DIAGNOSTIC
REPAIR
MANUAL

# Air-Cooled Product with Power Zone® 200 Control

GENERAC STANDBY GENERATORS

**⚠ CALIFORNIA WARNING**

This product can expose you to chemicals including benzene, a carcinogen and reproductive toxicant, which are known to the State of California to cause cancer and birth defects or other reproductive harm.

For more information, go to:

www.P65Warnings.ca.gov/

(W000808)

## 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.

## 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. This manual should not be distributed outside of Generac's dealer network.

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 their own nor the product’s 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.

## General Hazards

**⚠ DANGER**

Loss of life. Property damage. Installation must always comply with applicable codes, standards, laws and regulations. Failure to do so will result in death or serious injury. (000190)

**⚠ 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)

**⚠WARNING**

Electrocution. Potentially lethal voltages are generated by this equipment. Render the equipment safe before attempting repairs or maintenance. Failure to do so could result in death or serious injury. (000187)

**⚠WARNING**

Loss of life. This product is not intended to be used in a critical life support application. Failure to adhere to this warning could result in death or serious injury. (000209b)

**⚠WARNING**

Accidental Start-up. Disconnect the negative battery cable, then the positive battery cable when working on unit. Failure to do so could result in death or serious injury. (000130)

**⚠WARNING**

Equipment damage. Only qualified service personnel may install, operate, and maintain this equipment. Failure to follow proper installation requirements could result in death, serious injury, and equipment or property damage. (000182a)

**⚠WARNING**

Equipment damage. This unit is not intended for use as a prime power source. It is intended for use as an intermediate power supply in the event of temporary power outage only. Doing so could result in death, serious injury, and equipment damage. (000247a)

**⚠WARNING**

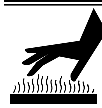
Electric shock. Only a trained and licensed electrician should perform wiring and connections to unit. Failure to follow proper installation requirements could result in death, serious injury, and equipment or property damage. (000155a)

**⚠WARNING**

Moving Parts. Do not wear jewelry when starting or operating this product. Wearing jewelry while starting or operating this product could result in death or serious injury. (000115)

**⚠WARNING**

Moving Parts. Keep clothing, hair, and appendages away from moving parts. Failure to do so could result in death or serious injury. (000111)



**⚠WARNING**

Hot Surfaces. When operating machine, do not touch hot surfaces. Keep machine away from combustibles during use. Hot surfaces could result in severe burns or fire. (000108)

**⚠WARNING**

Equipment and property damage. Do not alter construction of, installation, or block ventilation for generator. Failure to do so could result in unsafe operation or damage to the generator. (000146)

**⚠WARNING**

Risk of injury. Do not operate or service this machine if not fully alert. Fatigue can impair the ability to operate or service this equipment and could result in death or serious injury. (000215a)

**⚠WARNING**

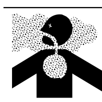
Environmental Hazard. Always recycle batteries at an official recycling center in accordance with all local laws and regulations. Failure to do so could result in environmental damage, death, or serious injury. (000228)

**⚠WARNING**

Injury and equipment damage. Do not use generator as a step. Doing so could result in falling, damaged parts, unsafe equipment operation, and could result in death or serious injury. (000216)

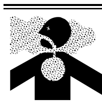
- Inspect the generator regularly, and contact the nearest IASD for parts needing repair or replacement.

## Exhaust Hazards



**⚠ DANGER**

Asphyxiation. Running engines produce carbon monoxide, a colorless, odorless, poisonous gas. Carbon monoxide, if not avoided, will result in death or serious injury. (000103)



**⚠ DANGER**

Asphyxiation. Carbon monoxide can kill in minutes. Operate this unit outdoors only. Failure to do so will cause death or serious injury. (000525)

**⚠WARNING**

Equipment and property damage. Do not alter construction of, installation, or block ventilation for generator. Failure to do so could result in unsafe operation or damage to the generator. (000146)

**⚠WARNING**

Asphyxiation. Always use a battery operated carbon monoxide alarm indoors and installed according to the manufacturer's instructions. Failure to do so could result in death or serious injury. (000178a)

## Electrical Hazards

**⚠DANGER**

Electrocution. Contact with bare wires, terminals, and connections while generator is running will result in death or serious injury. (000144)

**⚠DANGER**

Electrocution. Never connect this unit to the electrical system of any building unless a licensed electrician has installed an approved transfer switch. Failure to do so will result in death or serious injury. (000150)

**⚠DANGER**

Electrical backfeed. Use only approved switchgear to isolate generator from the normal power source. Failure to do so will result in death, serious injury, and equipment damage. (000237)

**⚠DANGER**

Electrocution. Verify electrical system is properly grounded before applying power. Failure to do so will result in death or serious injury. (000152)

**⚠DANGER**

Electrocution. Do not wear jewelry while working on this equipment. Doing so will result in death or serious injury. (000188)

**⚠DANGER**

Electrocution. Water contact with a power source, if not avoided, will result in death or serious injury. (000104)

**⚠DANGER**

Electrocution. In the event of electrical accident, immediately shut power OFF. Use non-conductive implements to free victim from live conductor. Apply first aid and get medical help. Failure to do so will result in death or serious injury. (000145)

## Fire Hazards

**⚠WARNING**

Fire hazard. Do not obstruct cooling and ventilating airflow around the generator. Inadequate ventilation could result in fire hazard, possible equipment damage, death or serious injury. (000217)

**⚠WARNING**

Fire and explosion. Installation must comply with all local, state, and national electrical building codes. Noncompliance could result in unsafe operation, equipment damage, death, or serious injury. (000218)

**⚠WARNING**

Fire hazard. Use only fully-charged fire extinguishers rated "ABC" by the NFPA. Discharged or improperly rated fire extinguishers will not extinguish electrical fires in automatic standby generators. (000219)

**⚠WARNING**

Electrocution. Refer to local codes and standards for safety equipment required when working with a live electrical system. Failure to use required safety equipment could result in death or serious injury. (000257)

**⚠WARNING**

Risk of Fire. Unit must be positioned in a manner that prevents combustible material accumulation underneath. Failure to do so could result in death or serious injury. (000147)

Comply with regulations the local agency for workplace health and safety has established. Also, verify that the generator is installed in accordance with the manufacturer's instructions and recommendations. Following proper installation, do nothing that might alter a safe installation and render the unit in noncompliance with the aforementioned codes, standards, laws, and regulations.

## Explosion Hazards

**⚠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)

**⚠DANGER**

Explosion and fire. Connection of fuel source must be completed by a qualified professional technician or contractor. Incorrect installation of this unit will result in death, serious injury, and property and equipment damage. (000151a)

**⚠DANGER**

Risk of fire. Allow fuel spills to completely dry before starting engine. Failure to do so will result in death or serious injury.

(000174)

**⚠WARNING**

Risk of Fire. Hot surfaces could ignite combustibles, resulting in fire. Fire could result in death or serious injury.

(000110)

## Battery Hazards

**⚠DANGER**

Electrocution. Do not wear jewelry while working on this equipment. Doing so will result in death or serious injury.

(000188)

**⚠WARNING**

Explosion. Do not dispose of batteries in a fire. Batteries are explosive. Electrolyte solution can cause burns and blindness. If electrolyte contacts skin or eyes, flush with water and seek immediate medical attention.

(000162)

**⚠WARNING**

Explosion. Batteries emit explosive gases while charging. Keep fire and spark away. Wear protective gear when working with batteries. Failure to do so could result in death or serious injury.

(000137a)

**⚠WARNING**

Electrical shock. Disconnect battery ground terminal before working on battery or battery wires. Failure to do so could result in death or serious injury.

(000164)

**⚠WARNING**

Risk of burns. Batteries contain sulfuric acid and can cause severe chemical burns. Wear protective gear when working with batteries. Failure to do so could result in death or serious injury.

(000138a)

**⚠WARNING**

Risk of burn. Do not open or mutilate batteries. Released electrolyte solution has been known to be harmful to the skin and eyes and to be toxic. If electrolyte contacts skin or eyes, flush with water and seek immediate medical attention.

(000163b)

Always recycle batteries in accordance with local laws and regulations. Contact your local solid waste collection site or recycling facility to obtain information on local recycling processes. For more information on battery recycling, visit Call2Recycle website at: ***http://Call2Recycle.org/locator***.

## General Rules

**⚠DANGER**

Loss of life. Property damage. Installation must always comply with applicable codes, standards, laws and regulations. Failure to do so will result in death or serious injury.

(000190)

**⚠DANGER**

Electrical backfeed. Use only approved switchgear to isolate generator from the normal power source. Failure to do so will result in death, serious injury, and equipment damage.

(000237)

**⚠WARNING**

Equipment damage. Only qualified service personnel may install, operate, and maintain this equipment. Failure to follow proper installation requirements could result in death, serious injury, and equipment or property damage.

(000182a)

**⚠WARNING**

Electrocution. Refer to local codes and standards for safety equipment required when working with a live electrical system. Failure to use required safety equipment could result in death or serious injury.

(000257)

**⚠WARNING**

Consult Manual. Read and understand manual completely before using product. Failure to completely understand manual and product could result in death or serious injury.

(000100a)

- Follow all safety precautions in the owner's manual, installation guidelines manual, and other documents included with the equipment.
- Never energize a new system without opening all disconnects and breakers.
- Always consult local code for additional requirements for where unit is being installed.
- Incorrect installation can result in personal injury and damage to the unit. It may also result in the warranty being suspended or voided. All instructions listed below must be followed including location clearances and pipe sizes.

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# Section 1 General Troubleshooting Guidelines

## 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.

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:

- J7 breakout harness
- General mechanics tool box
- A 1/4” and 3/8” metric and SAE socket set
- Allen wrenches (metric and SAE)
- Wrenches for flywheel nuts
- T30 star bit for enclosure disassembly
- Generator key
- 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 Field Pro app to access the run log of the Power Zone 200 controller to help identify what the controller 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.

### 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 preauthorization. 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 completed tests.

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.

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# Section 2 Generator Specifications

## 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, compression ratio, starter system, oil capacity, operating rpm, and fuel consumption, please refer to the specific unit's spec sheet located at www.generac.com.

**IMPORTANT NOTE: All unit specifications are subject to change.**

### Table 2-1. Generator

| Model | 10 kW | 14 kW | 18 kW | 22 kW | 24 kW | 26 kW | 28 kW |
|---|---|---|---|---|---|---|---|
| Rated voltage | 240 | | | | | | |
| Rated maximum load current (amps) at rated voltage with LP* | 42 | 58 | 75 | 92 | 100 | 108 | 116 |
| Main line circuit breaker (generator disconnect) | 45 amp | 60 amp | 80 amp | 100 amp | | 110 amp | 125 amp |
| Phase | 1 | | | | | | |
| Rated AC frequency | 60 Hz | | | | | | |
| Battery requirement (field supplied) | A0006487350<br>12 volts, AGM Powersport Battery Group BTX20L 310CCA minimum | | | | | | |
| Enclosure | Aluminum | | | | | | |
| Weight (lb / kg) (without battery) | 334 / 156 | 391 / 177 | 426 / 193 | 451 / 205 | 461 / 209 | 524 / 238 | 524 / 238 |
| Normal operating range | This unit is tested to perform within an operating temperature of -20 °F (-29 °C) to 122 °F (50 °C). For areas where temperatures fall below 32 °F (0 °C), a cold weather kit is recommended. When operated above 77 °F (25 °C), there may be a decrease in engine power. | | | | | | |
| These generators are rated in accordance with UL 2200, Safety Standard for Stationary Engine Generator Assemblies, and CSA-C22.2 No. 100-04 Standard for Motors and Generators.<br><br>* NG ratings will depend on specific fuel joules/BTU content. Typical derates are between 10-20% off the LP gas rating. | | | | | | | |

### Table 2-2. Engine

| Model | 10 kW | 14/18 kW | 22–28 kW |
|---|---|---|---|
| Engine type | G-Force™ 400 Series | G-Force™ 800 Series | G-Force™ 1000 Series |
| Number of cylinders | 1 | 2 | 2 |
| Displacement | 459 cc | 817 cc | 997 cc |
| Cylinder block | Aluminum with cast iron sleeve | | |
| Nominal Cylinder Compression ± 15% | 125 psi | 161 psi | 187 psi |
| Recommended spark plug | A0003637864 | | |
| Spark plug gap | 0.020 in (0.508 mm) | | |
| Starter | 12 VDC | | |
| Oil capacity including filter | Approx. 1.4 qt (1.3 L) | Approx. 2.5 qt (2.4 L) | Approx. 2.2 qt (2.1 L) |
| Recommended oil filter | 070185ES | | |
| Recommended air filter | 0E9371AS | 0J8478S | |
| Engine power is subject to and limited by such factors as fuel BTU/joules, ambient temperature, and altitude. Engine power decreases approximately 3.5% for each 1,000 ft (304.8 m) above sea level, and also will decrease approximately 1% for each 10 °F (6 °C) above 60 °F (15 °C) ambient temperature. | | | |

**Table 2-3. 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 | 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 (ohms) 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 2-4. Fuel Consumption***

| Unit | Natural Gas** | | Propane*** | |
|---|---|---|---|---|
| | 1/2 Load | Full Load | 1/2 Load | Full Load |
| 10 kW | 2.86 / 101 | 3.60 / 127 | 0.97 / 3.66 / 36 | 1.48 / 5.62 / 54 |
| 14 kW | 5.35 / 189 | 6.89 / 243 | 1.76 / 6.66 / 63 | 2.92 / 11.03 / 106 |
| 18 kW | 4.65 / 164 | 6.64 / 235 | 1.65 / 6.26 / 60 | 2.87 / 10.87 / 105 |
| 22 kW | 6.27 / 221 | 8.80 / 311 | 2.45 / 9.28 / 89 | 3.71 / 14.03 / 135 |
| 24 kW | 5.58 / 197 | 8.23 / 291 | 2.45 / 9.28 / 89 | 3.71 / 14.03 / 135 |
| 26 kW | 5.16 / 182 | 8.96 / 316 | 2.05 / 7.74 / 74 | 3.95 / 14.94 / 144 |
| 28 kW | 5.15 / 182 | 8.41 / 297 | 2.23 / 8.45 / 81 | 3.97 / 15.02 / 144 |

*Values given are approximate ** Natural gas is in $m^3$/h / $ft^3$/h ***Propane is in gal/h / L/h (LP) / $ft^3$/h (LPV)

## Table 2-5. Torque Specifications

| | | |
|---|---|---|
| Spark plug | 18 ft-lbs | 24 Nm |
| M6.3 Hi-lo into plastic base | 30 **in-lbs** | 3.4 Nm |
| M6.3 Hi-lo into controller | 20 **in-lbs** | 2.2 Nm |
| M8 - 1.25 Nylok nut onto vibration isolator stud | 60 **in-lbs** | 6.8 Nm |
| M8 - 1.25 Stator bolts | 78 **in-lbs** | 8.8 Nm |
| 3/8 - 24 Rotor bolt | 30 ft-lbs | 40 Nm |
| M6 - 1.0 Nut starter motor battery cable - 459cc | 36 **in-lbs** | 4 Nm |
| M8 - 1.25 Nut starter motor battery cable - 817cc–997cc | 84 **in-lbs** | 9.5 Nm |
| M8 - 1.25 Bolt exhaust manifold | 18 ft-lbs | 24 Nm |
| M12 - 1.25 O2 sensor | 13 ft-lbs | 17.6 Nm |
| 60 Hz Breaker terminal screw - #10 wire | 25 **in-lbs** | 2.8 Nm |
| 60 Hz Breaker terminal screw - #8, #6, #4, #3, & #2/0 wire | 45 **in-lbs** | 5 Nm |
| 50 Hz Breaker terminal screw - #8 & #10 wire | 25 **in-lbs** | 2.8 Nm |
| 50 Hz Breaker terminal screw - #6 wire | 45 **in-lbs** | 5 Nm |
| 1/4 - 28 Set screw neutral bus bar | 35 **in-lbs** | 3.9 Nm |
| M5 - 0.8 Nut for neutral bar | 30 **in-lbs** | 3.3 Nm |
| 7/16 - 20 Set screw neutral & ground lug | 10 ft-lbs | 13.5 Nm |
| M6 - 1.0 Grade 8.8 bolt into base threaded inserts | 60 **in-lbs** | 6.8 Nm |
| M6 - 1.0 Grade 8.8 bolt on sediment trap and fuel SOV | 84 **in-lbs** | 9.5 Nm |

## Table 2-5. Torque Specifications

| | | |
|---|---|---|
| M6 - 1.0 Exhaust flex pipe band clamp | 10 ft-lbs | 13.5 Nm |
| M6 - 1.0 Bolt for air-box thru mixer to intake | 96 **in-lbs** | 10.8 Nm |
| M6 - 1.0 Bolt for air-box to valve cover | 78 **in-lbs** | 8.8 Nm |
| M5 - 0.8 Taptite screw into aluminum | 40 **in-lbs** | 4.5 Nm |
| M5 - 0.8 Taptite screw into extruded hole | 35 **in-lbs** | 3.9 Nm |
| M6 - 1.0 Taptite screw into extruded hole | 55 **in-lbs** | 6.2 Nm |
| M8 - 1.25 Taptite screw into extruded hole | 14 ft-lbs | 18.9 Nm |
| M5 - 0.8 Nylok nut | 40 **in-lbs** | 4.5 Nm |
| #10 Hi-lo into plastic | 20 **in-lbs** | 2.2 Nm |
| M5 - 0.8 Bolt stator terminal block cover | 15 **in-lbs** | 1.7 Nm |
| M6 - 1.0 Taptite stator terminal block mounting | 35 **in-lbs** | 3.9 Nm |
| M6 - 1.0 Taptite stator duct mounting | 35 **in-lbs** | 3.9 Nm |
| M6 - 1.0 Taptite screw into intake side roof hinge | 84 **in-lbs** | 9.5 Nm |
| M5 - 0.8 Nylok nut onto stator block | 45 **in-lbs** | 5 Nm |
| 1/4 - 28 T-bolt clamp fuel hose | 78 **in-lbs** | 8.8 Nm |
| 3/4 - 24 Jam nut lock body on crossbar | 60 **in-lbs** | 6.8 Nm |
| 1/4 - 20 Screw for lock pawl to lock body | 40 **in-lbs** | 4.5 Nm |

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

# Component Locator

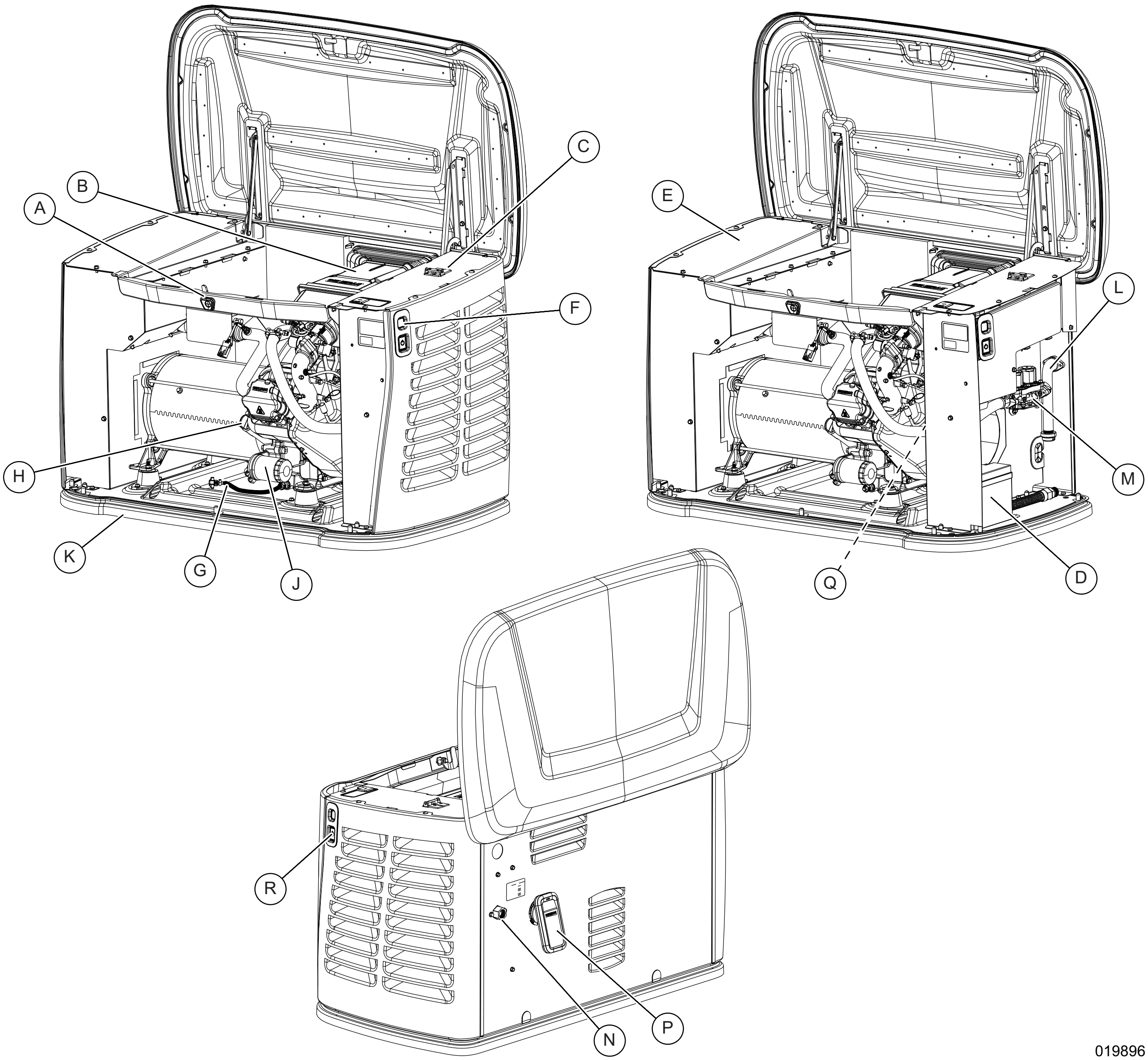


*Figure 2-1. 10 kW—Components and Control Locations*

| | | | | | |
|---|---|---|---|---|---|
| A | Lock with cover | G | Oil drain hose | M | Dual shutoff valve |
| B | Airbox with air cleaner | H | Oil fill cap/dipstick | N | Fuel inlet |
| C | Main line circuit breaker (generator disconnect) | J | Oil filter | P | Connectivity accessory |
| D | Battery compartment (battery not supplied) | K | Composite base | Q | Data decal location |
| E | Exhaust enclosure | L | Sediment trap | R | Generator emergency shutdown switch |
| F | Status LED indicators | | | | |

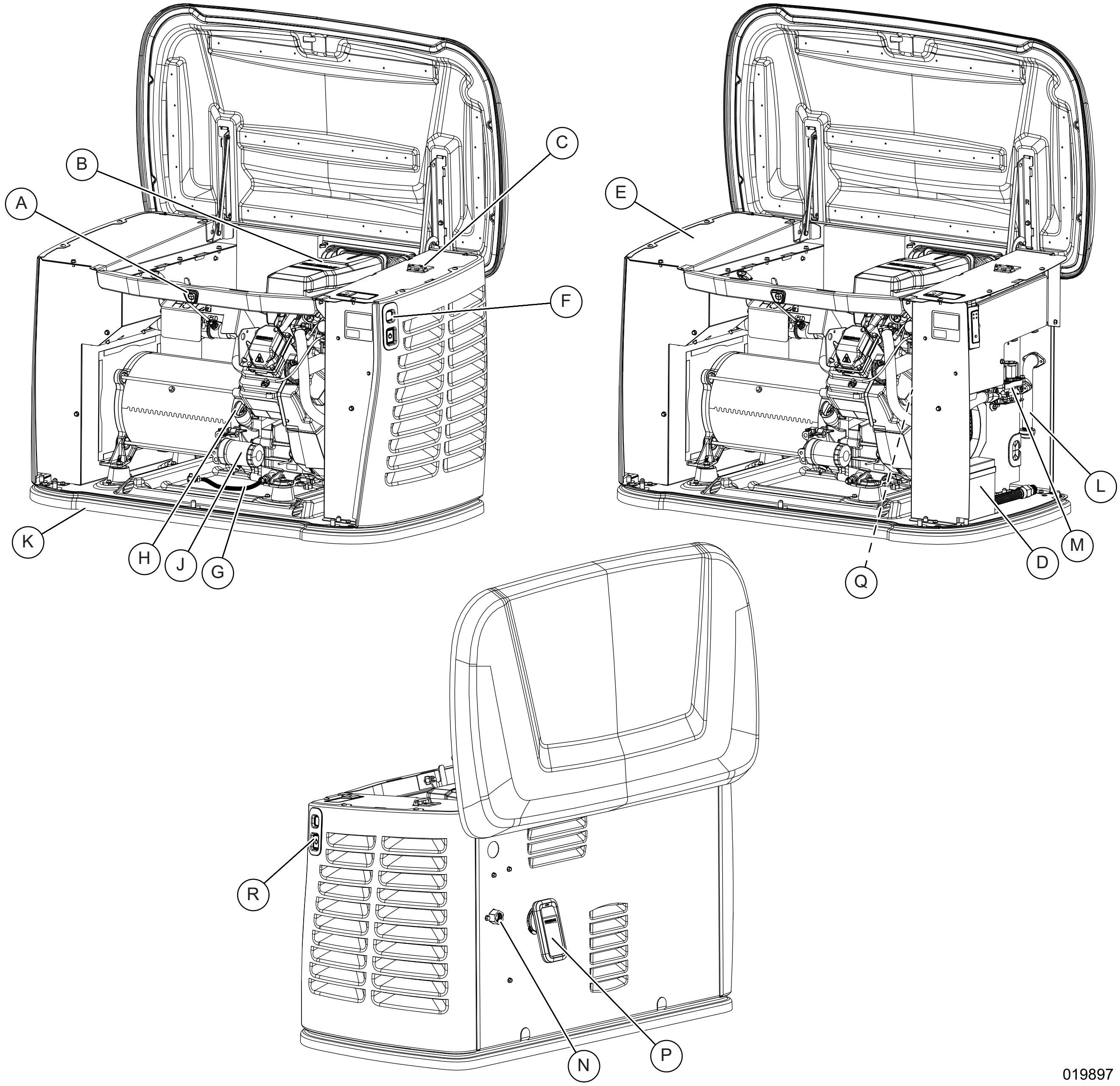


*Figure 2-2. 14 kW–18 kW—Components and Control Locations*

| | | | | | |
|---|---|---|---|---|---|
| A | Lock with cover | G | Oil drain hose | M | Dual shutoff valve |
| B | Airbox with air cleaner | H | Oil fill cap/dipstick | N | Fuel inlet |
| C | Main line circuit breaker (generator disconnect) | J | Oil filter | P | Connectivity accessory |
| D | Battery compartment (battery not supplied) | K | Composite base | Q | Data decal location |
| E | Exhaust enclosure | L | Sediment trap | R | Generator emergency shutdown switch |
| F | Status LED indicators | | | | |

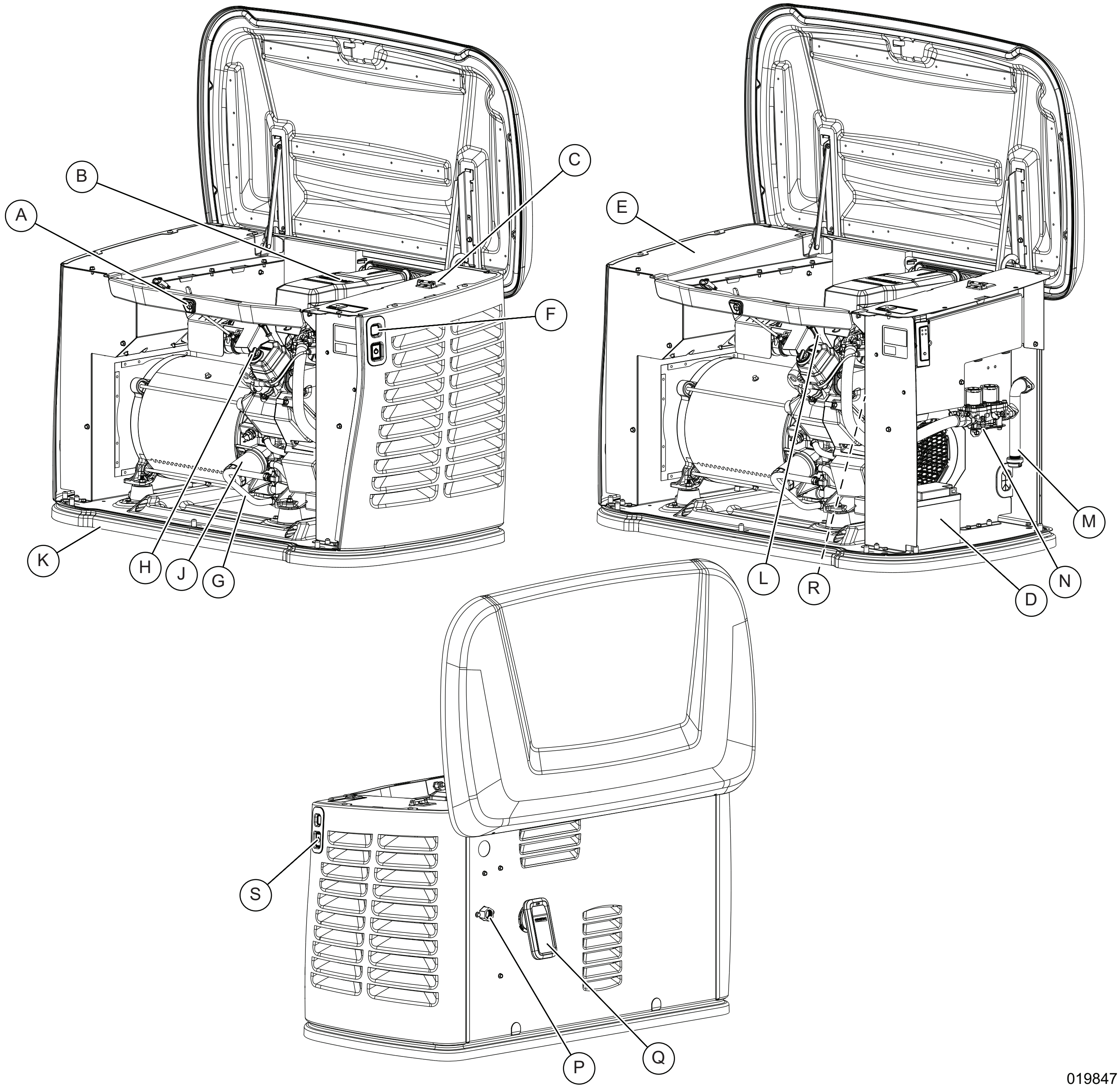


***Figure 2-3. 22 kW–28 kW—Components and Control Locations***

| | | | | | |
|---|---|---|---|---|---|
| A | Lock with cover | G | Oil drain hose | N | Dual shutoff valve |
| B | Airbox with air cleaner | H | Oil fill cap | P | Fuel inlet |
| C | Main line circuit breaker (generator disconnect) | J | Oil filter | Q | Connectivity accessory |
| D | Battery compartment (battery not supplied) | K | Composite base | R | Data decal location |
| E | Exhaust enclosure | L | Oil dipstick | S | Generator emergency shutdown switch |
| F | Status LED indicators | M | Sediment trap | | |

## Controller E-Codes

**NOTE:** For any Displayed Alarm in the Field Pro app, use the Action Step as a starting point.

| Displayed Alarm | Alarm/ Warning | E-Code | Condition Description | Action Step |
|---|---|---|---|---|
| Missing Config - Parameter Group | ALARM | 502 | Generator Model not selected, finish setup. | Call Technical support. |
| Missing Config - Fuel Type | ALARM | 504 | Generator fuel not selected, finish setup. | |
| Invalid Serial Number | ALARM | 505 | Invalid serial number in controller. | |
| Controller Fault | ALARM | 1000 | Controller memory failure. | |
| Controller Fault | ALARM | 1005 | Controller timer failure. | |
| Controller Fault | ALARM | 1006 | Internal Controller alarm. | |
| Overcrank | ALARM | 1100 | Engine cranks but will not start. | Fuel Supply and Pressure Test page 76 |
| Overspeed | ALARM | 1200 | Prolonged, Over 72 Hz for 3 seconds | Engine Speed Test page 70 |
| Overspeed | ALARM | 1205 | Prolonged, Over 75 Hz for 0.1 seconds (100 milliseconds) | |
| Overspeed | ALARM | 1208 | System overspeed from DPE sensing wires. | Call Technical support |
| RPM Sensor | ALARM | 1522 | Crankshaft Position Sensor RPM and DPE Frequency are both measured at 0 after crank command. | Battery and Cables Test page 63 |
| Underspeed | ALARM | 1600 | Unit is Overloaded | Overload Condition Test page 45 |
| Overvoltage | ALARM | 1800 | Prolonged Overvoltage | AC Output Voltage Test page 42 |
| Overvoltage | ALARM | 1801 | Instantaneous Overvoltage | |
| Undervoltage | ALARM | 1900 | Prolonged Undervoltage, Undervoltage due to loss of voltage for some time (10+ seconds). | Preliminary Output Voltage Test page 46 |
| Undervoltage | ALARM | 1901 | Instantaneous Undervoltage, Sudden loss of voltage (Less than 15V after 2 seconds past start-up). | |
| Undervoltage | ALARM | 1902 | Both Zero Crosses Missing. No voltage for over 1.5 seconds. | |
| Undervoltage | ALARM | 1906 | Single Zero Cross Missing. Zero cross missing for more 1.5 seconds. | |
| Undervoltage | ALARM | 1907 | After attempting to shed load, the generator remains overloaded. | Overload Condition Test page 45 |
| Keypad Missing | ALARM | 2070 | Controller does not recognize keypad presence. | Power cycle unit, if error reoccurs call Technical support. |
| Quadclops Missing | WARNING | 2075 | Controller does not recognize external LED indicators. | |
| Model ID Sync Failed | WARNING | 2090 | Communication failure between controller/radio/ECM. | Call Technical support. |
| Wiring Error | ALARM | 2094 | DC Wires 395A/B sees AC power. | Verify customer wiring to ATS/ Generator. |
| Fuel Type Sync Failed | WARNING | 2095 | Communication failure between controller/radio/ECM for fuel type. | Call Technical support. |
| Wiring Error | ALARM | 2098 | Wiring error, low voltage on 194, look for short or overload condition. | Transfer Control Wires Test page 92 |

| Displayed Alarm | Alarm/ Warning | E-Code | Condition Description | Action Step |
|---|---|---|---|---|
| Wiring Error | ALARM | 2099 | DC Wires 194/23 sees AC power. | Verify customer wiring to ATS/ Generator. |
| Overload Remove Load | ALARM | 2100 | Controller is detecting an overload condition. Hold off time is dependent on how far field current is above normal operation. | Overload Condition Test page 45 |
| AVR PWM Overload | ALARM | 2115 | AVR sensed overload. | |
| Serial Num Sync Failed | WARNING | 2120 | Communication failure between controller/radio/ECM for Serial number. | Call Technical support. |
| Run Hours Sync Failed | WARNING | 2125 | Communication failure between controller/radio/ECM for run hours. | |
| CANBus Error | ALARM | 2670 | Communication lost between ECM and Controller. | CAN bus Test page 65 |
| No Transfer Detected | WARNING | 2738 | The command to transfer has been issued by the controller, but no transfer has been detected. | Transfer Control Wires Test page 92 |
| Low Battery | WARNING | 2750 | Battery is less than 12.1 Volts for 60 seconds. | Battery and Cables Test page 63 |
| Very Low Battery | ALARM | 2751 | Battery voltage level less than 9.0 Volts for 60 seconds. | |
| Battery Problem | WARNING | 2760 | More than 16 Volts of battery voltage or 600 milliamperes of charge current at the end of an 18 hour charge cycle. | AC Battery Charger Test page 61 |
| Charger Warning | WARNING | 2770 | Battery voltage is less than 12.5 Volts after 18 hour charge cycle. | |
| Charger Missing AC | WARNING | 2780 | During charging, AC input to battery charger missing for greater than 3 minutes. | |
| SEEPROM Abuse | WARNING | 2790 | Internal Controller alarm | Power cycle unit, if error reoccurs call Technical support. |
| Emergency Shutdown Pressed | ALARM | 2800 | Emergency Shutdown active. | With unit off. Press and hold the OFF button on the control for 3 seconds to reset or contact Technical support. |
| Auxiliary Shutdown | ALARM | 2801 | Remote Emergency Shutdown active. | Verify remote E-Stop switch is not active, Verify wiring. Once remote E-Stop verified clear E-Stop on generator. With unit off. Press and hold the OFF button on the control for 3 seconds to reset or contact Technical support. |
| ECU Faulted | WARNING | 3000 | ECU faulted | Power cycle unit, if error reoccurs call Technical support. |
| Engine Throttle Valve 1 Position 1 | ALARM | 3100 | The engine throttle valve data received is valid but above normal operating range; high severe level. | Throttle Position Sensor Test page 91 |
| Engine Throttle Valve 1 Position 1 | ALARM | 3101 | The engine throttle valve data received is valid but below normal operating range; high severe level. | |
| Engine Throttle Valve 1 Position 1 | ALARM | 3103 | The engine throttle valve data received is valid but above normal operating range. Throttle Position signal voltage read above 4900 mV. | |
| Engine Throttle Valve 1 Position 1 | ALARM | 3104 | The engine throttle valve data received is valid but below normal operating range. Throttle Position signal voltage read below 250 mV | |
| Engine Throttle Valve 1 Position 1 | ALARM | 3107 | The engine throttle valve mechanical system does not respond as commanded. | Electronic Throttle Control Power Test page 68 |
| Engine Throttle Valve 1 Position 1 | WARNING | 3115 | The engine throttle valve is receiving voltage but the voltage is above range. | Throttle Position Sensor Test page 91 |
| Engine Throttle Valve 1 Position 1 | WARNING | 3117 | The engine throttle valve is receiving voltage but the voltage is below range. | |

| Displayed Alarm | Alarm/ Warning | E-Code | Condition Description | Action Step |
|---|---|---|---|---|
| Engine Fuel Delivery Pressure | ALARM | 3200 | The fuel pressure is reading above normal range - high severe level. | Fuel Pressure Sensor Test page 73 |
| Engine Fuel Delivery Pressure | ALARM | 3201 | The fuel pressure is reading below normal range - high severe level. | |
| Engine Fuel Delivery Pressure | ALARM | 3203 | The fuel pressure signal is reading above normal range. Signal is reading above 4900 mV. | |
| Engine Fuel Delivery Pressure | ALARM | 3204 | The fuel pressure signal is reading below normal range. Signal is reading below 120 mV | |
| Engine Fuel Delivery Pressure | WARNING | 3215 | The fuel pressure is reading above normal range - least severe level. | |
| Engine Fuel Delivery Pressure | WARNING | 3217 | The fuel pressure is reading below normal range - least severe level. | |
| Engine Oil Pressure | ALARM | 3301 | The engine oil pressure signal is below normal range - high severe level. | Oil Pressure Switch Test page 84 |
| Engine Oil Pressure | ALARM | 3304 | The engine oil pressure signal is reading above normal range. | |
| Engine Intake Manifold #1 Pressure | ALARM | 3400 | The engine intake manifold pressure signal is above normal range - high severe level. | Intake Manifold Pressure Sensor Test page 78 |
| Engine Intake Manifold #1 Pressure | ALARM | 3401 | The engine intake manifold pressure signal is below normal range - high severe level. | |
| Engine Intake Manifold #1 Pressure | ALARM | 3403 | The engine intake manifold pressure signal is reading above normal range. Signal voltage is above 4900 mV. | |
| Engine Intake Manifold #1 Pressure | ALARM | 3404 | The engine intake manifold pressure signal is reading below normal range. Signal voltage is below 250 mV. | |
| Engine Intake Manifold #1 Pressure | WARNING | 3415 | The engine intake manifold pressure signal is reading above normal range - least severe level. | |
| Engine Intake Manifold #1 Pressure | WARNING | 3417 | The engine intake manifold pressure signal is reading below normal range - least severe level. | |
| Engine Intake Manifold 1 Temperature | ALARM | 3500 | The engine intake manifold temperature reading is valid but above normal operating range; high severe level. | Intake Manifold Temperature Sensor Test page 79 |
| Engine Intake Manifold 1 Temperature | ALARM | 3501 | The engine intake manifold temperature reading is valid but below normal operating range; high severe level. | |
| Engine Intake Manifold 1 Temperature | ALARM | 3503 | The engine intake manifold temperature is reading below normal range. Resistance on signal is reading below 100 Ohms. | |
| Engine Intake Manifold 1 Temperature | ALARM | 3504 | The engine intake manifold temperature is reading above normal range. Resistance on signal is reading OL or above 65 kOhms. | |
| Engine Intake Manifold 1 Temperature | WARNING | 3515 | The engine intake manifold temperature reading is valid but above normal operating range; least severe level. | |
| Engine Intake Manifold 1 Temperature | WARNING | 3517 | The engine intake manifold temperature reading is valid but below normal operating range; least severe level. | |

| Displayed Alarm | Alarm/ Warning | E-Code | Condition Description | Action Step |
|---|---|---|---|---|
| Battery Potential / Power Input 1 | ALARM | 3803 | The battery voltage received is above the normal range, high severe level. Battery is reading voltage above 16 volts. | Battery Potential/Power Output 1 Test page 64 |
| Battery Potential / Power Input 1 | ALARM | 3804 | The battery voltage received is below the normal range, high severe level. Battery is reading voltage below 8.5 volts. | |
| Battery Potential / Power Input 1 | WARNING | 3815 | The battery voltage received is above the normal range, least severe level. Battery is reading voltage above 15 volts. | |
| Battery Potential / Power Input 1 | WARNING | 3817 | The battery voltage received is below the normal range, least severe level. Battery is reading voltage below 10 volts. | |
| Engine Position Sensor | ALARM | 4101 | The crankshaft sensor signal is reading below the normal range, high severe level. | Crank Position Sensor Test page 66 |
| Secondary Sync | ALARM | 4201 | The engine timing sensor signal is reading below the normal range, high severe level. | Engine Timing Sensor Test page 71 |
| O2 Sensor | ALARM | 4300 | The O2 sensor data received is valid but above normal operating range; high severe level. | Oxygen Sensor Test page 85 |
| O2 Sensor | ALARM | 4301 | The O2 sensor data received is valid but below normal operating range; high severe level. | |
| O2 Sensor | ALARM | 4303 | The O2 sensor is reading voltage above normal range, may be shorted to high voltage source. | |
| O2 Sensor | ALARM | 4304 | The O2 sensor is reading voltage below normal range. | |
| O2 Sensor | ALARM | 4307 | ECU faulted, exhaust / O2 alarm | Call Technical support |
| O2 Sensor | WARNING | 4315 | The O2 sensor data received is valid but above normal operating range; least severe level. | Oxygen Sensor Test page 85 |
| O2 Sensor | WARNING | 4317 | The O2 sensor data received is valid but below normal operating range; least severe level. | |
| Engine Ignition Coil #1 | ALARM | 4503 | The engine ignition coil 1 voltage data received is valid but above normal range. | Ignition Coil Test page 77 |
| Engine Ignition Coil #1 | ALARM | 4504 | The engine ignition coil 1 voltage data received is valid but below normal range. | |
| Engine Ignition Coil #1 | ALARM | 4507 | The engine ignition coil 1 mechanical system is not responding correctly. | |
| Engine Ignition Coil #2 | ALARM | 4603 | The engine ignition coil 2 voltage data received is valid but above normal range. | |
| Engine Ignition Coil #2 | ALARM | 4604 | The engine ignition coil 2 voltage data received is valid but below normal range. | |
| Engine Ignition Coil #2 | ALARM | 4607 | The engine ignition coil 2 mechanical system is not responding correctly. | |
| Engine Fuel Valve 1 Position | ALARM | 4900 | The fuel mixer position data received is valid but above normal operating range; high severe level. | Fuel Mixer Valve Test page 72 |
| Engine Fuel Valve 1 Position | ALARM | 4901 | The fuel mixer position data received is valid but below normal operating range; high severe level. | |
| Engine Fuel Valve 1 Position | ALARM | 4903 | The fuel mixer position is reading voltage above normal range. Fuel mixer position signal is reading above 4900 mV. | |
| Engine Fuel Valve 1 Position | ALARM | 4904 | The fuel mixer position is reading voltage below normal range. Fuel mixer position signal is reading below 120 mV. | |
| Engine Fuel Valve 1 Position | ALARM | 4907 | The fuel mixer mechanical system is not responding as commanded. | Mixer Valve Power Test page 82 |

| Displayed Alarm | Alarm/ Warning | E-Code | Condition Description | Action Step |
|---|---|---|---|---|
| Engine Fuel Valve 1 Position | WARNING | 4915 | The fuel mixer position data received is valid but above normal operating range; least severe level. | Fuel Mixer Valve Test page 72 |
| Engine Fuel Valve 1 Position | WARNING | 4917 | The fuel mixer position data received is valid but below normal operating range; least severe level. | |
| Engine Speed | ALARM | 5100 | The engine speed data received is valid but above normal operating range; high severe level. | Engine Speed Test page 70 |
| Engine Speed | ALARM | 5101 | The engine speed data received is valid but below normal operating range; high severe level. | |
| Engine Speed | WARNING | 5115 | The engine speed data received is valid but above normal operating range; least severe level. | |
| Engine Speed | WARNING | 5117 | The engine speed data received is valid but below normal operating range; least severe level. | |
| Cylinder Head Temperature 1 | ALARM | 5200 | The cylinder head temperature reading is valid but above normal operating range; high severe level. | Cylinder Head Temperature Sensor Test page 67 |
| Cylinder Head Temperature 1 | ALARM | 5201 | The cylinder head temperature reading is valid but below normal operating range; high severe level. | |
| Cylinder Head Temperature 1 | ALARM | 5203 | The cylinder head temperature is reading resistance above normal range. Resistance on signal is reading above 1.8 M ohms. | |
| Cylinder Head Temperature 1 | ALARM | 5204 | The cylinder head temperature is reading resistance below normal range. Resistance on signal is reading below 15 Ohms. | |
| Cylinder Head Temperature 1 | WARNING | 5215 | The cylinder head temperature reading is valid but above normal operating range; least severe level. | |
| Cylinder Head Temperature 1 | WARNING | 5217 | The cylinder head temperature reading is valid but below normal operating range; least severe level. | |
| Engine Fuel Shutoff 2 Control | ALARM | 5303 | The voltage for fuel shutoff signal is above nominal. | Fuel Shutoff 2 (SOV2) Control Test page 75 |
| Engine Fuel Shutoff 2 Control | ALARM | 5304 | The fuel shutoff signal is below nominal voltage. Short reading is detected for over 10 seconds or in 6 occurrences. | |
| Engine Oil Level | WARNING | 5415 | Oil level sensor signal is reading high. | Oil Level Sensor Test page 83 |
| Engine Oil Level | WARNING | 5417 | Oil level sensor signal is reading below nominal. | |
| Overload Cooldown | WARNING | 7000 | Unit running in cool down mode due to overload. | Allow unit to finish cooldown, verify load on unit (overload test). |

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## Introduction

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

The diagrams in this section describe the following scenarios:

- ***Utility Source Voltage Available***
- ***Initial Dropout of Utility Source Voltage***
- ***Utility Voltage Failure and Engine Cranking***
- ***Engine Startup and Running***
- ***Transfer to Standby***
- ***Utility Voltage Restored and Re-transfer to Utility***
- ***Engine Shutdown***

## Field Boost

The Power Zone 200 controller has an internal field flash circuit to boost the field. It is tied to the F+ output inside the controller.

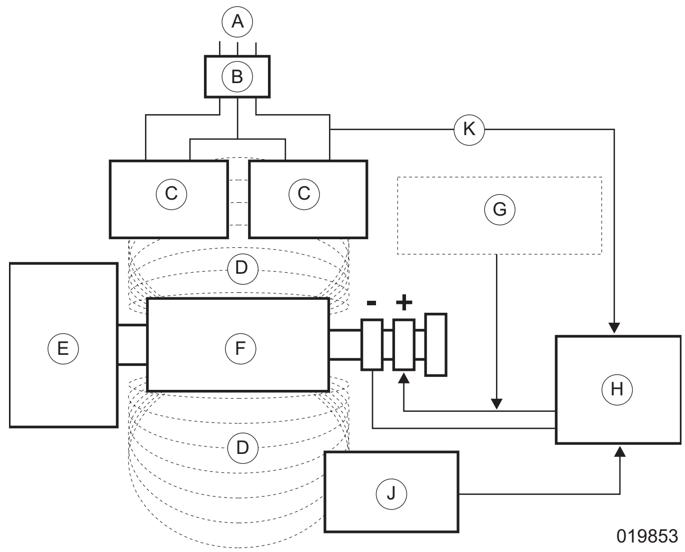
The dedicated field flash relay with logic is separate from and does not involve the start circuit. Depending on the firmware version, the field flash will turn on and off depending on engine speed and system voltage.

Field boost turns on at 3400 rpm. Field boost shuts off when system voltage reaches 80% of nominal (192 VAC on a 240V generator). If nominal voltage is not reached within 15 seconds, the controller will perform a run cycle (up to four minutes) to allow the generator to make a positive connection between the brushes and slip rings. After the run cycle, the generator will automatically shut down and restart once and monitor for voltage for approximately 15 seconds. If the generator is still unable to reach nominal voltage, it will shut down and alarm for undervoltage.

## Operation

### Engine Cranking

See ***Figure 1-1***. Once the engine is running at 3400 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. Field boost magnetism is capable of creating approximately one-half the unit’s rated voltage.




A. To Load
B. Main Line Circuit Breaker
C. Stator Power Winding
D. Magnetic Field
E. Engine - Direct drive
F. Rotor
G. Field Boost Circuit
H. Controller With Internal Automatic Voltage Regulator (AVR)
J. Stator Excitation Winding
K. Sensing

***Figure 1-1. Operating Diagram***

### Field Excitation

AC voltage from the DPE winding provides power to the AVR. The AVR gates and converts AC voltage to DC voltage, and provides regulated variable DC voltage to the rotor through Wires 4 and 0A. When the field flash relay disengages (above 80% of nominal output voltage), the AVR continues to provide 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 the AVR.

See ***Figure 4-2*** and ***Figure 4-3***. 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.

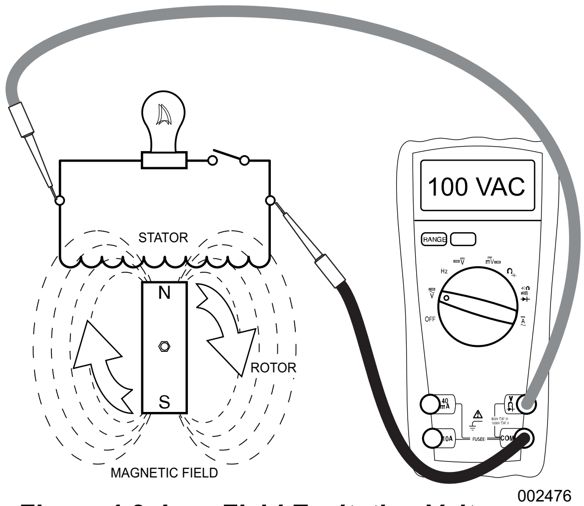



***Figure 4-2. Low Field Excitation Voltage = Low Magnetic Lines of Flux = Low AC Output***

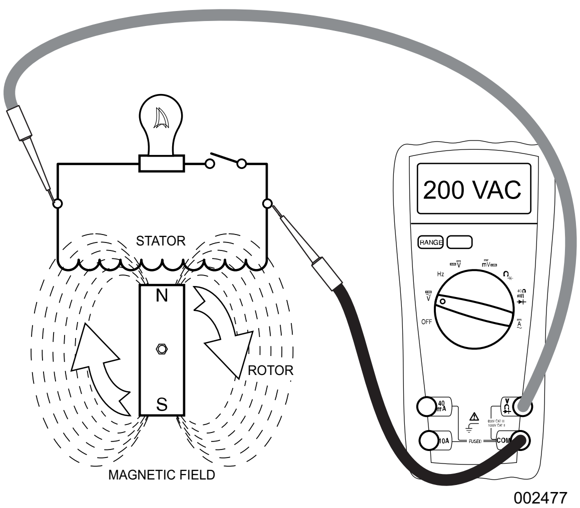



***Figure 4-3. Increased Field Excitation Voltage = Increased Magnetic Lines of Flux = Increased AC Output Voltage***

## 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 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.

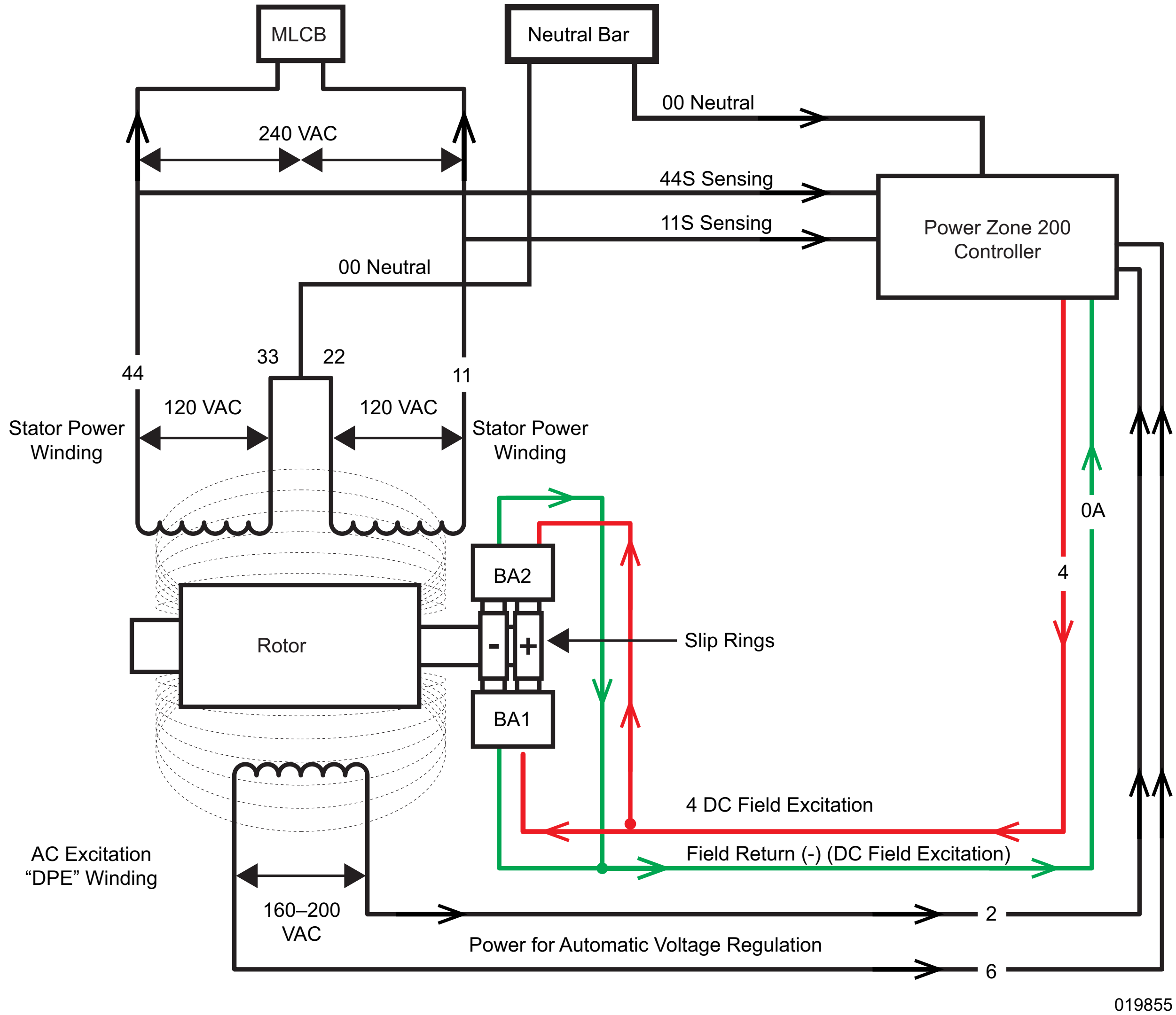



***Figure 4-4. Voltage Regulator Schematic***

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

# Utility Source Voltage Available

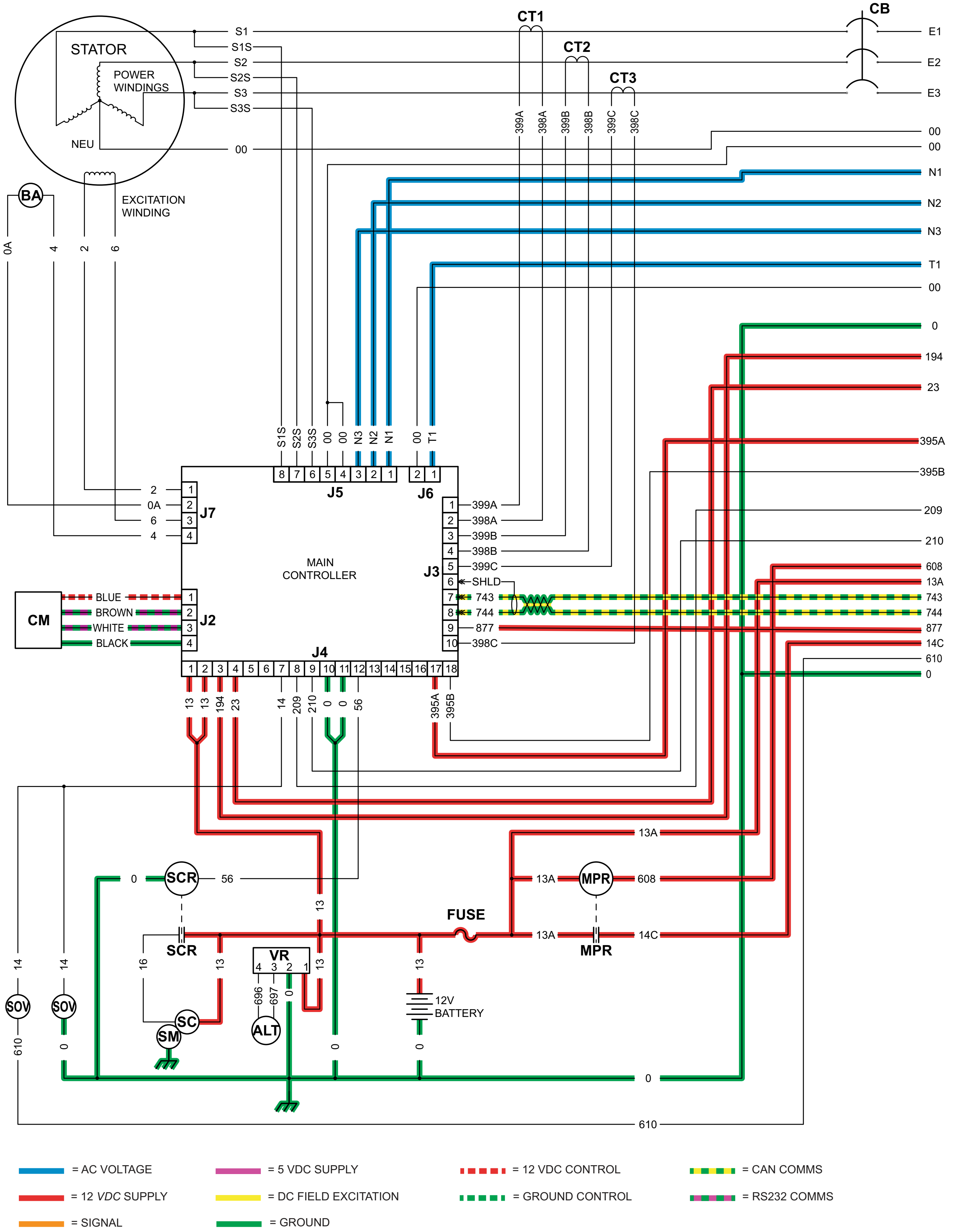
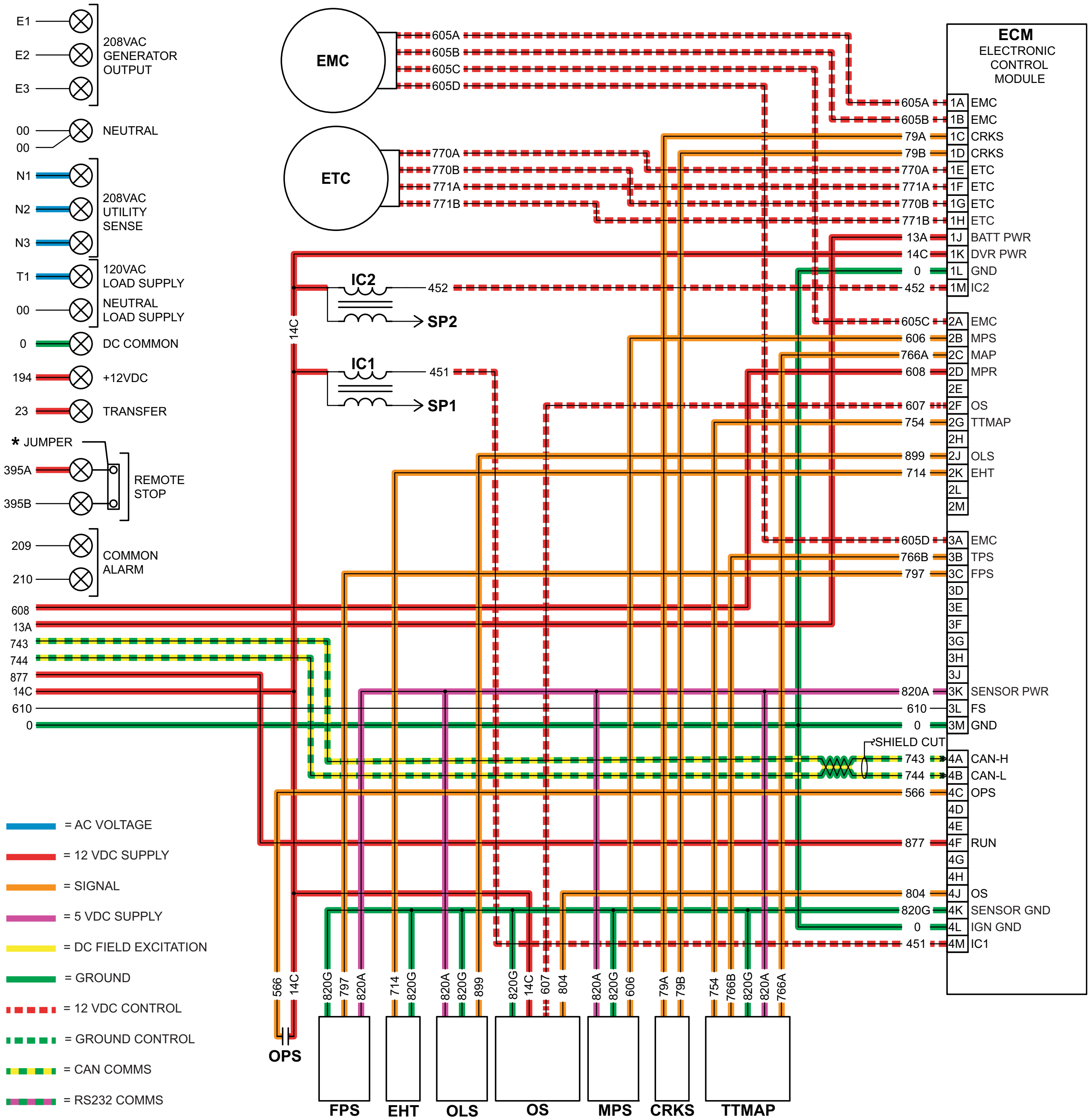



*Figure 4-5. Utility Source Voltage Available*

# Utility Source Voltage Available




| | | |
|---|---|---|
| ALT - ENGINE CHARGING ALTERNATOR | ETC - ELECTRONIC THROTTLE CONTROL VALVE | SC - STARTER CONTACTOR |
| BA - BRUSH ASSEMBLY | FPS - FUEL PRESSURE SENSOR | SCR - STARTER CONTACTOR RELAY |
| CB - CIRCUIT BREAKER | GND - GROUND | SM - STARTER MOTOR |
| CM - CONNECTIVITY MODULE | IC_ - IGNITION COIL | SOV - FUEL SHUT OFF VALVE |
| CRKS - CRANKSHAFT POSITION SENSOR | MPR - MASTER POWER RELAY | SP_ - SPARK PLUG |
| CT - CURRENT TRANSFORMER | MPS - MIXER POSITION SENSOR | TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE |
| ECM - ELECTRONIC CONTROL MODULE | OLS - OIL LEVEL SENSOR | VR - VOLTAGE REGULATOR |
| EHT - ENGINE HEAD TEMPERATURE SENSOR | OPS - OIL PRESSURE SWITCH | |
| EMC - ELECTRONIC MIXER CONTROL VALVE | OS - OXYGEN SENSOR | |

***Figure 4-6. Utility Source Voltage Available***

# Initial Dropout of Utility Source Voltage

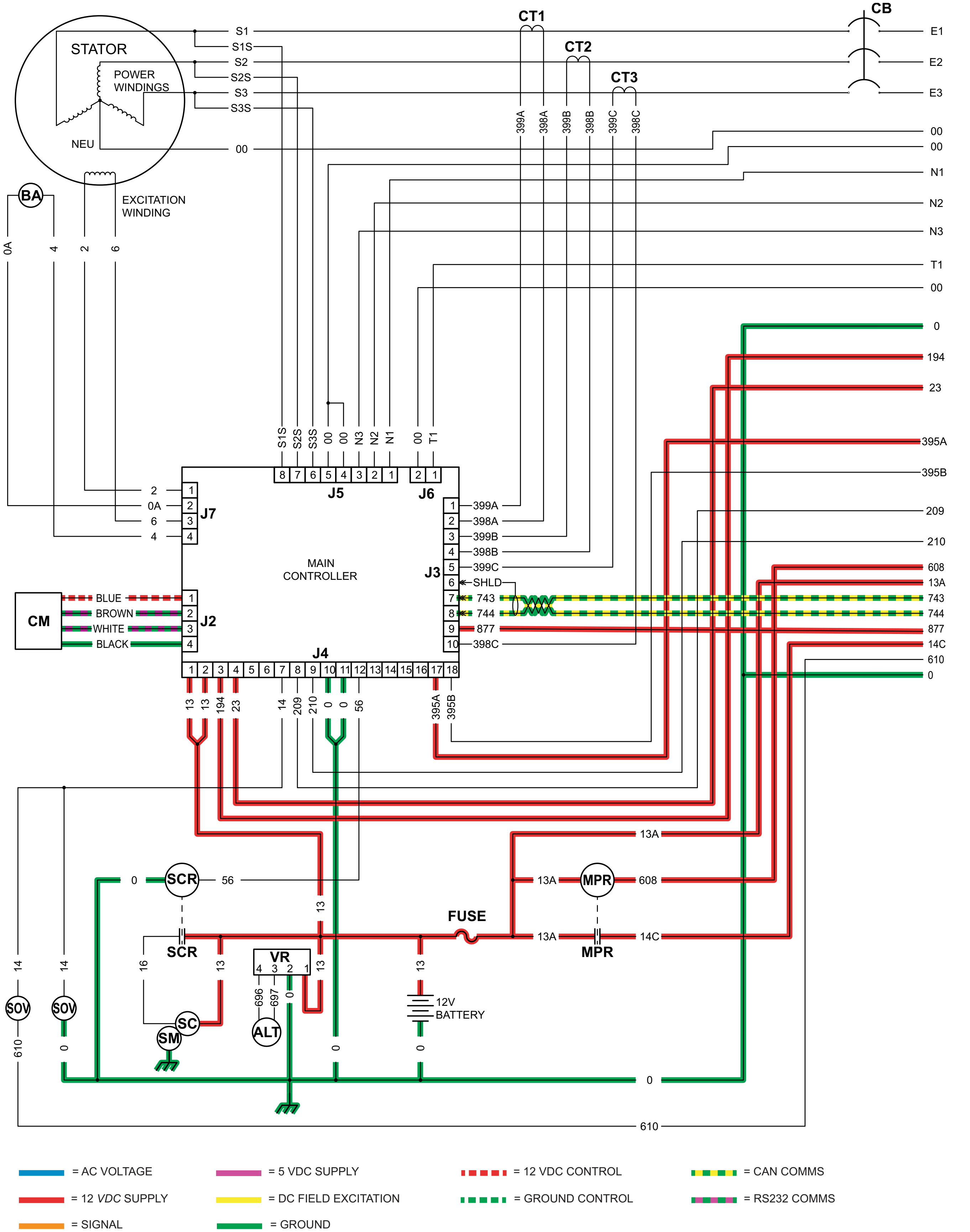
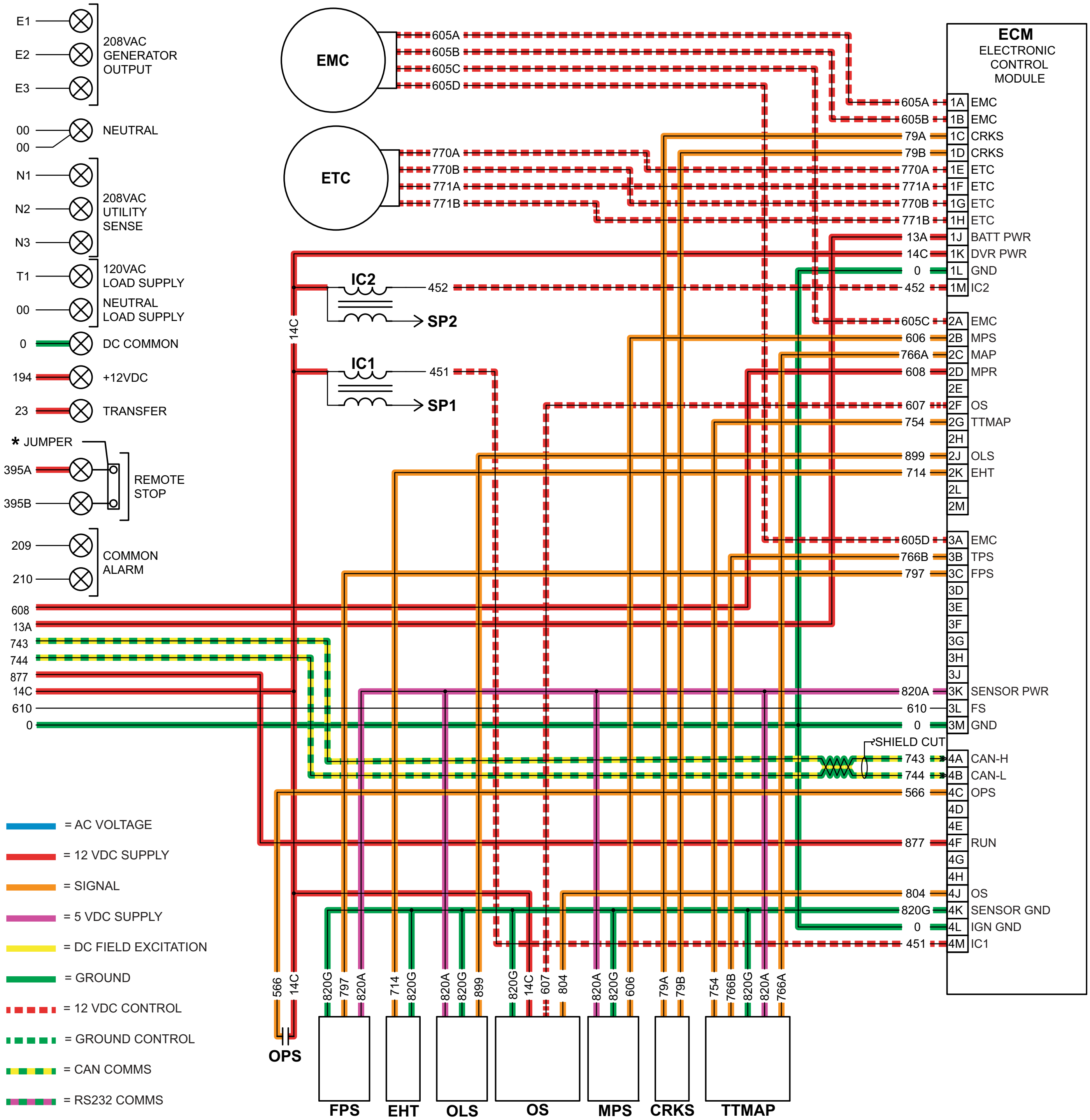



*Figure 4-7. Initial Dropout of Utility Source Voltage*

# Initial Dropout of Utility Source Voltage




ALT - ENGINE CHARGING ALTERNATOR
BA - BRUSH ASSEMBLY
CB - CIRCUIT BREAKER
CM - CONNECTIVITY MODULE
CRKS - CRANKSHAFT POSITION SENSOR
CT - CURRENT TRANSFORMER
ECM - ELECTRONIC CONTROL MODULE
EHT - ENGINE HEAD TEMPERATURE SENSOR
EMC - ELECTRONIC MIXER CONTROL VALVE
ETC - ELECTRONIC THROTTLE CONTROL VALVE
FPS - FUEL PRESSURE SENSOR
GND - GROUND
IC_ - IGNITION COIL
MPR - MASTER POWER RELAY
MPS - MIXER POSITION SENSOR
OLS - OIL LEVEL SENSOR
OPS - OIL PRESSURE SWITCH
OS - OXYGEN SENSOR
SC - STARTER CONTACTOR
SCR - STARTER CONTACTOR RELAY
SM - STARTER MOTOR
SOV - FUEL SHUT OFF VALVE
SP_ - SPARK PLUG
TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE
VR - VOLTAGE REGULATOR

*Figure 4-8. Initial Dropout of Utility Source Voltage*

# Utility Voltage Failure and Engine Cranking

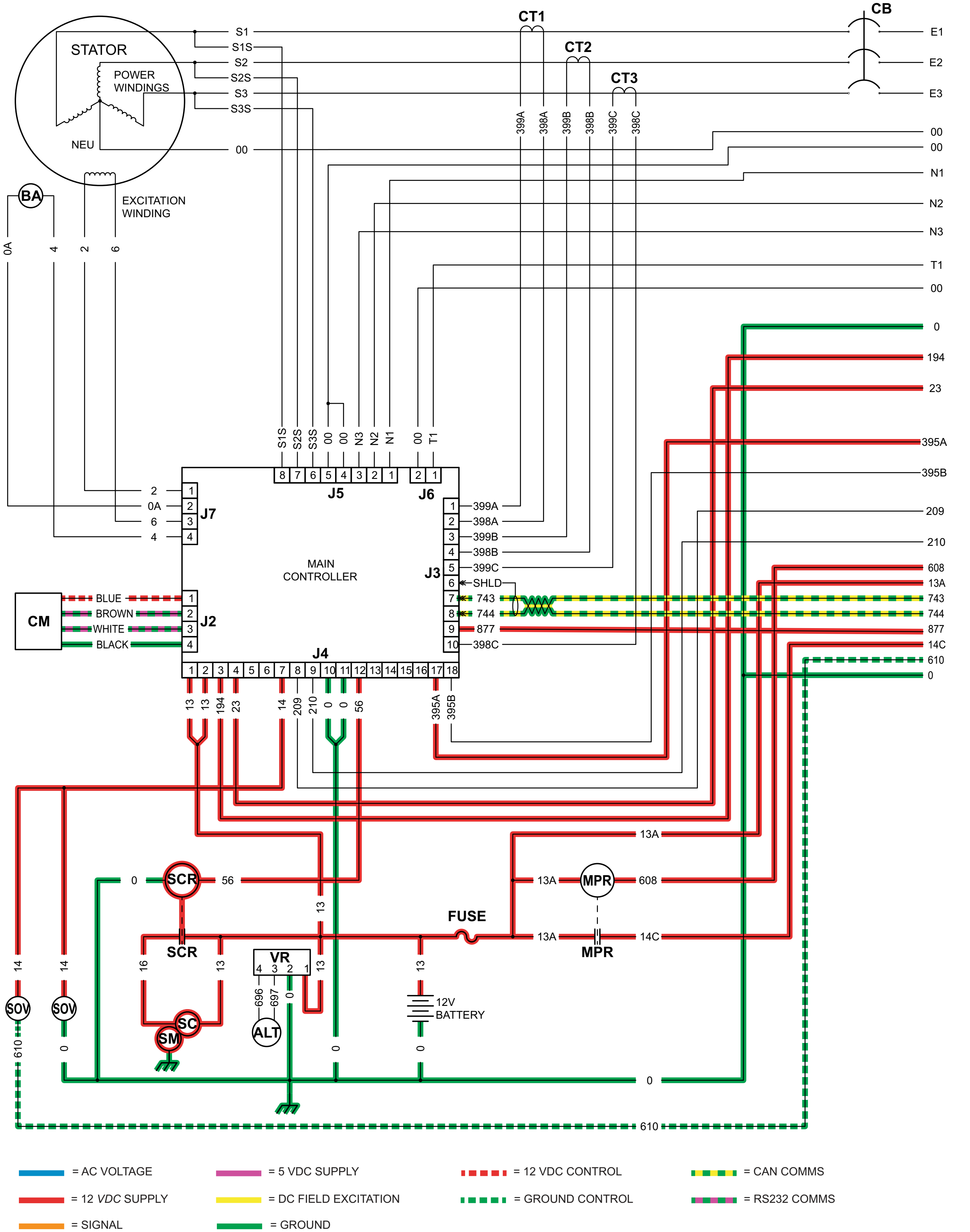
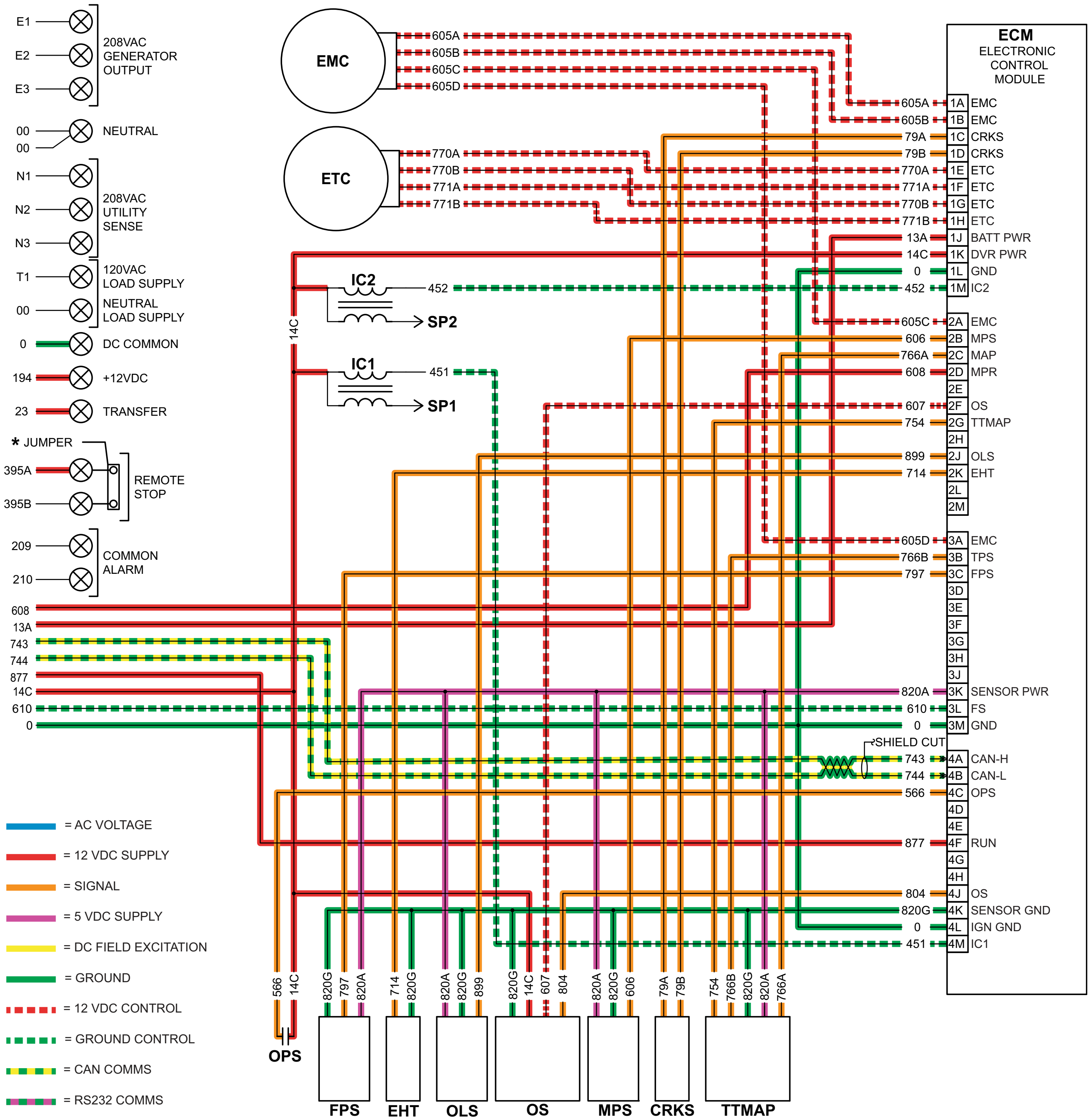



*Figure 4-9. Utility Voltage Failure and Engine Cranking*

# Utility Voltage Failure and Engine Cranking




| | | |
|---|---|---|
| ALT - ENGINE CHARGING ALTERNATOR | ETC - ELECTRONIC THROTTLE CONTROL VALVE | SC - STARTER CONTACTOR |
| BA - BRUSH ASSEMBLY | FPS - FUEL PRESSURE SENSOR | SCR - STARTER CONTACTOR RELAY |
| CB - CIRCUIT BREAKER | GND - GROUND | SM - STARTER MOTOR |
| CM - CONNECTIVITY MODULE | IC_ - IGNITION COIL | SOV - FUEL SHUT OFF VALVE |
| CRKS - CRANKSHAFT POSITION SENSOR | MPR - MASTER POWER RELAY | SP_ - SPARK PLUG |
| CT - CURRENT TRANSFORMER | MPS - MIXER POSITION SENSOR | TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE |
| ECM - ELECTRONIC CONTROL MODULE | OLS - OIL LEVEL SENSOR | VR - VOLTAGE REGULATOR |
| EHT - ENGINE HEAD TEMPERATURE SENSOR | OPS - OIL PRESSURE SWITCH | |
| EMC - ELECTRONIC MIXER CONTROL VALVE | OS - OXYGEN SENSOR | |

*Figure 4-10. Utility Voltage Failure and Engine Cranking*

# Engine Startup and Running

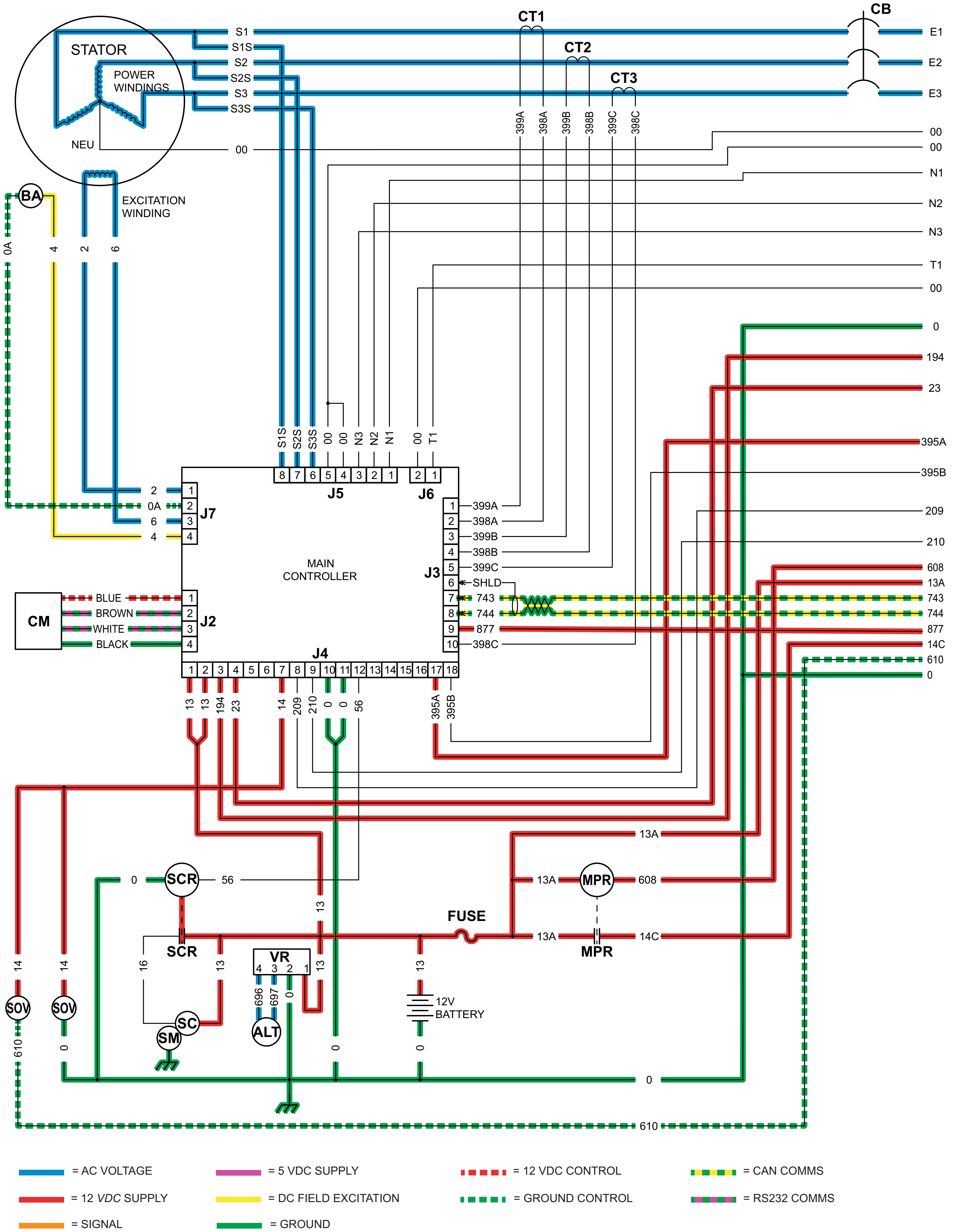
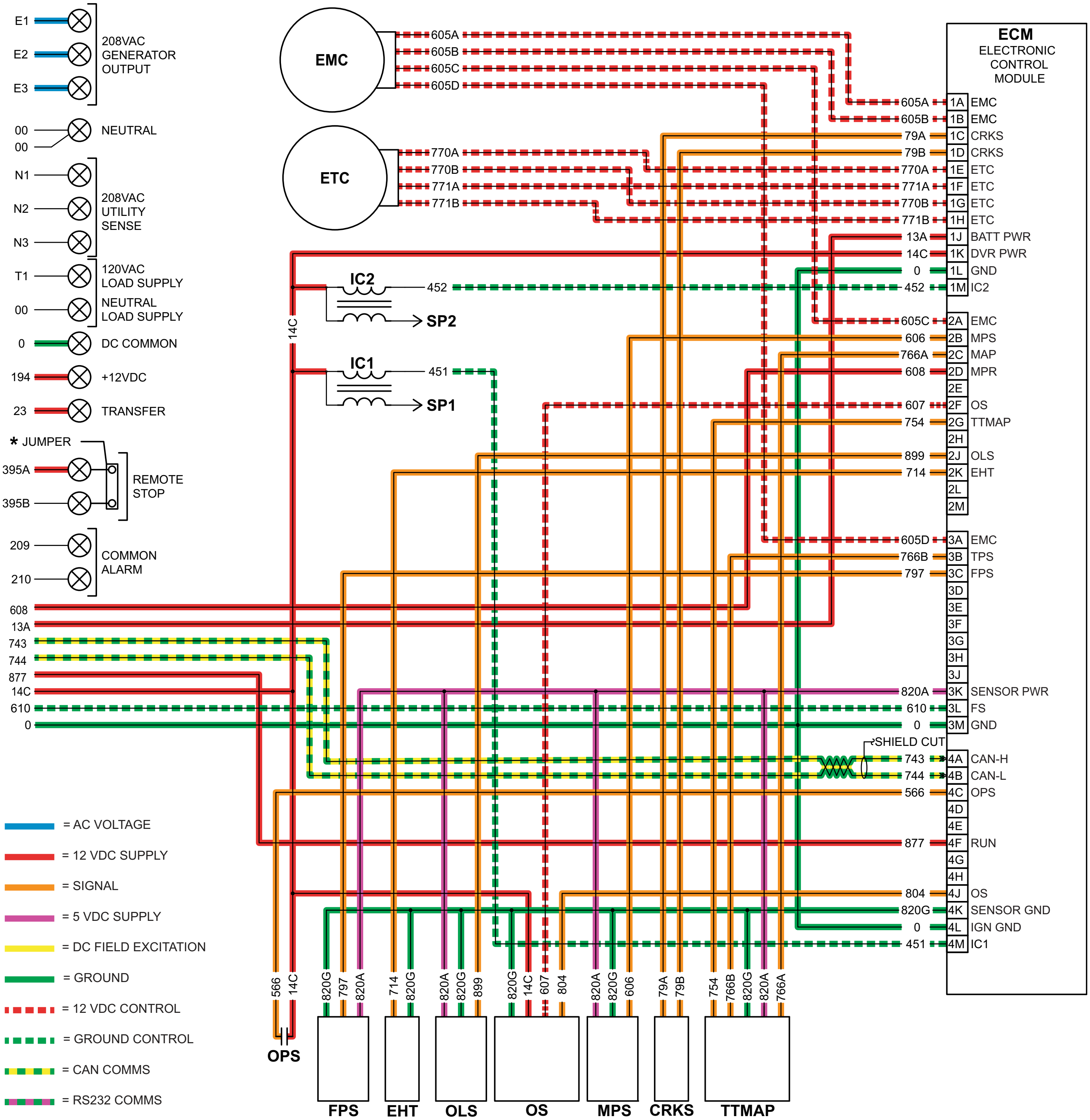



*Figure 4-11. Engine Startup and Running*

# Engine Startup and Running




| | | |
|---|---|---|
| ALT - ENGINE CHARGING ALTERNATOR | ETC - ELECTRONIC THROTTLE CONTROL VALVE | SC - STARTER CONTACTOR |
| BA - BRUSH ASSEMBLY | FPS - FUEL PRESSURE SENSOR | SCR - STARTER CONTACTOR RELAY |
| CB - CIRCUIT BREAKER | GND - GROUND | SM - STARTER MOTOR |
| CM - CONNECTIVITY MODULE | IC_ - IGNITION COIL | SOV - FUEL SHUT OFF VALVE |
| CRKS - CRANKSHAFT POSITION SENSOR | MPR - MASTER POWER RELAY | SP_ - SPARK PLUG |
| CT - CURRENT TRANSFORMER | MPS - MIXER POSITION SENSOR | TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE |
| ECM - ELECTRONIC CONTROL MODULE | OLS - OIL LEVEL SENSOR | VR - VOLTAGE REGULATOR |
| EHT - ENGINE HEAD TEMPERATURE SENSOR | OPS - OIL PRESSURE SWITCH | |
| EMC - ELECTRONIC MIXER CONTROL VALVE | OS - OXYGEN SENSOR | |

***Figure 4-12. Engine Startup and Running***

## Transfer to Standby

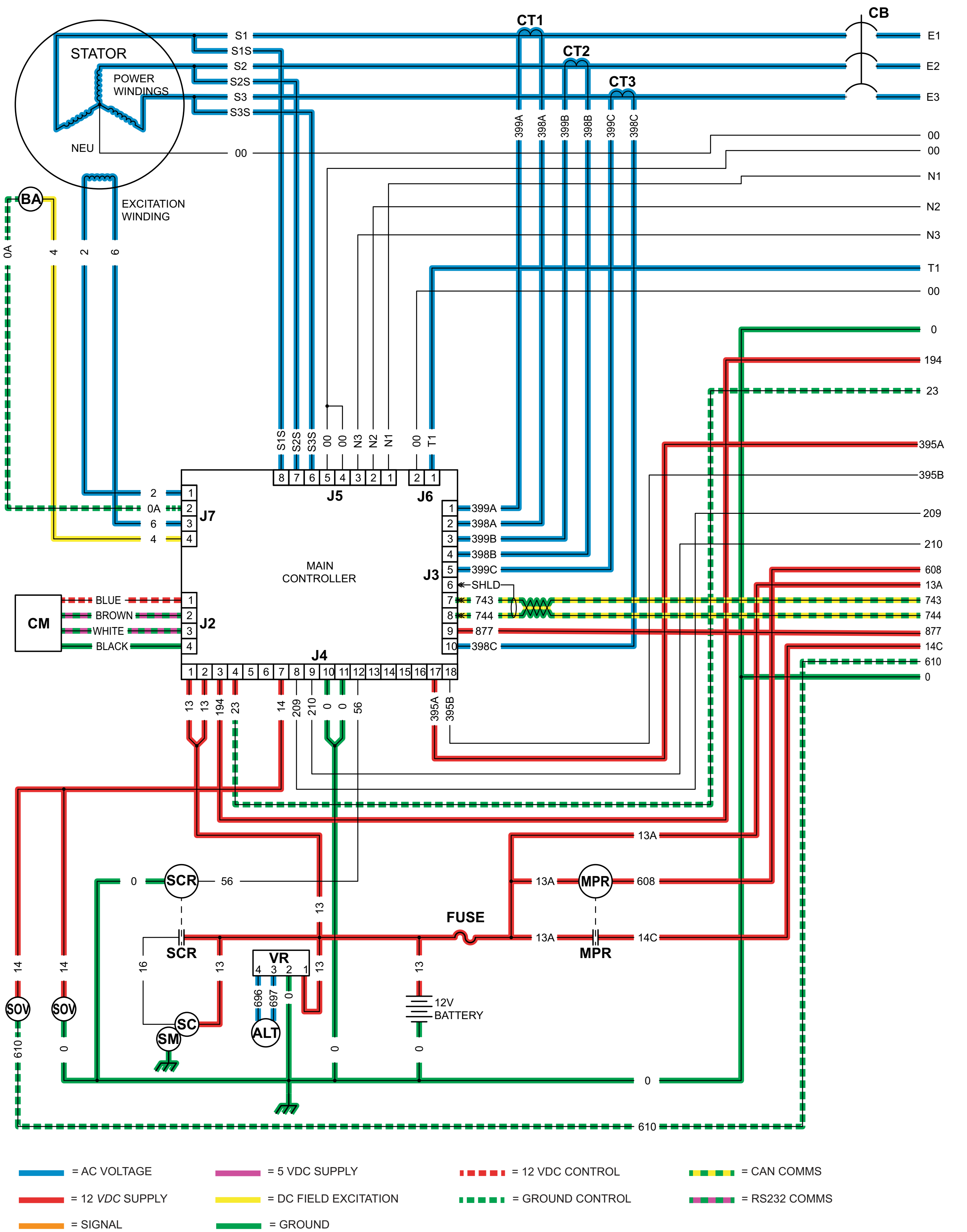
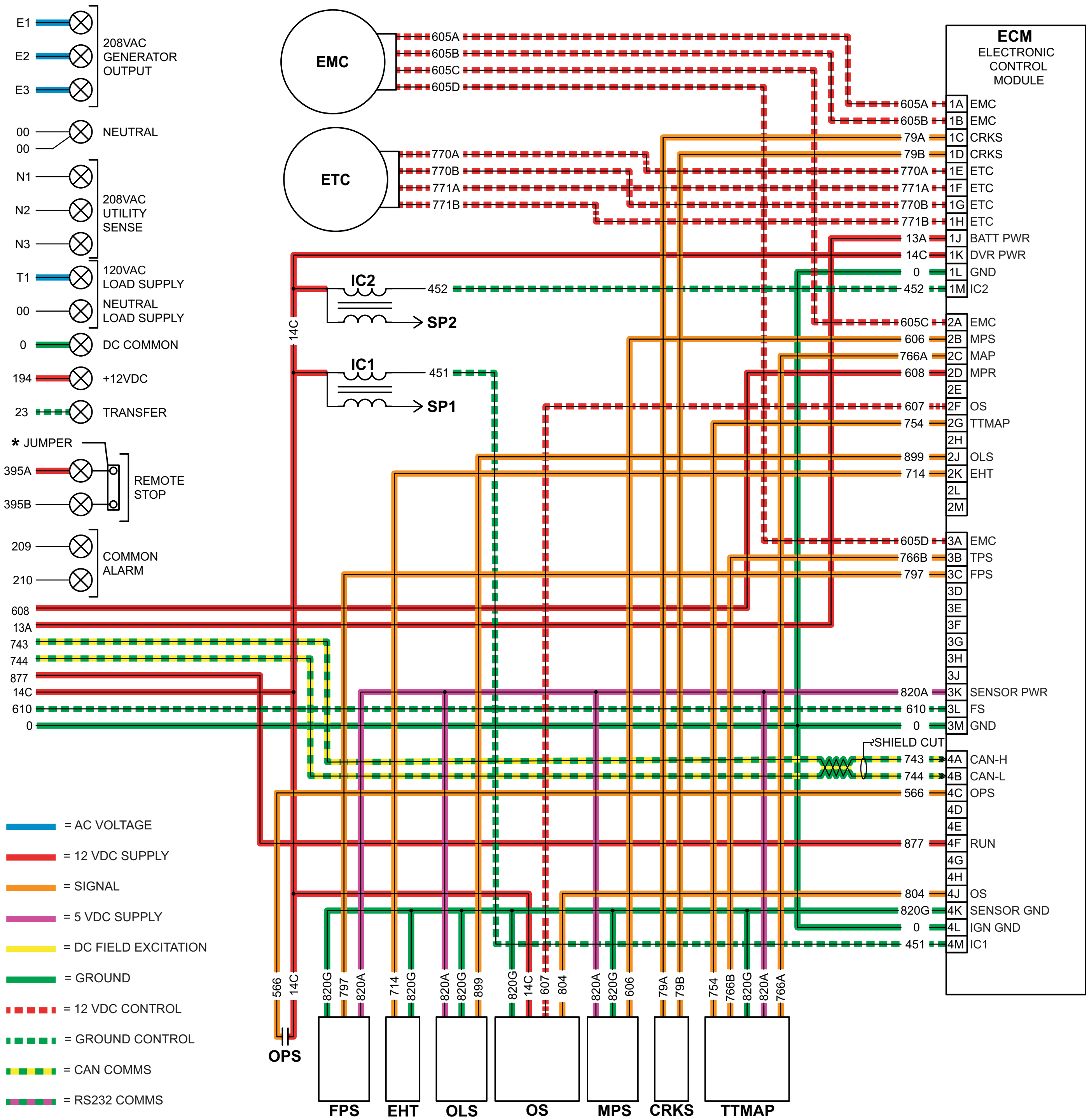



*Figure 4-13. Transfer to Standby*

# Transfer to Standby




| | | |
|---|---|---|
| ALT - ENGINE CHARGING ALTERNATOR | ETC - ELECTRONIC THROTTLE CONTROL VALVE | SC - STARTER CONTACTOR |
| BA - BRUSH ASSEMBLY | FPS - FUEL PRESSURE SENSOR | SCR - STARTER CONTACTOR RELAY |
| CB - CIRCUIT BREAKER | GND - GROUND | SM - STARTER MOTOR |
| CM - CONNECTIVITY MODULE | IC_ - IGNITION COIL | SOV - FUEL SHUT OFF VALVE |
| CRKS - CRANKSHAFT POSITION SENSOR | MPR - MASTER POWER RELAY | SP_ - SPARK PLUG |
| CT - CURRENT TRANSFORMER | MPS - MIXER POSITION SENSOR | TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE |
| ECM - ELECTRONIC CONTROL MODULE | OLS - OIL LEVEL SENSOR | VR - VOLTAGE REGULATOR |
| EHT - ENGINE HEAD TEMPERATURE SENSOR | OPS - OIL PRESSURE SWITCH | |
| EMC - ELECTRONIC MIXER CONTROL VALVE | OS - OXYGEN SENSOR | |

***Figure 4-14. Transfer to Standby***

# Utility Voltage Restored and Re-transfer to Utility

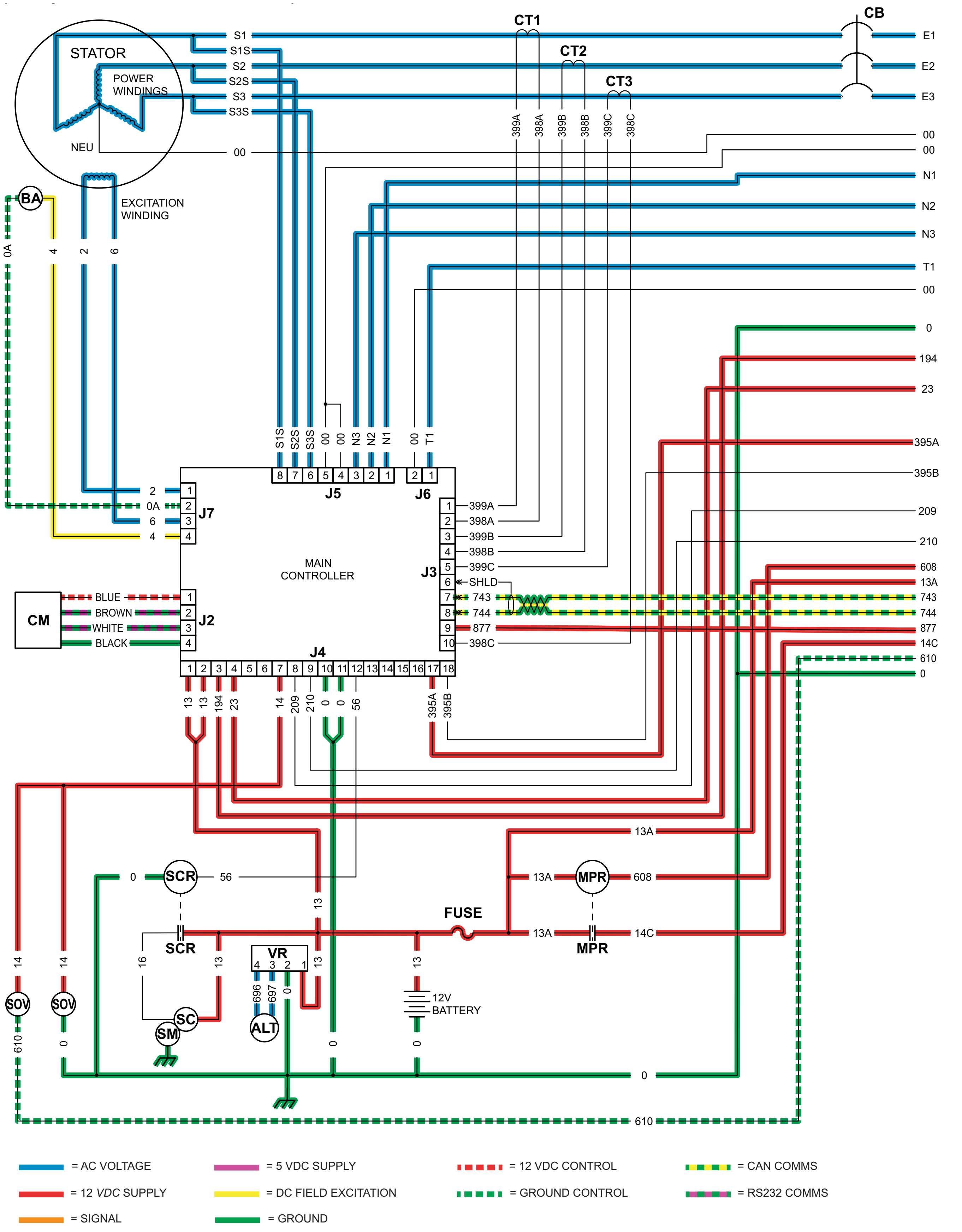
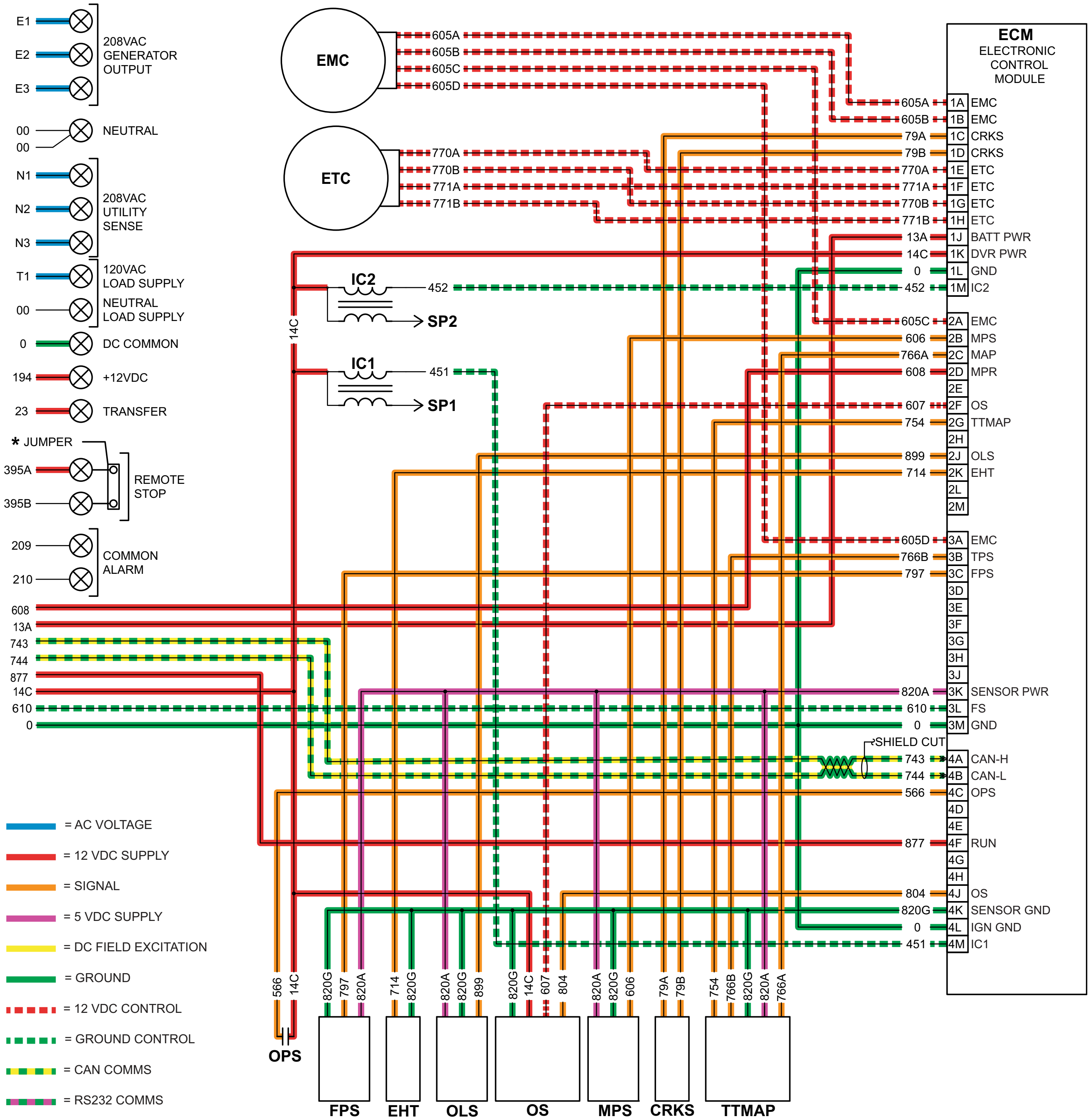



*Figure 4-15. Utility Voltage Restored and Re-transfer to Utility*

# Utility Voltage Restored and Re-transfer to Utility




ALT - ENGINE CHARGING ALTERNATOR
BA - BRUSH ASSEMBLY
CB - CIRCUIT BREAKER
CM - CONNECTIVITY MODULE
CRKS - CRANKSHAFT POSITION SENSOR
CT - CURRENT TRANSFORMER
ECM - ELECTRONIC CONTROL MODULE
EHT - ENGINE HEAD TEMPERATURE SENSOR
EMC - ELECTRONIC MIXER CONTROL VALVE
ETC - ELECTRONIC THROTTLE CONTROL VALVE
FPS - FUEL PRESSURE SENSOR
GND - GROUND
IC_ - IGNITION COIL
MPR - MASTER POWER RELAY
MPS - MIXER POSITION SENSOR
OLS - OIL LEVEL SENSOR
OPS - OIL PRESSURE SWITCH
OS - OXYGEN SENSOR
SC - STARTER CONTACTOR
SCR - STARTER CONTACTOR RELAY
SM - STARTER MOTOR
SOV - FUEL SHUT OFF VALVE
SP_ - SPARK PLUG
TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE
VR - VOLTAGE REGULATOR

***Figure 4-16. Utility Voltage Restored and Re-transfer to Utility***

# Engine Shutdown

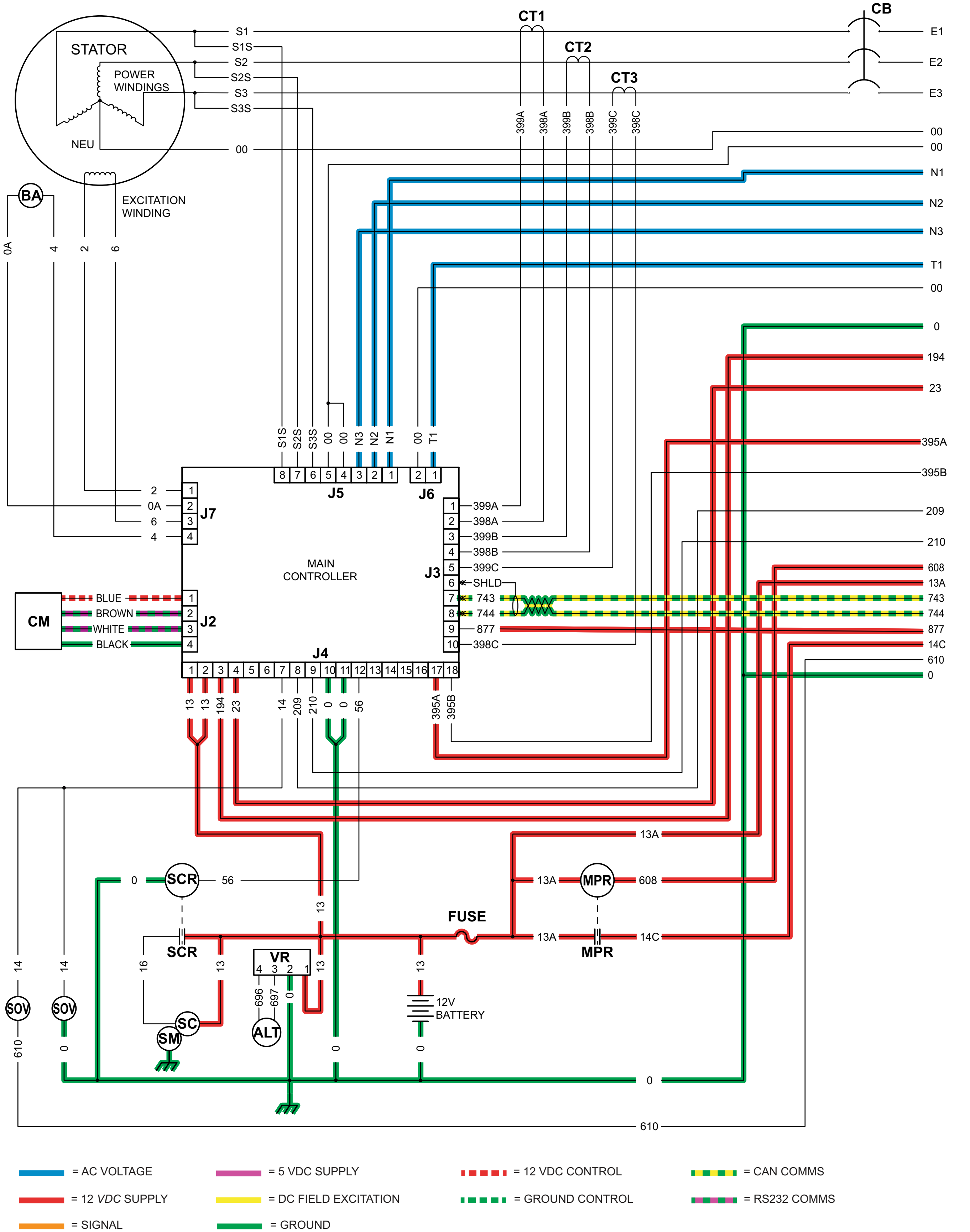
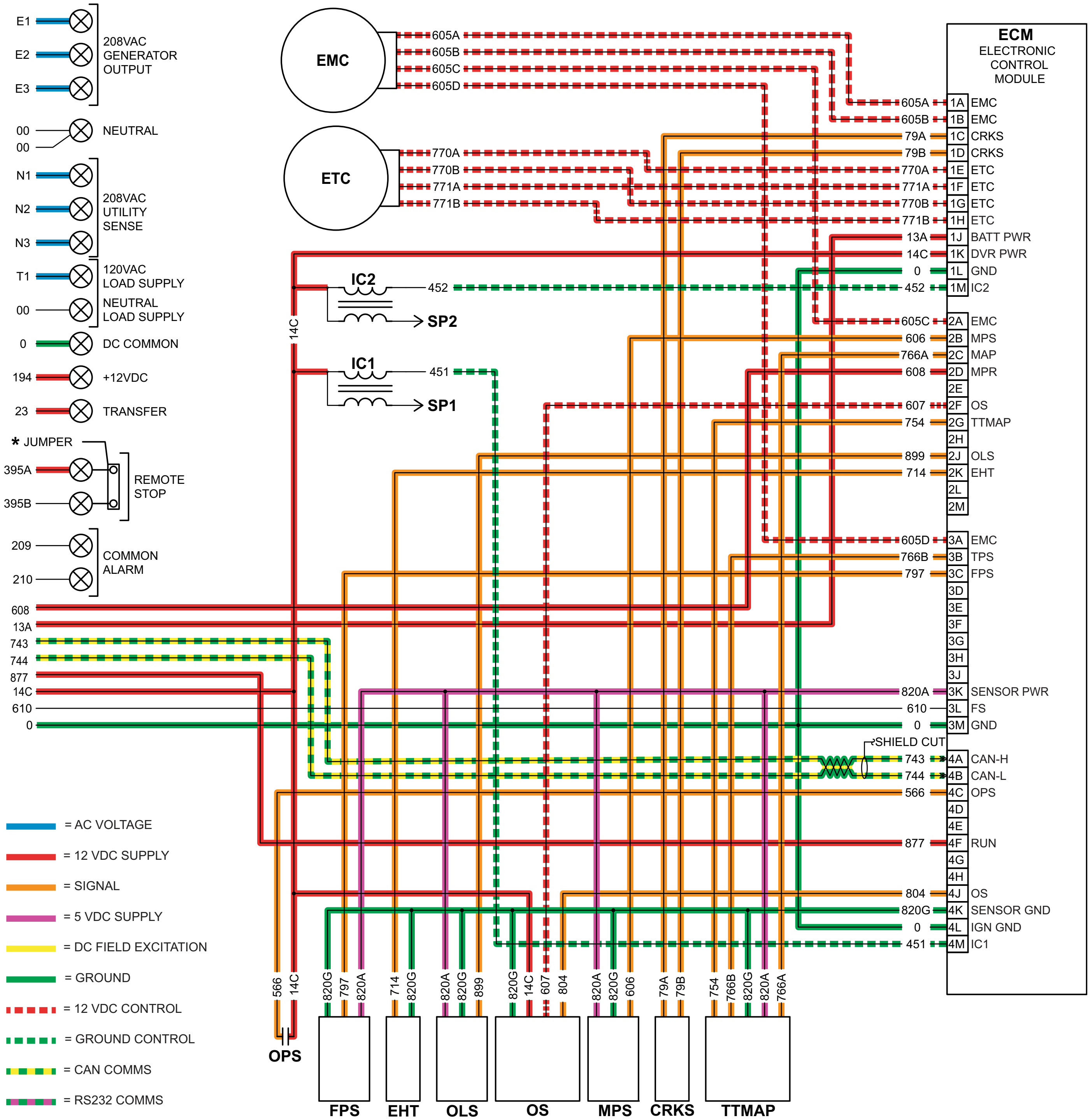



*Figure 4-17. Engine Shutdown*

# Engine Shutdown




| | | |
|---|---|---|
| ALT - ENGINE CHARGING ALTERNATOR | ETC - ELECTRONIC THROTTLE CONTROL VALVE | SC - STARTER CONTACTOR |
| BA - BRUSH ASSEMBLY | FPS - FUEL PRESSURE SENSOR | SCR - STARTER CONTACTOR RELAY |
| CB - CIRCUIT BREAKER | GND - GROUND | SM - STARTER MOTOR |
| CM - CONNECTIVITY MODULE | IC_ - IGNITION COIL | SOV - FUEL SHUT OFF VALVE |
| CRKS - CRANKSHAFT POSITION SENSOR | MPR - MASTER POWER RELAY | SP_ - SPARK PLUG |
| CT - CURRENT TRANSFORMER | MPS - MIXER POSITION SENSOR | TTMAP - THROTTLE TEMP. MANIFOLD AIR PRESSURE |
| ECM - ELECTRONIC CONTROL MODULE | OLS - OIL LEVEL SENSOR | VR - VOLTAGE REGULATOR |
| EHT - ENGINE HEAD TEMPERATURE SENSOR | OPS - OIL PRESSURE SWITCH | |
| EMC - ELECTRONIC MIXER CONTROL VALVE | OS - OXYGEN SENSOR | |

***Figure 4-18. Engine Shutdown***

## Utility Source Voltage Available

See *Figure 4-5* and *Figure 4-6*. 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, N2, and Neutral. The CONTACTOR is in the “Utility” position.
- Utility voltage is available to the controller via Wire N1, N2 and neutral (00).
- 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.
- The quad light annunciator is part of the controller and is visible on the side of the controller.

## Initial Dropout of Utility Source Voltage

See *Figure 4-7* and *Figure 4-8*. Should a Utility power failure occur, circuit condition may be briefly described as follows:

- The controller continually monitors for acceptable Utility voltage via N1, N2 and neutral (00). Should Utility voltage drop below approximately 77.5% (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 = 186 VAC | 60 Hz = 180–192 VAC |

**NOTE:** Dropout / pickup thresholds and associated timers can be configured in the Field Pro app during the guided install flow or the “Configurations” page available from the Generator Details dashboard.

## Utility Voltage Failure and Engine Cranking

See *Figure 4-9* and *Figure 4-10*.

- After the controller’s adjustable programmed timer has timed out, if Utility voltage is still below the programmed utility drop out level, the controller's logic will energize the internal crank relay followed by the internal run relay.
- When the internal crank relay energizes, 12 VDC is delivered to the starter contactor relay (SCR) via Wire 56. When the SCR energizes, its contacts close and battery voltage is delivered to a starter contactor (SC). When the SC energizes, its contacts close and battery voltage is delivered to the starter motor (SM); the engine is now cranking.
- With the engine cranking, oil pressure will begin to build in the engine, activating the contact in the oil pressure switch (OPS).

| 10 kW with 459cc Engine | 14–28 kW with 817 / 997cc Engine |
|---|---|
| 5 psi Normally Closed (NC) contact will open | 10 psi Normally Open (NO) contact will close |

- The ECM will open the throttle and mixer valves.
- With the engine cranking, a pulsing AC speed reference signal is generated by the CRKS and is delivered to the ECM. If a valid signal is received the ECM will begin firing the ignition coils. The ECM and controller will open their respective fuel valve to allow fuel to flow to the engine.

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

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

## Engine Startup and Running

See ***Figure 4-11*** and ***Figure 4-12***. With the fuel solenoid open and ignition occurring, the engine starts. Engine startup and running may be briefly described as follows:

- The CRKS delivers a speed signal to the ECM. The ECM sends the RPM data to the controller over the CAN communication signal. Once the controller determines that the engine is running, the controller:
  a. terminates cranking by de-energizing Wire 56 at approximately 2160 RPM.
  b. energizes a field flash relay in the controller at 3400 RPM which delivers 12 VDC internally to the controller to the Wire 4 output. The field boost will continue for a pre-determined time, or until field boost parameters are achieved, whichever occurs first.

**NOTE:** Dropout / pickup thresholds and associated timers can be configured in the Field Pro app during the guided install flow or the “Configurations” page available from the Generator Details dashboard.

  c. also at 3400 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 (adjustable). 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.

## Transfer to Standby

In ***Figure 4-13*** and ***Figure 4-14*** 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).
- When the transfer switch closes to standby, the Charger AC voltage input detect is used to detect that transfer switch has made contact. If the switch does not transfer, there will be a warning with E-code 2738.
- While running, the RPM data from the ECM over CAN will be used for the following functions:
  a. govern speed to maintain frequency through different loads
  b. overspeed
  c. underspeed
- 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 = 0.260 VAC

50 Amps = 0.518 VAC

75 Amps = 0.766 VAC

150 Amps = 1.552 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)

## Utility Voltage Restored and Re-transfer to Utility

See ***Figure 4-15*** and ***Figure 4-16***. The Load is powered by Generator voltage. On restoration of Utility voltage, the following events will occur:

- On restoration of Utility voltage above 86.5% (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 (adjustable).

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

**NOTE:** If programmed for 2 Wire Start mode, the transfer switch will operate as it does in Utility Loss mode.

| Utility Pickup | |
|---|---|
| **Factory Default** | **Util Recovery Volts** |
| 60 Hz = 208 VAC | 60 Hz = 202–214 VAC |

## Engine Shutdown

See ***Figure 4-17*** and ***Figure 4-18***. Following re-transfer back to the Utility source an “engine cool-down timer” on the controller starts timing. When the timer has expired (adjustable, default is 60 seconds), 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 shutoff valves (SOV) will close to terminate the fuel supply to the engine.
- After a short fuel burn off, when engine speed reduces to 350 rpm, the ECM will stop firing the ignition coils.
- Without fuel flow and without ignition the engine will shut down.
- Once engine is shutdown the generator controller will remove power to the ECM by turning off the main power relay (MPR) for 2.5 seconds. Then the MPR will be energized and the ECM will turn on.

**NOTE:** While the ECM is powering on it is typical to hear the stepper motors on the mixer go through their startup process.

## 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
- Power Zone 200 Controller
- LED Display
- Battery Charger
- AUTO-OFF-MANUAL
- 7.5 Amp Fuse
- Starter Contactor Relay
- Connector Pin Descriptions

## Customer Connection

The terminals of this terminal strip connect to identical 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 00/T2 (Internal Battery Charger) - 60/50 Hz Unit
- Wire 194 (Transfer Relay)
- Wire 23 (Transfer Relay)
- Wire 0 (DC Common)

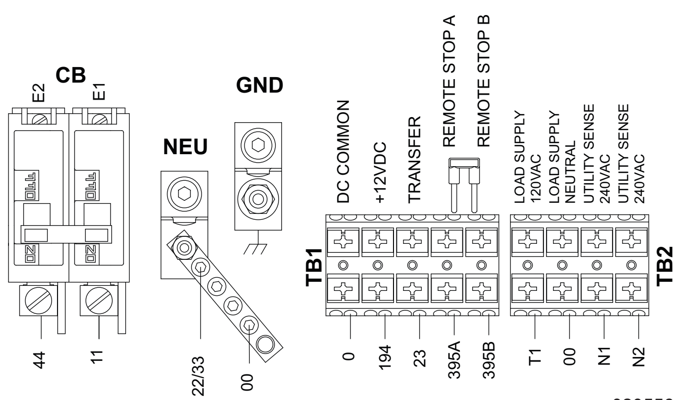



*Figure 5-1. Customer Connections*

## Power Zone 200 Controller

The Power Zone 200 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 per programmed setting.
- Automatic engine shutdown in the event of low oil pressure, high cylinder head temperature, over speed, no RPM sense, over crank, low battery, or other alarms.
- Maintains proper battery charge.

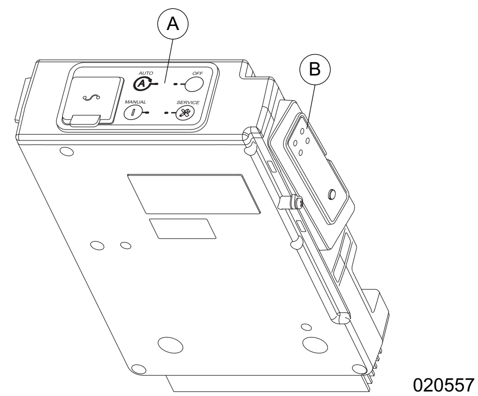



*Figure 5-2. Power Zone 200 Controller*

| | |
|---|---|
| A | Controller Mode Indicators |
| B | External LED Indicators |

### Controller Harness Connectors

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 ***Power Zone 200 Controller*** diagram in this section, as well as in Section 11 ***Controller and ECM Pin-outs***.

**IMPORTANT NOTE:** The generator engine will crank and start when the exerciser is set. The unit will also crank and start every programmed interval thereafter, on the programmed day and time.

**IMPORTANT NOTE:** The exercise interval can also be set to transfer on exercise at 3, 6, and 12 months. The generator will run this at normal speed even if low speed is selected for exercise.

## Controller Mode Indicator

Located on the generator controller, the LED Indicators provide a visual indication of the generator status.

- Green LED - Illuminates when the controller is set to AUTO mode
- Red LED - Illuminates when the controller is set to OFF mode. Red LED will flash when the Emergency Shutdown is activated
- Yellow LED - Illuminates when the controller is set to MANUAL mode.
- Blue LED - Illuminates when the controller is set to SERVICE mode. This LED will be lit in addition to the other Mode selection (Auto, Off or Manual). Blue LED will flash when controller is executing bootloader.

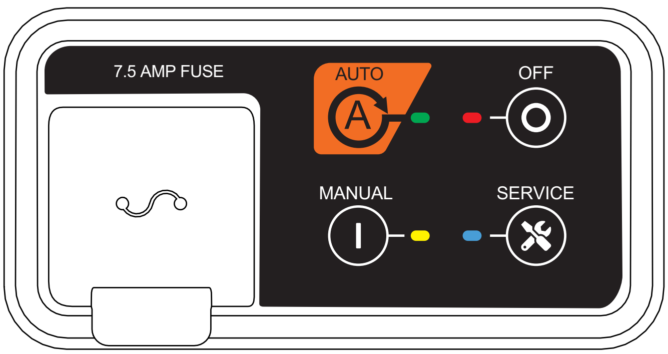



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*Figure 5-3. Controller Mode Indicators*

**NOTE:** All four Controller Mode Indicator LEDs will flash simultaneously when the controller is powering up.

## External LED Indicators

| | |
|---|---|
| OFF | solid red |
| OFF + ALARM | flashing red |
| OFF + WARNING/MAINT | solid red / flashing yellow |
| AUTO | solid green |
| AUTO + ALARM | solid green / flashing red |
| AUTO + WARNING/MAINT | solid green / flashing yellow |
| running in AUTO | solid green |
| AUTO + Utility Loss Delay Countdown | flashing green (2 sec) |
| running in AUTO + Transfer | flashing green (1 sec) |
| MANUAL + ALARM | flashing red / solid yellow |
| running in MANUAL + WARNING/MAINT | flashing yellow |
| running in MANUAL | solid yellow |
| running in MANUAL + Transfer | flashing green (1 sec) / solid yellow |
| Emergency Shutdown | flashing red |
| SERVICE (service button pressed) | solid blue + other LED color (green, yellow, or red) |
| Controller Firmware Update In Progress | all lights / flashing counterclockwise (red-green-yellow-blue) |
| ECM Firmware Update In Progress | all lights / flashing clockwise (red-blue-yellow-green) |

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## Control Panel Interface

### AUTO/OFF/MANUAL/SERVICE Buttons

| Button | Description of Operation |
|---|---|
| AUTO | Activates fully automatic system operation. Automatic operation allows unit to automatically start and exercise generator according to exercise timer settings (see Setting the Exercise Timer). |
| OFF | Shuts down engine and prevents automatic operation and exercise of unit. |
| MANUAL | Cranks and starts generator. Transfer to standby power will not occur unless there is a utility failure. |
| SERVICE | Suspends Mobile Link® and Fleet notifications and locks out the ability to receive remote start/stop commands. Allows unit to be placed in any other mode (AUTO, OFF, MANUAL) at the same time as SERVICE mode for diagnostics or servicing purposes. |

## Field Pro App

The generator details page is the dashboard view of the unit and is the landing page for users upon connecting to a previously commissioned generator.

**NOTE:** Connection between generator and Field Pro app can only be accomplished when the SERVICE button on the control panel interface is selected.

Users can view the generator's state/mode, status, telemetry data which dynamically updates when running, diagnostics info such as active alarms, warnings, log data (e-codes) and is also the location to find the generator's controller settings (e.g. exercise schedule)

The Status card at the top displays the mode and status of the generator.

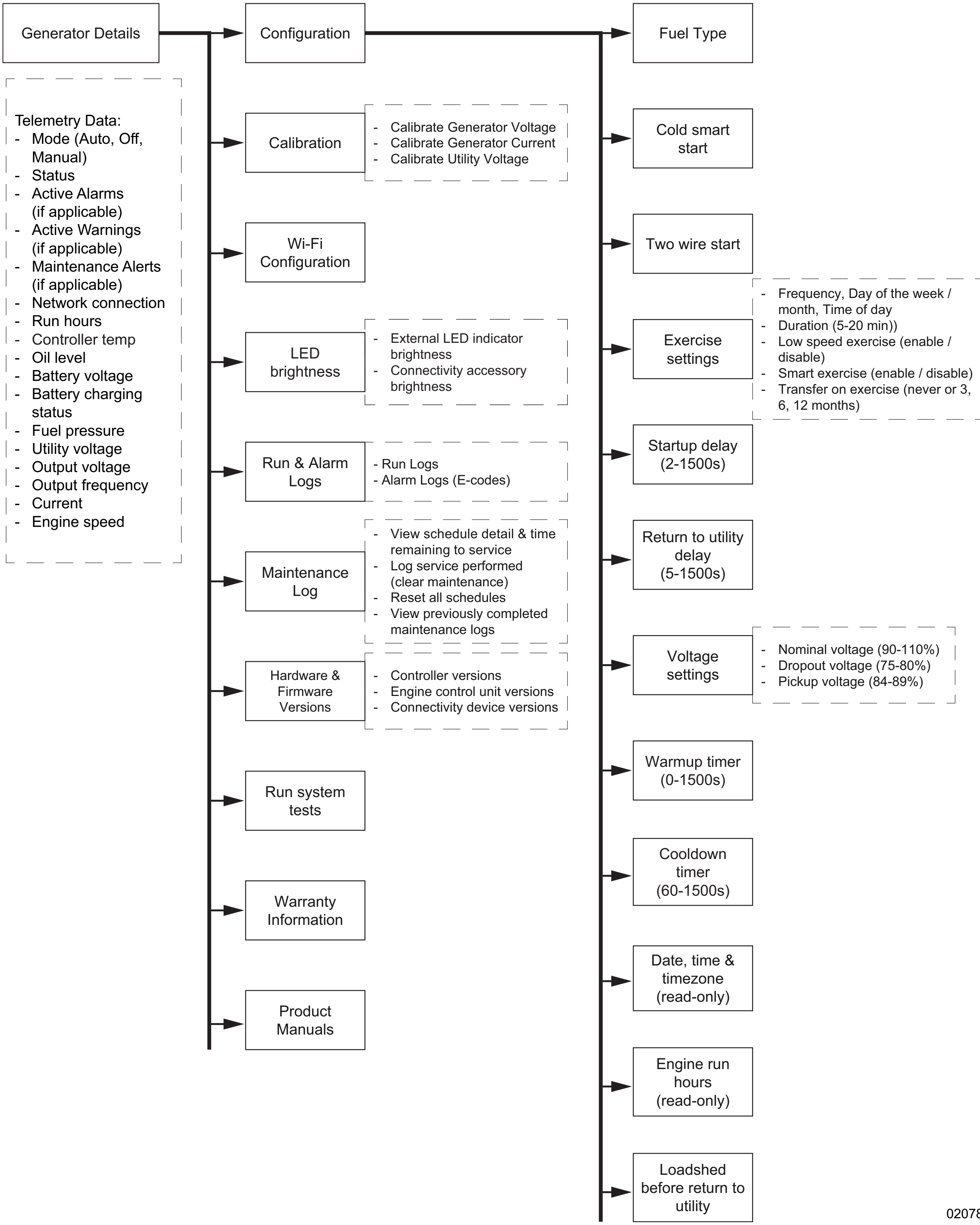
Controller settings are available from the Generator Details page.

Available settings will be based on user permissions.

The telemetry data displayed on the generator details dashboard changes based on the state of the equipment.

### For Advanced / certified users only

Allows a user to calibrate the Generator Voltage, Current, and Utility Voltage (recognized by the generator), and enable 2-wire start.



Generator Details
Telemetry Data:
- Mode (Auto, Off, Manual)
- Status
- Active Alarms (if applicable)
- Active Warnings (if applicable)
- Maintenance Alerts (if applicable)
- Network connection
- Run hours
- Controller temp
- Oil level
- Battery voltage
- Battery charging status
- Fuel pressure
- Utility voltage
- Output voltage
- Output frequency
- Current
- Engine speed
Configuration
Calibration
- Calibrate Generator Voltage
- Calibrate Generator Current
- Calibrate Utility Voltage
Wi-Fi Configuration
LED brightness
- External LED indicator brightness
- Connectivity accessory brightness
Run & Alarm Logs
- Run Logs
- Alarm Logs (E-codes)
Maintenance Log
- View schedule detail & time remaining to service
- Log service performed (clear maintenance)
- Reset all schedules
- View previously completed maintenance logs
Hardware & Firmware Versions
- Controller versions
- Engine control unit versions
- Connectivity device versions
Run system tests
Warranty Information
Product Manuals
Fuel Type
Cold smart start
Two wire start
Exercise settings
- Frequency, Day of the week / month, Time of day
- Duration (5-20 min))
- Low speed exercise (enable / disable)
- Smart exercise (enable / disable)
- Transfer on exercise (never or 3, 6, 12 months)
Startup delay (2-1500s)
Return to utility delay (5-1500s)
Voltage settings
- Nominal voltage (90-110%)
- Dropout voltage (75-80%)
- Pickup voltage (84-89%)
Warmup timer (0-1500s)
Cooldown timer (60-1500s)
Date, time & timezone (read-only)
Engine run hours (read-only)
Loadshed before return to utility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## Generator Battery Charger

**NOTE:** Battery Charging status can be viewed in the Field Pro app on the Generator Details dashboard.

**NOTE:** 50 Hz units use fuses F3 and F4 and a 220 VAC supply to the battery charger.

The charger operates between 12.2 VDC and 16.0 VDC at a maximum current of 5 amps. It will adjust the charging voltage depending on ambient temperature. It will charge at the higher voltage level when cold and the lower voltage level when hot. The battery charger is powered from a 120 VAC load side connection through a fuse (F3) in the transfer switch. It will also require a neutral wire to the charger power connection. This 120 VAC source must be connected to the generator in order to operate the charger.

**NOTE:** 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 power to the controller but in case of failure, the generator battery is used to supply power.

The battery charger will begin its charge cycle when voltage drops below 12.7 VDC. The charger provides current directly to the starting battery at a voltage determined by the ambient temperature for the 18 hour period. At the end of the 18 hour 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, a “Battery problem” is raised. If the battery voltage at the end of the 18 hour charge time is less than approximately 12.7 VDC open circuit, a “Charger warning” is raised. If the battery voltage is above 16.5 VDC, charger warning is raised and charging is disabled until the condition is corrected. There is also a warning for Charger AC missing which means the T1 or T2/00 wire is not powered and charger will not operate. If the battery voltage is above 18.5 VDC at any time, the charger output is disconnected from the battery and an alarm is raised.

The battery has a similar role as that found in an automobile application. It sits doing nothing (but can still supply current to the controller if the charger AC voltage is removed) until it either self-discharges below 12.7 VDC or an engine crank occurs (i.e. such as occurs during the weekly exercise). 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 controller has OFF-MANUAL-AUTO Mode membrane push buttons. See ***Figure 5-4*** for the location of the push buttons.

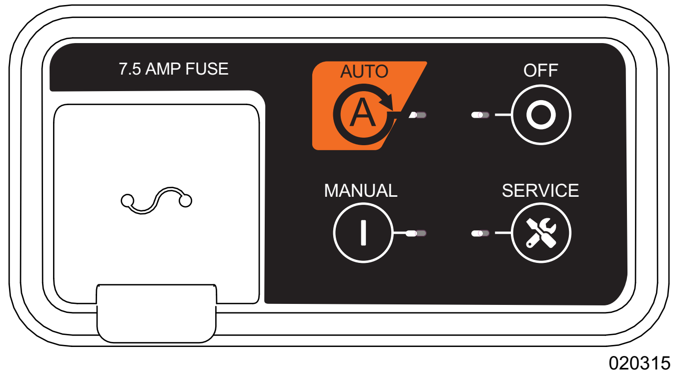



***Figure 5-4. Off-Manual-Auto Buttons***

## Fuse

The fuse protects the controller against excessive current. If the fuse has blown, engine cranking and operation will not be possible. The controller will remain powered as long as charger AC power is still present from Utility. Should fuse replacement become necessary, use only an equivalent 7.5 amp replacement fuse.

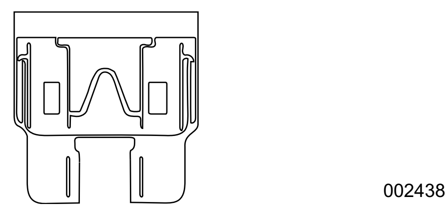



***Figure 5-5. Typical 7.5 Amp Fuse***

## Common Alarm Relay

The common alarm relay provides a set of normally closed (N.C.) contacts to drive a customer provided external alarm indication. When the control is powered up, if there are no Alarms, the relay contacts will be OPEN. Any ALARM (not warning) will trigger the common alarm relay to operate, closing the contacts.

The connections are made to the controller via Wires 209 and 210 by connecting to the dedicated wire connections.

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

**NOTE:** Contact rating is for resistive load only

## Circuit Pin Descriptions

The ***Power Zone 200 Controller*** diagram on the following page, as well as in Section 11 ***Controller and ECM Pin-outs***, provides the physical wire identification and circuit functions.

# Power Zone 200 Controller

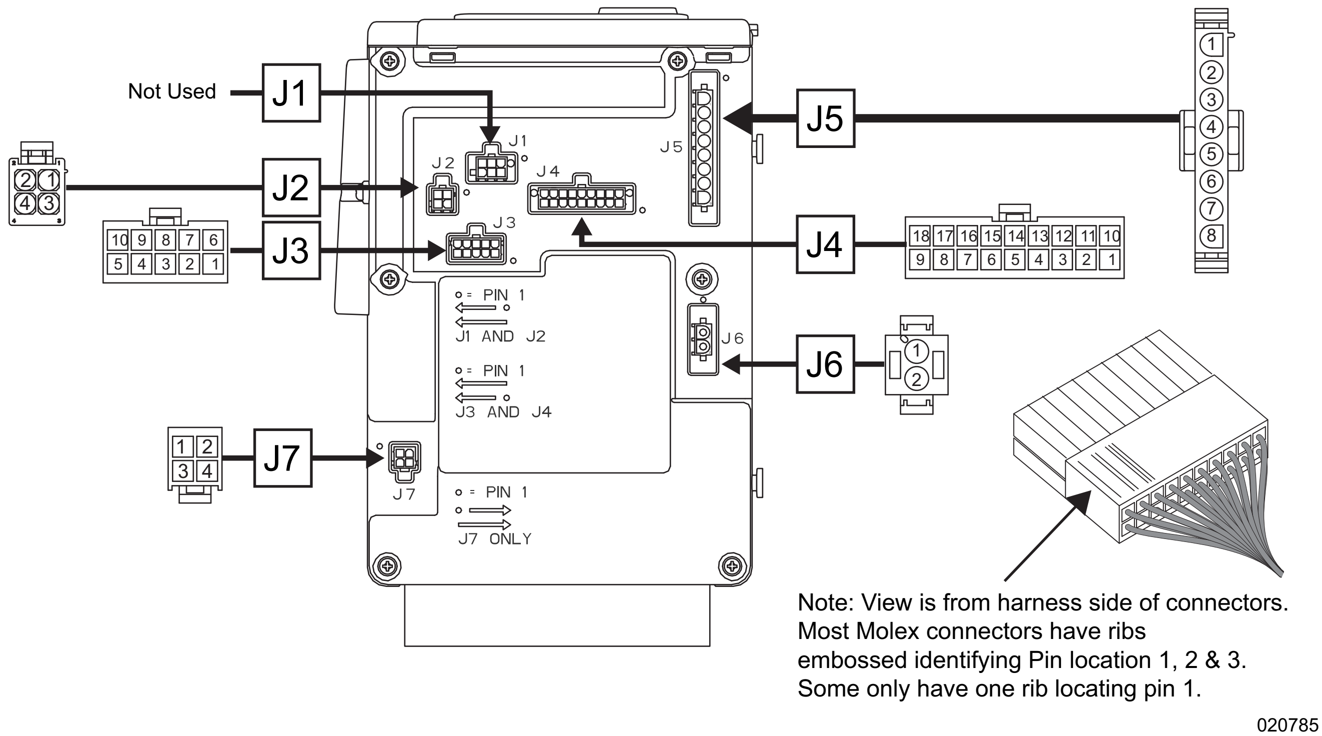



*Figure 5-6. Air-cooled Panel and Connectors (Harness End)*

| J2 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J2-1 | Blue | G3 Radio |
| J2-2 | Brown | G3 Radio |
| J2-3 | White | G3 Radio |
| J2-4 | Black | G3 Radio |

| J3 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J3-1 | 399A | Generator Current Sense |
| J3-2 | 398A | Generator Current Sense |
| J3-3 | 399B | Generator Current Sense |
| J3-4 | 398B | Generator Current Sense |
| J3-5 | 399C | Generator Current Sense (3-phase only) |
| J3-6 | SHLD | Shielding Wire for CAN bus Wiring |
| J3-7 | 743 | CAN bus |
| J3-8 | 744 | CAN bus |
| J3-9 | 877 | ECM Wake-Up |
| J3-10 | 398C | Generator Current Sense (3-phase only) |

| J4 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J4-1 | 13 | 12 VDC Unfused for the Controller |
| J4-2 | 13 | 12 VDC Unfused for the Controller |
| J4-3 | 194 | 12 VDC for the Transfer Relay |
| J4-4 | 23 | Switched to Ground (Internally) to Energize the Transfer Relay |
| J4-5 | — | Not Used |
| J4-6 | — | Not Used |
| J4-7 | 14 | 12 VDC for Fuel Shut Off Valves 1 & 2 (powered when Running) |
| J4-8 | 209 | Common Alarm Relay Input |
| J4-9 | 210 | Common Alarm Relay Output |
| J4-10 | 0 | Common Ground (DC) |
| J4-11 | 0 | Common Ground (DC) |
| J4-12 | 56 | 12 VDC Output to Starter Control Relay |
| J4-13 | — | Not Used |
| J4-14 | — | Not Used |
| J4-15 | — | Not Used |
| J4-16 | — | Not Used |
| J4-17 | 395A | Remote Stop A |
| J4-18 | 395B | Remote Stop B |

# Power Zone 200 Controller (continued)

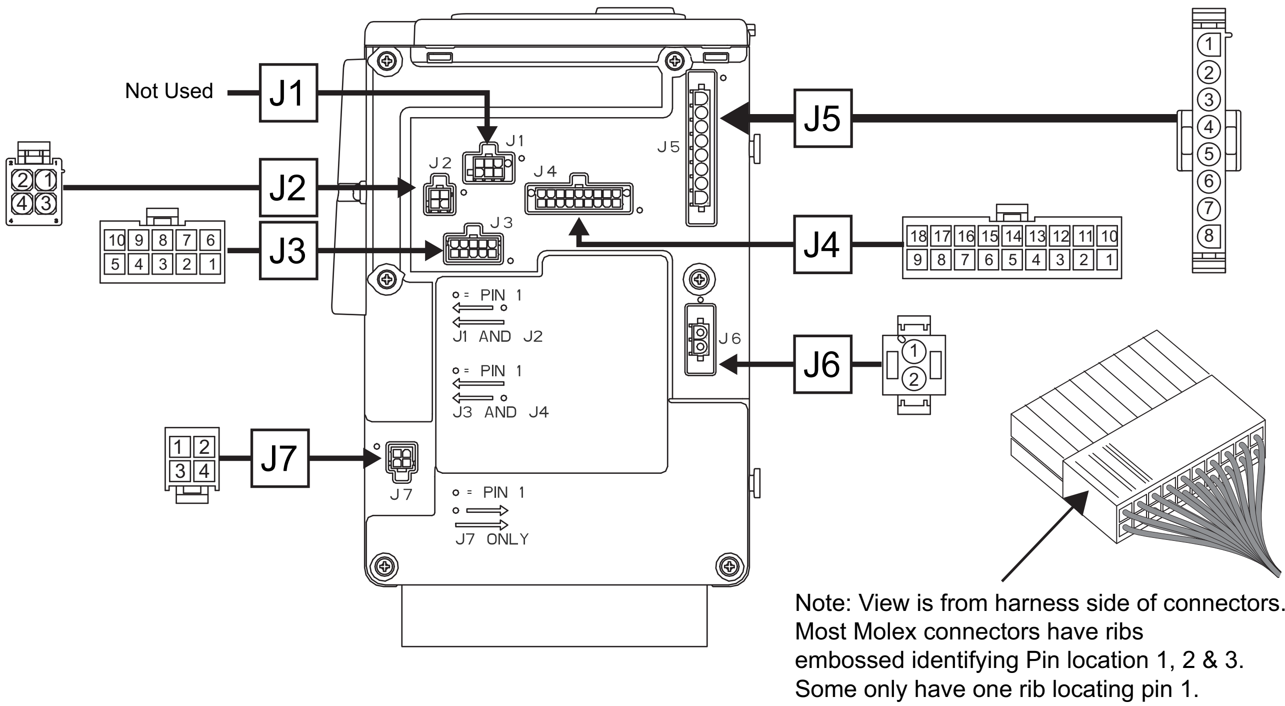



*Figure 5-7. Air-cooled Panel and Connectors (Harness End)*

| J5 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J5-1 | N1 | 240 VAC Utility Sensing Voltage |
| J5-2 | N2 | 240 VAC Utility Sensing Voltage |
| J5-3 | — | Not Used |
| J5-4 | 00 | Neutral Connection for Controller |
| J5-5 | 00 | Neutral Connection for Controller |
| J5-6 | — | — |
| J5-7 | 44S | 240 VAC Generator Voltage Sensing |
| J5-8 | 11S | 240 VAC Generator Voltage Sensing |

| J6 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J6-1 | T1 | 120 VAC Power for Internal Battery Charger |
| J6-2 | 00 | Neutral Connection for Internal Battery Charger |

| J7 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J7-1 | 2 | DPE Winding (AC Excitation Power) |
| J7-2 | 0A | Field Return (-) (DC Field Excitation) |
| J7-3 | 6 | DPE Winding (AC Excitation Power) |
| J7-4 | 4 | Field Flash/DC Excitation (+) |

## Introduction

This section provides acceptable procedures for the testing and evaluation of various problems that can occur on standby generators with air-cooled engines.

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

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

## Safety

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

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

## AC Troubleshooting

Continue to ask questions during the troubleshooting process. Asking some of these questions may help identify the problem more quickly.

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

## AC Excitation Winding Test

### General Theory

The controller's internal voltage regulator requires unregulated voltage from the stator to supply excitation power to the AVR. 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 undervoltage. This test will verify the integrity of the excitation (DPE) winding inside the stator and connections to the voltage regulator.

**NOTE:** Measure the resistance of the meter leads and subtract that reading from the actual reading to ensure accurate results.

### Procedure A – using J7 Breakout Harness, P/N A0000659764)

1. Set the DMM to measure resistance.
2. Disconnect the generator harness J7 connector.
3. Connect the female end of the J7 breakout harness to the unit harness.

**NOTE:** DO NOT CONNECT the male end of the J7 breakout harness to the controller.

4. Insert the meter test leads into the AC excitation test points of the breakout harness (2 and 6).
5. Record the reading.
   a. If the meter reading shows a resistance value consistent with the values found in Section 1.1 ***Specifications***, proceed to the ***AVR PWM Output Test***.
   b. If the meter reading shows an OPEN, proceed to ***Procedure B***.

### Procedure B

1. See ***Figure 6-1***. Disconnect the STR connector located in the wire harness.

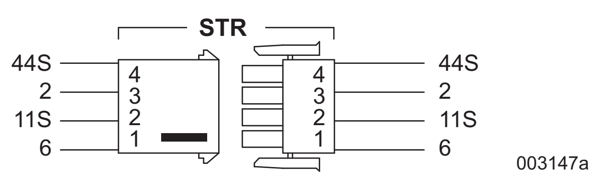



***Figure 6-1. Stator Connector (STR) Pin Locations***

2. Set the 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. Record the reading.

a. If the meter reading shows a resistance value consistent with the values found in Section 2 ***Specifications***, proceed to Step 4.
b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 2 ***Specifications***, proceed to ***Procedure C.***

4. Measure Wire 2 between the STR (stator) connector and the controller.
   a. If resistance measures less than 5 ohms, proceed to Step 5.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and proceed to Step 5.
5. Measure Wire 6 between the STR (stator) connector and the controller.
   a. If resistance measures less than 5 ohms, reconnect the STR harness and retest.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

### Procedure C

1. See ***Figure 6-2*** and ***Figure 6-3***. Remove the stator terminal block cover (A) and identify the studs containing Wires 2 and 6.

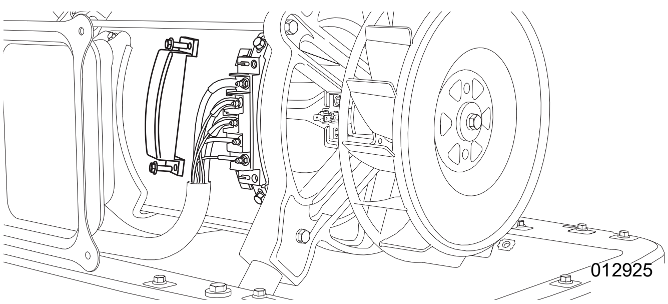



***Figure 6-2. Stator Terminal Block Cover***

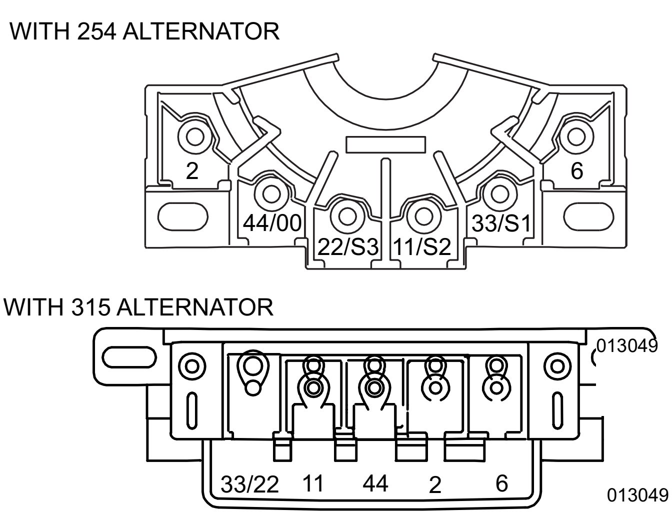



***Figure 6-3. Stator Terminal Block Wires***

2. Check to see that harness connections to the stator terminal block are tight and secure.
   a. If the connections pass inspection, proceed to Step 3.
   b. If the connections are faulty, repair the connections and retest.
3. Set the DMM to measure resistance.
4. Connect one meter test lead to the stud for Wire 2 and the other meter test lead to the stud for Wire 6. Record the reading.
   a. If the meter reading shows a resistance value consistent with the values found in Section 2 ***Specifications***, proceed to Step 5.
   b. If the meter indicated an OPEN or a value inconsistent with the values found in Section 2 ***Specifications***, replace the stator and retest.
5. Measure Wire 2 between the STR (stator) connector and the STB (stator terminal block).
   a. If resistance measures less than 5 ohms, proceed to Step 6.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and proceed to Step 6.
6. Measure Wire 6 between the STR (stator) connector and the STB (stator terminal block).
   a. If resistance measures less than 5 ohms, reinstall the stator block cover and proceed to the ***AVR PWM Output Test***.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

## AC Output Voltage Test

### General Theory

Use a DMM to check the generator's output voltage. Test output voltages at the unit's main circuit breaker (MLCB) terminals. Refer to the unit's Data Plate for rated line-to-line and line-to-neutral voltages.

**⚠ DANGER**

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

(000311)

**IMPORTANT NOTE:** During this test the generator will be running. Prior to starting the generator connect meter test clamps to the high voltage terminals. Stay clear of power terminals during the test. Verify the meter clamps are securely attached and will not shake loose.

### Procedure

1. Gain access to the MLCB on the generator by removing the controller fascia.
2. Set the DMM to measure AC voltage.
3. See ***Figure 6-4***. 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.

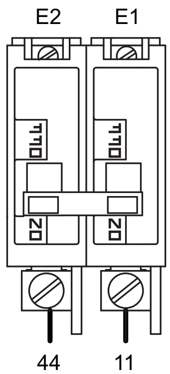



***Figure 6-4. MLCB Test Points***

4. Set the MLCB to the OFF position. Verify that all electrical loads are disconnected from the generator.
5. Set the controller to MANUAL.
6. Set the MLCB to the ON position. Record the voltage.
   a. If the DMM shows approximately 238–244 VAC, the output voltage is good.
   b. If the DMM shows a voltage outside of the above range, proceed to the AVR PWM Output Test.

## AVR PWM Output Test

### General Theory

This test is to verify that the controller is outputting PWM (pulse width modulated) switching to the field output.

**NOTE:** See ***Field Boost*** in Section 4 ***Operational Analysis***for analysis of field boost parameters.

### Procedure

1. Set the DMM to measure hertz (HZ).
2. Disconnect the J7 connector from the controller.
3. Connect the male end of the J7 breakout harness to the controller.
4. Connect the female end of the J7 breakout harness to the generator harness.
5. Place the red meter lead into the WAGO block for Wire 4.
6. Place the black meter lead into the WAGO block for Wire 0A.
7. Clear all faults and place generator in MANUAL. Record the Hz reading.
   a. If approximately 2000 Hz (2 kHz) is measured, AVR output regulation passes test. Proceed to the ***Brushes and Slip Rings Test***.
   b. If 0 Hz is measured, replace the Power Zone 200 controller and retest.

## Brushes and Slip Rings Test

### 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 impede the flow of current. This film usually develops during non-operational 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 10 ***Major Disassembly***.
2. Inspect the brush wires and verify they are secured and properly connected.
3. Inspect the brush assemblies for excessive wear, or damage.
4. Inspect the rotor slip rings. If their appearance is dull or tarnished, polish with a fine grade abrasive material.

**IMPORTANT NOTE:** Do not use metallic grit (such as emery cloth) to polish slip rings. This may cause irreversible damage to the rotor.

5. Disconnect the J7 harness connector from the controller containing Wires 4 and 0A.
6. Set the DMM to measure resistance.
7. Place the red meter lead on one of the disconnected wire ends for Wire 0A at the brushes. Using the appropriate back probe, insert the other lead to Wire 0A at the J7 connector and record the reading.
   a. If the resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
8. On the other brush assembly, place the red meter lead on one of the disconnected wire ends for Wire 0A at the brushes. Using the appropriate back probe, insert the other lead to Wire 0A at the J7 connector and record the reading.
   a. If the resistance measures less than 5 ohms, proceed to Step 9.

   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

9. Place the red meter lead on one of the disconnected wire ends for Wire 4 at the brushes. Using the appropriate back probe, insert the other lead to Wire 4 at the J7 connector and record the reading.
   a. If the resistance measures less than 5 ohms, proceed to Step 10.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
10. On the other brush assembly, place the red meter lead on one of the disconnected wire ends for Wire 4 at the brushes. Using the appropriate back probe, insert the other lead to Wire 4 at the J7 connector and record the reading.
    a. If the resistance measures less than 5 ohms, proceed to Step 11.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
11. With Wire 4 still disconnected at the brush assemblies, place the red meter lead on one of the disconnected wire ends for Wire 4 at the brushes and place the black lead on a frame ground. Record the reading. Move the red lead to the other Wire 4 connector at the brushes and record the reading.
    a. If the resistance measures OL on both wires, proceed to Step 12.
    b. If either wire shows a resistance value, replace wiring harness and retest.
12. Place the meter leads across the terminals of each brush holder. Record the readings.
    a. If the resistance value is consistent with the specifications chart, proceed to the ***Rotor Assembly Test***.
    b. If the resistance value is out of range or shows OL, proceed to Step 13.
13. Remove the affected brush assembly.
14. Set the DMM to measure continuity.
15. Place the red meter lead on the Wire 4 terminal and the black meter lead on the slip ring side of the brushes. Record the reading. Move the red meter lead to the Wire 0 terminal and record the reading.
    a. If OL is measured, replace the brush assembly and retest.
    b. If continuity is measured, proceed to the ***Rotor Assembly Test***.

# Current Calibration Procedure

## General Theory

When a Power Zone 200 controller is replaced, the calibration of both voltage and amperage will need to be verified so the controller is aligned with the generator's output. Calibration of current (amperage) is done with the use of a load bank that is set to at least 20% of the generator rated capacity.

**NOTE:** Calibration between the generator and controller is preset from the factory, and does not need adjustment. Only when replacing a controller will this need to be checked.

## Procedure

**NOTE:** In the Field Pro app, CT1 correlates to “AN” (Wire 11) and CT2 correlates to “BN” (Wire 44).

**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)

1. Gain access to the MLCB on the generator by removing the controller fascia.
2. Connect a load bank to the output circuit of the generator. This should be done at the generator MLCB.
3. Set the Amp Clamp to measure AC Amperage.
4. Using the Field Pro app, navigate to the “Calibration” screen.
5. Place the Amp Clamp over the circuit being calibrated.
6. Start the generator and allow it to warm up for 10 seconds.
7. Place a load on the generator that is at least 20% of the generator rated capacity.
8. On the Field Pro app under the “Current Calibration” box, enter the recorded amperage for the circuit being measured in the “Measured Current” box. Click the save icon.
9. Repeat Steps 5–8 on the other circuit.
10. Once completed, turn the generator OFF and remove test equipment.

# Field Boost Voltage Test

## General Theory

Wire 4 is used for both carrying the field flash voltage to the rotor to excite it, and also to send regulated voltage from the AVR to the rotor. This test will verify the integrity of Wire 4.

**NOTE:** See ***Field Boost*** in Section 4 ***Operational Analysis***for analysis of field boost parameters.

### Procedure

1. Set DMM to measure DC continuity.
2. Disconnect the J7 connector from the controller.
3. Connect the male end of the J7 breakout harness to the controller.

**IMPORTANT NOTE:** DO NOT CONNECT the female end of the J7 breakout harness to the generator harness.

4. Insert the red meter lead into the WAGO block for Wire 4.
5. Insert the black meter lead into the WAGO block for Wire 0A. Record the reading.
   a. If continuity is measured, proceed to Step 6.
   b. If continuity is not measured, proceed to the ***Brushes and Slip Rings Test***.
6. Clear any faults and start the generator in MANUAL. Record the voltage.
   a. If the voltage measures approximately 14 VDC, proceed to ***AVR PWM Output Test***.
   b. If the voltage measures approx. 3–4 VDC, check the connection and pins for the J7 connector. If the pins are damaged, replace the wiring harness and/or controller as necessary and retest. If the harness and controller pins pass inspection, proceed to the ***AC Excitation Winding Test***.
   c. If the voltage measures 0 VDC, check the integrity of the harness pins and connector. Repair/replace as necessary and retest. If all passes, proceed to the ***Internal Diode Test***.

## Internal Diode Test

### General Theory

A diode acts like an electronic one-way check valve that allows current to pass in only one direction to protect a circuit from an electrical “back feed”. When testing the internal diode, a DMM is used in the “Diode” function to apply a small amount of voltage across the circuit. This is used to verify that voltage will pass through in one direction (as the voltage is applied by the positive lead of the DMM) and not the other. Typically, when a diode is tested and working properly, one way will show approximately 0.5 VDC and the other will show OL.

### Procedure

1. Disconnect and remove the controller from the generator.
2. Set the DMM to the Diode function.
3. Locate the J7 connector on the back of the controller and connect the J7 breakout harness to the controller.
4. Insert the red meter lead into the WAGO block for Wire 0A and the black lead into the WAGO block for Wire 4. Record the reading.
   a. If approx. 0.5 VDC is measured, proceed to Step 5.
   b. If OL is measured, replace the controller and retest.
5. Insert the red meter lead into the WAGO block for Wire 2 and the black lead into the WAGO block for Wire 4. Record the reading.
   a. If approx. 0.5 VDC is measured, proceed to Step 6.
   b. If OL is measured, replace the controller and retest.
6. Insert the red meter lead into the WAGO block for Wire 6 and the black lead into the WAGO block for Wire 4. Record the reading.
   a. If approx. 0.5 VDC is measured, proceed to Step 7.
   b. If OL is measured, replace the controller and retest.
7. Set the DMM to measure resistance.
8. Insert the red meter lead into the WAGO block for Wire 2 and the black lead into the WAGO block for Wire 6. Record the reading.
   a. If resistance is greater than 1 Megohm, controller passes test. Proceed to the ***Brushes and Slip Rings Test***.
   b. If OL is measured, replace the controller and retest.

## Overload Condition Test

### General Theory

An “overload” condition exists when the generator rated amperage capacity has been exceeded. To test for an overload condition on an installed unit, the recommended method is to use an ammeter.

**NOTE:** Verify the Current Calibration is set correctly before proceeding. See the Current Calibration Procedure for information.

### Procedure

1. Set the ammeter to measure AC amperage.
2. Connect the clamp-on ammeter over Wires 11 and 44 on the generator side of the MLCB.
3. Transfer all of customer's typical electrical loads to the generator. Record the amperage.
   a. If the ammeter displays amperage readings that are higher than the rated capacity of the generator, reduce the loads to within the rated

capacity and advise the customer accordingly.

b. If the ammeter displays amperage readings that are below the generator's rated capacity, but the engine RPM and/or frequency dropped excessively, proceed to the ***Voltage and Frequency Under Load Test***.

## Preliminary Output Voltage Test

### General Theory

When an alarm of the 1900 group (Undervoltage) is active, certain tests need to be performed to determine the actual fault. Under certain conditions, the controller will allow up to four minutes to measure output voltage before shutting down on “undervoltage” during which the Field Pro app will read “Warming Up”. Measuring output voltage as described in this test will help determine the next step in troubleshooting.

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

**NOTE:** If the generator shuts down before this test is completed, clear the alarm and restart the test as needed to obtain the correct measurements.

### Procedure

1. Gain access to the main line circuit breaker (MLCB) on the generator by removing the controller fascia.
2. Set the MLCB to the OFF position.
3. Using the Field Pro app, navigate to view the *Output Voltage* input box.
4. Set the 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 generator side of the MLCB.
6. Set the controller to MANUAL. Allow generator to start and stabilize.
7. Record the voltage shown on the meter.
8. On the Field Pro app, add the AN and BN voltage together in the Output Voltage box. Record the total output voltage.
9. Turn OFF the generator.
10. Use ***Table 6-1*** to determine which test to perform.

**Table 6-1. Preliminary Output Voltage Test Results**

| Field Pro AC Voltage | AC Voltage measured at MLCB | Perform Test(s) |
|---|---|---|
| 0 | 0 (approx.) | ***Field Boost Voltage Test*** |
| 40–90 (approx.) | 40–90 (approx.) | ***AC Excitation Winding Test*** |
| 120 (approx.) | 240 (approx.) | ***Sensing Circuits Test*** |
| 240 (approx.) | 240 (approx.) | ***Voltage and Frequency Under Load Test*** |

## Rotor Assembly Test

### 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. Disassemble the generator until the brushes and slip rings are exposed. Refer to Section 10 ***Major Disassembly***.
2. Remove the brush assemblies from the slip rings to prevent interaction.
3. Set the DMM to measure resistance.
4. Connect the red meter lead to the positive slip ring (nearest the rotor bearing) and the black lead to the negative slip ring. Record the reading. Compare the reading with Section 2 ***Generator Specifications***.
   a. If the resistance is within specification, proceed to Step 5.
   b. If the resistance is out of specifications, replace the rotor and retest
5. Set the DMM to measure continuity.
6. Connect the red meter lead to the positive slip ring and the black meter lead to a chassis ground. Record the reading.
   a. If no continuity is measured, proceed to the ***Stator Test***.
   b. If continuity is measured, replace the rotor and retest.

## Sensing Circuits Test

### General Theory

The automatic voltage regulator (AVR) built into the Power Zone 200 controller needs a way to monitor the voltage the generator is providing to the customer's load. This is needed to regulate the voltage provided to the brushes to maintain 240 VAC under all load conditions. This test will verify the integrity of the sensing circuit.

- If one sensing wire is damaged, 240 VAC will be measured at the MLCB. However, the Field Pro app will display 120 on AN or BN (depending on which leg is damaged).
- If both sensing wires are damaged, up to 300 VAC may be measured on the MLCB. However, the Field Pro app will display 0 VAC on both AN and BN.

**NOTE:** Stator winding resistance values are very low. Some meters will not read such a low resistance and thus will show different ranges of resistance. The manufacturer recommends a high-quality DMM capable of reading a very low resistance.

## Procedure A

1. Open the Field Pro App to the Generator Details screen.
2. Start the generator in MANUAL. Once the generator stabilizes, look at the Output Voltage input box. The readings will be voltage to neutral on Line A and Line B. Each line should display 120 VAC ± 5%.
   a. If both lines display 120 VAC ± 5%, stop testing as the sensing circuit is working correctly.
   b. If one or both lines do not display 120 VAC ± 5%, proceed to Step 3.
3. Set the DMM to measure resistance.
4. Remove the 7.5 Amp fuse from the controller.
5. Locate and unplug the J5 connector on the back of the controller.
6. Locate the pins for Wires 11S and 44S.
7. Using appropriate back probes, record the resistance between Wires 11S and 44S.
   a. If the meter displays a resistance value consistent with the values found in Section 2 ***Generator Specifications***, check the connection and pins for the J5 connector. If the pins are found to be damaged, replace the wiring harness and/or controller as necessary and retest. If the harness and controller pins pass inspection, replace the controller and retest.
   b. If the meter displays OL, proceed to Procedure B.

## Procedure B

1. Set DMM to measure resistance.
2. See ***Figure 6-5***. Locate and disconnect STR connector in wire harness.

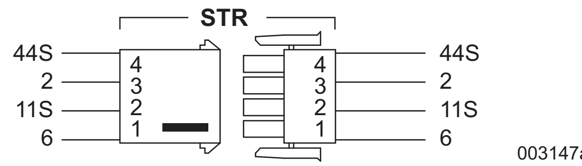



***Figure 6-5. Stator Connector (STR) Pin Locations***

3. Connect meter test leads the appropriate harness pins containing Wire 11S and Wire 44S in the STR connector leading to the Stator. Record the resistance.
   a. If the meter displays a resistance value consistent with the values found in Section 2 ***Generator Specifications***, replace the wiring harness and retest.
   b. If the meter displays OL, proceed to Step 4.
4. See ***Figure 6-6*** and ***Figure 6-7***. Remove the stator terminal block cover and identify the studs containing Wires 11S and 44S.

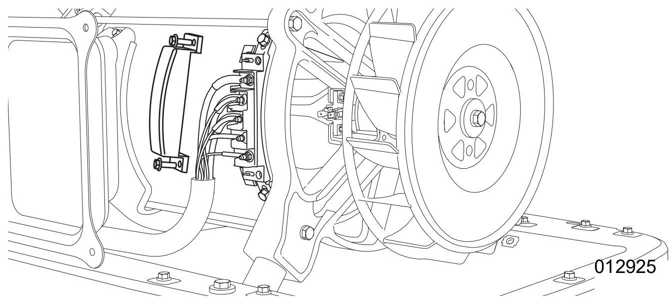



***Figure 6-6. Stator Terminal Block Cover***

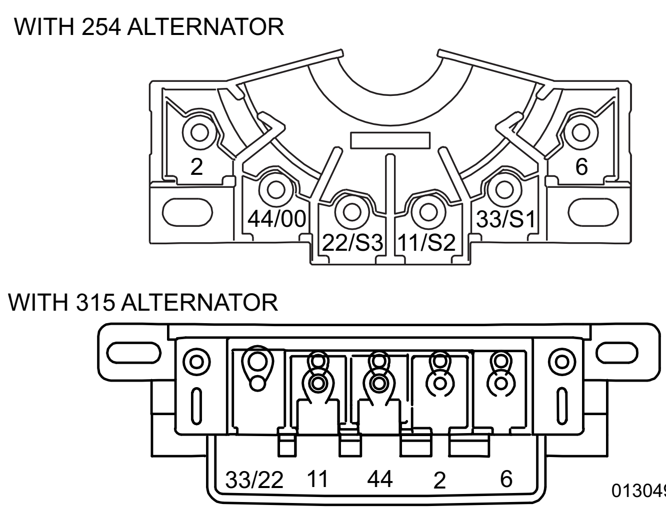



***Figure 6-7. Stator Terminal Block Wires***

5. Verify harness connections to the stator terminal block are tight and secure. If they are loose, tighten and retest.
6. Place the meter leads on the terminals for Wires 11 and 44. Record the reading.
   a. If the meter displays a resistance value of less than 1 ohm in Step 6, but displayed OL in Step 3, replace the wiring harness and retest.

b. If the meter displays OL or a value inconsistent with the values found in Section 2 ***Generator Specifications***, replace stator and retest.

c. If values are correct but a sensing issue is still present, go to ***Procedure C***.

### Procedure C

1. Set DMM to measure resistance.
2. Disconnect the J5 connector from the back of the controller. Visually inspect the controller and the harness pins for damage.
   a. If the pins pass inspection, proceed to Step 3.
   b. If the pins are found to be damaged, replace the wiring harness and/or controller as necessary and retest.
3. Using appropriate back probes, connect one meter test lead to J5-4. Connect the other meter test lead to J5-5. Record the resistance.
   a. If the meter displays a resistance value of up to 10 ohms, return to Procedure A and test again.
   b. If the meter displays OL, proceed to Step 4.
4. Disconnect Wire 00 (18 gauge white) from the neutral bar.
5. Connect one meter lead to the disconnected Wire 00 from the neutral bar and other meter lead to J5-4. Record the resistance.
   a. If the meter displays less than 5 ohms go to Step 6.
   b. If the meter displays OL, replace the wiring harness and retest.
6. Connect one meter lead to the disconnected Wire 00 from the neutral bar and other meter lead to J5-5. Record the resistance.
   a. If the meter displays less than 5 ohms go to Step 7.
   b. If the meter displays OL, replace the wiring harness and retest.
7. Disconnect Wire 22/33 from the neutral bar in the customer connection compartment and Wire 22/33 from the stator terminal block (STB).
8. Connect one meter lead to the disconnected Wire 22/33 at the neutral bar the other meter lead to the disconnected Wire 22/33 from the stator terminal block. Record the resistance.
   a. If the meter displays less than 5 ohms go to Step 9.
   b. If the meter displays OL, replace the wiring harness and retest.
9. Remove Wire 33 jumper (if equipped) from the STB.
10. Measure resistance across the disconnected Wire 33.
    a. If the meter displays less than 5 ohms proceed to the ***Voltage and Frequency Under Load Test***.
    b. If the meter displays OL, replace the wiring harness and retest.

## Stator Test

### 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 6-2*** has been provided to record the results. These results may be required when requesting factory support.

### Procedure

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. Remove the stator terminal block cover to expose all wires/studs (33/22, 11, 44, 2, and 6).
4. Verify harness connections to the stator terminal block are tight and secure. If any are found loose, tighten and retest.
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 6-2*** and follow the instructions within the table for repair procedures.

**Table 6-2. 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.<br>b. If results are within specification, 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 indicates a short-to-ground condition; replace the stator.<br>b. If results are OL, continue to next chart. | | |

**Table 6-2. Stator Results (w/STB terminal block)**

| Test For A Short Circuit Between Windings | | |
|---|---|---|
| Stator Stud Wire 2 or Wire 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, restart test again. | | |

## Utility Voltage Calibration

### General Theory

When a Power Zone 200 controller is replaced, the calibration of utility voltage will need to be verified so the controller is aligned with the incoming utility source voltage. Calibration of utility voltage is done with the generator not running and the utility breaker set to ON.

### Procedure

**NOTE:** In the Field Pro app, “AN” correlates to Wire N1 and “BN” correlates to Wire N2.

1. Gain access to the Customer Connections on the generator by removing the controller fascia.
2. Set the DMM to measure AC voltage.
3. Using the Field Pro app, navigate to the “Calibration” screen.
4. Place the red meter lead in the WAGO block terminal for Wire N1 and the black meter lead to the neutral block. Record the reading.
5. On the Field Pro app under the “Voltage Calibration” box, enter the recorded voltage under the “Measured Voltage” column for A to Neutral. Click the save icon.
6. Place the red meter lead in the WAGO block terminal for Wire N2 and the black meter lead to the neutral block. Record the reading.
7. On the Field Pro app under the “Voltage Calibration” box, enter the recorded voltage under the “Measured Voltage” column for B to Neutral. Click the save icon.
8. Once completed, remove test equipment.

## Voltage and Frequency Under Load Test

### 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 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 the DMM to measure AC voltage.
2. Connect an AC frequency meter and the DMM meter leads across the stator AC power winding leads.
3. Start the engine. Let it stabilize and warm-up.
4. Using a clamp-on ammeter to verify the load current, apply electrical loads to the generator equal to the rated capacity of the unit. Record the frequency and the voltage.
   a. If the DMM displays 60 Hz and approximately 240 VAC during full load, test passes.
   b. If the DMM displays a frequency and voltage that dropped while under full load with an engine that is affected, refer to the Field Pro app for the applicable engine E-code.
   c. If the DMM displays a frequency and voltage that dropped while under full load without an engine that is affected, proceed to ***AVR PWM Output Test***.

## Voltage Calibration

### General Theory

When a Power Zone 200 controller is replaced, the calibration of both voltage and amperage will need to be verified so the controller is aligned with the generator's output. Calibration of voltage is done **without** the use of a load bank.

**NOTE:** Calibration between the generator and controller is preset from the factory, and does not need adjustment. Only when replacing a controller will this need to be checked.

### Procedure

**NOTE:** In the app, “AN” correlates to Wire 11 and “BN” correlates to Wire 44.

1. Gain access to the main line circuit breaker (MLCB) on the generator by removing the controller fascia.
2. Set the DMM to measure AC voltage.
3. Set the MLCB to the “OFF” position.
4. Using the Field Pro app, navigate to the “Calibration” screen.
5. Place the red meter lead on the generator side of the MLCB terminal for Wire 11 and the black meter lead to the neutral block.
6. Start the generator in MANUAL and record the meter reading.

7. On the Field Pro app under the “Voltage Calibration” box, enter the recorded voltage under the “Measured Voltage” column for A to Neutral. Click the save icon.
8. Move the red meter lead to the generator side of the MLCB terminal for Wire 44 while leaving the black meter lead in place. Record the meter reading.
9. On the Field Pro app under the “Voltage Calibration” box, enter the recorded voltage under the “Measured Voltage” column for B to Neutral. Click the save icon.
10. Once completed, turn the generator OFF and remove test equipment.

## Engine Control Components

### Engine Control Module

The engine is controlled by an engine control module (ECM). The ECM controls fuel flow, air flow and ignition timing to maintain optimal engine performance. It does this by reading values from multiple sensors located on various engine components, interpreting the data and adjusting engine fuel flow, timing and intake air flow to maintain proper speed, performance and emissions characteristics.

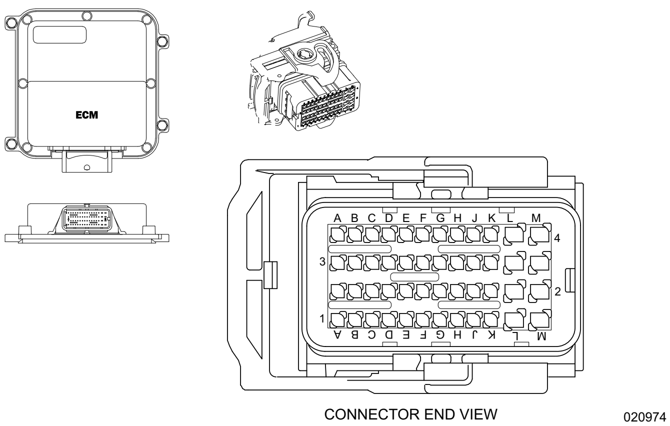



*Figure 7-1. Engine Control Module*

Sensors are used to monitor engine performance:

- **TTMAP** – Throttle Position/Manifold Absolute Pressure/Intake Air Temperature
- **CRKS** – Crankshaft Position
- **OS** – Oxygen Sensor
- **OLS** – Oil Level Sensor
- **OPS** – Oil Pressure Switch
- **MPS** – Mixer Position Sensor
- **FPS** – Fuel Pressure Sensor
- **EHT** – Engine Head Temperature Sensor

Engine performance and speed are controlled by:

- **ETC** – Electronic Throttle Control Valve
- **EMC** – Electronic Mixer Control Valve
- **IC** – Ignition Coil

Other control devices:

- **MPR** – Master Power Relay
- **SOV** – Fuel Shut Off Valve

The ECM is located behind the PZ200 controller in the customer connection area. A large single connector connects the ECM to the engine harness and also to the generator main control panel. Communication to the main control panel is achieved via a digital communications link CANBUS 2.0 J1939.

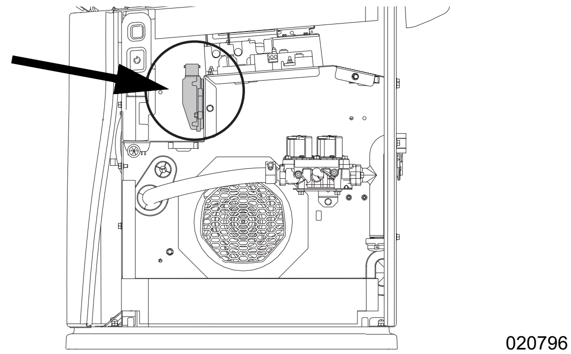



*Figure 7-2. ECM Location*

## Theory Of Operation – ECM ON/OFF

When the generator is powered up, the ECM is switched ON by Wire 877 (greater than 6 VDC = ON, less then 6 VDC = OFF). At the same time a CAN bus signal is sent from the control panel to the ECM to go active.

After the ECM is switched ON, it performs internal checks, and within 0.1–0.5 seconds it turns on the master power relay (MPR). The ECM will not allow the engine to start unless it also sees the generator controller command start from CAN message GC1 (Generator Controller 1) “START ENGINE”.

When the ECM senses a problem or a malfunction within the engine, a fault code is triggered. The ECM fault code will be read by the generator controller.

When the generator controller commands the engine to stop, it will first send GC1 “STOP” to the ECM.

**NOTE:** The ECM will stay powered up except to briefly turn off after a shutdown but then turn back on and stay on.

If Wire 877 turns off at any time while the engine is running, but no GC1 message is received, the ECM will treat this as a request to stop the engine. Both Wire 877 and GC1 are needed to start the engine, but either one can stop the engine.

## Wiring Harness

The wiring harness connects the ECM directly to the control panel and to the various engine sensors and controllers.

## Master Power Relay

See *Figure 7-3*. The master power relay (MPR), located under the control panel, supplies 12 VDC to:

- Ignition Coils
- Oxygen Sensor
- ECM Drivers
- Oil Pressure Switch

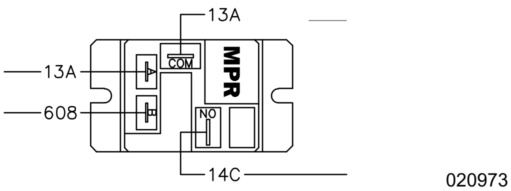



*Figure 7-3. Master Power Relay*

## Starter Contactor Relay/Solenoid

See *Figure 7-4*. The starter contactor relay (SCR) provides a safe and controlled method of energizing the solenoid located on the starter. The controller is responsible for energizing the relay when the start command is given.

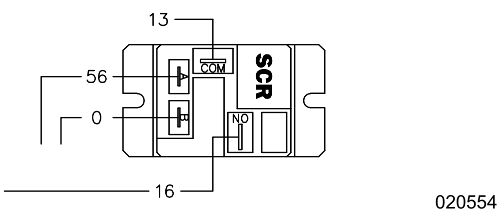



*Figure 7-4. Starter Control Relay*

## Throttle Body / Mixer and Electronic Throttle / Mixer Control

See *Figure 7-5*. The electronic throttle controller (ETC) (Item D) and electronic mixer controller (EMC) (Item C) are integrated with the throttle body / mixer assembly. The ETC (which controls air flow into the engine) and EMC (which controls fuel flow into the engine) receive signals from the engine control module (ECM) to open and adjust the valves in the throttle body and allow air and fuel to flow into the combustion chamber.

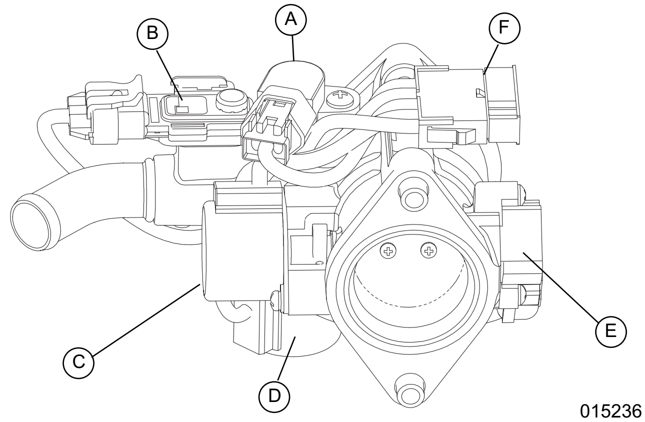



*Figure 7-5. Throttle Body / Mixer with Electronic Throttle Controller and Electronic Mixer Controller*

| | |
|---|---|
| A | Mixer Position Sensor (MPS) |
| B | Fuel Pressure Sensor (FPS) |
| C | Electronic Throttle Controller (ETC) |
| D | Electronic Mixer Controller (EMC) |
| E | Throttle Position, Temperature and Manifold Air Pressure Sensor (TTMAP) |
| F | Engine Throttle/Mixer Connector (ETMC) Connector |

## Throttle Position, Temperature and Manifold Air Pressure Sensor (TTMAP)

See *Figure 7-5*. The throttle position, temperature and manifold absolute pressure sensor (TTMAP) (Item E) monitors throttle temperature and manifold air pressure going into the engine. These parameters are sent to the ECM to assist in maintaining optimal spark and fuel delivery while the unit is running.

## Ignition Coils

See *Figure 7-6*. The ignition coils (IC1 and IC2) receive signal from the ECM to generate and deliver a high voltage signal to the spark plugs.

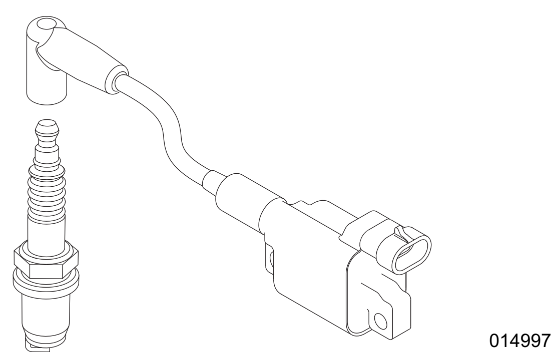



*Figure 7-6. Ignition Coil*

## Crankshaft Position Sensor (CRKS)

See ***Figure 7-7***. The crankshaft position sensor (CRKS) senses the timing teeth on the flywheel as it rotates. The flywheel has a 24 minus one tooth design where one position has no tooth present. The CRKS senses this gap during rotation and sends that signal to the ECM to determine the position of the crankshaft and camshaft.

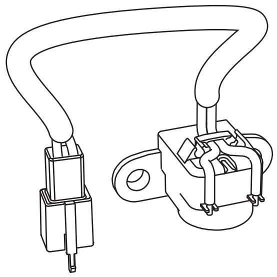



***Figure 7-7. Crankshaft Position Sensor***

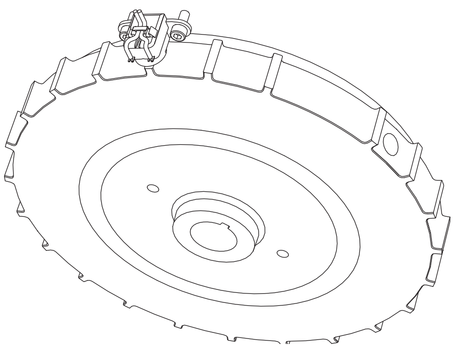



***Figure 7-8. Crankshaft Position Sensor and Flywheel***

## Engine Head Temperature Sensor (EHT)

See ***Figure 7-9***. The engine head temperature sensor (EHT) is located on cylinder #1 and secured in place by a bolt. The EHT monitors engine head temperature. This data is sent to the ECM to assist in maintaining optimal spark and fuel delivery while the unit is running.

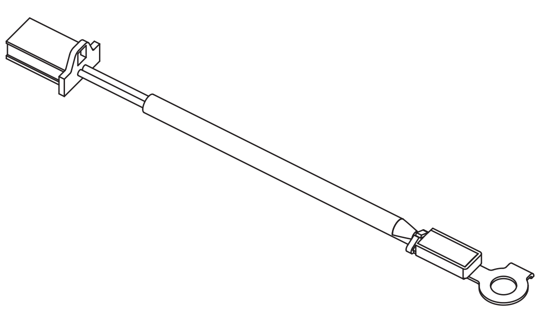



***Figure 7-9. Engine Head Temperature Sensor***

## Oxygen Sensor (OS)

See ***Figure 7-10***. The oxygen sensor (OS), located on the exhaust manifold, sends data to the ECM to assist in maintaining optimal fuel delivery while the unit is running.

The OS is heated by voltage from the ECM for optimum performance. The sensor sends a voltage signal indicating the oxygen level in the exhaust. The ECM uses that data to determine how much fuel to add for optimal emissions and power.

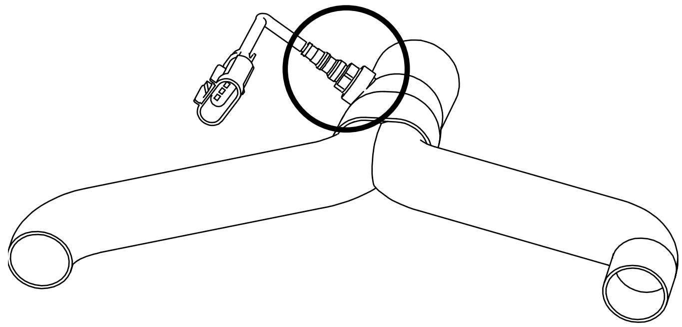



***Figure 7-10. Oxygen Sensor***

## Oil Pressure Switch (OPS)

See ***Figure 7-11***. The engine is equipped with a low oil pressure switch (OPS). The sensor works differently depending on the engine.

- 459cc 10 kW - The switch is a normally closed (NC) type that closes when the oil pressure drops below the set threshold.
- 817/997cc 14–28 kW - The switch is a normally open (NO) type that opens when the oil pressure drops below the set threshold.

Both types are connected to the ECM which will shutdown the engine and activate an alarm on a low pressure signal.

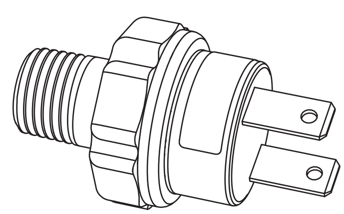



***Figure 7-11. Oil Pressure Switch***

| Generator | PSI | Type |
|---|---|---|
| 459cc 10 kW | 5 PSI | Normally Closed (NC) |
| 817 / 997cc 14–28 kW | 10 PSI | Normally Open (NO) |

## Oil Level Sensor (OLS)

See *Figure 7-12*. The Engine is equipped with a float style oil level sensor (OLS) to provide oil level reference only data to the ECM. The sensor will provide a warning to check, or check and add oil using the dipstick to set the correct oil level for the engine. Warnings for low and overfull will be presented if the conditions are met.

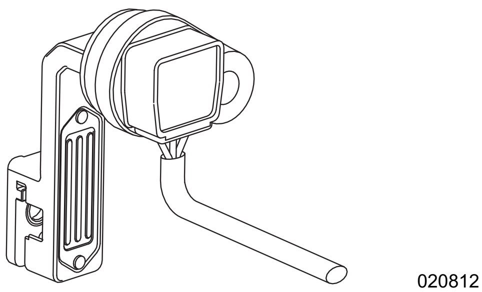
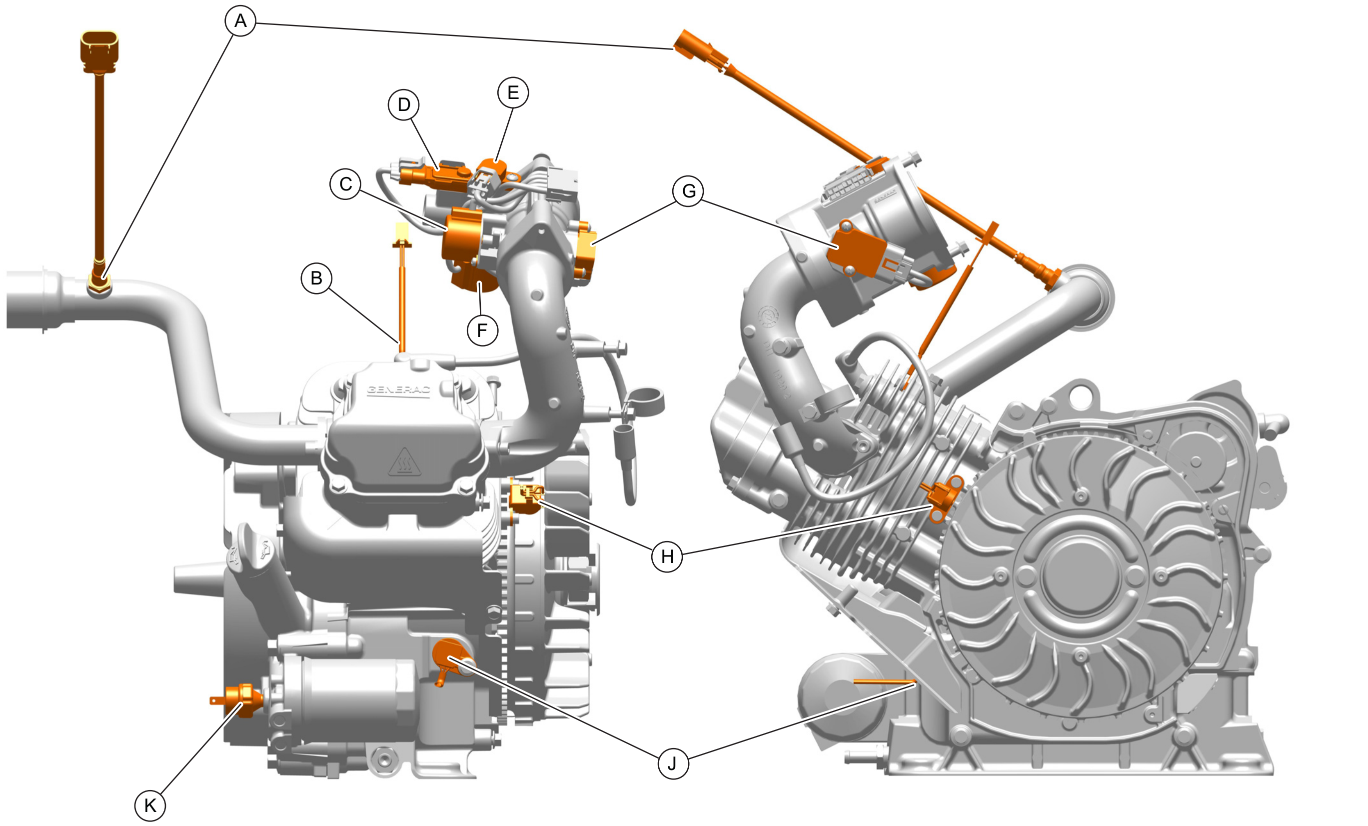



***Figure 7-12. Oil Level Sensor***

# Engine Control Locations

## 459 cc Single Cylinder Engine




| | |
|---|---|
| A | OS – Oxygen sensor |
| B | EHT – Engine Head Temperature Sensor |
| C | ETC – Electronic Throttle Control Valve |
| D | FPS – Fuel Pressure Sensor |
| E | MPS – Mixer Position Sensor |
| F | EMC – Electronic Mixer Control Valve |
| G | TTMAP – Throttle Position, Temperature and Manifold Air Pressure Sensor |
| H | CRKS – Crankshaft Position |
| J | OLS – Oil Level Sensor |
| K | OPS – Oil Pressure Switch |

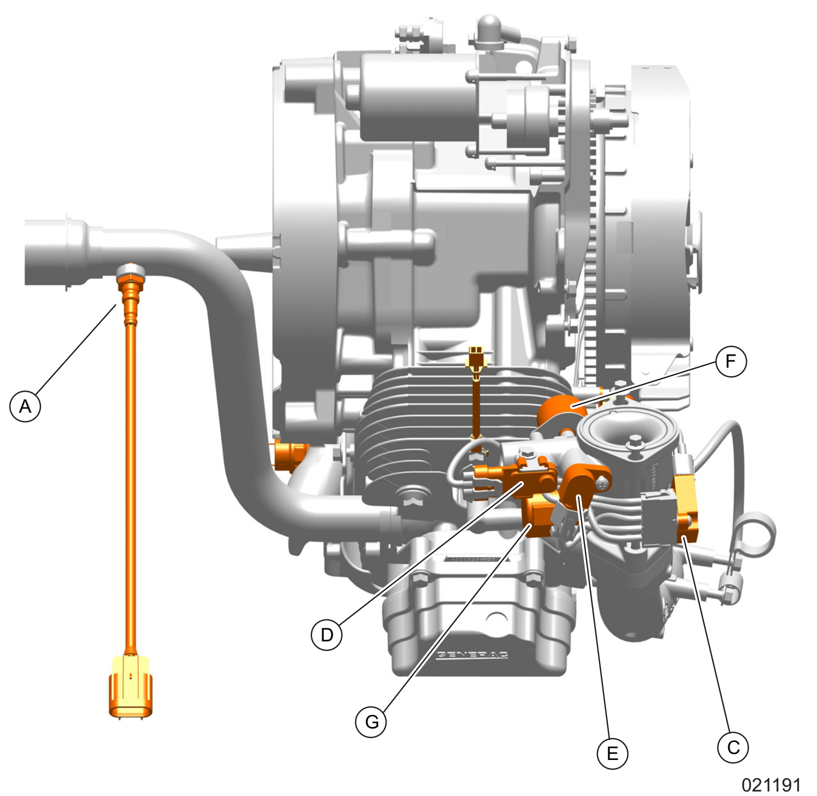
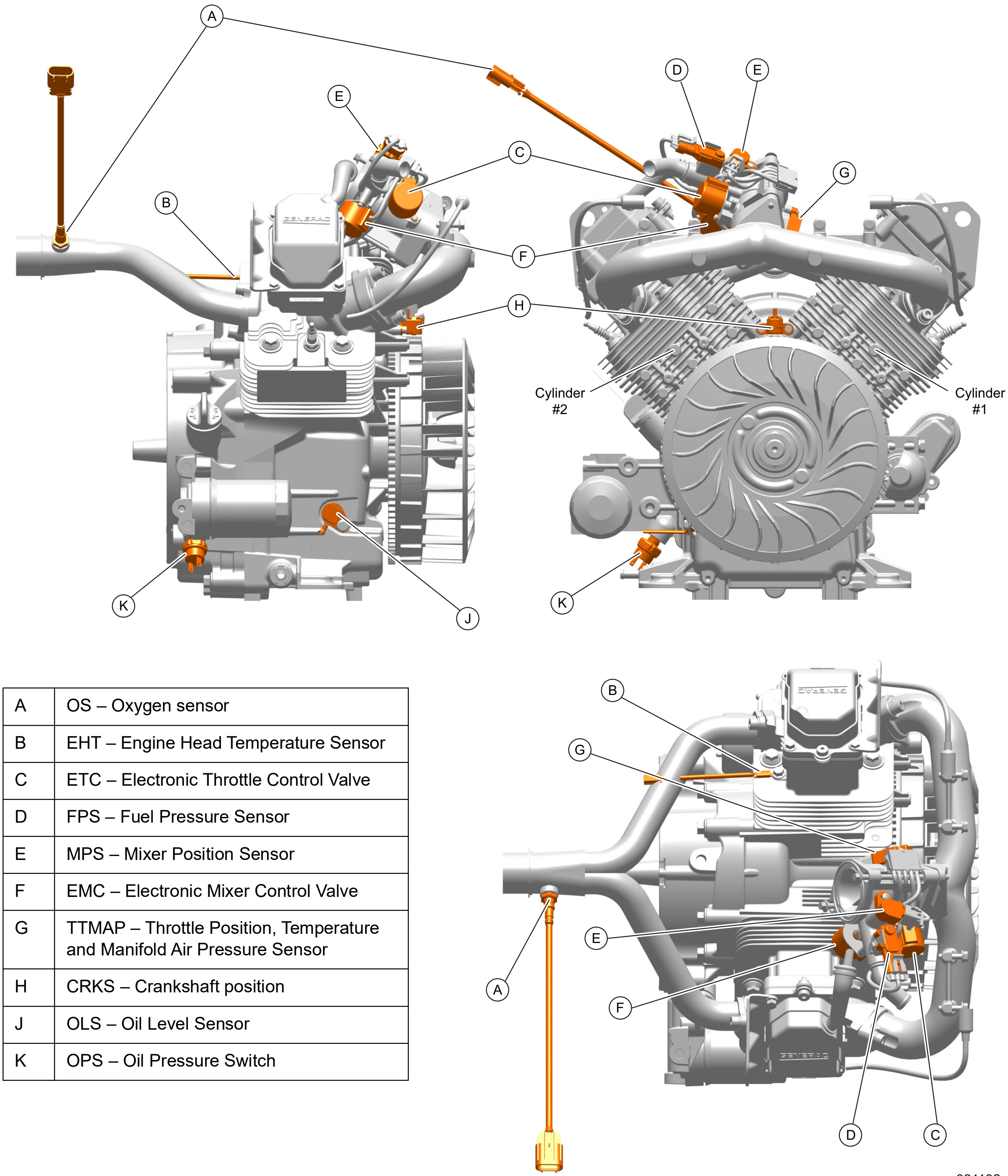



***Figure 7-13. Engine Control Locations***

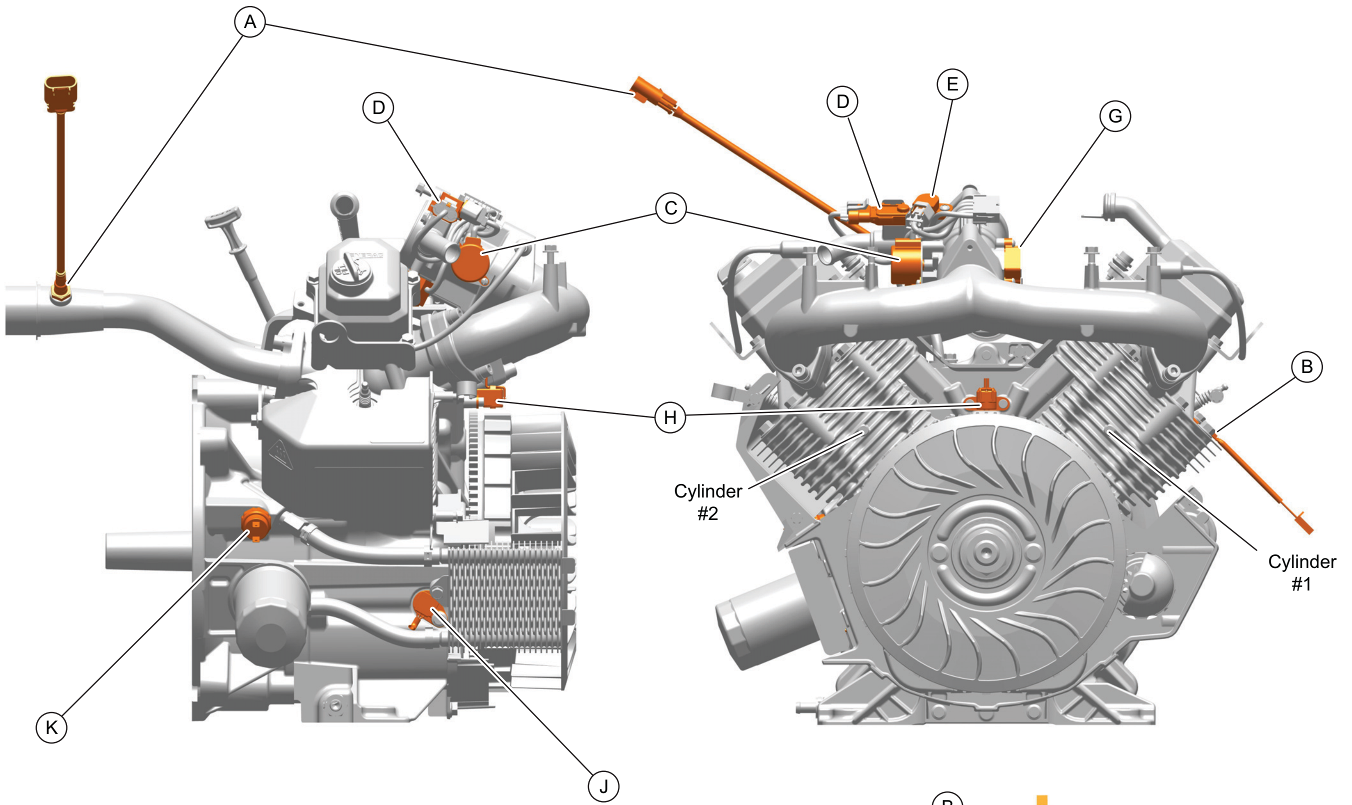
## 817 cc V-Twin Engine




| | |
|---|---|
| A | OS – Oxygen sensor |
| B | EHT – Engine Head Temperature Sensor |
| C | ETC – Electronic Throttle Control Valve |
| D | FPS – Fuel Pressure Sensor |
| E | MPS – Mixer Position Sensor |
| F | EMC – Electronic Mixer Control Valve |
| G | TTMAP – Throttle Position, Temperature and Manifold Air Pressure Sensor |
| H | CRKS – Crankshaft position |
| J | OLS – Oil Level Sensor |
| K | OPS – Oil Pressure Switch |

***Figure 7-14. Engine Control Locations***

## 997 cc V-Twin Engine




| | |
|---|---|
| A | OS – Oxygen Sensor |
| B | EHT – Engine Head Temperature Sensor |
| C | ETC – Electronic Throttle Control Valve |
| D | FPS – Fuel Pressure Sensor |
| E | MPS – Mixer Position Sensor |
| F | EMC – Electronic Mixer Control Valve |
| G | TTMAP – Throttle Position, Temperature and Manifold Air Pressure Sensor |
| H | CRKS – Crankshaft Position |
| J | OLS – Oil Level Sensor |
| K | OPS – Oil Pressure Switch |

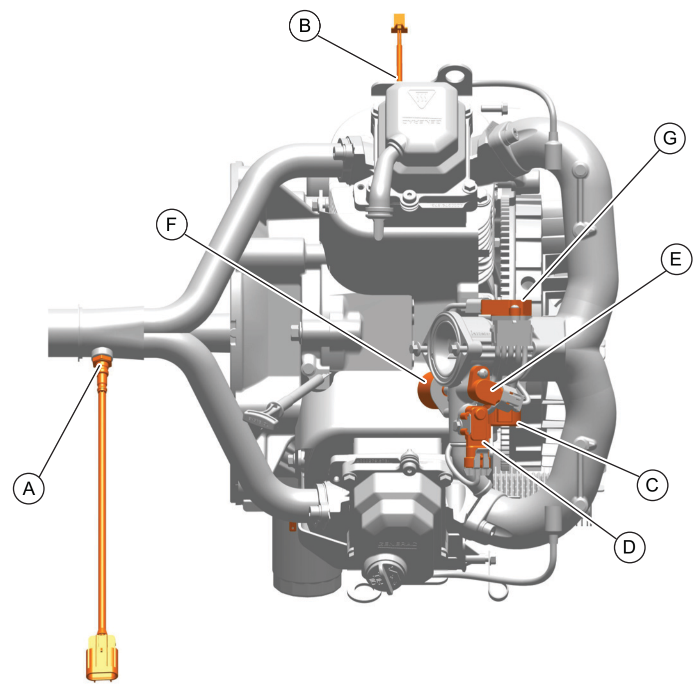



***Figure 7-15. Engine Control Locations***

## Troubleshooting Sensors

The engine uses four different sensor types:

### Two Wire Sensors

- **CRKS** – Crankshaft Position Sensor
- **EHT** – Engine Head Temperature Sensor
- **OPS** – Oil Pressure Switch

### Three Wire Sensors

- **MPS** – Mixer Position Sensor
- **FPS** – Fuel Pressure Sensor
- **OLS** – Oil level sensor

### Four Wire Sensors

- **OS** – Oxygen Sensor

### Five Wire Sensors

- **TTMAP** – Throttle Position/Manifold Absolute Pressure/Intake Air Temperature

## Troubleshooting Basics

Prior to troubleshooting steps, perform a thorough wiring harness inspection, looking for chafed or exposed conductors or pinched wires.

The engine sensors use a weather tight connector. Use of standard test probes will damage the sensor or connector. Use only needle type test probes that fit between the wire and insulator.

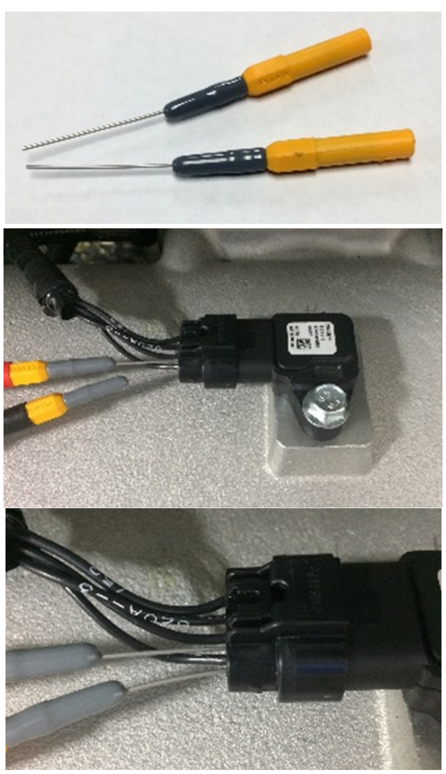


***Figure 7-16. Needle Type Test Probes***

**NOTE:** It is not recommended to use any testing device other than the manufacturer's approved test lead adapters (P/N A0000683522).

# Engine Control Module

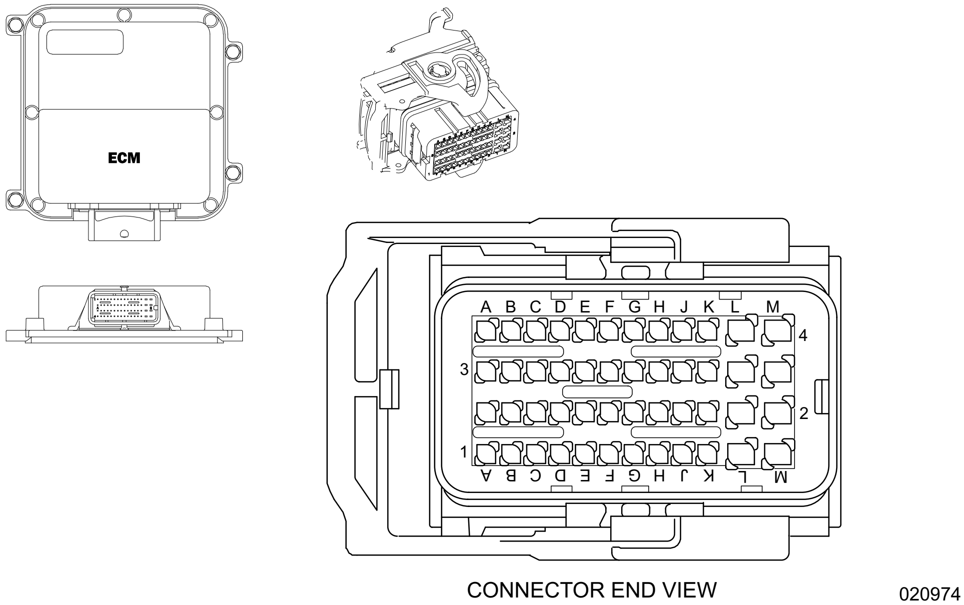



*Figure 7-17. Generac Engine Control Module (ECM) and Harness Connector*

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 1A | 605A | ETMC-13 |
| 1B | 605B | ETMC-14 |
| 1C | 79A | CRKS-A |
| 1D | 79B | CRKS-B |
| 1E | 770A | ETMC-9 |
| 1F | 771A | ETMC-11 |
| 1G | 770B | ETMC-10 |
| 1H | 771B | ETMC-12 |
| 1J | 13A | SPLICE 2 |
| 1K | 14C | SPLICE 6 |
| 1L | 0 | GND |
| 1M | 452 | IC2-C |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 2A | 605C | ETMC-15 |
| 2B | 606 | ETMC-7 |
| 2C | 766A | ETMC-6 |
| 2D | 608 | MPR-B |
| 2E | — | — |
| 2F | 607 | OS-B |
| 2G | 754 | ETMC-3 |
| 2H | — | — |
| 2J | 899 | OLS-C |
| 2K | 714 | EHT-1 |
| 2L | — | — |
| 2M | — | — |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 3A | 605D | ETMC-16 |
| 3B | 766B | ETMC-4 |
| 3C | 797 | ETMC-1 |
| 3D | — | — |
| 3E | — | — |
| 3F | — | — |
| 3G | — | — |
| 3H | — | — |
| 3J | — | — |
| 3K | 820A | SPLICE 7 |
| 3L | 610 | SOV2 |
| 3M | 0 | GND |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 4A | 743 | J3-7 |
| 4B | 744 | J3-8 |
| 4C | 566 | OPS |
| 4D | — | — |
| 4E | — | — |
| 4F | 877 | J3-9 |
| 4G | — | — |
| 4H | — | — |
| 4J | 804 | OS-C |
| 4K | 820G | SPLICE 8 |
| 4L | 0 | GND |
| 4M | 451 | IC1-C |

# ETMC Connector Harness

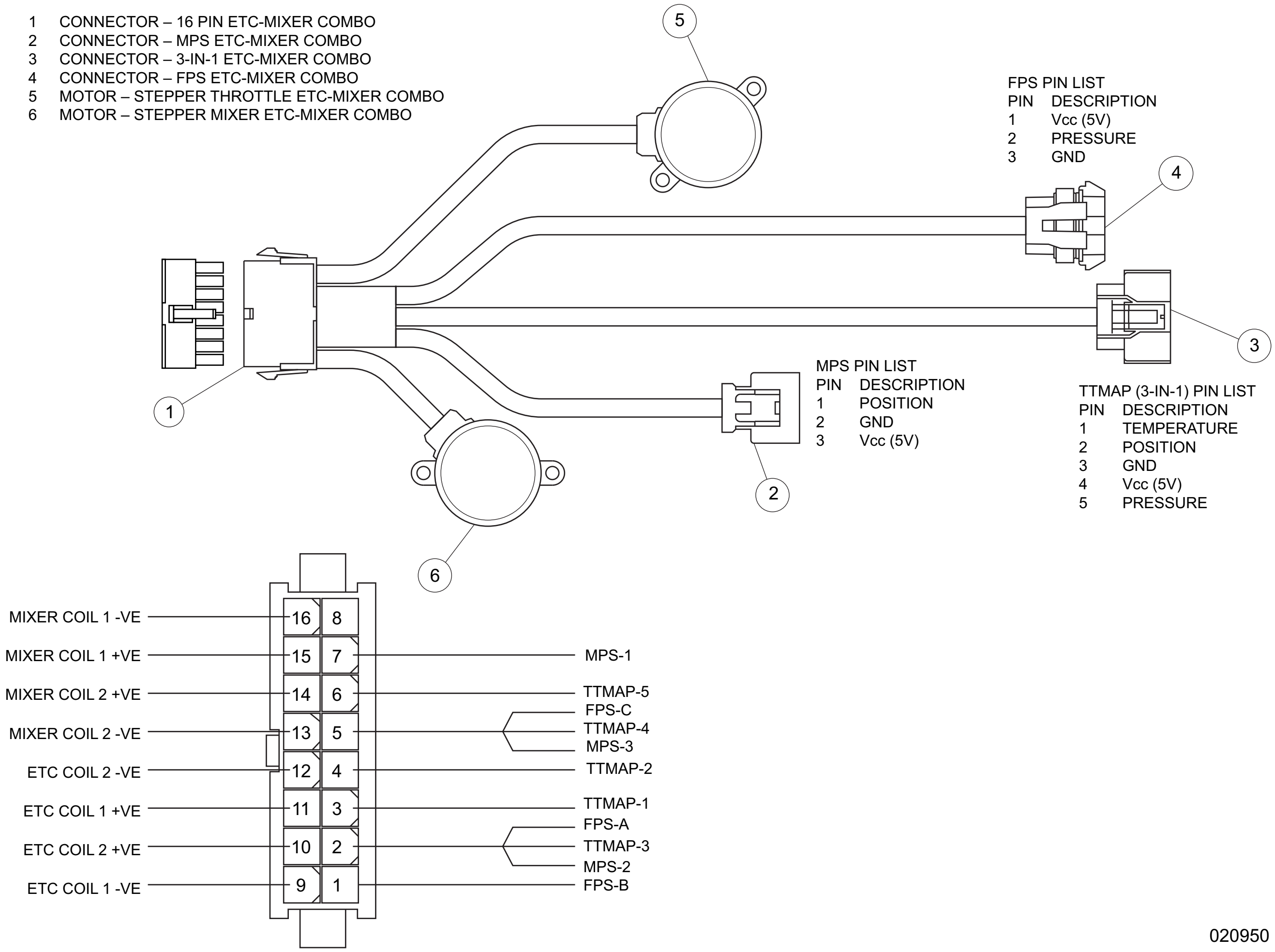



*Figure 7-18. ETMC Connector Harness*

## 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.

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 themselves that the procedure or method they have selected will jeopardize neither their own nor the products safety.

***Figure 8-1*** 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 8-1*** as needed to understand what the meter is indicating about the particular circuit that was tested.

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

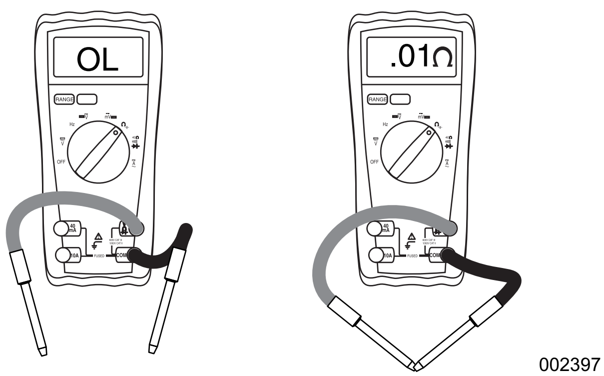



***Figure 8-1. INFINITY (Left) and CONTINUITY (Right) Meter Readings***

## 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 Field Pro app 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?

## AC Battery Charger Test

### General Theory

The generator depends on the 12 VDC circuit to operate many components in the generator. The 12V battery needs to remain charged to be prepared for a power outage event. When the generator is sitting in utility, the Power Zone 200 controller handles the battery charging through an internal charger. The charging rate will vary depending on ambient temperature.

**NOTE:** The internal battery charger receives AC voltage from the load side of the transfer switch whether the generator is operating or in standby.

### Procedure

1. Perform the ***Battery and Cables Test*** to verify the battery condition

   a. If the battery and cables pass inspection, proceed to Step 2
   b. If the battery or cables fail the inspection, repair/replace as necessary and retest.
2. Verify the E-Code(s) present.
   a. If E-code 2760 is present, proceed to Step 3.
   b. If E-code 2760 is NOT present, proceed to Step 5.
3. Set DMM to measure DC voltage.
4. Place the red meter lead on the battery positive terminal and the black meter lead on the battery negative terminal.
   a. If battery voltage is below 16.4 VDC, proceed to Step 5.
   b. If voltage is above 16.5 VDC, replace the controller and retest.
5. Set the DMM to measure AC voltage.
6. Using the appropriate back probes, insert the red meter lead to the T1 wire at the J6 connector on the back of the controller and the black meter lead to the 00 Wire at the J6 connector. Record the reading.
   a. If 120 VAC is measured, proceed to Step 7.
   b. If 120 VAC is not measured, proceed to the ***AC Input Voltage Test***.
7. Set DMM to measure DC voltage.
8. Place the red meter lead on the battery positive terminal and the black meter lead on the battery negative terminal.
   a. If battery voltage is below 12.6 VDC, proceed to Step 13.
   b. If voltage is above 12.6 VDC, proceed to Step 9.
9. Turn OFF the fuel source to the generator.
10. Set Controller to MANUAL.
    a. Allow generator to go through 5 crank cycles.
    b. Set generator to OFF.

**NOTE:** This step may cause an E-code of 1100 for Overcrank. Clear this fault and proceed to Step 11.

11. Using the Field Pro app, verify the Battery Charging status shows “Charging”. Check the Battery Voltage display in the app.
    a. If the battery voltage shows more than 12.8 VDC, proceed to Step 12.
    b. If the battery voltage shows less than 12.9 VDC, replace the controller and retest.
12. Turn ON the fuel source to the generator.
13. Locate connector J4 on the controller. Leaving the connector connected, use the appropriate back probes and connect the red meter lead to one of the Wire 13 pins and the black lead to one of the Wire 0 pins.
    a. If 12.9 VDC or greater is measured, proceed to Step 14.
    b. If 12.8 VDC or less is measured, check the connections and pins in the J4 connector for damage. If the pins are found to be damaged, replace the wiring harness and/or controller as necessary and retest. If the harness and controller pins pass inspection, replace the controller and retest.
14. Place the red meter lead on Wire 13 at the Starter Contactor (SC) and the black meter lead to the negative battery terminal.
    a. If 12.9 VDC or greater is measured, proceed to Step 15.
    b. If 12.8 VDC or less is measured, replace the wiring harness and retest.
15. Place the red meter lead on the battery positive terminal and the black meter lead on the battery negative terminal.
    a. 12.9 VDC or greater is measured, the battery charger is working and test is complete.
    b. 12.8 VDC or less is measured, replace the wiring harness and retest.

# AC Input Voltage Test

## General Theory

AC power needs to be provided to the controller to supply the internal battery charger with voltage to charge. This power comes from the T1 circuit that is in the transfer switch. If this is missing, the battery will not charge while in Standby.

**NOTE:** The transfer switch breaker needs to be switched to ON and power available to the breaker in order to power the T1 circuit.

## Procedure

1. Set the DMM to measure AC voltage.
2. Using appropriate back probes, insert the red meter lead into the T1 Wire at the J6 connector at the controller. Insert the black meter lead into the 00 Wire at the J6 connector at the controller. Record the reading.
   a. If 120 VAC is measured, voltage is available for battery charging/transfer signal. Test is completed.
   b. If 120 VAC is not measured, proceed to Step 3.
3. See ***Figure 8-2***. At the customer connection block, locate the T1 and 00 terminal connections at the WAGO block.

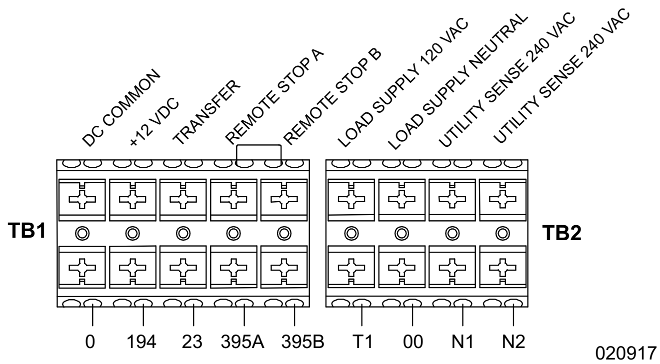



***Figure 8-2. Customer Connection Block***

4. Insert the red meter lead into the T1 Wire and the black meter lead into the 00 Wire. Record the reading.
   a. If 120 VAC is present, replace the wiring harness and retest.
   b. If 120 VAC is not measured, proceed to Step 5.
5. In the transfer switch, locate the terminals for the T1 Wire and the 00 Wire on the SACM/FCM. Connect the red meter lead to the T1 terminal and the black meter lead to the 00 terminal. Record the reading.
   a. If 120 VAC is present, repair the T1/00 wire between the transfer switch and the generator and retest.
   b. If 120 VAC is not present, proceed to Step 6.
6. Remove the T1 fuse from the SACM/FCM and test integrity of fuse.
   a. If fuse is blown, replace fuse and retest. If fuse continues to blow, check for short to ground in T1/00 circuit.
   b. If fuse is good, proceed to Step 7.
7. Verify there is 120 VAC available to the fuse holder.
   a. If 120 VAC is being measured at the fuse holder, replace the SACM/FCM and retest.
   b. If 120 VAC is not measured, repair the wire between the SACM/FCM and the transfer switch breaker and retest.

## Battery and Cables Test

### General Theory

Battery power is used for three key purposes, (a) crank the engine, (b) power the Power Zone 200 controller, and (c) power the ECM. Low or no battery voltage can result in failure of the engine to crank. Additionally, 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 integral battery charger in the Power Zone 200 controller is not designed to recharge a dead battery.

### Procedure A

1. Inspect battery cables and battery posts.
   a. If cable clamps or terminals are loose/ corroded, tighten/clean away all corrosion and retest.
   b. If connections pass inspection, proceed to Step 2.

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

2. 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.
   a. If any connections are found to be loose/ corroded, tighten/clean away all corrosion and retest.
   b. If connections pass inspection, proceed to ***Procedure B***.

### Procedure B

1. Remove the 7.5A fuse from the Power Zone 200 controller.
2. Disconnect the J6 connector to disable the battery charger.
3. Set the DMM to measure DC voltage.
4. Connect the red meter test lead to the positive battery post and connect the black meter test lead to the negative battery post.
5. Measure and record the OCV (Open Circuit Voltage).
   a. If battery voltage is 12.1 VDC or less, or if engine does not crank (turn over), proceed to ***Procedure C***.
   b. If battery voltage is 12.2–12.6 VDC or above and the engine does not crank, reinstall controller fuse, reconnect J6 connector, then proceed to ***Procedure D***.

### Procedure C

1. Perform a Conductance Test with a Conductance Type Battery Tester (follow the conductance battery tester manufacturer's instructions). Test results should not show anything lower than 75% of the battery's rated CCA.

a. If battery CCA is 75% or less, replace battery with new and retest.

b. If the above test results have been verified good, proceed to ***Procedure D***.

### Procedure D

**NOTE: *Engine must crank to properly measure voltage drop. A crank attempt will need to be performed. If the engine does not crank, proceed to the Starter Control Relay Test before moving to Procedure D*.**

1. Turn OFF the fuel source to the generator to prevent startup.
2. See ***Figure 8-3*** and ***Figure 8-4***. Refer to battery post and starter connections and perform a voltage drop tests as shown.
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 8-3*** and ***Figure 8-4***.

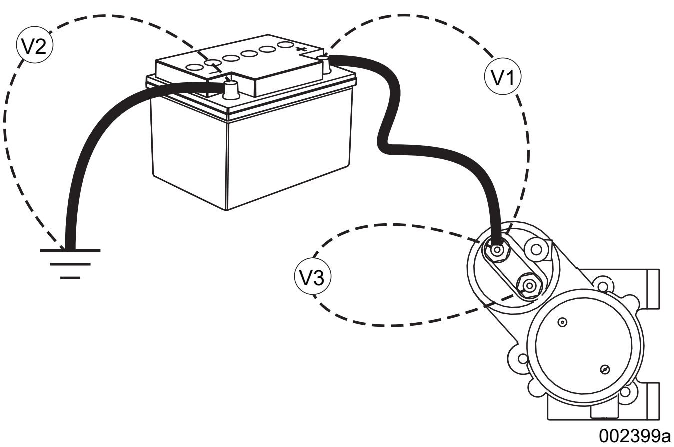



***Figure 8-3. Starter Circuit Voltage Drop Test***

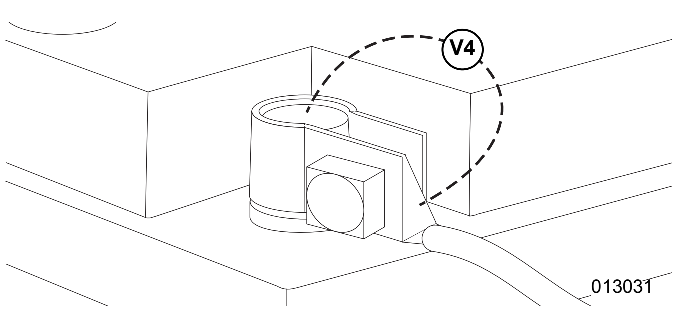



***Figure 8-4. Starter Circuit Voltage Drop Test***

5. If any of the voltages are greater than shown in ***Table 8-1***, repair or replace the component/harness as needed and retest.

**Table 8-1. Maximum Voltage Readings**

| DC Volts | Connection | Test |
|---|---|---|
| 0.20-0.30 | Across the cable | (VI & V2) |
| 0.20-0.30 | Across the starter contactor | (V3) |
| 0.00-0.10 | Battery Post to Battery Terminal | (V4) |

# Battery Potential/Power Output 1 Test

### General Theory

The ECM requires DC voltage to operate. DC voltage is provided by the generator battery. Once the ECM is powered up, it will monitor the battery voltage in the system. It does this to protect itself from damage that can occur from an overvoltage or undervoltage condition. If the voltage is outside of the normal range (10–15 VDC), it will trigger a fault to shut the generator down.

### Procedure

1. Check the connections at the battery.
   a. If the connections are found to be clean and tight, proceed to Step 2.
   b. If the connections are found to be loose or corroded, clean and tighten connections and retest.
2. Perform the ***Battery and Cables Test***.
   a. If the battery passes the test, proceed to Step 3.
   b. If the battery fails the test, replace the battery and retest.
3. Perform the ***AC Battery Charger Test***.
   a. If the AC battery charger passes the test, proceed to Step 4.
   b. If the AC battery charger fails the test, repair as necessary and retest.
4. Perform the ***Stator Battery Charger (Voltage Regulator) Test***.
   a. If the stator battery charger passes the test, proceed to Step 5.
   b. If the stator battery charger fails the test, repair as necessary and retest.
5. Set the DMM to measure DC voltage.

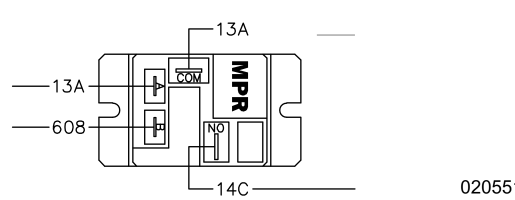



***Figure 8-5. Master Power Relay (MPR)***

6. Using the appropriate back probe, connect the red meter lead to Wire 13A at the COM terminal.

Connect the black meter lead to the battery negative terminal. Record the reading. Move the red meter lead to Wire 13A at the Pin A terminal and record that reading.

a. If battery voltage is measured at both wires, proceed to Step 8.

b. If battery voltage is measured at only 1 wire, replace the wiring harness and retest.

c. If battery voltage is not measured at either wire, proceed to Step 7.

7. Check the 15 Amp fuse located in line with Wire 13.

   a. If the fuse is good, replace the wiring harness and retest.

   b. If the fuse is blown, replace and retest. If the fuse continues to blow, check for short-to-ground and replace the faulty wiring harness/ components as needed and retest.

8. Set the DMM to measure continuity.

9. Disconnect the battery.

10. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.

    a. If the pins pass inspection, proceed to Step 11.

    b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.

11. Disconnect all 4 wires from the MPR. Visually inspect all the terminals and spade connectors for looseness/damage.

    a. If the terminals/spade connectors pass inspection, proceed to Step 12.

    b. If the terminals/spade connectors are found to be loose/damaged, replace the wiring harness and/or MPR and retest.

12. Place one meter lead on the MPR terminal for Wire 608 and the other meter lead on the terminal for Wire 13A from Terminal A at the MPR. Record the reading.

    a. If continuity is measured, proceed to Step 13.

    b. If continuity is not measured, replace MPR and retest.

13. Connect a 12 VDC power source across the terminals for Wires 608 and 13A at Pin A on the MPR to energize the relay. Place one meter lead to the terminal for Wire 13A at the COM terminal and the other meter lead to the terminal for Wire 14C. Record the reading.

    a. If continuity is measured, proceed to Step 14.

    b. If continuity is not measured, replace MPR and retest.

14. Connect one meter lead to the disconnected 13A Wire from the COM terminal at the MPR. Using the appropriate back probe, connect the other meter lead to the 13A Wire at the ECM. Record the reading.

    a. If resistance measures less than 5 ohms, continue to Step 15.

    b. If resistance measures greater than 5 ohms or reads OL, replace wiring harness and retest.

15. Connect one meter lead to the disconnected 13A Wire from terminal A at the MPR. Using the appropriate back probe, connect the other meter lead to the 13A Wire at the ECM. Record the reading.

    a. If resistance measures less than 5 ohms, proceed to Step 16.

    b. If resistance measures greater than 5 ohms or reads OL, replace wiring harness and retest.

16. Connect one meter lead to the disconnected 608 Wire at the MPR. Using the appropriate back probe, connect the other meter lead to the 608 Wire at the ECM. Record the reading.

    a. If resistance measures less than 5 ohms, proceed to Step 17.

    b. If resistance measures greater than 5 ohms or reads OL, replace wiring harness and retest.

17. Connect one meter lead to the disconnected 14C Wire at the MPR. Using the appropriate back probe, connect the other meter lead to the 14C Wire at the ECM. Record the reading.

    a. If resistance measures less than 5 ohms, replace the ECM and retest.

    b. If resistance measures greater than 5 ohms or reads OL, replace wiring harness and retest.

## CAN bus Test

### General Theory

A CAN bus network is a high-speed communication network that allows modules to “speak” with each other. Each module has a set internal resistance that each module recognizes to verify the network integrity. This test will verify that the network is working correctly.

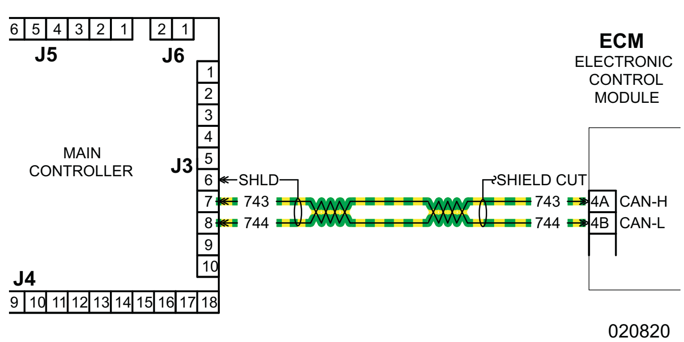



***Figure 8-6. CAN bus Diagram***

### Procedure

1. Set the DMM to measure resistance.
2. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 3.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
3. Connect one meter lead to the ECM pin for Wire 743 and the other meter lead to the ECM pin for Wire 744. Record the reading.
   a. If the resistance measures 120 ohms, proceed to Step 4.
   b. If the resistance measures other than 120 ohms, replace the ECM and retest.
4. Connect one meter lead to Wire 743 at the ECM harness and the other to Wire 744 at the ECM harness. Record the reading.
   a. If resistance measures 120 ohms, reconnect the ECM harness and proceed to Step 7.
   b. If resistance measures other than 120 ohms, reconnect ECM harness and proceed to Step 5.
5. Disconnect the J3 connector at the controller. Visually inspect the pins of both the controller and the J3 harness for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, repair/ replace the controller harness and/or controller as necessary and retest.
6. Connect one meter lead to Wire 743 at the J3 harness and the other to Wire 744 at the J3 harness. Record the reading.
   a. If resistance measures 120 ohms, replace the controller and retest.
   b. If resistance measures other than 120 ohms, replace the wiring harness and retest.
7. Set the DMM to measure DC voltage.
8. Using the appropriate back probes, insert one meter lead to Wire 877 at the J3 connector at the back the controller and the other to the battery negative terminal. Record the reading.
   a. If battery voltage is measured, proceed to Step 9.
   b. If no voltage is measured, replace the controller and retest.
9. Using the appropriate back probes, insert one meter lead to Wire 877 at the ECM connector and the other to the battery negative terminal. Record the reading.
   a. If battery voltage is measured, replace the ECM and retest.
   b. If no voltage is measured, replace wiring harness and retest.

## Crank Position Sensor Test

### General Theory

The ECM monitors the engine position using the crankshaft position sensor (CRKS). The engine flywheel has a 24 minus one tooth design. The CRKS uses the gap where the missing tooth is on the flywheel to report the engine position back to the ECM. The ECM uses this information to calculate the position of the crankshaft to control spark timing and monitor engine RPM.

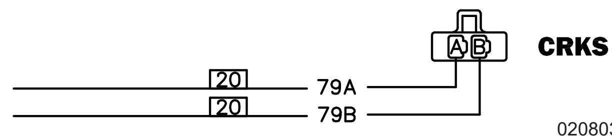



*Figure 8-7. Crank Position Sensor*

### Procedure

1. Check the CRKS sensor connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 2.
2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 4.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
4. Disconnect the harness connector at the CRKS. Visually inspect both the CRKS and CRKS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the CRKS and/or replace the wiring harness as necessary and retest.
5. Using the appropriate back probes, connect one meter lead to Wire 79A at the ECM and the other lead to Wire 79A at the harness side of the CRKS sensor.
   a. If resistance measures less than 5 ohms, proceed to Step 6.
   b. If resistance measures greater than 5 ohms or reads OL, replace wiring harness and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 79B at the ECM and the other

lead to Wire 79B at the harness side of the CRKS sensor.

a. If resistance measures less than 5 ohms, proceed to Step 7.

b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

7. Reconnect the ECM harness connector.
8. Using the appropriate back probes, back probe both sides of the sensor side of the CRKS sensor connector. The resistance of the sensor should measure approximately 100–200 ohms. Record the resistance reading.

   a. If the sensor resistance is outside of the range, replace the CRKS sensor and retest.

   b. If the sensor measures correctly, replace the ECM and retest.

## Cylinder Head Temperature Sensor Test

### General Theory

The ECM monitors the engine head temperature to protect the engine from damage due to overheating. The engine head temperature sensor (EHT) converts a temperature reading to a resistance number for the ECM to calculate the engine head temperature. The ECM will trigger a fault if the sensor resistance is below or above the specified programmed range in the ECM.

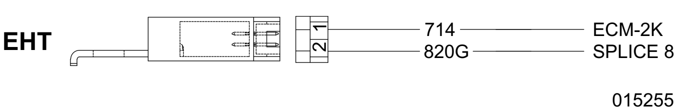



*Figure 8-8. Engine Head Temperature Sensor EHT*

### Procedure

1. Check the connector for the EHT sensor.

   a. If the connector is found to be loose or improperly connected, repair connection and retest.

   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 2.

2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.

   a. If the pins pass inspection, proceed to Step 4.

   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.

4. Disconnect the harness connector at the EHT sensor. Visually inspect the EHT sensor and harness pins for damage.

   a. If the pins pass inspection, proceed to Step 5.

   b. If the pins are found to be damaged, replace the EHT sensor and/or replace the wiring harness and retest.

5. Using the appropriate back probes, connect one meter lead to Wire 714 at the ECM and the other lead to Wire 714 at the EHT sensor.

   a. If resistance measures less than 5 ohms, continue to Step 6.

   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

6. Disconnect the ETMC connector.
7. Using appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the EHT sensor.

   a. If resistance measures less than 5 ohms, continue to Step 8.

   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

8. Reconnect the ETMC connector.
9. Reconnect the ECM harness connector.
10. Using appropriate back probes, back probe both sides of the sensor side of the EHT sensor connector. Record the resistance reading and reference the Resistance To Temperature Chart.

    a. If the sensor resistance is outside of the range for the current sensor temperature (± 10%), replace the EHT sensor and retest.

    b. If the sensor measures correctly, replace the ECM and retest.

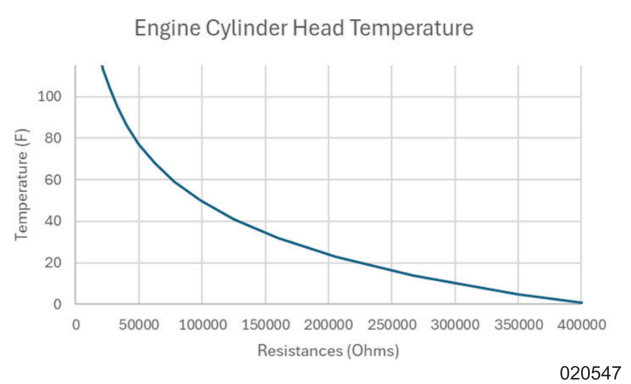



*Figure 8-9. Resistance To Temperature Chart*

## Cylinder Leak Down Test

### General Theory

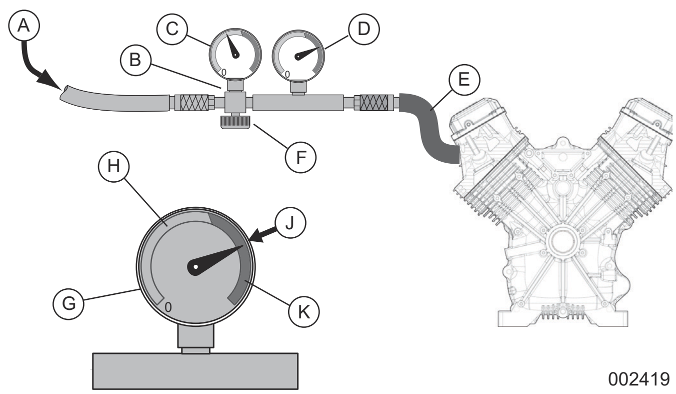
The cylinder leak down test checks the combustion chamber of the engine for the ability to properly seal for compression by measuring air leakage. This test is used in conjunction with the compression test to properly identify which part of the engine has failed before beginning disassembly.

**NOTE:** Refer to the cylinder leak down tester tool instructions for proper operation of tester.

### Procedure

1. Turn off the fuel supply to the generator.
2. Remove the 15A fuse from Wire 13.
3. Set the main line circuit breaker (MLCB) to OFF.
4. Disconnect the spark plug wire(s) from each spark plug.
5. Connect a spark tester to the cylinder head(s) and attach the spark plug wire(s) to the tester to properly ground the ignition coil(s).
6. Remove the spark plug(s).
7. Remove the valve cover(s).
8. Gain access to the generator fan assembly.
9. Using the fan bolt, rotate the engine crankshaft until the piston reaches top dead center (TDC) of the compression stroke of the cylinder being tested. In this position, both the intake and exhaust valves will be closed.

**NOTE:** If the engine is not properly positioned at TDC, the test results will be inaccurate.




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
J. Needle indicates minimal air leakage
K. Green range indicates acceptable leakage

***Figure 8-10. Cylinder Leakdown Tester***

10. Attach the cylinder leak down tester adapter to the spark plug hole being tested.
11. Connect an air source to the cylinder leak down tester per the tool manufacturer's requirements.

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

12. Connect the tool to the cylinder leak down tester adapter while monitoring the fan for engine rotation.

**NOTE:** If the fan rotates, repeat Step 9–11 to verify engine is at TDC. Record the leakage percentage.

   a. If testing a single cylinder engine, if leakage is less than 20% and no air leakage is heard, the engine cylinder is good. If testing a V-Twin engine, proceed to Step 13.
   b. If leakage is less than 20% but audible air leakage is heard, or if the leakage is greater than 20%, proceed to Step 14.

13. Repeat Steps 8–11 on the second cylinder.
   a. If leakage is less than 20% and no air leakage is heard, the engine cylinder is good.
   b. If leakage is less than 20% but audible air leakage is heard, or if the leakage is greater than 20%, proceed to Step 14.
14. Determine where the air leakage is coming from by listening for leakage as well feeling for leakage at these locations:

- Throttle plate - air escaping past intake valve.
- Muffler/exhaust - air escaping past exhaust valve.
- Breather/dipstick tube - air escaping past piston rings.
- Between cylinder head and block - air escaping between the cylinder head and block.

Record where leakage is coming from and contact Technical support for further instruction.

## Electronic Throttle Control Power Test

### General Theory

The ECM controls the electronic throttle control valve (ETC). The ECM uses the TTMAP sensor to verify the demand on the engine, and this will move the throttle plate position accordingly to maintain 3600 RPM.

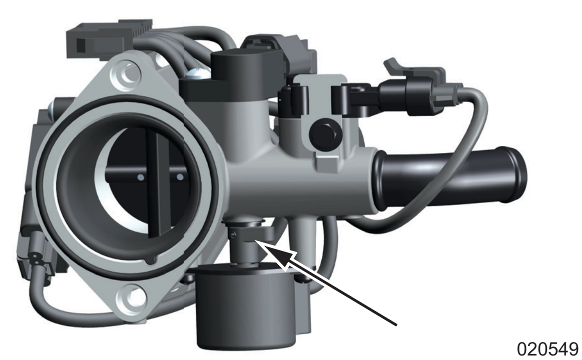



***Figure 8-11. External Throttle Valve Linkage***

## Procedure

1. Check the ETMC connector to verify it is connected correctly.
   a. If the connector passes, proceed to Step 2.
   b. If connector is found to be loose or improperly connected, repair the connector and retest.
2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 4.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
4. Disconnect the ETMC connector. Visually inspect the ETMC harness pins for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the wiring harness and/or mixer assembly and retest.

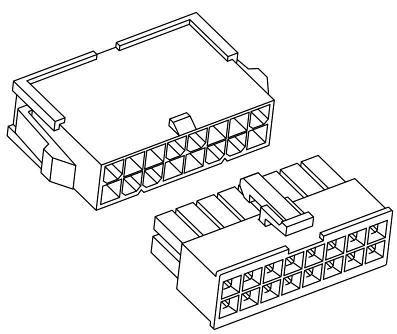

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***Figure 8-12. ETMC Connector Showing The ECM Connector From The Harness (Wire) Side***

5. Using the appropriate back probes, connect one meter lead to Wire 770A at the ECM and the other to Wire 770A at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, continue to Step 6.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 770B at the ECM and the other to Wire 770B at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 7.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
7. Using the appropriate back probes, connect one meter lead to Wire 771A at the ECM and the other to Wire 771A at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 8.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
8. Using the appropriate back probes, connect one meter lead to Wire 771B at the ECM and the other to Wire 771B at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 9.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
9. Using the appropriate back probes, connect one meter lead to Wire 770A on the mixer side of the ETMC harness and the other lead to Wire 771A on the mixer side of the ETMC harness.
   a. If the resistance measures between 37–39 k Ohms proceed to Step 10.
   b. If the resistance measures outside of the above range, replace the mixer assembly and retest.
10. Using the appropriate back probes, connect one meter lead to Wire 770B on the mixer side of the ETMC harness and the other lead to Wire 771B on the mixer side of the ETMC harness.
    a. If the resistance measures approximately 35–40 Ohms proceed to Step 11.
    b. If the resistance measures outside of the above range, replace the mixer assembly and retest.
11. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the ECM side of the ETMC connector.
    a. If the resistance measures less than 5 ohms, proceed to Step 12.
    b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
12. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the ECM side of the ETMC connector.
    a. If the resistance measures less than 5 ohms, proceed to Step 13.
    b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.

13. Set the DMM to measure DC voltage.
14. Reconnect the ETMC harness connector.
15. Reconnect the ECM harness connector.
16. Using the appropriate back probe, connect one meter lead to Wire 766B on the mixer side of the ETMC harness. Connect the other meter lead to the negative battery terminal. With the ECM powered on, the meter should display a voltage range of 0.5–4.5 VDC.
    a. If the voltage measured is correct, replace the ECM and retest.
    b. If 5V is measured, disconnect the TTMAP sensor and remeasure. If voltage drops, replace mixer assembly.
    c. If 0V is measured, move the meter lead from the negative battery terminal to the positive terminal. If voltage is measured, disconnect the TTMAP sensor. If the voltage drops, replace mixer assembly.

# Engine Compression Test

## General Theory

A loss or reduction in engine compression can result in a failure of the engine to start, poor engine running, and excessive emissions. Typically, a loss of compression is due to one or more of these factors:

- Leaking or blown cylinder head gasket.
- Improperly seated or sticking valves.
- Worn piston rings or cylinder (this can also result in high oil consumption).

## Procedure

**NOTE:** Battery and starting system need to be properly operational to ensure accurate test results.

1. Turn off the fuel supply to the generator.
2. Remove the 15A fuse from Wire 13.
3. Set the MLCB to OFF.
4. Remove the air cleaner lid.
5. Use a finger to manually open the throttle plate to the wide open position.
6. Disconnect the spark plug wire(s) from each spark plug and ground the wire(s).
7. Connect a spark tester to the cylinder head(s) and attach the spark plug wire(s) to the tester to properly ground the ignition coil(s).
8. Remove the spark plug(s).
9. Disconnect Wire 16 from the starter contactor (SC).
10. Connect one lead from the remote push button starter to the Wire 16 terminal on the SC.

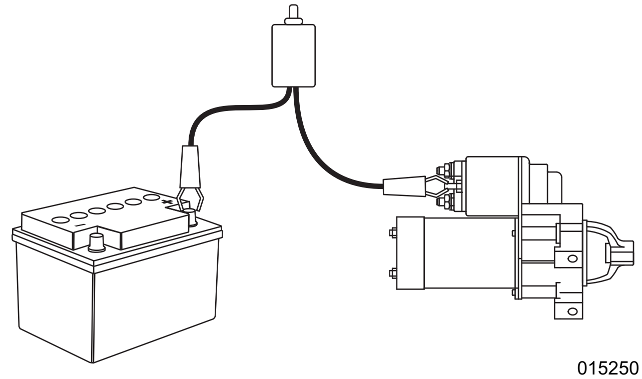



***Figure 8-13. Remote Push Button Starter Connected***

11. Connect the other lead from the remote push button starter to the positive battery terminal.
12. Install a compression test gauge into a cylinder.
13. Crank the engine until there is no further increase in pressure and record the highest reading obtained.
14. Repeat Steps 12–13 on the second cylinder if applicable.

**NOTE:** See Section 2 ***Generator Specifications*** to verify the proper compression reading ranges.

## Reading Results

The difference in pressure between the two cylinders should not exceed 25 percent. For example, if the pressure reading of cylinder #1 is 165 PSI and cylinder #2 is 160 PSI, that equates to a pressure difference of 5 PSI. Divide “5” by the highest reading (165 in this case) to obtain the percentages (3 percent in this case).

a. If the compression is within specifications and each cylinder is within 25 percent of each other, the engine condition is satisfactory.
b. If the compression is below specifications or the leakage between cylinders is greater than 25 percent, proceed to the ***Cylinder Leak Down Test***.

# Engine Speed Test

## General Theory

The ECM monitors the engine position using the crankshaft position sensor (CRKS). The engine flywheel has a 24 minus one tooth design. The CRKS uses the gap where the missing tooth is on the flywheel to report the engine position back to the ECM. The ECM uses this information to calculate the position of the crankshaft to control spark timing and monitor engine RPM. If the engine is running at an RPM outside of the pre-determined range, an E-code fault will be triggered.

## Procedure

1. Record all codes displayed in the Field Pro app.

   a. If there are other E-Codes for the throttle/mixer assembly or fuel supply/pressure, proceed to those diagnostic tests *before* moving to Step 2.
   b. If there are no other E-Codes in the system, proceed to Step 2.
2. Check the generator for an overload condition.
   a. If the generator is being overloaded, remove overload and retest.
   b. If no overload condition is present, proceed to Step 3.
3. Check throttle and mixer assembly for obstruction and/or mechanical damage.
   a. If obstruction is seen, remove and retest. If mechanical damage is found, replace mixer assembly and retest.
   b. If assembly does not have any obstruction or damage, proceed to Step 4.
4. Check the ETMC connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), Proceed to Step 5.
5. See ***Figure 8-14***. Clear any fault codes. While visually observing the external throttle valve linkage remove and reinstall the 15A fuse from the fuse holder in Wire 13. The throttle linkage should fully sweep then set itself for engine starting. Once the sweep is done, start generator in MANUAL.
   a. If the throttle assembly performs the sweep and the unit starts with no fault codes returning, discontinue diagnostics.
   b. If the throttle linkage does not move as described, proceed to the ***Electronic Throttle Control Power Test***.
   c. If the generator starts and produces a fault again and the throttle moves as designed, contact Technical Support for further assistance.

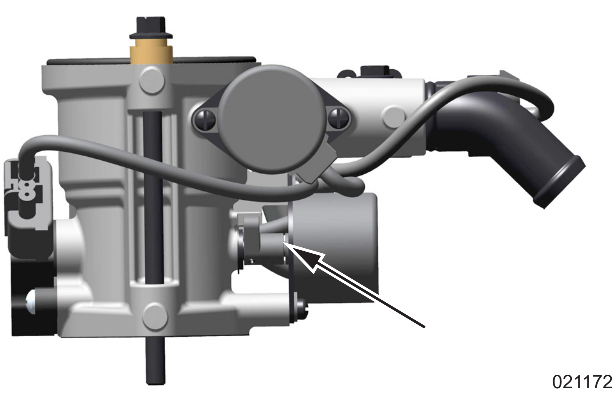



***Figure 8-14. External Throttle Valve Linkage***

# Engine Timing Sensor Test

## General Theory

The ECM needs to determine the position of the crankshaft and camshaft to command the ignition spark timing correctly for engine running. The ECM uses the crank position sensor (CRKS) and the throttle position, temperature and manifold air pressure sensor (TTMAP) to determine this calculation. When the generator is cranking above 300 RPM, the ECM will look to sync these two signals to calculate the spark timing. If a correlation (or sync) is not achieved, the ECM will trigger an E-code fault.

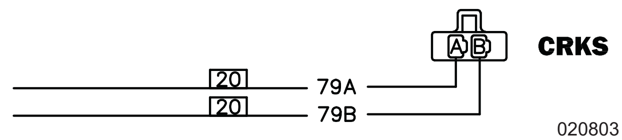



***Figure 8-15. Crank Position Sensor (CRKS)***

## Procedure

1. Check the CRKS sensor connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 2.
2. Check the ETMC connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 3.
3. Check the TTMAP sensor connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 4.
4. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.

5. Disconnect the harness connector at the CRKS. Visually inspect the CRKS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the CRKS and/or replace the wiring harness as necessary and retest.
6. Set the DMM to measure resistance.
7. Using the appropriate back probes, connect one meter lead to Wire 79A at the ECM and the other lead to Wire 79A at the harness side of the CRKS sensor.
   a. If resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
8. Using the appropriate back probes, connect one meter lead to Wire 79B at the ECM and the other lead to Wire 79B at the harness side of the CRKS sensor.
   a. If resistance measures less than 5 ohms, proceed to Step 9.
   b. If resistance measures greater than 5 Ohms or reads OL, replace the wiring harness and retest.
9. Reconnect the ECM harness connector.
10. Using the appropriate back probes, back probe both sides of the sensor side of the CRKS sensor connector. The resistance of the sensor should measure approximately 100–200 ohms. Record the resistance reading.
   a. If the sensor resistance is outside of this range, replace the CRKS sensor and retest.
   b. If the sensor measures correctly, replace the ECM and retest.

# Fuel Mixer Valve Test

## General Theory

The fuel valve is controlled by the ECM. The ECM uses the TTMAP sensor to verify the demand on the engine, and this will move the mixer plate position accordingly to maintain 3600 RPM. If the ECM detects a voltage reading outside of the pre-determined range of the MPS, an E-code fault will be triggered.

## Procedure

1. See ***Figure 8-16***. While visually observing the external mixer motor linkage, remove and reinstall the 15A fuse from the fuse holder in Wire 13. The mixer linkage should fully sweep then set itself for engine starting.

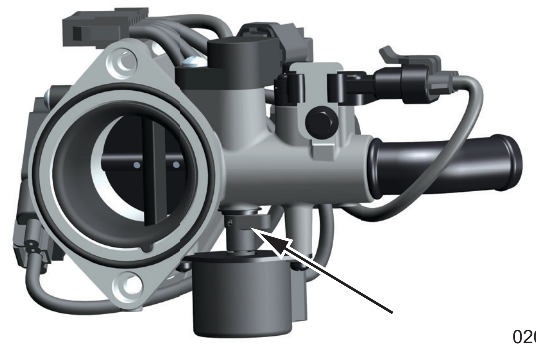



***Figure 8-16. External Mixer Valve Linkage***

   a. If the mixer linkage moves as described, proceed to Step 2.
   b. If the mixer plate does not move as described, proceed to the ***Mixer Valve Power Test***.
2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 4.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
4. Disconnect the harness connector at the MPS. Visually inspect both the MPS and MPS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the mixer assembly and retest.
5. Using the appropriate back probes, connect one meter lead to Wire 606 at the ECM and the other lead to Wire 606 at the MPS.
   a. If resistance measures less than 5 ohms, proceed to Step 6.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 8.
6. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the MPS.
   a. If resistance measures less than 5 ohms, proceed to Step 7.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 9.
7. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the MPS.
   a. If resistance measures less than 5 ohms, proceed to Step 11.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 10.
8. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the

appropriate back probes, connect one meter lead to Wire 606 at the ECM and the other lead to Wire 606 at the ECM side of the ETMC connector.

a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.

9. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
10. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
    c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
11. Set the DMM to measure DC voltage.
12. Reconnect the harness connector at the MPS.
13. Reconnect the ECM harness connector.
14. Using the appropriate back probe, connect one meter lead to Wire 820A at the MPS. Connect the other meter lead to battery ground.
    a. If 5V is measured, proceed to Step 15.
    b. If 5V is not measured, replace ECM and retest.
15. Using the appropriate back probe, connect one meter lead to Wire 820G at the MPS. Connect the other meter lead to battery ground.
    a. If no voltage is measured, proceed to Step 17.
    b. If voltage is measured, proceed to Step 16.
16. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the mixer assembly.
    a. If a ***short-to-power*** is found, replace the wiring harness and/or mixer assembly and retest.
    b. If no ***short-to-power*** is found, replace the ECM and retest.
17. Using the appropriate back probe, connect one meter lead to Wire 606 at the MPS. Connect the other meter lead to battery ground. With the ECM powered on, the meter should display a voltage range of 0.5–4.5 VDC.
    a. If the voltage measured falls within that range, replace ECM and retest
    b. If the voltage measured is outside of that range, replace the mixer assembly and retest.

# Fuel Pressure Sensor Test

## General Theory

The ECM monitors the fuel supply pressure using the Fuel Pressure Sensor (FPS). The sensor converts a pressure reading to a voltage number for the ECM to monitor. This voltage reading is used to monitor the fuel pressure to confirm to the ECM the pressure range is correct to run the engine without damaging it. If the ECM detects a voltage reading outside of the pre-determined range of the FPS, an E-code fault will be triggered.

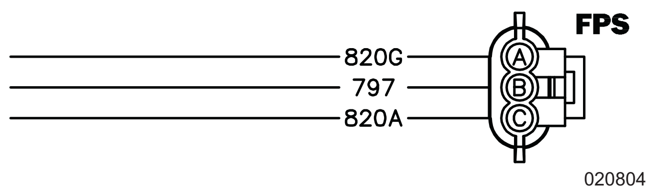



***Figure 8-17. Fuel Pressure Sensor***

## Procedure

1. Clear all faults and attempt to start the generator in Manual.
   a. If the generator will not start, check the static fuel pressure.
   b. If the fuel pressure is within specification, proceed to Step 3.
   c. If the static fuel pressure is not within specification, proceed to the ***Fuel Supply and Pressure Test***.
   d. If the generator will start and run, proceed to Step 2.
2. Perform ***Fuel Supply and Pressure Test*** to verify the generator has the correct fuel pressure.
   a. If the fuel pressure is within specification, proceed to Step 3.
   b. If the fuel pressure is out of specification, repair root cause and retest.
3. Set the DMM to measure resistance.

4. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
5. Disconnect the harness connector at the FPS. Visually inspect both the FPS and FPS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the FPS and/or the mixer assembly as necessary and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 797 at the ECM and the other lead to Wire 797 at the FPS.
   a. If resistance measures less than 5 ohms, proceed to Step 7.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 9.
7. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the FPS.
   a. If resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 10.
8. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the FPS.
   a. If resistance measures less than 5 ohms, proceed to Step 12.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 11.

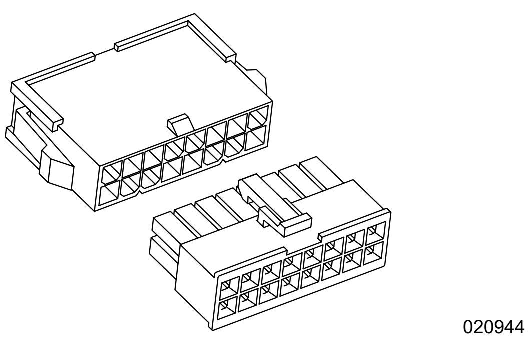



***Figure 8-18. ETMC Connector Showing The ECM Connector From The Harness (Wire) Side***

9. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 797 at the ECM and the other lead to Wire 797 at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
10. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
11. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If the resistance measures greater than 5 ohms or OL, replace wiring harness and retest.
12. Set the DMM to measure DC voltage.
13. Reconnect the ETMC harness connector.
14. Reconnect the harness connector at the FPS.
15. Reconnect the ECM harness connector.
16. Using the appropriate back probe, connect one meter lead to Wire 820A at the FPS. Connect the other meter lead to battery ground.
   a. If 5V is measured, proceed to Step 17.
   b. If 5V is not measured, replace ECM and retest.
17. Using the appropriate back probe, connect one meter lead to Wire 820G at the FPS. Connect the other meter lead to battery ground.
   a. If no voltage is measured, proceed to Step 19.
   b. If voltage is measured, proceed to Step 18.
18. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the mixer assembly.
   a. If a ***short-to-power*** is found, replace the wiring harness and/or mixer assembly and retest.
   b. If no ***short-to-power*** is found, replace the ECM and retest.

19. Using the appropriate back probe, connect one meter lead to Wire 797 at the FPS. Connect the other meter lead to battery ground. With the ECM powered on, the meter should display a voltage range of 0.5–4.5 VDC.
    a. If the voltage measured falls within that range, replace ECM and retest.
    b. If the voltage measured is outside of that range, replace the FPS and retest.

## Fuel Shutoff 2 (SOV2) Control Test

### General Theory

When the generator is commanded to start, the Power Zone 200 Controller sends battery voltage to fuel shut off valve 1 (SOV1) and fuel shut off valve 2 (SOV2). Once the ECM sees over 75 RPM, it provides the ground (internally) to complete the circuit to power up SOV2. When the generator shuts down, it will remove power from Wire 14 to close the fuel shut off valves, along with the ECM removing the ground from SOV2. The ECM will monitor SOV2 and generate a fault code if the valve does not respond as intended.

### Procedure

1. See ***Figure 8-19***. While visually observing the external throttle valve linkage, remove and reinstall the 15A fuse from fuse holder in Wire 13. The throttle linkage should fully sweep then set itself for engine starting.

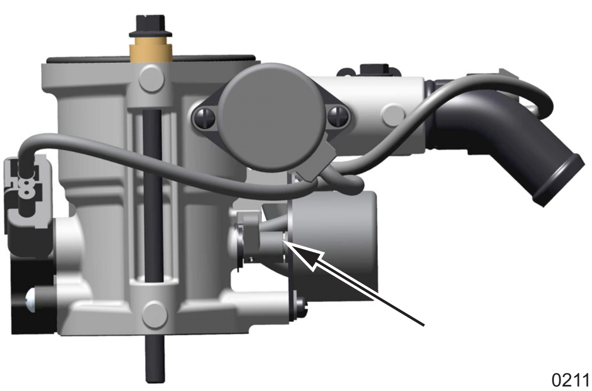



***Figure 8-19. External Throttle Valve Linkage***

    a. If the throttle valve linkage moves as described, proceed to Step 2.
    b. If the throttle valve linkage does not move as described, proceed to ***Electronic Throttle Control Power Test***.
2. Place a hand on both SOVs and crank the generator in MANUAL.
    a. If the valves clicked, proceed to the ***Fuel Supply and Pressure Test*** to verify the fuel pressure is correct.
    b. If neither valve clicked, proceed to ***Wire 14 Test***.
    c. See ***Figure 8-20***. If only the valve CLOSEST to the fuel inlet pipe (A) clicked, proceed to Step 3.

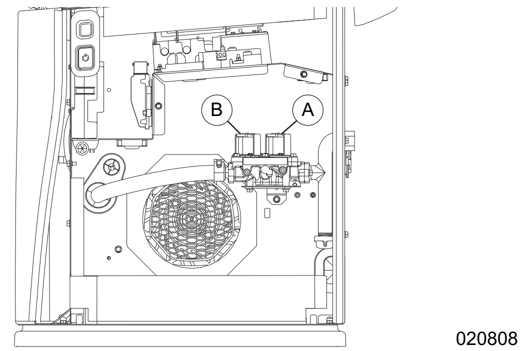



***Figure 8-20. Fuel Shut Off Valve 1 (SOV1) and Fuel Shut Off Valve 2 (SOV2)***

3. Set the DMM to measure resistance.
4. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 5.
    b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
5. Disconnect Wire 610 at SOV2 and visually inspect the SOV2 harness pins for damage.
    a. If the pins pass inspection, proceed to Step 6.
    b. If the pins are found to be damaged, replace SOV2 and/or the wiring harness and retest.
6. Using the appropriate back probe, insert one meter lead into the pin for Wire 610 at the ECM harness and connect the other lead to Wire 610 at SOV2. Record the reading.
    a. If the resistance measures less than 5 ohms, continue to Step 7.
    b. If the resistance measures greater than 5 ohms or OL, replace wiring harness and retest.
7. Set the DMM to measure DC voltage.
8. Reconnect the ECM harness connector.
9. Reconnect Wire 610 at SOV2.
10. Using the appropriate back probe, insert one meter lead to Wire 610 at SOV2 and connect the other lead to battery ground. Crank the generator in MANUAL. The meter should switch from showing battery voltage to showing nearly no voltage while cranking.
    a. If the voltage measures less than 0.5V, clear faults and retest.
    b. If the voltage measures more than 0.5V, proceed to Step 11.
11. Check for a ***short-to-power*** between Wire 610 at the ECM and Wire 610 at SOV2.

a. If a ***short-to-power*** is found, replace the wiring harness and retest.

b. If no ***short-to-power*** is found, replace the ECM and retest.

## Fuel Supply and Pressure Test

**⚠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)

### General Theory

The air-cooled generator is designed to operate on both natural gas (NG) and propane (LP) as a fuel. The following conditions apply for the unit to operate properly:

- 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 3.5 inches water column for natural gas (NG) or 10 inches water column for LP gas.
- Maximum gaseous fuel pressure at the generator fuel inlet connection is 7 inches water column for natural gas or 12 inches water column for LP gas.
- When propane gas is used, only a “vapor withdrawal” system may be used. This system uses the gas that forms above the liquid fuel.
- The gaseous fuel system must be properly tested for leaks following installation and periodically thereafter. **No leakage is permitted.** Leak testing methods must comply strictly with gas codes.

**IMPORTANT NOTE:** Visually inspect the fuel shut off valves for signs of leaks or damage.

**IMPORTANT NOTE:** Refer to installation manual to confirm correct pipe sizing before testing unit. If pipe sizing and/or the regulator is inadequate, correct the pipe sizing/regulator 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 shut off valves should be between 3.5–7 inches water column for natural gas (NG), or 10–12 inches water column for LP gas.

1. Record all codes displayed in the Field Pro app.
   a. If there are other E-Codes for the throttle/mixer assembly or fuel supply/pressure, proceed to those diagnostic tests before proceeding to Step 2.
   b. If there are no other E-Codes in the system, proceed to Step 2.
2. See ***Figure 8-23*** and ***Figure 8-22***. While visually observing the external mixer/throttle motor linkage, remove and reinstall the 15A fuse from the fuse holder in Wire 13. The mixer/throttle linkage should fully sweep then set itself for engine starting.
   a. If the mixer/throttle linkage moves as described, proceed to Step 3.
   b. If the mixer plate does not move as described, proceed to the ***Mixer Valve Power Test***. If the throttle linkage does not move as described, proceed to the ***Electronic Throttle Control Power Test***.

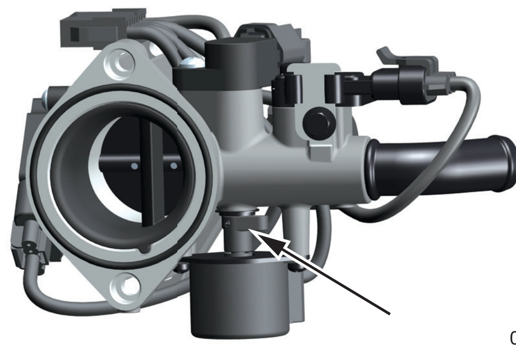



***Figure 8-21. External Mixer Valve Linkage***

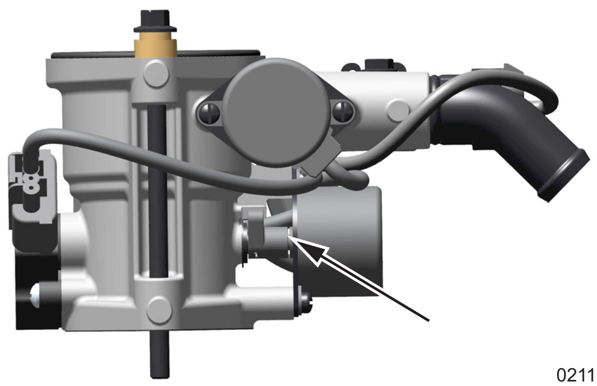



***Figure 8-22. External Throttle Valve Linkage***

3. See ***Figure 8-23*** for the fuel pressure test point on the fuel shut off valves. Static fuel pressure can be checked at Port 1 (A) and running pressure can be checked at Port 2 (B).

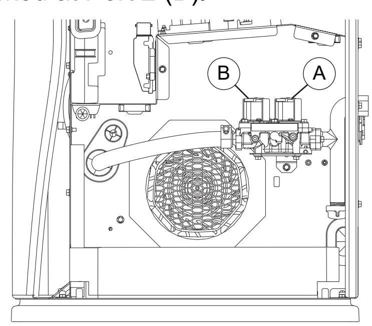



***Figure 8-23. Gas Pressure Test Points***

**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.

4. Turn off the fuel supply.
5. Connect a manometer to Port 1. Turn the fuel supply back on and record the fuel pressure reading.
   a. If the fuel pressure measures within the range of the fuel type being used, proceed to Step 6.
   b. If the fuel pressure if outside of the range of the fuel type being used, the fuel supply pressure and/or regulator need to be inspected. Once this is corrected, retest fuel pressure.
6. Turn off the fuel supply.
7. Connect a manometer to Port 2. Turn the fuel supply back on. Set the generator to MANUAL and record the fuel pressure reading.
   a. If the fuel pressure measures within the range of the fuel type being used, proceed to Step 8.
   b. If the fuel pressure measures below the minimum allowed pressure, but is greater than 0, replace the SOV assembly and retest.
   c. If no fuel pressure is measured, proceed to the ***Wire 14 Test***.
8. Connect the generator to a load bank capable of loading the generator to its rated capacity. Start the generator in MANUAL and apply the load to the generator. Record the fuel pressure reading.
   a. If the fuel pressure stays above the minimum pressure range for the fuel type being used, the fuel pressure and supply is good. Refer back to previous test and follow the “Fuel Pressure Within Specifications” path.
   b. If the fuel pressure drops below the minimum pressure range and/or the pressure changes more than 2 inches of water column erratically, the fuel supply pressure and/or regulator need to be inspected. Once this is corrected, retest fuel pressure.

# Ignition Coil Test

## 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 8-24***. When using this style spark tester, the adjustment screw must be set to the 10kV mark to accurately test for spark.

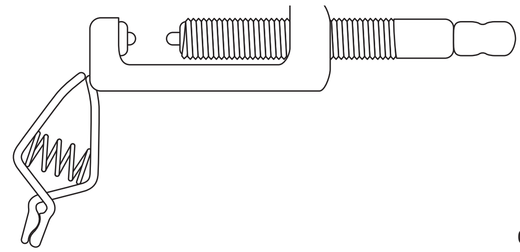



***Figure 8-24. Spark Tester***

**NOTE:** On V-Twin engines, the two ignition coil connectors appear identical and can be connected to the wrong coil. IC1 is for cylinder #1 on the back side of the generator (the cylinder on the starter side of the engine) and IC2 is for cylinder #2 on the front side of the generator (the cylinder on the oil filter side of the engine).

## Procedure

1. Turn off the fuel supply to the generator.
2. Remove spark plug wire(s) from the spark plug(s).
3. Attach the spark plug wire(s) to a spark tester that is clamped to the cylinder head.
4. Set the controller to MANUAL.
5. While the engine is cranking, observe the spark tester.
   a. If the spark jumps the tester gap, the ignition system is providing proper spark for ignition. If testing a single cylinder generator, proceed to the ***Spark Plug Condition Test***. If testing a V-Twin generator, proceed to Step 6.
   b. If the spark fails to jump the tester gap, proceed to Step 7.
6. On V-Twin generators, repeat Steps 4 and 5 on the other cylinder of the engine.
   a. If the spark jumps the tester gap, the ignition system is providing proper spark for ignition.
   b. If the spark fails to jump the tester gap, proceed to Step 7.
7. Remove spark tester and disconnect the ignition coil harness connector. Visually inspect the coil and coil harness pins for damage.
   a. If the pins pass inspection, proceed to Step 8.
   b. If the pins are found to be damaged, replace the ignition coil and/or the wiring harness as necessary and retest.
8. Set the DMM to measure resistance.
9. See ***Table 8-2*** for test point locations and accepted values.
   a. If the values are within specification, replace the ECM and retest.
   b. If the values are outside of the specified ranges, replace the ignition coil and retest.

**Table 8-2.**

| | |
|---|---|
| Primary resistance (measured between Coil Pin A and Coil Pin C) | 1.4 Ohms ± 10% |
| Secondary resistance (measured between Coil Pin C and the Spark Plug Wire) | 26 K Ohms ± 10% |

## Intake Manifold Pressure Sensor Test

### General Theory

The ECM monitors the engine intake manifold temperature using the TTMAP sensor. The sensor converts a temperature reading to a resistance number for the ECM to monitor. This resistance reading is used to monitor the intake manifold air temperature to make the proper fuel trim adjustments for emissions and performance. If the ECM detects a voltage reading outside of the predetermined range of the TTMAP sensor, an E-code fault will be triggered.

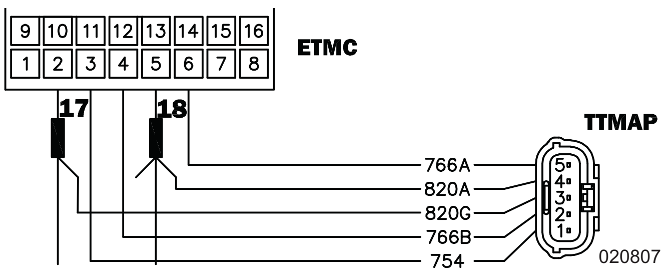



*Figure 8-25.*

### Procedure

1. Verify the air filter is not clogged and air intake is not obstructed.
   a. If obstructions are found, correct condition and retest.
   b. If no obstructions are found, proceed to Step 2.

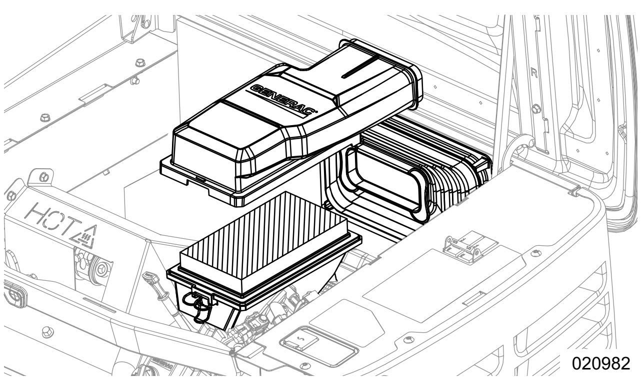



***Figure 8-26. Correct Orientation of Air Filter***

2. Verify the throttle opening is clear of any obstructions.
   a. If obstructions are found, correct condition and retest.
   b. If no obstructions are found, proceed to Step 3.
3. Check the TTMAP connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 4.
4. Set the DMM to measure resistance.
5. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
6. Disconnect the harness connector at the TTMAP. Visually inspect both the TTMAP and TTMAP harness pins for damage.
   a. If the pins pass inspection, proceed to Step 7.
   b. If the pins are found to be damaged, replace the mixer assembly and retest.
7. Using the appropriate back probes, connect one meter lead to Wire 766A at the ECM and the other lead to Wire 766A at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 10.
8. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 9.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 11.
9. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 13.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 12.

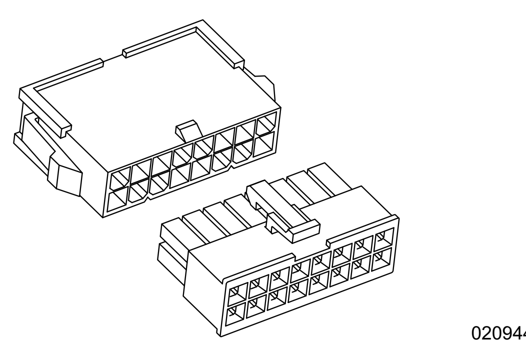



***Figure 8-27. ETMC Connector Showing The ECM Connector From The Harness (Wire) Side***

10. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 766A at the ECM and the other lead to Wire 766A on the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
    c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
11. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A on the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
    c. If resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
12. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and connect the other lead to Wire 820G on the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
    c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
13. Set the DMM to measure DC voltage.
14. Reconnect the harness connector at the TTMAP.
15. Reconnect the ECM harness connector.
16. Using the appropriate back probe, connect one meter lead to Wire 820A at the TTMAP. Connect the other meter lead to battery ground.
    a. If 5V is measured, proceed to Step 17.
    b. If 5V is not measured, replace ECM and retest.
17. Using the appropriate back probe, connect one meter lead to Wire 820G at the TTMAP. Connect the other meter lead to battery ground.
    a. If no voltage is measured, proceed to Step 19.
    b. If voltage is measured, proceed to Step 18.
18. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the mixer assembly.
    a. If a ***short-to-power*** is found, replace the wiring harness and/or mixer assembly and retest.
    b. If no ***short-to-power*** is found, replace the ECM and retest.
19. Using the appropriate back probe, connect one meter lead to Wire 766A at the TTMAP. Connect the other meter lead to battery ground. With the ECM powered on, you should see a voltage range of 0.5 - 4.5 VDC.
    a. If the voltage measured falls within that range, replace ECM and retest
    b. If the voltage measured is outside of that range, replace the mixer assembly and retest.

## Intake Manifold Temperature Sensor Test

### E-Codes 3500-3517

### General Theory

The ECM monitors the engine intake manifold pressure using the TTMAP sensor. This sensor converts a pressure reading to a voltage number for the ECM to monitor. This voltage reading is used to control both the fuel delivery and ignition timing of the engine. If the ECM detects a voltage reading outside of the pre-determined range of the TTMAP sensor, an E-code fault will be triggered.

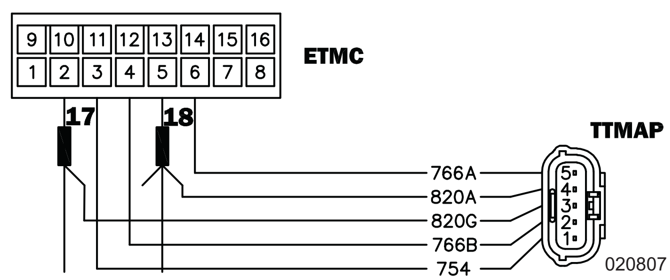



***Figure 8-28. Intake Manifold Temperature Sensor***

### Procedure

1. Check the connections at both the ETMC and TTMAP.
    a. If any connection is found to be loose or improperly connected, repair connection and retest.
    b. If all connections are properly seated and connected (or reseating the connectors did not correct the issue), proceed to Step 2.
2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 4.

   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
4. Disconnect the harness connector at the TTMAP. Visually inspect both the TTMAP and the TTMAP harness pins for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the mixer assembly and retest.
5. Using the appropriate back probes, connect one meter lead to Wire 754 at the ECM and the other lead to Wire 754 at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 6.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 8.
6. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 7.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 9.
7. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the TTMAP.
   a. If resistance measures less than 5 ohms, proceed to Step 11.
   b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 10.

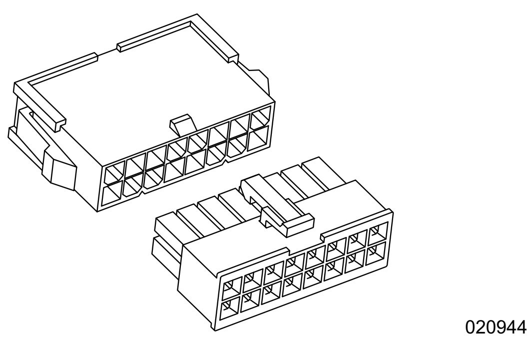



***Figure 8-29. ETMC Connector Showing The ECM Connector From The Harness (Wire) Side***

8. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 754 at the ECM and the other lead to Wire 754 at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
9. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
10. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the ECM side of the ETMC connector.
   a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
   b. If resistance measures less than 5 ohms, replace the mixer assembly and retest.
   c. If resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
11. Set the DMM to measure DC voltage.
12. Reconnect the harness connector at the TTMAP.
13. Reconnect the ECM harness connector.
14. Using the appropriate back probes, connect one meter lead to Wire 820A at the TTMAP. Connect the other lead to battery ground.
   a. If 5V is measured, proceed to Step 15.
   b. If 5V is not measured, replace ECM and retest.
15. Using the appropriate back probes, connect one meter lead to Wire 820G at the TTMAP. Connect the other lead to battery ground.
   a. If no voltage is measured, proceed to Step 17.
   b. If voltage is measured, proceed to Step 16.
16. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the mixer assembly.
   a. If a ***short-to-power*** is found, replace the wiring harness and/or mixer assembly and retest.
   b. If no ***short-to-power*** is found, replace the ECM and retest.
17. Disconnect the ECM connector.
18. Set the DMM to measure resistance.
19. Using the appropriate back probes, connect one meter lead to Wire 754 at the ECM. Connect the other lead Wire 820G at the ECM. Record the resistance reading and compare it to the chart below.

a. If the resistance reading is correct for the ambient temperature reading (± 10%), proceed to Step 20.

b. If the resistance measured is out of the range on the chart, replace the mixer assembly and retest.

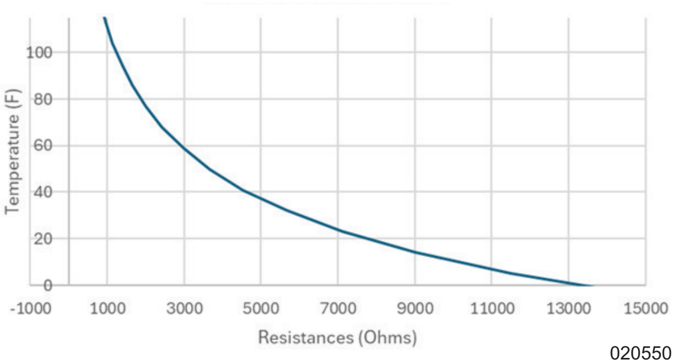



*Figure 8-30. Intake Air Temperature*

20. Reconnect the ECM connector.
21. Using the appropriate back probe, connect one meter lead to Wire 606 on the mixer side of the ETMC harness. Connect the other lead to the negative battery terminal. With the ECM powered on, a voltage range of 0.5–4.5 VDC should be measured.
    a. If the voltage measured is correct, replace the ECM and retest.
    b. If 5V is measured, disconnect the MPS and remeasure. If voltage drops, replace mixer assembly.
    c. If 0V is measured, move the meter lead from the negative battery terminal to the positive terminal. If voltage is measured, disconnect the MPS. If the voltage drops, replace mixer assembly.

## Master Power Relay Test

### General Theory

The master power relay (MPR) provides power to IC1 and IC2 (ignition coils), OPS (oil pressure sensor), OS (oxygen sensor), and to the ECM. The MPR coil is energized by the ECM grounding Wire 608 and power Wire 13A from the battery. The MPR connects Wire 13A to Wire 14C.

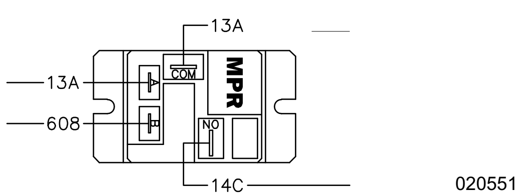



*Figure 8-31. Master Power Relay (MPR)*

### Procedure

1. Set the DMM to measure DC voltage.
2. Using the appropriate back probe, connect the red meter lead to Wire 13A at the COM terminal. Connect the black meter lead to the battery negative terminal. Record the reading. Move the red meter lead to Wire 13A at the Pin A terminal and record that reading.
    a. If battery voltage is measured at both wires, proceed to Step 4.
    b. If battery voltage is measured at only 1 wire, replace the wiring harness and retest.
    c. If battery voltage is not measured at either wire, proceed to Step 3.
3. Check the 15 Amp fuse located in line with Wire 13.
    a. If the fuse is good, replace the wiring harness and retest.
    b. If the fuse is blown, replace and retest. If the fuse continues to blow, check for short to ground and replace the faulty wiring harness/components as needed and retest.
4. Set the DMM to measure continuity.
5. Disconnect the battery.
6. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 7.
    b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
7. Disconnect all four (4) wires from the MPR. Visually inspect all the terminals and spade connectors for looseness/damage.
    a. If the terminals/spade connectors pass inspection, proceed to Step 8.
    b. If the terminals/spade connectors are found to be loose/damaged, replace the wiring harness and/or MPR and retest.
8. Place one meter lead on the MPR terminal for Wire 608 and the other meter lead on the terminal for Wire 13A from Terminal A at the MPR. Record the reading.
    a. If continuity is measured, proceed to Step 9.
    b. If continuity is not measured, replace MPR and retest.
9. Connect a 12 VDC power source across the terminals for Wires 608 and 13A at Pin A on the MPR to energize the relay. Place one meter lead to the terminal for Wire 13A at the COM terminal and the other meter lead to the terminal for Wire 14C. Record the reading.
    a. If continuity is measured, proceed to Step 10.

   b. If continuity is not measured, replace MPR and retest.

10. Connect one meter lead to the disconnected 13A Wire from the COM terminal at the MPR. Using the appropriate back probe, connect the other meter lead to Wire 13A at the ECM. Record the reading.
    a. If resistance measures less than 5 ohms, continue to Step 11.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
11. Connect one meter lead to the disconnected Wire 13A from terminal A at the MPR. Using the appropriate back probe, connect the other meter lead to Wire 13A at the ECM. Record the reading.
    a. If resistance measures less than 5 ohms, proceed to Step 12.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
12. Connect one meter lead to the disconnected Wire 608 at the MPR. Using the appropriate back probe, connect the other meter lead to Wire 608 at the ECM. Record the reading.
    a. If resistance measures less than 5 ohms, proceed to Step 13.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
13. Connect one meter lead to the disconnected Wire 14C at the MPR. Using the appropriate back probe, connect the other meter lead to Wire 14C at the ECM. Record the reading.
    a. If resistance measures less than 5 ohms, replace the ECM and retest.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

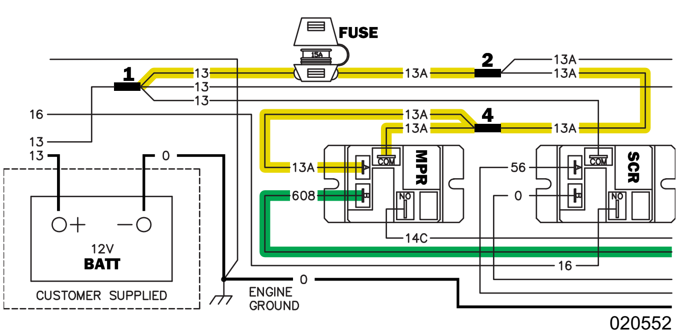



*Figure 8-32.*

# Mixer Valve Power Test

## General Theory

The engine control module (ECM) controls the electronic mixer control valve (EMC). The ECM uses the TTMAP sensor to verify the demand on the engine, and this will move the mixer plate position accordingly to maintain 3600 RPM.

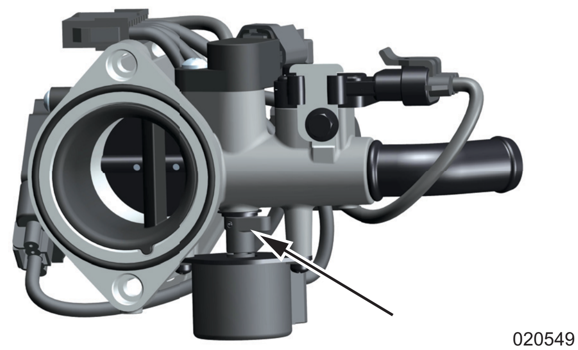



***Figure 8-33. External Mixer Valve Linkage***

## Procedure

1. Verify the ETMC connector is fully seated and check the integrity of the pins.
    a. If the connector passes, proceed to Step 2.
    b. If any pins are found to be defective, replace pins and retest.
2. Set the DMM to measure resistance.
3. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 4.
    b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
4. Disconnect the ETMC connector. Visually inspect the ETMC harness pins for damage.
    a. If the pins pass inspection, proceed to Step 5.
    b. If the pins are found to be damaged, replace the wiring harness and/or mixer assembly and retest.

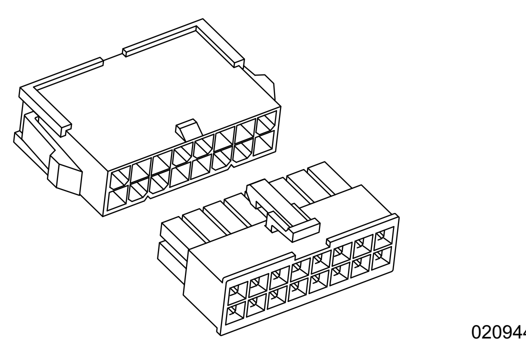


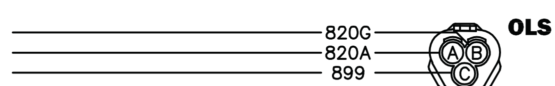

***Figure 8-34. ETMC Connector Showing The ECM Connector From The Harness (Wire) Side***

5. Using the appropriate back probes, connect one meter lead to Wire 605A at the ECM and the other to Wire 605A at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 6.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 605B at the ECM and the other to Wire 605B at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 7.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
7. Using the appropriate back probes, connect one meter lead to Wire 605C at the ECM and the other to Wire 605C at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 8.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
8. Using the appropriate back probes, connect one meter lead to Wire 605D at the ECM and the other to Wire 605D at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 9.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
9. Using the appropriate back probes, connect one meter lead to Wire 605A on the mixer side of the ETMC harness and the other lead to Wire 605B on the mixer side of the ETMC harness.
   a. If the resistance measures between 37–39 k Ohms, proceed to Step 10.
   b. If the resistance measures outside of the above range, replace the mixer assembly and retest.
10. Using the appropriate back probes, connect one meter lead to Wire 605C on the mixer side of the ETMC harness and the other lead to Wire 605D on the mixer side of the ETMC harness.
   a. If the resistance measures approximately 35–40 Ohms, proceed to Step 11.
   b. If the resistance measures outside of the above range, replace the mixer assembly and retest.
11. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 12.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
12. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the ECM side of the ETMC connector.
   a. If the resistance measures less than 5 ohms, proceed to Step 13.
   b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
13. Set the DMM to measure DC voltage.
14. Reconnect the ETMC harness connector.
15. Reconnect the ECM harness connector.
16. Using the appropriate back probe, connect one meter lead to Wire 766B on the mixer side of the ETMC harness. Connect the other meter lead to the negative battery terminal. With the ECM powered on, a voltage range of 0.5–4.5 VDC should be measured.
   a. If the voltage measured is correct, replace the ECM and retest.
   b. If 5V is measured, disconnect the TTMAP sensor and remeasure. If voltage drops, replace mixer assembly.
   c. If 0V is measured, move the meter lead from the negative battery terminal to the positive terminal. If voltage is measured, disconnect the TTMAP sensor. If the voltage drops, replace mixer assembly.

## Oil Level Sensor Test

### General Theory

The ECM monitors the engine oil level using the oil level sensor (OLS). This sensor converts a level reading to a voltage number for the ECM to monitor. This voltage is used to monitor the engine oil level to determine if the engine can be safely operated. If the ECM detects a voltage reading outside of the predetermined range of the OLS sensor, an E-code fault will be triggered.




020805

*Figure 8-35. Oil Level Sensor*

### Procedure

1. Check the engine oil level using the oil dipstick.
   a. If the oil level is high, remove excess oil from the engine and retest.
   b. If the oil level is low, add oil to the engine to bring it to the proper level and retest.
   c. If the oil level is correct (or issue is still present after adding oil), proceed to Step 2.
2. Verify the OLS connector is properly seated and connected.
   a. If the connector is loose or not properly connected, repair connection and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 3.
3. Set the DMM to measure resistance.
4. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
5. Disconnect the harness connector at the OLS. Visually inspect both the OLS and OLS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the OLS and/or replace the wiring harness as necessary and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 899 at the ECM and the other lead to Wire 899 at the OLS.
   a. If resistance measures less than 5 ohms, proceed to Step 7.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
7. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the OLS.
   a. If resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
8. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the OLS.
   a. If resistance measures less than 5 ohms, proceed to Step 9.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
9. Set the DMM to measure DC voltage.
10. Reconnect the harness connector at the OLS.
11. Reconnect the harness connector at the ECM.
12. Using the appropriate back probe, connect one meter lead to Wire 820A at the OLS. Connect the other meter lead to battery ground.
    a. If 5V is measured, proceed to step 13.
    b. If 5V is not measured, replace the ECM and retest.
13. Using the appropriate back probe, connect one meter lead to Wire 820G at the OLS. Connect the other meter lead to battery ground.
    a. If no voltage is measured, proceed to Step 15.
    b. If voltage is measured, proceed to Step 14.
14. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the OLS.
    a. If a ***short-to-power*** is found, replace the wiring harness and retest.
    b. If no ***short-to-power*** is found, replace the ECM and retest.
15. Using the appropriate back probe, connect one meter lead to Wire 899 at the OLS. Connect the other meter lead to battery ground. With the ECM powered on, you should see a voltage range of 0.5–4.5 VDC.
    a. If the voltage measured falls within that range, replace ECM and retest
    b. If the voltage measured is outside of that range, replace the OLS and retest.

## Oil Pressure Switch Test

### General Theory

The engine requires oil pressure to lubricate all the moving components in the engine. The oil pressure switch is a continuity switch that signals to the ECM if the engine has oil pressure or not. If the pressure drops below the minimum threshold, the ECM will shut down the engine to prevent damage.

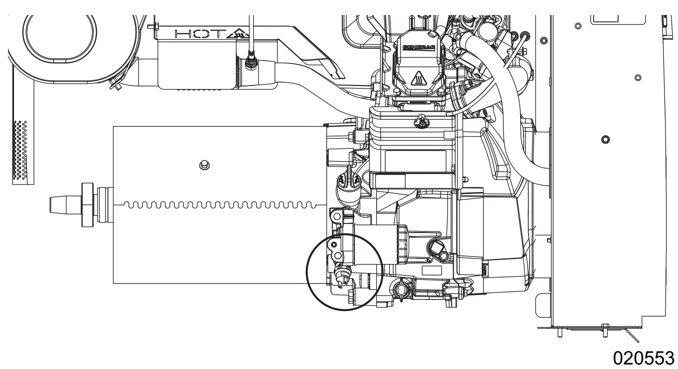



***Figure 8-36. Oil Pressure Switch***

### Procedure

1. Check the engine oil level.
   a. If oil level is low, proceed to Step 2.
   b. If oil level is correct, proceed to Step 3.
2. Add oil to bring engine to correct oil level. Start engine and monitor.
   a. If fault is resolved, no further diagnosis is needed.
   b. If the fault is still present, proceed to Step 3.
3. Check the connectors at the OPS.
   a. If the connectors are found to be loose or improperly connected, repair connectors and retest.
   b. If the connectors are properly seated and connected (or reseating the connectors did not correct the issue), proceed to Step 4.
4. Disconnect the harness connector at the OPS. Visually inspect both the OPS and OPS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 5.
   b. If the pins are found to be damaged, replace the OPS and/or replace the wiring harness as necessary and retest.
5. Remove the OPS from the engine.
6. Install a manual oil pressure gauge where the OPS was. Start the engine in MANUAL. Record the reading.
   a. If the oil pressure is above 10 PSI (817/997cc) or 5 PSI (459cc), proceed to Step 7.
   b. If the oil pressure is below 10 PSI (816/997cc) or 5 PSI (459cc), shut engine down and contact Generac technical support.

**IMPORTANT NOTE:** Continued operation with low oil pressure will result in engine damage!

7. Reinstall OPS on the engine.
8. Set the DMM to measure resistance.
9. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 10.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
10. Use the appropriate back probe, connect one meter lead to Wire 566 at the ECM and the other lead to Wire 566 at the OPS.
    a. If resistance measures less than 5 ohms, proceed to Step 11.
    b. If resistance measures greater than 5 ohms or reads OL, replace the ECM harness and retest.
11. Use the appropriate back probe, connect one meter lead to Wire 14C at the ECM and the other lead to Wire 14C at the OPS.
    a. If resistance measures less than 5 ohms, proceed to Step 12.
    b. If resistance measures greater than 5 ohms or reads OL, replace the ECM harness and retest.
12. Reconnect the ECM harness connector.
13. Set the DMM to measure continuity.
14. Connect one meter lead to each terminal on the OPS. Crank the engine and observe the meter.
    - 459cc Engine:
      a. Once the engine passes over 5 PSI, the meter should show a loss of continuity across the sensor. If continuity is shown above 5 PSI, replace OPS and retest.
      b. If the OPS shows a loss of continuity above 5 PSI as designed, replace the ECM and retest.
    - 817/997cc Engine:
      a. Once the engine passes over 10 PSI, the meter should show continuity across the sensor. If no continuity is shown above 10 PSI, replace OPS and retest.
      b. If the OPS shows continuity above 10 PSI as designed, replace ECM and retest.

## Oxygen Sensor Test

### General Theory

The ECM needs to adjust the air/fuel ratio to optimize engine performance, efficiency, and emissions output. The ECM requires a real-time monitor to know what adjustments to the mixer are needed. The ECM uses an oxygen sensor (OS) to make those calculations. This sensor monitors the amount of oxygen in the exhaust gas and compares it a fresh air sample pulled from around the sensor to determine how much fuel is in the exhaust. The sensor operates in the 0–1 VDC range. The higher the voltage reading, the richer (lower oxygen amount) the exhaust gas is. The lower the voltage reading, the leaner (higher oxygen amount) the exhaust is. The ECM will then use this voltage to adjust either by adding more fuel to richen the mixture or subtracting fuel out to lean out the mixture. When the oxygen sensor is below approximately 600 ºF, the voltage reading will be inaccurate. To decrease the warm-up time needed, an oxygen sensor heater circuit is used to warm-up the sensing element. If the ECM detects a voltage reading outside of the pre-determined range of the OS, an E-code fault will be triggered.

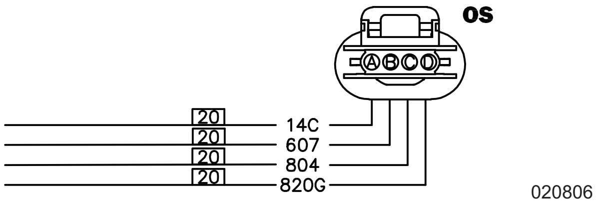



*Figure 8-37. Oxygen Sensor*

## Procedure

1. Remove the air filter and manually actuate the throttle with a finger to feel for resistance in the movement. A slight drag should be felt as the throttle moves.
   a. If only slight drag is found, proceed to Step 2.
   b. If there is resistance, check for obstructions causing the binding. If none are found, replace the mixer assembly and retest.
2. See ***Figure 8-38***. Check the gaskets for the air intake system for leaks or tears.

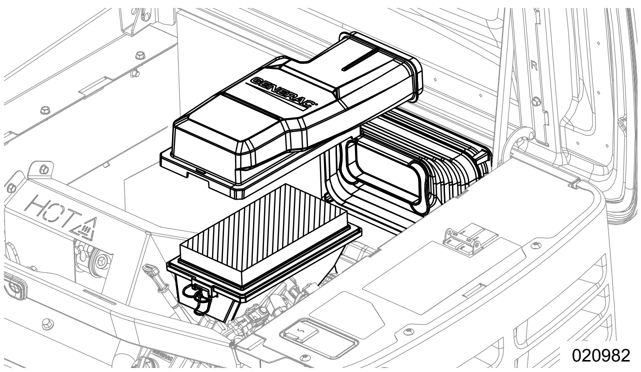



*Figure 8-38. Correct Orientation for Air Filter*

   a. If no leaks or tears are found, proceed to Step 3.
   b. If leaks or tears are found, replace damaged gaskets and retest.
3. Check the exhaust system for leaks and verify the oxygen sensor (OS) is tight.
   a. If no leaks are found and the sensor is tight, proceed to Step 4.
   b. If any exhaust leaks are found, or the OS is loose, replace damaged gaskets/tighten OS as necessary and retest.
4. Set the DMM to measure resistance.
5. Disconnect the harness connector at the engine control module (ECM). Visually inspect the pins for both the ECM and the ECM harness for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
6. Disconnect the harness connector at the OS. Visually inspect both the OS and OS harness pins for damage.
   a. If the pins pass inspection, proceed to Step 7.
   b. If the pins are found to be damaged, replace the OS and/or replace the wiring harness as necessary and retest.
7. Using the appropriate back probes, connect one meter lead to Wire 607 at the ECM and the other lead to Wire 607 at the OS.
   a. If resistance measures less than 5 ohms, continue to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
8. Using the appropriate back probes, connect one meter lead to Wire 804 at the ECM and the other lead to Wire 804 at the OS.
   a. If resistance measures less than 5 ohms, continue to Step 9.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
9. Using the appropriate back probes, connect one meter lead to Wire 14C at the ECM and the other lead to Wire 14C at the OS.
   a. If resistance measures less than 5 ohms, continue to Step 10.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
10. Disconnect the engine throttle/mixer connector (ETMC).
11. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the OS.
   a. If resistance measures less than 5 ohms, continue to Step 12.
   b. If resistance measures greater than 5 ohms or reads OL, replace the ECM harness and retest.
12. Reconnect the ETMC connector.
13. Set the DMM to measure DC voltage.
14. Reconnect the OS harness connector.
15. Reconnect the ECM harness connector.
16. Using the appropriate back probe, connect one meter lead to Wire 14C at the OS. Connect the other meter lead to battery ground. Start the generator in MANUAL. Record the reading.
   a. If battery voltage is measured, proceed to Step 19.
   b. If battery voltage is not measured, proceed to Step 17.

17. Turn generator OFF.
18. Disconnect the connector for Wire 14C at the master power relay (MPR). Place the red meter lead on the MPR terminal and the other meter lead to battery ground.
    a. If battery voltage is measured, replace the wiring harness and retest.
    b. If battery voltage is not measured, proceed to the ***Master Power Relay Test***.

**NOTE:** Allow the generator to run for at least 2 minutes to warm oxygen sensor to operating temperature.

19. Using the appropriate back probe, connect one meter lead to Wire 804 at the OS. Connect the other meter lead to battery ground.
    a. If the voltage reading is outside of the operating range (0.1–1.2V), replace the OS and retest.
    b. If the voltage is within operating range, replace the ECM and retest.

# Spark Plug Condition Test

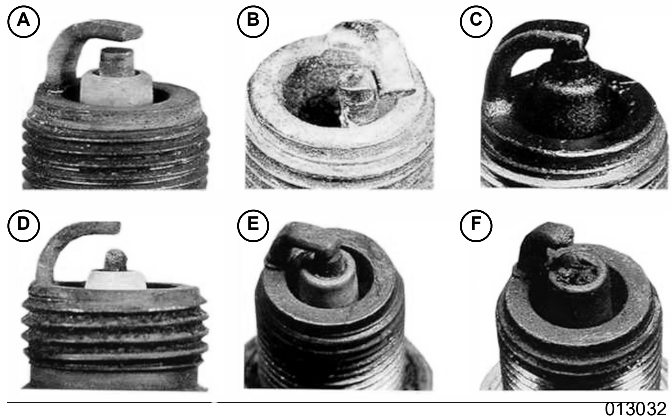
## General Theory

When a no start condition is encountered and the ignition system is providing ample spark to the spark plugs, the spark plug condition needs to be checked. The spark plugs used in a gaseous powered generator are subjected to much higher ignition temperatures than those in a gasoline engine. These spark plugs are also subjected to much higher cylinder pressures due to the high compression ratios used in gaseous generator engines.

Because gaseous fuels are more difficult to ignite, the spark plug gap needs to be accurate to properly ignite the fuel in the cylinder. If the gap is incorrect or the spark plugs are worn or fouled, the engine can suffer a misfire/ rough running condition.

## Procedure

1. See ***Figure 8-39***. Remove spark plug(s) and inspect for any visible damage.
2. Replace any spark plug having burned electrodes, worn electrodes, or cracked porcelain.




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

***Figure 8-39. Spark Plug Conditions***

3. See ***Figure 8-40***. Use a wire feeler gauge to set the gap on new or existing spark plugs as per Section 2 ***Generator Specifications***.
4. Evaluate the condition of the spark plugs.
    a. If the electrodes are worn, burned, or damaged, replace the spark plugs and retest.
    b. If the spark plugs pass inspection, proceed to ***Engine Compression Test*** or ***Cylinder Leak Down Test***.

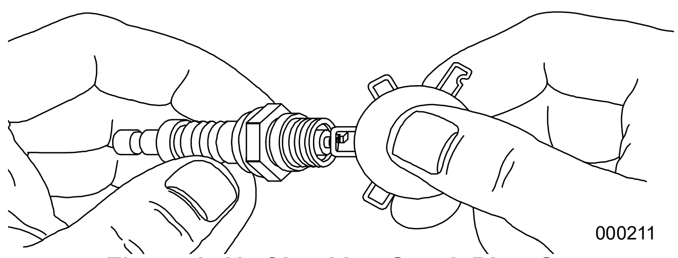



***Figure 8-40. Checking Spark Plug Gap***

# Stator Battery Charger (Voltage Regulator) Test

## General Theory

The engine flywheel has magnets that provide the engine stator with a way to produce current to charge the generator's 12V battery while the engine is running. This ensures the generator can maintain the battery with sufficient charge to continue operation for the duration of the outage. The nominal charging current is 10A at 13.5V at 3600 RPM operation. The stator will only provide voltage when connected to the battery with the voltage regulator (VR) unit. If the voltage on the battery is below or above the operating range of 8.5V–16.5V an E-code fault will be triggered.

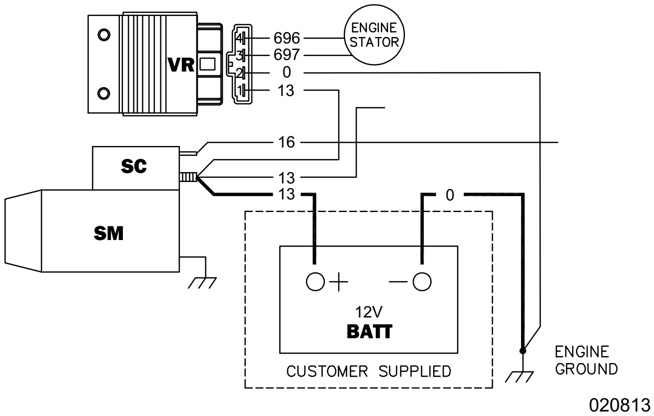



*Figure 8-41. Stator Battery Charger Circuit*

## Procedure

1. Check the VR connector to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 2.
2. Check the connection from the VR connector to the SC to verify it is connected correctly.
   a. If the connector is found to be loose or improperly connected, repair the connector and retest.
   b. If the connector is properly seated and connected (or reseating the connector did not correct the issue), proceed to Step 3.
3. Disconnect the battery.
4. Disconnect the J6 connector from the back of the controller.
5. Disconnect the VR connector at both the VR and the SC. Visually inspect the pins for both the VR and the VR harness for damage.
   a. If the pins pass inspection, proceed to Step 6.
   b. If the pins are found to be damaged, replace the wiring harness and/or VR as necessary and retest.
6. Set the DMM to measure resistance.
7. Using the appropriate back probe, insert one meter lead to Wire 13 at the VR connector and the other to the ring terminal at the SC. Record the reading.
   a. If resistance measures less than 5 ohms, proceed to Step 8.
   b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
8. Using the appropriate back probe, insert one meter lead to Wire 0 at the VR connector and the other to the battery negative terminal. Record the reading.
   a. If resistance measures less than 5 ohms, proceed to Step 9.
   b. If resistance measures greater than 5 ohms or reads OL, check that the ground connection for Wire 0 at the backside of the engine is clean and tight. If the connection passes inspection, replace the wiring harness and retest.
9. Using the appropriate back probes, insert the meter leads to the yellow wires at the VR connector. Record the reading.
   a. If resistance measures less than 5 ohms, proceed to Step 10.
   b. If resistance measures greater than 5 ohms or reads OL, replace the stator and retest.
10. Set the DMM to measure DC voltage.
11. Reconnect the VR connector at both the VR and the SC.
12. Reconnect the battery.
13. Place the meter leads across the battery terminals. Measure the voltage of the battery and record the reading. Leave meter leads connected here for Step 14.
14. Start the generator in MANUAL. Allow the generator to run for 15 seconds. Record the battery voltage reading.

**NOTE:** Ignore any Charger Missing AC warnings in this step.

   a. If the battery voltage is above the reading recorded in Step 13 and the generator does not show any faults, the Stator Battery Charger is working as designed. Proceed to Step 15.
   b. If the battery voltage measures the same or less than what was recorded in Step 13, replace the VR and retest.
15. Reconnect the J6 connector and clear the Charger Missing AC warning if applicable.

# Starter Motor Test

## 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) producing low or no rpm.
  – Open armature (wire broken) producing low or no rpm and excessive current draw.
  – Grounded armature (wire insulation worn and wire touching armature lamination or shaft) producing excessive current draw or no rpm.
- Broken, damaged or weak magnets.
- Starter drive dirty or binding.

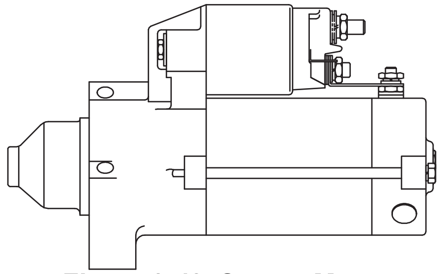



***Figure 8-42. Starter Motor***

### General Theory

The ***Battery and Cables Test*** verified that the battery is fully charged and that the battery cables and connections are within the voltage drop specifications. The ***Starter Control Relay Test*** verified that both the circuit board is delivering DC voltage to the starter control relay (SCR) and the SCR is working as designed. The ***Starter Contactor Test*** 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.
2. Connect the red meter test lead to the positive lead on the SC and connect the black meter lead to the starter motor case.
3. Set the controller to MANUAL and watch the meter. Meter should show battery voltage, the starter motor should operate, and the engine should crank.
   a. If the meter shows battery voltage but the starter does not engage, replace the starter and retest.
   b. If battery voltage is shown and the starter motor tries to engage (pinion engages) but the engine does not crank, check for mechanical binding of the engine and/or rotor.

## Starter Contactor Test

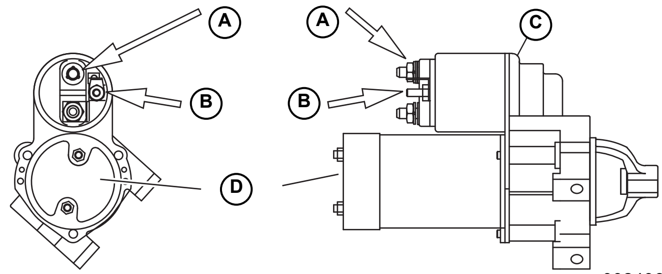
### General Theory

The coil in the starter contactor (SC) must energize and its normally open contacts must close or the engine will not crank. This test will determine if the SC is not 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 8-43*** for Test Points.




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

***Figure 8-43. Starter Contactor***

1. Set DMM to measure DC voltage.
2. Connect the positive meter lead to the positive post of the battery and connect the negative meter lead to the negative post of the battery.
   a. If at least 12 VDC is measured, record that reading and proceed to Step 3.
   b. If less than 12 VDC is measured, proceed to the ***Battery and Cables Test*** to check the battery condition.
3. Connect the positive meter lead to Test Point A and connect the negative meter lead to the negative post of the battery. Record the reading.
   a. If the battery voltage measured is within 0.3 V of the measurement in Step 2, proceed to Step 4.
   b. If the battery voltage measured is more than 0.3V different from the measurement in Step 2, proceed to the ***Battery and Cables Test*** to check for the voltage loss on the cable.
4. Connect the red meter lead to Test Point B and connect the black meter lead to the negative post of the battery. Set the generator to MANUAL. Record the reading.
   a. If battery voltage was measured, proceed to the ***Starter Motor Test***.
   b. If battery voltage was not measured, proceed to Step 5.
5. Set the DMM to measure resistance.
6. Disconnect Wire 16 at both the SCR and SC. Connect the red meter lead to the SC end of Wire 16 and the black lead to the SCR end of the wire. Record the reading.
   a. If the resistance measures less than 5 ohms, proceed to the ***Starter Control Relay Test***.
   b. If the resistance is greater than 5 ohms or reads OL, replace the wiring harness and retest.

## Starter Control Relay Test

### 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).

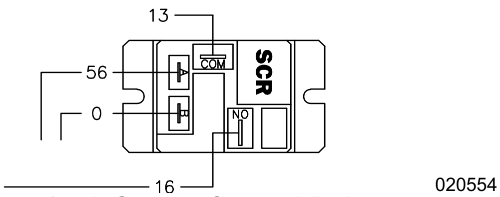



*Figure 8-44. Starter Control Relay*

### Procedure

1. Set the DMM to measure DC voltage.
2. Locate and disconnect Wire 56 from the SCR. Visually inspect the terminal for Wire 56 on the SCR and the Wire 56 harness connection for damage.
   a. If both pass inspection, reconnect Wire 56 to the SCR and proceed to Step 3.
   b. If either is found to be damaged, replace the SCR and/or replace the wiring harness and retest.
3. Connect one meter test lead to Wire 56 and the other meter test lead to the battery negative terminal. Set the controller to MANUAL. Record the reading.
   a. If battery voltage was measured, Wire 56 is working as intended, proceed to Step 5.
   b. If battery voltage was not measured, proceed to Step 4.
4. Using the appropriate back probes, insert one meter lead to Wire 56 at the J4 controller connector ***while leaving the connector connected to the controller***. Connect the other meter lead to ground. Set the controller to MANUAL and record the reading.
   a. If battery voltage is measured, go Step 5.
   b. If no voltage is measured, check the harness and controller pins.
   c. If the pins are found to be damaged, replace the wiring harness and/or controller as necessary and retest.
   d. If the harness and controller pins pass inspection, replace the controller and retest.
5. Disconnect all four (4) wires from the SCR. Visually inspect all the terminals and spade connectors for damage.
   a. If the terminals/spade connectors pass inspection, proceed to Step 6.
   b. If the terminals/spade connectors are found to be damaged, replace the SCR and/or replace the wiring harness as necessary and retest.
6. Connect the positive meter lead to Wire 13 at the SCR and connect the negative meter lead to the battery negative terminal. Record the reading.
   a. If battery voltage was measured, proceed to Step 7.
   b. If battery voltage was NOT measured, replace the wiring harness and retest.
7. Disconnect battery.
8. Disconnect the J4 harness connector from the controller.
9. Set the DMM to measure resistance.
10. Using the appropriate back probes, connect one meter lead to Wire 56 at the J4 connector and the other lead to Wire 56 at the SCR. Record the reading.
    a. If the resistance measures less than 5 ohms, proceed to Step 11.
    b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
11. Connect the red meter lead to the Wire 13 terminal at the SC and connect the black lead to the Wire 13 terminal at the SCR. Record the reading.
    a. If resistance is less than 5 ohms, proceed to Step 12.
    b. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
12. Connect the red meter lead to Wire 16 at the SCR and the black meter lead to Wire 16 at the SC. Record the reading.
    a. If the resistance measures less than 5 ohms, proceed to Step 13.
    b. If the resistance measures greater than 5 Ohms or measures OL, replace the wiring harness and retest.
13. Connect the positive meter lead to Wire 0 at the SCR and connect the negative meter lead to the negative battery terminal. Record the reading.
    a. If the resistance measures less than 5 ohms, proceed to Step 14.
    b. If the resistance measures greater than 5 ohms or measures OL, check the ground connection at the ground block for a corroded or loose connection. If passes inspection, replace the wiring harness and retest.
14. Connect the red meter lead to the terminal for Wire 56 and the black meter lead to the terminal for Wire 0 on the SCR. Record the reading.
    a. If resistance measured is less than 150 ohms, proceed to Step 15.

    b. If the resistance measures greater than 150 ohms or measures OL, replace the SCR and retest.

15. Connect a 12 VDC power source across the terminals for Wires 56 and 0 on the SCR to energize the relay. Place one meter lead to the terminal for Wire 13 the other meter lead to the terminal for Wire 16 on the SCR. Record the reading.
    a. If resistance is less than 150 ohms measured, the SCR test passes. Reinstall all connectors, reconnect battery, and proceed to the ***Starter Contactor Test***.
    b. If continuity is not measured, replace the SCR and retest.

# Throttle Position Sensor Test

## General Theory

The ECM controls the electronic throttle control valve (ETC). The ECM uses the TTMAP sensor to verify the demand on the engine, and this will move the throttle plate position accordingly to maintain 3600 RPM.

## Procedure

1. Verify the throttle plate can move freely when actuated manually. If there is resistance, check for obstructions causing the binding. If none are found, replace the mixer assembly and retest.
2. While visually observing the external throttle valve linkage (see picture below), remove and reinstall the 15A fuse from the fuse holder in Wire 13. The throttle linkage should fully sweep then set itself for engine starting.

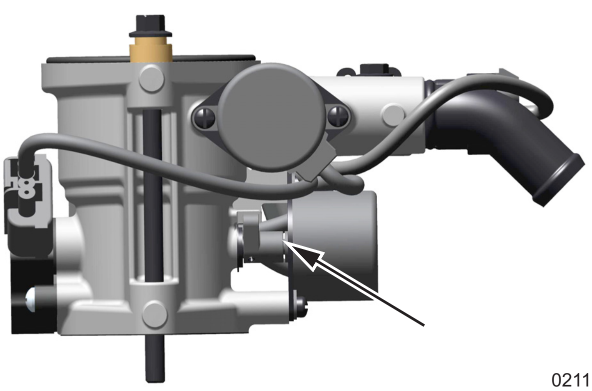



***Figure 8-45. External Throttle Valve Linkage***

    a. If the throttle valve linkage moves as described, proceed to Step 3.
    b. If the throttle valve linkage does not move as described, proceed to the ***Electronic Throttle Control Power Test***.

3. Set the DMM to measure resistance.
4. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 5.
    b. If the pins are found to be damaged, replace the ECM harness and/or ECM as necessary and retest.
5. Disconnect the harness connector at the TTMAP. Visually inspect both the TTMAP and TTMAP harness pins for damage.
    a. If the pins pass inspection, proceed to Step 6.
    b. If the pins are found to be damaged, replace the mixer assembly and retest.
6. Using the appropriate back probes, connect one meter lead to Wire 766B at the ECM and the other lead to Wire 766B at the TTMAP.
    a. If resistance measures less than 5 ohms, proceed to Step 7.
    b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 9.
7. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other lead to Wire 820A at the TTMAP.
    a. If resistance measures less than 5 ohms, proceed to Step 8.
    b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 10.
8. Using the appropriate back probes, connect one meter lead to Wire 820G at the ECM and the other lead to Wire 820G at the TTMAP.
    a. If resistance measures less than 5 ohms, proceed to Step 12.
    b. If resistance measures greater than 5 ohms or reads OL, proceed to Step 11.
9. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 766B at the ECM and the other to Wire 766B at the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.
    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.
    c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.
10. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probes, connect one meter lead to Wire 820A at the ECM and the other to Wire 820A at the ECM side of the ETMC connector.
    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly

and retest.

b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.

c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.

11. Disconnect the ETMC connector. Visually inspect the ETMC connector pins for damage. Using the appropriate back probe, connect one meter lead to Wire 820G at the ECM and the other to Wire 820G at the ECM side of the ETMC connector.

    a. If the pins are found to be damaged, replace the wiring harness and/or the mixer assembly and retest.

    b. If the resistance measures less than 5 ohms, replace the mixer assembly and retest.

    c. If the resistance measures greater than 5 ohms or OL, replace the wiring harness and retest.

12. Set the DMM to measure DC voltage.

13. Reconnect the ETMC harness connector.

14. Reconnect the harness connector at the TTMAP.

15. Reconnect the ECM harness connector.

16. Using the appropriate back probe, connect one meter lead to Wire 820A at the TTMAP. Connect the other meter lead to battery ground.

    a. If 5V is measured, proceed to Step 17.

    b. If 5V is not measured, replace ECM and retest.

17. Using the appropriate back probe, connect one meter lead to Wire 820G at the TTMAP. Connect the other meter lead to battery ground.

    a. If no voltage is measured, proceed to Step 19.

    b. If voltage is measured, proceed to Step 18.

18. Check for a ***short-to-power*** between Wire 820G at the ECM and Wire 820G at the mixer assembly.

    a. If a ***short-to-power*** is found, replace the wiring harness and/or mixer assembly and retest.

    b. If no ***short-to-power*** is found, replace the ECM and retest.

19. Using the appropriate back probe, connect one meter lead to Wire 766B at the TTMAP. Connect the other meter lead to battery ground. With the ECM powered on, the meter should display a voltage range of 0.5–4.5 VDC.

    a. If the voltage measured falls within that range, replace ECM and retest

    b. If the voltage measured is outside of that range, replace the mixer assembly and retest.

# Transfer Control Wires Test

## General Theory

The transfer switch is controlled by the Power Zone 200 controller in the generator. Wire 194 has 12 VDC supplied from the controller to the transfer switch. This provides battery power to the transfer relay (also powers the SACM/FCM module in some configurations). Wire 23 is switched to ground in the Power Zone 200 controller when transfer to generator is commanded by the PZ200 controller. When Wire 23 is grounded, the relay is activated which causes the contactor to switch from Utility position to Standby position allowing the generator output voltage to connect to the load lugs to supply power to the customer.

If Wire 194 is shorted-to-ground in the wiring or a damaged SACM/FCM/controller output causes the voltage to drop to less than 3 VDC, the controller will turn off the output and set a Transfer Wiring Alarm. If the problem is found and corrected, the voltage will be close to battery voltage after clearing the alarm. Clearing the alarm will reset the output and return it to 12 VDC unless the overload is still present. If it is still present, the output will again turn off and set an alarm. Wire 0 is used as a ground for the 12 VDC power to the SACM/FCM.

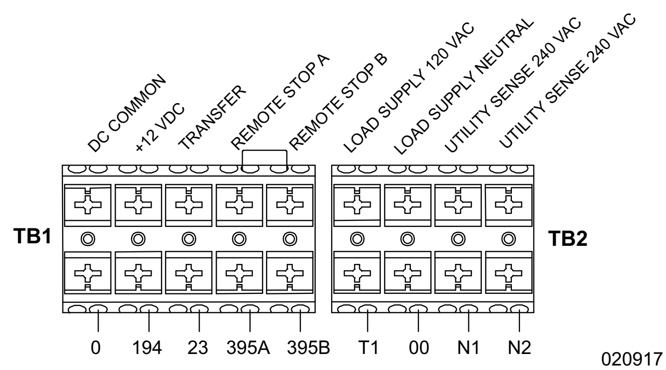



***Figure 8-46. Customer Connection Block and Transfer Control Wires***

## Procedure

1. Set the DMM to measure DC voltage.

2. Locate Wires 194 and 0 at the Customer Connection Block.

3. Insert the red meter lead into the WAGO block terminal for Wire 194 and the black meter lead into the WAGO block terminal for Wire 0. Record the reading.

    a. If the voltage measures less than 3 VDC, proceed to Testing Wire 194.

    b. If the voltage measures 11 VDC or greater, proceed to Testing Wire 23.

**NOTE:** The T1 and 00 Charger input voltage is used to confirm transfer to standby has occurred. If this voltage is not seen after transfer signal has been sent, E-code 2738 (No Transfer Detected) will be set as a warning.

## Testing Wire 194

**NOTE:** Wire 194 will not be powered if there is an active alarm for Transfer Warning. The alarm will need to be cleared at each step to perform the test correctly.

1. Set the DMM to measure DC Voltage.
2. At the transfer switch, disconnect Wire 194 at the SACM/FCM.
3. Connect the red meter lead to the disconnected Wire 194. Place the black meter lead on the terminal connection for Wire 0 on the SACM/FCM. Record the reading.
   a. If the voltage measures less than 3 VDC, reconnect Wire 194 and proceed to Step 5.
   b. If the voltage measures above 11 VDC, reconnect Wire 194 and proceed to Step 4.
4. Place the red meter lead on the terminal for Wire 194 on the SACM/FCM. Place the black meter lead on the terminal for Wire 0 at the SACM/FCM. Record the reading.
   a. If the voltage measures less than 3 VDC, replace the SACM/FCM and retest.
   b. If the voltage measures above 11 VDC, and no transfer to standby occurs, refer to the *Residential and Commercial Transfer Switches Diagnostic Manual* for diagnosis.
5. Disconnect Wire 194 from the transfer switch side of the WAGO block in the customer connection block.
6. Place the red meter lead in the WAGO block terminal for Wire 194. Place the black meter lead in the WAGO block terminal Wire 0. Record the reading.
   a. If the voltage measures above 11 VDC, replace Wire 194 between the customer connection block and the SACM/FCM and retest.
   b. If the voltage measures less than 3 VDC, reconnect Wire 194 and proceed to Step 7.
7. Disconnect Wire 194 from the generator side of the WAGO block in the customer connection block.
8. Connect the red meter lead to the disconnected Wire 194. Place the black meter lead in the WAGO block terminal Wire 0. Record the reading.
   a. If the voltage measures above 11 VDC, replace the WAGO block and retest.
   b. If the voltage measures less than 3 VDC, reconnect Wire 194 and proceed to Step 9.
9. Disconnect the battery.
10. Remove AC utility power from the generator.
11. Disconnect the J4 connector at the controller. Visually inspect the pins for both the controller and the J4 connector for damage.
    a. If the pins pass inspection, proceed to Step 12.
    b. If the pins are found to be damaged, replace the wiring harness and/or controller and retest.
12. Check for a short to ground on Wire 194 between the J4 connector and the WAGO block.
    a. If a short to ground is found, replace the wiring harness and retest.
    b. If no short to ground is found, replace the controller and retest.

## Testing Wire 23

**NOTE:** Confirm the MLCB is set to ON for this procedure.

1. Remove all AC and DC power from transfer switch. Verify all connections in the transfer switch are tight.
   a. If connections pass inspection, proceed to Step 2.
   b. If connections fail inspection, repair as necessary and retest.
2. Set the DMM to measure DC Voltage.
3. Place the generator in AUTO and remove utility source voltage. Watch for the green LED in the status LED indicators on the side of the controller to begin flashing.
4. Place the red meter lead on the terminal for Wire 194 at the SACM/FCM. Place the black meter lead on the terminal for Wire 23 at the SACM/FCM. Record the reading.
   a. If the voltage measures near 12–14 VDC and no transfer to standby occurs, refer to the *Residential and Commercial Transfer Switches Diagnostic Manual* for diagnosis.
   b. If the voltage reads close to 0 VDC even with the LED flashing, proceed to Step 5.
5. With the generator still running, remove Wire 23 from the SACM/FCM and place a jumper wire from the Wire 23 terminal to ground in the transfer switch.
   a. If the transfer to standby occurs, reconnect Wire 23 to the SACM/FCM and proceed to Step 6.
   b. If no transfer occurs, replace the SACM/FCM and retest.
6. With the generator still running, remove Wire 23 from the transfer switch side of the WAGO block in the customer connection block and ground the wire.
   a. If transfer to standby occurs, reconnect Wire 23 and proceed to Step 7.
   b. If no transfer to standby occurs, repair Wire 23 between the customer connection block and the transfer switch and retest.

7. With the generator still running, remove Wire 23 from the generator side of the WAGO block at the customer connection block. Insert a jumper wire in that terminal and ground the wire.
   a. If transfer to standby occurs, proceed to Step 8.
   b. If transfer to standby does not occur, replace WAGO block and retest.
8. Turn generator OFF.
9. Disconnect the battery.
10. Remove AC utility power from the generator.
11. Disconnect the J4 connector at the controller. Visually inspect the pins for both the controller and the J4 connector for damage.
    a. If the pins pass inspection, proceed to Step 12.
    b. If the pins are found to be damaged, replace the wiring harness and/or controller and retest.
12. Set the DMM to measure continuity.
13. Using the appropriate back probe, connect the red meter lead to Wire 23 at the J4 connector. Place the black meter lead on the disconnected Wire 23 at the WAGO block. Record the reading.
    a. If the wire does not have continuity, replace the wiring harness and retest.
    b. If the wire has continuity, replace the controller and retest.

# Wire 14 Test

## General Theory

When the engine begins cranking and speed reaches 75 RPM, power is supplied to Wire 14 to open both fuel shut-off valves (SOVs). When the engine is commanded off, power to Wire 14 is removed, which in turn will de-energize both solenoids and close the SOVs.

## Procedure

1. Set the DMM to measure DC voltage.
2. Locate the J4 connector on the back of the Power Zone 200 Controller.
3. Locate Wire 14 in Pin position 7 of the J4 connector.
4. Using appropriate back probes, insert the red meter lead in position 7 and the black meter lead on battery negative terminal.

**NOTE:** Leave the black meter lead on battery negative terminal through Step 10.

5. Press the MANUAL button on the Controller. Record the reading on the meter.
   a. If battery voltage is measured, proceed to Step 6.
   b. If no voltage is measured, check the connection and pins for the J4 connector. If the pins are found to be damaged, replace the wiring harness and/or controller as necessary and retest.
   c. If the harness and controller pins pass inspection, replace the controller and retest.
6. Locate SOV1 and SOV2 in the battery compartment.

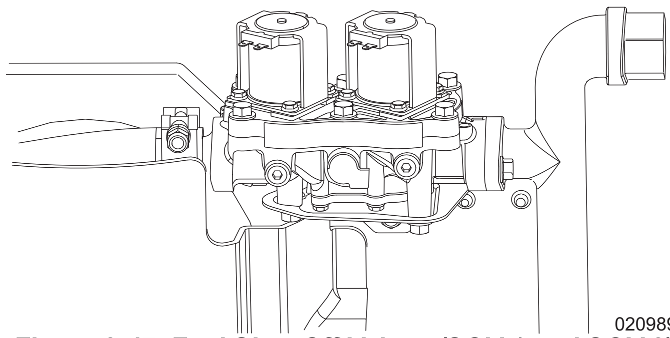



*Figure 8-47. Fuel Shut-Off Valves (SOV 1 and SOV 2)*

7. Using the appropriate back probe, insert the red meter lead to Wire 14 on SOV1.
8. Press the MANUAL button on the controller. Record the reading on the meter.
   a. If battery voltage is measured, proceed to Step 9.
   b. If no voltage is measured, replace the wiring harness and retest.
9. Using the appropriate back probe, insert the red meter lead to Wire 14 on SOV2.
10. Press the MANUAL button on the controller. Record the reading on the meter.
    a. If battery voltage is measured, proceed to Step 11.
    b. If no voltage is measured, replace the wiring harness and retest.
11. Set the DMM to measure resistance.
12. Disconnect Wire 0 on SOV 1. Connect the red meter lead to Wire 0 and the other lead to the ground bar. Record the reading.
    a. If resistance measures less than 5 ohms, proceed to Step 13.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.
13. Disconnect the wires to both SOV1 and SOV2. Connect the meter leads across the terminals of each solenoid. Record the reading.
    a. If resistance measured between 5–60 ohms, proceed to Step 14.
    b. If the resistance measured less than 5 ohms, more than 60 ohms, or OL, replace the fuel shut off valve assembly and retest.

14. Disconnect the harness connector at the ECM. Visually inspect the pins for both the ECM and the ECM harness for damage.
    a. If the pins pass inspection, proceed to Step 15.
    b. If the pins are found to be damaged, replace either the wiring harness or ECM as needed and retest.
15. Connect the red meter lead to Wire 610 at SOV2. Using the appropriate back probe, insert the black meter lead in the ECM side of Wire 610 Pin location 3L. Record the reading on the meter.
    a. If resistance measures less than 5 ohms, replace the ECM and retest.
    b. If resistance measures greater than 5 ohms or reads OL, replace the wiring harness and retest.

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# Section 9 Electrical Data

## Introduction

Go to www.generac.com (http://www.generac.com/service-support/product-support-lookup) for the most current wiring diagrams and electrical schematics. Use model or serial number.

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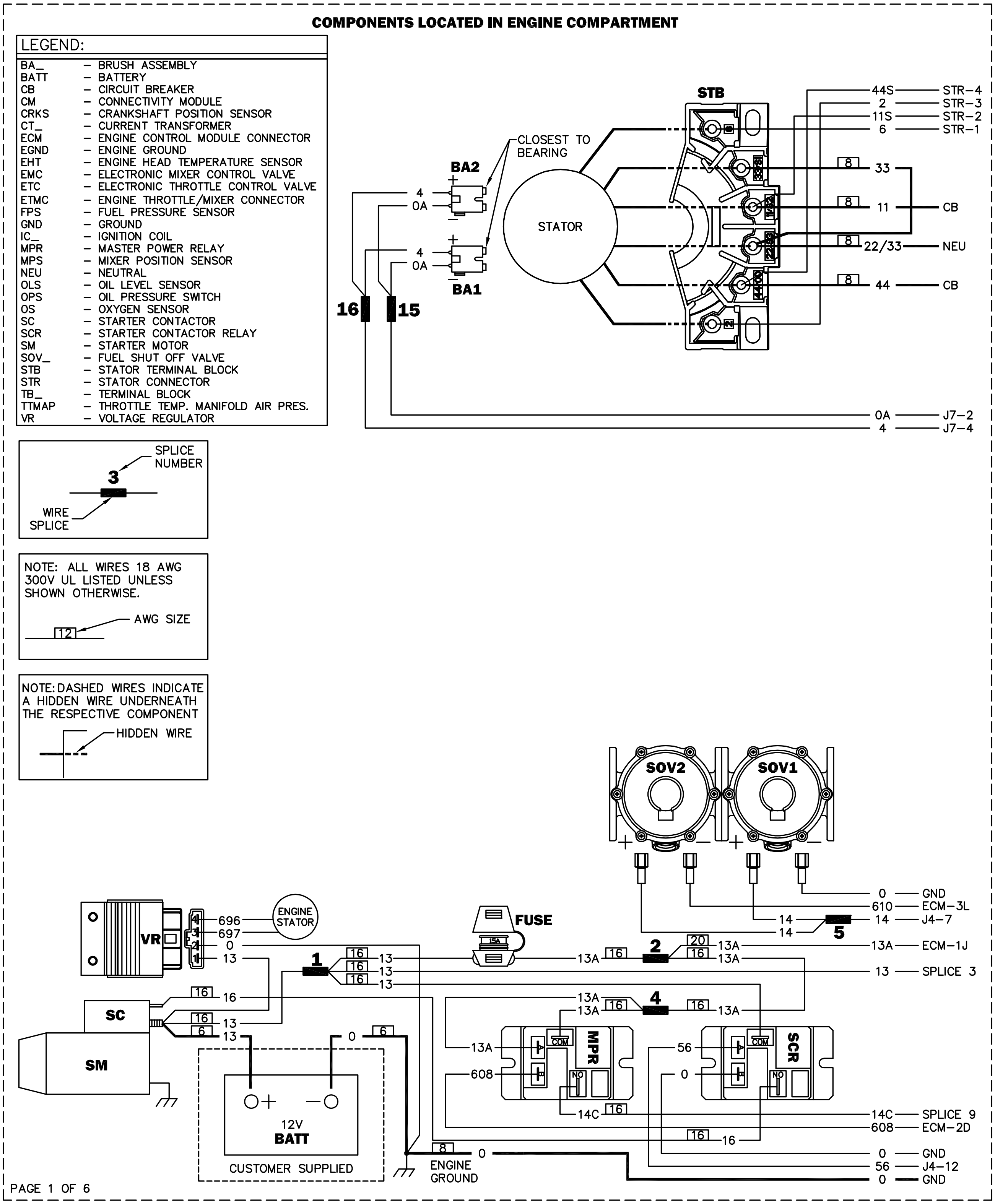
GROUP WD

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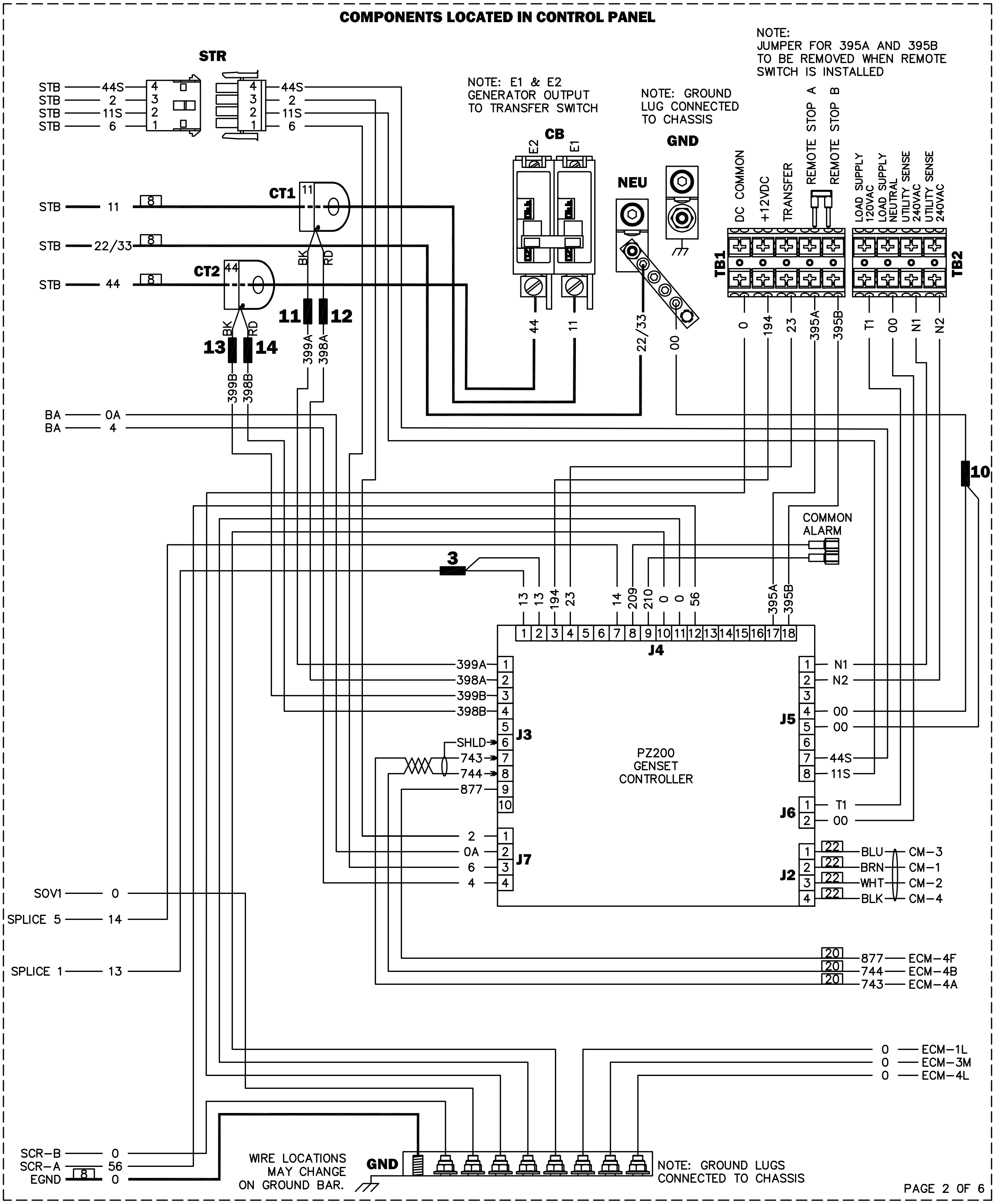
## A0005639540-B WD/SD HSB PZ200 SSI 60HZ 459 (page 2 of 6)

GROUP WD

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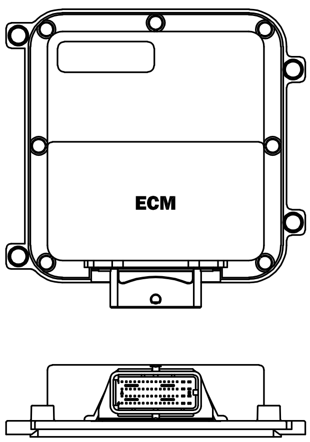
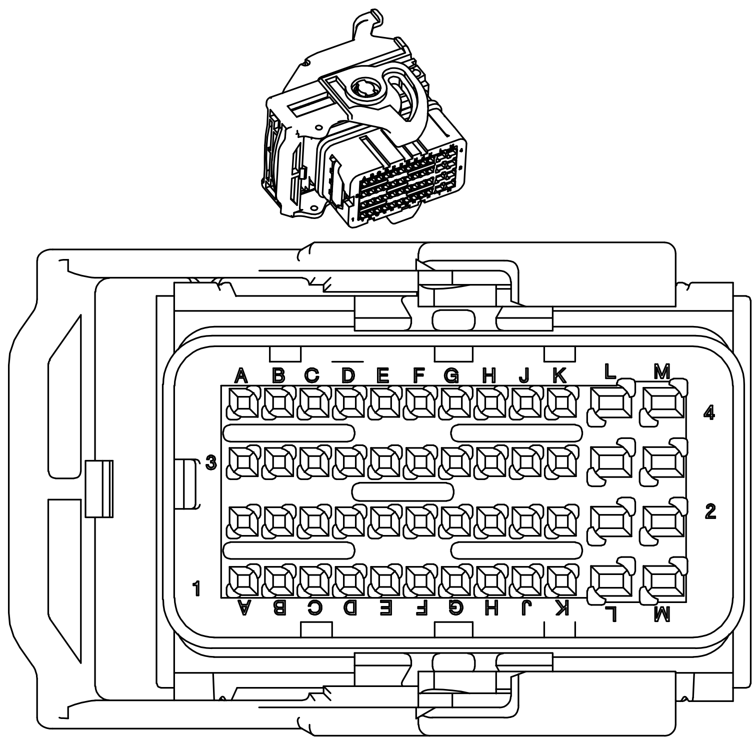
GROUP WD

**COMPONENTS LOCATED IN CONTROL PANEL**

**ENGINE CONTROL MODULE**




CONNECTOR END VIEW

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 1A | 605A | ETMC–13 |
| 1B | 605B | ETMC–14 |
| 1C | 79A | CRKS–A |
| 1D | 79B | CRKS–B |
| 1E | 770A | ETMC–9 |
| 1F | 771A | ETMC–11 |
| 1G | 770B | ETMC–10 |
| 1H | 771B | ETMC–12 |
| 1J | 13A | SPLICE 2 |
| 1K | 14C | SPLICE 6 |
| 1L | 0 | GND |
| 1M | – | – |

PIN LIST

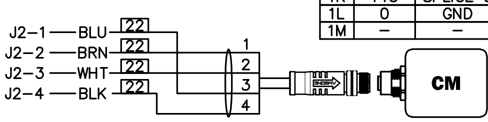
| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 2A | 605C | ETMC–15 |
| 2B | 606 | ETMC–7 |
| 2C | 766A | ETMC–6 |
| 2D | 608 | MPR–B |
| 2E | – | – |
| 2F | 607 | OS–B |
| 2G | 754 | ETMC–3 |
| 2H | – | – |
| 2J | 899 | OLS–C |
| 2K | 714 | EHT–1 |
| 2L | – | – |
| 2M | – | – |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 3A | 605D | ETMC–16 |
| 3B | 766B | ETMC–4 |
| 3C | 797 | ETMC–1 |
| 3D | – | – |
| 3E | – | – |
| 3F | – | – |
| 3G | – | – |
| 3H | – | – |
| 3J | – | – |
| 3K | 820A | SPLICE 7 |
| 3L | 610 | SOV2 |
| 3M | 0 | GND |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 4A | 743 | J3–7 |
| 4B | 744 | J3–8 |
| 4C | 566 | OPS |
| 4D | – | – |
| 4E | – | – |
| 4F | 877 | J3–9 |
| 4G | – | – |
| 4H | – | – |
| 4J | 804 | OS–C |
| 4K | 820G | SPLICE 8 |
| 4L | 0 | GND |
| 4M | 451 | IC1–C |

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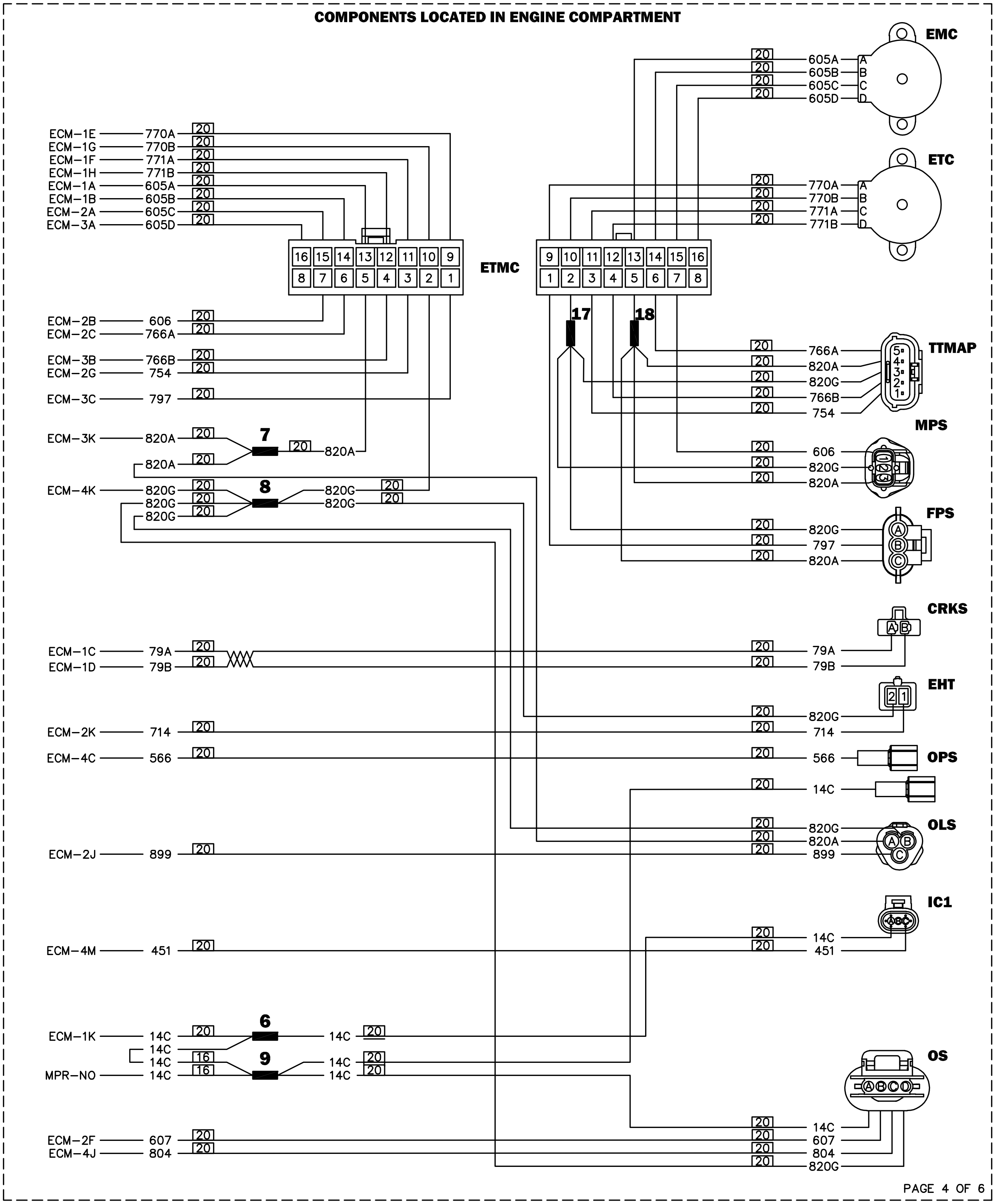
## A0005639540-B WD/SD HSB PZ200 SSI 60HZ 459 (page 4 of 6)

GROUP WD

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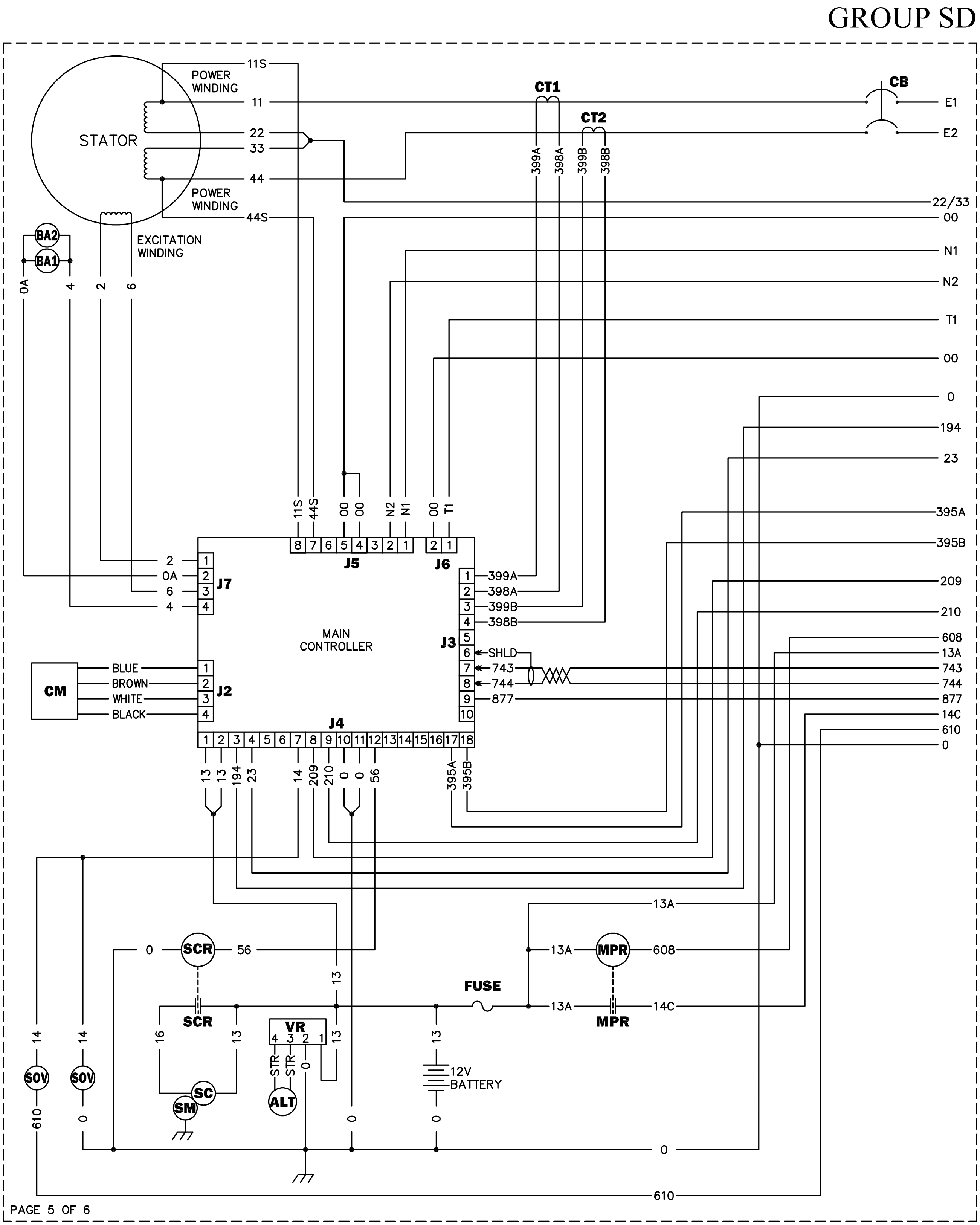
## A0005639540-B WD/SD HSB PZ200 SSI 60HZ 459 (page 5 of 6)




SCHEMATIC - DIAGRAM

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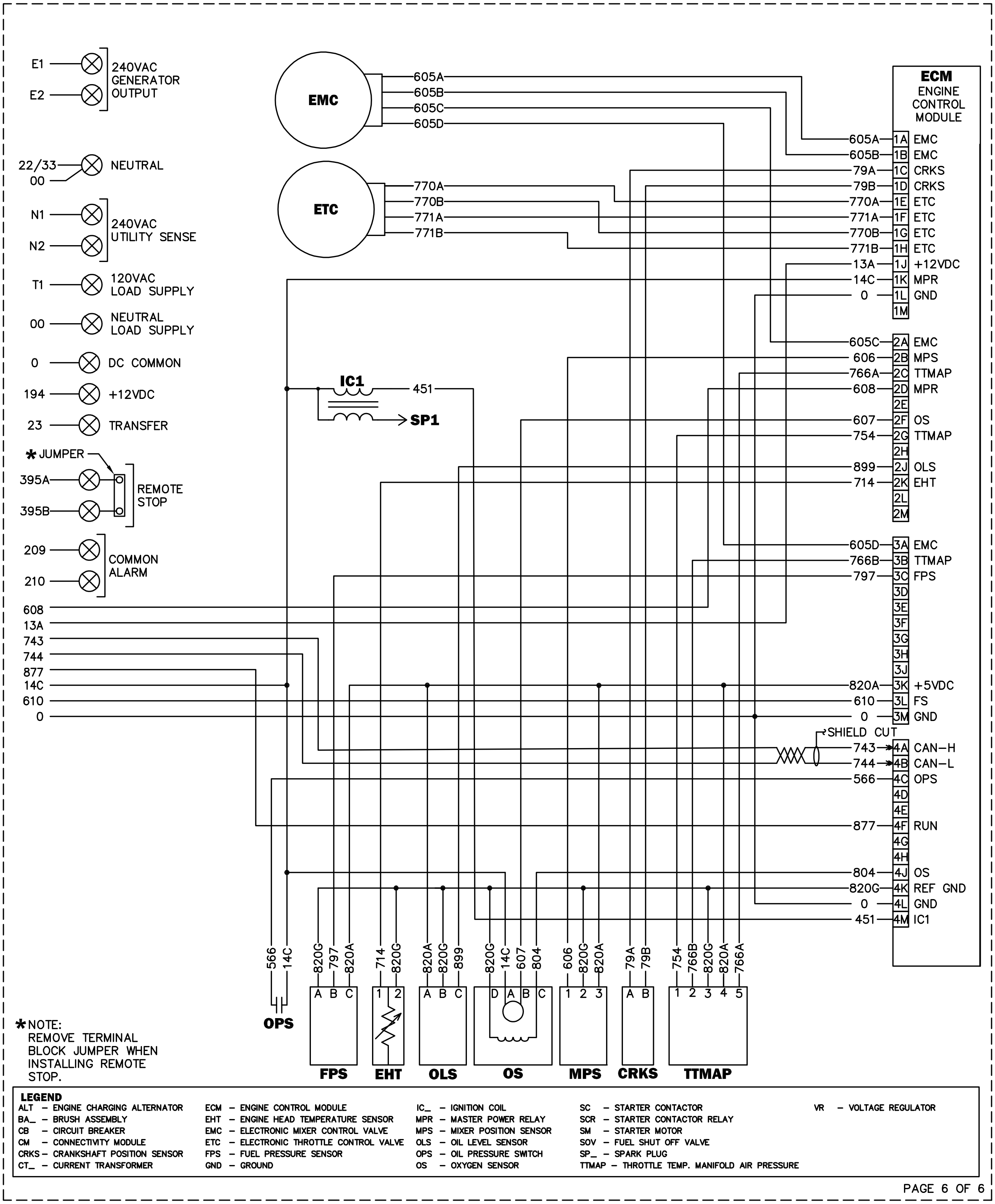
## A0005639540-B WD/SD HSB PZ200 SSI 60HZ 459 (page 6 of 6)

GROUP SD

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## A0005639538-B WD/SD HSB PZ200 SSI 60HZ 817/997 (1 of 6)

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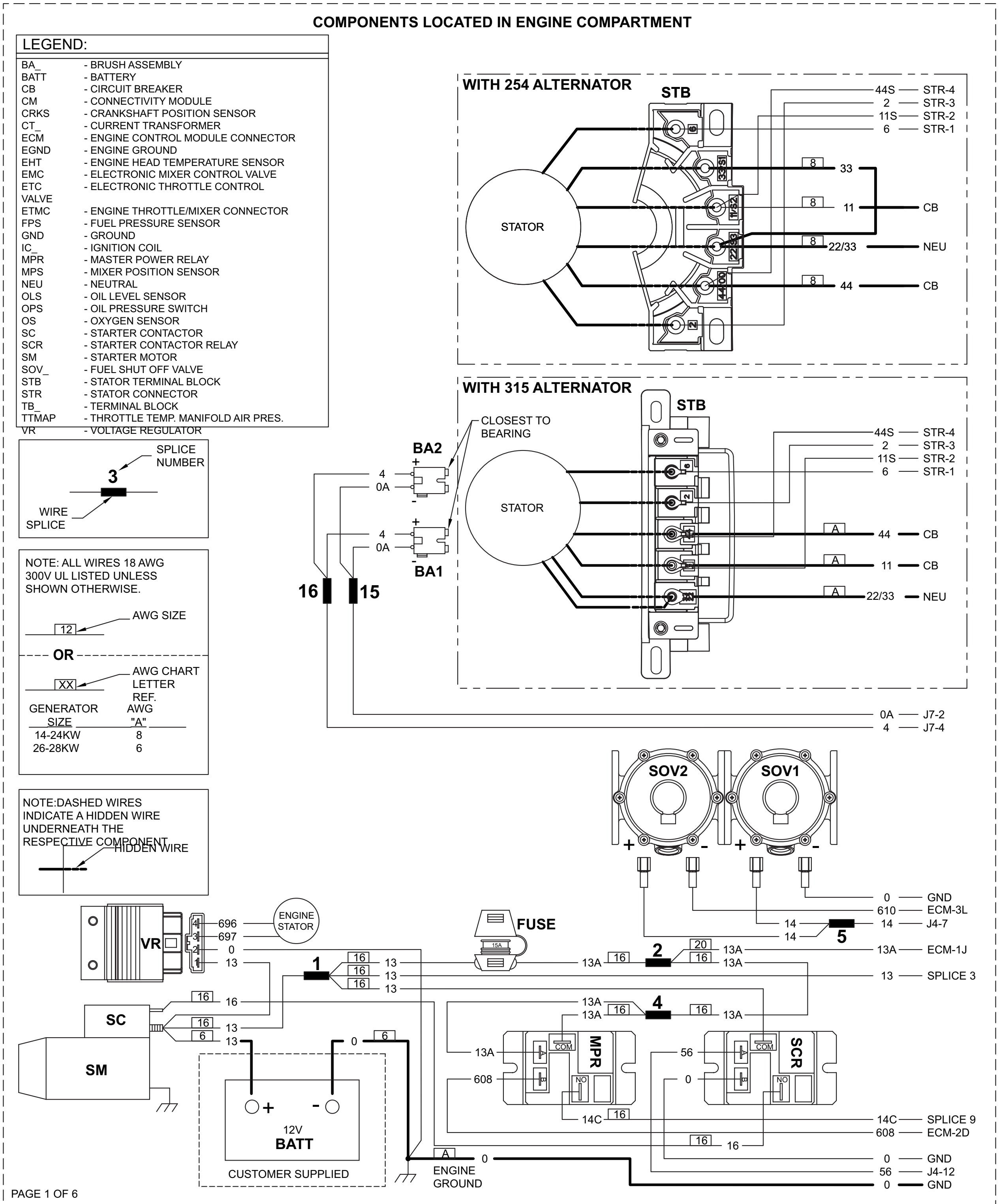


WIRING - DIAGRAM

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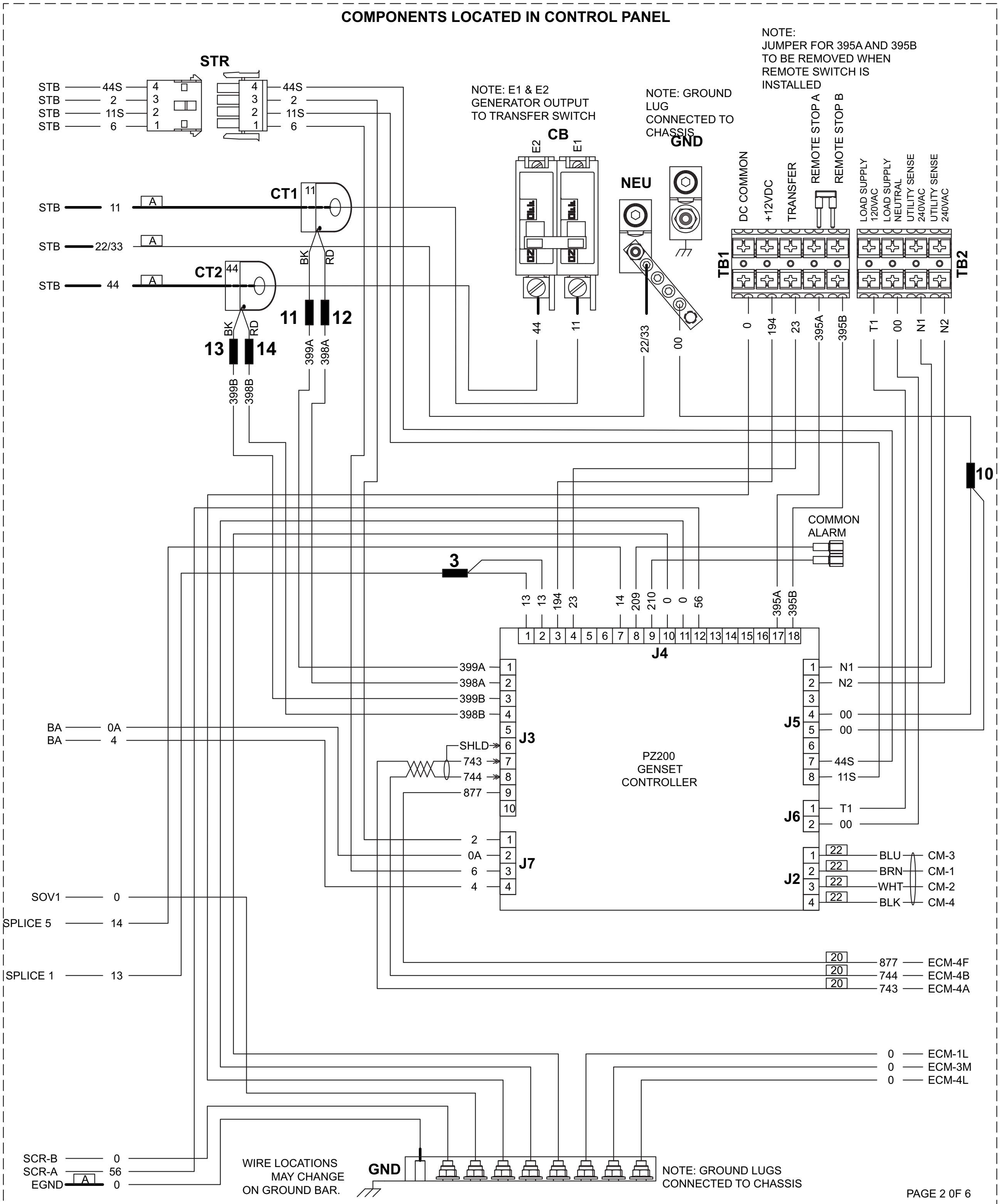
DRAWING #: A0005639538

## A0005639538-B WD/SD HSB PZ200 SSI 60HZ 817/997 (page 2 of 6)

GROUP WD

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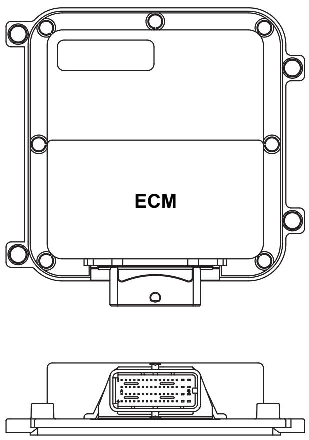
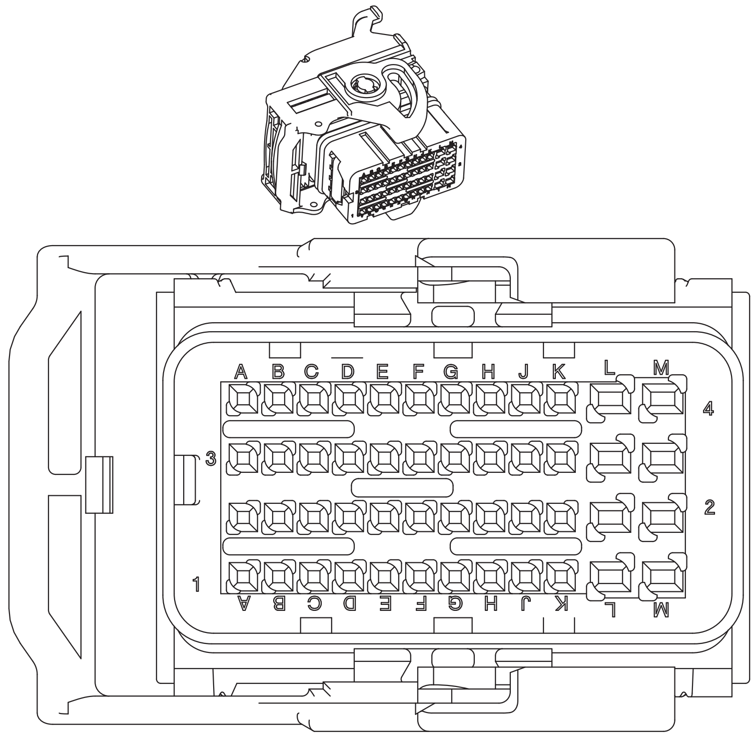
## A0005639538-B WD/SD HSB PZ200 SSI 60HZ 817/997 (page 3 of 6)

GROUP WD

**COMPONENTS LOCATED IN CONTROL PANEL**

**ENGINE CONTROL MODULE**




CONNECTOR END VIEW

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 1A | 605A | ETMC-13 |
| 1B | 605B | ETMC-14 |
| 1C | 79A | CRKS-A |
| 1D | 79B | CRKS-B |
| 1E | 770A | ETMC-9 |
| 1F | 771A | ETMC-11 |
| 1G | 770B | ETMC-10 |
| 1H | 771B | ETMC-12 |
| 1J | 13A | SPLICE 2 |
| 1K | 14C | SPLICE 6 |
| 1L | 0 | GND |
| 1M | 452 | IC2-C |

PIN LIST

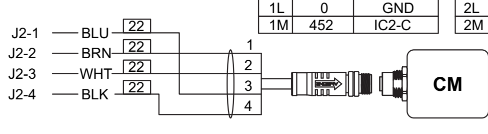
| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 2A | 605C | ETMC-15 |
| 2B | 606 | ETMC-7 |
| 2C | 766A | ETMC-6 |
| 2D | 608 | MPR-B |
| 2E | - | - |
| 2F | 607 | OS-B |
| 2G | 754 | ETMC-3 |
| 2H | - | - |
| 2J | 899 | OLS-C |
| 2K | 714 | EHT-1 |
| 2L | - | - |
| 2M | - | - |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 3A | 605D | ETMC-16 |
| 3B | 766B | ETMC-4 |
| 3C | 797 | ETMC-1 |
| 3D | - | - |
| 3E | - | - |
| 3F | - | - |
| 3G | - | - |
| 3H | - | - |
| 3J | - | - |
| 3K | 820A | SPLICE 7 |
| 3L | 610 | SOV2 |
| 3M | 0 | GND |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 4A | 743 | J3-7 |
| 4B | 744 | J3-8 |
| 4C | 566 | OPS |
| 4D | - | - |
| 4E | - | - |
| 4F | 877 | J3-9 |
| 4G | - | - |
| 4H | - | - |
| 4J | 804 | OS-C |
| 4K | 820G | SPLICE 8 |
| 4L | 0 | GND |
| 4M | 451 | IC1-C |

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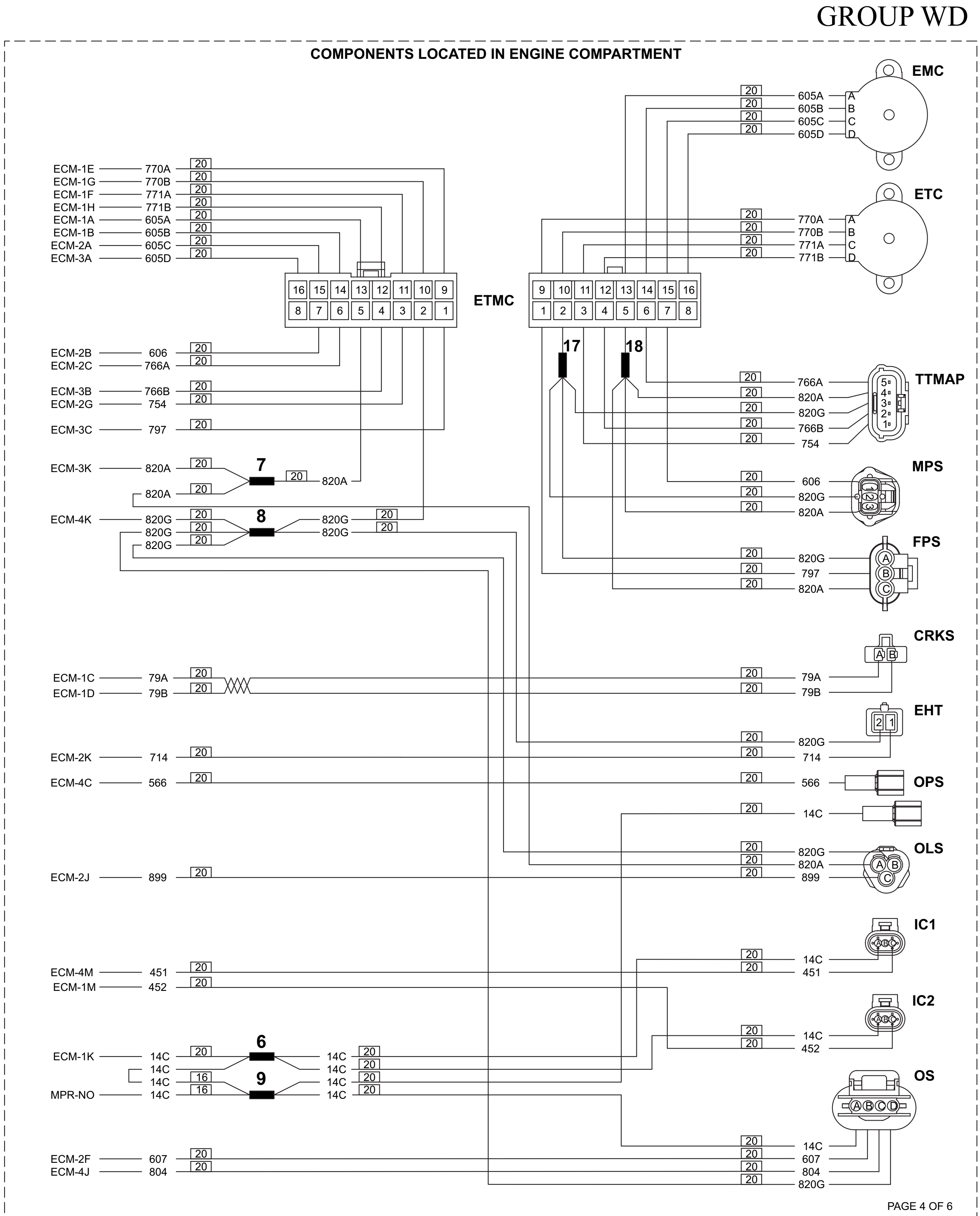


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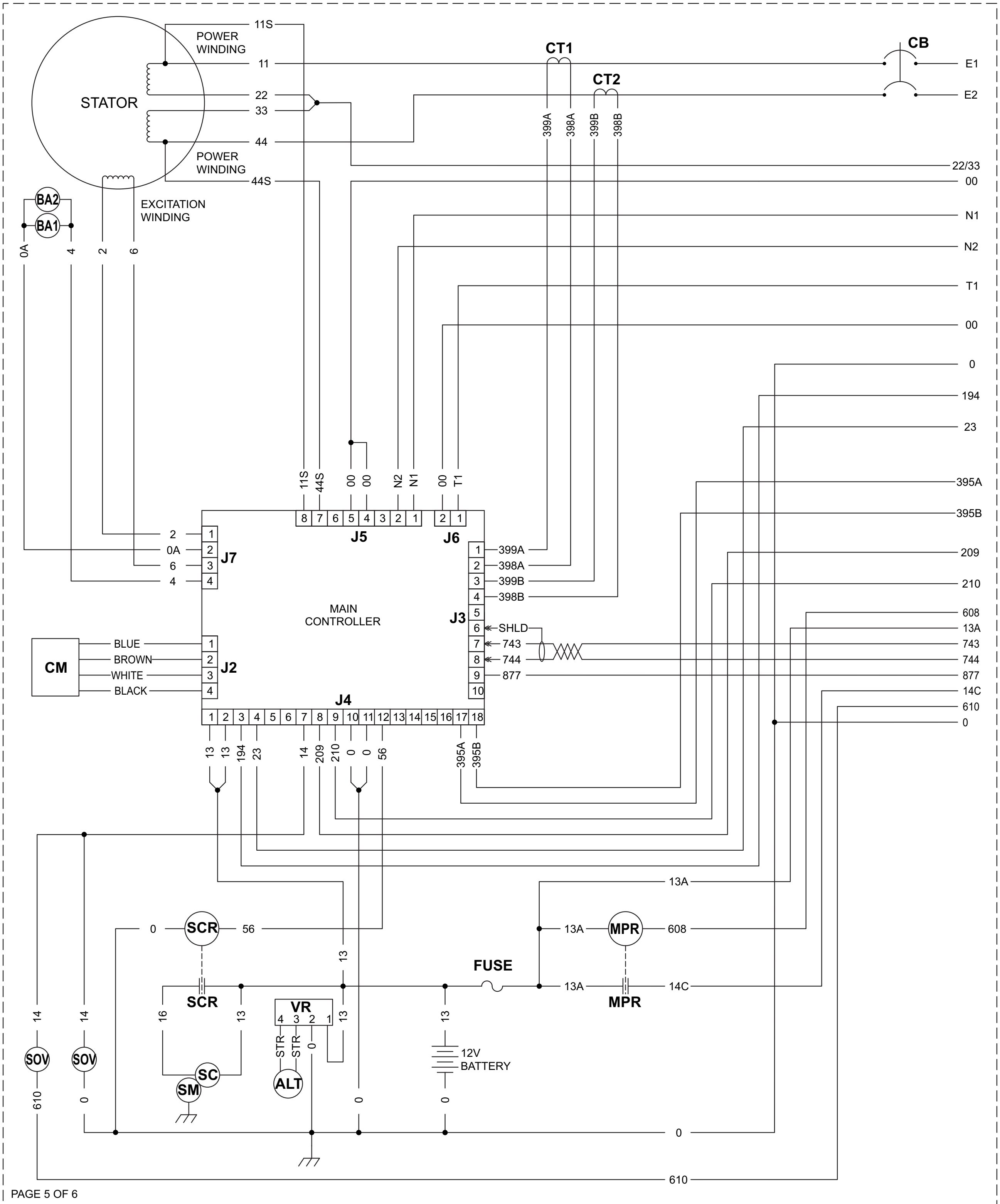


SCHEMATIC - DIAGRAM

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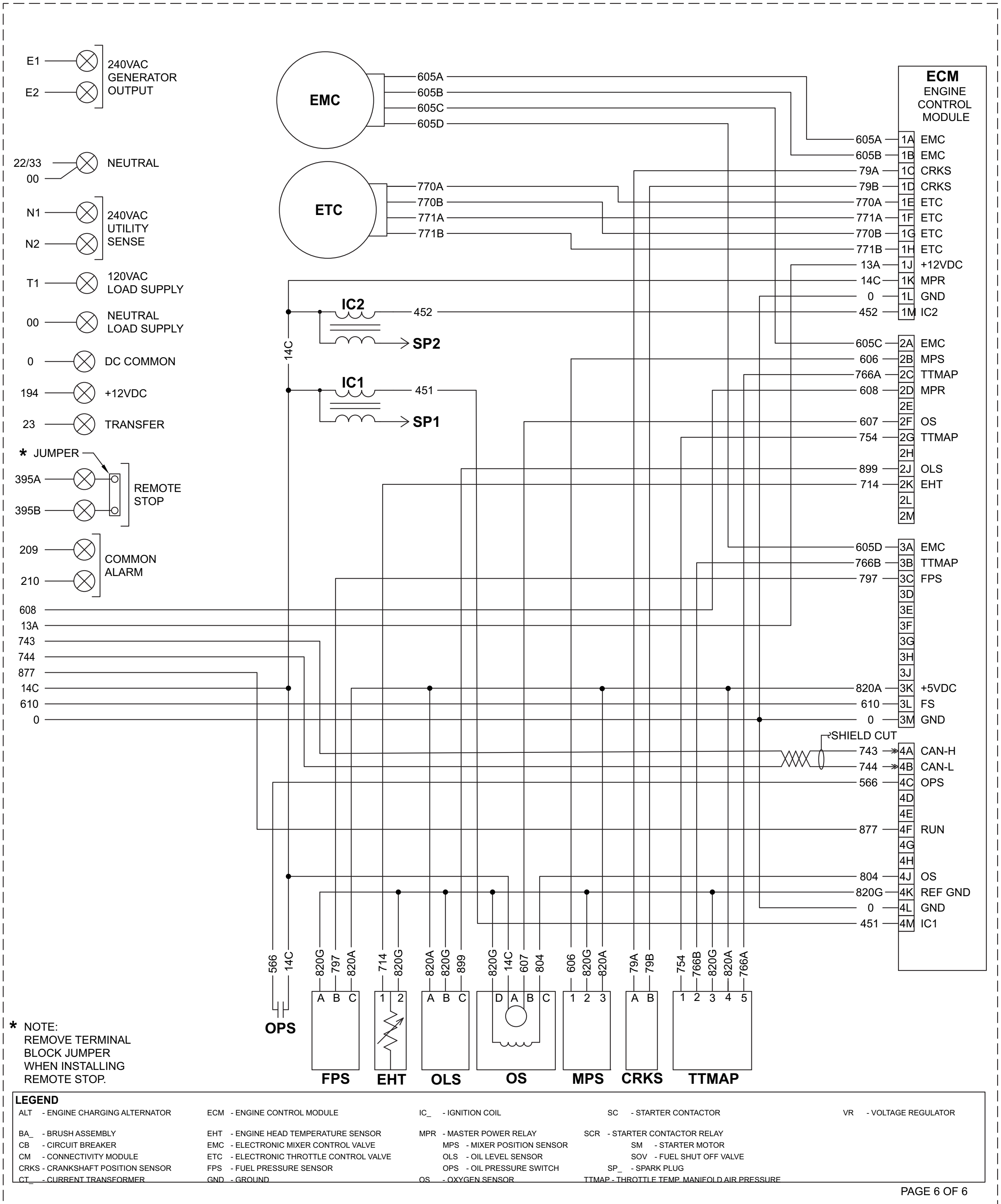


SCHEMATIC - DIAGRAM

REVISION: CN-0100171-B

PZ200 SSI 60HZ 817/997

DATE: 05/02/2025

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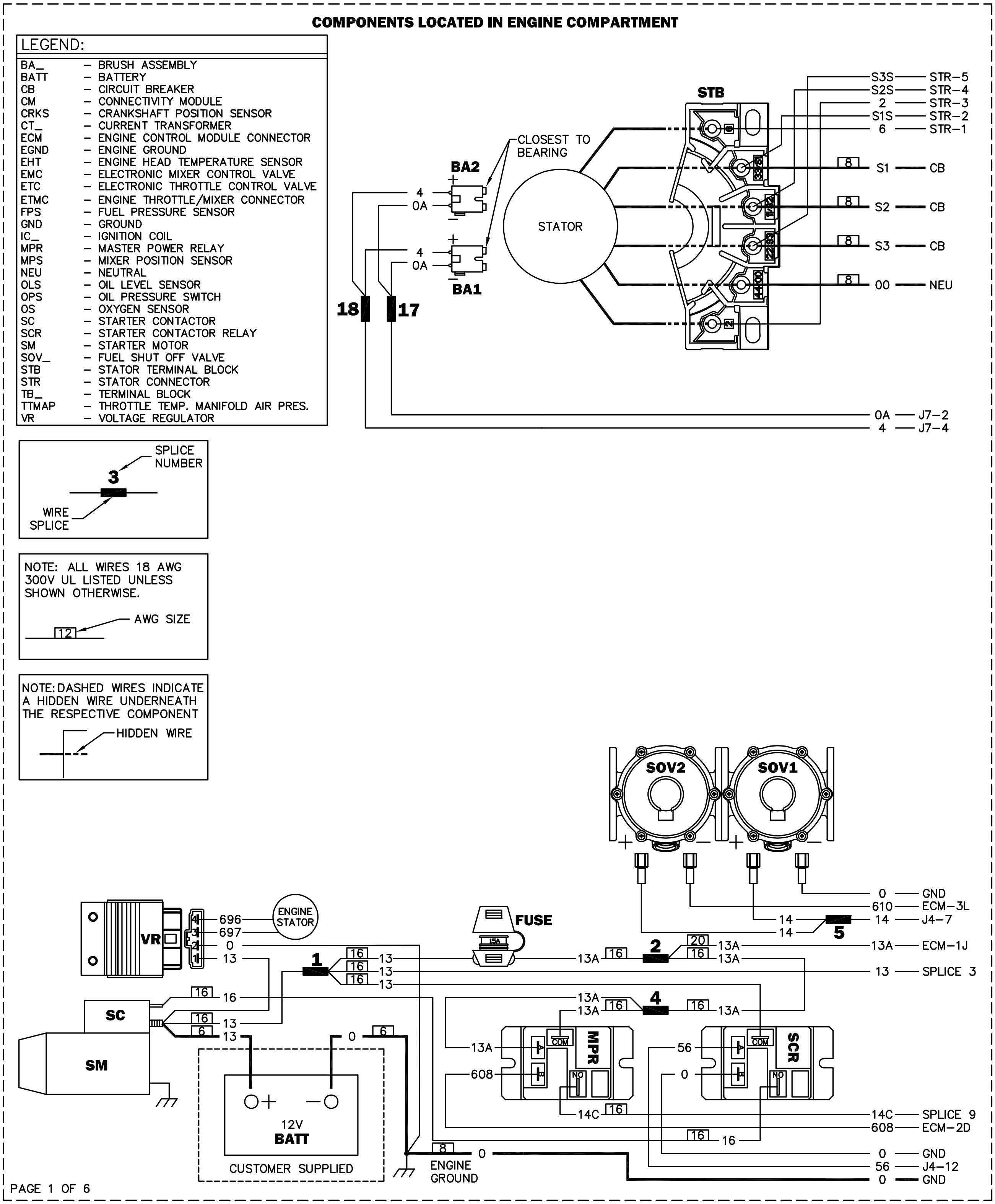
DRAWING #: A0005639538

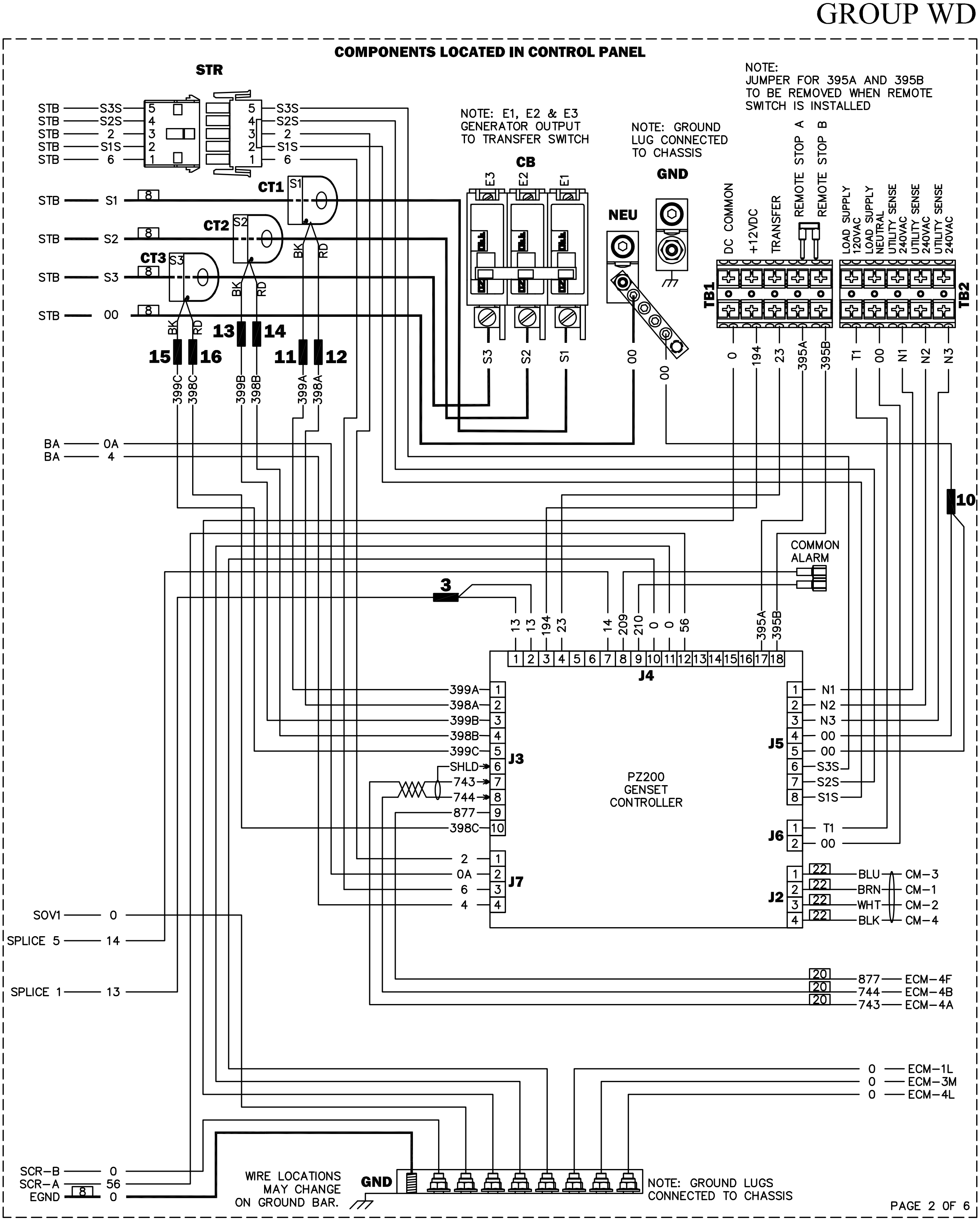
## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 1 of 6)

GROUP WD




WIRING - DIAGRAM
REVISION: CN-0100171-B
PZ200 SSI 60HZ 3PH 817/997
DATE: 05/02/2025
PAGE 1 OF 6
DRAWING #: A0005639541

## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 2 of 6)




WIRING - DIAGRAM

REVISION: CN-0100171-B

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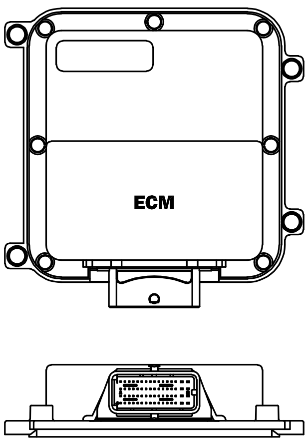
DRAWING #: A0005639541

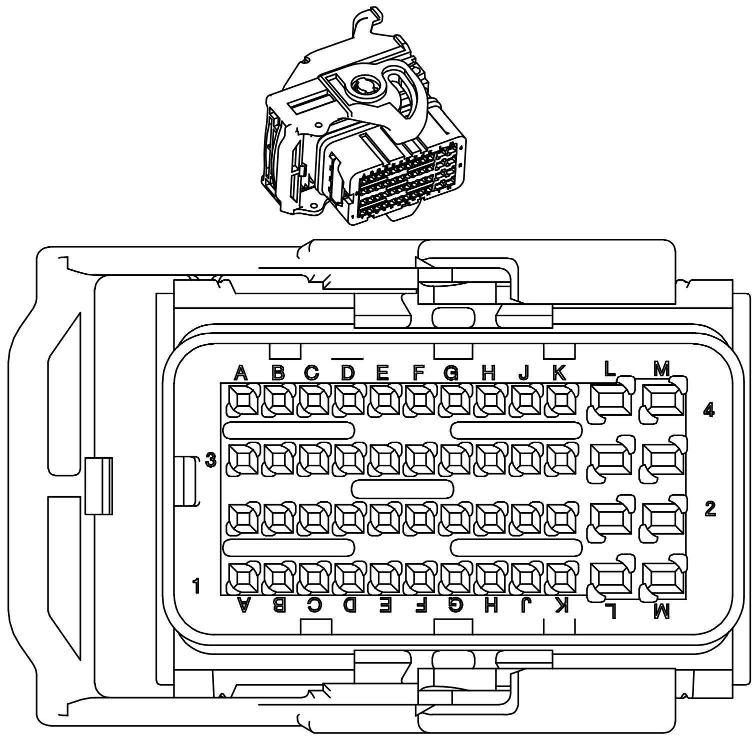
## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 3 of 6)

GROUP WD

COMPONENTS LOCATED IN CONTROL PANEL

ENGINE CONTROL MODULE




CONNECTOR END VIEW

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 1A | 605A | ETMC–13 |
| 1B | 605B | ETMC–14 |
| 1C | 79A | CRKS–A |
| 1D | 79B | CRKS–B |
| 1E | 770A | ETMC–9 |
| 1F | 771A | ETMC–11 |
| 1G | 770B | ETMC–10 |
| 1H | 771B | ETMC–12 |
| 1J | 13A | SPLICE 2 |
| 1K | 14C | SPLICE 6 |
| 1L | 0 | GND |
| 1M | 452 | IC2–C |

PIN LIST

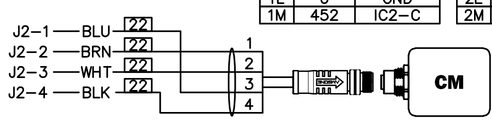
| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 2A | 605C | ETMC–15 |
| 2B | 606 | ETMC–7 |
| 2C | 766A | ETMC–6 |
| 2D | 608 | MPR–B |
| 2E | – | – |
| 2F | 607 | OS–B |
| 2G | 754 | ETMC–3 |
| 2H | – | – |
| 2J | 899 | OLS–C |
| 2K | 714 | EHT–1 |
| 2L | – | – |
| 2M | – | – |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 3A | 605D | ETMC–16 |
| 3B | 766B | ETMC–4 |
| 3C | 797 | ETMC–1 |
| 3D | – | – |
| 3E | – | – |
| 3F | – | – |
| 3G | – | – |
| 3H | – | – |
| 3J | – | – |
| 3K | 820A | SPLICE 7 |
| 3L | 610 | SOV2 |
| 3M | 0 | GND |

PIN LIST

| ECM | | |
|---|---|---|
| PIN | WIRE | TO |
| 4A | 743 | J3–7 |
| 4B | 744 | J3–8 |
| 4C | 566 | OPS |
| 4D | – | – |
| 4E | – | – |
| 4F | 877 | J3–9 |
| 4G | – | – |
| 4H | – | – |
| 4J | 804 | OS–C |
| 4K | 820G | SPLICE 8 |
| 4L | 0 | GND |
| 4M | 451 | IC1–C |

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WIRING - DIAGRAM

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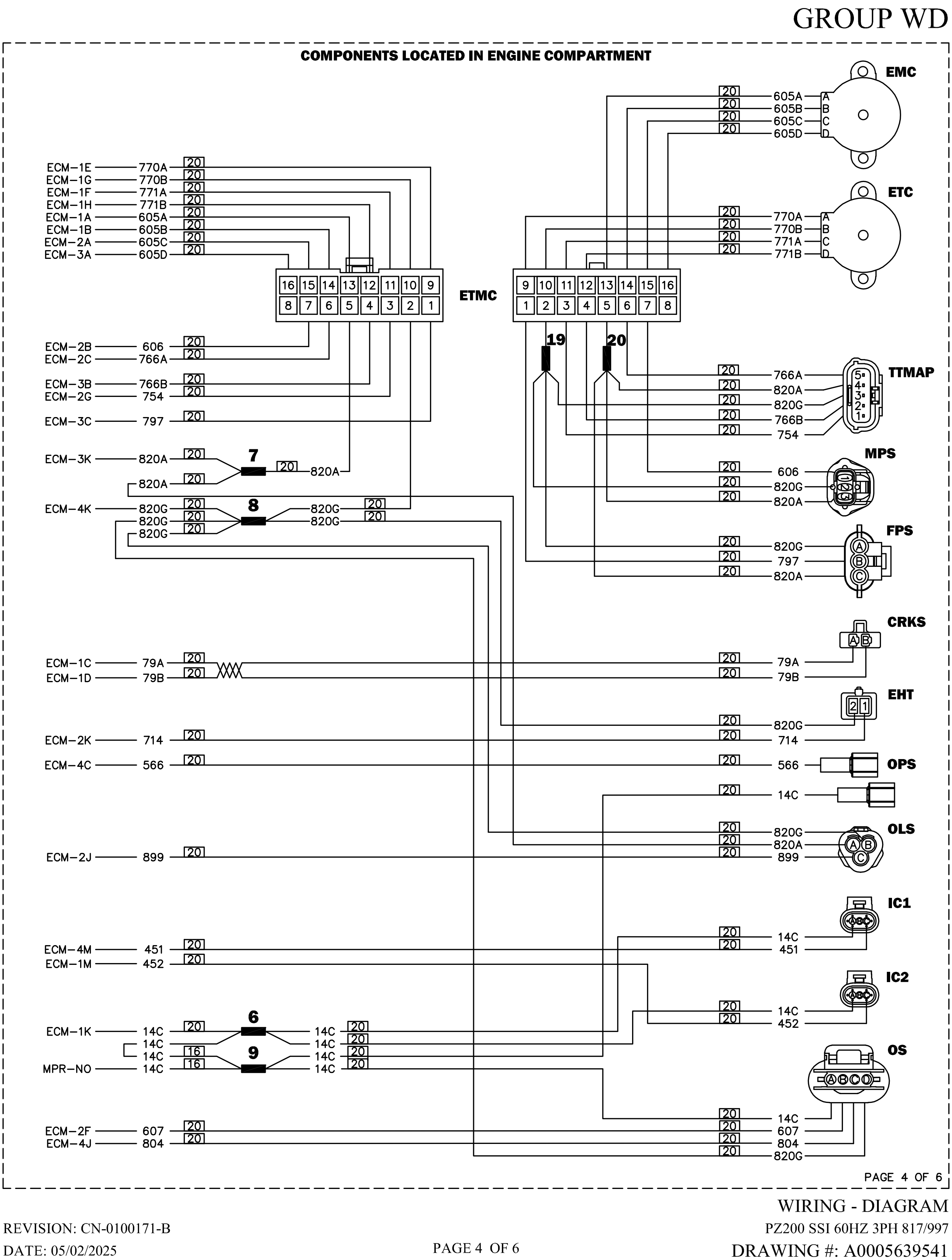
PAGE 3 OF 6

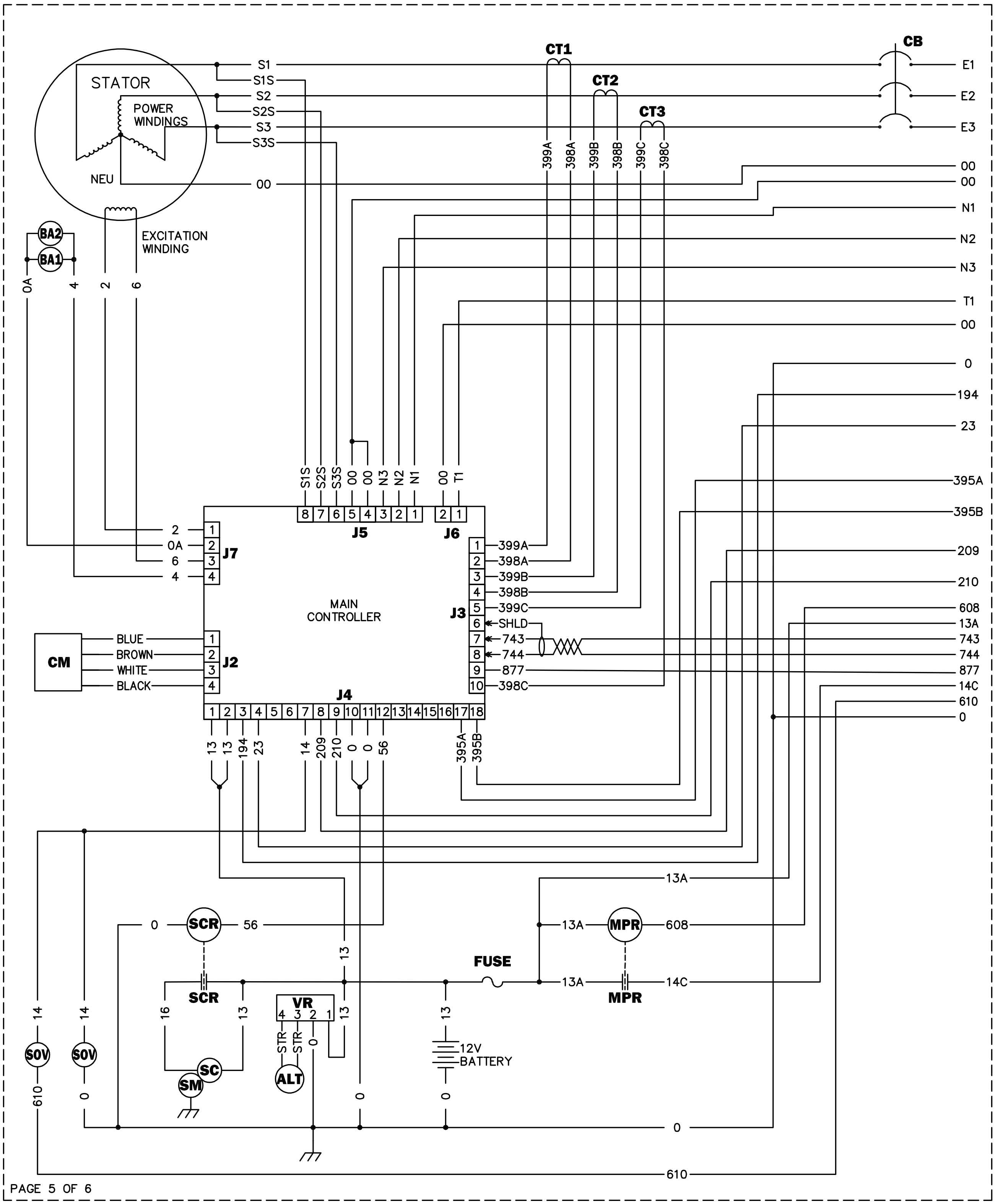
DRAWING #: A0005639541

## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 4 of 6)



## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 5 of 6)

GROUP SD




SCHEMATIC - DIAGRAM

REVISION: CN-0100171-B

PZ200 SSI 60HZ 3PH 817/997

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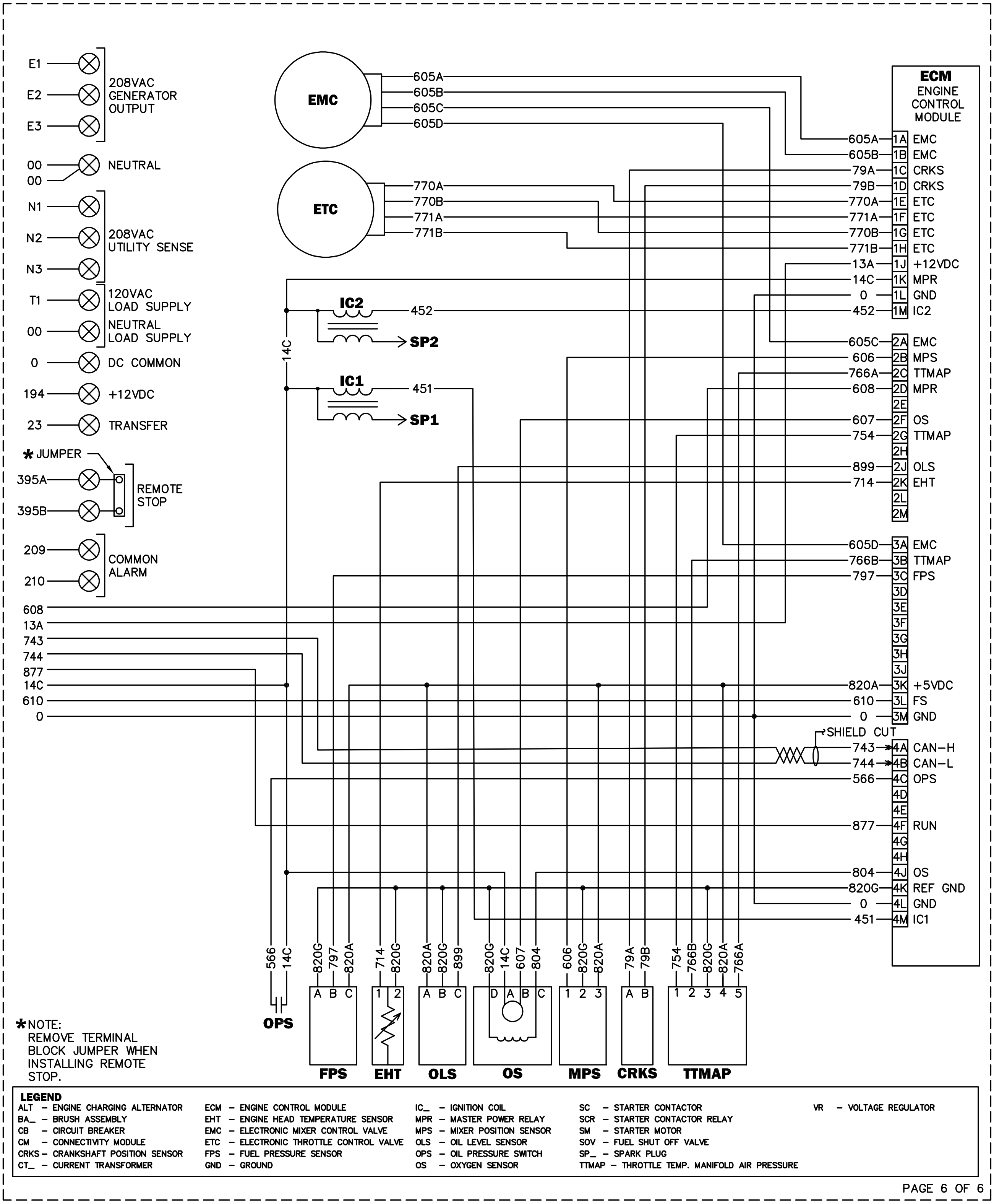
PAGE 5 OF 6

DRAWING #: A0005639541

## A0005639541-B WD/SD HSB PZ200 SSI 60Hz 3P 817/997 (page 6 of 6)

GROUP SD




SCHEMATIC - DIAGRAM

PZ200 SSI 60HZ 3PH 817/997

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DRAWING #: A0005639541

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# Major Disassembly

## 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.

(000191)

## 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

## Preparation for Disassembly

1. Turn off fuel supply to generator.
2. Remove utility power source from the generator.
3. Unlock the roof.
4. Lift the roof.
5. Set the generator controller to OFF.

## Disassembly

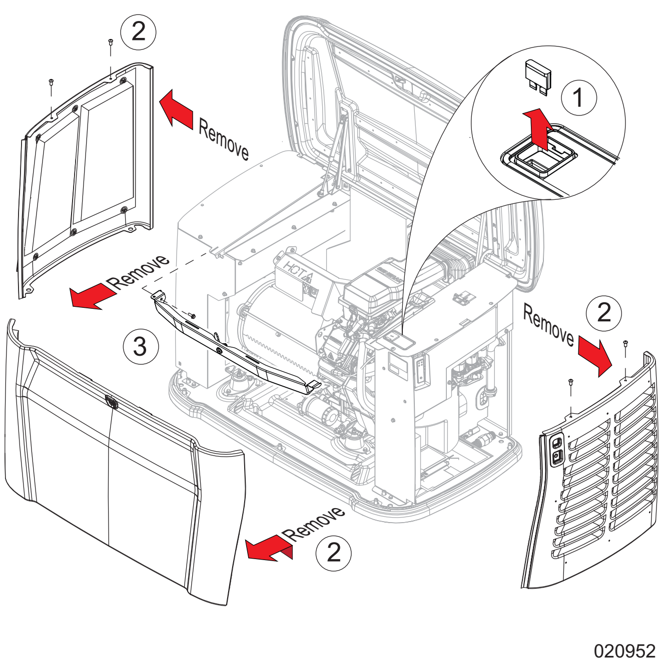



*Figure 10-1.*

1. Remove the 7.5 fuse from the controller.
2. Remove the front panel and side panels.
    a. Lift and remove front panel.
    b. Remove two screws from each side panel and lift panels.
3. Disconnect negative battery terminal.
4. Use a 10 mm socket to remove two (2) bolts from the center support.

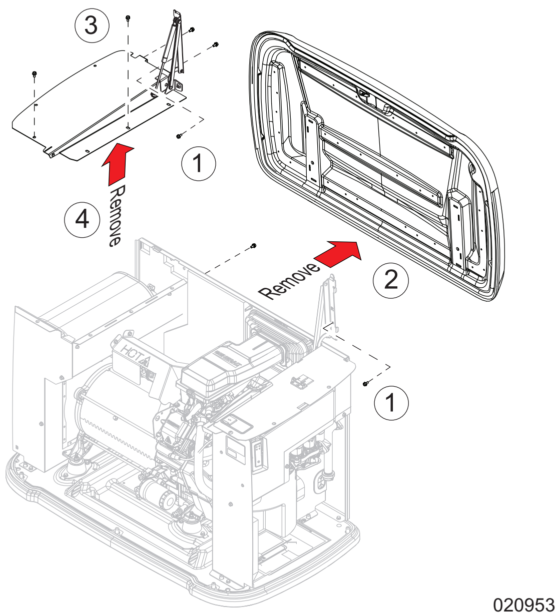



*Figure 10-2.*

1. Remove one bolt from each bracket on the underside of the roof.
2. Remove roof from brackets by sliding up and lifting away.

**⚠WARNING**

Personal injury. Excessive weight. Two person lift. Use only appropriate techniques when lifting equipment. Improper lifting techniques could result in equipment damage, death or serious injury.(000805)

3. Remove 4 screws from top exhaust cover.
4. Remove top exhaust cover.

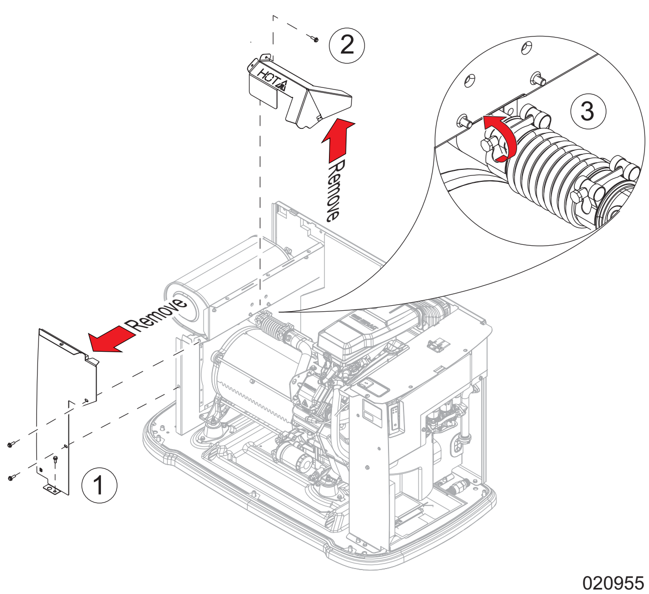



*Figure 10-3.*

1. Remove bolt from bottom of front exhaust cover and two screws from the front of the cover.
2. Use a 10 mm socket to remove two bolts from the exhaust flex pipe cover. Remove the exhaust flex pipe cover.
3. Loosen the bolt on the rear exhaust flex pipe clamp.

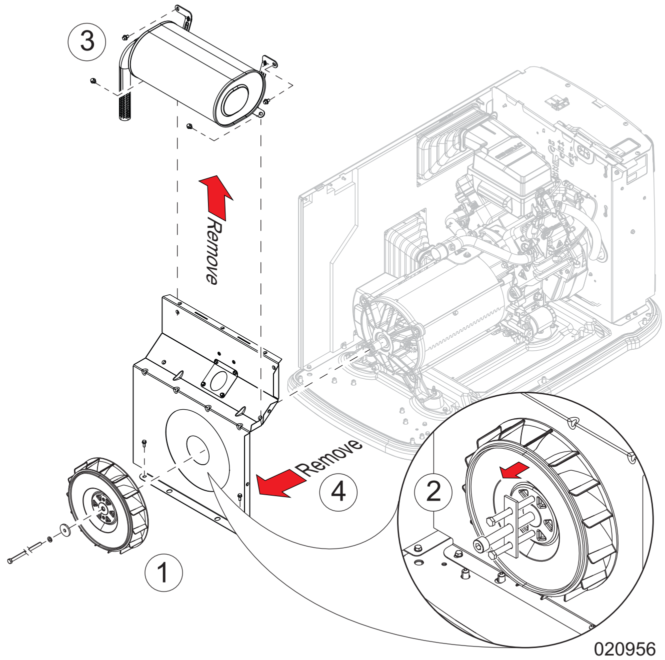



*Figure 10-4.*

1. Use a 9/16” socket to remove rotor bolt.
2. Thread a 3 inch M12 x 1.75 bolt into rotor end, leaving about 1/2” of thread exposed in preparation for next Step.
   a. 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.

   b. Tighten the central puller shaft with a wrench to loosen the fan from the rotor shaft.
   c. Remove the fan from the rotor.

**NOTE:** Use a wrench to prevent the fan from rotating while using the vibration dampener puller.

3. Remove bolts and muffler from rear exhaust divider panel.
4. Remove rear exhaust divider panel.

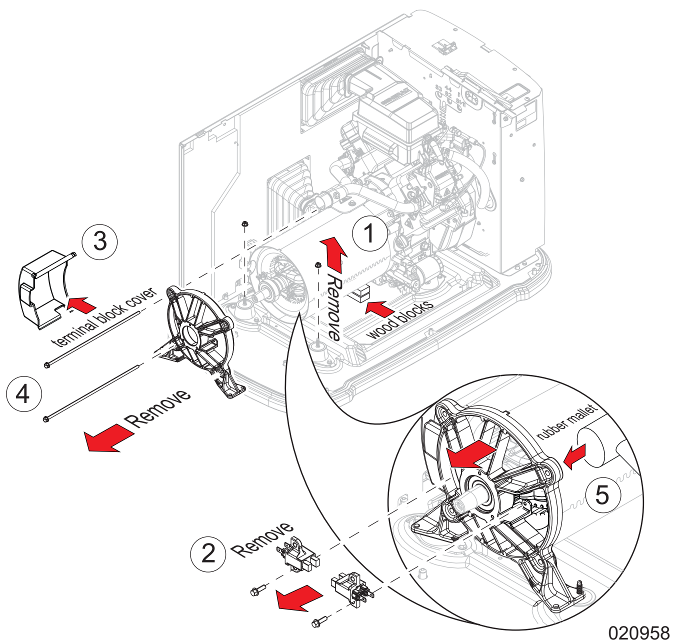



*Figure 10-5.*

1. 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.
2. Disconnect wires from both brush assemblies and remove brush assemblies.
3. Remove the stator terminal block (STB) cover
   a. Cut the cable ties holding the stator terminal block (STB) cover.
4. Use a 13 mm socket to remove the four (4) stator bolts.
5. 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.

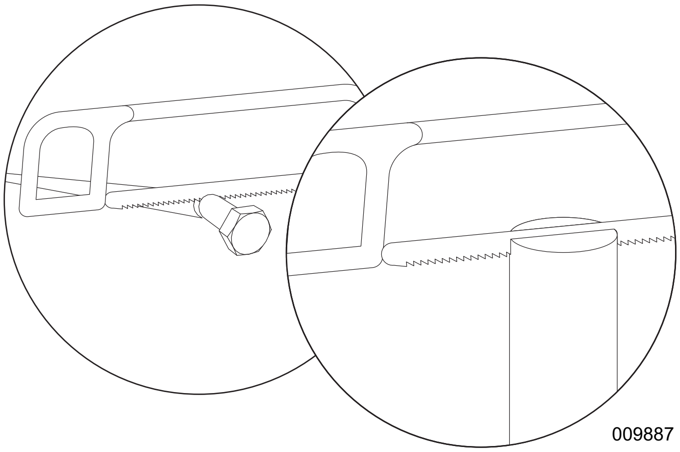



***Figure 10-6.***

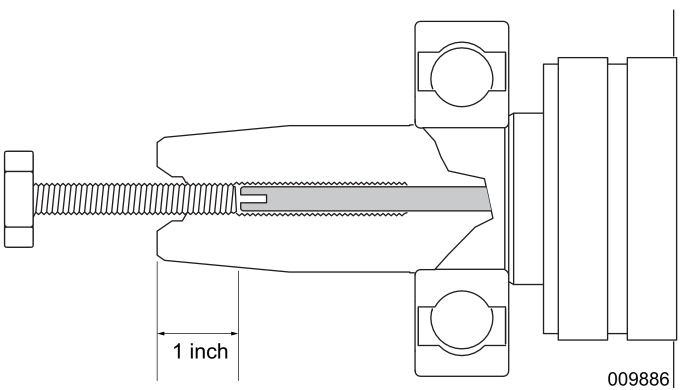



***Figure 10-7.***

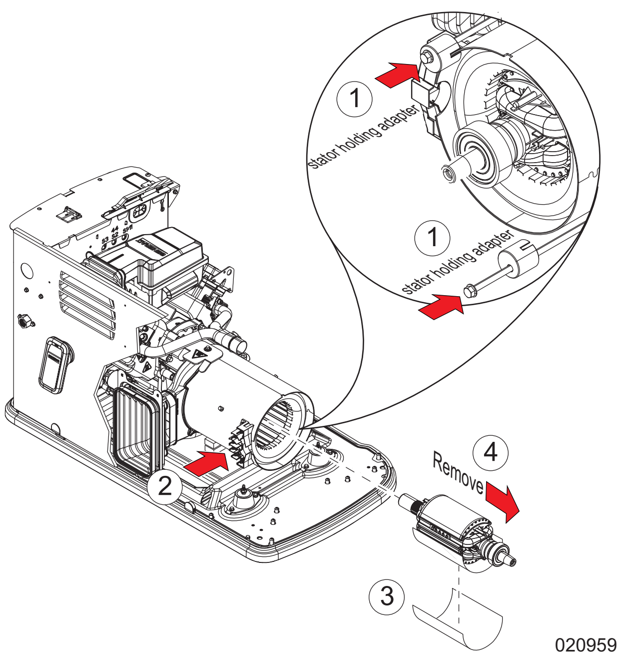



***Figure 10-8.***

## Modify Existing Rotor Bolt for Rotor Removal

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.
3. Using a flat blade screwdriver, thread the cut rotor bolt into the crankshaft, allowing about an inch of threads exposed for the following steps.
4. Screw a 3" M12 x 1.75 bolt into rotor end.
5. Apply torque to the 3" M12 x 1.75 bolt until rotor breaks free from the tapered engine crankshaft.

1. Insert two previously removed stator bolts into the two stator holding adapters (P/N 0K8824).
2. Remove stator wires from stator terminal block (STB).
3. Insert the rotor protector sheet (A) (PN 0K8210) between the rotor and stator assembly.
4. Carefully slide rotor (on protective sheet) out of the stator can. Place the rotor in a safe area to prevent any damage.
5. Remove the modified rotor bolt from the crankshaft.

**⚠WARNING**

Personal injury. Excessive weight. Lift using appropriate lifting eyes and use appropriate lifting equipment to lift unit. Incorrect lifting techniques could result in death, serious injury, or equipment damage. (000224a)

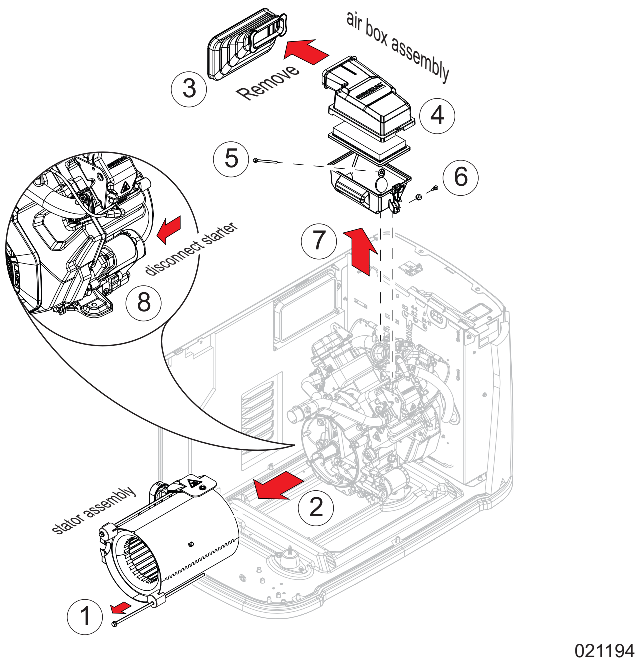



*Figure 10-9.*

1. Remove two stator bolts and stator holding adapters.
2. Remove stator.

**⚠WARNING**

Personal injury. Excessive weight. Lift using appropriate lifting eyes and use appropriate lifting equipment to lift unit. Incorrect lifting techniques could result in death, serious injury, or equipment damage. (000224a)

3. Remove air box cover boot.
4. Remove air box cover.
5. Remove air filter.
6. Remove
7. Remove
8. Disconnect starter wires.

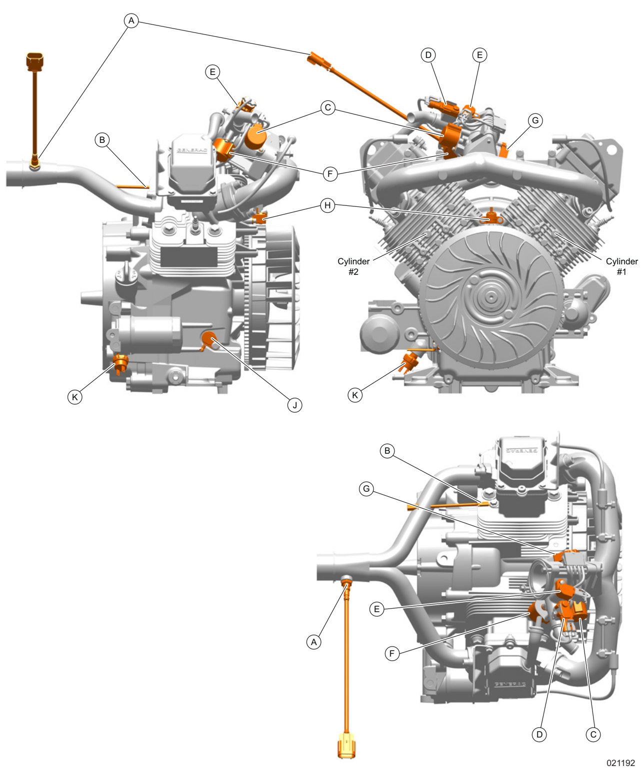



*Figure 10-10.*

See ***Figure 7-13***, ***Figure 7-14***, or ***Figure 7-15*** in Section 7 ***Engine Control Module***. Disconnect harness connectors from all engine mounted controls and sensors.

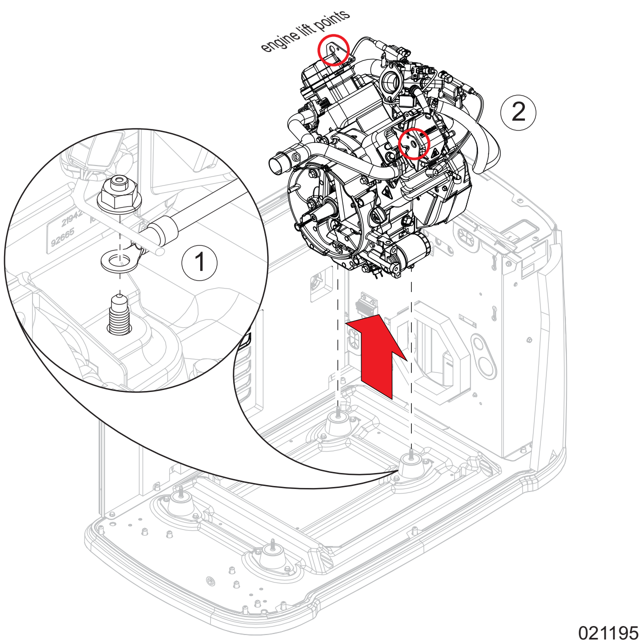



*Figure 10-11.*

1. Remove nuts from two engine mounts and disconnect engine ground wire.
2. Use appropriate equipment to lift engine from base.

**WARNING**

Personal injury. Excessive weight. Lift using appropriate lifting eyes and use appropriate lifting equipment to lift unit. Incorrect lifting techniques could result in death, serious injury, or equipment damage. (000224a)

## Assembly

1. Follow disassembly steps in reverse.

## Power Zone 200 Controller

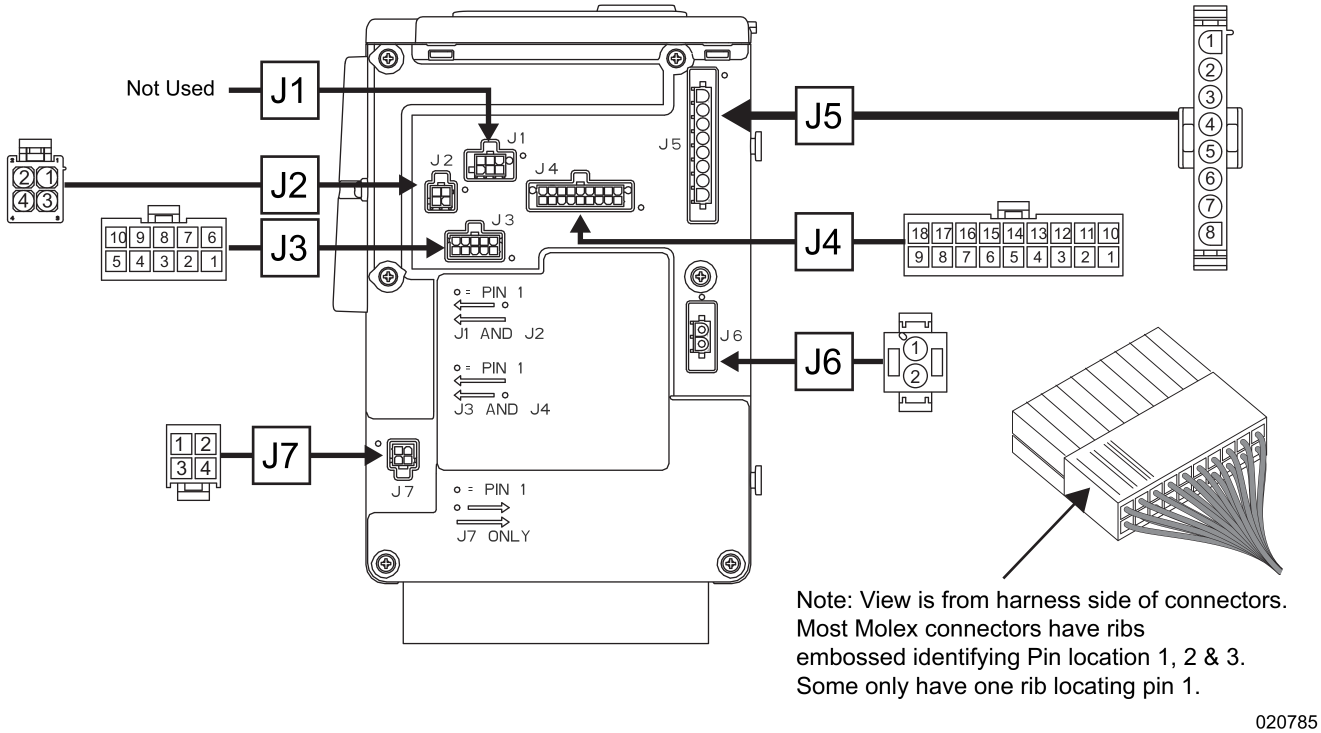



***Figure 11-1. Air-cooled Panel and Connectors (Harness End)***

| J2 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J2-1 | Blue | G3 Radio |
| J2-2 | Brown | G3 Radio |
| J2-3 | White | G3 Radio |
| J2-4 | Black | G3 Radio |

| J3 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J3-1 | 399A | Generator Current Sense |
| J3-2 | 398A | Generator Current Sense |
| J3-3 | 399B | Generator Current Sense |
| J3-4 | 398B | Generator Current Sense |
| J3-5 | 399C | Generator Current Sense (3-phase only) |
| J3-6 | SHLD | Shielding Wire for CAN bus Wiring |
| J3-7 | 743 | CAN bus |
| J3-8 | 744 | CAN bus |
| J3-9 | 877 | ECM Wake-Up |
| J3-10 | 398C | Generator Current Sense (3-phase only) |

| J4 Connector | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J4-1 | 13 | 12 VDC Unfused for the Controller |
| J4-2 | 13 | 12 VDC Unfused for the Controller |
| J4-3 | 194 | 12 VDC for the Transfer Relay |
| J4-4 | 23 | Switched to Ground (Internally) to Energize the Transfer Relay |
| J4-5 | — | Not Used |
| J4-6 | — | Not Used |
| J4-7 | 14 | 12 VDC for Fuel Shut Off Valves 1 & 2 (powered when Running) |
| J4-8 | 209 | Common Alarm Relay Input |
| J4-9 | 210 | Common Alarm Relay Output |
| J4-10 | 0 | Common Ground (DC) |
| J4-11 | 0 | Common Ground (DC) |
| J4-12 | 56 | 12 VDC Output to Starter Control Relay |
| J4-13 | — | Not Used |
| J4-14 | — | Not Used |
| J4-15 | — | Not Used |
| J4-16 | — | Not Used |
| J4-17 | 395A | Remote Stop A |
| J4-18 | 395B | Remote Stop B |

# Power Zone 200 Controller (continued)

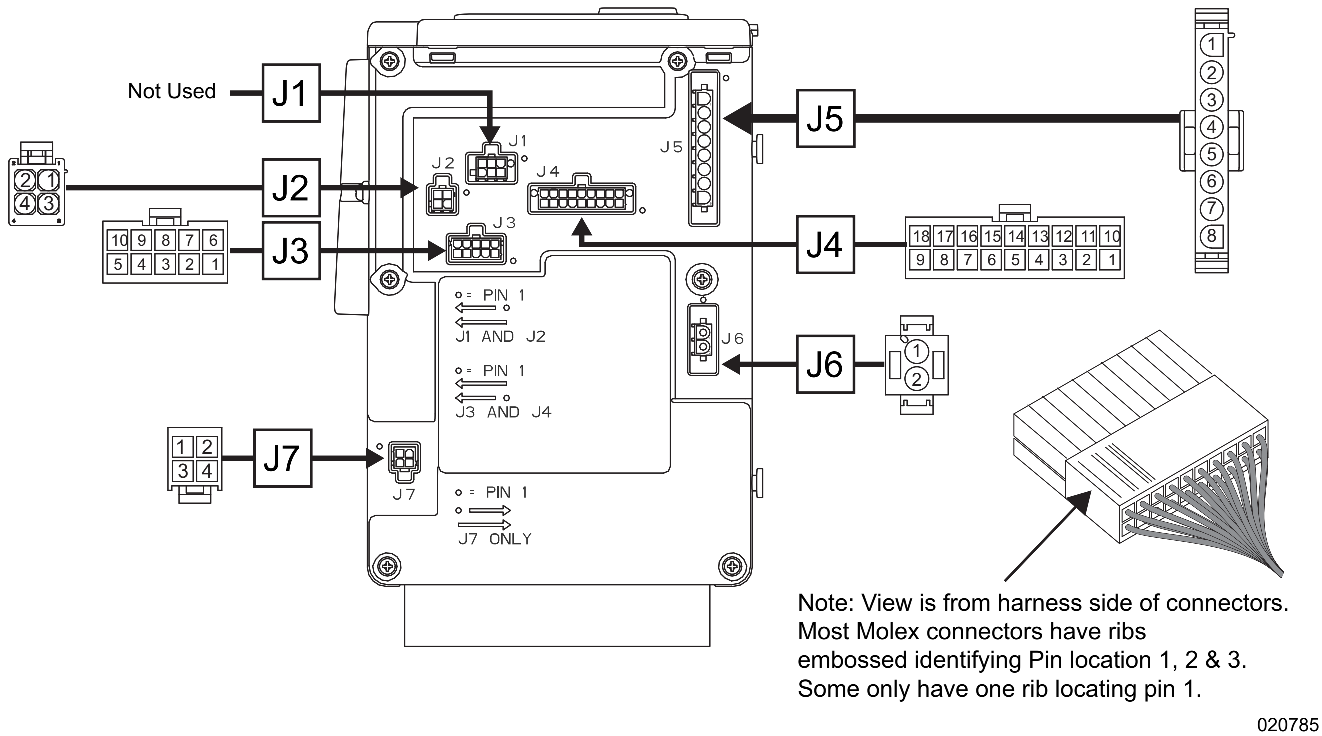



*Figure 11-2. Air-cooled Panel and Connectors (Harness End)*

| **J5 Connector** | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J5-1 | N1 | 240 VAC Utility Sensing Voltage |
| J5-2 | N2 | 240 VAC Utility Sensing Voltage |
| J5-3 | — | Not Used |
| J5-4 | 00 | Neutral Connection for Controller |
| J5-5 | 00 | Neutral Connection for Controller |
| J5-6 | — | — |
| J5-7 | 44S | 240 VAC Generator Voltage Sensing |
| J5-8 | 11S | 240 VAC Generator Voltage Sensing |

| **J6 Connector** | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J6-1 | T1 | 120 VAC Power for Internal Battery Charger |
| J6-2 | 00 | Neutral Connection for Internal Battery Charger |

| **J7 Connector** | | |
|---|---|---|
| **Pin** | **Wire** | **Circuit Function** |
| J7-1 | 2 | DPE Winding (AC Excitation Power) |
| J7-2 | 0A | Field Return (-) (DC Field Excitation) |
| J7-3 | 6 | DPE Winding (AC Excitation Power) |
| J7-4 | 4 | Field Flash/DC Excitation (+) |

# Engine Control Module

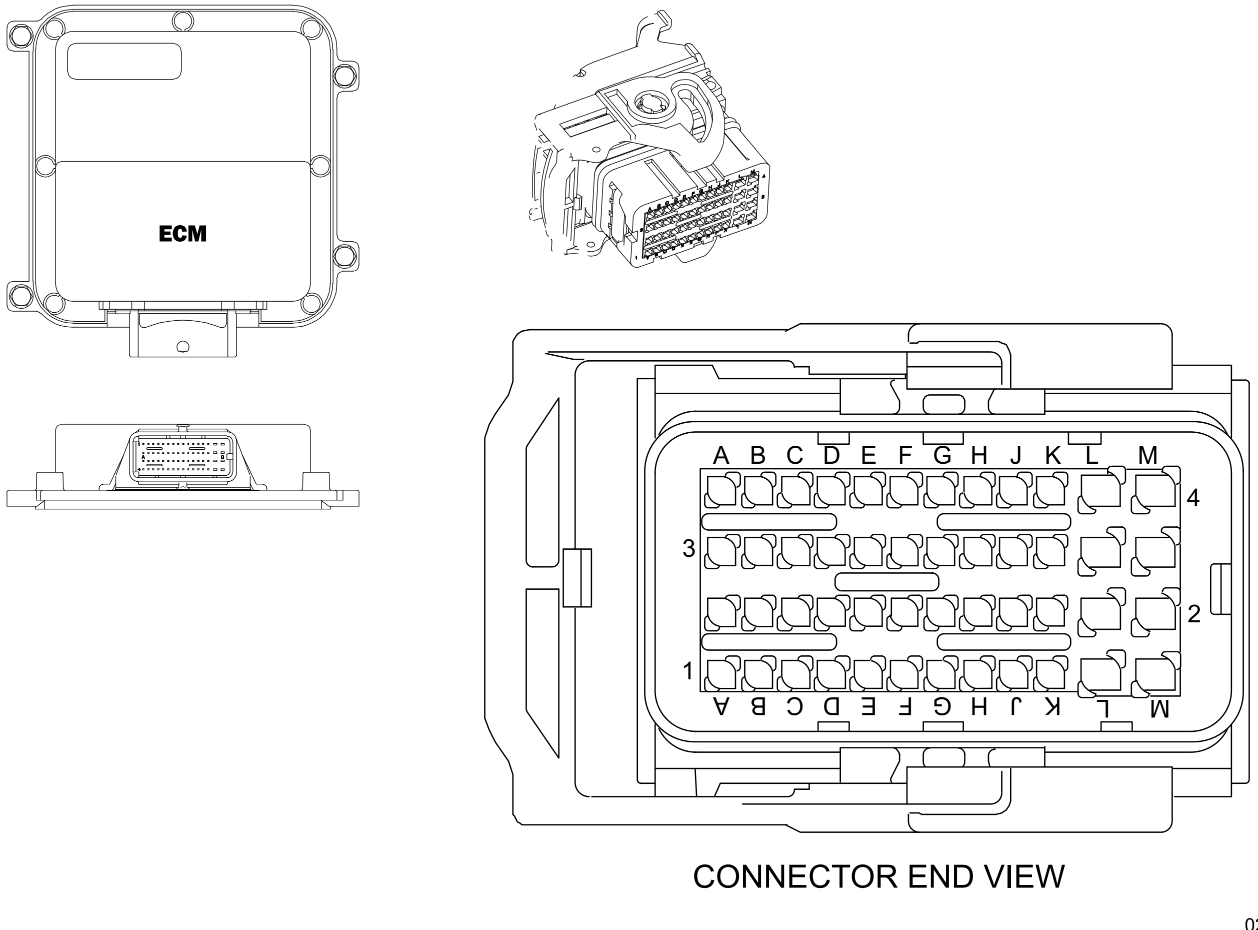



***Figure 11-3. Generac Engine Control Module (ECM) and Harness Connector***

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 1A | 605A | ETMC-13 |
| 1B | 605B | ETMC-14 |
| 1C | 79A | CRKS-A |
| 1D | 79B | CRKS-B |
| 1E | 770A | ETMC-9 |
| 1F | 771A | ETMC-11 |
| 1G | 770B | ETMC-10 |
| 1H | 771B | ETMC-12 |
| 1J | 13A | SPLICE 2 |
| 1K | 14C | SPLICE 6 |
| 1L | 0 | GND |
| 1M | 452 | IC2-C |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 2A | 605C | ETMC-15 |
| 2B | 606 | ETMC-7 |
| 2C | 766A | ETMC-6 |
| 2D | 608 | MPR-B |
| 2E | — | — |
| 2F | 607 | OS-B |
| 2G | 754 | ETMC-3 |
| 2H | — | — |
| 2J | 899 | OLS-C |
| 2K | 714 | EHT-1 |
| 2L | — | — |
| 2M | — | — |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 3A | 605D | ETMC-16 |
| 3B | 766B | ETMC-4 |
| 3C | 797 | ETMC-1 |
| 3D | — | — |
| 3E | — | — |
| 3F | — | — |
| 3G | — | — |
| 3H | — | — |
| 3J | — | — |
| 3K | 820A | SPLICE 7 |
| 3L | 610 | SOV2 |
| 3M | 0 | GND |

| Pin List | | |
|---|---|---|
| **Pin** | **Wire** | **To** |
| 4A | 743 | J3-7 |
| 4B | 744 | J3-8 |
| 4C | 566 | OPS |
| 4D | — | — |
| 4E | — | — |
| 4F | 877 | J3-9 |
| 4G | — | — |
| 4H | — | — |
| 4J | 804 | OS-C |
| 4K | 820G | SPLICE 8 |
| 4L | 0 | GND |
| 4M | 451 | IC1-C |

# ETMC Connector Harness

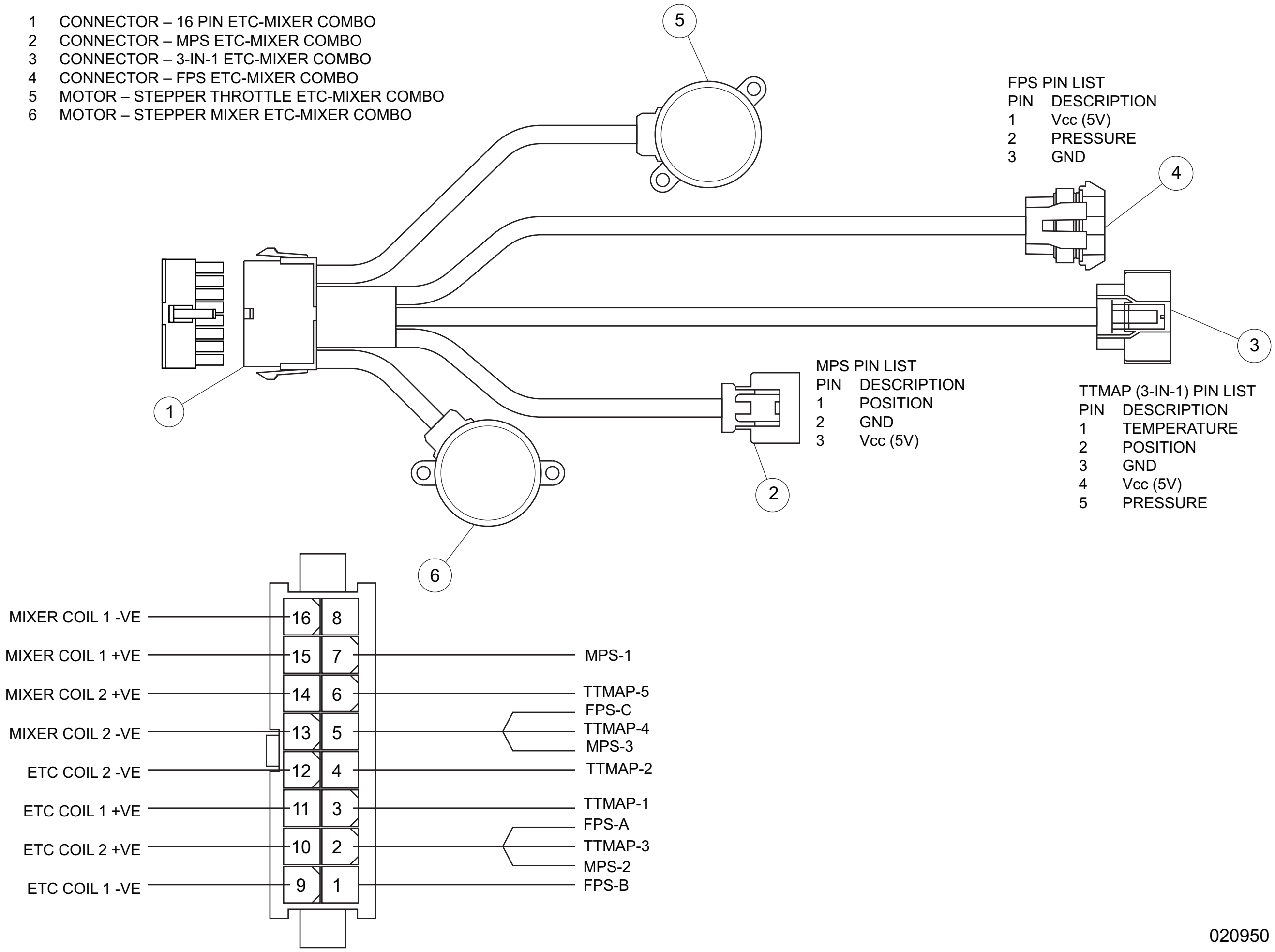


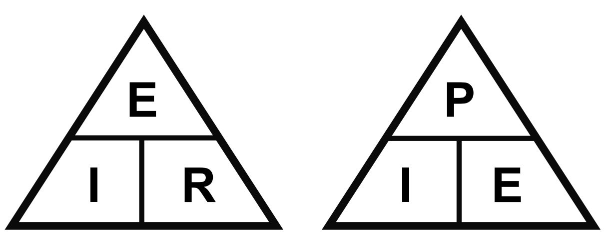

*Figure 11-4. ETMC Connector Harness*

# 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 | $\frac{\text{HP} \times 0.746}{\text{Efficiency}}$ | $\frac{\text{HP} \times 0.746}{\text{Efficiency}}$ |
| 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 |




003003

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

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