Charging System - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS) - Overview

Overview

The generator is driven by the FEAD belt. When the engine is started, the generator begins to generate AC voltage which is internally converted to DC voltage. The DC voltage level is controlled by the voltage regulator (located on the rear of the generator) and is supplied to the battery.

The PCM controls the voltage regulation setpoint and communicates this information to the generator internal voltage regulator over a generator communication (GENCMD) communication circuit. The PCM receives generator load and error conditions from the generator over the generator monitor (GENMON) circuit.

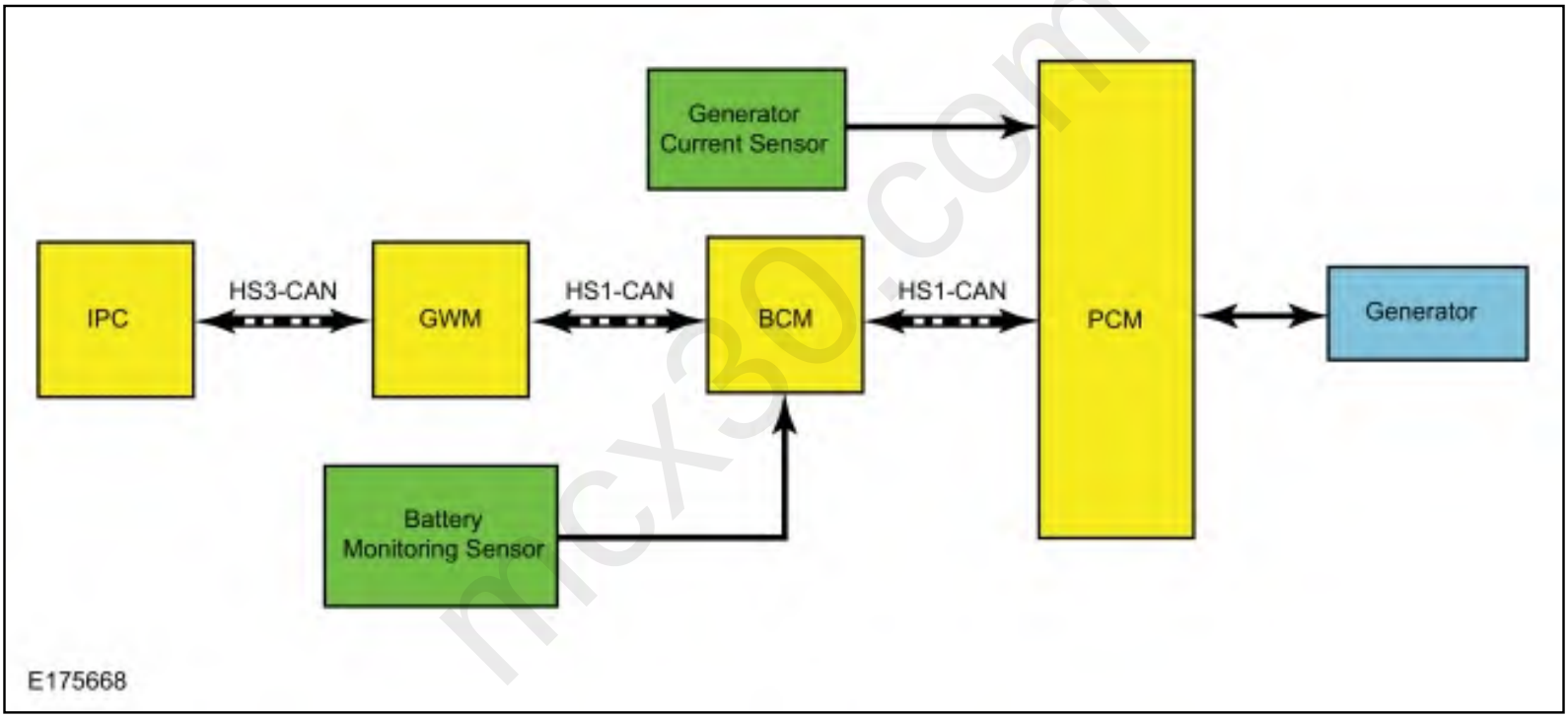
This vehicle is equipped with a load shed strategy. The BCM uses the battery monitoring sensor to monitor the battery state of charge and condition. The battery monitoring sensor is attached to the negative battery post.

The PCM adjusts the engine idle stability and torque control using information from the generator current sensor.

Charging System - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS) - System Operation and Component Description

System Operation

System Diagram



Network Message Chart

Module Network Input Messages — Body Control Module (BCM)

Broadcast Message	Originating Module	Message Purpose
Alternator fault	PCM	The PCM has detected a fault in the generator or generator circuits.

Module Network Input Messages — Instrument Panel Cluster (IPC)

Broadcast Message	Originating Module	Message Purpose
Power system status	BCM	Reports any generator/charging system faults. Used for charging system fault indicator.
Load Shed Request	BCM	Used to indicate what level of load shed is commanded.

Module Network Input Messages — Powertrain Control Module (PCM)

Broadcast Message	Originating Module	Message Purpose
Load Shed Request	BCM	Used to indicate what level of load shed is commanded.

Charging System

The PCM controlled Smart Charge charging system determines the optimal voltage setpoint for the charging system and communicates this information to the voltage regulator. The Smart Charge charging system sets Diagnostic Trouble Codes (DTCs) when a charging system fault is present. All of the Diagnostic Trouble Codes (DTCs) can set continuous faults, but not all Diagnostic Trouble Codes (DTCs) set as on-demand faults.

This system uses 2 communication lines between the PCM and the generator/voltage regulator: A generator communication (GENCMD) line communicates the desired setpoint from the PCM to the voltage regulator, and a generator monitor (GENMON) line communicates the generator load and error conditions to the PCM. Both of these use PWM. The PCM sends the GENCMD command only when it is necessary to adjust the voltage setpoint. If the setpoint does not need to be changed, several seconds may elapse between PCM GENCMD commands. This normal operation appears in the PID as occasional bursts of pulse-width commands. In addition to these two circuits, a third pin on the voltage regulator, the "A" circuit pin, is dedicated to monitor, or sense, the battery voltage.

The PCM simultaneously controls and monitors the generator output. When the current consumption is high or the battery is discharged, the PCM raises engine speed as needed to increase generator output. The generator charges the battery and at the same time supplies power for all of the electrical loads. The battery is more effectively charged with a higher voltage when the battery is cold and a lower voltage when the battery is warm.

The PCM turns off the generator during cranking to reduce the generator load and improve cranking speed. Once the engine starts, the PCM slowly increases generator output to the desired voltage.

The PCM reports any charging system faults and sends a message through the HS-CAN1 to the BCM. The BCM controls the charging system warning indicator by sending a message through the GWM to the IPC. The status of the PCM charging system warning indicator and/or message is confirmed by viewing PCM PID generator fault indicator lamp (GENFIL). Any charging system fault detected by the PCM results in 1 or more Diagnostic Trouble Codes (DTCs) being set and the PID GENFIL having a status of On. If equipped with a charging system warning

indicator, the IPC turns the indicator on or off. If equipped with a message center, the IPC displays a CHECK CHARGING SYSTEM message. In some instances, the CHECK CHARGING SYSTEM message may not display if the ignition is on and the engine is off.

Under certain circumstances, the charging system may have a concern but will still keep the battery charged and the vehicle running. GENCMD normally initiates charging but with a fault in this circuit, the generator can self-excite and start charging on its own. The charging system warning indicator is illuminated and/or the CHECK CHARGING SYSTEM message is displayed, and the generator operates in a default mode (approximately 13.5 volts).

Electrical Energy Management System

NOTICE: When any vehicle module is being programmed, connect an external battery charger to make sure the module programming is completed without interruption due to the load shedding feature becoming active. The external battery charger must maintain a system voltage above 13 volts. This may require a charger setting higher than the lowest charge setting. The external battery charger negative connection must be made to an engine or vehicle chassis ground and not the negative battery terminal. If the connection is to the negative battery terminal, load shedding may begin and module programming may be corrupted. After charging has begun, start the engine to clear any load shed states and then turn the engine off and proceed with programming.

This vehicle is equipped with an Electrical Energy Management system which manages battery charging and monitors the battery state of charge. The Electrical Energy Management system software is housed in the BCM. It has the algorithms and control structure for the Smart Regenerative Charging, and Load Shed Control Strategy. The Electrical Energy Management system is equipped with a battery monitoring sensor and generator current sensor to monitor the battery. These sensors serve as input to the Electrical Energy Management system software. If the sensors malfunction due to wiring issues or failure, a DTC will be set. In most cases the Electrical Energy Management system functions will be turned off until the sensor operation is restored.

Battery State of Charge

The Electrical Energy Management system monitors the battery current flow and voltage to determine the battery state of charge. During the drive cycle the Electrical Energy Management system software monitors the charge and discharge current and increases the state of charge during charging, and decreasing it during discharge. During rest periods (key off with no electrical loads) when the vehicle enters sleep mode, the battery voltage is sampled to calibrate the state of charge. The battery monitoring sensor automatically executes a calibration anytime the vehicle enters sleep mode and the total vehicle current draw is below 300mA. It takes 8 hours in the sleep mode to calibrate the battery state of charge to high accuracy. If the system draw has not allowed the battery state of charge to calibrate over the previous 7 days, the state of charge quality factor changes to identify this and some Electrical Energy Management system functions may be temporarily turned off until a calibration takes place.

NOTE: *Any devices left attached to the power socket that draw more than 200mA (or less depending on other battery loads), prevents the battery monitoring sensor from calibrating the battery state of charge.*

Engine Off Load Shed

The BCM uses the battery monitoring sensor to keep track of the battery state of charge. When the engine is off

and the BCM determines the battery state of charge is below 50%, or 45 minutes have elapsed, a load shed message is sent over the CAN. This message turns off the audio/navigation system to save the remaining battery charge. Under this condition the FCDIM (without touchscreen controls) displays System Off to Save Battery Turn Ignition Off, or the FDIM (with touchscreen controls) displays SYSTEM OFF TO SAVE BATTERY PLEASE TURN IGNITION OFF OR START ENGINE to notify the driver that battery protection actions are active.

Engine off load shedding occurs when the engine is not running and the ignition is in the ACC, RUN or delayed accessory position. This load shed state clears once the vehicle has been started and the battery state of charge recovers. If the engine off load shed occurs, the audio/navigation system turns off.

When the ignition is in the RUN position and load shed occurs, the IPC message center may display either TURN POWER OFF TO SAVE BATT (base message center) or TURN POWER OFF TO SAVE BATTERY (optional message center). The audio/navigation system shuts down after the message center displays the warning.

If a fault occurs with the battery monitoring sensor or circuit(s), the only engine off load shed strategy that is active is a 45 minute timer. After 45 minutes have elapsed, the audio/navigation system turns off. To clear the load shed state, restart the engine.

When the ignition is in the OFF position or the ignition key is removed, the infotainment extended play feature can be enabled. When infotainment extended play is enabled and a load shed message is received over the CAN extended play will turn off to save the remaining battery charge. Under this condition FCDIM displays SYSTEM OFF TO SAVE BATTERY to notify the driver that battery protection are active. For more information,
Refer to: Message Center - System Operation and Component Description (413-01 Instrumentation, Message Center and Warning Chimes, Description and Operation).

Engine Running Load Shed

When the BCM and/or PCM senses voltage is low, with the engine running, the BCM sends a message to either minimize or shut down the climate controlled seats, rear defrost, heated mirrors and climate control blower motor to improve system voltage. Under this condition, the IPC message center displays LOW BATTERY FEATURES TEMPORARILY TURNED OFF to notify the driver that battery protection actions are active during a Load Shed 2 continuous event.

For more information on message center messages, Refer to the Owner's Literature or
Refer to: Message Center - System Operation and Component Description (413-01 Instrumentation, Message Center and Warning Chimes, Description and Operation).

There are 3 states of engine running load shed:

Load Shed State	Entry Conditions	Impact to Features	Clear Conditions

Load shed 1	Alternator at full load and battery discharging while driving. System voltage less than 11.5 volts	These loads are incrementally reduced (if equipped): Heated steering wheel and climate controlled seats. These loads are turned off (if equipped): smart trailer tow battery charge, heated mirrors, heated backglass, and heated windshield.	System operating at normal power level.
Load shed 2 transient	EPAS indicating reduced voltage and increased current. System voltage less than 11 volts	These loads are turned off without customer indication (if equipped): Heated steering wheel, smart trailer tow battery charge, climate controlled seats, heated mirrors, heated backglass, and heated windshield.	System operating at normal power level.
Load shed 2 continuous	Load Shed 2 Transient condition in excess of 20 seconds	In addition to Load Shed 2 Transient, these loads are turned off (if equipped): 110-volt inverter, heated windshield, and climate control blower (reduced speed less FMVSS required operation). During Load Shed 2 the Continuous feature on indication will turn off for these loads: heated steering wheel, climate controlled seats, heated mirrors, and heated backglass.	System operating at normal power level.

Battery Charging

When it is necessary to charge the vehicle battery it is important to properly connect the charger for the Electrical Energy Management system to measure the energy input to the system to keep an accurate state of charge. Connect the charger positive cable to the battery positive post, and place the charger negative cable to a vehicle ground. Do not connect the charger negative cable to the battery negative terminal. Connecting the charger directly to the battery negative post bypasses the vehicle sensors, preventing the battery monitoring sensor from detecting the charge current. As a result the battery state of charge does not reflect the charging. For a good connection point, follow the negative cable from the battery monitoring sensor to the vehicle body connection (typically on the shock tower sheet metal). The placement of the battery is such that the battery negative terminal is located under the sheet metal shroud making sheet metal ground the obvious choice for the charger.

If the battery is being charged due to a load shedding message, only properly charging the battery assists in

clearing this message. If the charger was improperly installed, the Electrical Energy Management system calibrates the battery state of charge after about 8 hours.

NOTICE: If the charger is incorrectly connected to the battery negative terminal, DO NOT reset the battery monitoring system using the diagnostic scan tool. This reset is reserved only for new battery installation. This reset will clear the learned battery data, the battery time in service, and will affect the aging algorithm parameters, which have been learned since the installation of the battery.

Jump Starting

When it is necessary to jump start the vehicle it is important to properly connect the cables for the Electrical Energy Management system to measure the energy input to the system to keep an accurate state of charge. Connect the positive cable to the battery positive post and the jump start negative cable to a vehicle ground. Do not connect to the negative battery terminal. Connecting directly to the battery negative post bypasses the ability of the vehicle to measure the input current with the battery monitoring sensor, and does not adjust the battery state of charge accordingly. For a good connection point, follow the negative cable from the battery monitoring sensor to the vehicle body connection (typically on the shock tower sheet metal). If the vehicle was improperly jump started, the Electrical Energy Management system calibrates the battery state of charge after about 8 hours.

NOTICE: If the cables are incorrectly connected to the battery negative terminal, DO NOT reset the battery monitoring system using the scan tool. This reset is reserved only for new battery installation. This reset will clear the learned battery data, the battery time in service, and will affect the aging algorithm parameters, which have been learned since the installation of the battery.

Battery Replacement

If the vehicle battery is replaced, it is very important to perform the battery monitoring system reset using the diagnostic scan tool. If the battery monitoring system reset is not carried out, it holds the old battery parameters and time in service counter in memory. Additionally it tells the system the battery is in an aged state and may limit the Electrical Energy Management system functions. For more information,
Refer to: Battery and Cables - System Operation and Component Description (414-01 Battery, Mounting and Cables, Description and Operation).

Component Description

Generator

The generator is equipped with an electronic internal voltage regulator and a serviceable generator clutch pulley.

Generator Current Sensor

The generator current sensor is attached to the generator B+ cable. It is supplied a 5-volt reference voltage and a ground from the PCM. The generator current sensor is a Hall-effect sensor that supplies an analog feedback signal to the PCM. The PCM uses this information for battery charging strategy and idle stability and torque control.

Battery Monitoring Sensor

The battery monitoring sensor is integrated with the negative battery terminal clamp and cable assembly, which provides a ground to the sensor. The battery monitoring sensor measures voltage, current, and temperature of the battery and uses these inputs to calculate the battery condition. The sensor transmits this information through a LIN circuit to the BCM. The battery monitoring sensor has a 2-pin connector providing battery voltage and LIN connections.

Powertrain Control Module (PCM)

The PCM monitors and controls the charging system.

Generator Clutch

The primary function of the generator clutch is to separate the generator rotor inertia from the FEAD belt, lowering belt tension at high Revolutions Per Minute (RPM) and reducing NVH. The generator clutch is serviced separately from the generator.