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2012 FORD Mustang Convertible OEM Service and Repair Workshop Manual

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

414-00 Charging System - General Information	***2022 F-150***
Description and Operation	***Procedure revision date: 10/8/2020***

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

Smart Regenerative Charging

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

The PCM (powertrain control module) controls the voltage regulation setpoint and communicates this information to the generator internal voltage regulator over a LIN (local interconnect network) communication circuit.

This vehicle is equipped with an Electrical energy management system (load shed strategy). The BCM (body control module) monitors the battery state of charge using information from the battery monitoring sensor attached to the negative battery post and manages battery charging.

The PCM (powertrain control module) monitors the generator current using over LIN (local interconnect network) . The information supplied to the PCM (powertrain control module) from the generator current sensor is used by the PCM (powertrain control module) to adjust the engine idle stability and torque control.

Smart Regenerative Charging is an intelligent charge control system that calculates and regulates the set generator voltage.

The basic idea of the system is to increase the generator charge voltage when the vehicle is decelerating and reduce it when it is accelerating.

This means that during the acceleration phase, there is no additional energy demand as a result of having a high generator load; however generator load is increased when the vehicle is decelerating.

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

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

System Operation

System Diagram

6	PCM (powertrain control module)
7	Secondary Generator
8	Primary Generator
9	Battery Current Sensor

Charging System

The PCM (powertrain control module) 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 is designed to set a DTC (diagnostic trouble code) when a charging system fault is present. All of the DTC (diagnostic trouble code) can set continuous faults, but not all DTC (diagnostic trouble code) s set as on-demand faults.

The smart regenerative charge system primary strategy is stored in the BCM (body control module) . The BCM (body control module) receives information relating to the battery condition from the battery monitoring sensor via a LIN (local interconnect network) . The BCM (body control module) calculates and sends the set value needed for the generator charging voltage via the HS-CAN (high-speed controller area network) to the PCM (powertrain control module) . The PCM (powertrain control module) then adjusts the value received (if necessary) and sends it to the generator via a different LIN (local interconnect network) . The charging voltage is adjusted depending on various parameters, such as the current level of engine efficiency. The smallest possible set value for the generator voltage is 12.2 volts, while the maximum charging voltage can be anywhere between 14.5 and 14.9 volts. However, when the battery is in a refresh phase, the voltage may occasionally reach up to 15.2 volts. These refresh phases are required when the battery charge status is 80% over long periods of time, which increases the risk of sulfation in the battery cells.

The PCM (powertrain control module) simultaneously controls and monitors generator output. When the current consumption is high or the battery is discharged, the PCM (powertrain control module) raises engine speed as needed to increase generator output. The generator charges the battery and at the same time supplies power for all 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 (powertrain control module) turns off the generator during cranking to reduce the generator load and improve cranking speed. Once the engine starts, the PCM (powertrain control module) slowly increases generator output to the desired voltage.

The PCM (powertrain control module) reports any charging system faults and sends a message through the HS-CAN (high-speed controller area network) to the BCM (body control module) . The BCM (body control module) then sends a message over the MS-CAN to the IPC (instrument panel cluster) , which controls the charging system warning indicator. The status of the PCM (powertrain control module) charging system

due to the current being used bypassing the battery monitoring sensor. Refer to the Battery Monitoring Sensor component description in this section.

Battery State of Charge

The battery monitoring system charges the battery current flow and voltage to determine the battery state of charge. During the drive cycle the battery monitorning 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 sensor automatically executes this calibration anytime the vehicle enters sleep mode and when the total vehicle current draw is below 400mA. It takes 4 to 6 hours in the sleep mode to calibrate the battery state of charge to high accuracy. If the system draw does not allow the battery state of charge calibration over the previous 7 to 10 days the state of charge quality factor changes to flag this and some battery monitoring system functions, which rely on the accuracy of the battery state of charge, may be temporarily turned off until a calibration takes place.

NOTE

Any devices left attached to the power socket that draw in excess of 200mA (or less depending on other battery loads), prevents a battery monitoring sensor from calibrating the battery state of charge.

Engine Off Load Shed

When the ignition is in ACC or ON mode and the BCM (body control module) determines the battery voltage or the battery state of charge has dropped below set levels, a low battery warning message is displayed in the message center. Should the battery voltage or the battery state of charge continue to drop, the audio system is powered down to save the remaining battery charge. This load shed state clears once the vehicle is started and battery state of charge is allowed to recover.

When the ignition is in the ON mode and load shed occurs, the message center displays the corresponding message to notify the driver that battery protection actions are active. The audio 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 system turns off. To clear the load shed state, restart the engine.

When the BCM (body control module) and/or PSCM (power steering control module) voltage is low, with the engine running, a message is sent by the BCM (body control module) to either minimize or shut down the climate controlled seats, rear defrost, heated mirrors and DATC (dual automatic temperature control) blower motor to improve system voltage. Under this condition, the IPC (instrument panel cluster) message center displays either LOW BATTERY LESS FEATURES (base message center) or LOW BATTERY FEATURES TEMPORARILY TURNED OFF (optional message center) to notify the driver that battery protection actions are active.

		control) , the blower motor is reduced to 50% speed. • If equipped, DC/AC inverter (AC powerpoint) is disabled. • The base IPC (instrument panel cluster) message center displays LOW BATTERY LESS FEATURES. • The optional IPC (instrument panel cluster) message center displays LOW BATTERY FEATURES TEMPORARILY TURNED OFF.	

Battery Charging

When it is required to charge the vehicle battery, connect the positive connection to the battery positive post, and place the charger negative cable to vehicle ground. Do not connect the negative charger cable to the battery negative terminal. Connecting directly to the battery negative terminal bypasses the vehicle sensors, not allowing the battery monitoring sensor to detect the charge current. As a result the battery state of charge does not reflect the charging. Look for the body ground cable coming off the clamp or the battery monitoring sensor and try and connect in this location (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 properly installed, the battery monitoring sensor 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 for new battery installation only. 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 required to jump start the vehicle, just like battery charging, it is important to connect the cables properly for the battery monitoring system to measure the energy input to the system to keep an accurate state of charge. Connect the positive connection to the battery positive post, and connect the negative cable

data, the battery time in service, and will affect the aging algorithm parameters, which have been learned since the installation of the battery.

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 the LIN (local interconnect network) circuit to the BCM (body control module) . The battery monitoring sensor has a 2-pin connector providing battery voltage and LIN (local interconnect network) connections.

The battery monitoring sensor is an input to the Electrical Energy Management system software. If the sensor malfunctions due to wiring issues or failure, a DTC (diagnostic trouble code) sets. In most cases the Electrical Energy Management system functions are turned off until the sensor operation is restored.

Powertrain Control Module (PCM)

The PCM (powertrain control module) monitors and controls the charging system.

Generator Clutch

The generator clutch is serviced separately from the generator. The primary function is to separate the generator rotor inertia from the FEAD (front end accessory drive) belt, lowering belt tension at high Revolutions Per Minute (RPM) and reducing NVH (noise, vibration and harshness) .

Battery Monitoring Sensor

The Battery Monitoring Sensor continuously monitors the condition of the battery.

The sensor is equipped to vehicles which have Smart Regenerative Charging or Start-Stop. These systems require knowledge of the battery state of charge. The Battery Monitoring Sensor is the sensor used to provide this information.

Battery Monitoring Sensor connection

The Battery Monitoring Sensor is clamped directly to the negative terminal of the battery and grounds to the vehicle at the chassis ground connection point by means of a thick (25 to 35mm²) cable and eyelet. External customer loads must **only** be connected to the vehicle at the customer battery connection point. If the external customer load is connected at the negative battery post, the Battery Monitoring Sensor accuracy cannot be guaranteed.

It is recommended that the Battery Monitoring Sensor pole clamp is not removed unless a battery replacement is required. Should the battery need to be isolated, this should be done by disconnecting the ground eyelet at the chassis ground.

Battery Monitoring Sensor reset

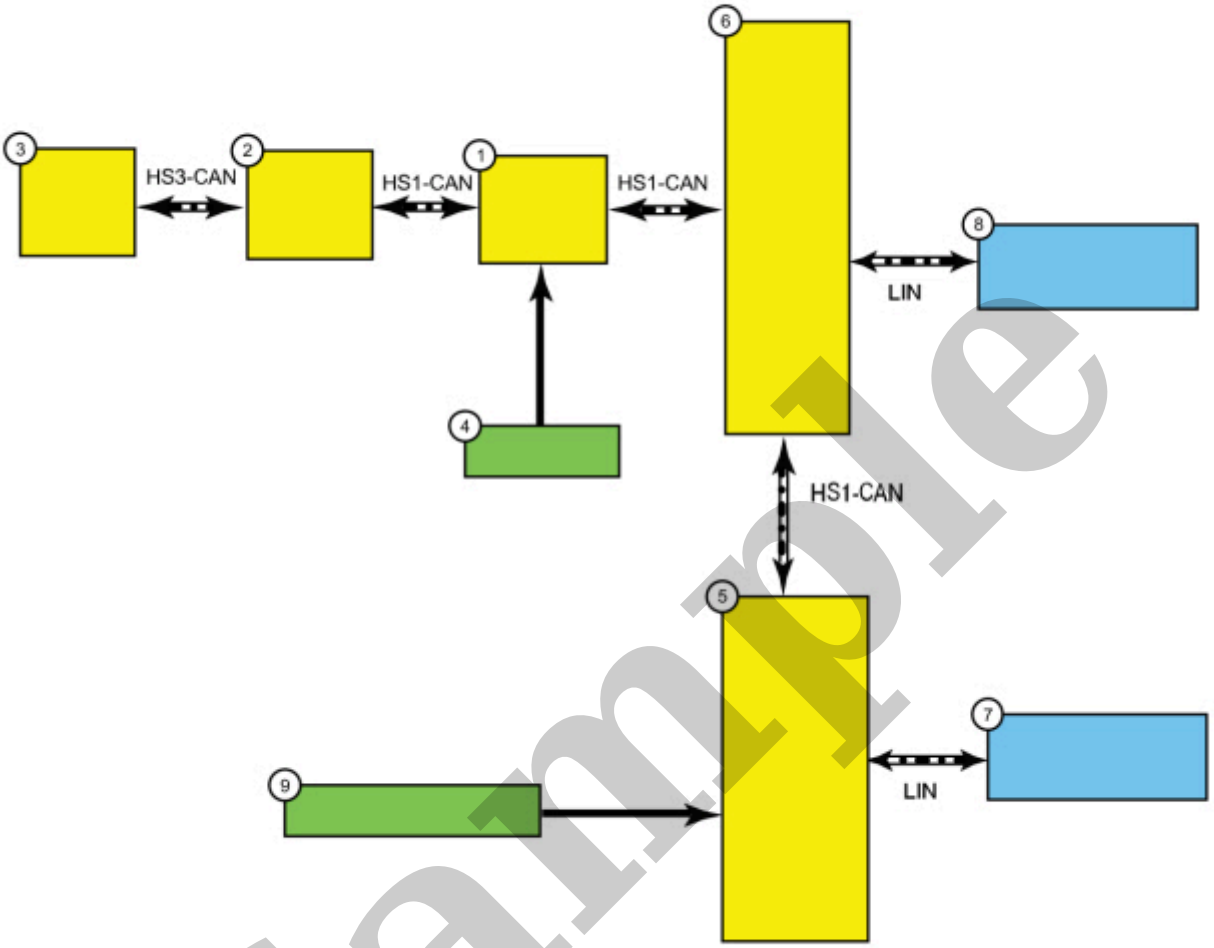
The Battery Monitoring Sensor also estimates losses in the battery capacity over time. The Battery Monitoring Sensor should be reset to factory default settings, when the battery is replaced.

It is urgently recommended that the replacement battery has the exact same specification as the original battery. If it does not, the accuracy of the Battery Monitoring Sensor outputs will be compromised.

The Battery Monitoring Sensor reset is part of the battery replacement procedure in IDS (Integrated Diagnostic System) .

DC (direct current) / AC (alternating current) INVERTER

The DC (direct current) / AC (alternating current) inverter converts 12 volts DC to 110 volts AC to power AC devices rated 400 watts or less.



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Item	Description
1	BCM (body control module)
2	GWM (gateway module A)
3	IPC (instrument panel cluster)
4	BMS (battery monitoring sensor)
5	DC (direct current) / AC (alternating current) Invertor

warning indicator message can be confirmed by viewing the PCM (powertrain control module) Generator Fault Indicator Lamp (GENFIL) PID (parameter identification) . Any charging system fault detected by the PCM (powertrain control module) results in 1 or more Diagnostic Trouble Codes (DTCs) being set and the GENFIL PID (parameter identification) having a status of ON. If equipped with a charging system warning indicator, the IPC (instrument panel cluster) turns the indicator on or off. If equipped with a message center, the IPC (instrument panel cluster) displays the corresponding message to notify the driver of the condition.

Under certain circumstances, the charging system may have a concern but still keeps the battery charged while the vehicle is running. The LIN (local interconnect network) is normally used to initiate charging, but with a fault in this circuit the generator self-excites or begins charging on its own. The charging system warning indicator is illuminated and/or the corresponding message to notify the driver of the condition 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 also utilizes a load shed strategy to help control discharge of the battery and prevent, when possible, an excessively low battery state of charge. The BCM (body control module) uses a battery monitoring sensor to monitor the battery state of charge.

- Generator current sensor
- Battery current sensor

These sensors serve as input to the Electrical Energy Management system software. If the sensors malfunction due to wiring issues or failure, a DTC (diagnostic trouble code) will be set. In most cases the Electrical Energy Management system functions will be turned off until the sensor operation is restored.

To maintain correct operation of the load shed system, any electrical devices or equipment must be grounded to the chassis ground and not the negative battery terminal. A connection to the negative battery terminal causes an inaccurate measurement of the battery state of charge and incorrect load shed system operation