Charging System Description and Operation

12 V Battery

The following information is for the 12 V battery only.

For information about charging the high voltage drive motor batteries, refer to Drive Motor Battery System Description.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. The main difference between a conventional generator charging system and this system is that the generator has been replaced by the T18 Battery Charger. The T18 Battery Charger provides the power to charge the battery from the high voltage system. There are many modes of operation and they include:

- Pre-sleep Mode (Active when vehicle is OFF)
- Enhanced Battery Support Mode (charging the 12 V battery when off) (Active when vehicle OFF)
- Transport/Logistics Mode
- Normal Mode
- Battery Sulfation Mode
- Battery Saver Mode (Levels 1-3 Vehicle ON, Propulsion OFF 4-9 Vehicle OFF Propulsion OFF)
- Headlamp Mode
- Voltage Reduction/Fuel Economy Mode
- Plant Assembly Mode

Charging System Components

Battery Charger

The T18 Battery Charger provides the power to charge the battery from the high voltage system. The K16A Battery Energy Control Module 1 uses two circuits to control and monitor the state of the T18 Battery Charger. The control circuit 8444 functions much like the L - Terminal circuit on a generator equipped vehicle. A high side driver in the K16A Battery Energy Control Module 1 applies a duty cycle voltage to the T18 Battery Charger. The duty cycle controls the T18 Battery Charger output. The K16A Battery Energy Control Module 1 monitors the state of the T18 Battery Charger control circuit 8444. The K16A Battery Energy Control Module 1 will detect faults on the T18 Battery Charger control circuit 8444 when the vehicle is ON.

Drive Motor/Generators

The drive motor/generators are serviceable components located within each transmission. When the rotors are spun, an alternating current (AC) is induced into the stator windings. This AC voltage is then sent to each K107 Drive Motor Control Module where it is converted to high voltage direct current (DC) power. The output of the K107 Drive Motor Control Module is converted into low voltage electrical power by the accessory DC power converter module T18 Battery Charger for use by the vehicle's electrical system to maintain electrical loads and battery charge.

Body Control Module (BCM)

The Body Control Module (BCM) is a GMLAN device. It communicates with the K16A Battery Energy Control Module 1 and the instrument panel cluster for electrical power management

K16A Battery Energy Control Module 1 which sends this information to the T18 Battery Charger. The BCM monitors the B110 Battery Monitor Module, the battery positive voltage circuit, and estimated battery temperature to determine C1 Battery state of charge.

Battery Monitor Module

The body control module (BCM) is a GMLAN device. It communicates with the K16A Battery Energy Control Module 1 and the instrument panel cluster for electrical power management operation. The BCM determines the desired voltage set point and sends the information to the K16A Battery Energy Control Module 1 which sends this information to the T18 Battery Charger. The BCM monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge.

Battery Energy Control Module 1

The K16A Battery Energy Control Module 1 receives control decisions based on messages from the K9 Body Control Module (BCM) as well as the T18 Battery Charger

Battery Energy Control Module 2

The K16B Battery Energy Control Module 2 communicates with T18 Battery Charger to control the voltage set point sent to the T18 Battery Charger during the battery maintenance mode.

Instrument Panel Cluster

The instrument panel cluster provides a means of customer notification in case of a failure and a voltmeter. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM.

Normal Mode

The BCM will enter Normal Mode whenever 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).
- Vehicle Speed is greater than 145 km/h (90 mph)
- Current Sensor Fault Exists
- System Voltage was determined to be below 12.56 V
- Tow/Haul Mode is enabled (if equipped)

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.

Battery Sulfation Mode

Battery sulfation mode is used to help maintain the battery life. The charging system will enter a battery sulfation mode which tries to increase the vehicle charging when the charging system voltage is less than 13.2 V for about 30 minutes. Once in this mode, the BCM will set a targeted output voltage between 13.9–15.5 V for about 5 minutes. Following this 5 minutes, the BCM will then determine which mode to enter depending on the system voltage requirements.

Pre-Sleep

When the vehicle is turned off the BCM will command the T18 Battery Charger to run for a minimum of 10 minutes with the high voltage contactors closed after Propulsion is turned Off. The

continuously if there is a battery issue or drain. The High Voltage (HV) Battery will not drop below 12%, regardless of the 12 V battery level or condition.

Enhanced Battery Support Mode (EBSM)

Enhanced Battery Support Mode is designed to ensure the 12V battery has a good state of charge. It accomplishes this by checking the voltage of the 12 V battery and providing a charge if needed.

When the vehicle is asleep for 11 hours or if the BCM is woke up by any internal or external event, EBSM will activate if Battery State Of Charge (SOC) is low. The BCM will send a request to the K16 Battery Energy Control Module to command the T18 Battery Charger to run until the 12 V battery is charged to a value between to 76.5% to 83.5% or the T18 Battery Charger has run for a maximum of 2 hours with the high voltage contactors closed whichever occurs first.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the ambient air temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is greater than −8 A but less than 5 A, and the battery state of charge is greater than or equal to 85 percent. Its targeted T18 Battery Charger set-point voltage is the open circuit voltage of the battery and can be between 12.6–13.2 V. The BCM will exit this mode and enter Normal Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode whenever the high or low beam headlamps are ON. Voltage will be regulated between 13.9–15 V.

Voltage Reduction

The BCM will enter Voltage Reduction Mode when the calculated battery temperature is above 0°C (32°F) and the calculated battery current is greater than −7 A but less than 1 A. Its targeted T18 Battery Charger set-point voltage is 12.9–15 V. The BCM will exit this mode once the criteria are met for Normal Mode.

Plant Assembly Mode

The BCM will increase charging voltage for the first 500 miles of operation in an effort to ensure that the 12 V battery is fully charged when the vehicle is delivered to the customer.

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. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the charging system, 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 adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during Vehicle OFF and during Vehicle in Service Mode. During Vehicle 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. During Vehicle ON mode, 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.

Instrument Panel Cluster Operation

Charge Indicator Operation

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

- The K16A Battery Energy Control Module 1 detects system voltage less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the K16A Battery Energy Control Module 1 requesting illumination.
- The BCM determines that the system voltage is less than 11 V or greater than 16 V.
- The instrument panel cluster receives a GMLAN message from the BCM indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each Vehicle ON cycle. The indicator illuminates for approximately 3 seconds.

Battery Voltage Gauge Operation

The instrument panel cluster displays the system voltage as received from the BCM over the GMLAN serial data circuit. If there is no communication with the BCM then the gauge will indicate minimum.

This vehicle is equipped with a regulated voltage control system. This will cause the voltmeter to fluctuate between 12–14 V as opposed to non-regulated systems which usually maintain a more consistent reading of 14 V. This fluctuation with the regulated voltage control system is normal system operation and NO repairs should be attempted.

SERVICE BATTERY CHARGING SYSTEM

The BCM and the K16A Battery Energy Control Module 1 will send a GMLAN message to the driver information center for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is displayed whenever the charge indicator is commanded ON due to a failure.