

## Section 3

# High-Voltage Battery

**Overview** The sealed nickel-metal hydride (Ni-MH) battery technology developed for the hybrid system provides both high power density and excellent longevity. The hybrid system controls charge and discharge rates to keep the HV battery at a constant State of Charge (SOC).

### ***HV Battery Layout***

The HV Battery, Battery ECU and SMR (System Main Relay) are enclosed in a single case located in the luggage compartment behind the rear seat.

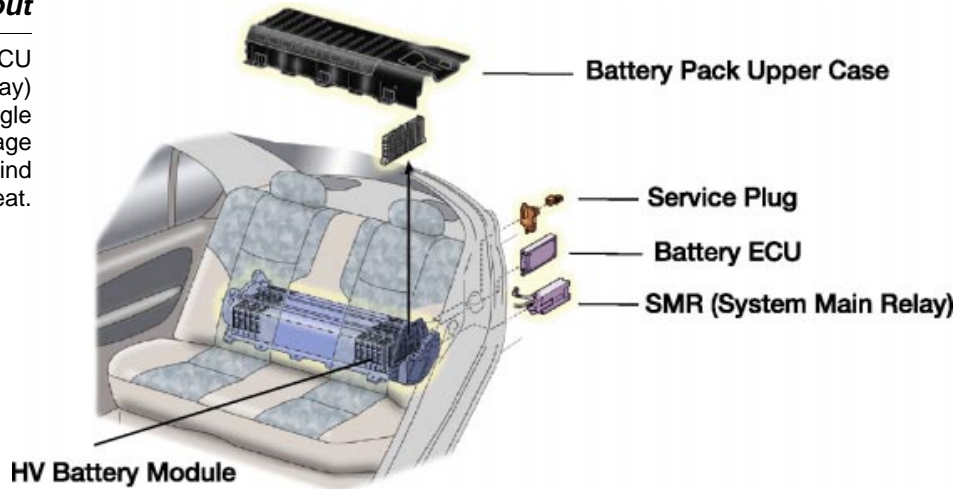


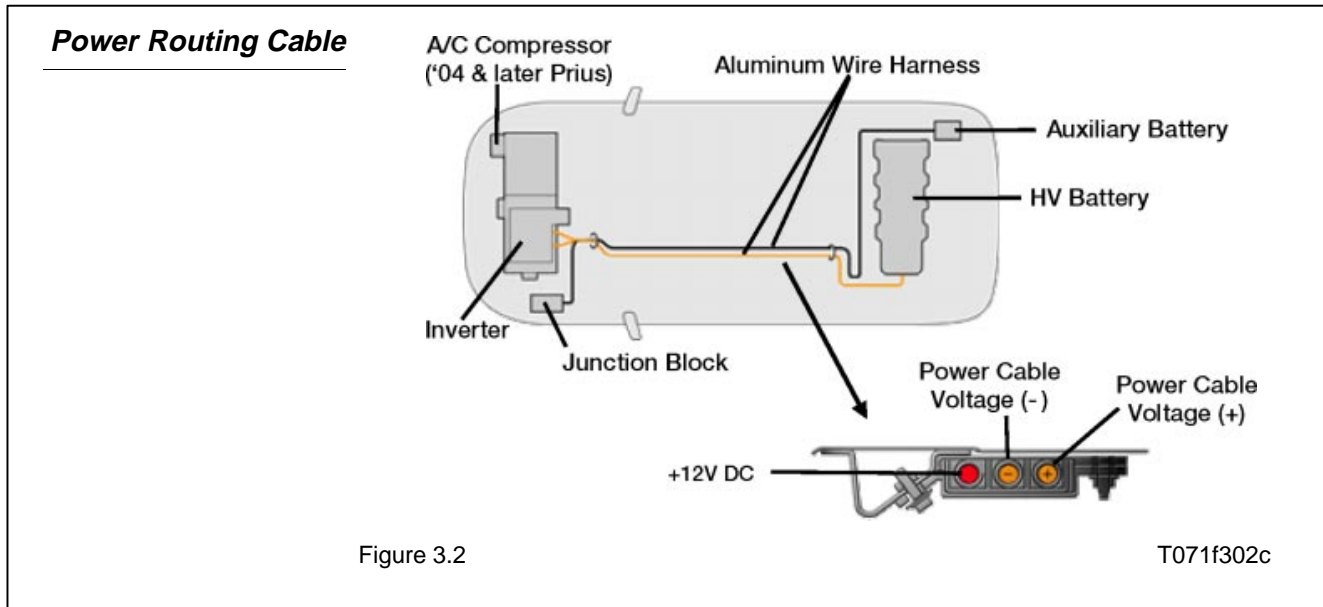
Figure 3.1

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**Power Cable** The power cable is a high-voltage, high-amperage cable that connects the HV battery with the inverter and the inverter with MG1 and MG2. In the '04 & later Prius, the power cable also connects the inverter with the A/C compressor.

The power cable is routed under the rear seat, through the floor panel, along the under-the-floor reinforcement, and connects to the inverter in the engine compartment. The 12V DC wiring harness follows a similar route from the auxiliary battery to the front of the vehicle.

The power cable is shielded to reduce electromagnetic interference. For identification purposes, the high-voltage wiring harness and connectors are color-coded orange to distinguish them from ordinary low-voltage wiring.



**HV - Nickel-Metal Hydride Battery**

The HV battery pack contains six nickel-metal hydride 1.2V cells that are connected in series to form one module.

In the '01-03 Prius, 38 modules are divided into two holders and connected in series. Thus, the HV battery contains a total of 228 cells and has a rated voltage of 273.6V.

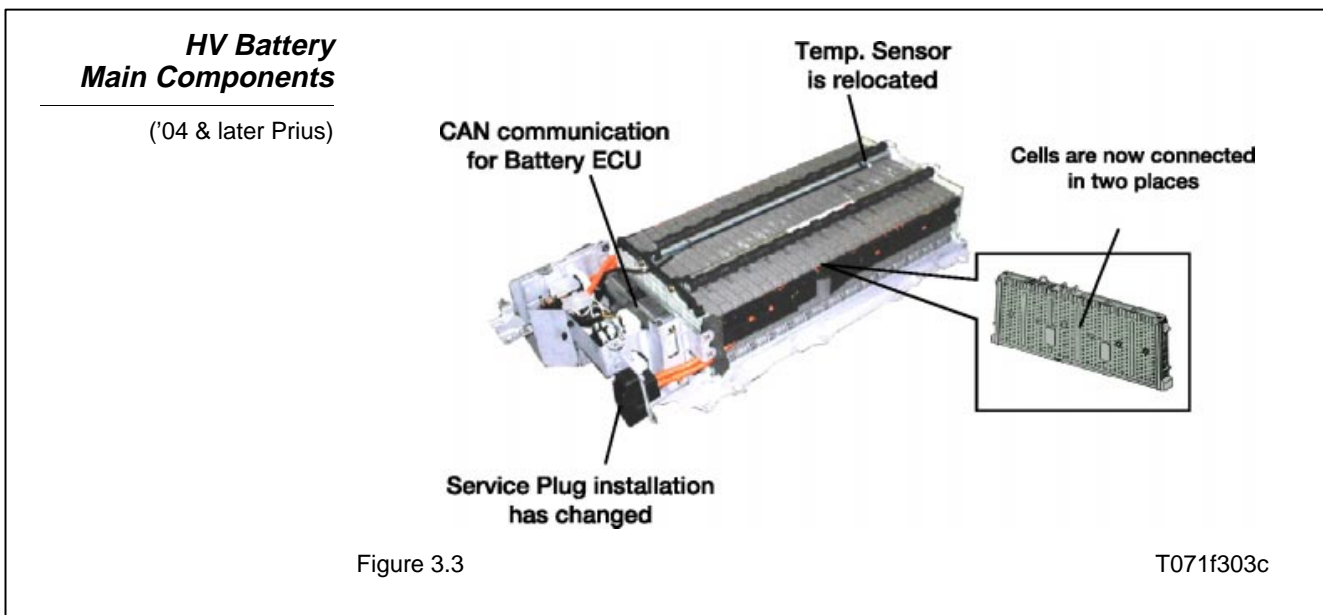
In the '04 and later Prius, 28 modules are connected for a rated voltage of 201.6V. The cells are connected in two places to reduce the internal resistance of the battery.

The electrode plates in the HV battery are made of porous nickel and metal hydride alloy.

**NOTE**

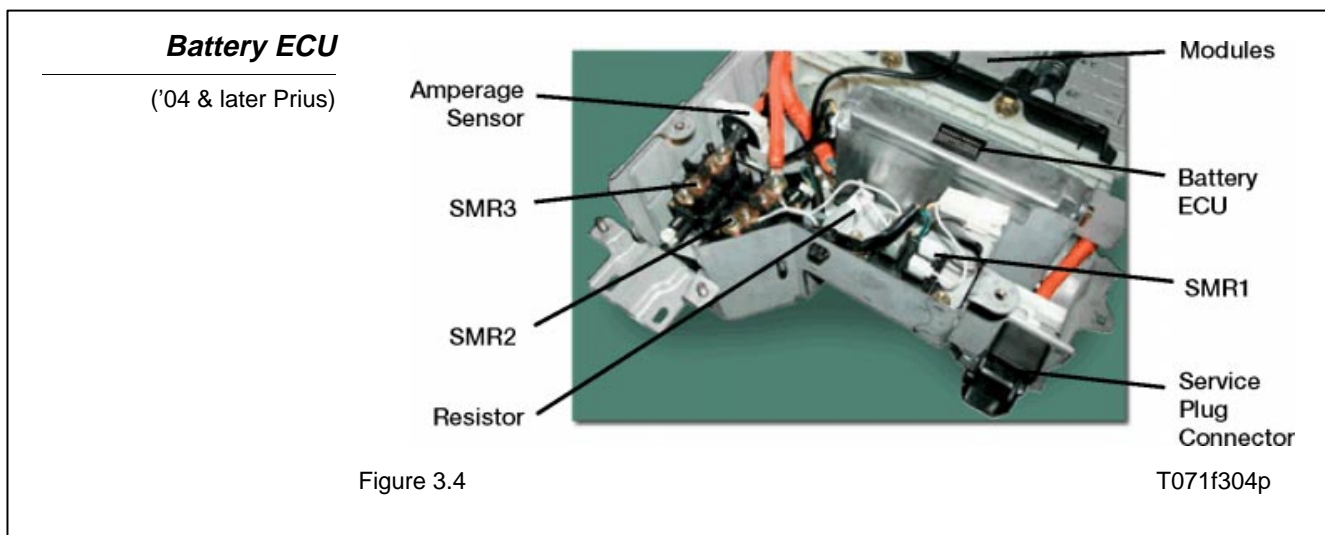
For battery recycling information, please refer to the Warranty Policy and Procedure manual.

<b><i>HV Battery Pack Information</i></b>	HV Battery Pack	'04 Prius and Later	'01-'03 Prius
Battery pack voltage		201.6V	273.6V
Number of Ni-MH battery modules in the pack		28	38
Number of cells		168	228
Ni-MH battery module voltage		7.2V	←



**Battery ECU** The battery ECU provides the following functions:

- It estimates the charging/discharging amperage and outputs charge and discharge requests to the HV ECU so that the SOC can be constantly maintained at a center level.
- It estimates the amount of heat generated during charging and discharging, and adjusts the cooling fan to maintain HV battery temperature.
- It monitors the temperature and voltage of the battery and if a malfunction is detected, can restrict or stop charging and discharging to protect the HV battery.

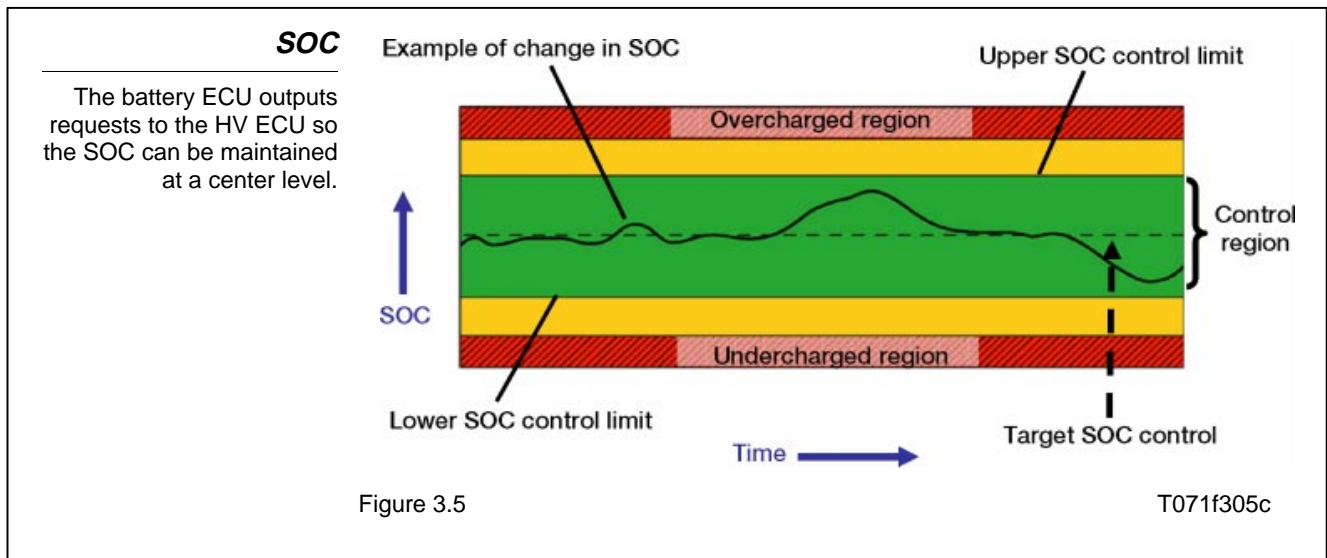


**State Of Charge (SOC)** The battery ECU constantly monitors HV battery temperature, voltage and amperage. It also checks for leaks in the HV battery.

While the vehicle is in motion, the HV battery undergoes repetitive charge/discharge cycles as it becomes discharged by MG2 during acceleration, and charged by the regenerative brake during deceleration. The Battery ECU estimates the charge/discharge amperage and outputs charge/discharge requests to the HV ECU to maintain the SOC at a median level.

The target SOC is 60%. When the SOC drops below the target range, the battery ECU informs the HV ECU. The HV ECU then signals the engine ECM to increase power to charge the HV battery. If the SOC is below 20%, the engine is not producing power.

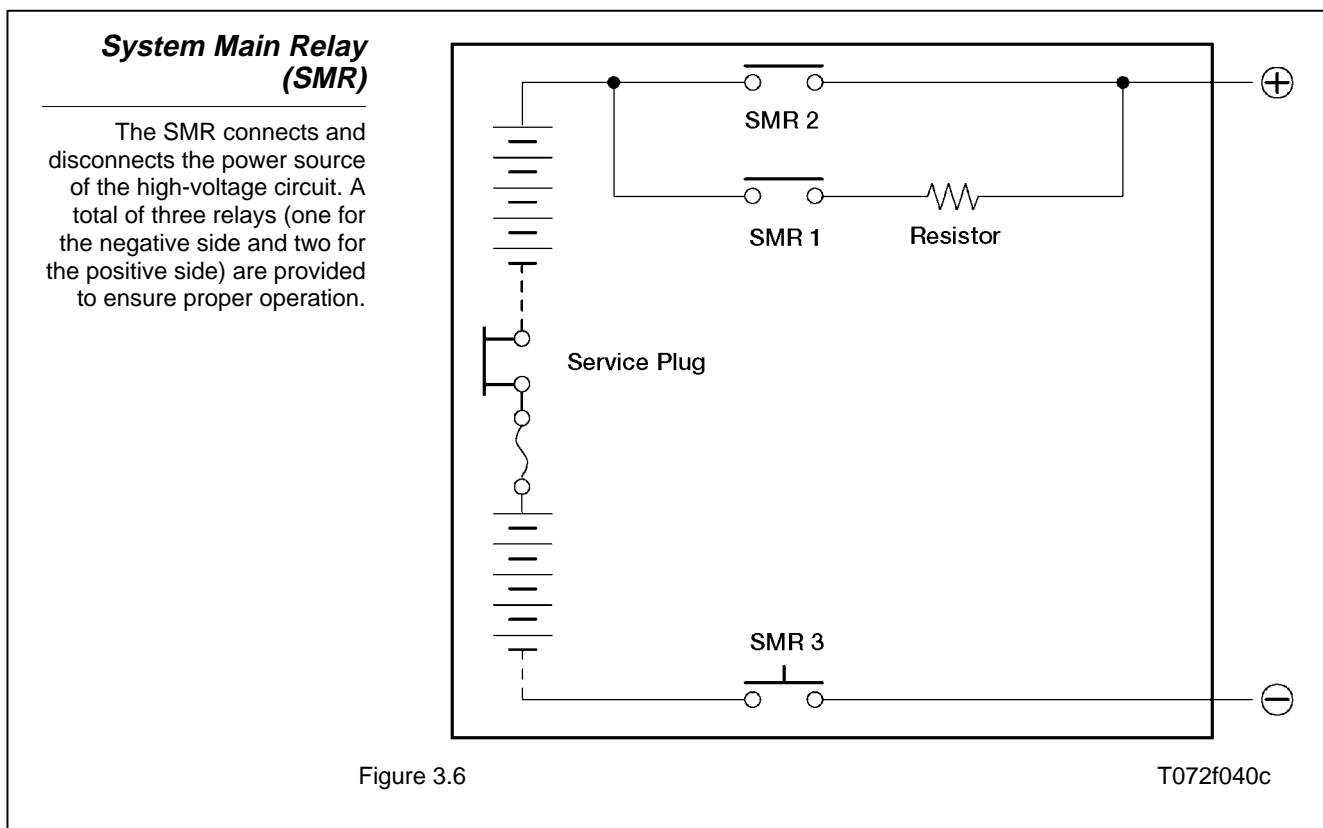
**Delta SOC** The normal, low to high SOC deviation is 20%. If the Delta SOC exceeds 20%, this means that the HV battery ECU cannot correct or maintain the SOC difference within the acceptable range.



**System Main Relay (SMR)** The System Main Relay (SMR) connects and disconnects power to the high-voltage circuit based on commands from the HV ECU. A total of three relays (one for the negative side and two for the positive side) are provided to ensure proper operation.

When the circuit is energized, SMR1 and SMR3 are turned ON. The resistor in line with SMR1 protects the circuit from excessive initial current (called 'inrush' current). Next, SMR2 is turned ON and SMR1 is turned OFF, allowing current to flow freely in the circuit.

When de-energized, SMR2 and SMR3 are turned OFF in that order and the HV ECU verifies that the respective relays have been properly turned OFF.



**Service Plug** When the service plug is removed the high-voltage circuit is shut OFF at the intermediate position of the HV battery.

The service plug assembly contains a safety interlock reed switch. Lifting the clip on the service plug opens the reed switch, shutting OFF the SMR.

The main fuse for the high-voltage circuit is inside the service plug assembly.

**NOTE**

For safety reasons, you must always turn the vehicle OFF before removing the service plug.

**HV Battery Cooling System**

The battery ECU detects battery temperature via three temperature sensors in the HV battery and one intake air temperature sensor. Based on those readings, the battery ECU adjusts the duty cycle of the cooling fan to maintain the temperature of the HV battery within the specified range.

The battery ECU keeps the fan OFF or running at LO if:

- The A/C is being used to cool the vehicle.
- Some margin is left in the temperature of the battery.

**HV Battery Cooling System**

('01-'03 Prius)

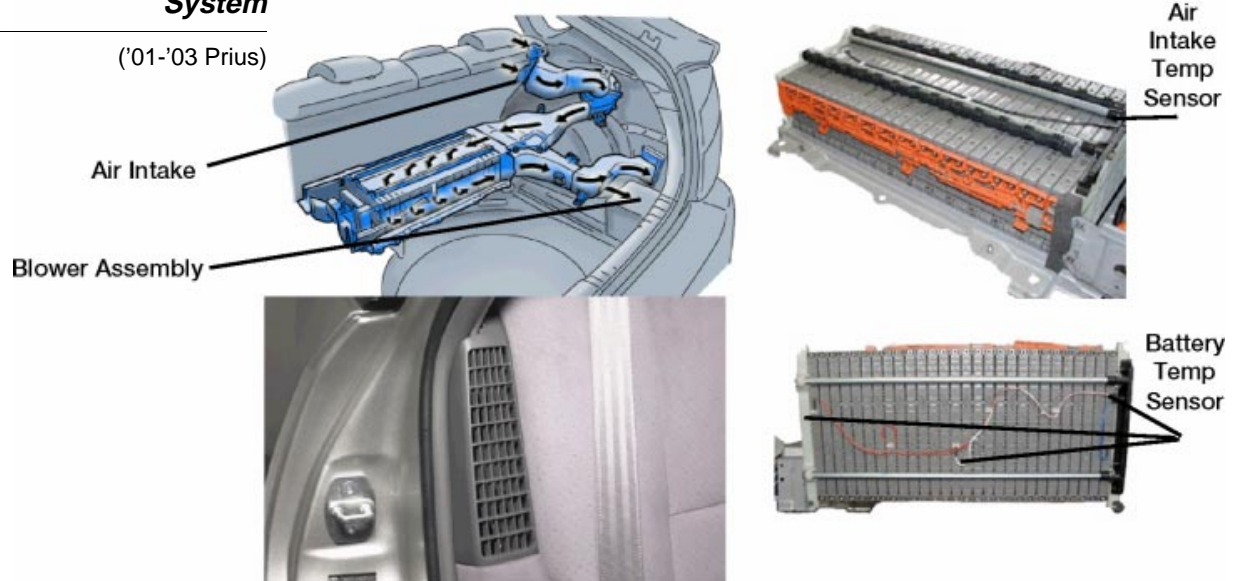


Figure 3.9

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### ***HV Battery Cooling System***

('04 & later Prius)

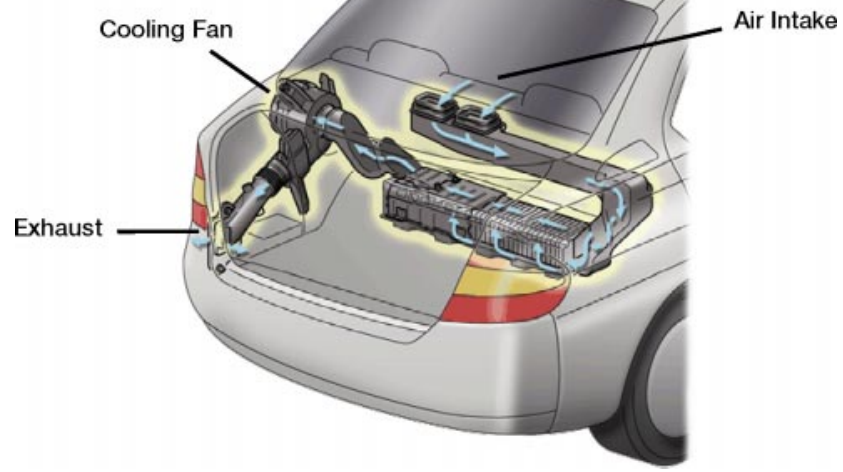


Figure 3.10

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**Auxiliary Battery** The Prius uses an Absorbed Glass Mat (AGM) 12V maintenance free auxiliary battery. This 12V battery powers the vehicle's electrical system similar to a conventional vehicle. The battery is grounded to the metal chassis of the vehicle and vented to ambient (outside) air with a tube.

This battery is very sensitive to high-voltage. When charging the auxiliary battery you should use the Toyota approved charger, because a standard battery charger does not have the proper voltage control and may damage the battery. If the approved charger is not available you may use a trickle charger if the amperage is kept below 3.5 A.

The battery should be removed from the vehicle during charging. However, it is safe to jump-start the Prius from either the battery or the jump-start terminal under the hood. This will allow the vehicle's charging system to restore the battery to normal SOC.

If the vehicle will not be used for more than two weeks, disconnect the 12V battery to prevent it from discharging. Always make sure that all doors are properly closed and that the interior lights are OFF, especially overnight. These situations will quickly deplete the 12V battery.



### ***Auxiliary Battery***

In glass mat batteries, the electrolyte is trapped in separators to reduce the amount of hydrogen gas released when the battery is charged.

Glass mat batteries are sealed and the electrolyte cannot be replaced.

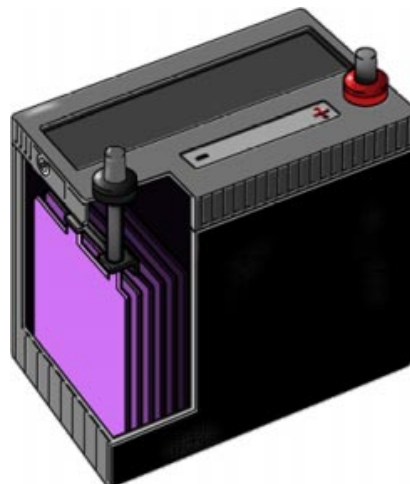


Figure 3.11

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### ***Auxiliary Battery Charging***

('04 & later Prius)

There is a remote access B + terminal in the main junction block under the hood, so it is no longer necessary to remove interior trim pieces to gain access to the battery.

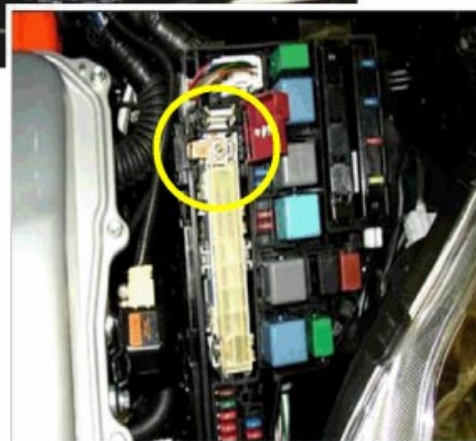


Figure 3.12

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**Notes**



## WORKSHEET 3-1

### Hybrid Diagnostic Trouble Codes

Vehicle	Year/Prod. Date	Engine	Transmission
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### Worksheet Objectives

In this worksheet you will diagnose hybrid malfunctions by viewing DTCs, Information Codes, and the HV ECU Data List.

### Tools and Equipment

- Vehicle
- Diagnostic Tester
- Printer
- Repair Manual or TIS

### Section 1: Hybrid Diagnosis

1. When starting the vehicle (READY light ON) do any warning lights illuminate? If so, which ones?

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2. Connect the Diagnostic Tester to DLC3. Select **Codes All** to check all the ECUs.

3. How many systems are checked when using Codes All?

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4. List the systems that show **NG** (No Good).

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5. Now view the Information Codes by pressing enter on the systems that say NG, then press enter again. Highlight the number next to **INFORMATION** and press enter.

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6. Use the Repair Manual or TIS to look up the DTC and Information Code in order to find what part of the system is affected. List this information below.

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7. Is there any information in the **HV ECU Data List** that can help you diagnose the vehicle? If so, print and highlight the information.
8. After diagnosing the vehicle, clear the codes and return to the classroom.

***Hint: To clear DTCs, you must exit out of CODES ALL and enter each section individually.***



**SELF-ASSESSMENT 3-1**  
*Hybrid Diagnostic Codes*

Name:	Date:
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**Self-assessment Objectives**

Review this sheet as you are doing the Hybrid DTC Diagnosis worksheet. Check off either category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The **Comments** section is for you to write notes on where to find the information, questions, etc.

I have questions

I know I can

Topic			Comment
Locate vehicle warning lights.			
View Codes All using the Diagnostic Tester.			
View the Information Codes.			
Use TIS & Repair Manual to research these codes.			
View the HV ECU Data List.			
Clear Codes.			



**Notes**