DIAGNOSTIC REPAIR MANUAL

50 Hz and 60 Hz Air-Cooled Product with Evolution™ and Evolution 2.0™ Control

STANDBY GENERATORS

⚠WARNING

CANCER AND REPRODUCTIVE HARM
www.P65Warnings.ca.gov.

(000393a)

Safety

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

⚠DANGER

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

(000001)

⚠WARNING

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

(000002)

⚠CAUTION

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

(000003)

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

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

Tech Name ______________________

Tech ID ______________________

Dealer Number ______________________

Read This Manual Thoroughly

This diagnostic manual has been written and published by Generac to aid qualified Generac dealer technicians and company service personnel when servicing the products described herein.

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

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

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

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

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

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

Replacement Parts

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

Section 4 – Disassembly

Section 5 – Electrical Data

Appendix

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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.

Stator Winding Resistance Values / Rotor Resistance

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

	Power Windings Across 11–22	Power Windings Across 33–44	Power Windings Across 11–44 at Stator Terminal Block (if equipped)	Excitation Windings Across 2–6	Rotor Resistance
ALL	0.00–0.30	0.00–0.30	0.6–1.0	0.8–1.5	4–15

* 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
24 kW	203/5.75	306/8.66	2.53/9.57	3.90/14.77
26 kW	188/5.32	333/9.43	2.06/7.78	3.63/13.73

* 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	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	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	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	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	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	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) 20/22/24/26 kW	2	Approx. 1.9 Qt/ 1.8L	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.

Torque Specifications

Stator Bolts	6 ft-lbs (+1 / -0)	8.13 Nm
Rotor Bolt	30 ft-lbs	40.6 Nm
Engine Adapter	25 ft-lbs	33.8 Nm
Exhaust Manifold	18 ft-lbs	25 Nm
M5-0.8 Taptite Screw Into Aluminum	25–50 **in-lbs**	2.82–5.64 Nm
M5-0.8 Taptite Screw Into Pierced Hole	25–50 **in-lbs**	2.82–5.64 Nm
M6-1.0 Taptite Screw Into Aluminum	50–96 **in-lbs**	5.64–10.84 Nm
M6-1.0 Taptite Screw Into Pierced Hole	50–96 **in-lbs**	5.64–10.84 Nm
M6-1.0 Taptite Screw Into Weldnut	50–96 **in-lbs**	5.64–10.84 Nm
M8-1.25 Taptite Screw Into Aluminum	12–18 ft-lbs	16–25 Nm
M8-1.25 Taptite Screw Into Pierced Hole	12–18 ft-lbs	16–25 Nm
M6-1.0 Nylok Nut Onto Weld Stud	16–65 **in-lbs**	1.8–7.34 Nm
M6-1.0 Nylok Nut Onto Hinge Stud	30–36 **in-lbs**	3.39–4.0 Nm
Stator Terminal Block Mounting/Cover Fasteners	15 **in-lbs**	1.69 Nm
Stator Terminal Lead Stud Fasteners	35 **in-lbs**	3.95 Nm
Spark Plug	18 ft-lbs	25 Nm
Flywheel Nut 816/999 Engines NUT HEX M24-2.0 G8 YEL CHR	150 ft-lbs	204.0 Nm
Flywheel Nut 410/460 Engines NUT HEX M20-1.5 G8 YEL CHR	90 ft-lbs	122 Nm

NOTE: Torques values are dynamic, with ±10% tolerance unless otherwise noted.

Component Locator

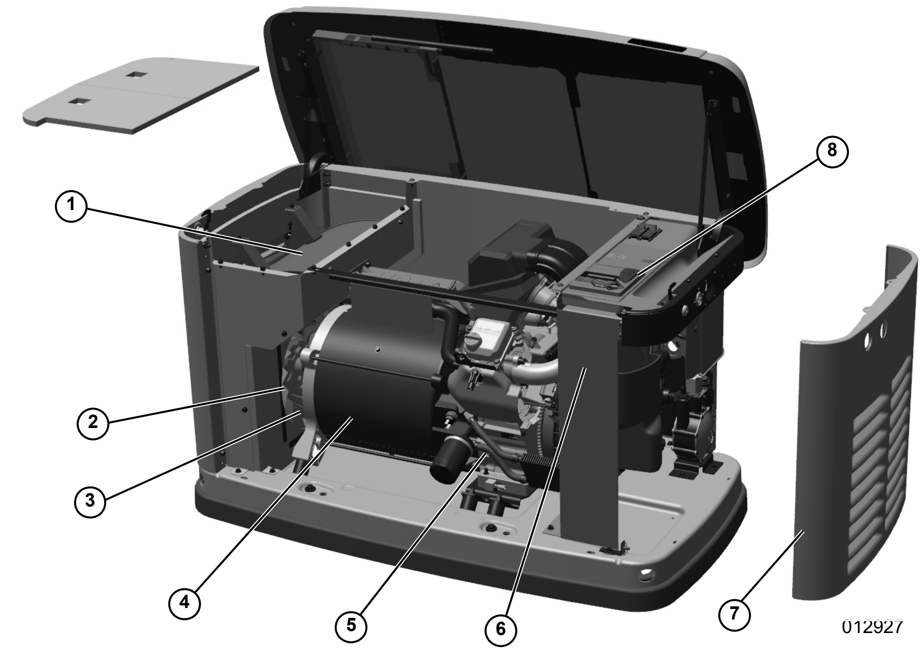

Figure 1-1.

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

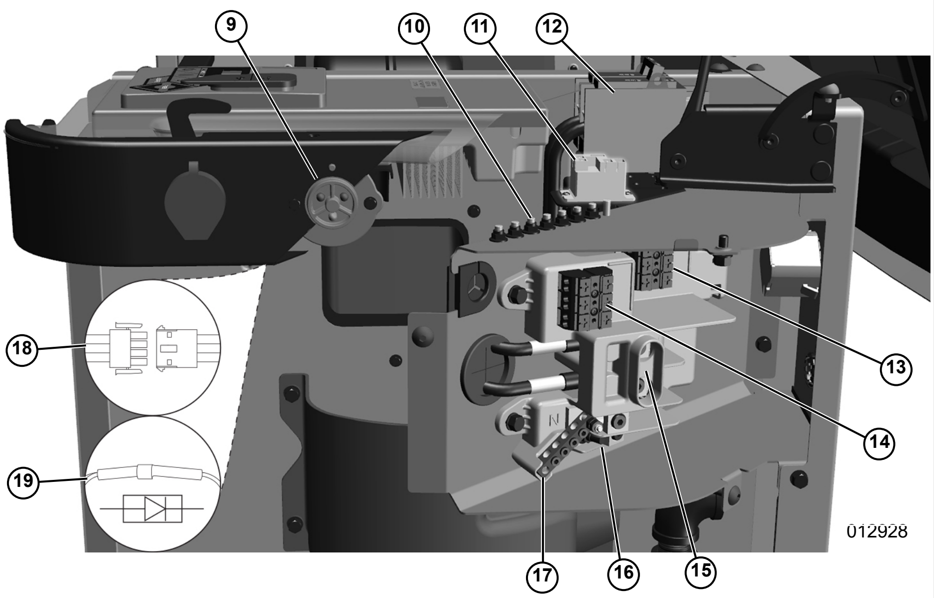

Figure 1-2.

9. LED Status
10. Chassis ground lugs
11. Starter Control 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 (STR) Connector (in harness)
19. Field Boost Diode (in harness)

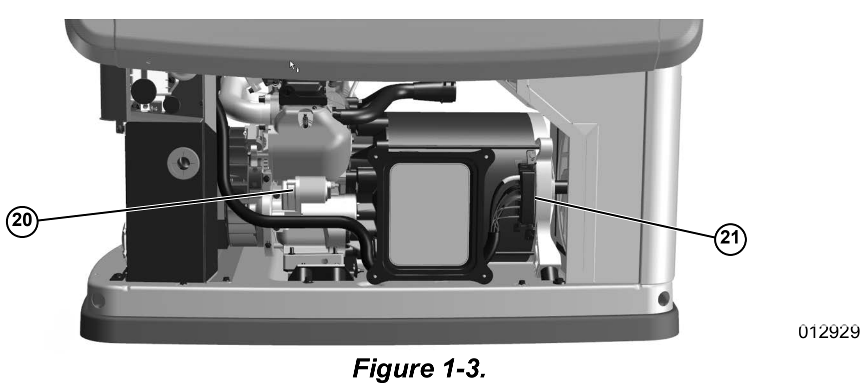

Figure 1-3.

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

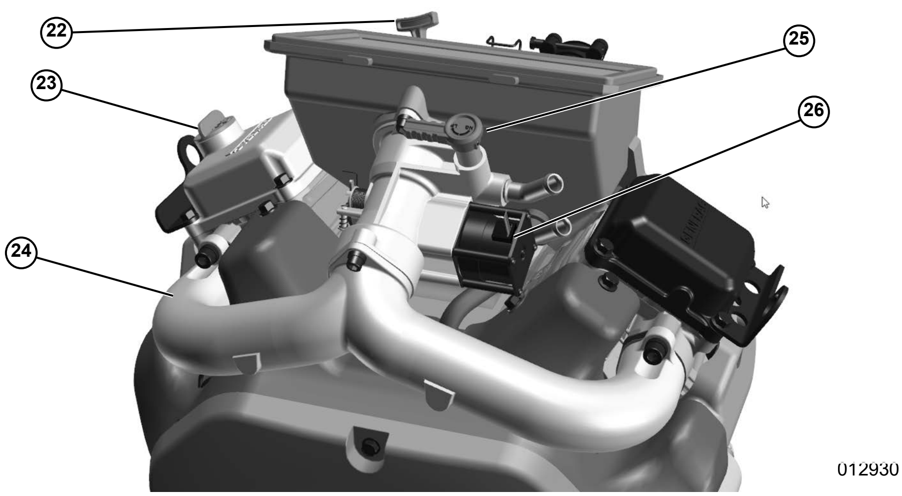

Figure 1-4.

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

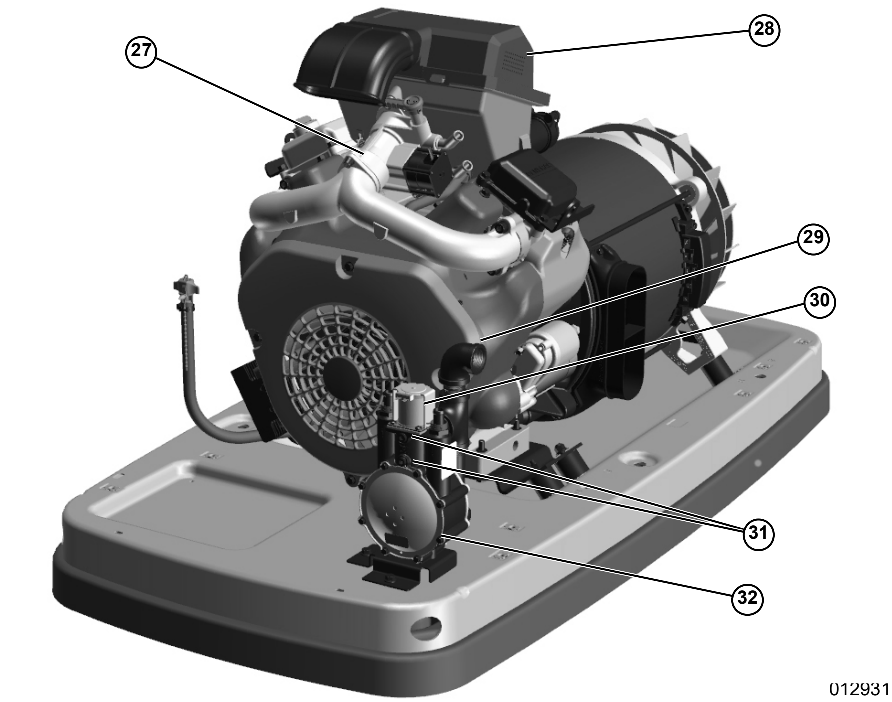

Figure 1-5.

27. Venturi Mixer
28. Air Filter
29. Fuel Supply
30. Fuel Solenoid
31. Test Ports - Top Static Pressure, Bottom Running Pressure.
32. Demand Regulator

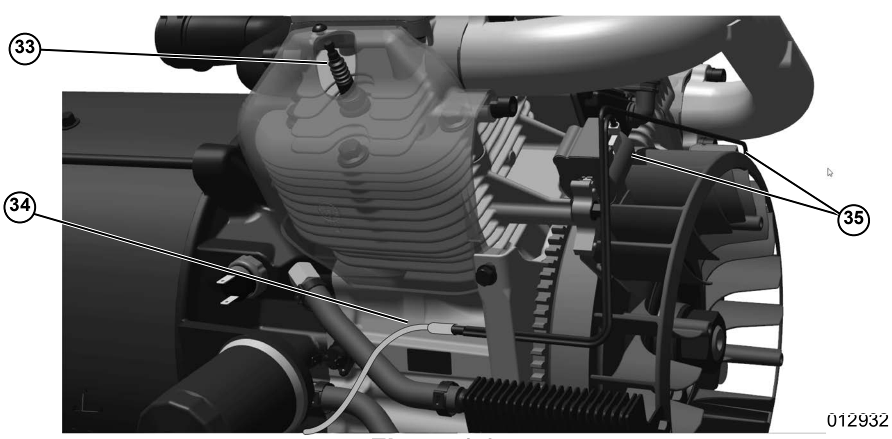

Figure 1-6.

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

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	Description	Action Step
Controller Fault	ALARM		**No E-code on HSB**	Update Firmware – Alternate Method, Section 1.3. 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 or No Rotation Warning	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, Test 50 or Test 54
Underspeed	ALARM	1603	**Underspeed** The engine never comes up to 3600 RPM.	Test 54
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**.	Problem 1
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**.	Problem 1
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**.	Check customer connections and stator connections Problem 1
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**.	Problem 1

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	Description	Action Step
Wiring Error or "Transfer Wire Warning"	ALARM	2098	**Mis-wired Customer connection** Insufficient DC voltage on transfer power output.	Update Firmware and verify correct placement of control wires in the customer connection and transfer switch.
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).	Test 14 or Problem 18
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.
Shutdown Switch	ALARM	2800	External shut down circuit is open.	Test 69
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Problem 22
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	Problem 22
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. Test 50

Table 1-4. Symptom Related Diagnostic Guide	
Problem - Symptom	**Go To…**
Aux Shutdown - E2800	Test 69
Battery is Dead	Section 3.5, Problem 22
Charger Missing AC	Problem 22
Charger Warning	Problem 22
Controller displays “Model Ident Problem Fix Harness Resistor”	Section 3.5, Problem 23
Controller Fuse (7.5 Amp - F1) Blown (open)	Section 3.5, Problem 19
Controller Goes Dark and Reboots when Starting	Section 3.5, Problem 22
Controller Displays “Warming Up” longer than 5 seconds	Section 2.2, Problem 1
Engine Backfires and/or Hunts or Erratic Operation	Section 3.5, Problem 18
Engine Cranks but Will Not Start	Section 3.5, Problem 17
Engine Starts Hard and/or Runs Rough or Lacks Power	Section 3.5, Problem 18
Engine Will Not Crank When Controller Set to MANUAL	Section 3.5, Problem 16
Engine Will Not Crank in AUTO When Utility Power Fails	Section 3.5, Problem 15
Generator Produces High Voltage - E1800	Section 2.2, Problem 2
Generator Shuts Down for Undervoltage	Section 2.2, Problem 1
Generator starts in AUTO with Utility present	Refer to RTS Transfer Switch Diagnostic Manual P/N A0001157652
Generator Will Not Exercise	Section 3.5, Problem 20
High Temperature - E1400	Test 62
Incorrect Voltage Output, but does not Trigger a Shutdown	Section 2.2, Problem 4
“Invalid Serial Number” - Force Firmware Update, Power Cycle Controller.	Section 1.3 Update Firmware - Alternate Method. If fault is still present, replace controller.
Low Battery	Section 3.5, Problem 22
Low Oil Pressure - E1300	Test 61
Model Ident Problem - Fix Harness Resistor	Problem 23
No Quiet Test Mode	Section 3.5, Problem 21
Oil Leak	Appendix B Basic Maintenance – Oil Leaks
Over Crank - E1100	Section 3.5, Problem 17
Overload Remove Load - E2100	Test 15
Overspeed - E1200, E1205	Test 54
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 or No Rotation Warning (Engine Does Not Crank) - E1505, E1515	Problem 15
Shutdown Fault Occurred During Crank Attempt, Start or Run	Section 3.5, Problem 14
Under Speed - E1600, E1603	Problem 3, Test 50, Test 54
Undervoltage - E1900, E1901, E1902, E1906	Section 2.2, Problem 1

Table 1-4. Symptom Related Diagnostic Guide	
Problem - Symptom	**Go To…**
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 - E2098	Verify firmware is up to date. Check voltage on Wire 194 / locate where voltage is dropping
Wiring Error - E2099	Check Wiring Interconnection

Wiring Error – E2099 Check Wiring Interconnection

Customer connection low voltage and high voltage crossed.

1. Verify wires match at both the customer connection terminals on both factory side and Installation side.
2. Verify wires are landed on the SACM in the transfer switch area as well.
   a. If wires are landed incorrectly re-land to appropriate location.
   b. If wires are landed to correct location proceed to Step 3
3. Set meter to measure AC voltage.
4. Place red meter lead Wire 194 in customer connection area and place black lead on ground
   a. If no AC voltage found move to Step 5
   b. If AC voltage is found proceed to Step 6
5. Place red meter lead to wire 23 in customer connection area and place black lead to ground.
   a. If No AC voltage is found attempt to clear code and run generator.
   b. If AC voltage is found proceed to step 6
6. With meter leads remaining in position and using following all safety procedures begin removing AC customer connection wires one at a time (T1, N1, N2) to see which wire may be allowing voltage to bleed over.

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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.

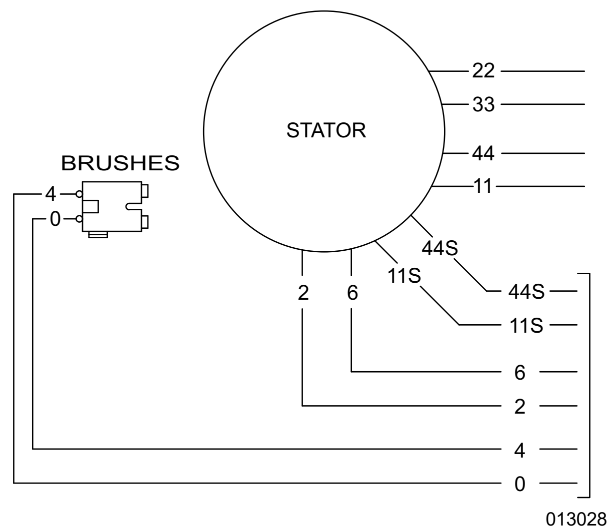


Figure 1-7. Typical Stator Output Leads

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.

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

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

Use the 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.

NOTE: Use a non-caustic cleaning solution to remove oil and grease. Simple Green® cleaner and degreaser is recommended.

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.

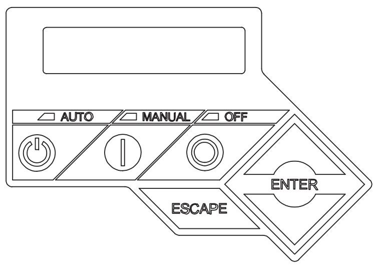
2. Disconnect all wires in a manner that allows the alternator to be completely disconnected.
3. Provide an external source to blow warm, dry air through the generator interior (around the rotor and stator windings.

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.



000425

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)

Maintenance (Evolution 2.0)

The MAINTENANCE Menu displays the following selections: Battery, Maint Log, Run Hrs, and Scheduled.

Battery	Run Hrs
Main. Log	Scheduled

009018

Figure 1-16. Maintenance (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
- Language Update
- Wi-Fi Enable

Table 1-5. Cold Smart Start Parameters

Node	8–20 kW	22–26 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

Battery

View the status or condition of the units battery.

Run Hrs

View the amount of actual run hours on the unit.

Scheduled

View when the next scheduled maintenance is due.

Main. Log

Review the history of maintenance recorded on the unit.

Evolution Dealer Menu

Dealer Code

UP, UP, ESC, DN, UP, ESC, UP, ENTER

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
- SVN Version Number
- Build Number
- Node Hz Volts
- Serial Number

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

Dealer Edit

The Dealer Edit Menu displays these selections:

- Startup Delay (sec)
- 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 right 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.

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.

Inputs and Outputs

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*** Input 2 is ON (Low Oil Pressure). This indicates the unit is shut down.

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

Evolution 2.0/Sync 3.0 HSB Menu Map—EDIT

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

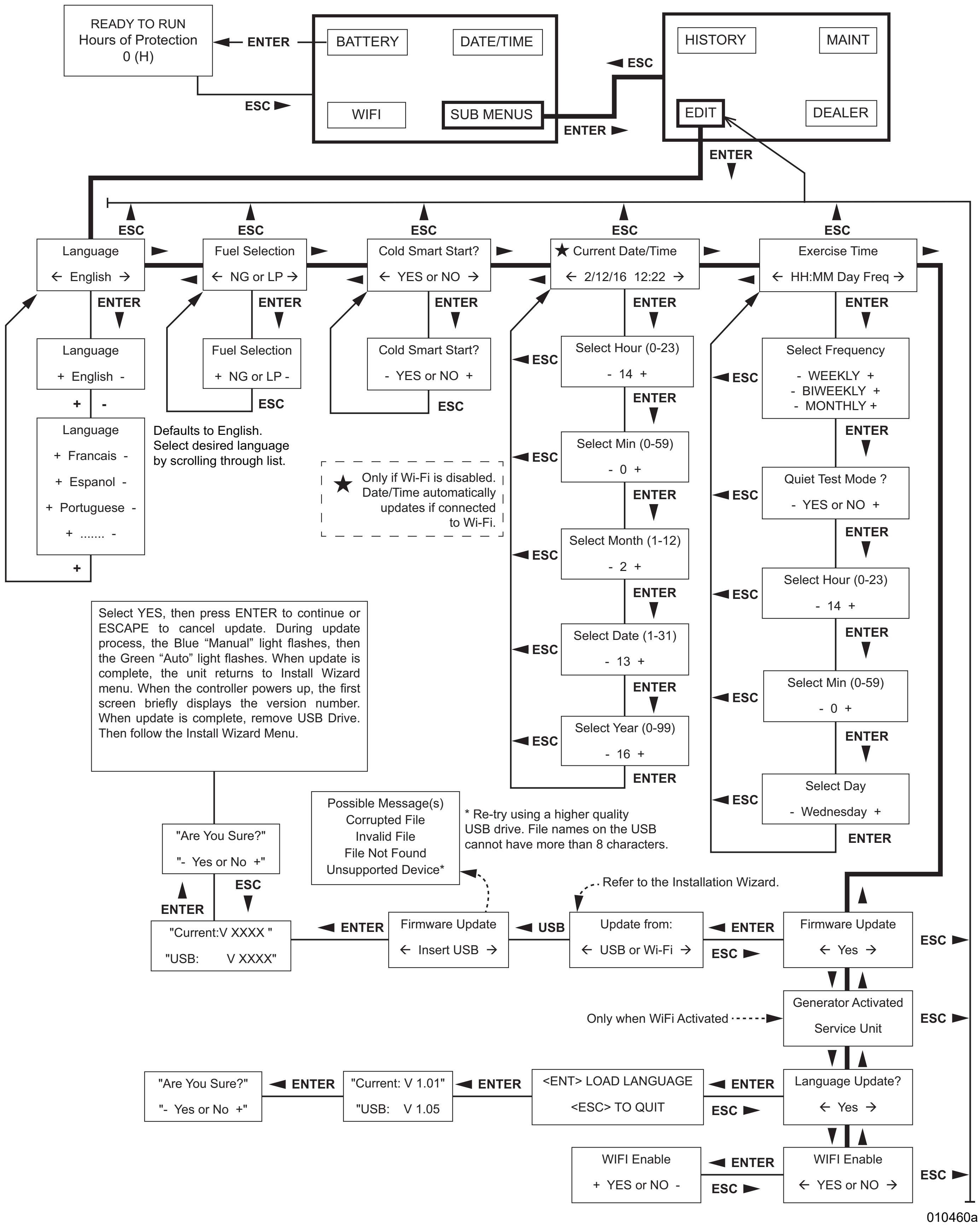


Figure 1-20. Evolution 2.0/Sync 3.0 HSB Menu Map—EDIT

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.

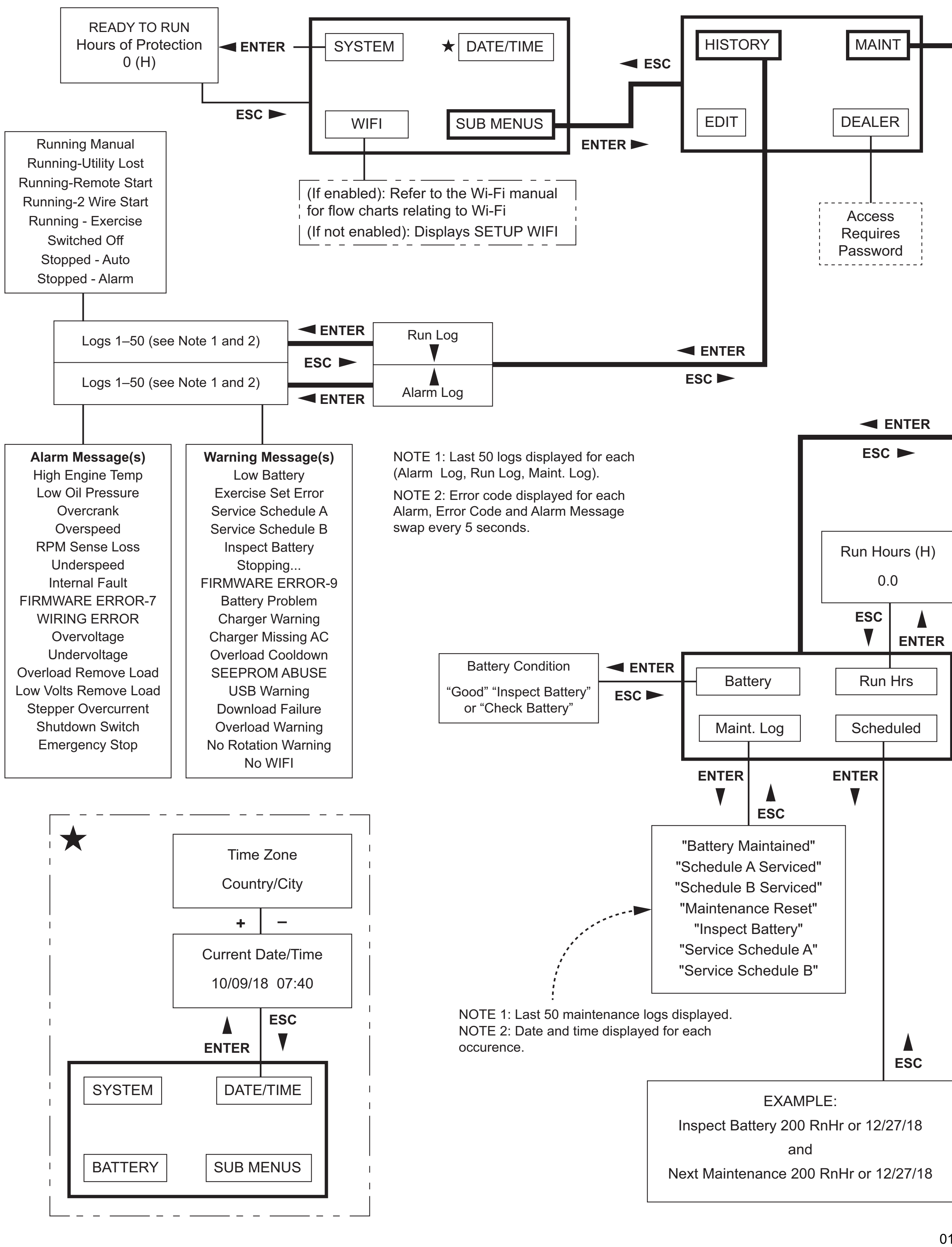


Figure 1-21. Evolution 2.0/Sync 3.0 HSB Menu Map—HISTORY, MAINT

Evolution 2.0/Sync 3.0 HSB Menu Map—SYSTEM

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

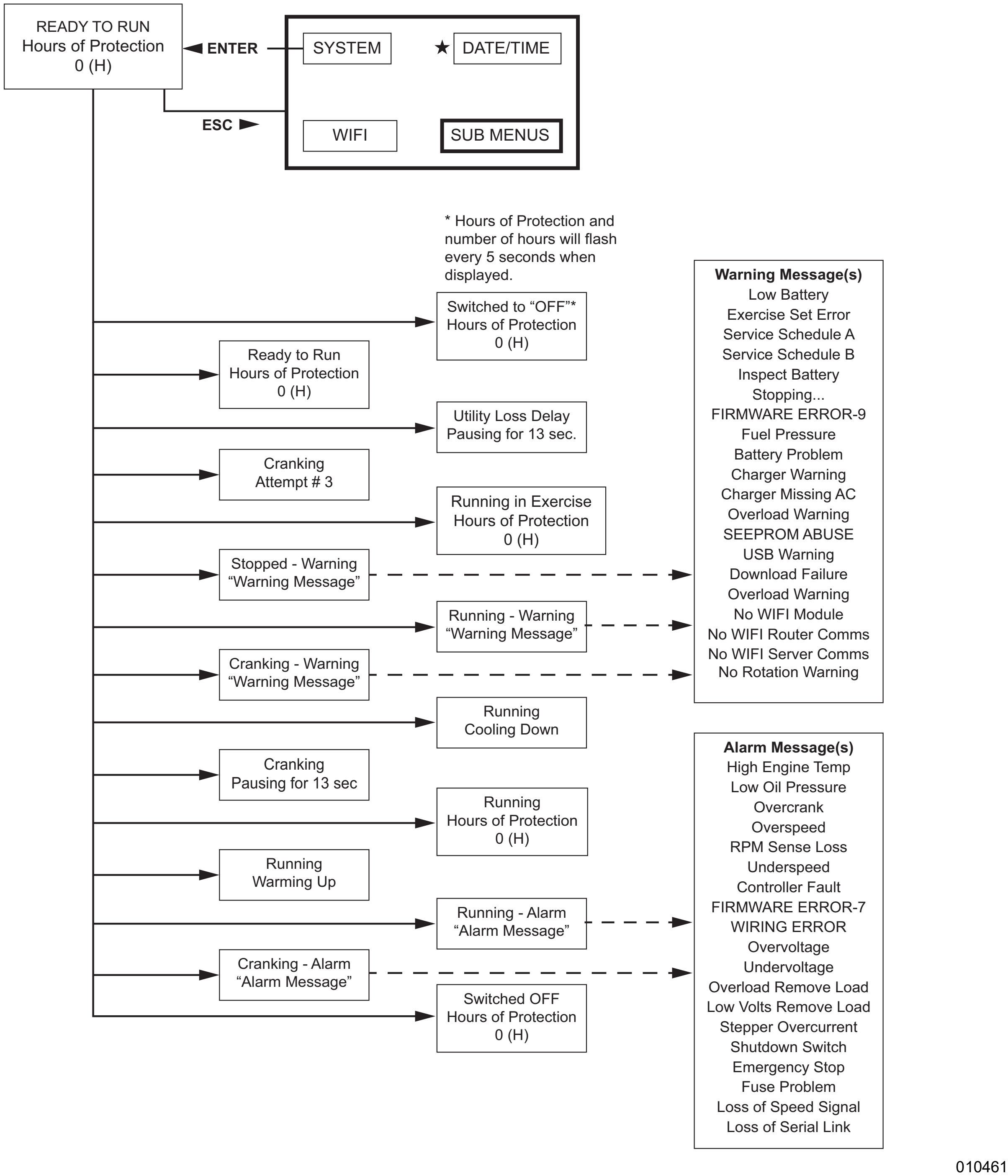
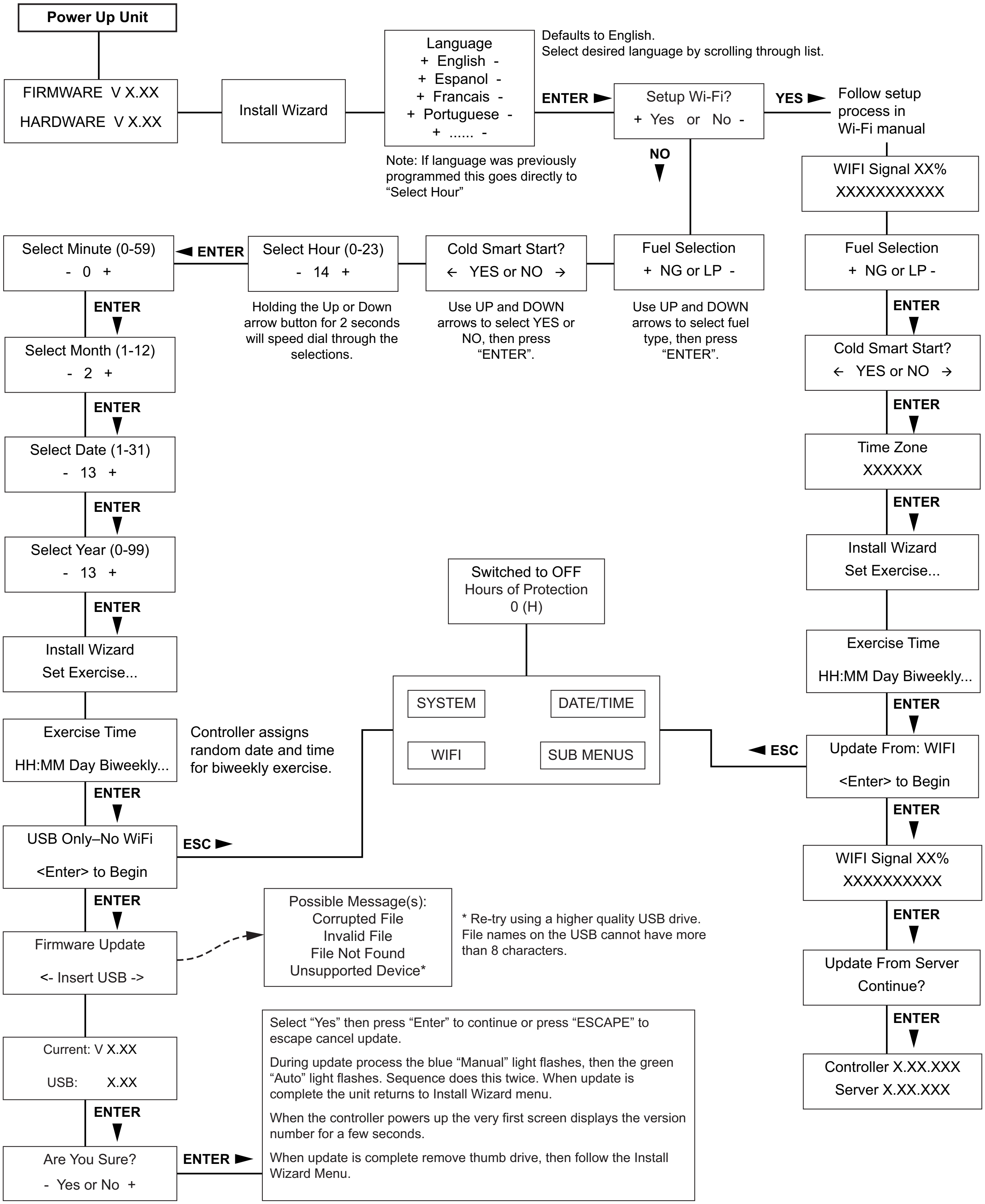


Figure 1-22. Evolution 2.0/Sync 3.0 HSB Menu Map—SYSTEM

Evolution 2.0/Sync 3.0 HSB Menu Map—ACTIVATION

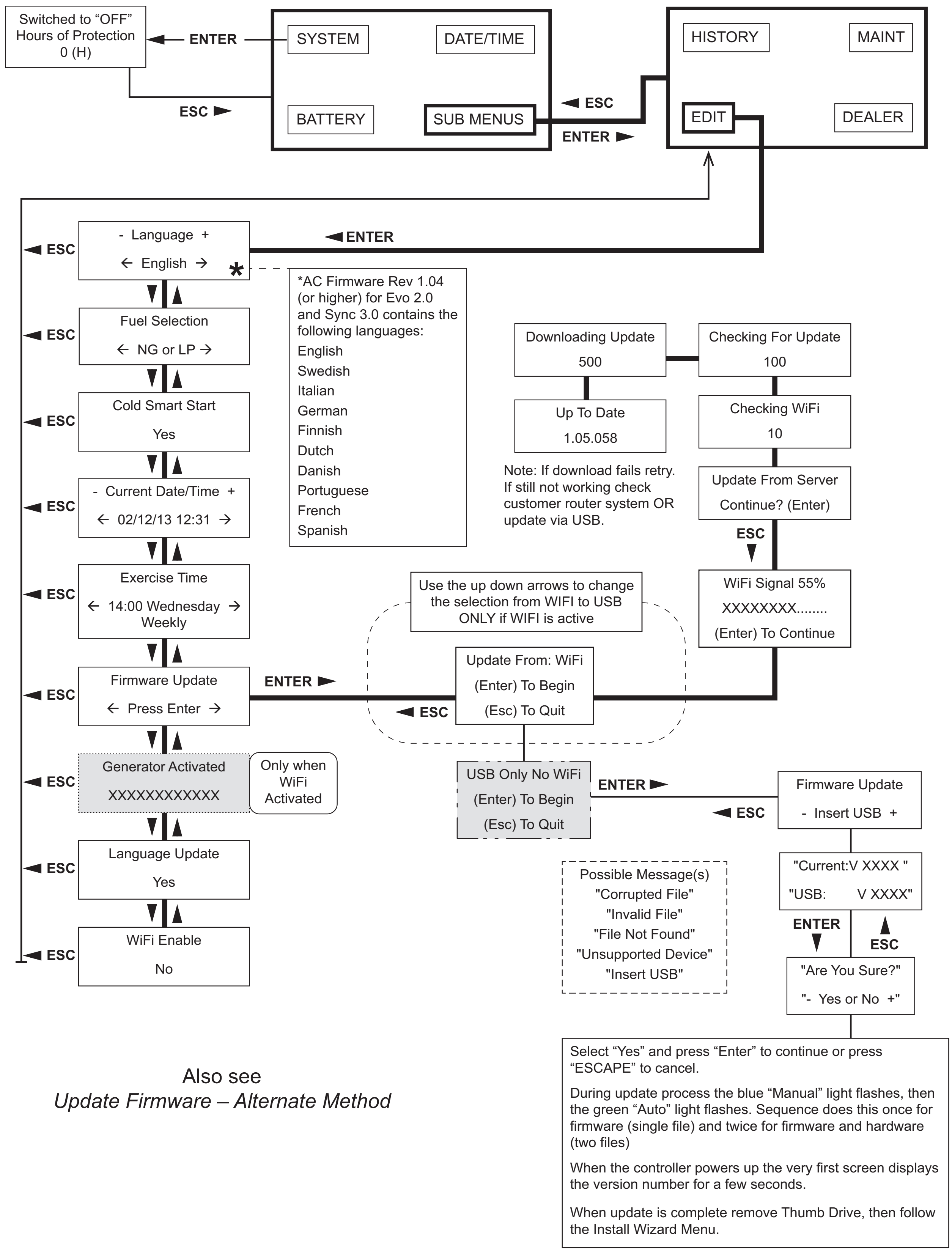


010462

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.



Also see
Update Firmware – Alternate Method

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

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER EDIT

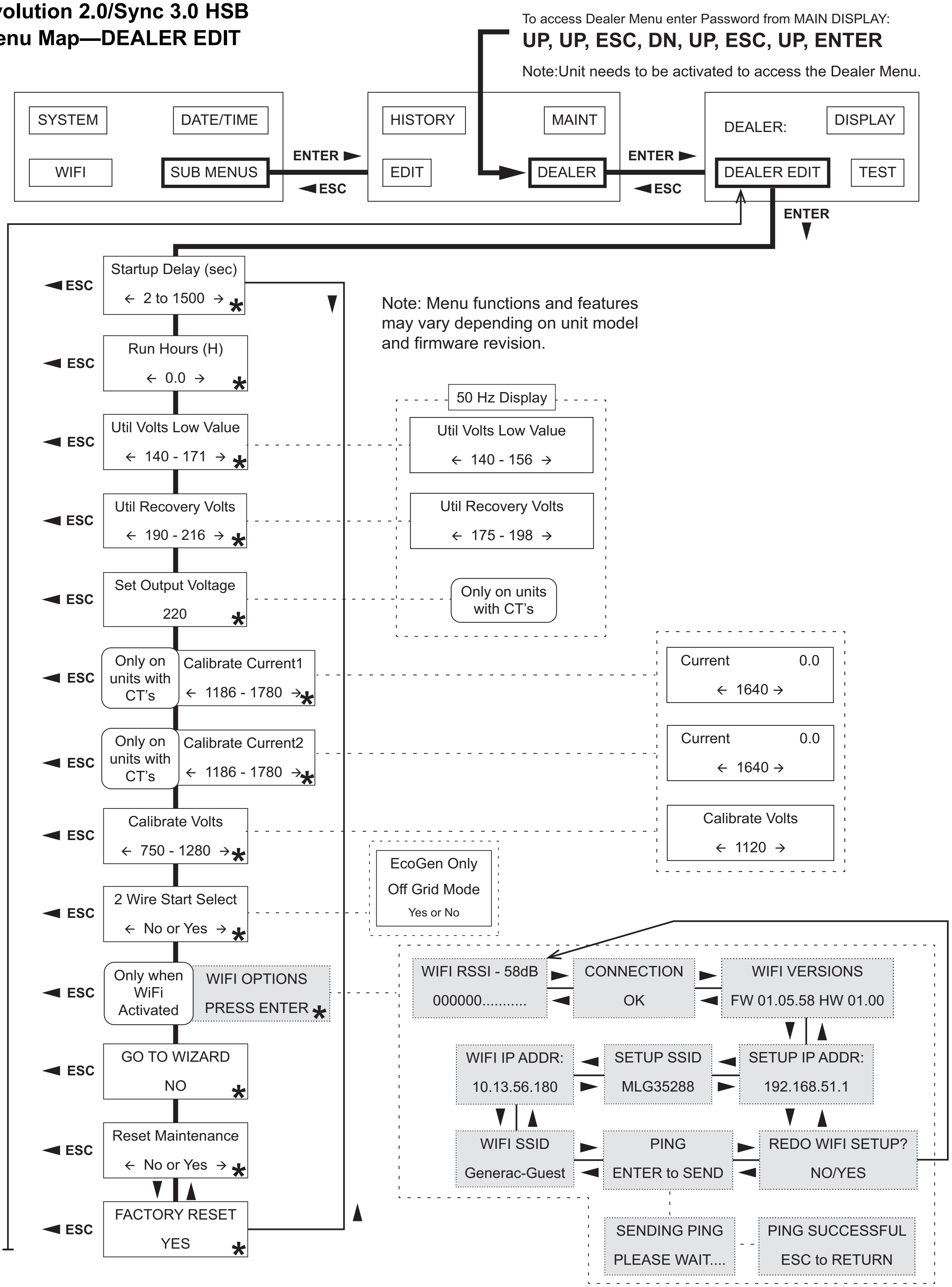


Figure 1-25. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER EDIT

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER TEST

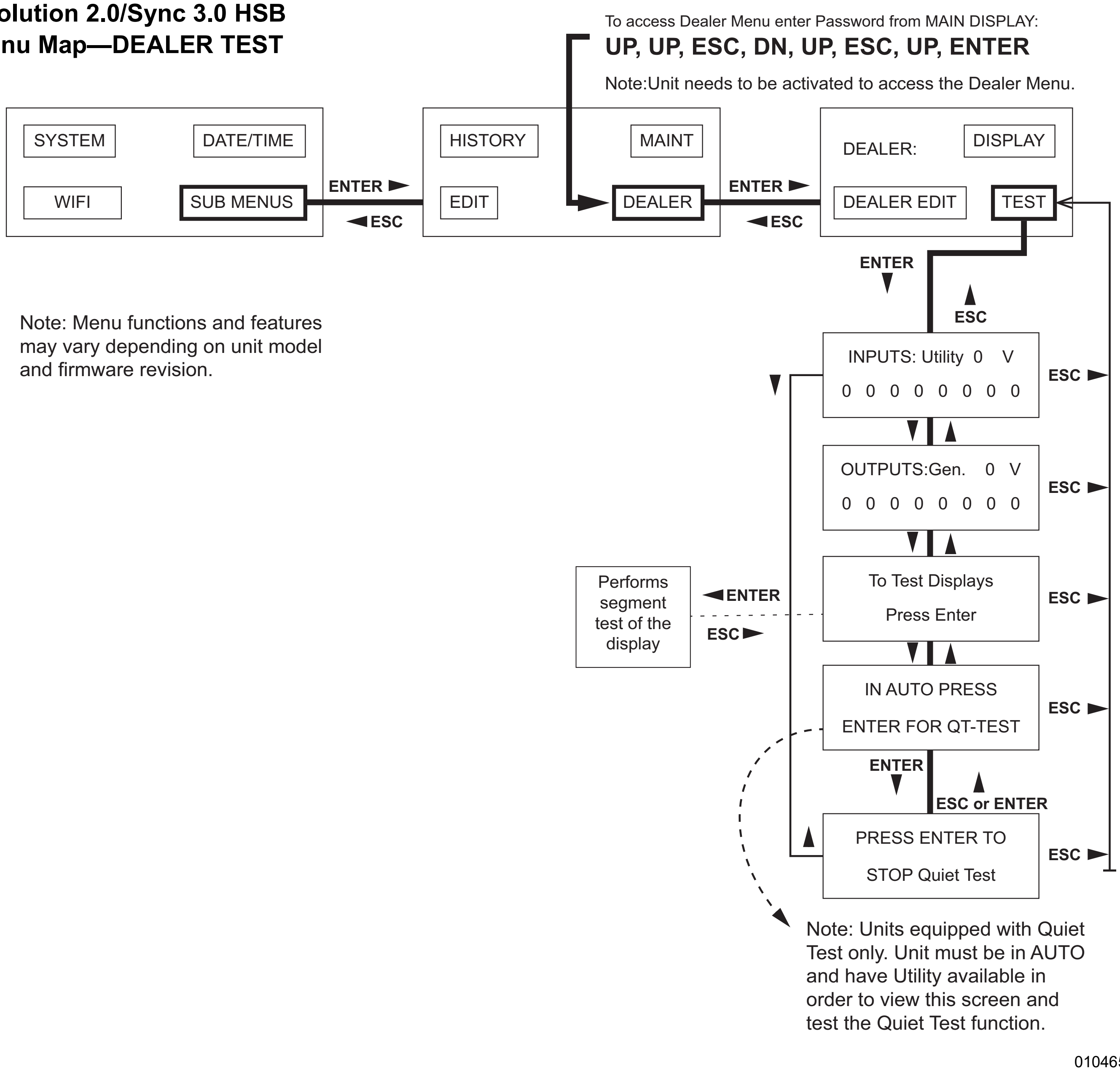


Figure 1-26. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER TEST

Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER DISPLAY

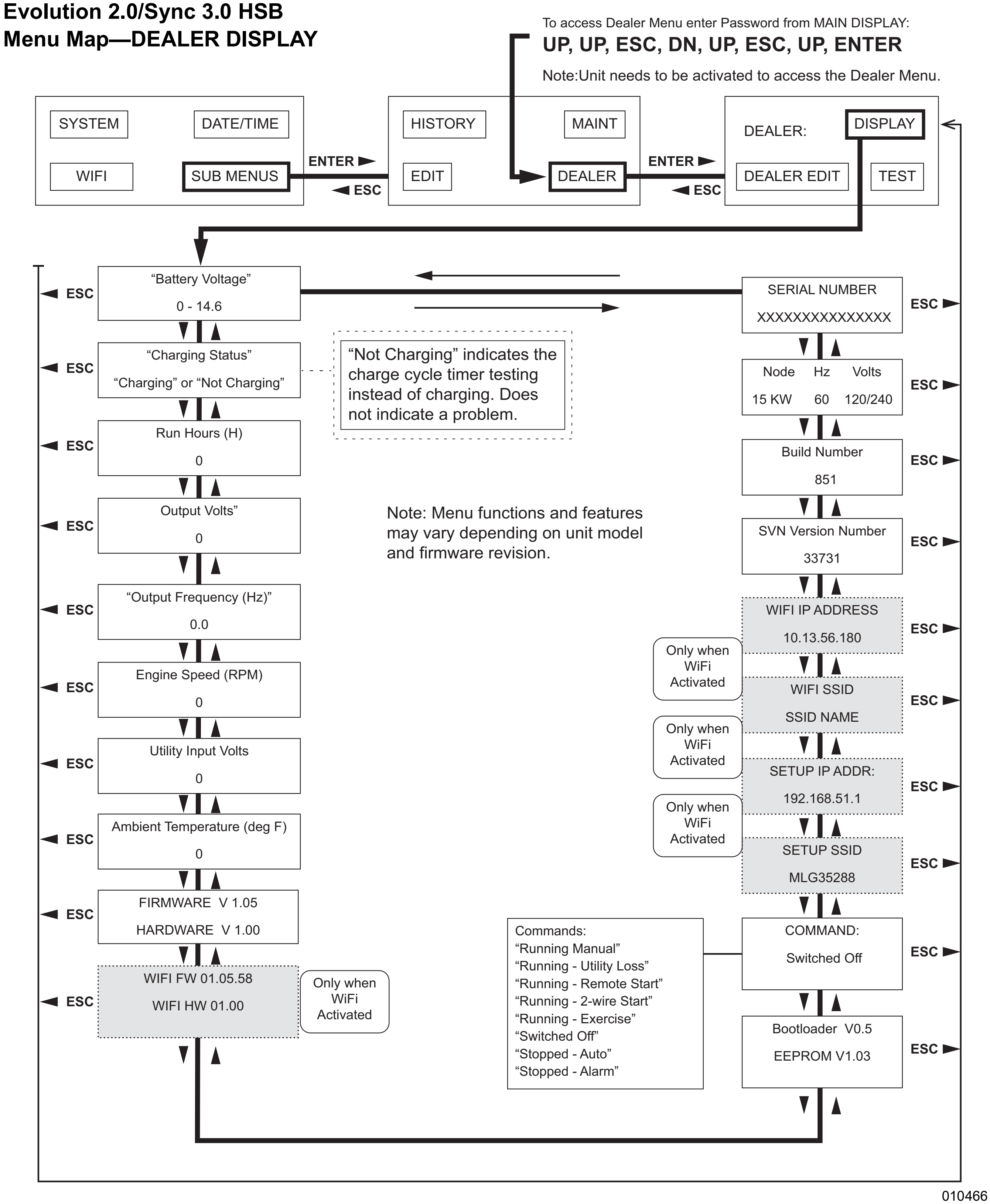


Figure 1-27. Evolution 2.0/Sync 3.0 HSB Menu Map—DEALER DISPLAY

Evolution 1.0/Sync 2.0 HSB Menu Map—EDIT

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

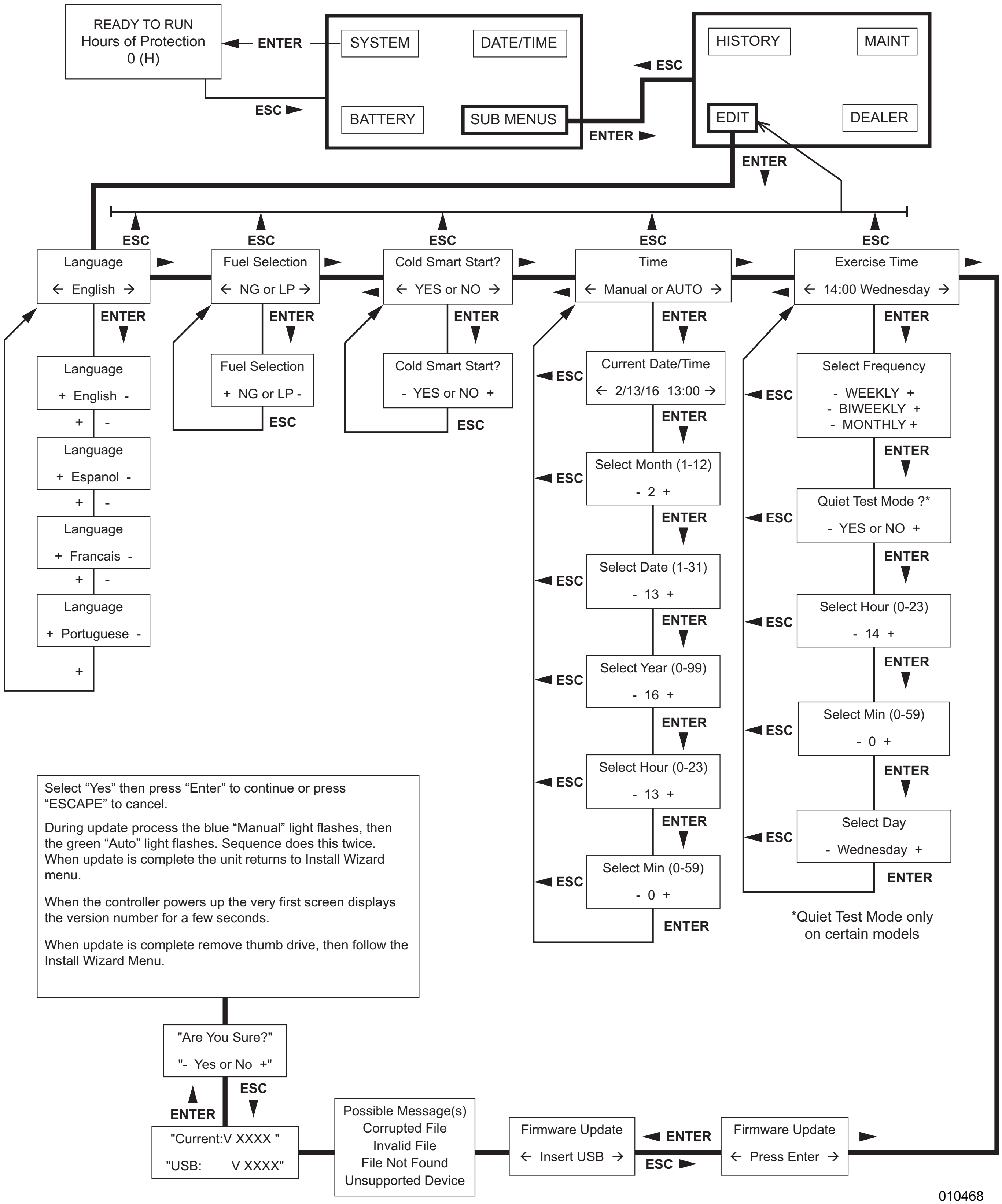


Figure 1-28. Evolution 1.0/Sync 2.0 HSB Menu Map—EDIT

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.

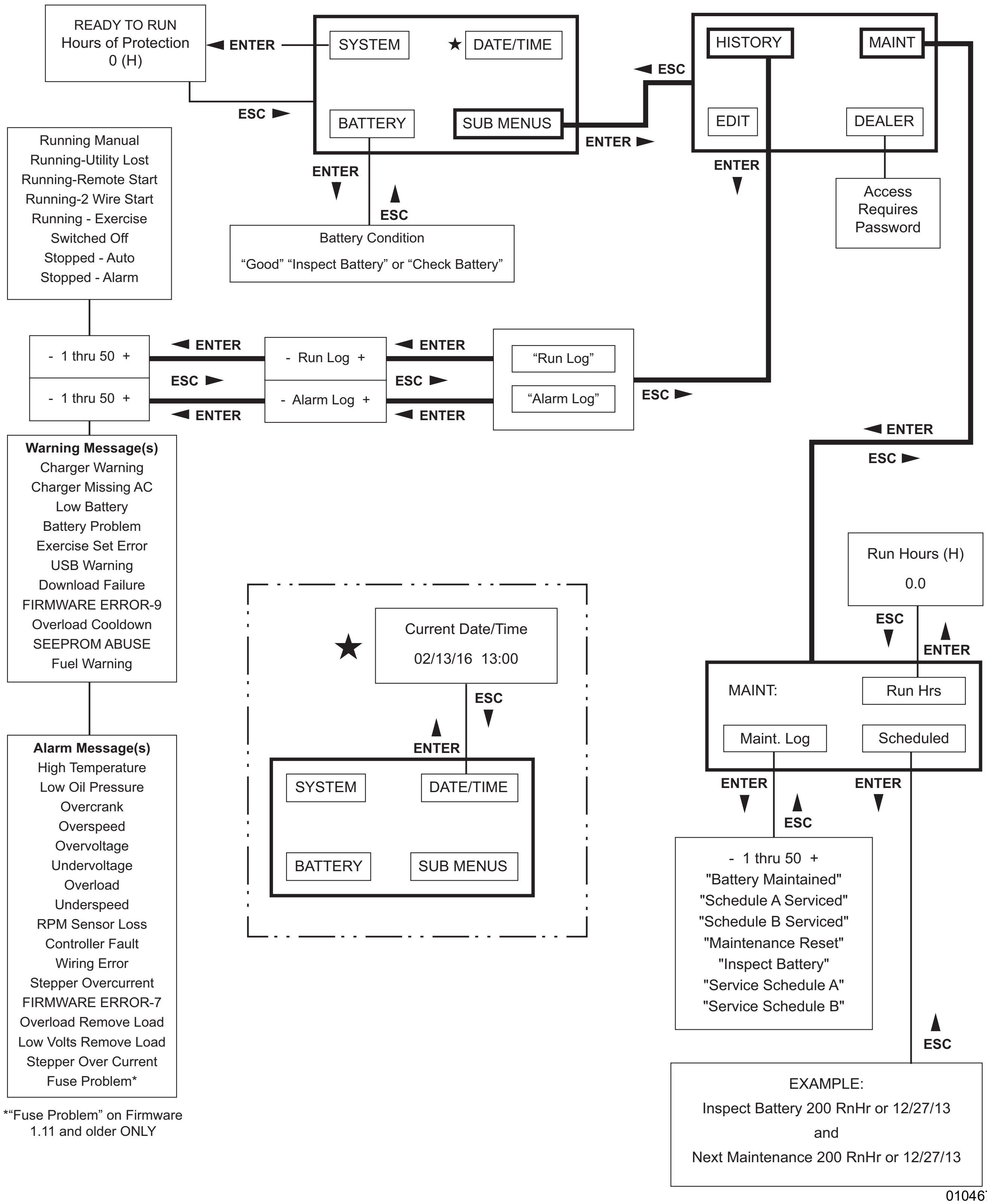


Figure 1-29. Evolution 1.0/Sync 2.0 HSB Menu Map—HISTORY, MAINT

Evolution 1.0/Sync 2.0 HSB Menu Map—ACTIVATION

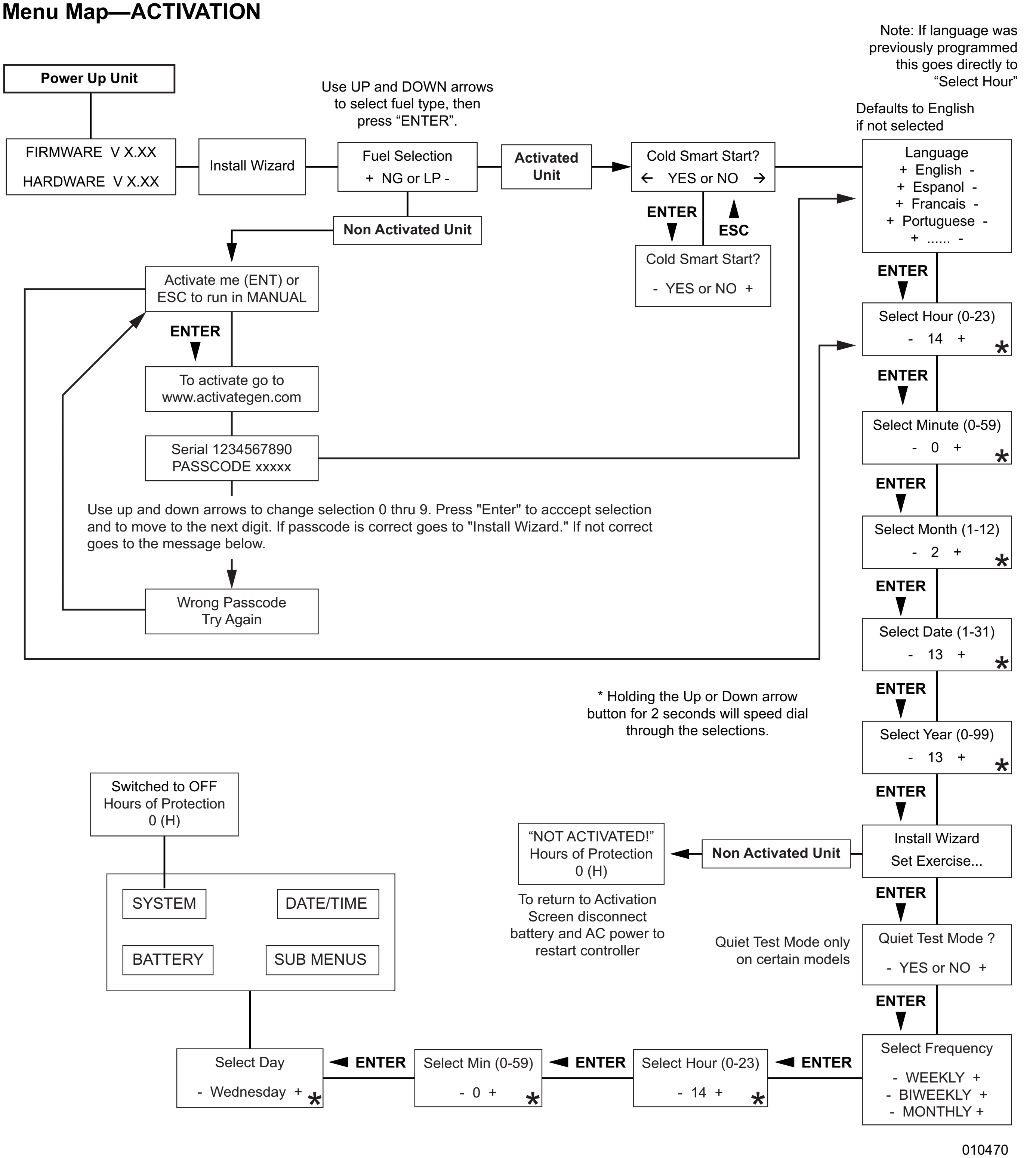
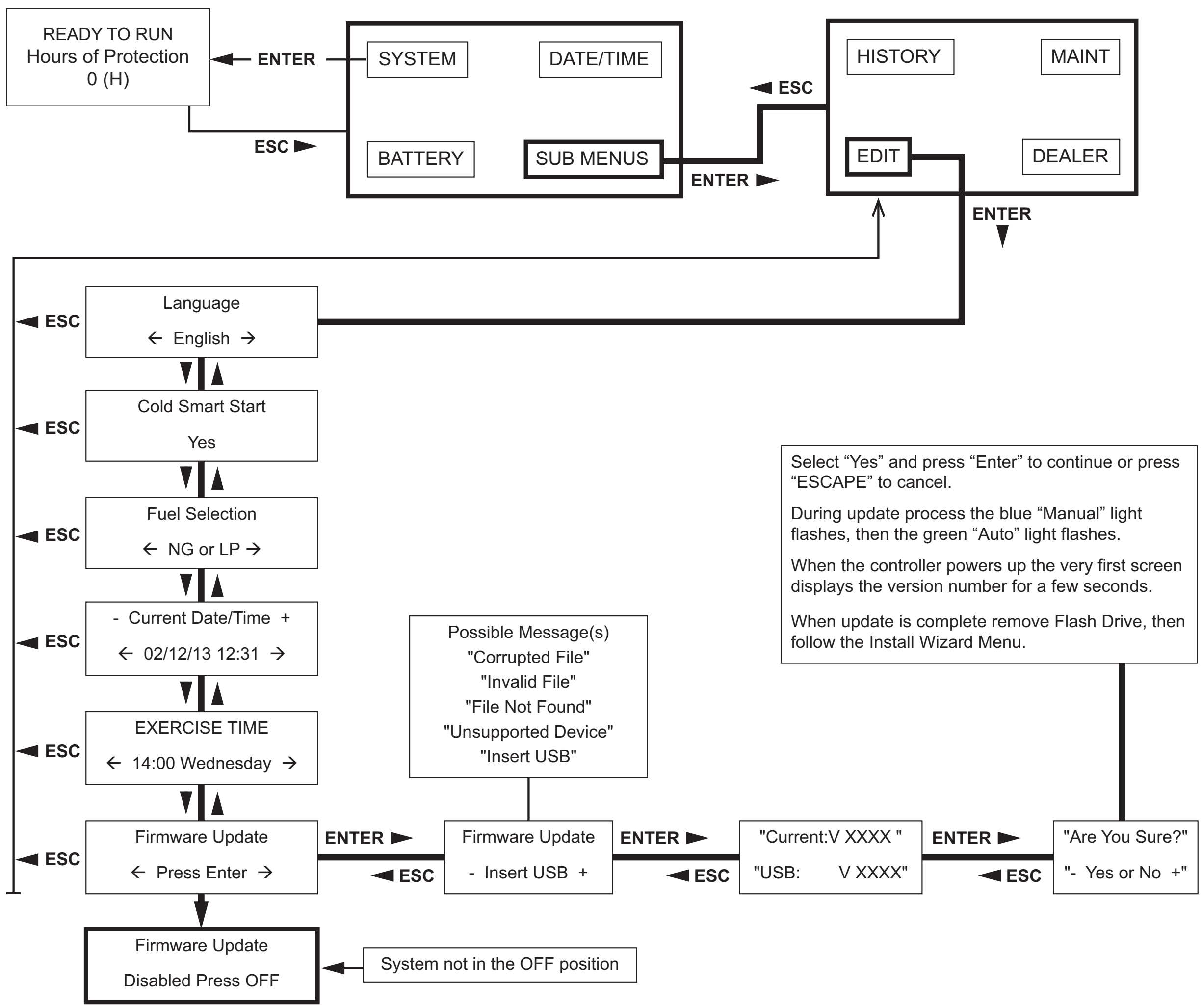


Figure 1-30. Evolution 1.0/Sync 2.0 HSB Menu Map—ACTIVATION

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

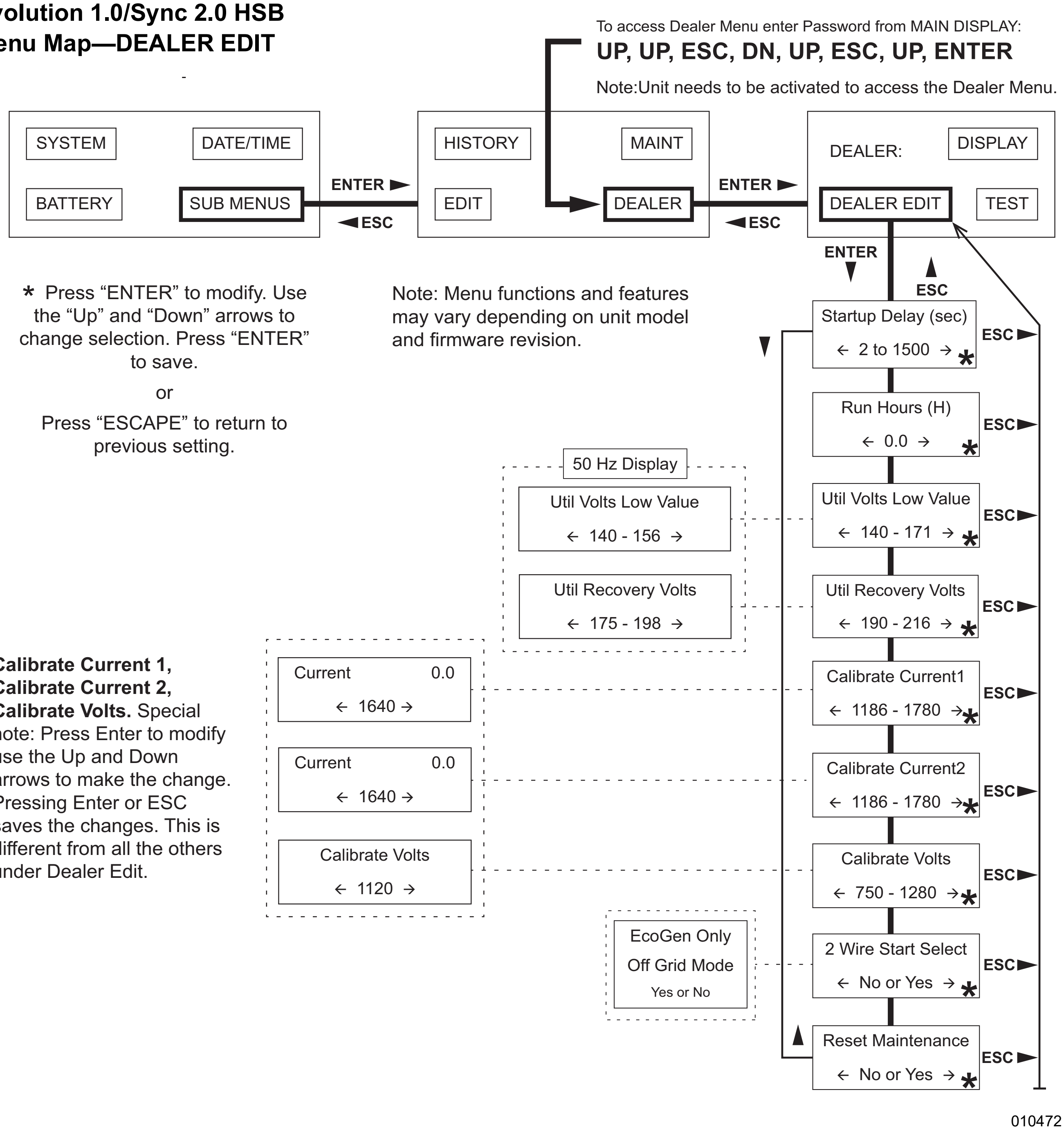


Figure 1-32. Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER EDIT

Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER TEST

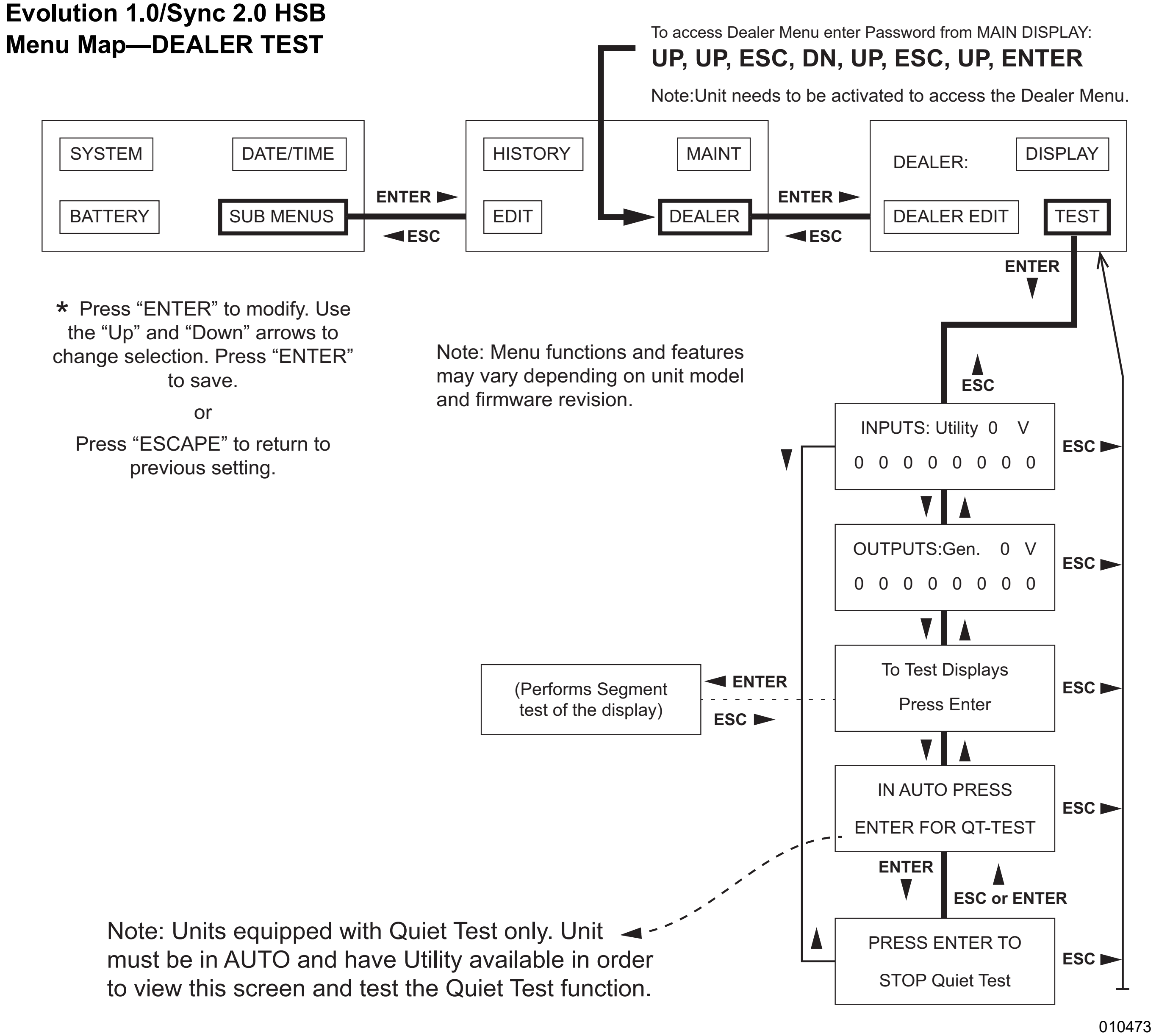


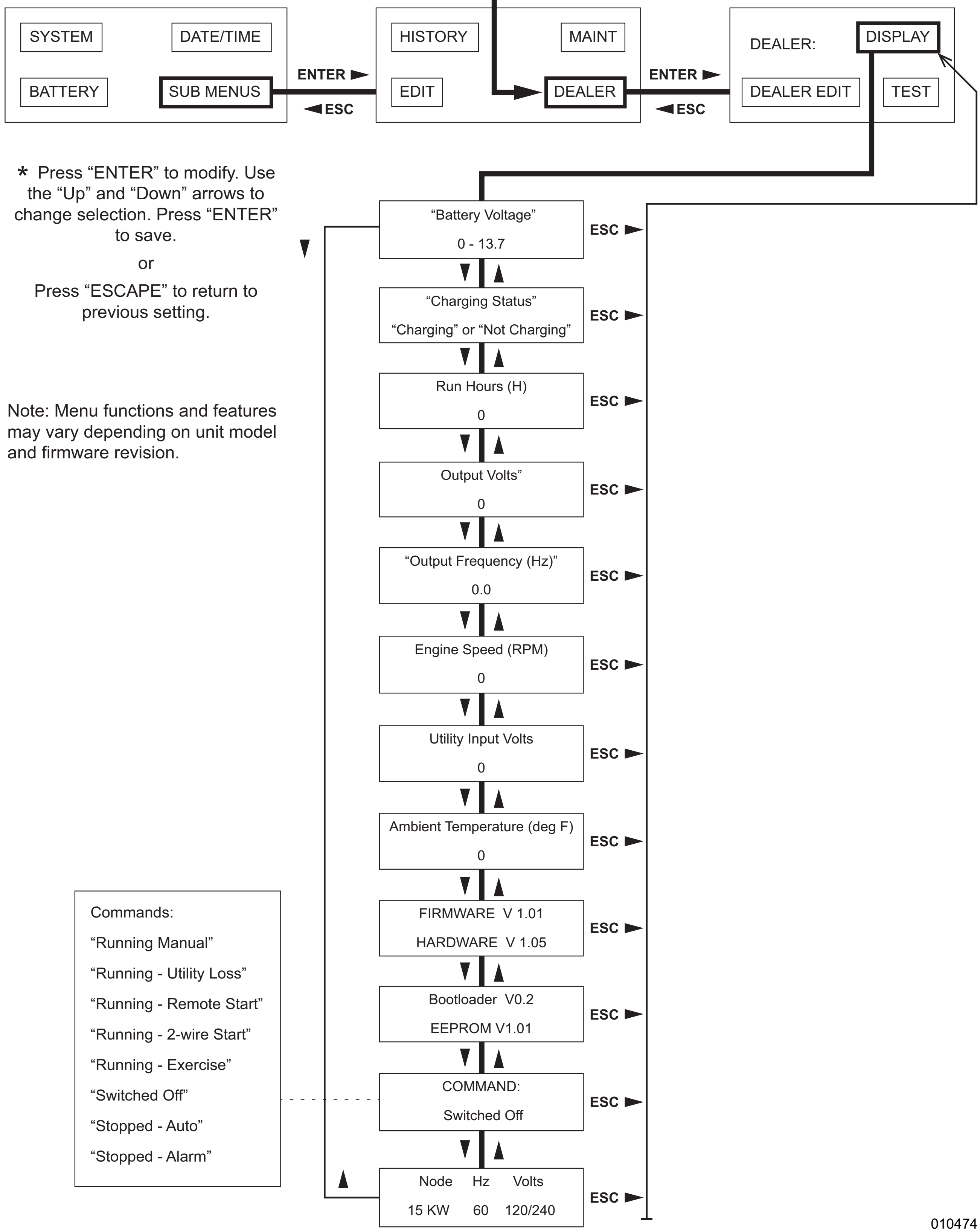
Figure 1-33. Evolution 1.0/Sync 2.0 HSB Menu Map—DEALER TEST

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.



* Press "ENTER" to modify. Use the "Up" and "Down" arrows to change selection. Press "ENTER" to save.

or

Press "ESCAPE" to return to previous setting.

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

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.

NOTE: See ***Appendix A*** ***Controller Identification*** for procedures for downloading firmware from GenService, initiating/formatting the flash drive, downloading the firmware file to the flash drive, and downloading the firmware into the Evolution Controller. Also see Generac Information Bulletin PIB12-04-AG.

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).

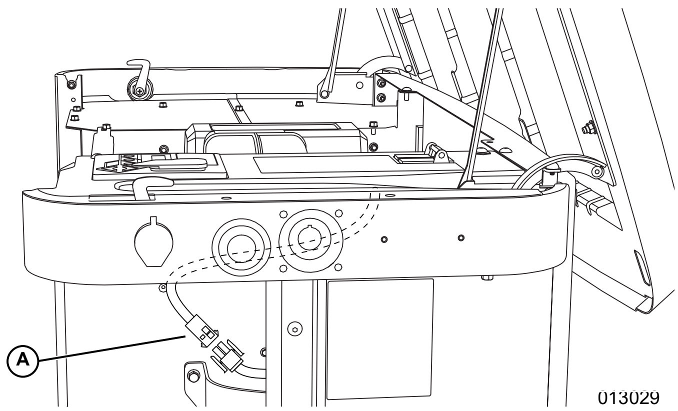


Figure 1-34. T1 Connection

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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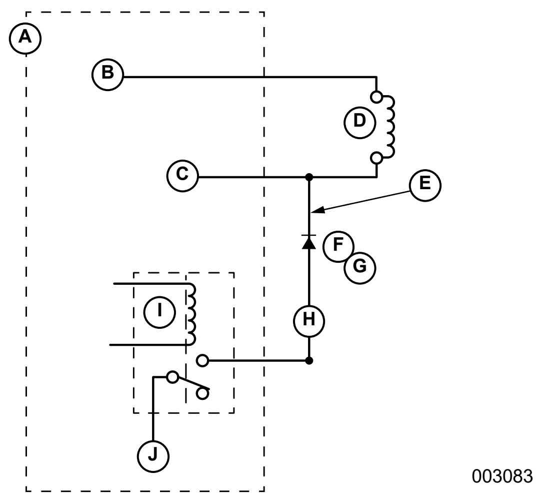
Field Boost

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 versions 1.12 and above and all Evolution 2.0 Firmware – Field boost turns on at 2200 rpm. Field boost shuts off when system voltage reaches 40–80% of nominal voltage (90-192 VAC on a 240V generator).

Operation

Engine Cranking

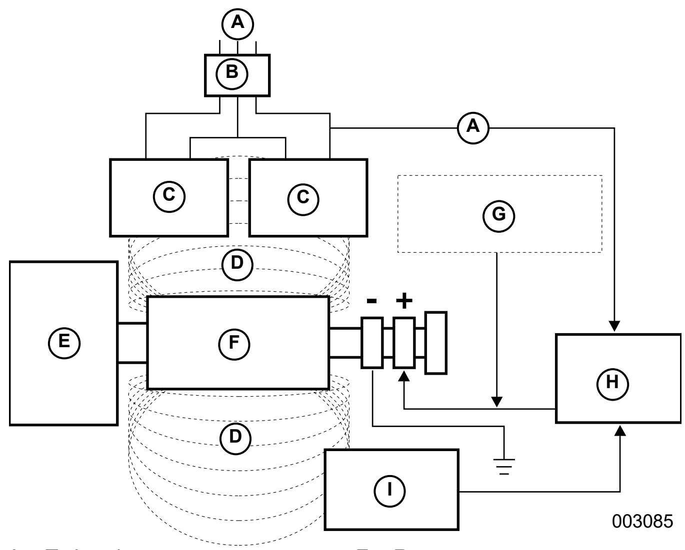
See *Figure 2-2*. Once the engine is running at 2200 rpm, field boost voltage causes the rotor to magnetize. The rotor magnetic field induces a voltage into the stator AC power windings, and the stator excitation (DPE) windings. During cranking, field boost magnetism is capable of creating approximately one-half the unit's rated voltage.

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 40–80% 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.



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

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.

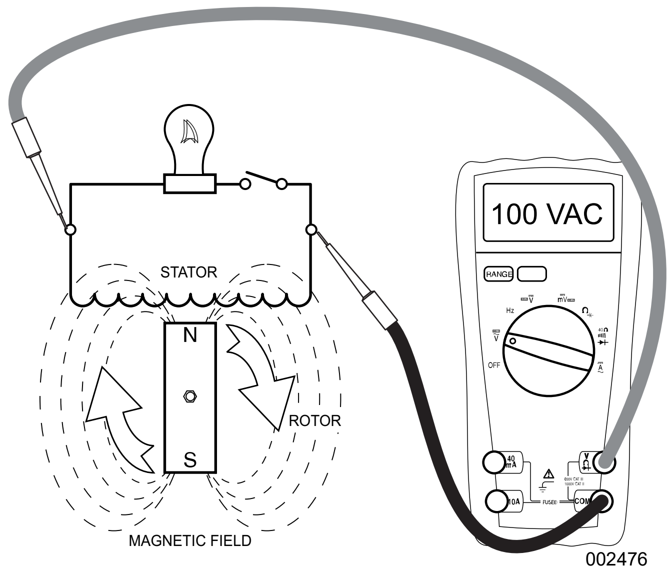


Figure 2-3. Low Field Excitation Voltage = Low Magnetic Lines of Flux = Low AC Output

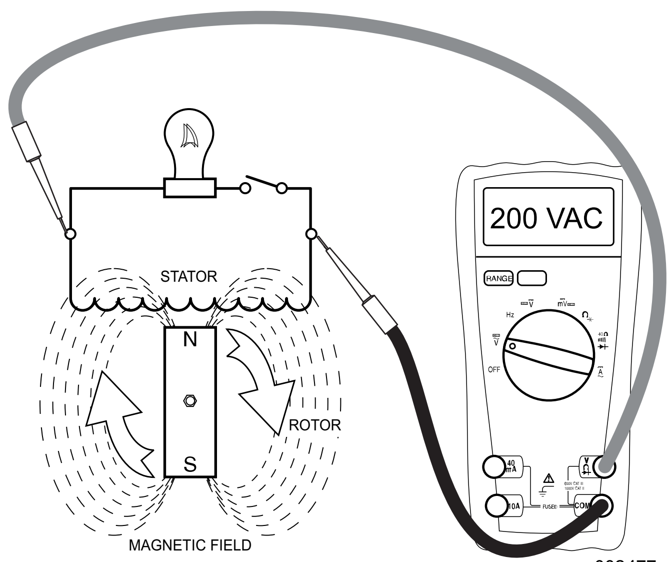


Figure 2-4. Increased Field Excitation Voltage = Increased Magnetic Lines of Flux = Increased AC Output Voltage

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.

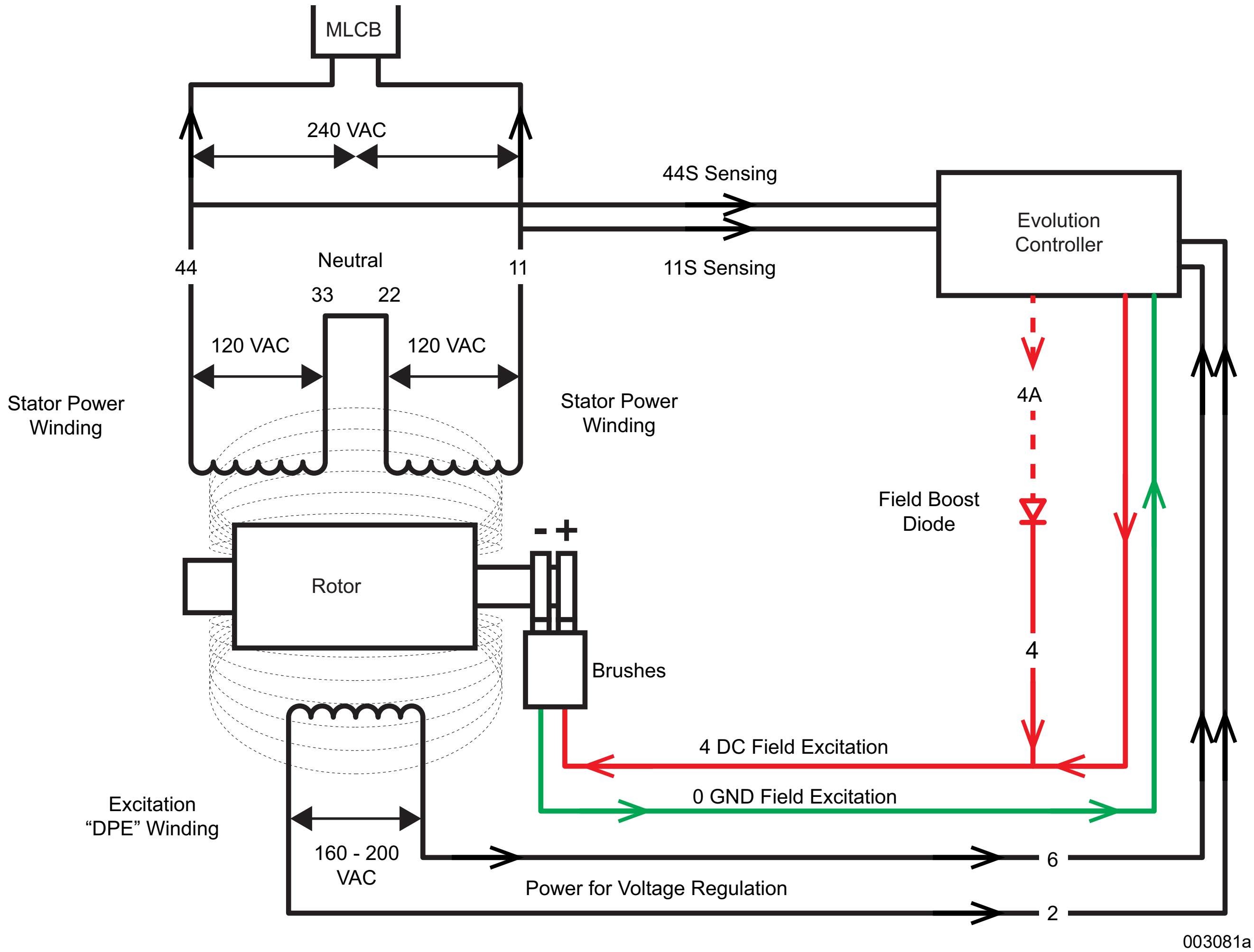


Figure 2-5. Evolution (All) Voltage Regulator Schematic

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	Description	Action Step
Controller Fault	ALARM		**No E-code on HSB**	Update Firmware – Alternate Method, Section 1.3. 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 or No Rotation Warning	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, Test 50 or Test 54
Underspeed	ALARM	1603	**Underspeed** The engine never comes up to 3600 RPM.	Test 54
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**.	Problem 1
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**.	Problem 1
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**.	Check customer connections and stator connections Problem 1

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	Description	Action Step
Undervoltage	ALARM	1906	**Single Zero Cross missing** Undervoltage due to faulty excitation winding, zero cross circuit, or circuit in general. Possible cause: field boost hardware failure. (One zero cross missing greater than 1.5 sec) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Problem 1
Wiring Error or “Transfer Wire Warning”	ALARM	2098	**Mis-wired Customer connection** Insufficient DC voltage on transfer power output.	Update Firmware and verify correct placement of control wires in the customer connection and transfer switch.
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).	Test 14 or Problem 18
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.
Shutdown Switch	ALARM	2800	External shut down circuit is open.	Test 69
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Problem 22
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	Problem 22
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. Test 50

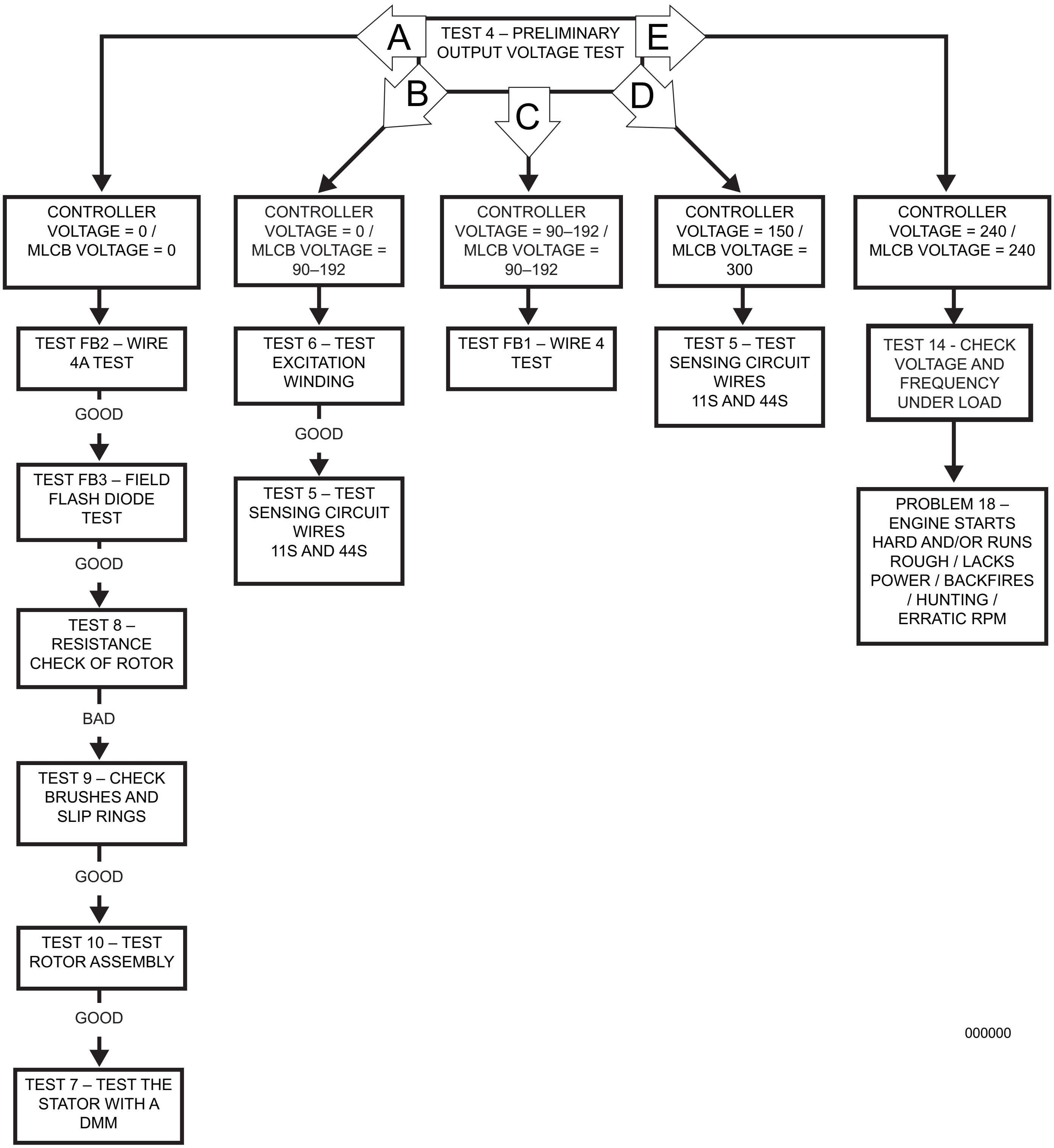
Introduction

Use the "Troubleshooting Flow Charts" in conjunction with the detailed instructions in Section 2.4, ***Diagnostic Tests*** . Test numbers and/or verbiage used in the flow charts correspond to the numbered tests and/or verbiage in Section 2.4.

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

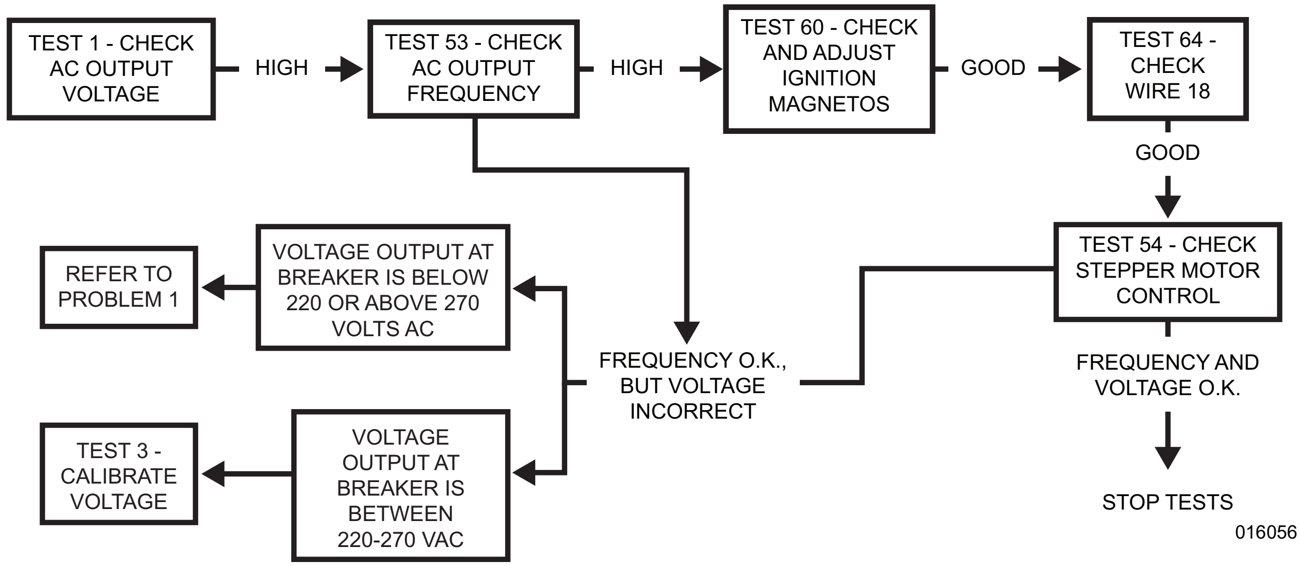
Problem 1 – Generator Shuts Down for Undervoltage

NOTE: Verify controller has latest firmware prior to troubleshooting.



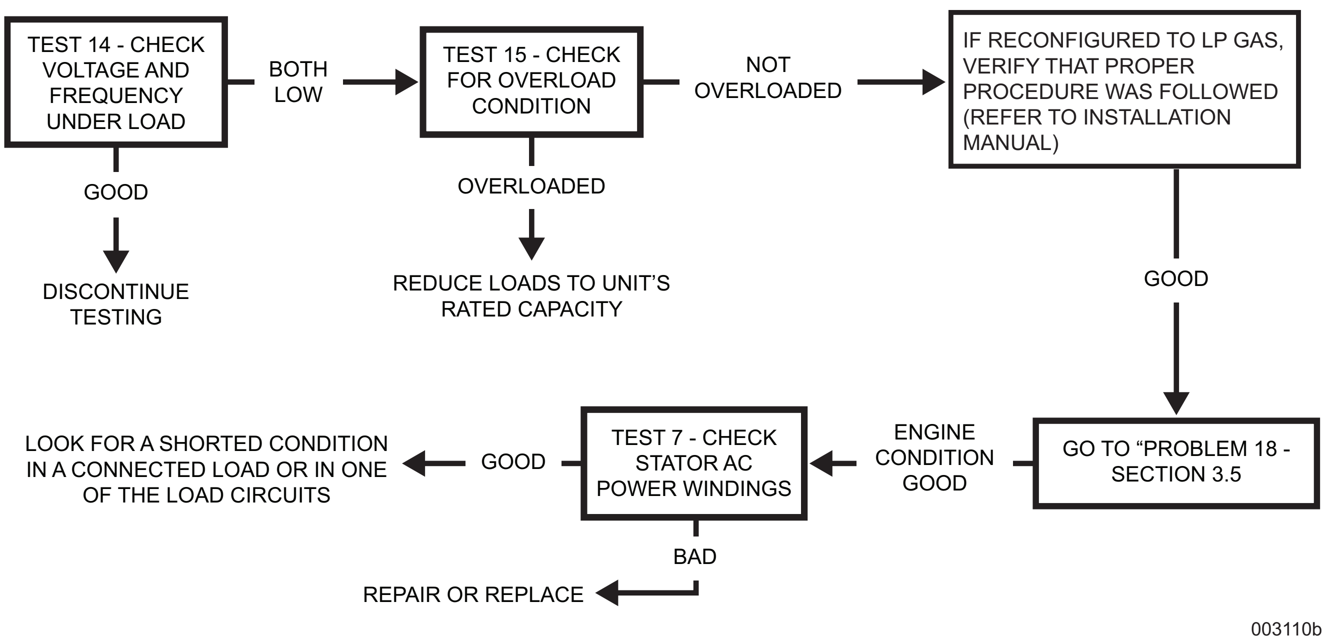
IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

Problem 2 – Generator Produces High Voltage

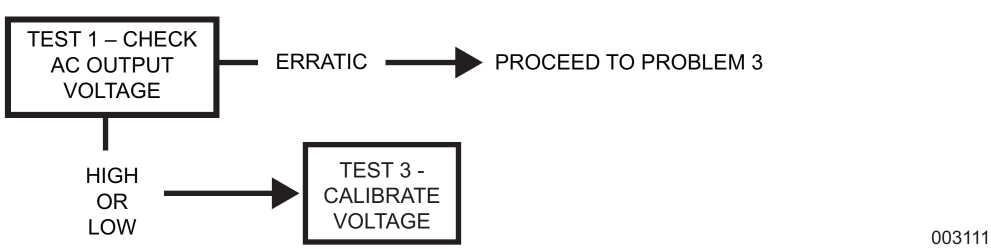


IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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!

Introduction

This section familiarizes the service technician with recommended procedures for testing and evaluating various problems that can occur on air-cooled home standby products. Become familiar with these guidelines before attempting to troubleshoot any of the three main generator components: AC generator, air-cooled engine, transfer switch.

Troubleshooting flow charts provide the simplest and quickest means of troubleshooting typical problems that might occur on air-cooled home standby products. Performing the appropriate tests as indicated by the flow charts will help identify faulty components and systems. The components or systems can be repaired or replaced as necessary once identified.

The test procedures in each section require a basic knowledge of electricity and electrical safety, hand tool skills, and use of multimeters.

Testing and troubleshooting methods covered in this manual are not exhaustive. No attempt has been made to discuss, evaluate, or advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Any test method not recommended herein must be deemed safe for personnel and equipment.

Recommended Tools

In addition to standard hand tools, some test procedures require the use of specialized test equipment as follows:

- 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 2-6*** and Appendix A ***Controller Identification*** for further details.

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Figure 2-6. J3 Breakout Harness

- It is not recommended to use any testing device other than the manufacturer's approved test lead adapters.A meter that measures AC voltage and frequency, DC voltage and current, and has the ability to record minimum and maximum values. Digital multimeters (DMM) are recommended.
- Standard meter test leads, and appropriate testing probes.

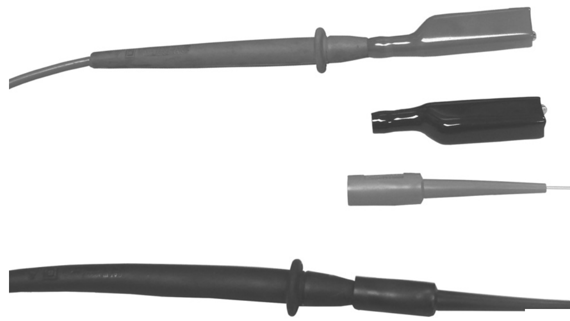

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Figure 2-7. Test Probes

NOTE: The manufacturer carries a set of flexible pin leads (P/N 0J09460SRV) for use with AMP connector plugs. These can also be used and are recommended for back probing MOLEX (white) connectors. Optionally, but least recommended, the manufacturer also carries a set of acceptable piercing probes (P/N 0G7172). Other suppliers piercing probes may be used. Fluke also provides a high quality piercing probes (P/N AC89).

Recommended Tools Check List

- General mechanics tool box
- A 1/4" and 3/8" metric and SAE socket set
- Allen wrenches (metric and SAE)
- Wrenches for flywheel nuts
- A meter capable of measuring frequency (Hz), AC and DC volts, DC amps, and Ohms
- A clamp-on ammeter
- Manometer
- Spark tester
- Compression gauge
- Oil pressure gauge
- Leak down tester

Troubleshooting Reminders and Tips

The most important step in troubleshooting is to correctly identify the problem. Use the run log of the Evolution panel to help identify what the panel is seeing. Use the alarm log to view the faults that caused the warning or alarm shutdown. The Date/Time stamp provides the date and time (to the second) that the alarm event occurred. If there are several alarms that all have the same date-time stamps, go to the first in the series of alarms for that time. Some failures can cause a cascading series of faults to occur, one right after the other. Compare the alarm log and the run log to each other to see the operational sequence of events.

For example: If the unit shut down on “ALARM - Low Oil Pressure”, look to see what time the unit started. If it started at 8/20/23 14:27:30 (2:27 pm), and shut down on low oil pressure on 8/30/23 10:15:22 (10:15 am), then the most likely cause of the loss of oil pressure was low oil level. The unit ran, providing power, for 10 days straight (approximately 234 hours). This could be validated by checking the oil level of the unit. Air-cooled engines will use oil while running. If run for extended periods of time (several weeks for instance) they will require periodic shut-down to check oil level and do a general inspection.

Determine the applicable flow chart to use to help diagnose the problem. Use the table of contents (TOC) for the part of the generator you are working with.

- Use **Section 2 – AC Generators** for problems involving voltage.
- Use **Section 3 – Engine/DC Control** for engine problems.

The TOC will help clarify the problem and which flow chart to use. For each flow chart, start at the top and use the indicated test to verify whether or not a component or control item is working properly. At the end of each test follow the GOOD or BAD arrows and perform the next test.

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

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

Important Note Concerning Connectors

A number of the tests require the use of a multimeter/ volt-meter and a set of wire piercing probes.

It is very easy to damage the female pins in the connectors and is important to remember to use the appropriate back probing tools when testing.

Contacting Technical Support

Any repair using parts from the Level 1 or Level 2 required stock part kit does not require a control number, a call to technical support, or any kind of pre-authorization. Troubleshoot unit, perform repair, and file standard claim on GenService.

Repairs exceeding $3,000, replacement of major component, or parts that needed to be ordered and a second trip made can have a control number assigned for the job.

Technical support will not send out parts other than engines, rotors, stators, or other large/heavy major components. Warranty parts should be stocked or ordered from GenService

Be on-site and be sure to check the warranty status of the unit before calling. Some generators may be under full warranty, others may be in parts-only coverage that will require billing the end user for the work.

Before calling in, have the following information ready:

- Dealer account number
- Technician ID number
- Unit serial number
- Test results from following the flowchart in the diagnostic manual.

Technical Support is working from the basic test results that should already be performed. If this information is not available, you may be asked to call back after testing is complete.

Don't overlook the basics - weak batteries, fuel pressure, installation issues, maintenance issues.

Following these guidelines will provide the best service and shortest wait times to all technicians working in the field.

Section 2.4 Diagnostic Tests

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 be satisfied that the chosen procedure or method will jeopardize neither personnel 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 asking questions during troubleshooting. 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 did the LCD display?
- 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.

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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 2-8***. With the engine shut down, connect the meter test leads across the load terminals of the generator MLCB. This will measure line-to-line voltage.

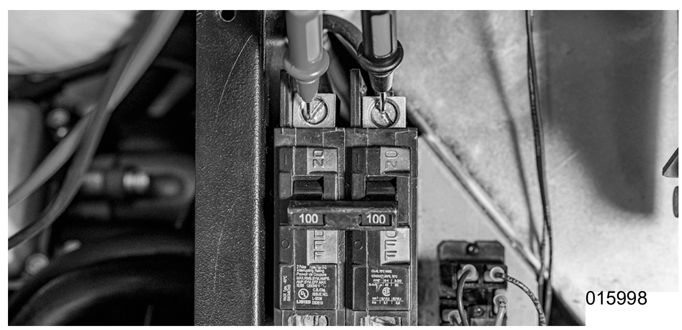

Figure 2-8. MLCB Test Points

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

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

5. Set the MLCB to the "Closed" position. Measure and record the voltage.
6. Set the controller to OFF.

Results

1. If the DMM indicated approximately 240–244 VAC, the output voltage is good. Discontinue testing.
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 correct voltage output was not achieved using the window specified, refer to "Problem 1" Section 2.2.

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. Verify pin and connection integrity at the controller. If good replace the controller.
2. If 0 volts was measured, repair or replace Wire 4 from the controller to the field flash diode.

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. If no voltage is measured remove the J2 Molex connector.
8. Insert red back probe into controller where male 4A pin is located.
9. Touch the black probe lead to the negative post.
10. Clear all faults on the control panel and set to MANUAL mode.
11. Measure and record field flash voltage.

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 and follow "GOOD" path.
2. If no voltage is measured in Step 6 or Step 11 replace the Evolution controller.

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.
   a. 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.

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

NOTE: Leave wire harness/harnesses unplugged.

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

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 10, the diode is good. Replace 7.5 amp fuse and wire harness/harnesses into proper receptacles. If GOOD refer back to flow chart.
2. If readings of INFINITY (OL) on Step 7 and INFINITY on Step 10, 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 10, Diode is bad (shorted), diode needs to be repaired/replaced.

Test 4 – Preliminary Output Voltage Test

NOTE: This test is for Evolution 1.0 firmware (v1.12 and above) and Evolution 2.0 (all firmware).

NOTE: If generator is equipped with a stator terminal block (STB), refer to SIB21-06-HAC.

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 “Undervoltage”. The controller will read “Warming Up”. 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>Output 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

Displayed Controller Voltage	Voltage AC measured at MLCB	Perform Test(s)	Flow Chart Path Begin
0	90–192 (± 10%)	*Test 6 – Test Excitation Winding*	Problem 1, Path B
90–192 (± 10%)	90–192 (± 10%)	*Test FB1 – Wire 4 Test*	Problem 1, Path C
0	0	*Test FB2 – Wire 4A Test*	Problem 1, Path A
~50% of measured voltage	≥300	*Test 5 – Test Sensing Circuit Wires 11S and 44S*	Problem 1, Path D
240 (approx.)	240 (approx.)	*Test 14 – Check Voltage and Frequency Under Load*	Problem 1, Path E

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.

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***, check pins/connector integrity at controller and repair/replace if needed. If OK, replace Evolution controller.
   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 2-9***. Locate and disconnect STR connector in wire harness.

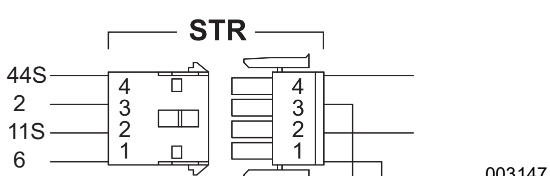

Figure 2-9. Stator Connector (STR) Pin Locations

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***, replace stator.

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

1. Set DMM to measure resistance.
2. See ***Figure 2-9***. 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***, repair or replace Wire 11S and Wire 44S between the STR Connector and the J1 Connector.
   b. If the meter indicated OPEN, proceed to Step 4.
4. See ***Figure 2-10*** and ***Figure 2-11***. Remove the stator terminal block cover and identify the studs containing Wires 11S and 44S.

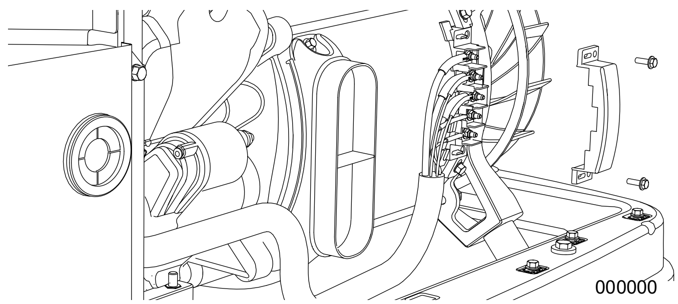

Figure 2-10. Stator Terminal Block Cover

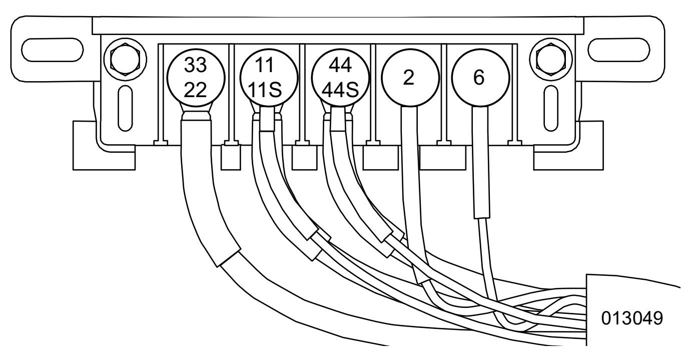

Figure 2-11. Stator Terminal Block Wires

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.

b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 1.1 ***Specifications***, replace stator.

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.

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 flow chart.
   b. If meter indicated an OPEN, proceed to Procedure B or C.

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 flow chart.
   b. If meter indicated an OPEN, proceed to Procedure B or C.

Procedure B – Units with STR Connector Only

1. See ***Figure 2-12***. Disconnect the STR connector located in the wire harness.

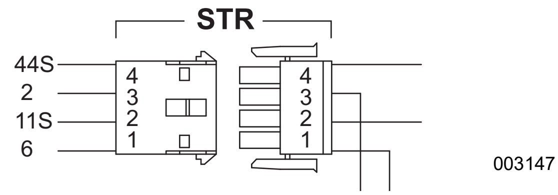

Figure 2-12. Stator Connector (STR) Pin Locations

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***, replace stator.

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

1. See ***Figure 2-12***. 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 2-13*** and ***Figure 2-14***. Remove the stator terminal block cover (A) and identify the studs containing Wires 2 and 6.

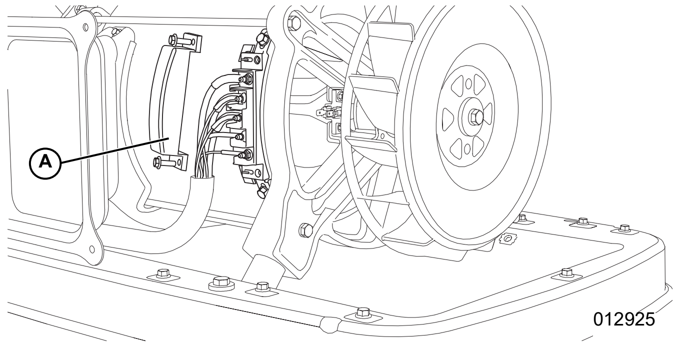

Figure 2-13. Stator Terminal Block (STB)

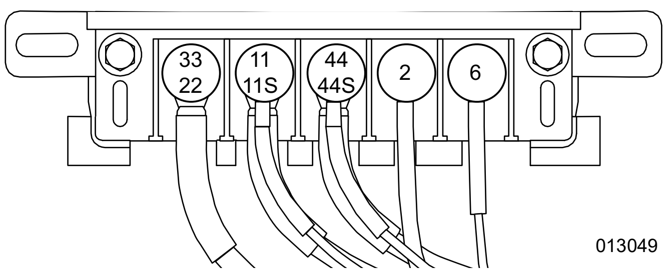

Figure 2-14. Stator Terminal Block Wires

5. Check to see that harness connections to the stator terminal block 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***, replace stator.

Results

Specific results may vary based on step within procedure.

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

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

Test Point A	Test Point B	Value in Ohms
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	
a. If results are OL or out of specification, replace the stator. b. If results are within specification, continue to next chart.		
Test Windings for a Short to Ground		
Stator Lead Wire 11	Ground	
Stator Lead Wire 33	Ground	
STR Pin 2 Wire 11S	Ground	
STR Pin 4 Wire 44S	Ground	
STR Pin 1 Wire 6	Ground	
a. Any results other than OL indicate a “short-to-ground” condition; replace the stator. b. If results are OL, continue to next chart.		
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	
a. If resistance is measured between any test points, replace the stator. b. If results are OL, return to Test 4.		

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.

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 2-12***. 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 2-2***.

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

1. Disconnect Wires 11 and 44 from the main line circuit breaker (MLCB).
2. Disconnect Wires 22 and 33 from the NEUTRAL connection in the customer connections compartment.
3. See ***Figure 2-12***. Disconnect the STR connector located in the wire harness.
4. See ***Figure 2-15***. Remove the stator terminal block cover (A) to expose all wires/studs (33/22, 11, 44, 2, and 6).
5. Verify harness connections to the stator terminal block are tight and secure.

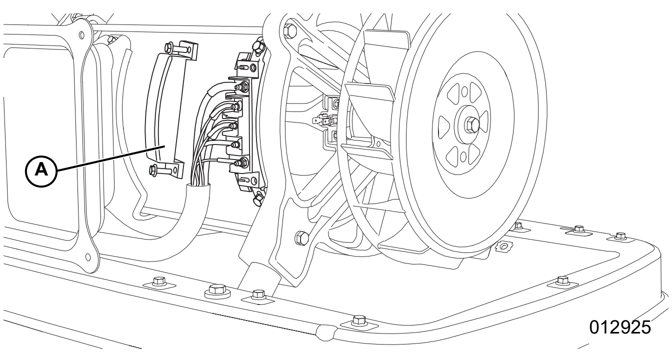

Figure 2-15. Stator Terminal Block (STB)

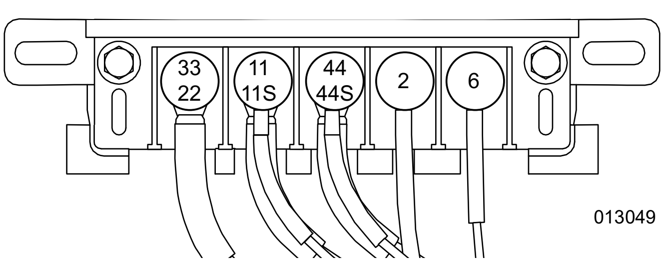

Figure 2-16. Stator Terminal Block Wires

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

Table 2-3. Stator Results (w/STB terminal block)

Test Point A	Test Point B	Results
Resistance Test with Wires removed from terminal block		
Stator Stud Wire 11	Stator Stud Wire 44	
Stator Stud Wire 2	Stator Stud Wire 6	
a. If results are OL or out of specification, replace the stator. b. If results are within specifications, continue to next chart.		
Test Windings for a Short to Ground		
Stator Stud Wire 11	Ground	
Stator Stud Wire 2		
a. Any results other than OL indicate a “short-to-ground” condition; replace the stator. b. If results are OL, continue to next chart.		
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	
a. If resistance is measured between any test points, replace the stator. b. If results are OL, return to Test 4.		

Results

Specific results may vary based on tables within procedure.

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 Section 1.1 ***Specifications*** for correct Rotor resistance values.

1. If the DMM indicated the correct resistance values in Steps 5 and 6, go to Test 4.
2. If the DMM indicated INFINITY in Steps 5 and 6, refer back to flowchart.

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 4.1 ***Major Disassembly***.
2. Inspect the brush wires and verify they are secured and properly connected. Repair or replace as needed.
3. Inspect the brush assembly for excessive wear, or damage. Repair or replace as needed.
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 disconnected Wire 0 (from brush) and the controller connector Wire 0.
   - If the DMM indicated INFINITY (OL), 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 disconnected Wire 4 (from 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, continue to Step 10.
10. Place the meter leads across the terminals of the brush holder and measure resistance.
    - If resistance value is consistent with the specifications chart, test is good. Refer back to the flowchart.
    - If the DMM indicates OL, proceed to Step 11.
11. Remove the brushes.
12. Place one meter lead on Wire 4 or Wire 0 terminal and the other meter lead to the slip ring side of the brush respectively.
    - If INFINITY is measured on either side of the brushes, replace the brushes.
    - If CONTINUITY is measured, test is good. Refer back to the flowchart.

Results

Specific results may vary based on step within procedure.

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***. If resistance is within specifications refer back to flowchart.
2. If resistance is not within specifications from Step 3, replace the rotor assembly.
3. If DMM indicated continuity in Step 4, replace the rotor. If DMM did not indicate continuity in Step 4, refer back to flowchart.

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 17 – Current Calibration (8–26 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

See ***Table 4-4***. 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).

Table 4-4. Approximate Values (when back-probed at connector)

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

DANGER

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

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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 Control 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 0 (Common Ground)
- Wire 00 (Neutral for Battery Charger)
- Wire 194 (Transfer Relay)
- Wire 23 (Transfer Relay)

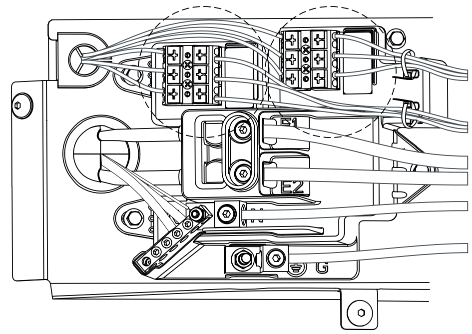

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Figure 3-1. 2017 Evolution Customer Connections

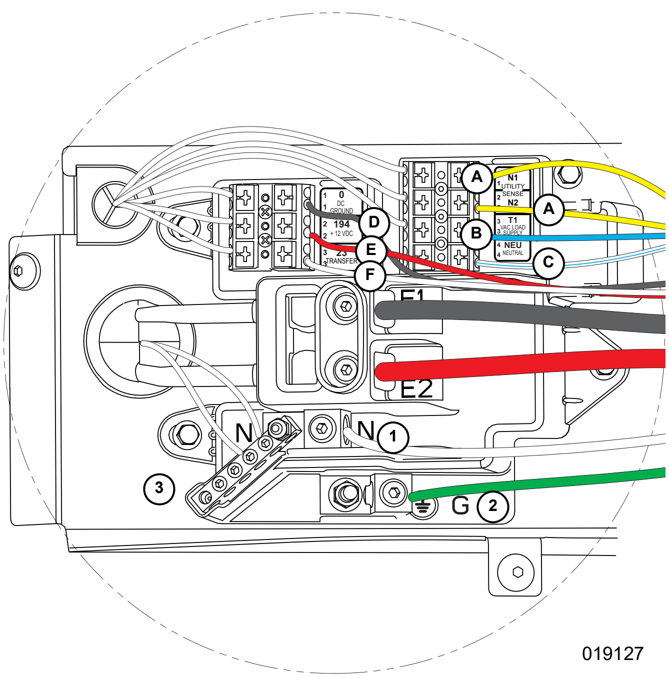

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Table 3-1. Control Panel Connections		
Terminal Numbering Decal		Wire Numbers
A	YELLOW #1 & #2	N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3	T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C	WHITE (Blue Stripe)	00 - Neutral for Battery Charger
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
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 (2023 and newer) Control Wiring - 60 Hz (found behind control board)

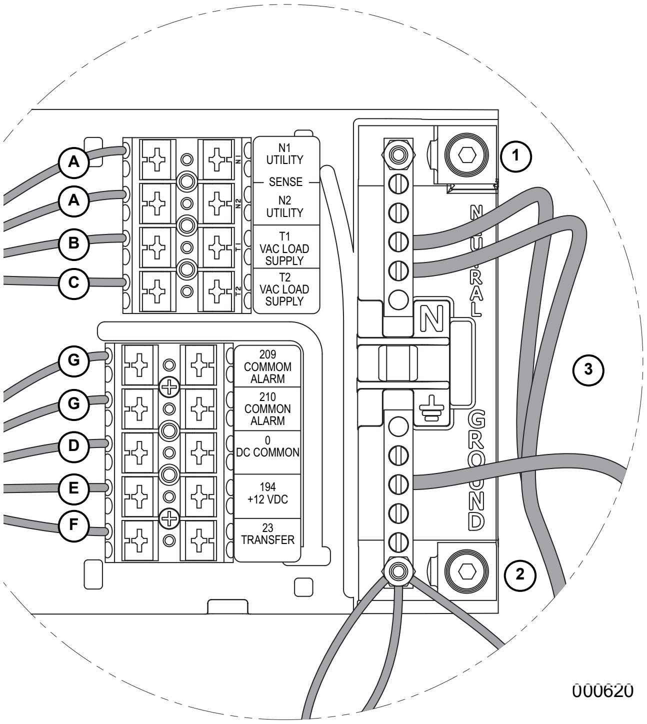

Table 3-3. Control Panel Connections		
Terminal Numbering Decal		Wire Numbers
A	YELLOW #1 & #2	N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3	T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C*	WHITE #4	T2 - Fused 120 VAC for Battery Charger (*see NOTE)
D	BLACK #3	0 - DC (-)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

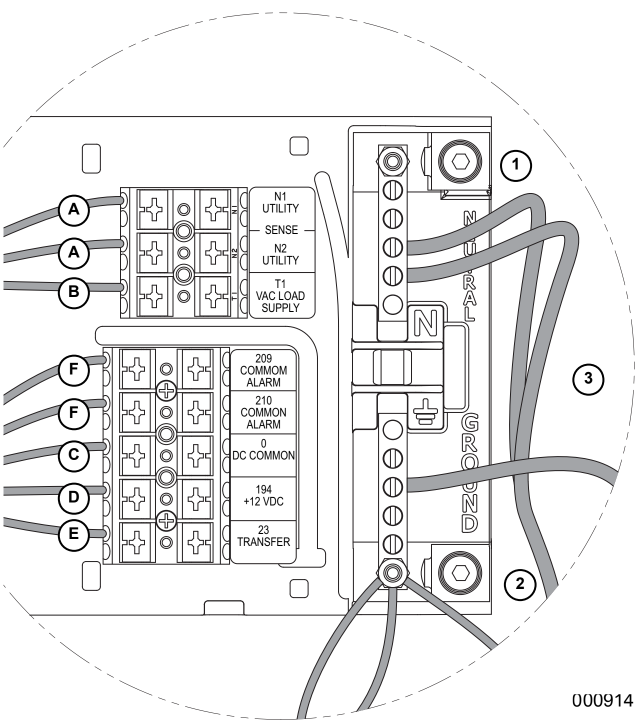

Table 3-5. Control Panel Connections		
Terminal Numbering Decal		Wire Numbers
A	YELLOW #1 & #2	N1 & N2 - 240 VAC - Sensing for Utility Dropout and Pickup
B*	BLUE #3	T1 - Fused 120 VAC for Battery Charger (*see NOTE)
C	BLACK #3	0 - DC (-) Common Ground Wire
D	RED #4	194 - DC (+) 12 VDC for Transfer Controls
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 3-6. 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 3-4. Evolution (2016 and older) Control Wiring - 60 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 3-7*** for the specific position and function. See ***Menu System Navigation*** to view state of output or input.

Table 3-7. 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 3-5*** for the location of the push buttons.

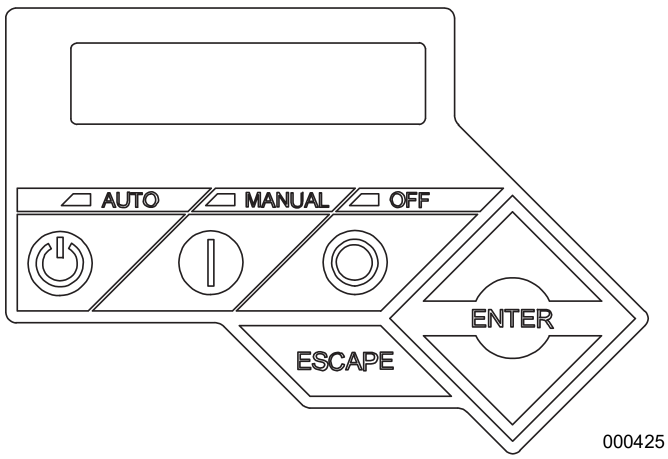

Figure 3-5. Evolution controller Off-Manual-Auto Buttons

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.

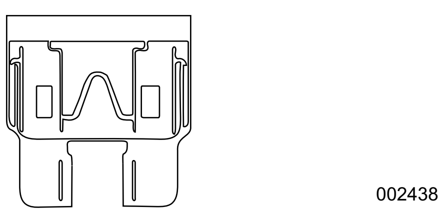

Figure 3-6. Typical 7.5 Amp Fuse

Starter Control Relay/Solenoid

(V-Twins)

See ***Figure 3-7***. The starter control 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.

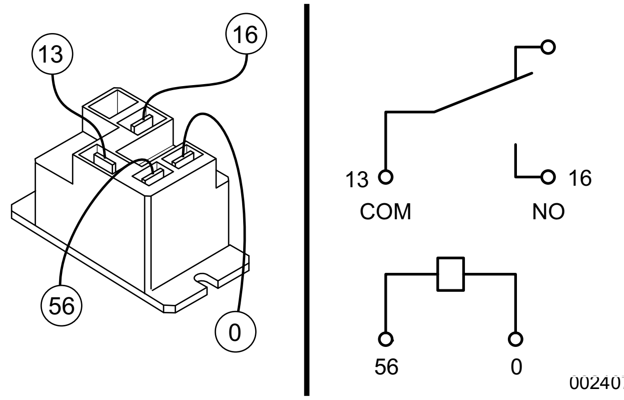

Figure 3-7. Starter Control Relay (V-twin Units)

(410cc Single Cylinder Engine Units Only)

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

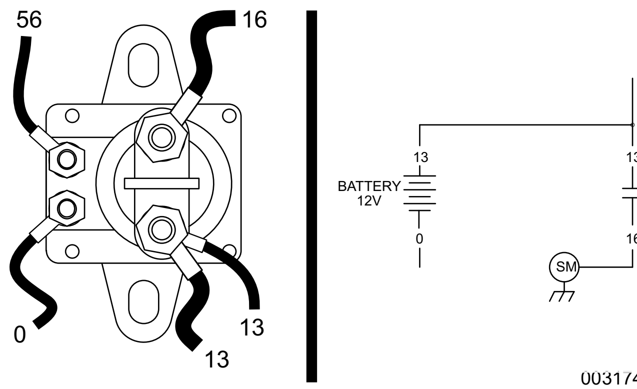

Figure 3-8. The Starter Contactor (410cc Single Cylinder Units)

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 3-8. 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.

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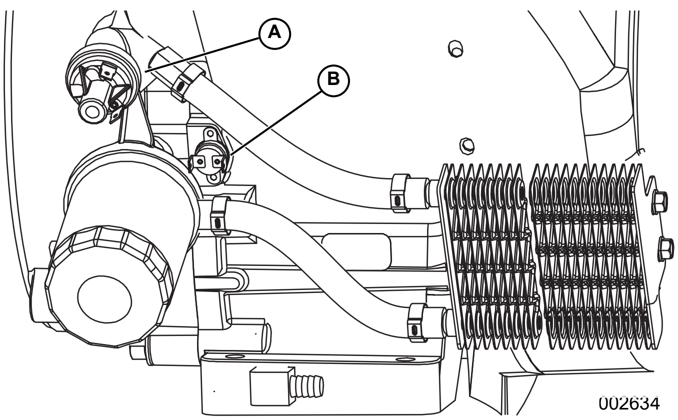
Engine Protective Devices

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 3-9. Engine Protective Switches

Low Oil Pressure

(E-Code 1300)

All Evolution 2017 and Prior Models

See ***Figure 3-9***. 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 3-9***. The contacts of this switch are normally open and will close Wire 85 to ground, Wire 0, 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 Wire 85 from ground, Wire 0, 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 via Wire 18 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 3-9. 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.

Evolution Warnings and Alarm Parameters

Table 3-10. Evolution Warnings and Alarm Parameters

Description	Hold-off Time	Duration Time	Continuous or 2 looks	Upper threshold	Lower threshold	Lockout Type
Low Oil Pressure	5 seconds	8 seconds	2 looks	Digital input	Digital input	Hard Lockout
RPM Sensor Loss	3 seconds 4 sec (8 kW only)	1.1 seconds	Continuous	Timed signal loss	Timed signal loss	2 Re crank, Hard Lockout
No Rotation Warning	0 seconds	3 sec (if ignition pulse triggers is 2 or more) otherwise, 4 sec	Continuous	RPM < 2200RPM	RPM < 1500RPM	Warning
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 and 00 (Neutral) 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.

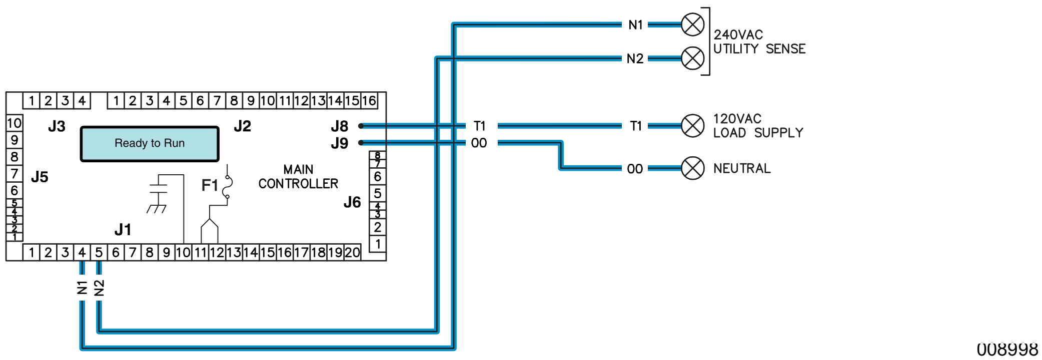

Figure 3-10.

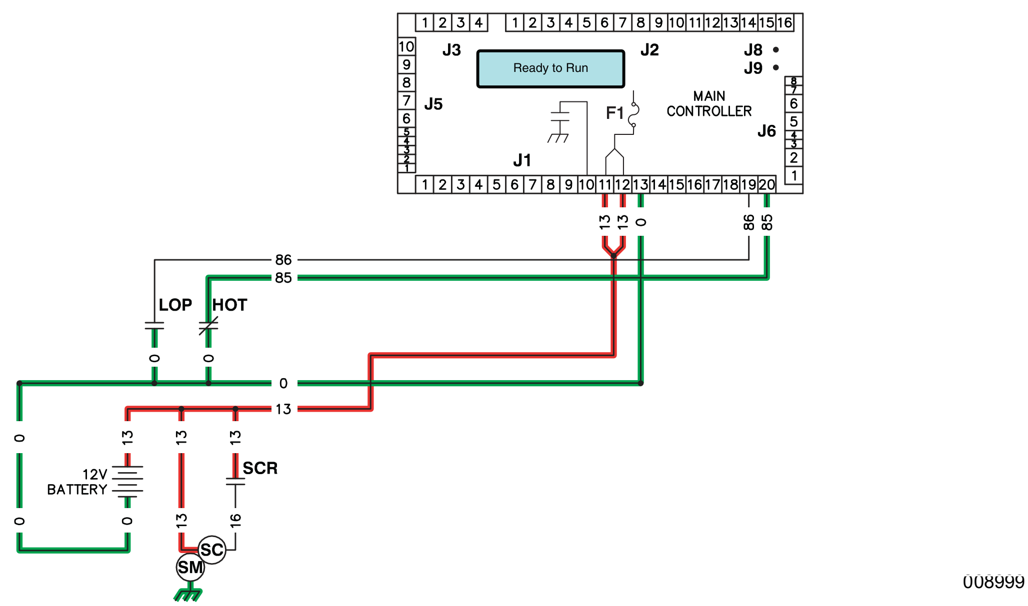

Figure 3-11.

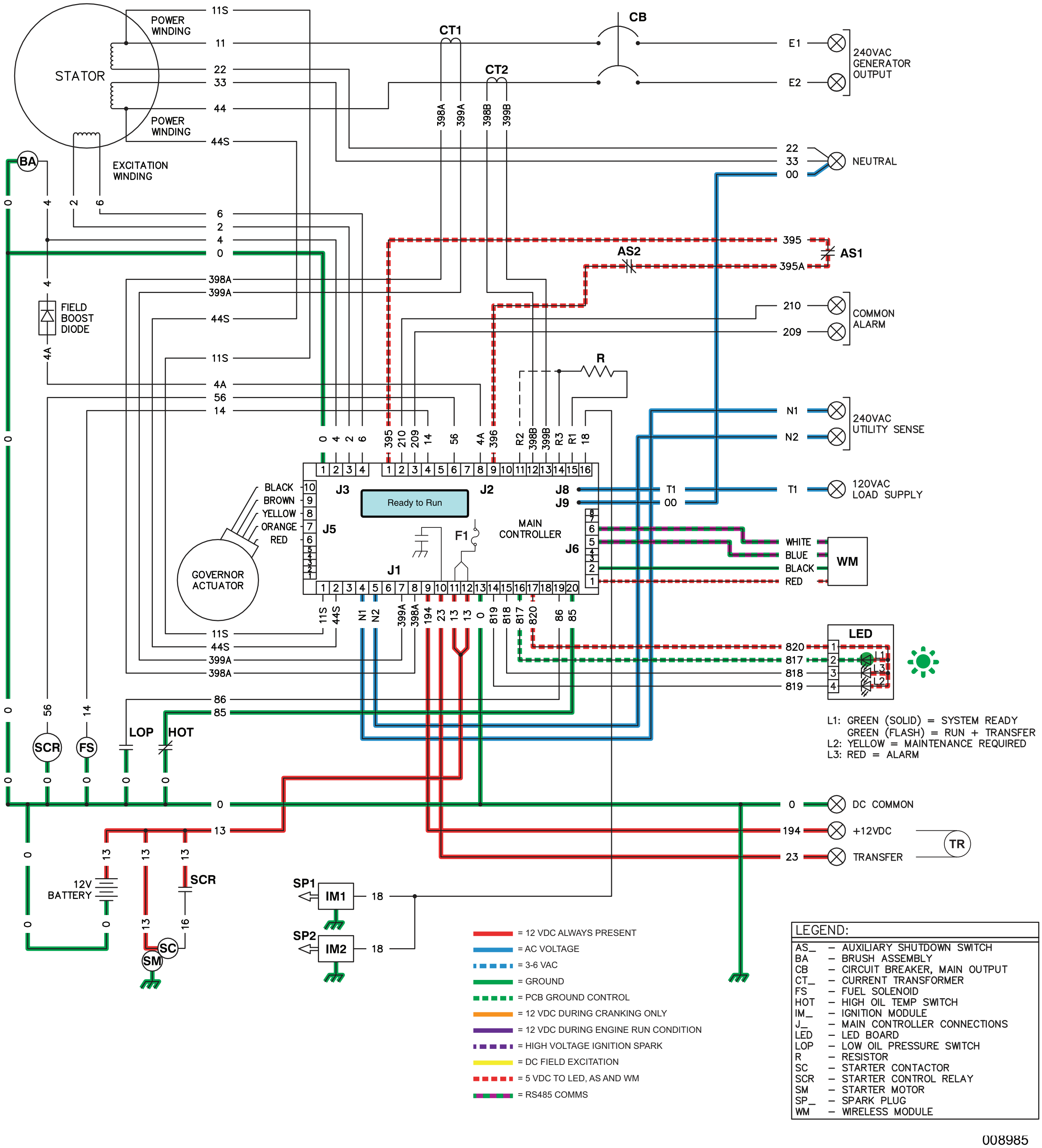

Figure 3-12. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See ***Figure 3-14***. 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	**Util Volts Low Value**
60 Hz = 156 VAC	60 Hz = 140-171 VAC
50 Hz = 142 VAC	50 Hz = 140-156 VAC

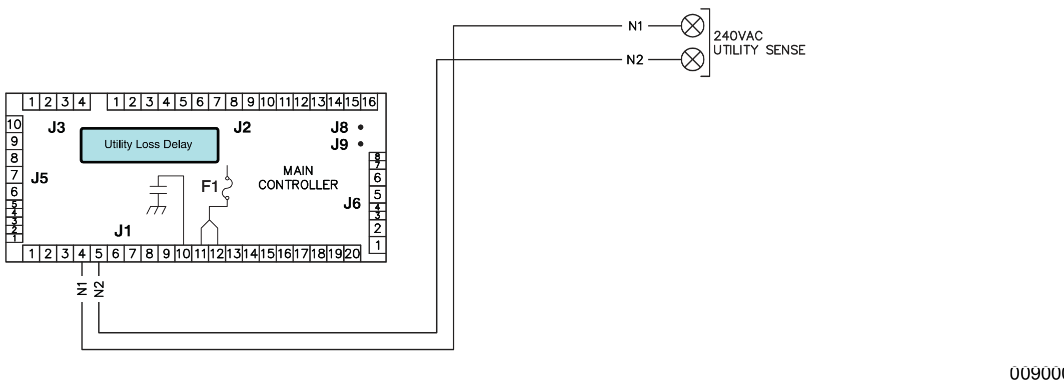

Figure 3-13.

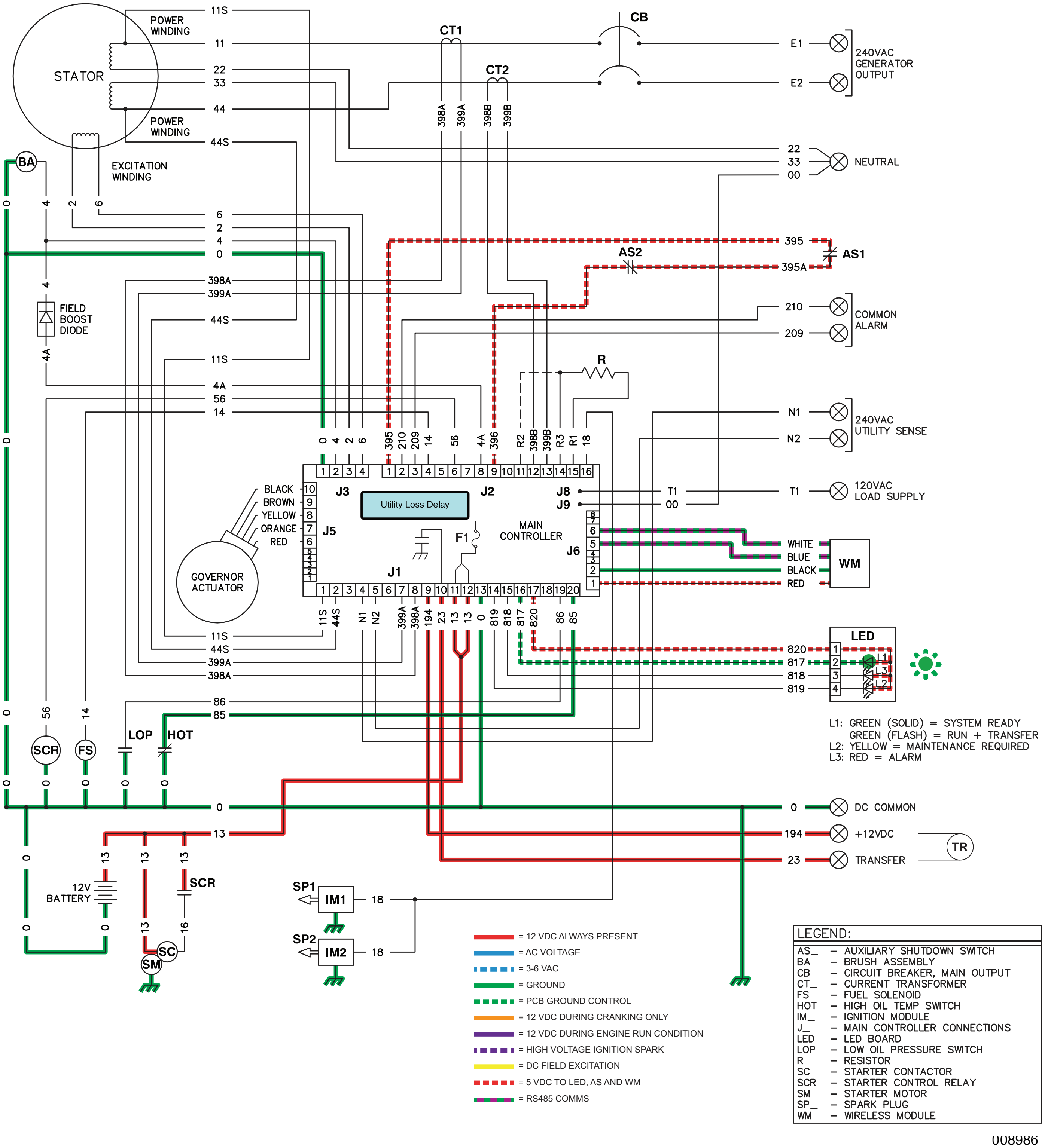

Figure 3-14. Initial Dropout of Utility Source Voltage

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 control relay (SCR) via Wire 56. When the SCR energizes, its contacts close and battery voltage is delivered to a starter contactor (SC). When the SC energizes, its contacts close and battery voltage is delivered to the starter motor (SM); the engine is now cranking.
- With the engine cranking, oil pressure will begin to build in the engine, closing the contact in the low oil pressure switch (LOP).
- 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.

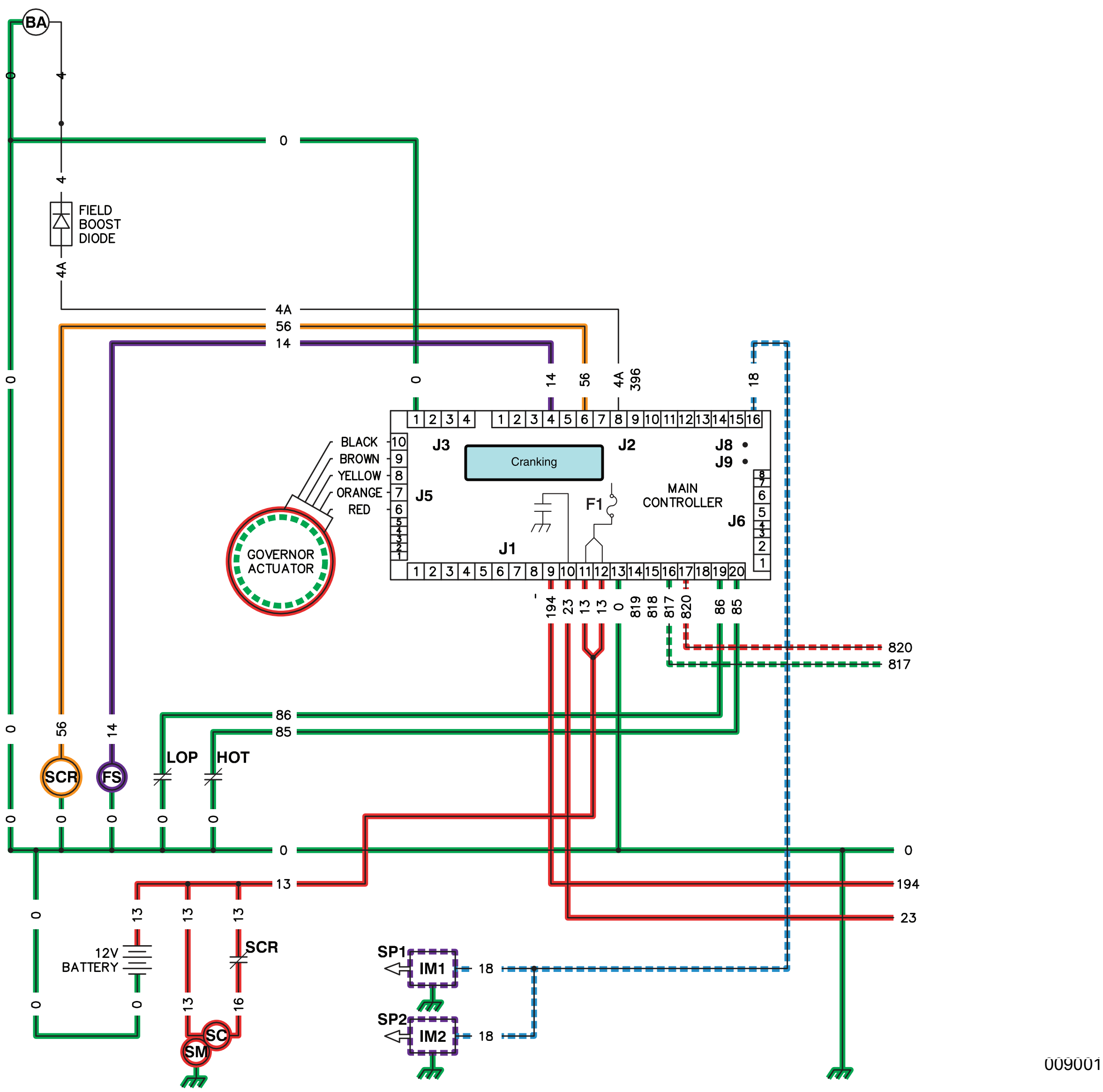

Figure 3-15.

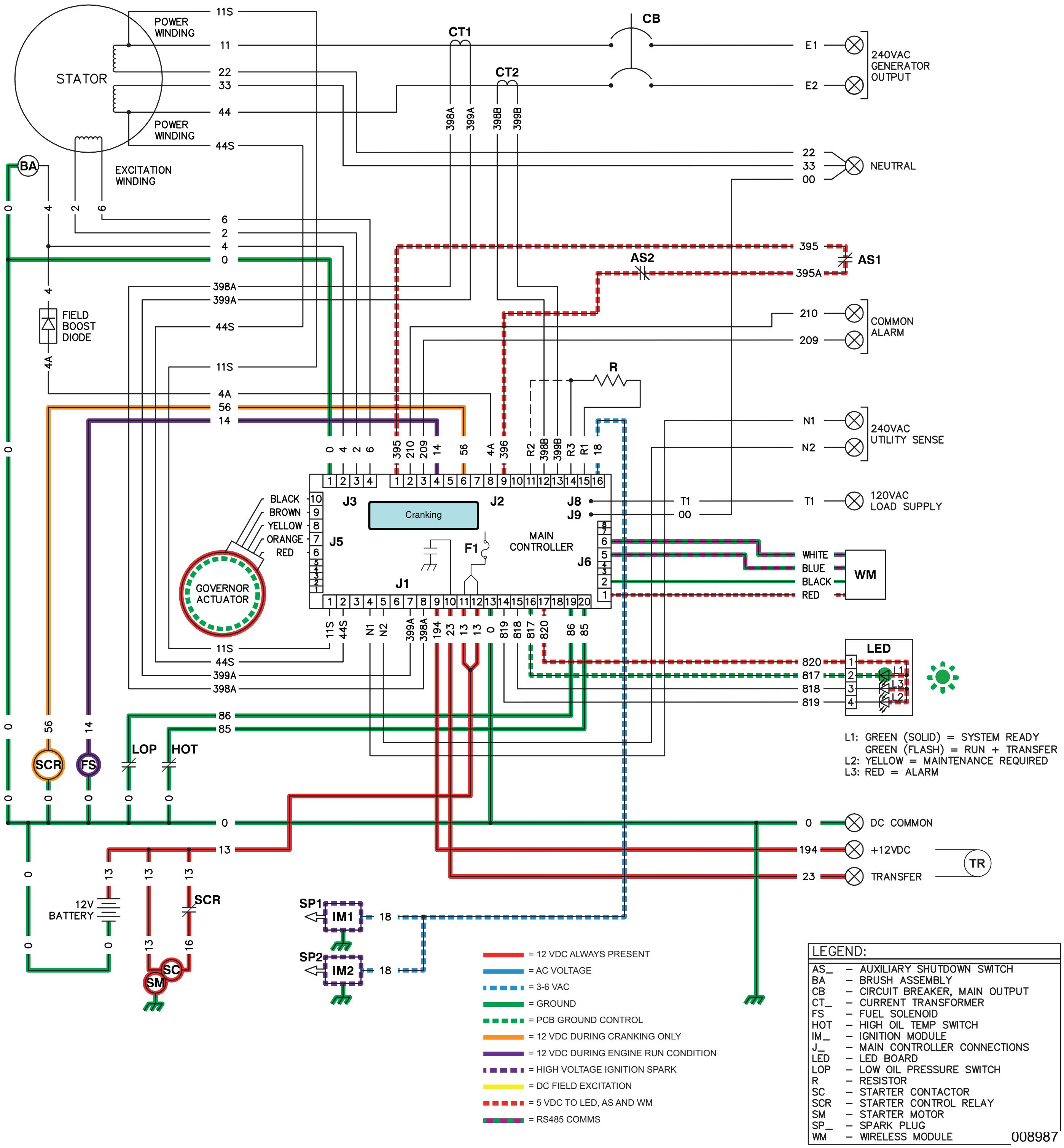

Figure 3-16. Utility Voltage Failure and Engine Cranking

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.

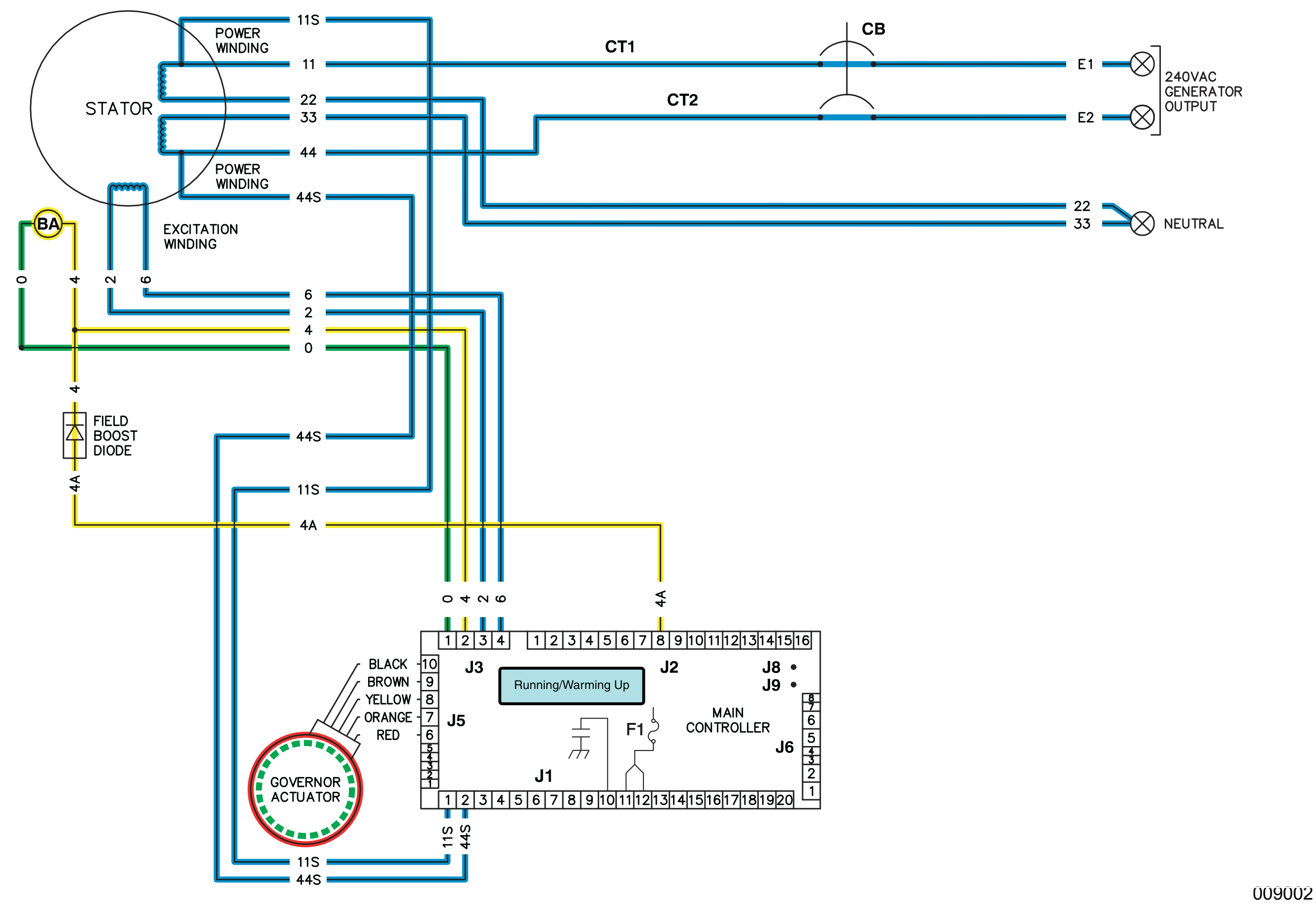

Figure 3-17.

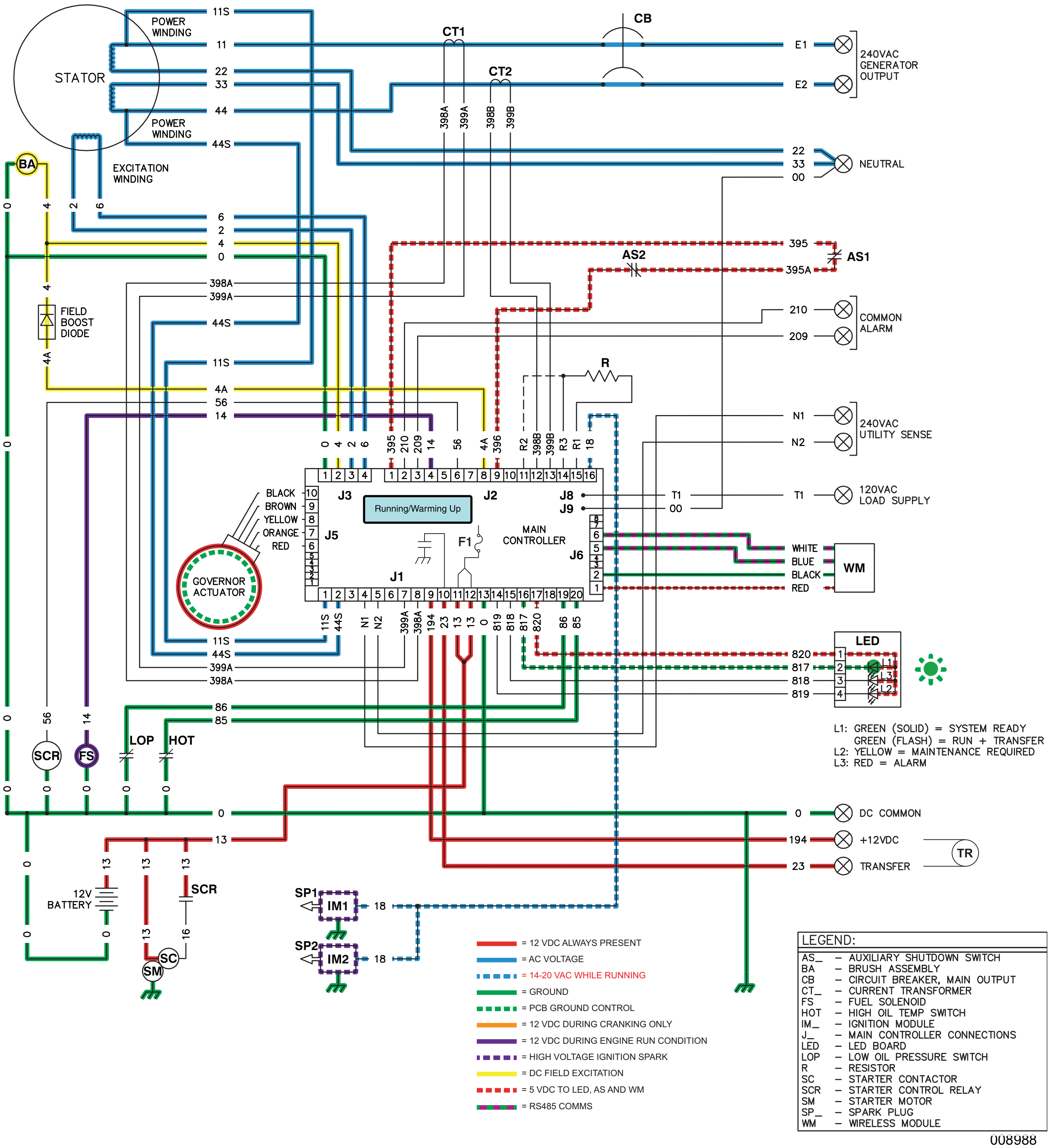

Figure 3-18. Engine Startup and Running

Transfer to Standby

In ***Figure 3-20*** 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 minimal 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)

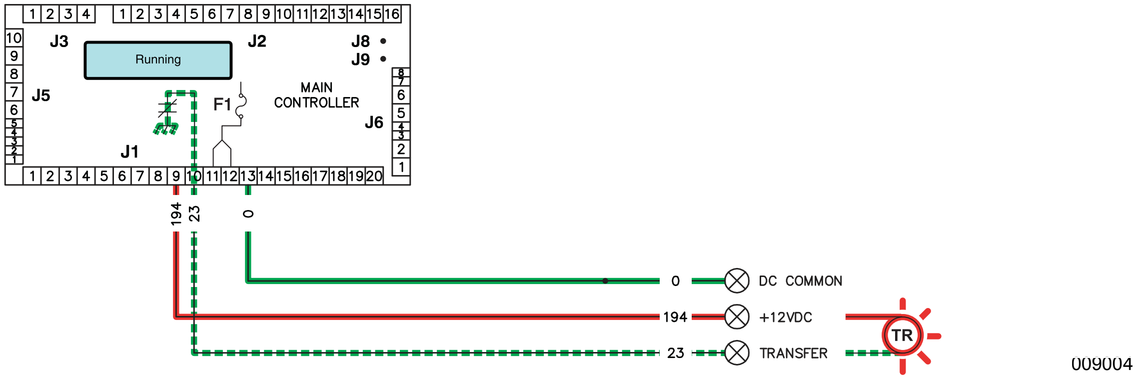

Figure 3-19.

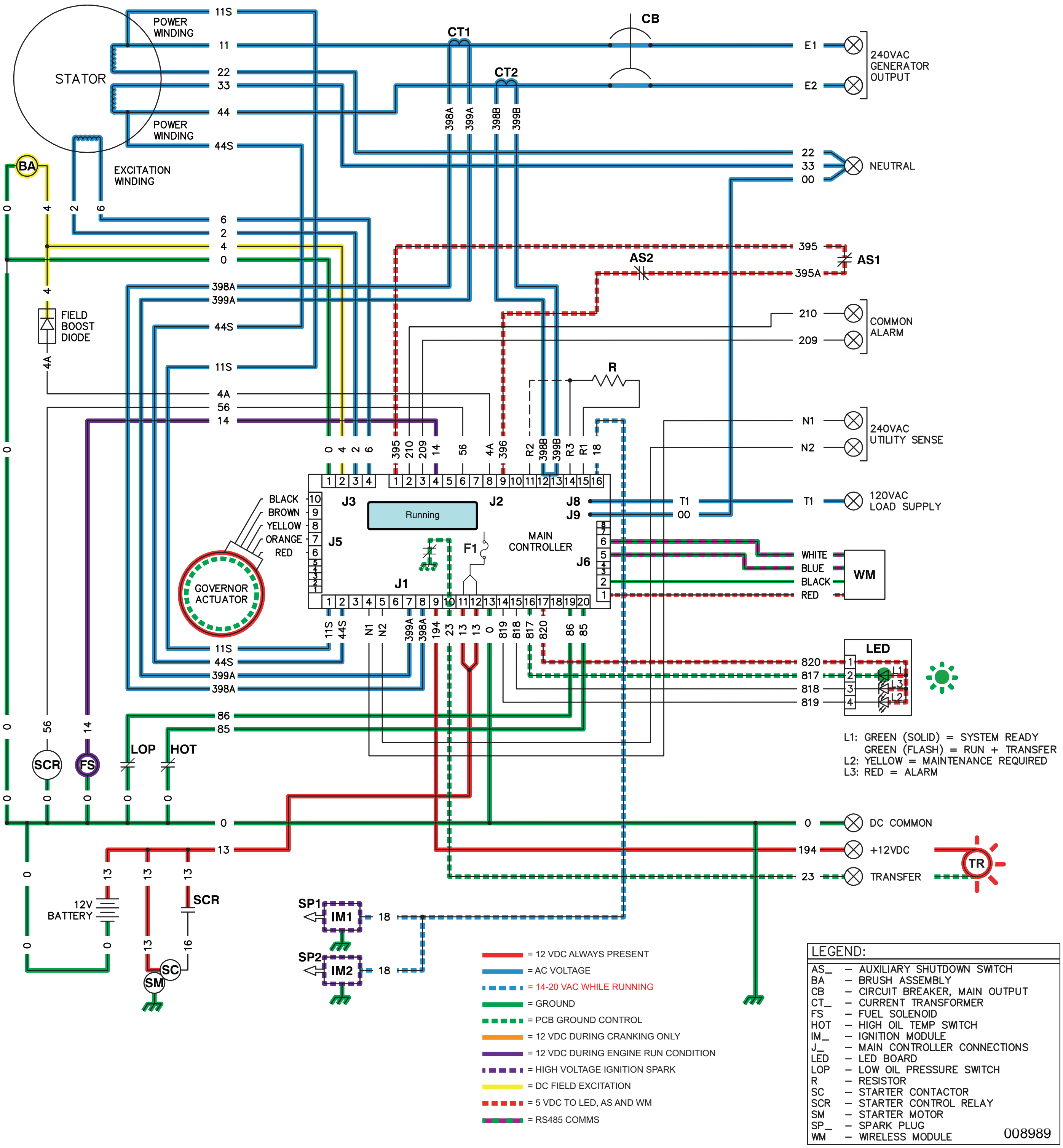

Figure 3-20. Transfer to Standby

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 for 60 seconds 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	**Util Recovery Volts**
60 Hz = 190 VAC	60 Hz = 190-216 VAC
50 Hz = 175 VAC	50 Hz = 175-198 VAC

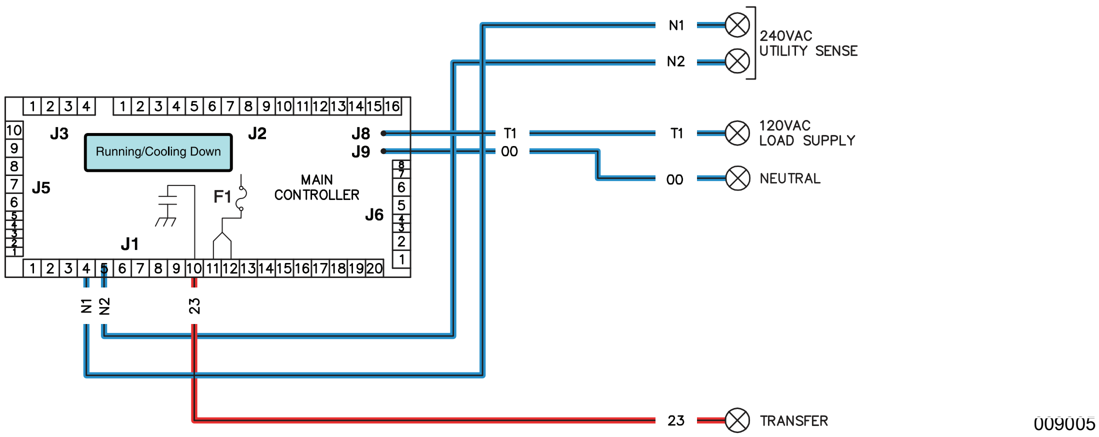

Figure 3-21.

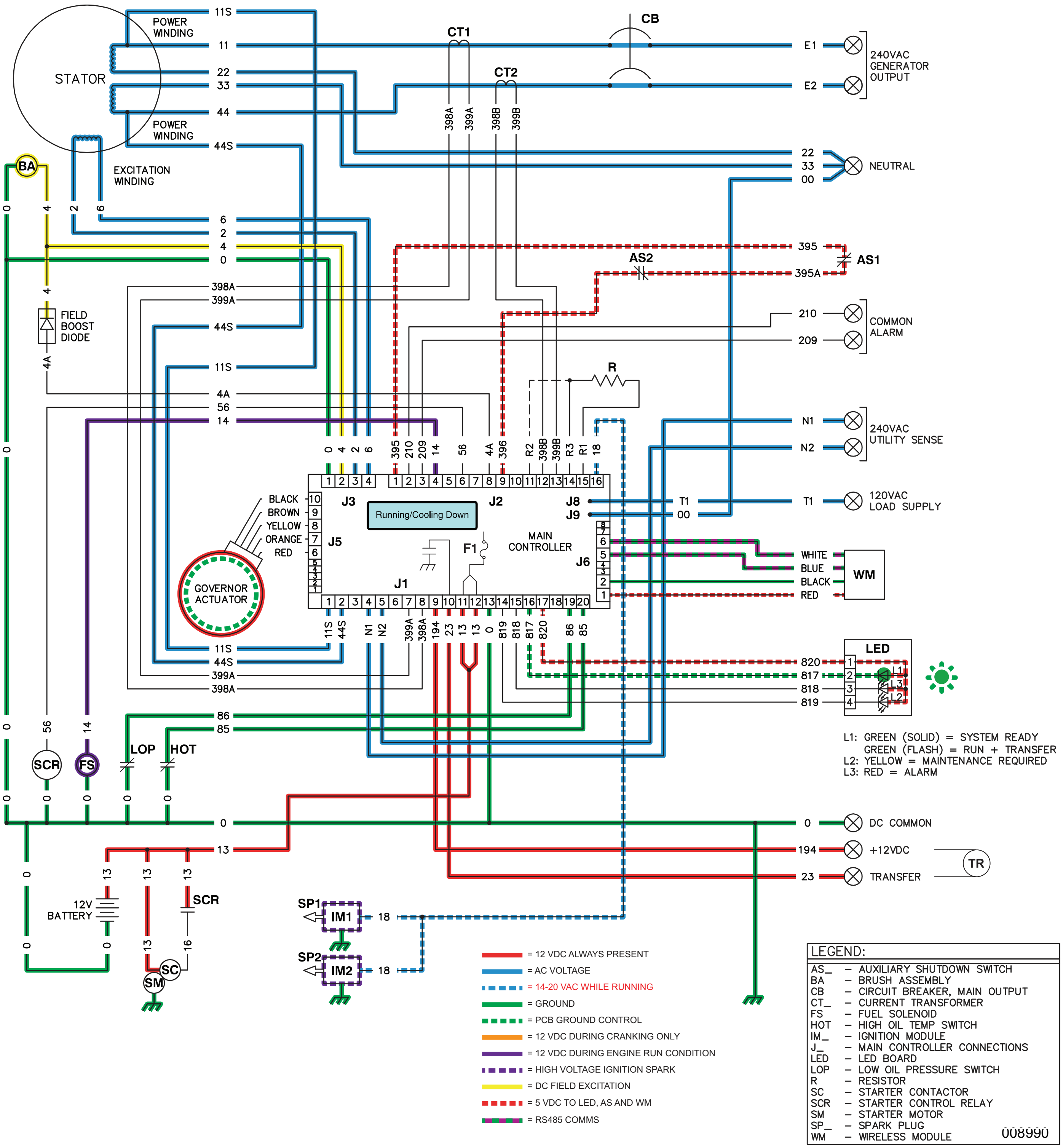

Figure 3-22. Utility Voltage Restored and Re-transfer to Utility

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.

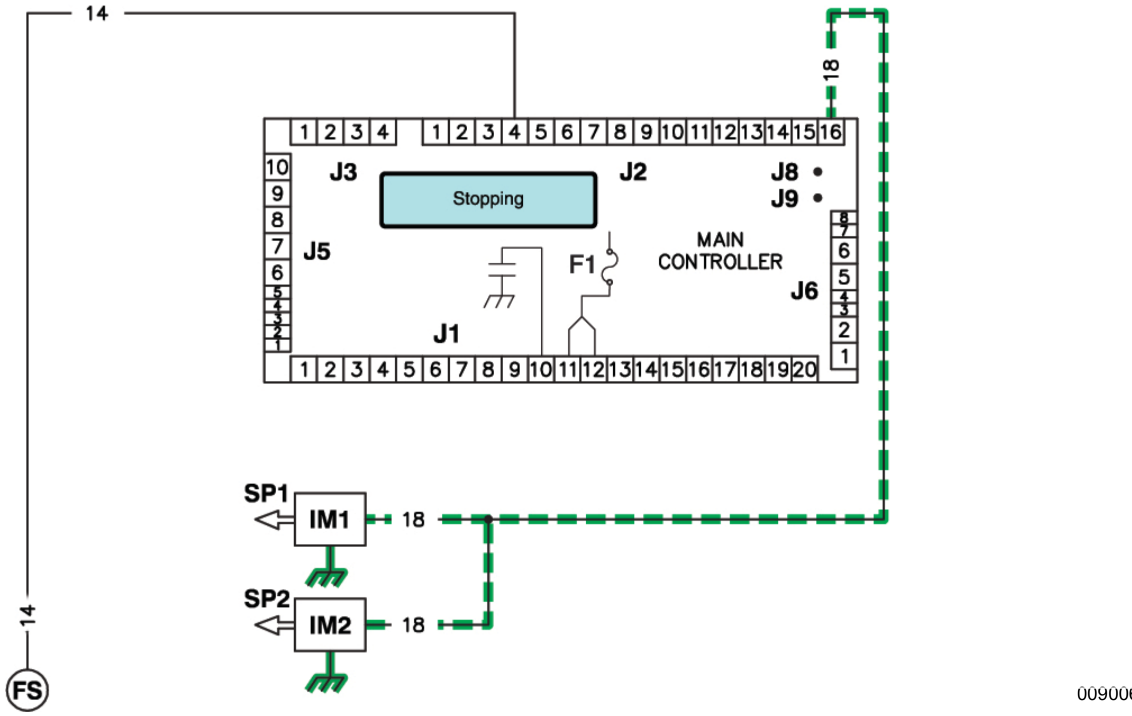

Figure 3-23.

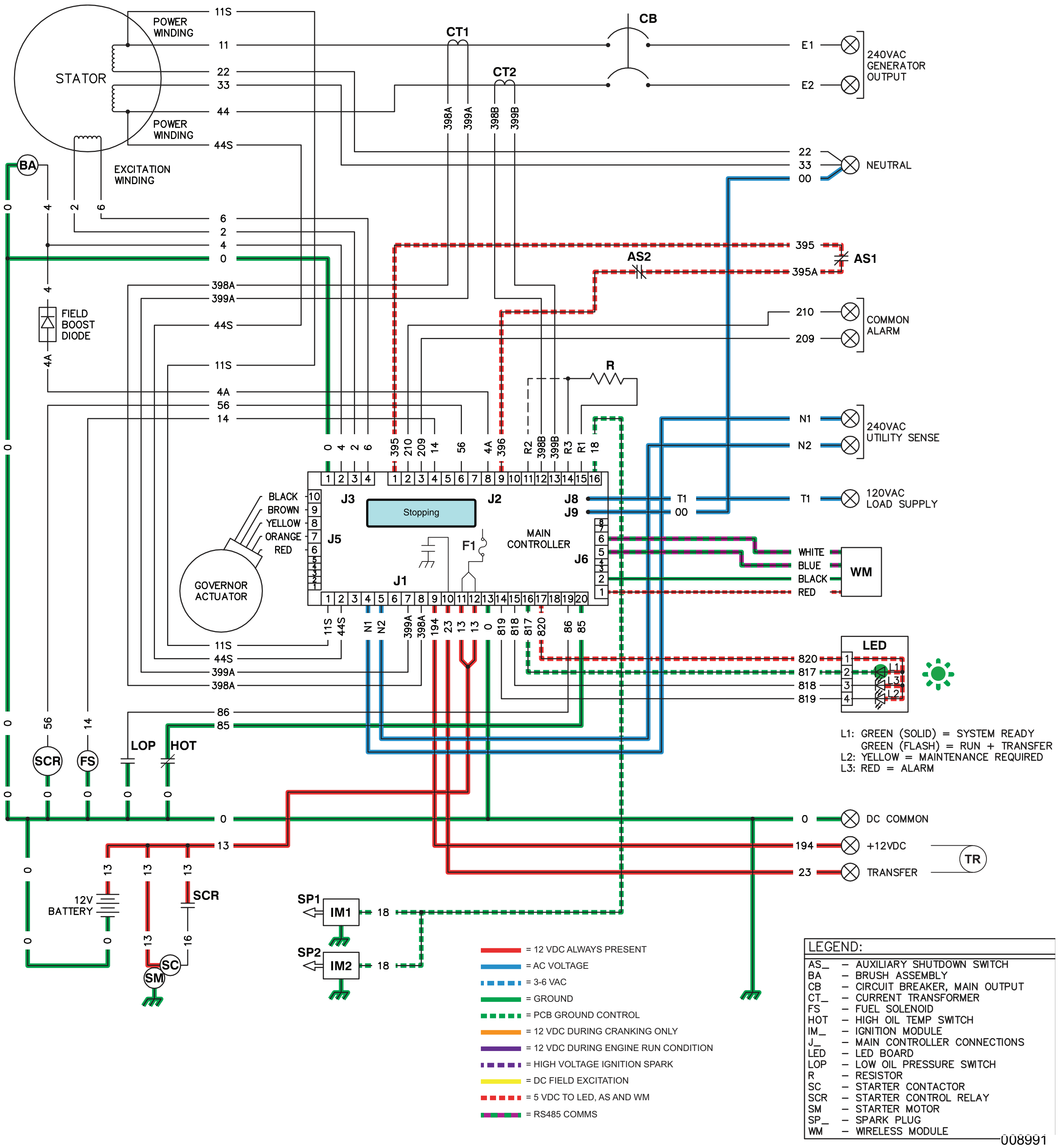

Figure 3-24. Engine Shutdown

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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.

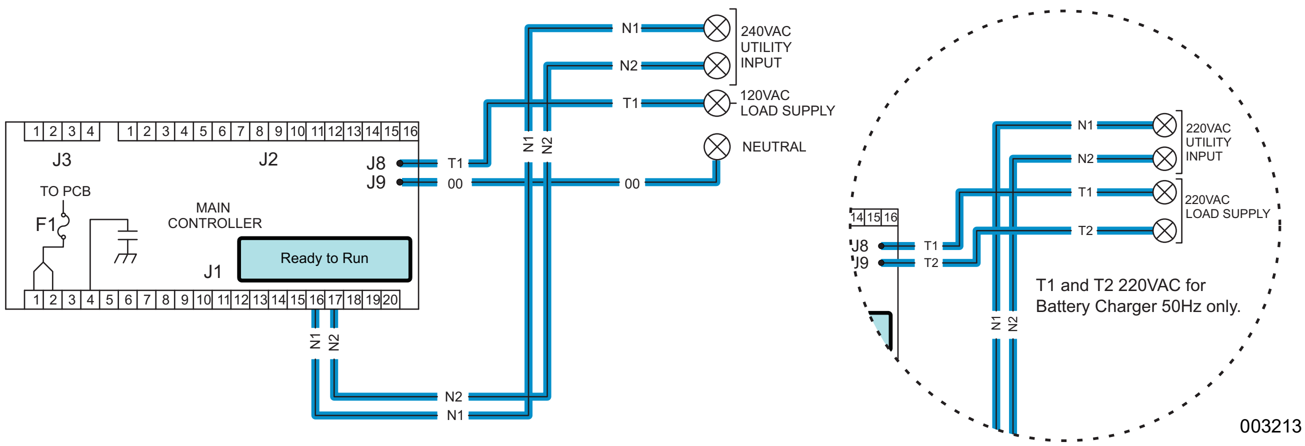

Figure 3-25.

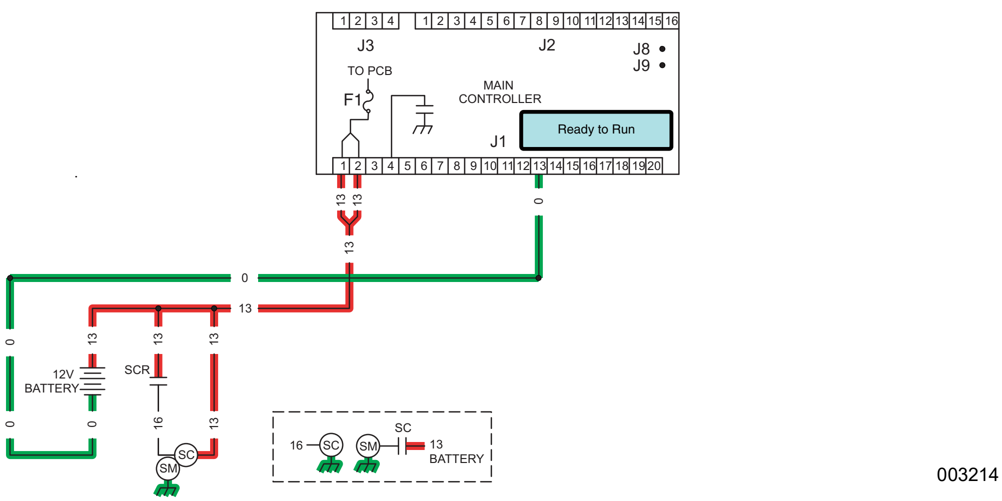

Figure 3-26.

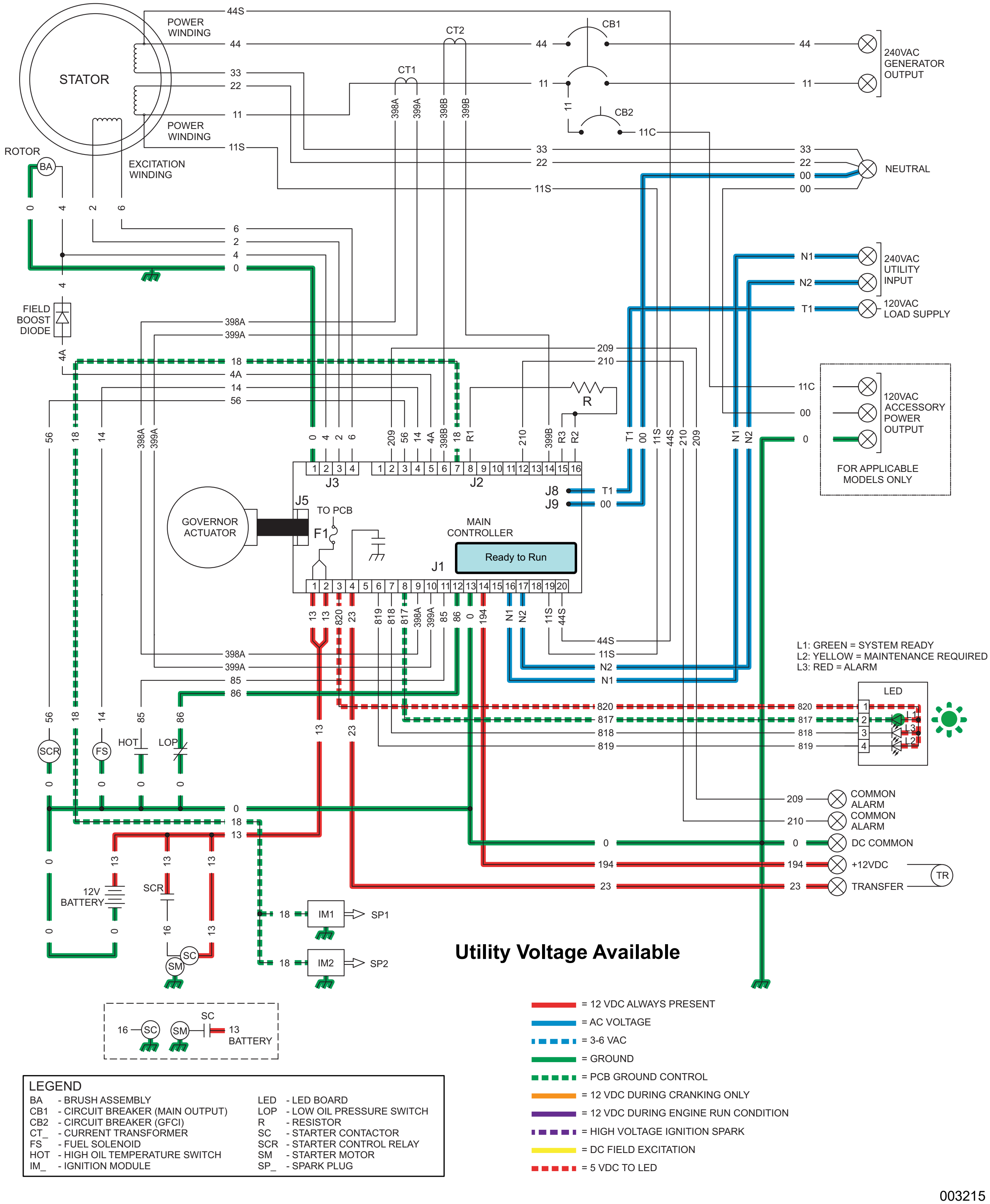

Figure 3-27. Utility Source Voltage Available

Initial Dropout of Utility Source Voltage

See ***Figure 3-29***. 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	**Util Volts Low Value**
60 Hz = 156 VAC	60 Hz = 140-171 VAC
50 Hz = 142 VAC	50 Hz = 140-156 VAC

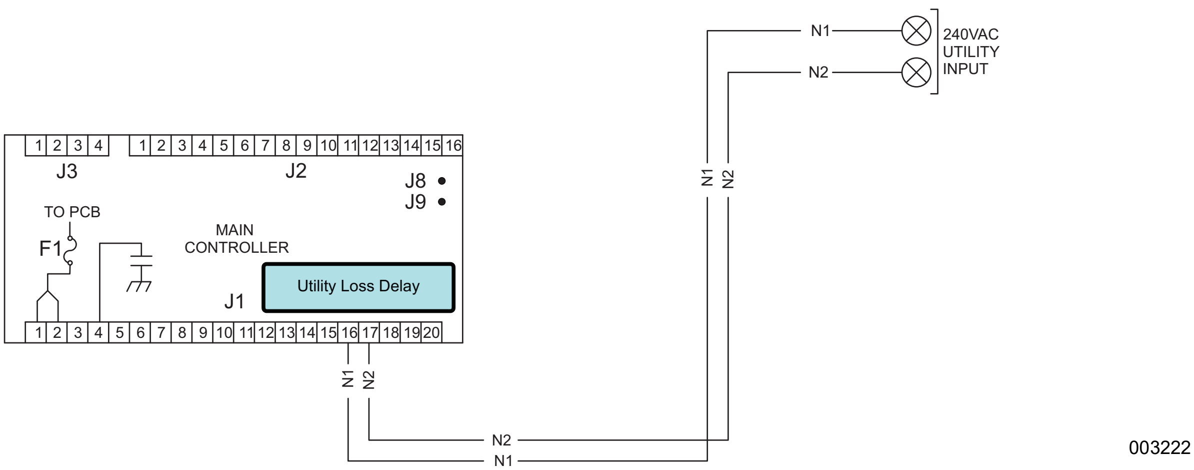

Figure 3-28.

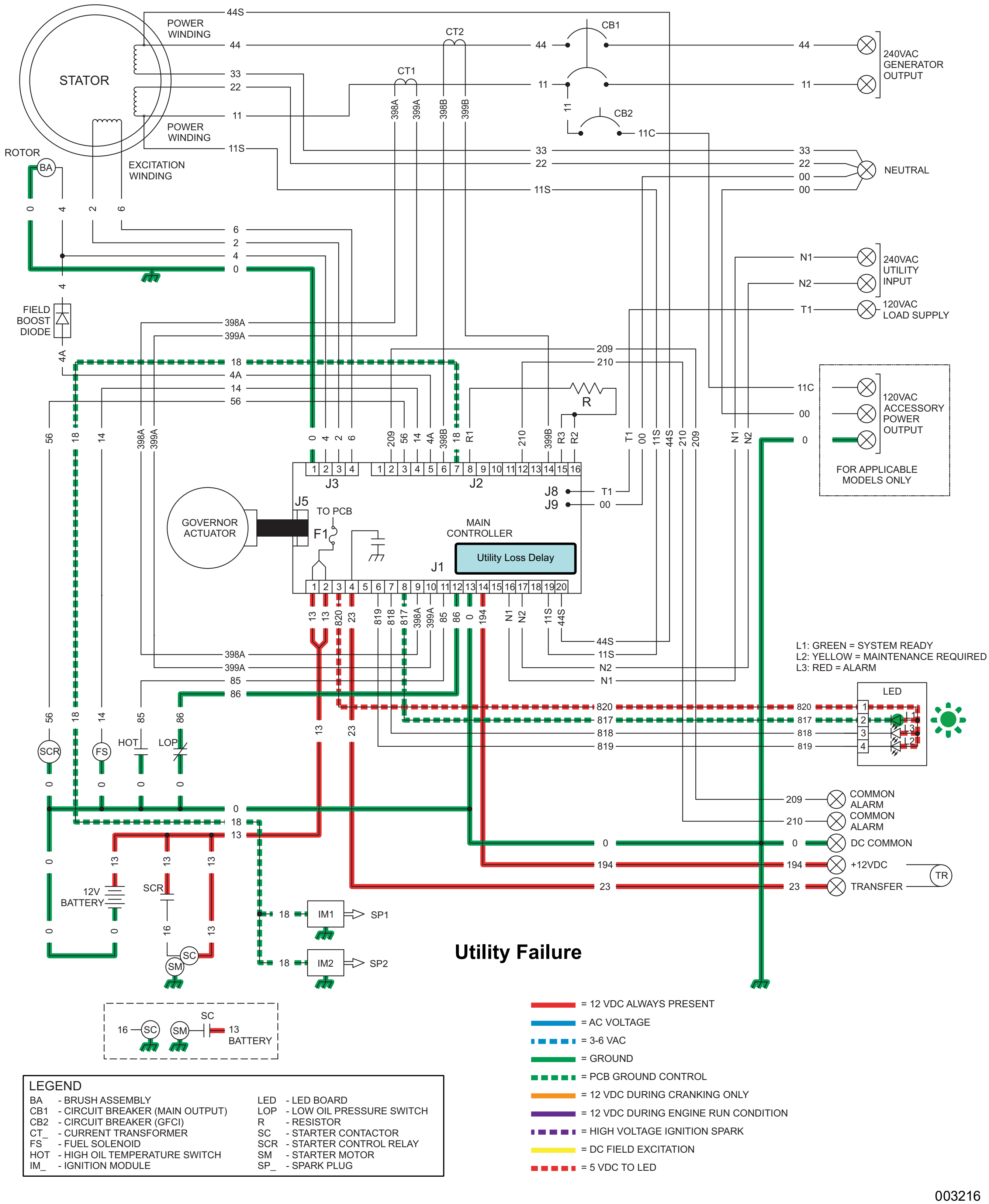

Figure 3-29. Initial Dropout of Utility Source Voltage

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 control relay (SCR) via Wire 56. When the SCR energizes, its contacts close and battery voltage is delivered to a starter contactor (SC). When the SC energizes, its contacts close and battery voltage is delivered to the starter motor (SM); the engine is now cranking.
- With the engine cranking, oil pressure will begin to build in the engine, opening the contact internal to the low oil pressure switch.
- 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.

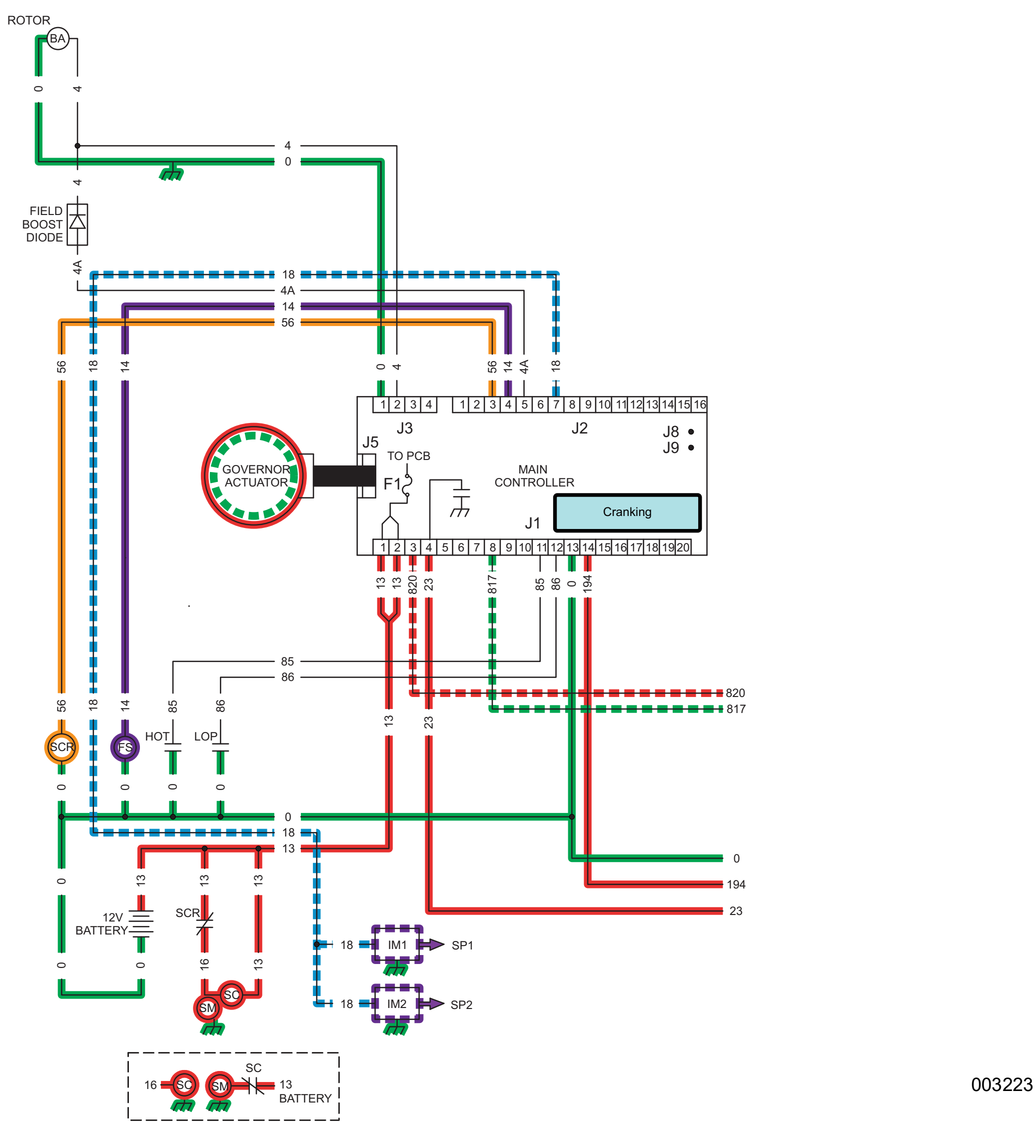

Figure 3-30.

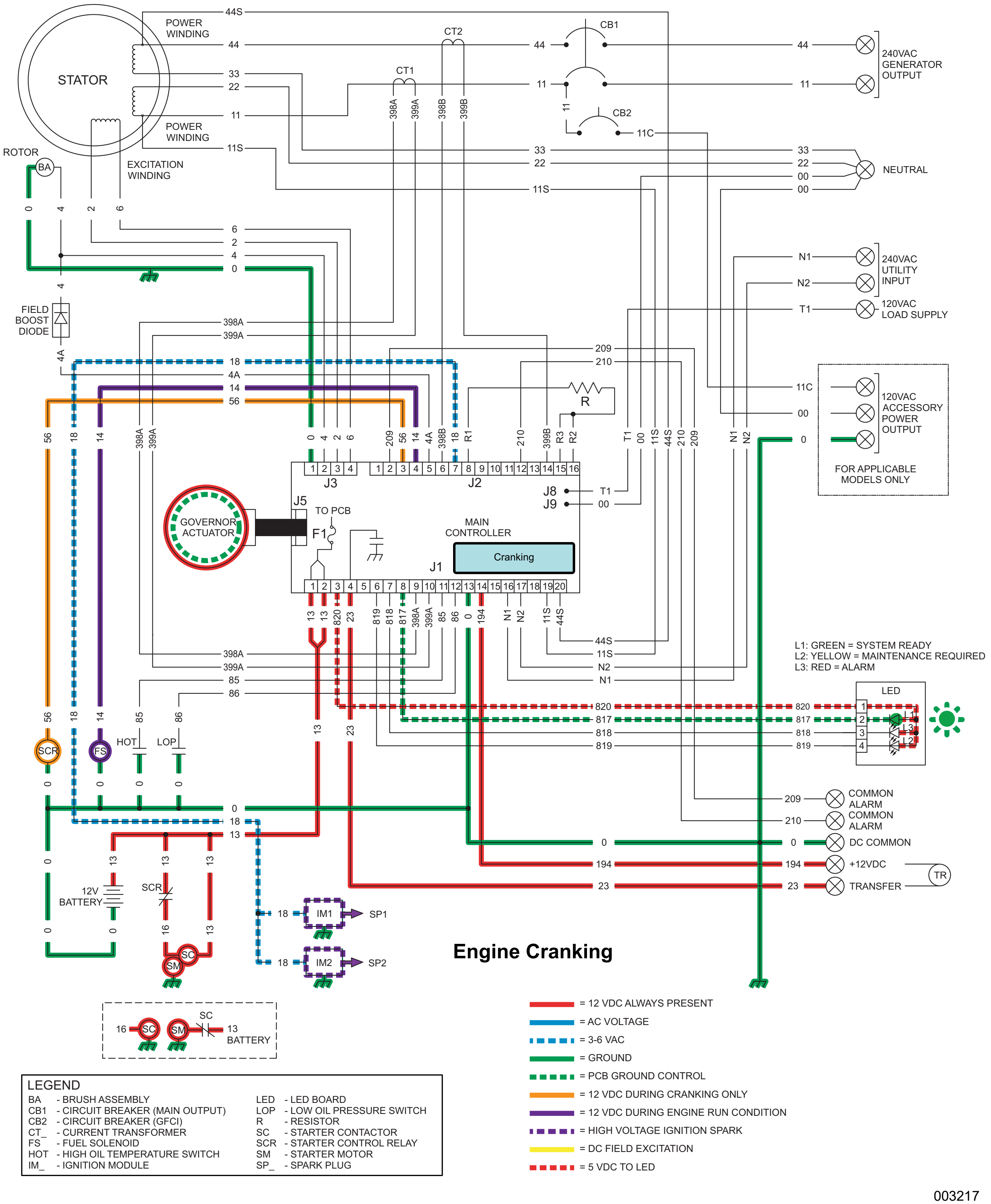

Figure 3-31. Utility Voltage Failure and Engine Cranking

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.

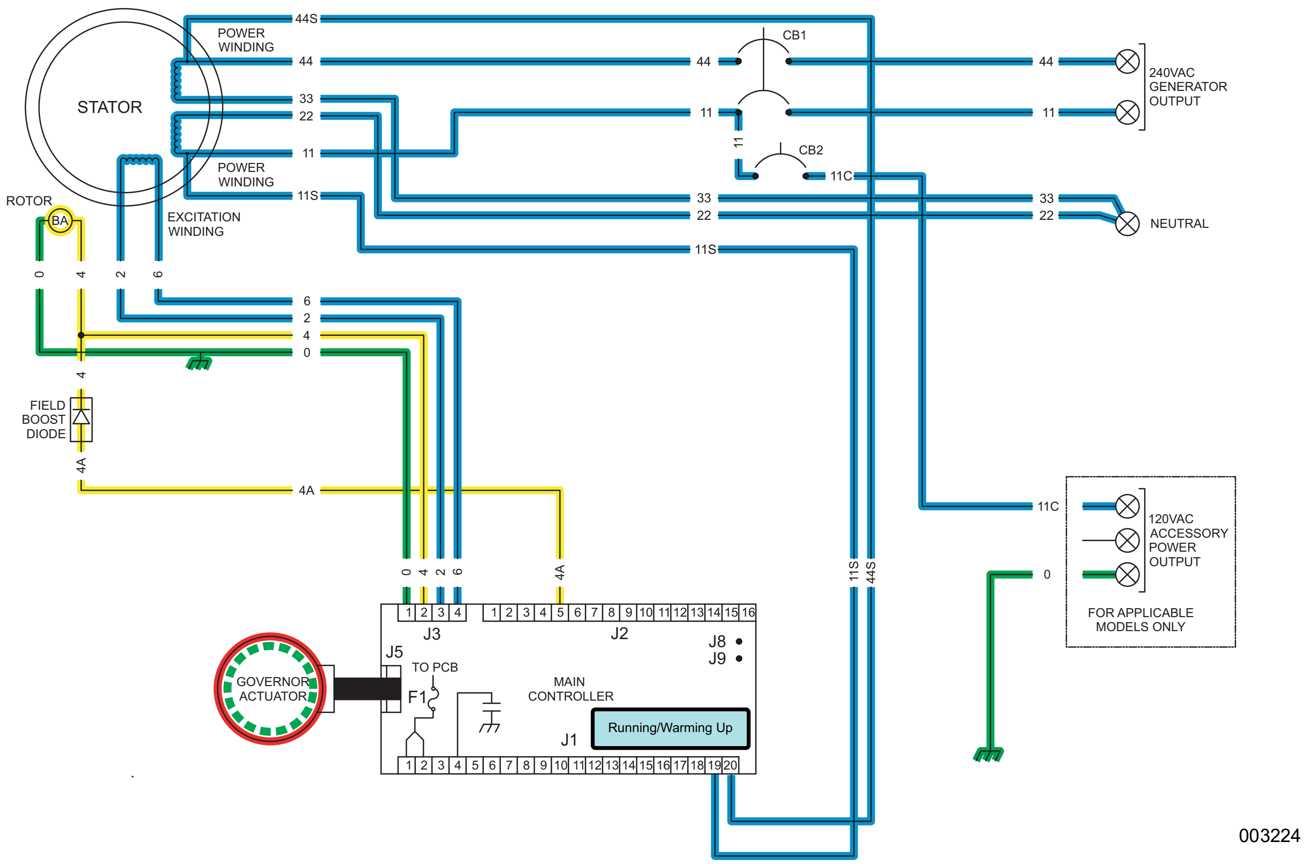

Figure 3-32.

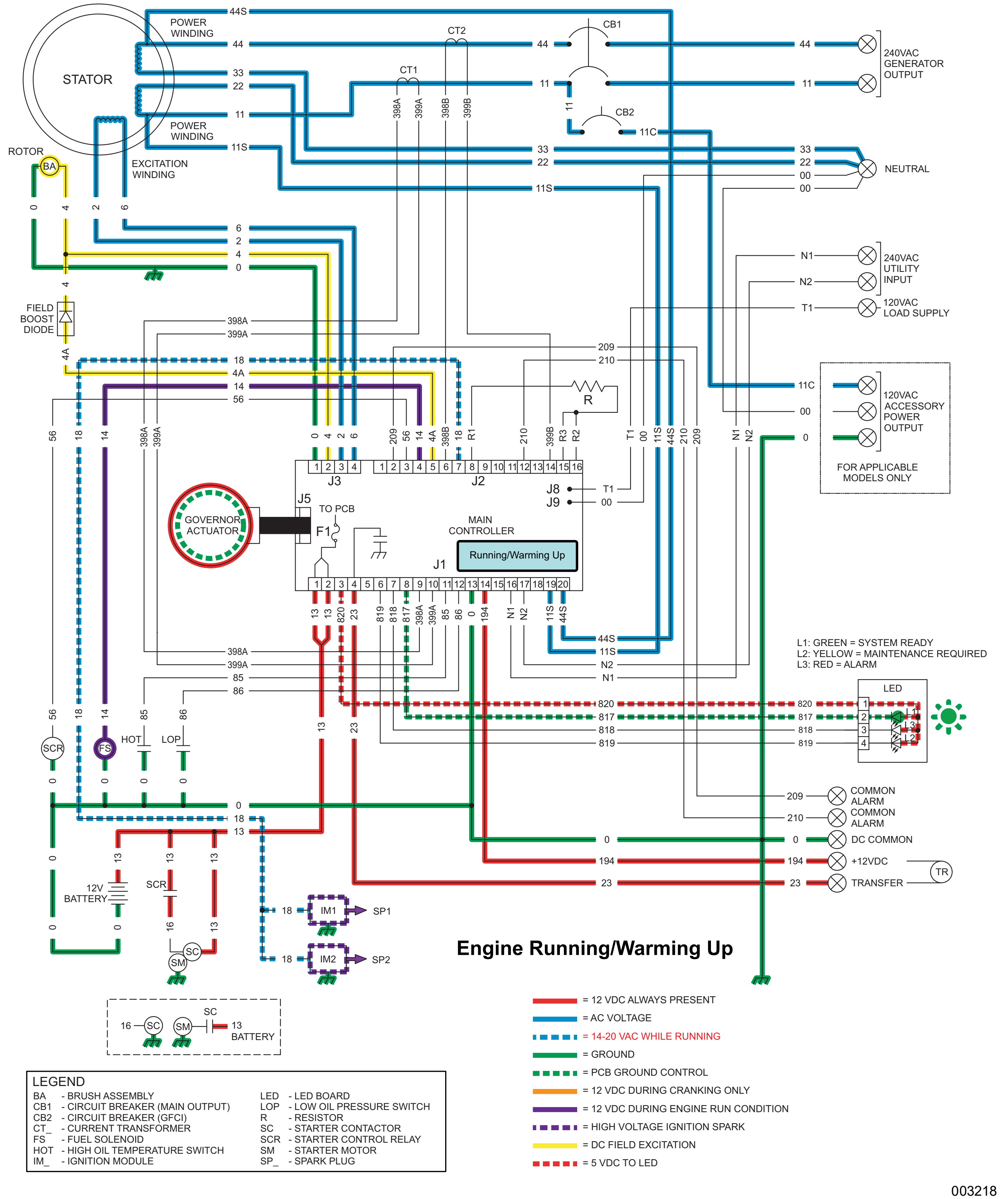

Figure 3-33. Engine Startup and Running

Transfer to Standby

In *Figure 3-35* 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 minimal 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)

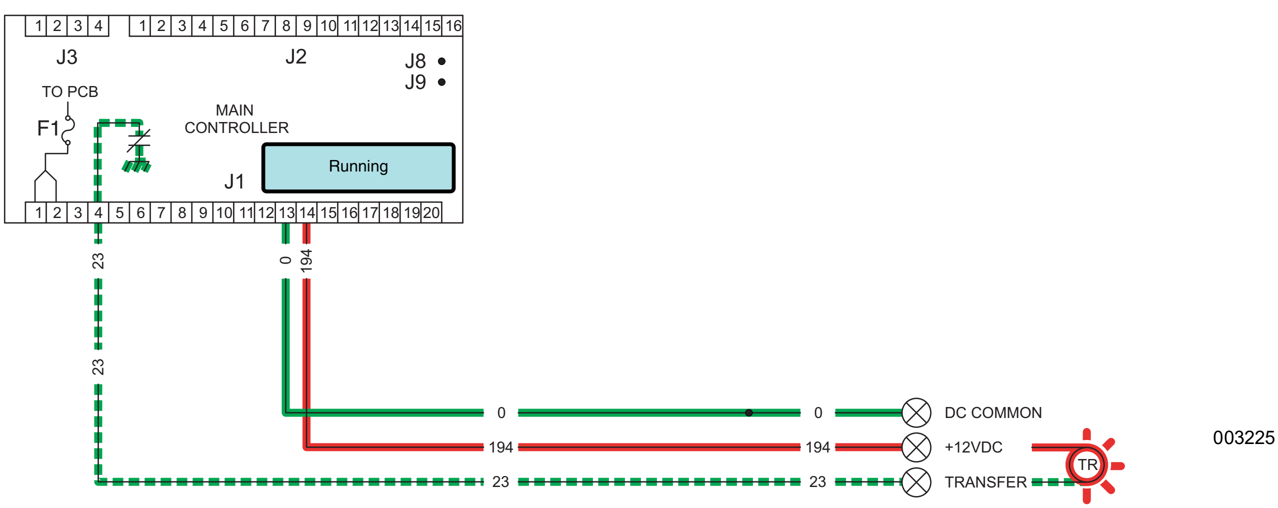

Figure 3-34.

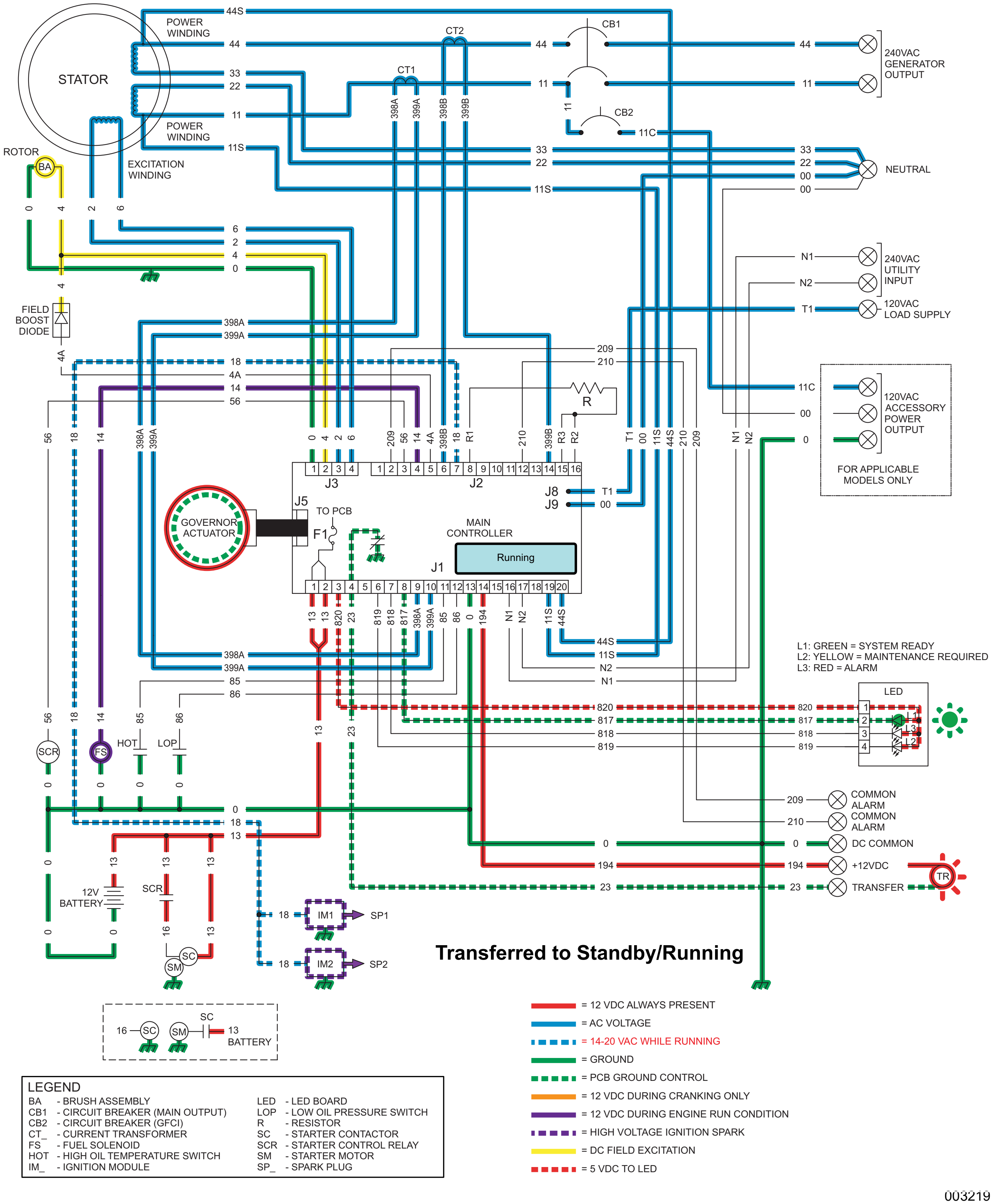

Figure 3-35. Transfer to Standby

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 for 60 seconds 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	**Util Recovery Volts**
60 Hz = 190 VAC	60 Hz = 190-216 VAC
50 Hz = 175 VAC	50 Hz = 175-198 VAC

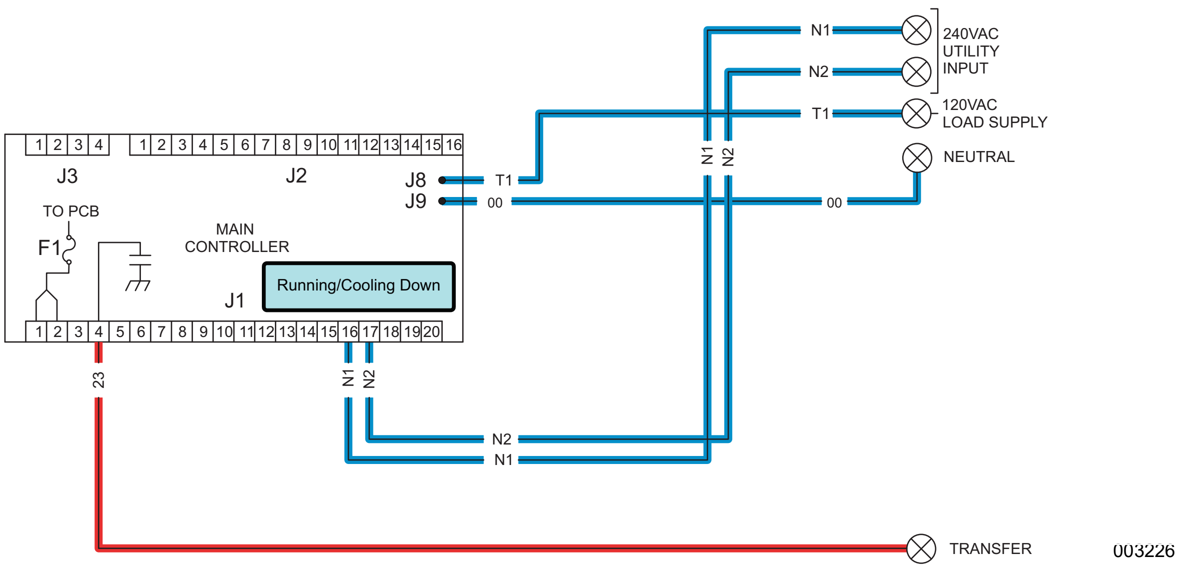

Figure 3-36.

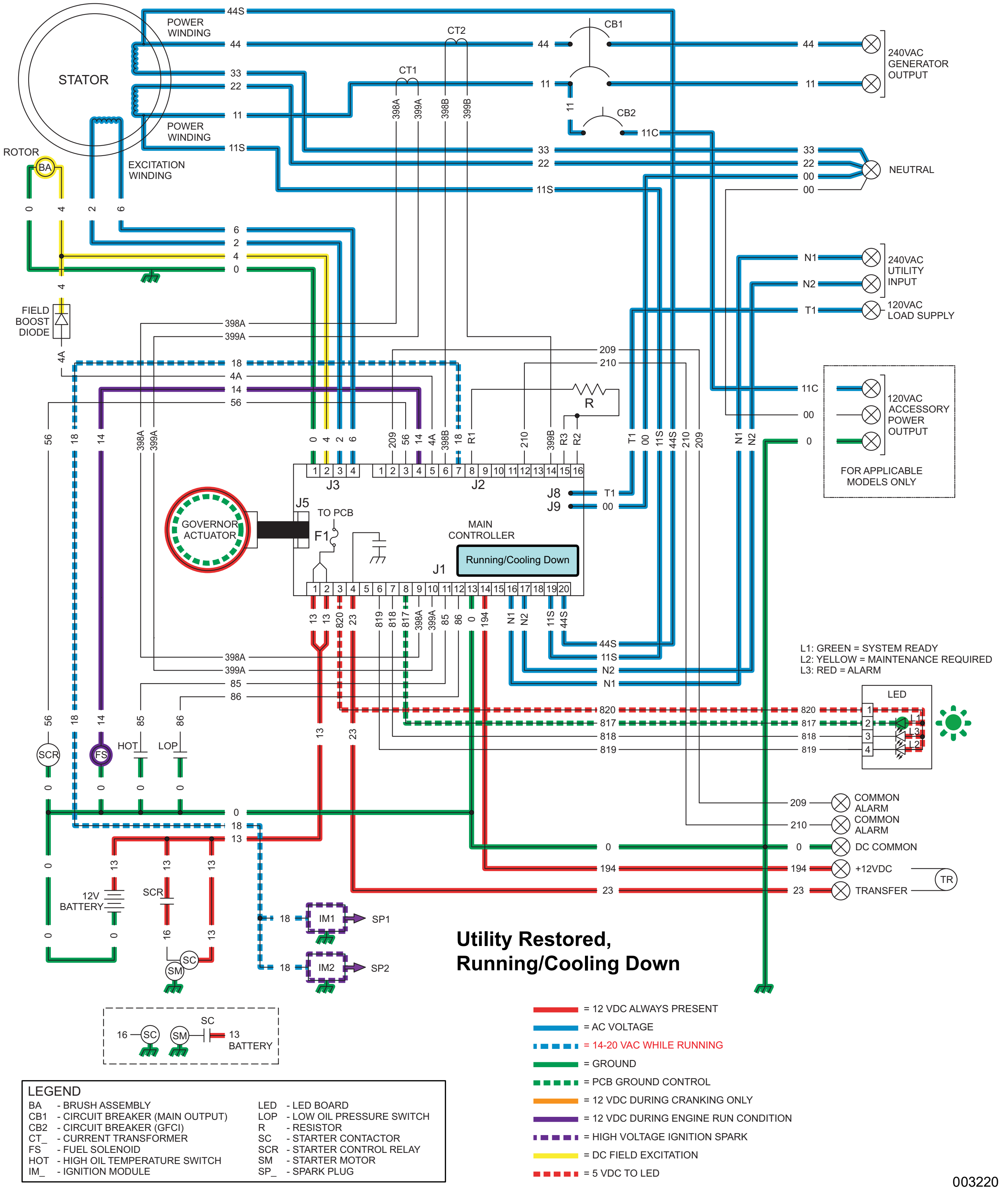

Figure 3-37. Utility Voltage Restored and Re-transfer to Utility

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.

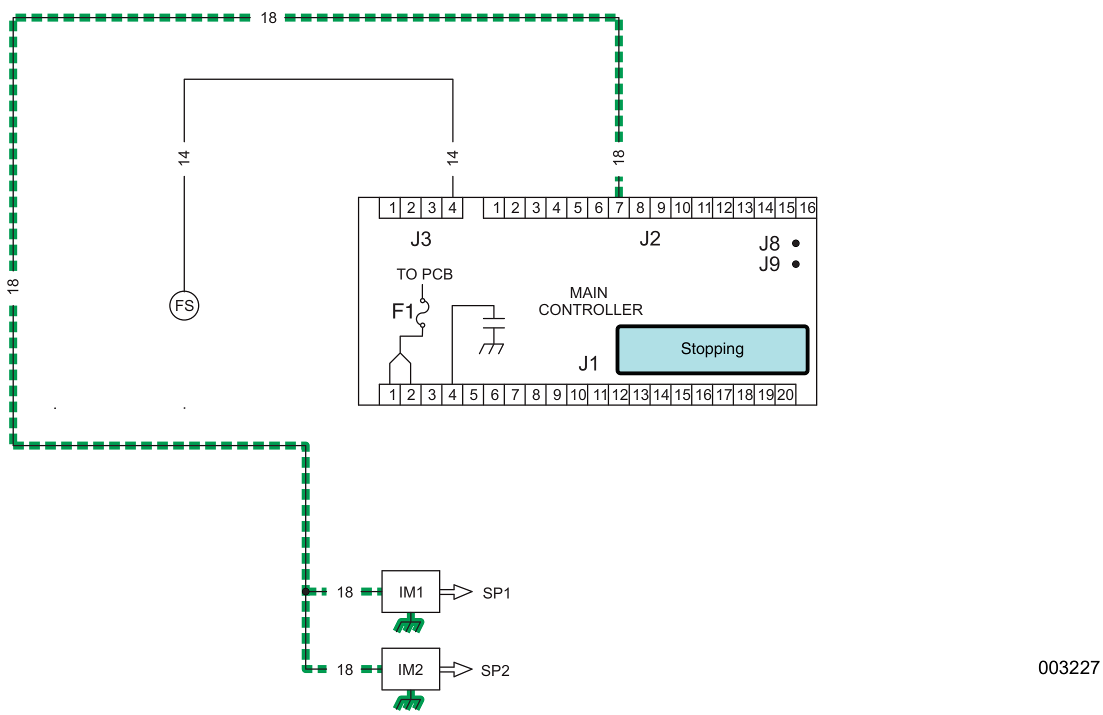

Figure 3-38.

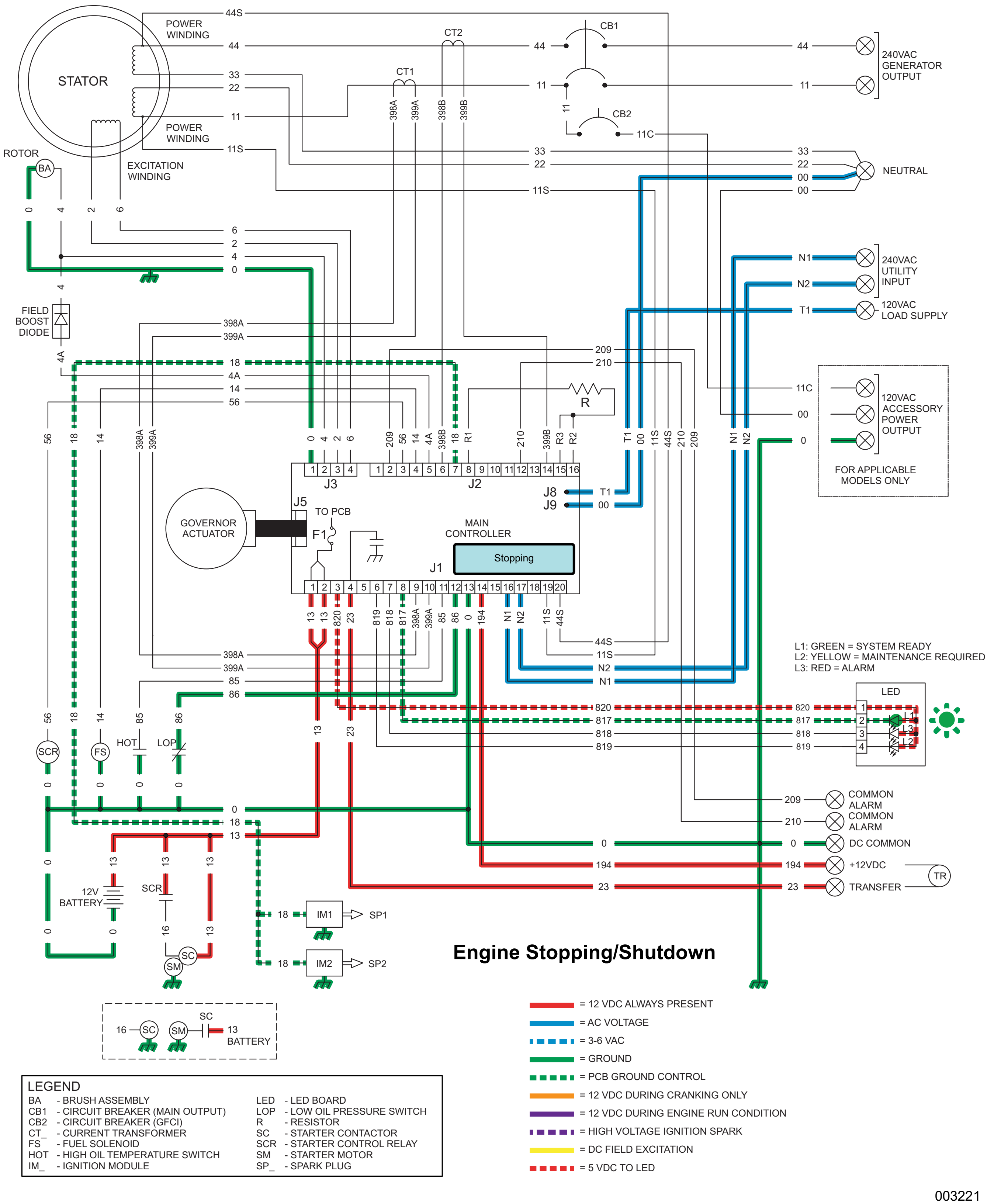

Figure 3-39. Engine Shutdown

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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	Description	Action Step
Controller Fault	ALARM		**No E-code on HSB**	Update Firmware – Alternate Method, Section 1.3. 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 or No Rotation Warning	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, Test 50 or Test 54
Underspeed	ALARM	1603	**Underspeed** The engine never comes up to 3600 RPM.	Test 54
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**.	Problem 1
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**.	Problem 1
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**.	Check customer connections and stator connections Problem 1

Evolution™ Controller E-Codes

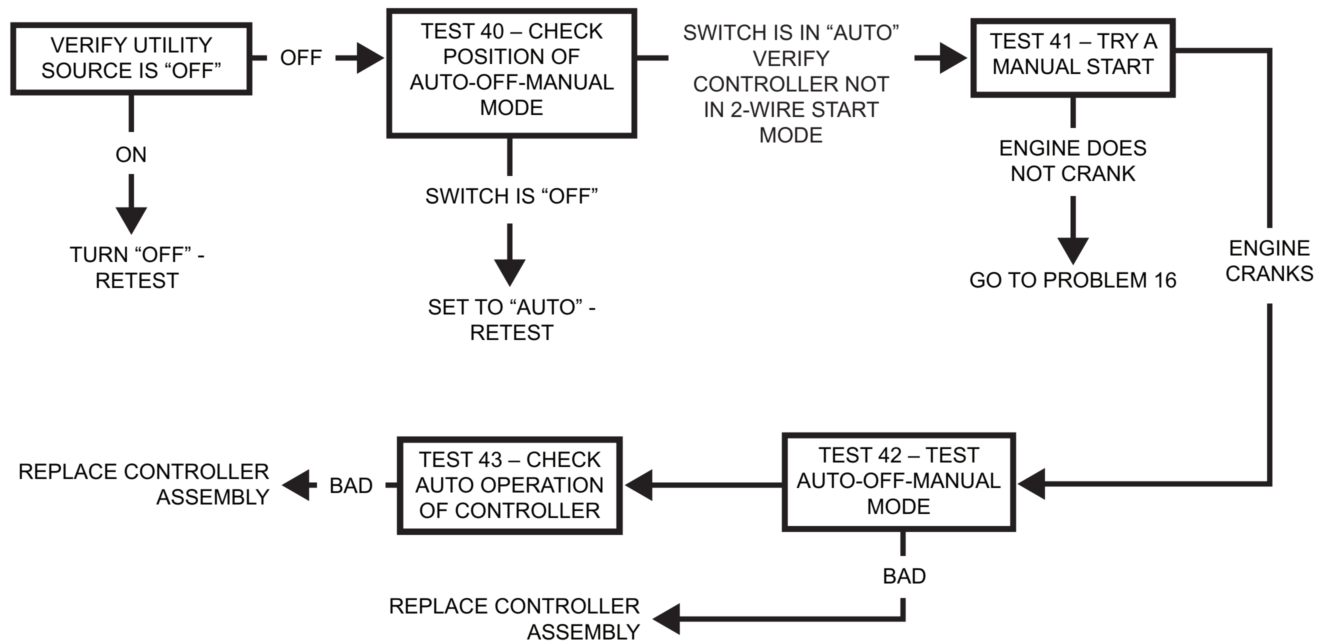
NOTE: For any Displayed Alarm on the controller, use the Action Step as a starting point.

Displayed Alarm	Alarm/ Warning	E-Code	Description	Action Step
Undervoltage	ALARM	1906	**Single Zero Cross missing** Undervoltage due to faulty excitation winding, zero cross circuit, or circuit in general. Possible cause: field boost hardware failure. (One zero cross missing greater than 1.5 sec) Controller will display “WARMING UP” for 4 minutes. Refer to **Section 2.2**.	Problem 1
Wiring Error or “Transfer Wire Warning”	ALARM	2098	**Mis-wired Customer connection** Insufficient DC voltage on transfer power output.	Update Firmware and verify correct placement of control wires in the customer connection and transfer switch.
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).	Test 14 or Problem 18
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.
Shutdown Switch	ALARM	2800	External shut down circuit is open.	Test 69
Low Battery	WARNING		Condition->Battery less than 12.1 Volts for 60 seconds	Problem 22
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	Problem 22
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

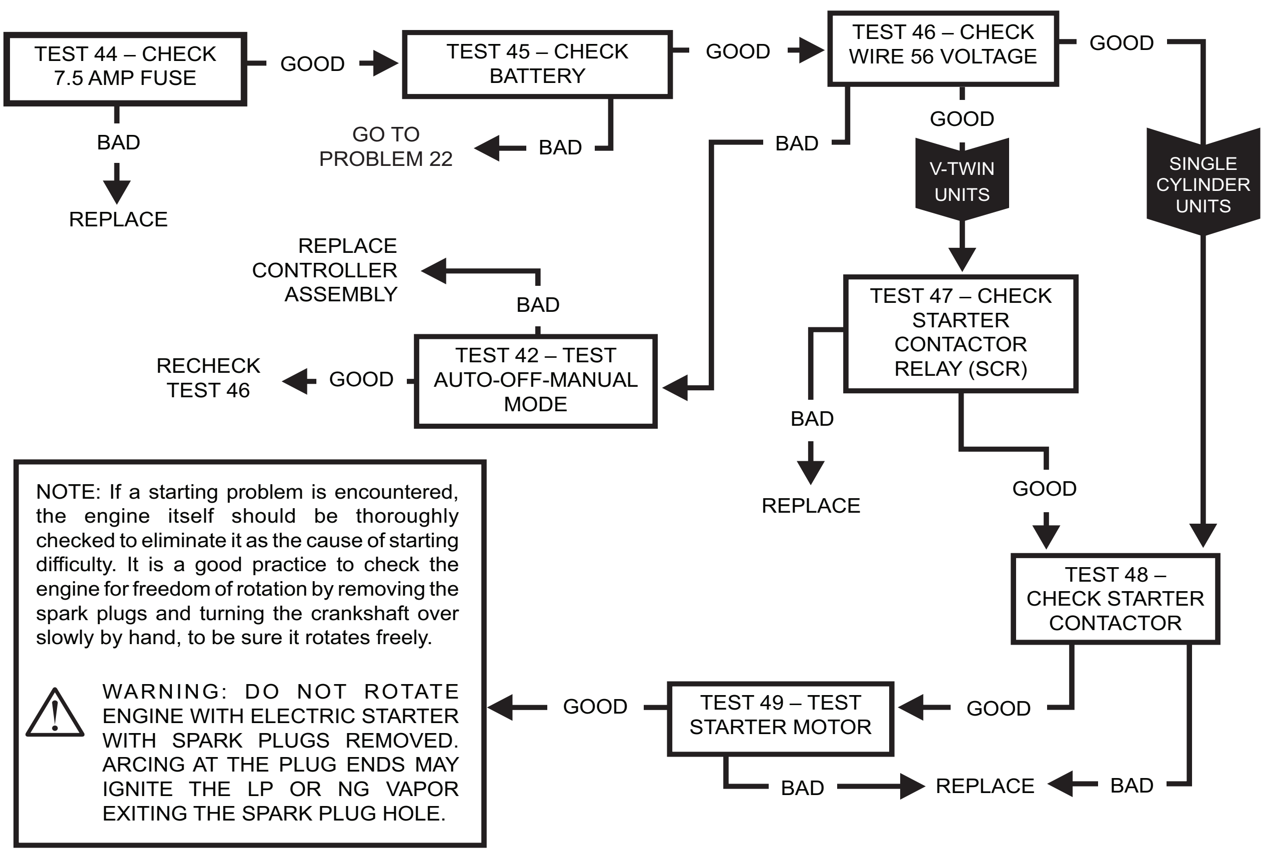
Additional Codes For 8 and 9 kW Units (Evolution 1.0 Controller Only)

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. Test 50

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



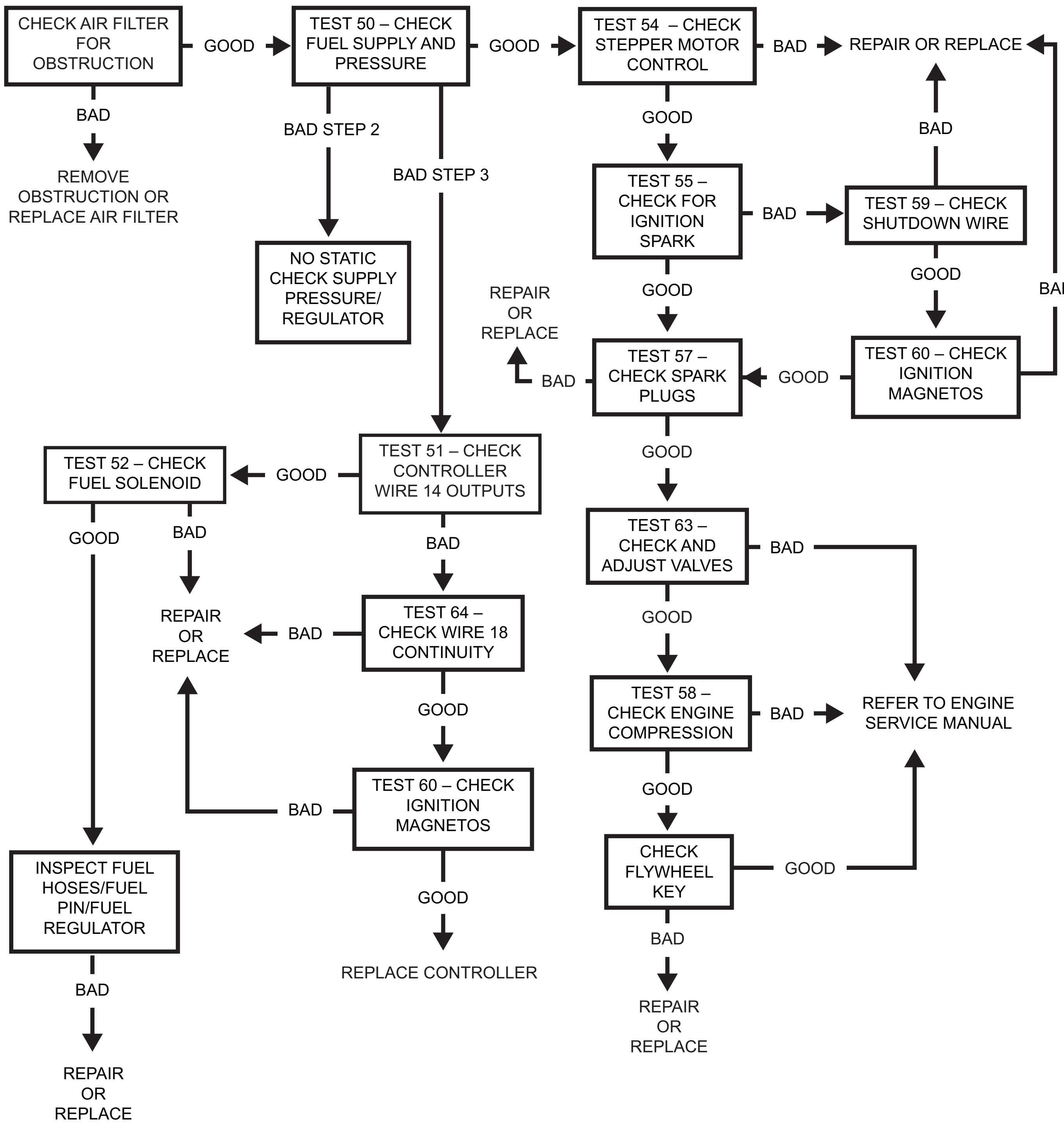
Problem 16 – Engine Will Not Crank When Controller is Set to MANUAL



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

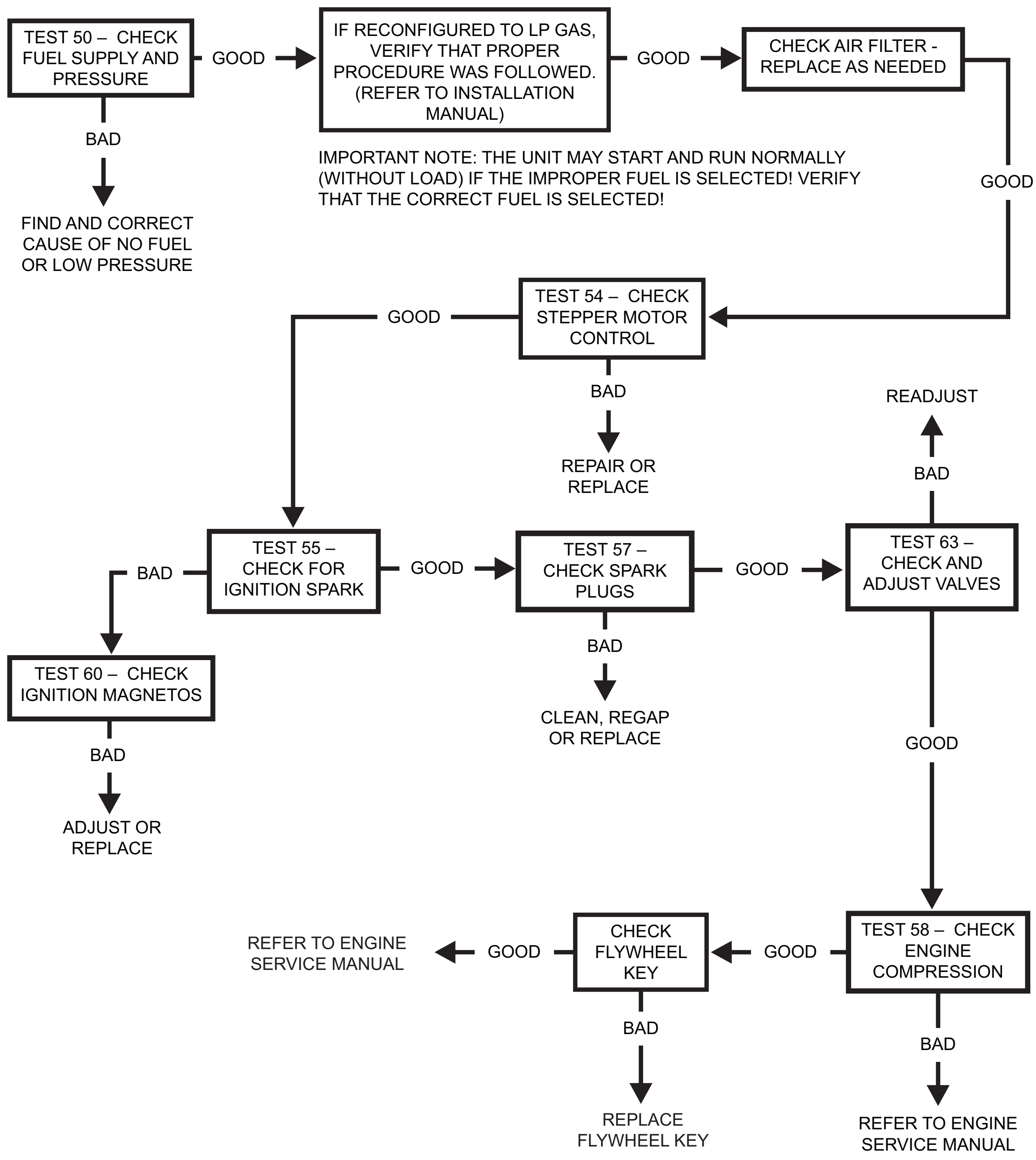
Problem 17 – Engine Cranks but Will Not Start

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



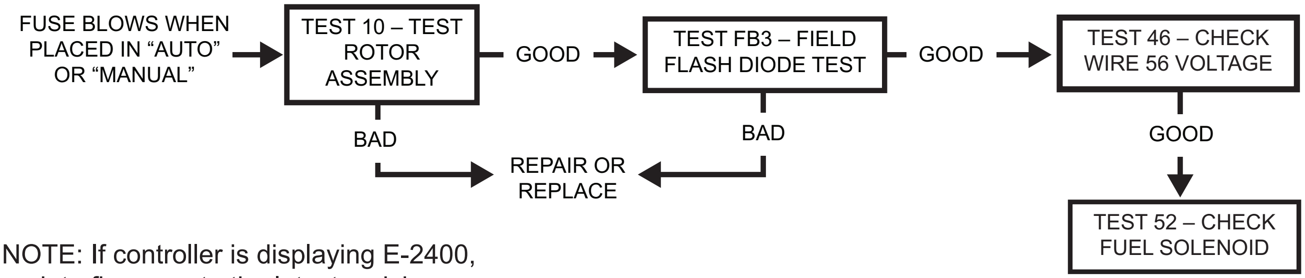
IMPORTANT NOTE: Clear any faults in the controller before proceeding with any running diagnostic steps!

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



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

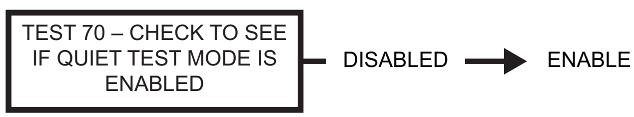
Problem 19 – 7.5 Amp Fuse (F1 in Controller) Blown



NOTE: If controller is displaying E-2400, update firmware to the latest revision.

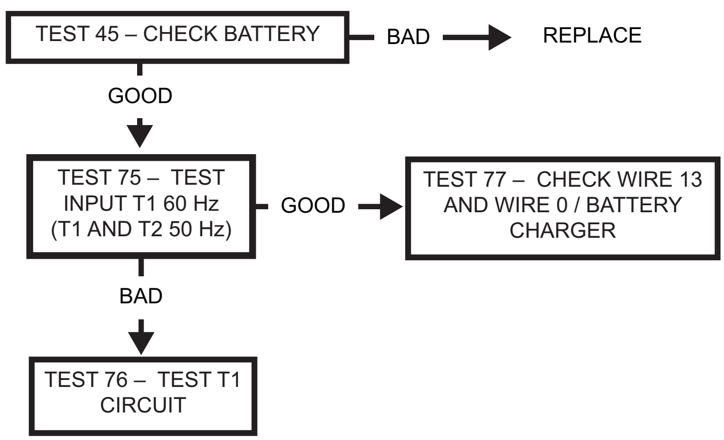
Problem 20 – Generator Will Not Exercise

Problem 21 – No Quiet Test Mode



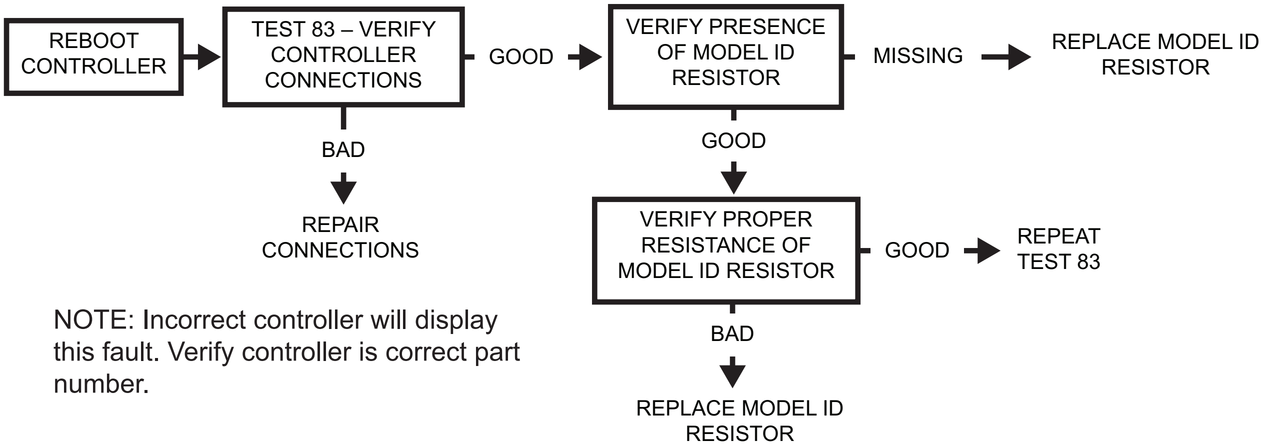
Problem 22 – Battery is Dead / Controller Goes Dark When Unit Tries to Start

Note: T1 = 60 Hz, T1 & T2 = 50 Hz



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

Problem 23 - Controller displays "Model Ident Problem Fix Harness Resistor" fault



NOTE: Incorrect controller will display this fault. Verify controller is correct part number.

Problem 24 - Generator Starts in Auto With Utility Present

Refer to RTS Transfer Switch Diagnostic Manual P/N A0001157652

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

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Section 3.6 Diagnostic Tests

Introduction

This section familiarizes the service technician with acceptable procedures for the testing and evaluation of various problems that can occur on standby generators with air-cooled engines. The numbered tests in this section correspond with the flow charts in ***Section 3.5, Troubleshooting Flowcharts***.

Some test procedures in this section require the use of specialized test equipment, meters, or tools. Most tests can be performed with a digital multimeter (DMM). An AC frequency meter is required where frequency readings must be taken.

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

Figure 3-40 shows the DMM in two different states. The left DMM indicates an OPEN circuit or INFINITY. The right DMM indicates a dead short or CONTINUITY. Throughout the troubleshooting, refer back to ***Figure 3-40*** as needed to understand what the meter is indicating about the particular circuit that was tested.

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

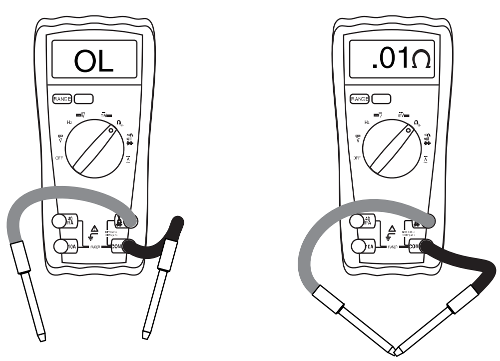

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Figure 3-40. INFINITY (Left) and CONTINUITY (Right) Meter Readings

Safety

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

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

Engine/DC Troubleshooting

It is good practice to continue asking questions during the troubleshooting process. Asking some of these questions during evaluation may help identify a problem more quickly.

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

Test 40 – Check position of AUTO-OFF-MANUAL Mode

General Theory

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

NOTE: Verify controller is not in Two-Wire Start mode.

Procedure

With the controller set to AUTO, test automatic operation. Testing of automatic operation can be accomplished by turning off the Utility power supply to the transfer switch. When the Utility power is turned off the generator should crank and start. Following startup, transfer to the "Standby" position should occur.

Results

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

Test 41 – Try a Manual Start

General Theory

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

Procedure

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

Results

1. If the engine cranks manually, but does not crank automatically, refer back to flow chart.
2. If the engine does not crank manually proceed to **Problem 16**.

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

Procedure

1. See ***Figure 3-41***. Navigate to the Input Screen using the menu system for the controller being worked on.

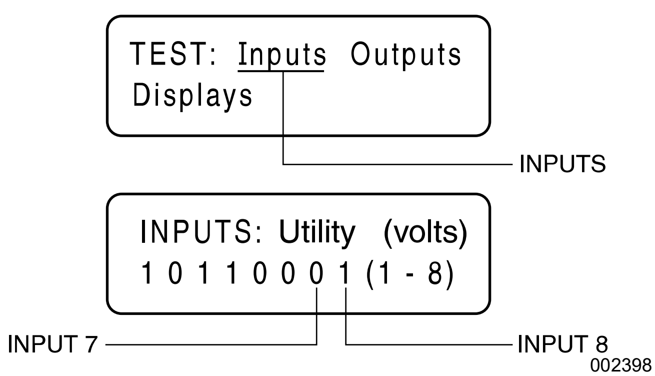


Figure 3-41. The Input Screens

2. With the Inputs Screen displayed, set the controller to AUTO. If the controller reads the auto input from the switch, Input 7 will change from "0" to "1". See ***Table 3-7*** in Section 3.1 for a description of the inputs.
3. With the Inputs Screen displayed place the controller to MANUAL. If the controller reads an input from the Switch, Input 8 will change from "0" to "1".
4. With the controller set to OFF, both inputs will read zero.

Results

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

Test 43 – Test Auto Operations of the Controller

General Theory

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

Procedure

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

Results

Refer back to the flow chart.

Test 44 – Check 7.5 Amp Fuse

(Alarm Code 2400 Firmware 1.11 and Older)

NOTE: Use the Alarm Log in the control panel to help troubleshoot various problems. With utility available and a blown 7.5 amp fuse, when attempting a MANUAL start, the controller will fault for RPM Sense Loss. The ALARM LOG will display "1. RPM Sense Loss" and "2. No Rotation Warning". With utility failure, a blown 7.5 amp fuse, and controller set to AUTO, the controller will go dark and does not log either an ALARM or WARNING.

General Theory

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

Procedure

Remove and inspect the 7.5 amp fuse (F1). Visually inspect the fuse and fuse element. If the fuse element looks good, or if it cannot be visually inspected, test the fuse for an open with a DMM or Continuity Tester.

Results

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

Test 45 – Check Battery and Cables

General Theory

Battery power is used to (a) crank the engine and (b) to power the circuit board. Low or no battery voltage can result in failure of the engine to crank and the controller to blank out and restart in either MANUAL or AUTO modes of operation. As well, if there is a loose connection or corrosion associated with a wire (positive or negative), battery voltage may be present, but because of the high resistance, will not allow current to flow.

Electrical voltage drop varies according to current flow. Unless the circuit is operated so current flows through it, voltage drop cannot be measured. To properly measure voltage drop, a crank attempt will need to be performed. This test will determine whether the battery, battery cables, or both are at fault.

NOTE: The battery charger in the control panel is not designed to recharge a dead battery.

Procedure A. Inspect Battery Cables, Terminals, and Connections

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

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

3. Verify all cable clamps are tight. The Red battery cable from the starter contactor (SC) must be securely attached to the positive (+) battery post. The Black cable from the frame ground stud must be tightly attached to the negative (-) battery post.
4. If the above inspection points have been verified satisfactory, proceed to Procedure B.

Procedure B. Perform a Battery Open Circuit Voltage Test

1. See *Figure 3-42*. Remove the T1 fuse from the transfer switch or disconnect the J8-J9 connector for T1 (A) to disable the battery charger.

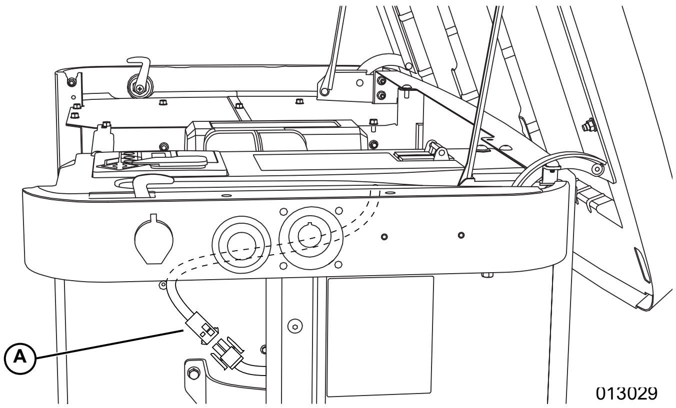


Figure 3-42. T1 Connection

2. Set a DMM to measure DC voltage.
3. Connect the red meter test lead to the positive battery post and connect the black meter test lead to the negative battery post.
4. Measure and record the OCV (Open Circuit Voltage)

Procedure B Results

1. If battery voltage is 12.1 VDC or less, or if engine does not crank (turn over), proceed to Procedure C.
2. If battery voltage is 12.2–12.6 VDC or above and the engine does or does not crank, proceed to Procedure D.

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

IMPORTANT NOTE: To properly load test a battery when using a resistance type load tester, the battery must be completely full of electrolyte, fully charged and the load applied must be 1/2 of the battery's CCA Rating. (e.g. 540/2=270A) For this reason, a resistance type load tester is not recommended.

1. Remove 7.5 amp fuse from the controller.
2. See *Figure 3-42*. Remove the T1 fuse from the transfer switch or disconnect the J8-J9 connector for T1 to disable the battery charger.
3. Connect the test leads to the positive and negative posts of the battery being tested and follow the conductance battery tester manufacturer's instructions. Test results should not indicate

anything lower than 60% of the battery's rated CCA. If battery CCA is 60% or less, replace battery with new.

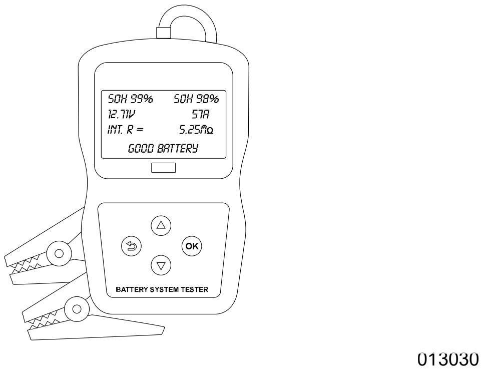


Figure 3-43. Conductance Type Battery Tester

4. If the above test results have been verified as satisfactory, proceed to Procedure D.

Procedure D. Perform Starter Circuit Voltage Drop Test

NOTE: Engine must crank to properly measure voltage drop. A crank attempt will need to be performed. Test 46 – Check Wire 56 Voltage, Test 47 – Test Starter Control Relay, and Test 48 – Test Stater Contactor must be verified and need to work to perform Procedure D.

1. Turn off the fuel source and remove Wire 14 from the fuel solenoid to inhibit any possible startup.
2. See ***Figure 3-44*** and ***Figure 3-45***. Refer to battery post and starter connections and perform a voltage drop tests as indicated.

NOTE: Some older single cylinder units have a bulkhead mounted starter solenoid.

3. Set the controller to MANUAL. Measure and record the voltage.
4. Record readings from test points V1, V2, V3, and V4 as depicted in Figure ***Figure 3-44*** and ***Figure 3-45***.

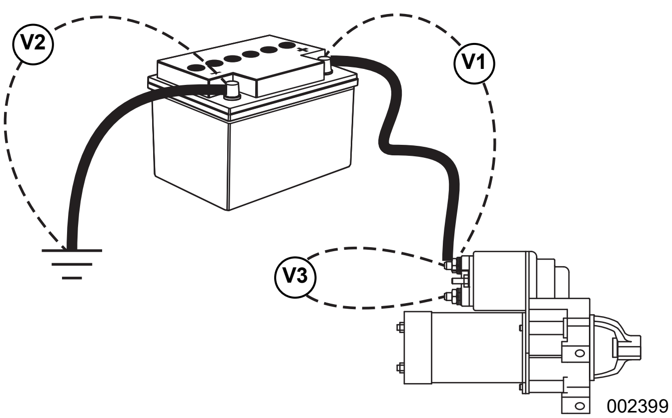


Figure 3-44.

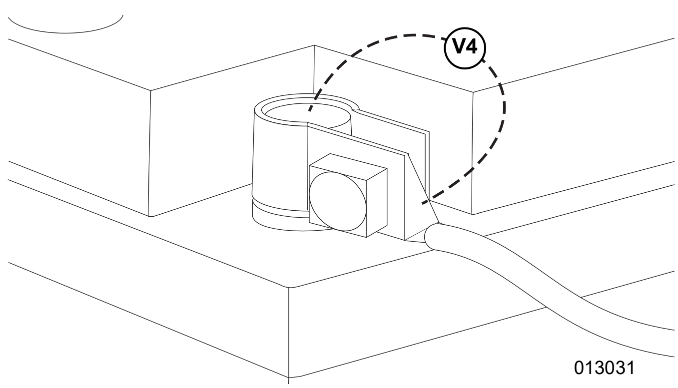


Figure 3-45.

5. Although resistance-free connections, wires and cables would be ideal, most of them will contain at least some voltage drop. Maximum voltage readings are shown in ***Table 3-11***:
6. If any of the voltages are greater than indication in ***Table 3-11***, repair or replace the component as needed.
7. After repairs are made, perform Procedure C (Conductance Test) and record the value for future record keeping.

Table 3-11. Maximum Voltage Readings

DC Volts	Connection	Test
0.00-0.10	Battery Post to Battery Terminal	(V4)
0.10-0.20	Any Ground	Ground
0.20-0.30	Across a wire or cable	(Vl & V2)
0.20-0.30	Across a switch or starter contactor	(V3)
0.40-0.50	Across an entire circuit	(Pos or Neg)

Procedure E. Perform Starter Circuit Voltage Drop Test

For troubleshooting battery cables and ground connections. Usual symptoms would be no crank, controller reboots itself, or buzzing noise when the starter should be engaging.

NOTE: Voltage drop testing only works while the circuit is loaded.

1. Check battery voltage – should be greater than 12.5 VDC if the charger is working.
2. See ***Figure 3-46***. Jump Wire 13 to Wire 16 at the SCR – if battery voltage is good, the starter should start cranking. If it does, do a wiggle test on battery cables, terminals and ground connections

NOTE: Recheck battery voltage – if the battery voltage has dropped below 12 VDC, replace battery. Do not do any further troubleshooting until a new battery has been installed.

3. Set DMM to measure DC volts.
4. See *Figure 3-46*. Make the following measurements while Wire 13 and Wire 16 are still jumped together.
   a. Negative test lead on negative battery post, positive test lead on engine block. Meter should read less than 0.5 VDC. If it is more than that, either the negative cable is bad or there is a poor/loose ground connection somewhere (or both).
   b. Positive test lead on positive battery post, negative test lead on Wire 13 at the starter (other end of the red battery cable). Meter should read less than 0.5 VDC. If it is more than that, the positive cable is bad.

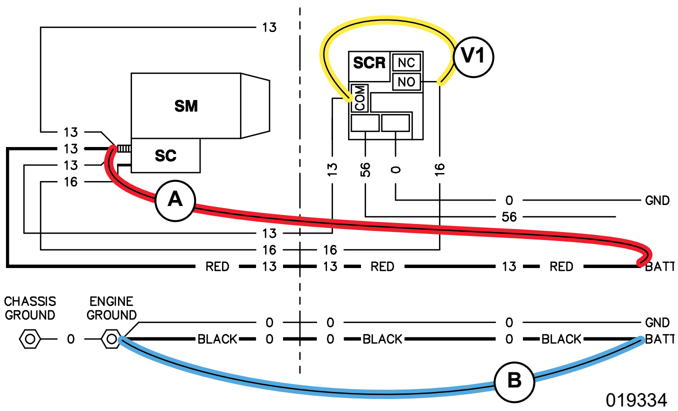


Figure 3-46. Voltage Drop Connections

Results

Whatever voltage is present on measurements 4a and 4b is the amount voltage "lost" between those two points due to loose connection or corrosion. If voltage drop test reads 12 VDC, then 100% of DC power is lost on the measured cable.

Test 46 – Check Wire 56 Voltage

General Theory

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

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

Procedure

1. Set the DMM to measure DC voltage.
2. Locate and disconnect Wire 56 from the SCR on V-Twin units and the SC on single cylinder units.
3. Connect one meter test lead to Wire 56 and the other meter test lead to the battery negative terminal.
4. Set the controller to MANUAL. Observe the meter. The DMM should indicate battery voltage. If battery voltage was measured, stop testing and refer back to the flow chart. If voltage was NOT measured, proceed to Step 5.

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

5. Navigate to the Digital Output Screen using the menu system for the controller being worked on.
   a. Digital Output 6 is Wire 56 output from the board.
6. Set the controller to MANUAL and observe digital output Number 6. If the controller is working correctly output Number 6 will change from a "0" to a "1". Observe and record the change in state.
   a. If output does not change, replace controller.
   b. If the controller indicated a "1" then proceed to the next step.
7. Set a DMM to measure DC volts. Use one meter lead to back probe Wire 56 at the controller connector, leaving the connector connected to the controller. Connect the other meter lead to ground. Set the controller to MANUAL and measure the voltage.
   a. If battery voltage is measured go step 8.
   b. If no voltage is measured, verify Molex pin and wire connection is good. If good replace the controller.
8. Set a DMM to measure resistance.
9. Remove 7.5 amp fuse.
10. Disconnect the harness connector from the controller.
11. Remove Wire 56 from the starter control relay (V-twin units) or from the starter contactor (single cylinder units).
12. Connect one meter test lead to disconnected Wire 56 and connect the other meter test lead to the controller side of the harness (Wire 56), measure and record the resistance.

Results

1. If the DMM indicated battery voltage in Step 4, refer back to the flow chart.
2. If the Digital Output in Step 6 did not change, replace the controller.
3. If the DMM did NOT indicate CONTINUITY in Step 12, repair or replace Wire 56 between the controller side of the harness and the relay or contactor.
4. If controller indicated "1" in Step 6, voltage present at Wire 56 at controller Step 7, and continuity indicated on Wire 56 Step 12, results are good. Before replacing the controller, check for a loose connection between controller and SCR.

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

General Theory

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

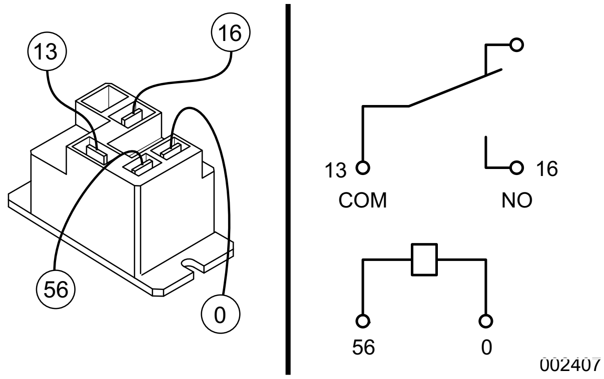


Figure 3-47. Starter Control Relay (V-Twin Engine)

Procedure

1. Set a DMM to measure DC voltage.
2. Disconnect Wire 13 from the SCR located in the control panel.
3. Connect the positive meter test lead to Wire 13 and connect the negative meter test lead to a common ground. Measure and record the voltage.
4. Connect Wire 13 to the SCR.
5. Disconnect Wire 16 from the SCR.
6. Connect the positive meter test lead to the **terminal** on the SCR <u>from which</u> Wire 16 was removed and connect the negative meter test lead to a common ground.

IMPORTANT NOTE: <u>Do not test wire.</u>

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

Results

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

Test 48 – Test Starter Contactor

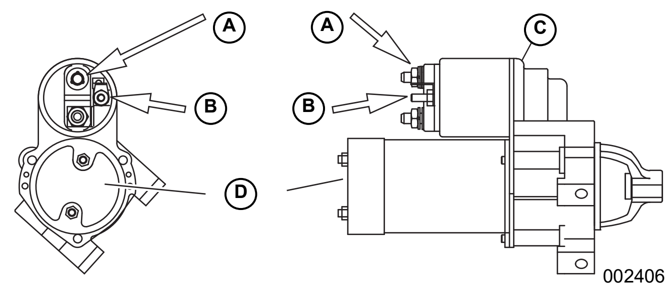
General Theory

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

Procedure

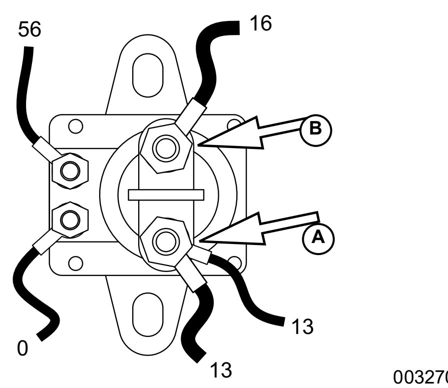
Carefully inspect the starter motor cable that runs from the battery to the starter motor. Cable connections must be clean and tight. If connections are dirty or corroded, remove the cable and clean cable terminals and terminal studs. Replace any cable that is defective or badly corroded.

See ***Figure 3-48*** and ***Figure 3-49*** for Test Points.



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

Figure 3-48. Starter Contactor (V-Twins and units with 426cc Engine)



A. Test Point A
B. Test Point B

Figure 3-49. Starter Contactor (410cc Single Cylinder Engine Units Only)

1. Set DMM to measure DC voltage.
2. Connect the positive meter test lead to the positive post of the battery and connect the negative meter test lead to the negative post of the battery. The DMM

should indicate battery voltage. This measurement will be a reference during the testing procedure.

3. Connect the positive meter test lead to Test Point A and connect the negative meter test lead to an engine ground. Measure and record the voltage.
4. Connect the positive meter test lead to Test Point B and connect the negative meter test lead to an engine ground.
5. Set the controller to MANUAL. Measure and record the voltage at Test Point B. The contactor should energize.

Results: V-Twin Engine

1. If the DMM did not indicate battery voltage in Step 5, measure the resistance on Wire 16 between the SCR and the contactor. If OL was measured on the meter, repair or replace Wire 16 between the SCR and the contactor.

Results: 410cc Single Cylinder Engine Units Only

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

Results: 426cc or 460cc Single Cylinder Engine Units Only

1. If battery voltage was indicated in Steps 3 and 5, stop testing and refer back to the flowchart.
2. If battery voltage was indicated in Step 3, but not in Step 5, measure the resistance between Test Point B and Controller connection point for Wire 56 (Use Appendix A for pin locations). If OL was measured on the meter, repair or replace Wire 56. If resistance was measured, refer back to the flow chart.

Test 49 – Test Starter Motor

Conditions Affecting Starter Motor Performance

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

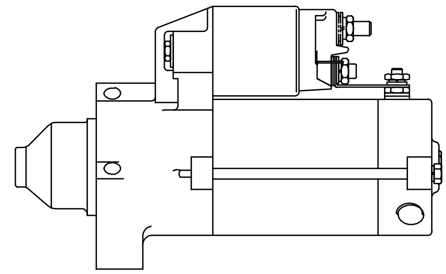


Figure 3-50. Starter Motor (V-Twins and units with 426cc and 460cc engines)

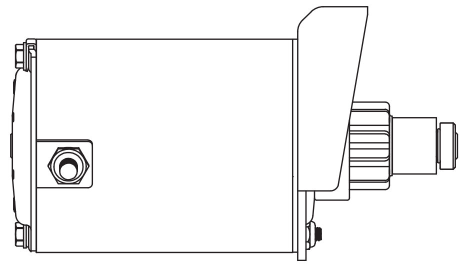


Figure 3-51. Starter Motor (410cc Single Cylinder Engine Units Only)

General Theory

Test 45 verified that the battery is fully charged and that the battery cables and connections are within the voltage drop specifications. Test 46 verified that the circuit board is delivering DC voltage to the starter control relay (SCR). Test 47 verified the operation of the SCR. Test 48 verified the operation of the starter contactor (SC). Another possible cause of an “Engine Won’t Crank” problem is a failure of the starter motor itself.

Procedure

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

Results

1. If battery voltage is indicated on the meter but starter motor did not operate, remove and bench test the starter motor.
2. If battery voltage was indicated and the starter motor tried to engage (pinion engaged), but engine did not crank, check for mechanical binding of the engine or rotor.
3. If engine turns over slightly, go to ***Test 63 – Check and Adjust Valves***. If valve clearance is too loose the valves will not fully open which could slow down cranking of the engine.

Test 50 – Check Fuel Supply and Pressure

General Theory

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

- An adequate gas supply and sufficient fuel pressure must be available or the engine will not start.
- Minimum recommended gaseous fuel pressure at the generator fuel inlet connection is 5 inches water column for natural gas (NG) or 10 inches water column for LP gas.
- Maximum gaseous fuel pressure at the generator fuel inlet connection is 7 inches water column for natural gas or 12 inches water column for LP gas.

IMPORTANT NOTE: In localities where only low pressure NG is available, 3.5 inches water column is an acceptable minimum when oversized piping is incorporated.

- When propane gas is used, only a "vapor withdrawal" system may be used. This type of system utilizes the gas that forms above the liquid fuel. The vapor pressure must be high enough to ensure engine operation.
- The gaseous fuel system must be properly tested for leaks following installation and periodically thereafter. No leakage is permitted. Leak test methods must comply strictly with gas codes.

IMPORTANT NOTE: Visually inspect the fuel regulator and plenum tank for signs of leaks or damage.

⚠DANGER

Explosion and fire. Fuel and vapors are extremely flammable and explosive. No leakage of fuel is permitted. Keep fire and spark away. Failure to do so will result in death or serious injury. (000192)

IMPORTANT NOTE: Verify that the fuel selector is properly set for the supplied fuel type. Remove selector pin. Verify gaskets are properly placed and not blocking a jet.

IMPORTANT NOTE: Refer to installation manual to confirm correct pipe sizing before testing unit. If pipe sizing is inadequate, correct pipe sizing before continuing with diagnostics.

Procedure

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

1. See *Figure 3-52* and *Figure 3-53* for the gas pressure test point on the fuel demand regulator. Static fuel pressure can be checked at Port 1 (A) on all fuel regulators. Running fuel pressure can be checked at Port(s) 2 and/or 3 (B) on all fuel regulators.

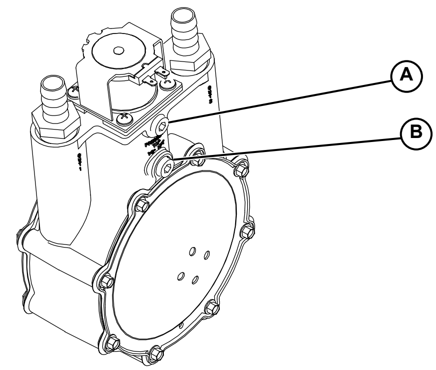


Figure 3-52. Gas Pressure Test points (8–26 kW without Plenum)

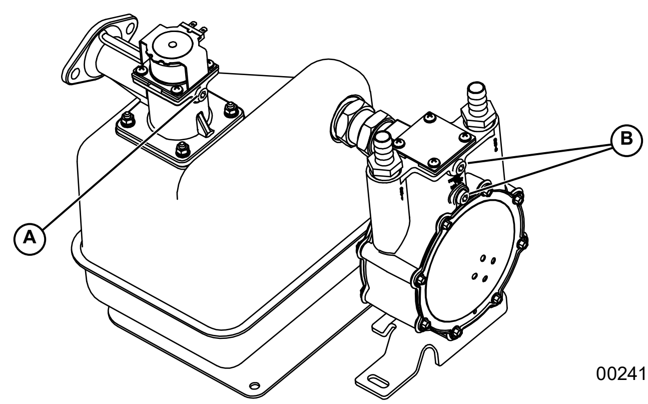


Figure 3-53. Gas Pressure Test points (12–20 kW with Plenum)

2. With the manometer connected properly to Port 1 (A), check the static pressure. Nominal fuel pressure should be measured. If pressure is measured, go to Step 3. If pressure is not measured, refer back to the flowchart (Check Supply Pressure/Regulator).
3. With the manometer properly connected to Port 2 or Port 3 (B), set the controller to MANUAL mode and check the cranking and/or running pressure. Nominal fuel pressure should be measured while cranking or running. If pressure is not measured refer back to the flow chart (Go to ***Test 51 – Check Controller Wire 14 Outputs***).

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

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

Units with a Plenum Tank Only

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

Results

1. If fuel supply and pressures are adequate in Step 2 and Step 3, but engine will not start refer back to the flow chart (Good flow path).
2. If fuel supply was not good in Step 2, return to flow chart and check supply regulator.
3. 3. If fuel supply was not good in Step 3, return to flow chart and continue with Test 51.

NOTE: If the manometer shows excessive pressure drop or unstable readings, this could be due to undersized fuel pipe or the regulator being too close to the generator.

NOTE: If pressure is above specifications correct/adjust supply regulator to generator to maintain proper fuel pressure.

Test 51 – Check Controller Wire 14 Outputs

General Theory

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

Procedure

1. Set the controller to OFF.
2. Set DMM to measure DC voltage.
3. Disconnect Wire 14 and Wire 0 from the fuel solenoid (FS).
4. Connect the positive test lead to the disconnected Wire14 from Step 3 and connect the negative test lead to Wire 0.
5. Set the controller to MANUAL. The meter should indicate battery voltage once the engine rotates.
   a. If battery voltage is indicated, test is complete. Refer back to flow chart.
   b. If battery voltage is not measured connect negative test led to battery ground and repeat this step. If battery voltage is now measured, repair or replace Wire 0. If battery voltage is still not measured, proceed to Step 6.
6. Navigate to the Digital Output display using the menu system for the controller.

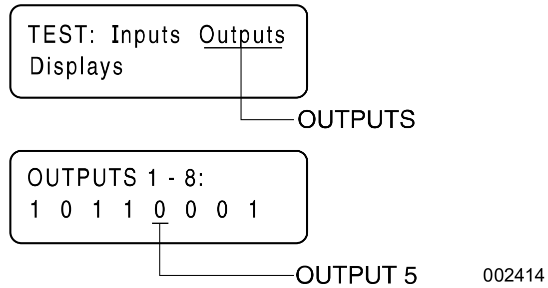


Figure 3-54. The Output Screens

7. Output 5 is Wire 14 out from the controller. If the controller is functioning properly, Output 5 will change from a “0” to a “1” while the unit is cranking.
   a. If the DMM did NOT indicate voltage in Step 5 and output did not change in Step 7, replace the controller.
   b. If the DMM did NOT indicate voltage in Step 5 and the output in Step 7 changed, proceed to Step 8.
8. Disconnect the 7.5 amp Fuse.
9. Disconnect the appropriate harness connector from the controller.
10. Set a DMM to measure resistance.
11. Connect one meter test lead to Wire 14 (disconnected in Step 3). Connect the other meter test lead to Wire 14 at the controller side of the harness connector (Wire 14). See “Appendix A” for proper wire and connector pin identification.
   a. If the DMM indicated CONTINUITY repeat Step 5 and then retest.
   b. If CONTINUITY is not measured, repair or replace Wire 14 between the controller harness connector and the fuel solenoid.

Results

Refer back to flow chart.

Test 52 – Check Fuel Solenoid

General Theory

In Test 51, if battery voltage was delivered to Wire 14, the fuel solenoid should have energized and opened to allow fuel through the demand regulator. This test will verify whether the fuel solenoid is operating or not.

Procedure: 8–26 kW Units

1. Set DMM to measure resistance.
2. Disconnect Wire 14 and Wire 0 on the fuel solenoid. Connect meter leads across the two spade terminals of the solenoid. Measure and record the resistance. Compare the resistance measured to the values in ***Table 3-12***.

Results

1. If the resistance measured was within specification, refer back to the flow chart.

2. If the resistance measured was NOT within specification, replace the solenoid.

Table 3-12.

Fuel Solenoid	Resistance (approximate)
Short Solenoid Nominal Resistance	5–50 ohms
Tall Solenoid Nominal Resistance	5–60 ohms

Test 53 – Check AC Output Frequency

General Theory

Generator AC frequency is proportional to the operating speed of the rotor. The 2-Pole rotor will produce a 50 Hertz AC frequency at 3000 rpm and a 60 Hertz AC frequency at 3600 rpm.

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

Tools Required

- A meter capable of measuring AC frequency.

Procedure

1. Place the MLCB in the OFF position.
2. See ***Figure 3-55***. Connect an accurate AC frequency meter across the Wires 11 and 44 Terminals of the generator main line circuit breaker (MLCB).

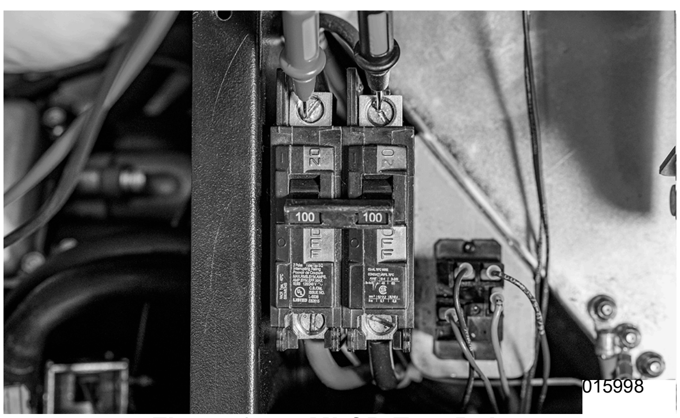


Figure 3-55. MLCB Test Points

3. Set the controller to MANUAL.
4. Let engine stabilize. Measure and record the frequency.

Results

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

Test 54 – Check Stepper Motor Control

General Theory

The stepper motor should sweep the mixer linkage and throttle plates to a full open position (opening both venturis), back to a closed position and then to the starting position (a slight opening of the throttle in the small venturi).

Procedure: V-Twin and Single Cylinder

NOTE: Before performing this test, verify current generator node using the Dealer>Display menu. If correct node is shown, continue with this test. If incorrect node is shown, go to ***Test 83 – Verify Model ID Resistor Connections*** before continuing with this test.

1. Gain visual access to the mixer throttle linkage.
2. Set the controller to MANUAL.
3. See ***Figure 3-56–Figure 3-59***. Observe and record the stepper motor movement.
   a. If movement was SEEN, continue to Step 4.
   b. If movement was NOT SEEN, verify J5 connector is seated properly and pins are not damaged. Reconnect and repeat Steps 2, and 3. If movement was seen after retesting, proceed to Step 4.

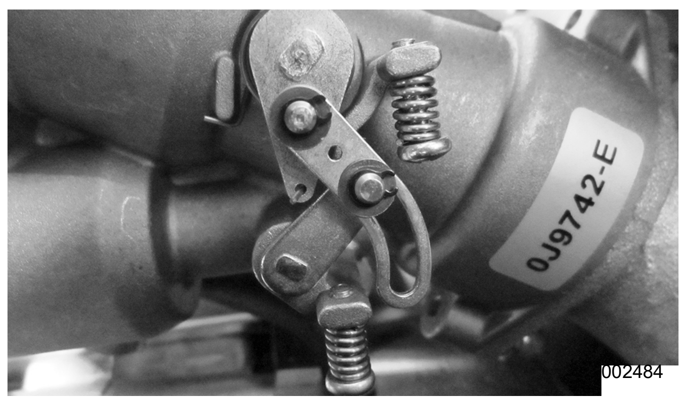


Figure 3-56. Stepper Motor Starting Position and/or Mid-point

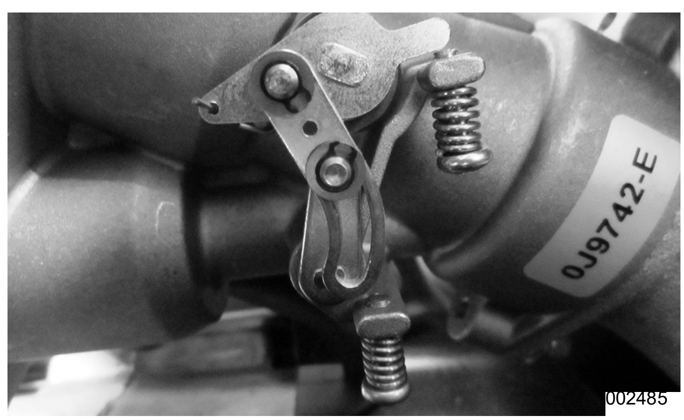


Figure 3-57. Stepper Motor Wide Open = Opens Both Venturis

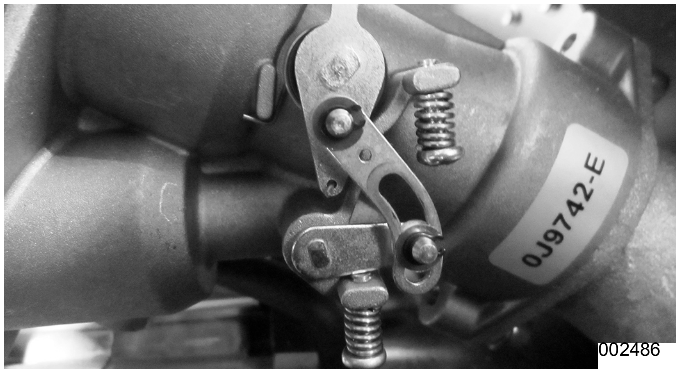


Figure 3-58. Stepper Motor Closed – Closes Both Venturis

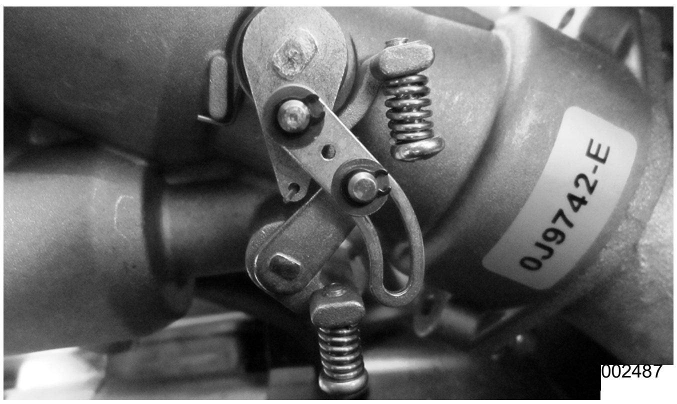


Figure 3-59. Stepper Motor Mid-point = Starting Point, Smaller Venturi Partially Open

4. Remove air cleaner cover to visually access the mixer throttle plates.
5. Disconnect J5 connector from controller.
6. Physically move throttle from closed to open and verify all movement with linkage and throttle plates. The stepper motor will have minimal resistance as it is moved manually through its travel.
    a. If any mechanical issue is noted (binding or throttle plate) replace the mixer assembly.
    b. If movement was seen in Step 3 test is complete, go back to flowchart.
    c. If movement was seen in Step 6 but no movement seen in Step 3 proceed to next step.
7. Set the DMM to measure resistance.

NOTE: Press meter leads firmly onto the exposed terminals of the connector. Do not probe into the connector or wires.

8. Connect the meter test leads across points A and B as shown in ***Table 3-13*** and compare to the specified value.

Results

Specific results may vary based on step within procedure.

1. If the stepper motor indicated appropriate resistance values, replace the controller.
2. If the stepper motor indicated inappropriate resistance values, replace the mixer assembly.

Table 3-13. Stepper Motor Testing

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

Test 55 – Check for Ignition Spark

General Theory

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

See ***Figure 3-60***. When using this style spark tester the adjustment screw must be set to the proper distance for the type of ignition system being tested.

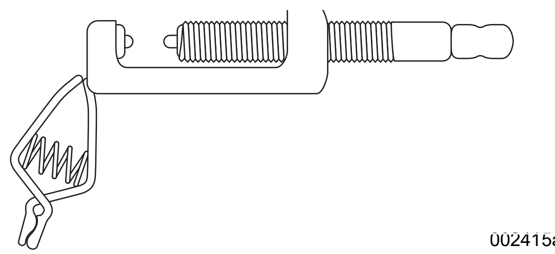


Figure 3-60. Spark Tester

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

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

Procedure

1. Turn off the fuel supply to the generator.
2. Remove spark plug leads from the spark plugs.
3. See ***Figure 3-61***. Attach the clamp of the spark tester to the engine cylinder head.
4. Attach the spark plug lead to spark tester terminal.
5. Set the controller to MANUAL.
6. While the engine is cranking, observe the spark tester. If spark jumps the tester gap, the engine ignition system is operating satisfactorily.

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

Figure 3-61. Checking Ignition Spark

7. See ***Figure 3-62***. To determine if an engine miss is ignition related, connect the spark tester in series with the spark plug wire and spark plug. Then, crank and start the engine. A spark miss will be readily apparent. If spark jumps the spark tester gap regularly, but the engine miss continues, the problem is in the spark plug or in the fuel system.

V-Twin Only

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

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

Figure 3-62. Checking Engine Miss

Results

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

Test 57 – Check Condition of Spark Plugs

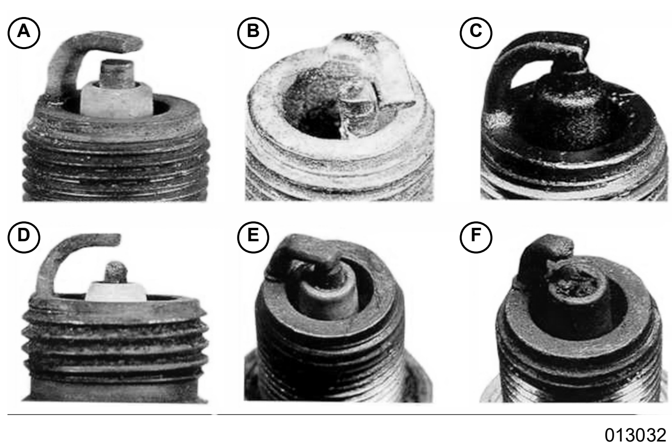
General Theory

If the engine will not start and Test 55 indicated good ignition spark, a possible cause could be fouled or damaged electrodes. Spark plugs used in gaseous powered engines have a much higher ignition temperature compared to gasoline engines. The spark plug(s) are under much higher cylinder pressures due to higher compression ratios.

Because gaseous fuels are more difficult to ignite, the gap between the electrodes of the spark plug must be properly sized for the spark to ionize the gap. If the spark plug gap is incorrect it will affect the energy needed to spark, which can cause misfires or poor ignition of the fuel mixture.

Procedure

1. Remove spark plug(s) and inspect for any visible damage.
2. Replace any spark plug having burned electrodes or cracked porcelain.
3. See ***Figure 3-64***. Use a wire feeler gauge to set the gap on new or existing spark plugs as per ***Specifications***.



A.	Normal	D.	Overheated
B.	Mechanical Damage	E.	Insulator Glazing
C.	Oil Fouled	F.	Pre-Ignition

Figure 3-63. Spark Plug Conditions

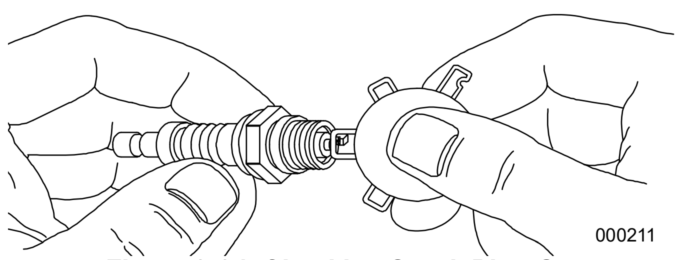


Figure 3-64. Checking Spark Plug Gap

Results

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

NOTE: Always check the specifications of the unit you are working on for correct plug and settings. See Section 1.1 ***Specifications***.

NOTE: Tighten spark plug(s) to 18 ft-lbs (25 Nm).

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

Introduction

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

- Will not start
- Lack of power
- Runs Rough
- Vibration
- Overheating
- High Oil Consumption
- Inability to carry full load

Check Compression

General Theory

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

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

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

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

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

Procedure

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

NOTE: See ***Specifications*** in Section 1.1 for acceptable compression values.

Results

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

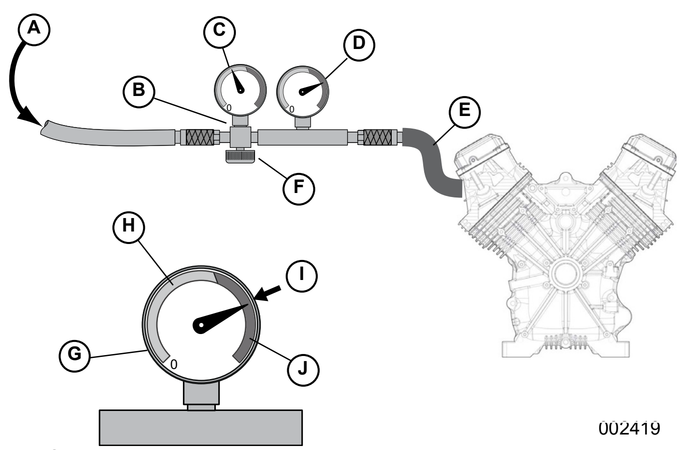
Example 1: If the pressure reading of Cylinder #1 is 165 PSI and of Cylinder #2 is 160 PSI the difference is 5 PSI. Divide “5” by the highest reading (165) to obtain the percentage of 3.0 percent.

Cylinder Leak Down Test

General Theory

The Cylinder Leak Down Tester checks the sealing (compression) ability of the engine by measuring air leakage from the combustion chamber. Compression loss can present many different symptoms. This test is designed to detect the section of the engine where the fault lies before disassembling the engine. ***Figure 3-65*** represents a standard tester available on the market.

NOTE: Refer to the tool manufacturer's instructions for variations of this procedure.



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

Figure 3-65. Cylinder Leakdown Tester

Procedure

1. Shut off the fuel supply.
2. Remove the spark plug(s) from the cylinder.
3. Gain access to the flywheel or to the generator fan assembly. Remove the valve cover.
4. Rotate the engine crankshaft until the piston reaches top dead center (TDC) of the compression stroke on the cylinder being tested. In this position, both the intake and exhaust valves will be closed. If the engine is not properly positioned at TDC the results of the test may be inaccurate.
5. Attach cylinder leak down tester adapter to spark plug hole.
6. Connect an air source of 90 PSI to the cylinder leak down tester.

NOTE: Refer to the tool manufacturer's instructions for proper setting.

7. Monitor the flywheel/generator fan for rotation from top dead center as you apply air in the next step.
8. Adjust the regulated pressure on the gauge to the manufactures setting for the tool that you are using—typically 90 psi. Verify flywheel/fan has not rotated.
9. Read the gauge on the tester for cylinder percent of leakage. A leakage of 20 percent is normally acceptable. Use good judgment, and listen for air escaping at the carburetor (air intake), the exhaust, the side of the head where head and block join, and the crankcase breather. This will help determine where the fault lies.
10. Repeat Steps 1 through 9 on remaining cylinder if applicable.

Results

- Air escapes at the carburetor (air intake) – check intake valve.
- Air escapes through the exhaust – check exhaust valve.
- Air escapes through the breather – check piston rings.
- Air escapes between the cylinder head and block – replace head gasket and check both gasket surfaces.

Test 59 – Check Shutdown Wire

General Theory

The controller uses Wire 18 for two purposes:

- to measure engine rpm.
- to shutdown the engine. During a shutdown, controller logic will apply a ground to Wire 18. Wire 18 is connected to the Ignition Magneto(s). The grounded magneto will not be able to produce spark.

Procedure

1. See ***Figure 3-66*** and ***Figure 3-67***. Disconnect Wire 18.

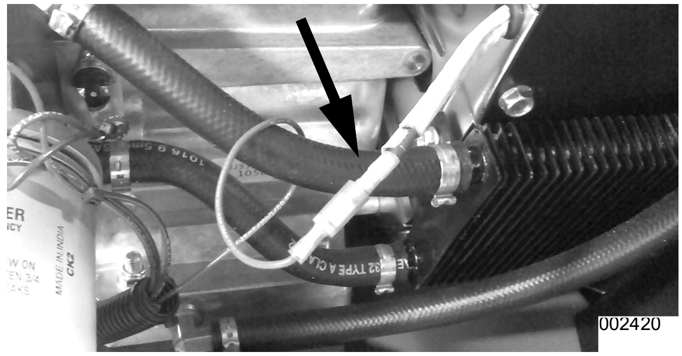


Figure 3-66. Wire 18 Connection – V-Twin Units

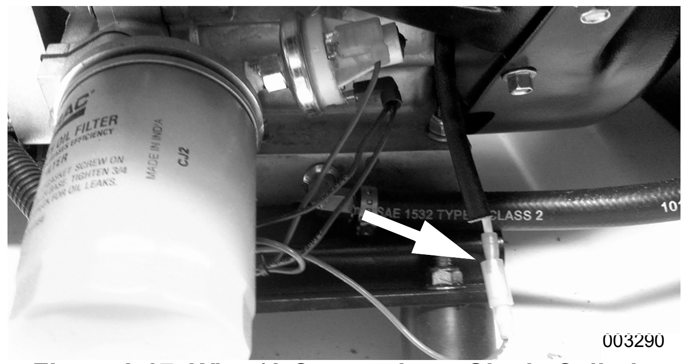


Figure 3-67. Wire 18 Connection – Single Cylinder Units

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

Results

1. If the DMM indicated CONTINUITY to ground in Step 6, repair or replace shorted ground Wire 18 between the engine and the controller connector.
2. If the DMM indicated INFINITY to ground in Step 6, replace the control board and re-test for spark.
3. If ignition (spark) was not present in Step 2 with Wire 18 disconnected, proceed to ***Test 60 – Check and Adjust Ignition Magnetos***.

Test 60 – Check and Adjust Ignition Magnetos

General Theory

In Test 55, a spark tester was used to check for engine ignition. If sparking or weak spark occurred, one possible cause might be the ignition magneto(s). This test consists of checking values across the primary and secondary windings of the magneto and adjusting the air gap between the ignition magneto(s) and the flywheel. The flywheel and flywheel key will also be checked during this test.

NOTE: On V-Twin units a diode is installed in the primary winding inside the coil. This is done to inhibit a spark occurring on both magnetos at the same time.

IMPORTANT NOTE: On V-Twin units both ignition coils must be installed in the correct orientation with the white dot marking facing away from the engine.

Procedure: Testing Magnetos

1. See ***Figure 3-66*** and ***Figure 3-67***. Disconnect Wire 18 at the bullet connector.
2. Depending on engine type, disconnect spark plug wires from the spark plugs on one or both cylinders.
3. Set DMM to measure resistance when performing resistance checks and to Diode function when performing the Diode Test.
4. Follow the chart connections and record readings on DMM to chart.

NOTE: Readings are approximate.

5. **Secondary Resistance Check:** Connect a meter lead to the spark plug wire and connect the other meter lead to battery ground. Record the readings and compare to ***Table 3-14***. Readings are approximate.
6. **Primary Resistance Check:** Connect the meter lead indicated in ***Table 3-14*** to the bolt connector or bullet connector where Wire 18 was disconnected in Step 1. Connect the other meter lead to the spark plug wire or to ground. Perform all tests as indicated in ***Table 3-14***.
7. **Diode Check:** Connect the meter lead indicated in ***Table 3-15*** to the bolt connector or bullet connector where Wire 18 was disconnected in Step 1. Connect the other meter lead to ground. Perform all tests as indicated in ***Table 3-15***.
8. On V-twin generators, repeat Steps 5 and 6 on Cylinder Two. If readings are not measured, replace the magnetos.

NOTE: On V-twin generators it is recommended to replace magnetos in pairs.

NOTE: Readings can change based on supplier changes. Check GENservice or contact Generac for updates.

NOTE: Resistance values can vary depending on the type and quality of meter being used.

Table 3-14.

Measurements with Wire 18 disconnected			
Magneto Wire Diagnostics		**V-Twins**	**Single Cyl**
POS Test Lead	**NEG Test Lead**	**Ohms**	**Ohms**
To Magneto Wire	To Ground	250k–2.5 M	.5-1.0
To Ground	To Magneto Wire	OL	3.0
To Magneto Wire	To Plug Wire	250k–2.5 M	10-11 K
To Plug Wire	To Magneto Wire	OL	10-11 K
To Plug Wire	To Ground	7-14 K	9-16 K
Measurements with Wire 18 connected			
AC Voltage Wire 18 Backprobed		**V-Twins**	**Single Cyl**
Cranking		3-5 VAC	1.5-2 VAC
Running @ 3600 rpm		14-20 VAC	7-8.5 VAC
Running @ 3000 rpm		11.5-16.5 VAC	5.8-7 VAC
Frequency		**V-Twins**	**Single Cyl**
Cranking		35-45 Hz	13-17 Hz
Running @ 3600 rpm		120 Hz	60 Hz
Running @ 3000 rpm		100 Hz	50 Hz

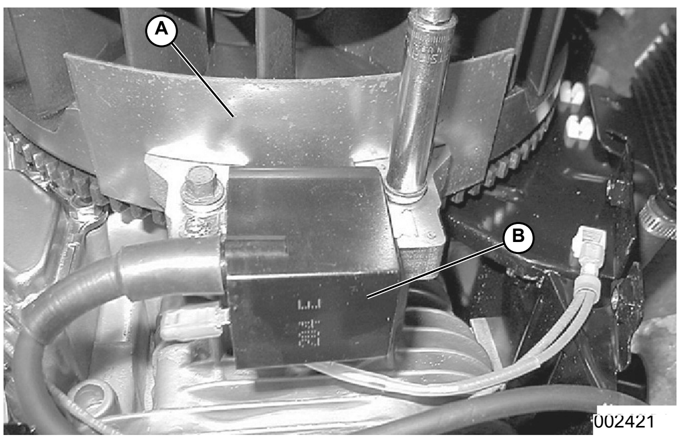
Table 3-15.			
Diode Test		**V-Twins**	**Single Cyl**
POS Test Lead	**NEG Test Lead**	**VDC**	**VDC**
To Magneto Wire	To Ground	0.5-0.6	N/A
To Ground	To Magneto Wire	OL	N/A

Procedure: Adjusting Magneto Flywheel Gap

The air gap between the ignition magneto and the flywheel on single cylinder engines is not adjustable. Proceed directly to Step 10 for single cylinder engines.

For V-twin engines, proceed as follows:

1. See ***Figure 3-68***. Rotate the flywheel (by hand) until the magnet is under the module (armature) laminations.



A. 0.008-0.012” Gauge
B. Magneto

Figure 3-68. Setting Ignition Magneto Air Gap

2. Place a 0.008-0.012 inch (0.20-0.30mm) non metallic thickness gauge between the flywheel magnet and the module laminations.

NOTE: A typical business card is approximately 0.010 inch thick.

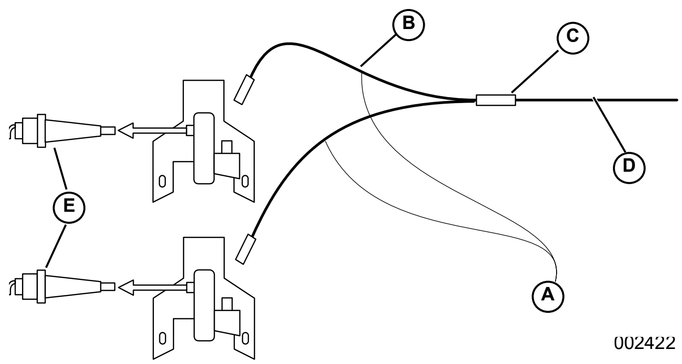
3. Loosen the mounting screws and let the magnet pull the magneto down against the thickness gauge.
4. Tighten mounting bolts to 5.6–7.4 ft-lbs (7.6–10 Nm).
5. To remove the thickness gauge, rotate the flywheel (manually).
6. Repeat the above procedure for the second magneto.
7. Repeat ***Test 55 – Check for Ignition Spark*** and check for spark across the spark tester gap.
    a. A spark test may be conducted with unit disassembled by following this procedure.
    b. Battery must be connected.
    c. The harness connector must be connected to the controller.
    d. Remove Wire 56 from the SCR located beneath the controller.

NOTE: Verify all debris is cleared from the engine compartment and all body parts are clear from flywheel before proceeding.

    e. Refer to ***Test 55 – Check for Ignition Spark***.
    f. Connect a jumper wire to the 194 terminal block. Connect the other end to where Wire 56 was disconnected in Step 7d. The engine should crank once the jumper from 194 is connected.
8. If spark was not indicated, replace magnetos.

NOTE: If gap is only adjusted, properly test the magnetos by cranking the engine before reassembly. Spark should be present on both cylinders.

9. If air gap was not out of adjustment, test ground wires.
10. Set a DMM to the measure resistance.
11. See ***Figure 3-69***. Disconnect the engine wire harness from the ignition magnetos.
    - See ***Figure 3-66*** and ***Figure 3-67***. Disconnect Wire 18 at the bullet connector.



A. Remove leads
B. Engine wire harness
C. Bullet connector
D. Wire 18 to circuit board
E. Spark plug

Figure 3-69. Engine Ground Harness

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

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

NOTE: The armature air gap is fixed for single cylinder engine models and is not adjustable. Visually inspect the armature air gap and hold down bolts.

Results

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

Procedure, Replacing Magnetos:

1. Follow all steps of ***Major Disassembly***.
2. Once the magnetos are visible, make note of how they are connected.

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

3. See ***Figure 3-70***. Cylinder one is the back cylinder.
4. See ***Figure 3-71***. Cylinder two is the front cylinder.
5. See ***Figure 3-72***. When installing new magnetos there will be one with a short plug wire and one with a longer plug wire.

NOTE: Magneto gap to flywheel 0.008–0.012 inch (0.20–0.30 mm).

NOTE: On V-Twin units both ignition coils must be installed in the correct orientation with the white dot marking facing away from the engine.

6. Short plug Wire will be installed on back cylinder (Cylinder One).
7. Long plug wire (B) will be installed on front cylinder (Cylinder Two).
8. Verify installation of magnetos correctly by ensuring both spark plug wires point to the back of the enclosure and shutdown terminals are nearest cylinder head as shown in ***Figure 3-73*** and ***Figure 3-74***.
9. Tighten mounting bolts to 5.6–7.4 ft-lbs (7.6–10 Nm).

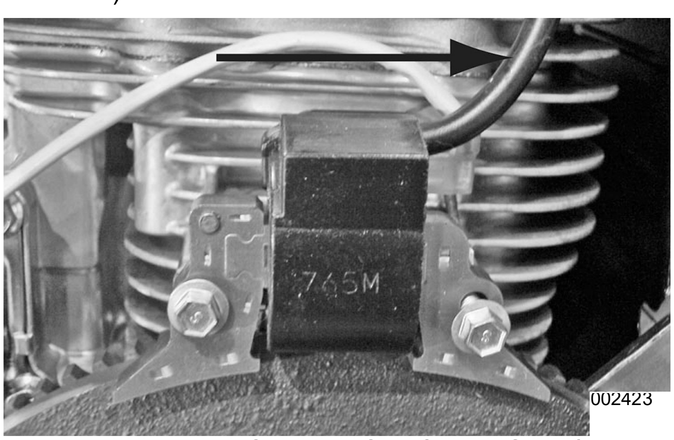


Figure 3-70. Cylinder One (Back, Short)

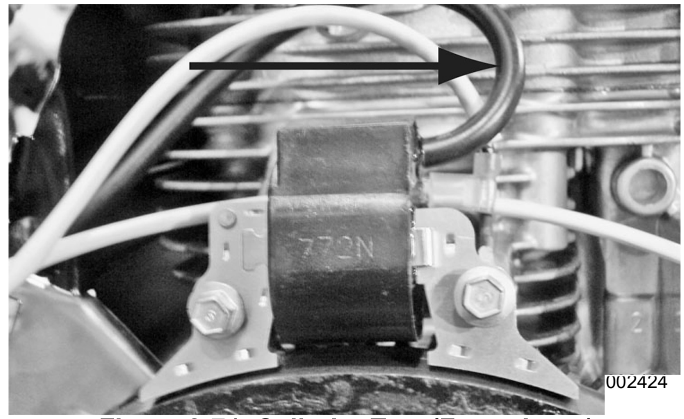
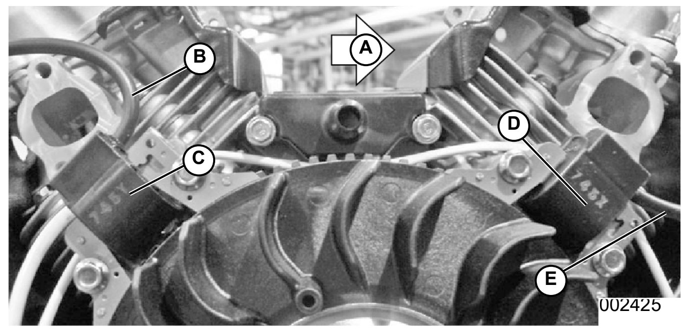


Figure 3-71. Cylinder Two (Front, Long)



A. Back Of Enclosure
B. Long Spark Plug Wire
C. Cylinder Two
D. Cylinder One
E. Short Spark Plug Wire

Figure 3-72. Magneto Positions

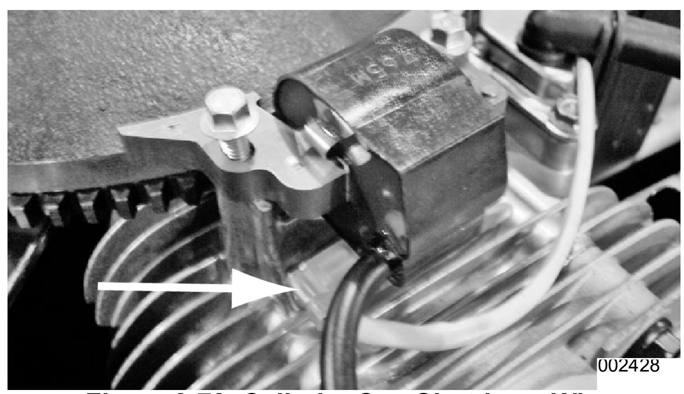


Figure 3-73. Cylinder One Shutdown Wire

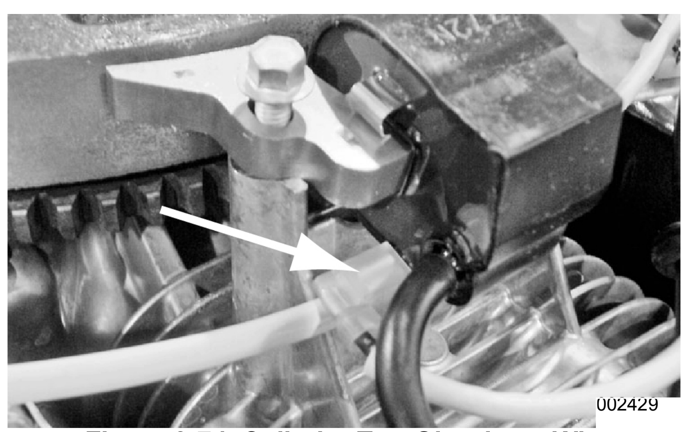


Figure 3-74. Cylinder Two Shutdown Wire

Test 61 – Check Oil Pressure Switch (LOP) and Wire 86 (E-Code 1300)

General Theory

If the engine cranks and starts, then shuts down within about 5 (five) to 10 (ten) seconds with a Shutdown-Alarm Low Oil Pressure, the cause may be one or more of the following:

- Low engine oil level.
- Low oil pressure.
- A defective oil pressure switch (LOP).

IMPORTANT NOTE: Evolution 1.0 oil pressure switch is Normally Closed (N.C.) with no oil pressure. Evolution 2.0 oil pressure switch is Normally Open (N.O.) with no oil pressure. Identify and verify correct controller and switch part numbers are installed.

Procedure

1. Check engine crankcase oil level. If necessary, add the recommended oil to the dipstick FULL mark. DO NOT OVERFILL ABOVE THE FULL MARK.
2. With oil level correct, try starting the engine.
   a. If engine still cranks and starts, but then shuts down, go to Step 3.
   b. If engine cranks and runs normally, discontinue tests.
3. On Evolution 1.0 units, disconnect Wire 86 and Wire 0 from the LOP switch terminals. On Evolution 2.0 connect a jumper between Wire 86 and Wire 0 from the LOP switch terminals.
4. Remove the switch and install an oil pressure gauge in its place.
5. Start the engine while observing the oil pressure reading on the gauge.

NOTE: Normal oil pressure is approximately 20–70 psi with engine running. If normal oil pressure is indicated, go to Step 5 of this test.

IMPORTANT NOTE: If oil pressure is below switch threshold, shut engine down immediately. A problem exists in the engine lubrication system.

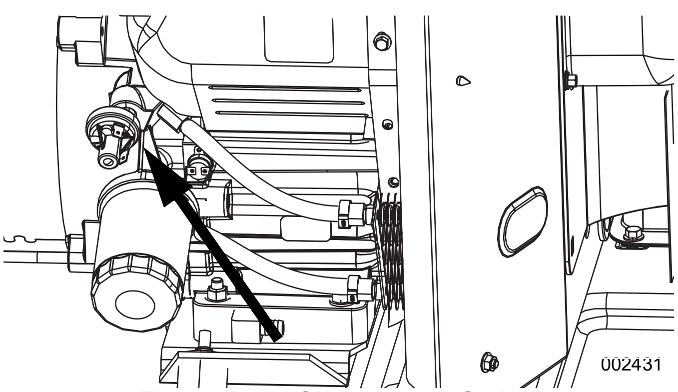


Figure 3-75. Oil Pressure Switch

NOTE: The oil pressure switch is rated at 10 psi for V-twin engines, and 5 psi for single cylinder engines.

6. Remove the oil pressure gauge and reinstall the oil pressure switch. Do NOT connect Wire 86 or Wire 0 to the switch terminals.
   a. Set a DMM to measure resistance.
   b. Connect the DMM test leads across the LOP switch terminals. With the engine shut down, the DMM should indicate:
      - Evolution 1.0—CONTINUITY. If INFINITY was measured, replace the LOP switch.
      - Evolution 2.0—INFINITY. If CONTINUITY was measured, replace the LOP switch.
   c. With the DMM still connected to the LOP switch, set the AUTO-OFF-MANUAL switch MANUAL. The DMM should indicate:
      - Evolution 1.0—INFINITY after the engine has had a chance to build pressure.
      - Evolution 2.0—CONTINUITY after the engine has had a chance to build pressure.
7. See *Figure 3-76*. Navigate to the Digital inputs display screen of the controller being worked on.

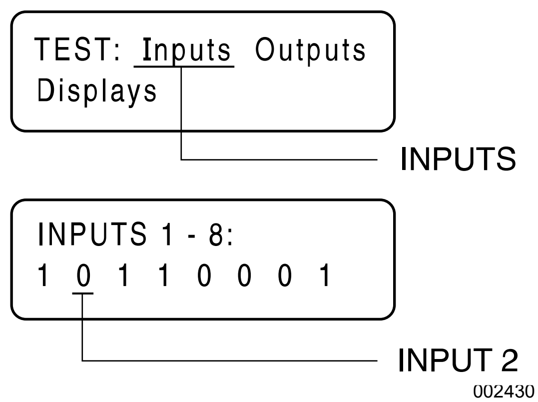


Figure 3-76. The Input Screens

   a. Digital Input 2 is Wire 86 from the LOP switch to the board.
   b. Set the controller to MANUAL.
   c. Observe Input 2 for a change from “1” to “0”.
   d. A visible change on Input 2 indicates that the control board sensed the LOP switch changed states. If the generator still shuts down, replace controller.
   e. If the input did change states, the LOP switch is good. An intermittent oil pressure problem may still be present and should be checked with a mechanical gauge as in Step 4.
8. Set the DMM to measure DC voltage.
   a. Disconnect Wire 86 at the low oil pressure switch.
   b. Connect the Black meter test lead to a good ground, and the Red meter test lead to Wire 86. Approximately 3.3 VDC should be

measured. If 3.3 VDC is not measured, go to Step 7and check continuity on Wire 86 from the LOP switch back to the J4 connector.

9. Keep the DMM set to measure resistance.
   a. Disconnect the appropriate harness connector from the controller and disconnect Wire 86 and Wire 0 from the LOP switch.
   b. Connect one meter test lead to the disconnected Wire 86 and connect the other meter test lead to Wire 86. The DMM should indicate CONTINUITY. If CONTINUITY was not measured repair or replace Wire 86 between the LOP switch and the controller harness connector.
   c. With Wire 86 still disconnected from the LOP switch and the controller harness connector, connect one meter test lead to disconnected Wire 86 and the other meter test lead to an engine ground. The DMM should indicate INFINITY. If CONTINUITY was measured a short to ground exists on Wire 86. Repair or replace as needed.

Results

1. If the switch operated properly and proper oil pressure was measured, and Wires 86 and 0 tested good, and/or the Input would not change on the controller, replace the controller.

Test 62 – Check High Temperature Switch (E-Code 1400)

General Theory

If the temperature switch contacts have failed in a closed position, the engine will fault out on “OVERTEMP”. If the unit is in an overheated condition, the switch contacts will close at 310 °F (154 °C) This is normally caused by inadequate airflow through the generator.

NOTE: Evolution 1.0 high oil temperature switch is Normally Open (N.O.) with no high oil temperature condition. Evolution 2.0 is Normally Closed (N.C.) with no high oil temperature condition.

Procedure

1. Verify that the engine has cooled down (engine block is cool to the touch). This will allow the contacts in the High Oil Temperature Switch to open.
2. Check the installation and area surrounding the generator. There should be at least three feet of clear area around the entire unit. Make sure that there are no obstructions preventing cooling air from entering or exiting the enclosure.
3. Disconnect Wire 85 and Wire 0 from the High Oil Temperature Switch.
4. Set a DMM to measure resistance. Connect the test leads across the switch terminals. The meter should read INFINITY (0L).
5. If the switch tested good in Step 4, and a true overtemperature condition has not occurred, proceed to step 6.
6. Remove harness connector from the controller.
7. Set the DMM to measure resistance.
8. Connect one test lead to Wire 85 (disconnected from High Oil Temperature Switch). Connect the other test lead to an engine ground. INFINITY should be measured.

Testing High Temperature Switch

9. Remove the High Oil Temperature Switch.
10. See *Figure 3-77*. Immerse the sensing tip of the switch in oil, along with a suitable thermometer.
11. Set a DMM to measure resistance. Then, connect the DMM test leads across the switch terminal and the switch body. The meter should read INFINITY.
12. Heat the oil in the container. When the thermometer reads approximately 299-321 °F (148-160 °C), the DMM should indicate CONTINUITY.

Results

1. If the switch fails Step 4, or Steps 11-12, replace the switch.
2. If INFINITY was not measured in Step 8, repair or replace Wire 85 between the Circuit Board and the High Oil Temperature Switch.

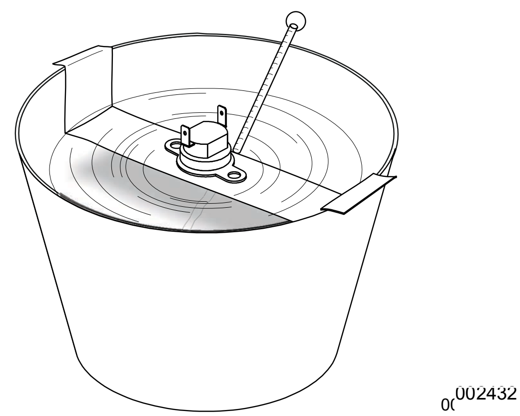


Figure 3-77. Testing the Temperature Switch

Test 63 – Check and Adjust Valves

General Theory

Improperly adjusted valves can cause various engine related problems including, but not limited to, hard starting, rough running and lack of power. The valve adjustment procedures for single cylinder and V-twin engines are different and vary according to engine displacement.

NOTE: 2019 and newer units with 816cc engines have hydraulic valve lifters which do not require adjustment.

Check Valve Clearance

⚠DANGER

Automatic start-up. Disconnect utility power and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

(000191)

NOTE: The engine should be cool before checking the valve clearance. Adjustment is not needed if valve clearance is within the dimensions provided in Section 1.1 ***Specifications***.

Verify the piston is at Top Dead Center (TDC) of its compression stroke (both valves closed).

NOTE: A small non-metallic object, such as a plastic straw, can be inserted through the spark plug opening and rested on the piston. Piston movement will cause the object to move up and down, giving a visual indication of TDC.

Adjust Valve Clearance

See ***Figure 3-78*** or ***Figure 3-79***. Check and adjust the valve to rocker arm clearance as follows:

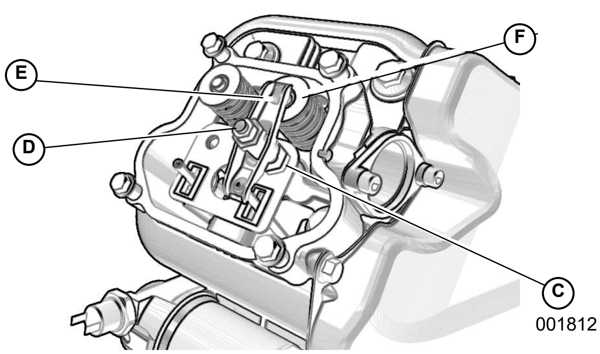


Figure 3-78. Valve Clearance Adjustment (9 kW - 426cc / 10 kW - 460cc engine)

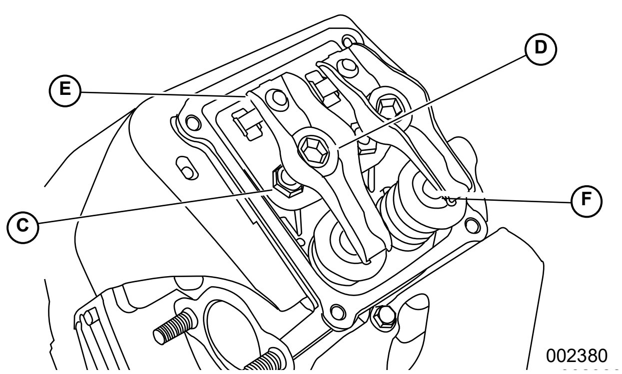


Figure 3-79. Valve Clearance Adjustment (8 kW, 11-26 kW - 530cc through 999cc)

1. Remove the four screws attaching the valve cover and remove valve cover.
2. Discard valve cover gasket.
3. Loosen the rocker jam nut (C) using a 10 mm wrench (9-11 kW units) or 13 mm wrench (16-24 kW units.)
4. Turn the pivot ball stud (D) using a 14 mm wrench (9 kW units), 8 mm wrench (11 kW units), or 10 mm Allen wrench (16-24 kW units) while checking clearance between the rocker arm (E) and the valve stem (F) with a feeler gauge. Adjust clearance as per Section 1.1 ***Specifications***.

NOTE: Hold the rocker arm jam nut in place as the pivot ball stud is turned.

5. When valve clearance is correct, hold the pivot ball stud (D) in place with a wrench and tighten the rocker arm jam nut. Tighten the jam nut according to the following torque specifications:

8 kW	174 **in-lbs** (19.68 Nm)
9 kW	53 **in-lbs** (6.0 Nm)
11 kW	72 **in-lbs** (8.2 Nm)
16–26 kW	174 **in-lbs** (19.68 Nm)

6. After tightening the jam nut, check valve clearance again to verify it did not change.
7. Install new valve cover gasket.
8. Install the valve cover. Tighten fasteners in a cross pattern to:

8 kW	48 **in-lbs** (5.4 Nm)
9 kW	80 **in-lbs** (9.0 Nm)
11–26 kW	60 **in-lbs** (6.8 Nm)

9. Repeat the process for the other cylinder if unit is a V-Twin.

Test 64 – Check Wire 18

General Theory

During cranking and running, the controller receives a pulse from the ignition magneto(s) via Wire 18. During cranking, this signal has an AC voltage of approximately 3–6 Volts on V-twin engines, and approximately 2–3 Volts on single cylinder engines. If the controller does not receive this signal, the unit will shut down.

Procedure A

1. Set the digital multimeter (DMM) to measure AC voltage.
2. Disconnect Wire 14 at the fuel solenoid to inhibit any possible startup.
3. See ***Figure 3-80***. Back probe one meter test lead to Wire 18 harness connector. Do not disconnect this wire. Connect the other meter test lead to engine ground.

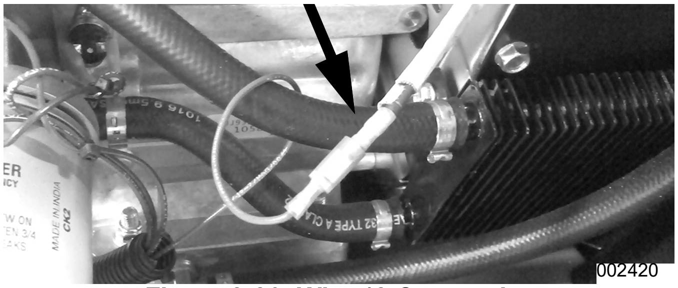


Figure 3-80. Wire 18 Connection

4. Set the controller to MANUAL. While unit is cranking measure and record the voltage.
   a. If the DMM indicated approximately 3–6 VAC for V-twin or 2–3 VAC for single cylinder, go to Procedure B.
   b. If the DMM did NOT indicate the appropriate voltage, go to the Step 5.
5. Disconnect Wire 18 from magneto sensing lead.
6. Connect one meter test lead to the magneto wire terminal and the other meter test lead to an engine ground.
7. Set the controller to MANUAL. While unit is cranking measure and record the voltage.
   a. If the DMM indicated approximately 3–6 VAC for V-Twin and 2–3 VAC for single cylinder, go to Procedure B.
   b. If the DMM did NOT indicate the appropriate voltage, go to ***Test 60 – Check and Adjust Ignition Magnetos***.

Procedure B

1. Set the DMM to measure resistance.
2. Disconnect the harness connector containing Wire 18 from the Evolution controller.
3. Connect one meter test lead to Wire 18 and the other meter test lead to an engine ground. Measure and record the resistance.
   a. If the DMM indicated low resistance (0.01 ohms), check for a short to ground in the Wire 18 circuit.
   b. If the DMM indicated INFINITY (OL), go to Step 4.
4. Connect one meter test lead to harness side of Wire 18 that connected to the magneto and connect the other meter test lead to Wire 18 at the controller connector.
   a. If the DMM indicated CONTINUITY, stop testing and verify proper operation of the unit.
   b. If the DMM indicated high resistance or INFINITY (OL), an OPEN circuit exists on Wire 18. Repair or replace Wire 18 between the magneto connector and the controller connector.

Test 65 – Test Exercise Function

General Theory

The following parameters must be met in order for the weekly exercise to occur:

- Exercise Time set in controller.
- Controller set to AUTO.

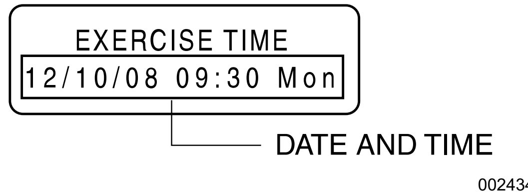


Figure 3-81. The Exercise Screen

Procedure: 8–14 kW (EVO 1.0 Controller)

NOTE: Utility voltage must be present.

Make a record of the date and time the generator is set to exercise.

1. Record the current date and time of the unit.
2. Navigate to the Exercise settings screen of the controller being worked on.
3. Press “Enter”.
4. Adjust exercise time to 5 minutes ahead of the date and time noted in Step 1.
5. Return to the Main Display where “READY TO RUN” is displayed. The controller must be in AUTO mode with utility present for the unit to exercise.
6. Watch the generator display and note the time. When the date and time reaches the time that was programmed for exercise the unit should crank and run. “Running in Exercise” will display if the exercise feature is working properly.

Procedure: 15–24 kW (EVO 1.0 Controller) 11–26 kW (Honeywell™) 9–26 kW (EVO 2.0 Controller)

NOTE: Utility voltage must be present for exercise to occur.

1. Set the controller to AUTO.
2. Enter the Dealer Password to enter the Dealer Edit Menu.
3. Select “Test.”
4. Press ENTER.
5. Press arrow key until “IN AUTO PRESS ENTER FOR QT-TEST” is displayed.
6. Press ENTER.
7. The generator should start and run the low speed exercise.
8. To stop test press ENTER.

Results

1. In all models, if the unit starts in MANUAL, but fails to exercise without any ALARMS present, replace the controller.

Test 69 – Aux Shutdown Test

General Theory

The generator is required to have at least one shutdown switch mounted on the outside of the enclosure. This switch should never be blocked or covered for any reason. Units up to 14 kW require one switch and units 15 kW and above require an additional switch on the inside of the enclosure. Both switches must be set to the ON position.

NOTE: If Aux shutdown on Evolution 1.0 ONLY jump J2 connector pins 9 and 10 (order P/N 0J0973A qty 2).

NOTE: When troubleshooting with J2 connector disconnected from controller, E-code 2800 may be displayed on controller.

Procedure

1. Remove F1 Fuse and disconnect the appropriate controller connector containing Wires 395 and 396.

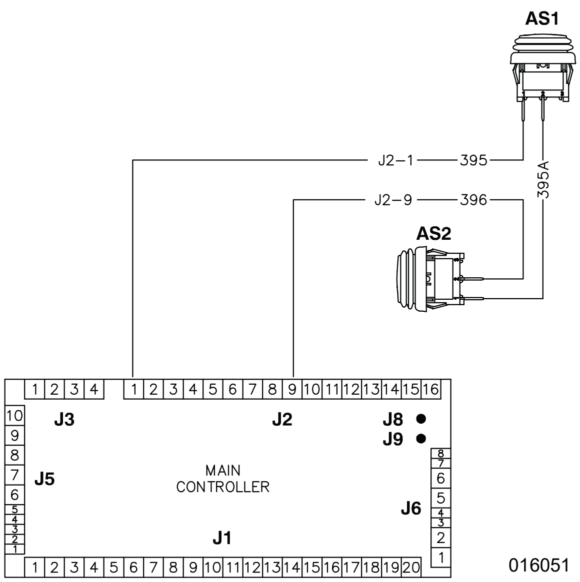


Figure 3-82.

2. Set DMM to measure resistance. Connect meter leads to Wire 395 and Wire 396.
   a. If continuity is measured, verify pin/socket and wire integrity at connector to ensure good connection to controller. If OK and the Alarm Shutdown Switch (E-code 2800) will not clear, replace controller.
   b. If OL/infinity is measured, continue to next step.
3. Locate Shutdown Switch(es) and disconnect Wires 395/395A and 396.
4. Connect meter leads to switch(es) and turn switch(es) OFF/ON.
   a. If continuity is measured when ON and OL when OFF, switch(es) is OK. Continue to next step.
   b. If measured resistance is not changing from continuity to OL, replace faulty switch(es).
5. Connect meter leads to Wires 395, 395A (if applicable), and 396 between controller connector, AS1 and AS2 to test individual wire integrity.
   a. If OL is measured on any wire, repair/replace wire and retest.
   b. If continuity is measured on all wires, verify pins/sockets and continue to next step.
6. Connect all wires/connectors to controller and switch(es).
7. Navigate to the Input Screen using the menu system for the controller.
8. With the Inputs Screen displayed and the Shutdown Switch in the ON position, Input 1 will display “0”. Set the Shutdown Switch(es) to the OFF position and verify Input 1 changes from “0” to “1”. Set the Shutdown Switch(es) to the ON position and verify Input 1 changes from “1” to “0”.
   a. If the Input displays correctly and the Alarm Shutdown Switch (E-code 2800) will not clear, replace controller.
   b. If the Input does not display correctly or does not change, replace controller.
   c. If the Input displays correctly and the E-code clears, stop testing.

Test 70 – Check For Quiet Test Mode

(Available only on certain models)

General Theory

Some generators are equipped with a low speed exercise function. When enabled, the low speed exercise function allows the generator to exercise at a lower rpm. When low speed exercise is disabled the generator will exercise at 3600 rpm.

Procedure (If equipped)

1. From the main display enter the Edit Menu using the menu map.
2. Press UP or DOWN Arrow key until “Exercise Time” is displayed.
3. Press ENTER.
4. “Quiet Test Mode? Yes or No” will be displayed. Press UP or DOWN Arrow key until “Yes” is displayed.
5. Press ENTER to save change.
6. Return to Main Display.

Results

Enable the exercise function if it is not already enabled. Refer back to flow chart.

Test 75 – Test 120 Volt Input (T1) 60 Hz 240 Volt Input (T1 - T2) 50 Hz

General Theory

The controller requires 120 VAC (60 HZ Unit) or 240 VAC (50 HZ Unit) supplied from the LOAD side of the contactor in the transfer switch to function properly.

Controller uses T1 for BCH and power to the Evolution control board. With loss of utility and blown fuse, the Evolution controller will shut down due to no power on circuit board.

Procedure

NOTE: "Inspect Battery" alarm may appear while performing this test procedure. Ignore this alarm, it is a symptom of the test procedure.

1. Locate the 7.5 amp fuse on the controller.
2. Remove the fuse and observe the LCD screen.

Results

1. If the controller remained illuminated or continued to show its status after the fuse was removed, the 120 VAC (60 Hz) or 240 VAC (50 Hz) input is good. Return to the flow chart and follow the GOOD flow path.
2. If the controller powered down when the fuse was removed, the controller is not getting the 120 VAC (60 Hz) or 240 VAC (50 HZ) input. Return to the flow chart and follow the BAD flow path.

Test 76 – Test T1 Circuit

General Theory

This test is to ensure that 120 VAC is being supplied from the "customer load" along with a proper Neutral connection tying back to the transfer switch panel. The 120 VAC is used to power to battery charger internal to the Evolution controller. The Neutral will either connect to the neutral bar at the customer connection on the generator or will connect to TB2, then connect to the neutral bar at the transfer switch.

Procedure

1. Set DMM to measure AC voltage.
2. Place red meter lead on T1 and black meter lead on 00 at the J8/J9 connector on the controller side.
   a. If 0 VAC is measured, continue to next step.
   b. If 120 VAC is measured, check connection and pins to ensure good connection. If OK, replace controller.
3. Place red meter lead on T1 at the TB2 connection and black meter lead on 00 at the Neutral or Wago block (if equipped)/TB2 connection at the customer connection.
   a. If 0 VAC is measured, continue to next step.
   b. If 120 VAC is measured, check connections, pins and wires between TB1/Neutral and J8/J9 connector to find where 120 VAC is dropped.

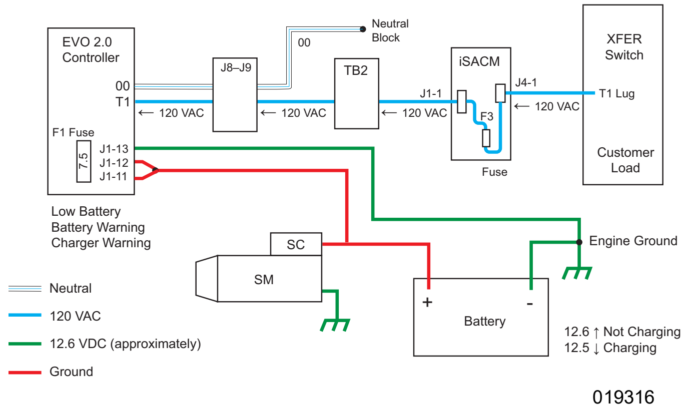


Figure 3-83.

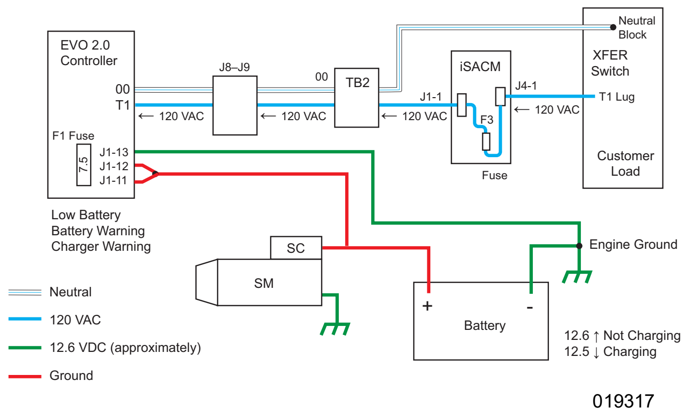


Figure 3-84.

4. Place red meter lead on T1 at the ISACM (J1-1) connection and black meter lead on 00 at the Neutral bar at the transfer switch.
   a. If 0 VAC is measured, continue to next step.
   b. If 120 VAC is measured, check connections, pins and wires between ISACM and TB2 connector to find where 120 VAC is dropped.
5. Remove and inspect F3 fuse (T1) from transfer switch.
   a. If fuse good, reinstall F3 fuse and continue to next step.
   b. If fuse bad, replace F3 fuse with known good fuse and check for voltage at J8/J9 connector. If fuse continues to blow, check for short to ground.
6. Place red meter lead on T1 at the ISACM (J4-1) and black meter lead on 00 at the Neutral bar.
   a. If 0 VAC is measured, continue to next step.
   b. If 120 VAC is measured, check connection/ pins and ensure F3 fuse is properly installed and voltage is available at the fuse. If 0 VAC is measured at the F3 fuse, replace ISACM module.

7. Place red meter lead on T1 at the customer load side of the transfer switch and black meter lead on 00 at the Neutral bar.
   a. If 0 VAC is measured, verify transfer switch mechanism is in correct position. Continue to next step.
   b. If 120 VAC is measured, check connection/ pins between customer load and ISACM (J4-1).
8. With transfer switch in correction position, verify proper voltage and Neutral from source is available. Check that MLCB (Utility/Generator) is closed and voltage is available.
   a. If voltage is available on one side of the MLCB but not the other, verify the breaker is closed and replace if necessary.
   b. If voltage is available on both sides of the MLCB, check contacts inside of the transfer mechanism. If OK, retest for 120 VAC at controller and repeat test.

Results

Specific results may vary based on step within procedure.

Test 77 – Check Wire 13 and Wire 0 / Battery Charger

General Theory

This test is to ensure that battery voltage is available at the controller, the battery charging status and the voltage output from the charger.

NOTE: The battery may show a surface charge with the charger ON/OFF. A blown fuse will show 0.0 Battery Voltage in the controller as well as a “Not Charging” status.

Procedure

1. Set DMM to measure DC voltage.
2. Place red meter lead on the positive battery post (+) and black meter lead on the negative battery post (-).
   a. If battery voltage is below 12.6 VDC, continue to step 6.
   b. If voltage is above 12.5 VDC, continue to next step.
3. Disconnect Wire 14 at fuel solenoid or turn off fuel supply to generator.
4. Remove 7.5AMP fuse.
5. Reinstall 7.5 AMP fuse. This will cause charger to start. Check Charging Status under the Dealer>Display menu.
   a. If controller displays “Not Charging” and battery voltage is below 12.6 VDC, verify digital output channel 4 displays a 1. If 1 is shown, replace controller.
   b. If controller displays “Charging”, continue to next step.

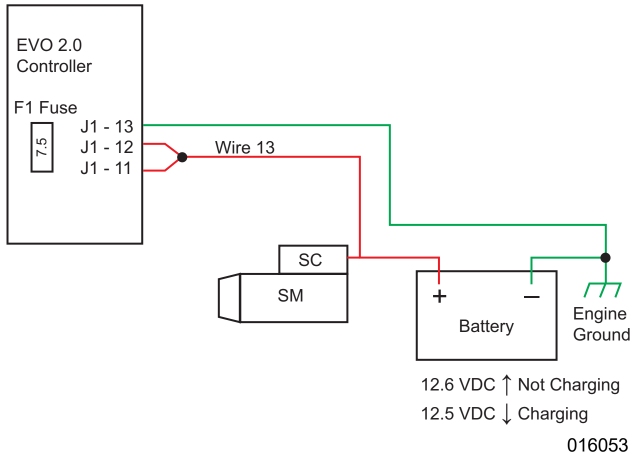


Figure 3-85.

6. Check Battery Voltage under the Dealer>Display menu.
   a. If controller displays less than 12.9 VDC, replace controller.
   b. If controller displays more than 12.8 VDC, continue to next step.
7. Locate Wire 13 and Wire 0 at back of controller. Do not disconnect the connector.
8. Place red meter lead at Wire 13 and black meter lead at Wire 0 at back of controller.
   a. If 12.9 VDC or greater is measured, continue to next step.
   b. If 12.8 VDC or less is measured, check connection and pins at controller. If OK, replace controller.
9. Place red meter lead at Wire 13 at starter contactor and black meter lead at ground.
   a. If 12.9 VDC or greater is measured, continue to next step.
   b. If 12.8 VDC or less is measured, check connection, pins and wires from controller to starter contactor.
10. Place red meter lead on positive battery post (+) and black meter lead on negative battery post (-) at battery.
   a. If 12.9 VDC or greater is measured, battery charger is working and test is complete.
   b. If 12.8 VDC or less is measured, check connection, pins and wires from starter contactor to battery.

Results

Specific results may vary based on step within procedure.

Test 83 – Verify Model ID Resistor Connections

General Theory

Table 5-16 identifies Model ID resistors for specific air-cooled generator models. The Model ID Resistor allows the controller to identify the size/model of the generator and is specific to each model. When replacing (or removing and reinstalling) an Evolution 1.0 (Sync 2.0) or Evolution 2.0 (Sync 3.0) controller, if the controller is not powered up in the proper sequence, it will result in a “Model Ident Problem Fix Harness Resistor” fault. This fault does not have an associated E-Code.

Procedure

1. Disconnect battery charger supply voltage (T1) to the controller (J8-J9 connector).
2. Remove 7.5 Amp fuse in the controller. This will power down the controller.
3. Disconnect harness connectors J1 and J2.
4. Inspect the following pins for any looseness or poor connections. Refer to Appendix A.
   a. Evolution 2.0 (Sync 3.0) - J2-11, J2-14 and J2-15.
   b. Evolution 1.0 (Sync 2.0) - J2-8, J2-15 and J2-16.

NOTE: Certain models may not use all 3 wire/pins.

5. Reconnect harness connectors J2 and then J1 (specifically in this order).
6. Install 7.5 Amp fuse in the controller. This will power up the controller.
7. Reconnect battery charger supply voltage (T1) to the controller (J8-J9 connector).
8. When the controller has powered up, it will display the Install Wizard. Make any necessary adjustments to the controller settings and verify correct operations of generator and transfer switch.

Result

If the “Model Ident Problem Fix Harness Resistor” does not reappear, discontinue testing.

If the “Model Ident Problem Fix Harness Resistor” fault returns, or is intermittently persistent, test the Model ID resistor for proper resistance. Replace the Model ID harness resistor if resistance reading is outside of specification and restarting the controller did not correct the fault.

NOTE: Refer to Service Information Bulletin SIB14-11-ALL for further information.

Table 5-16. Model ID Resistor Data

Part Number	Generator Node	Resistance Pin 1 to Pin 3	Resistance Pin 1 to Pin 2
0K0258A	8 kW / 10 kW	2.4k	OL
0K0258B	9 kW	365	OL
10000003605	EVO2.0 Ecogen	3.2k	OL
0K0258D	13 kW	4.1k	OL
0K0258E	14 kW / 22 kW	787	OL
0K0258F	15 kW / 22 kW	5.3k	OL
0K0258G	16 kW	6.8k	OL
0K0258H	17 kW	1.2k	OL
0H0258J	20 kW	1.8k	OL
0K0258K	20 kW Synergy / 208 3 -Phase	8.6k	OL
0K0258L	EVO1.0 Ecogen / 308 3-Phase	11.3k	OL
0K0258M	8 kVA 50 Hz	15k	OL
0K0258N	10 kVA 50 Hz	21k	OL
0K0258P	13 kVA 50 Hz	31.6k	OL
0K0258Q	EVO 1.0 11 kW	56.2k	OL
0K0258AA	EVO 2.0 11 kW	2.4k	Continuity
0K0258BB	22 kW	365	Continuity
10000033399	16 kW with 816cc	3.2k	Continuity

Table 5-16. Model ID Resistor Data

Part Number	Generator Node	Resistance Pin 1 to Pin 3	Resistance Pin 1 to Pin 2
A0000923647	14 kW with 816cc	4.1k	Continuity
A0000923648	18 kW with 816cc	787	Continuity
0K0258AA	24 kW	2.4k	Continuity
A0001840869	26 kW	5.3k	Continuity

Front Engine Access (2016 and prior models)

Safety

1. Set the controller to OFF.
2. See *Figure 4-1*. Remove the 7.5 amp main fuse.
3. Remove the N1 and N2 fuses from the transfer switch.

Figure 4-1. Remove 7.5 Amp Fuse

4. Turn off fuel supply to the generator and remove the flex-line from the fuel regulator.
5. Remove Utility power from the generator.
6. Remove the front door.
7. Remove battery from the generator.

Front Engine Access

1. **Remove Controls Cover:** See *Figure 4-2*. Depending on unit, use a Torx T-27 socket or 5/32” (4 mm) Hex Allen socket to remove screws and ground washer from the controls cover. Remove the controls cover.

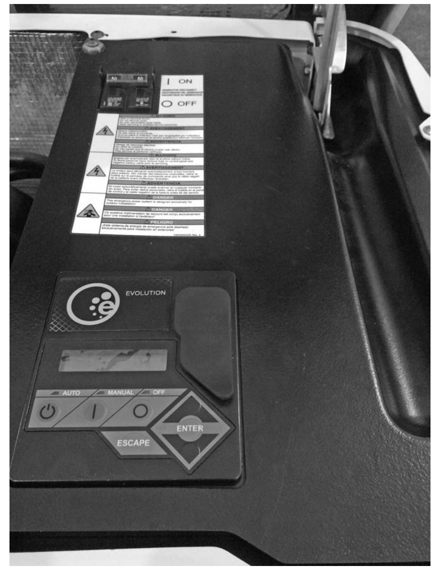


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Figure 4-2.

2. **Remove Controller:** See *Figure 4-3*. Use a 1/4” socket to remove the screw that is directly underneath the support bracket and then slide the controller back to line up the tabs on the controller with the openings on the divider wall.

Figure 4-3. Tabs on Controller

3. **Remove Control Harnesses:** See *Figure 4-4*. Disconnect all connectors and remove the controller.

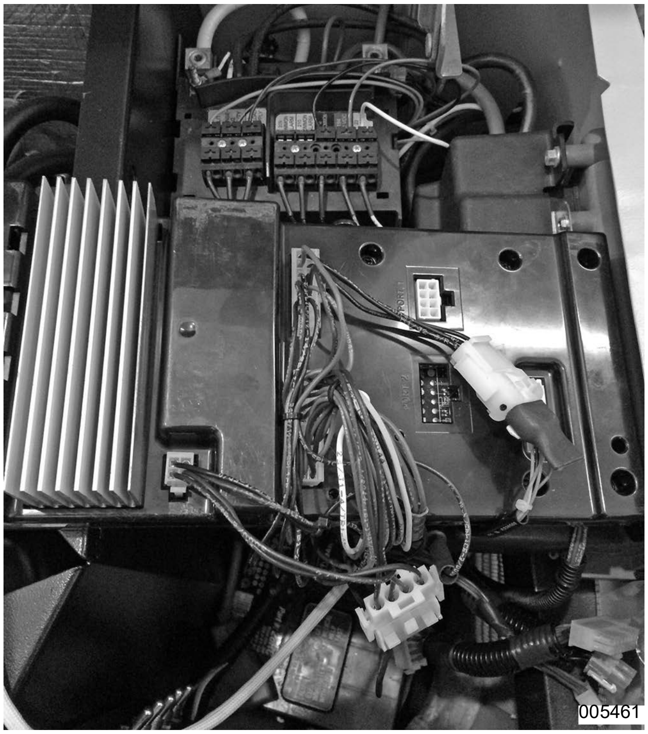

Figure 4-4. Controller Connections

4. **Remove Stator Wires:** See *Figure 4-5*. Remove all wires from the main circuit breaker, remove the neutral and ground wires from landing lugs.

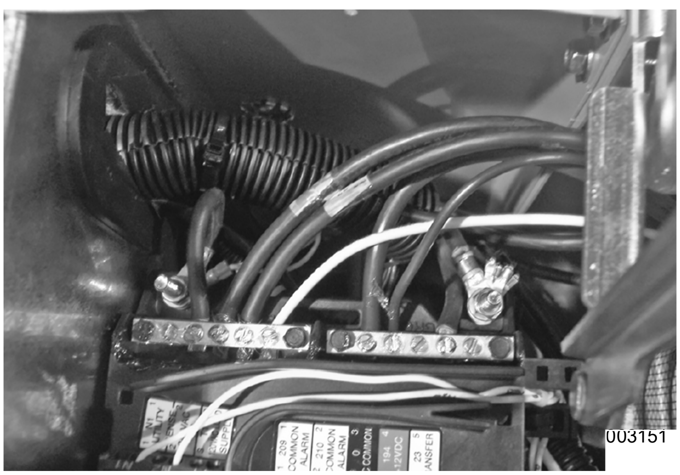

Figure 4-5.

5. **Remove Control Wires:** See *Figure 4-6*. Remove Wires N1, N2, T1, 0, 194, 23, GFCI Outlet, and unit status lights from the control box.

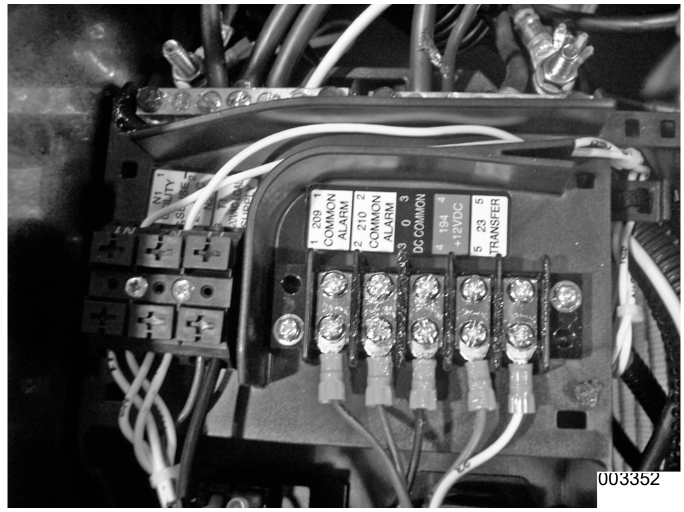

Figure 4-6.

6. **Remove Engine Intake Baffle:** See *Figure 4-7*. Use a 10 mm socket to remove the two bolts from the engine intake baffle. Pull baffle out carefully, there are tabs holding the backside of the baffle to the divider panel.

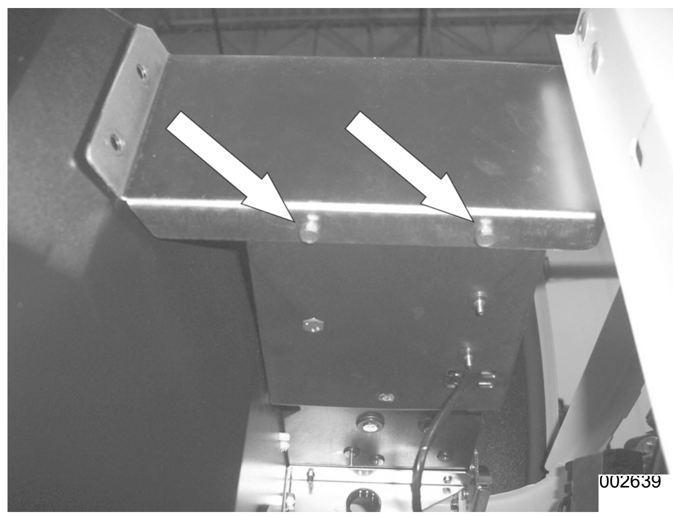

Figure 4-7.

Figure 4-8.

7. **Loosen Side Panel:** See *Figure 4-7*. Using a 10 mm socket remove the two bolts from the base of the enclosure side panel.
8. **Unbolt Enclosure Side Panel Mounting Bracket:** See *Figure 4-7*. Using a 10 mm socket remove the two bolts from the enclosure side panel mounting bracket.

Figure 4-9.

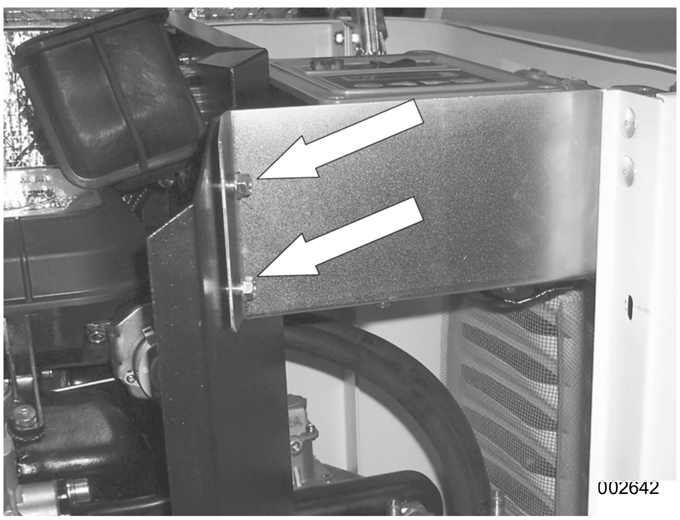

Figure 4-10.

9. **Remove Fuel Regulator:** See *Figure 4-11*. Remove the two fuel hoses at the top of the regulator. Use a 10 mm socket to remove one 10 mm bolt from the base of the plenum and one 10 mm bolt from the base of the fuel regulator. Flex the enclosure side out to allow for room to remove the regulator assembly.

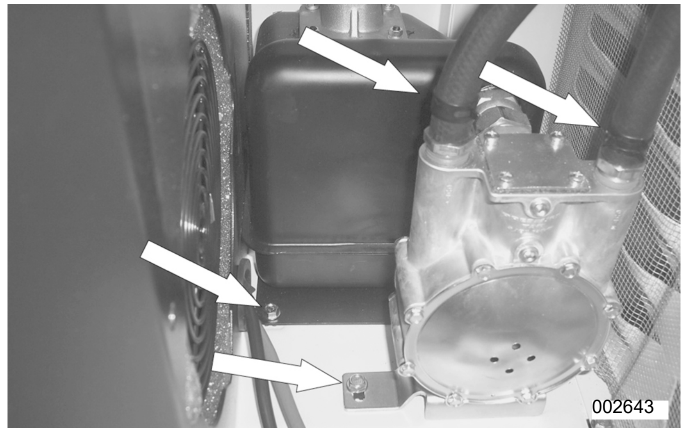

Figure 4-11.

10. **Remove Engine Divider Panel:** See *Figure 4-12*. Use a 10 mm socket to remove the rear 10 mm bolt from the base of the enclosure. See *Figure 4-13*. Remove the front 10 mm bolt from the base of the enclosure.

Figure 4-12.

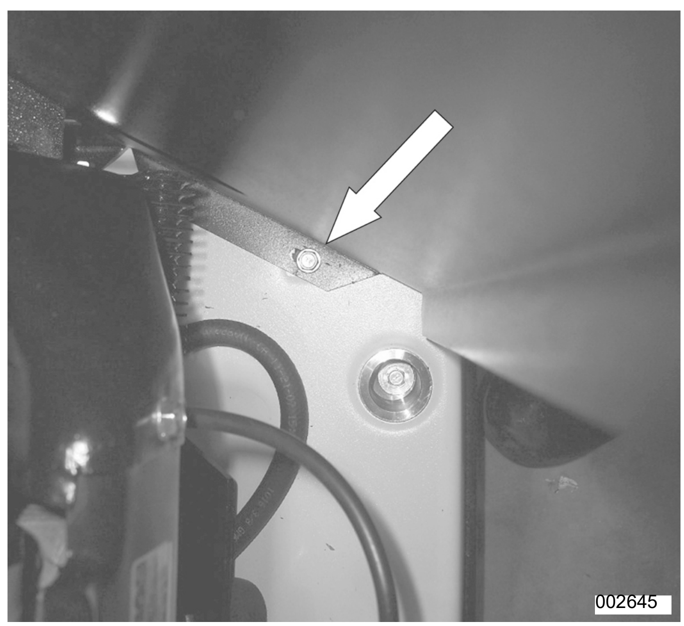

Figure 4-13.

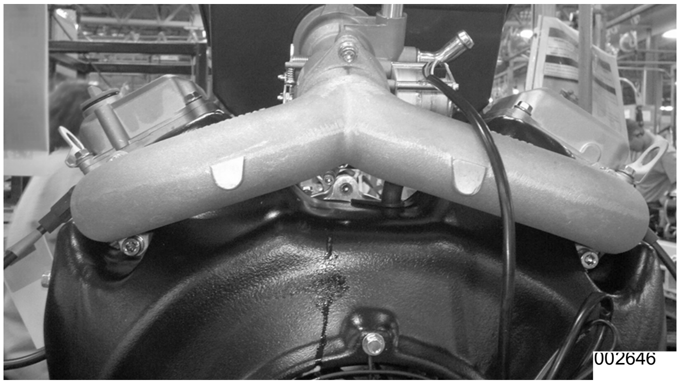

Figure 4-14. Intake Manifold

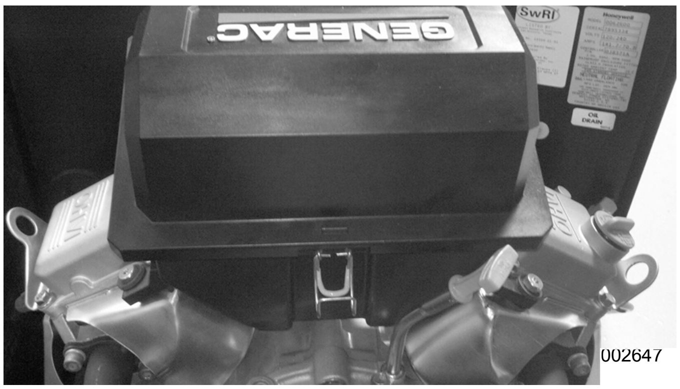

Figure 4-15. Air Box

11. **Unbolt Oil Cooler:** See ***Figure 4-16***. Use a 10 mm socket to remove the two 10 mm bolts from the front of the oil cooler. See ***Figure 4-17***. Remove the two 10 mm bolts from the rear of the oil cooler.

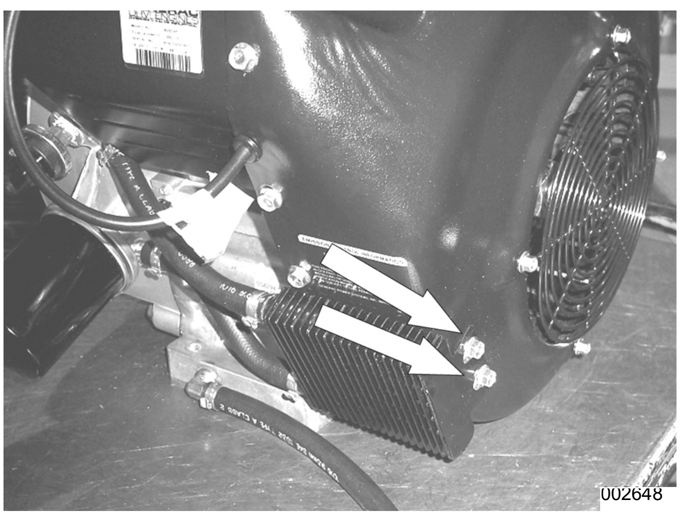

Figure 4-16.

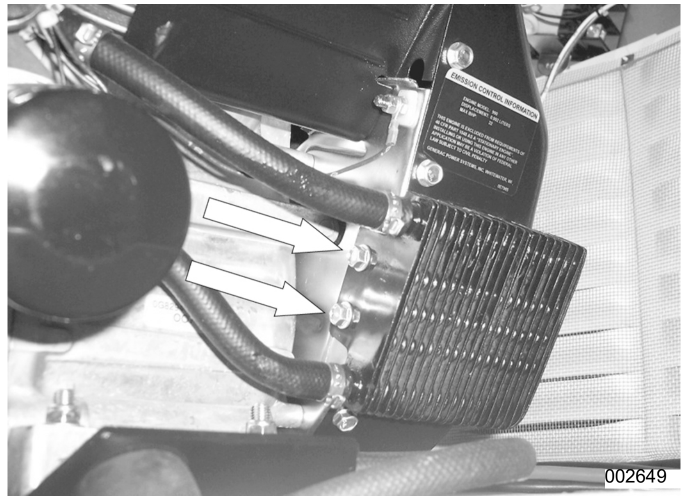

Figure 4-17.

12. **Remove Blower Housing:** See ***Figure 4-18***. Use a 4 mm Allen wrench to remove one button head cap screw from top of blower housing. Use a 10 mm socket to remove one 10 mm bolt from the top of the blower housing.

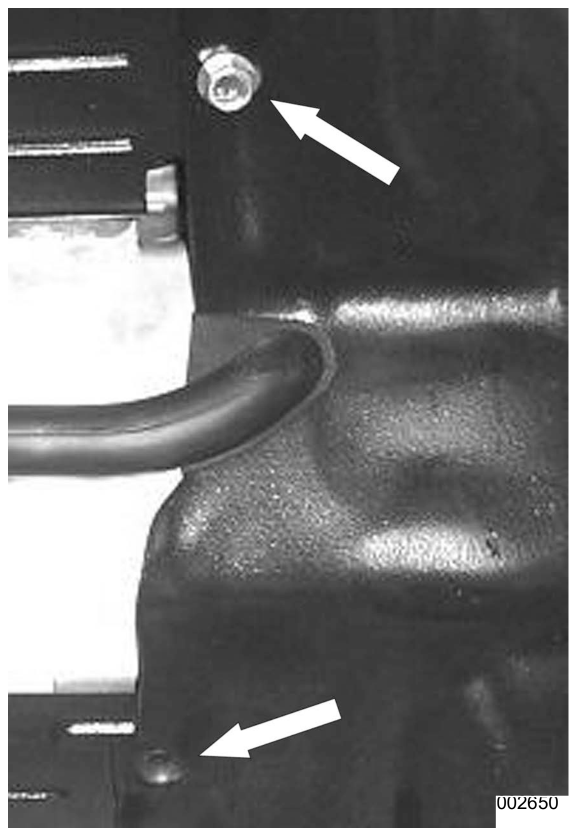

Figure 4-18.

13. See ***Figure 4-19*** and ***Figure 4-20***. Use a 10 mm socket to remove four 10 mm bolts from the right-side of the blower housing, and four 10 mm bolts from the left-side of the blower housing.
14. Remove blower housing.

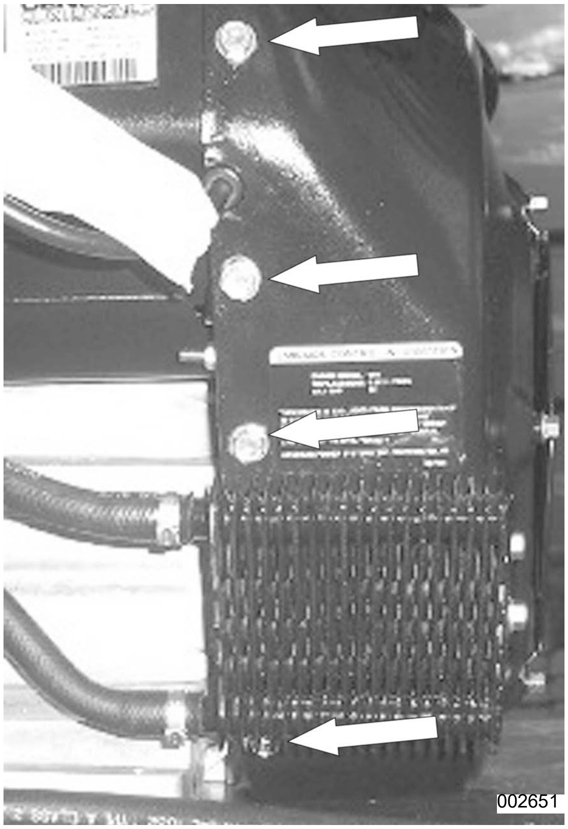

Figure 4-19.

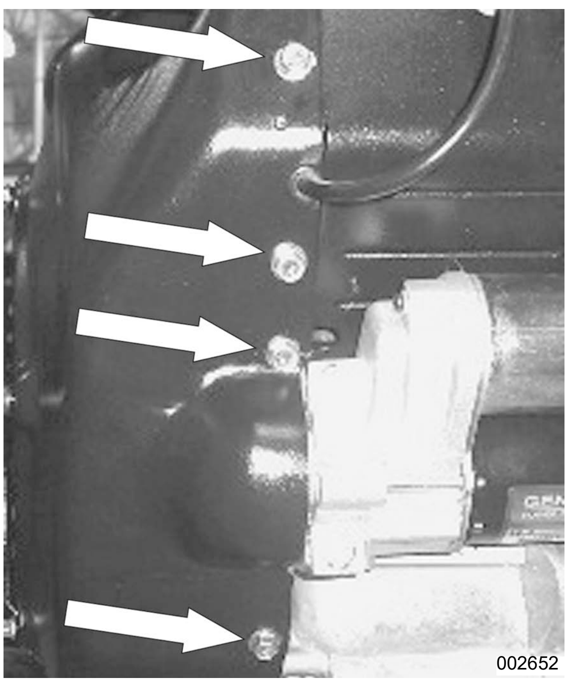

Figure 4-20.

2017 and Newer HSB Front Access

1. Set the controller to OFF.
2. Remove the 7.5 amp main fuse.

Figure 4-21.

3. Remove the N1 and N2 fuses from the transfer switch.
4. Turn off fuel supply to the generator.
5. Remove the front door and the right side access panel
6. Remove battery.

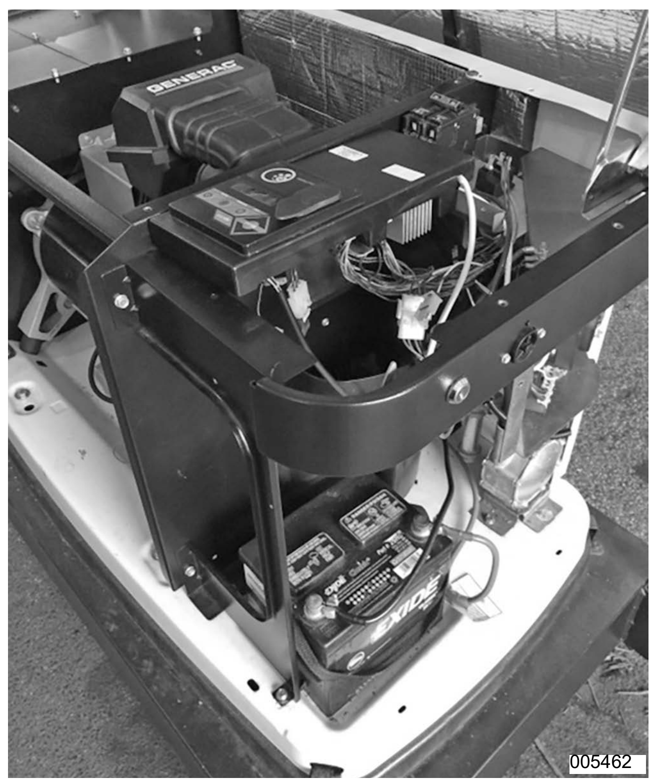

Figure 4-22.

7. **Remove Controls Cover:** Use a 4mm Hex Allen socket to remove the bolts and ground washer from the controls cover.
8. Remove the controls cover.
9. Remove the controller.

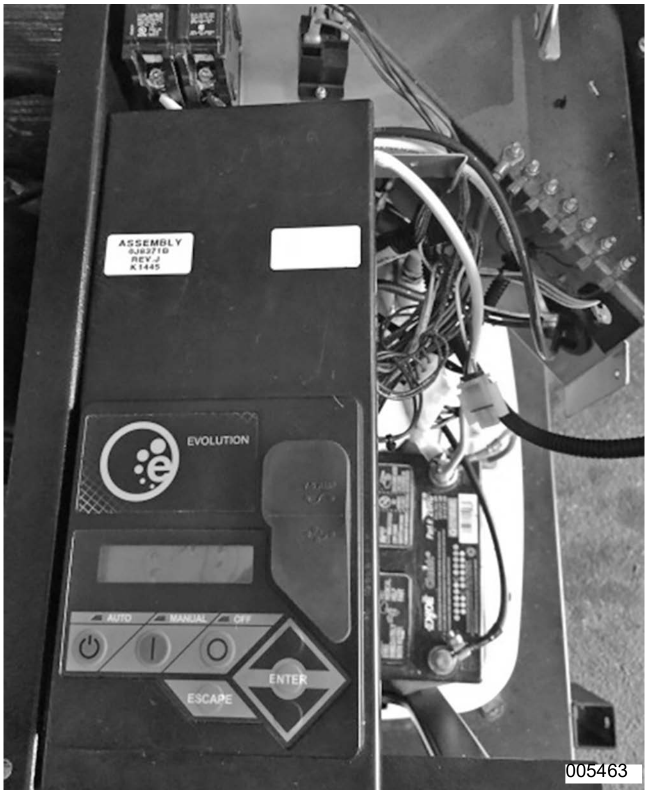

Figure 4-23.

10. Remove control harnesses.
11. Disconnect all connectors and remove the controller.

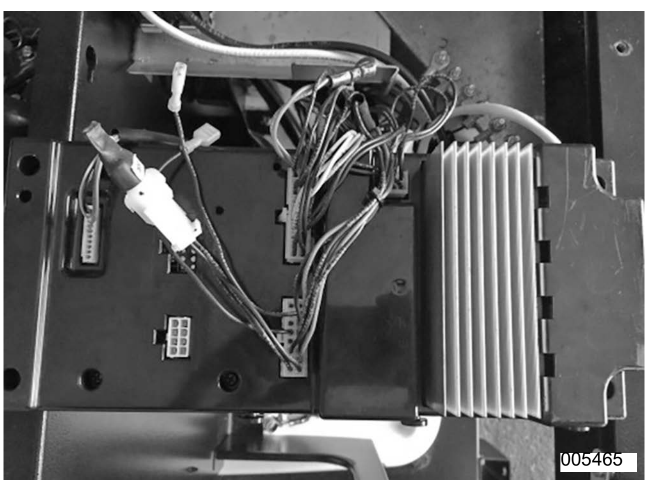

Figure 4-24.

12. Remove right side support panel from divider panel.

Figure 4-25.

13. Remove engine intake baffle.
14. Use a 10 mm socket to remove the two bolts from the engine intake baffle. Pull baffle out carefully. There are tabs holding the back of the baffle to the divider panel.

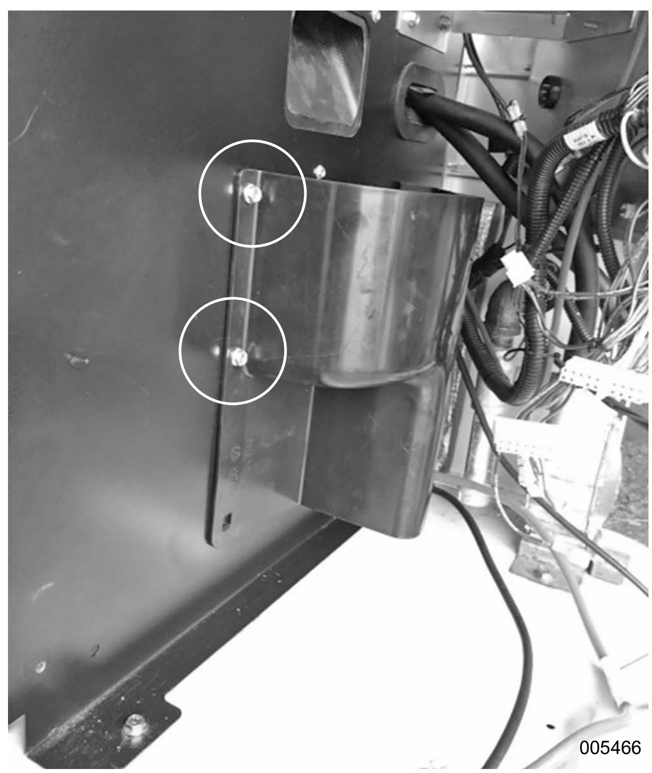

Figure 4-26.

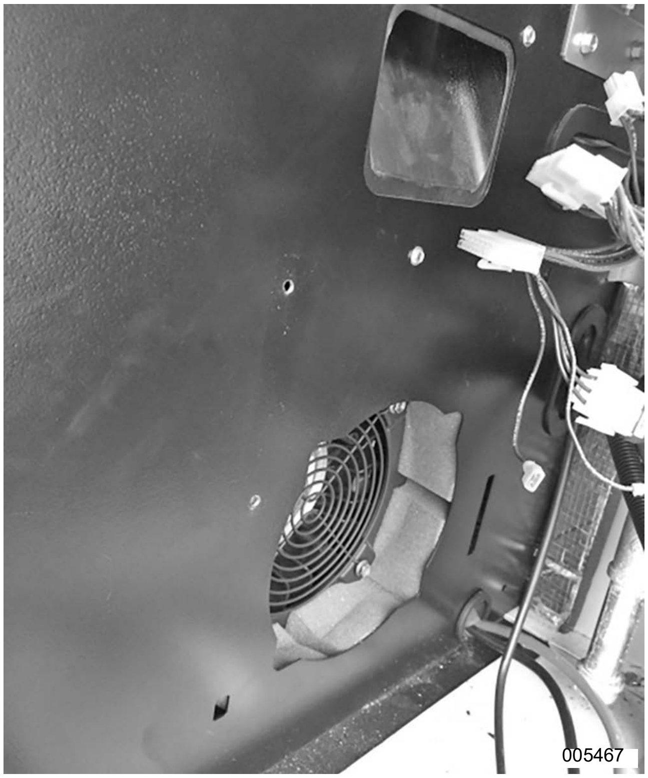

Figure 4-27.

15. Remove circuit breaker mounting plate.

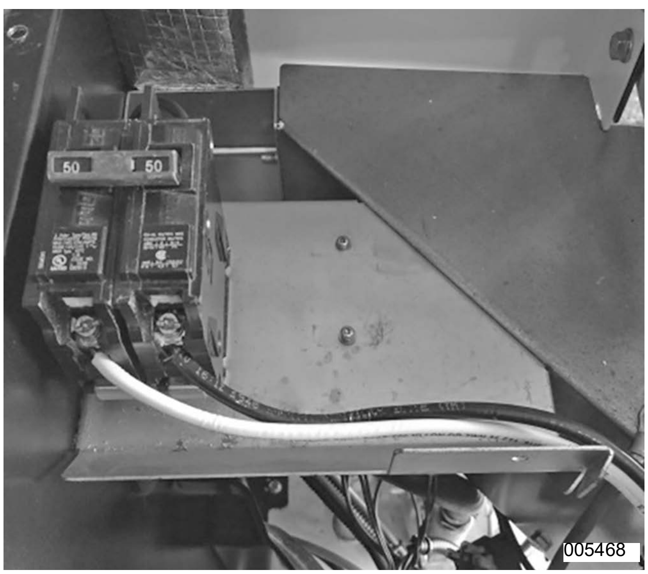

Figure 4-28.

16. Remove cap screw located above the electrical connection pad in the customer connection area.

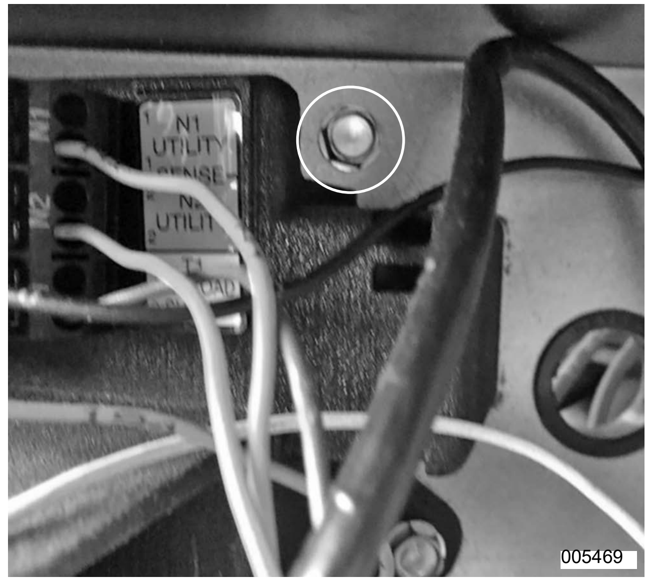

Figure 4-29.

17. Remove the 2 inside cap screws under the breaker tray connecting to the divider panel.

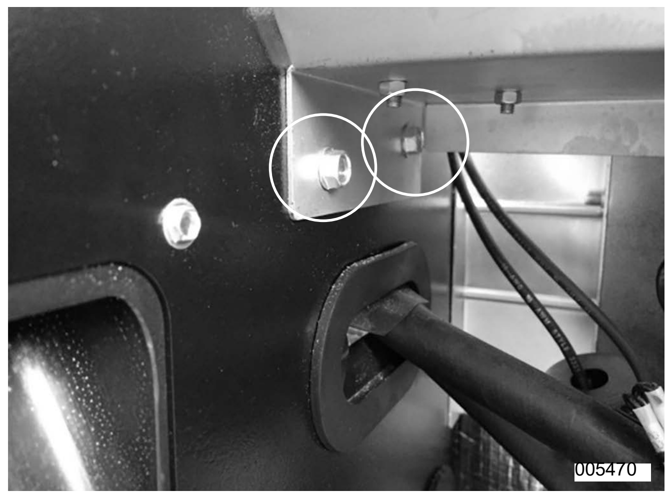

Figure 4-30.

18. Disconnect wires from breaker.

Figure 4-31.

19. Swing breaker with tray out of the way leaving the wires on the outlet side of breaker connected.
20. Remove air cleaner cover and rubber inlet duct.

Figure 4-32.

21. Remove the 2 brass colored mounting screws from the divider panel to the base.

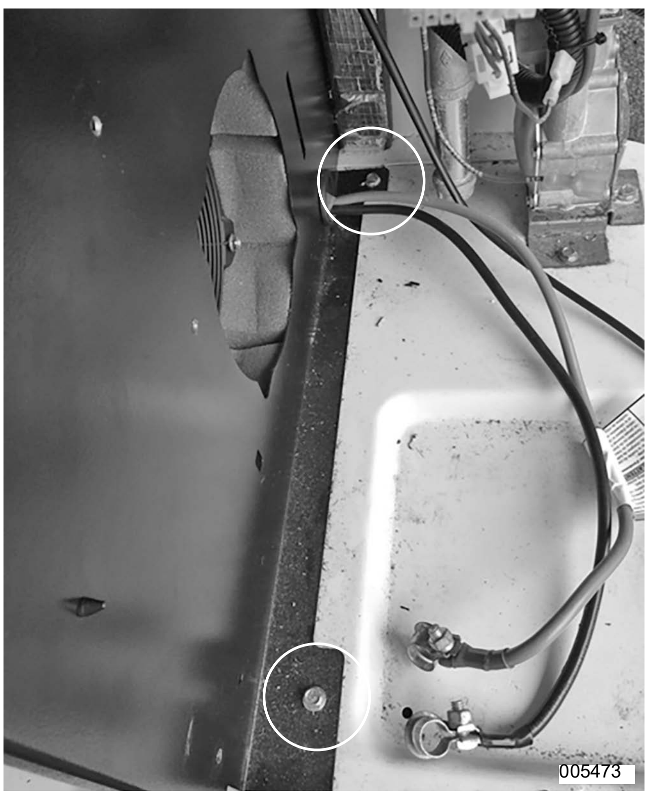

Figure 4-33.

22. Remove two cap screws from the back of the divider panel (located on the engine side).

Figure 4-34.

23. Remove Allen screw back side of divider panel to back panel of generator.

Figure 4-35.

24. Pivot panel out for access to front of engine.

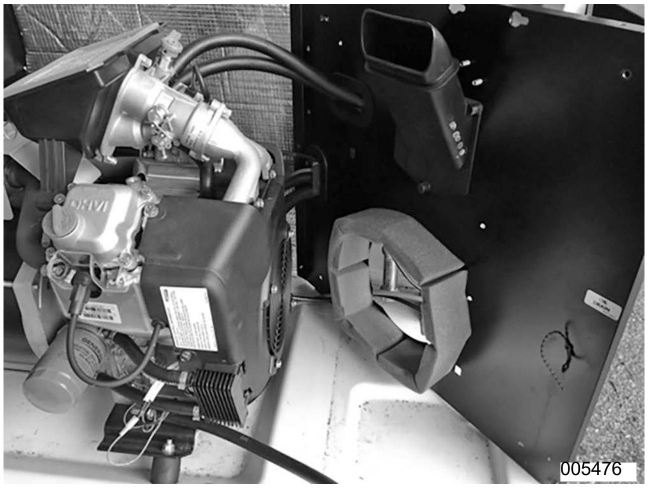

Figure 4-36.

25. Remove the blower housing (front engine cover) per Engine Service manual procedures.

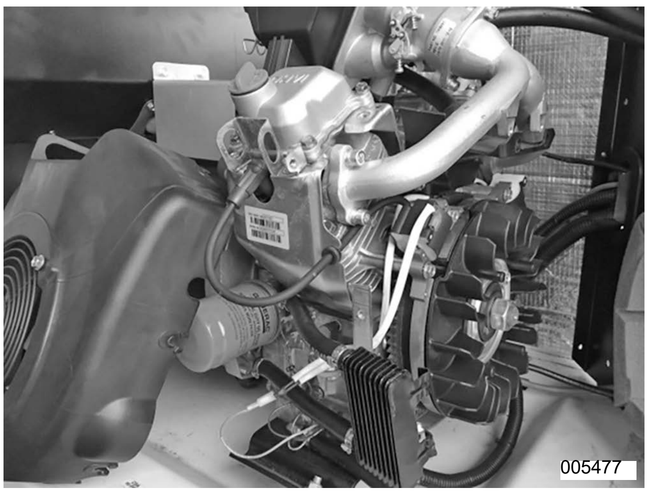

Figure 4-37.

26. Reassemble in reverse order.

Major Disassembly (2016 and prior models)

Safety

1. Set the controller to OFF.
2. See ***Figure 4-38***. Remove the 7.5 amp main fuse.
3. Remove the N1 and N2 fuses from the transfer switch.

Figure 4-38. Remove 7.5 Amp Fuse

4. Turn off fuel supply to the generator and remove the flex-line from the fuel regulator.
5. Remove Utility power from the generator.
6. Remove the front door.
7. Remove battery from the generator.

Stator/Rotor/Engine Removal

1. **Remove Top Exhaust Enclosure Covers:** See ***Figure 4-39***. Use a 10 mm socket to remove the nine bolts from the exhaust top covers. Remove covers.

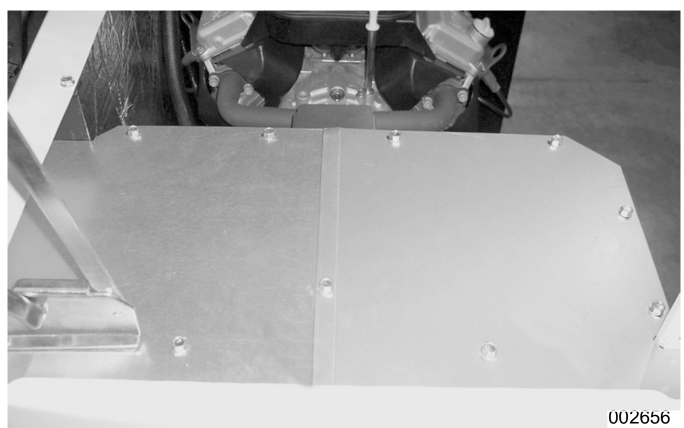

Figure 4-39.

2. **Remove Side Exhaust Enclosure Cover:** See ***Figure 4-40***. Use a 10 mm socket to remove the five bolts from the exhaust side cover. Remove side covers.

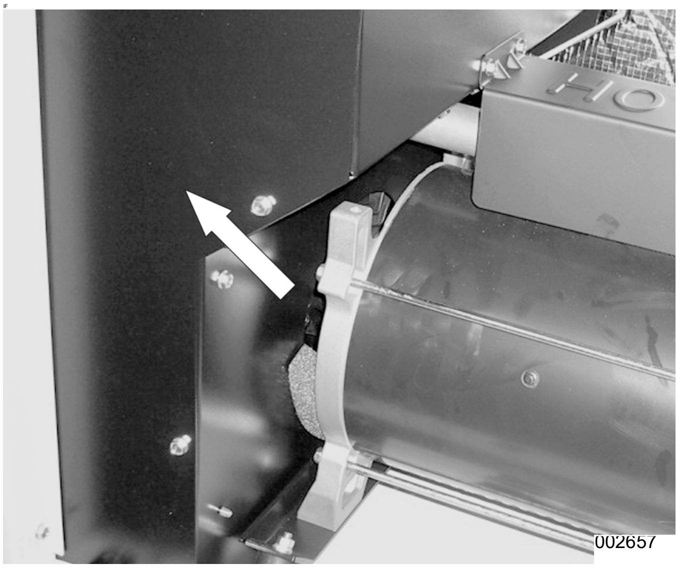

Figure 4-40.

3. **Remove Exhaust Flex Cover:** See ***Figure 4-41***. Use a 10 mm socket to remove the two bolts from the exhaust flex pipe cover. Remove the cover.

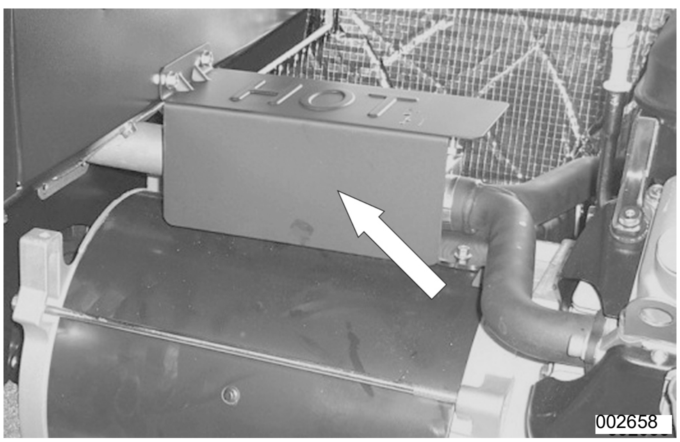

Figure 4-41.

4. **Remove Exhaust Flex Pipe:** See ***Figure 4-42***. Use a ½” socket to remove the front and rear muffler clamp. Slide exhaust flex toward engine to completely expose the muffler flange.

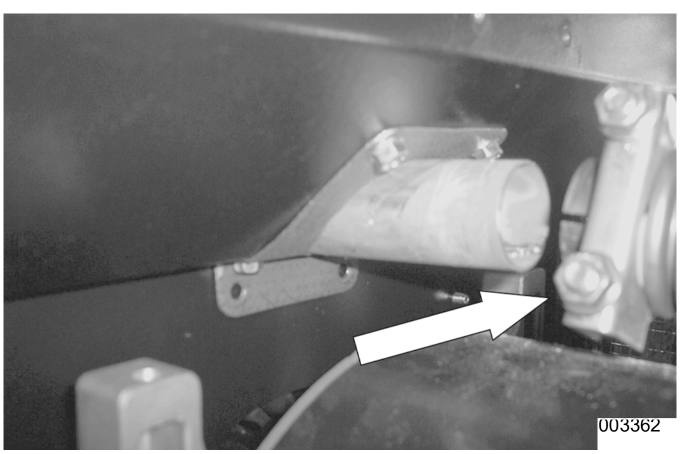

Figure 4-42.

5. **Muffler Assembly:** See ***Figure 4-43***. Depending on the clamp, use a ½” or 10 mm socket to remove the muffler clamp and flex pipe. Leave muffler attached to the divider panel.

Figure 4-43.

6. **Remove Left-side Enclosure:** See ***Figure 4-44***. Use a 10 mm ratchet wrench to remove the horizontal 10 mm bolt that connects the side panel to the back panel.
7. Use a 10 mm socket to remove three bolts from the base of the enclosure.

NOTE: The muffler is shown removed for better view of the bolts.

8. See ***Figure 4-45***. Use a 10 mm socket and wrench to remove the top hinge bolt and loosen the bottom bolt.
9. While holding the roof, remove the bottom hinge bolt.
10. Remove the side panel by sliding it forward then re-install the hinge bolt.

NOTE: The muffler has been removed for better view of the bolts.

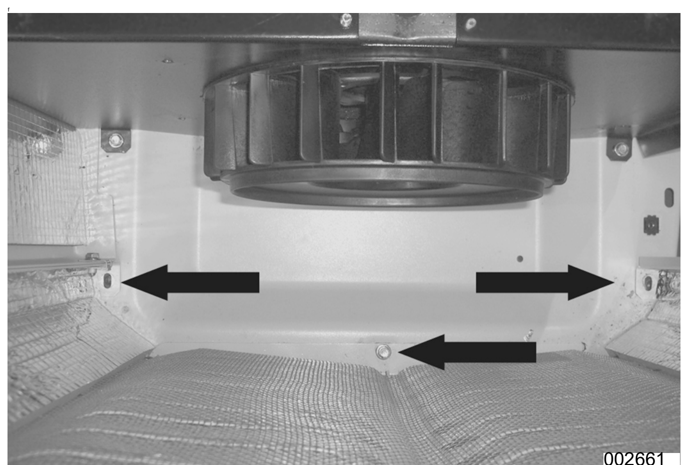

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Figure 4-44.

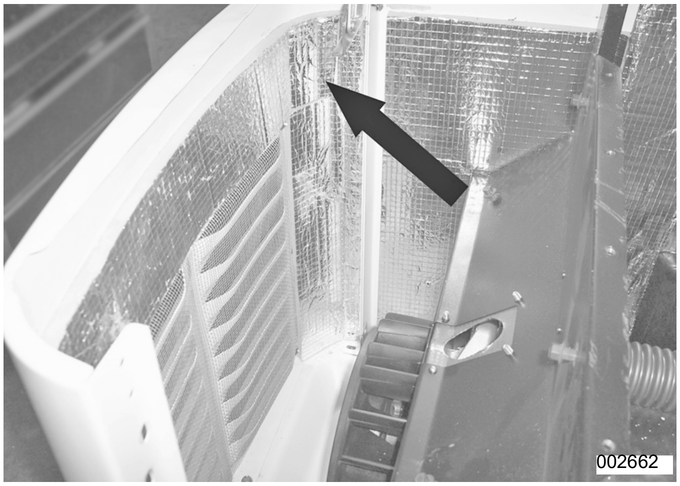

Figure 4-45.

11. **Remove Fan Housing Cover:** See ***Figure*** . Use a 10 mm socket to remove four bolts from the fan housing cover (if equipped).
12. Remove the fan housing cover.

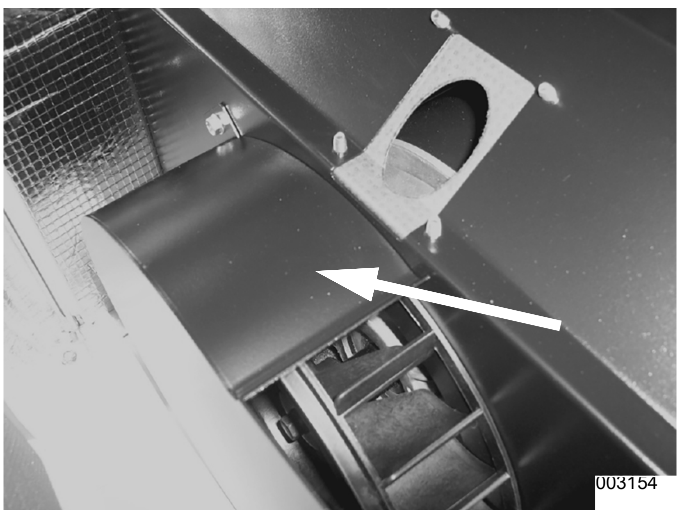

Figure 4-46.

13. **Remove Rotor Bolt:** See ***Figure 4-47***. Use a 9/16” socket to remove rotor bolt.

Figure 4-47.

NOTE: See ***Figure 4-48***. After removing the rotor bolt, install a 12 mm x 1.75 mm cap screw in the end of the rotor shaft. This will be used in conjunction with the puller in the following step.

Figure 4-48.

14. **Remove Rotor Fan:** See ***Figure 4-49***. Attach a vibration dampener or suitable puller to the fan using two M8 x 1.25 bolts.
15. Remove the fan from the rotor.

Figure 4-49.

16. **Remove Alternator Divider Panel:** See ***Figure 4-50***. Depending on the unit, use a 10 mm socket or 4 mm Allen wrench to remove two bottom base bolts.

NOTE: Muffler assembly remains attached to the alternator divider panel during removal.

17. Use a T27 torx driver to remove one top rear bolt.
18. Remove the panel.

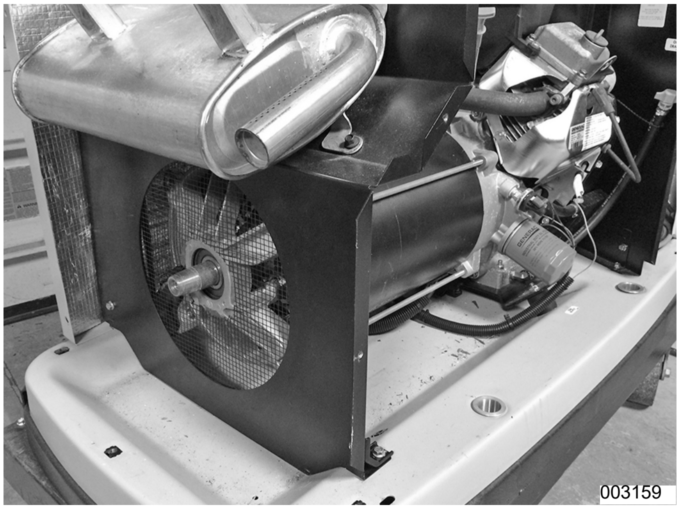

Figure 4-50.

19. **Remove Brushes:** See ***Figure 4-51***. Use a 7 mm socket to remove brushes.

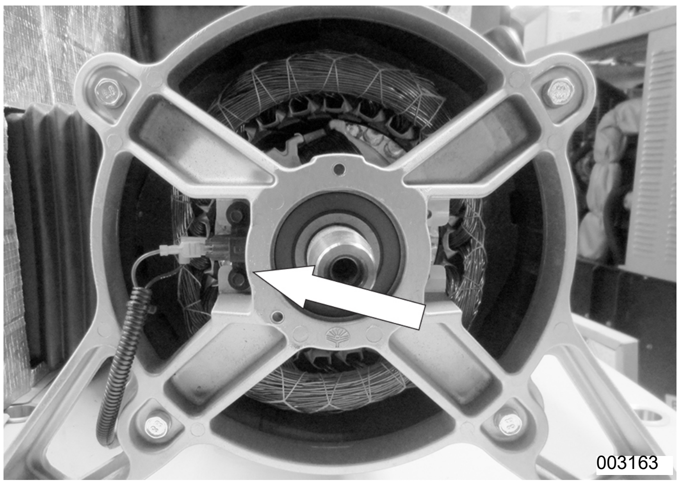

Figure 4-51. Brushes Location

20. **Remove Brush Wires:** See ***Figure 4-52***. Use a side cutters to remove the tie wraps securing the brush wires to the outside of stator.

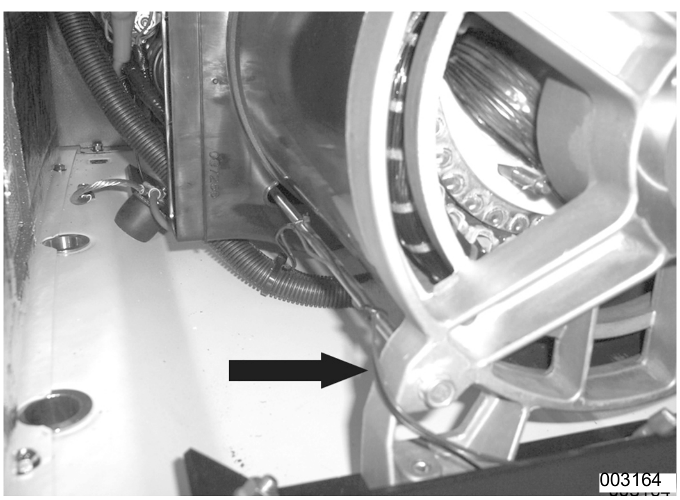

Figure 4-52.

21. **Remove Controls Cover:** See ***Figure 4-53***. Use a Torx T-27 socket or 5/32” Hex Allen socket to remove two bolts and ground washer from the controls cover. Remove the controls cover.

22. **Remove Stator Wires:** See ***Figure 4-53***. Remove all connectors from the controller, remove all wires the common neutral and ground wires from landing lugs, and remove wires from main beakers.

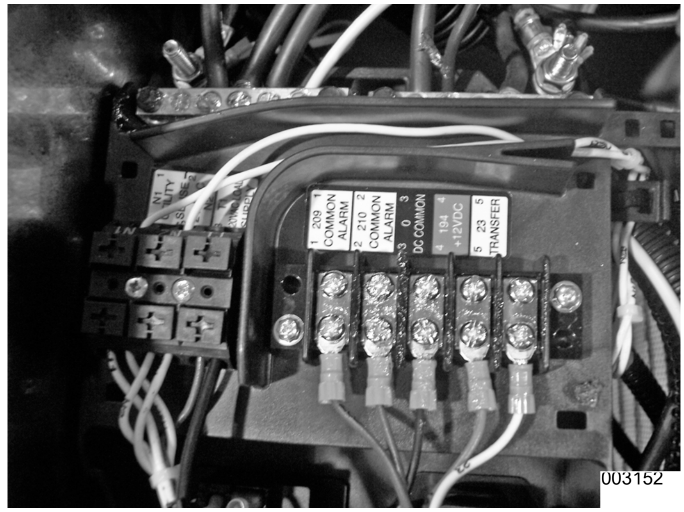

Figure 4-53.

23. **Alternator Air Intake Bellows Removal:** See ***Figure 4-54***. Remove alternator intake bellows.

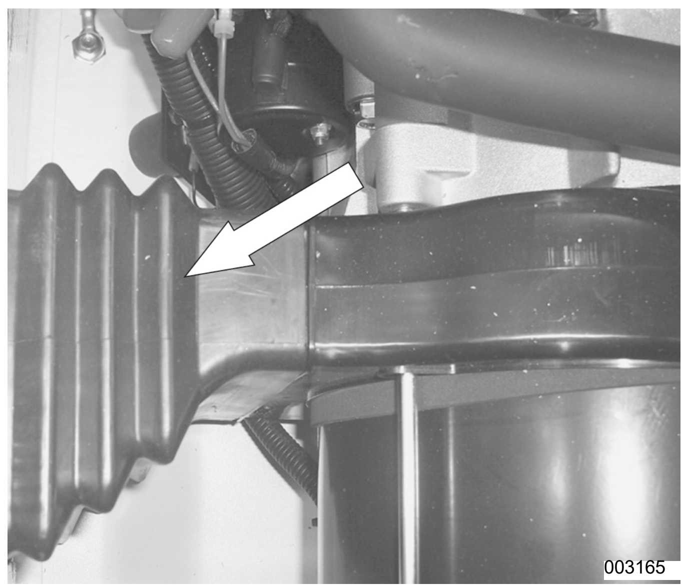

Figure 4-54.

24. **Rear Bearing Carrier Removal:** See ***Figure 4-55***. Use a 13 mm socket to remove the two nuts from the alternator mounting bracket rubber mounts.

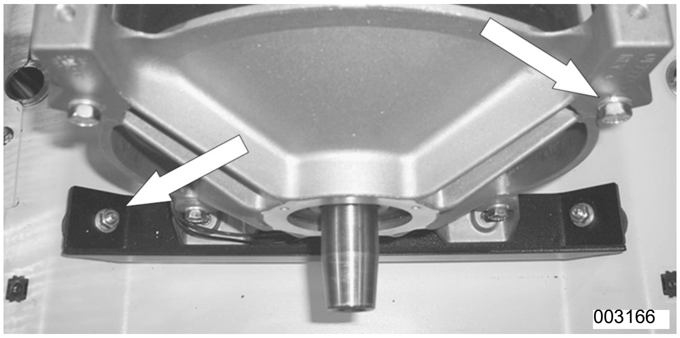

Figure 4-55.

25. See ***Figure 4-57***. Lift the back end of the alternator up and place a 2”x 4” piece of wood under the engine*.

NOTE: *See ***Figure 4-56***. On Evolution product there is a center engine mount and clamping screw. This clamping screw must be loosened before lifting the alternator up to set the wood block in place.

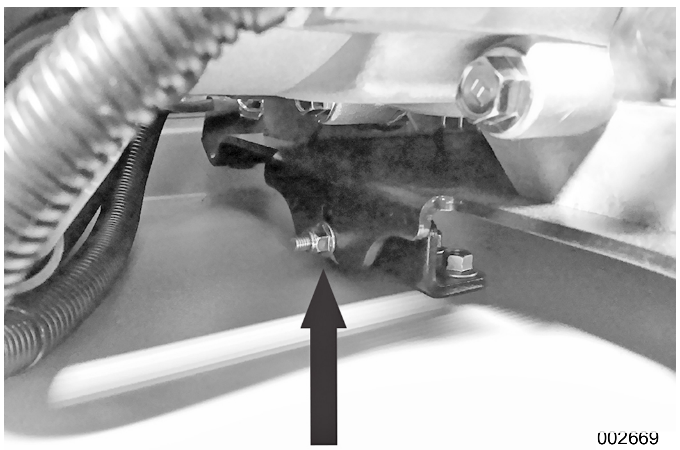

Figure 4-56.

26. Use a 13 mm socket to remove the four stator hold down bolts.
27. Use a small rubber mallet to remove the rear bearing carrier.

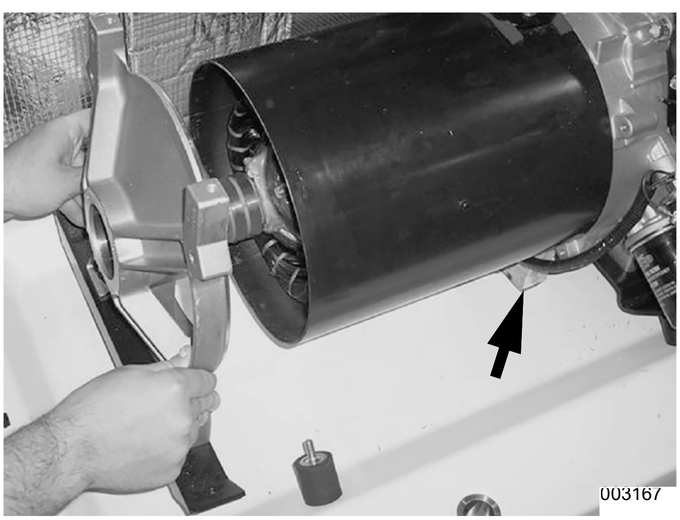

Figure 4-57.

28. See ***Figure 4-58***. Remove stator.

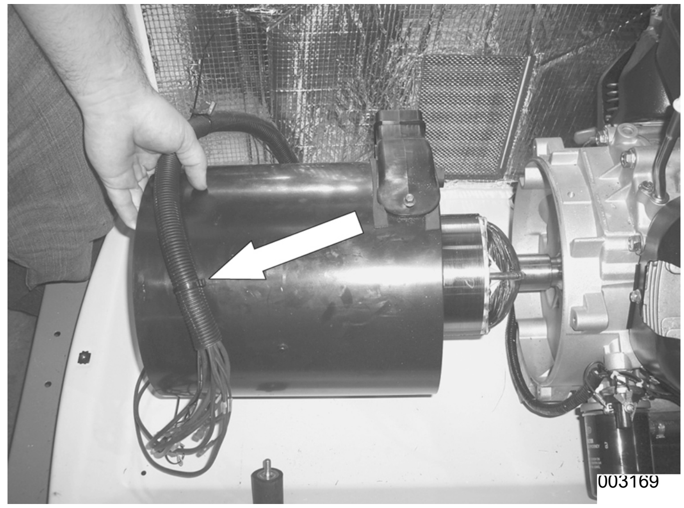

Figure 4-58.

29. **Rotor Removal:**

NOTE: Each model uses a specific rotor bolt. Verify the correct bolt is being used for the rotor being serviced.

a. Cut 0.5 inches from the rotor bolt. Slot the end of the bolt to suit a flat blade screwdriver.
b. Slide the rotor bolt back through the rotor and use a screwdriver to screw it into the crankshaft. Be sure to thread in a minimum of 3/8” to ensure enough threads for puller cap screw.
c. Screw a 3” M12x1.75 cap screw into rotor.
d. Apply torque to the 3” M12x1.75 cap screw until taper breaks free from crankshaft.

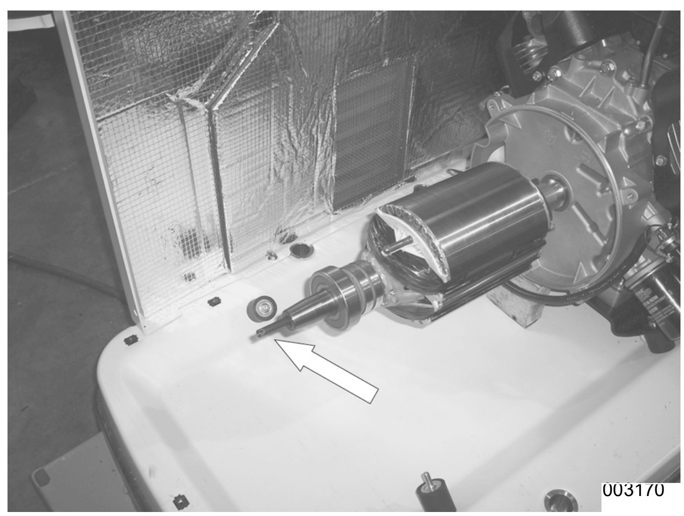

Figure 4-59.

30. **Remove Engine:** See ***Figure 4-60***. Using a 13 mm socket, remove the two engine mount nuts with ground wires.

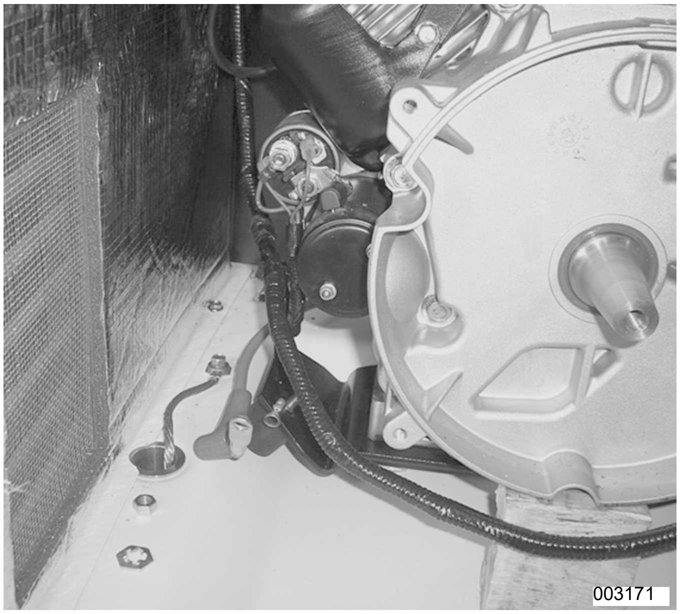

Figure 4-60.

31. See ***Figure 4-61***. Using proper lifting equipment remove the engine.

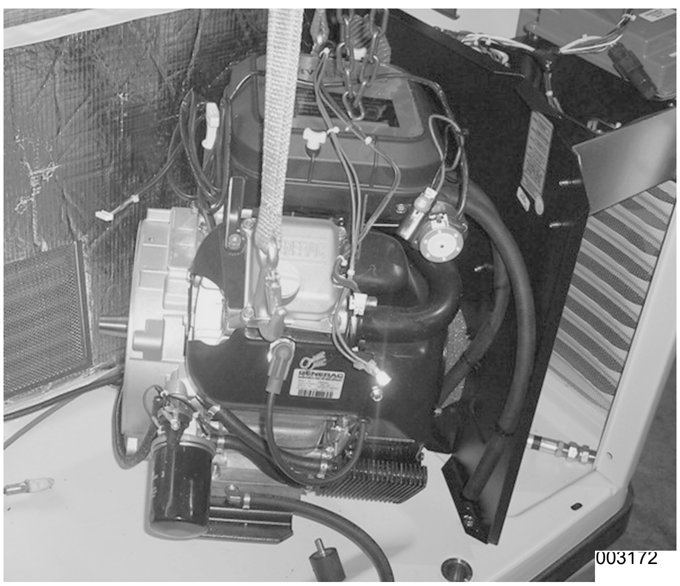

Figure 4-61.

Torque Specifications

Stator Bolts	6 ft-lbs (+1 / -0)
Rotor Bolt	30 ft-lbs
Engine Adapter	25 ft-lbs
Exhaust Manifold	18 ft-lbs
M5-0.8 Taptite Screw Into Aluminum	25-50 **in-lbs**
M5-0.8 Taptite Screw Into Pierced Hole	25-50 **in-lbs**
M6-1.0 Taptite Screw Into Aluminum	50-96 **in-lbs**
M6-1.0 Taptite Screw Into Pierced Hole	50-96 **in-lbs**
M6-1.0 Taptite Screw Into Weldnut	50-96 **in-lbs**
M8-1.25 Taptite Screw Into Aluminum	12-18 ft-lbs
M8-1.25 Taptite Screw Into Pierced Hole	12-18 ft-lbs
M6-1.0 Nylok Nut Onto Weld Stud	16-65 **in-lbs**
M6-1.0 Nylok Nut Onto Hinge Stud	30-36 **in-lbs**

NOTE: Torques values are dynamic, with ±10% tolerance unless otherwise noted.

Major Disassembly(2017 and newer models)

Safety

DANGER

Automatic start-up. Disconnect utility power and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

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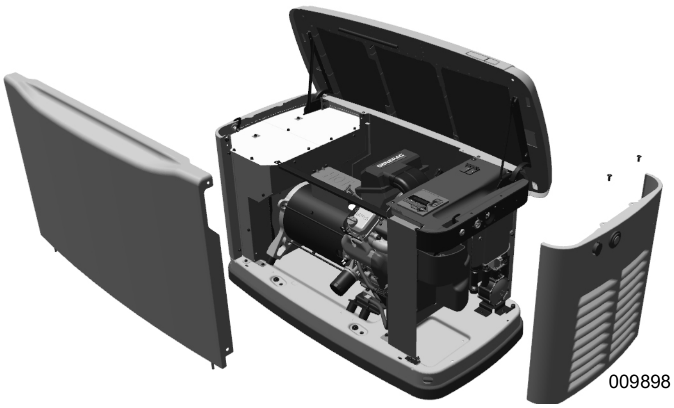

Figure 4-62.

1. Lift the hood.
2. Remove front door.
3. Remove right side panel.

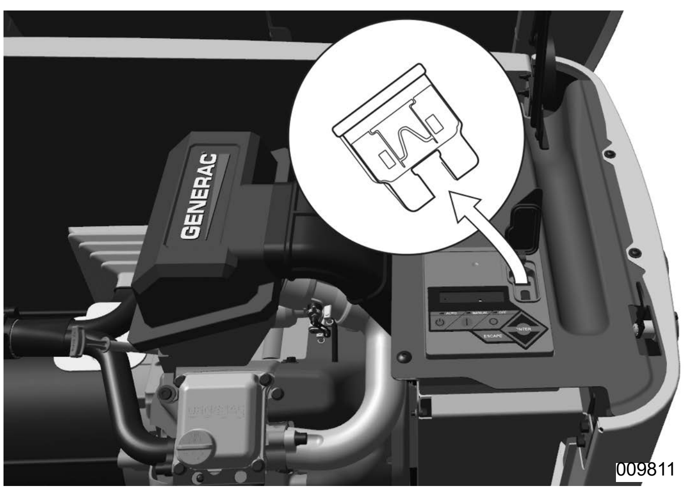

Figure 4-63.

4. Set the controller to OFF.
5. Remove 7.5 amp main fuse.
6. Remove N1 and N2 fuses from the transfer switch.
7. Remove T1/T2 fuse(s) to disable battery charging.
8. Turn off fuel supply to generator.
9. Disconnect negative battery cable from battery.

Stator and Rotor Removal

Required Tools

- Stator holding adapters (PN 0K8824)
- Rotor protector sheet (PN 0K8210)
- Vibration dampener puller
- 3 inch M12x1.75 Bolt
- Standard mechanics tool set
- Rubber mallet or dead-blow hammer
- Torque wrenches (Inch lbs and Foot lbs)
- 3 or 4 small 2”x4” blocks of wood.

Removing Center Support

Figure 4-64.

10. Use a 10 mm socket to remove two (2) bolts from the center support.

Removing Top Exhaust Enclosure Covers

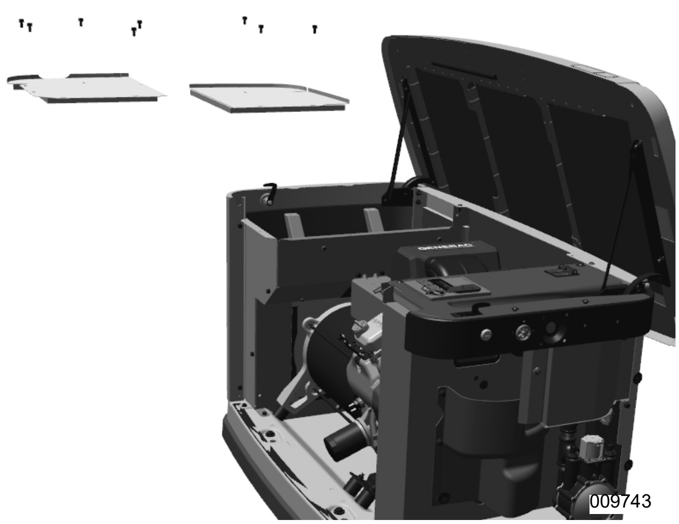

Figure 4-65.

1. Use a 10 mm socket to remove nine (9) bolts from the exhaust top covers.
2. Remove covers.

Removing Side Exhaust Enclosure Cover

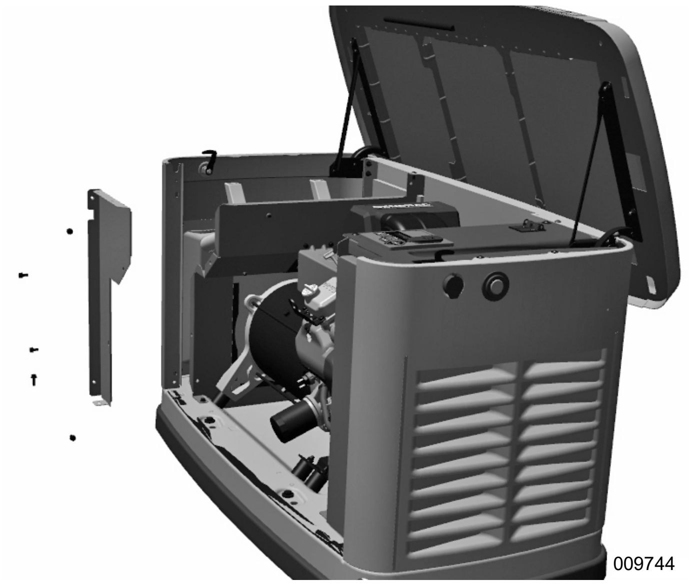

Figure 4-66.

1. Use a 10 mm socket to remove five (5) bolts from the exhaust side cover.
2. Remove exhaust side cover.

Removing Exhaust Flex Cover

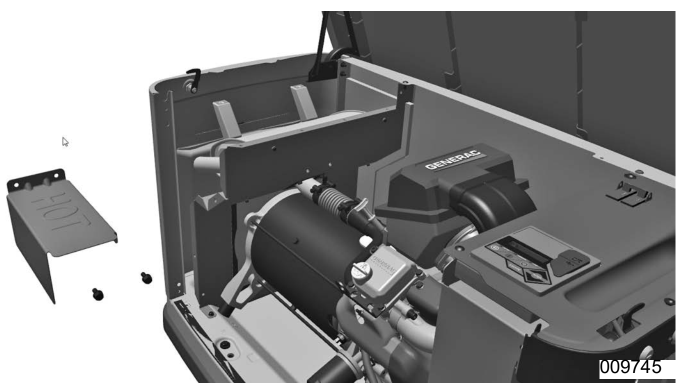

Figure 4-67.

1. Use a 10 mm socket to remove two bolts from the exhaust flex pipe cover.
2. Remove the cover.

Loosening Exhaust Flex Pipe

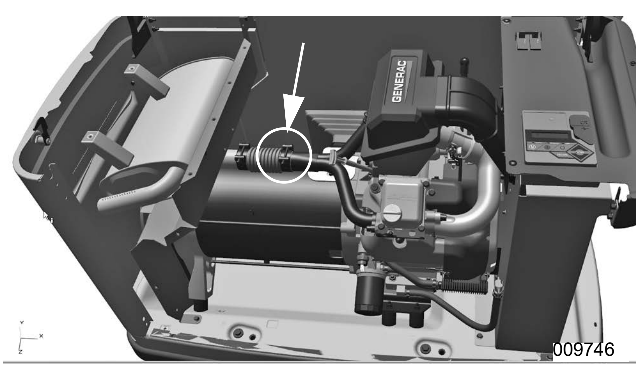

Figure 4-68.

1. Use a 10mm socket to loosen the right side muffler clamp.

NOTE: Exhaust flex will be removed with the muffler, resonator and divider panel as a complete assembly.

Removing Left-side Enclosure

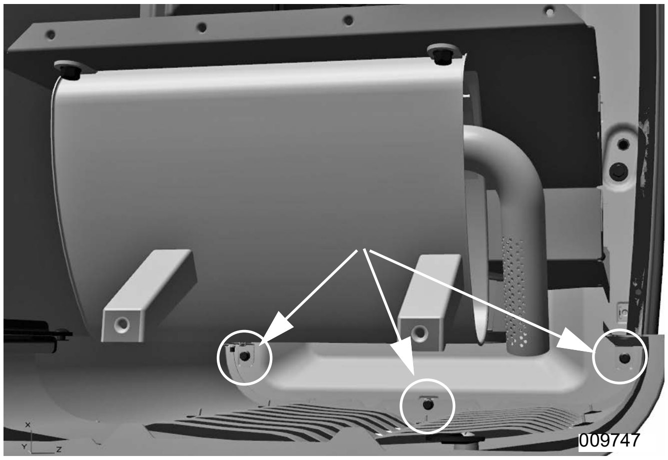

Figure 4-69. Three bolts at base of enclosure

1. Locate three (3) bolts at the base of left side enclosure.

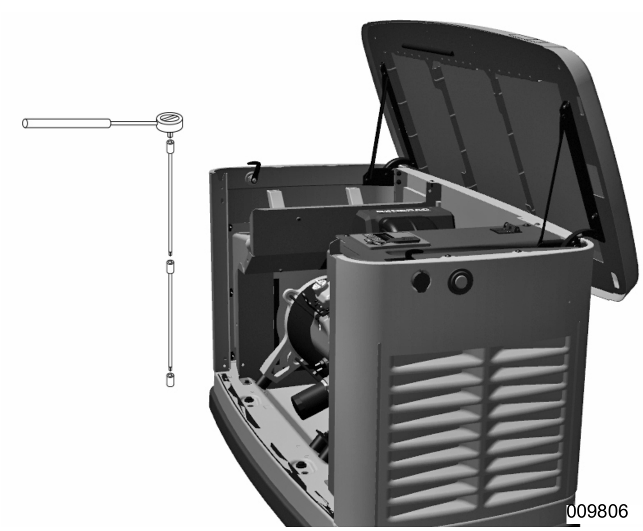

Figure 4-70.

2. Use a 10mm socket with a long extension to remove three bolts from the base of the enclosure.

NOTE: Procedure may require more than one socket extender.

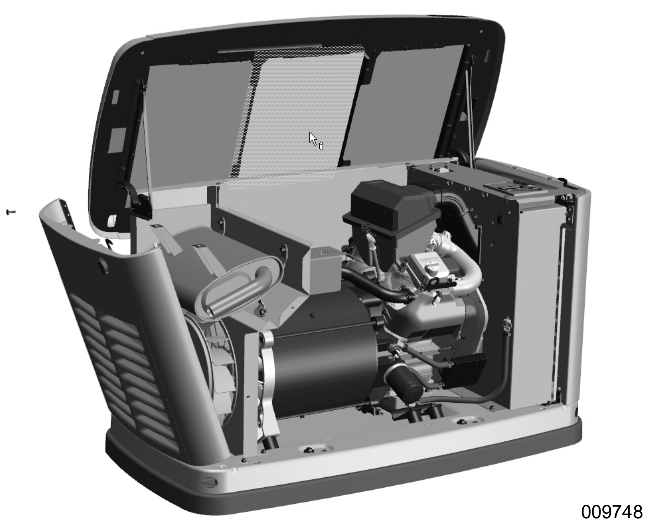

Figure 4-71.

3. Use a 10 mm socket and wrench to remove the top hinge bolt and loosen the bottom bolt.
4. While supporting the roof, remove the bottom hinge bolt.
5. Remove the side panel by tipping it out.

NOTE: Continue supporting roof.

Figure 4-72.

6. Insert one of the hinge bolts through the hinge and through the back cover to support the roof in place.

Removing Rotor Bolt

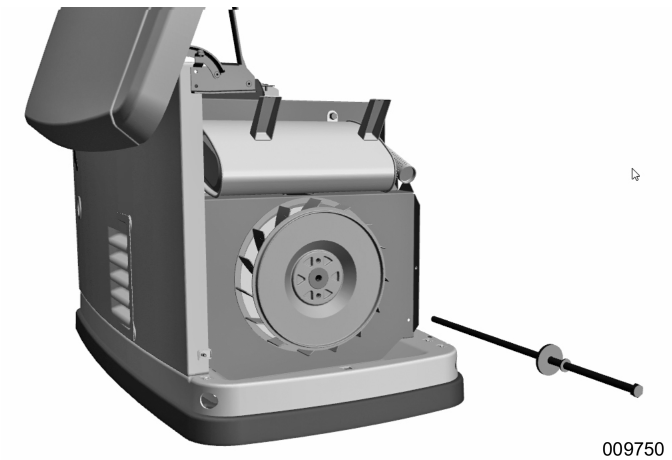

Figure 4-73.

1. Use a 9/16” socket to remove rotor bolt.

Removing Fan

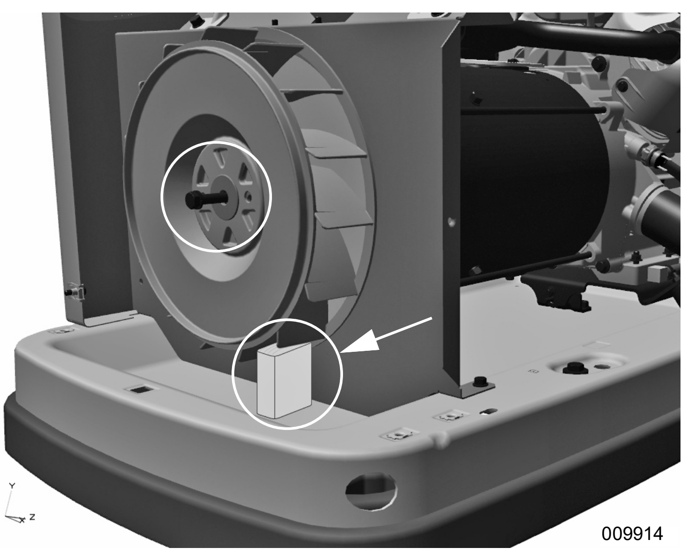

Figure 4-74.

1. Thread a 3 inch M12 x 1.75 bolt into rotor end, leaving about 1/2” of thread exposed in preparation for next step.

NOTE: Wedge a 2”x4” block of wood between base and fan blade to hold fan stationary.


009879

Figure 4-75.

2. Attach a vibration dampener puller or suitable alternative puller to the fan using two M8 x 1.25 bolts.

NOTE: Thread the puller bolts at least ½” into the fan.

3. Tighten the central puller shaft with a wrench to loosen the fan from the rotor shaft.

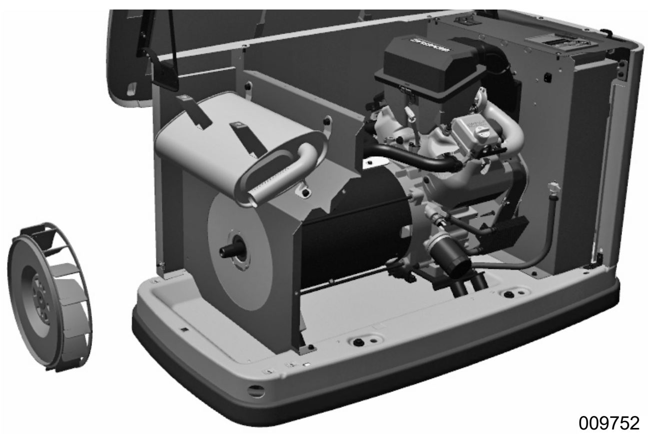
009752

Figure 4-76.

4. Remove the fan from the rotor.

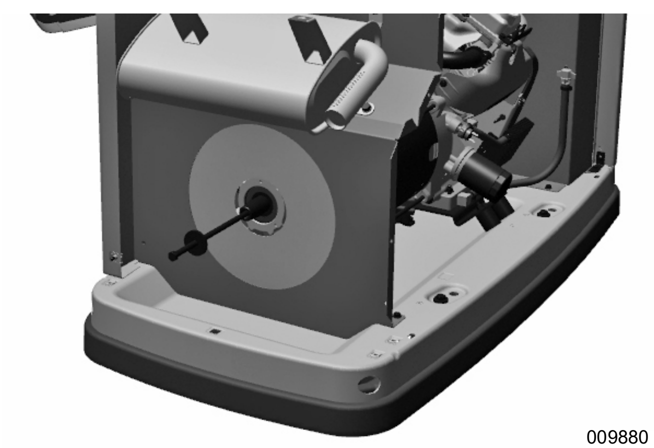
009880

Figure 4-77.

5. Re-install the long rotor bolt with washer and tighten finger tight.

Removing Alternator Divider Panel

Figure 4-78.

1. Use a 10 mm socket wrench to remove two bottom base bolts.
2. Use a 4mm Allen wrench to remove one top rear bolt.
3. Remove the panel with muffler and flex pipe still attached.

NOTE: Muffler and flex pipe remain attached to alternator divider panel during removal.

Removing Brushes

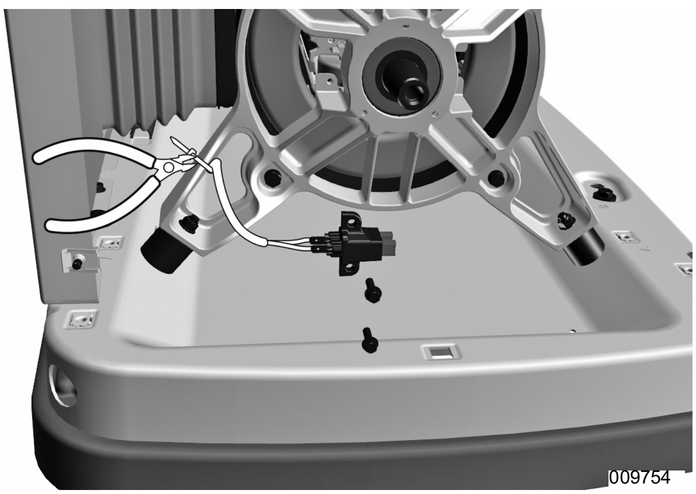

Figure 4-79.

1. Use a 7mm socket to remove brush assembly with brush wires attached.
2. Use wire cutters to remove any tie wraps securing brush wire harness to the outside of the stator.
3. Set brushes and wire harness assembly aside to a safe place.

Loosening Engine Mount

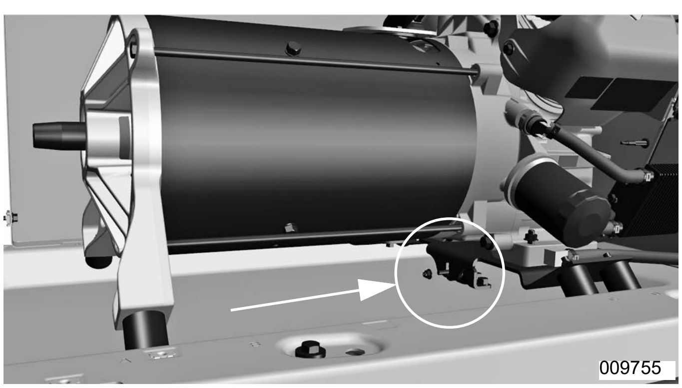

Figure 4-80.

1. Loosen the engine mount located underneath the engine near where the alternator and engine are joined.

NOTE: The engine mount must be loosened before lifting the alternator.

Removing Rear Bearing Carrier

1. Use a 13mm socket to remove the nuts from the two bearing carrier lower mounting bracket rubber mounts.

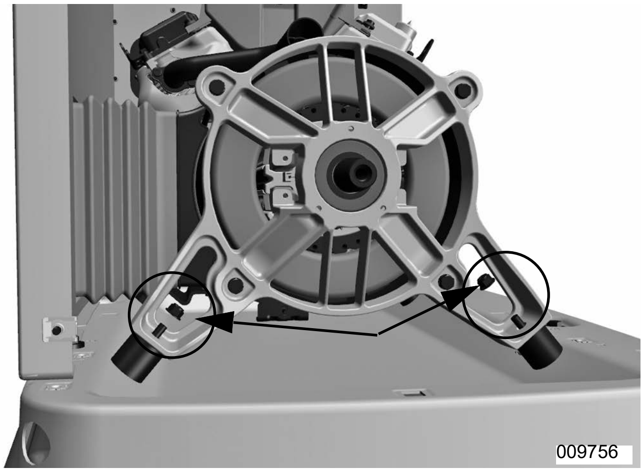

Figure 4-81.

2. Lift the back end of the alternator up and place a 2" x 4" piece of wood under the stator. Use additional blocks of wood if needed.

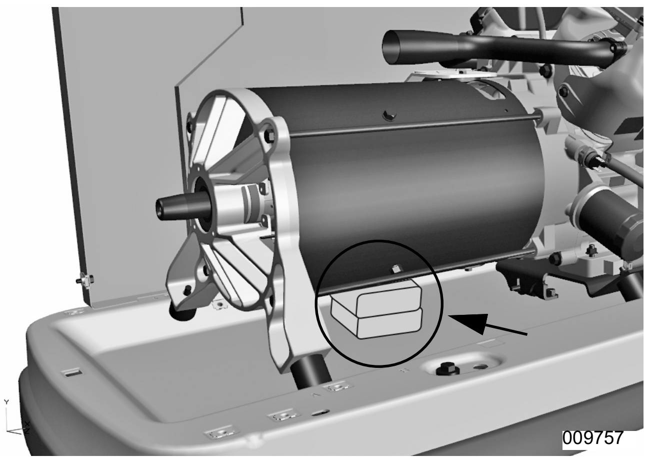

Figure 4-82.

3. Use a 13 mm socket to remove the four (4) stator bolts.

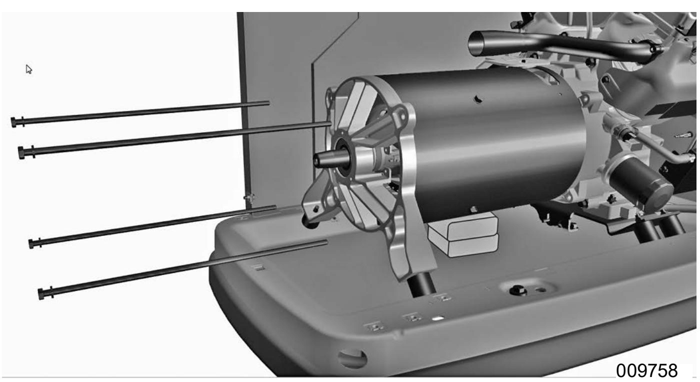

Figure 4-83.

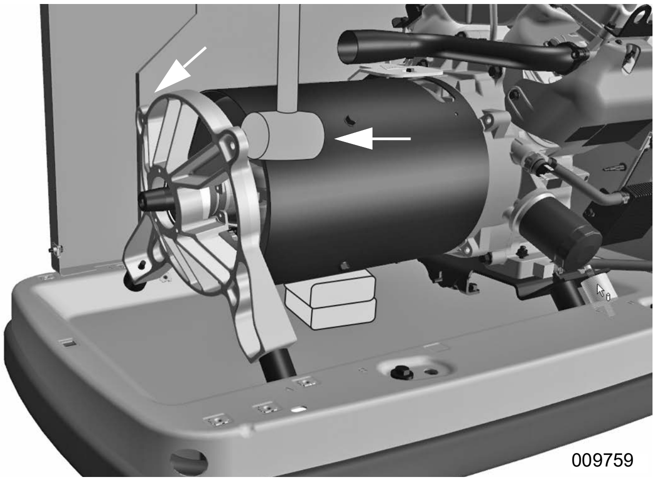

Figure 4-84.

Figure 4-85.

4. Use a small rubber mallet or suitable dead-blow hammer to remove the rear bearing carrier.

NOTE: Use short deliberate blows and alternate tapping between the upper lobes of the bearing carrier until it is free from the alternator can and rotor shaft bearing.

Installing Stator Holding Tool

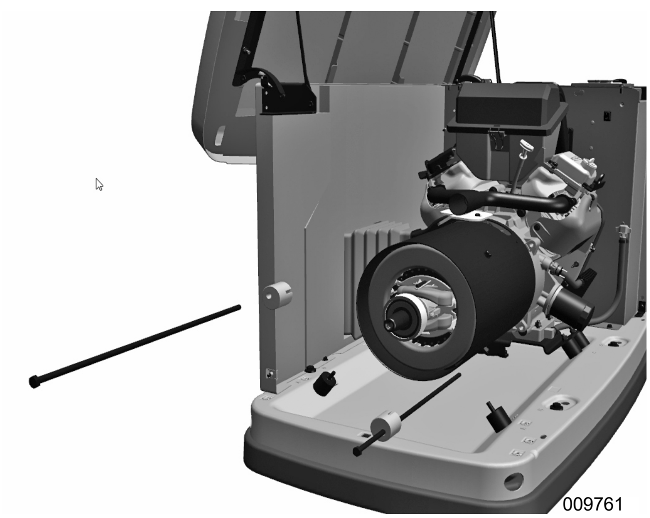

Figure 4-86.

5. Insert two previously removed stator bolts into the two stator holding adapters (P/N 0K8824).

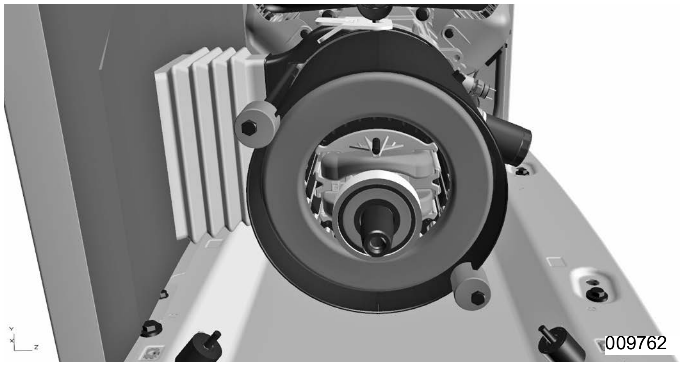

Figure 4-87.

6. Screw the bolts into the engine at the 10 o'clock and 4 o'clock positions. Tighten only enough to hold the stator in place.

NOTE: DO NOT OVER TIGHTEN.

Separating Rotor

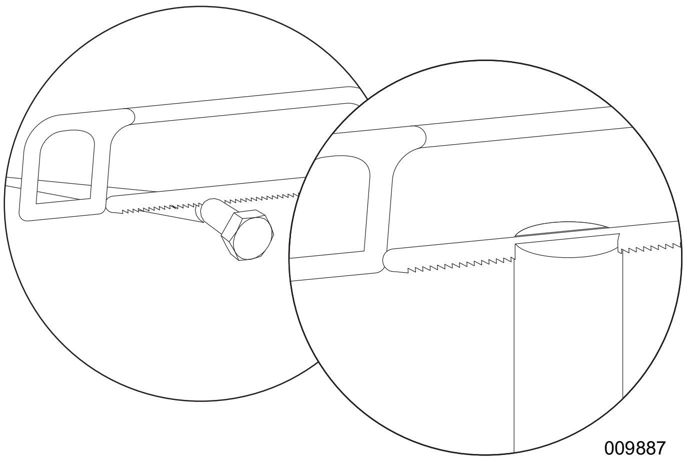

Figure 4-88.

1. Remove rotor bolt and cut 1.25 in (38.1 mm) from head of bolt, leaving bolt 16.25 in (41.28 cm) length.
2. Use a hacksaw or suitable cutting wheel to cut a slot in the cut end of the rotor bolt.

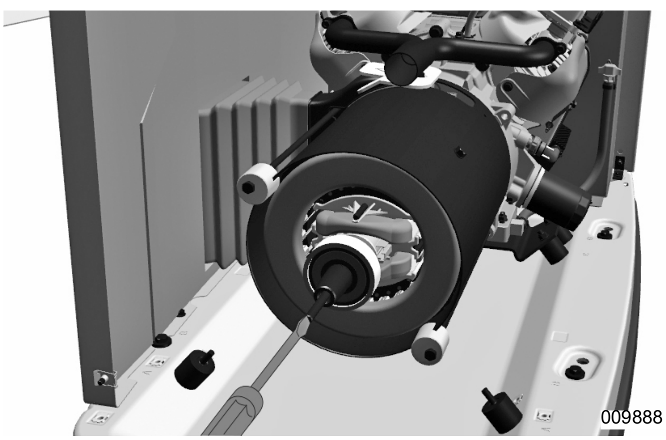

Figure 4-89.

3. Thread the cut rotor bolt into the crankshaft, allowing about an inch of threads exposed for the following steps.

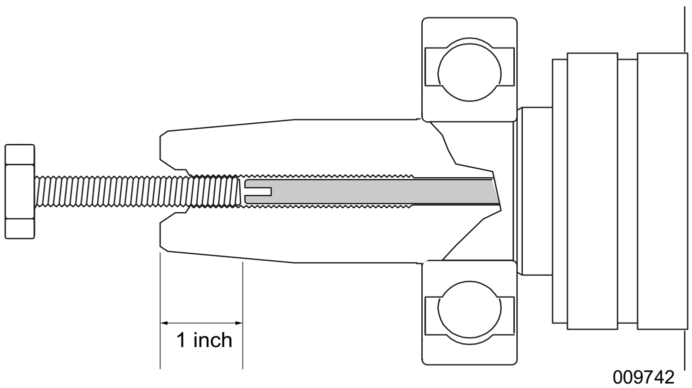

Figure 4-90.

4. Screw a 3" M12 x 1.75 bolt (PN 0H48930203) into rotor end.

Rotor Removal Protection

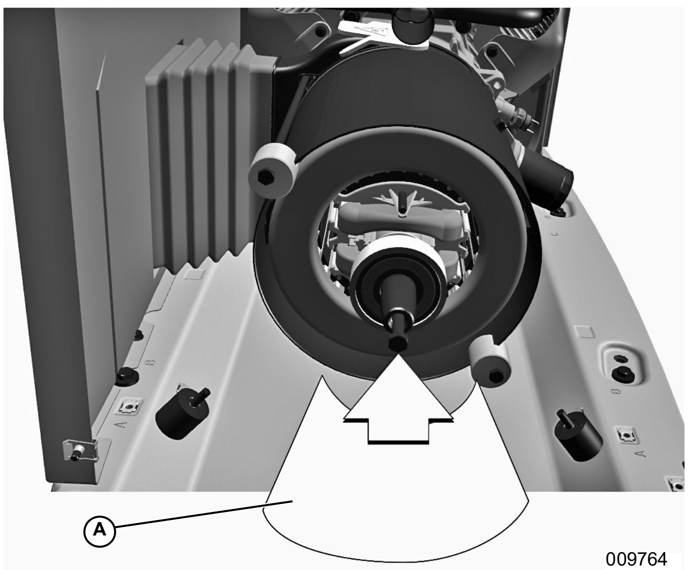

Figure 4-91.

5. Insert the rotor protector sheet (A) (PN 0K8210) between the rotor and stator assembly.

Removing Rotor

Figure 4-92.

1. Apply torque to the 3" M12 x 1.75 bolt until rotor breaks free from the tapered engine crankshaft.

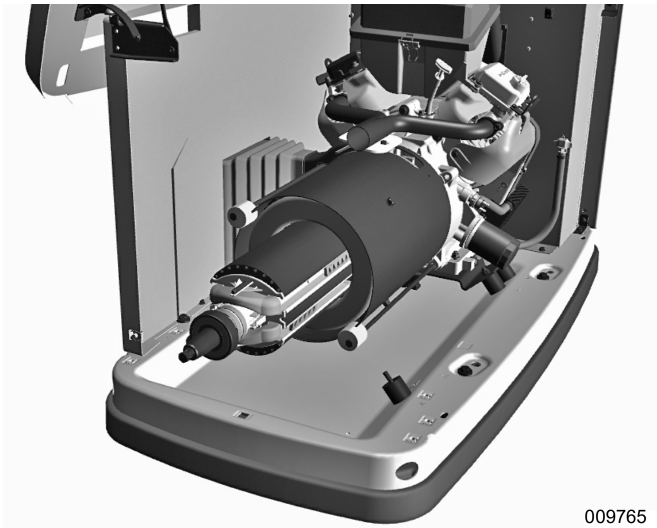

Figure 4-93.

2. Carefully slide rotor (on protective sheet) out of the stator can. Place the rotor in a safe area to prevent any damage.
3. Remove the modified rotor bolt from the crankshaft.

Removing Stator Wires (Units without STB Terminal Block)

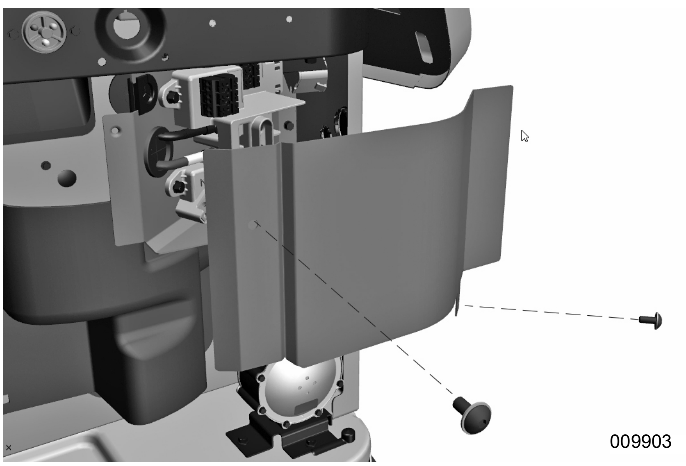

Figure 4-94.

1. Loosen two (2) screws and remove customer connection access panel.

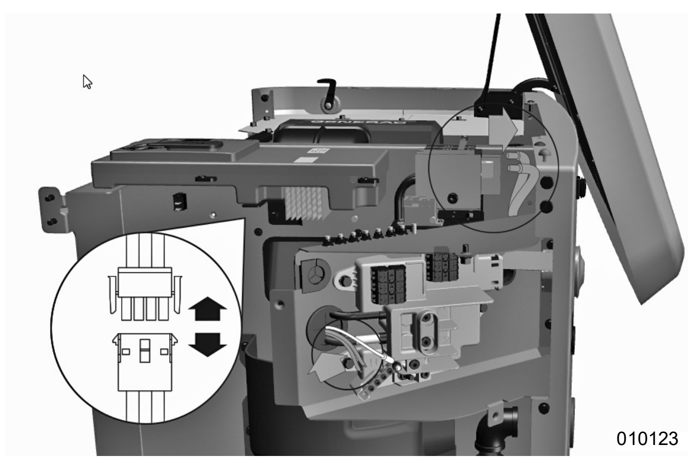

Figure 4-95.

2. Remove Wire 11 and Wire 44 from MLCB (A).
3. Remove Wire 22 and Wire 33 (B) from the terminal strip.
4. Disconnect STR connector (C).

Removing Stator Wires (Units with STB Terminal Block)

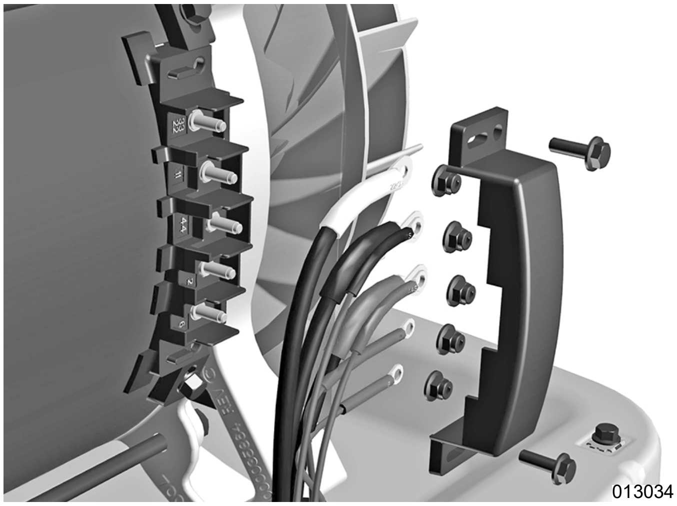

Figure 4-96.

1. Remove all wires from STB terminal Block

Alternator Air Intake

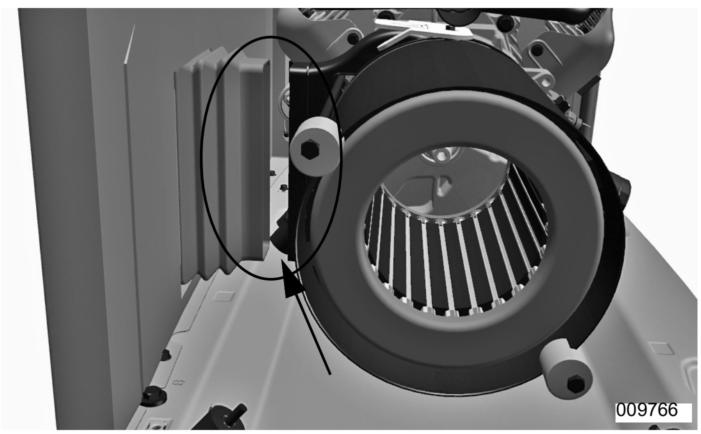

Figure 4-97.

1. Disconnect alternator intake bellows.

NOTE: Leave the molded duct attached to the stator can in place.

Removing Stator

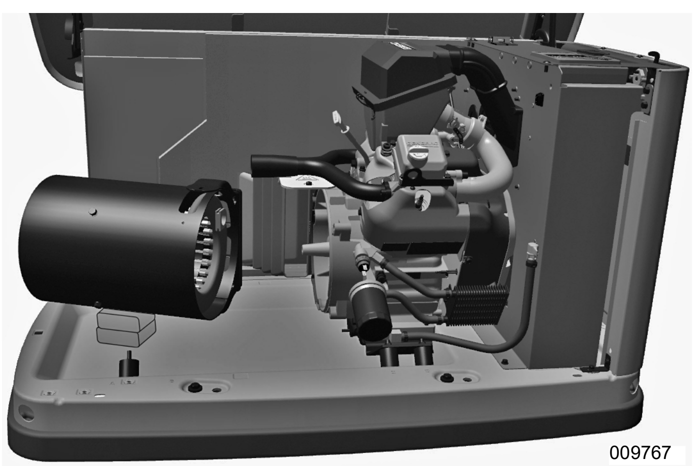

Figure 4-98.

1. Use short 2" x 4" pieces of wood to support the stator.
2. Remove the two stator bolts and holding adapters.
3. Separate the stator from the engine.

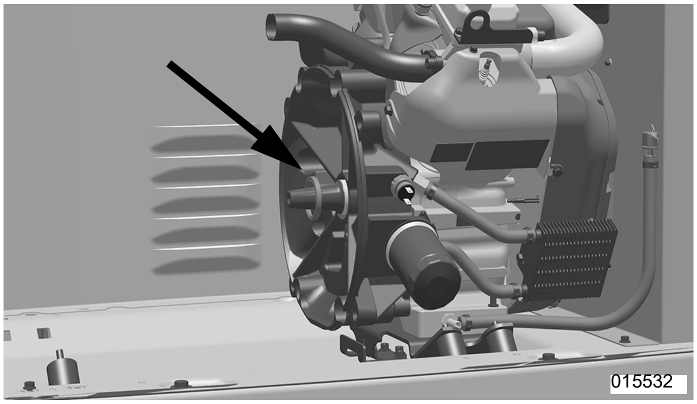

Figure 4-99.

4. Remove PTO oil seal.

Engine Removal

Removing Air Filter And Air Box Cover

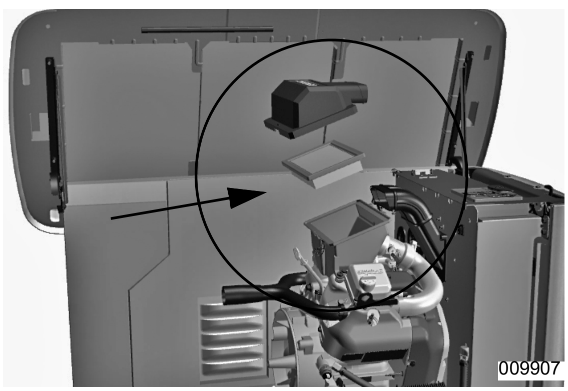

Figure 4-100.

1. Remove air box cover and air filter.

Disconnecting All Wires, Harnesses, and Hoses From Engine

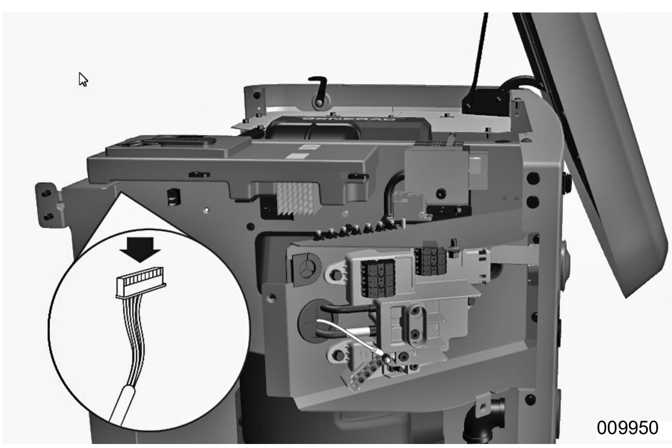

Figure 4-101.

1. Disconnect J5 stepper motor harness connector from controller.

Figure 4-102.

2. Disconnect positive battery cable (Wire 13) from starter
3. Disconnect Wire 16 (v-twin) or Wire 56 (single cylinder) from starter solenoid.

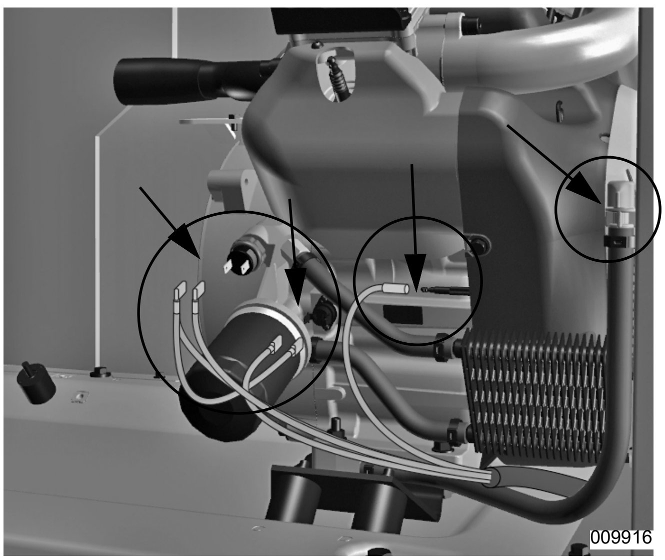

Figure 4-103.

4. Disconnect Wire 85 and Wire 0 from the high oil temperature switch (HOT).
5. Disconnect Wire 86 and Wire 0 from the low oil pressure switch (LOP).
6. Disconnect Wire 18 bullet connector.
7. Release the plug end of the oil drain hose from the stowage retainer.

Figure 4-104.

8. Disconnect fuel hoses from mixer assembly.

Removing Engine

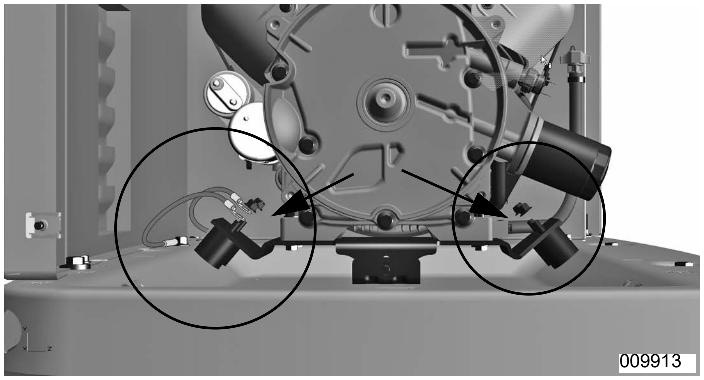

Figure 4-105.

1. Remove four (4) nuts from engine mount studs.
2. Disconnect ground wire from engine mount stud.

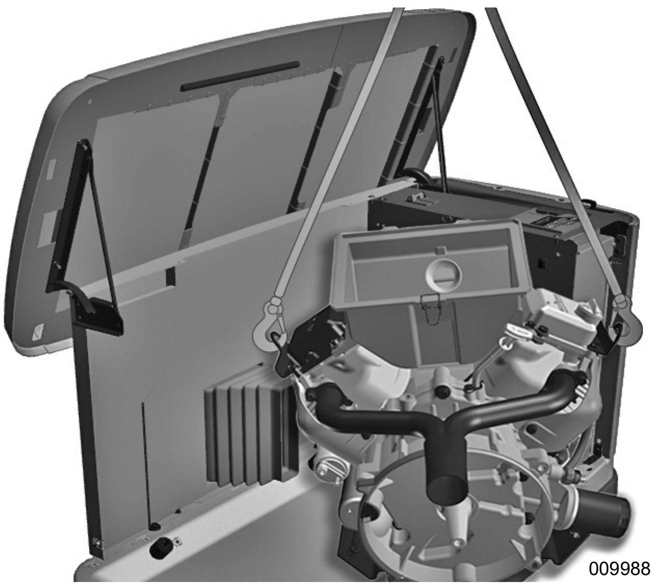

Figure 4-106.

3. Use proper lifting equipment to lift and remove the engine.

NOTE: Secure the loose ends of the oil drain hose and the stepper motor harness to the engine to avoid damage when lifting.

Engine Installation

Required Tools

- Hoist or winch for lifting engine
- Standard mechanics tool set

Installing Engine

Figure 4-107.

1. Use proper lifting equipment to lift the engine into place.

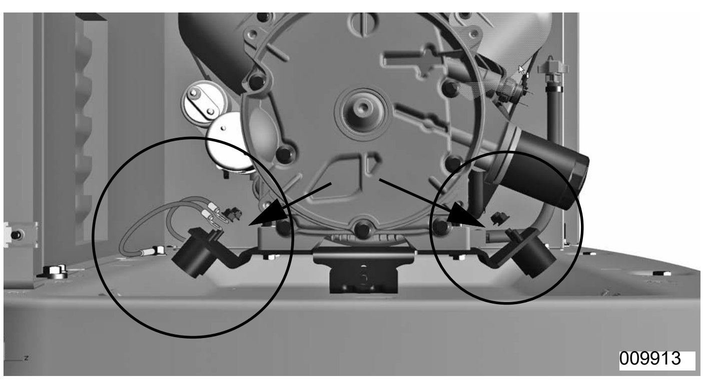

Figure 4-108.

2. Install four (4) nuts to engine isolator studs.
3. Connect ground wire to engine isolator stud.
4. Install and tighten nuts.

NOTE: See ***Torque Specifications*** for proper torque values.

Connecting All Wires, Harnesses, and Hoses To Engine

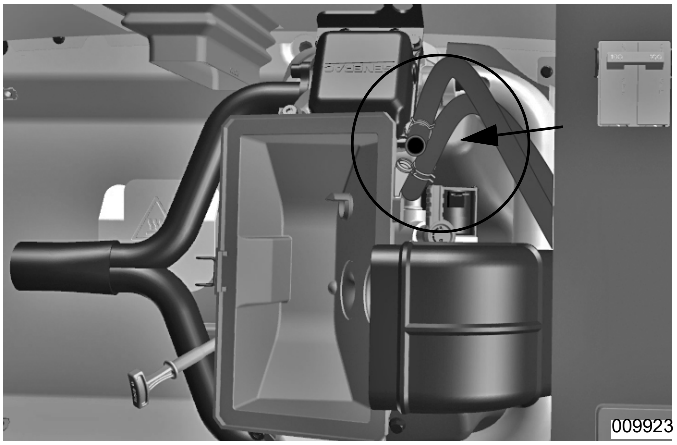

Figure 4-109.

1. Connect fuel hoses to mixer assembly and properly position clamps.

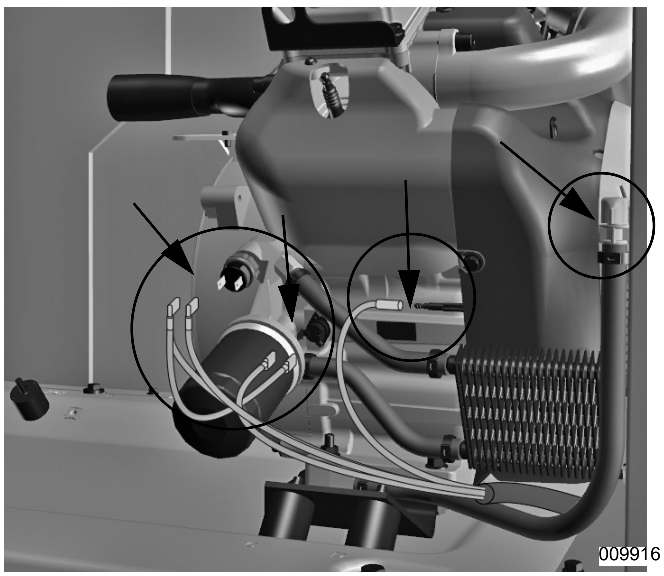

Figure 4-110.

2. Connect Wire 85 and Wire 0 to the high oil temperature switch (HOT).
3. Connect Wire 86 and Wire 0 to the low oil pressure switch (LOP).
4. Connect Wire 18 bullet connector.
5. Attach the plug end of the oil drain hose to the stowage retainer.

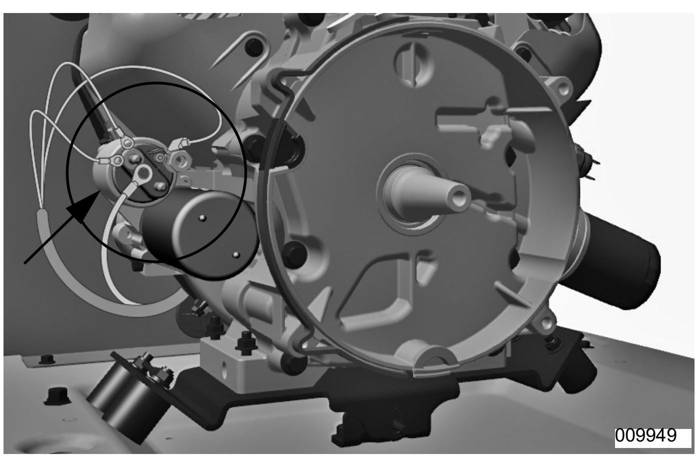

Figure 4-111.

6. Connect positive battery cable (Wire 13) to starter
7. Connect Wire 16 (v-twin) or Wire 56 (single cylinder) to starter solenoid.

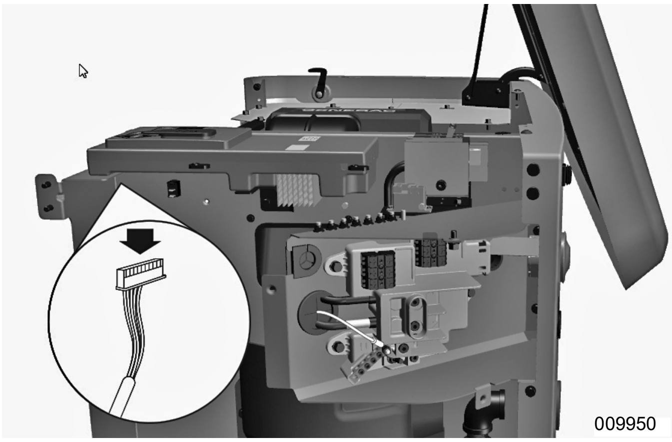

Figure 4-112.

8. Connect J5 stepper motor harness connector to controller.

NOTE: Properly route stepper motor harness in the reverse order of removal.

Installing Air Filter And Air Box Cover

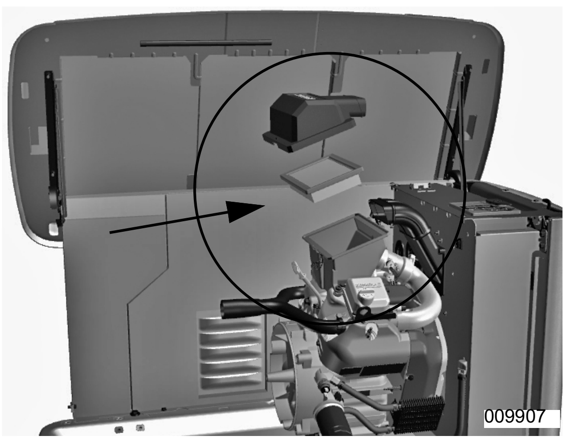

Figure 4-113.

1. Install air filter and air box cover.

Stator and Rotor Installation

Required Tools

- Stator holding adapters (PN 0K8824)
- Rotor protector sheet (PN 0K8210)
- Vibration dampener puller
- 3 inch M12x1.75 Bolt
- Standard mechanics tool set
- Rubber mallet or dead-blow hammer
- Torque wrenches (Inch lbs and Foot lbs)
- 3 or 4 small 2"x4" blocks of wood.

Installing Stator

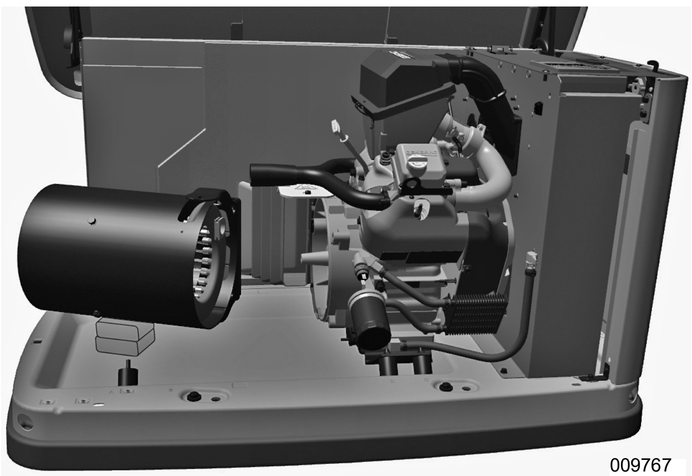

Figure 4-114.

1. Use short 2" x 4" pieces of wood to support the stator.

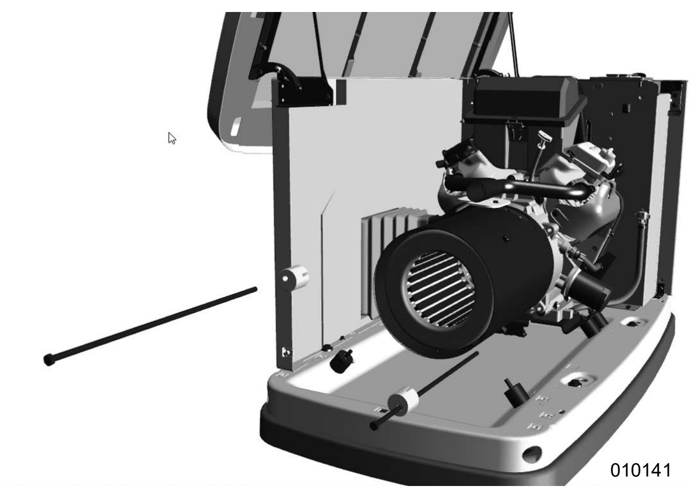

Figure 4-115.

2. Insert two stator bolts into the two stator holding adapters (0K8824).
3. Screw the bolts into the engine at the 10 o'clock and 4 o'clock positions. Tighten only enough to hold the stator in place.

NOTE: Do not over tighten.

Alternator Air Intake

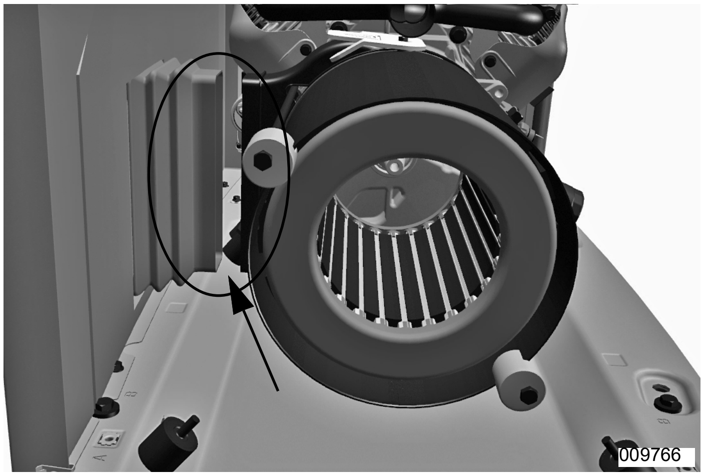

Figure 4-116.

1. Connect alternator intake bellows to the molded duct attached to the stator can.

Connecting Stator Wires

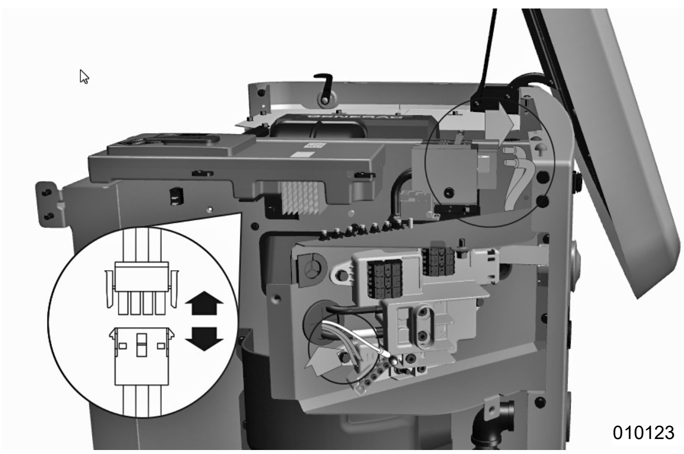

Figure 4-117.

1. Connect Wire 11 and Wire 44 to MLCB (A).
2. Connect Wire 22 and Wire 33 (B) to the terminal strip.
3. Connect STR connector (C).

NOTE: Properly route all stator wires in the reverse order of removal.

Installing Customer Connection Access Panel

Figure 4-118.

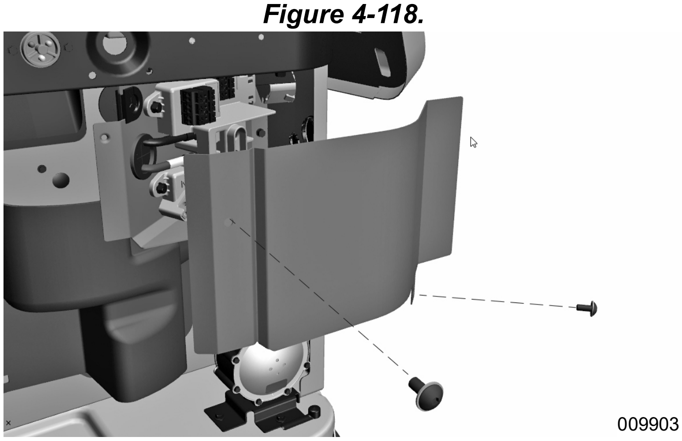

Figure 4-119.

1. Install customer connection access panel and tighten two (2) screws.

Installing Rotor and Rear Bearing Carrier

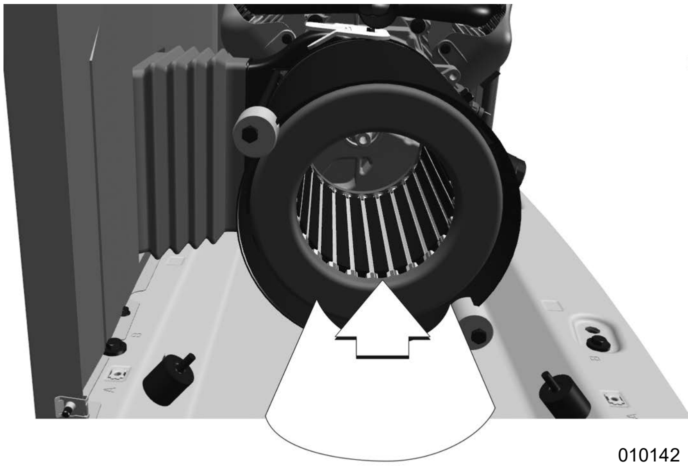

Figure 4-120.

1. Insert the rotor protector sheet (A) (PN 0K8210) into stator assembly.

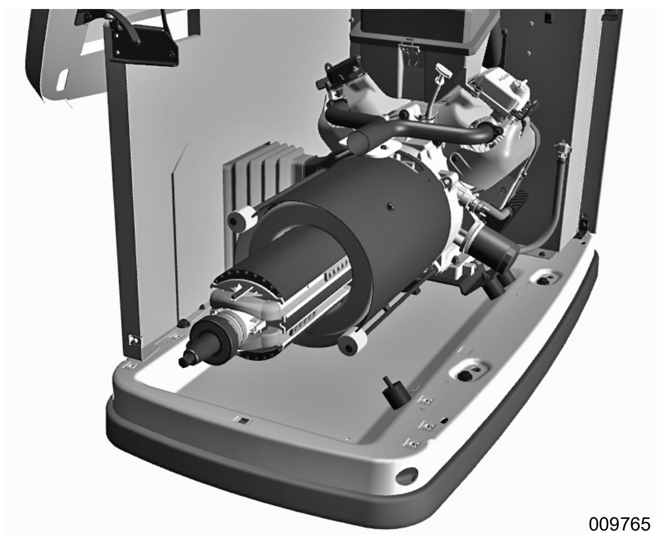

Figure 4-121.

2. Carefully slide rotor (on protective sheet) into the stator can.

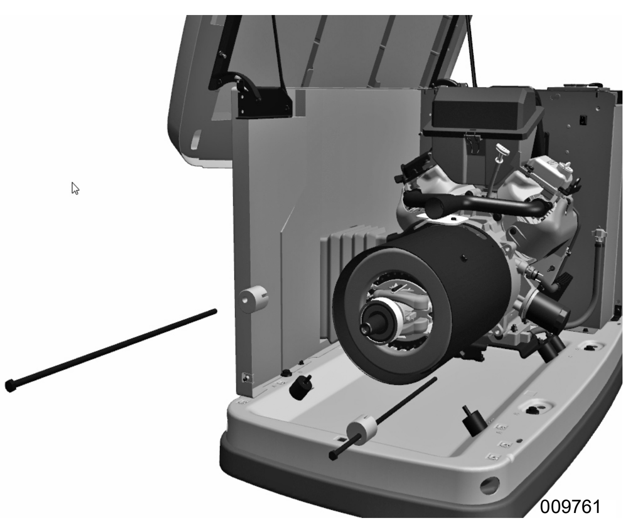

Figure 4-122.

3. Remove the two stator holding adapters (0K8824) and stator bolts.

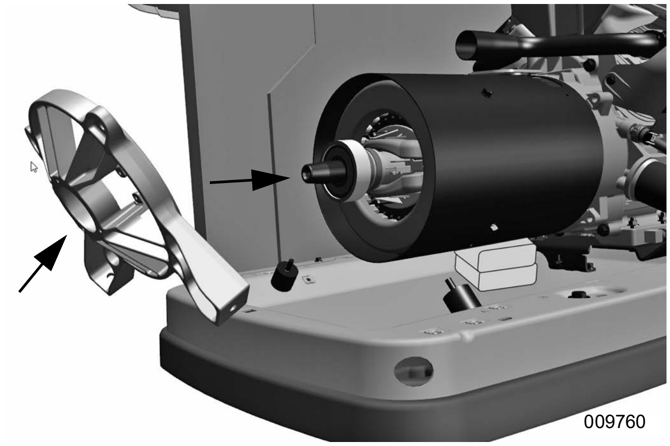

Figure 4-123.

4. Set the rear bearing carrier in place on the mounting isolators.

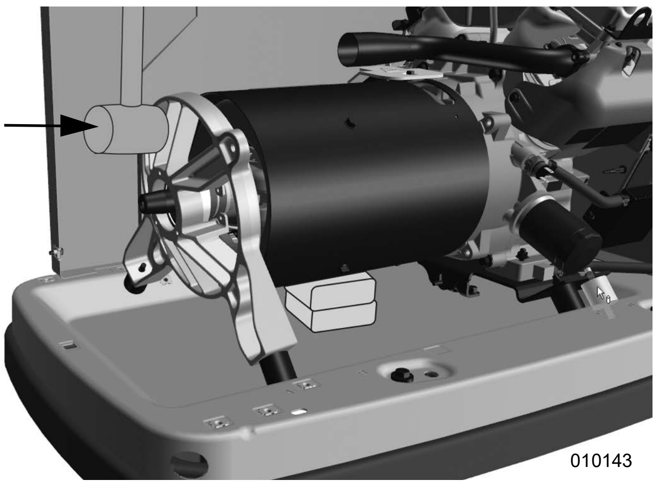

Figure 4-124.

5. Use a small rubber mallet or suitable dead-blow hammer to set the rear bearing carrier in place.

NOTE: Use short deliberate blows to tap the bearing carrier until firmly seated on stator.

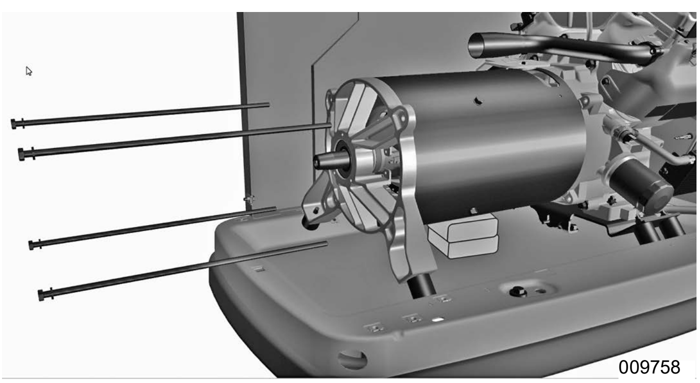

Figure 4-125.

6. Install the four (4) stator bolts and lock washers.
7. Use a 13 mm socket to tighten stator bolts.

IMPORTANT NOTE: Stator bolts must be tightened to the correct specification. See ***Torque Specifications*** for proper values.

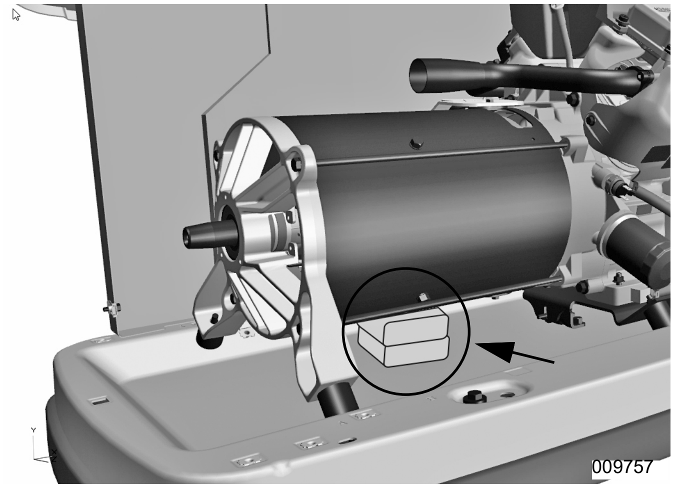

Figure 4-126.

8. Remove blocks of wood from under stator.

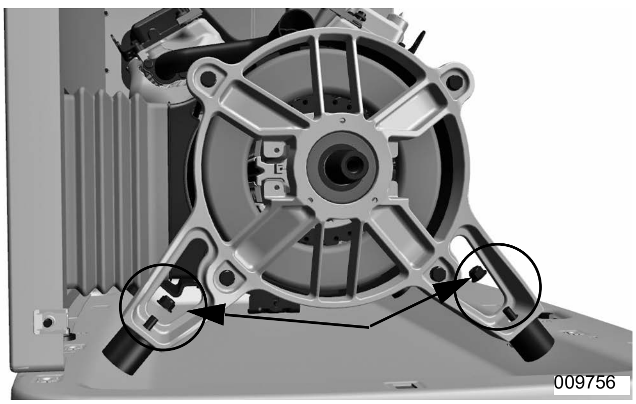

Figure 4-127.

9. Use a 13mm socket to install and tighten the nuts onto the two bearing carrier isolators.

NOTE: See ***Torque Specifications*** for proper torque values.

Tightening Engine Mount

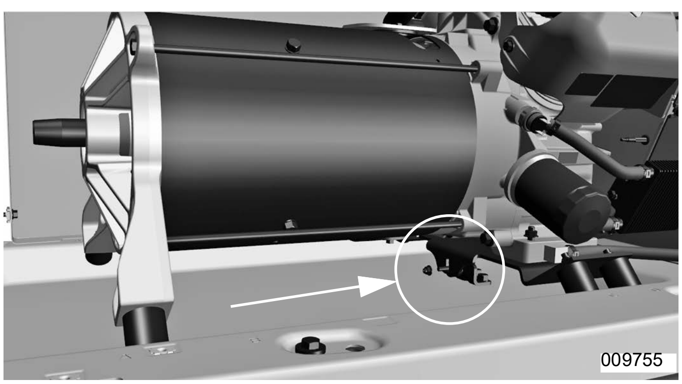

Figure 4-128.

1. Install and tighten the engine mount nut.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Brushes

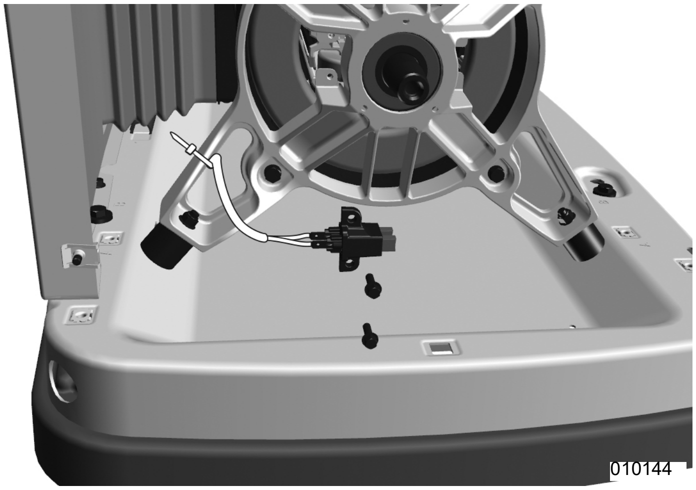

Figure 4-129.

1. Install brush assembly and tighten screws with a 7mm socket.
2. Use tie wraps to secure brush wire harness to the outside of the stator.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Alternator Divider Panel

Figure 4-130.

1. Set the divider panel and muffler assembly in place.

NOTE: Be sure to guide exhaust flex onto the exhaust pipe while setting divider in place.

2. Use a 10 mm socket wrench to tighten two bottom base bolts.
3. Use a 4mm Allen wrench to tighten one top rear bolt.

NOTE: See ***Torque Specifications*** for proper values.

NOTE: The rear lower mounting tab on the divider panel may be facing in or out.

Installing Fan and Rotor Bolt

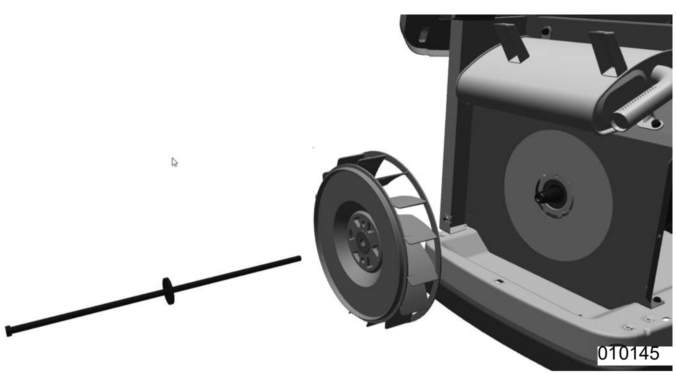

Figure 4-131.

1. Install the fan on the rotor shaft.
2. Insert the rotor bolt and washer into the rotor shaft.
3. Use a 9/16” socket to tighten rotor bolt.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Left-side Enclosure

1. Set the side panel in place.

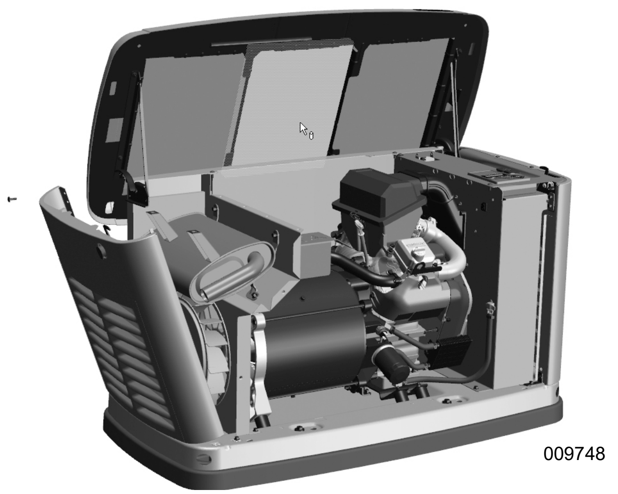

Figure 4-132.

2. Install three (3) bolts at the base of left side enclosure.

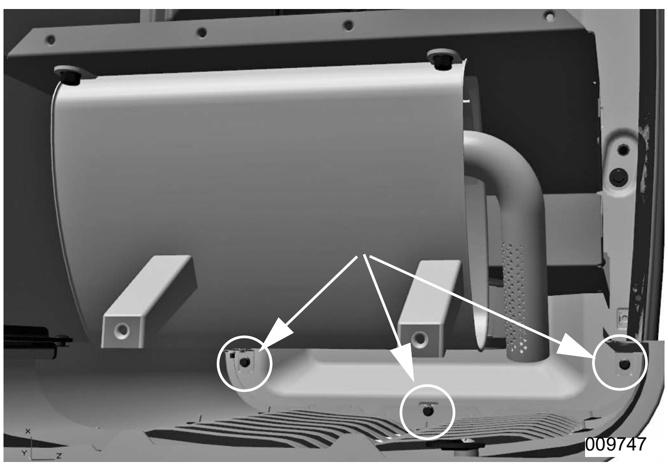

Figure 4-133. Three bolts at base of enclosure

3. Use a 10mm socket with a long extension to tighten the bolts.

NOTE: See ***Torque Specifications*** for proper torque values.

NOTE: Procedure may require more than one socket extension.

Figure 4-134.

Figure 4-135.

4. While supporting hood, unsecure hinge from back panel and place hinge bolts through side panel and back panel holes.
5. Tighten bolts.

See ***Torque Specifications*** for proper torque values.

Tightening Exhaust Flex Pipe

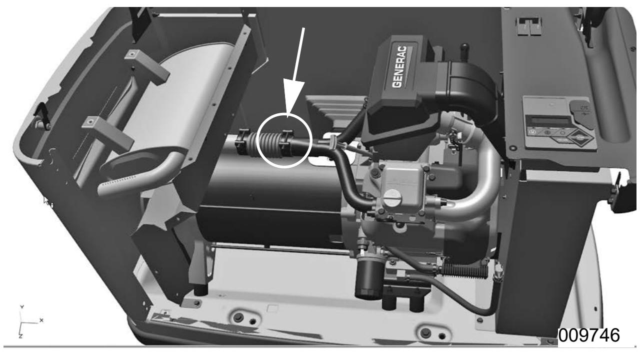

Figure 4-136.

1. Use a 10mm socket to tighten the right side muffler clamp.

Installing Exhaust Flex Cover

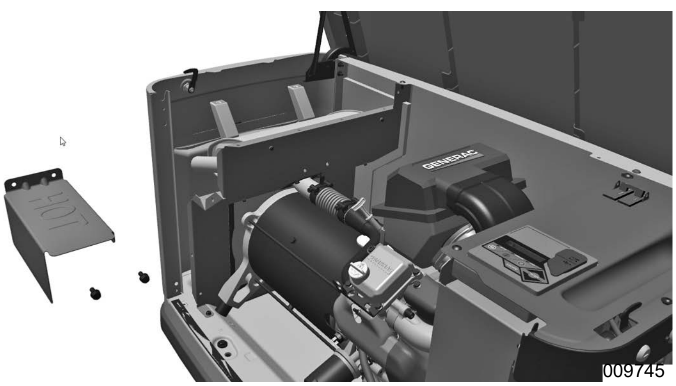

Figure 4-137.

1. Install the exhaust flex pipe cover.
2. Use a 10 mm socket to tighten two bolts.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Side Exhaust Enclosure Cover

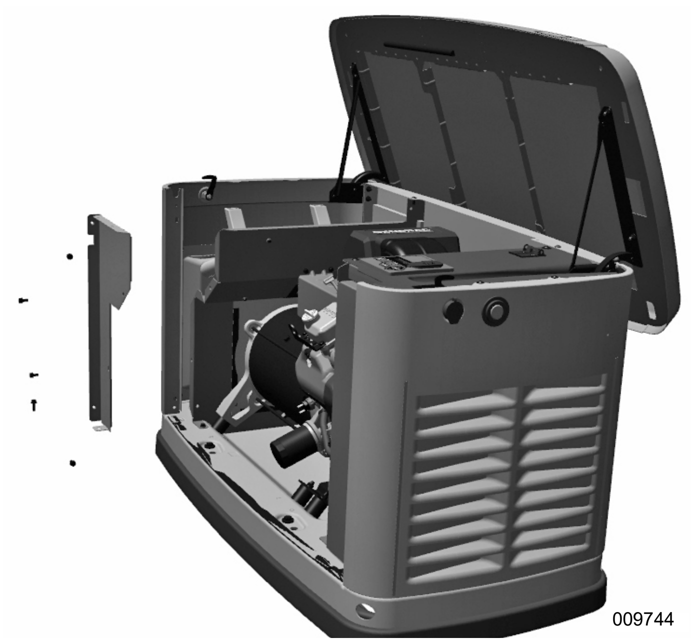

Figure 4-138.

1. Install exhaust side cover.
2. Use a 10 mm socket to tighten five (5) bolts on the exhaust side cover.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Top Exhaust Enclosure Covers

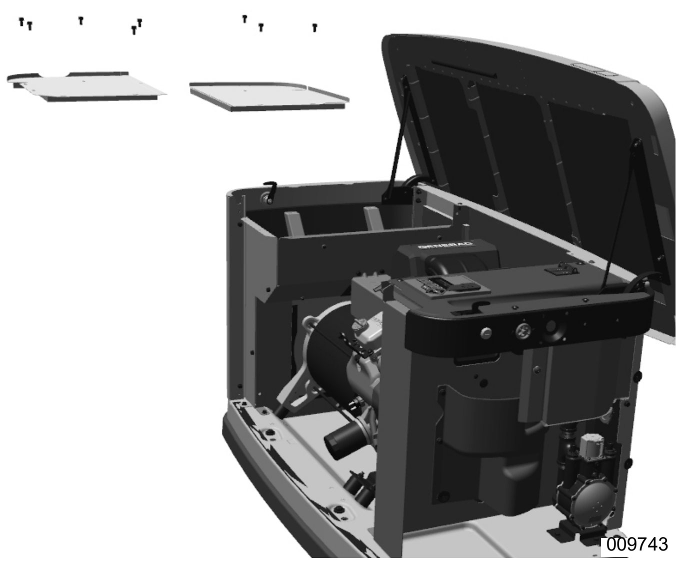

Figure 4-139.

1. Install exhaust top covers.
2. Use a 10 mm socket to tighten nine (9) bolts on the exhaust top covers.

NOTE: See ***Torque Specifications*** for proper torque values.

Installing Center Support

Figure 4-140.

1. Install the center support.
2. Use a 10 mm socket to tighten two (2) bolts.

NOTE: See ***Torque Specifications*** for proper torque values.

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Section 5.1 *Index of Wiring Diagrams and Electrical Schematics*

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

Table 5-1.

Drawing Number	Description	Notes
10000006453-E	WD/SD Air-cooled HSB Evolution 2.0 w/426-460cc Engine 60 Hz	426–460cc Engine 60 Hz
10000017243-A	WD/SD Air-cooled HSB Evolution 2.0 w/816-999cc Engine 60 Hz	816–999cc Engine 60 Hz
10000007481-G	WD/SD Air-cooled HSB Evolution 2.0 50 Hz 1-phase CE	50 Hz 1-phase CE - Europe certification
10000008280-G	WD/SD Air-cooled HSB Evolution 2.0 50 Hz Australia	530–999cc Engine 50 Hz Australia
0L6822-B	WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 9 kW 60 Hz	
0L6823-B	WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 60 Hz	
0L6824-B	WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 50 Hz	
0K2945-E	WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 8 kW 60 Hz	
0J9961-D	WD/SD Air-cooled Pre 2016 Evolution 1.0 (not Evolution 2.0) 11–24 kW 60 Hz	11–24 kW 60 Hz
A0000189156-C	WD/SD Air-cooled Evolution 2.0 w816-999cc Engine kW 60 Hz with Stator Terminal Block	816–999cc Engine kW 60 Hz with Stator Terminal Block
A0003415229-B	WD/SD AC HSB EVO2 60HZ 426 NEC2023	With Neutral Termination For Customer Connection
A0003423403-B	WD/SD AC HSB EVO2 1PH STB NEC2023	With Stator Terminal Block
A0003423402-B	WD/SD AC HSB EVO2 60HZ 816/999 NEC2023	With Neutral Termination For Customer Connection
A0003423405-B	WD/SD AC HSB EVO2 60HZ 999 ECO NEC2023	With Neutral Termination For Customer Connection (Ecogen)

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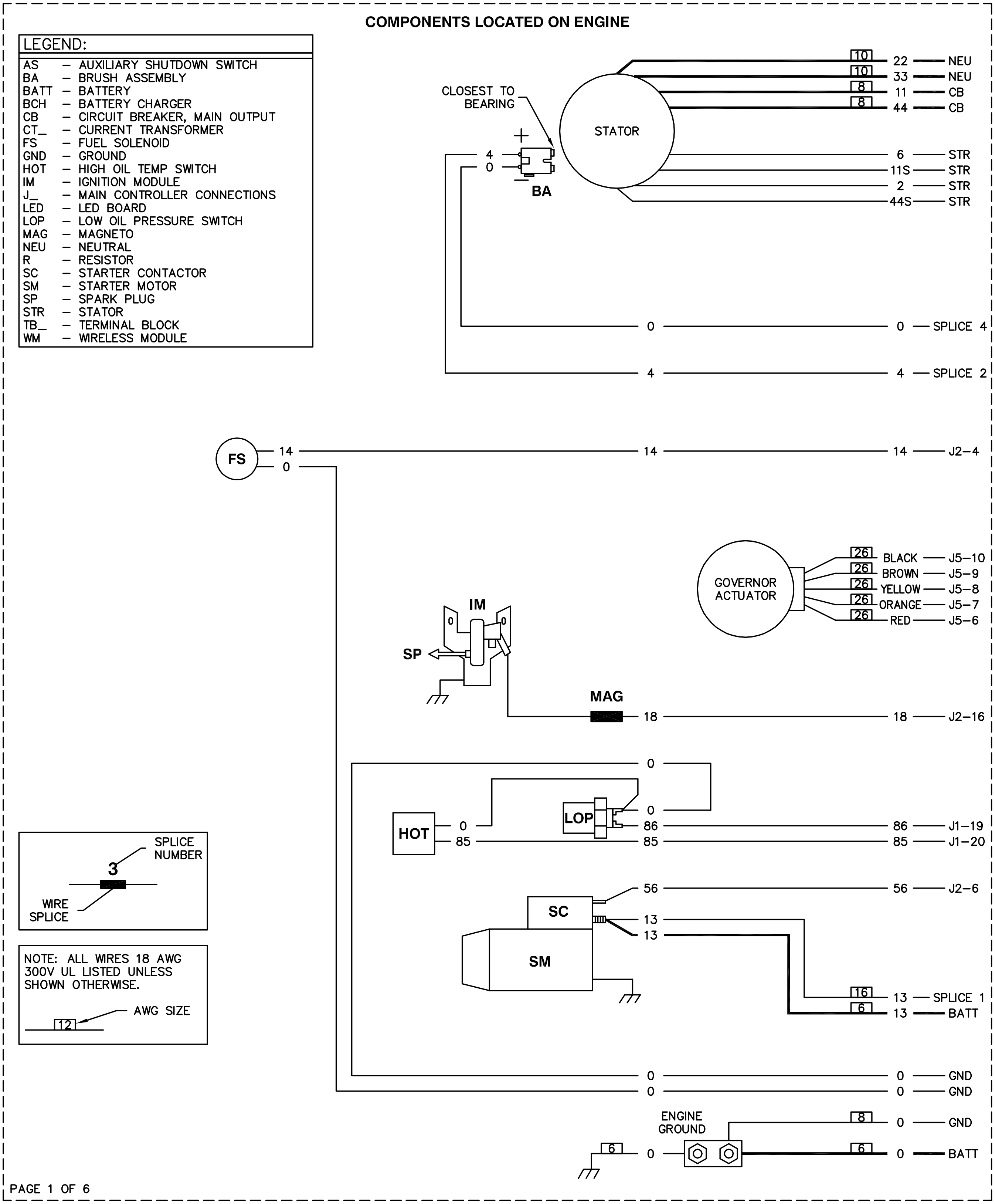
Section 5.2 *10000006453-E WD/SD Air-cooled HSB Evolution 2.0 w/426-460cc Engine 60 Hz*

426–460cc Engine 60 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: E

AC HSB EVO2 60HZ 426

DATE: 08/10/17

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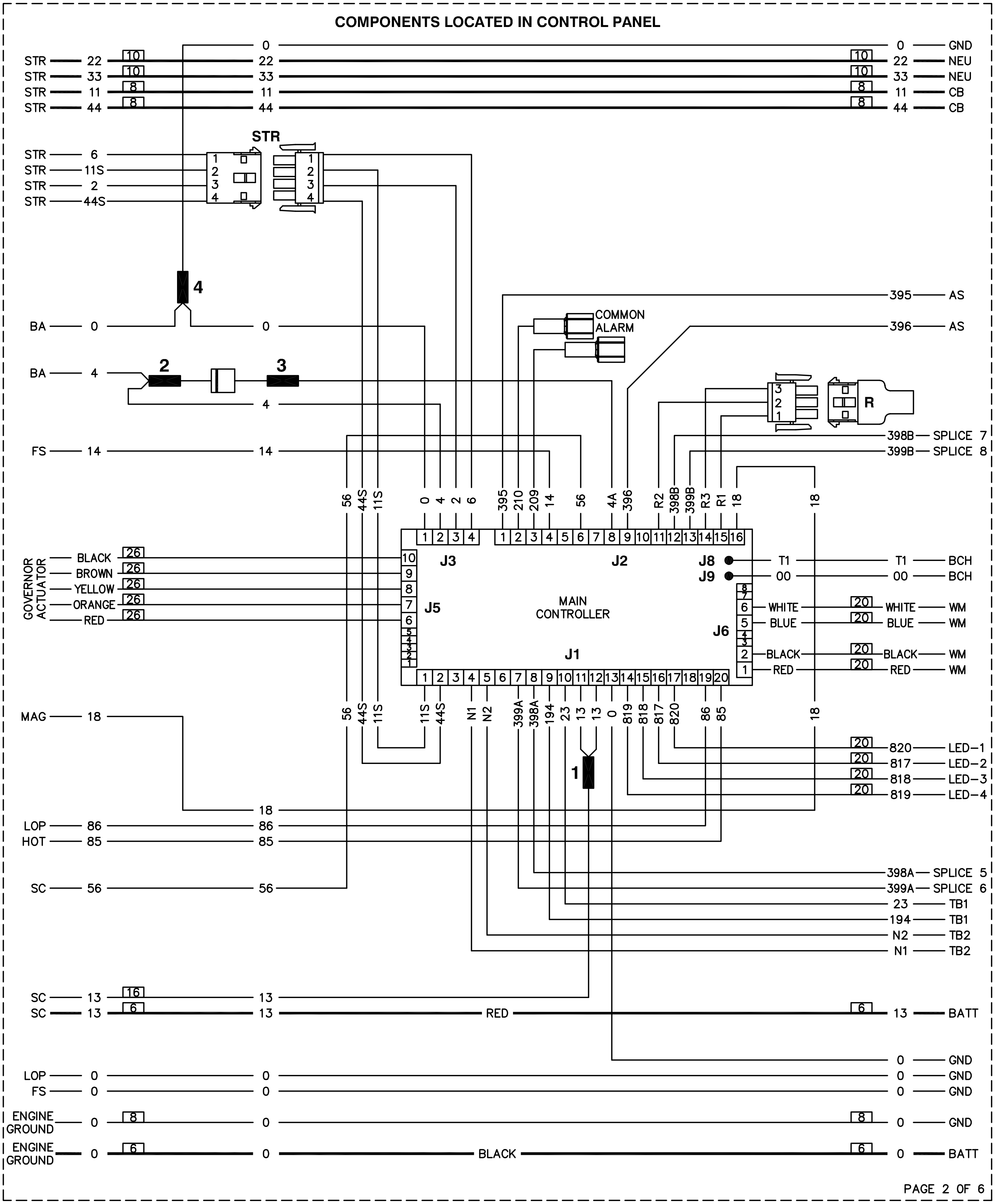
DRAWING #: 10000006453

GROUP WD



WIRING - DIAGRAM

REVISION: E

AC HSB EVO2 60HZ 426

DATE: 08/10/17

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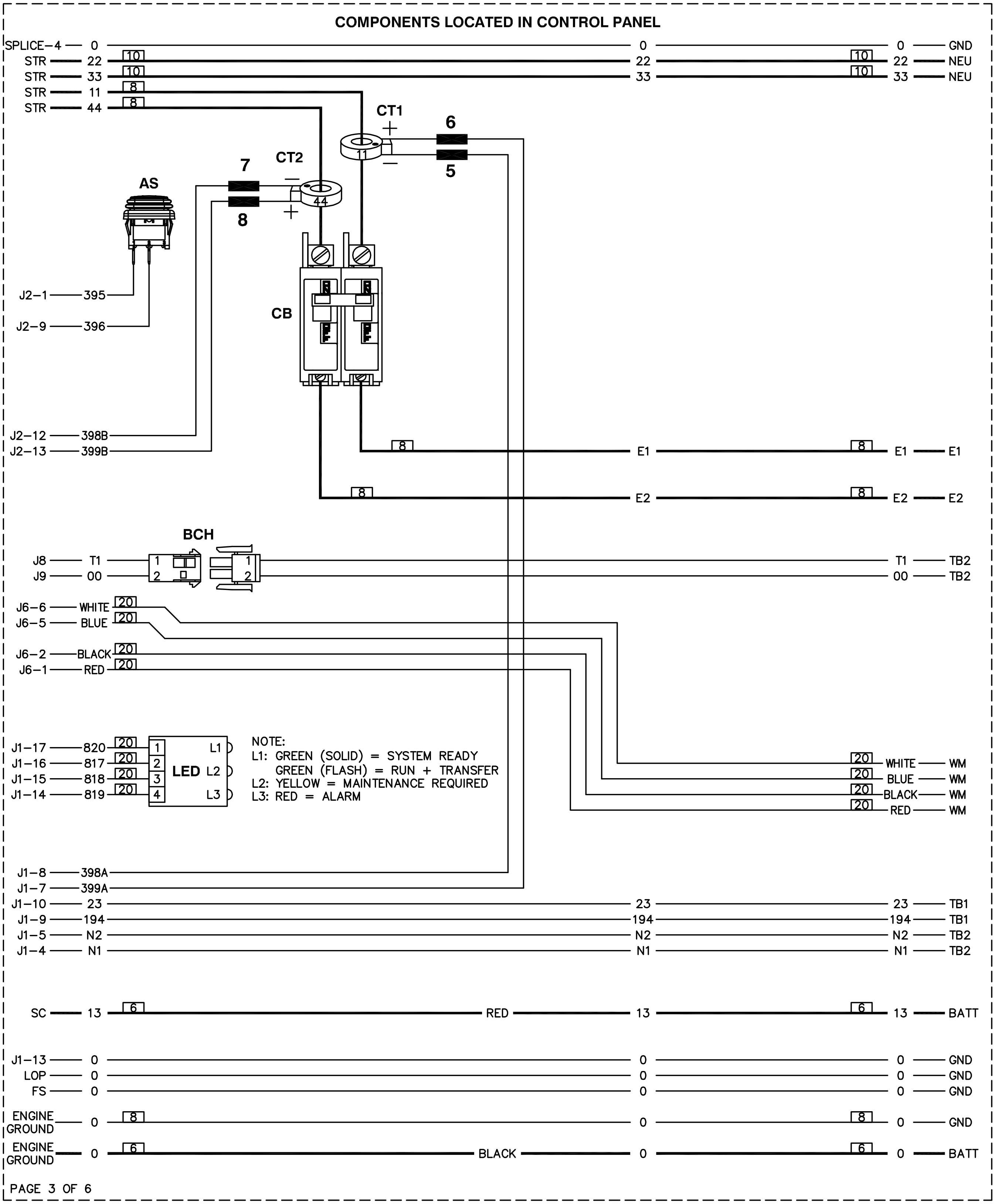
DRAWING #: 10000006453

GROUP WD



WIRING - DIAGRAM

REVISION: E

AC HSB EVO2 60HZ 426

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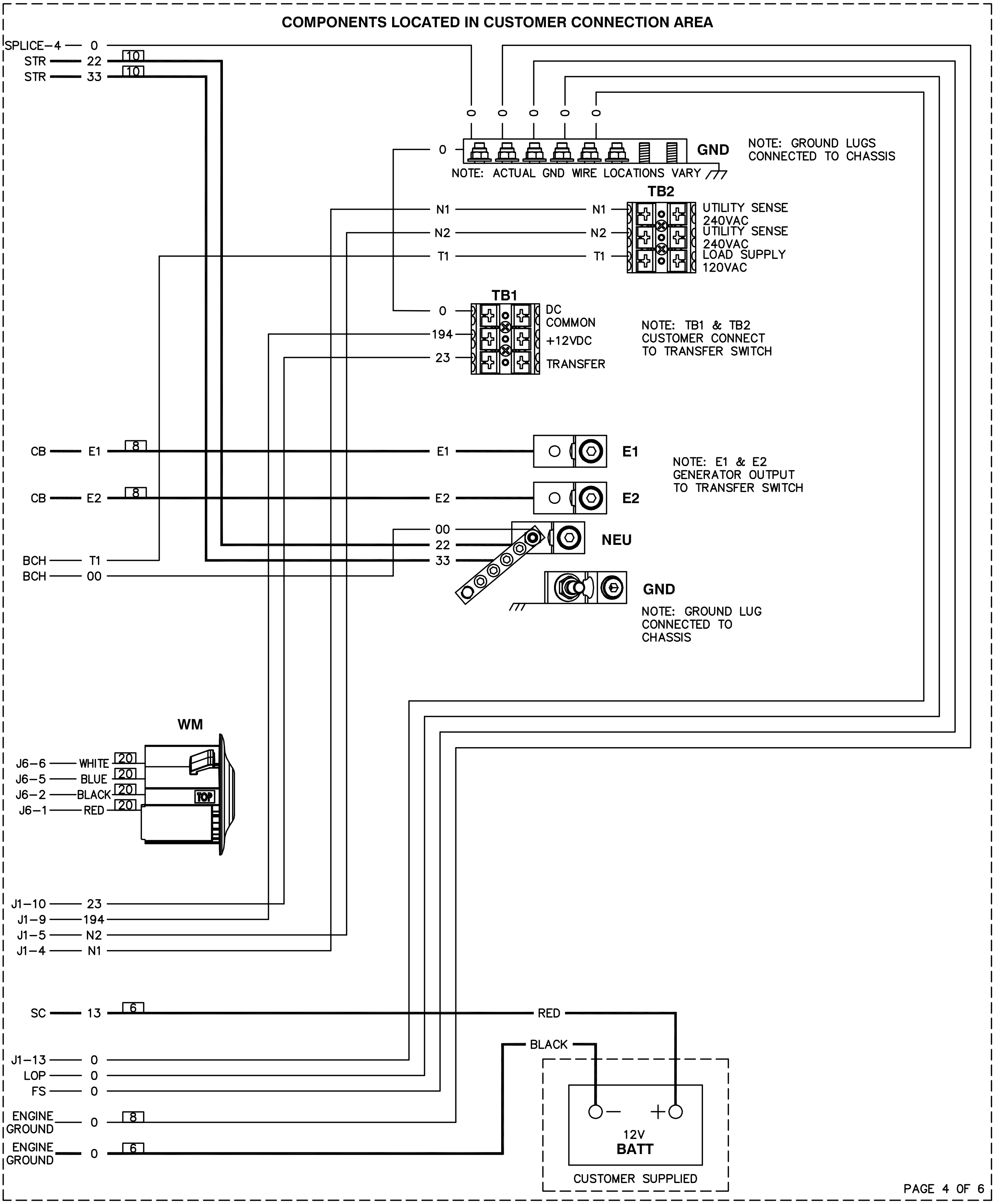
DRAWING #: 10000006453

GROUP WD



WIRING - DIAGRAM

REVISION: E

AC HSB EVO2 60HZ 426

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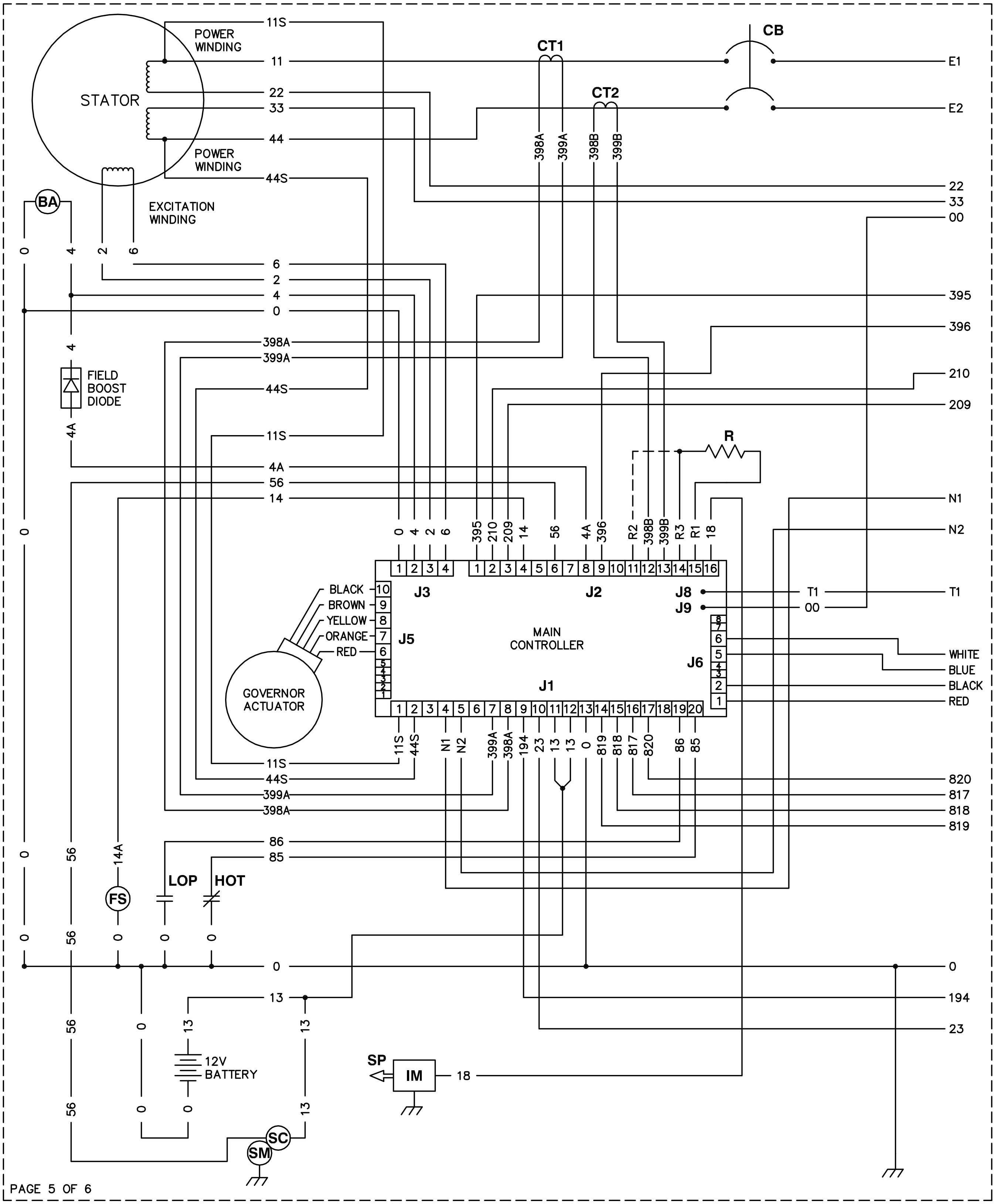
DRAWING #: 10000006453

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: E

AC HSB EVO2 60HZ 426

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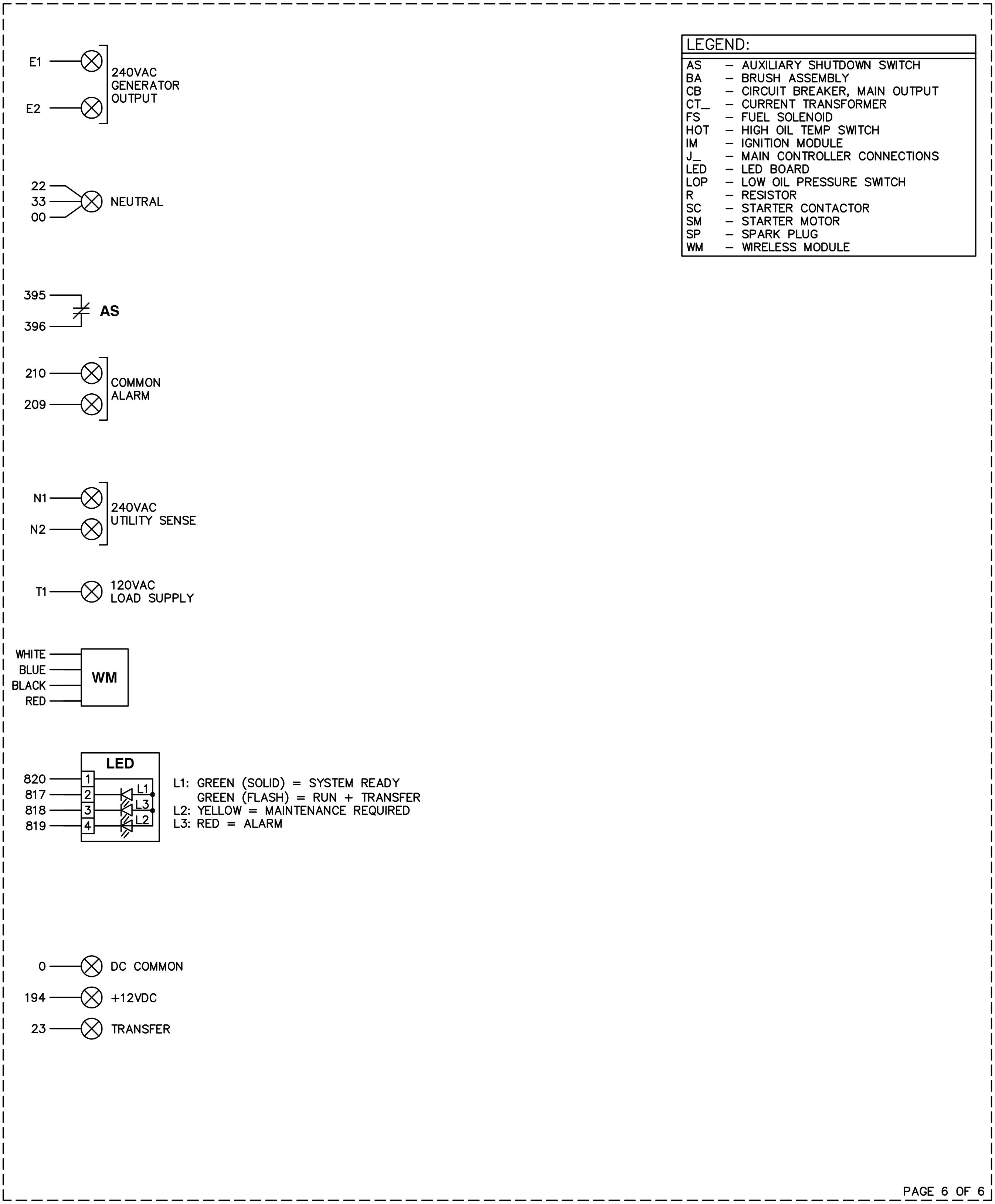
GROUP WD



SCHEMATIC - DIAGRAM

AC HSB EVO2 60HZ 426

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DRAWING #: 10000006453

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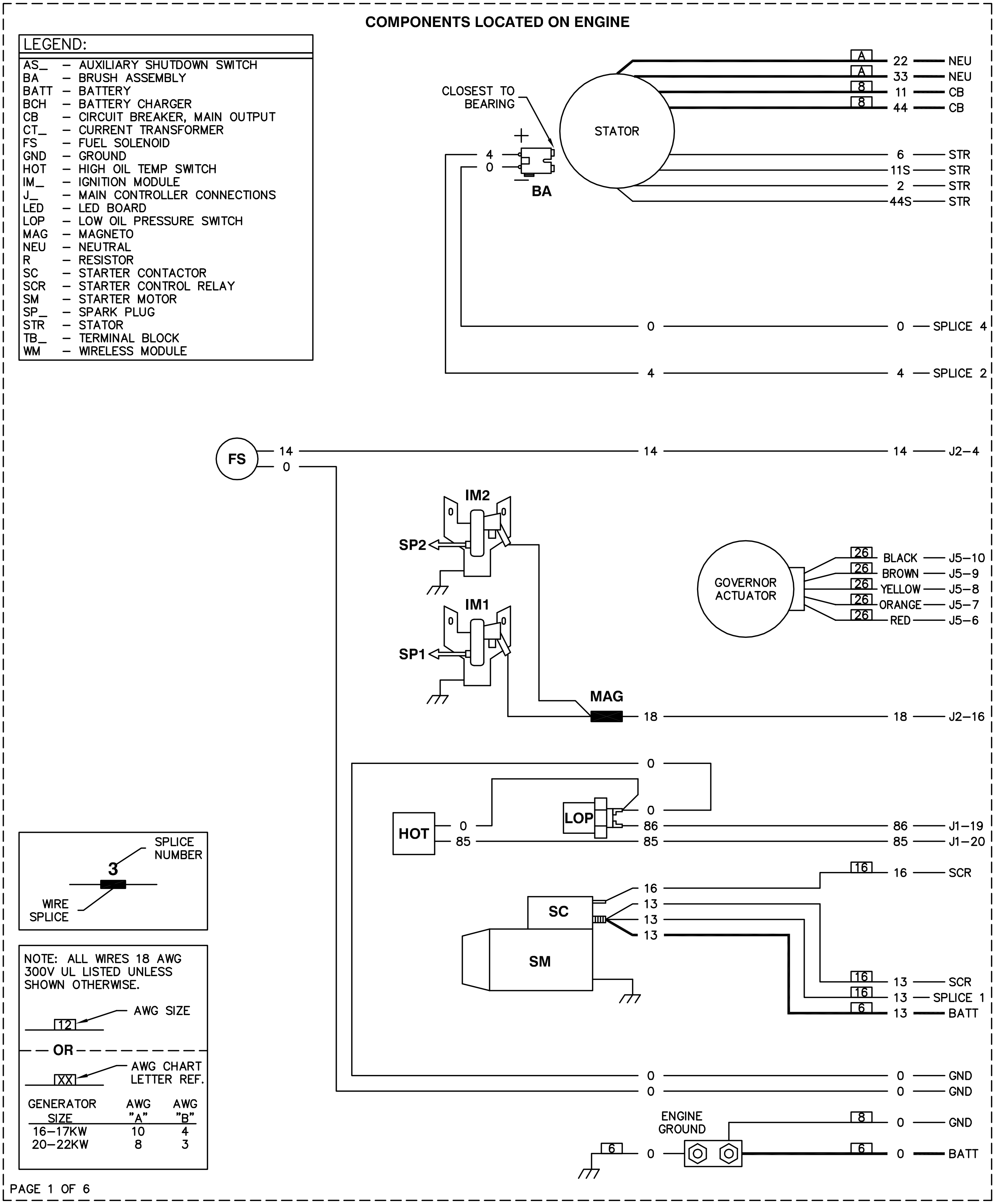
Section 5.3 *10000017243-A WD/SD Air-cooled HSB Evolution 2.0 w/816-999cc Engine 60 Hz*

816–999cc Engine 60 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: A

AC HSB EVO2 60HZ 999

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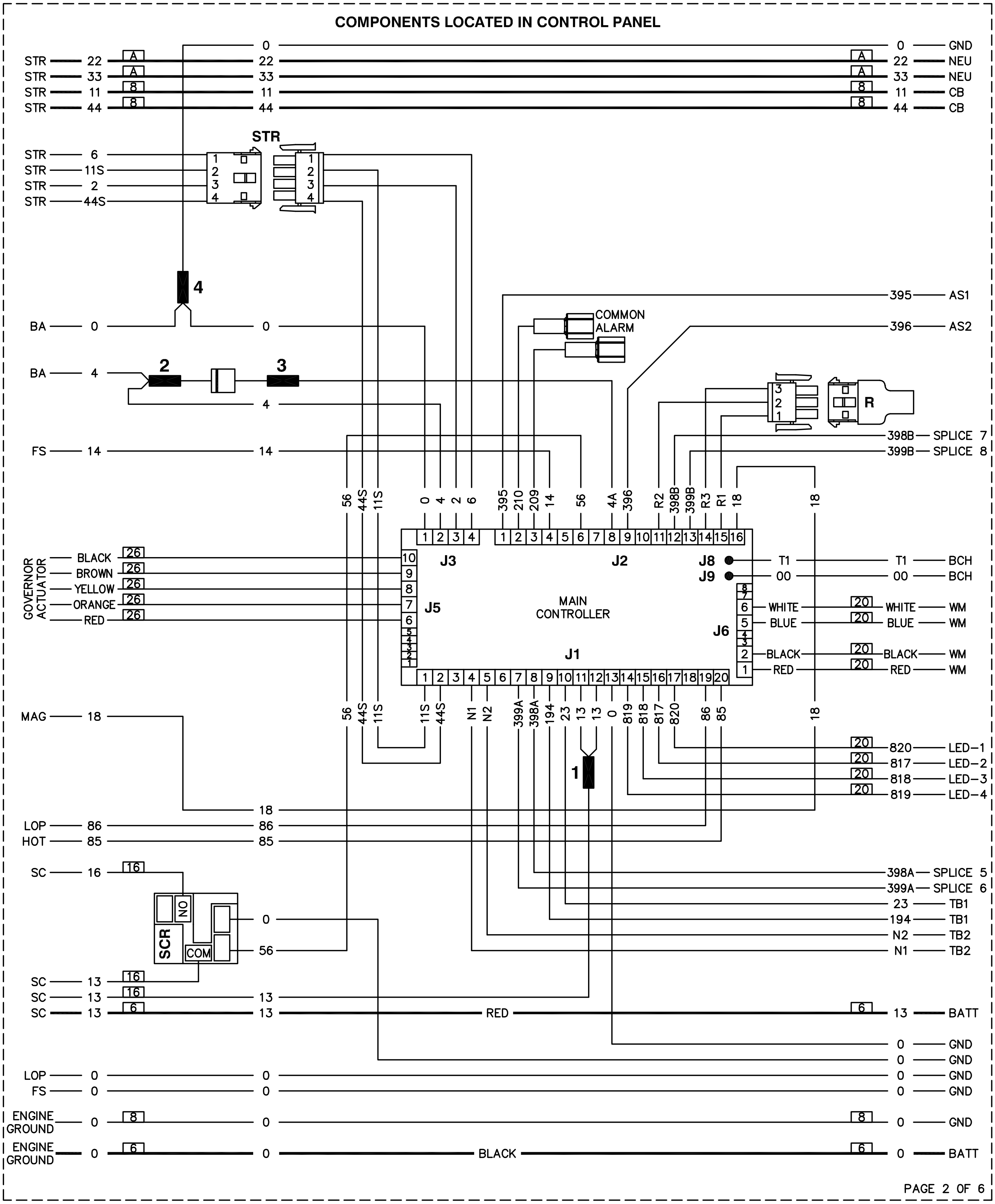
DRAWING #: 10000017243

GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 60HZ 999

REVISION: A

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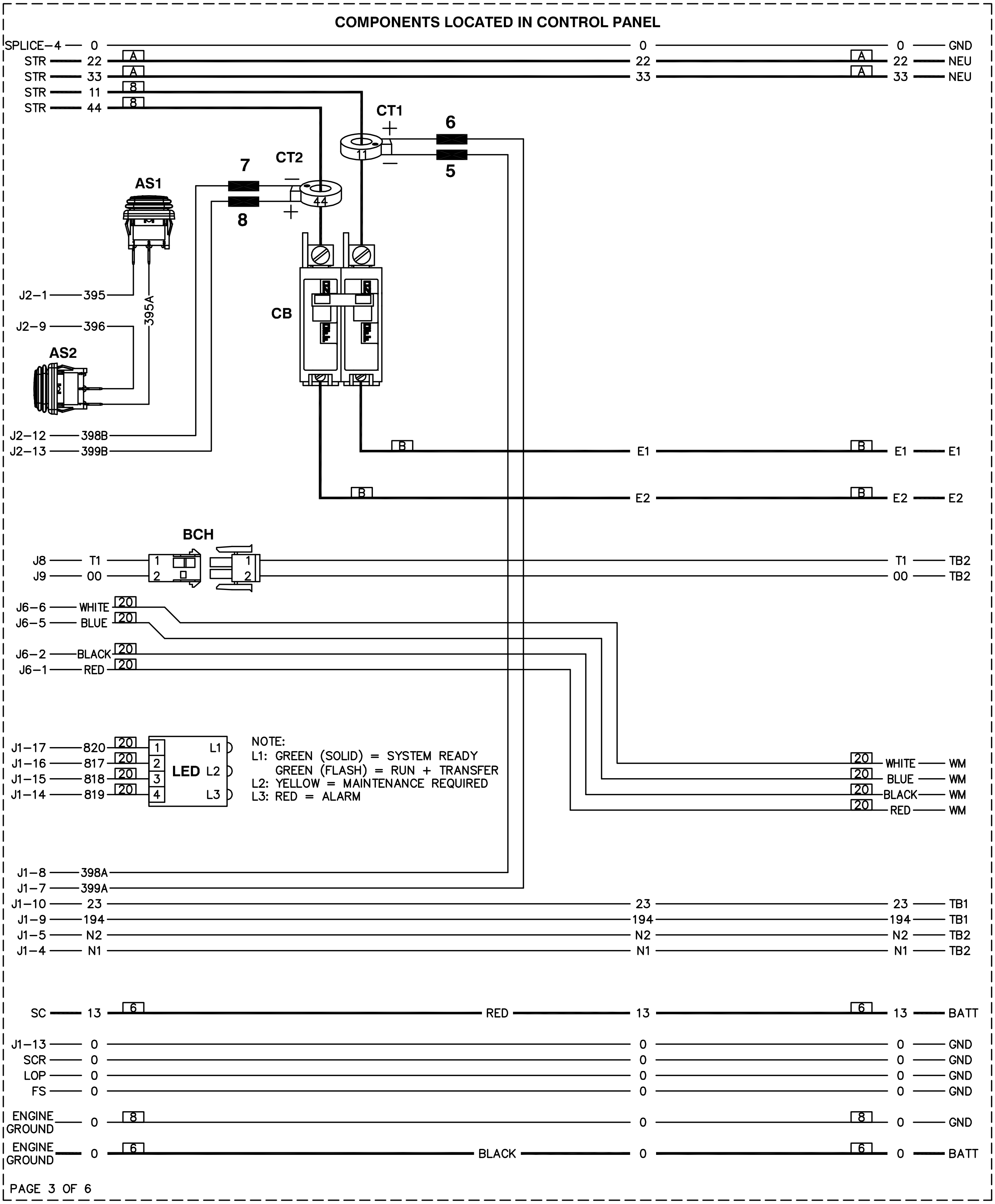
DRAWING #: 10000017243

GROUP WD



WIRING - DIAGRAM

REVISION: A

AC HSB EVO2 60HZ 999

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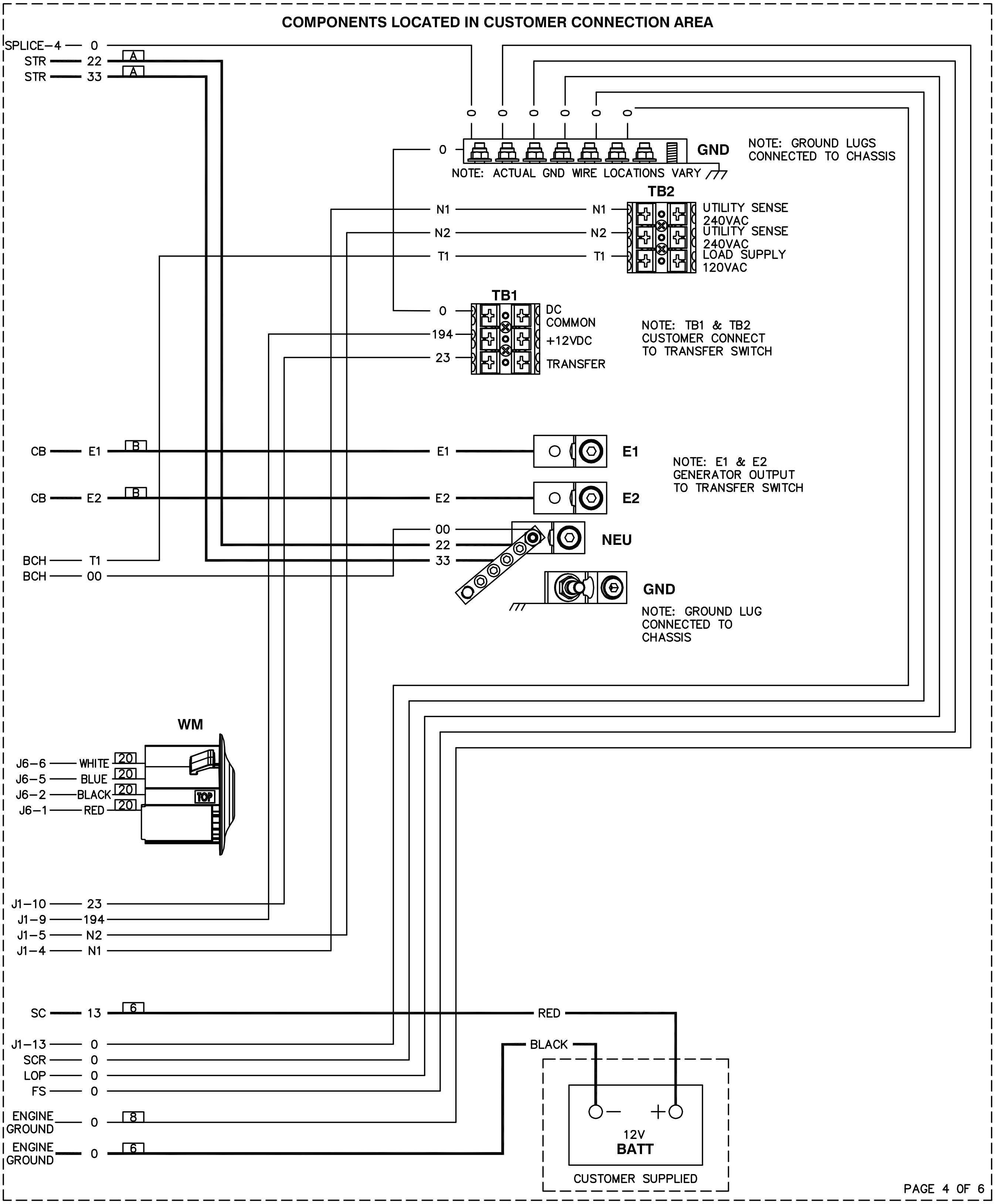
DRAWING #: 10000017243

GROUP WD



WIRING - DIAGRAM

REVISION: A

AC HSB EVO2 60HZ 999

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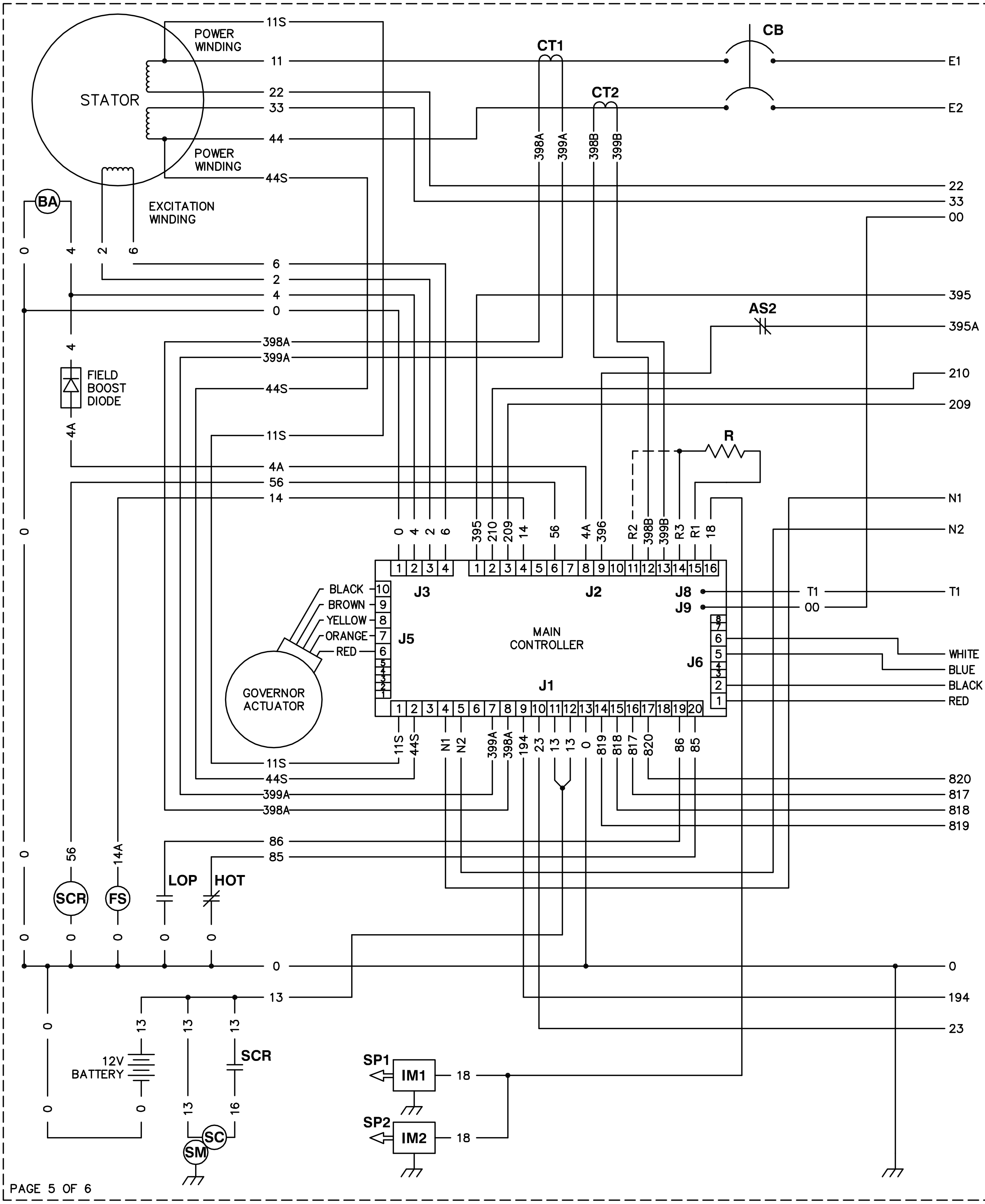
DRAWING #: 10000017243

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: A

AC HSB EVO2 60HZ 999

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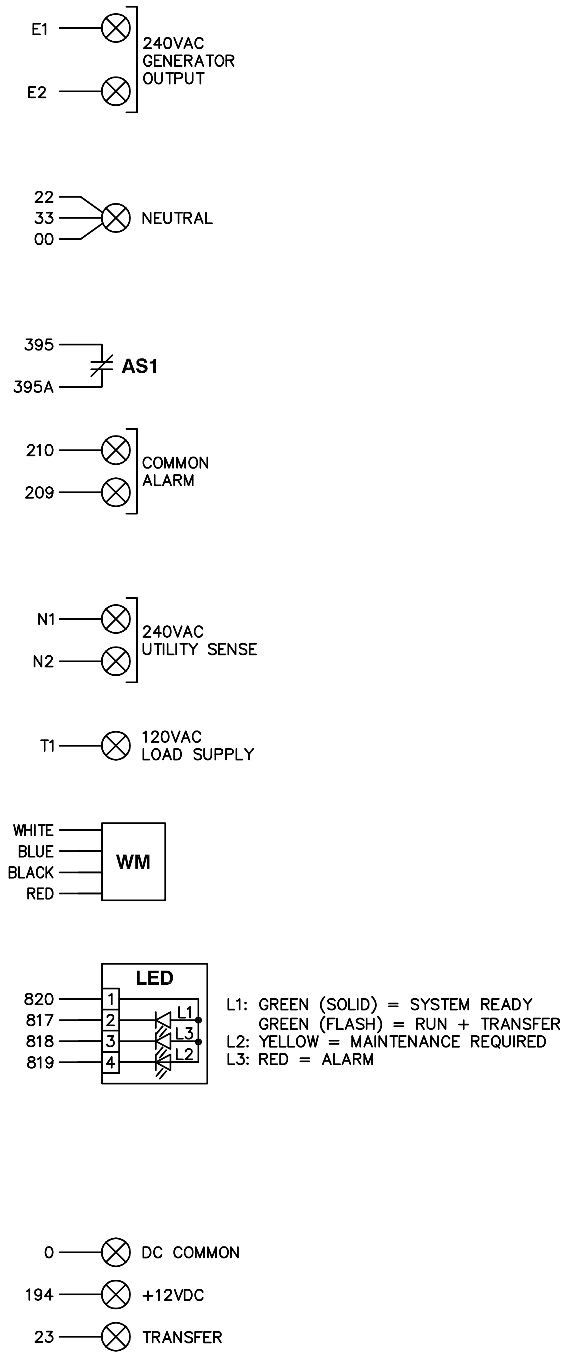
DRAWING #: 10000017243

GROUP WD

LEGEND:	
AS_	– AUXILIARY SHUTDOWN SWITCH
BA	– BRUSH ASSEMBLY
CB	– CIRCUIT BREAKER, MAIN OUTPUT
CT_	– CURRENT TRANSFORMER
FS	– FUEL SOLENOID
HOT	– HIGH OIL TEMP SWITCH
IM_	– IGNITION MODULE
J_	– MAIN CONTROLLER CONNECTIONS
LED	– LED BOARD
LOP	– LOW OIL PRESSURE SWITCH
R	– RESISTOR
SC	– STARTER CONTACTOR
SCR	– STARTER CONTROL RELAY
SM	– STARTER MOTOR
SP_	– SPARK PLUG
WM	– WIRELESS MODULE



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AC HSB EVO2 60HZ 999

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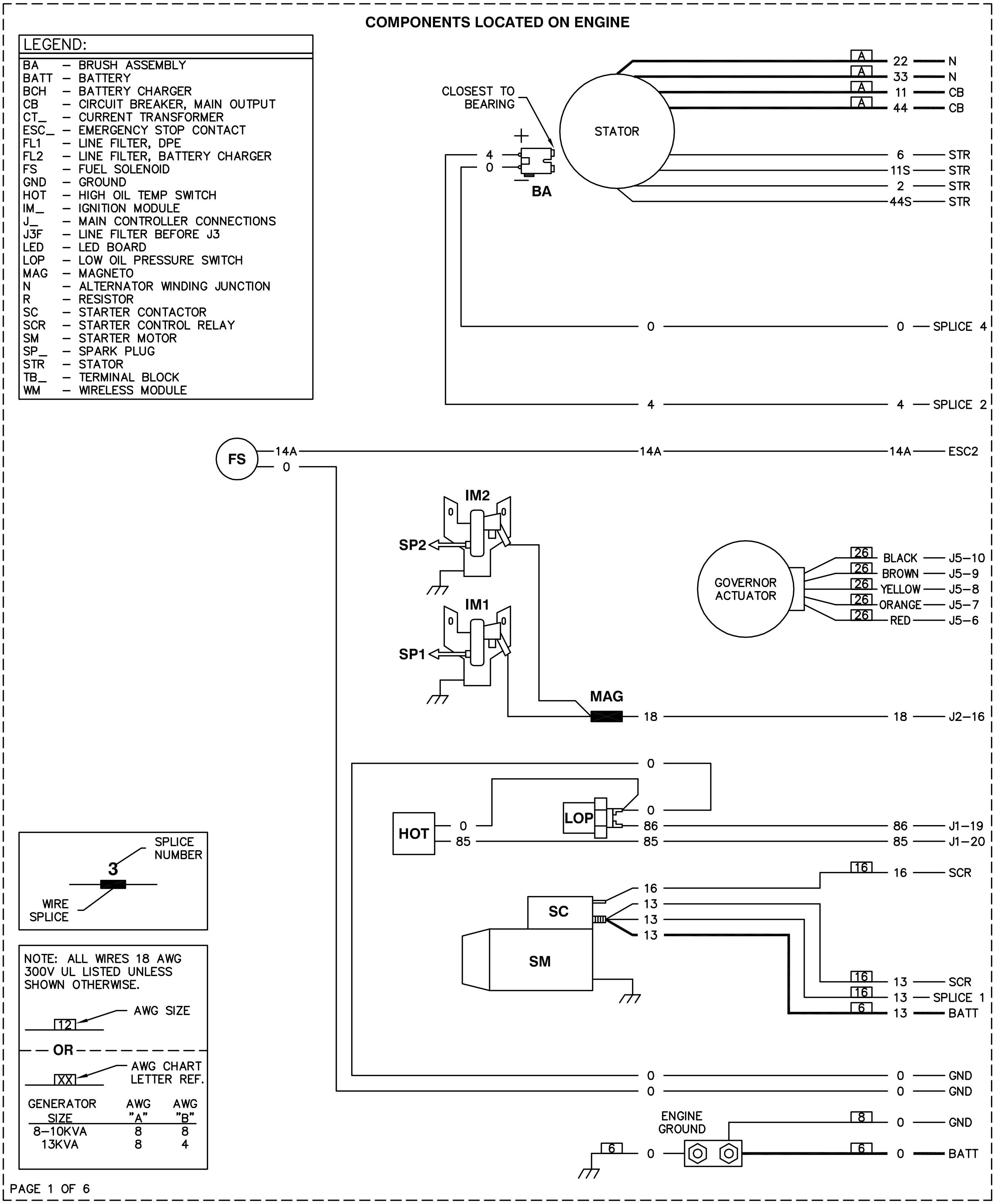
Section 5.4 *10000007481-G WD/SD Air-cooled HSB Evolution 2.0 50 Hz 1-phase CE*

50 Hz 1-phase CE - Europe certification

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ 1PH CE

DATE: 06/28/18

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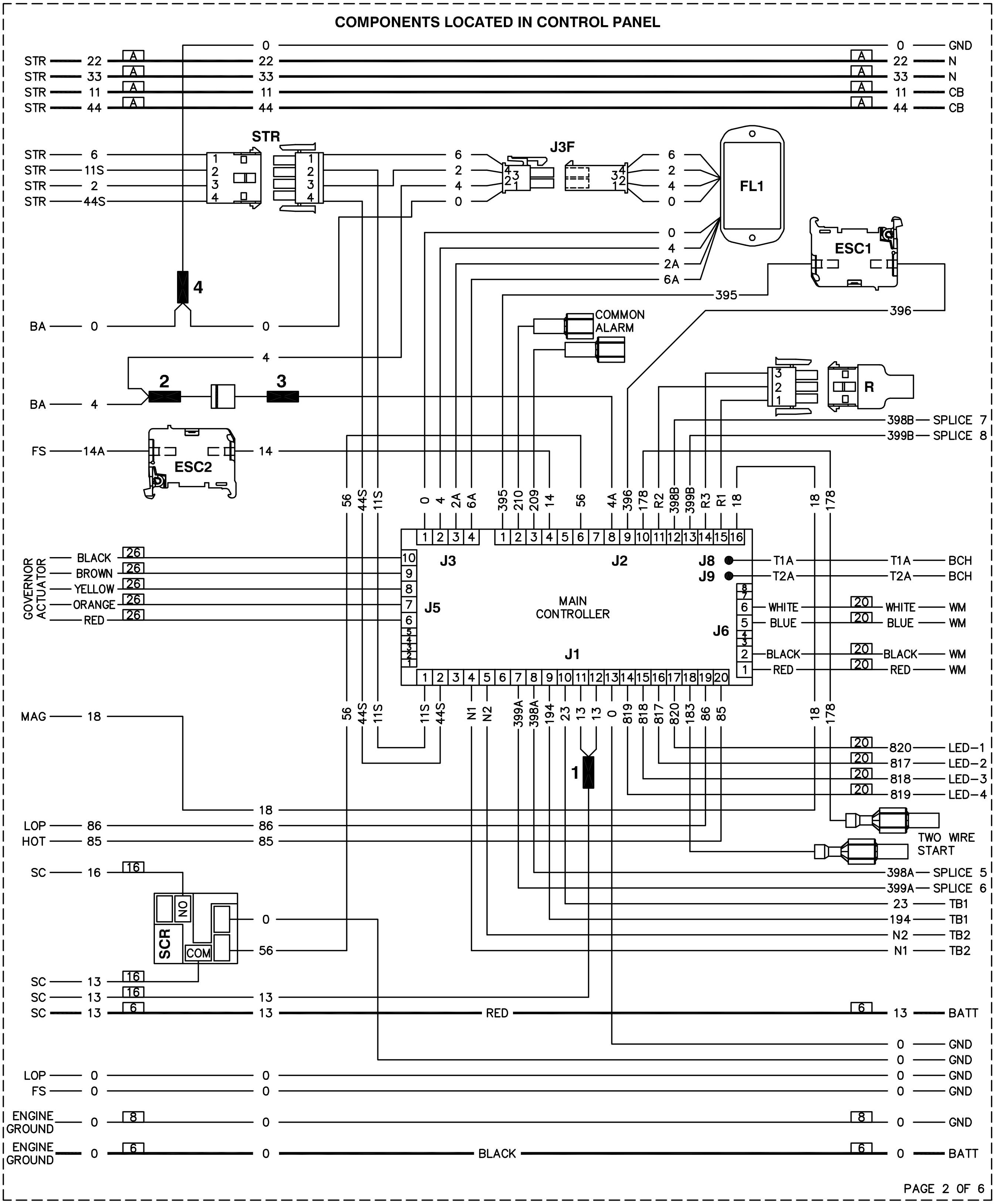
DRAWING #: 10000007481

GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ 1PH CE

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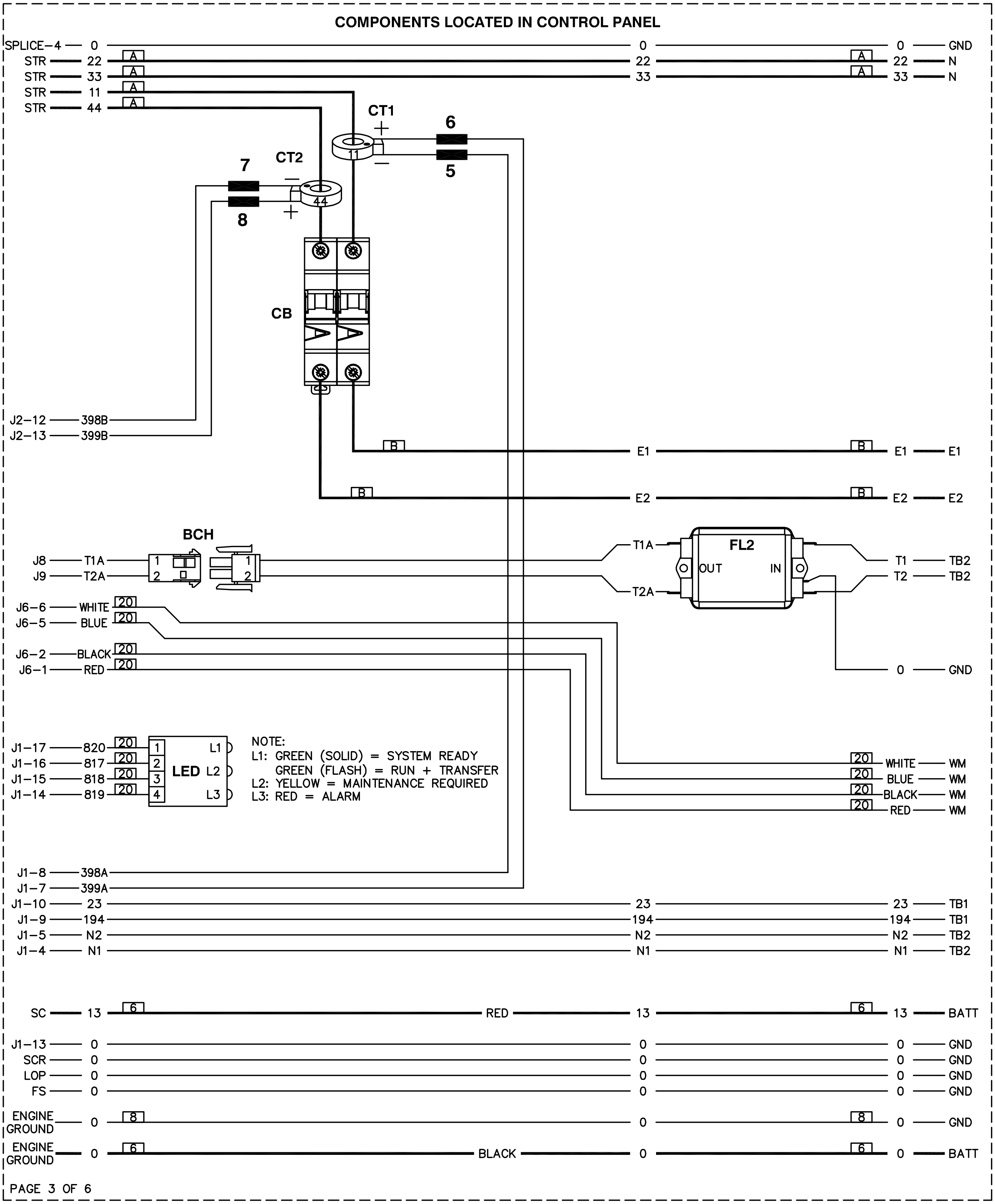
GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ 1PH CE

DATE: 06/28/18

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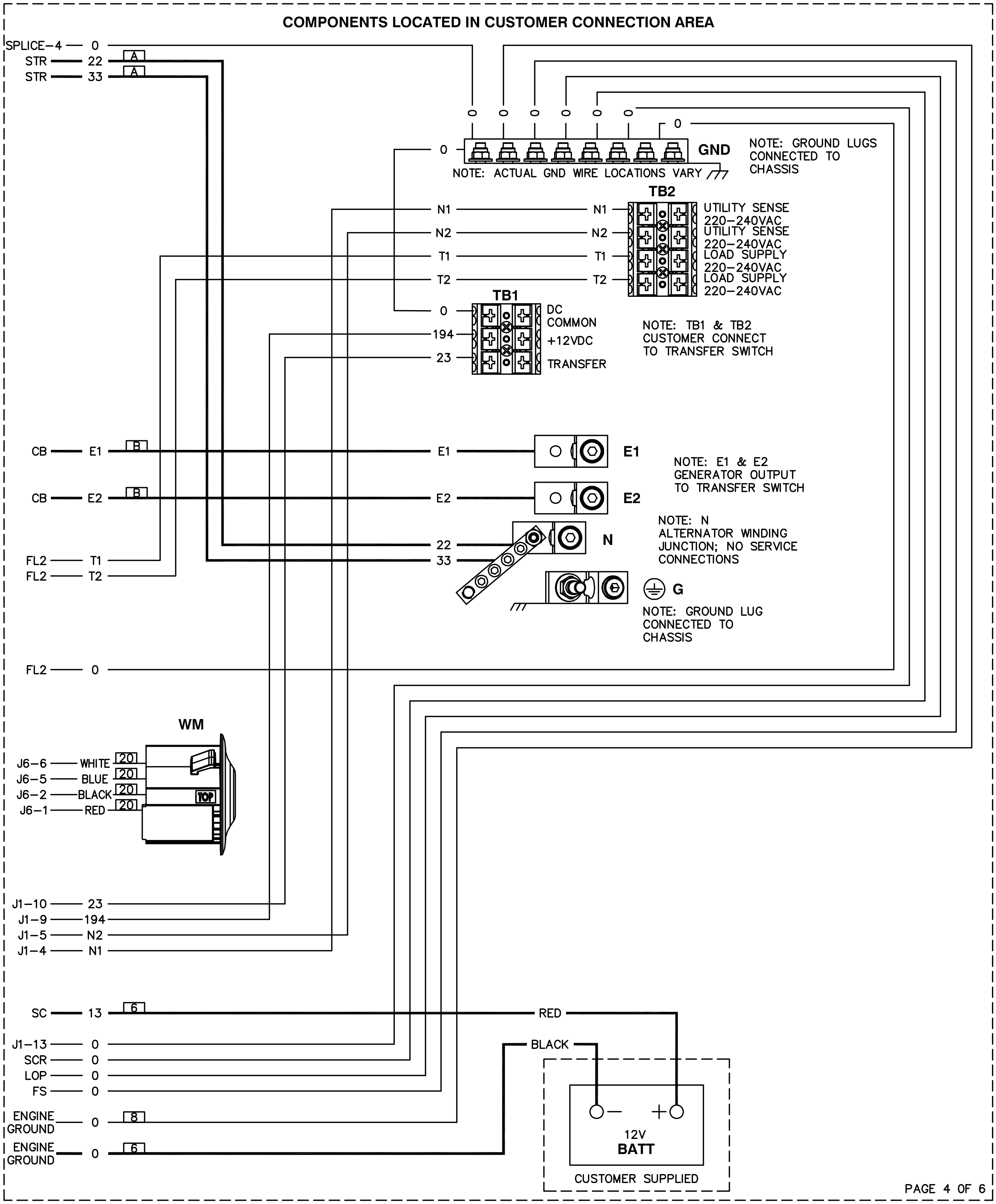
GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 50HZ 1PH CE

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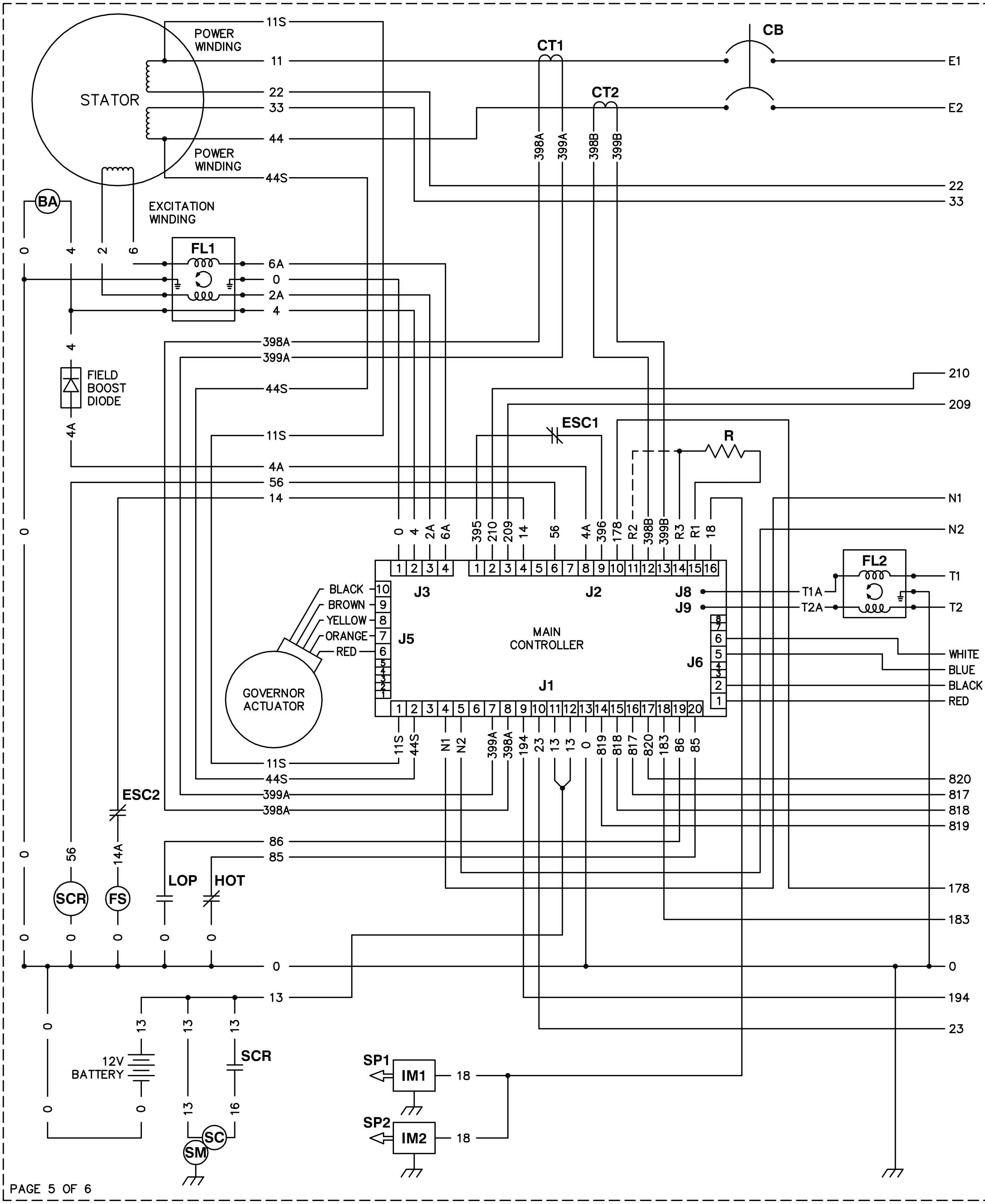
GROUP WD



SCHEMATIC - DIAGRAM

AC HSB EVO2 50HZ 1PH CE

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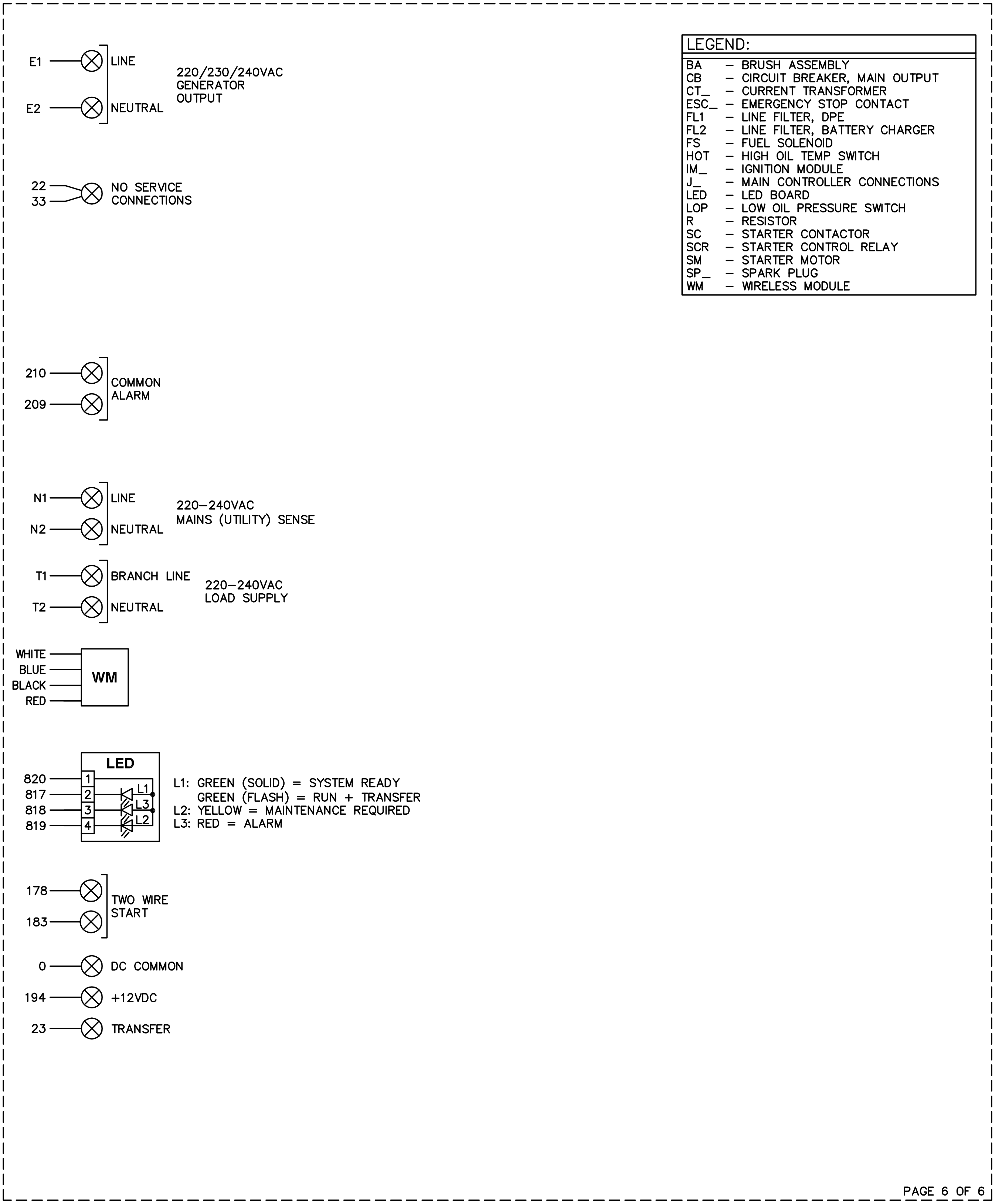
GROUP WD



SCHEMATIC - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ 1PH CE

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DRAWING #: 10000007481

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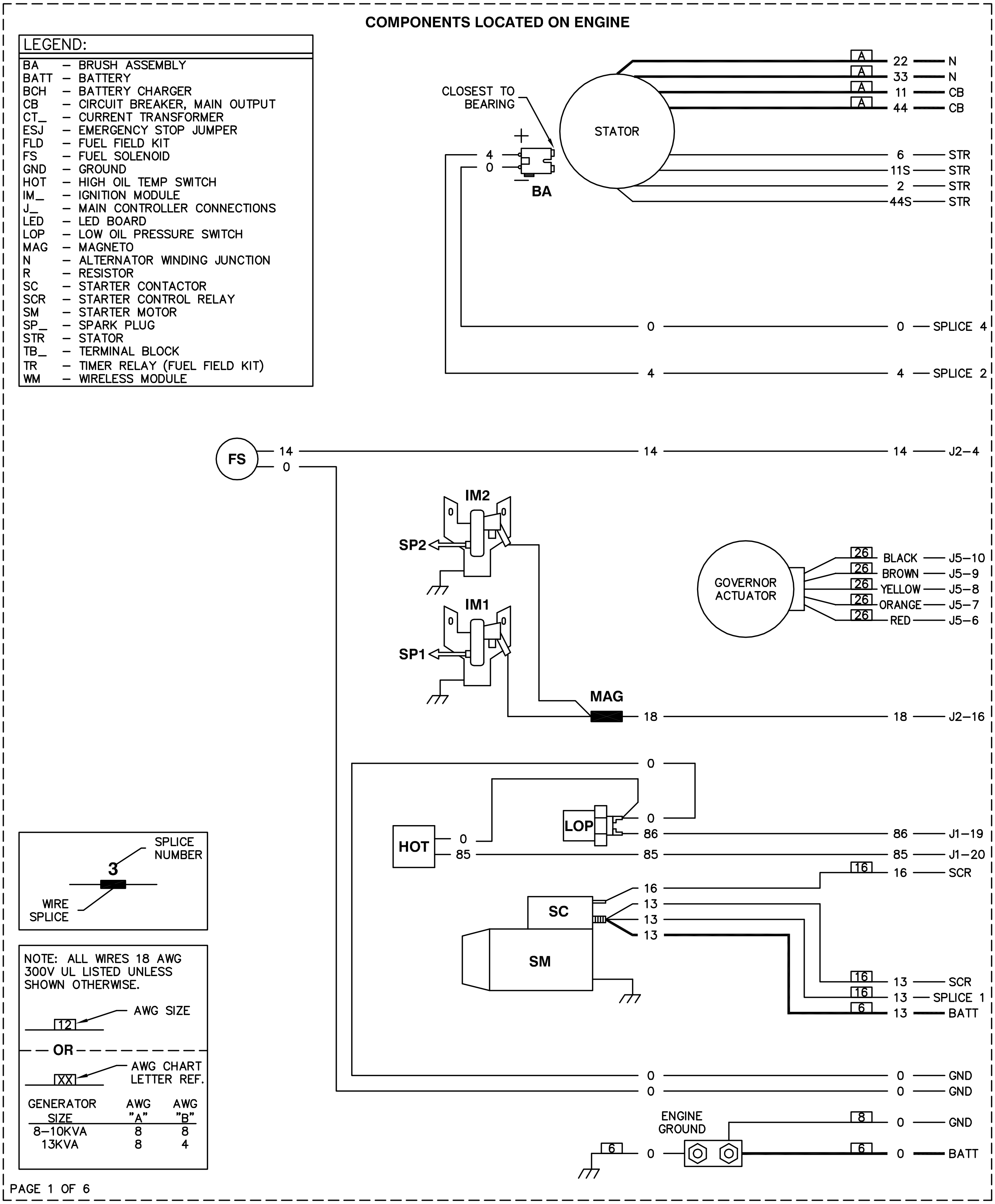
Section 5.5 *10000008280-G WD/SD Air-cooled HSB Evolution 2.0 50 Hz Australia*

530–999cc Engine 50 Hz Australia

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM
AC HSB EVO2 50HZ AUS
DRAWING #: 10000008280

REVISION: G
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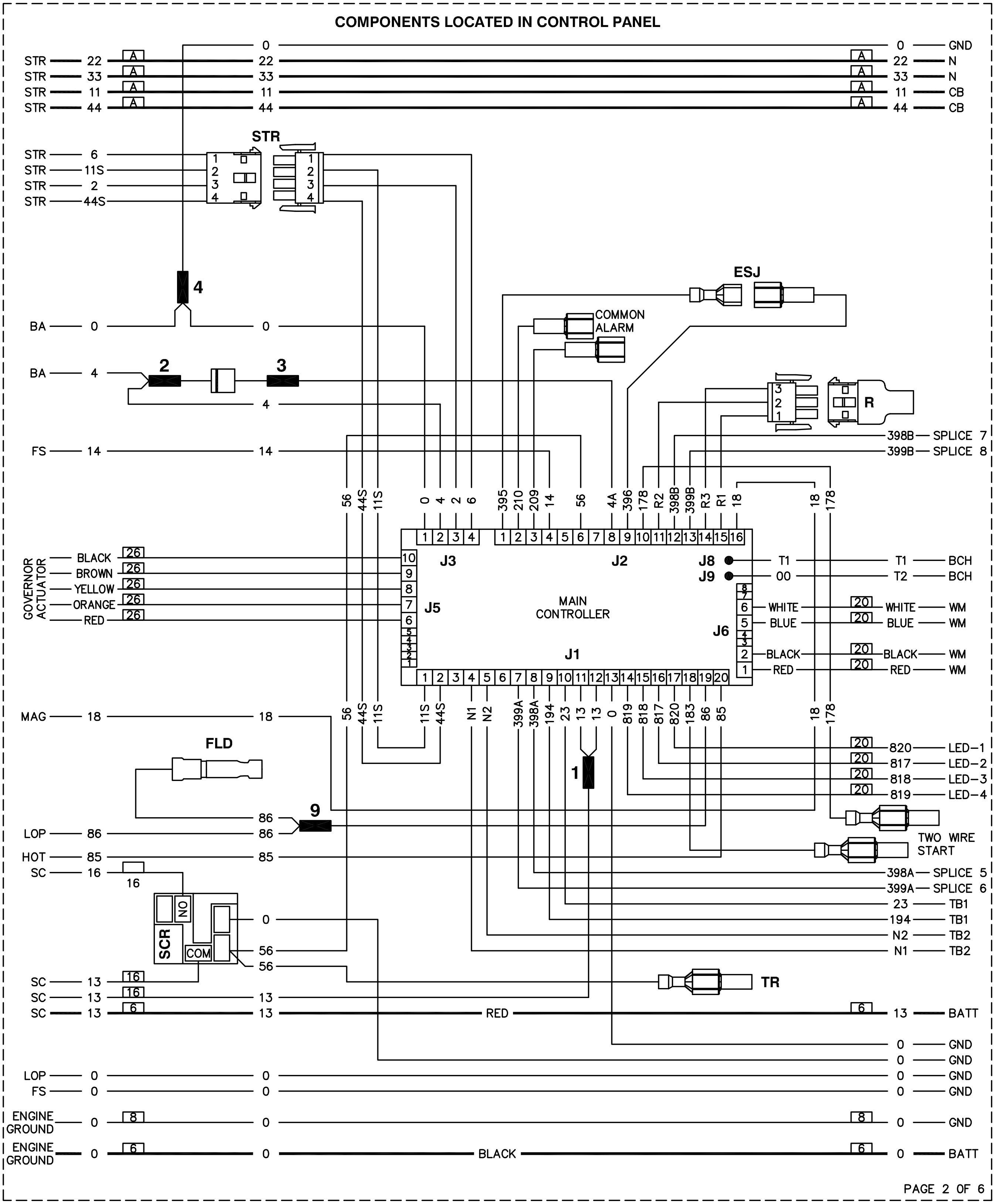
GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ AUS

DATE: 06/28/18

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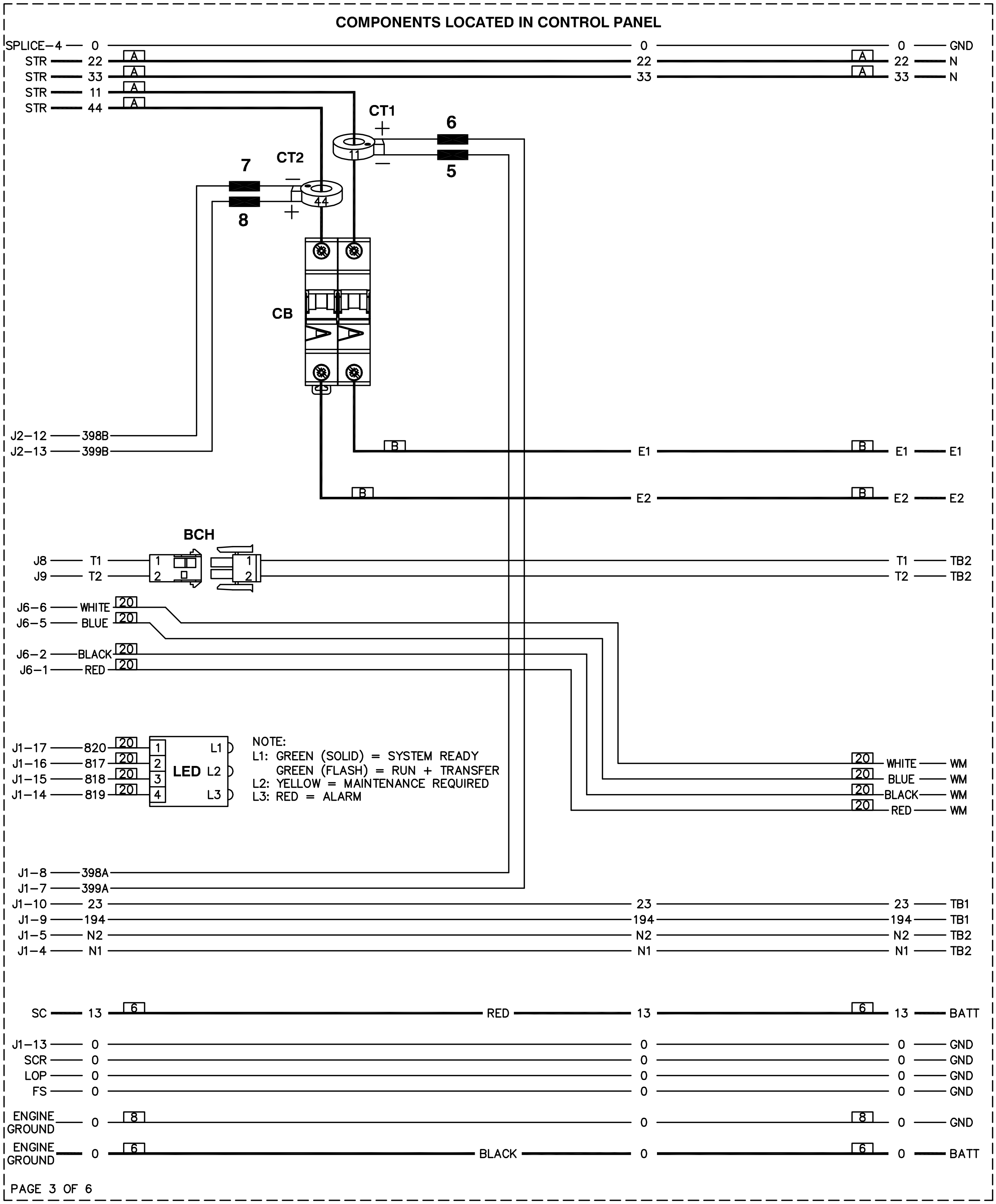
DRAWING #: 10000008280

GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ AUS

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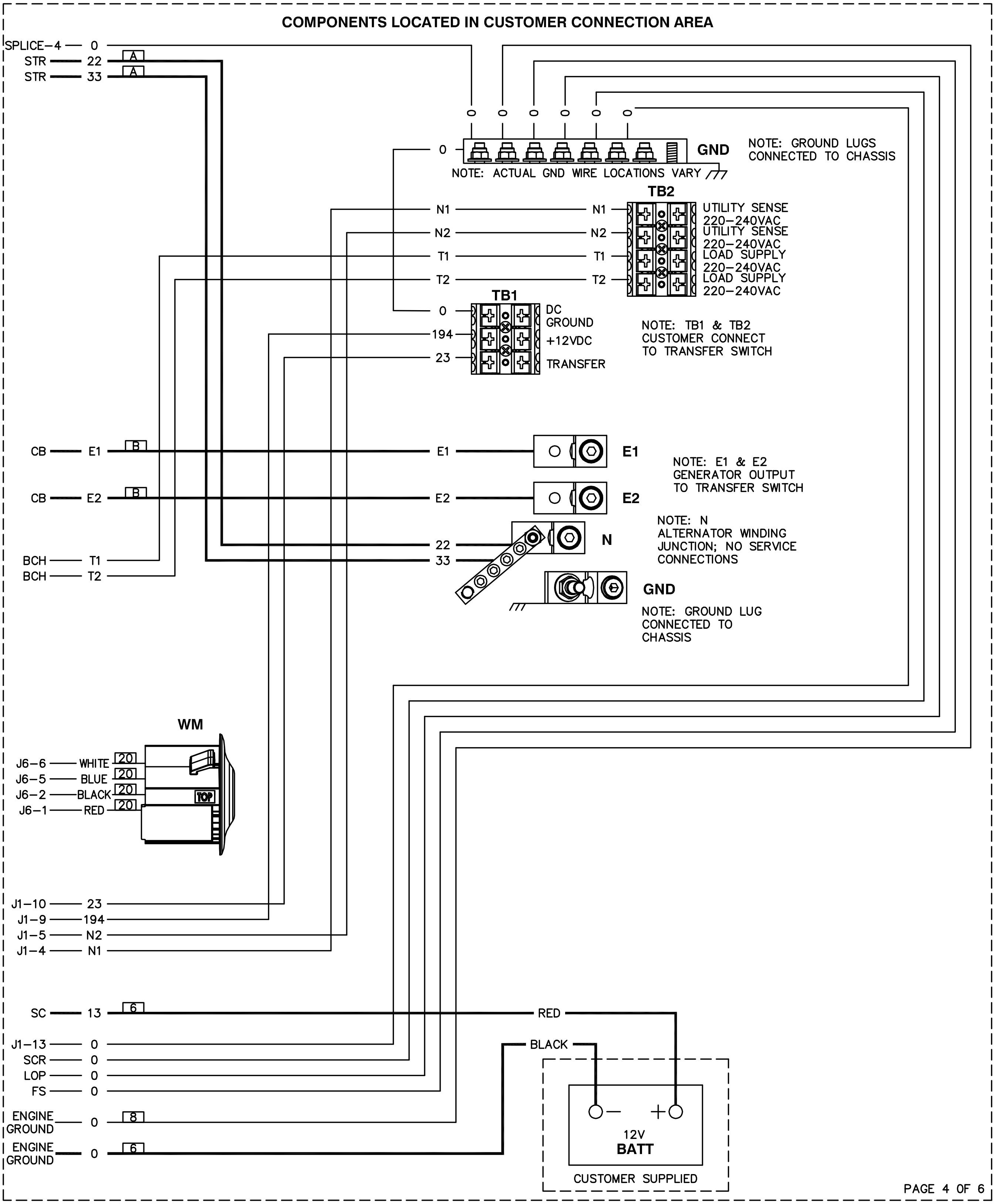
DRAWING #: 10000008280

GROUP WD



WIRING - DIAGRAM

REVISION: G

AC HSB EVO2 50HZ AUS

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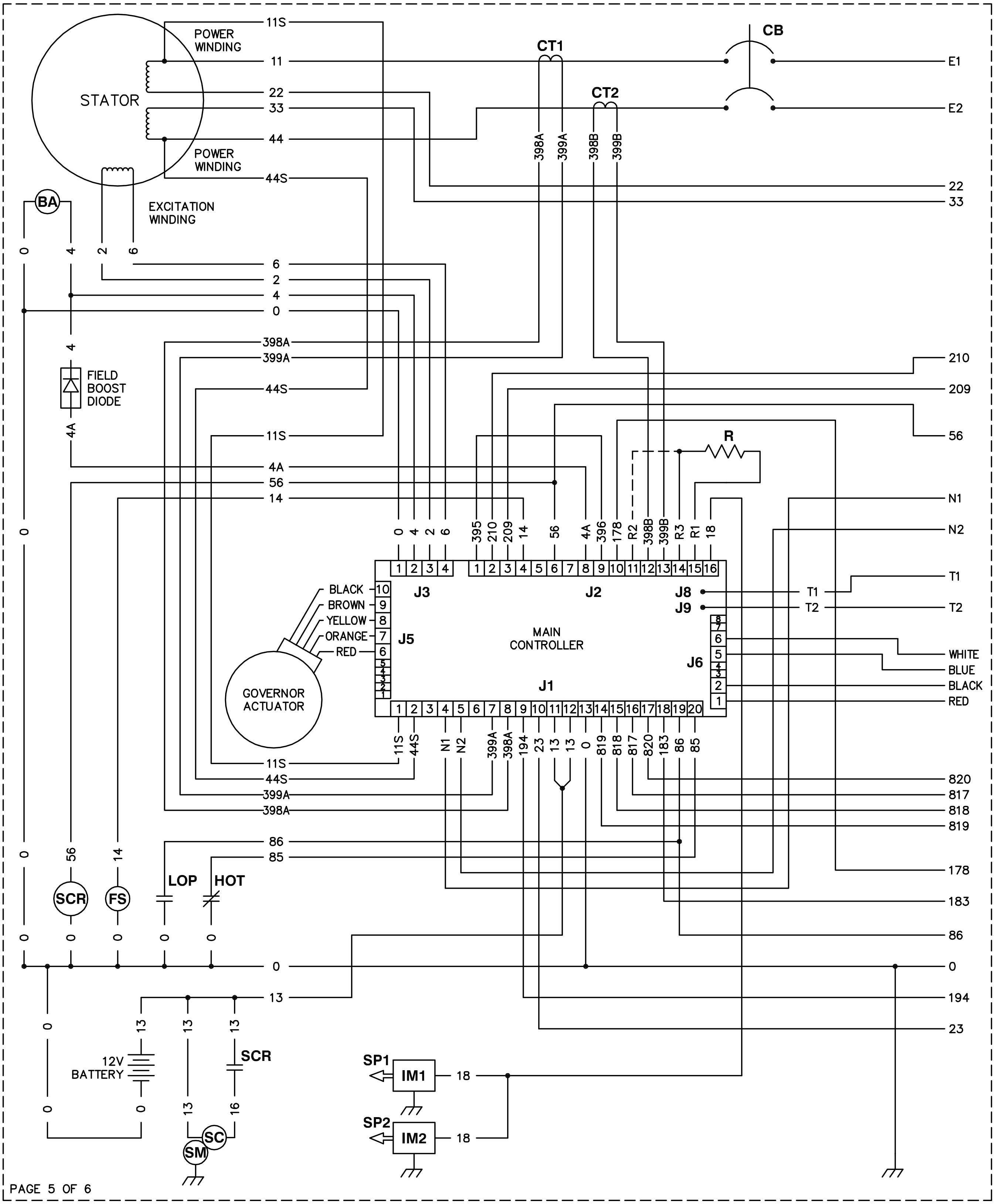
DRAWING #: 10000008280

GROUP WD



SCHEMATIC - DIAGRAM

AC HSB EVO2 50HZ AUS

REVISION: G

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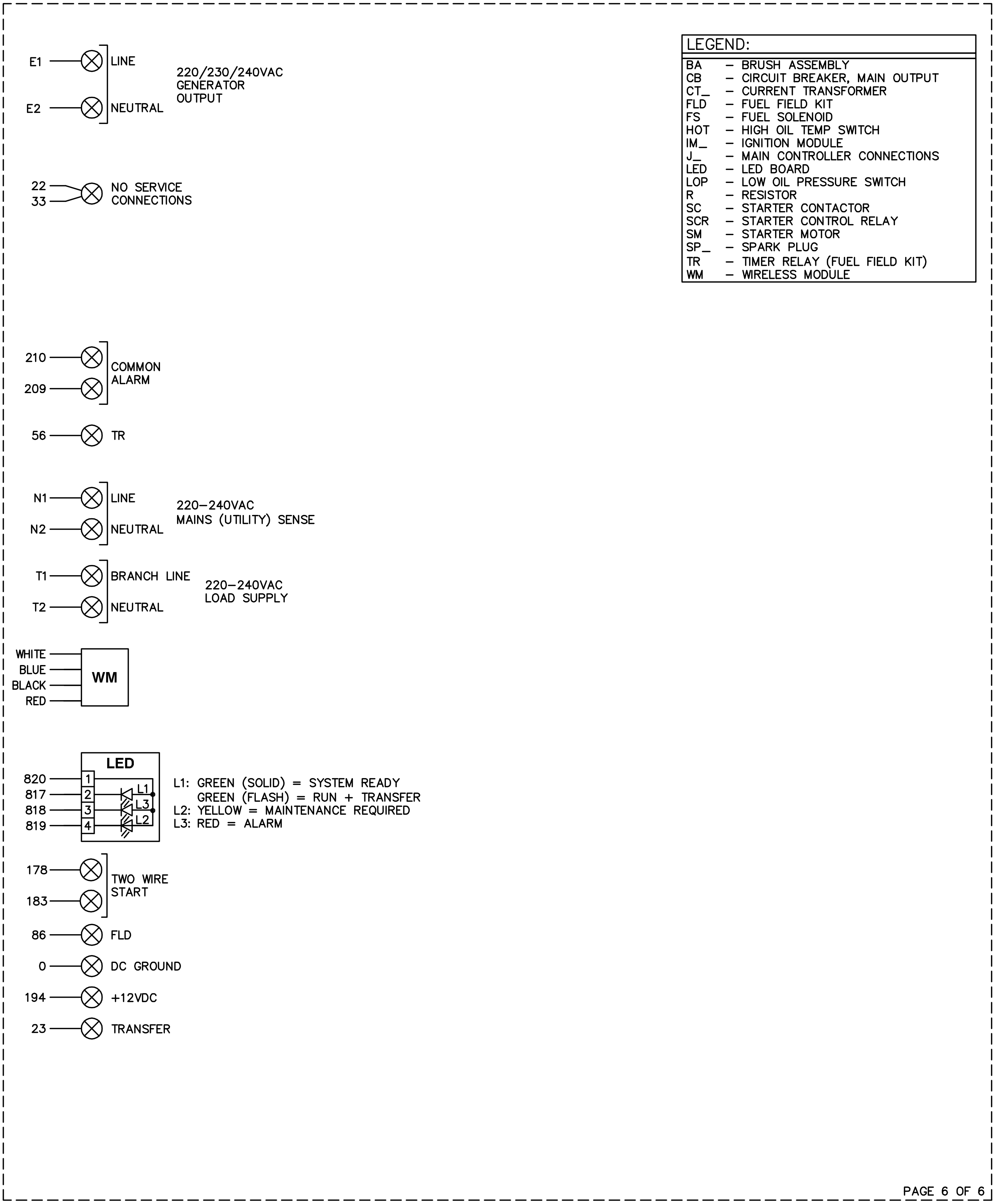
DRAWING #: 10000008280

GROUP WD



SCHEMATIC - DIAGRAM

AC HSB EVO2 50HZ AUS

REVISION: G

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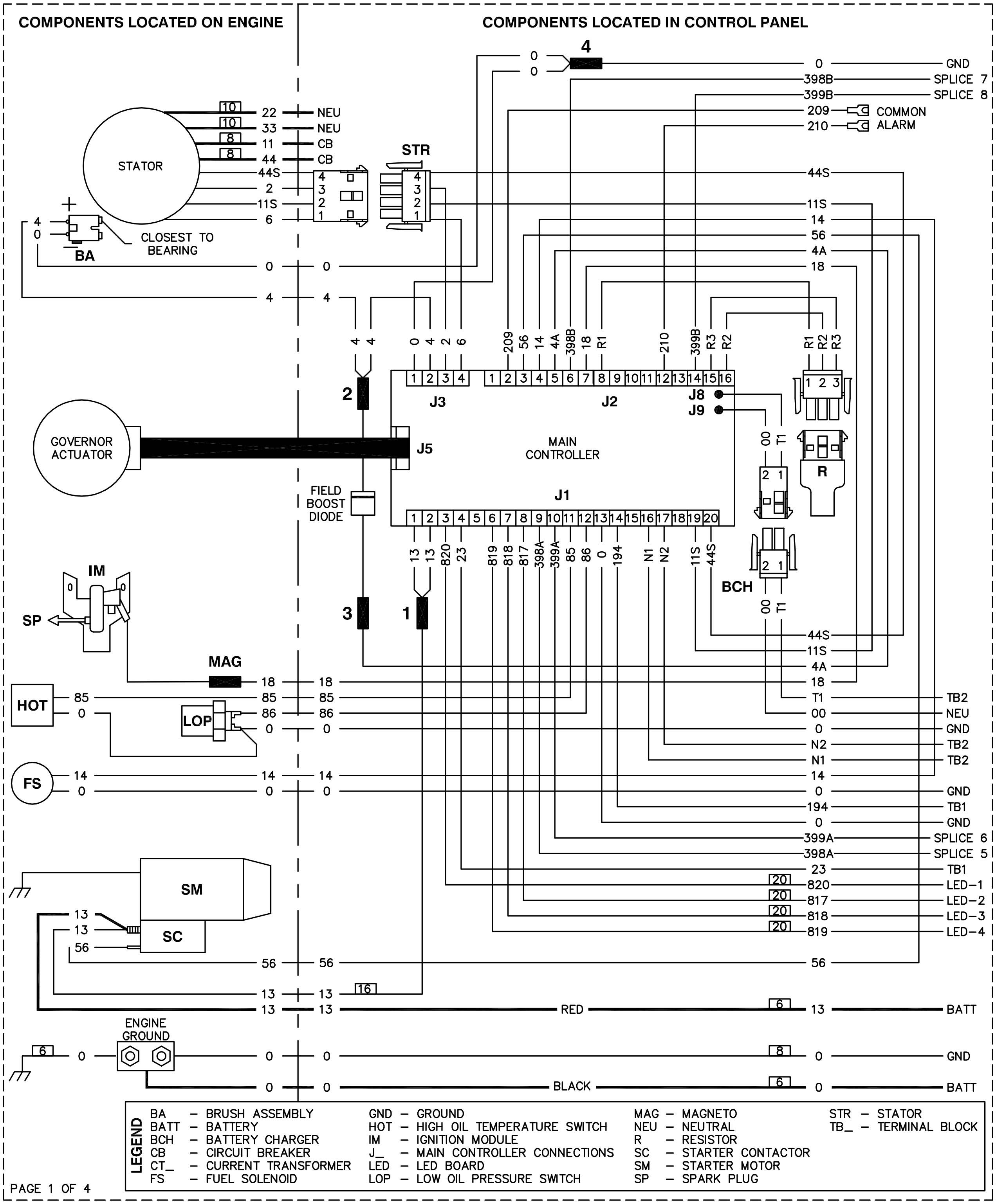
Section 5.6 *0L6822-B WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 9 kW 60 Hz*

9 kW 60 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM
AIR COOLED HSB 9KW

REVISION: B

DATE: 03/08/17

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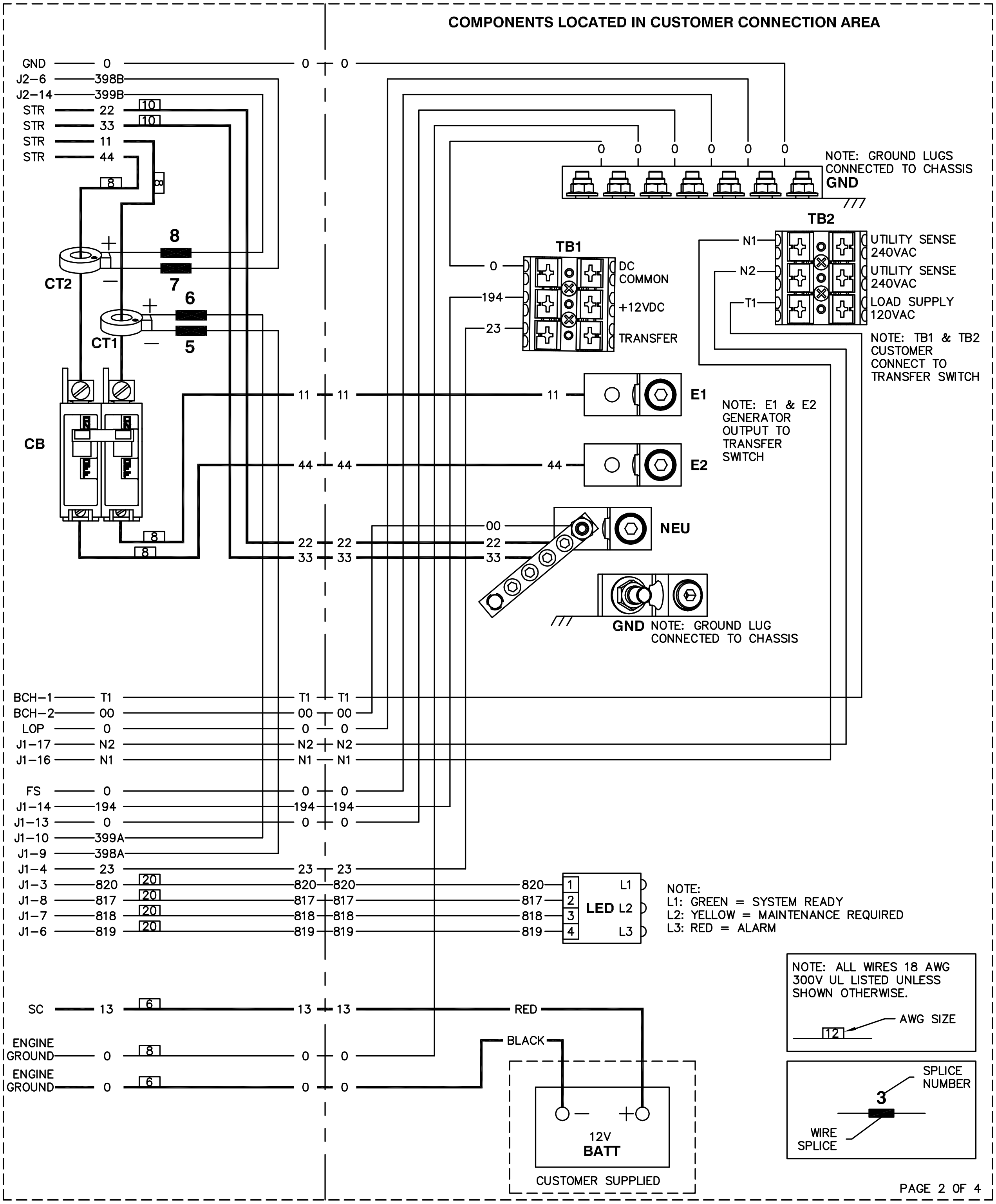
DRAWING #: 0L6822

GROUP WD



WIRING - DIAGRAM

REVISION: B

AIR COOLED HSB 9KW

DATE: 03/08/17

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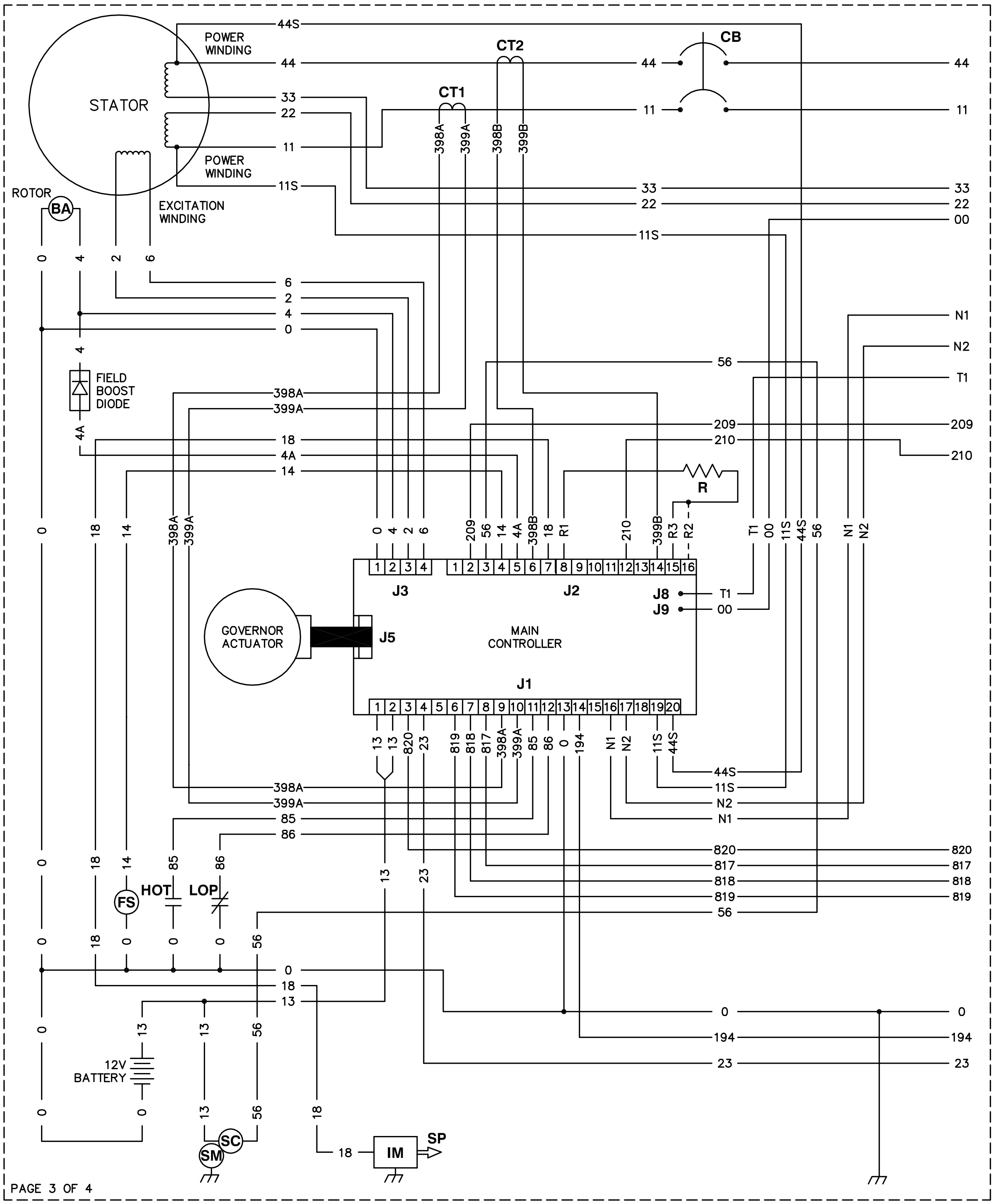
DRAWING #: 0L6822

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AIR COOLED HSB 9KW

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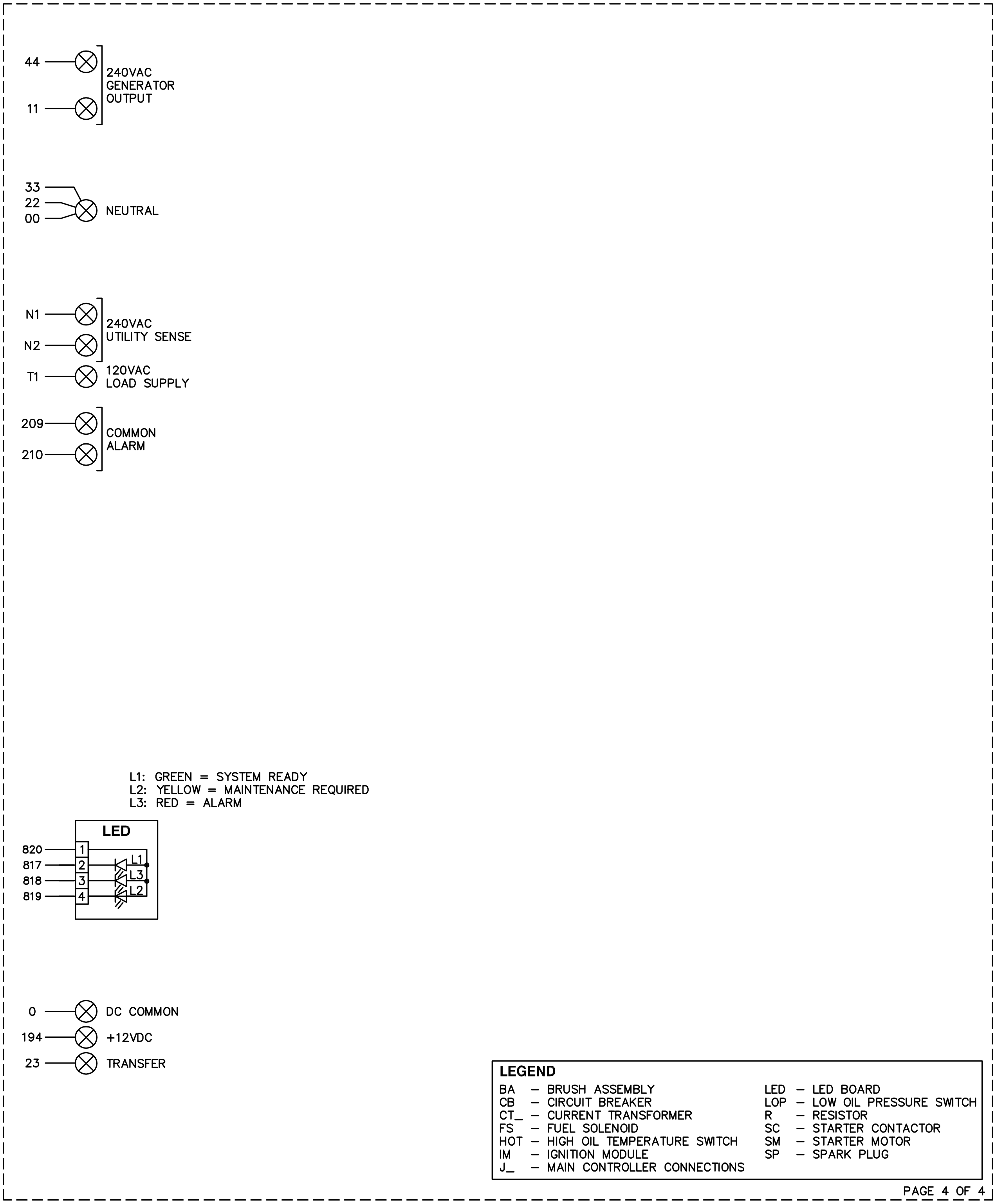
DRAWING #: 0L6822

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AIR COOLED HSB 9KW

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DRAWING #: 0L6822

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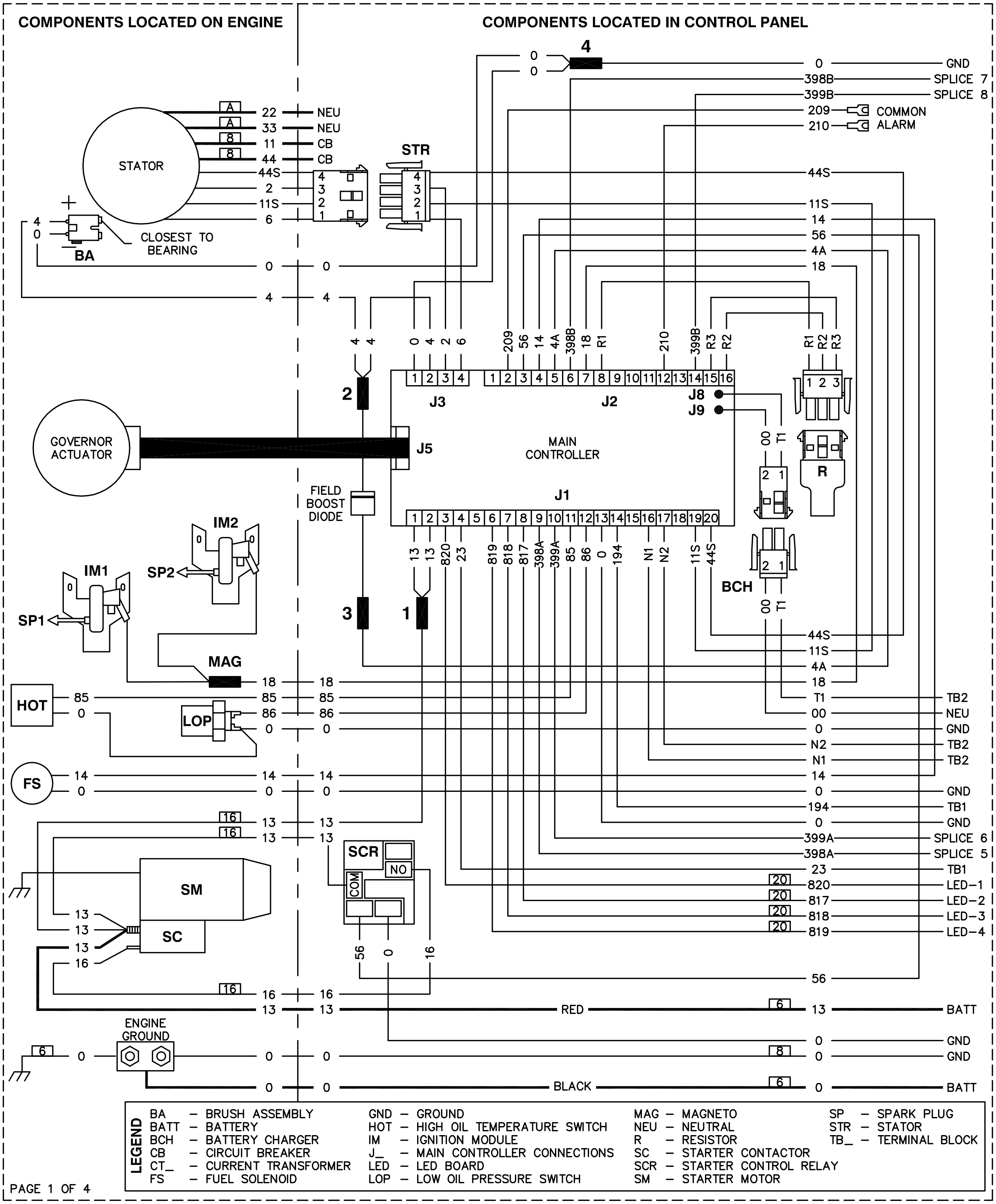
Section 5.7 *0L6823-B WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 60 Hz*

60 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: B

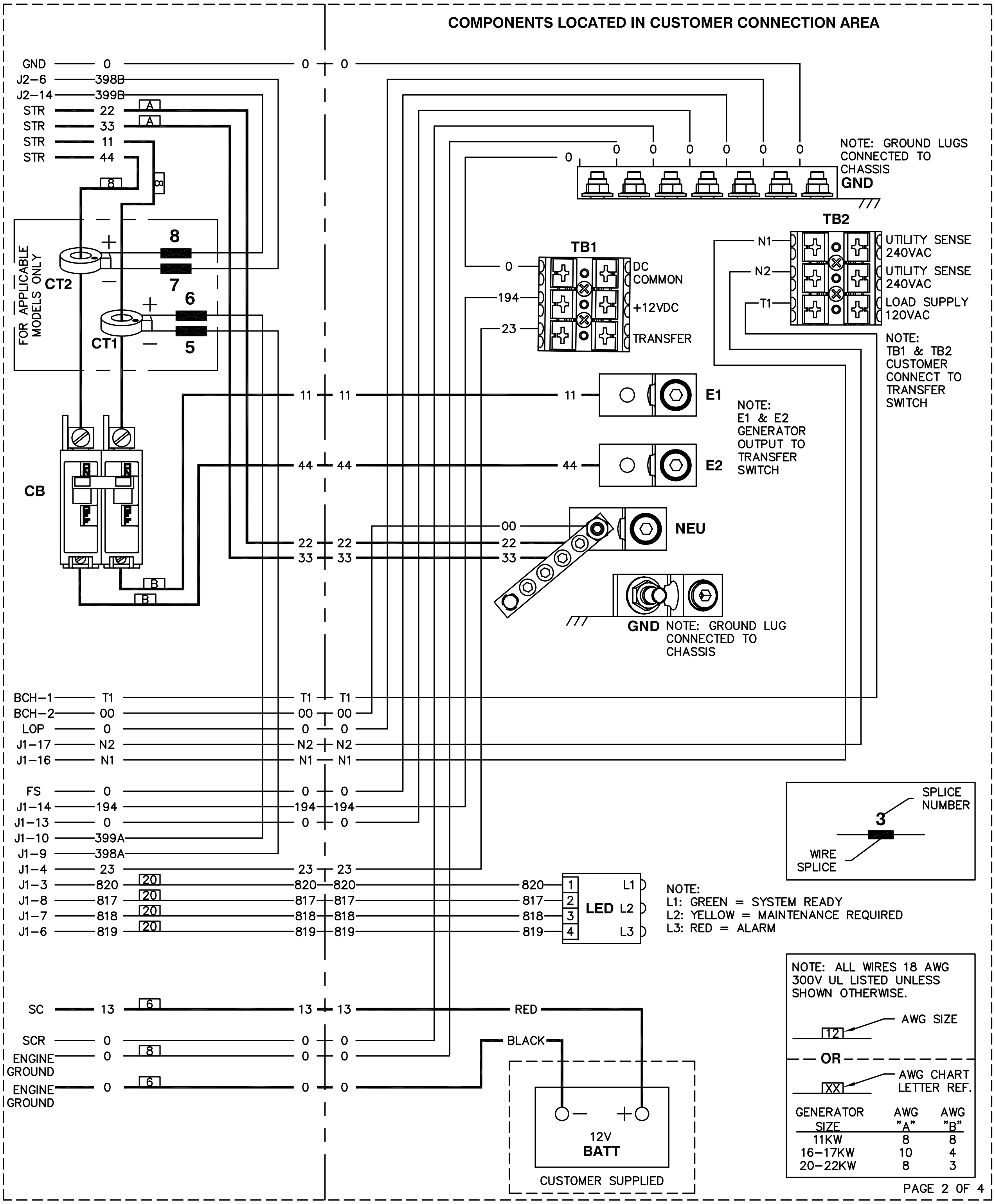
AIR COOLED HSB 60HZ

DATE: 03/15/17

PAGE 1 OF 4

DRAWING #: 0L6823

GROUP WD



WIRING - DIAGRAM

REVISION: B

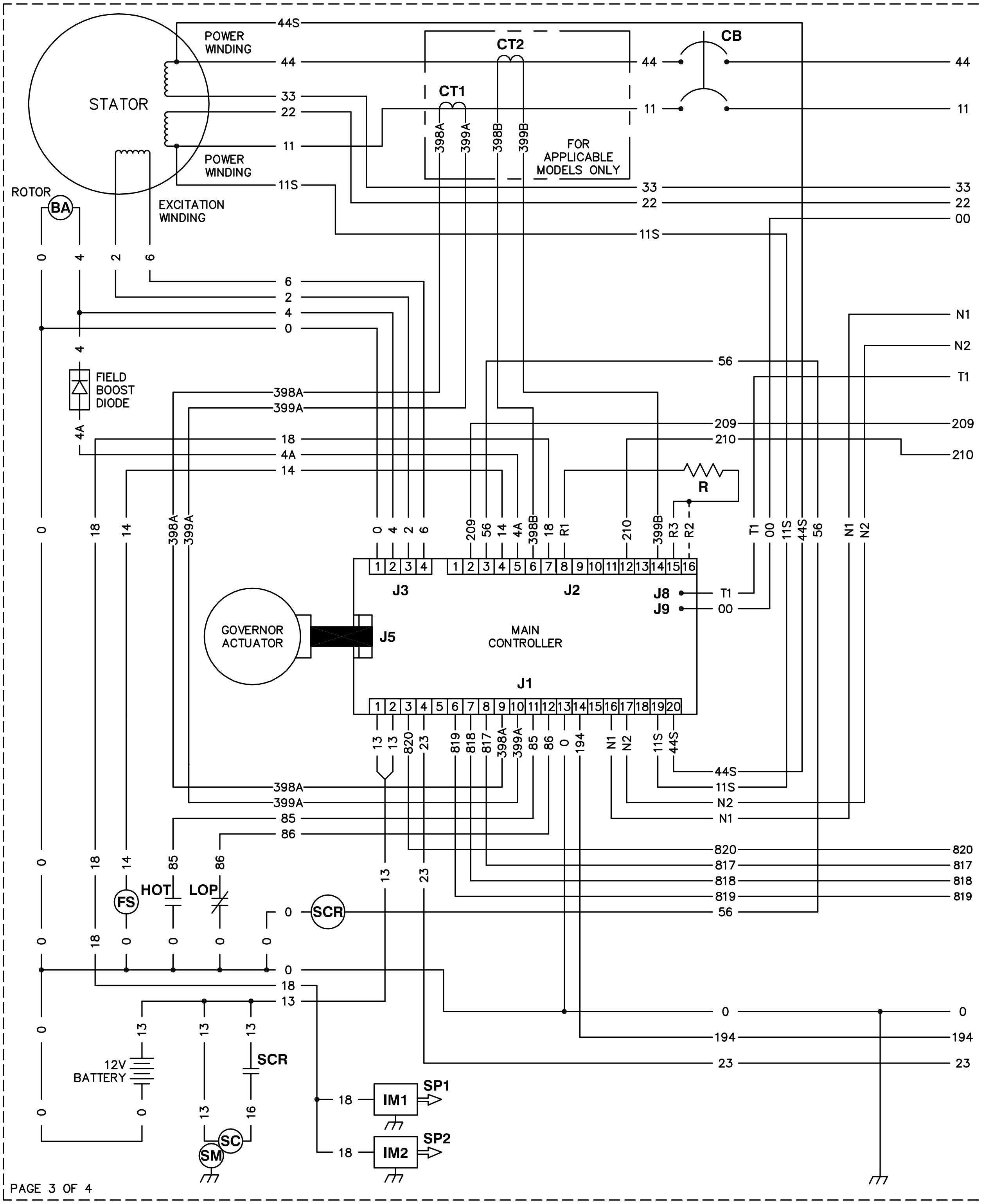
AIR COOLED HSB 60HZ

DATE: 03/15/17

PAGE 2 OF 4

DRAWING #: 0L6823

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

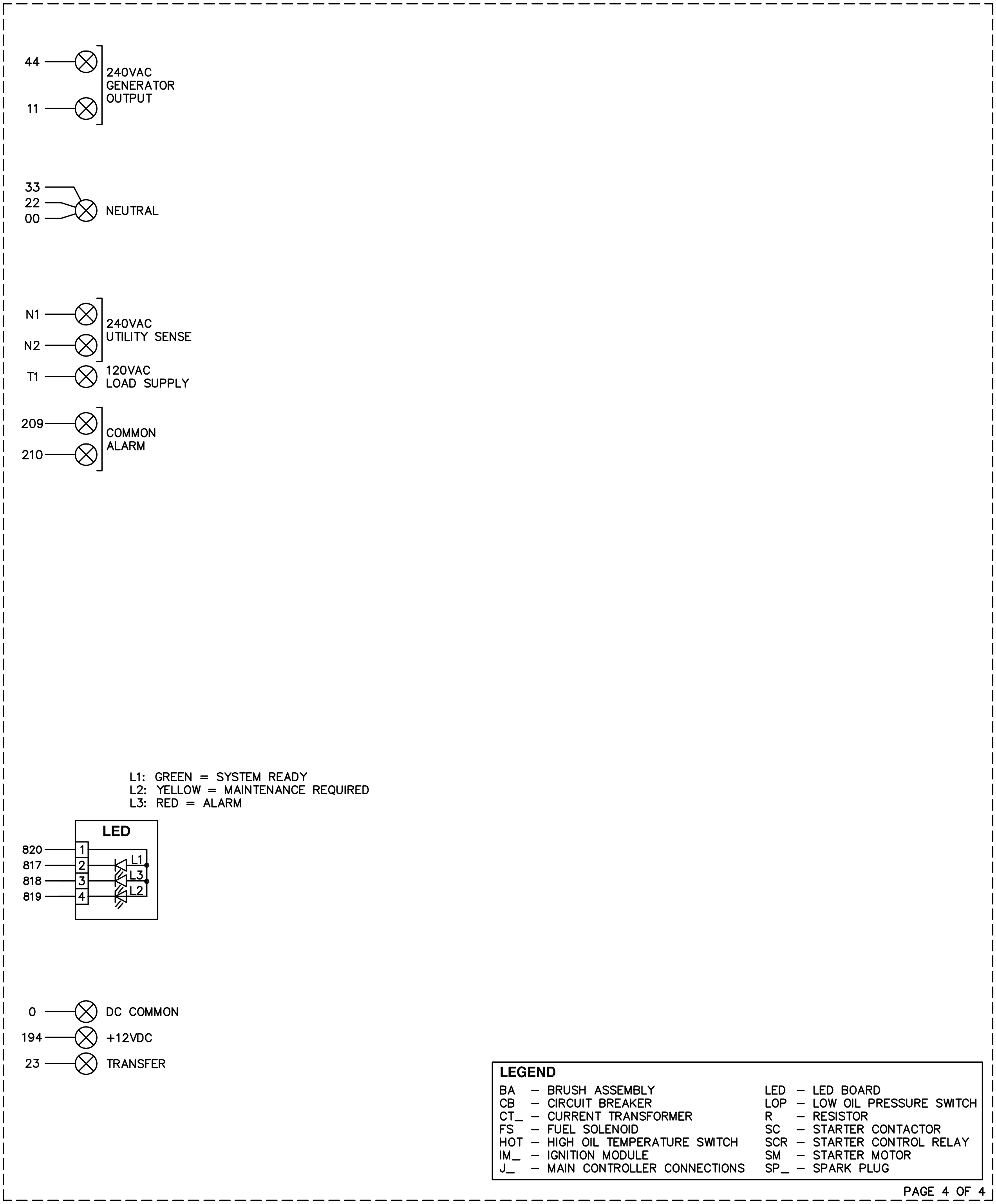
AIR COOLED HSB 60HZ

DATE: 03/15/17

PAGE 3 OF 4

DRAWING #: 0L6823

GROUP WD



LEGEND

BA	– BRUSH ASSEMBLY	LED	– LED BOARD
CB	– CIRCUIT BREAKER	LOP	– LOW OIL PRESSURE SWITCH
CT_	– CURRENT TRANSFORMER	R	– RESISTOR
FS	– FUEL SOLENOID	SC	– STARTER CONTACTOR
HOT	– HIGH OIL TEMPERATURE SWITCH	SCR	– STARTER CONTROL RELAY
IM_	– IGNITION MODULE	SM	– STARTER MOTOR
J_	– MAIN CONTROLLER CONNECTIONS	SP_	– SPARK PLUG

SCHEMATIC - DIAGRAM

REVISION: B
AIR COOLED HSB 60HZ

DATE: 03/15/17
PAGE 4 OF 4
DRAWING #: 0L6823

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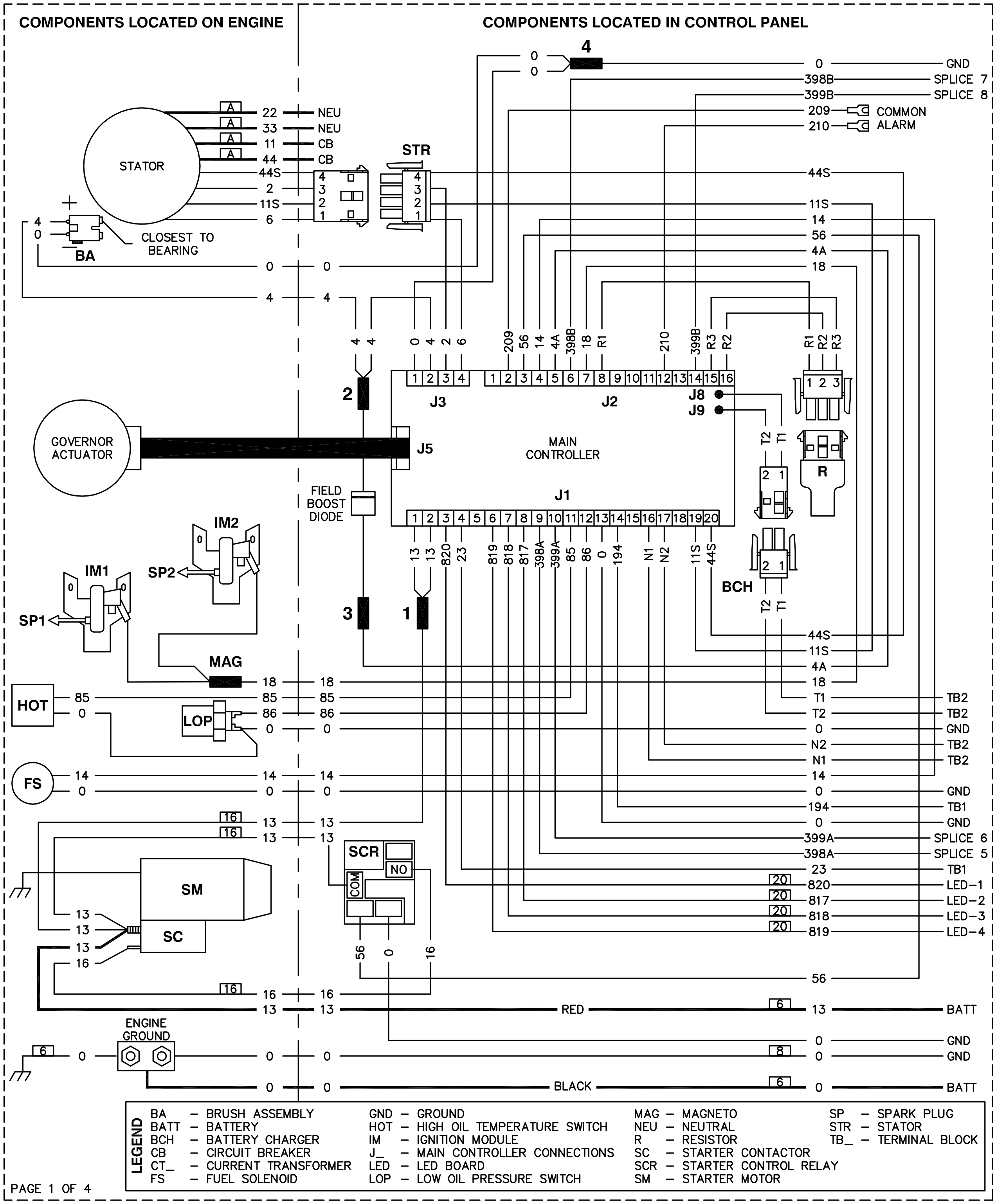
Section 5.8 *0L6824-B WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 50 Hz*

50 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: B

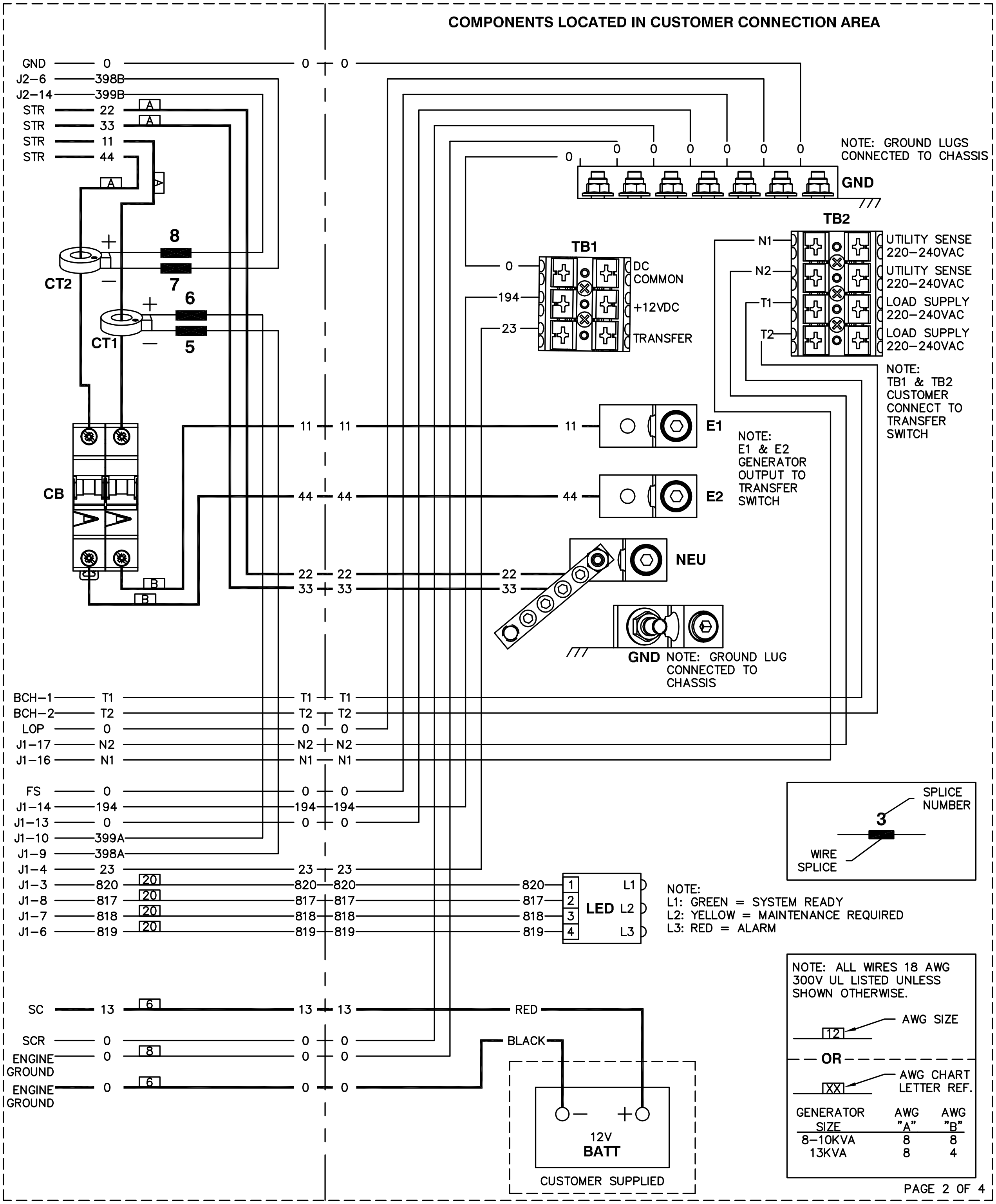
AIR COOLED HSB 50HZ

DATE: 03/08/17

PAGE 1 OF 4

DRAWING #: 0L6824

GROUP WD



WIRING - DIAGRAM

REVISION: B

AIR COOLED HSB 50HZ

DATE: 03/08/17

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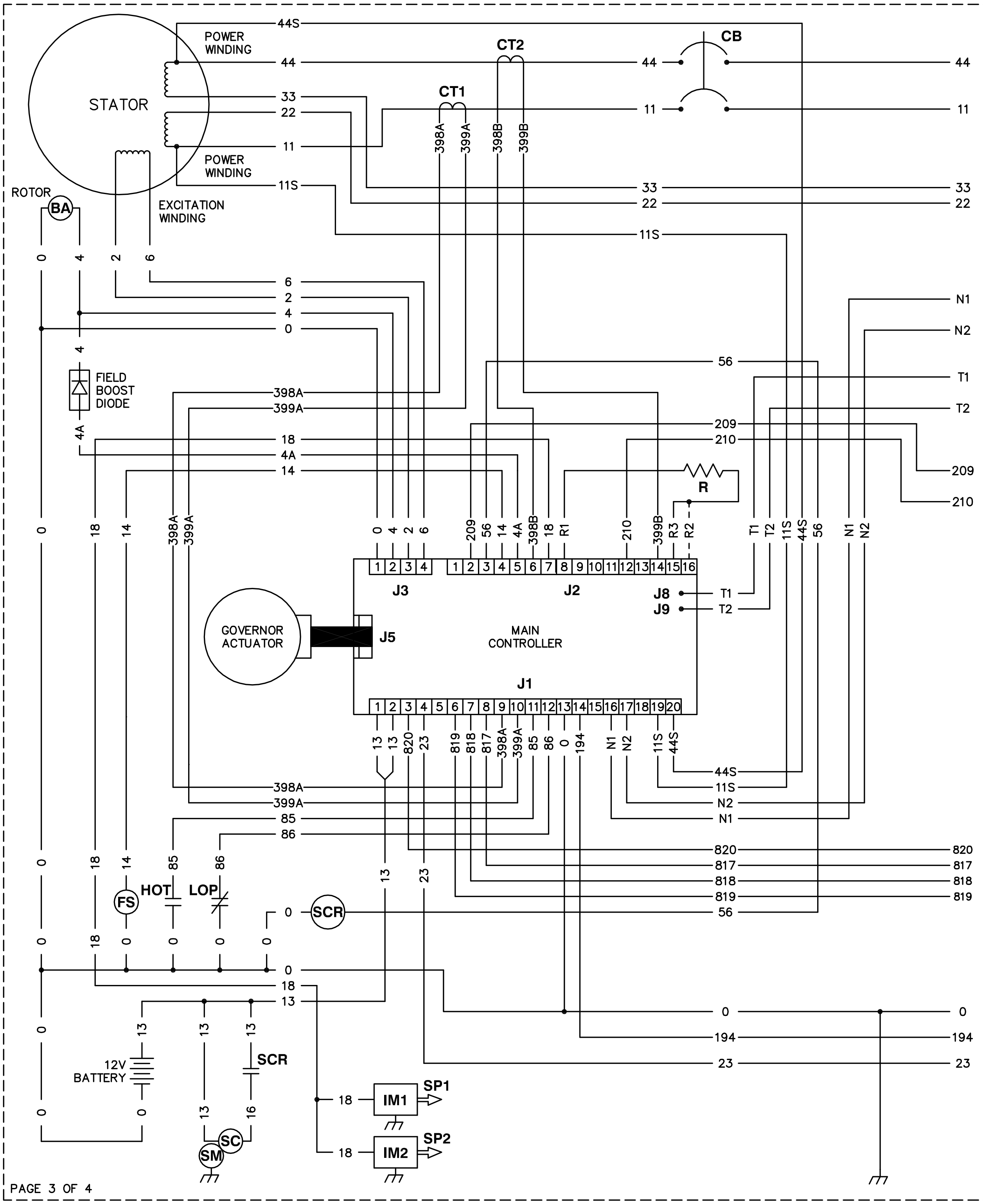
DRAWING #: 0L6824

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

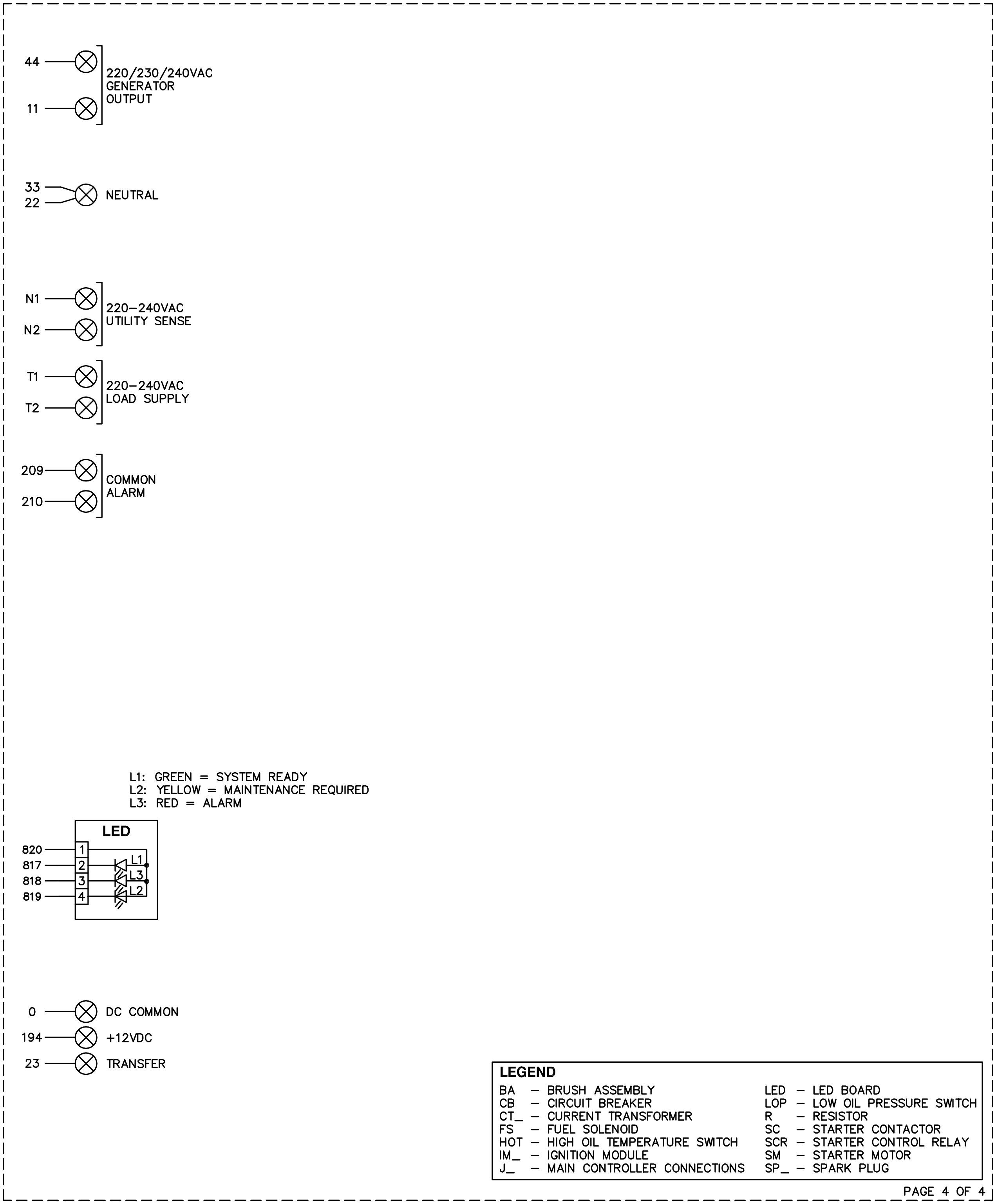
AIR COOLED HSB 50HZ

DATE: 03/08/17

PAGE 3 OF 4

DRAWING #: 0L6824

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AIR COOLED HSB 50HZ

DATE: 03/08/17

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DRAWING #: 0L6824

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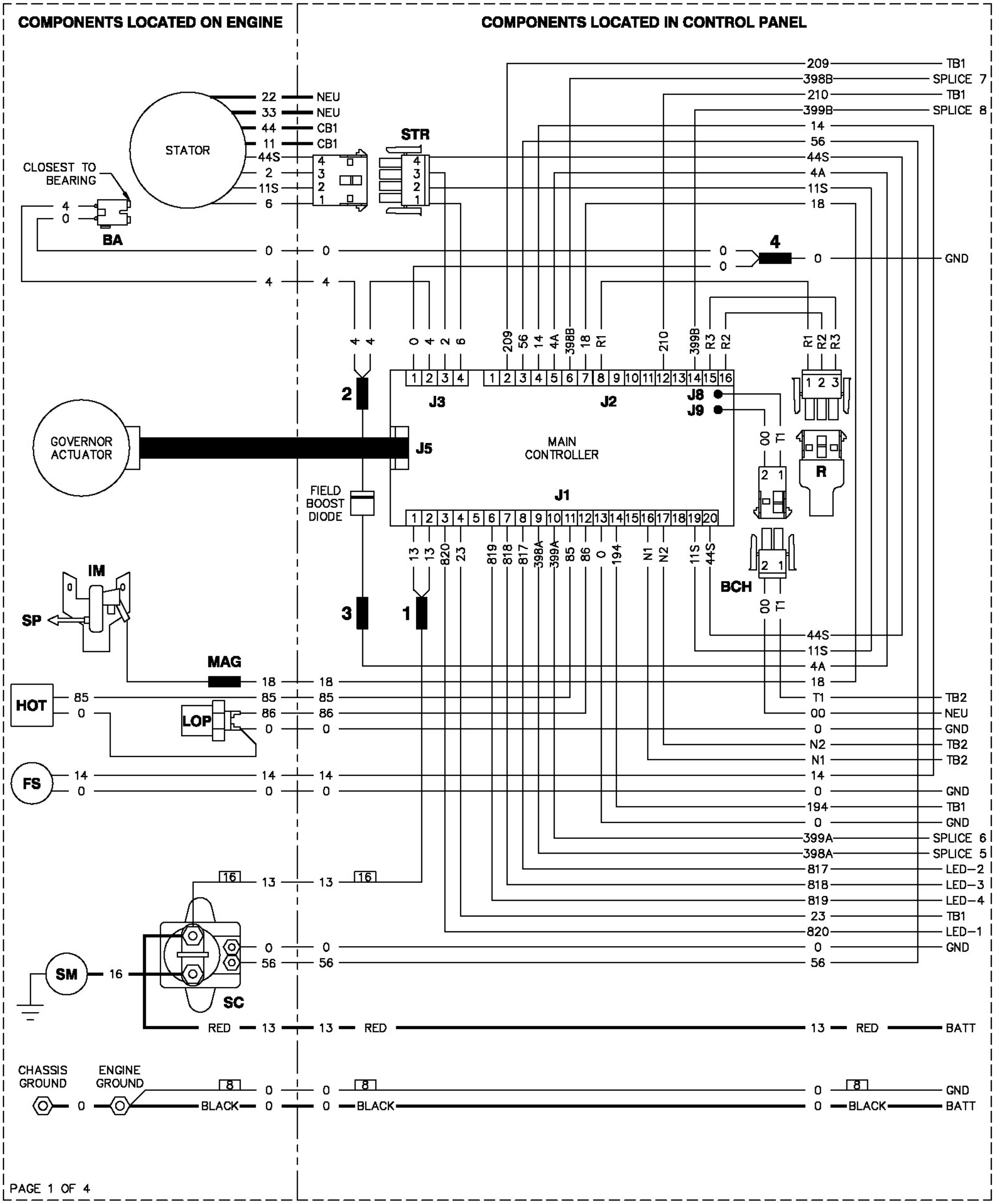
Section 5.9 *0K2945-E WD/SD Air-cooled 2017 Evolution 1.0 and newer (not Evolution 2.0) 8 kW 60 Hz*

8 kW 60 Hz

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP G

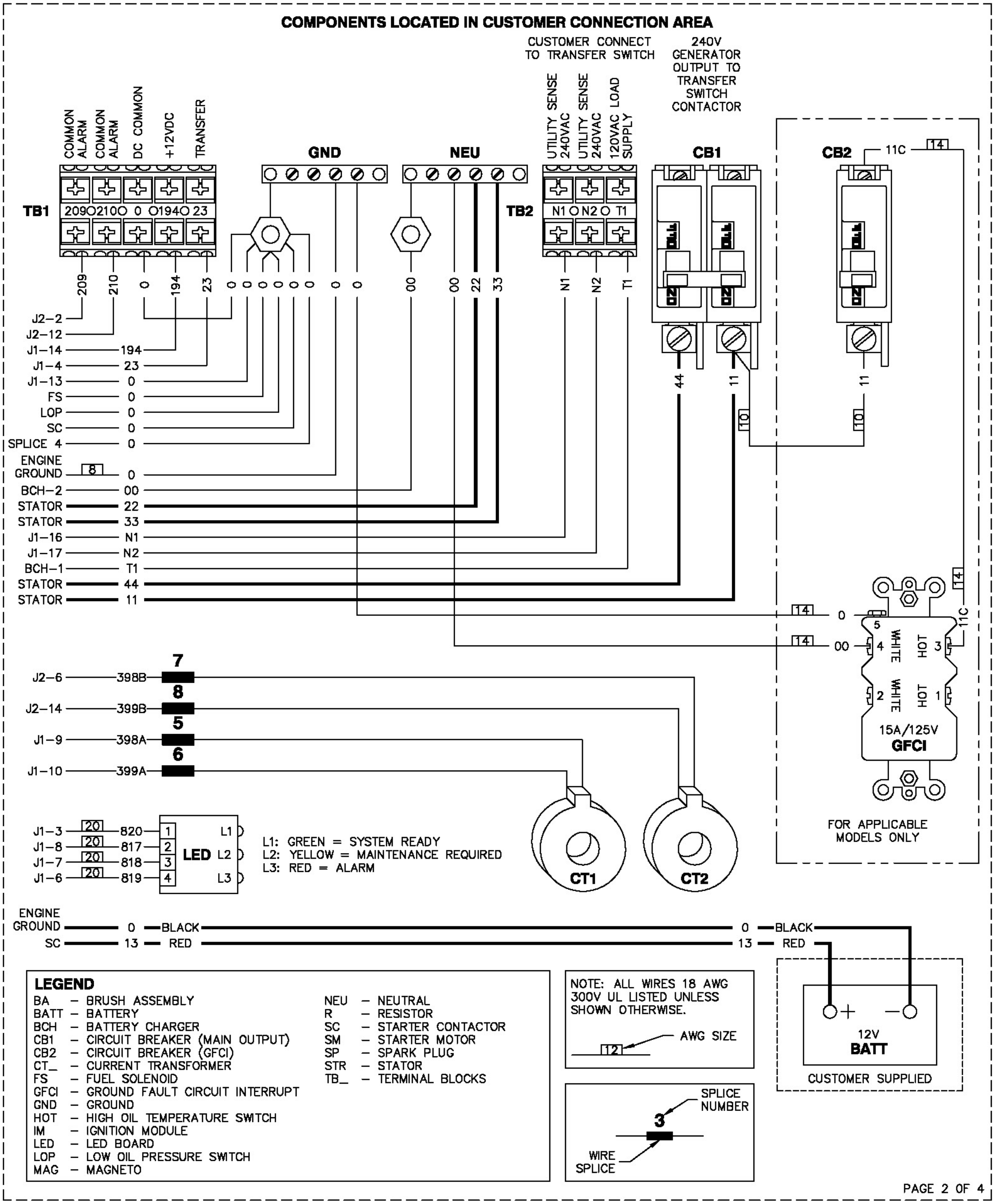


WIRING - DIAGRAM

REVISION: J-7579-E | 8KW 2013 AIR COOLED HSB

DATE: 1/21/14 | PAGE 1 OF 4 | DRAWING #: 0K2945

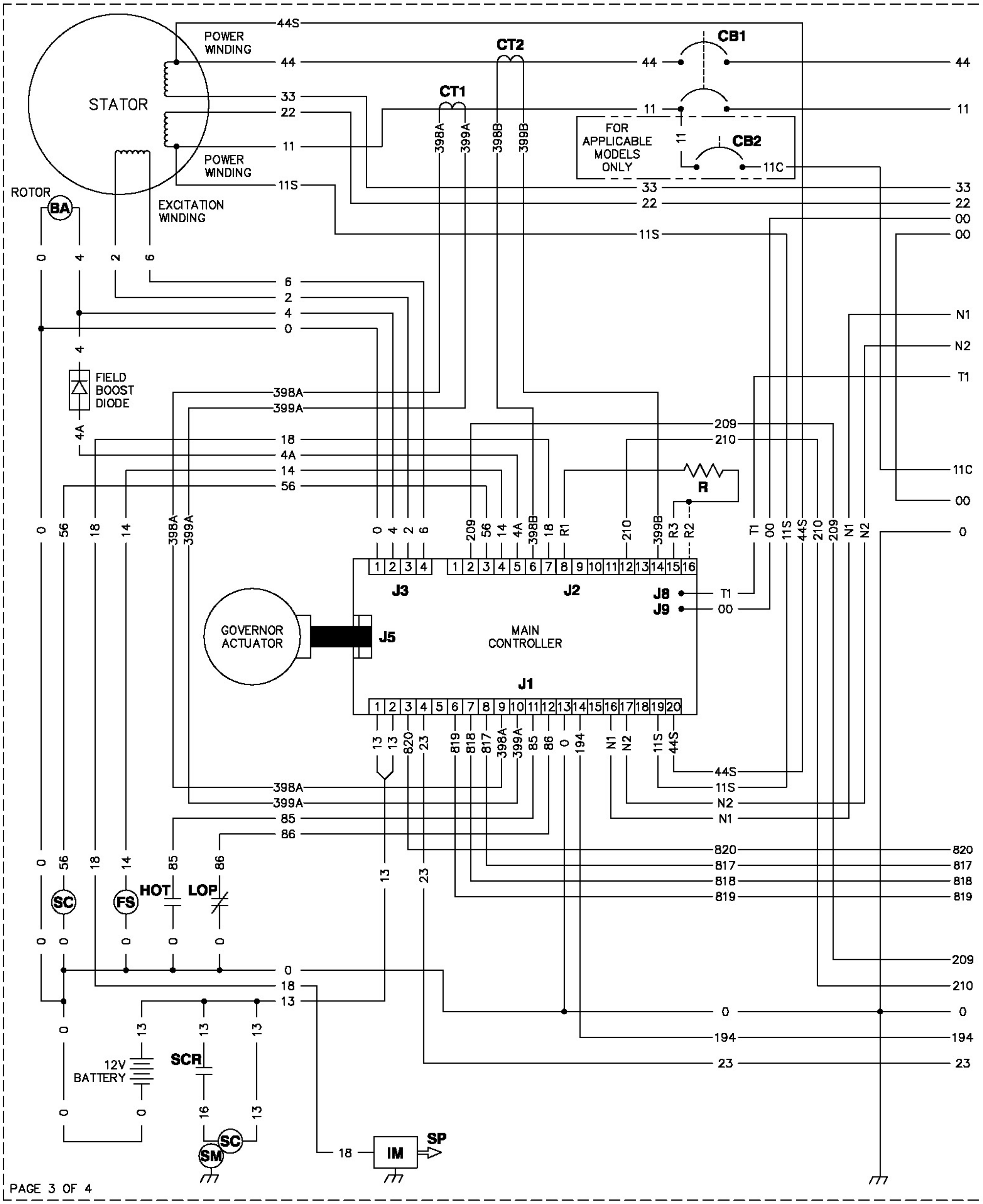
GROUP G



WIRING - DIAGRAM
8KW 2013 AIR COOLED HSB

REVISION: J-7579-E
DATE: 1/21/14
PAGE 2 OF 4
DRAWING #: 0K2945

GROUP G



SCHEMATIC - DIAGRAM

REVISION: J-7579-E

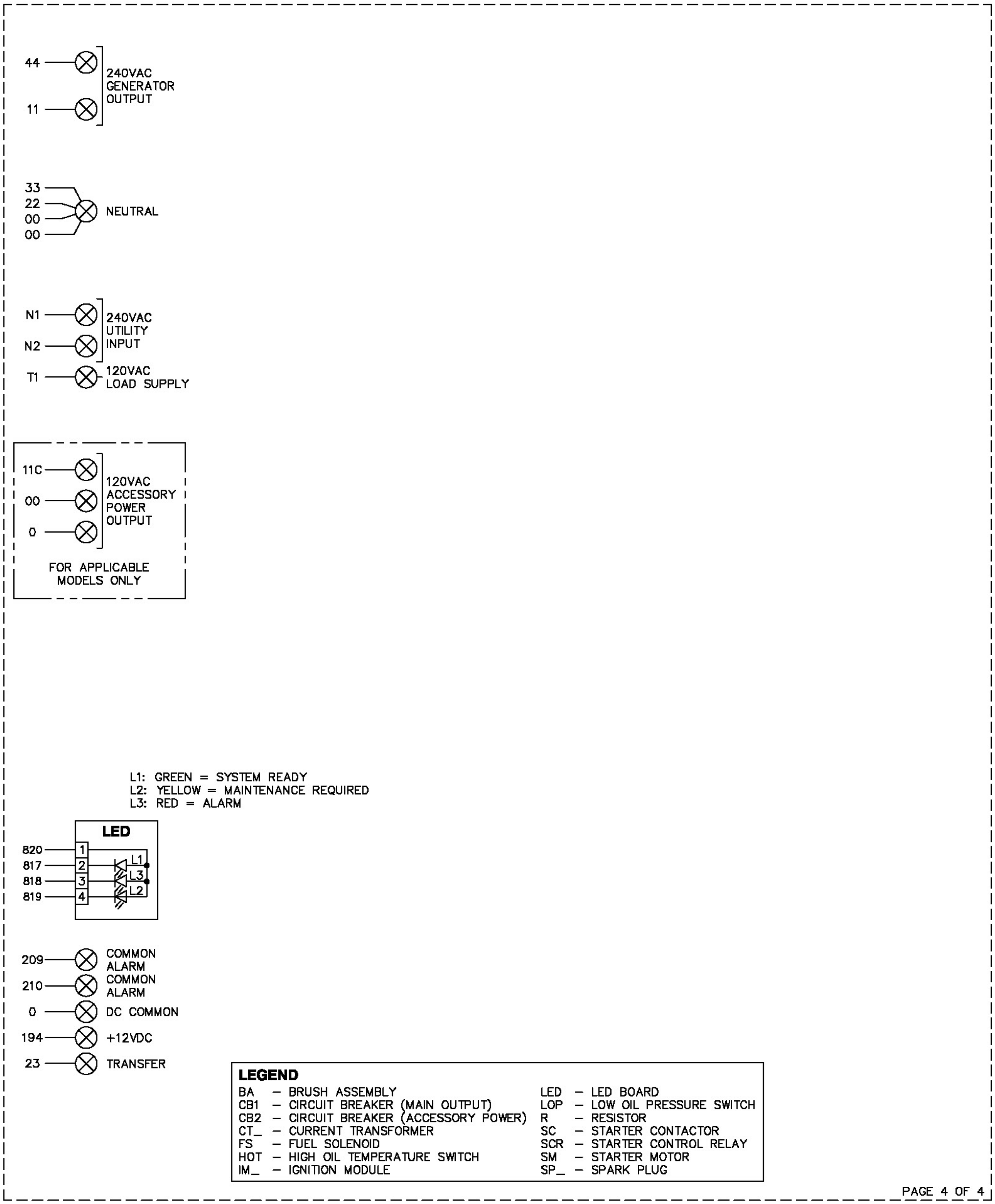
8KW 2013 AIR COOLED HSB

DATE: 1/21/14

PAGE 3 OF 4

DRAWING #: 0K2945

GROUP G



SCHEMATIC - DIAGRAM

REVISION: J-7579-E | **8KW 2013 AIR COOLED HSB**

DATE: 1/21/14 | **PAGE 4 OF 4** | **DRAWING #: 0K2945**

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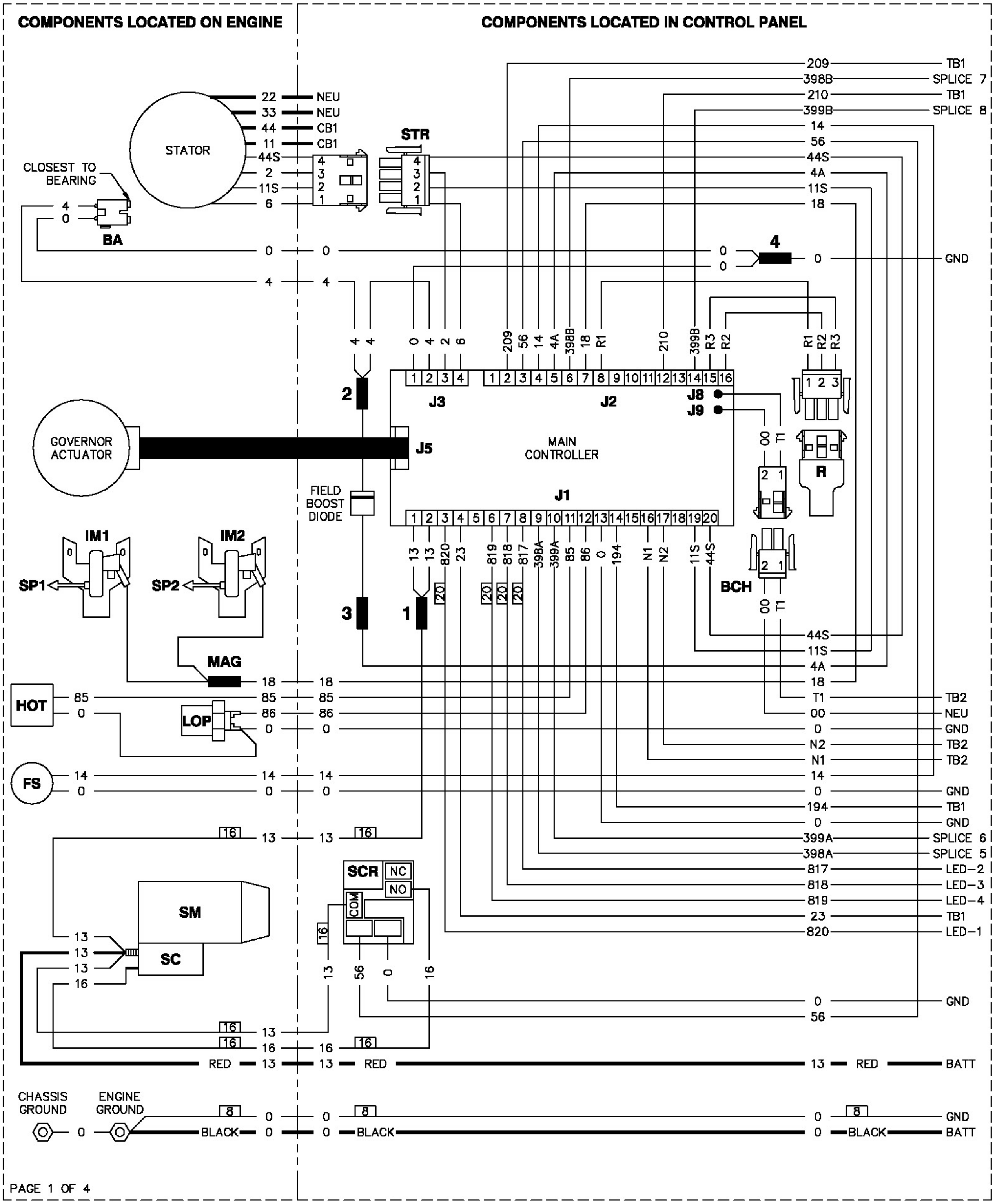
Section 5.10 *0J9961-D WD/SD Air-cooled Pre 2016 Evolution 1.0 (not Evolution 2.0) 11-24 kW 60 Hz*

11-24 kW 60 Hz with Stator Terminal Block

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP G



WIRING - DIAGRAM

REVISION: J-5714-D

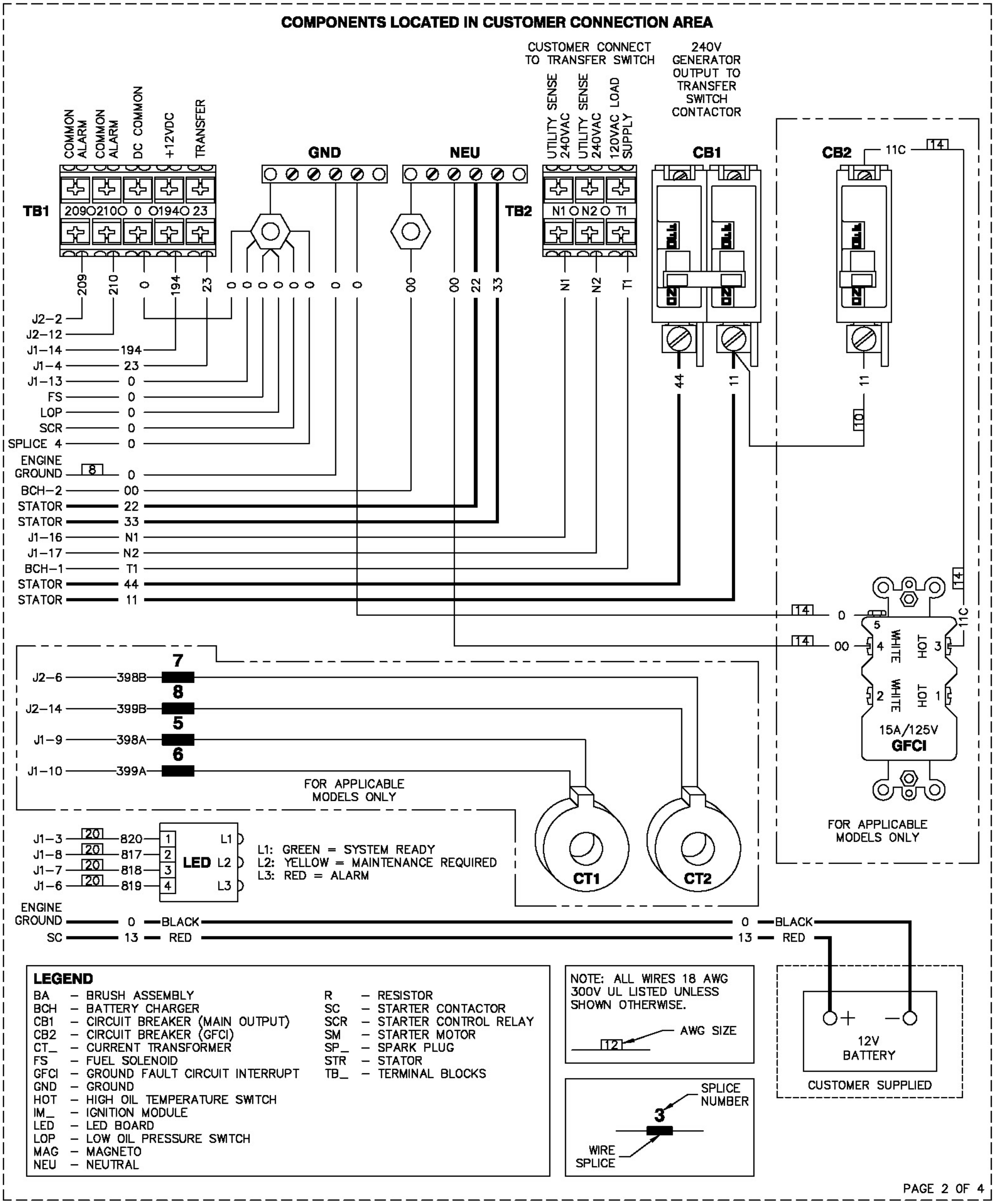
2013 AIR COOLED HSB 60HZ

DATE: 6/19/13

PAGE 1 OF 4

DRAWING #: 0J9961

GROUP G



WIRING - DIAGRAM

2013 AIR COOLED HSB 60HZ

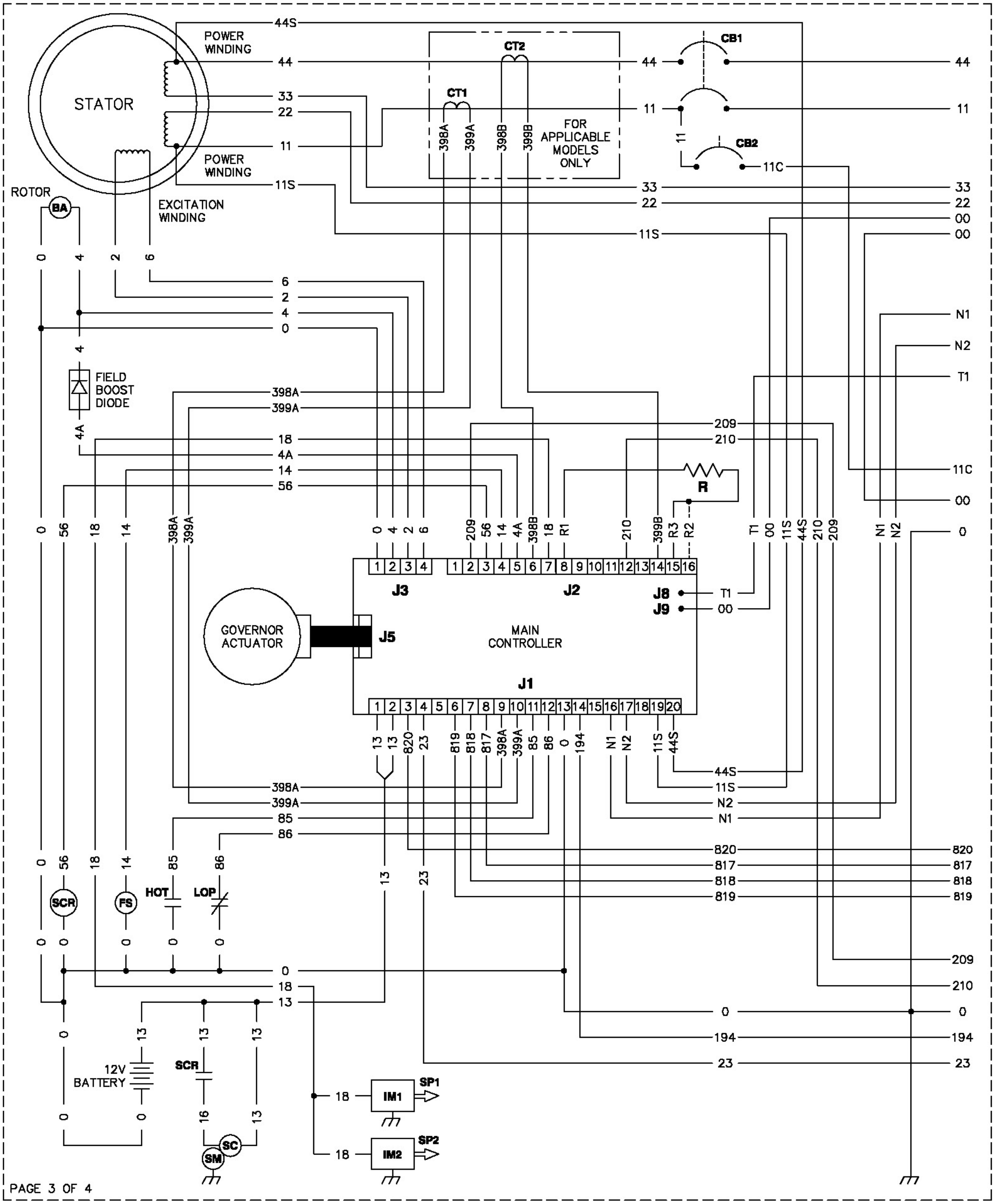
REVISION: J-5714-D

DATE: 6/19/13

PAGE 2 OF 4

DRAWING #: 0J9961

GROUP G



SCHEMATIC - DIAGRAM

2013 AIR COOLED HSB 60HZ

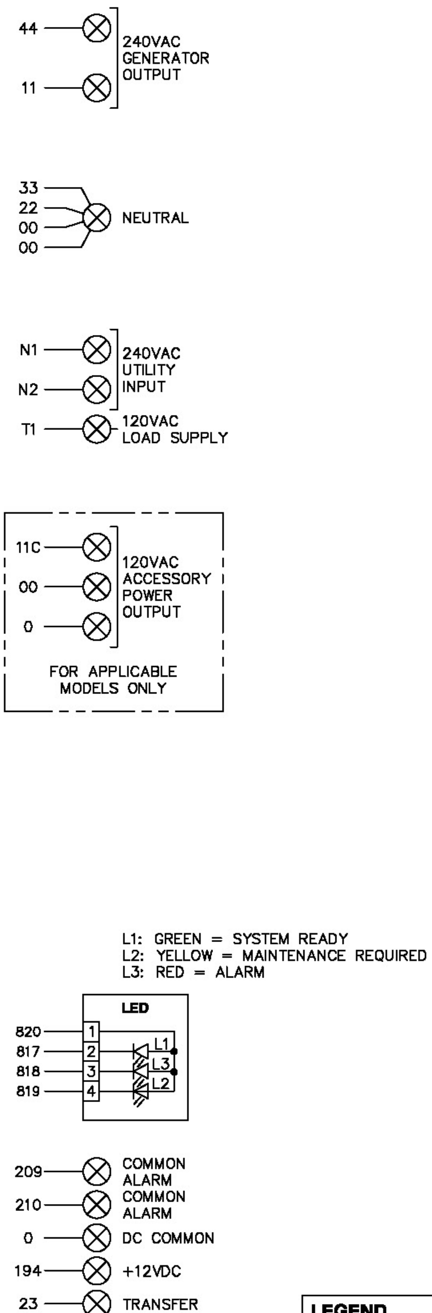
REVISION: J-5714-D

DATE: 6/19/13

PAGE 3 OF 4

DRAWING #: 0J9961

GROUP G



LEGEND

BA – BRUSH ASSEMBLY	LED – LED BOARD
CB1 – CIRCUIT BREAKER (MAIN OUTPUT)	LOP – LOW OIL PRESSURE SWITCH
CB2 – CIRCUIT BREAKER (GFCI)	R – RESISTOR
CT_ – CURRENT TRANSFORMER	SC – STARTER CONTACTOR
FS – FUEL SOLENOID	SCR – STARTER CONTROL RELAY
HOT – HIGH OIL TEMPERATURE SWITCH	SM – STARTER MOTOR
IM_ – IGNITION MODULE	SP_ – SPARK PLUG

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SCHEMATIC - DIAGRAM

2013 AIR COOLED HSB 60HZ

REVISION: J-5714-D

DATE: 6/19/13

PAGE 4 OF 4

DRAWING #: 0J9961

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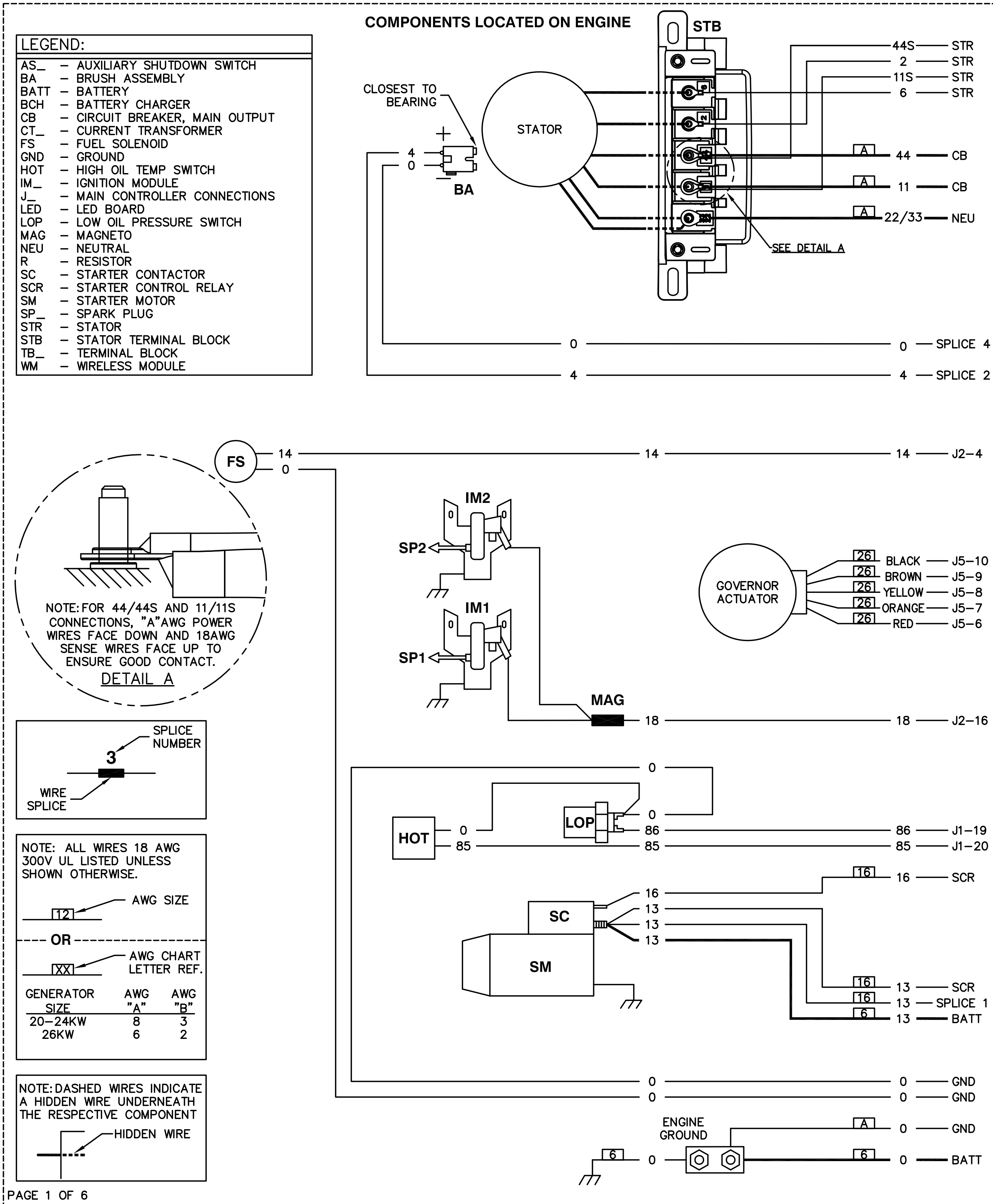
Section 5.11 *A0000189156-C WD/SD Air-cooled Evolution 2.0 w816-999cc Engine kW 60 Hz*

816–999cc Engine kW 60 Hz with Stator Terminal Block

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

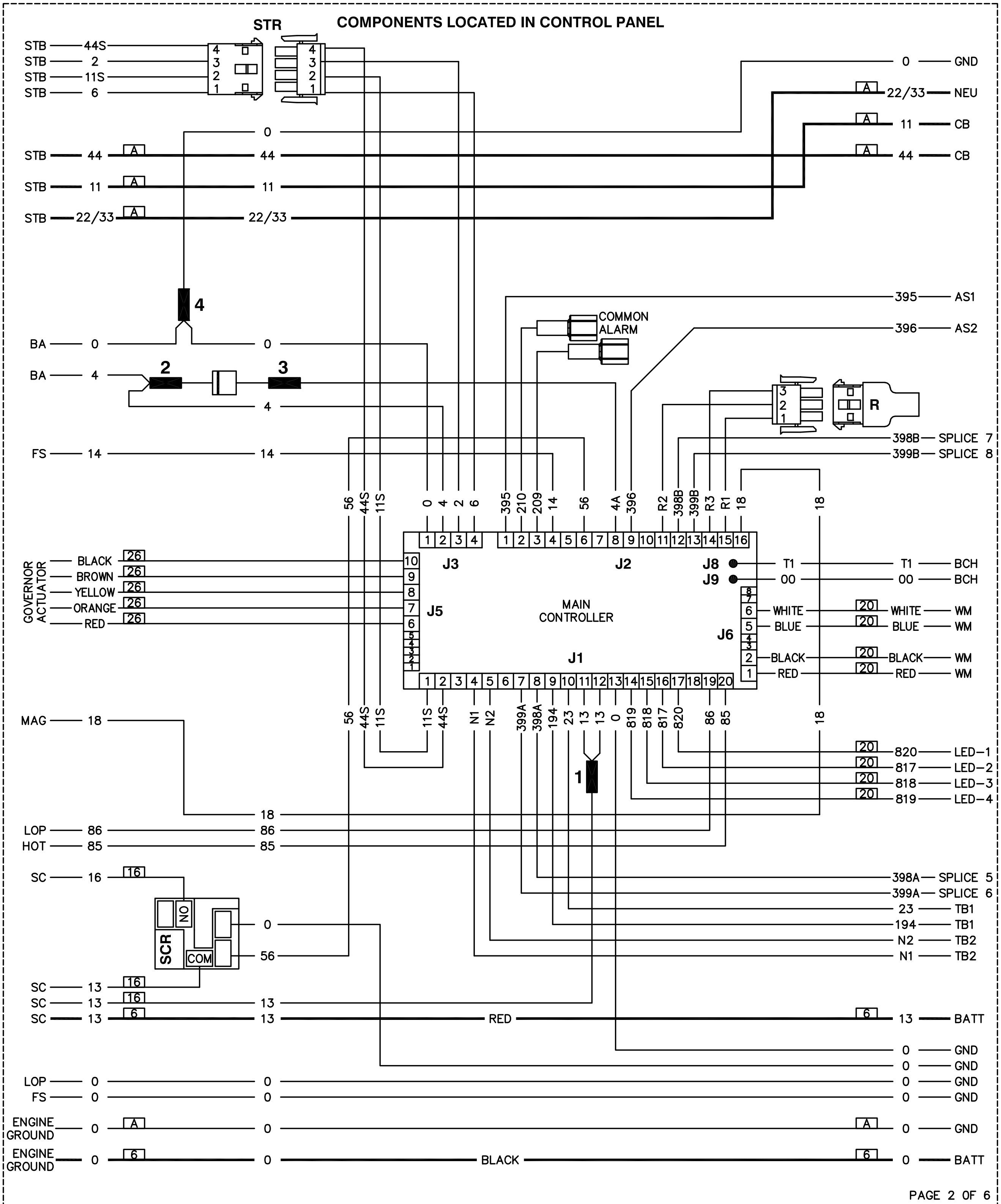
GROUP WD



WIRING - DIAGRAM
AC HSB EVO2 60HZ 1PH W/ STB

REVISION: C
DATE: 2/27/24
PAGE 1 OF 6
DRAWING #: A0000189156

GROUP WD



WIRING - DIAGRAM

REVISION: C

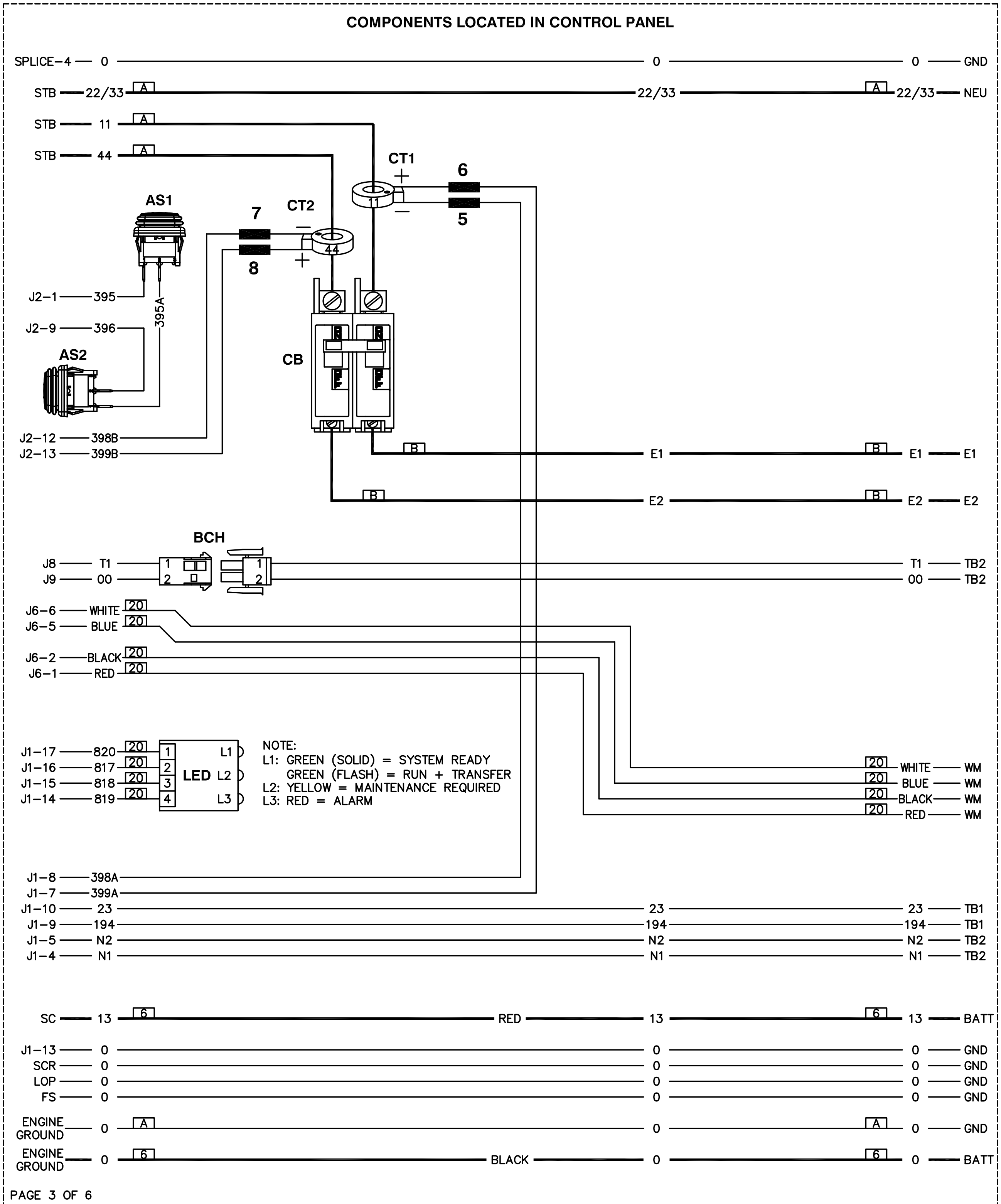
AC HSB EVO2 60HZ 1PH W/ STB

DATE: 2/27/24

PAGE 2 OF 6

DRAWING #: A0000189156

GROUP WD



WIRING - DIAGRAM

REVISION: C

AC HSB EVO2 60HZ 1PH W/ STB

DATE: 2/27/24

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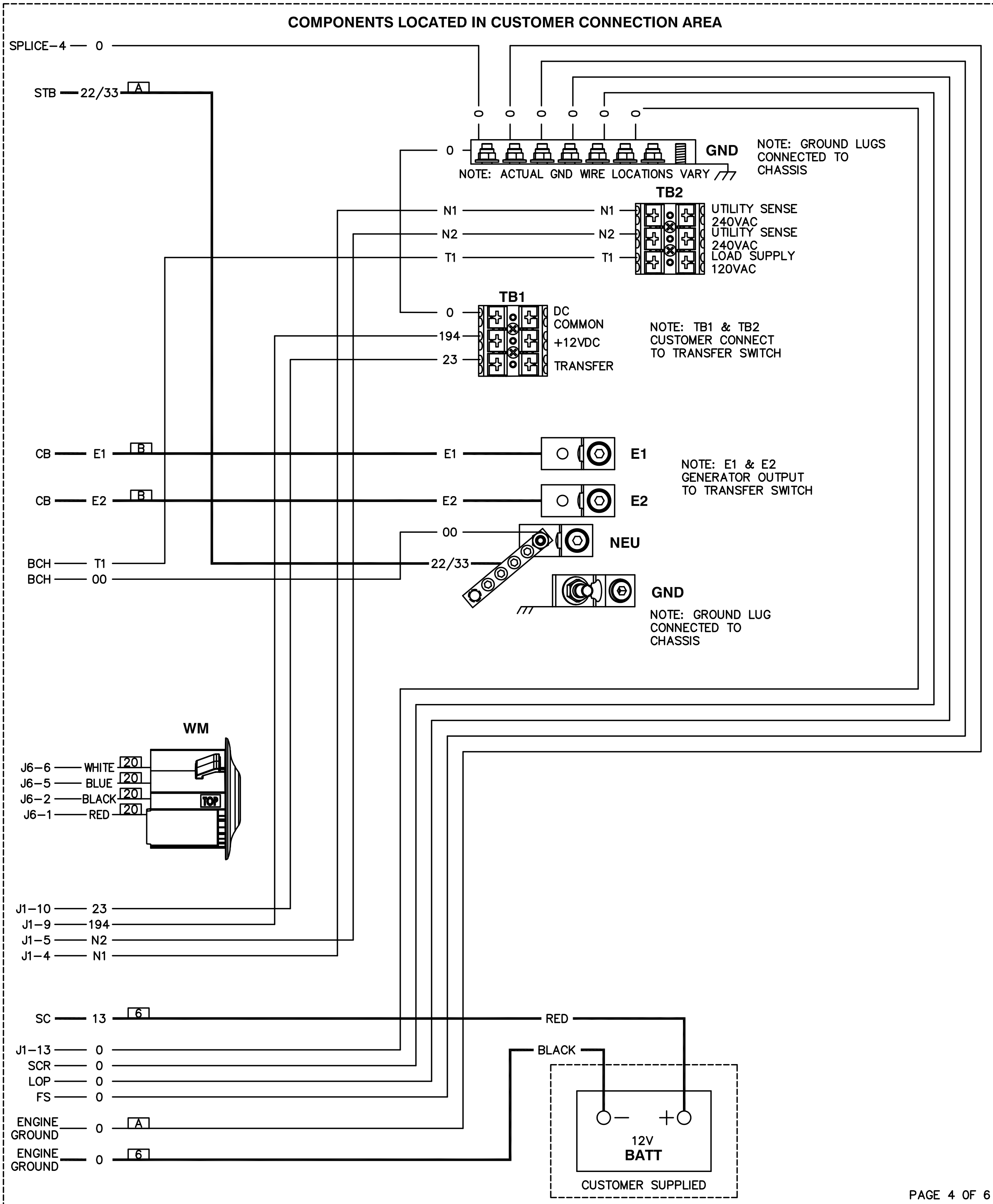
DRAWING #: A0000189156

GROUP WD



WIRING - DIAGRAM

REVISION: C

AC HSB EVO2 60HZ 1PH W/ STB

DATE: 2/27/24

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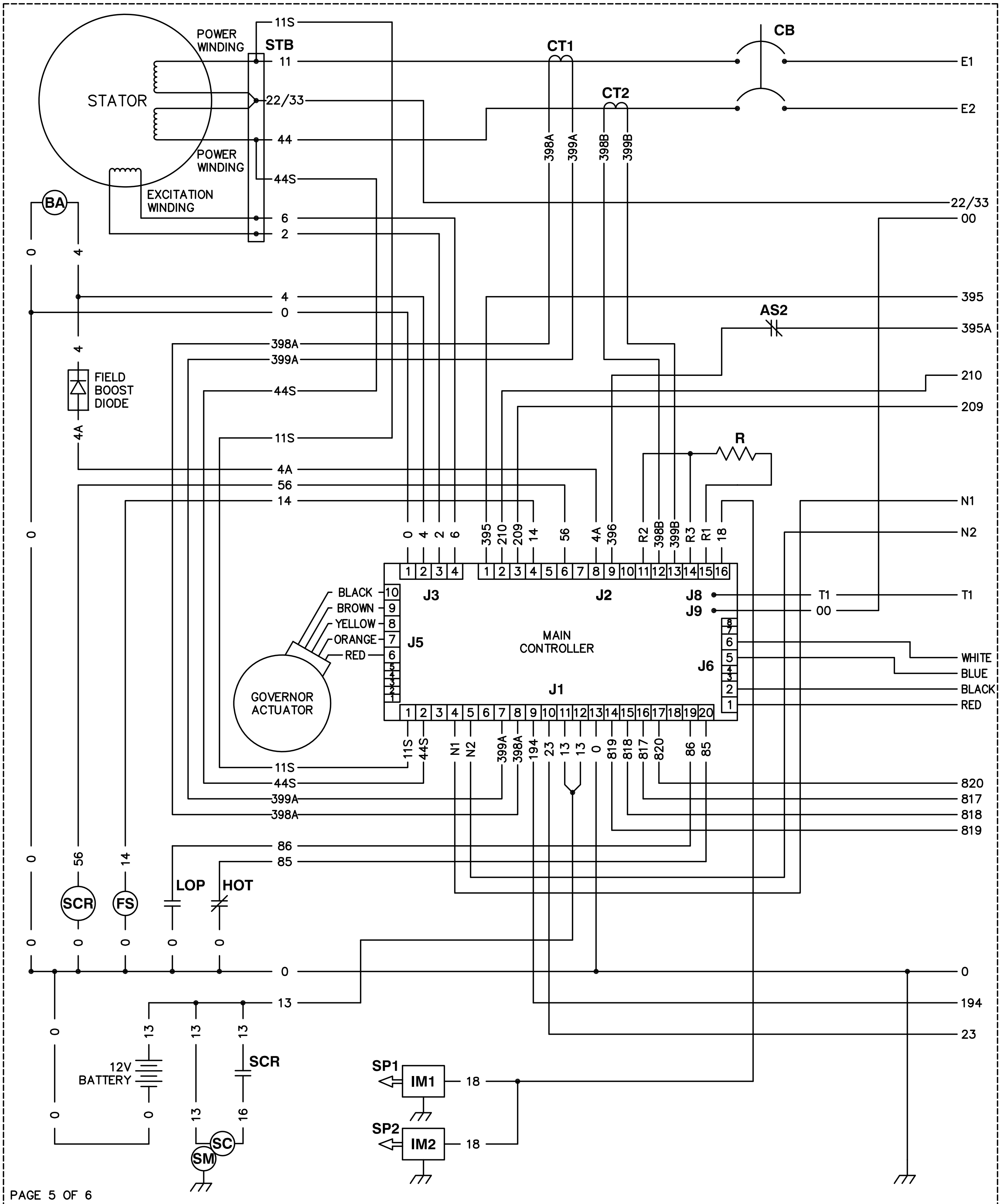
DRAWING #: A0000189156

GROUP WD



SCHEMATIC - DIAGRAM
AC HSB EVO2 60HZ 1PH W/ STB
DRAWING #: A0000189156

REVISION: C
DATE: 2/27/24

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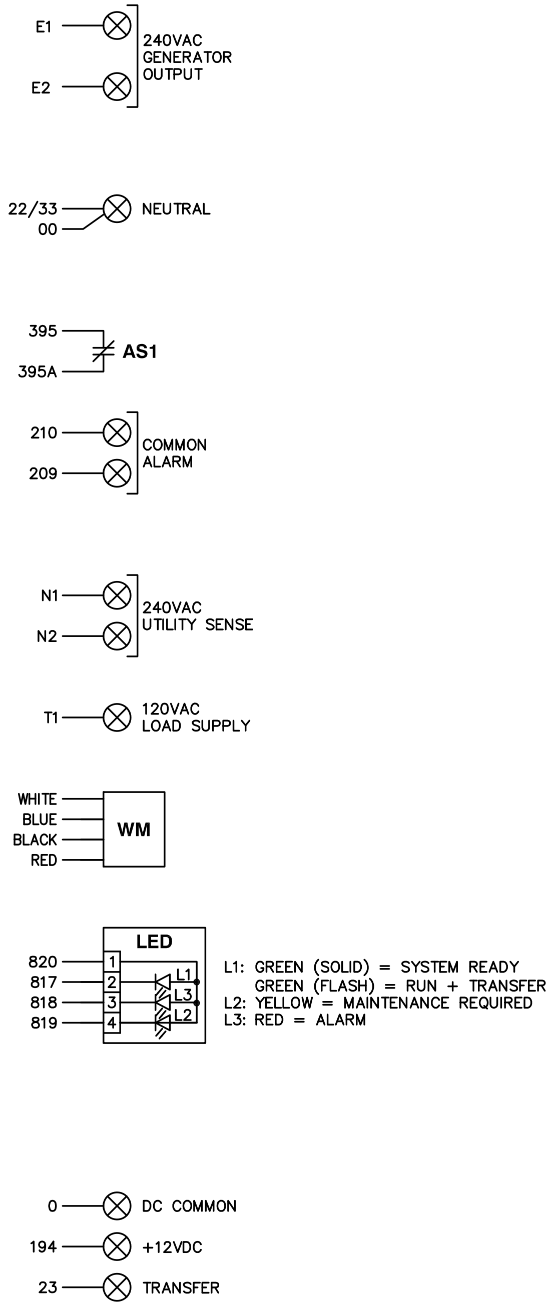
GROUP WD

LEGEND:	
AS_	– AUXILIARY SHUTDOWN SWITCH
BA	– BRUSH ASSEMBLY
CB	– CIRCUIT BREAKER, MAIN OUTPUT
CT_	– CURRENT TRANSFORMER
FS	– FUEL SOLENOID
HOT	– HIGH OIL TEMP SWITCH
IM_	– IGNITION MODULE
J_	– MAIN CONTROLLER CONNECTIONS
LED	– LED BOARD
LOP	– LOW OIL PRESSURE SWITCH
R	– RESISTOR
SC	– STARTER CONTACTOR
SCR	– STARTER CONTROL RELAY
SM	– STARTER MOTOR
SP_	– SPARK PLUG
STB	– STATOR TERMINAL BLOCK
WM	– WIRELESS MODULE



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SCHEMATIC - DIAGRAM

REVISION: C

AC HSB EVO2 60HZ 1PH W/ STB

DATE: 2/27/24

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DRAWING #: A0000189156

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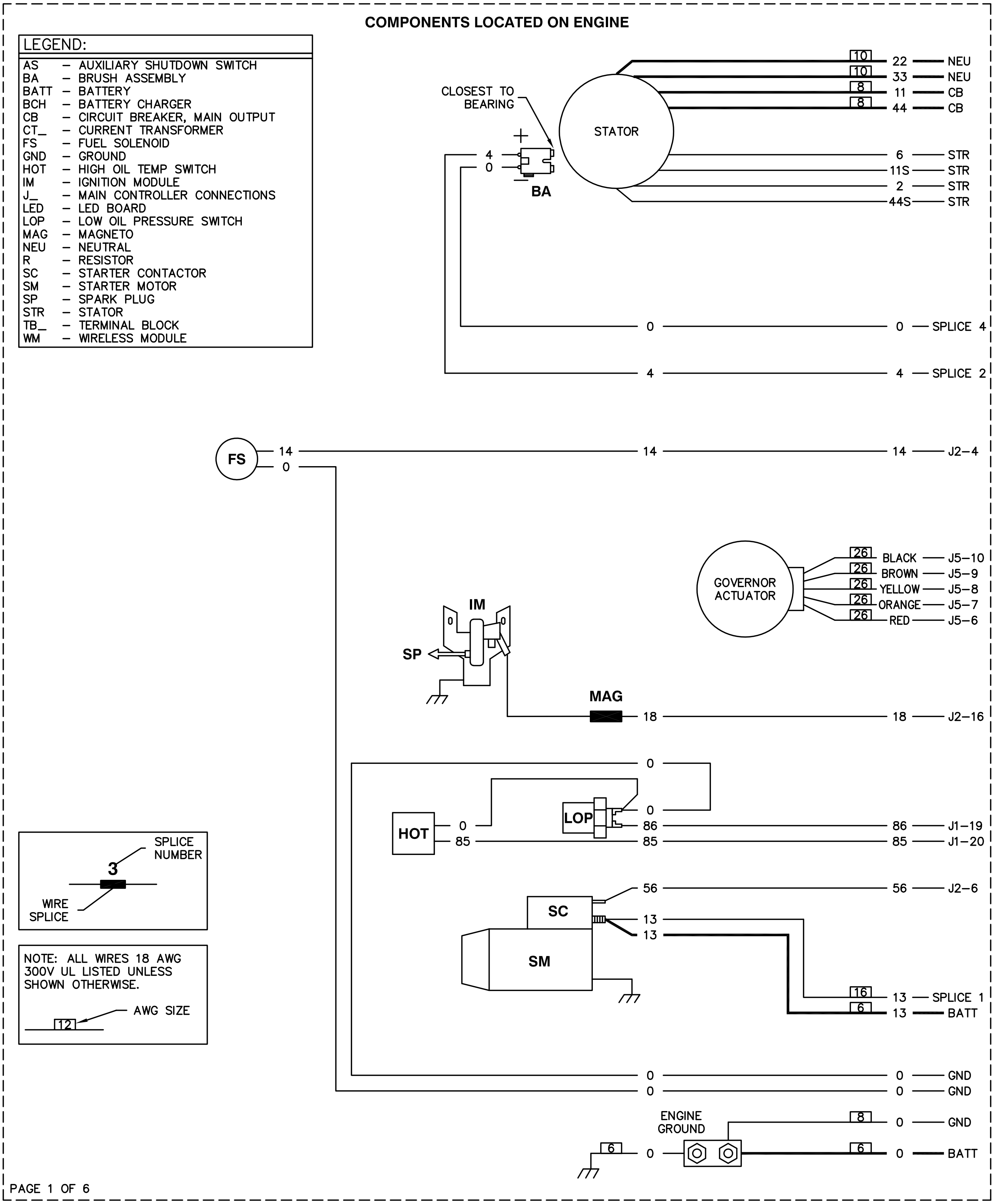
Section 5.12 *A0003415229-B WD/SD AC HSB EVO2 60HZ 426 NEC2023*

With Neutral Termination For Customer Connection

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 60HZ 426 NEC2023

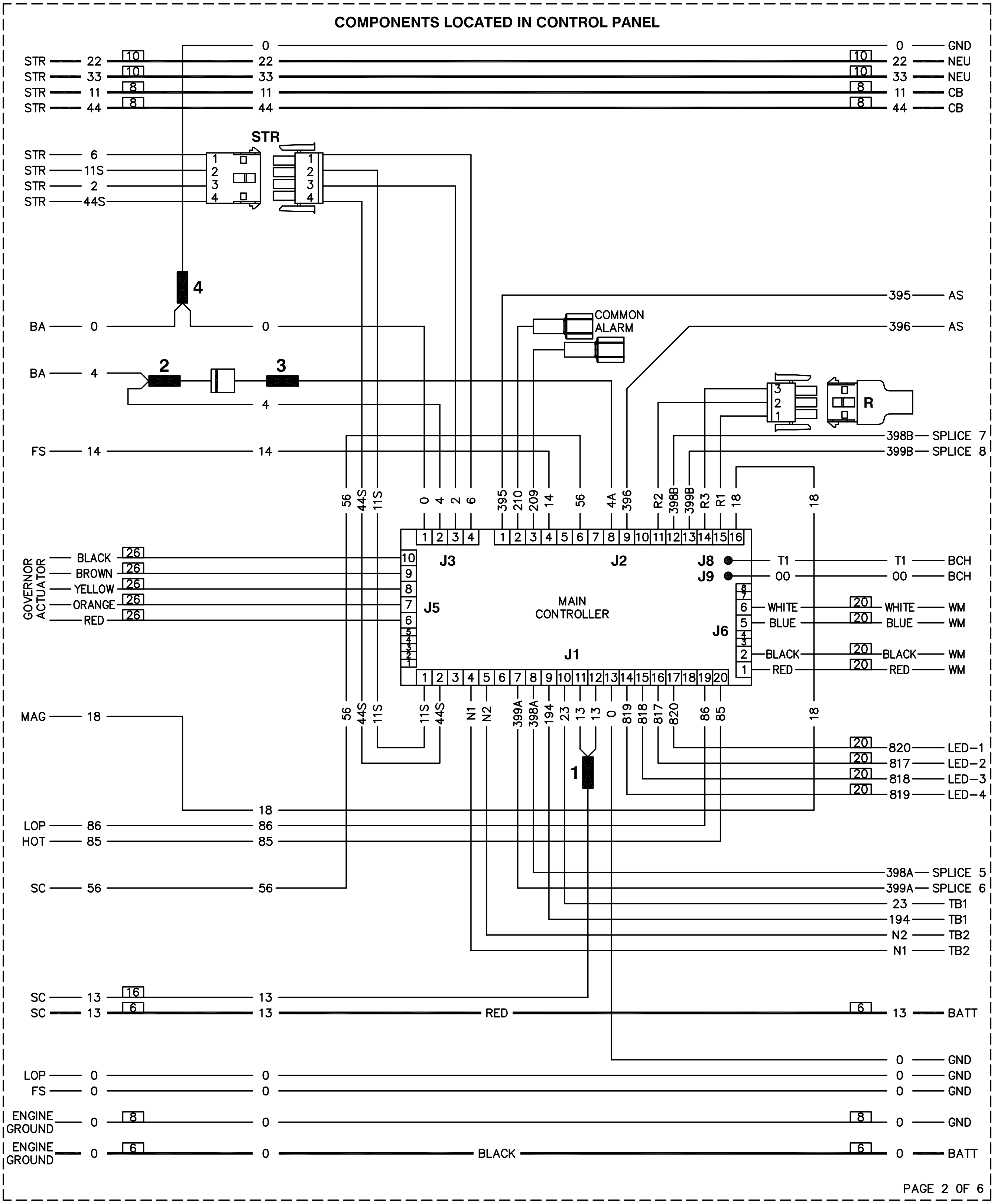
REVISION: B

DATE: 03/20/24

PAGE 1 OF 6

DRAWING #: A0003415229

GROUP WD



WIRING - DIAGRAM

REVISION: B

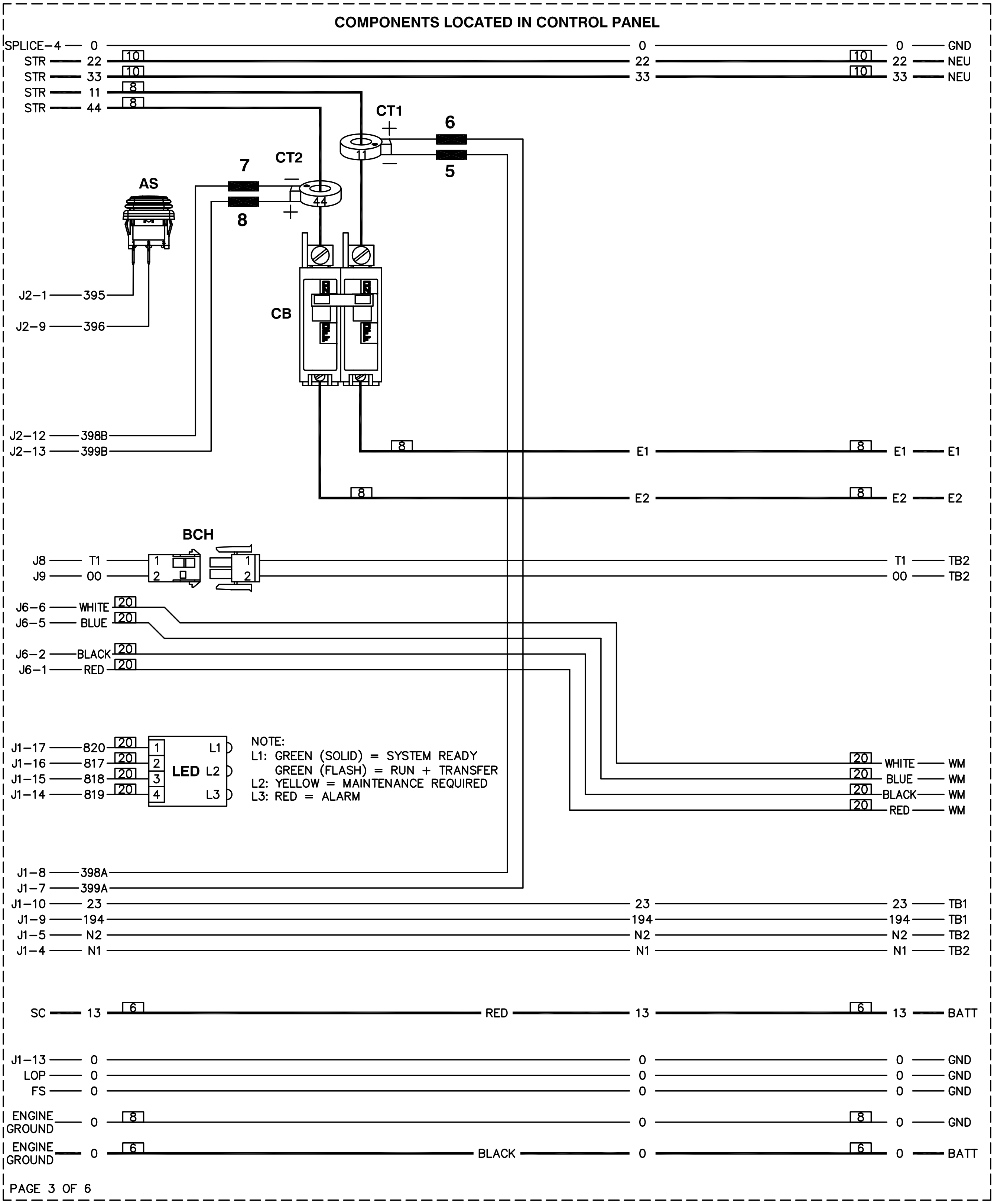
AC HSB EVO2 60HZ 426 NEC2023

DATE: 03/20/24

PAGE 2 OF 6

DRAWING #: A0003415229

GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 60HZ 426 NEC2023

REVISION: B

DATE: 03/20/24

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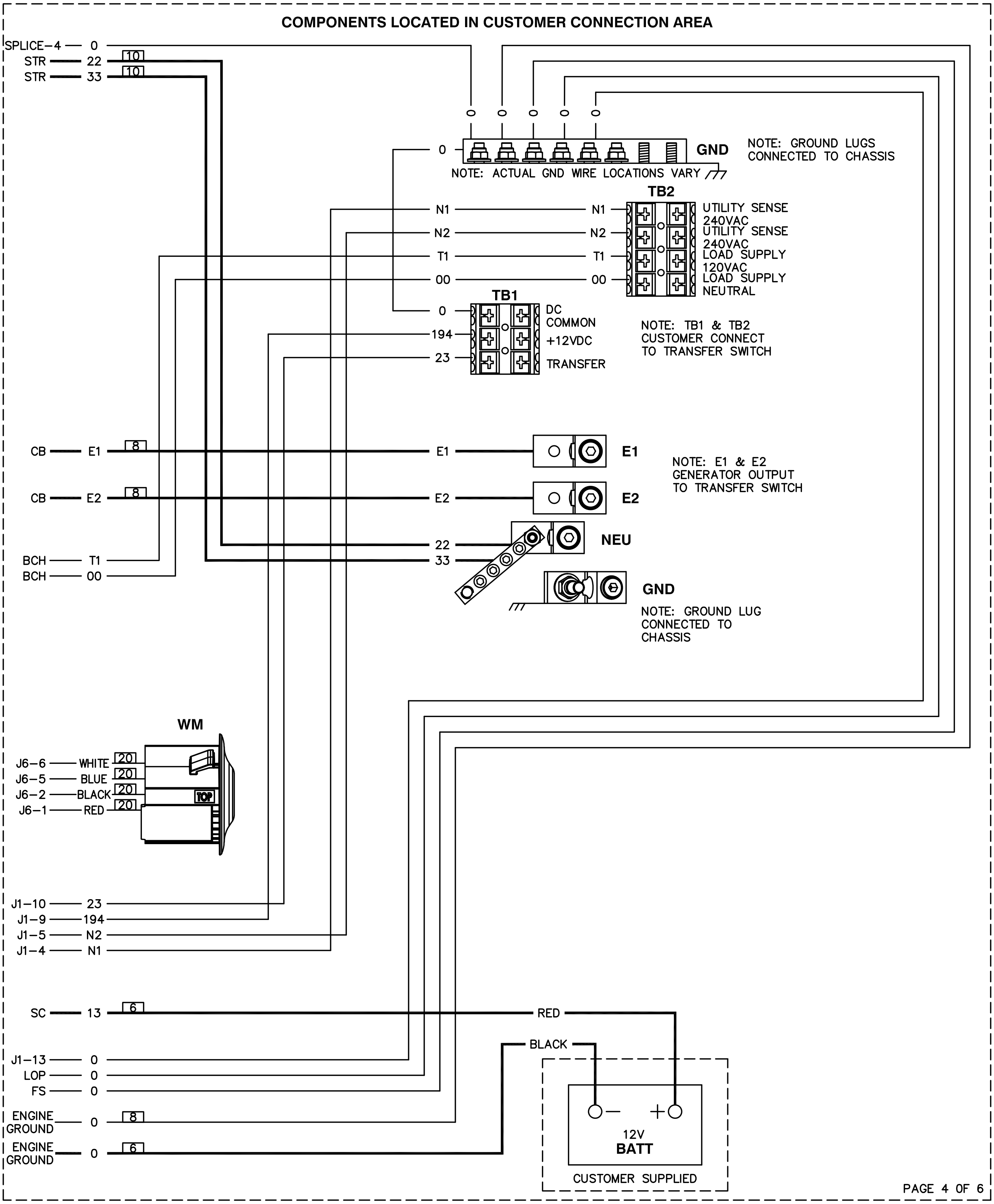
DRAWING #: A0003415229

GROUP WD



WIRING - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 426 NEC2023

DATE: 03/20/24

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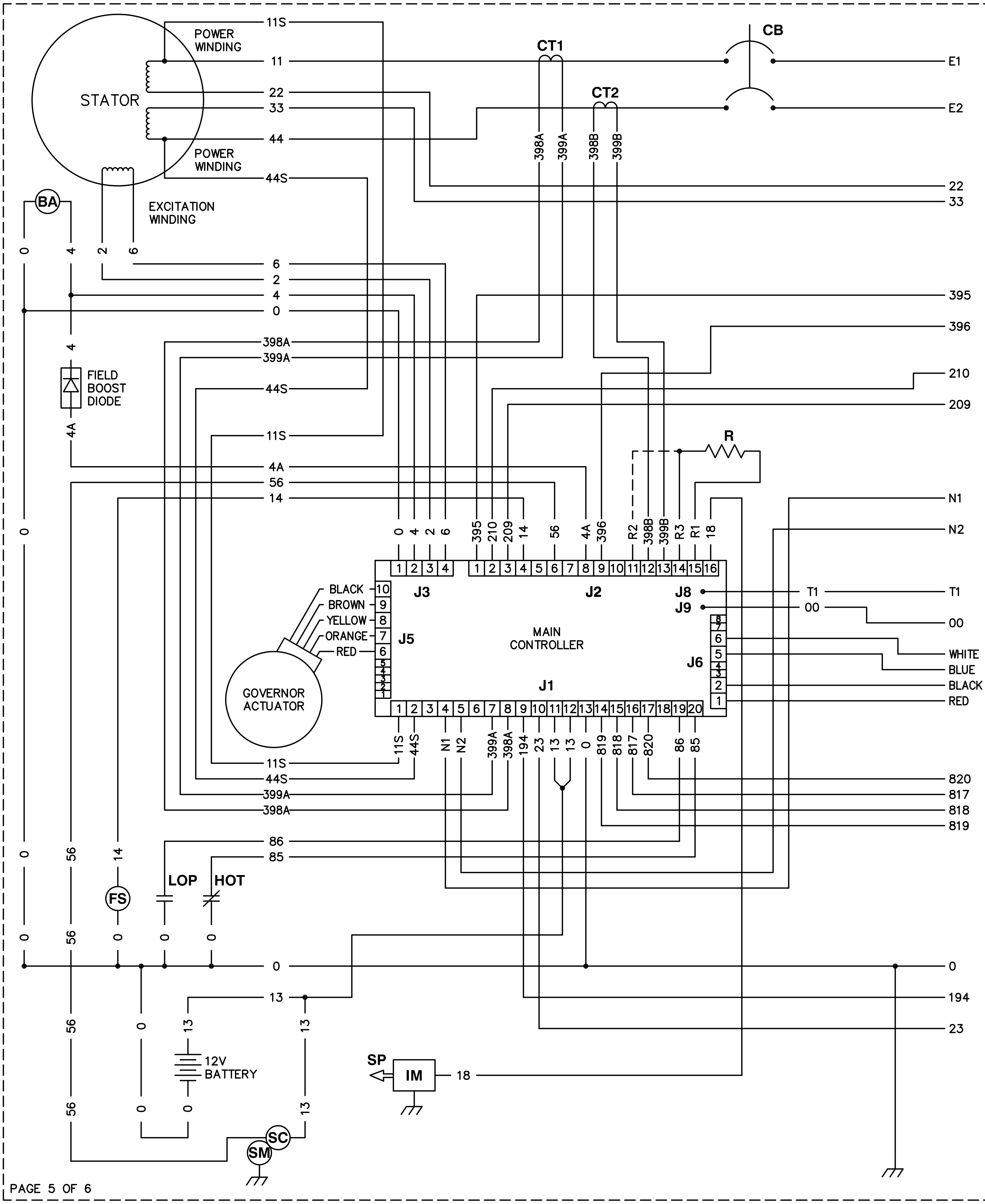
DRAWING #: A0003415229

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 426 NEC2023

DATE: 03/20/24

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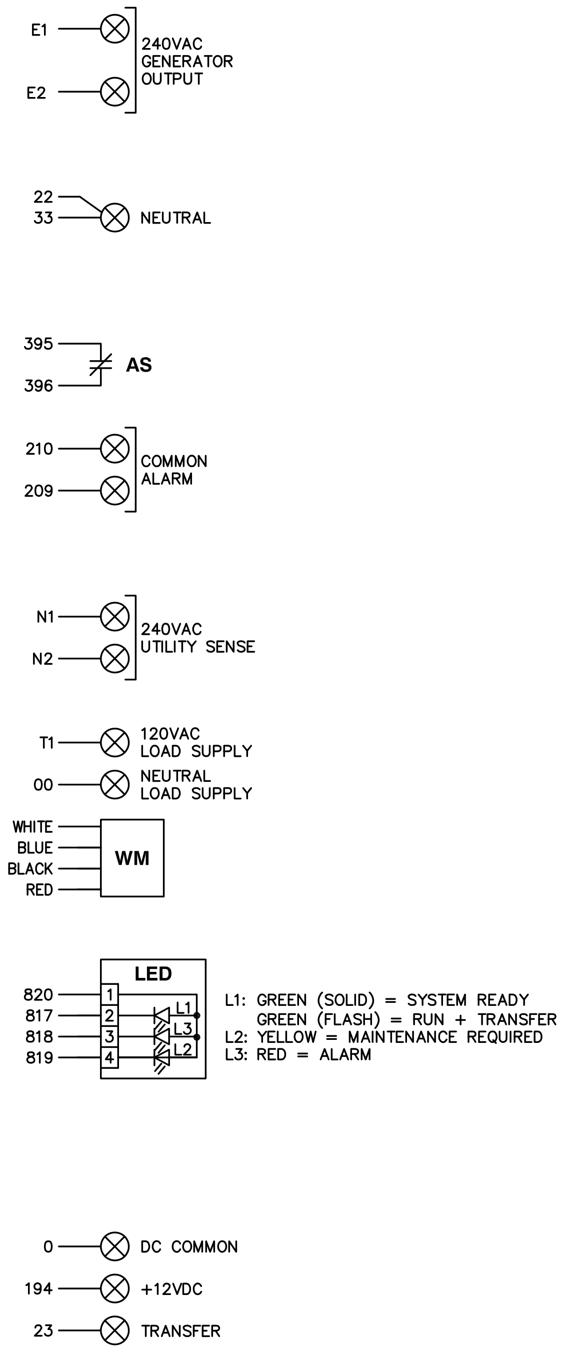
DRAWING #: A0003415229

GROUP WD



LEGEND:

AS	– AUXILIARY SHUTDOWN SWITCH
BA	– BRUSH ASSEMBLY
CB	– CIRCUIT BREAKER, MAIN OUTPUT
CT_	– CURRENT TRANSFORMER
FS	– FUEL SOLENOID
HOT	– HIGH OIL TEMP SWITCH
IM	– IGNITION MODULE
J_	– MAIN CONTROLLER CONNECTIONS
LED	– LED BOARD
LOP	– LOW OIL PRESSURE SWITCH
R	– RESISTOR
SC	– STARTER CONTACTOR
SM	– STARTER MOTOR
SP	– SPARK PLUG
WM	– WIRELESS MODULE

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SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 426 NEC2023

DATE: 03/20/24

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DRAWING #: A0003415229

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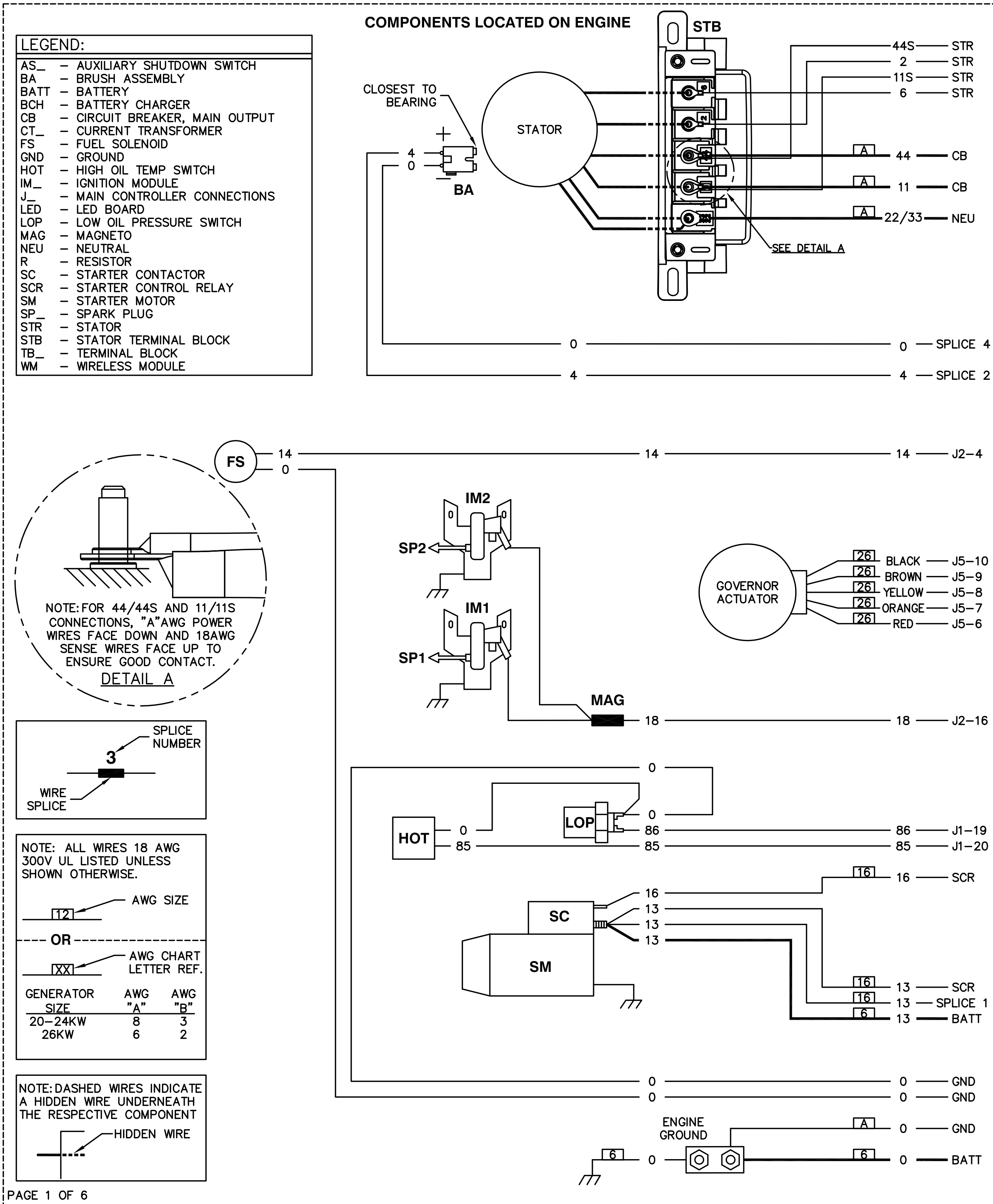
Section 5.13 *A0003423403-B WD/SD AC HSB EVO2 1PH STB NEC2023*

With Stator Terminal Block

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD

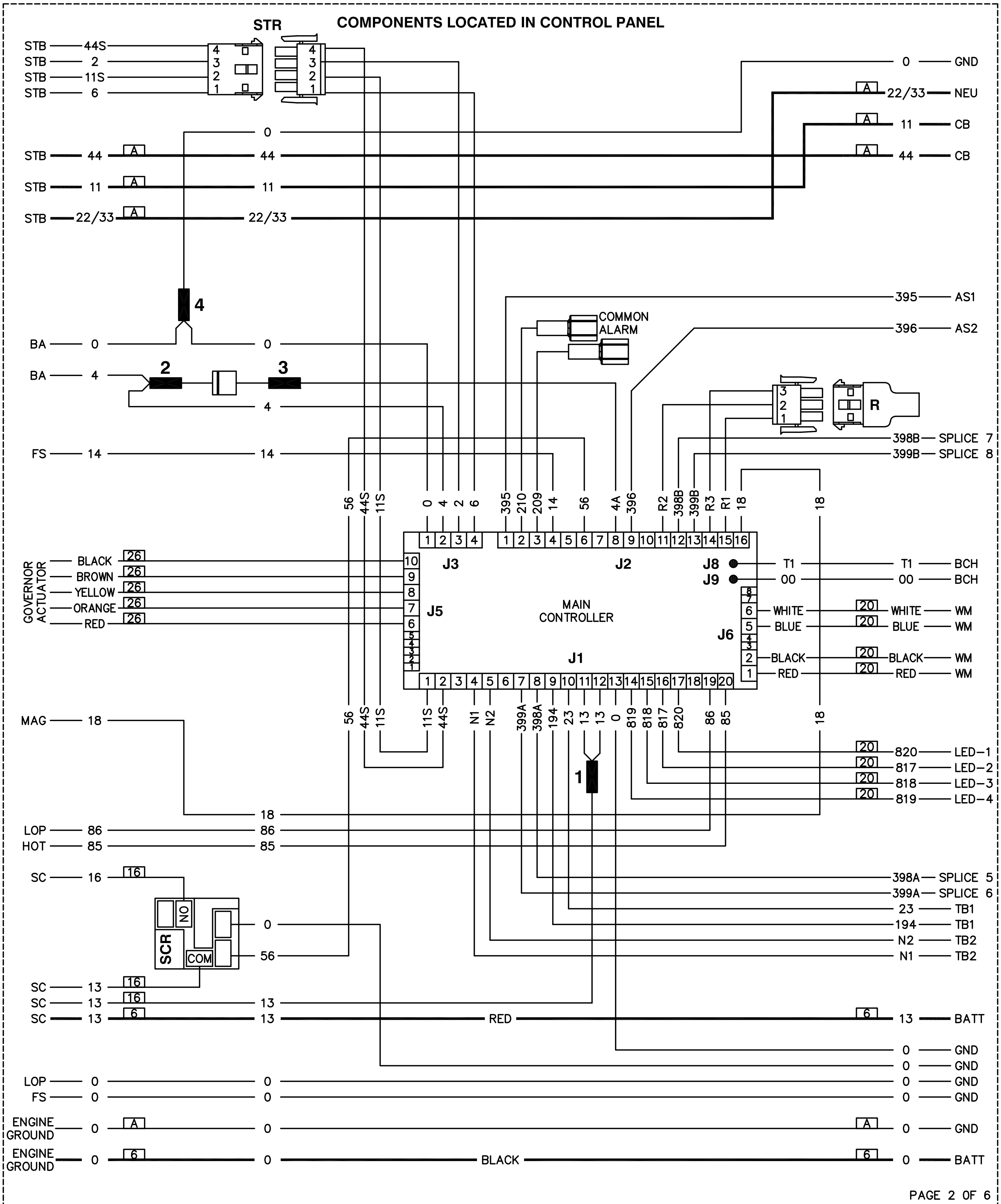


WIRING - DIAGRAM
AC HSB EVO2 60HZ 1PH STB NEC2023
DRAWING #: A0003423403

REVISION: B
DATE: 03/20/24

PAGE 1 OF 6

GROUP WD



WIRING - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 1PH STB NEC2023

DATE: 03/20/24

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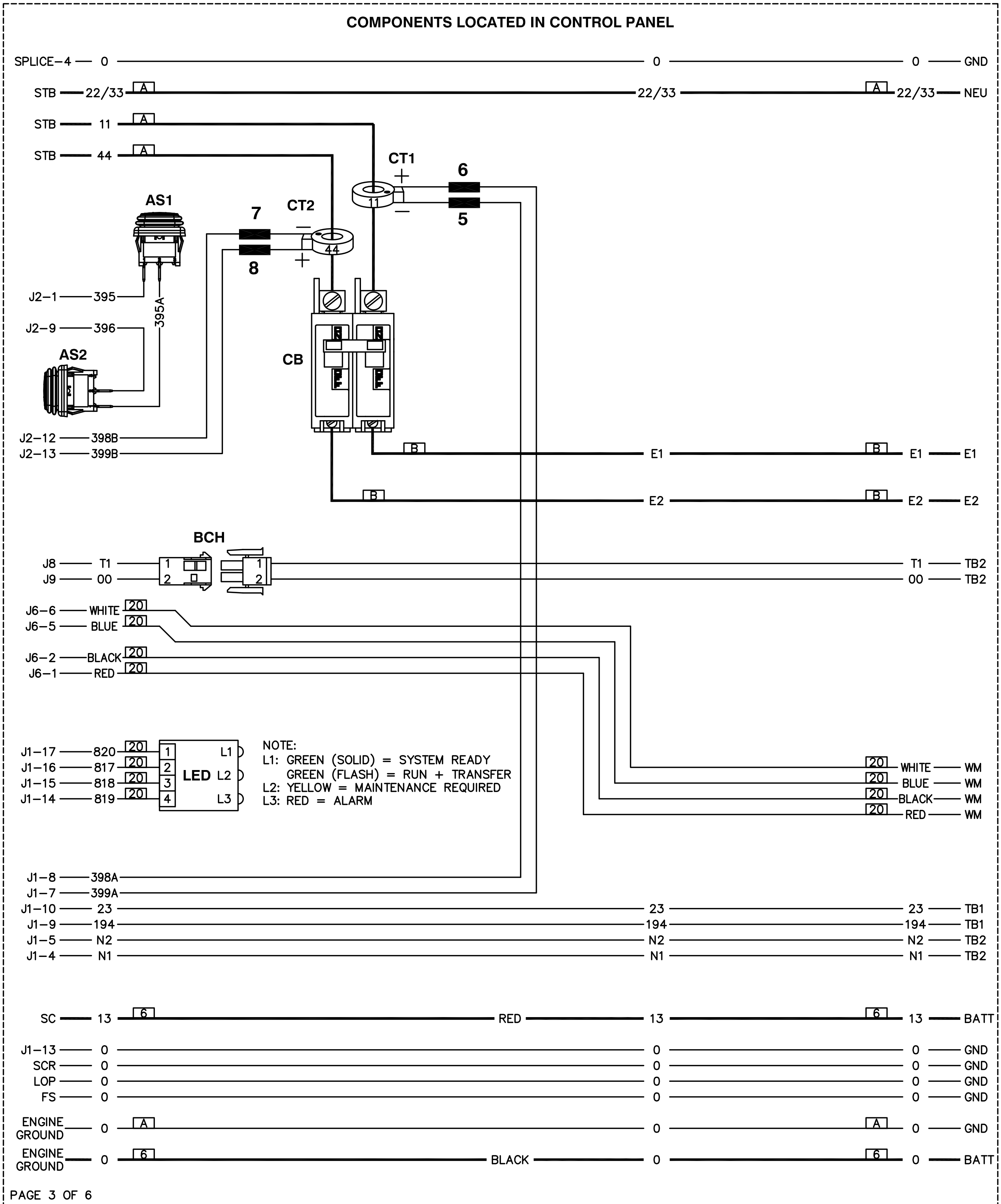
DRAWING #: A0003423403

GROUP WD



WIRING - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 1PH STB NEC2023

DATE: 03/20/24

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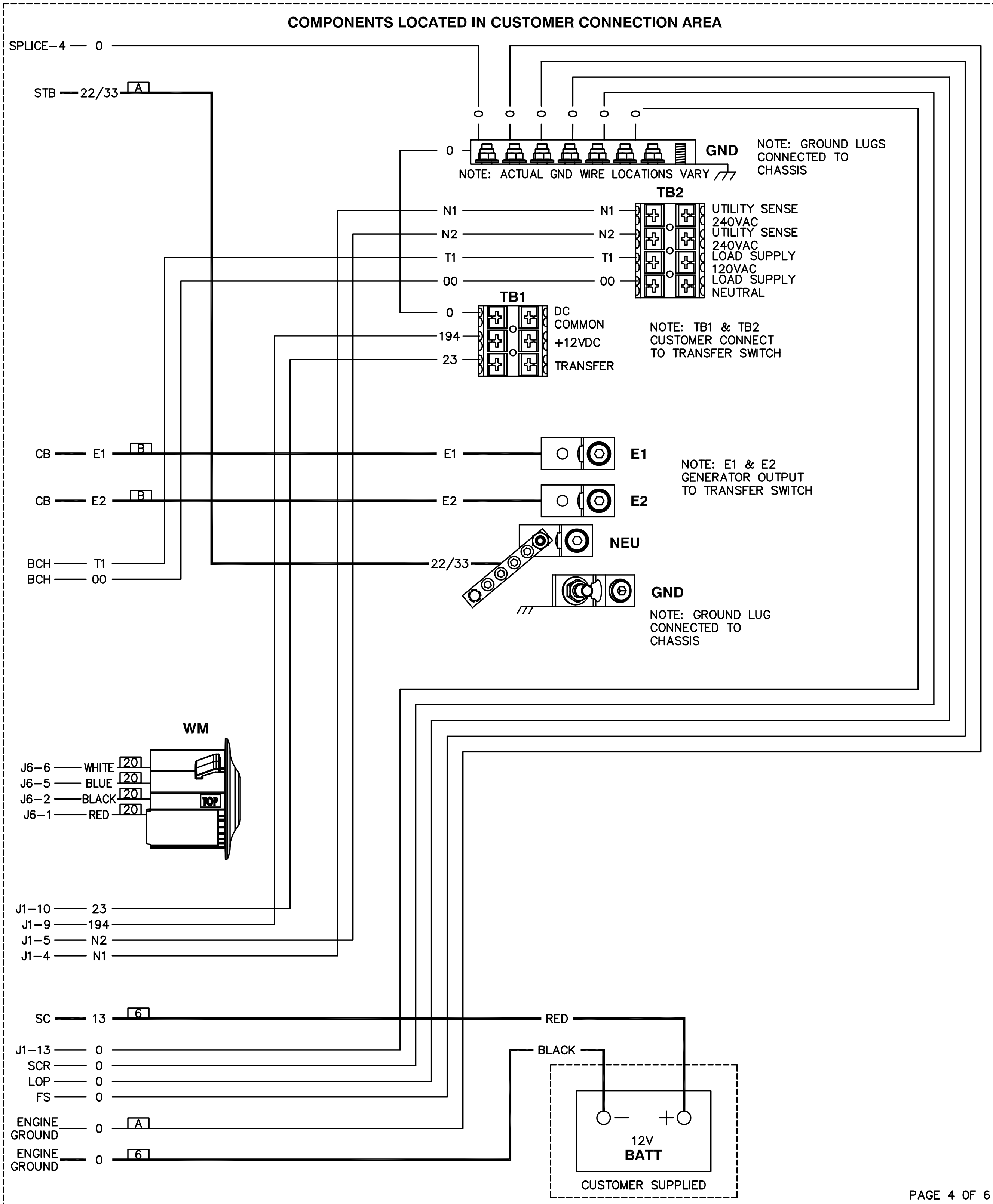
DRAWING #: A0003423403

GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 60HZ 1PH STB NEC2023

DRAWING #: A0003423403

REVISION: B

DATE: 03/20/24

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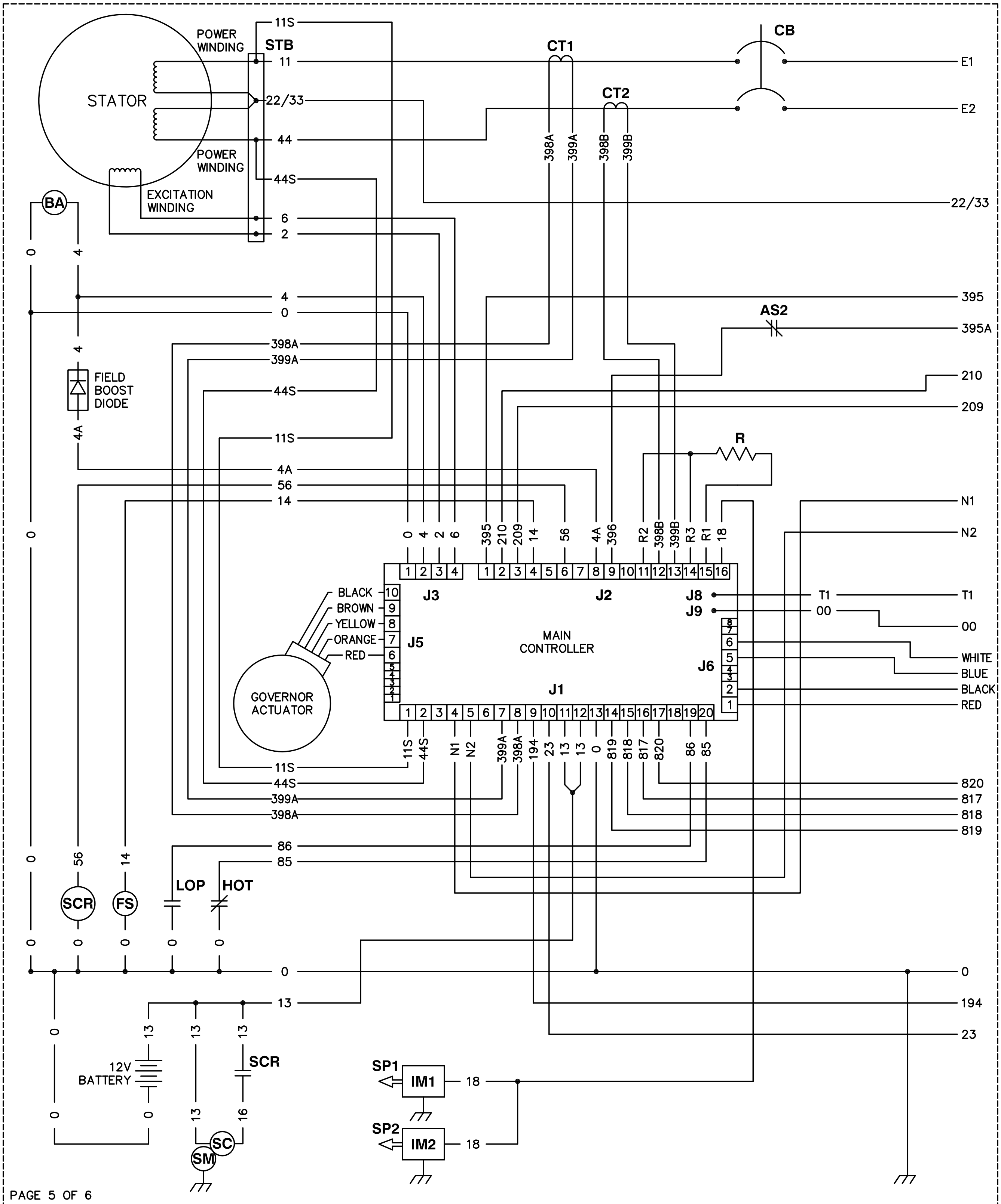
GROUP WD



SCHEMATIC - DIAGRAM

AC HSB EVO2 60HZ 1PH STB NEC2023

REVISION: B

DATE: 03/20/24

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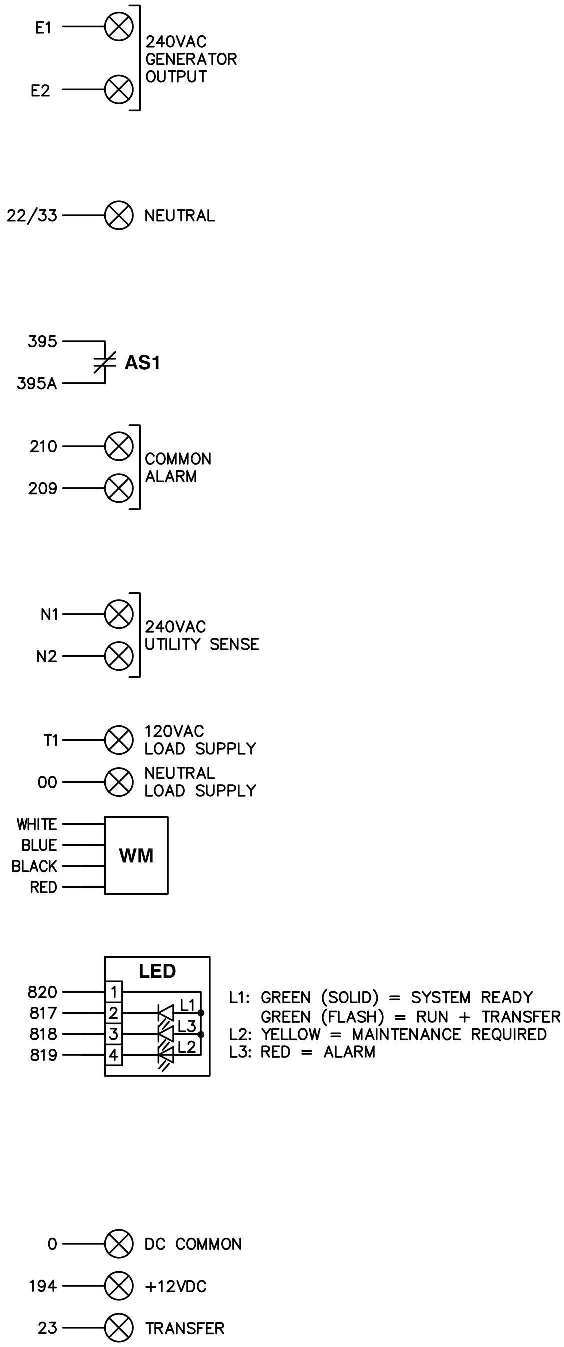
DRAWING #: A0003423403

GROUP WD



LEGEND:

AS_	– AUXILIARY SHUTDOWN SWITCH
BA	– BRUSH ASSEMBLY
CB	– CIRCUIT BREAKER, MAIN OUTPUT
CT_	– CURRENT TRANSFORMER
FS	– FUEL SOLENOID
HOT	– HIGH OIL TEMP SWITCH
IM_	– IGNITION MODULE
J_	– MAIN CONTROLLER CONNECTIONS
LED	– LED BOARD
LOP	– LOW OIL PRESSURE SWITCH
R	– RESISTOR
SC	– STARTER CONTACTOR
SCR	– STARTER CONTROL RELAY
SM	– STARTER MOTOR
SP_	– SPARK PLUG
STB	– STATOR TERMINAL BLOCK
WM	– WIRELESS MODULE

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SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 1PH STB NEC2023

DATE: 03/20/24

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DRAWING #: A0003423403

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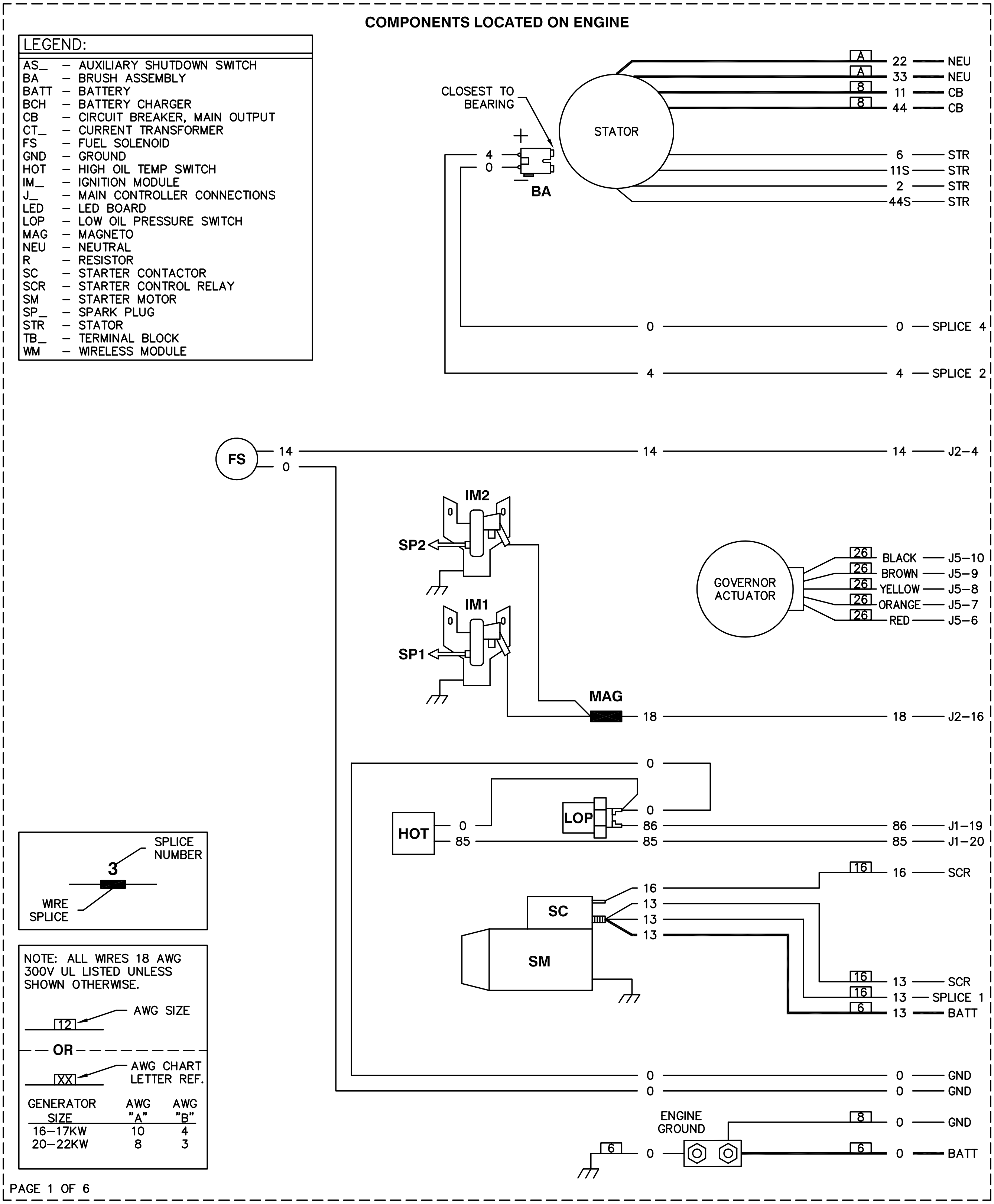
Section 5.14 *A0003423402-B WD/SD AC HSB EVO2 60HZ 816/999 NEC2023*

With Neutral Termination For Customer Connection

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: B

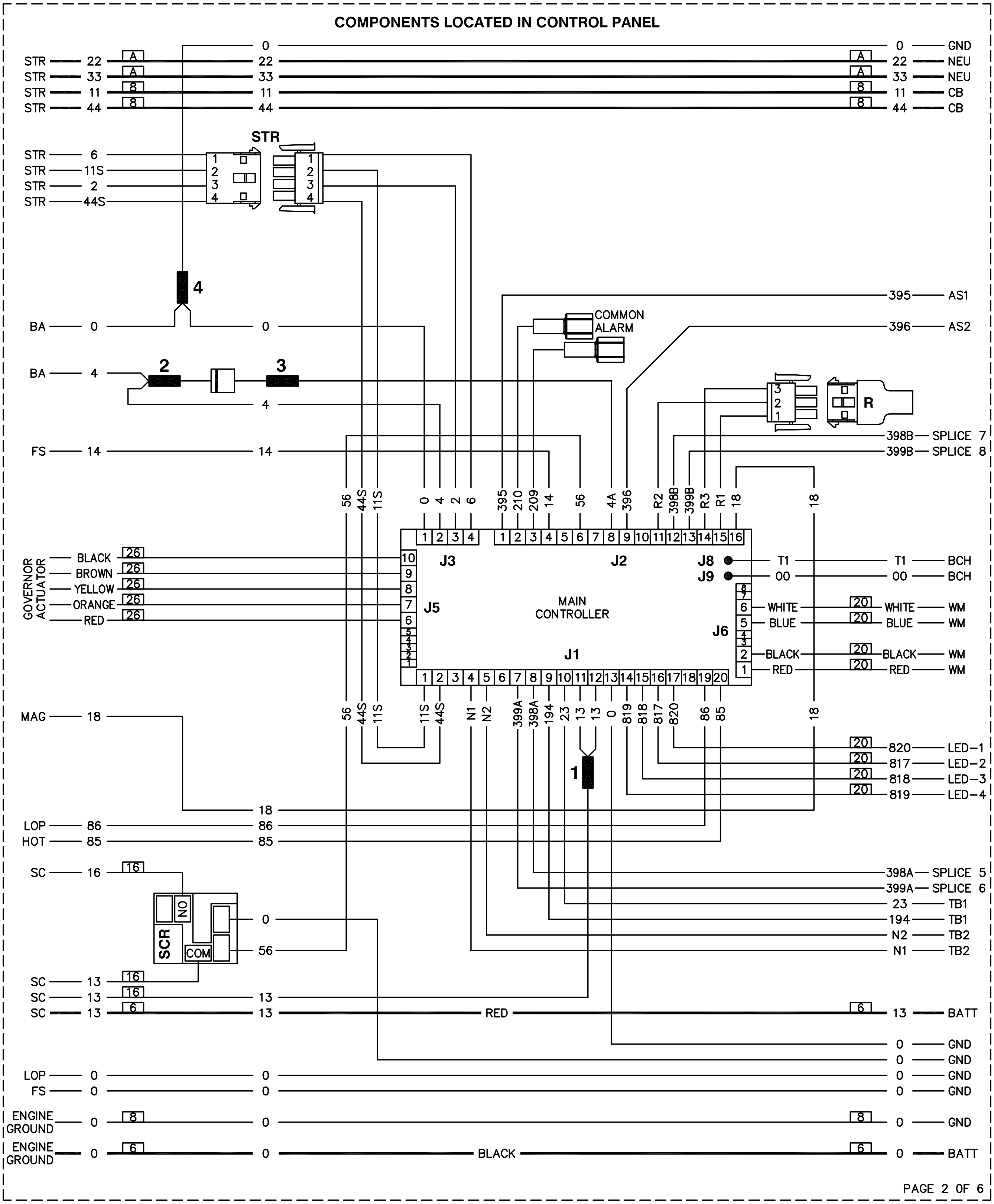
AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

PAGE 1 OF 6

DRAWING #: A0003423402

GROUP WD



WIRING - DIAGRAM

REVISION: B

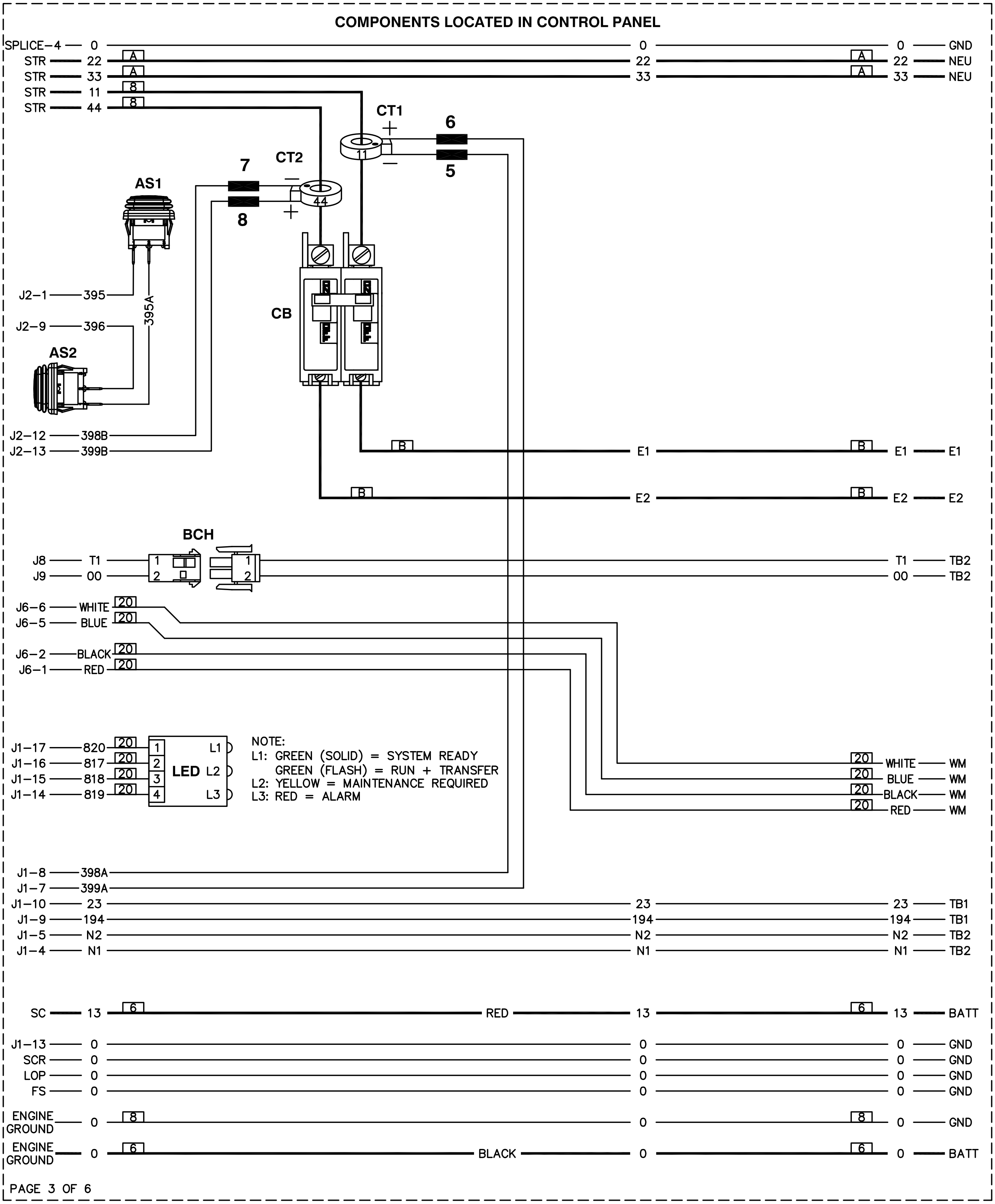
AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

PAGE 2 OF 6

DRAWING #: A0003423402

GROUP WD



WIRING - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

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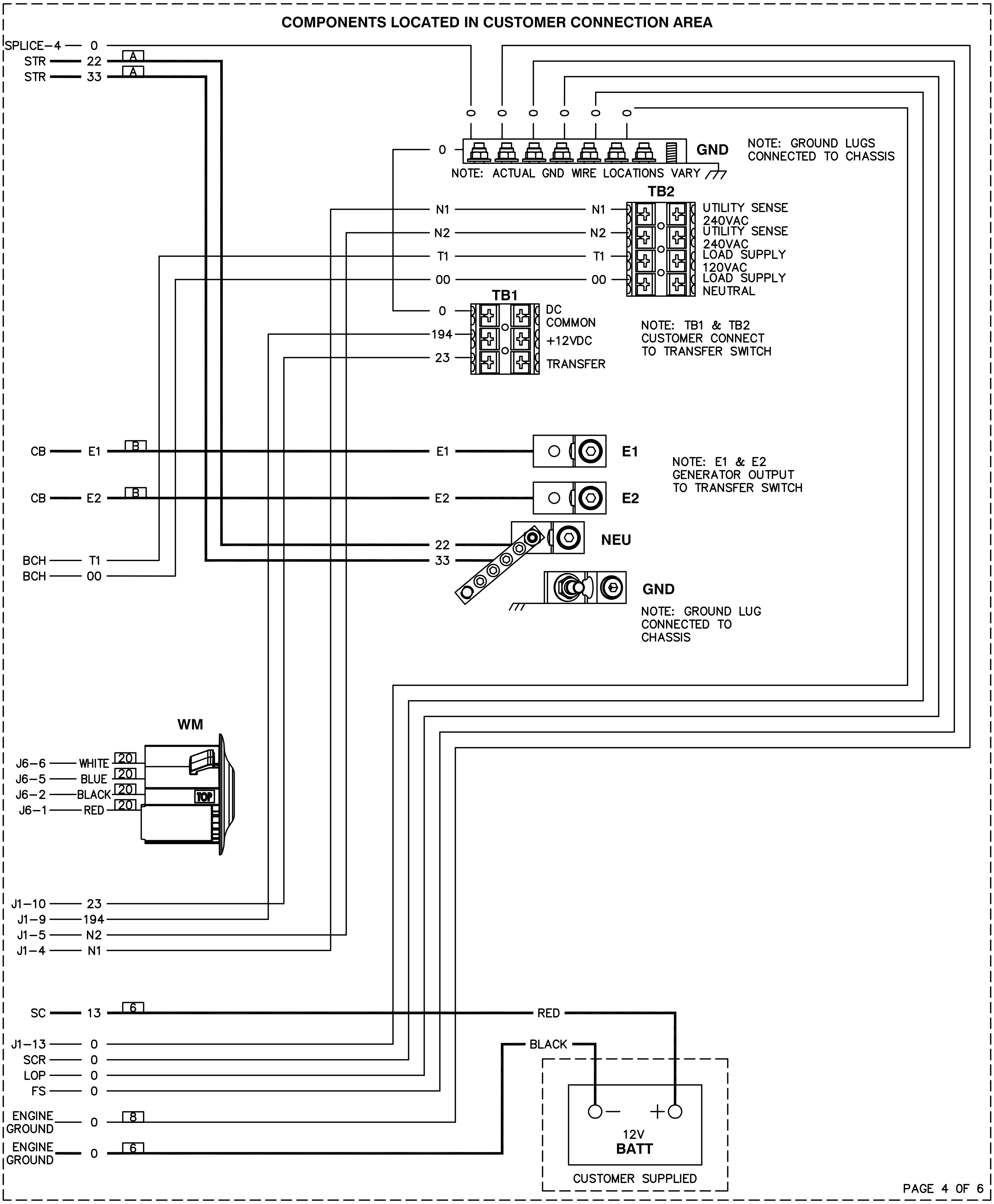
DRAWING #: A0003423402

GROUP WD



WIRING - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

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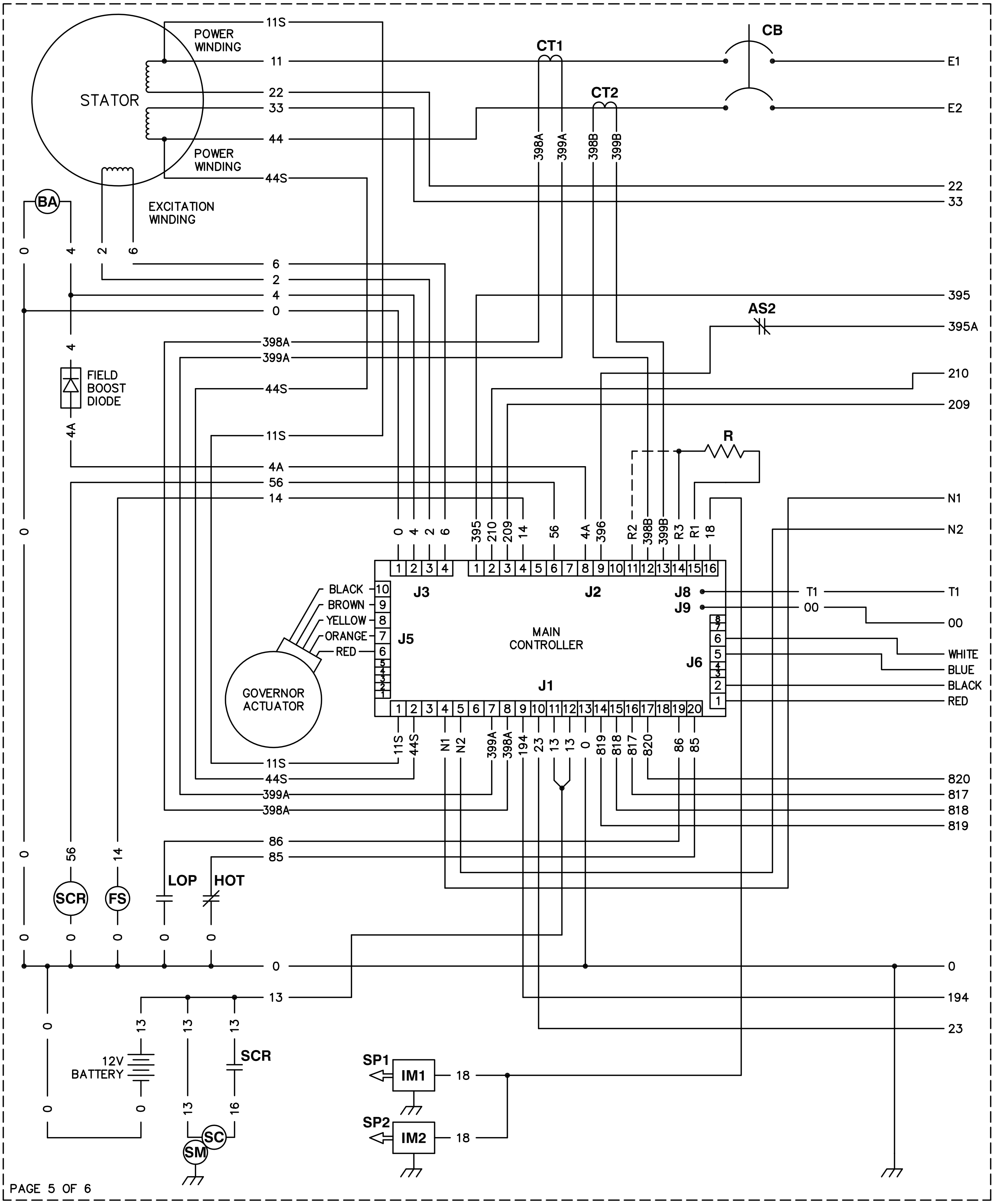
DRAWING #: A0003423402

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

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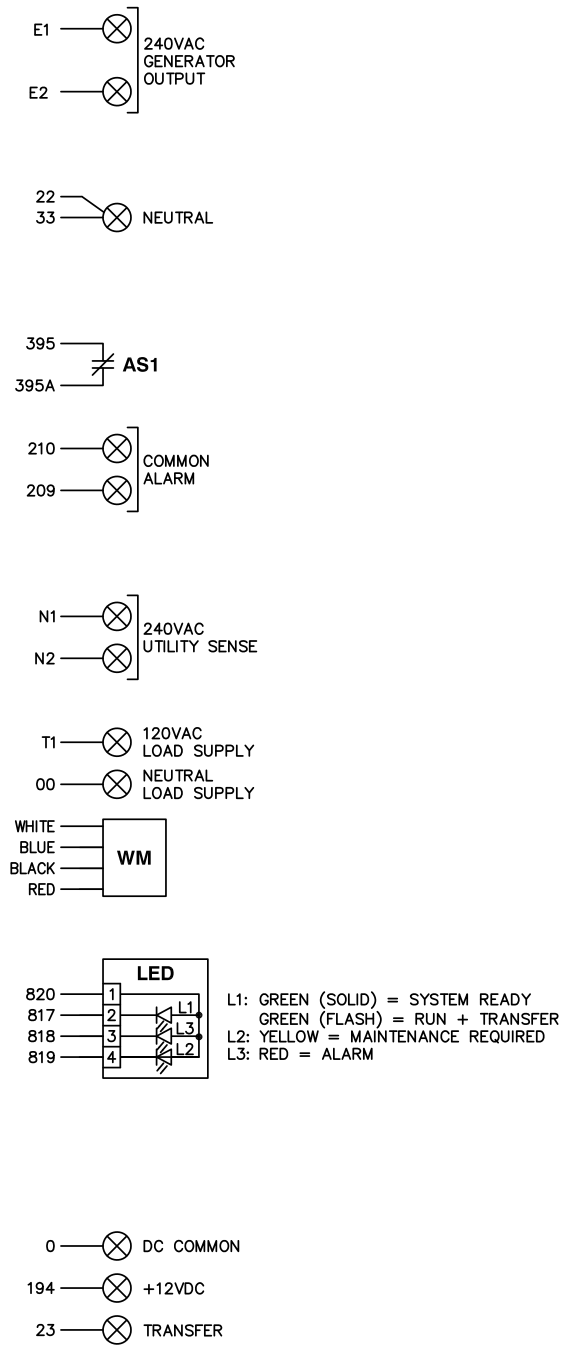
DRAWING #: A0003423402

GROUP WD

LEGEND:	
AS_	– AUXILIARY SHUTDOWN SWITCH
BA	– BRUSH ASSEMBLY
CB	– CIRCUIT BREAKER, MAIN OUTPUT
CT_	– CURRENT TRANSFORMER
FS	– FUEL SOLENOID
HOT	– HIGH OIL TEMP SWITCH
IM_	– IGNITION MODULE
J_	– MAIN CONTROLLER CONNECTIONS
LED	– LED BOARD
LOP	– LOW OIL PRESSURE SWITCH
R	– RESISTOR
SC	– STARTER CONTACTOR
SCR	– STARTER CONTROL RELAY
SM	– STARTER MOTOR
SP_	– SPARK PLUG
WM	– WIRELESS MODULE



PAGE 6 OF 6

SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 816/999 NEC2023

DATE: 03/20/24

PAGE 6 OF 6

DRAWING #: A0003423402

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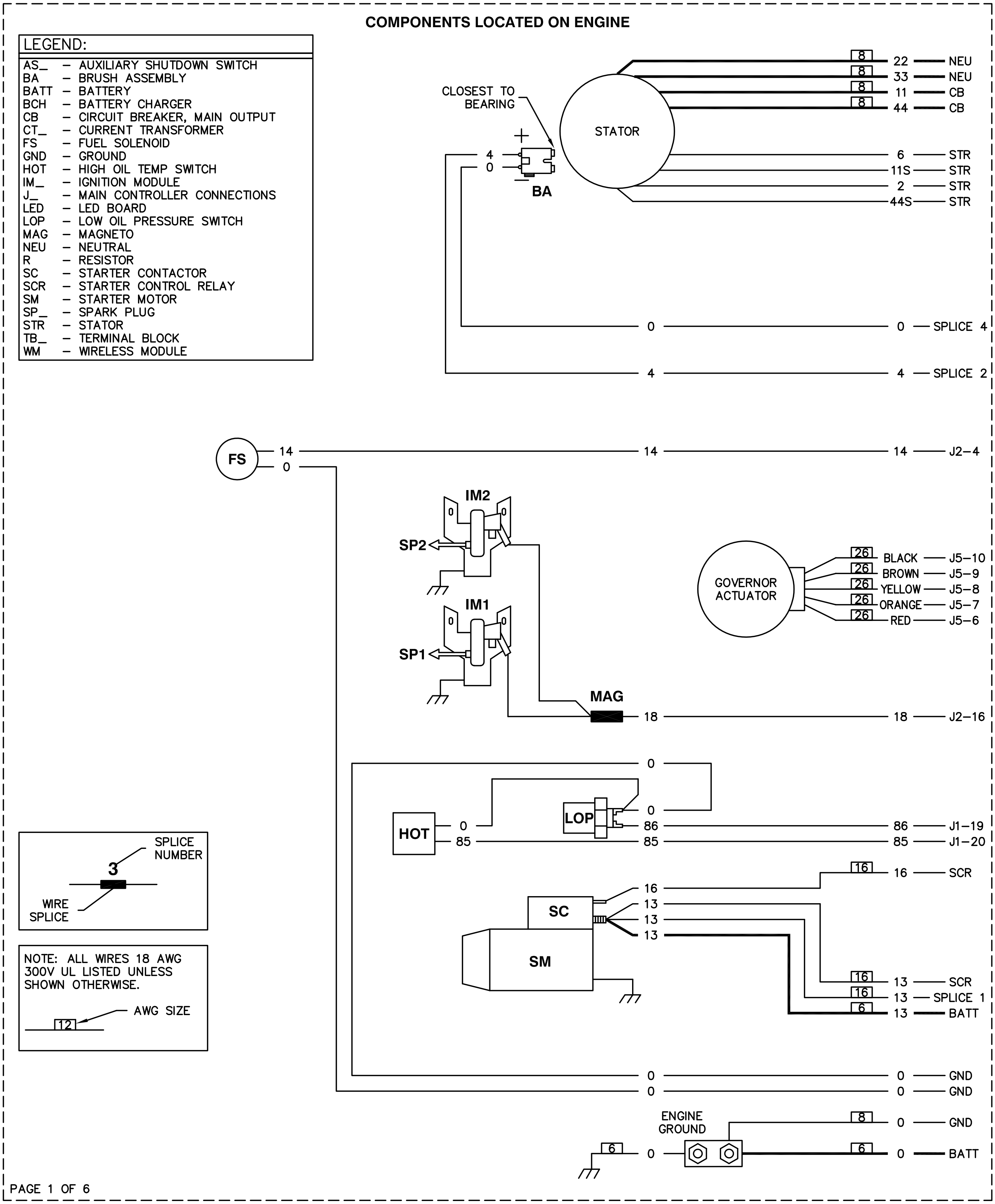
Section 5.15 *A0003423405-B WD/SD AC HSB EVO2 60HZ 999 ECO NEC2023*

With Neutral Termination For Customer Connection (Ecogen)

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer’s website.

GROUP WD



WIRING - DIAGRAM

REVISION: B

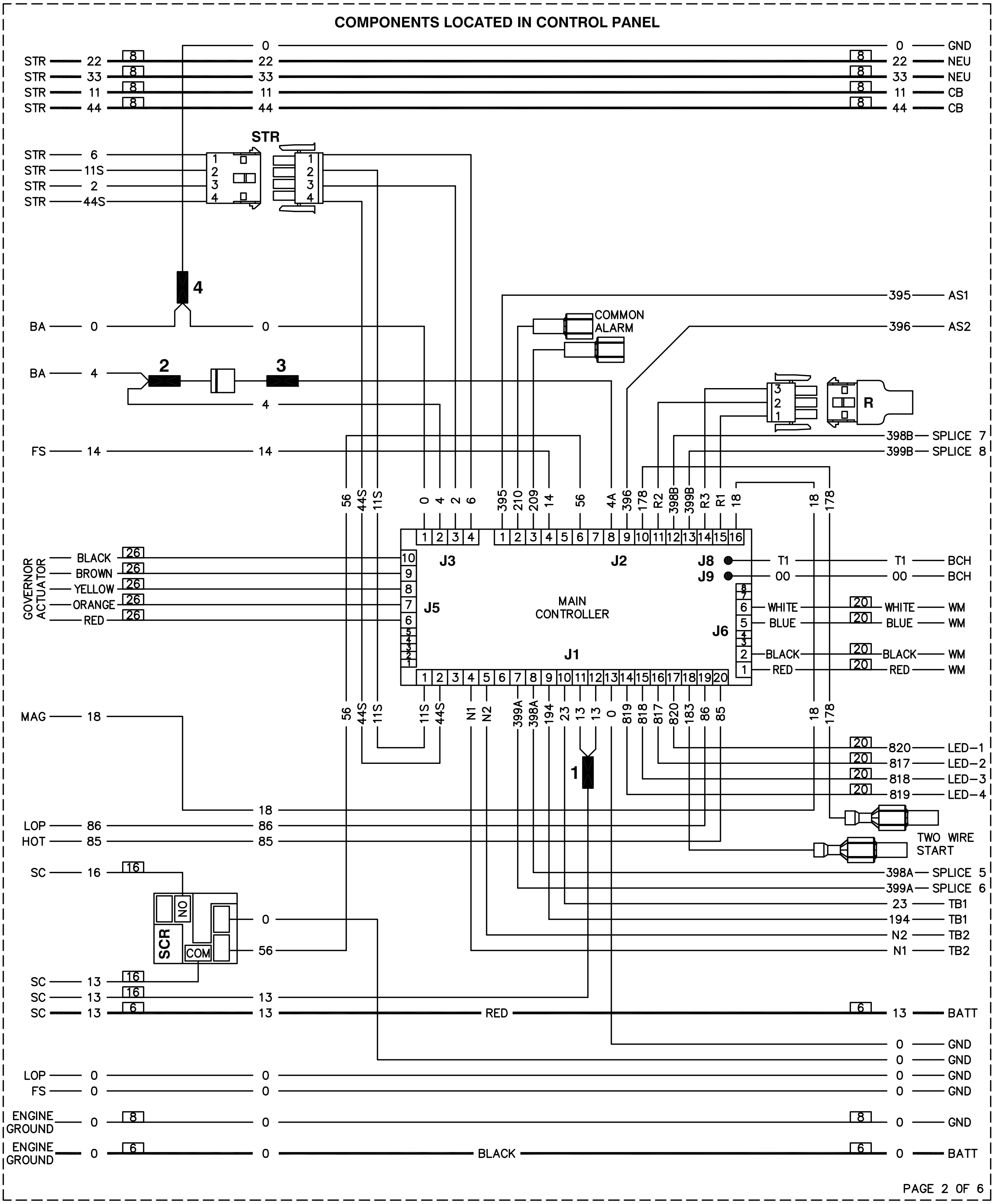
AC HSB EVO2 60HZ 999 ECO NEC2023

DATE: 03/20/24

PAGE 1 OF 6

DRAWING #: A0003423405

GROUP WD



WIRING - DIAGRAM

REVISION: B

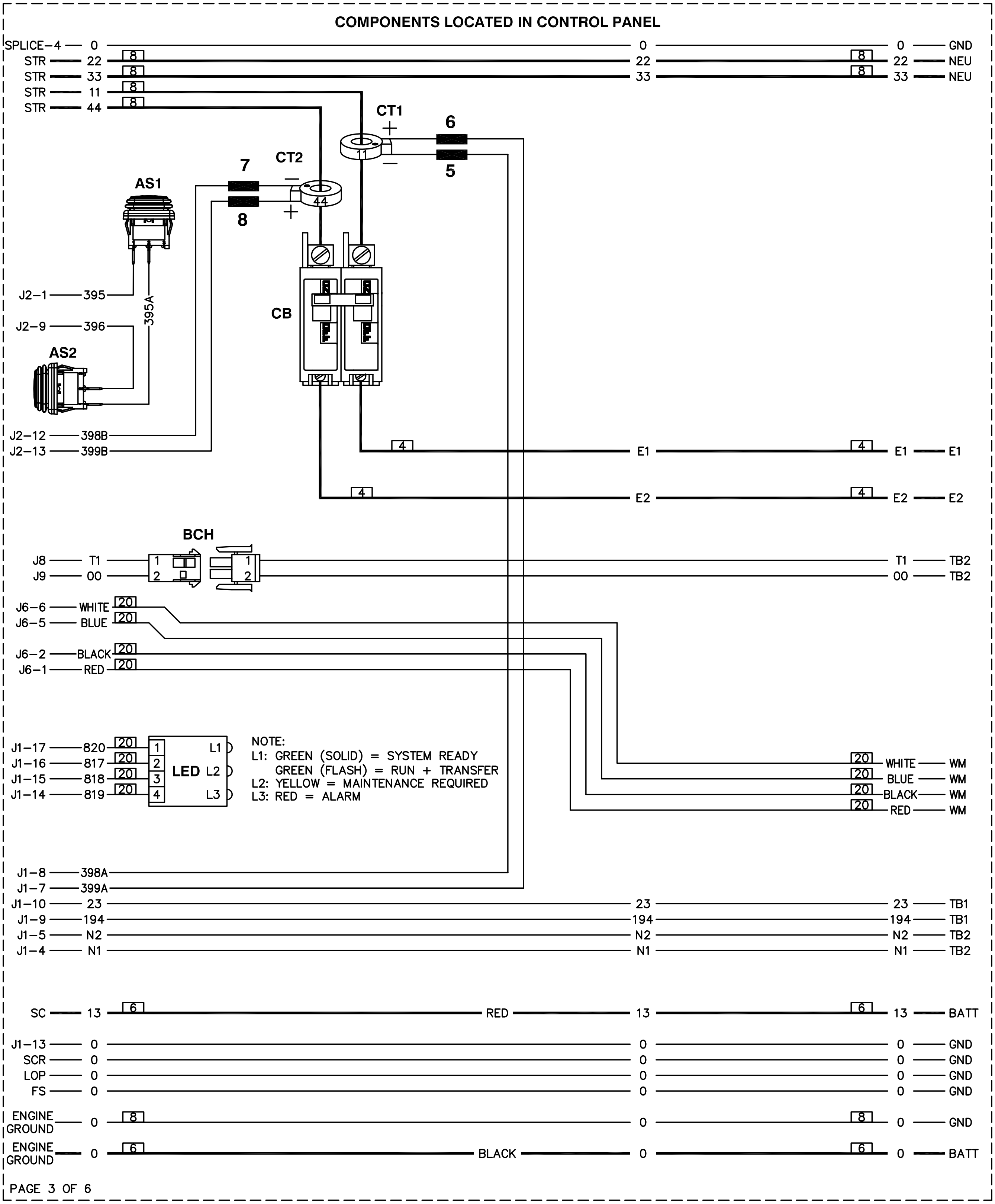
AC HSB EVO2 60HZ 999 ECO NEC2023

DATE: 03/20/24

PAGE 2 OF 6

DRAWING #: A0003423405

GROUP WD



WIRING - DIAGRAM

REVISION: B

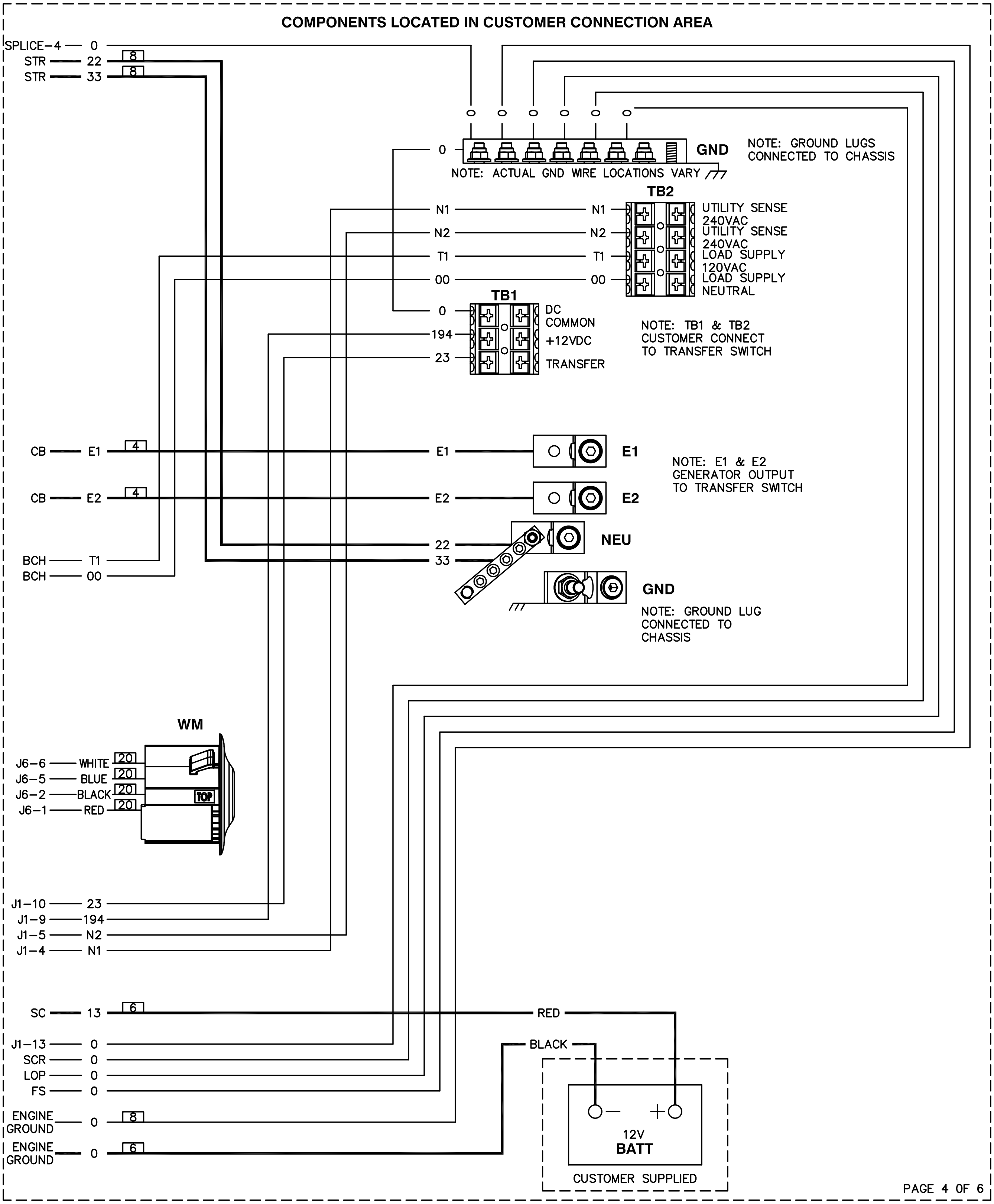
AC HSB EVO2 60HZ 999 ECO NEC2023

DATE: 03/20/24

PAGE 3 OF 6

DRAWING #: A0003423405

GROUP WD



WIRING - DIAGRAM

REVISION: B

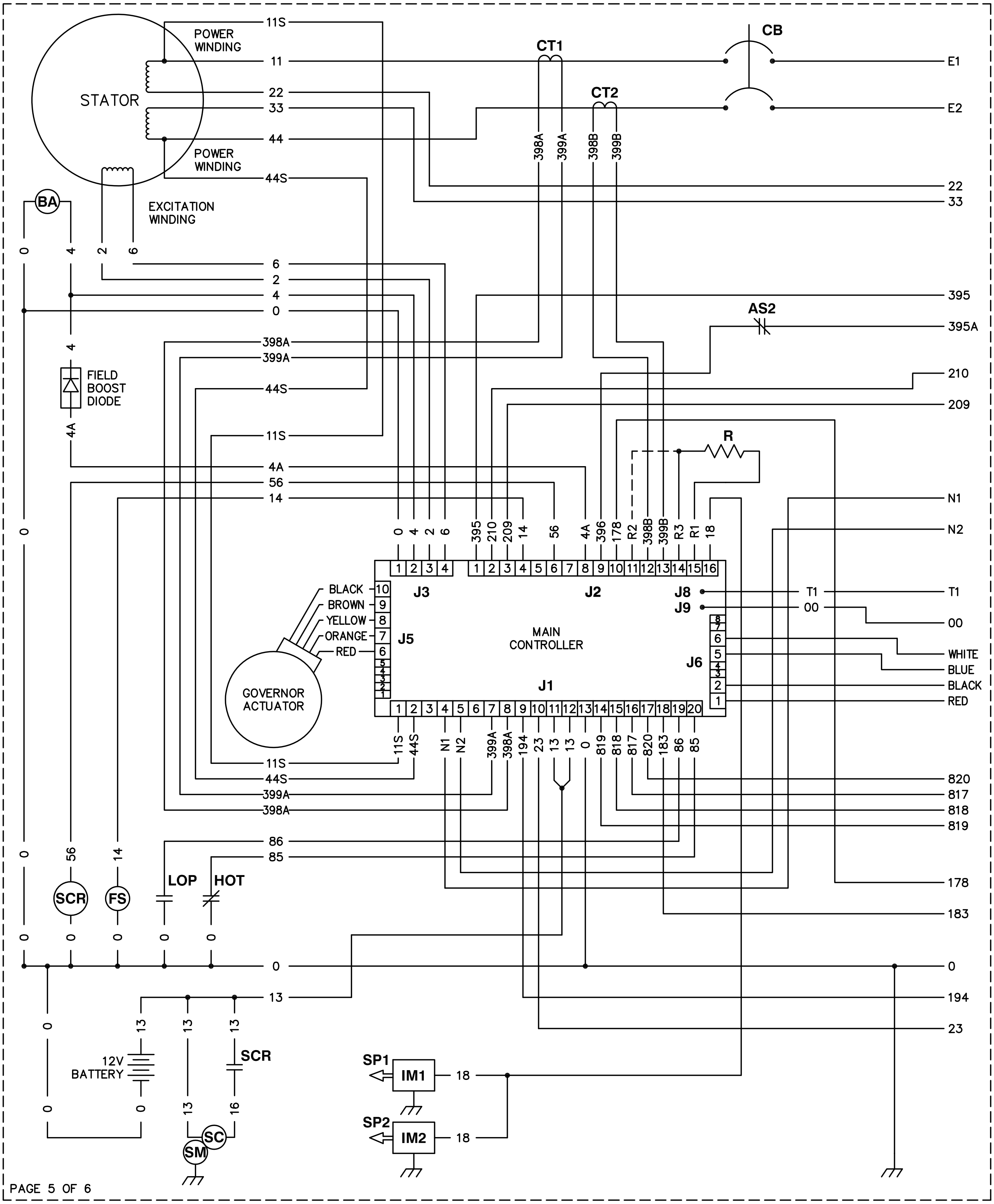
AC HSB EVO2 60HZ 999 ECO NEC2023

DATE: 03/20/24

PAGE 4 OF 6

DRAWING #: A0003423405

GROUP WD



SCHEMATIC - DIAGRAM

REVISION: B

AC HSB EVO2 60HZ 999 ECO NEC2023

DATE: 03/20/24

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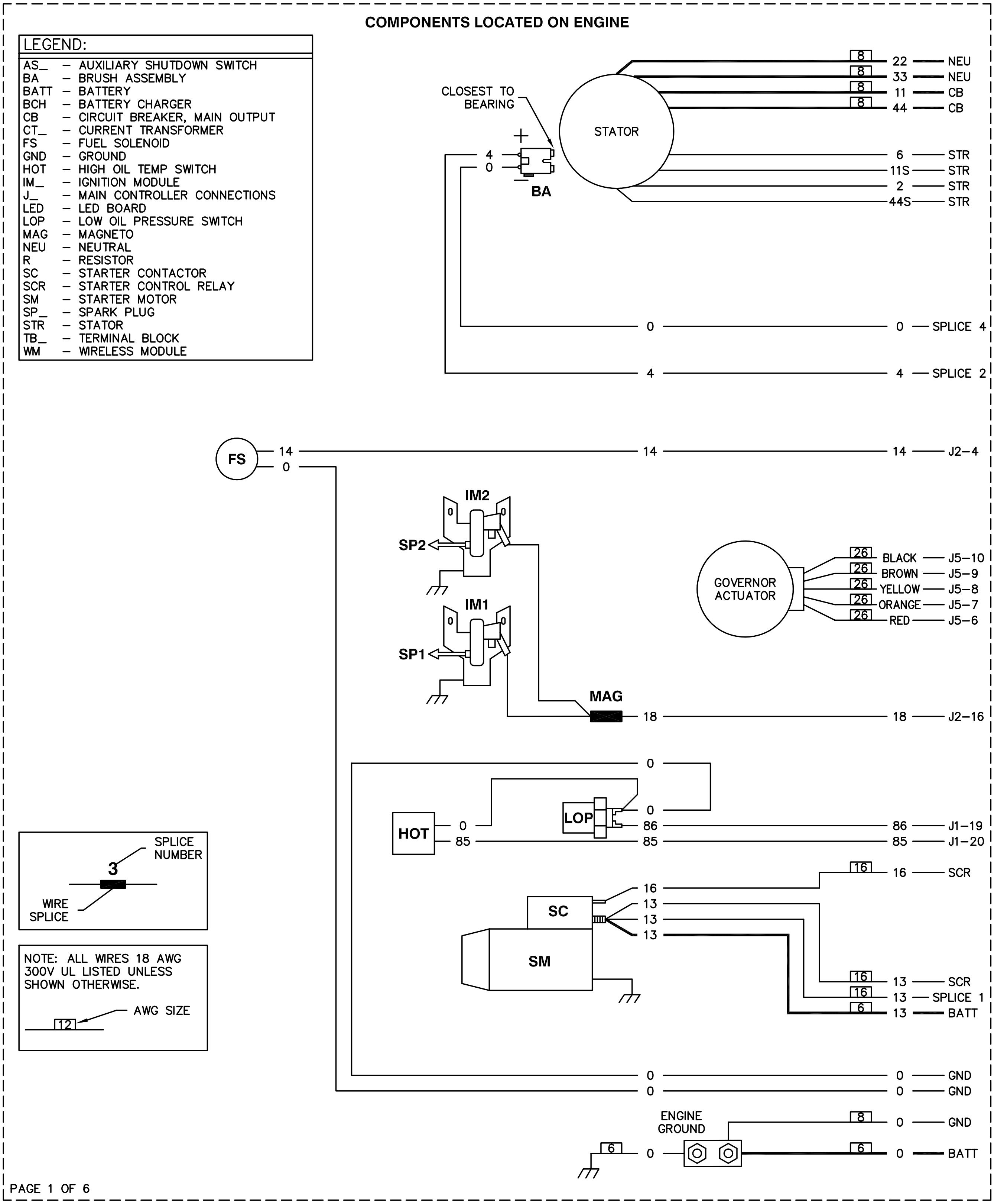
DRAWING #: A0003423405

GROUP WD



WIRING - DIAGRAM

AC HSB EVO2 60HZ 999 ECO NEC2023

REVISION: B

DATE: 03/20/24

PAGE 1 OF 6

DRAWING #: A0003423405

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Important Note

Use wire numbers only and disregard any specific "J" Connector references. Utilize the wire numbers and controller pin out chart in this appendix per specific connector styles!

Probing and Pin Extraction

Use the special tool (P/N 0J09460SRV) to back probe the connector.

NOTE: DO NOT front probe Molex Connectors.

Diagnostic procedures in this manual do not call out the connector or pin number, only the wire number.

This section (Appendix A) is to be used as a resource to identify the correct pin location and connector on the controller being diagnosed.

NOTE: If probing and/or back-probing results in a "BAD" condition, before condemning the controller, remove the pin/plug in question and verify the pin/plug is not distorted, bent and/or not making electrical contact! Repair as needed!

Figure A-1. Special Tool (P/N 0J09460SRV) Back Probe

Figure A-2. Back-Probing Molex Connector

Figure A-3. Molex Pin Extractor Tool Part# 0K4445

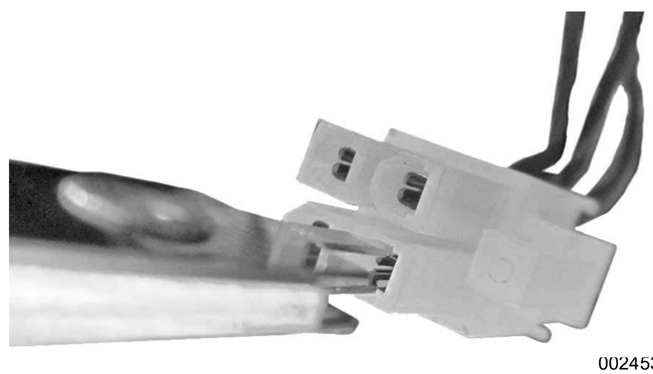
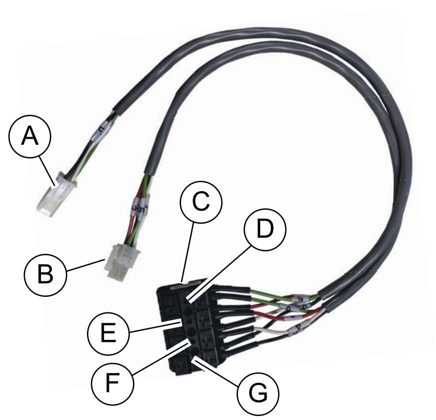


Figure A-4. Using Molex Pin Extractor Tool

J3 Breakout Harness Test Procedures

Part Number A0000659764



011874

Figure 2. J3 Breakout Harness

A	Female end J3	E	Wire 2
B	Male end J3	F	Wire 4
C	WAGO block	G	Wire 0
D	Wire 6	—	—

Testing Voltage

Checking DC Voltage on Wires 4 and 0

Proceed as follows to check DC voltage on Wires 4 and 0 using a DMM:

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. See ***Figure 2***. Connect male end (B) of J3 breakout harness to controller.
4. Connect female end (A) of J3 breakout harness to generator harness.
5. Set digital multimeter (DMM) to measure DC volts.
6. Insert DMM test leads to DC Excitation (Wires 4 [F] and 0 [G]) test points of the J3 breakout harness.
7. Set generator to MANUAL and observe DMM for DC volts.

See air cooled diagnostic manual 10000041488 (rev B or higher) for further information.

Checking AC Voltage on Wires 2 and 6

Proceeds as follows to check AC voltage on Wires 2 and 6 using a DMM:

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. Connect male end of J3 breakout harness to controller.
4. Connect female end of J3 breakout harness to generator harness.
5. Set DMM to measure AC volts.
6. Insert DMM test leads to AC Excitation (Wire 2 [E] and 6 [D]) test points of the J3 breakout harness.
7. Set generator to MANUAL and observe DMM for AC volts.

See air cooled diagnostic manual 10000041488 (rev B or higher) for further information.

Testing Resistance

Checking Rotor Winding Resistance on Wires 4 and 0

Proceed as follows to check rotor winding resistance on Wires 4 and 0 using a DMM:

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. Connect female end of J3 breakout harness to generator harness.

NOTE: Do not connect male end of J3 breakout harness to controller.

4. Set DMM to measure resistance.
5. Insert DMM test leads into DC Excitation (Wire 4 and 0) test points of J3 breakout harness.
6. Observe DMM for resistance on DC Excitation windings (4 and 0).

See air cooled diagnostic manual 10000041488 (rev B or higher) for further information.

Checking AC Excitation Winding Resistance on Wires 2 and 6

Proceed as follows to check AC Excitation winding resistance on Wires 2 and 6 using a DMM:

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. Connect female end of J3 breakout harness to generator harness.

NOTE: Do not connect male end of J3 breakout harness to controller.

4. Set DMM to measure resistance.
5. Insert DMM test leads into AC Excitation (Wire 2 and 6) test points of J3 breakout harness.
6. Observe DMM for resistance on AC Excitation windings (2 and 6).

See air cooled diagnostic manual 10000041488 (rev B or higher) for further information.

Testing Fixed Excitation

Checking Rotor Winding Current Draw Using Wires 4 and 0 (Static and Running)

Proceed as follows to check rotor winding current draw using Wires 4 and 0 using a DMM:

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. Connect female end of J3 breakout harness to generator harness.

NOTE: Do not connect male end of J3 breakout harness to controller.

4. Set DMM to measure current (10A). See DMM manufacturer's specific instructions to configure for amp draw testing.
5. See ***Figure 3***. Apply DC power to Wire 4 (F) and Wire 0 (G) test points of the WAGO end (C) of the J3 breakout harness using a 12 VDC power supply (generator battery) (J) with the DMM (H) in series.

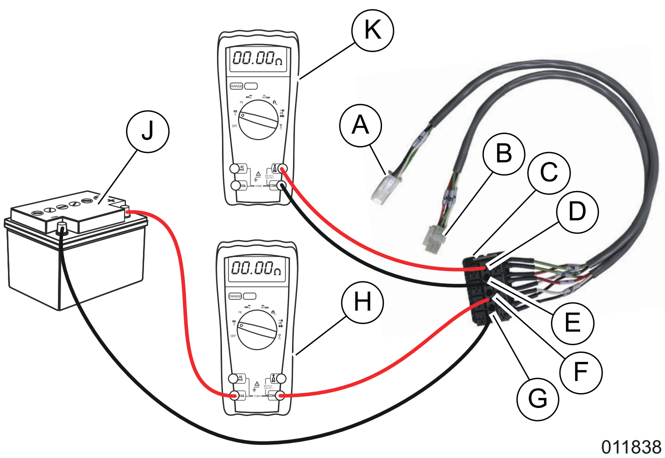


Figure 3. J3 Breakout Harness Testing Setup

6. Observe DMM for current draw on rotor winding circuit (4 and 0).
7. Set generator to MANUAL and observe DMM for current (amps).

See air cooled diagnostic manual 10000041488 (rev B or higher) for further information.

Checking Fixed (Steady) AC Excitation on Wires 2 and 6 While Running

Proceed as follows to check fixed AC excitation on Wires 2 and 6 while running:

IMPORTANT NOTE: A second meter is required to complete this test.

1. Verify generator is in OFF mode.
2. Disconnect generator harness J3 connector.
3. See ***Figure 3***. Connect female end (B) of J3 breakout harness to generator harness.

NOTE: Do not connect male end (A) of J3 breakout harness to controller.

4. Set first DMM (H) to measure current (10A). See DMM manufacturer's specific instructions to configure for amp draw testing.
5. Set second DMM (K) to measure AC volts. Insert DMM test leads into AC Excitation (Wire 2 and 6) test points.
6. See ***Figure 3***. Apply DC power to Wire 4 and Wire 0 test points of the WAGO end of the J3 breakout harness using a 12 VDC power supply (generator battery) with the DMM in series.
7. Observe second DMM for AC volts on the AC Excitation circuit (Wire 2 and 6).

See Air Cooled Diagnostic Manual 10000041488 (rev B or higher) for further information.

Evolution 2.0 Controller

See *Figure A-1* – Evolution Air-cooled Controller has 3 Molex style connectors on the back (J1, J2, & J3), one actuator connector (J5), a battery charger connector (J8 & J9), and a connector socket for remote accessories (J6).

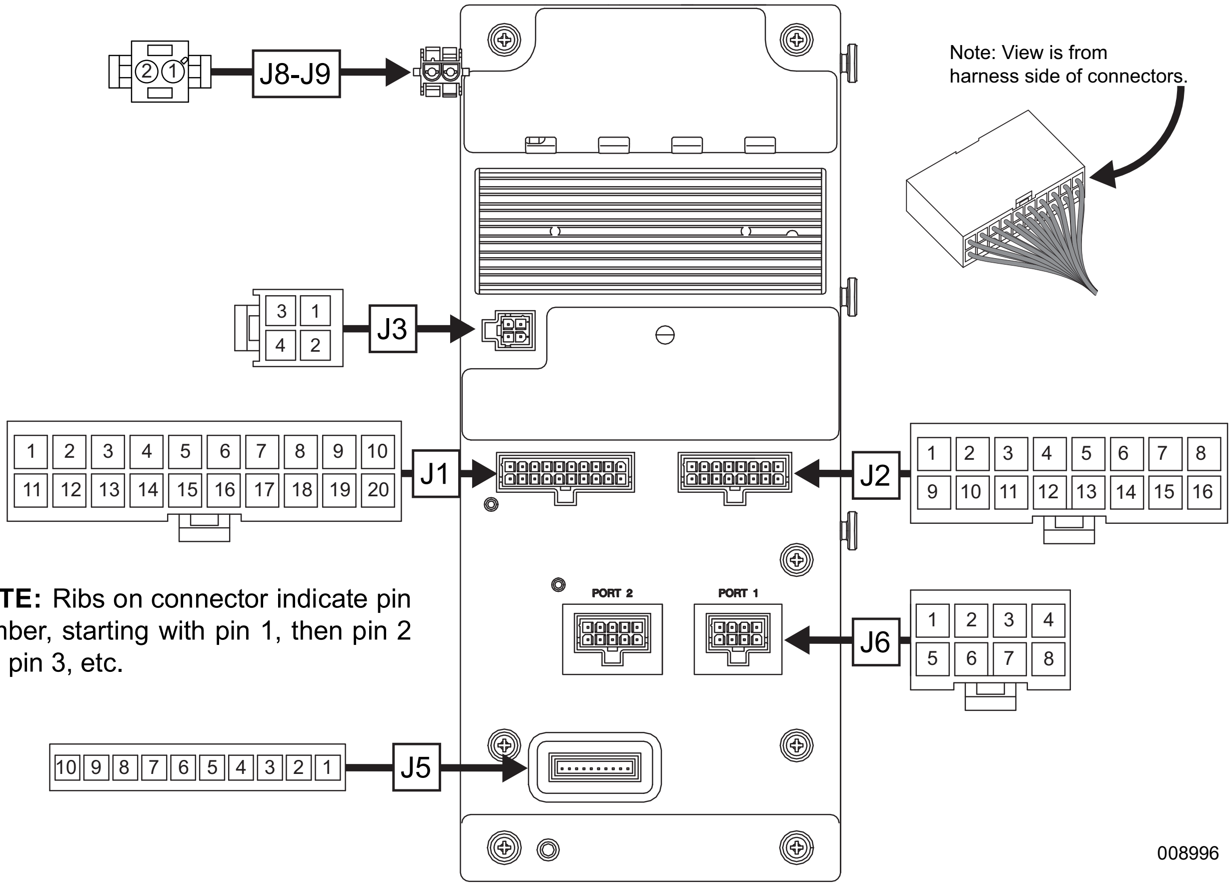


Figure A-1. Evolution 2.0 Air-cooled Panel and Connectors (Harness End)

J1 Connector		
Pin	**Wire**	**Circuit Function**
J1-1	11S	208/240 VAC Generator Voltage Sensing
J1-2	44S	208/240 VAC Generator Voltage Sensing
J1-3	–	Not Used - UL Required Spacing
J1-4	N1	240 VAC (60hz) 190 - 208 VAC (50Hz) Utility sensing voltage
J1-5	N2	240 VAC (60hz) 190 - 208 VAC (50Hz) Utility sensing voltage
J1-6	–	Not Used - UL Required Spacing
J1-7	398A	Generator Current Sense A (+)
J1-8	399A	Generator Current Sense A (Gnd)
J1-9	194	Provides 12 VDC to the transfer relay
J1-10	23	Switched to ground (internally) to energize the Transfer Relay
J1-11	13	12 VDC un-fused for the controller
J1-12	13	12 VDC un-fused for the controller
J1-13	0	Common Ground (DC) DC Field Excitation Ground
J1-14	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J1-15	818	Grounded by the controller to turn on Alarm (Red) LED
J1-16	817	Grounded by the controller to turn on System Ready (Green) LED
J1-17	820	Positive voltage (5VDC) for status LEDs
J1-18	178	Not Used, Optional - 2-Wire Start (return)
J1-19	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is ungrounded by loss of oil pressure in the LOP switch
J1-20	85	High temperature shutdown: Shutdown occurs when Wire 85 is ungrounded by contact opening in the oil temperature switch

J2 Connector		
Pin	**Wire**	**Circuit Function**
J2-1	395	Auxiliary Shutdown Ground
J2-2	210	Common Alarm Relay Output
J2-3	209	Common Alarm Relay Input
J2-4	14	12 VDC output for engine run condition. Fuel solenoid supply voltage.
J2-5	–	Not Used
J2-6	56	12 VDC output to starter control relay/ solenoid
J2-7	–	Not Used
J2-8	4A	DC (+) Field Excitation (Before Field Boost Diode)
J2-9	396	Auxiliary Shutdown: When wire 396 is grounded
J2-10	183	Not Used, Optional - 2-Wire Start (+5 VDC)
J2-11	R2	Model ID Resistor
J2-12	399B	Generator Current Sense B1
J2-13	398B	Generator Current Sense B2
J2-14	R3	Model ID Resistor (+)
J2-15	R1	Model ID Resistor (-)
J2-16	18	1. Reference signal - Controller receives speed sensing during start and run. 2. Ignition Shutdown - Controller grounded for shutdown.

J3 Connector		
Pin	**Wire**	**Circuit Function**
J3-1	0	Common Ground (DC) DC Field Excitation Ground
J3-2	4	DC (+) Field Excitation
J3-3	2	DPE Winding (AC Excitation power)
J3-4	6	DPE Winding (AC Excitation power)

J5 Connector		
Pin	**Wire**	**Circuit Function**
J5-1	–	Not Used
J5-2	–	Not Used
J5-3	–	Not Used
J5-4	–	Not Used
J5-5	–	Not Used
J5-6	Red	Red Stepper Power
J5-7	Orange	Stepper Motor B2 Coil
J5-8	Yellow	Stepper Motor B1 Coil
J5-9	Brown	Stepper Motor A2 Coil
J5-10	Black	Stepper Motor A1 Coil

J6 Connector		
Pin	**Wire**	**Circuit Function**
J6-1	Red	Accessory (5V)
J6-2	Black	Accessory (Gnd)
J6-3	–	Accessory (+12V)
J6-4	–	PORT 2 (Gnd)
J6-5	Blue	RS485 Data (-)
J6-6	White	RS485 Data (+)
J6-7	–	PORT 2 Receive
J6-8	–	PORT 2 Transmit

J8-J9 Connector		
Pin	**Wire**	**Circuit Function**
1	T1	120 - 240 VAC Power for the Battery Charger
2	00 - 60 Hz T2 - 50 Hz	60 Hz - Neutral Connection for T1 50 Hz - Line 2 for Battery Charger

Evolution 1.0 Controller

See ***Figure A-2*** – Evolution 1.0 Air-cooled Controller has 3 Molex style connectors on the back (J1, J2, & J3), one actuator connector (J5), a battery charger connector (J8 & J9), and a connector socket for a remote annunciator (optional accessory).

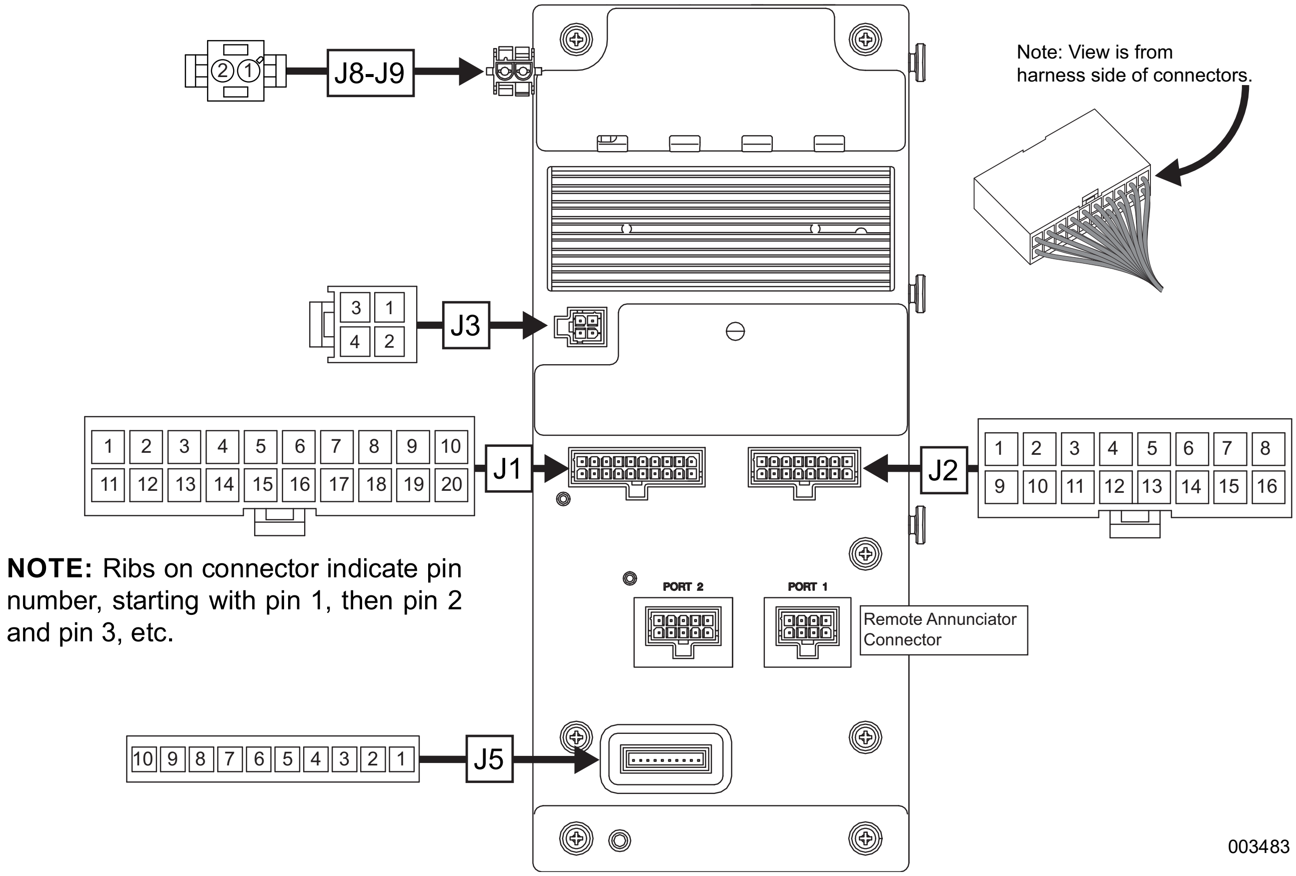


Figure A-2. Evolution 1.0 Air-cooled Panel and Connectors (Harness End)

J1 Connector		
Pin	**Wire**	**Circuit Function**
J1-1	13	12 VDC un-fused for the controller
J1-2	13	12 VDC un-fused for the controller
J1-3	820	Positive voltage (5VDC) for status LEDs
J1-4	23	Switched to ground (internally) to energize the Transfer Relay
J1-5	178	Not Used, Optional - 2-Wire Start (return)
J1-6	819	Grounded by the controller to turn on the Maintenance (Yellow) LED
J1-7	818	Grounded by the controller to turn on Alarm (Red) LED
J1-8	817	Grounded by the controller to turn on System Ready (Green) LED
J1-9	398A	Generator Current Sense A2
J1-10	399A	Generator Current Sense A1

J1 Connector		
Pin	**Wire**	**Circuit Function**
J1-11	85	High temperature shutdown: Shutdown occurs when Wire 85 is grounded by contact closure in the oil temperature switch
J1-12	86	Low oil pressure shutdown: Shutdown occurs when Wire 86 is grounded by loss of oil pressure in the LOP switch
J1-13	0	Common Ground (DC) DC Field Excitation Ground
J1-14	194	Provides 12 VDC to the transfer relay
J1-15	-	Not Used - UL Required Spacing
J1-16	N1	240 VAC Utility sensing voltage
J1-17	N2	240 VAC Utility sensing voltage
J1-18	-	Not Used - UL Required Spacing
J1-19	11S	240 VAC Generator Voltage Sensing
J1-20	44S	240 VAC Generator Voltage Sensing

J2 Connector		
Pin	**Wire**	**Circuit Function**
J2-1	-	Not Used
J2-2	209	Common Alarm Relay Output
J2-3	56	12 VDC output to starter control relay/ solenoid
J2-4	14	12 VDC output for engine run condition. Fuel solenoid supply voltage.
J2-5	4A	DC (+) Field Excitation (Before Field Boost Diode)
J2-6	398A	Generator Current Sense B2
J2-7	18	1. Reference signal - Controller receives speed sensing during start and run. 2. Ignition Shutdown - Controller grounded for shutdown.
J2-8	R1	Model ID Resistor
J2-9	-	Not Used
J2-10	-	Not Used
J2-11	183	Not Used, Optional - 2-Wire Start
J2-12	210	Common Alarm Relay Output
J2-13	-	Not Used
J2-14	399B	Generator Current Sense B1
J2-15	R3	Model ID Resistor
J2-16	R2	Model ID Resistor

J3 Connector		
Pin	**Wire**	**Circuit Function**
J3-1	0	Common Ground (DC) DC Field Excitation Ground
J3-2	4	DC (+) Field Excitation
J3-3	2	DPE Winding (AC Excitation power)
J3-4	6	DPE Winding (AC Excitation power)

J5 Connector		
Pin	**Wire**	**Circuit Function**
J5-1	-	Not Used
J5-2	-	Not Used
J5-3	-	Not Used
J5-4	-	Not Used
J5-5	-	Not Used
J5-6	Red	Stepper Power
J5-7	Orange	Stepper Motor B2 Coil
J5-8	Yellow	Stepper Motor B1 Coil
J5-9	Brown	Stepper Motor A2 Coil
J5-10	Black	Stepper Motor A1 Coil

J8-J9 Connector		
Pin	**Wire**	**Circuit Function**
1	T1	120 VAC Power for the Battery Charger
2	00 - 60 Hz T2 - 50 Hz	60 Hz - Neutral Connection for T1 50 Hz - Line 2 for Battery Charger

Procedures For Downloading Firmware From GenService

initiating/formatting the Flash Drive, downloading the firmware file to the Flash Drive, and downloading the firmware into the Evolution Controller.

NOTE: Only the SanDisk Ultra Backup™ 32GB or smaller and Gorilla Drives 32GB or smaller Flash Drives have been tested and should be used. Generac does not supply these flash drives. They can be obtained locally through any computer or online retail store.

Procedure

1. Log into GenService. (service.generac.com)
2. See ***Figure A-3***. Click on the “Documentation” tab.

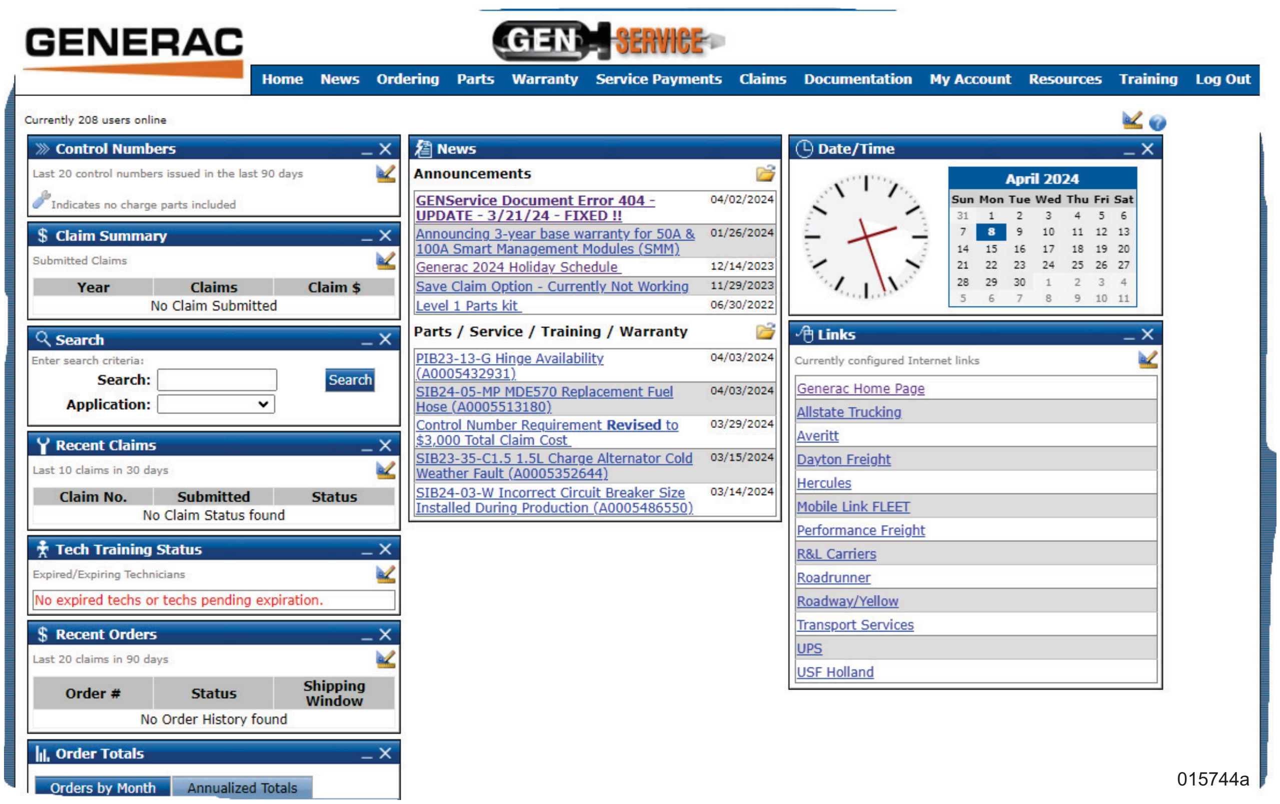


Figure A-3. Documentation Tab

3. Click on “Service Documents”.
4. See ***Figure A-4***. On the left side of the display, click “Air-Cooled Firmware” to open folder.

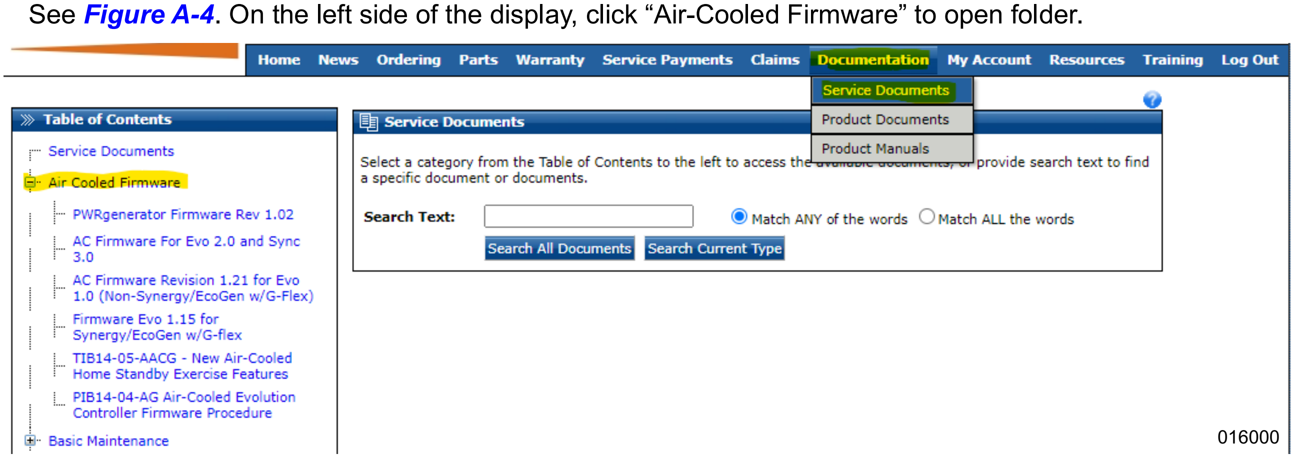
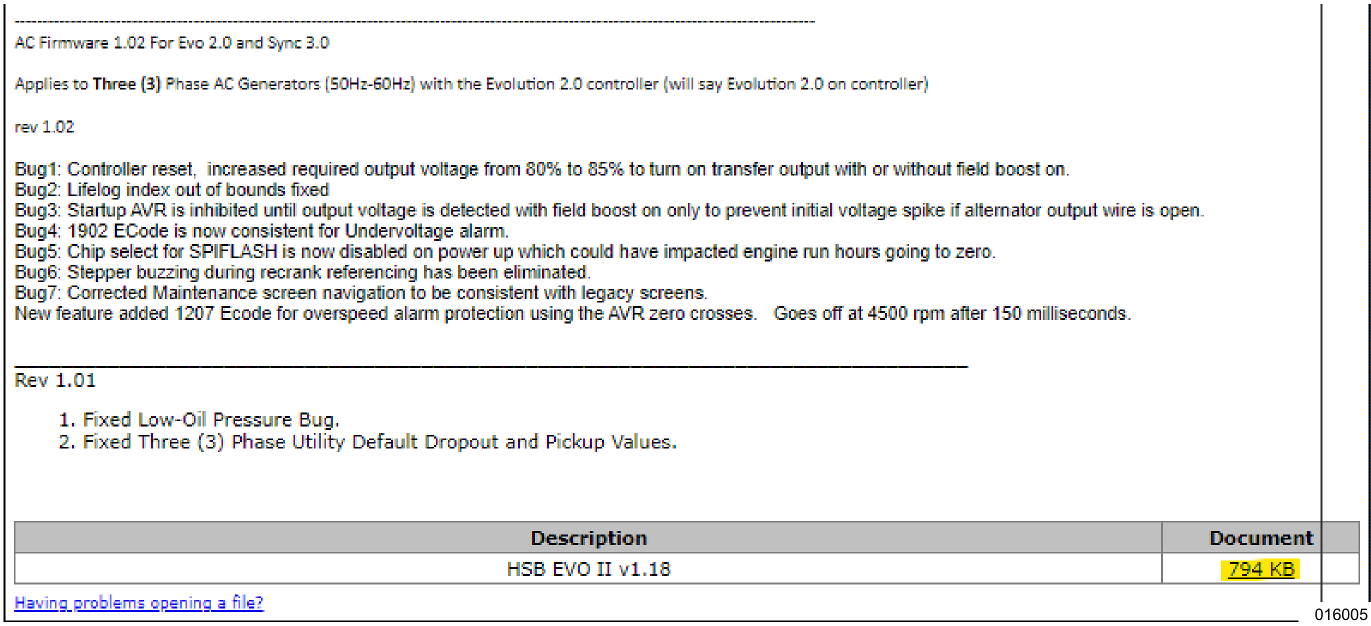


Figure A-4. Air-Cooled Firmware Location

5. Click the latest appropriate firmware (ex: “Air-Cooled Evolution Firmware Upgrade Version 1.07"). File information may vary depending on which firmware is downloaded.

6. See ***Figure A-5***. Click blue document file size.


AC Firmware 1.02 For Evo 2.0 and Sync 3.0

Applies to **Three (3)** Phase AC Generators (50Hz-60Hz) with the Evolution 2.0 controller (will say Evolution 2.0 on controller)

rev 1.02

Bug1: Controller reset, increased required output voltage from 80% to 85% to turn on transfer output with or without field boost on.
Bug2: Lifelog index out of bounds fixed
Bug3: Startup AVR is inhibited until output voltage is detected with field boost on only to prevent initial voltage spike if alternator output wire is open.
Bug4: 1902 ECode is now consistent for Undervoltage alarm.
Bug5: Chip select for SPIFLASH is now disabled on power up which could have impacted engine run hours going to zero.
Bug6: Stepper buzzing during recrank referencing has been eliminated.
Bug7: Corrected Maintenance screen navigation to be consistent with legacy screens.
New feature added 1207 Ecode for overspeed alarm protection using the AVR zero crosses. Goes off at 4500 rpm after 150 milliseconds.

Rev 1.01

1. Fixed Low-Oil Pressure Bug.
2. Fixed Three (3) Phase Utility Default Dropout and Pickup Values.

Description	Document
HSB EVO II v1.18	794 KB

Having problems opening a file?

016005

Figure A-5. Air-Cooled Firmware Document File Size

7. See ***Figure A-6***. Click “Open”.

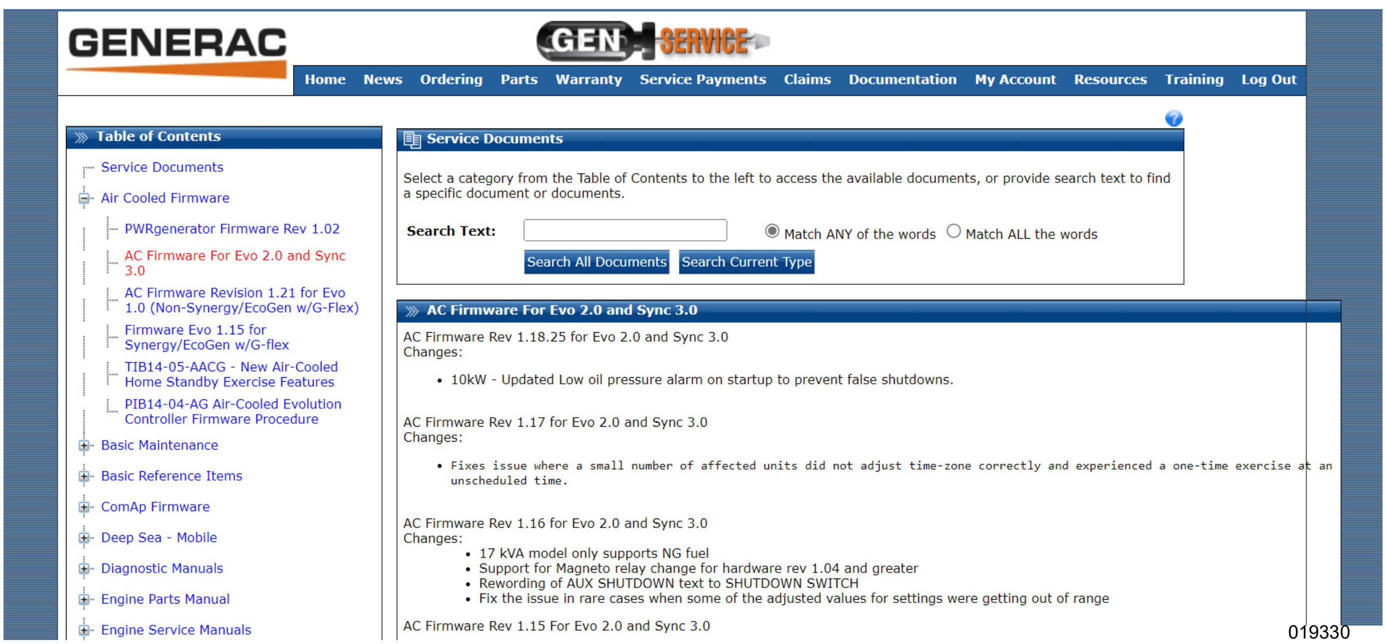


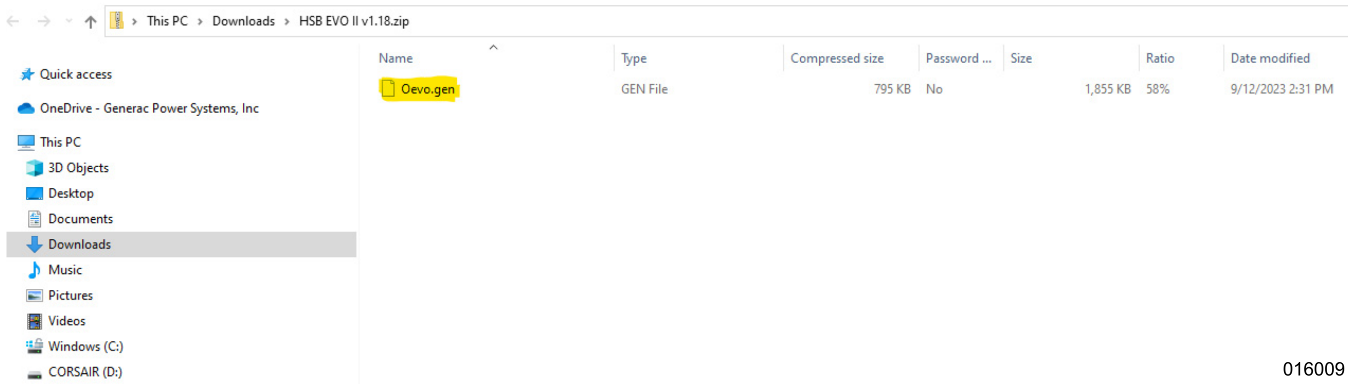
Figure A-6.

8. This will open as a .zip file.

9. Click **once** to highlight the appropriate firmware folder.

IMPORTANT NOTE: Do not double click or open the firmware file. Doing so may corrupt it!

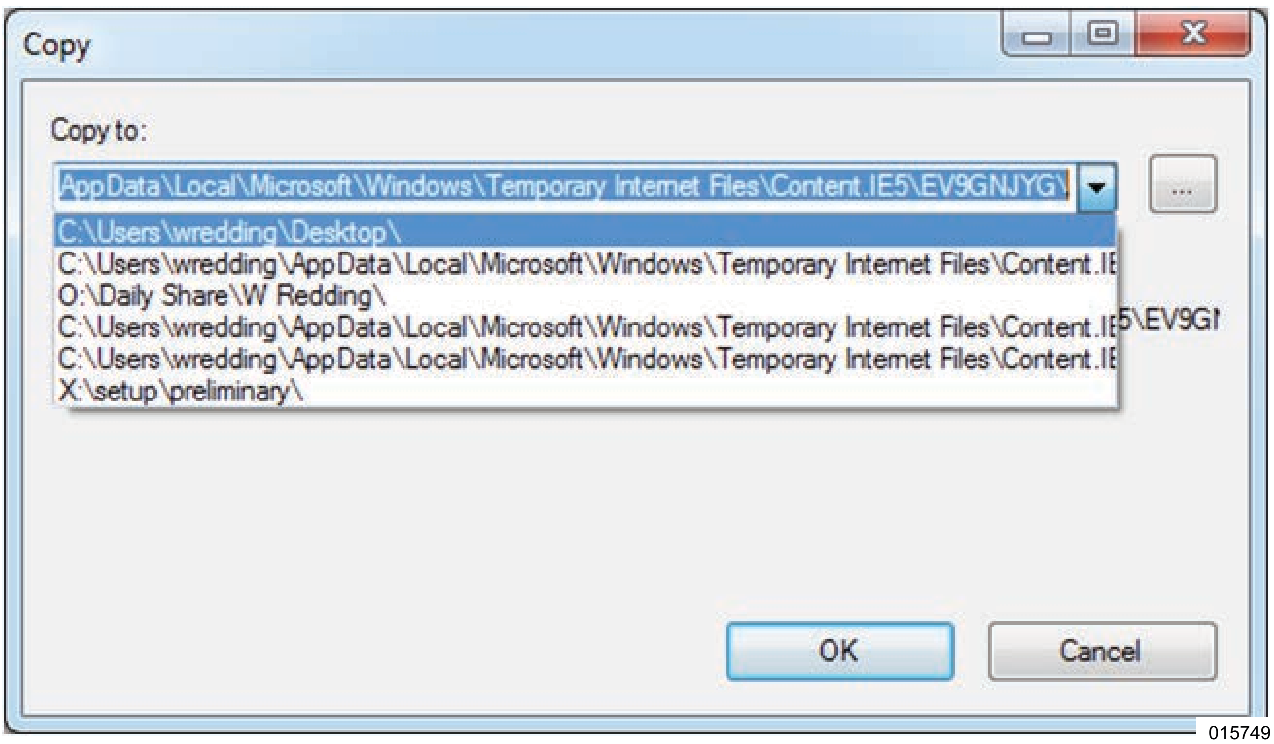
10. See ***Figure A-7***. Click “Extract”.



016009

Figure A-7. Click Extract

11. See ***Figure A-8***. Copy to "Desktop" and click "OK". A folder with the matching name will be on your desktop.



015749

Figure A-8. Copy to Desktop

Initiating The Flash Drive

Required Tools

Computer and qualified flash drive

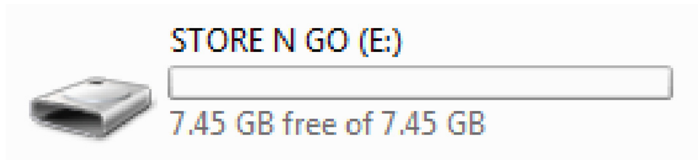
Procedure

1. See ***Figure A-9***. Insert flash drive into a USB port of the computer. When installing the flash drive to the computer, it will go through the initialization of the drivers for the new flash drive.

015750

Figure A-9. Installing Flash Drive

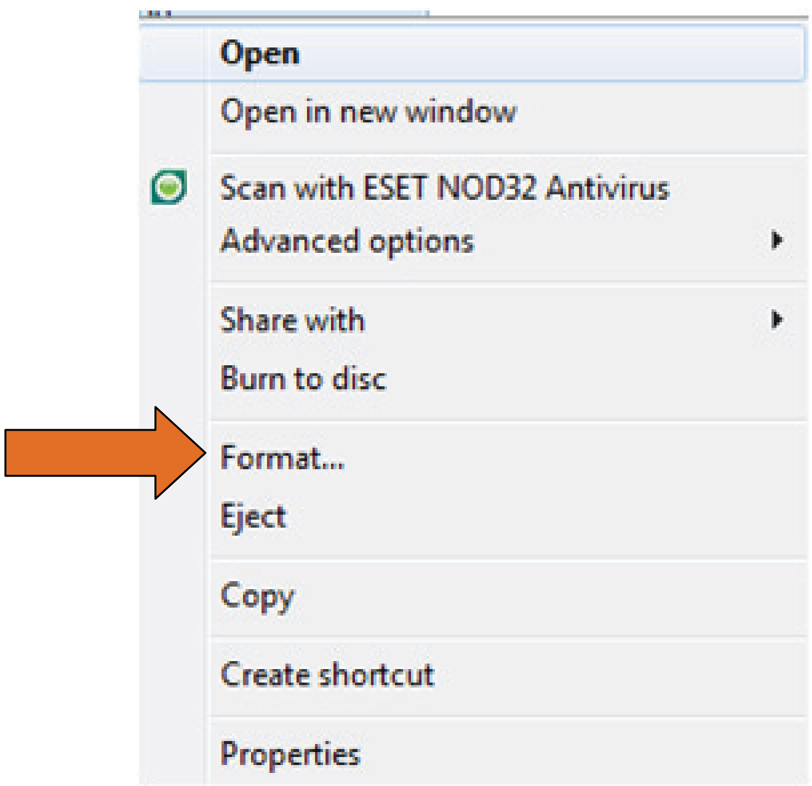
2. Once the drivers have been loaded and the system recognizes the drive, format the new flash drive to insure compatibility and Firmware update operation.
3. See ***Figure A-10***. Depending on the operating system for the computer, locate the recently attached flash drive (see the example below).



015751

Figure A-10. Locate Flash Drive

4. See ***Figure A-11***. Right click the drive. This brings up a sub menu shown below. Select “Format”.



015752

Figure A-11. Select Format

NOTE: Not all operating systems (OS) offer FAT32 as a file type. See OS manufacturers reference informa- tion for assistance.

5. See ***Figure A-12***. The Format menu will appear. Be sure the file system “FAT32” is selected, as “eXFAT” will not work.

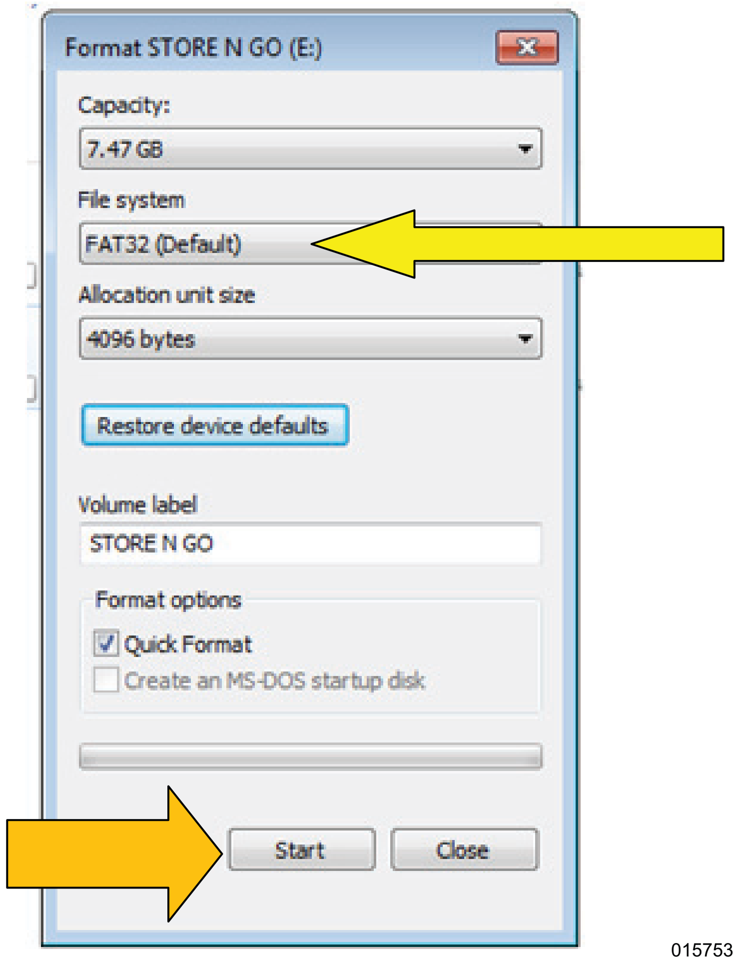
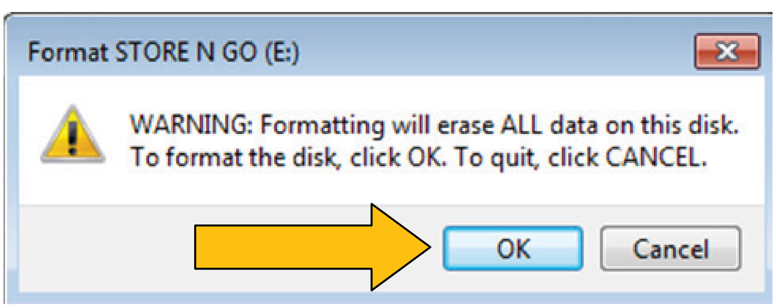


Figure A-12. Format Menu

6. With the correct file system selected, select “Start” to begin the process.

NOTE: See Figure 13. A warning will display. Select “OK” when ready.

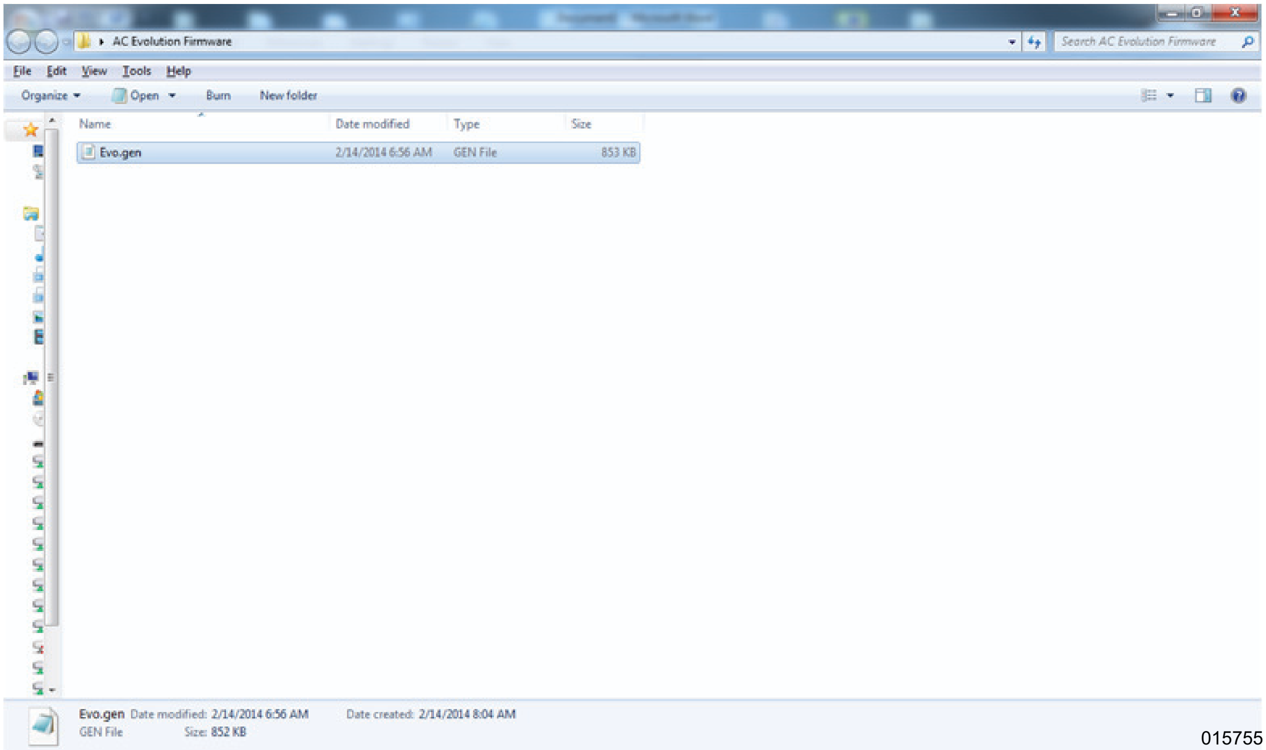


015754

Figure A-13. Select OK

7. Once the format is completed click “Close” on the Format screen. The flash drive is now correctly formatted and ready for file transferring.
8. Click and open the folder on the desktop.
9. See Figure 14. Click once to highlight the file and right click the mouse and “Copy”.

IMPORTANT NOTE: Do not double click or open the firmware file. Doing so may corrupt it!



015755

Figure A-14. Highlight File and Copy

10. See Figure 15 and Figure 16. Paste the firmware file into the empty flash drive and verify the file is now on the flash drive.

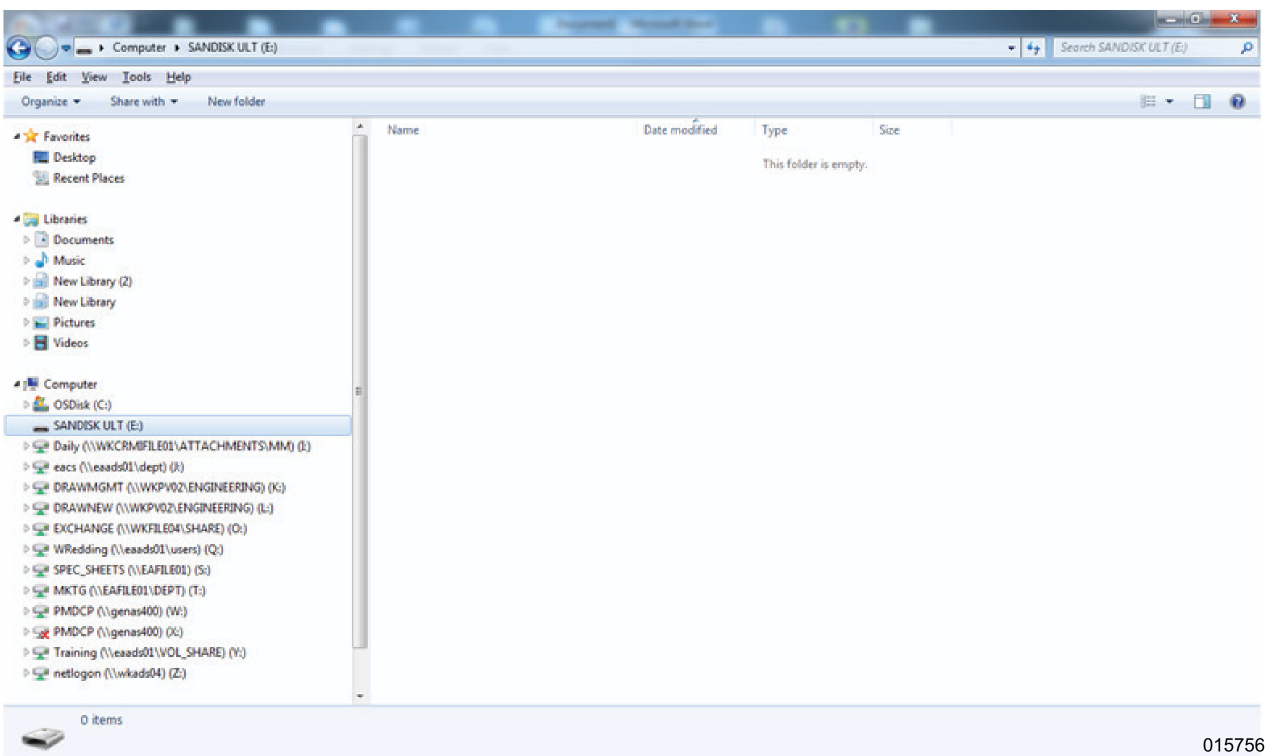


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Figure A-15. Paste File

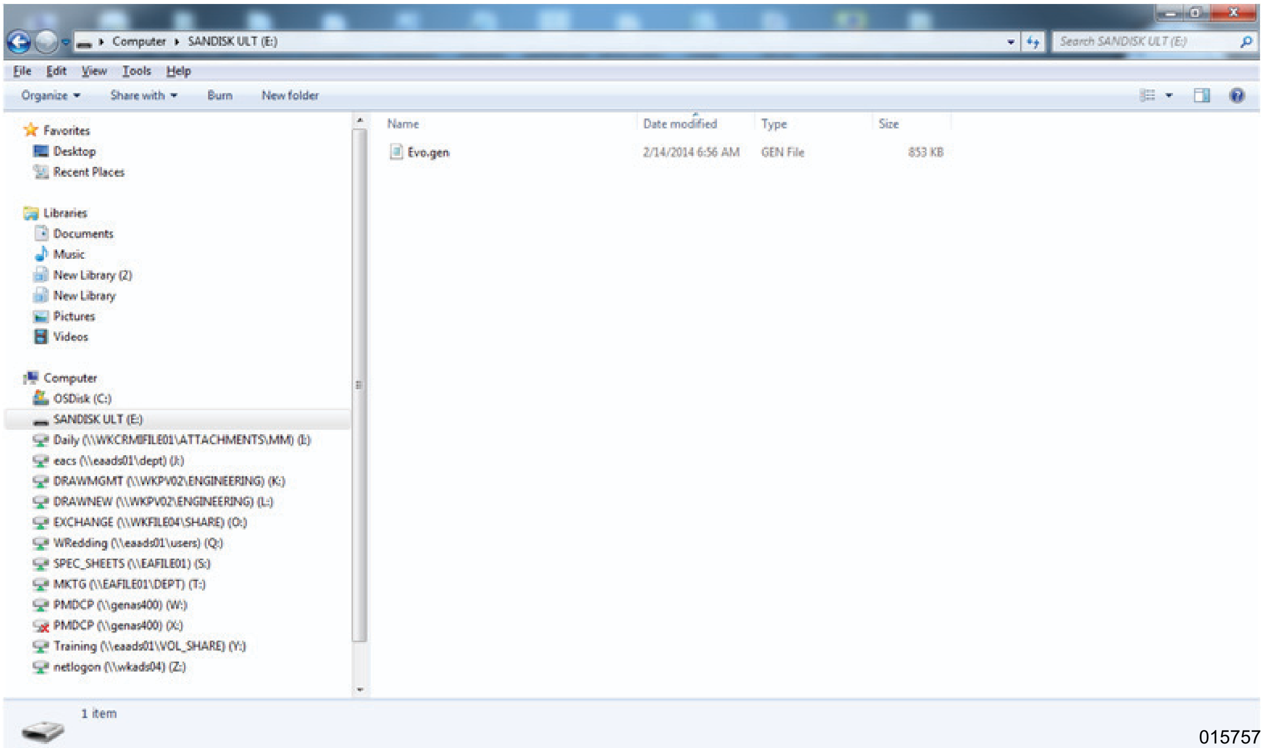

Figure A-16. Verify File

NOTE: Add multiple firmware files to the same USB drive, if necessary. Do not create subfolders. All files must be in the main folder.

11. Eject the flash drive.
12. The flash drive is now ready to download the firmware upgrade into the controller.

NOTE: Reference correct menu map when installing firmware.

IMPORTANT NOTE: The blue “Manual” light will flash, then the green “Auto” light flashes. It does this once for firmware (single file), and twice for firmware and hardware (two files).

13. After the Firmware update concludes, follow the “Install Wizard” to verify correct fuel, time and date etc. on the unit. Simulate a power outage to verify the full system is operating correctly.

Air-Cooled Evolution Bootloader Troubleshooting

NOTE: There are three notification LEDs on User Interface (Auto = Green, Manual = Blue, Off = Red). The User Run notification is the Blue LED.

Problem	Correction
• Power Up/Reboot • Flashing User Run Notification LED • **CONTROLLER DOES NOT RUN**	The Bootcode has detected that there is no application or the application is corrupted. The User Run Notification flashing LED is a signal that it cannot proceed with the boot process and it is looking for an application to download. Use the recommended USB flash drive and place a valid “Evo.gen” file in the root directory. Insert it into the controllers USB port and watch for the green LED to flash which indicates the download process has begun.
• Power Up/Reboot – USB Inserted • Flashing User Run Notification LED • **CONTROLLER DOES NOT RUN**	If a USB device with the “Evo.gen” file is inserted, the “Evo.gen” file might be misnamed or not in the root directory.
• Power Up/Reboot – USB Inserted – w/ “Evo.gen” file • Flashing User Run Notification LED – Followed by flashing Green • **CONTROLLER DOES NOT RUN** • **Repeats**	The Bootcode has found the “Evo.gen” file on the stick and has validated it. After downloading the file to the unit, it has detected that the file is corrupt and will not proceed with the boot process and continues to look for an application to download. This is only possible if the flash memory in the controller is defective and the unit cannot be programmed. Replace the controller.
• Power Up/Reboot – USB Inserted – w/ “Evo.gen” file • Flashing User Run Notification LED • Flashing Red LED • **CONTROLLER DOES NOT RUN**	The Bootcode has found the “Evo.gen” file on the stick and has determined that there is a problem with it. It has also detected that there is no application or the application is corrupted in flash. 1. Try reinserting the USB flash drive. 2. Try recopying the file to the USB flash drive. 3. Try using another USB flash drive with a fresh copy of the file. OR The “Evo.gen” file might be fine, but the USB device being used might be unsupported. Use the recommended USB flash drive.
• Power Up/Reboot – USB Inserted – w/ “Evo.gen” file • Flashing User Run Notification LED • Flashing Red LED • **CONTROLLER RUNS OLD APPLICATION**	The Bootcode has found the “Evo.gen” file on the flash drive and has determined that there is a problem with it. It has also determined that the application on the unit is still valid and continues the boot process so the unit can run. The problem that the Bootcode has seen should be reported by the application for a few seconds at the start of the application.

• Attempt download of “Evo.gen” file • **OLD APPLICATION SHOWS “Invalid File” MESSAGE**	The “Evo.gen” file doesn’t have the proper identification in the file and is rejected by the Bootcode. Perhaps the file was renamed? Obtain the recommended USB flash drive and place a valid “Evo.gen” file in the root directory. Insert it into the controllers USB port and watch for the green LED to flash which indicates the download process has begun.
• Attempt download of “Evo.gen” file • **OLD APPLICATION SHOWS “Corrupted File” MESSAGE**	The “Evo.gen” file was CRC tested and it failed. The file has been altered in some way. Obtain the recommended USB flash drive and place a valid “Evo.gen” file in the root directory. Insert it into the controllers USB port and watch for the green LED to flash which indicates the download process has begun.
• Attempt download of “Evo.gen” file • **OLD APPLICATION SHOWS “Unsupported Device” MESSAGE**	The USB device was recognized, but the Bootcode wasn't able to use it correctly. It may have drawn too much current. Obtain the recommended USB flash drive and place a valid “Evo.gen” file in the root directory. Insert it into the controllers USB port and watch for the green LED to flash which indicates the download process has begun.
• Attempt download of “Evo.gen” file • **OLD APPLICATION SHOWS “Unsupported Device” MESSAGE** • **CONTROLLER APPEARS TO “LOCK UP” FOR AN EXTENDED PERIOD**	The over current “software fuse” has been tripped. It resets at about 50 seconds. Remove the device from the USB port and wait, or navigate out of the USB menus and back in to reset. **Do not use unsupported device!**
• Using Evolution Serial Download Tool • Attempt selection of “Evo.gen” file • **TOOL REPORTS AN ERROR WITH THE FILE**	Verify an “Evo.gen” is being selected and not a hex file. It's also possible that the file has become corrupted in some way. Obtain the recommended USB flash drive and place a valid “Evo.gen” file in the root directory.
• Attempt download of “Evo.gen” file – Know file is valid • **CONTROLLER RUNS OLD APPLICATION**	Verify there is only one file in the root directory of the flash drive. If it takes too long to find the “Evo.gen” file, the boot process can time out and will jump to the already loaded code.

How To Diagnose Oil Leaks On Air-cooled Generators

From SIB13-06-AAC

June 2013 Rev. B

Special Tools Required: Oil, Inspection Mirror, Flashlight, Oil Dye Kit or UV Oil Leak Kit

Procedure

1. Start by first checking that the unit is not overfilled with oil by checking the dip stick. Overfilling an engine with oil can cause oil to leak.
2. Inspect the enclosure for any patterns to the oil leak. If possible, try to trace the oil back to a generalized location. If able to determine a general origin, skip to step 5. If more investigation is needed, proceed to the next step.
3. Clean the entire enclosure/engine of oil. A non-chlorinated brake cleaner will do a good job of this. This will help to trace back any new oil leaks. After cleaning the engine, look for a presence of oil that was not there prior to cleaning. If new oil leakage becomes apparent, trace it back to a generalized location and proceed to step 5. If the unit is not leaking oil while in the “off” mode, you will need to go to the next step and run it in the “manual” mode to make it leak. Using an oil dye may make it easier to trace back a difficult leak. The dye will go in with the oil to create a stain on the block. A UV dye will also stain the block, but that stain will illuminate under UV illumination. The oil that is shipped in new generators has a UV dye already in the oil. Follow manufacturer’s directions when using these leak detection kits.
4. Make sure that the engine oil is up to the “full” mark on the dip stick. Run the generator in the “manual” mode and look for any leakage that occurs while running the unit. While the unit is running, you will be able to see the direction from which any leaked oil is coming. If still unable to see the source of the leak, it may require further disassembly, which is outlined in the next step.
5. Follow proper safety protocols and begin disassembly (if necessary). If oil is being blown all over the engine, it is likely that it is coming from somewhere below the blower housing, which will require removal of the blower housing and possibly the flywheel. If it is going into the alternator but is not coming from the flywheel side of the engine, it will require removal of the rotor/stator.

NOTE: It may be necessary to use an inspection mirror and flashlight for hard to view areas.

* The following picture shows an oil dye (non-UV type) used to find the source of a small oil leak that only occurred while the unit was running. The addition of this oil dye helped to trace back the oil to its point of origin which, in this case, was a tiny pinhole in the alternator side of the engine block.

Possible Sources of Oil Leaks:

1. **Crankshaft Seals:** The crank shaft seal creates an oil barrier between the crank shaft and the case. There is one on either side of the crank shaft. If this seal is nicked, malformed, cracked, or improperly installed, oil can leak past the crank shaft. Crank seal failures typically cause very large amounts of oil to leak. They leak much more heavily when the engine is running than they do when it is not running. The front crank shaft seal can cause oil to dissipate onto the front face of the engine. This oil will be blown onto the sides of the engine by the flywheel fan while running. Rear crank shaft seals can cause oil to dissipate into the inside of the stator. These failures typically cause a leak that is not apparent on any other sides of the engine other than the stator side. Leakage normally occurs between the rotating shaft and the seal. Leakage can also take place between the outer edges of the seal and the mating surfaces of the crankcase bore. UV leak dye is particularly effective finding these types of leaks. See Figure 1.

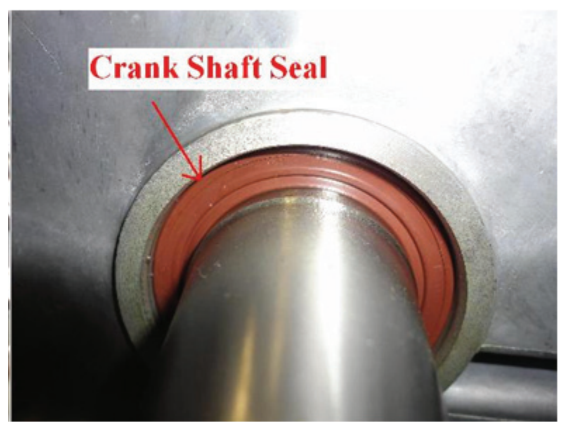

Figure B-1. Crankshaft Seal

2. **Breather:** The oil breather can fail in several ways. The breather itself can fail, causing oil to leak out of the breather. The breather gasket can fail, which will let oil out past the breather assembly. The screws that secure the breather and gasket to the engine can back out, causing the seal to be weak. Breather leaks only occur while the engine is running. See ***Figure B-2***.

Figure B-2. Oil Breather Leak

3. **Oil cooler/Oil cooler lines:** There are several spots on the oil cooler that are susceptible to leaks. The hoses themselves can have a defect that may cause them to leak. The hoses may also leak oil past the Oetiker clamps that hold them secure. The brass fittings that connect the engine case to the oil cooler hoses may also leak if the seal is not oil-tight.
4. **Crank Case Gasket:** Crank case gasket failures will typically cause a slow to medium leak that occurs while the engine is both running and not running. The dominant characteristic of a case gasket leak is that it “seeps”. The best way to confirm a case gasket leak is to clean the engine and run an oil dye in it. The stain from the oil dye will be very apparent as the oil seeps out between the case. If a case gasket leak is found, confirm that all of the engine case bolts are tightened to spec. See Figure 3.

Figure B-3. Crankcase Leakage Location

5. **Low Oil Switch:** A leaking low oil switch will leak slowly while the engine is off and will leak more heavily when the unit is running and the oil system is under pressure. This leak can be easily found by cleaning the engine and running it until oil is apparent near the low oil switch.
6. **Engine Block Defect:** A crack in the engine block will have different symptoms depending on where it is. These are most easily pinpointed by using an oil dye. ***Figure B-4*** shows a pinhole in an engine block seen with an oil dye.

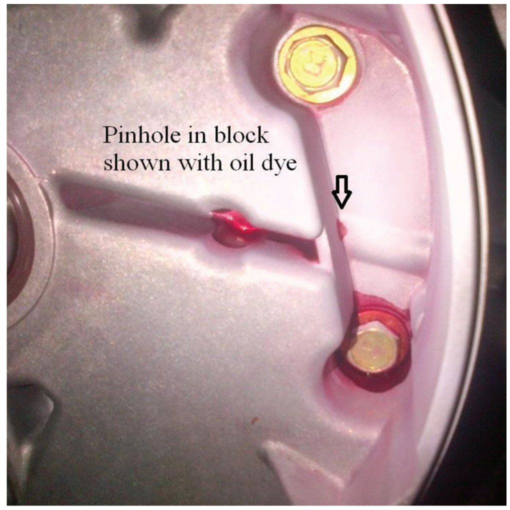

Figure B-4. Oil dye Usage

7. **Oil Drain Hose/Drain Hose Fitting:** The oil drain hose may leak at the fitting, the hose itself, or at the cap if it is not tightened securely. They may occur while the engine is running or while the engine is off. These leaks are most easily found by cleaning the engine and letting it sit/run until the leak appears.
8. **Oil Filter:** Oil filter leaks will leak slowly while the engine is off and will leak more heavily when the unit is running and the oil system is under pressure. This leak can be easily found by cleaning the engine and running it until oil is apparent near the filter.
9. **Oil Filter Adapter Gasket (8kw and 10kw units):** Oil Filter adapter leaks will have the same characteristics of an oil filter leak; however the leak will be sourced behind the oil filter on the gasket between the adapter base and the engine case.
10. **Rear Oil Drain Plugs (Pre-Nexus Units):** There is a small plug on the rear side of previous model 410 and 990 engines. It is located on the back side of the engine opposite the oil drain hose fitting. This plug can leak while the unit is running and while the unit is not running.
11. **Head Gasket:** A head gasket leak will only leak while the unit is running. Oil going through up into the valve cover area would get past this gasket causing oil to leak only while the unit is running. A bad head gasket may cause a low cylinder

compression situation and cause the unit to do poorly on a leak down test. On a leak down test, it may be possible to hear the air escaping out past the head gasket. The unit may also show excessive oil deposits from the muffler/exhaust discharge area.

12. **Valve Cover Gasket:** A head gasket leak will only be active while the unit is running. It may cause some small dripping after the unit has shut down also; but the majority of oil will leak while the unit is running. These leaks are easy to find by cleaning the engine off and running it until oil is visible near the valve cover gasket.
13. **Dip Stick O-Ring:** There is an o-ring at the base of the dip stick tube. If this gasket fails, oil will seep out near the base of the dip stick while the unit is running. This leak can be easily found by cleaning the oil off and running the unit until oil comes out near the base of the dip stick.

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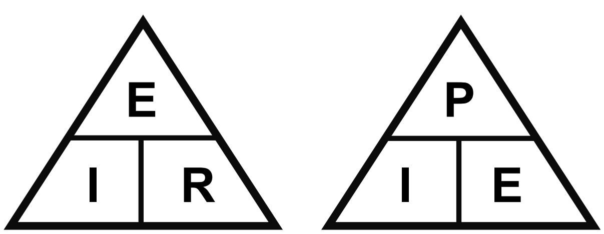
Electrical Formulas

To Find	Known Values	1-phase	3-phase
Kilowatts (kW)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73 \times PF}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73}{1000}$
Amperes	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$	$\frac{kW \times 1000}{E \times 1.73 \times PF}$
Watts	Volts, Amps, Power Factor	Volts x Amps	E x I x 1.73 x PF
No. of Rotor Poles	Frequency, RPM	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$
Frequency	RPM, No. of Rotor Poles	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{\text{Efficiency}}$	$\frac{HP \times 0.746}{\text{Efficiency}}$
Resistance	Volts, Amperes	$\frac{E}{I}$	$\frac{E}{I}$
Volts	Ohm, Amperes	I x R	I x R
Amperes	Ohms, Volts	$\frac{E}{R}$	$\frac{E}{R}$

E = Volts   I = Amperes   R = Resistance (Ohms)   PF = Power Factor

Term	Symbol	Measurement
Current	I	Amps
Wattage	P	Watts
Voltage	E	Volts
Resistance	R	Ohms



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Constant	Shift		Result	
Voltage E	Resistance Increase	⇧	Current Decrease	⇩
Voltage E	Resistance Decrease	⇩	Current Increase	⇧
Resistance R	Voltage Decrease	⇩	Current Decrease	⇩
Resistance R	Voltage Increase	⇧	Current Increase	⇧
Current I	Resistance Decrease	⇩	Voltage Decrease	⇩
Current I	Resistance Increase	⇧	Voltage Increase	⇧
Power P	Voltage Increase	⇧	Power Increase	⇧
Power P	Voltage Decrease	⇩	Power Decrease	⇩
Power P	Current Increase	⇧	Power Increase	⇧
Power P	Current Decrease	⇩	Power Decrease	⇩

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