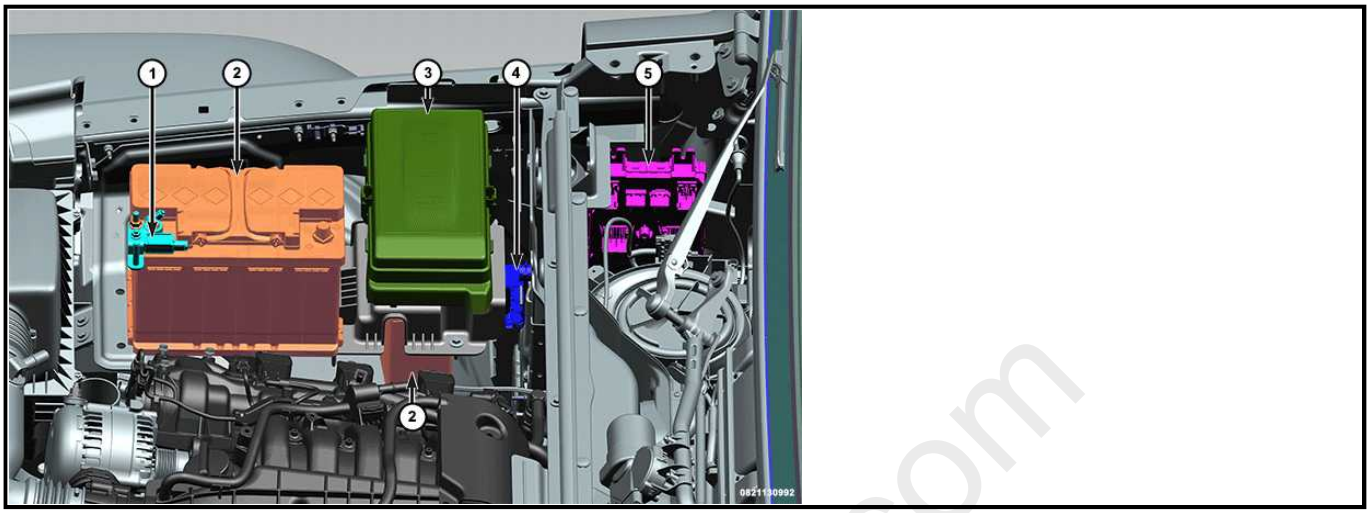
DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

DESCRIPTION



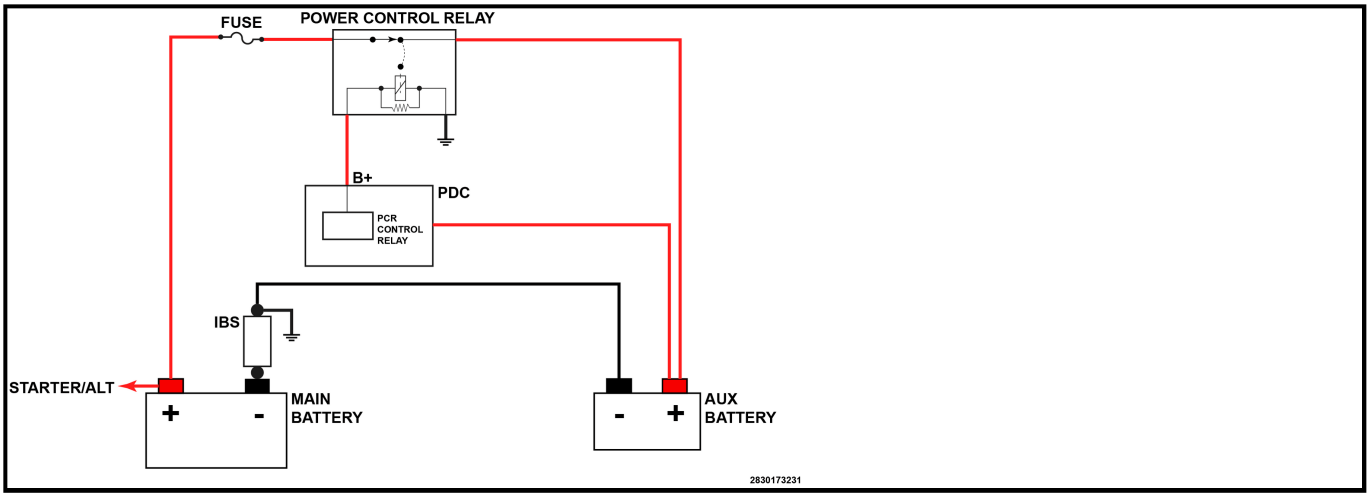
COMPONENT INDEX

1.	Intelligent Battery Sensor (IBS)
2.	Dual Battery System (Auxiliary and Cranking) - Auxiliary battery is located beneath the Power Distribution Center (PDC)
3.	Main Power Distribution Center (PDC)
4.	Power Control Relay (PCR)
5.	Body Control Module (BCM)
-	PCR Control Relay - Located in the PDC
-	Battery Cables

SYSTEM OPERATION - DUAL BATTERY 12 VOLT BATTERY SYSTEM

The dual battery Engine Stop/Start (ESS) system consists of four main components that are connected to and operate the starting, charging and vehicle electrical systems. These are the main battery, auxiliary battery, Power Control Relay (PCR) and dual battery system fuse. The power control relay separates the system into two sides, the main battery side and auxiliary battery side. The generic graphic below shows a simplified diagram of the components for ease in understanding the system configuration.

- The **main battery** is the larger battery that is directly connected to the starter and alternator when the batteries are isolated.
- The **auxiliary battery** is the smaller battery that is directly connected to the Power Distribution Center (PDC) powering the modules and accessories when the batteries are isolated. The negative cable for the auxiliary battery connects to the main battery negative cable end.



There is an Intelligent Battery Sensor (IBS) connected in series on the main battery negative cable which provides information about the batteries to the Body Control Module (BCM) over a Local Interface Network (LIN) bus. The IBS monitors the current flow going out of the battery, and current flowing into the battery during charging to make these calculations. Some of the information stored and provided by the IBS are:

- Battery voltage
- Battery temperature
- Battery State of Charge (SOC) - The battery SOC is the percentage of battery charge based on measured voltage, charge and discharge rates.
- Battery State of Function (SOF) - The SOF is the calculated voltage that the battery will drop to when the starter is engaged to crank the engine.
- Battery State of Health (SOH) - The SOH is the measurement of current battery capacity along with depreciation in battery health.

The BCM broadcasts the IBS data over the CAN bus. The Powertrain Control Module will use the battery SOC to determine charge rates as well as when to allow features such as the Engine Stop/Start (ESS) system to function. The BCM will uses the battery information received from the IBS to make decisions on load shedding when battery SOC is determined to be low.

In a normally functioning system, **the two batteries and sides of the system are always connected through the power control relay except for the brief periods during cranking events.** Both batteries are connected to the entire electrical system during this mode. This allows charging of the auxiliary battery through it's connection to the main battery side, and the main battery to be connected to the Power Distribution Center (PDC) and assist the auxiliary battery in operating the modules and accessories. Since the batteries are nearly always connected, the IBS info provided will be the average SOC of the two batteries. The PCM can determine the SOC of each battery during a cranking event when the batteries are isolated for a brief period during initial starter engagement. During this period, the battery voltage provided to the PCM is coming from only the auxiliary battery, and the battery voltage reported from the IBS will only be reporting the main battery voltage. This helps the PCM to make a determination on allowing ESS operation.

FUNCTIONAL DESCRIPTION - BATTERIES

Batteries are designed to store electrical energy in a chemical form. A standard 12 volt battery will typically have 6 cells connected in series that are made up of a positive and negative plate. Each cell will typically provide approximately 2.1 volts. As the battery discharges, the flow of electrons causes a chemical reaction between the sulfuric acid and the plates causing the plates to become sulfated with lead. Charging the battery will reverse the process, changing the plates back into spongy lead and lead dioxide, and the water back into sulfuric acid.

The battery is vented to release excess hydrogen gas that is created when the battery is being charged or discharged. However, even with these vents, hydrogen gas can collect in or around the battery. If hydrogen gas is exposed to flame or sparks, it may ignite. If the electrolyte level is low, the battery may arc internally and explode.

The dual battery Engine Stop/Start (ESS) system has a main battery and auxiliary battery.

- The main battery is the larger battery that is directly connected to the starter and alternator when the batteries are disconnected.
- The auxiliary battery is the smaller battery that is directly connected to the Power Distribution Center (PDC) powering the modules and accessories when the batteries are disconnected.

In a normally functioning system, **the two batteries and sides of the system are always connected through the power control relay except for the brief periods during cranking events.** Both batteries are connected to the entire electrical system during this mode. This allows charging of the auxiliary battery through it's connection to the main battery side, and the main battery to be connected to the Power Distribution Center (PDC) and assist the auxiliary battery in operating the modules and accessories.

CHARGING AND TESTING THE BATTERIES: The batteries should be charged one of two ways depending on the situation and reason for charging.

1. **CHARGING USING THE GR8 BATTERY TESTER** - It was previously documented to never blind charge a vehicle at the pole clamp. However, if the vehicle is brought in with a battery issue or complaint, and the battery is being charged and tested using the GR8 Battery Tester, the tester should be connected directly to the Pole clamp at the negative Battery post. With the updates done on the GR8 Battery Tester, it will not test the battery correctly if connected and charged through the IBS. After performing any testing requiring blind charging, a battery has been replaced or after any repairs are made, the IBS learning curve should be initiated to allow the IBS to update quickly. **See the IBS Component Functional Description information for details on initiating the IBS learning curve.**
2. **CHARGING USING A STANDARD BATTERY CHARGER** - This should only be performed if the vehicle was not brought in for a battery issue and the batteries are depleted during service. the batteries should be charged through the IBS. To do this the negative clamp on the charger should be placed on the negative cable attachment to the IBS, the Jump Post terminal if equipped, or a good chassis ground, NOT the Pole clamp at the negative Battery post. Without proper clamp placement, the IBS data will not update.

The PCM performs diagnostics to determine if the batteries are connected and disconnected at the appropriate times. To do this the PCM monitors the main battery voltage from the IBS feedback and the auxiliary battery voltage from the fused B+ circuit at the PCM.

FUNCTIONAL DESCRIPTION - BATTERY CABLES

The battery cables connect the battery terminal posts to the vehicle electrical systems. These cables also provide a path back to the battery for electrical current generated by the charging system to restore the voltage potential of the batteries. The female battery terminal clamps on the ends of the battery cables provide a strong and reliable connection of the battery cable to the battery terminal posts. The terminal pinch bolts allow the female terminal clamps to be tightened around the male terminal posts on the top of the battery. The eyelet terminals secured to the opposite ends of the battery cables from the female battery terminal clamps provide secure and reliable connection of the battery cables to the vehicle electrical systems.

On dual battery systems, the negative battery cable from the auxiliary battery connects to the negative battery cable of the main battery at the battery cable end. Both batteries are then grounded through the main battery cable connection to ground.

FUNCTIONAL DESCRIPTION - INTELLIGENT BATTERY SENSOR (IBS)

The Intelligent Battery Sensor (IBS) is an electrical shunt with a microprocessor that is mounted in-line with the negative battery cable. The IBS monitors the battery voltage as well as current flow into and out of the battery. The IBS has a built-in thermistor that calculates the battery temperature. The microprocessor uses this data to calculate battery State of Charge (SOC), battery internal resistance, charge received, electrical demand, and time in service. This information is reported through the LIN Bus circuit to the Body Control Module (BCM). The BCM broadcasts the information to the Powertrain Control Module (PCM) over the CAN Bus.

The IBS SOC data is also used by the BCM and other modules to determine when to begin disabling certain vehicle features that draw excessive electrical loads due to a low battery SOC. The SOC threshold for starting to disable features can vary based on vehicle and engine but is typically in the 50% to 60% range.

On the dual battery Stop/Start systems, the IBS is connected to the main battery. Since the two batteries are connected to each other most of the time, the battery SOC reported by the IBS is reporting the average SOC of the two batteries. It is possible for one battery to be fully charged and the other battery discharged causing the overall SOC to be low. If the SOC is low, both batteries should be checked for proper charge and functionality before checking for an issue with the IBS.

The IBS SOC may read low when both batteries test good. The following items can contribute to, and should be considered when diagnosing a low SOC condition before replacing an IBS or battery:

- If the vehicle is jump started at the battery posts bypassing the IBS.
- If the battery is blind charged at the battery posts bypassing the IBS.
- Repeated short trip driving events not allowing enough charge time.
- The IBS accuracy is off and needs to relearn the battery SOC.

Depending on the vehicle, there could be a non-MIL DTC (P057F) set, or an EVIC message indicating a low battery state of charge limiting some features, such as ESS. In some cases, properly charging the batteries through the IBS can raise the IBS SOC enough to regain functionality and repair the issue. However, it can sometimes take two or three, 4-hour BUS off sleep cycles for an IBS to learn and update the battery SOC. The IBS can be initiated into a learning curve by completely disconnecting the IBS from the battery, and disconnecting harness connector for 20 seconds. The IBS battery feed, LIN Bus and ground circuits should be checked before reconnecting the IBS. The IBS should default to approximately 80% SOC when reconnected. However, the IBS accuracy is determined to be low until the IBS can relearn battery SOC. This occurs after an engine run cycle and a subsequent ignition off sleep cycle of between one to four hours. Some features will be disabled until the IBS SOC is updated.

FUNCTIONAL DESCRIPTION - POWER DISTRIBUTION CENTER (PDC)

The Power Distribution Center (PDC) is designed to provide safe, reliable, centralized and convenient access to distribution of the electrical current required to operate all of the many standard and optional factory-installed electrical and electronic powertrain, chassis, safety, comfort and convenience systems. At the same time, these systems were designed to provide centralized locations for conducting diagnosis of faulty circuits and for sourcing the additional current requirements of many aftermarket vehicle accessory and convenience items. The PDC connects directly to the Battery Positive (B+) cable.

The power distribution systems also incorporate the following various types of circuit control, and protection features:

- Automatic resetting circuit breakers
- Cartridge fuses
- Blade fuses
- Removable relays
- Non serviceable Printed Circuit Board (PCB) relays

FUNCTIONAL DESCRIPTION - BODY CONTROL MODULE (BCM)

The Body Control Module (BCM) is the gateway for all bus communications needing to be gated from one bus network to a different bus network.

The BCM obtains battery voltage information from the Intelligent Battery Sensor (IBS) over the Local Interface Network (LIN) bus. The BCM is the LIN master for the IBS and manages the IBS initialization, LIN communication, signal gating and IBS diagnostics.

Load Shedding

Using the LIN, the BCM communicates with the IBS to provide load shedding. Load shedding is activated under the following conditions:

- The engine must be running with an engine speed equal to or higher than 400 RPM for greater than 50 seconds.
- The battery State of Charge (SOC) supplied signal value sent by the IBS over the LIN bus to the BCM must be less than or equal to 55%.
- The battery voltage measured by the IBS and supplied to the BCM over the LIN bus must be less than or equal to 12.2 volts.

When the vehicle is in a load shed operating state, the BCM will bus a signal to the Instrument Panel Cluster (IPC) to illuminate the "Battery Saver On" indicator.

If the battery SOC rises to a level equal to or greater than 65% and the battery voltage rises to 13 volts or higher, load shedding will begin to reverse itself putting the vehicle back to a normal operating state.

Any transition of the ignition state will reset all of the load shed output signals and therefore cancel load shedding operation.

Battery Critical State

If the battery SOC is equal to or less than 35% and the battery voltage is equal to or less than 11.8 volts, a "Battery Reached Critical State" output signal is broadcast by the BCM. Another condition to set this output signal is that the battery voltage is less than or equal to 10.9 volts and the state of charge is less than or equal to 55%.

When the battery reaches critical state, only electrical loads essential to vehicle operation are allowed to be turned on. The following actions are recommended to be taken:

- Heated seats and the heated steering wheel are disabled for the duration of the ignition cycle
- Rear defroster and heated mirrors time out in 30 seconds each time the customer turns them on for the duration of the ignition cycle
- The Heating, Ventilation, and Air Conditioning (HVAC) system is allowed only minimal loads for visibility requirements for the duration of the ignition cycle
- On vehicles equipped with an eTorque system, the Power Inverter Module (PIM) is disabled for the duration of the ignition cycle
- Audio and Telematic systems will only allow minimal loads for communications and emergency requirements for the duration of the ignition cycle

There is no load shed recovery for a battery critical state and the vehicle operation will remain in this state until the ignition is cycled.

Inputs

- Battery voltage, temperature and state of charge information is provided through LIN communication from the IBS

Outputs

- IBS LIN communication for strategy management
- The BCM broadcasts the battery information on both the Controller Area Network-Chassis (CAN-C) and the CAN-Interior High Speed (CAN-IHS) data bus networks
- Load shedding management to the relevant nodes on all bus networks

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - DUAL BATTERIES 12 VOLT SYSTEM

WARNING: **IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING OR LOOSE POSTS, DO NOT TEST, ASSIST-BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY OR VEHICLE DAMAGE MAY RESULT.**

WARNING: **EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY OR VEHICLE DAMAGE MAY RESULT.**

WARNING: **THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.**

DIAGNOSIS AND TESTING - BATTERY SYSTEM: The battery, starting, and charging systems are inter-related. The diagnostics covered below are testing the complete system. In order for the engine to start and the batteries to maintain a proper charge, all of the components that are used in these systems must perform within specifications. It is important that the battery, starting, and charging systems be thoroughly tested and inspected any time a battery needs to be charged or replaced. The cause of abnormal battery discharge, overcharging or early battery failure must be diagnosed and corrected before a battery is replaced and before a vehicle is returned to service. The Powertrain Control Module (PCM) monitors these systems for faults. If the PCM has a Diagnostic Trouble Code (DTC) stored against any of these systems, the DTC(s) should be diagnosed using the DTC diagnostic test procedure.

PRELIMINARY BATTERY CHECKS: Verify each of the following before charging and testing the batteries.

1. Inspect the batteries for any physical damage to the battery or posts.
    - If physical damage is obvious, replace the battery and retest.
2. Verify the batteries are the proper size and rating for the vehicle. Refer to **BATTERY** .
    - If the either battery does not meet the required specifications, replace the battery and retest.
3. Verify the battery and cable connections are tight and clean. Check the battery cable connections at the battery posts, alternator terminal and ground locations.
    - Clean and repair any poor connections and retest.
4. Verify the charging system is operating properly.
    - If the charging system output is low, repair the inoperative charging system.
5. If the vehicle has a no crank condition but the electrical system has power check the starting system operation.
    - Repair the inoperative starting system if required.
6. If applicable, check the battery electrolyte level. Always use the necessary safety precautions when working with batteries to prevent possible serious or fatal injury.
    - If the electrolyte level is low, fill to the proper level and retest.
7. If the battery, starting and charging systems test good, but the battery discharges after sitting for a short period, check the electrical system for an ignition off draw. Refer to **IGNITION OFF DRAW TEST** .

If all preliminary checks are good, continue testing the battery system below.

CHECKING FOR A DISCONNECT BETWEEN THE BATTERIES: Besides an open cable or poor connection, the two components that can cause a disconnect between the batteries is the power control relay and the fuse.

TECH TIPS:

- The normally closed power control relay should be de-energized and closed 99% of the time. It is only opened by the PCM during the starter in-rush at initial engine cranking.
- On some vehicles with a fuse array, the nuts that connect the cables to the fuse array can loosen and lose the proper torque specifications. This can cause an excessive current draw condition damaging the fuse and causing a disconnect between the power control relay and main battery. This can often be seen by discoloration of the cable ends. at the fuse location.

1. **This step is checking for a disconnect between the batteries at the power control relay.** Measure the voltage at both cable end terminals of the power control relay. This can be done with the engine running, with the ignition on or off. The voltage should be the same at both terminals.
    1. If the voltage is not the same on both terminals, the normally closed relay is stuck open. The power control relay will be stuck open if it is being energized. This can happen if there is voltage on the control circuit due to the PCR control relay in the PDC being stuck on, or if the control circuit is shorted to voltage. Continue to step 2.
    2. If the voltage is the same at both terminals, the relay is not stuck open. Continue to step 3.
2. Disconnect the power control relay harness connector. This should cause the relay to de-energize and close if it is being electrically held on (open). Check for voltage on the control circuit.
    1. If voltage is present, the PCR control relay inside the PDC is stuck on, or the control circuit between the PCR control relay and the power control relay is shorted to voltage.
    2. If voltage is NOT present, and the relay is still open with the harness connector unplugged, replace the faulty power control relay.
3. Measure the voltage across the terminals of the main battery. Compare the main battery voltage to the voltage at the power control relay terminals. If there are no disconnects between the main battery and power control relay, the voltage readings will be the same.
    1. If the voltage reading at the power control relay is lower than the main battery voltage, there is a disconnect. Check the fuse in the system between the main battery and power control relay. If the fuse is open, verify the cables are not shorted to ground and replace the fuse or fuse array depending on vehicle configuration. If the fuse to good, check the positive cables and connections on the main battery side of the system for opens or poor connections.

        NOTE: **It is very important to torque the nut holding the cables to the correct specification. A loose torque on a cable nut can cause excessive current draw on the system and damage the fuse.**

    2. If the main battery voltage matches the power control relay, continue to the CHECKING FOR A DEPLETING OR DEPLETED AUXILIARY BATTERY information below.

CHECKING FOR A DEPLETING OR DEPLETED AUXILIARY BATTERY: On some vehicles the auxiliary battery can be difficult to access for testing with the GR8 battery tester. This information describes an alternative way of to perform a State Of Charge (SOC) check of the auxiliary battery to determine if the GR8 battery tester should be used. This should be done after testing for and determining there is not a disconnect between the main battery and power control relay.

TECH TIPS:

- If the auxiliary battery requires testing with the GR8 battery tester, **the GR8 battery tester must be connected directly to the battery posts.**
- After either battery is charged or replaced, an IBS reset should be performed. If the IBS reset is not performed, it can take several days of run time and sleep cycles for the IBS to learn the battery SOC after a battery is blind charge or replaced. The IBS reset allows the IBS to start with a default 80% SOC, and will detect that the battery has been charged or replaced. This can allow many of the vehicle features to operate normally. The IBS also initiates a quick learning curve which allows the IBS to update the actual battery SOC after a 4 hour sleep cycle.

1. Turn the ignition off. To check the auxiliary battery SOC, measure the voltage as close to the auxiliary battery as possible (recommend at the power control relay). Disconnect the main battery positive cable. **Use caution** when disconnecting the positive cable since the electrical system is still connected to and powered by the auxiliary battery. The auxiliary battery voltage should not drop off drastically. Typically it should still be above 12v if the battery is charged properly.
    1. If the voltage drops sharply when the main battery is disconnected, verify a good auxiliary battery ground cable connection at the main battery negative terminal. If the connection is good, the auxiliary battery should be isolated and tested with the GR8 battery tester. Refer to the CHECKING FOR A DEPLETING OR DEPLETED BATTERY WITH THE GR8 TESTER information below.
        - Perform an IBS reset by removing the IBS from the battery cable end and disconnecting the IBS harness connector for 30 seconds after an auxiliary battery is charged or replaced. This will allow the IBS to default to an 80% SOC and initiate the quick learning curve.
    2. If the voltage is near or above 12v, continue to step 2.
2. To load test the auxiliary battery without the GR8 battery tester, turn the ignition on, and turn on several loads (headlights, HVAC blower, rear defrost, etc.) for approximately 1 1/2 minutes while monitoring the auxiliary battery voltage at the power control relay. DO NOT EXCEED 2 MINUTES. The voltage should be near or above 10v after approximately 1 1/2 minutes. Next turn the loads and ignition off. Monitor the voltage for another 1 1/2 minutes at the power control relay. The voltage should recover back to 12v.
    1. If the auxiliary battery does not appear to be charged or functioning as described, isolate and test the auxiliary battery at the battery posts with the GR8 battery tester.
        - Perform an IBS reset by removing the IBS from the battery cable end and disconnecting the IBS harness connector for 30 seconds after an auxiliary battery is charged or replaced. This will allow the IBS to default to an 80% SOC and initiate the quick learning curve.
    2. If the auxiliary battery appears to be charged and functioning properly, isolate and test the main battery with the GR8 battery tester. Refer to the TESTING A BATTERY WITH THE GR8 TESTER information below.

TESTING A BATTERY WITH THE GR8 TESTER: Always use the Midtronics GR8 Instruction information that was supplied with the tester as a reference. If the Instruction information is not available the following procedure can be used:

WARNING: **Always wear appropriate eye protection and use extreme caution when working with batteries.**

NOTE: **Previous service information reported never to blind charge the battery around the Intelligent Battery Sensor (IBS). Software changes to the GR8 battery tester has improved how the battery is tested. However, this requires the GR8 battery tester to be connected directly to the battery posts, bypassing the IBS when testing the main battery. Before connecting the GR8 battery tester, verify that the tester has been updated to the latest software version.**

1. Disconnect the battery positive and negative cables to isolate the battery. Connect the (special tool #GR8-1220KIT-CHRY, AGM Battery Tester/Charger Station) directly to the battery posts and select the battery charging and testing procedure on the screen.
2. Follow the prompts on the GR8 battery tester screen and fill in the vehicle information.
3. When the battery test has completed, the tester will display the results on the screen.
4. While viewing the battery test result, press the CODE button and the tester will prompt you for the last 4 digits of the Vehicle Identification Number (VIN). Use the UP/DOWN arrow buttons to scroll to the correct character; then press ENTER to select and move to the next digit. Then press the ENTER button to view the SERVICE CODE. Pressing the CODE button a second time will return you to the test results.
    1. If the battery fails the load testing below, record the failure code and replace the battery.
    2. If the battery DOES NOT fail the load testing below, reconnect the battery and retest the system. If the battery, starting and charging systems test good, but the battery discharges after sitting, check

the electrical system for an ignition off draw. Refer to **IGNITION OFF DRAW TEST** .

NOTE: **The SERVICE CODE is required on every warranty claim submitted for battery replacement.**

NOTE: **Perform an IBS reset by removing the IBS from the battery cable end and disconnecting the IBS harness connector for 30 seconds after an auxiliary battery is charged or replaced. This will allow the IBS to default to an 80% SOC and initiate the quick learning curve. For a detailed explanation on the IBS reset, refer to the Battery System Description and Operation.**

CHECKING FOR THE POWER CONTROL RELAY NOT DISCONNECTING PROPERLY WHEN COMMANDED DURING CRANKING: It can be difficult to test the power control relay for properly disconnecting during an engine cranking event without using a lab scope. This is due to the relay only being energized (opened) for approximately 20-40ms.

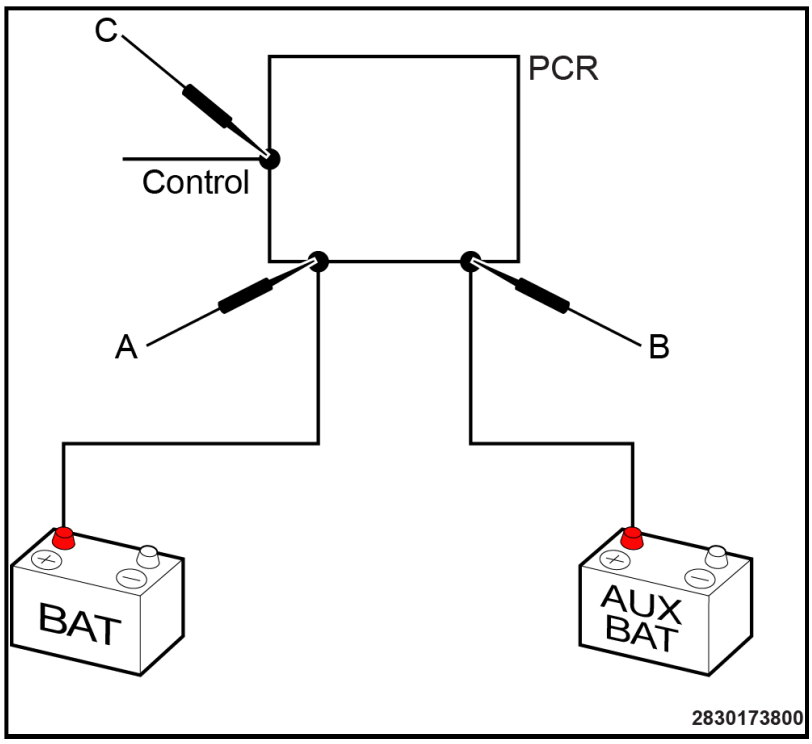
TECH TIPS:

- The normally closed power control relay should be closed 99% of the time. It is only opened by the PCM during the starter in-rush at initial engine cranking.
- A severely depleted auxiliary battery could set a fault due to the voltage difference between the batteries being less than the calibrated threshold during a cranking event when the batteries are separated.

1. Disconnect the power control relay harness connector. Load test the power control relay coil ground circuit.
    1. If the ground circuit fails the load test, repair the ground circuit for an open or high resistance.
    2. If the ground circuit passes the load test, reconnect the power control relay harness connector.
        - Continue to step 2 to test without a lab scope.
        - Continue to step 4 to test with a lab scope.
2. The relay should energize and open when 12v is supplied to the relay on the control circuit, which comes from the output of the PCR control relay inside the PDC. The PCR control relay is typically a Printed Circuit Board (PCB) relay which cannot be removed and jumped across. Turn the ignition on and perform one of the following to energize the power control relay:
    1. If there is an actuator available in the scan tool, command the power control relay on.
    2. Using a test light connected to ground, back probe the PCR control relay low side driver control circuit at the PDC connector to energize the relay.
    3. Using a fused jumper connected to B+, back probe the power control relay control circuit at the power control relay harness connector to energize the relay.

    Continue to step 3.

3. With 12v provided to the power control relay, measure the voltage at both cable end terminals of the power control relay. If the relay is disconnected, the voltage on the auxiliary battery terminal should start to drop below the voltage on the main battery terminal due to the load on the auxiliary battery.
    1. If the voltage starts to drop on the terminal that leads to the auxiliary battery, the relay is functioning properly.
    2. If the voltage drops drastically below approximately 8v on the terminal connected to the auxiliary battery, isolate and test the auxiliary battery with the GR8 battery tester.
    3. If the voltage at both terminals remains the same, replace the power control relay and retest.
        - Perform an IBS reset by removing the IBS from the battery cable end and disconnecting the IBS harness connector for 30 seconds after an auxiliary battery is charged or replaced. This will allow the IBS to default to an 80% SOC and initiate the quick learning curve.



4. To test with a lab scope, connect channel A to the main battery side terminal of the power control relay. Connect channel B to the auxiliary battery side terminal of the power control relay. Connect channel C to the control circuit at the power control relay. Set the channels to the 20v scale. Crank the engine and record the voltage reads. The voltage on the main battery (channel A) side should drop considerably during cranking. At initial starter in-rush the voltage can drop to as low as 7.0 volts. If the power control relay is operating correctly, you should simultaneously see 12v present on the control circuit (channel C) and the auxiliary battery side voltage (channel B) should stay near 12v during the initial 20-40ms of starter engagement. After this brief period, channel C should drop back to 0v and the relay will de-energize (close), and the voltages should equalize on channel A and channel B.
    1. If the auxiliary battery voltage (channel B) stays near 12v as the main battery voltage (channel A) drops at initial cranking, the power control relay and system are functioning properly.
    2. If the auxiliary battery voltage (channel B) stays the same as the main battery voltage (channel A) when the voltage drops at initial cranking, the power control relay likely did not open.
        - If 12v was present on the control circuit (channel C), the relay is faulty. Replace the relay and retest.
        - If 12v was NOT present on the control circuit (channel C), check the control circuit and fuse for an open. If the fuse is open, check the circuit for a short to ground. If the circuit and fuse check good, check the operation of the PCR Control Relay inside the PDC.
    3. If the auxiliary battery voltage (channel B) drops severely (below approximately 8.0 volts) but is not the same as the main battery voltage (channel A) at initial cranking, the auxiliary battery is likely faulty or severely undercharged. Test the auxiliary battery using the GR8 Battery Tester.

IGNITION OFF DRAW TEST

The term Ignition-OFF Draw (IOD) identifies a normal condition where power is being drained from the battery with the ignition switch in the OFF position. A normal vehicle electrical system will draw up to 50 milliamperes (0.050 ampere) with the ignition switch in the OFF position, and all non-ignition controlled circuits in proper working order. Up to 50 mA are needed to enable the memory functions for the Powertrain Control Module (PCM), digital clock, electronically tuned radio, and other modules which may vary with the vehicle equipment.

Excessive IOD can be caused by:

- Electrical items left on
- Inoperative or improperly adjusted switches
- Inoperative or shorted electronic modules and components

- An internally shorted generator
- Intermittent shorts in the wiring

If the IOD is over 50 milliamperes, the problem must be found and corrected before replacing a battery. In most cases, the battery can be charged and returned to service after the excessive IOD condition has been corrected.

1. Verify that all electrical accessories are OFF. Turn OFF all lamps, remove the ignition key, and close all doors. If the vehicle is equipped with an illuminated entry system or an electronically tuned radio, allow the electronic timer function of these systems to shut OFF (time out). This may take up to thirty minutes.

   Refer to the following Electronic Module Ignition-OFF Draw Table for more information:

ELECTRONIC MODULE IGNITION-OFF DRAW (IOD) TABLE			
Module	**Time Out? (If Yes, Interval And Wake-Up Input)**	**IOD**	**IOD After Time Out**
Radio	No	200 mA for 30 minutes after ignition is shut OFF. Base vehicle IOD 25 mA when bus(es) are down and all modules are in 'sleep' mode.	N/A
USB/MEDIA Ports	Yes/Ignition on	0.38mA for 60 minutes after ignition is shut OFF. Base vehicle IOD 25 mA when bus(es) are down and all modules are in 'sleep' mode.	N/A
Audio Power Amplifier	No	up to 1 mA	N/A
Powertrain Control Module (PCM)	No	0.95 mA	N/A
Instrument Panel Cluster (IPC)	No	0.44 mA	N/A

2. Determine that the under hood lamp is operating properly, then disconnect the lamp wire harness connector or remove the lamp bulb.
3. Turn OFF all electrical accessories.
4. Disconnect and isolate the negative battery cable. If equipped with an Intelligent Battery Sensor (IBS), disconnect the IBS connector first before disconnecting the negative battery cable.

   NOTE: **If equipped, disconnect the negative side of the Auxiliary Battery. This must be disconnected for the duration of the test.**

   CAUTION: **Do not open any doors, or turn on any electrical accessories with the lowest milliampere scale selected, or the multi-meter may be damaged.**

5. Connect a 10 gauge jumper wire between the negative battery cable and the negative battery post.
6. Turn the ignition key ON and then OFF and wait for all systems to enter sleep mode. **This can take up to 60 minutes.**

   NOTE: **Do not break the connection between the jumper wire and the battery. If the connection between the negative battery and the negative cable terminal clamp is lost during any part of the IOD test, the electronic timer function will be activated and all of the tests will have to be repeated.**

7. Set an electronic digital multimeter to its highest amperage scale. Connect the multimeter to the battery negative cable terminal clamp and the negative battery terminal, but not on the jumper connection.

8. Remove the jumper wire without breaking the digital multimeter connection.
9. The multimeter leads must be securely clamped to the battery negative cable terminal clamp and the negative battery terminal, but not the jumper wire.
10. The high amperage IOD reading on the multimeter should be very low or nonexistent, depending upon the electrical equipment in the vehicle. If the amperage reading remains high, remove and replace each fuse or circuit breaker in the Body Control Module (BCM) and Power Distribution Center (PDC), one at a time until the amperage reading becomes very low, or nonexistent. Refer to the appropriate wiring information for complete BCM and PDC, circuit breaker, and circuit identification. This will isolate each circuit and identify the circuit that is the source of the high amperage IOD. If the amperage reading remains high after removing and replacing each fuse, disconnect the wire harness from the generator. If the amperage reading now becomes very low or nonexistent, diagnose and repair the Charging System as necessary. After the high amperage IOD has been corrected, switch the multimeter to progressively lower amperage scales and, if necessary, repeat the fuse and circuit breaker remove-and-replace process to identify and correct all sources of excessive IOD. It is now safe to select the lowest milliampere scale of the multimeter to check the low-amperage IOD.
11. Observe the multimeter reading. The low-amperage IOD should not exceed 50 milliamperes (0.050 ampere). If the current draw exceeds 50 milliamperes, isolate each circuit using the fuse and circuit breaker remove-and-replace process. The multimeter reading will drop to within the acceptable limit when the source of the excessive current draw is disconnected. Repair this circuit as required; whether a wiring short, incorrect switch adjustment, or an inoperative component is the cause.

OPEN CIRCUIT VOLTAGE TEST

A battery open circuit voltage (no load) test will show the approximate state of charge of a battery.

Before proceeding with this test, completely charge the battery. Refer to **12 VOLT BATTERY CHARGING** .

1. Before measuring the open circuit voltage, the surface charge must be removed from the battery. Turn on the headlights for 15 seconds, then allow up to five minutes for the battery voltage to stabilize.
2. Disconnect and isolate the negative battery cable. If equipped with an Intelligent Battery Sensor (IBS), disconnect the IBS connector first before disconnecting the negative battery cable.
3. Using a voltmeter connected to the battery posts (see the instructions provided by the manufacturer of the voltmeter), measure the open-circuit voltage.

See the Open Circuit Voltage Table. This voltage reading will indicate the battery state of charge, but will not reveal its cranking capacity. If a battery has an open-circuit voltage reading of 12.4 volts or greater, it may be load tested to reveal its cranking capacity.

OPEN CIRCUIT VOLTAGE TABLE	
Open Circuit Voltage	**Charge Percentage**
11.7 volts or less	0%
12.0 volts	25%
12.2 volts	50%
12.4 volts	75%
12.8 volts or more	100%

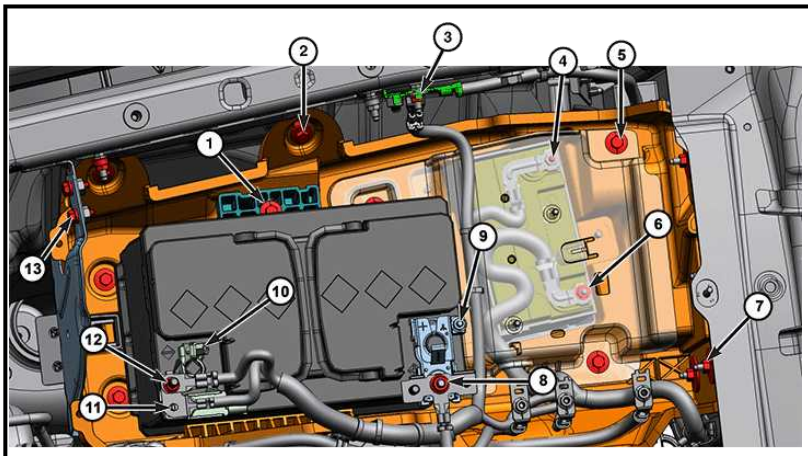
TECHNICAL SPECIFICATIONS

BATTERY

Â	3.6L w/ESS	3.6L w/ESS Optional	3.0L Diesel	Auxiliary Battery
Voltage (V)	12	12	12	12
Capacity (Ah)	65	70	80	12
Intensity (A)	600	650	700	200

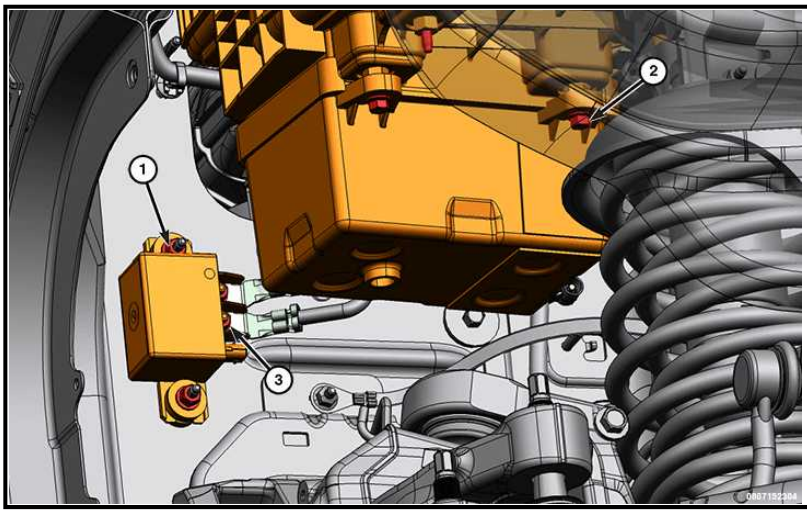
TORQUE SPECIFICATIONS

BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only



STANDARD PROCEDURE

12 VOLT BATTERY CHARGING

WARNING: **Never exceed twenty amperes when charging a cold (-1Â° C [30Â° F] or lower) battery. The battery may arc internally and explode. Personal injury or vehicle damage may result.**

WARNING: **If the battery shows signs of freezing, leaking, loose posts, do not test, assist-boost, or charge. The battery may arc internally and explode. Personal injury or vehicle damage may result.**

WARNING: **EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY OR VEHICLE DAMAGE MAY RESULT.**

WARNING: **THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.**

CAUTION: **Always disconnect and isolate the battery negative cable before charging a battery. Do not exceed sixteen volts while charging a battery. Damage to the vehicle electrical system components may result.**

CAUTION: **Battery electrolyte will bubble inside the battery case during normal battery charging. Electrolyte boiling or being discharged from the battery vents indicates a battery overcharging condition. Immediately reduce the charging rate or turn off the charger to evaluate the battery condition. Damage to the battery may result from overcharging.**

CAUTION: **The battery should not be hot to the touch. If the battery feels hot to the touch, turn off the charger and let the battery cool before continuing the charging operation. Damage to the battery may result.**

CHARGING A BATTERY: Batteries should be charged one of two ways depending on the situation and reason for charging. A battery is fully-charged when:

- The Midtronics (special tool #GR8-1220KIT-CHRY, AGM Battery Tester/Charger Station) tester indicates battery is GOOD.
- All of the battery cells are gassing freely during battery charging.
- An Open-circuit voltage of the battery is 12.6 volts or above.

NOTE: **It was previously documented to never blind charge a vehicle at the pole clamp. However, if the vehicle is brought in with a battery issue or complaint, and the battery is being charged and tested using the GR8 Battery Tester, the tester should be connected directly to the Pole clamp at the negative Battery post. With the updates done on the GR8 Battery Tester, it will not test the battery correctly if connected and charged through the Intelligent Battery Sensor (IBS). After performing any testing requiring blind charging, a battery has been replaced or after any repairs are made, the IBS reset should be initiated to allow the IBS to update quickly. See the IBS Component Functional Description information in the Battery System Description and Operation for details on initiating the IBS learning curve.**

CHARGING USING THE GR8 BATTERY TESTER (RECOMMENDED)

1. The GR8 tester software has been updated to improve testing and charging. Before connecting the GR8 battery tester, verify that the tester has been updated to the latest software version.
2. Disconnect the battery cables from the battery posts.
3. Connect the GR8 battery tester to the vehicle and select battery charging.
4. Pick the type of battery being charged (AGM, Lead Sulfated).

   NOTE: **If unsure which type of battery is being tested, check the sticker on top of the battery. AGM batteries will typically be called out on the sticker indicating that the battery is an AGM battery. On some vehicles the battery thermal cover may need to be pulled back to see the sticker.**

5. Charge the battery with the GR8 tester.

   NOTE: **An AGM battery should never be charged above 14.4 volts. A standard flooded battery should not be charged above 14.4 volts for an extended period.**

6. The screen should display the amperage, voltage, and the expected charge time.

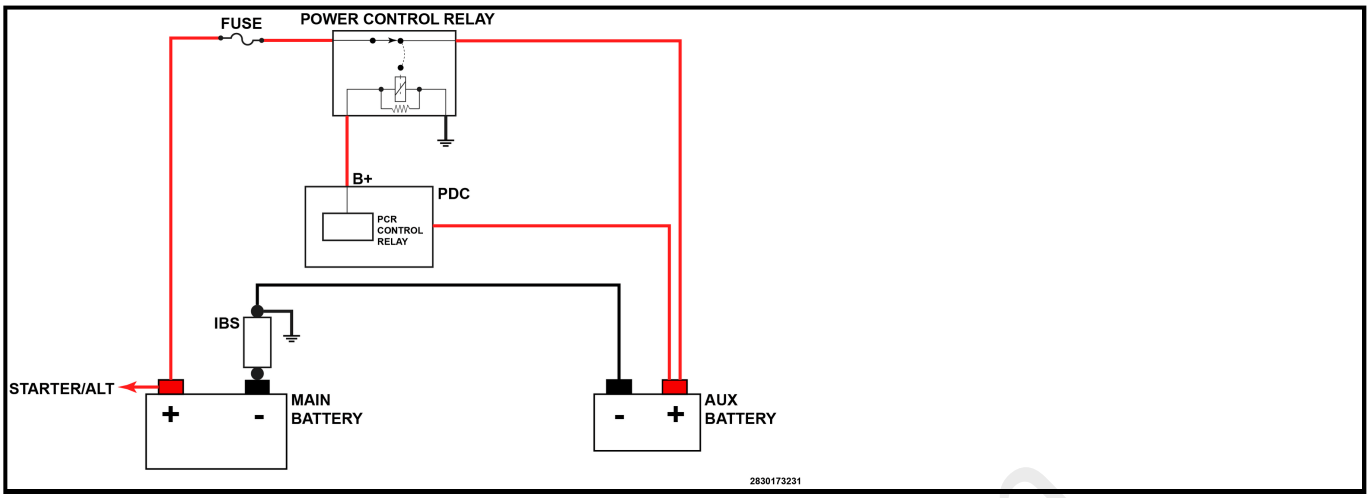
CHARGING USING A STANDARD BATTERY CHARGER

- This should only be performed if the vehicle was not brought in for a battery issue and a battery is depleted during service. The battery should be charged through the IBS. To do this the negative clamp on the charger should be placed on the negative cable attachment to the IBS, the Jump Post terminal if equipped, or a good chassis ground, NOT the Pole clamp at the negative Battery post. Without proper clamp placement, the IBS data will not update.

NOTE: **An AGM battery should never be charged above 14.4 volts. A standard flooded battery should not be charged above 14.4 volts for an extended period.**

Perform an IBS reset by removing the IBS from the battery cable end and disconnecting the IBS harness connector for 30 seconds after an auxiliary battery is charged or replaced on a dual 12 volt battery system. This will allow the IBS to default to an 80% State Of Charge (SOC) and initiate the quick learning curve. For a detailed explanation on the IBS reset, refer to the Battery System Description and Operation.

BATTERY DISCONNECT - DUAL 12 VOLT BATTERY SYSTEM



On this dual battery system the auxiliary battery ground cable connects to the main battery cable end (shown in generic graphic above) and grounds through the main battery ground cable connection to the body, chassis or engine (depending on vehicle). Therefore, simply disconnecting and isolating the main battery negative cable clamp from the main battery post will not isolate the auxiliary from the vehicle's electrical system. The auxiliary battery will still be grounded through it's connection to the main battery negative cable end. If both battery negative cables are not isolated it will result in the vehicle electrical system and Power Distribution Center (PDC) still having battery connection which can cause vehicle wiring damage or deployment of air bags on re-connection.

DUAL BATTERY DISCONNECT PROCEDURE:

1. Turn the ignition off. Wait five minutes to allow the main modules to go to sleep.
2. Disconnect and isolate the supplemental (auxiliary) battery negative cable from the main battery negative cable end. This will disconnect and isolate the auxiliary battery ground.
3. The main battery ground can be disconnected by removing the main battery negative cable from the negative battery cable end, or by disconnecting the IBS connector, loosening the negative battery clamp nut and removing the negative battery cable end from the battery post. Either method will disconnect the main battery. Both batteries should be disconnected from the vehicle electrical system.
4. Measure the voltage at the PDC positive battery cable connection to verify the vehicle electrical system is powered down.

NOTE: **On some vehicles a small amount of voltage may be present (typically less than approximately 0.5 volts) due to capacitors is some modules still having voltage stored. Anything less than 1.0 volts should be safe.**

DUAL BATTERY CONNECT PROCEDURE:

1. Connect the main battery negative clamp to the post and tighten to the proper specifications, or connect the main battery negative cable to the negative cable clamp. Refer to **TORQUE SPECIFICATIONS** . If the main battery negative cable is connected with a nut, install the nut and tighten to the proper specifications. Refer to **TORQUE SPECIFICATIONS** .
2. Connect the IBS harness connector if disconnected.
3. Connect the auxiliary battery negative cable to the main battery negative cable clamp. If connected by a nut, install the nut and tighten to the proper specifications. Refer to **TORQUE SPECIFICATIONS** .

NOTE: **Overtightening of the nuts connecting the negative cables to the IBS may cause damage to the IBS or break the stud.**

BATTERY

REMOVAL AND INSTALLATION

PRIMARY BATTERY - LHD

REMOVAL

WARNING: **To protect the hands from battery acid, a suitable pair of heavy duty rubber gloves should be worn when removing or servicing a battery. Safety glasses also should be worn.**

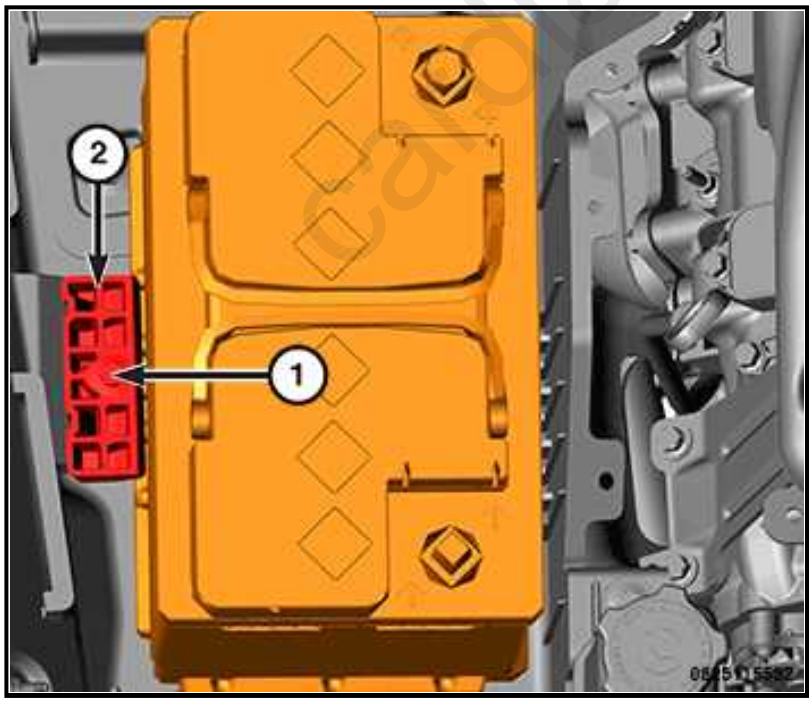
WARNING: **Remove metallic jewelry to avoid injury by accidental arcing of battery current.**

WARNING: **The battery negative and positive cable polarity are different from the gasoline engine equipped vehicles to the diesel engine equipped vehicles. Please note the location of the positive and negative cables prior to service of the battery or related components.**

1. Disconnect and isolate the negative battery cable(s). Refer to **CABLES, BATTERY** .
2. Disconnect and isolate the positive battery cable.

NOTE: **On the positive cable there is a plastic clip that will be attached to the cable, you must use a trim stick to remove the clip lock to the battery or it will break off from the cable.**

3. Remove the thermal guard (if equipped) from the battery.



1 - Battery Bracket Bolt
2 - Battery Bracket

4. Remove the battery bracket bolt and remove the battery bracket.
5. Remove the battery from the vehicle.

INSTALLATION

WARNING: **The battery negative and positive cable polarity are different from the gasoline engine equipped vehicles to the diesel engine equipped vehicles. Please note the location of the positive and negative cables prior to service of the battery or related components.**

During installation, torque the fasteners to the specifications in the torque table(s) below.

Follow the removal procedure in reverse for general reassembly of the components on the vehicle. The steps listed below are calling out specific procedures that should be followed during installation.

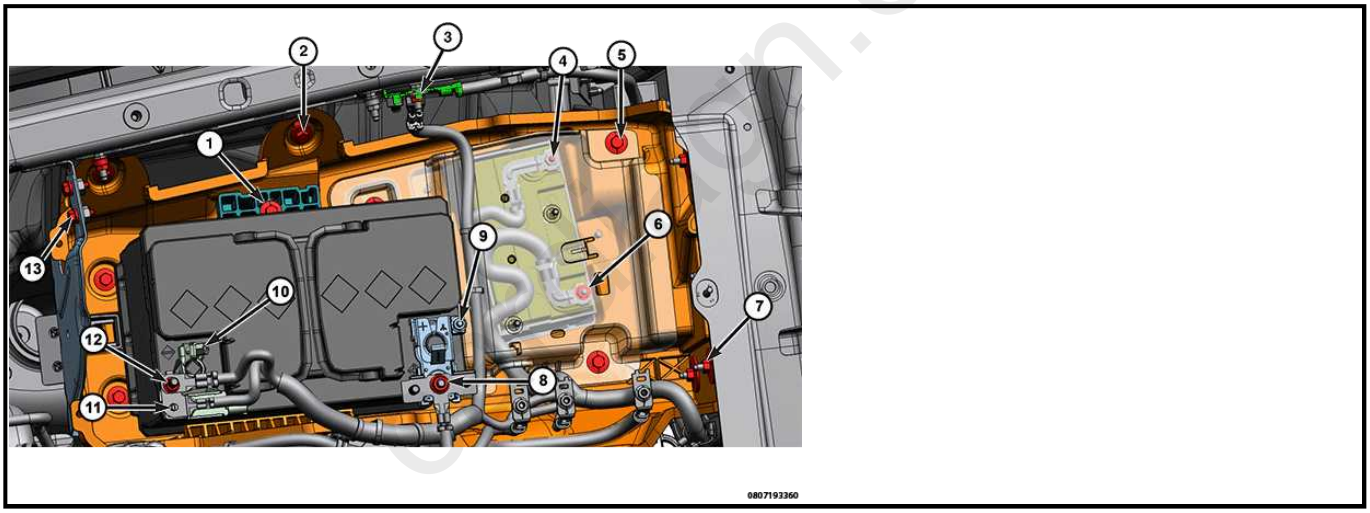
- When replacing the battery, the thermal guard MUST be transferred to the new battery (if equipped).
- Install the battery in the vehicle making sure that the thermal guard (if equipped) is present and the battery is properly positioned in the battery tray.

NOTE: **Left hand drive gasoline engine shown, left hand drive diesel similar. Right hand drive gasoline and diesel similar with the battery and related components packaged on the left side of the engine compartment.**

- Verify that all features are operating properly before returning vehicle.

TORQUE SPECIFICATIONS

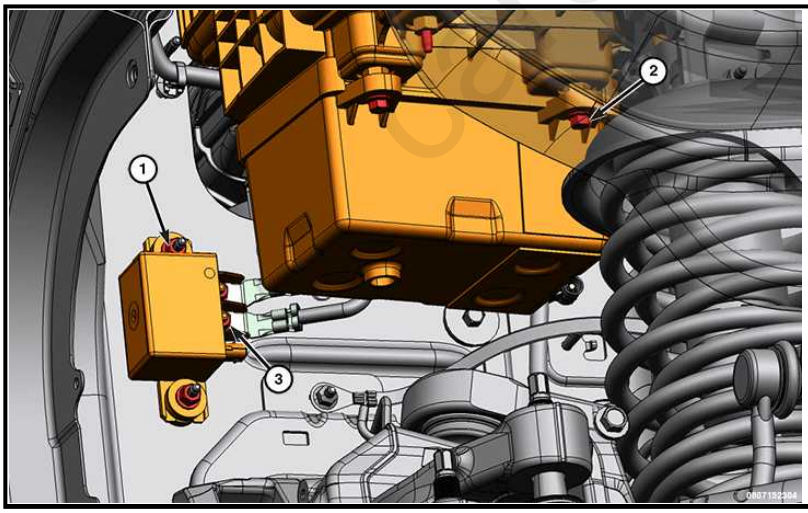
BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
			NEW fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only



BATTERY, SUPPLEMENTAL

REMOVAL AND INSTALLATION

SUPPLEMENTAL BATTERY - LHD

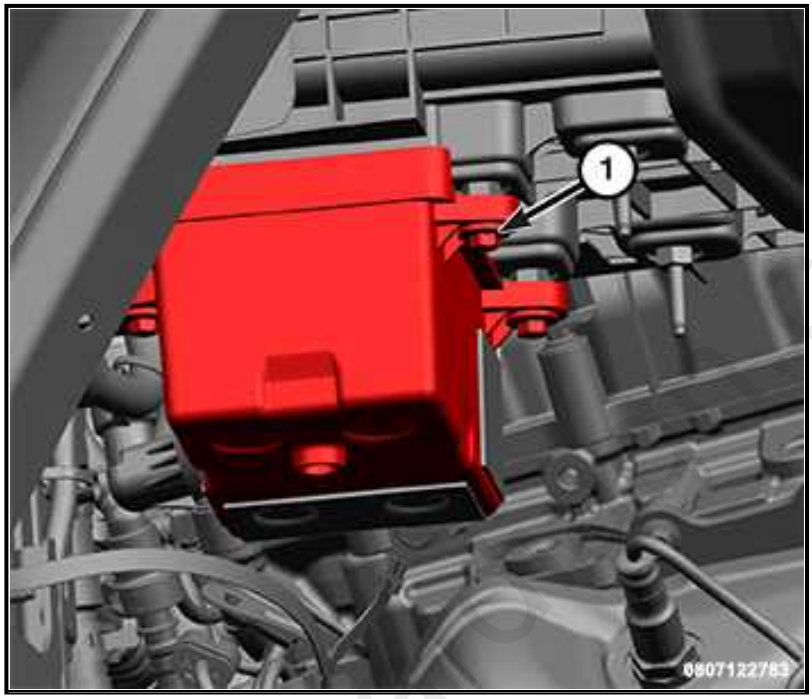
REMOVAL

WARNING: **To protect the hands from battery acid, a suitable pair of heavy duty rubber gloves should be worn when removing or servicing a battery. Safety glasses also should be worn.**

WARNING: **Remove metallic jewelry to avoid injury by accidental arcing of battery current.**

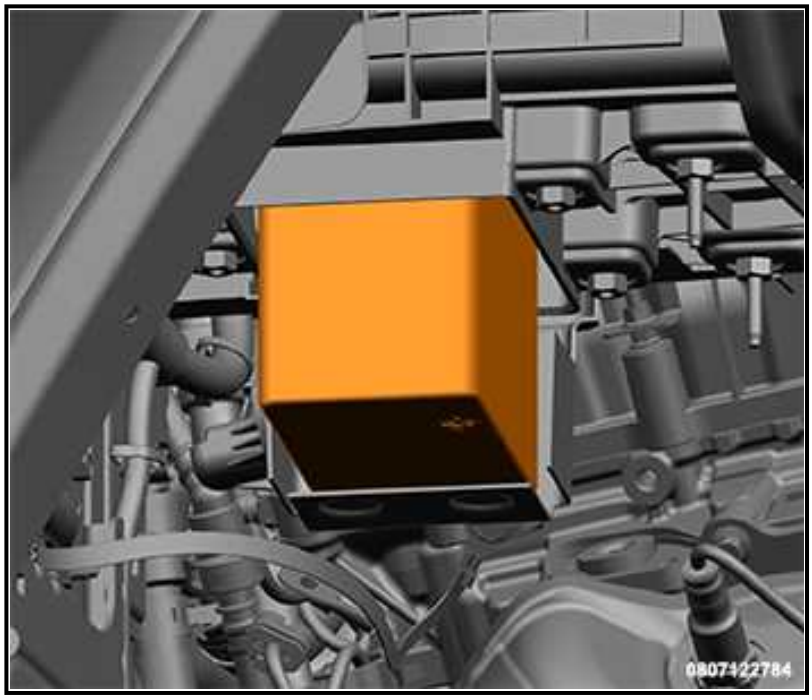
WARNING: **The battery negative and positive cable polarity are different from the gasoline engine equipped vehicles to the diesel engine equipped vehicles. Please note the location of the positive and negative cables prior to service of the battery or related components.**

1. Disconnect and isolate the negative battery cable(s). Refer to **CABLES, BATTERY** .
2. Remove the right front splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL AND INSTALLATION** , or **SHIELD, SPLASH, REAR WHEELHOUSE, REMOVAL AND INSTALLATION** .



1 - Supplemental Battery Tray Bolts

3. Remove the 3 bolts from the bottom of the Supplemental battery tray.



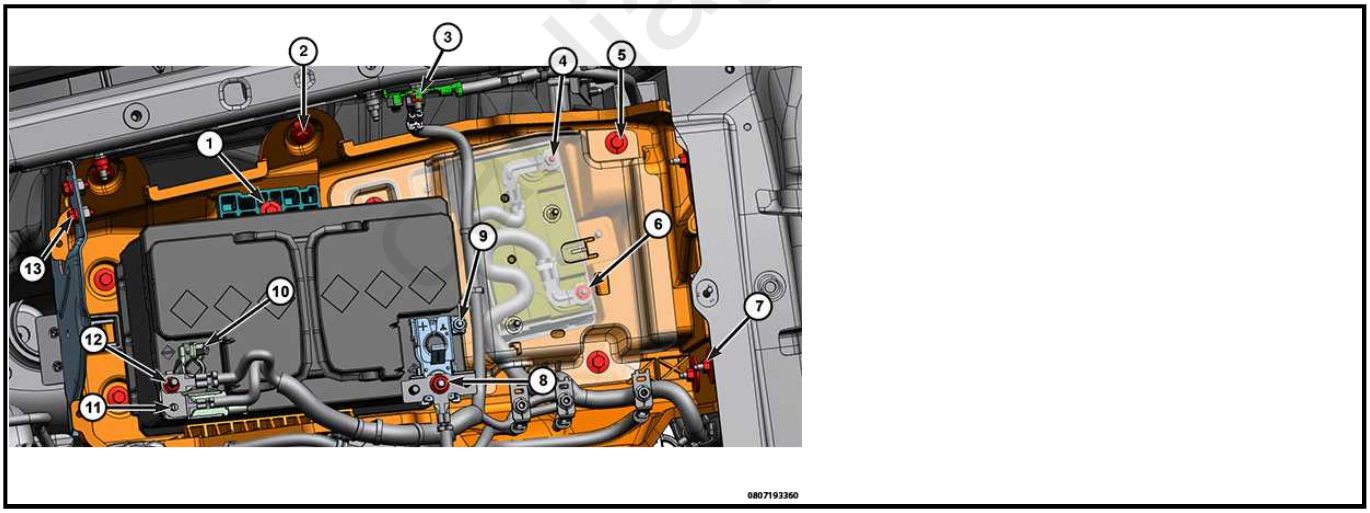
4. Remove the battery far enough out to gain access to the negative and positive cables for the supplemental battery. Disconnect and isolate both cables.
5. Remove the supplemental battery.

During installation, torque the fasteners to the specifications in the torque table(s) below.

Follow the removal procedure in reverse for general reassembly of the components on the vehicle.

TORQUE SPECIFICATIONS

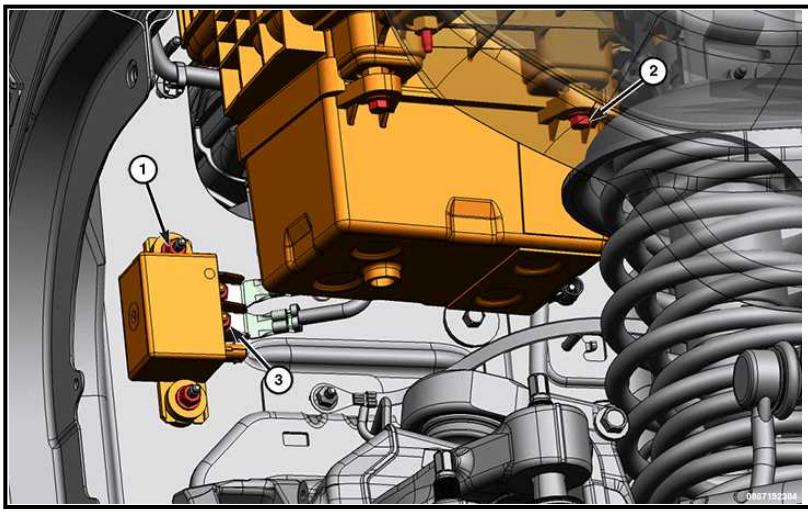
BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only



SUPPLEMENTAL BATTERY - DIESEL

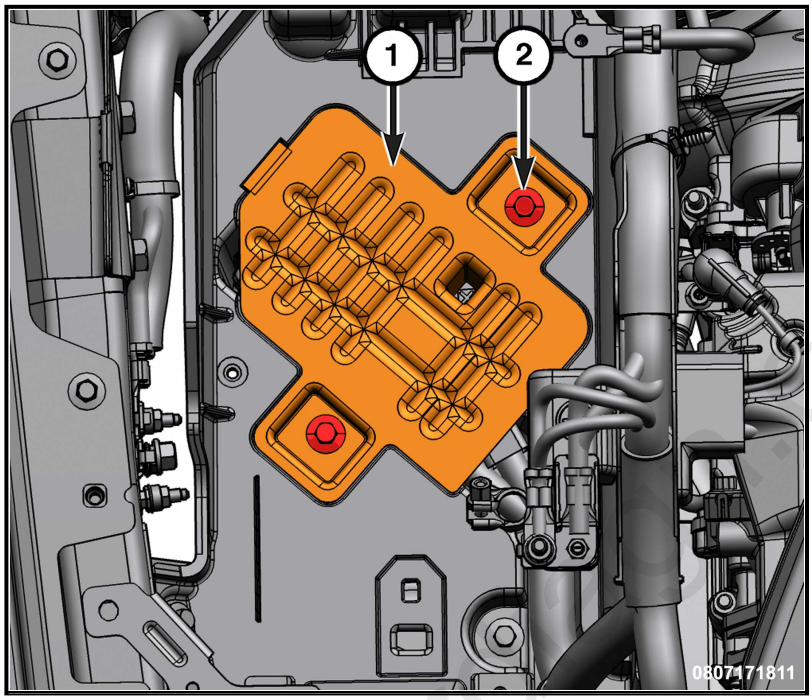
REMOVAL

WARNING: **To protect the hands from battery acid, a suitable pair of heavy duty rubber gloves should be worn when removing or servicing a battery. Safety glasses also should be worn.**

WARNING: **Remove metallic jewelry to avoid injury by accidental arcing of battery current.**

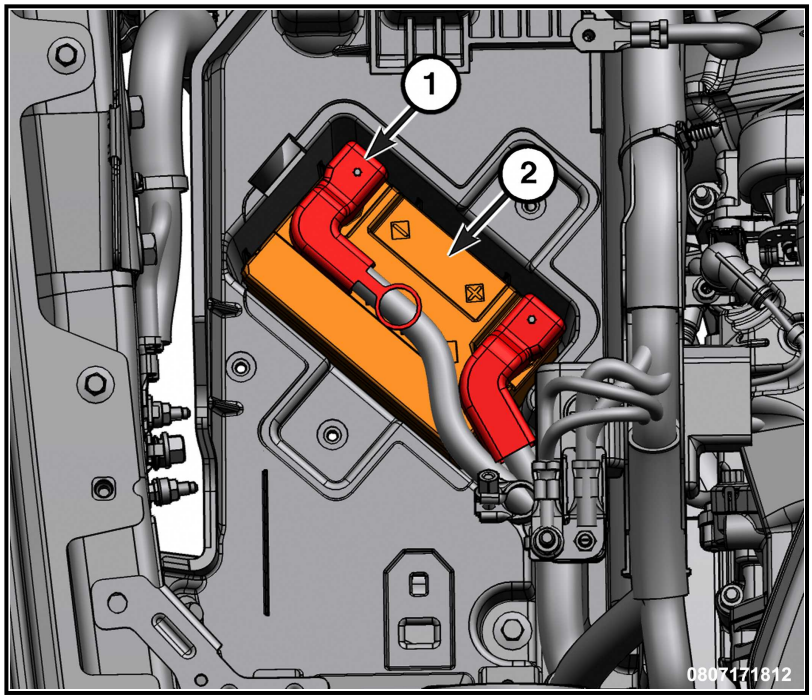
WARNING: **The battery negative and positive cable polarity are different from the gasoline engine equipped vehicles to the diesel engine equipped vehicles. Please note the location of the positive and negative cables prior to service of the battery or related components.**

1. Remove the main battery Refer to **BATTERY, REMOVAL AND INSTALLATION**, and **BATTERY, SUPPLEMENTAL, REMOVAL AND INSTALLATION**.



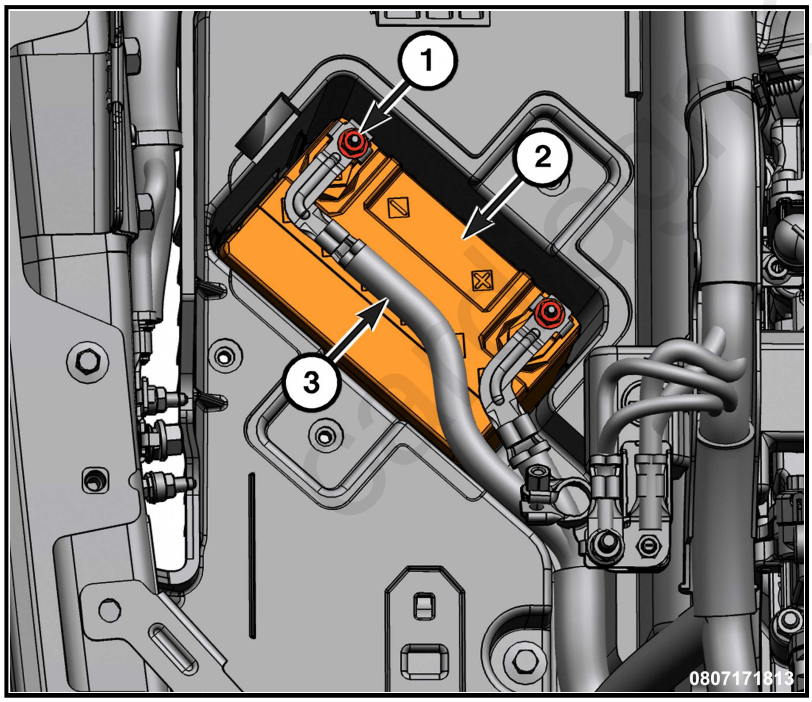
1 - Supplemental Battery Cover
2 - Cover Bolts

2. Remove the fasteners and the supplemental battery cover from the vehicle.



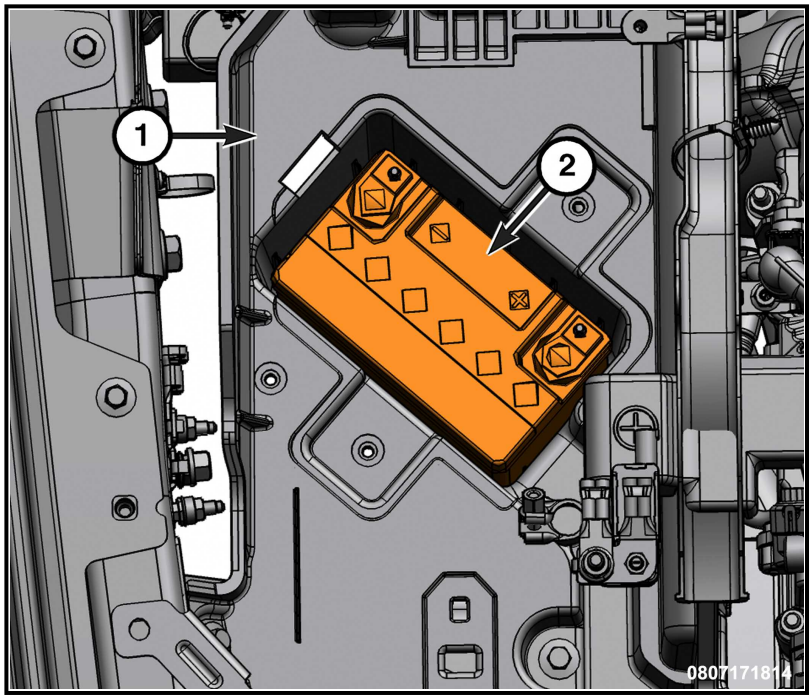
1 - Battery Terminal Covers
2 - Supplemental Battery

3. Release the protective battery terminal covers from the battery terminals and set aside.



1 - Battery Terminal Fasteners
2 - Supplemental Battery

4. Remove the fasteners from the supplemental battery post and set aside.



1 - Battery Tray
2 - Supplemental Battery

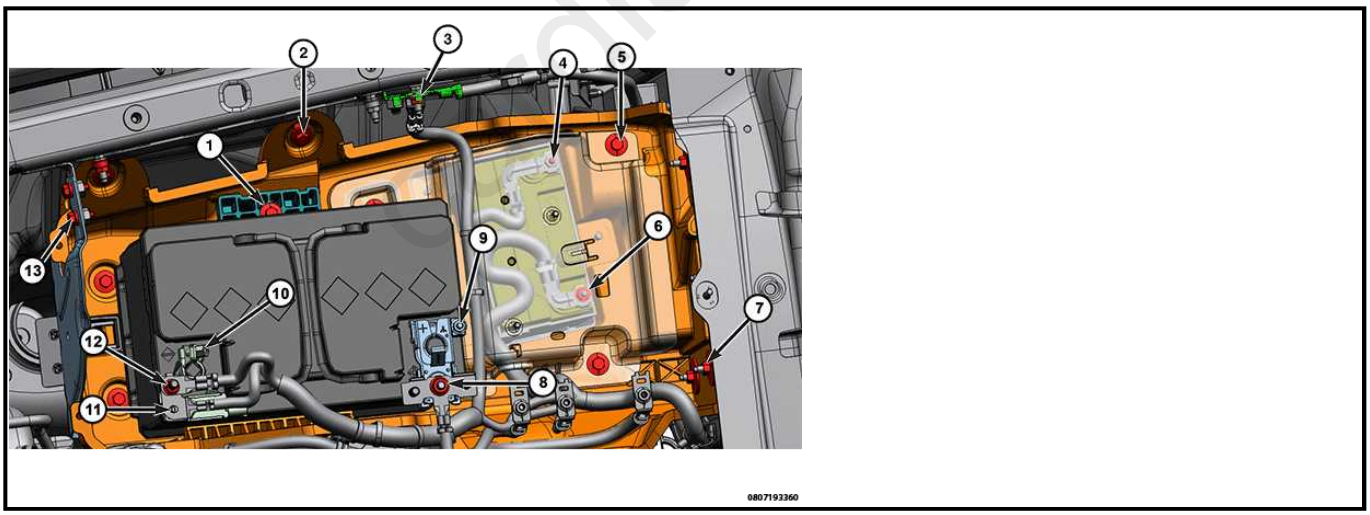
5. Remove the supplemental battery from the battery tray.

During installation, torque the fasteners to the specifications in the torque table(s) below.

Follow the removal procedure in reverse for general reassembly of the components on the vehicle.

TORQUE SPECIFICATIONS

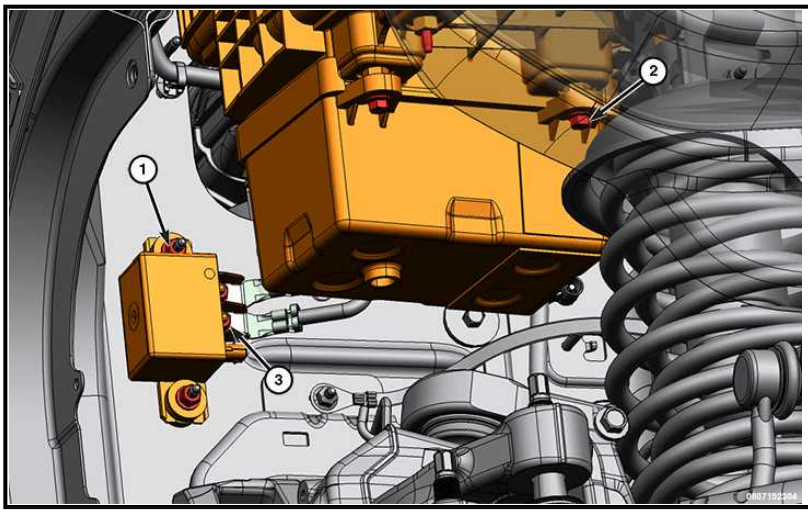
BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only



CABLES, BATTERY

REMOVAL AND INSTALLATION

REMOVAL AND INSTALLATION

The Battery cables for the battery Negative and Positive cables are part of the main harness and are not serviced separately. Please review the parts look up for the correct main harness per the application.

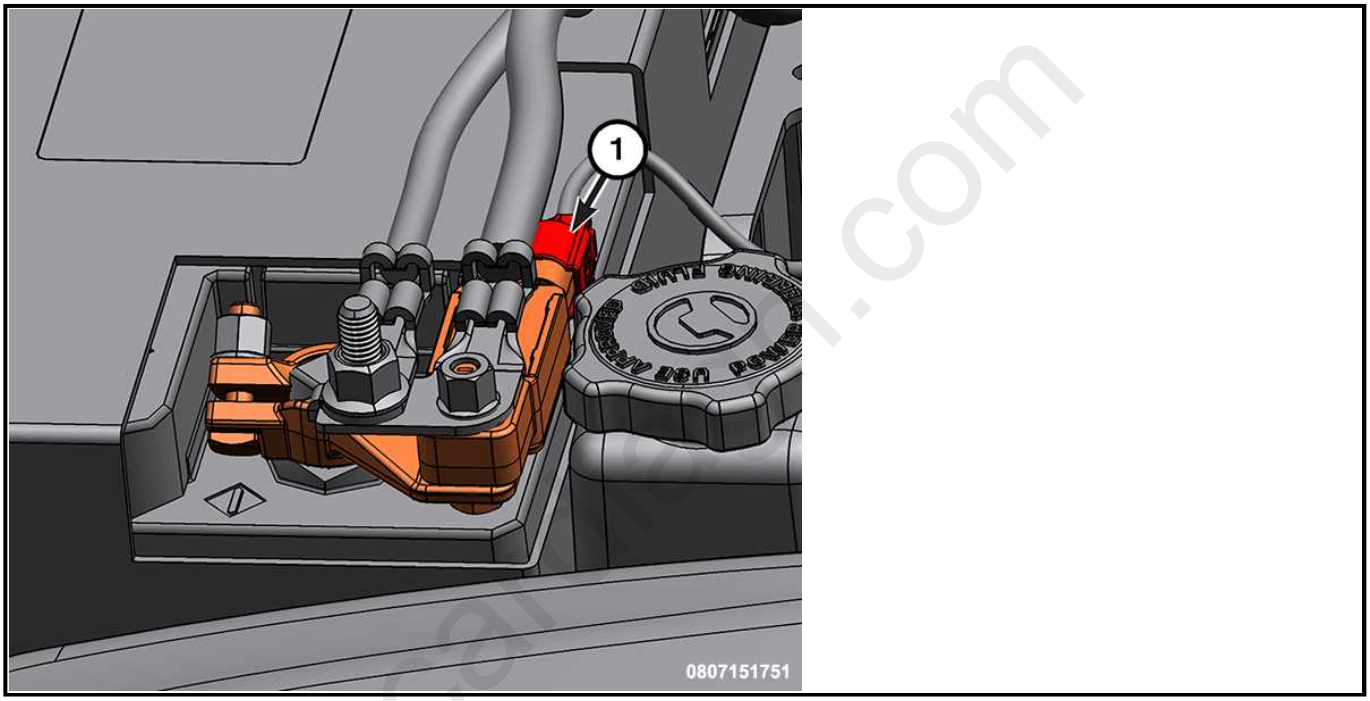
SENSOR, INTELLIGENT BATTERY (IBS)

REMOVAL AND INSTALLATION

INTELLIGENT BATTERY SENSOR (IBS)

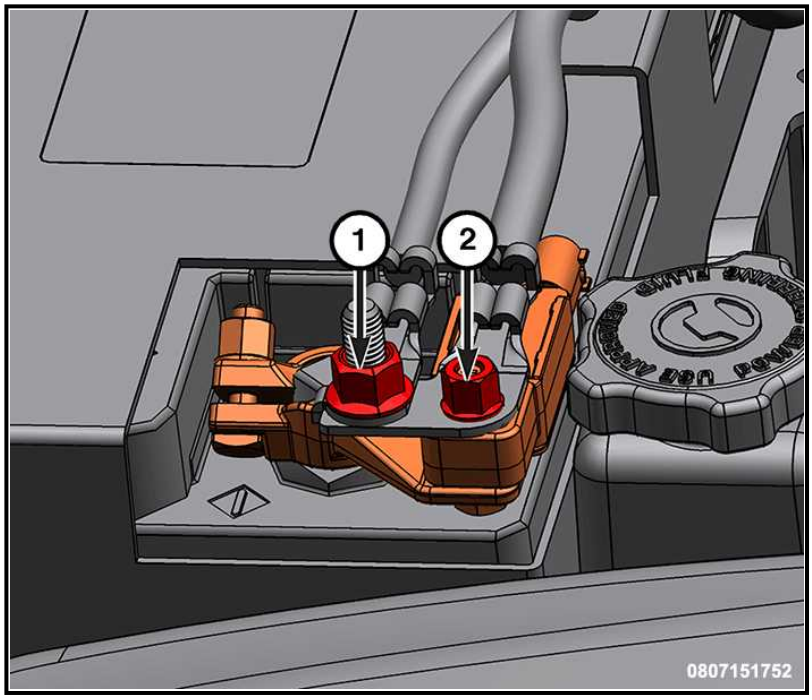
REMOVAL

NOTE: **Vehicle with auxiliary battery shown all others similar.**



1 - IBS Wire Harness Connector

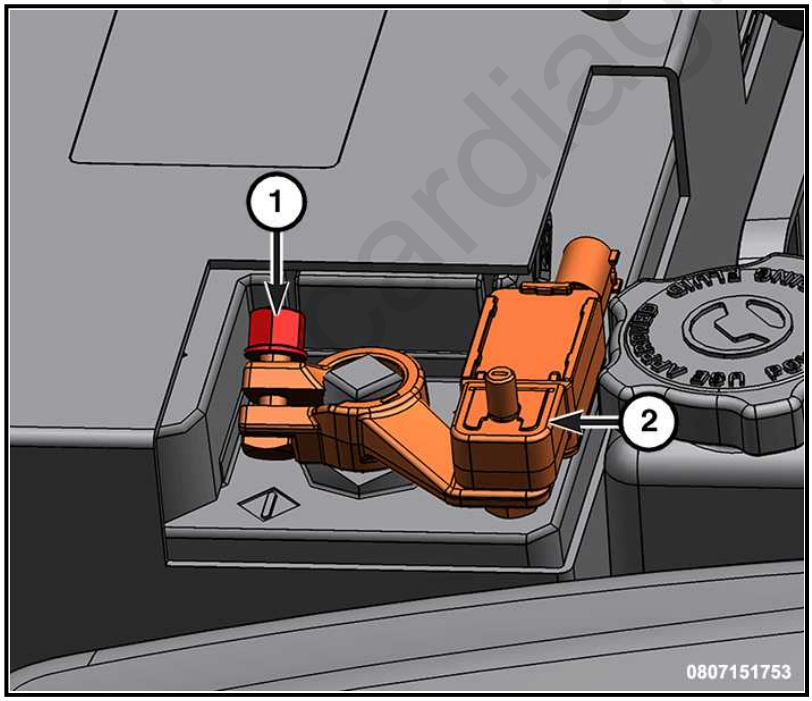
1. Disconnect the electrical connector from the IBS.



1 - M8 Nut
2 - M6 Nut

NOTE: **Failure to isolate the negative cables may cause damage to the auxiliary battery and other components.**

2. Stabilize the IBS, remove the M8 nut, remove the M6 nut, remove and isolate both negative battery cables.



1 - M6 Nut
2 - Intelligent Battery Sensor (IBS)

NOTE: **Do not remove the M6 nut from the IBS, it is a capture nut and if removed will damage the IBS.**

3. Loosen the M6 nut from the IBS, using the appropriate battery terminal puller, remove the IBS from the negative battery post.

INSTALLATION

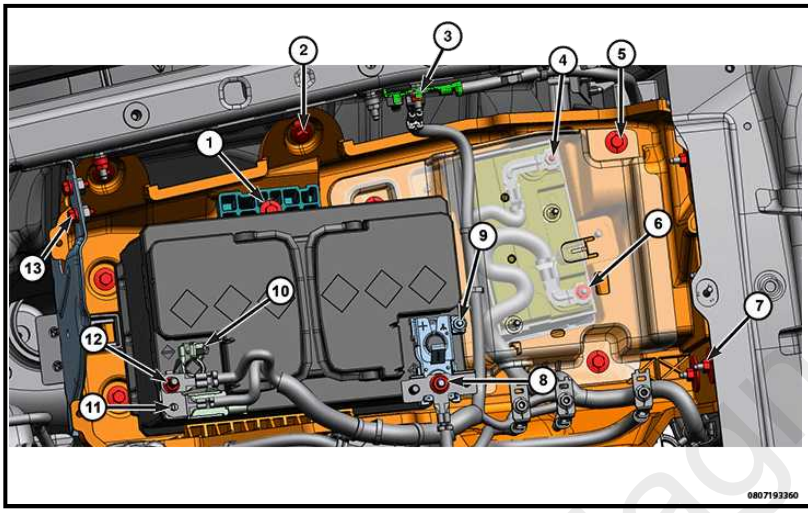
During installation, torque the fasteners to the specifications in the torque table(s) below.

Follow the removal procedure in reverse for general reassembly of the components on the vehicle. The steps listed below are calling out specific procedures that should be followed during installation.

- **DO NOT** use a hammer to tap down the sensor. Use a post spreader to open the post if reusing the existing sensor.
- Avoid IBS rotation during tightening to avoid contact of the 2 way connector or breakage may occur.
- Place the IBS onto the negative battery post and push the IBS down until properly seated on the negative battery post. Stabilize the IBS and tighten the battery terminal nut.

TORQUE SPECIFICATIONS

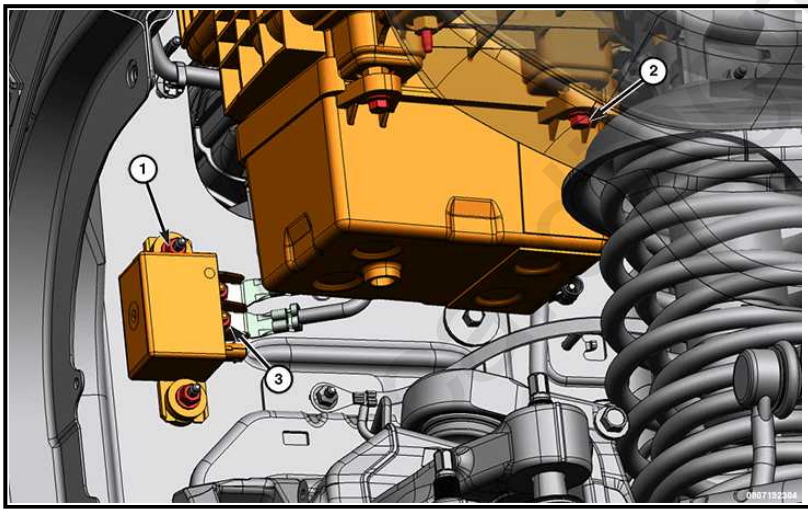
BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only



TRAY, BATTERY

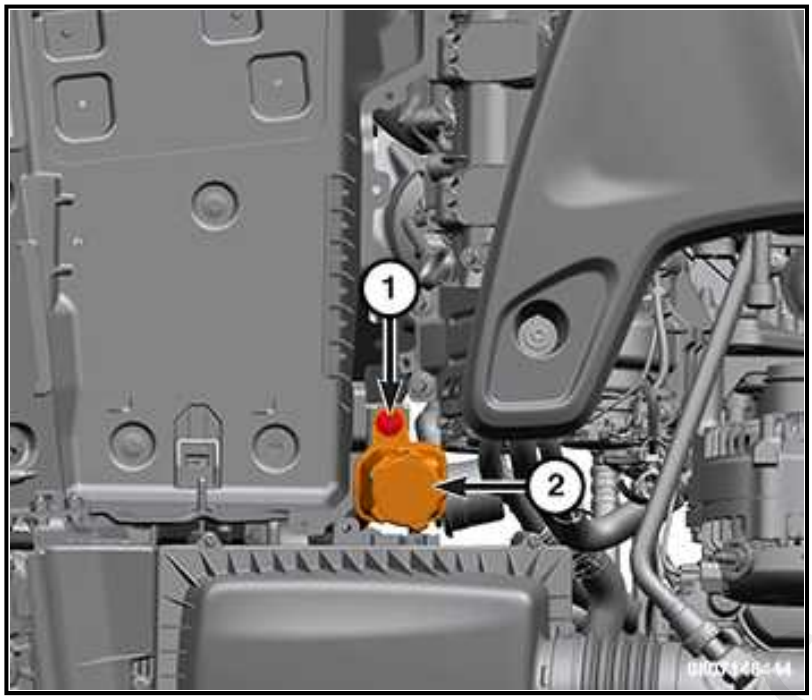
REMOVAL AND INSTALLATION

BATTERY TRAY - GAS (LHD)

NOTE: **Left hand drive shown. Right hand drive similar with the battery and related components packaged on the left side of the engine compartment.**

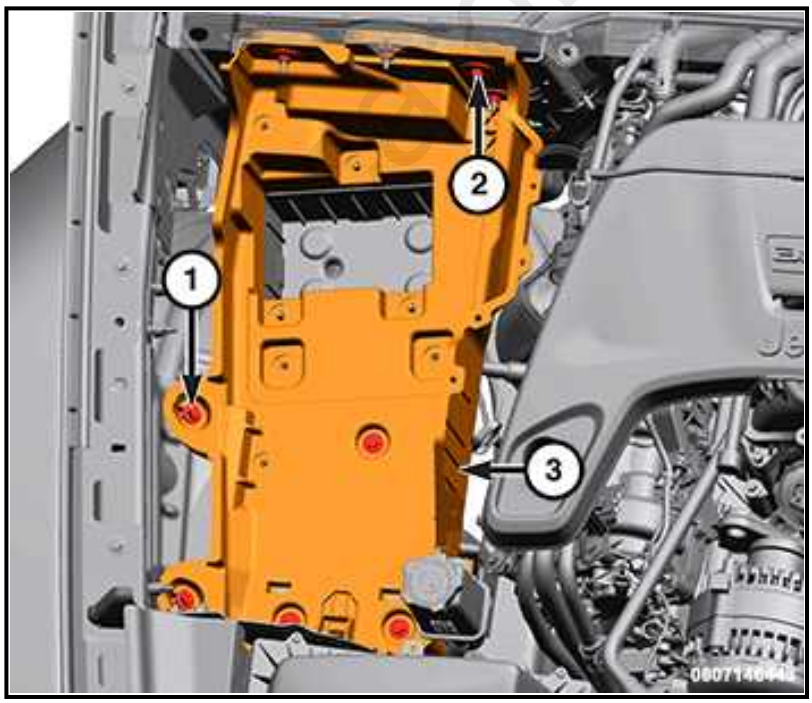
1. Disconnect and isolate the negative battery cable(s). Refer to **CABLES, BATTERY** .
2. Remove the air filter assembly. Refer to **BODY, AIR CLEANER, REMOVAL AND INSTALLATION** .
3. Remove the main battery. Refer to **BATTERY, REMOVAL AND INSTALLATION**, and **BATTERY, SUPPLEMENTAL, REMOVAL AND INSTALLATION**.

4. Remove the Power Distribution Center (PDC). Refer to **CENTER, POWER DISTRIBUTION (PDC), REMOVAL AND INSTALLATION** .
5. Remove the PDC tray from the battery tray.
6. Remove the supplemental battery. Refer to **BATTERY, REMOVAL AND INSTALLATION**, and **BATTERY, SUPPLEMENTAL, REMOVAL AND INSTALLATION**.



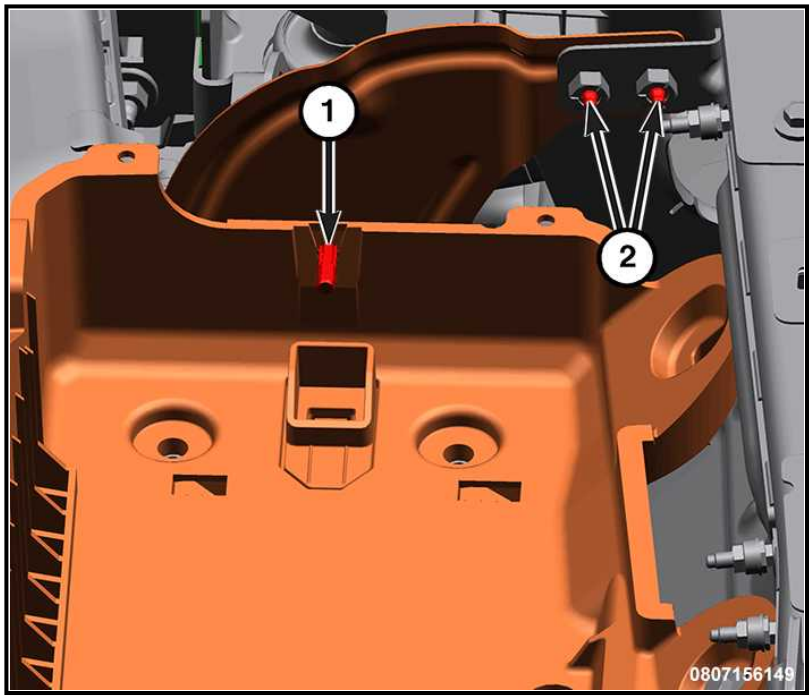
1 - Power Steering Reservoir Bolt
2 - Power Steering Reservoir

7. Remove the bolt and position power steering reservoir aside.
8. On Diesel applications, remove the PCM control relay and set it aside.



1 - Battery Tray Bolts
2 - Battery Tray Nuts
3 - Battery Tray

9. Remove and **DISCARD** the battery tray bolts and nuts.



1 - Battery Tray
2 - Battery Tray to Bracket Bolts

10. Remove and **DISCARD** the two battery tray to bracket bolts.
11. Lift the battery tray out of the engine compartment and remove from the vehicle.

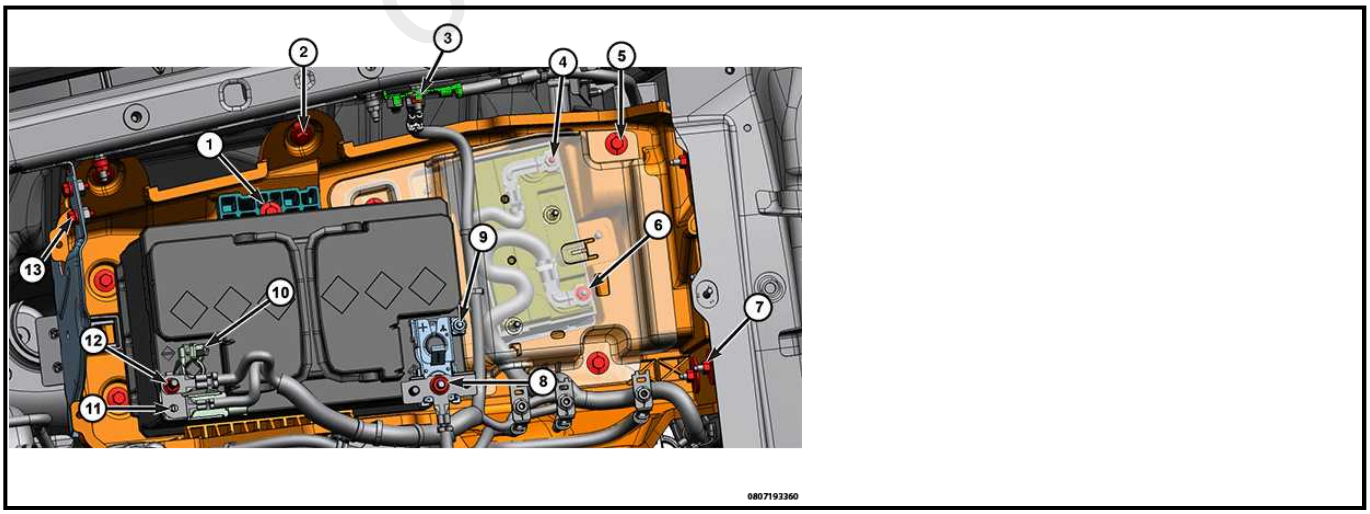
INSTALLATION

During installation, torque the fasteners to the specifications in the torque table(s) below.

Follow the removal procedure in reverse for general reassembly of the components on the vehicle.

TORQUE SPECIFICATIONS

BATTERY SYSTEM



CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	Battery Hold Down Bolt	**6 N.m (53 In. Lbs.)**	-
2	Battery Tray Bolts	**6 N.m (53 In. Lbs.)**	Do not reuse these fasteners. If removed, a

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
			NEW fastener must be installed and tightened to specifications.
3	Negative Battery Cable to Body M6	**12 N.m (9 Ft. Lbs.)**	-
4	Auxiliary Battery - M6 Double Ended Torx Stud	**6 N.m (53 In. Lbs.)**	-
5	Auxiliary Battery Cover to Battery Tray	**4 N.m (35 In. Lbs.)**	-
6	Auxiliary Battery M6 Nut	**6 N.m (53 In. Lbs.)**	-
7	Battery Tray Nuts	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
8	Battery Positive Cable M6	**9 N.m (80 In. Lbs.)**	-
9	Battery Positive Cable M5	**9 N.m (80 In. Lbs.)**	-
10	Intelligent Battery Sensor (IBS) To Negative Post	**7 N.m (62 In. Lbs.)**	-
11	Auxiliary Negative Cable to Negative Cable at Battery	**8 N.m (71 In. Lbs.)**	-
12	Negative Cable To Intelligent Battery Sensor (IBS)	**10 N.m (89 In. Lbs.)**	-
13	Battery Tray To Front Bracket Support	**4 N.m (35 In. Lbs.)**	Do not reuse these fasteners. If removed, a **NEW** fastener must be installed and tightened to specifications.
-	Negative Battery Cable to Body M8	**8 N.m (71 In. Lbs.)**	-

CALLOUT	DESCRIPTION	SPECIFICATIONS	COMMENT
1	PCR Mount To Ground	**11 N.m (8 Ft. Lbs.)**	-
2	Auxiliary Battery Tray To Battery Tray	**8 N.m (71 In. Lbs.)**	-
3	B+ Wire To PCR Positive Terminals	**11 N.m (8 Ft. Lbs.)**	-
-	Battery Ground To Frame	**8 N.m (71 In. Lbs.)**	-
-	Ground To PCR Bracket	**9 N.m (80 In. Lbs.)**	Right Hand Drive Only
-	Negative Cable Stud	**15 N.m (11 Ft. Lbs.)**	Right Hand Drive Only