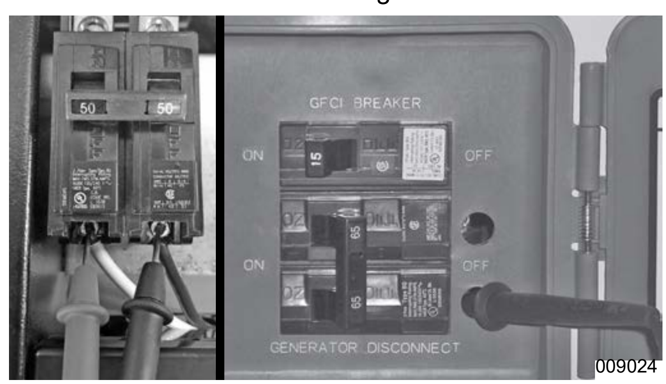


Figure 2-6. MLCB Test Points 2017 and Newer (Left) Pre 2017 (Right)

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. On the controller, press the ESC key until the main menu is present. (See ***Evolution Menu System Navigation***)
4. From the main menu enter the dealer password and proceed to DEALER > DEALER EDIT > CALIBRATE VOLTAGE then press ENTER.
5. After pressing enter, a value will appear on the screen.
6. Using appropriate back probes, measure output voltage at the AVR connector (Wires 11S and 44S).

NOTE: The default setting from the factory for calibration is 1024. The Evolution controller is adjustable from 750-1280.

7. Set controller to MANUAL and allow engine to start.
8. While the unit is running, use the UP or DOWN arrows to adjust the calibration setting. A higher value will create a lower voltage. A lower value will create a higher voltage.
9. 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 (See ***Evolution Menu System 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 – Wire 4 Test

General Theory

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

NOTE: See ***Field Boost*** in Section 2.1 for analysis of field boost parameters.

Procedure (using J3 Breakout Harness)

1. Set DMM to measure DC voltage.
2. Disconnect the generator harness J3 connector from the controller.
3. Connect the female end of the J3 breakout harness to the unit harness.

IMPORTANT NOTE: DO NOT CONNECT the male end of the J3 breakout harness to the controller.

4. Insert meter test leads into the DC excitation test points of the breakout harness (4 and 0).
5. Clear all faults and place generator in MANUAL mode and start engine.
6. Observe the meter for DC Field Flash Voltage.

Procedure (without using J3 Breakout Harness)

1. Set DMM to measure DC voltage.
2. Locate Wire 4 on back of control panel. Disconnect the wire harness connector from the control panel.
3. Insert the Red meter lead adapter into the back of the wire harness on Wire 4.
4. Place Black lead on a good common ground or negative post on the engine battery.
5. Clear all faults and place generator in the manual mode and start engine.
6. Measure and record field flash voltage.

NOTE: See ***Field Boost*** in Section 2.1 for analysis of 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 – Wire 4A Test

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 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 – Field Flash Diode Test

General Theory

When testing a diode using the Diode function on the meter, DC voltage will be displayed on the meter. The meter is applying a small amount of voltage (from the meter's battery) across the circuit and is measuring how much voltage (pressure) it takes to open the diode. Approximately 0.5 volts DC is typical. A diode that measures 0.5 VDC in one direction and "0L" in the other is a good working diode. This test is to verify that the field flash diode is working properly.

Procedure (using J3 Breakout Harness)

1. Remove 7.5 amp fuse from control panel.
2. Set DMM to diode check function (preferred). If the DMM does not have a diode check selection, use the resistance or "Ohms" selection.
3. Locate and disconnect Wire 4A wire harness connector from control panel.
4. Locate and disconnect the generator harness J3 connector from the controller.
5. Connect the female end of the J3 breakout harness to the unit harness.

IMPORTANT NOTE: DO NOT CONNECT the male end of the J3 breakout harness to the controller.

NOTE: J2 harness connector remains unplugged and the J3 breakout harness remains connected to the harness for the remaining steps.

6. With appropriate test probe adapter, insert the black meter lead into the back of the wire harness on Wire 4A.
7. Insert the red meter test lead into the J3 Breakout Harness Wire 4 test point.
8. Record reading on the meter.
9. With appropriate test probe adapter, insert the red meter lead into the back of the wire harness on Wire 4A.
10. Insert the black meter test lead into the Wire 4 test point on the J3 breakout harness.
11. Record reading on the meter.

Procedure (without using J3 Breakout Harness)

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 (Diode setting) or approximately 2.07M OHMS (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 4 – Fixed Excitation Test/Rotor Amp Draw Test

General Theory

A fixed DC current supplied 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. Using 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.

Use ***Table 2-5*** to record the results of the following procedure. These results may be required when requesting factory support.

Table 2-5. Test 4 Results

Test Point	Results	
Wires 2 and 6 Voltage		VAC
Wires 11s and 44s 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.

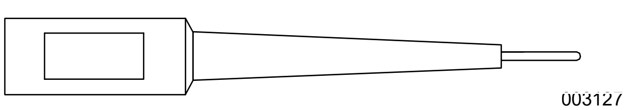


Figure 2-7. Narrow Test Probe

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 Evolution controllers with white Molex connectors (back-probe only).

Optional Tools

- ***J3 Breakout Harness Test Procedures*** Part Number A0000659764

Procedure: Fixed Excitation Test

IMPORTANT NOTE: DO NOT proceed to Step 1 until the Preliminary Output Voltage Test has 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.

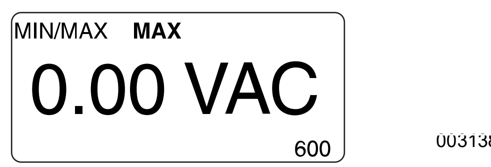


Figure 2-8.

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 11S and the appropriate harness pin for Wire 44S.
13. Set the controller to MANUAL.
14. Measure and record the voltage indicated between Wire 11S and 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.

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 2-7***. 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 VDC/12.3 Ohms = 1.05 DC Amps

Table 2-6. 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 2-7. TEST 4 Results – Fixed Excitation Test/Rotor Amp Draw Test (8–24 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 ↕ 24 kW	2.0A ↕ 1.0A	2.0A ↕ 1.0A	2.0A ↕ 1.0A	Zero Current Draw	Above 2.5A	2.0A ↕ 1.0A	Zero Current Draw	2.0A ↕ 1.0A
Running Rotor Amp Draw	8 kW ↕ 24 kW	2.0A ↕ 1.0A	2.0A ↕ 1.0A	2.0A ↕ 1.0A	Zero Current Draw	Above 2.5A	2.0A ↕ 1.0A	Zero Current Draw	Above 2.5A
Note: Lower kW units typically have a higher current draw and higher kW units typically have a lower current draw. 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 2.2 “Problem 1”* →									

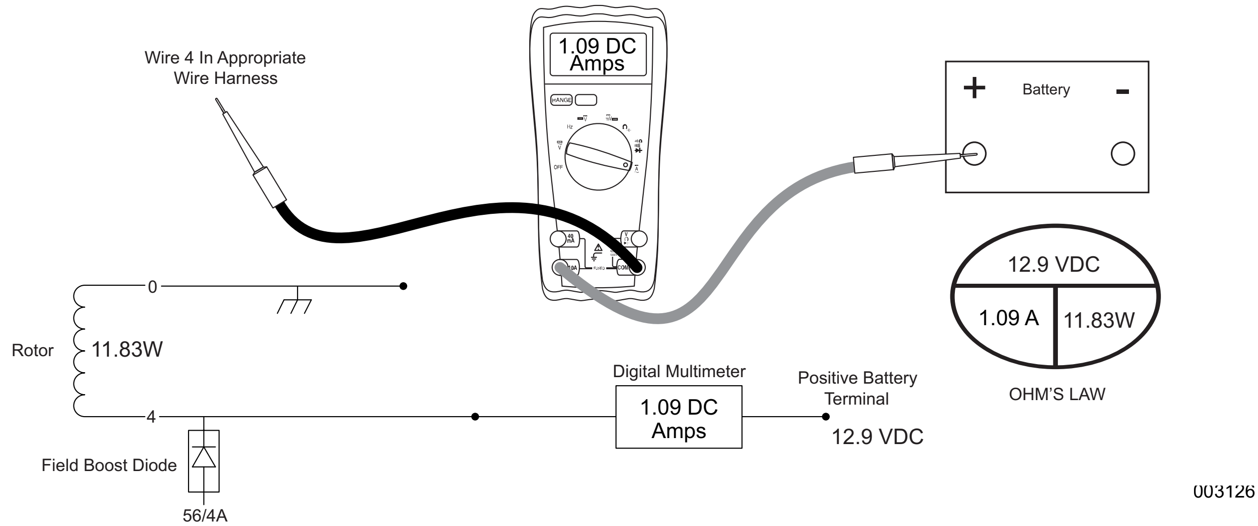


Figure 2-9. Rotor Amp Draw Test

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 11S and 44S

General Theory

The voltage regulator (internal to the controller) requires a reference voltage 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 full field the rotor, produce in excess of 300 VAC and 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 (P/N 0J09460SRV) for this application are available. See ***Figure 2-7***.

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

NOTE: Stator winding resistance values are very low. 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.

Procedure A

1. Remove the 7.5 amp fuse from the control panel.
2. Gain access to and expose the lower harness connections under the controller.
3. Disconnect harness connector J1 from the controller which contains Wires 11S and 44S.
4. Set the DMM to measure resistance.
5. Connect one meter test lead to the appropriate harness pin for Wire 11S. Connect the other meter test lead to the appropriate harness pin for Wire 44S. 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 flow chart (Good).
   b. If the meter indicated OPEN, proceed to Procedure B or Procedure C.

Procedure B – Units with STR Connector Only

1. Set DMM to measure resistance.
2. See ***Figure 2-10***. Locate and disconnect STR connector in wire harness.

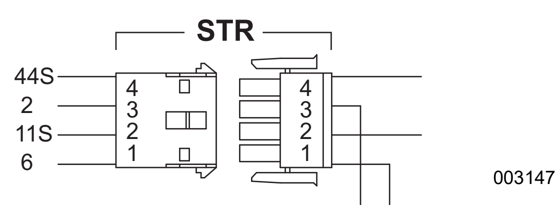


Figure 2-10. Stator Connector (STR) Pin Locations

3. Connect meter test leads the appropriate harness pins containing Wire 11S and Wire 44S in the STR connector leading to the Stator. Measure and record the resistance.
   a. If the meter indicated a resistance value consistent with the values found in Section 1.1 ***Specifications***, repair or replace Wire 11S and/or Wire 44S between the STR Connector and the J1 Connector.
   b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, go to Test 7.

Procedure C – Units with STR Connector and STB Stator Terminal Block

1. Set DMM to measure resistance.
2. See ***Figure 2-10***. Locate and disconnect STR connector in wire harness.
3. Connect meter test leads to the appropriate harness pins containing Wire 11S and Wire 44S in the STR connector leading to the stator. 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 OPEN, proceed to Step 4.
4. See ***Figure 2-11*** and ***Figure 2-12***. Remove the stator terminal block cover and identify the studs containing Wires 11S and 44S.

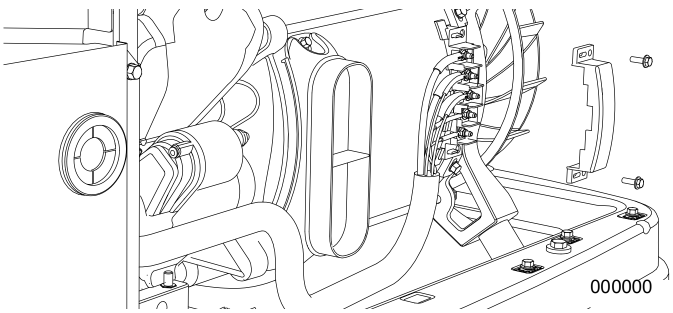


Figure 2-11. Stator Terminal Block Cover

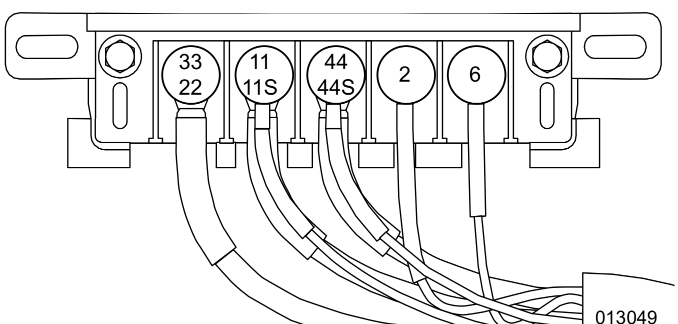


Figure 2-12. Stator Terminal Block Wires

5. Verify harness connections to the stator terminal block are tight and secure.
6. Observe the meter for resistance of the sensing circuit (11S and 44S) on the Terminal studs.
   a. If the meter indicated a resistance value of less than 0.3 ohms in Step 6, but was OPEN in Step 3, repair or replace Wire 11S and/or Wire 44S between the STR Connector and the STB Terminal Block. Refer back to flow chart (Good).
   b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, go to Test 7.

Test 6 – Test Excitation Winding

General Theory

The controller's internal voltage regulator requires unregulated voltage from the stator 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

- **MINIMUM:** Meter test leads capable of measuring voltage inside a connector without damaging the socket. A set of black and red test leads (P/N 0J09460SRV) for this application are available. See ***Figure 2-13***.

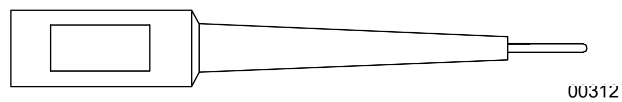


Figure 2-13. Narrow Test Probe

- **SUGGESTED:** A J3 Breakout Harness, P/N A0000659764 allows ease of meter lead connectivity. The J3 Breakout Harness with instructions is available as a kit P/N A0001273377. See ***Figure 2-14***.

Figure 2-14. J3 Breakout Harness

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

NOTE: Zero the meter leads or subtract meter lead resistance from actual reading to ensure accurate results.

Procedure A – using J3 Breakout Harness, P/N A0000659764

1. Disconnect the generator harness J3 connector.
2. Connect the female end of the J3 breakout harness to the unit harness.
3. DO NOT CONNECT the male end of the J3 breakout harness to the controller.
4. Insert meter test leads into the AC excitation test points of the breakout harness (6 and 2).
5. Observe the meter for resistance on the excitation winding (6 and 2).

a. If meter indicated a resistance value consistent with the values found in Section 1.1 ***Specifications***, stop testing and refer back to Problem 1 flow chart, Path C. (Good).

b. If meter indicated an OPEN, proceed to Procedure B.

Procedure A – not using J3 Breakout Harness

1. Remove the 7.5 amp fuse from the control panel.
2. Gain access to and expose the lower harness connections under the controller.
3. Disconnect the J3 harness connector containing Wires 2 and 6 from the controller.
4. Set 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. Observe the meter for resistance on the Excitation winding (6 and 2).
   a. If meter indicated a resistance value consistent with the values found in Section 1.1 Specifications, stop testing and refer back to Problem 1 flow chart, Path C. (Good).
   b. If meter indicated an OPEN, proceed to Procedure B or C.

Procedure B – Units with STR Connector Only

1. See ***Figure 2-15***. Disconnect the STR connector located in the wire harness.

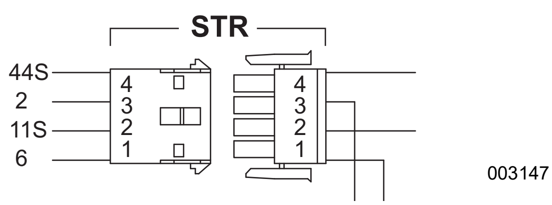


Figure 2-15. Stator Connector (STR) Pin Locations

2. Set DMM to measure resistance.
3. On the STR connector that leads to the stator, connect one meter test lead to Wire 2 and the other meter test lead to Wire 6. Observe the meter for resistance on the excitation winding (6 and 2) at the STR connector.
   a. If the meter indicated a resistance value consistent with the values found in Section 1.1 ***Specifications***, repair or replace Wire 2, Wire 6, or both wires between the controller and the STR (stator) connector. Measure Ohms between Wire 2 and 2 or Wire 6 and 6 to confirm which wire is open.
   b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, go to Test 7.

Procedure C – Units with STR Connector and STB Stator Terminal Block

1. See ***Figure 2-15***. Disconnect the STR connector located in the wire harness.
2. Set DMM to measure resistance.
3. On the STR connector that leads to the stator, connect one meter test lead to Wire 2 and the other meter test lead to Wire 6. Observe the meter for resistance on the excitation winding (6 and 2) at the STR connector.
   a. If the meter indicated a resistance value consistent with the values found in Section 1.1 ***Specifications***, repair or replace Wire 2, Wire 6, or both wires between the controller and the STR (stator) connector. Measure Ohms between Wire 2 and 2 or Wire 6 and 6 to confirm which wire is open.
   b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, go to Step 4.
4. See ***Figure 2-16*** and ***Figure 2-17***. Remove the stator terminal block cover (A) and identify the studs containing Wires 2 and 6.

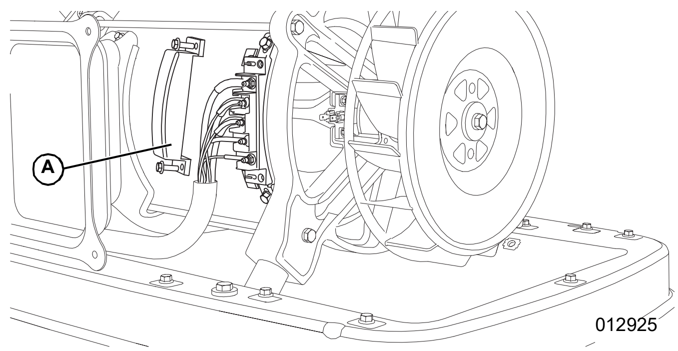


Figure 2-16. Stator Terminal Block (STB)

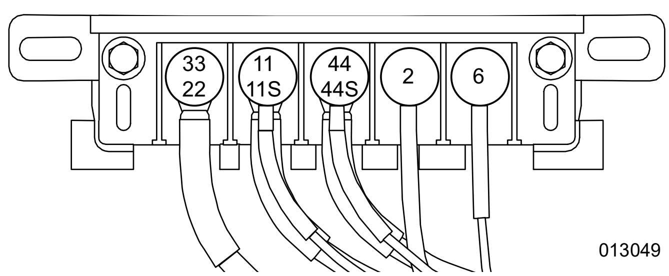


Figure 2-17. Stator Terminal Block Wires

5. Check to see that harness connections to the stator terminal block (P/N A0000029777) are tight and secure.
6. Set DMM to measure resistance.
7. Observe the meter for resistance of the excitation winding (6 and 2) on the terminal studs.
   a. If the meter indicated a resistance value consistent with the values found in Section 1.1 ***Specifications***, repair or replace Wire 2, Wire

6, or both wires between the STR (stator) connector and the STB (stator terminal block). Measure Ohms between Wire 2 and 2 or Wire 6 and 6 to confirm which wire is open.

b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, go to Test 7.

Results

1. See ***Figure 2-16***. If the meter indicated a resistance value of OPEN in Procedure A, but a resistance value consistent with the values found in ***Specifications*** in Procedure B or Procedure C, repair or replace Wire 2 and/or 6 between the referenced connection points. Measure continuity on Wire 2 or Wire 6 between the referenced connection points to confirm which (or both) wire(s) is/are open.
2. If the meter indicated a resistance value consistent with the values found in ***Specifications*** in Procedure A, Procedure B or Procedure C, stop testing and refer back to the flow chart (GOOD).
3. If the meter indicated a resistance value of OPEN or a resistance value inconsistent with the values found in ***Specifications*** in Procedure B or Procedure C, go to Test 7.

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 2-8 has been provided to record the results of the following procedure. These results may be required when requesting factory support.

IMPORTANT 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.

Required Tools

- Meter test leads capable of measuring voltage inside a connector without damaging the socket. A set of black and red test leads (P/N 0J09460SRV) for this application are available. See ***Figure 2-18***.

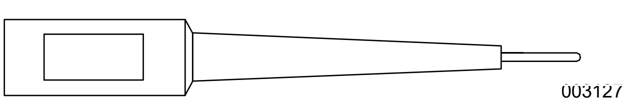


Figure 2-18. Narrow Test Probe

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

Resistance Test with Neutrals Disconnected (with STR Connector only)

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. See ***Figure 2-15***. Disconnect the STR (stator) connector on the harness.
4. Isolate all disconnected leads from each other and keep from touching the frame during 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 2-8***.

Table 2-8. Stator Results (w/STR connector)

Test Point A	Test Point B	Results
Resistance Test with Neutrals Disconnected		
Stator Lead Wire 11	Stator Lead 22	
Stator Lead Wire 33	Stator Lead 44	
STR Pin 2 Wire 11S	Stator Lead 22	
STR Pin 4 Wire 44S	Stator Lead 33	
STR Pin 1 Wire 6	STR Pin 3 Wire 2	
Test Windings for a Short to Ground		
Stator Lead Wire 11	Ground	
Stator Lead Wire 44	Ground	
STR Pin 4 Wire 44S	Ground	
STR Pin 2 Wire 11S	Ground	
STR Pin 3 Wire 2	Ground	
Test For A Short Circuit Between Windings		
STR Pin 3 Wire 2	STR Pin 2 Wire 11S	
STR Pin 3 Wire 2	STR Pin 4 Wire 44S	
STR Pin 3 Wire 2	Stator Lead Wire 11	
STR Pin 3 Wire 2	Stator Lead Wire 44	
Stator Lead Wire 11	STR Pin 4 Wire 44S	
Stator Lead Wire 11	Stator Lead Wire 44	

Resistance Test with Neutrals Connected (with STB Stator Terminal Block only)

1. See ***Figure 2-19***. Remove the stator terminal block cover (A) to expose all wires/studs (33/22, 11, 44, 2, and 6).

2. Verify harness connections to the stator terminal block are tight and secure.

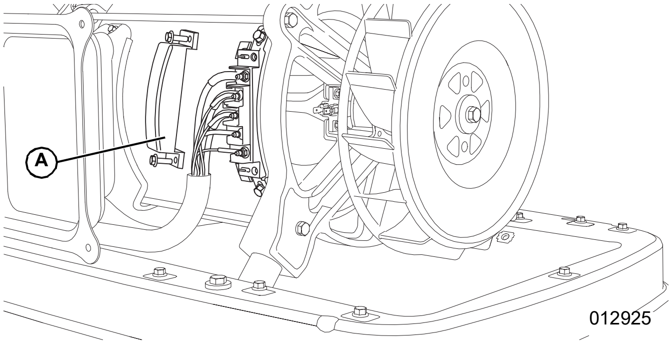


Figure 2-19. Stator Terminal Block (STB)

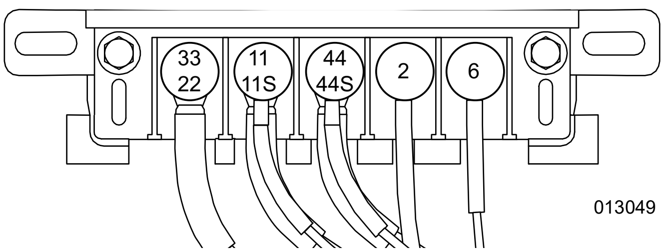


Figure 2-20. Stator Terminal Block Wires

3. Set DMM to measure resistance.
4. Measure and record the resistance values for each set of windings between the A and B test points as shown in ***Table 2-9***.

Table 2-9. Stator Results (w/STB terminal block)

Test Point A	Test Point B	Results
Resistance Test with Neutrals Disconnected		
Stator Stud Wire 11	Stator Stud Wire 44	
Stator Stud Wire 2	Stator Stud Wire 6	
Test Windings for a Short to Ground		
Stator Stud Wire 11 or 44	Ground	
Stator Stud Wire 2		
Test For A Short Circuit Between Windings		
Stator Stud Wire 2 or 6	Stator Stud Wire 11	
	Stator Stud Wire 22/33	
	Stator Lead Wire 44	

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.

Procedure

1. Remove the 7.5 amp fuse from the control panel.
2. Remove the cover and controller to expose the lower harness connections.
3. Disconnect the J3 harness connector containing Wires 4 and 0 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.

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 and 6, refer back to flowchart (Good).
2. If the DMM indicated INFINITY in Steps 5 and 6, refer back to flowchart (Rotor 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 field excitation current to the rotor.

Procedure

1. Disassemble the generator until the brushes and slip rings are exposed. Refer to Section 5.1 ***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 (such as emery cloth) to polish slip rings. This may cause irreversible damage to the rotor.

5. Disconnect the J3 harness connector from the controller containing Wires 4 and 0.
6. Set the DMM to measure resistance.
7. Wire 0, located on the negative brush terminal, provides an electrical connection to ground for the rotor and the voltage regulator in the controller. To test this wire for an OPEN condition, remove Wire 0 from the brush assembly. Measure resistance between the negative brush and the controller connector Wire 0.
   - If the DMM indicated INFINITY, repair or replace Wire 0 at the point of failure.
   - If the DMM indicated CONTINUITY, continue to Step 8.
8. Wire 4, located on the positive brush terminal, provides an electrical connection for excitation current to flow between the rotor and the voltage regulator in the controller. To test this wire for an OPEN condition, remove Wire 4 from the brush assembly. Measure resistance between the negative brush and the controller connector Wire 4.
   - If the DMM indicated INFINITY, repair or replace Wire 4 at the point of failure.
   - If the DMM indicated CONTINUITY, continue to Step 9.
9. With Wire 4 still disconnected at the brush assembly, connect one meter test lead to Wire 4 at the brush and connect the other meter test lead to frame ground.
   - If the DMM indicated CONTINUITY, repair or replace Wire 4 at the point of failure.
   - If the DMM indicated INFINITY, refer back to the 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 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 240 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.

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 3.5** ***Troubleshooting Flowcharts*** and **Section 3.6** ***Diagnostic Tests***. For further engine repair information, refer to the appropriate engine service manual.

Test 17 – Current Calibration (8–20 KW Units)

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)

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)

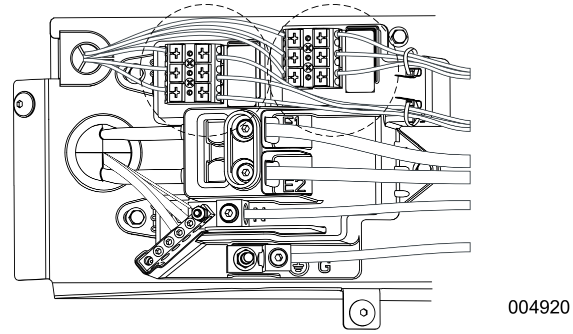


Figure 3-1. 2017 Evolution Customer Connections

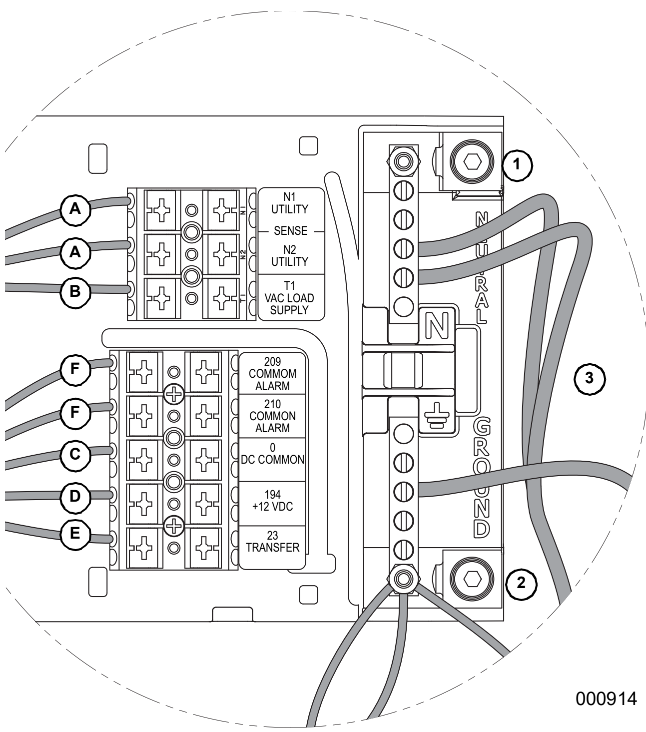


Table 3-1. Control Panel Connections

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 3-2. 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.	

Figure 3-2. Evolution (2016 and older) Control Wiring - 60 Hz (found behind control board)

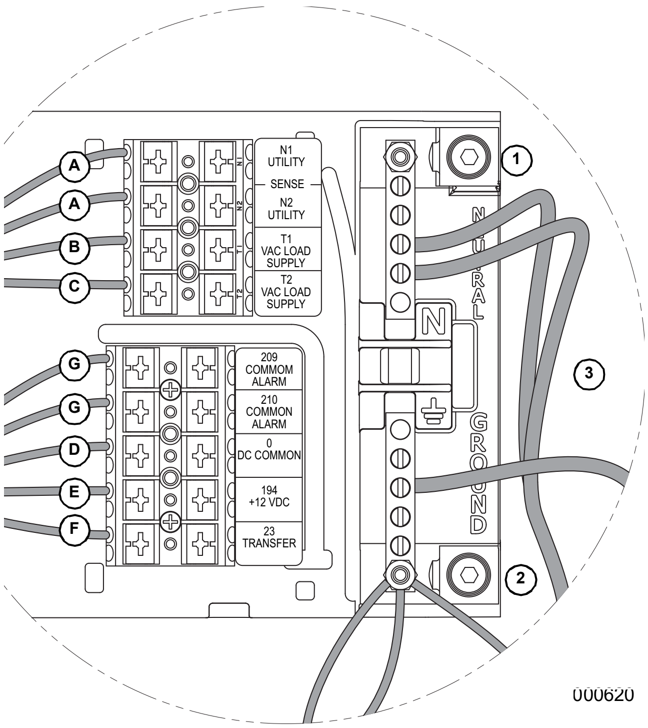


Table 3-3. Control Panel Connections		
Terminal Numbering Decal		Wire Numbers
A	YELLOW #1 & #2	N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3	T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C*	WHITE #4	T2 - Fused 120 VAC for Battery Charger (*see NOTE)
D	BLACK #3	0 - DC (-) 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.		

Table 3-4. 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)

Figure 3-3. Evolution (2016 and older) 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 3-5*** for the specific position and function. See ***Menu System Navigation*** to view state of output or input.

Table 3-5. Digital Inputs and Outputs		
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
* Evolution1.0 (firmware v1.18 and higher) and Evolution 2.0 (all firmware) units.		

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 1.0 (firmware v1.17 and higher) and Evolution 2.0 (all firmware) 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, a “Charger 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 ºF 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 ºF 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 Evolution controller has OFF-MANUAL-AUTO Mode membrane push buttons. See *Figure 3-4* for the location of the push buttons.

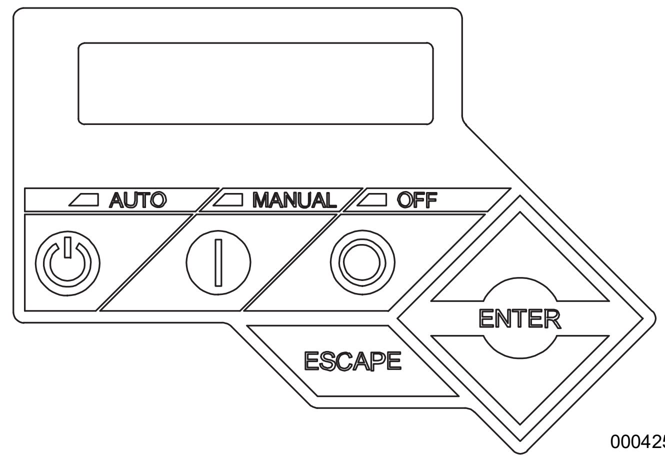


Figure 3-4. Evolution controller Off-Manual-Auto Buttons

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.

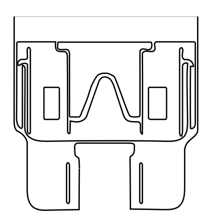


Figure 3-5. Typical 7.5 Amp Fuse

Starter Contactor Relay/Solenoid

(V-Twins and units with 426cc Engine)

See *Figure 3-6*. 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.

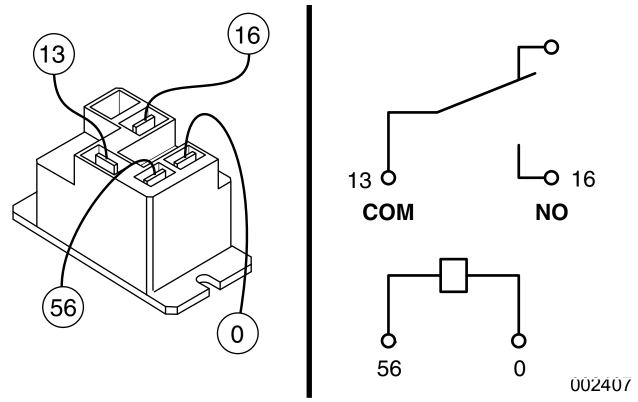


Figure 3-6. Starter Contactor Relay (V-twin Units)

(410cc Single Cylinder Engine Units Only)

See ***Figure 3-7***. 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.

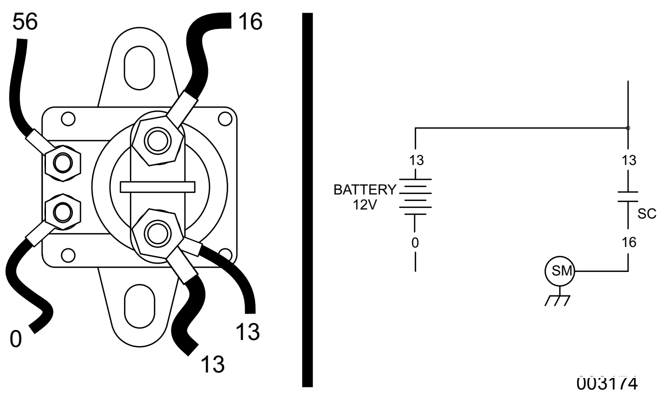


Figure 3-7. The Starter Contactor (Single Cylinder Units)

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 Evolution units (2016 and older), the connections are made to the generator customer connection terminal strip (or WAGO block) at Terminals 1 and 2 (Wires 209 and 210).

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

Table 3-6. Specifications	
Contact Rating:	200 mA at 12 VDC

NOTE: Contact rating is for resistive load only

Circuit Pin Descriptions

Appendix A ***Controller Identification*** provides the physical wire identification and circuit functions.

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*** 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.

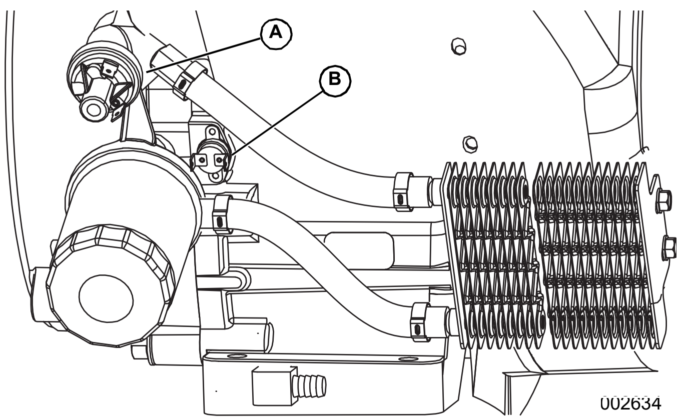
Engine Protective Devices

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 3-8. Engine Protective Switches

Low Oil Pressure

(E-Code 1300)

All Evolution 2017 and Prior Models

See ***Figure 3-8***. 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.

All Evolution 2.0 and Newer Models: This switch has normally open contacts that are held closed by engine oil pressure during cranking and startup. Should oil pressure drop below approximately 10 psi, the switch contacts will open. Upon opening of the switch contacts, Wire 86 circuit from the controller will be disconnected from ground. The controller’s logic responds in the same way as Evolution 1.0, shutting the unit down.

High Temperature Switch

(E-Code 1400)

All Evolution 2017 and Prior Models

See ***Figure 3-8***. The contacts of this switch are normally open and will close if the temperature exceeds approximately 293 ºF (144 ºC), 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.

All Evolution 2.0 and Newer Models: The contacts of this switch are normally closed and will open if the temperature exceeds approximately 310 ºF (154 ºC), 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

(E-Code 1200 and 1205)

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.

Evolution 2.0 Overspeed

(E-Code 1207)

The controller monitors the zero cross timing of the AVR to determine alternator frequency. Alternator frequency is an indicator of speed. Set for 150 milliseconds of 4500 rpm or higher. Used if the normal ignition pulse sequence(s) are not being seen by the controller.

RPM Sensor Failure
(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.

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 3-7. 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 3-8. 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 60 Hz	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
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 (Evolution 1.0)	15 seconds	As long as AC is missing	Continuous except cranking	NA	NA	Warning
Charger Missing AC (Evolution 2.0)	3 Minutes	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 3.3 Operational Analysis – Evolution 2.0

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. (220-240 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.

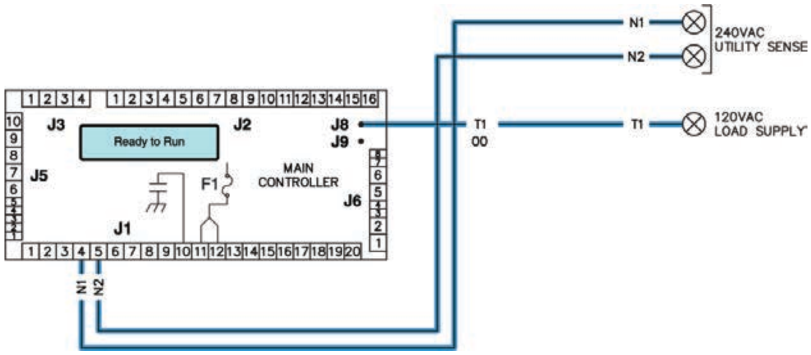

Figure 3-9.

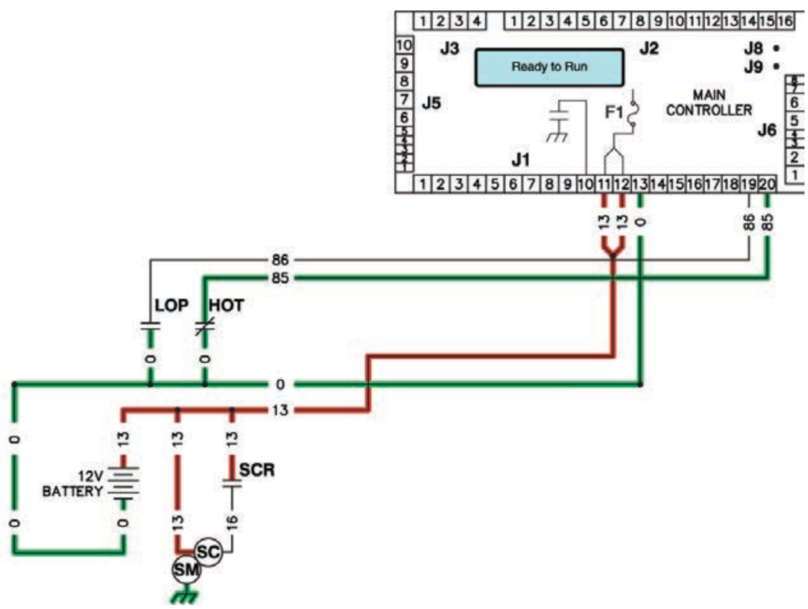

Figure 3-10.

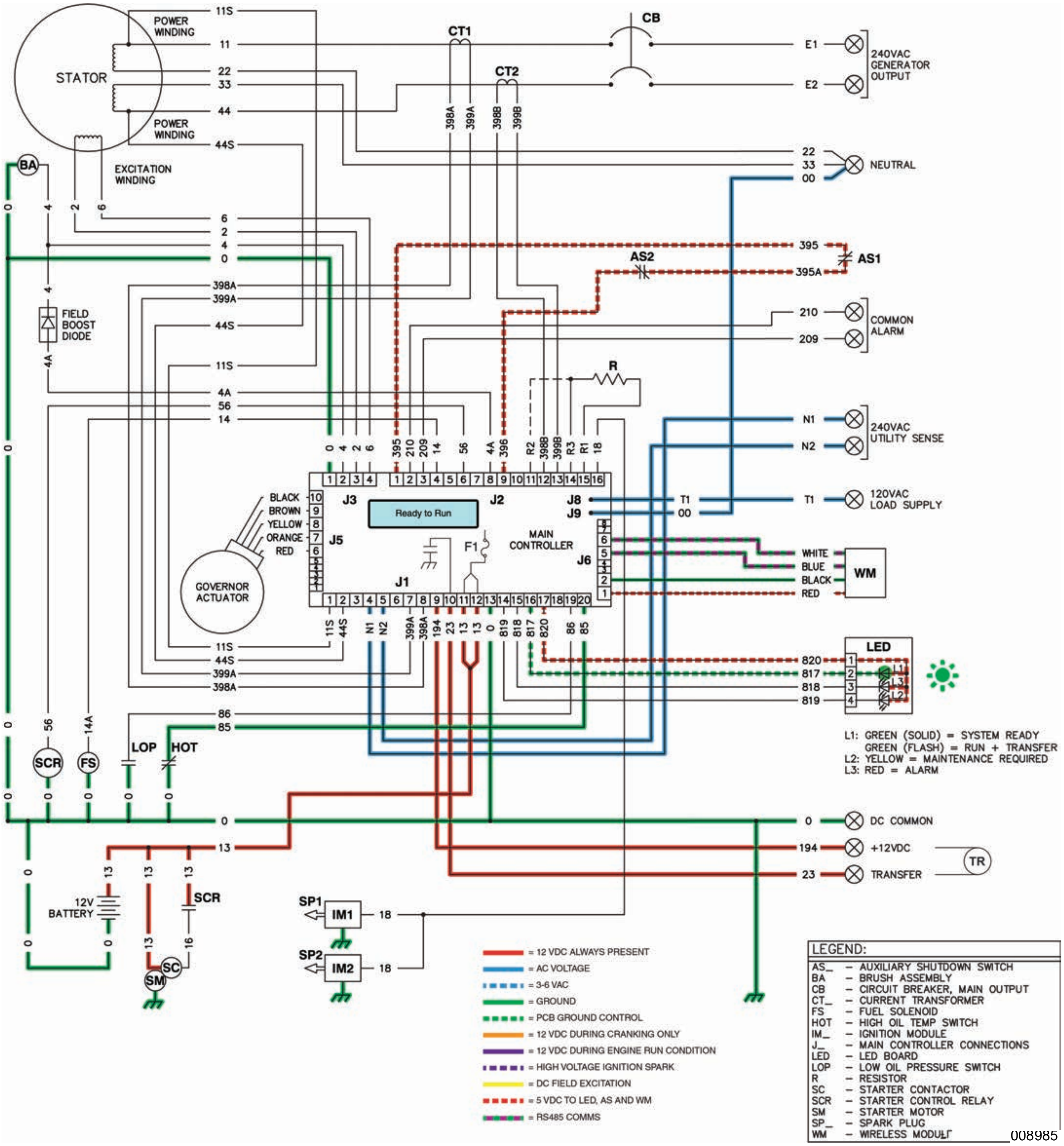

Figure 3-11. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See *Figure 3-13*. 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

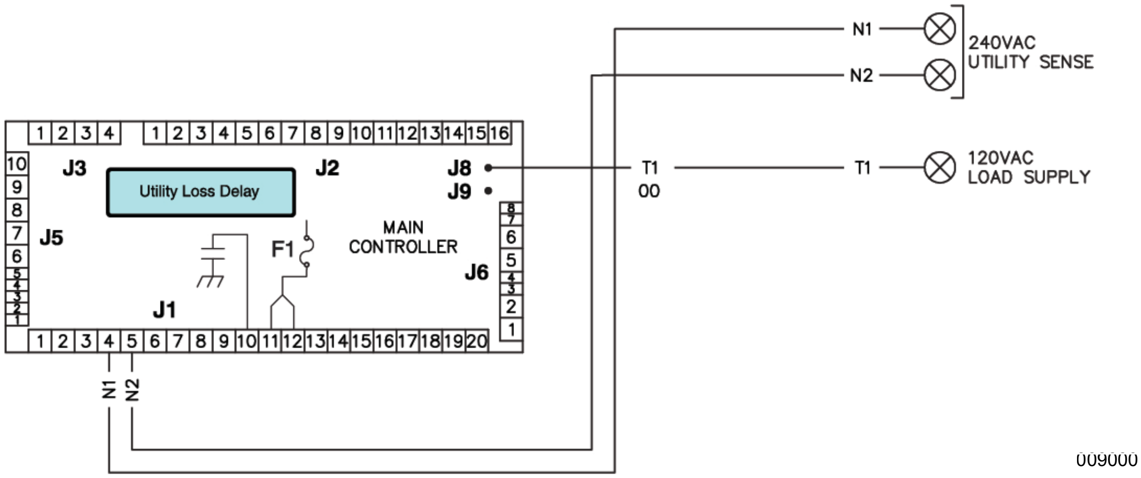

Figure 3-12.

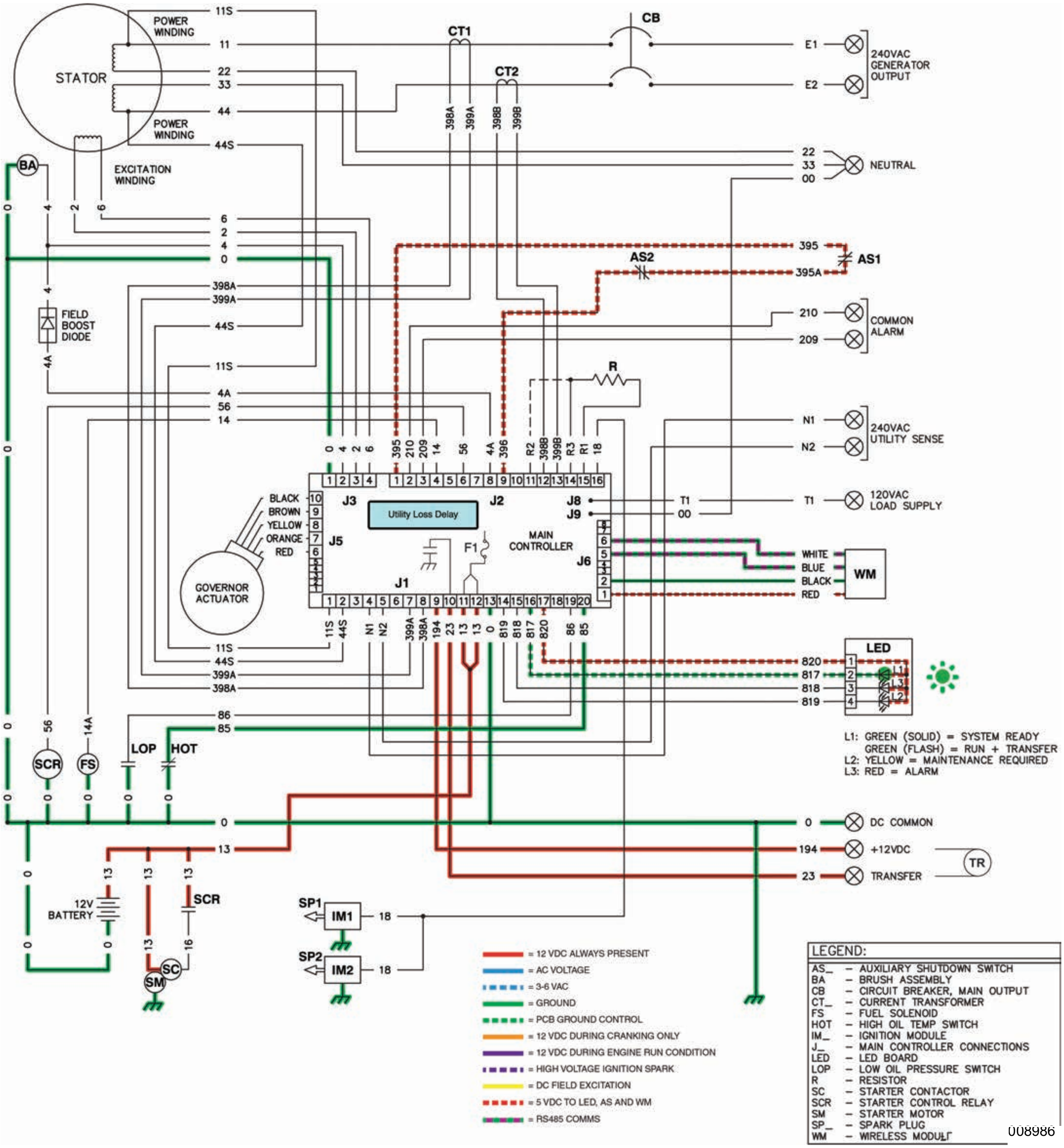

Figure 3-13. Initial Dropout of Utility Source Voltage

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.

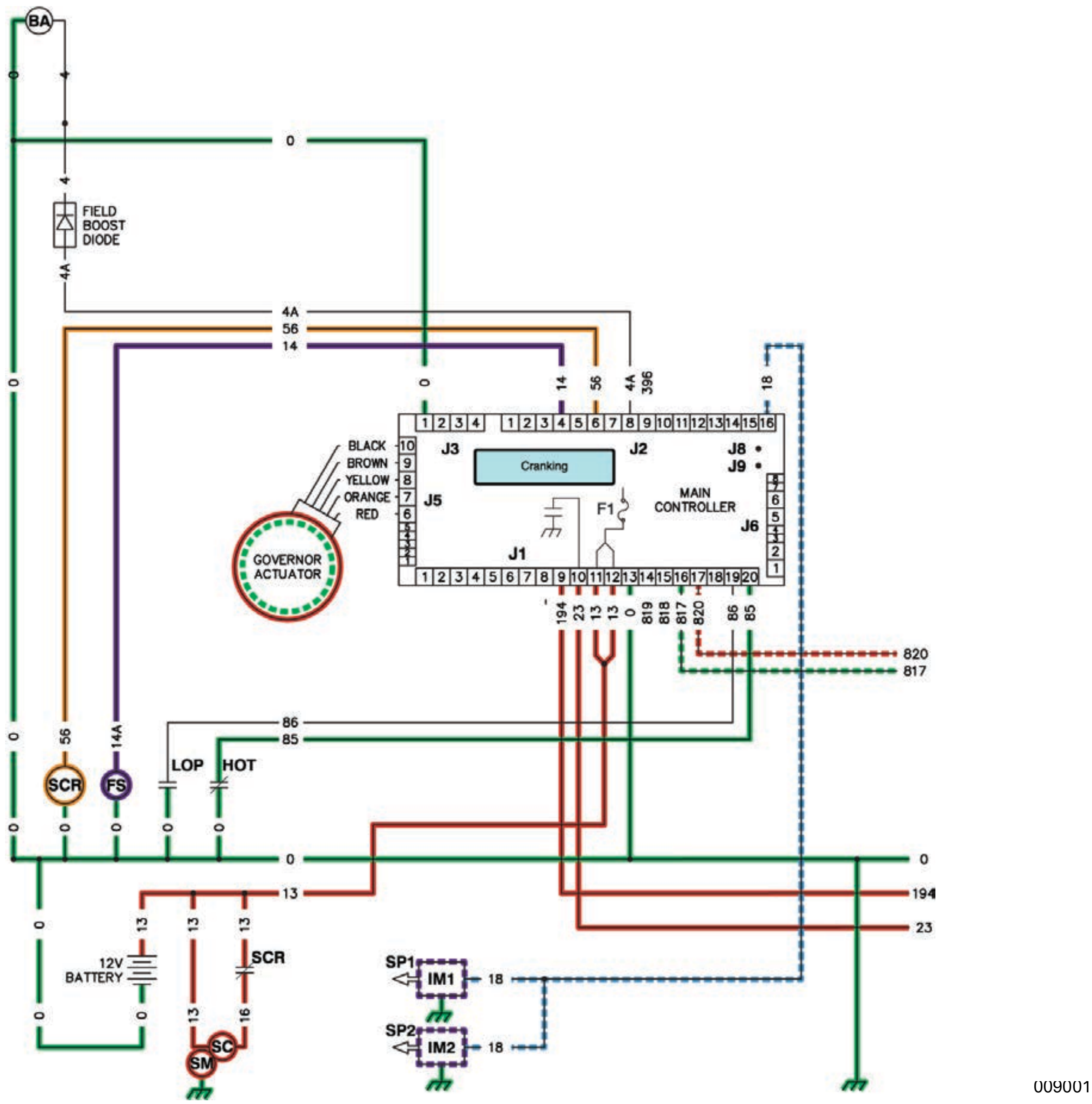

Figure 3-14.

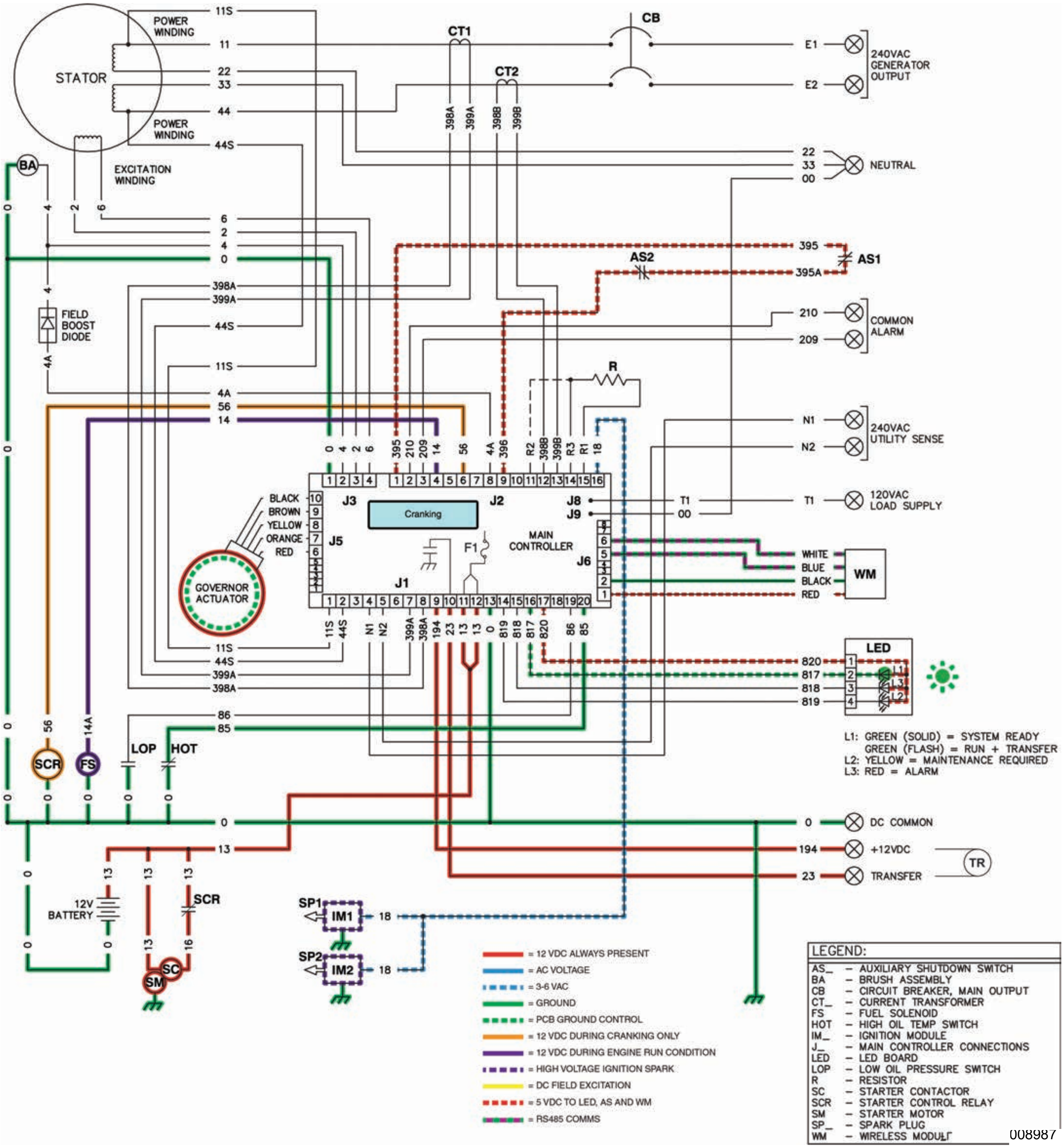

Figure 3-15. Utility Voltage Failure and Engine Cranking

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 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.

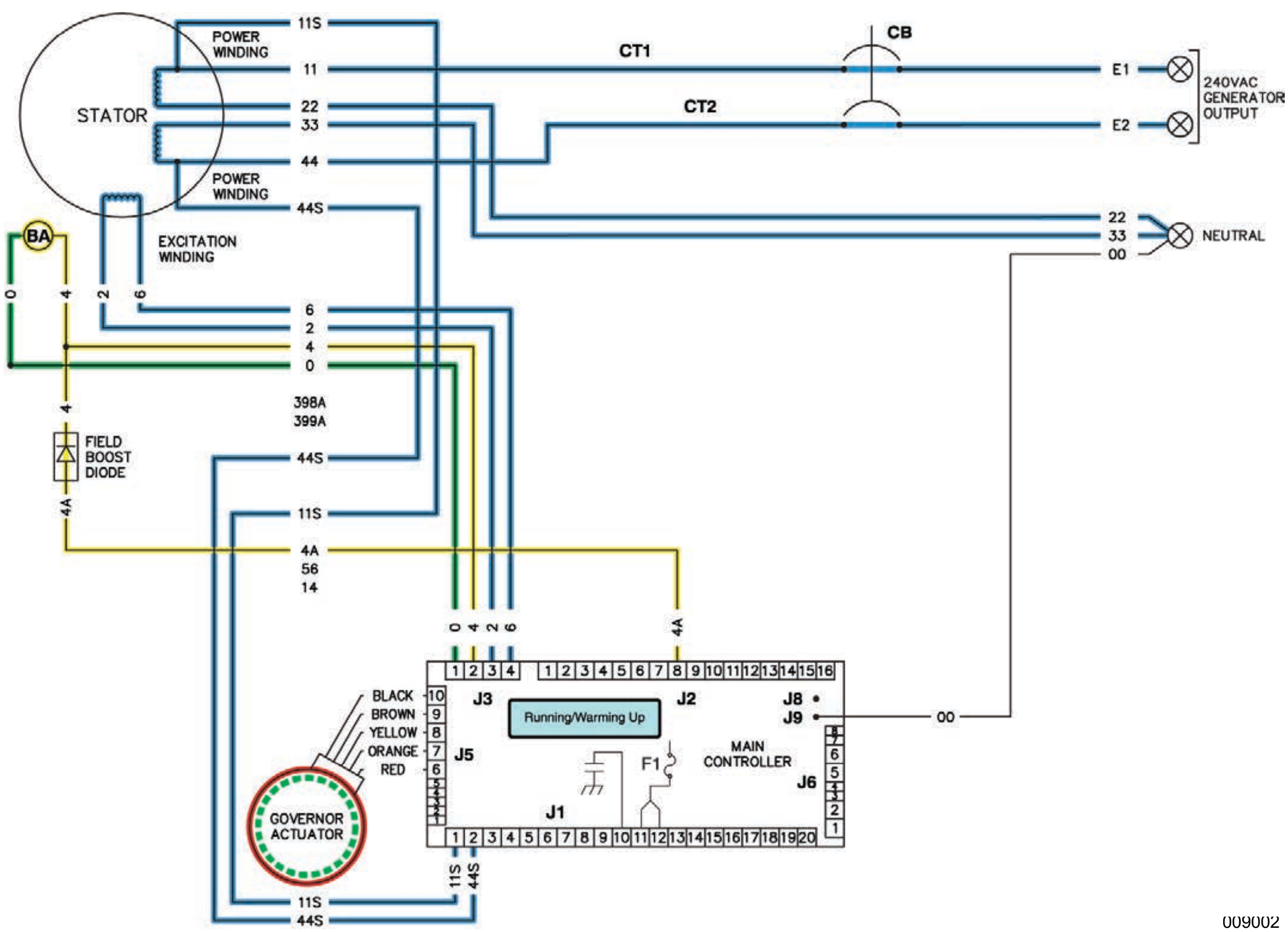

Figure 3-16.

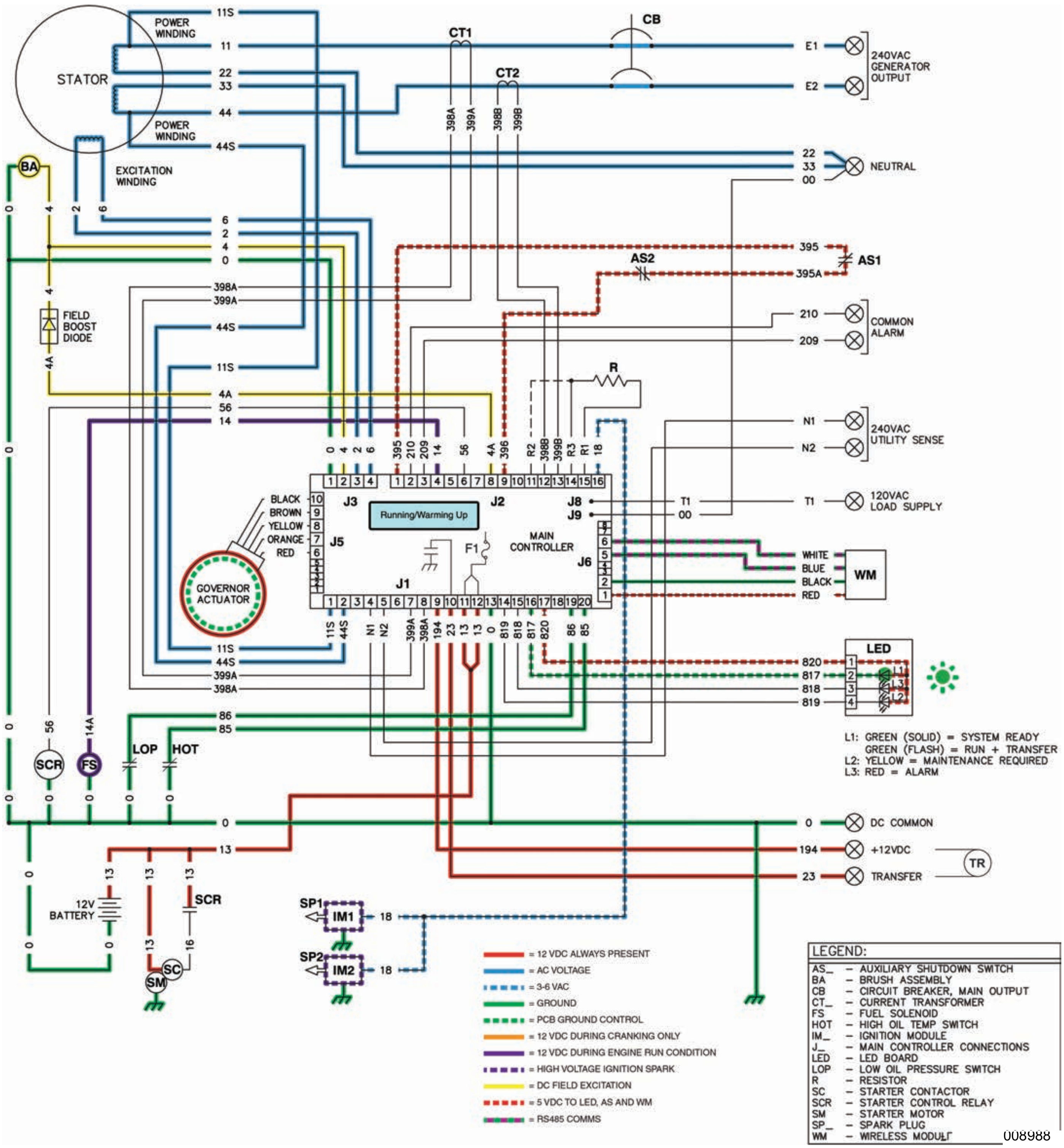

Figure 3-17. Engine Startup and Running

Transfer to Standby

In ***Figure 3-19*** 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 via Wire 194. The 12 VDC circuit is completed back to the controller via Wire 23. However, the controller’s logic holds Wire 23 open from ground and the transfer relay is de-energized.
- When the “engine warm-up timer” expires, the controller will take Wire 23 to ground. The transfer 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)

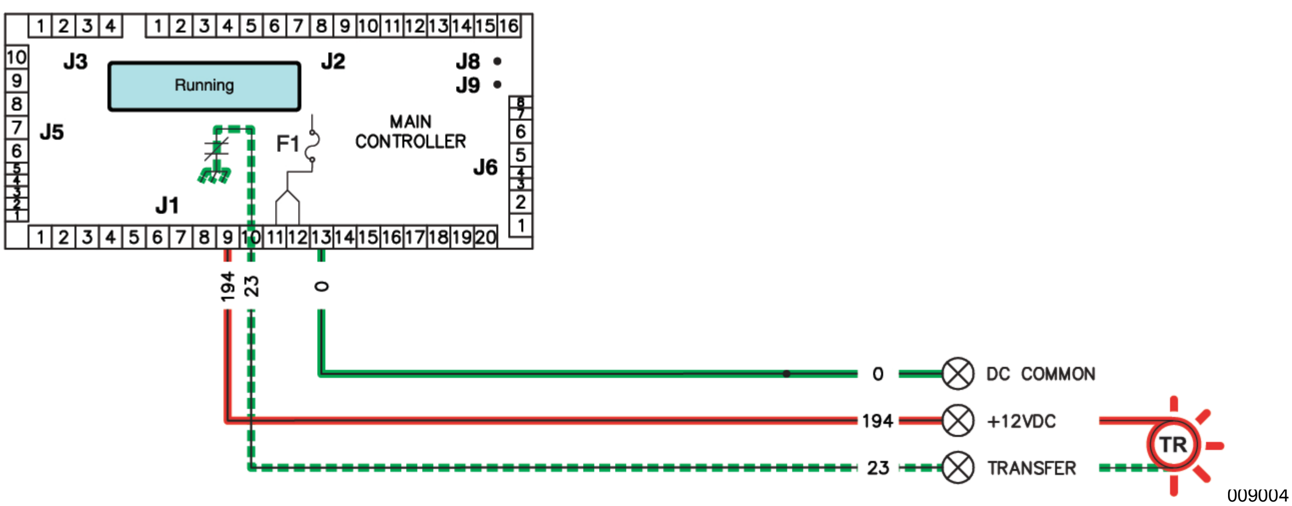

Figure 3-18.

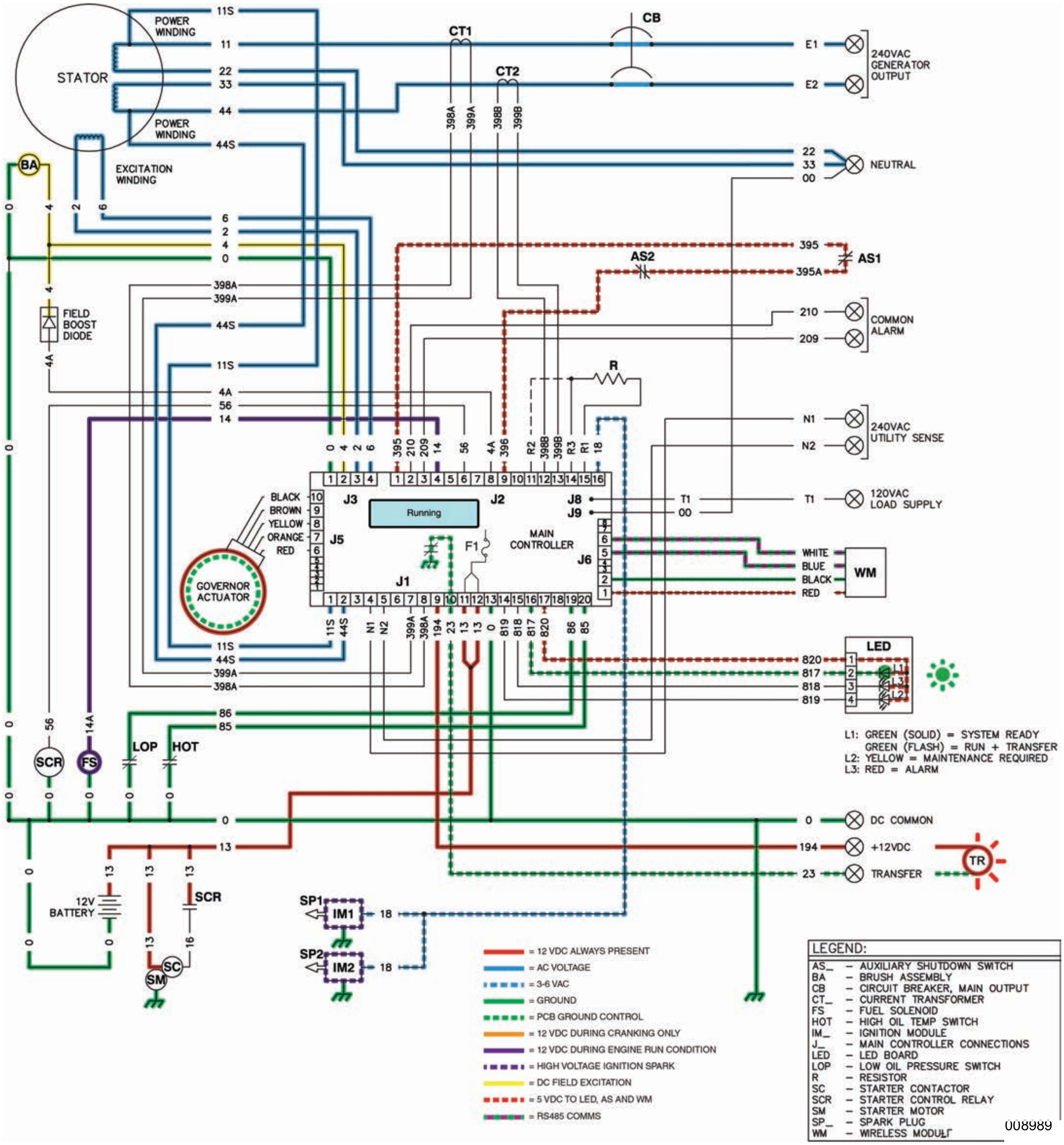

Figure 3-19. Transfer to Standby

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 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

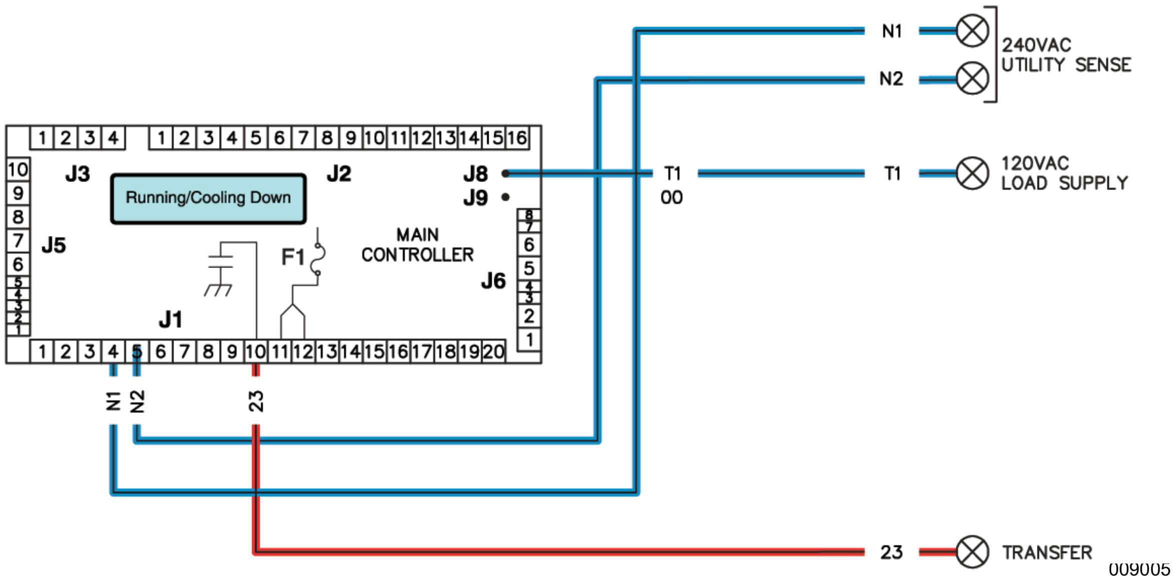

Figure 3-20.

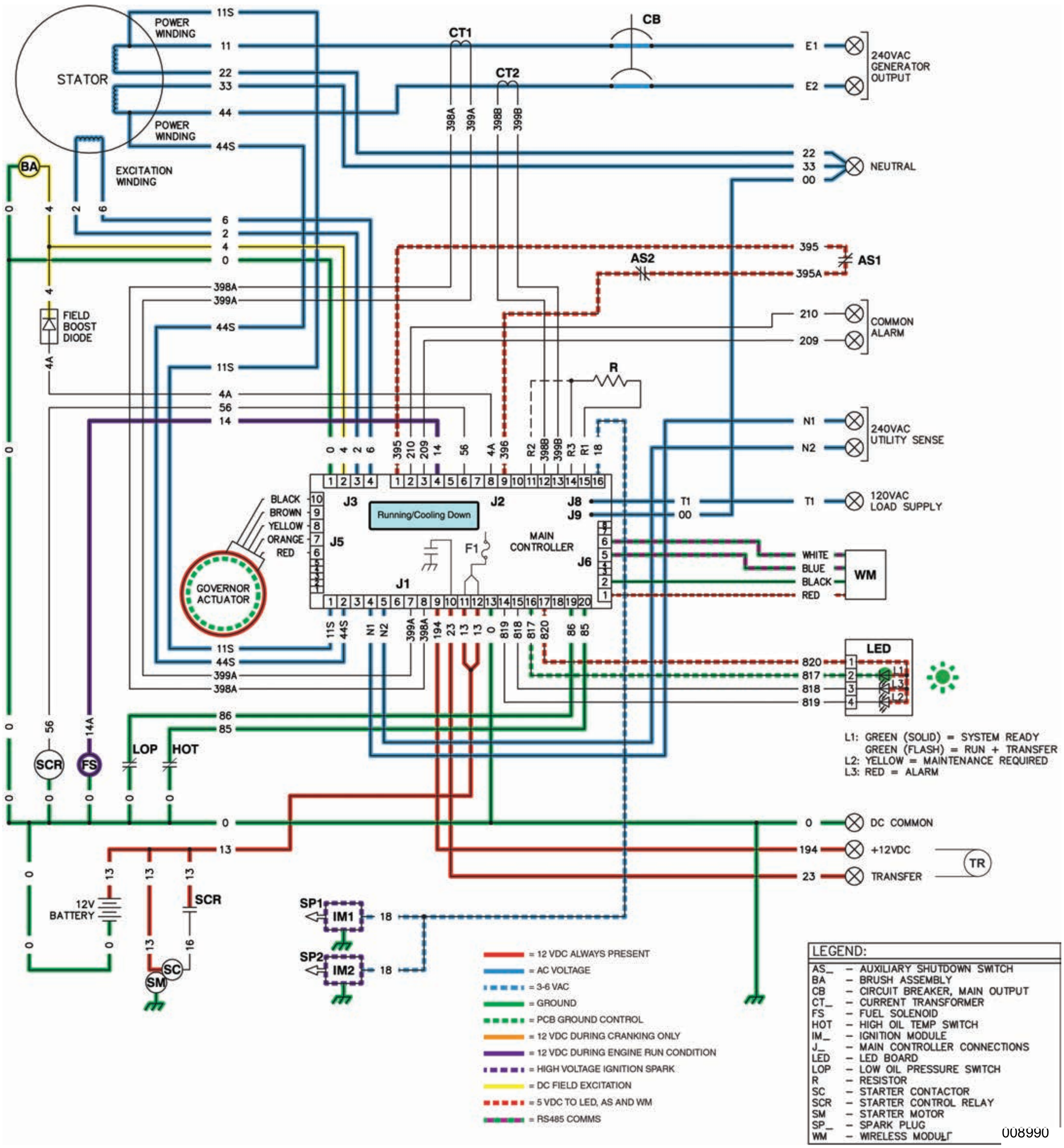

Figure 3-21. Utility Voltage Restored and Re-transfer to Utility

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:

- Wire 14 (run circuit) will de-energize and the fuel solenoid will close to terminate the fuel supply to the engine.
- After a short fuel burn off, 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.

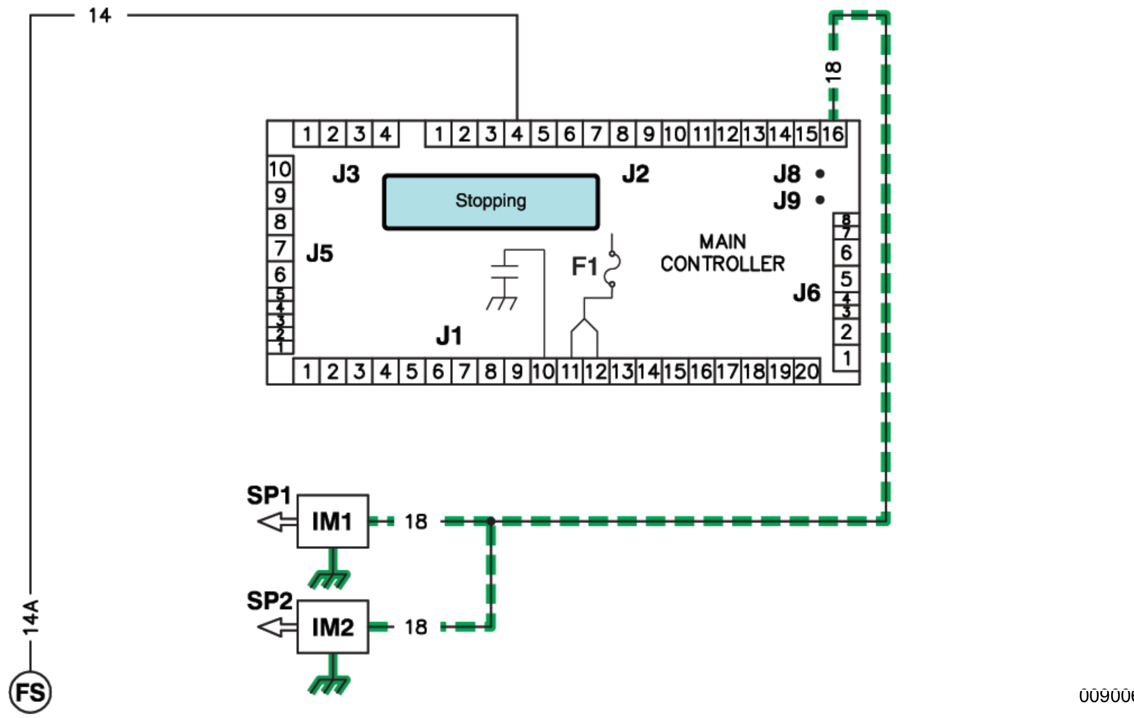

Figure 3-22.

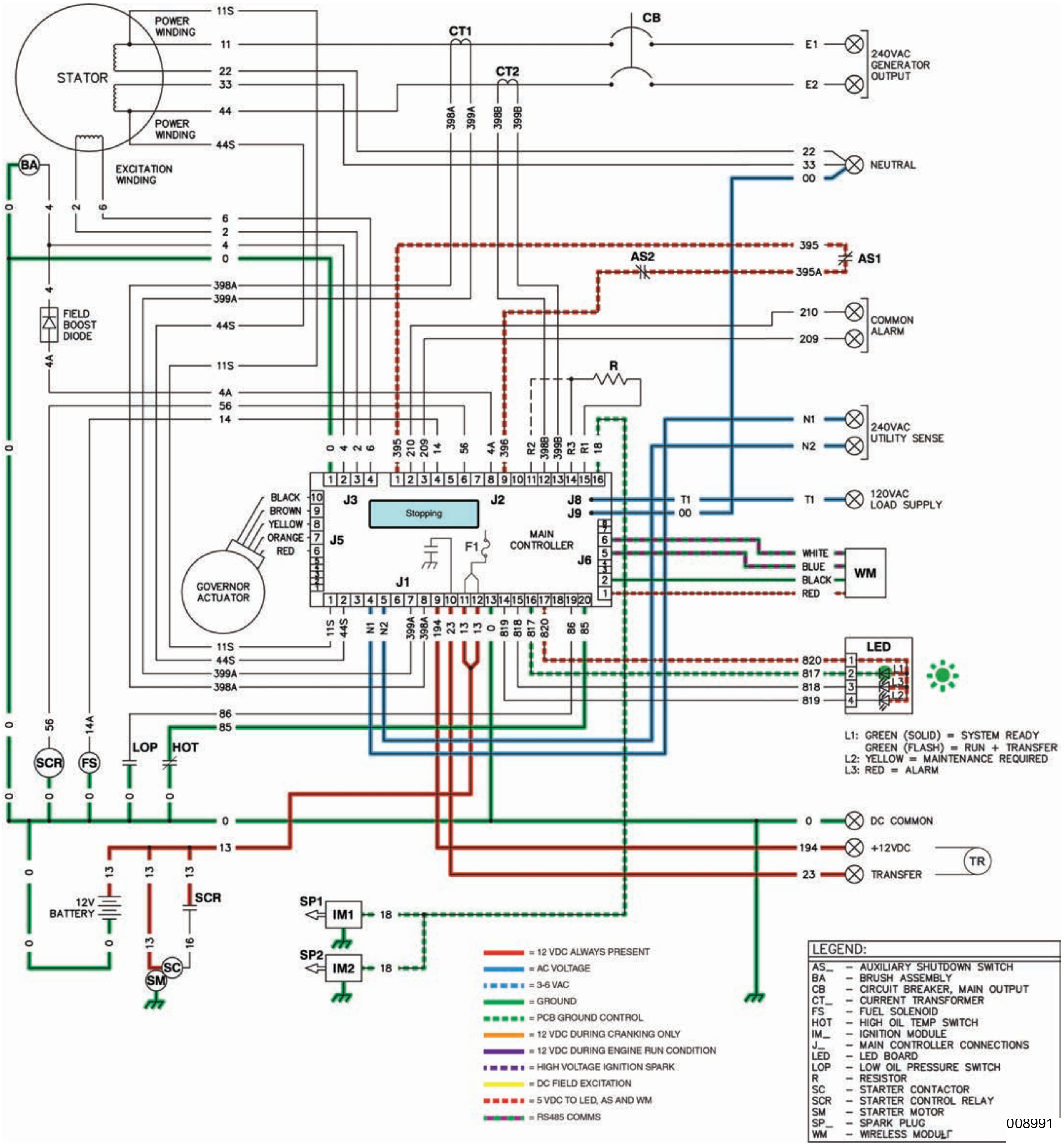

Figure 3-23. Engine Shutdown

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Section 3.4 Operational Analysis – Evolution 1.0

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.

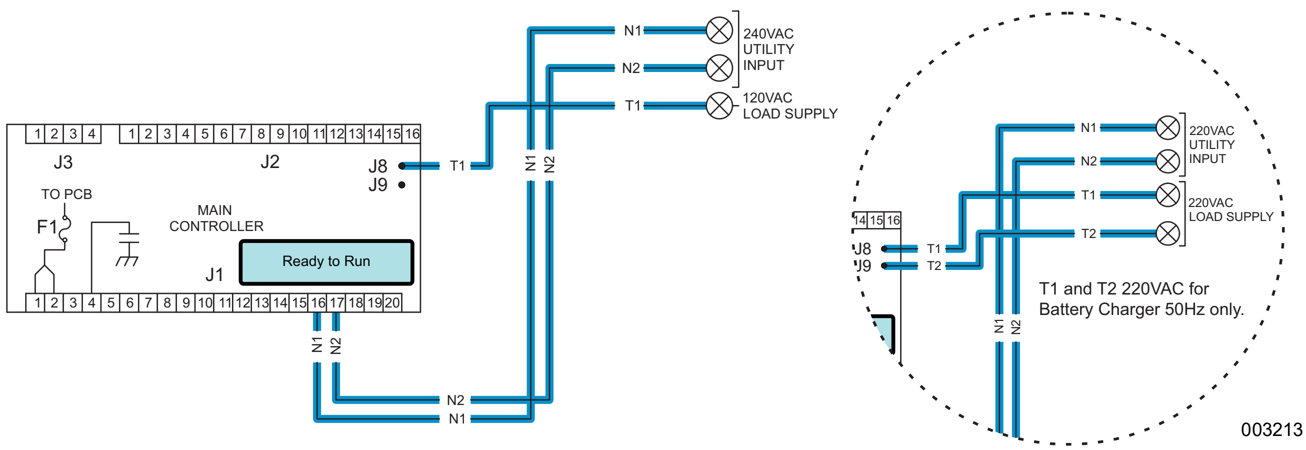


Figure 3-24.

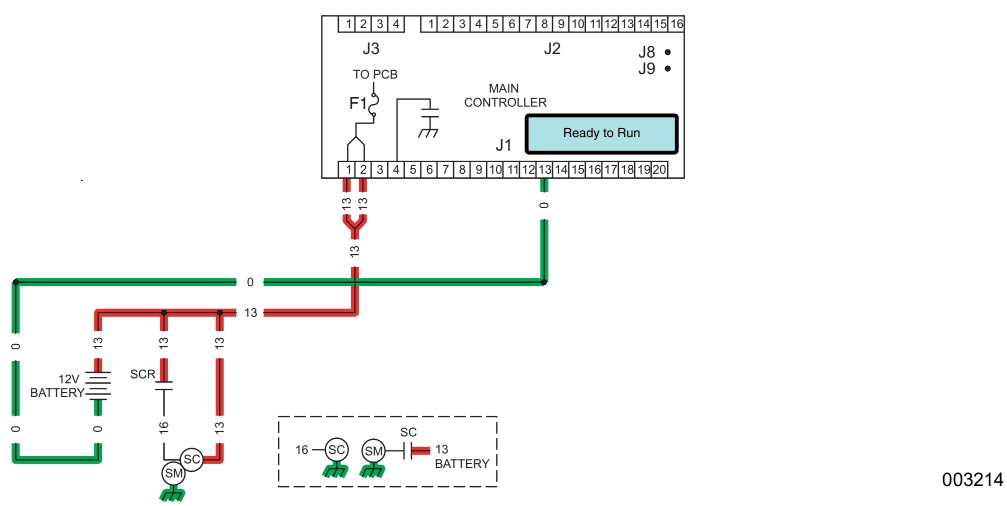


Figure 3-25.

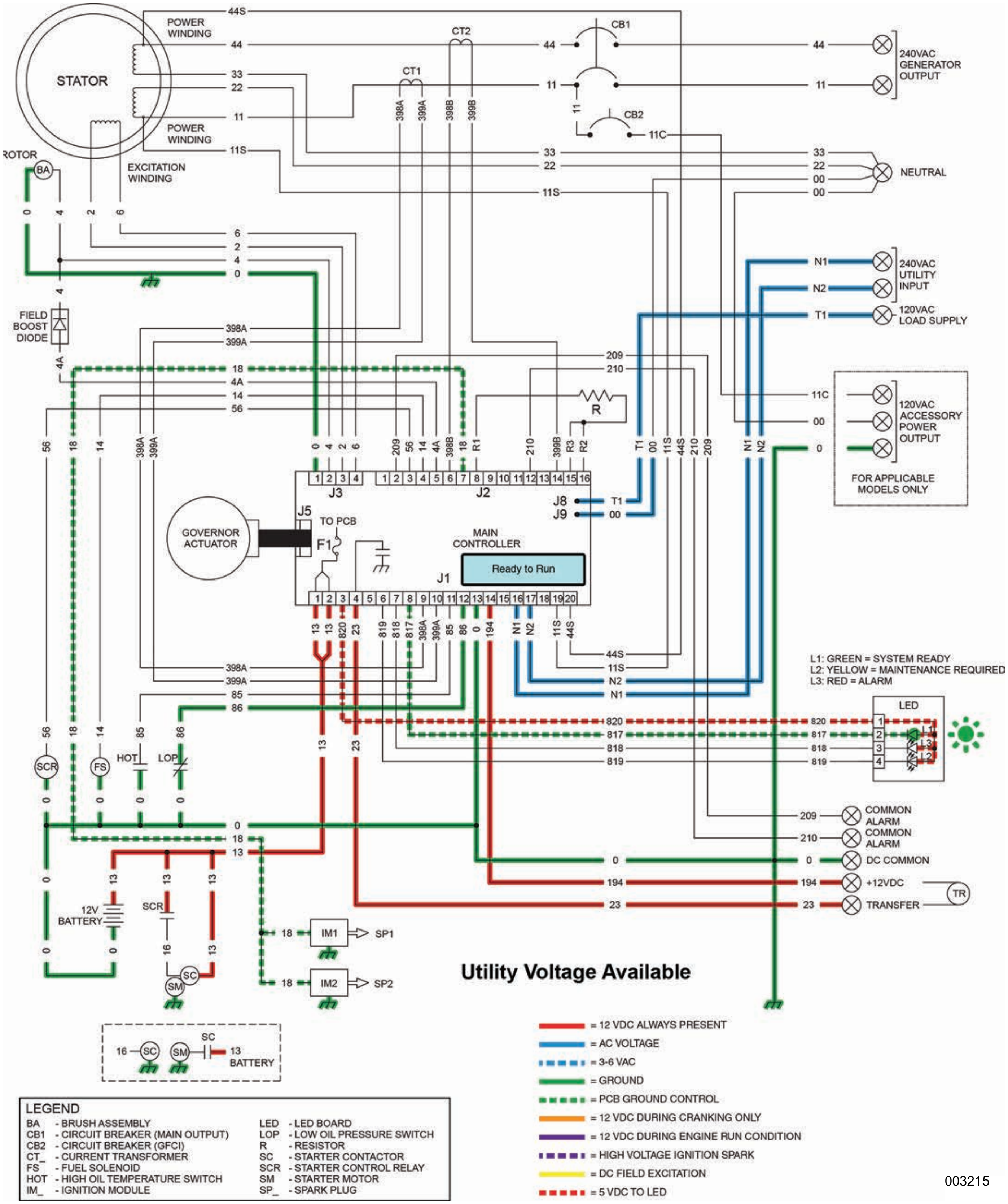


Figure 3-26. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See ***Figure 3-28***. 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

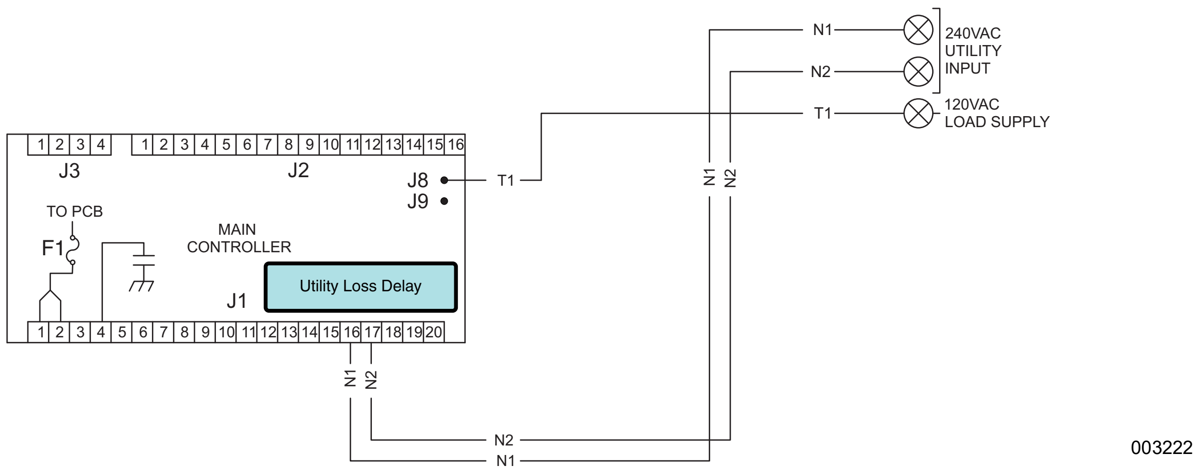


Figure 3-27.

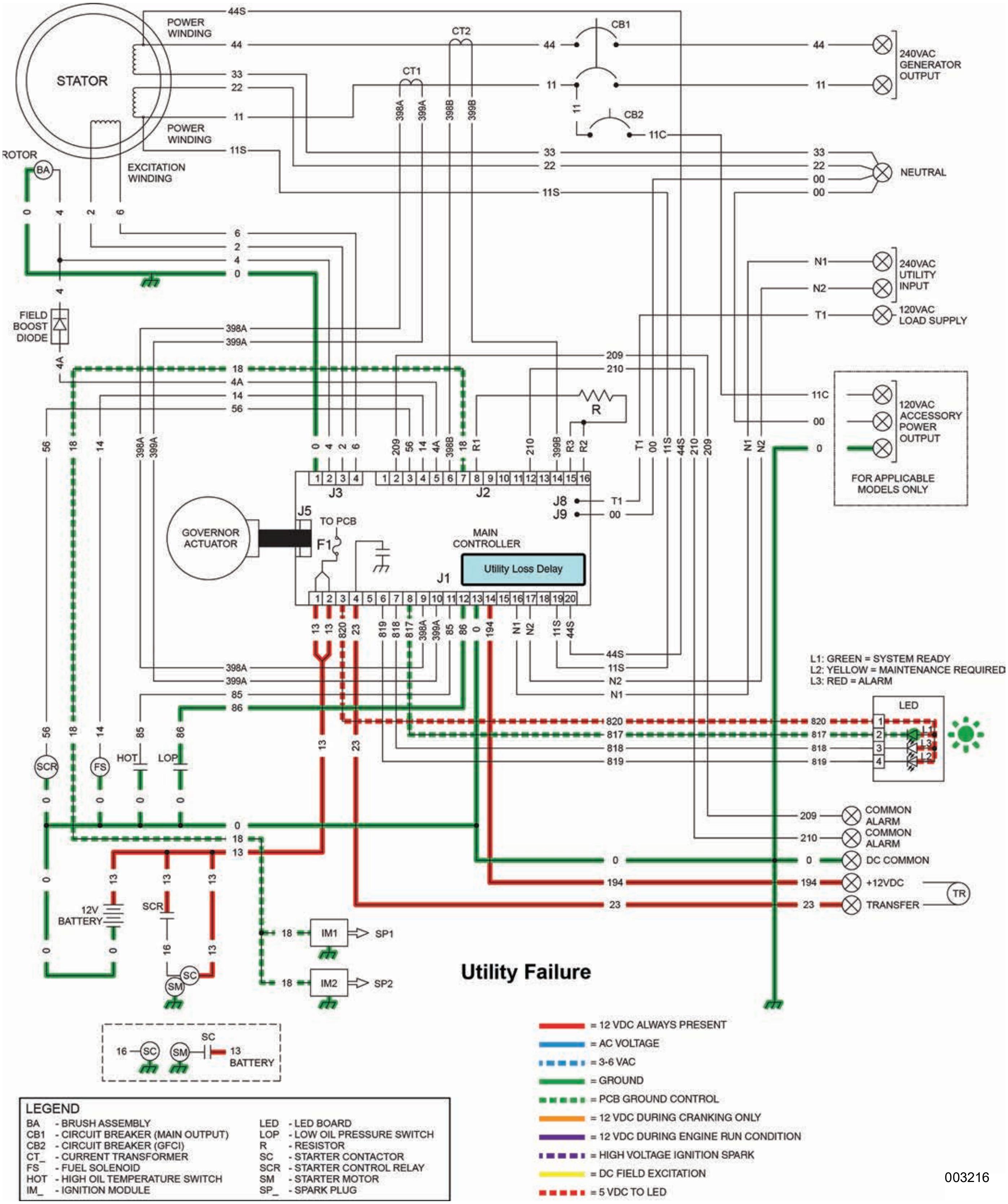


Figure 3-28. Initial Dropout of Utility Source Voltage

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.

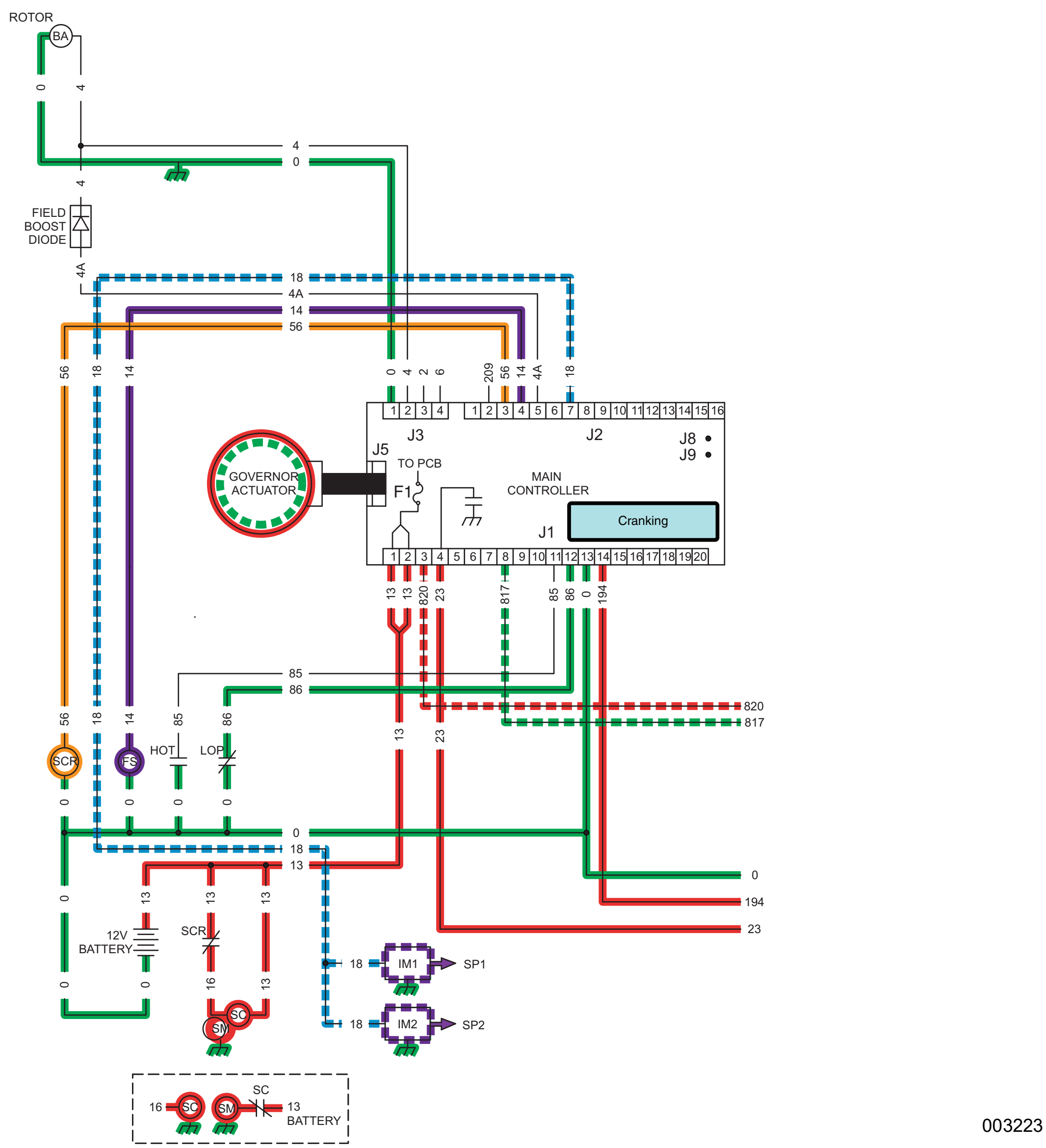


Figure 3-29.

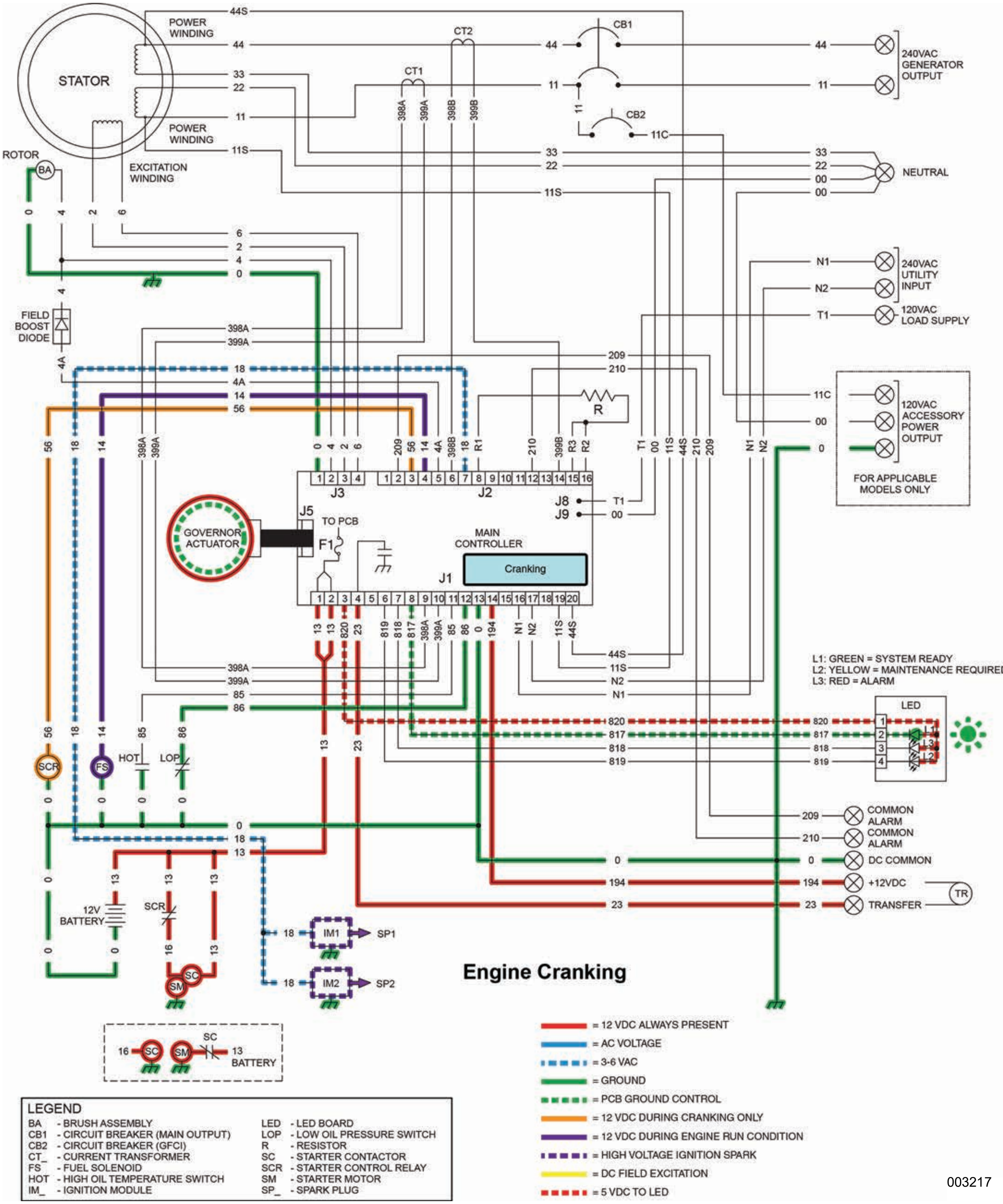


Figure 3-30. Utility Voltage Failure and Engine Cranking

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 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.

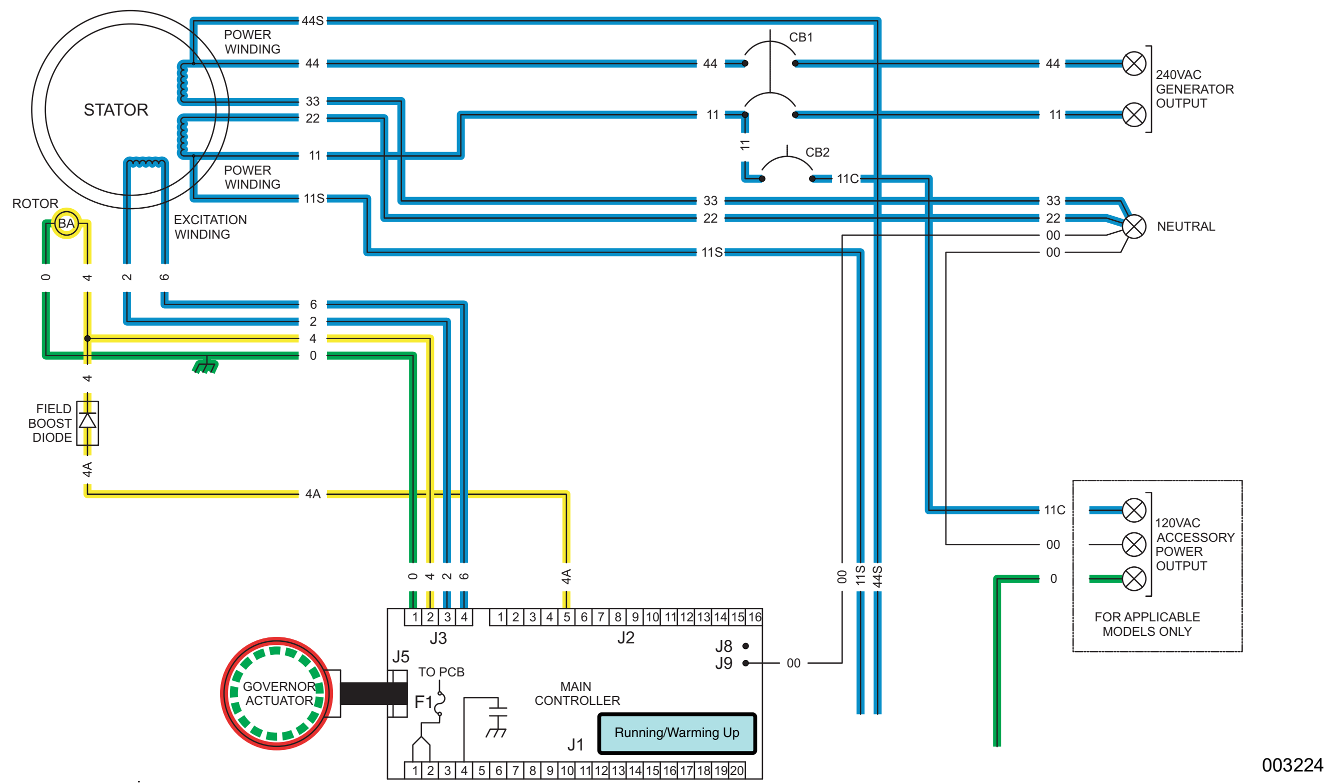


Figure 3-31.

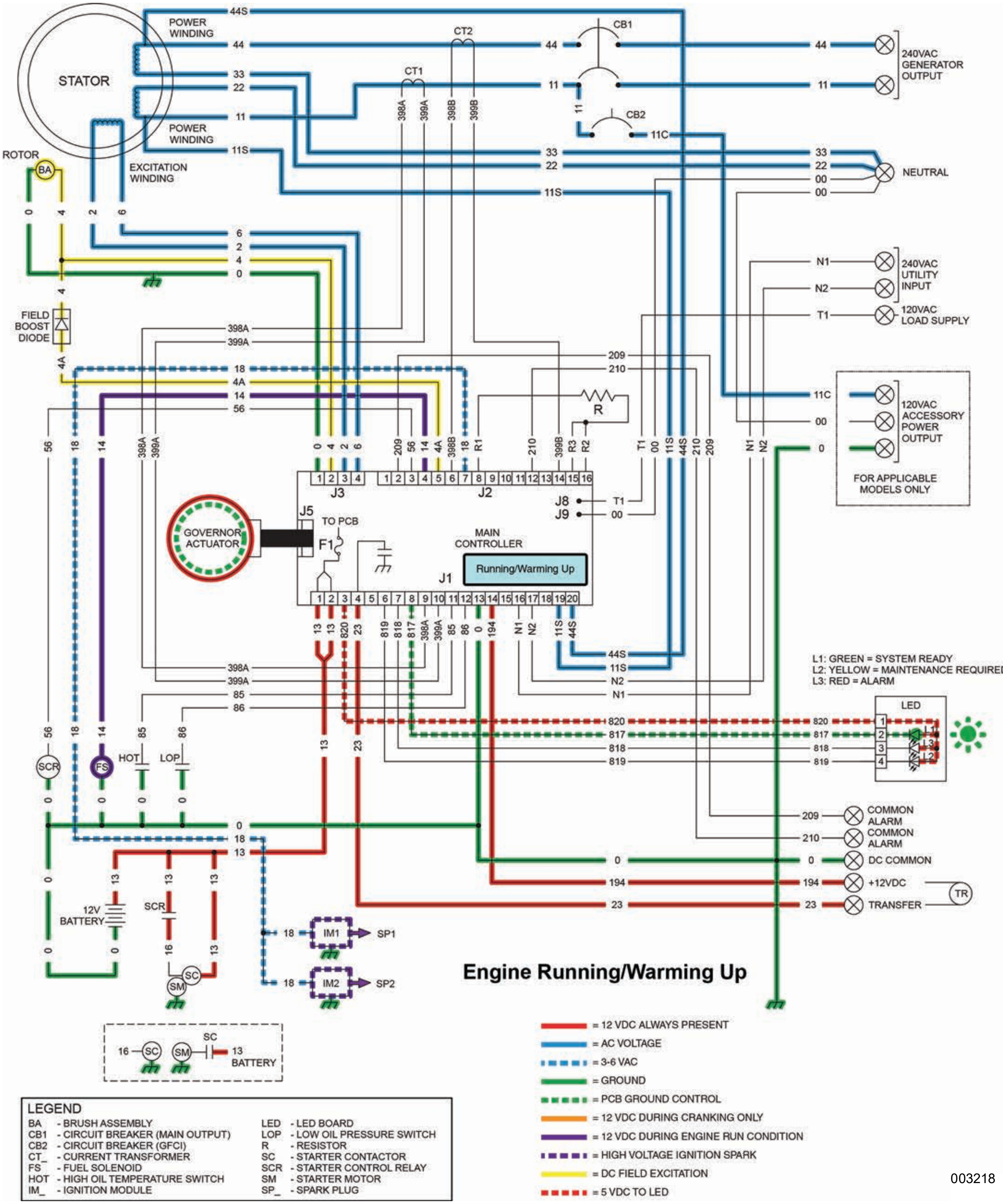


Figure 3-32. Engine Startup and Running

Transfer to Standby

In ***Figure 3-34*** 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 via Wire 194. The 12 VDC circuit is completed back to the controller via Wire 23. However, the controller's logic holds Wire 23 open from ground and the transfer relay is de-energized.
- When the "engine warm-up timer" expires, the controller will take Wire 23 to ground. The transfer 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)

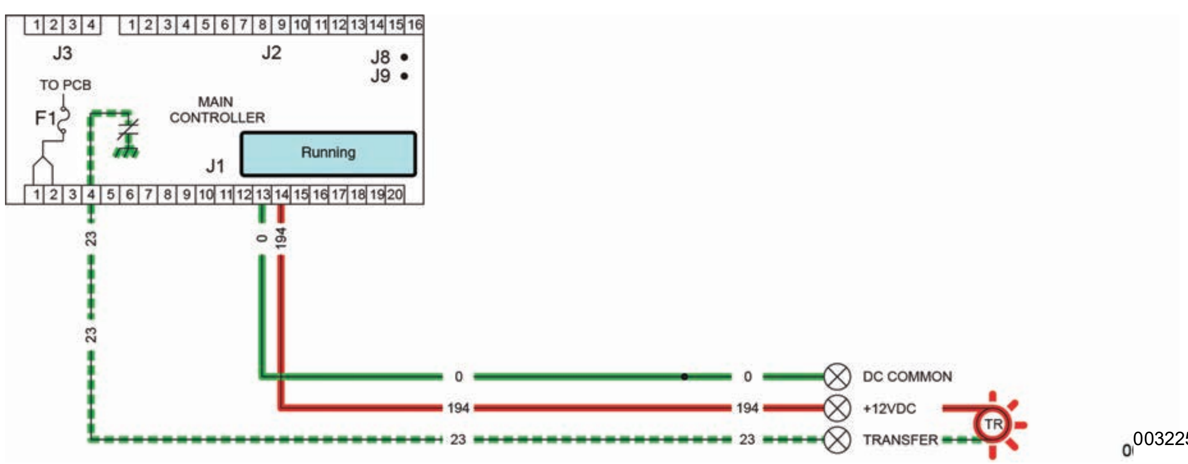


Figure 3-33.

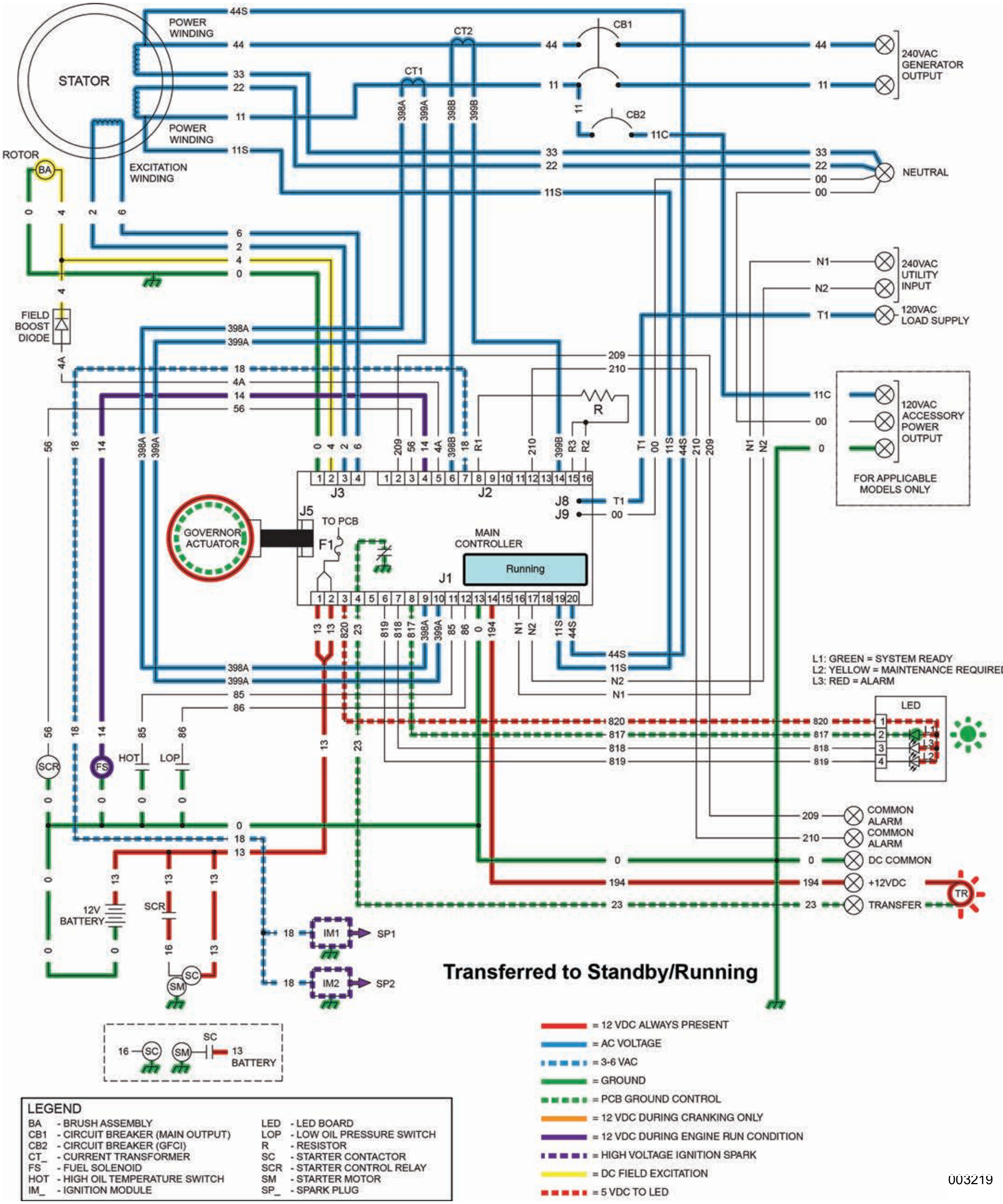


Figure 3-34. Transfer to Standby

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 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

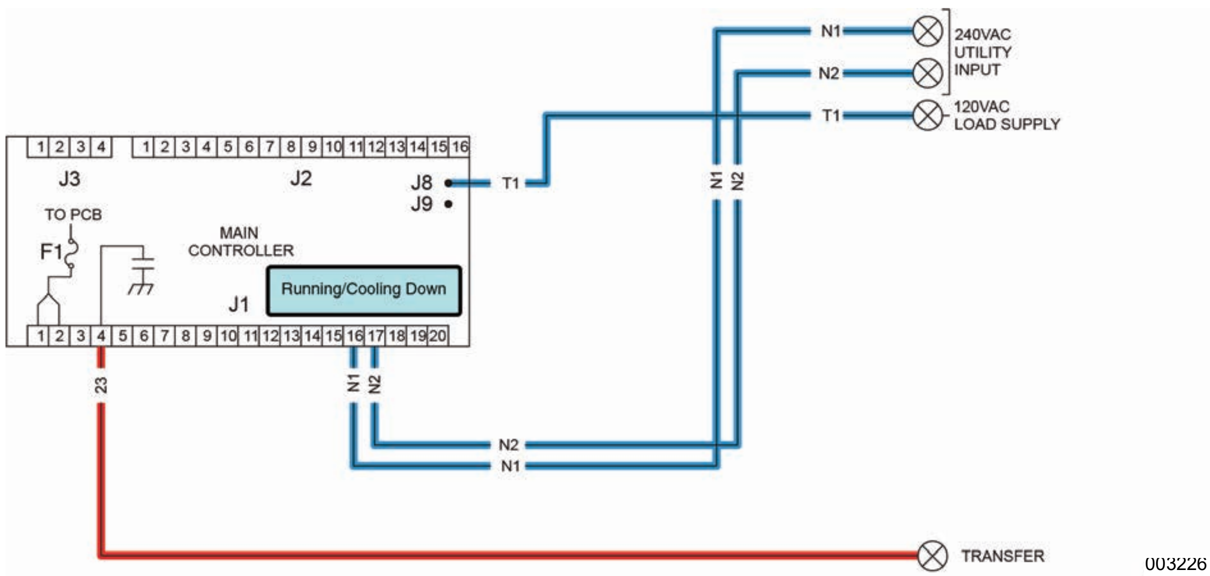


Figure 3-35.

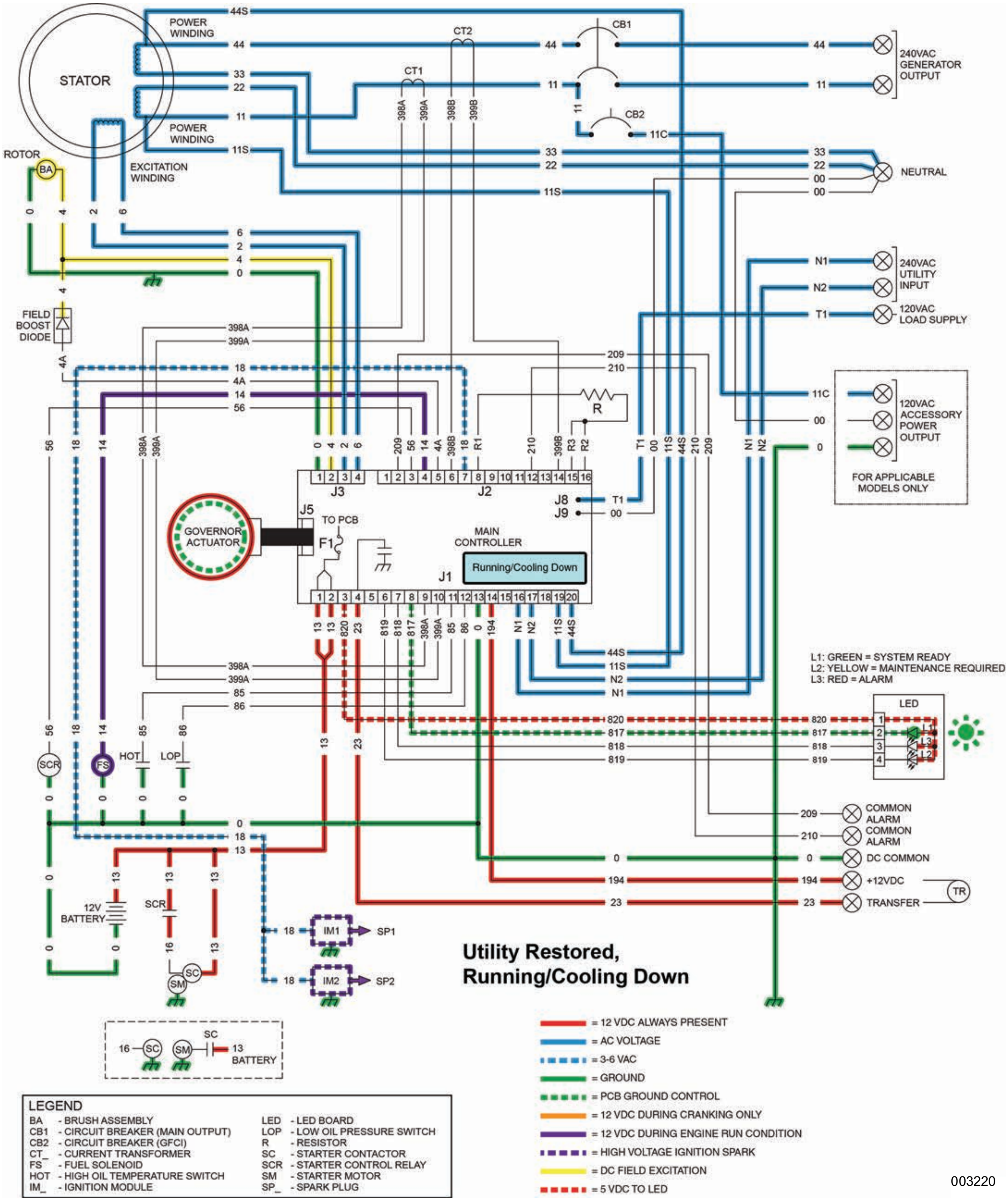


Figure 3-36. Utility Voltage Restored and Re-transfer to Utility

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:

- 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.

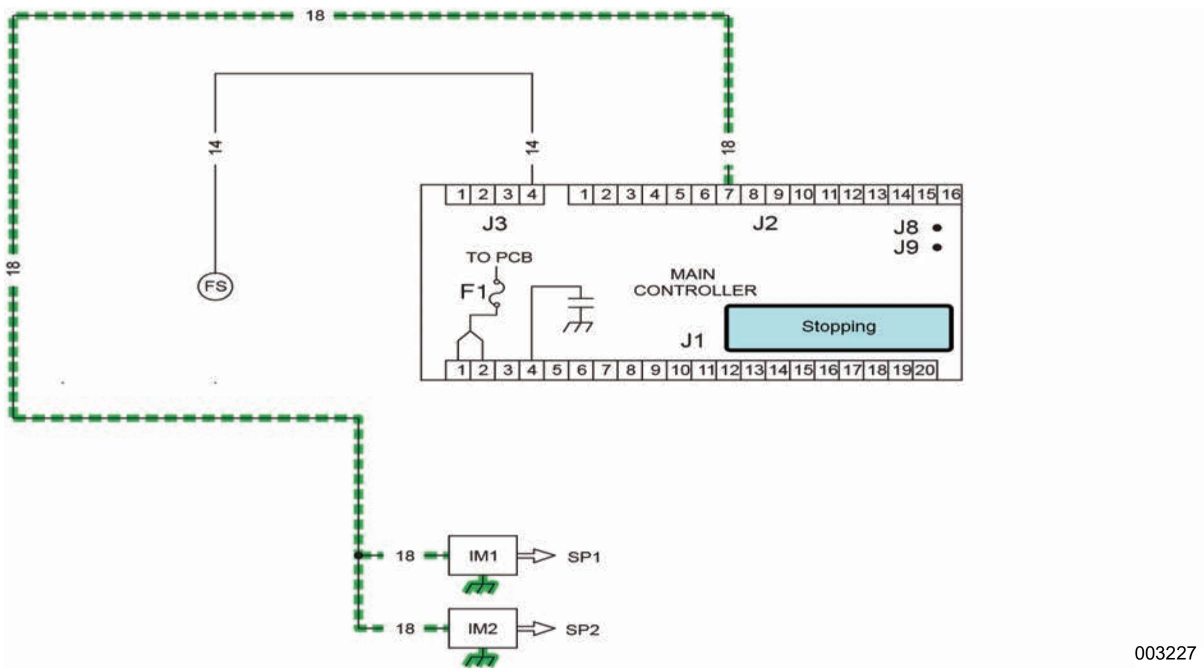


Figure 3-37.

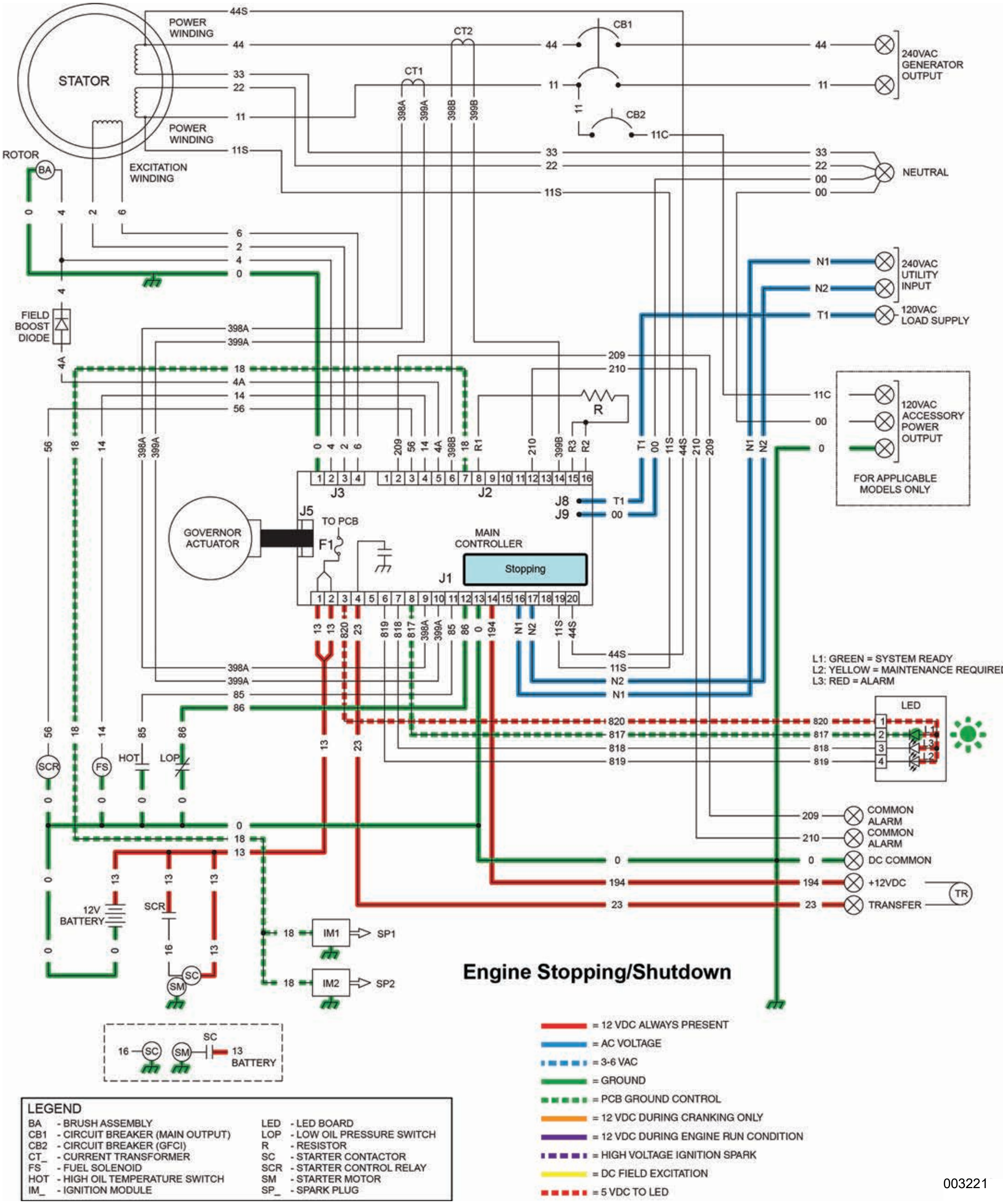


Figure 3-38. Engine Shutdown

Evolution™ Controller E-Codes

NOTE: For any Displayed Alarm on the controller, use the Action Step as a starting point.

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 54
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 54
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 54
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) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.
Undervoltage	ALARM	1901	**Instantaneous** **Undervoltage due to sudden loss of voltage.** (Voltage less than 15 sec 2 sec+) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has 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) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.
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) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Perform Preliminary Output Voltage Test Note: Verify controller has latest firmware.

Evolution™ Controller E-Codes

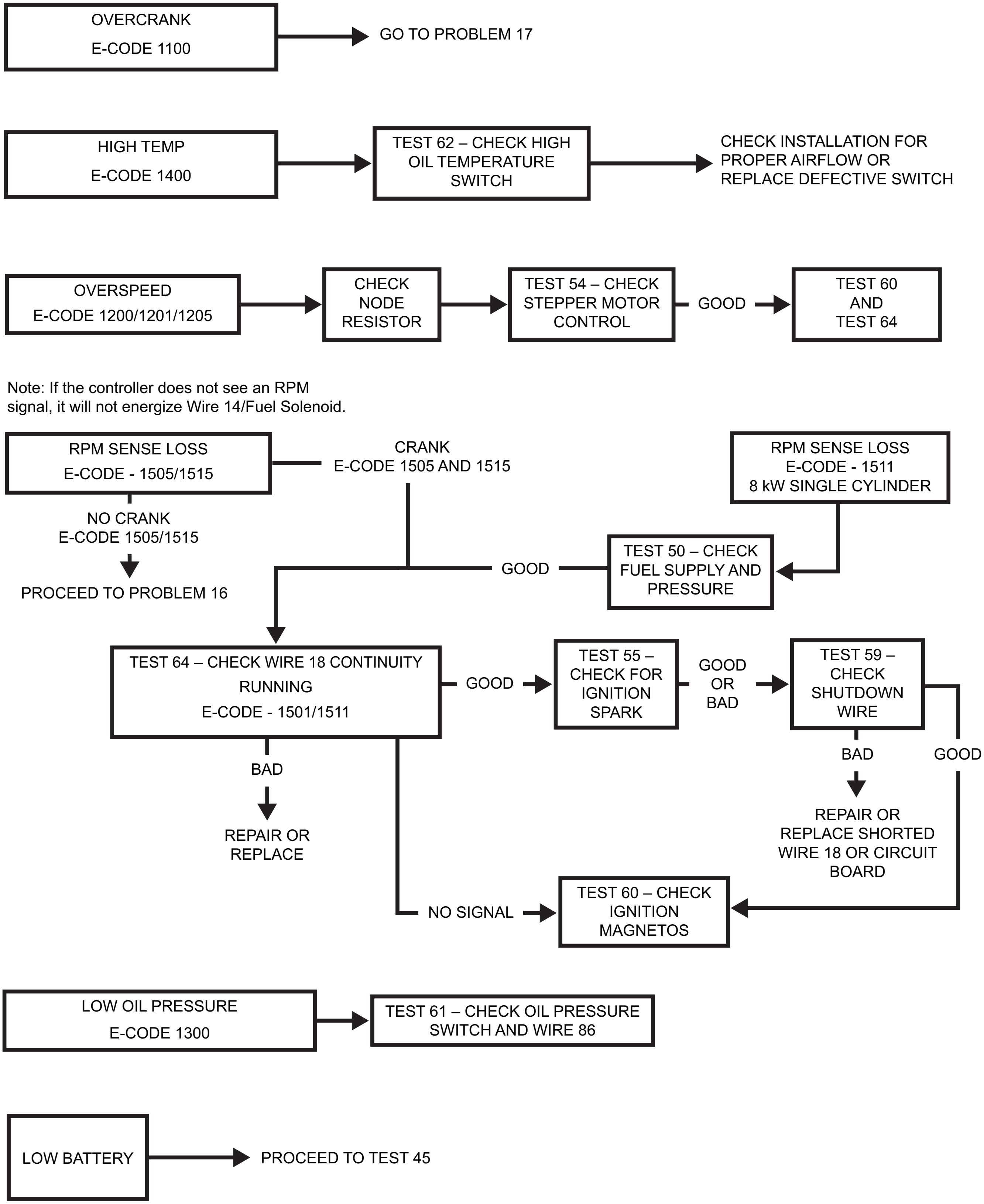
NOTE: For any Displayed Alarm on the controller, use the Action Step as a starting point.

Displayed Alarm	Alarm/ Warning	E-Code Breakdown	Description	Action Step
Wiring Error	ALARM	2098	**Mis-wired Customer connection** Insufficient DC voltage on transfer power output.	Check for shorted 194 to ground. Refer to RTS Diagnostic Manual A0001176044.
Wiring Error	ALARM	2099	**Mis-wired** Customer connection low voltage and high voltage wires are crossed.	Check for AC voltage on Wire 194 at 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 load shed functionality. (Change load dynamics or utilize load shed).	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 54 Note: Verify controller has latest firmware.
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 Note: Verify controller has latest firmware.
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
Model Ident Problem - Fix Harness Resistor			Controller was powered up before the resistor plug was connected.	Problem 23 - Controller displays “Model Ident Problem Fix Harness Resistor” fault
	Service Schedule		Service Schedule A 200hours 2 years Service Schedule B 400 Hours 4 years	Perform Maintenance

Additional Codes For 8 and 9 kW Units (Evolution 1.0 Controller Only)

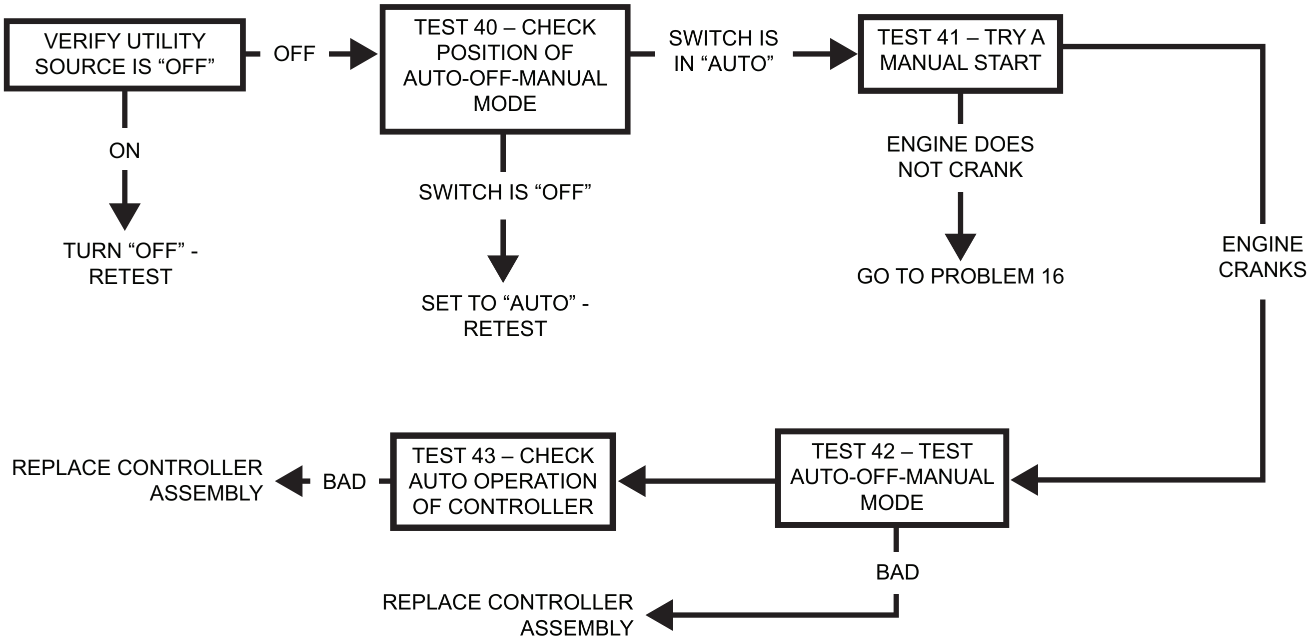
Displayed Alarm	Alarm/ Warning	E-Code Breakdown	Description	Action Step
Overcrank	ALARM	1101	**Engine/Starter Problem** Limiting number of cranking cycles to protect the starter motor.	If the engine has tried to crank for 10 times unsuccessfully, this will trigger.
Overload Remove Load	ALARM	2102	**Overloaded** 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

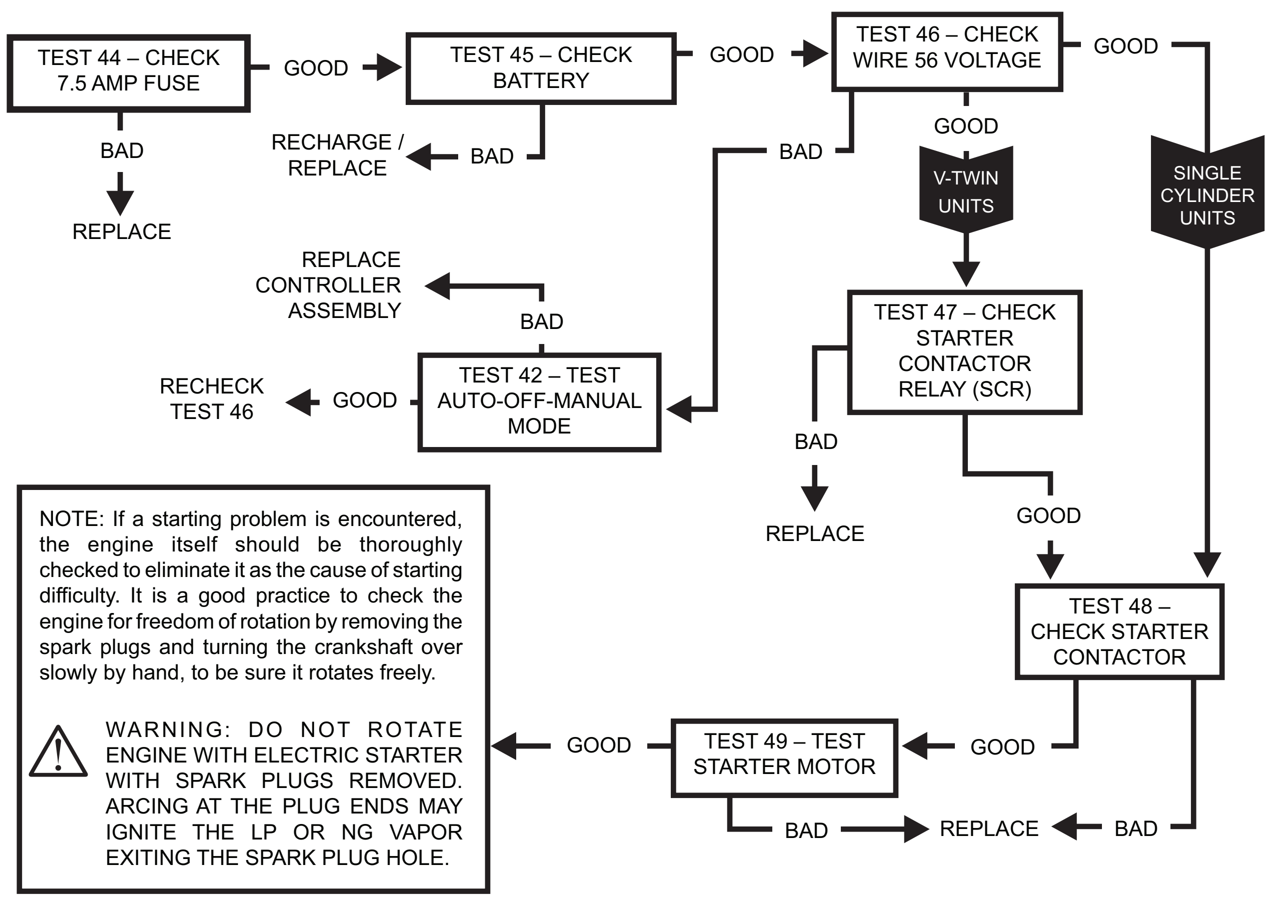


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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



Problem 16 – Engine Will Not Crank When Controller is Set to MANUAL or Controller Goes Dark and Reboots



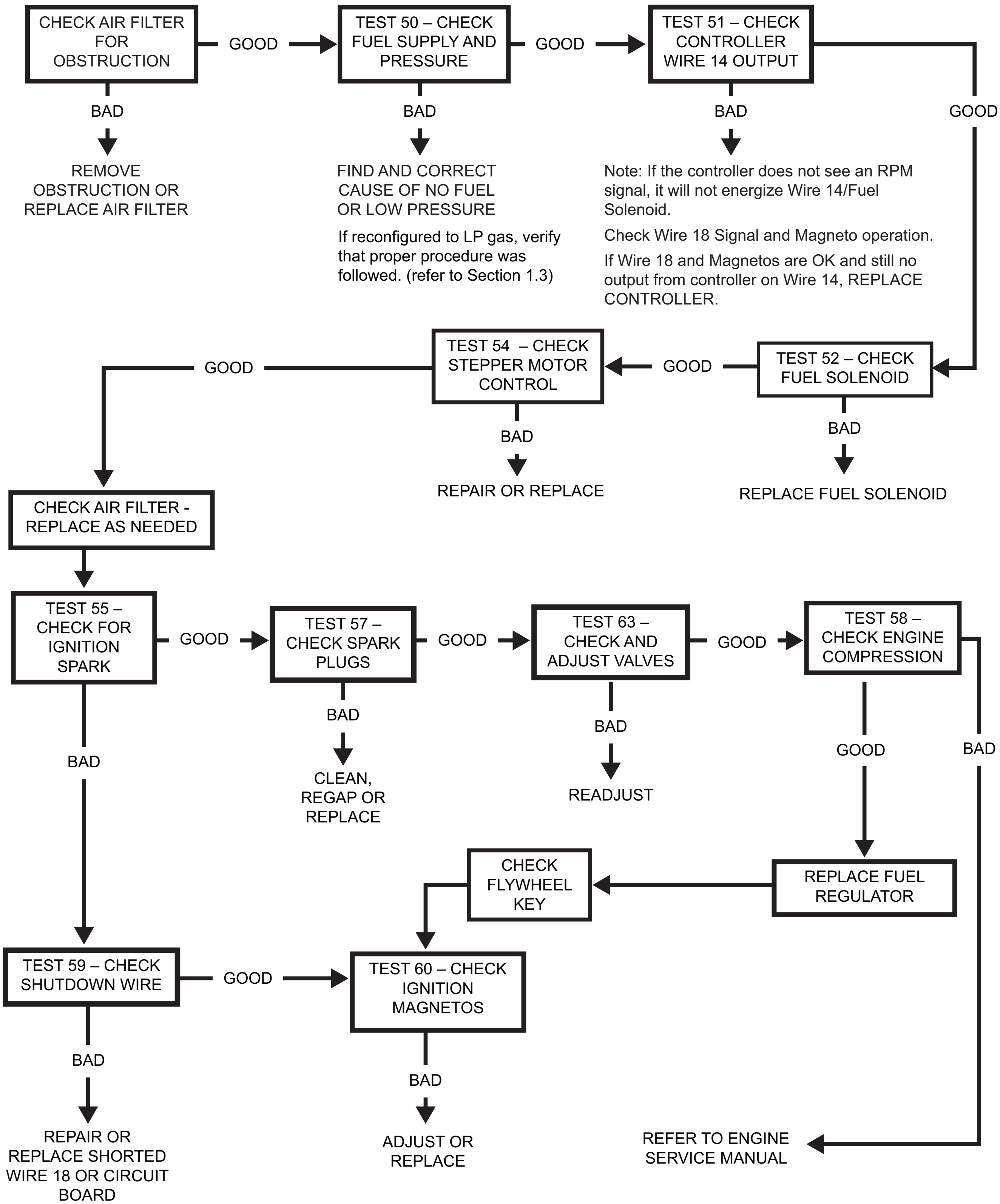
NOTE: If a starting problem is encountered, the engine itself should be thoroughly checked to eliminate it as the cause of starting difficulty. It is a good practice to check the engine for freedom of rotation by removing the spark plugs and turning the crankshaft over slowly by hand, to be sure it rotates freely.

WARNING: DO NOT ROTATE ENGINE WITH ELECTRIC STARTER WITH SPARK PLUGS REMOVED. ARCING AT THE PLUG ENDS MAY IGNITE THE LP OR NG VAPOR EXITING THE SPARK PLUG HOLE.

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

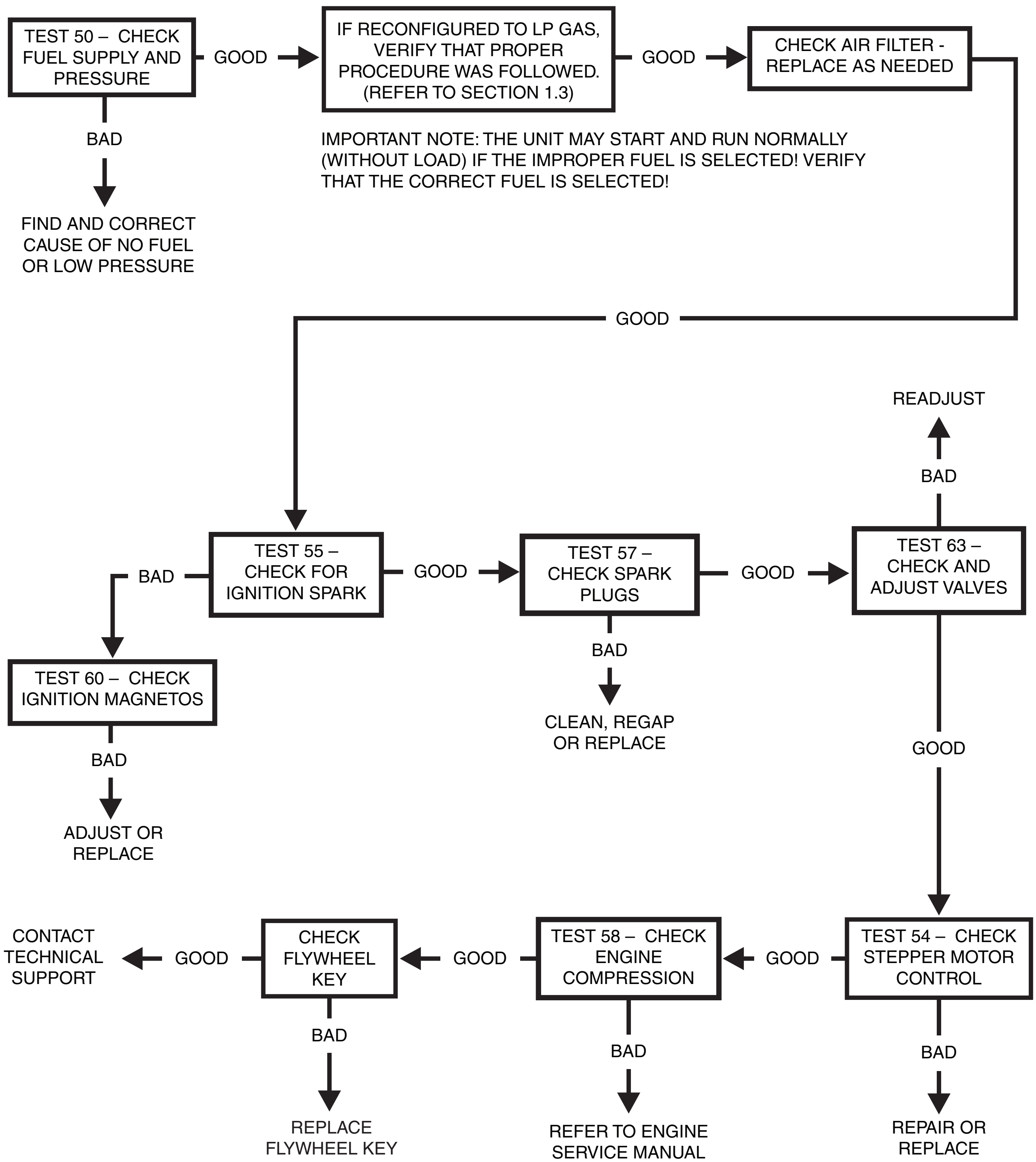
Problem 17 – Engine Cranks but Will Not Start

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!