

Component Procedures: Charging System

Table of Contents

1. Parts and Labor (itype_189)
2. Charging System (Article 11915)
3. Charging System Test (Article 11921)
4. Charge Indicator Malfunction (Article 11015)

Component Procedures: Charging System

Parts and Labor (itype_189)

Labor

Operation	Qualifier Path	Skill	Std Hrs	Wty Hrs
Inspect	Alternator > Charging Circuit, Inspect	B	0.5	0.0
Remove & Replace	Alternator > Alternator, R&R	B	1.3	0.0
Remove & Replace	Alternator > Relay, R&R	B	0.3	0.0

Charging System (Article 11915)

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to either the negative or positive battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–95

percent. Between 0–5 percent and 95–100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

Figure 1: Charging System Block Diagram

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance through the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–95 percent. Between 0–5 percent and 95–100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle Generator Output Voltage

10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–99 percent. Between 0–5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2–3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for more than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging

voltage between 13.9–15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than –8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5–13.1 V. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9–14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 ampere and greater than –7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V.

The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.

- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.

- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

Charging System Test (Article 11921)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit Short to Ground Open/High Resistance Short to Voltage Signal Performance

B+ – P0621 — —

Control – L Terminal P0621 P0621 P0621 —

Signal – F Terminal P0622 P0622 P0622 P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5–99%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Circuit/System Verification

- Ignition ON.

- Verify that no G13 Generator , B18 Battery Current Sensor or B110 Battery Sensor Module DTCs are set that would cause a charging system concern.

- If DTCs are set Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If no DTCs are set

- Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.

- If less than 12 V Refer to Battery Inspection/Test .

- If 12 V or greater

- Engine running, all accessories OFF.

- Verify the scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 40% to 90% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.

- If the battery voltage does not continually increase Refer to Circuit/System Testing.

- If the battery voltage continually increases

- All OK.

Circuit/System Testing

- Ignition OFF.

- Test for less than 2 Ω between the G13 Generator housing and C1 Battery negative terminal.

- If 2 Ω or greater Repair the open/high resistance in the circuit.

- If less than 2 Ω

- Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2, 1 X1 or 1 X2 and ground.

- If the test lamp does not illuminate and the circuit fuse is good

- Remove the test lamp and disconnect the B+ cable at the G13 Generator

- Test for less than 2 Ω in the B+ circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- If the test lamp does not illuminate and the circuit fuse is open

- Remove the test lamp, disconnect the C1 Battery negative cable, and disconnect the G13 Generator B+ cable.

- Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, test or replace the G13 Generator.

- If the test lamp illuminates

- Test or replace the G13 Generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Generator Replacement

Charge Indicator Malfunction (Article 11015)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The engine Control Module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON

signal circuit. The ECM should detect low voltage on the generator turn on signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit. If a malfunction is detected the ECM will illuminate the charge indicator in the instrument cluster.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Master Electrical Component List

Description and Operation

Indicator/Warning Message Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- Ignition ON, engine running.

- Verify the scan tool Battery Voltage parameter is between 12.5–15.5 V.

- If not 12.5–15.5 V Refer to Charging System Test .

- If 12.5–15.5 V

- Verify the charge indicator turns on and off when commanding the All Indicators test ON and OFF with the scan tool.

- If the charge indicator always stays on or always stays off Replace the P16 Instrument Cluster.

- If the charge indicator turns on and off as commanded

- All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for Instrument Cluster replacement, programming, and setup