

SONATA

Plug-in

hybrid

Emergency Response Guide



NEW THINKING.
NEW POSSIBILITIES.



HYUNDAI

Contents

Introduction

Sonata Plug-in Hybrid Identification 2

- General Vehicle Description 2
- Identifying a Hyundai Plug-in Hybrid 2

Sonata Plug-in Hybrid main systems 7

- Key Specifications 7
- Vehicle Components Location 8
- Vehicle Components 9
- Plug-in Hybrid System Operation
- Airbag system (SRS : Supplemental Restraint System) 14

Emergency procedures 16

- Initial response: Identify, Immobilize and Disable 16
- Extraction Operations 22
- Submersion 22
- Vehicle Fire 23
- High-Voltage Battery Damage and Fluid Leaks 24

Roadside Assistance

- Towing 25
- To Jump Start the Car 26

Document Purpose

The purpose of this document is to familiarize emergency responders and the towing/roadside assistance industry with the proper methods to handle the Hyundai Sonata Plug-in Hybrid in an emergency situation. This guide offers a basic overview of key vehicle systems and provides instructions for dealing with the different types of situations encountered by emergency responders. The emergency response procedures for this vehicle are somewhat similar to a conventional Sonata with additional information provided on dealing with the high-voltage electrical system.

Vehicle Description

As with other plug-in hybrids, the Hyundai Sonata Plug-in Hybrid uses a conventional gasoline powered internal combustion engine paired with a high-voltage electric motor to propel the vehicle. The high-voltage battery is recharged by an external power source such as a charging station through charging port. It is also recharged while the vehicle is being driven. This is accomplished through the use of a generator that produces electricity during driving and braking.



General Vehicle Description

The Hyundai Sonata Plug-in Hybrid is built on a conventional Sonata chassis and therefore the four door sedan looks very similar to its conventional counterpart with a few notable exceptions. The safest method is to assume that any Sonata you respond to is a Hybrid vehicle until proven otherwise. Using the information provided in this section, responders will be able to differentiate between the two.

Identifying a Hyundai Plug-in Hybrid vehicle

Plug-in Hybrid badge on Trunk and Blue Drive badge on side of Vehicle

The Hyundai Sonata Plug-in Hybrid can be easily identified by the Plug-in Hybrid badge located on the trunk lid and the Blue Drive badge on the both sides of the vehicle, beside the charging port cap on the left side of the vehicle.

DANGER Electrocutation Risk

Badging can become hidden after a crash due to damage to the vehicle. Always be sure to utilize additional methods of identification before determining there is no badge present.

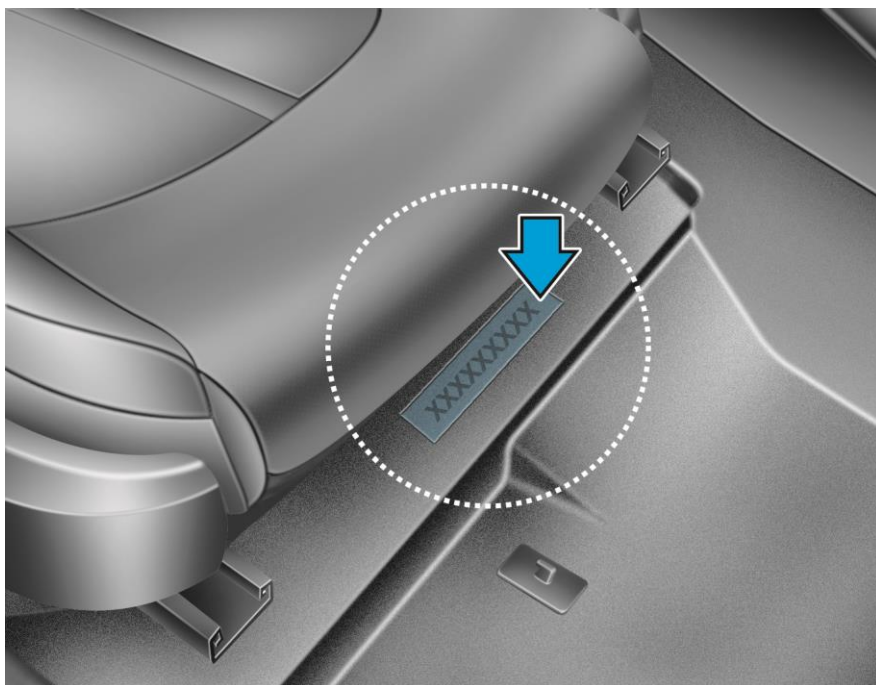
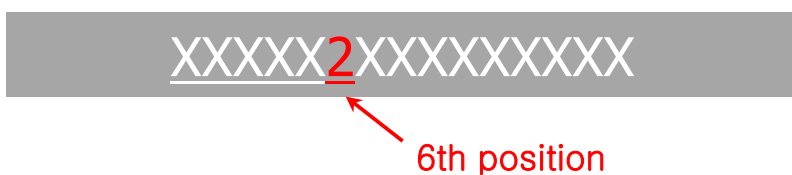


Sonata Plug-in Hybrid Identification

VIN number

The Vehicle Identification Number (VIN) identifies the Plug-in Hybrid Vehicle with a “2” displayed in the 6th position, as shown in the below drawing.

The VIN is punched on the floor under the passenger seat. The number 2 in the 6th character of the VIN indicates that it is a Plug-in Hybrid with 2.0 gasoline engine.



Sonata Plug-in Hybrid Identification

4

Engine Compartment

Unlike the conventionally powered Sonata, the Hybrid version has a plastic engine cover with “hybrid” clearly shown on it.



Additionally, there are orange colored high-voltage electrical cables in the engine compartment.



Vehicle Underside

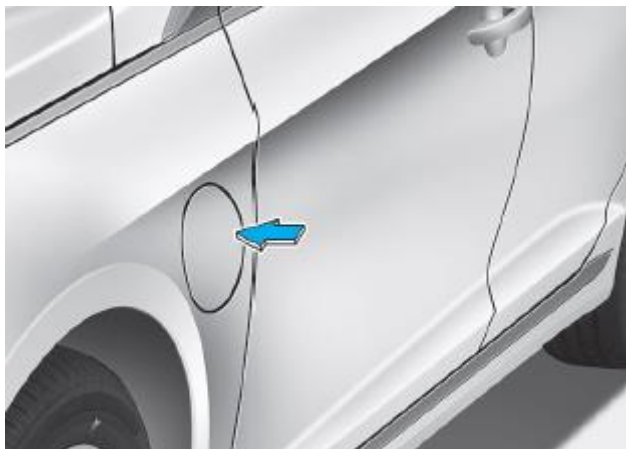
An orange colored cable covered by the under cover is also visible on the underside of the vehicle. This cable runs along the passenger side from the rear of the vehicle to the engine compartment.



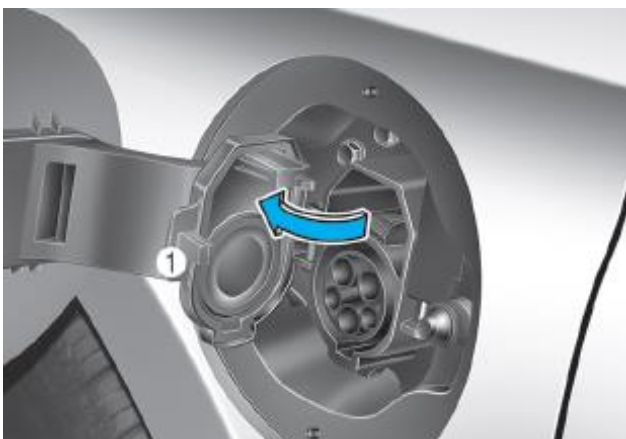
Charging Port

The Charging Port is located on the front fender covered by the charging port cap and it has one port for AC normal charging.

How to open the charging port

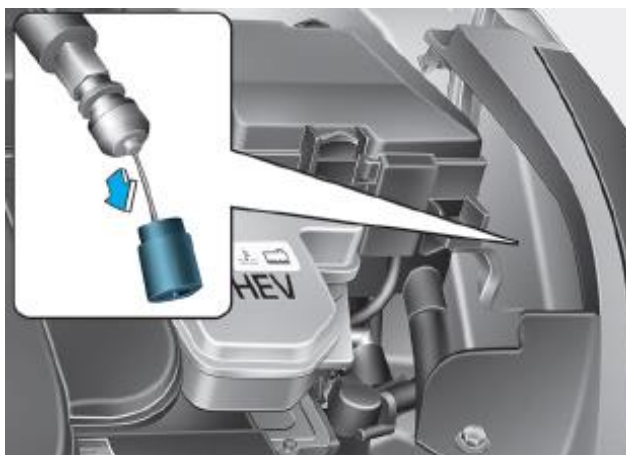


1. Depress the brake pedal and apply the parking brake.
2. Turn OFF all switches, move the shift lever to P (Park), and turn OFF the vehicle.
3. Open the charging door by pressing it.



4. Open the charging inlet cover (1).

Unlock Charging Door in Emergency



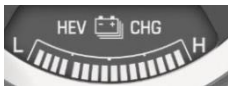
If the charging door does not open or the charging cable is not disconnected, open the hood and pull the emergency cable lightly as shown left. The charging door will then open.

Sonata Plug-in Hybrid Identification

6

Plug-in Hybrid Vehicle Cluster Instrument Panel

The Plug-in Hybrid Vehicle Instrument Cluster Panel displays the Plug-in Hybrid vehicle specific features that identify the Sonata as a plug-in hybrid vehicle. Also “**plug-in hybrid**” symbol is located at the upper of the left side of the Instrument Cluster Panel.



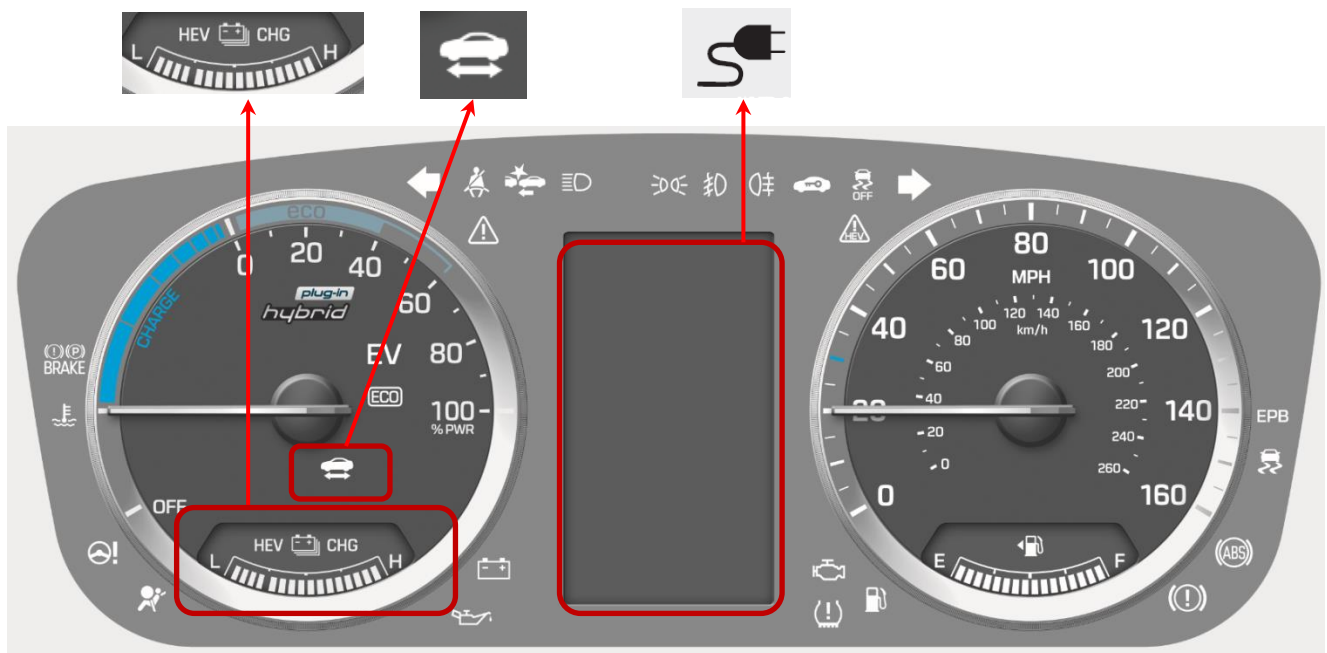
: The Plug-in Hybrid Mode Gauge indicates the driving mode of the vehicle.



: The “**Ready**” Light indicates the vehicle is ready for driving.

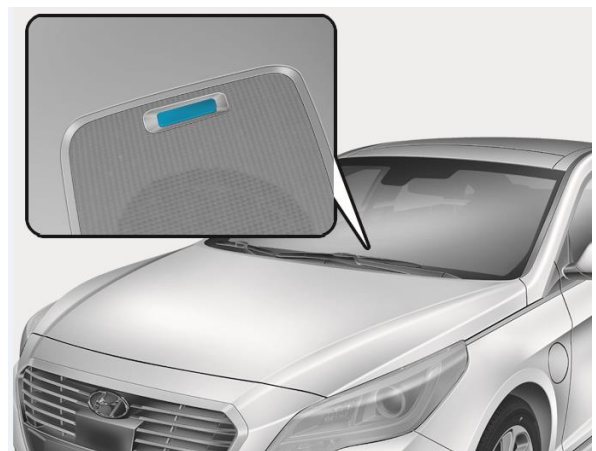


: The charging cable indicator displays the cable is connected.



Charge Status Indicator

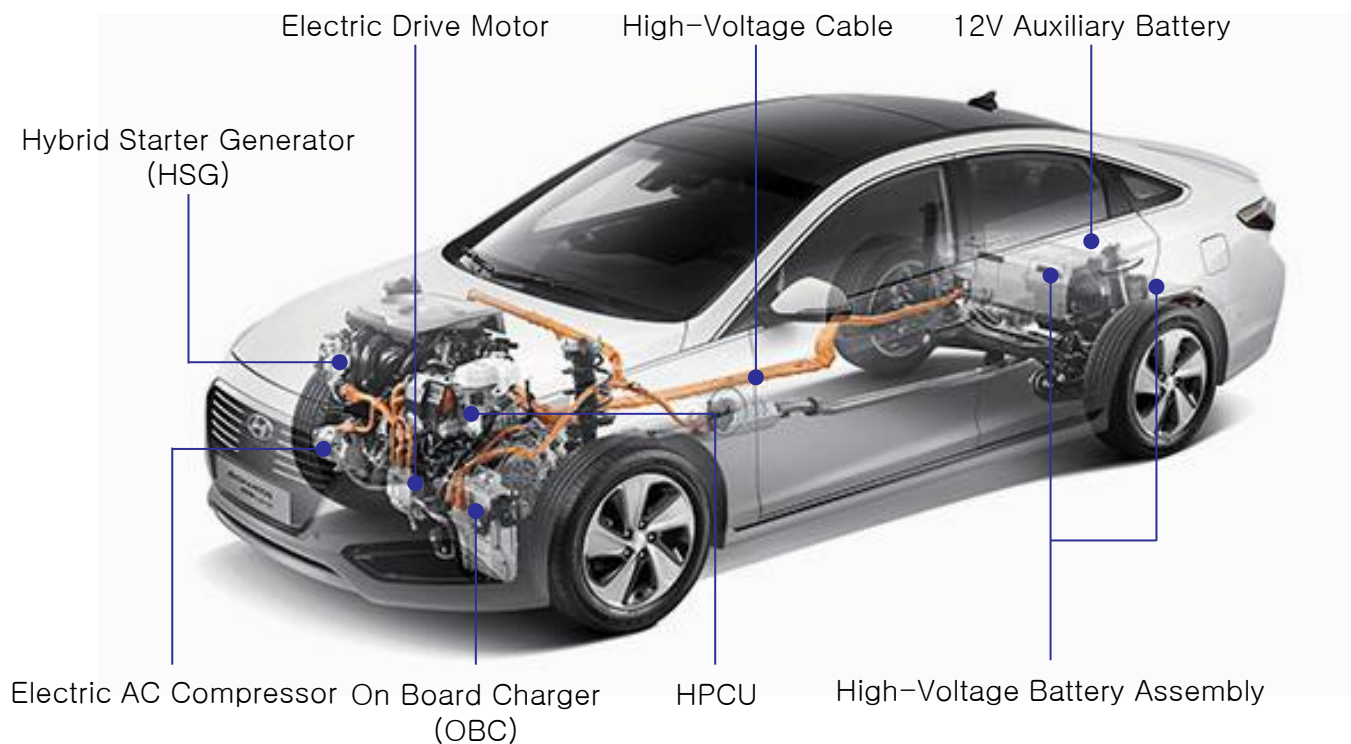
The battery charge status indicator, visible from outside, at the center of the crash-pad, is illuminated when the vehicle is charging.



Key Specifications

Item		Plug-in Hybrid
Engine	Displacement	2.0L GDI Hybrid Engine
Transmission	Type	6speed Automatic Transmission
Fuel Tank	Capacity (U.S.gal / ℓ)	14.5 / 55
Motor	Type	Permanent Magnet Synchronous Motor
	Max. Output (kW)	50
	Max Torque (Nm)	205
Inverter	Input Voltage (V)	240 ~ 413V
High Voltage Battery	Type	Lithium-ion polymer
	Rated Voltage (V)	360
	Capacity (Ah) / Energy (kwh)	27.2 / 9.8
	Number for Packs (Cell / Module)	96CELL / 12MODULE

Vehicle Components Location



OBC	On-Board Charger : Battery charging equipment (AC → DC)
HPCU	Hybrid Power Control Unit (Inverter + LDC + HCU)
LDC	Low Power DC-DC Converter : Charge 12V supplementary battery
Inverter	DC → AC (from battery to motor) AC → DC (charge using regenerative braking)
Motor	When current flows through the coil. It generates a rotating magnetic field and generates motor torque.
High voltage battery	Supplies and stores electric energy to traction motor.

Vehicle Components

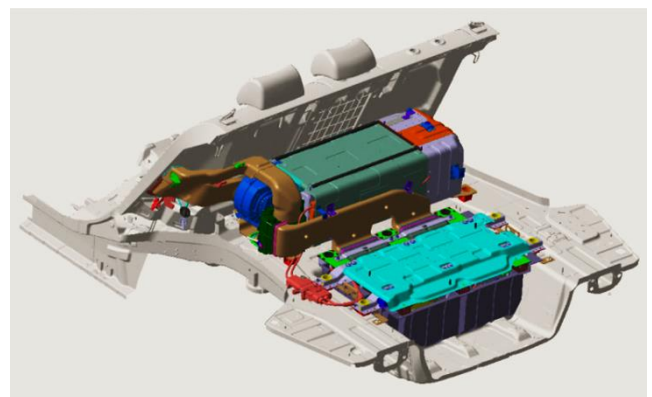
12V Auxiliary Battery

The 12V Auxiliary Battery is located in the trunk on the passenger side of the vehicle and is accessed by removing a small cover. This battery powers all of the standard electronics like radio, air conditioner, etc. It also supplies current to the high-voltage system relays, which control the flow of high-voltage current.



High-Voltage (HV) Battery

The Lithium-ion Polymer HV battery contains a gel electrolyte and is made up of 96 – 3.75V cells wired in series for a nominal voltage of 360V with 27.2 Ah of capacity. The battery consists of two parts located behind the rear seat in the trunk area and under the trunk area.



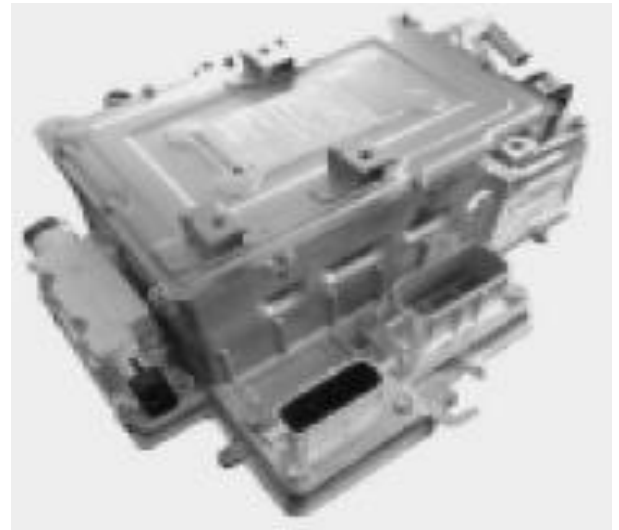
High-Voltage Cabling

The high-voltage cabling in the Sonata Plug-in Hybrid is orange per the SAE standard. These cables run along the passenger side from the rear of the vehicle where they connect to the HV battery up to the front of the vehicle where they connect to the Electric Drive Motor and other HV components.



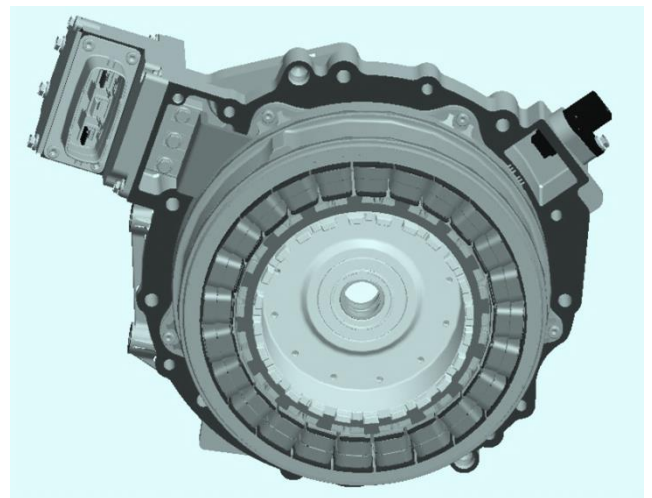
Hybrid Power Control Unit

The Hybrid Power Control Unit (HPCU) assembly consists of three components: a Hybrid Control Unit (HCU), an Inverter (Motor Control Unit (MCU)) as well as a Low-voltage DC-DC Converter (LDC). The HPCU assembly contains capacitors which take about 5–10 minutes to discharge after the high-voltage system is shut down.



Electric Drive Motor

Mounted between the engine and transmission, the Electric Drive Motor is used for vehicle propulsion. During deceleration or braking, it acts as an alternator and charges the HV battery by converting the vehicle's kinetic energy into electrical energy.



Hybrid Starter Generator (HSG)

The HSG is mounted to the front of the engine near the intake manifold. It cranks the engine or starting and acts as a generator when the HV battery needs charging. As this is one of the major components of the HV system, its electrical connection is clearly visible via an orange HV cable.



Air Conditioning Compressor

The Air Conditioning Compressor is mounted to the engine directly below the HSG. It is also powered by the high-voltage system, so its electrical connection via an orange HV cable is easily noticeable as well.



On-Board Charger (OBC)

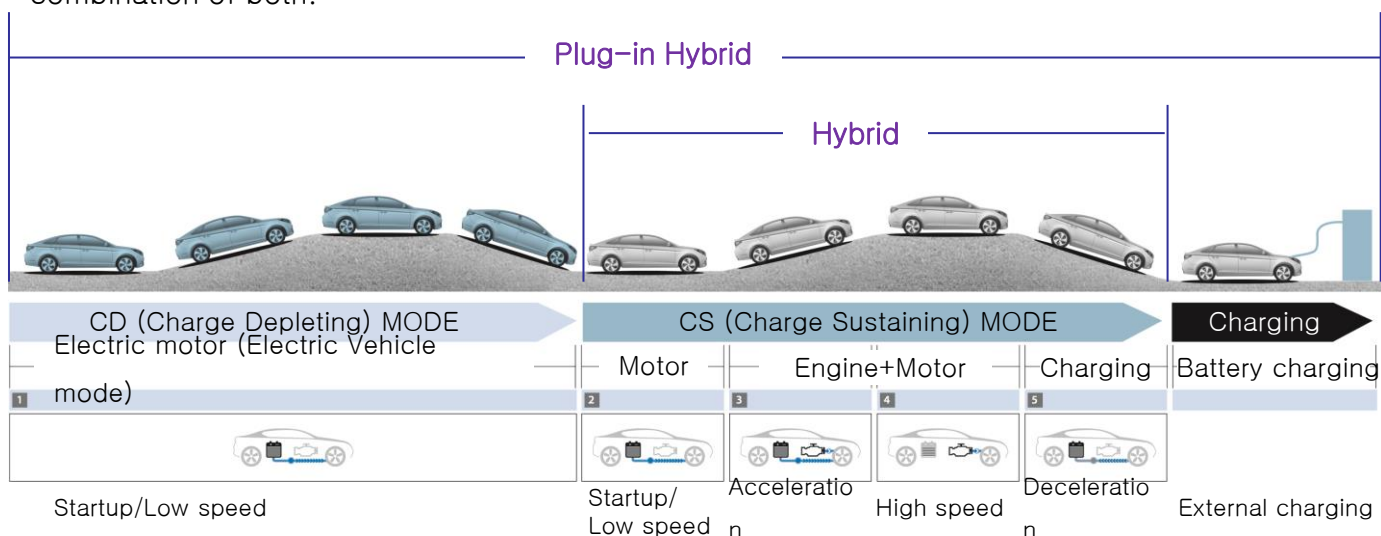
The OBC is the battery charging equipment that converts external AC to DC to charge the high voltage battery.



Plug-in Hybrid System Operation

Operating Parameters

The Plug-in Hybrid Sonata has two modes of using charged electricity. One is Charge Depleting (CD) mode where the vehicle is propelled by the electric motor only until it depletes to the predefined level of high-voltage battery. The other one is Charge Sustaining (CS) mode where the vehicle is propelled by either the gasoline engine or the Electric Drive Motor, or a combination of both.

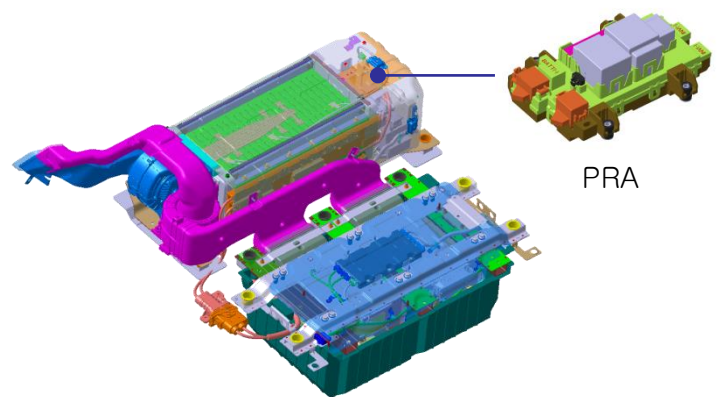


High-Voltage Electrical Isolation

Unlike the 12V electrical system that is grounded to the vehicle's chassis, the Sonata Plug-in Hybrid's high-voltage electrical system is designed to be isolated from the vehicle.

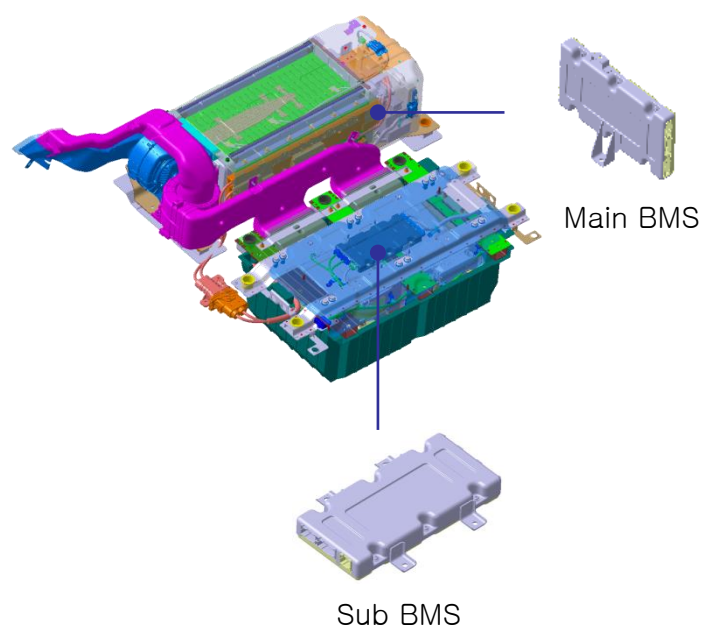
Regulation of High-Voltage Electrical Current

Current from the High-Voltage Battery is controlled by the Power Relay Assembly (PRA), which consists of Positive and Negative Main Relays, a Pre-charge Relay, Pre-charge Resistor, and the Battery Current Sensor. The PRA is located inside the High-Voltage Battery Pack Assembly and controls the high-voltage power circuit between the High-Voltage Battery and the Hybrid Power Control Unit.



High-Voltage Safety System

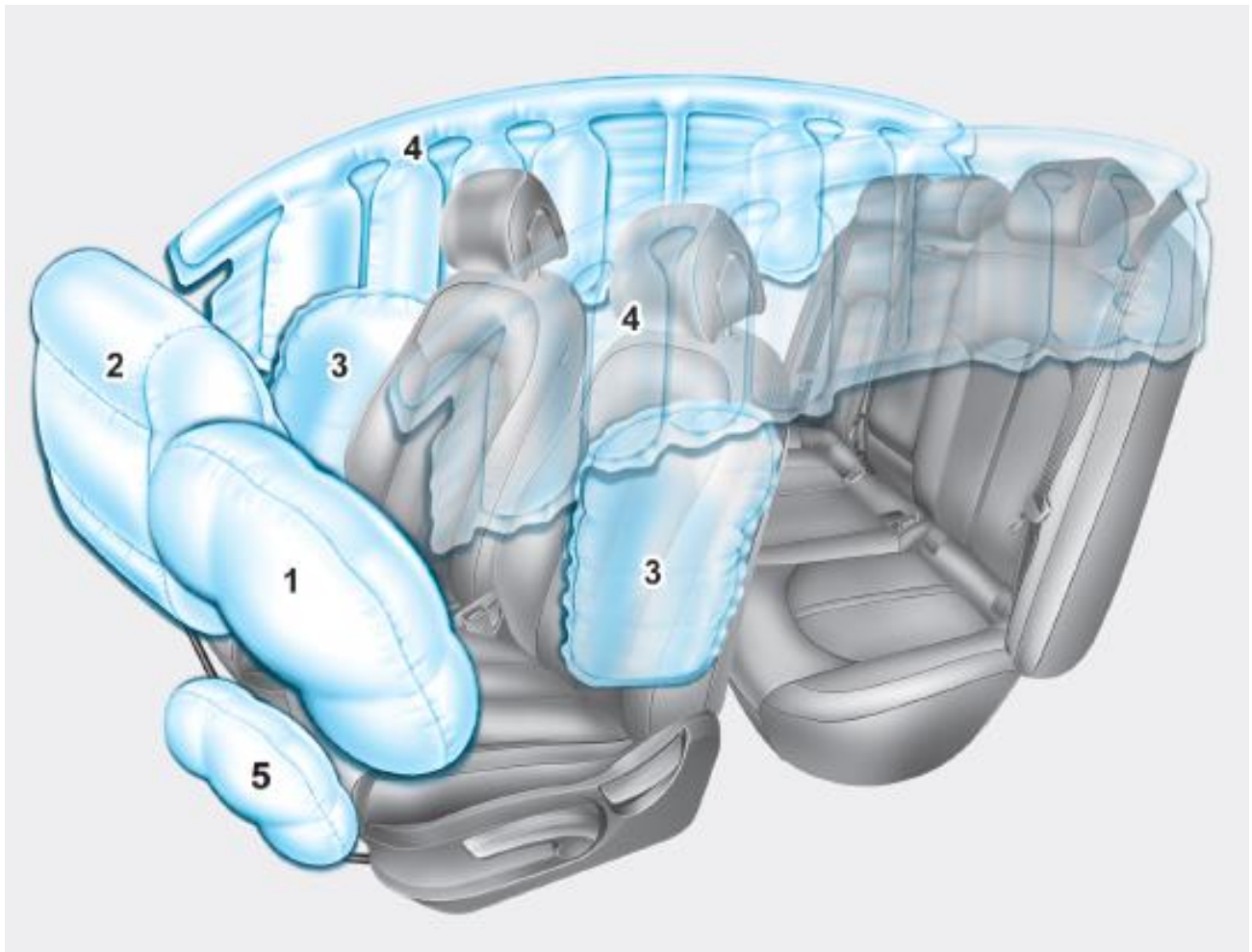
There are multiple safety systems incorporated into the Sonata Plug-in Hybrid. The system that protects the High-Voltage Electrical System is called the Battery Management System (BMS). The BMS is located inside the High-Voltage Battery assembly and measures several parameters to maintain the optimal performance of the High-Voltage Battery. It controls the battery cooling fan to ensure proper battery operation. In addition, if a system fault occurs, the BMS turns off the PRA to protect the system.



Airbag system (SRS : Supplemental Restraint System)

Airbag

Seven airbags are installed in the Sonata Plug-in Hybrid as shown below. Before starting any emergency procedure, make sure the vehicle ignition is turned off, disconnect the negative cable from the 12V auxiliary battery to prevent accidental deployment of airbags.



* The actual air bags and seats in the vehicle may differ from the illustration

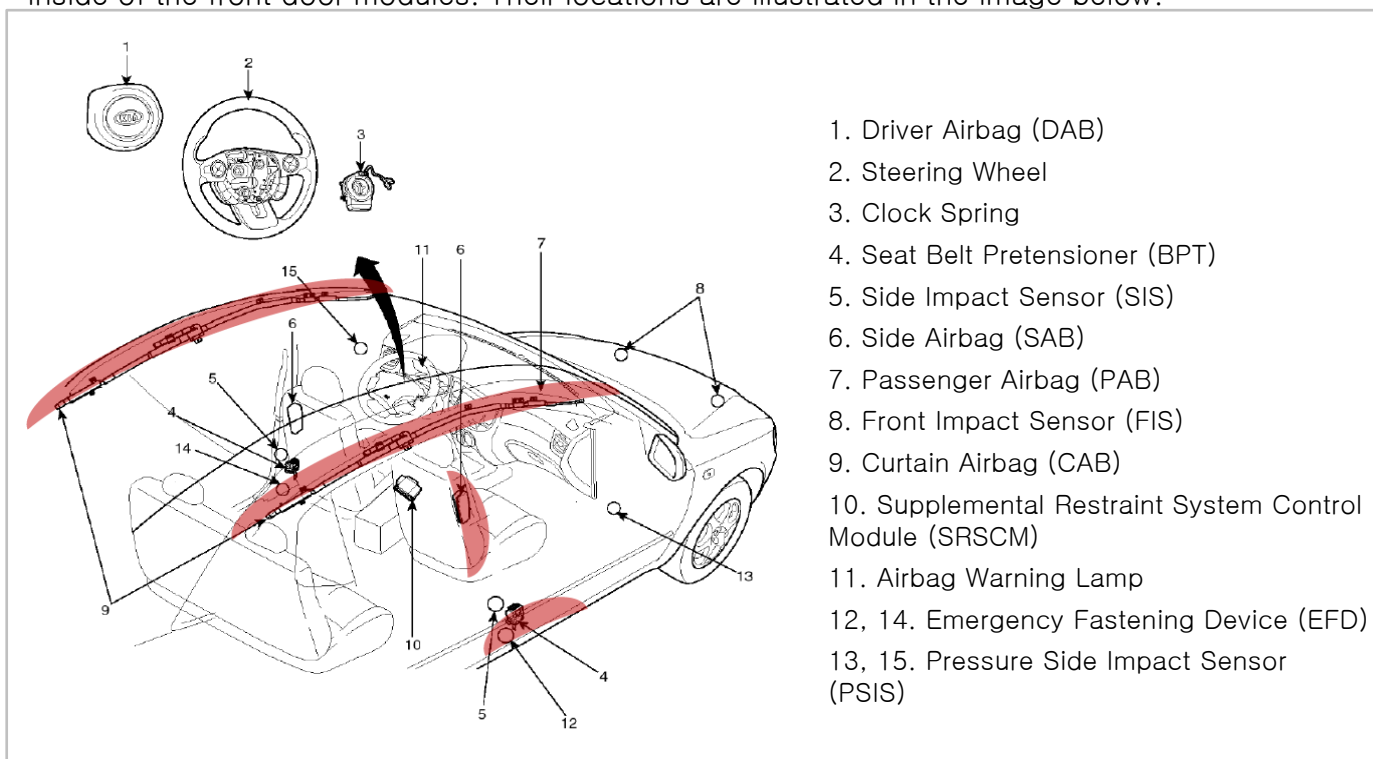
Number	Name	Location
1	Driver's front airbag	Driver side
2	Passenger's front airbag	Passenger side
3	Side airbag	Driver / Passenger side
4	Curtain airbag	Driver / Passenger side
5	Knee airbag	Driver side

Seat Belt Pretensioners

The Sonata Plug-in Hybrid is equipped with driver's and front passenger's seat belts with pretensioners. When the seat belt pretensioners are activated in a collision, a loud noise may be heard and fine dust, which may appear to be smoke, may be visible in the passenger compartment. These are normal operating conditions and are not hazardous. The seat belt pretensioner assembly mechanisms may become hot during activation, and may need several minutes to cool after they have been activated.

Sensors and Control Module

The airbags and pretensioners are managed by the SRS Control Module, or SRSCM, which is located below the front of the center console. In addition, there are four side impact sensors : two conventional accelerometer sensors in the B-pillars, and two pressure sensing sensors inside of the front door modules. Their locations are illustrated in the image below.



⚠ WARNING

- Unintentional deployment of SRS components can result in serious injury or death.
Do not cut through any component.
- SRS components may remain powered and active for up to 3 minutes after the 12V electrical system is shut off or disabled. Disconnect the battery negative cable and wait for at least 3 minutes before beginning work.

Initial Response:

The following procedures should be used whenever you are dealing with a Sonata Plug-in Hybrid at an emergency scene. All other operations should be consistent with your department's standard operating procedures or guides.

Identify

When dealing with a Sonata at the scene of an accident, emergency responders should always assume that it is a hybrid model until it can be proven otherwise using the identification features outlined in this ERG. External badging will usually be the first clue but it can often be hidden by damage caused in a crash. Always be sure to inspect multiple sides of the vehicle as well as using the clues found under the hood and in the interior of the vehicle.



Immobilize

The next step is to immobilize the vehicle to prevent any accidental movement that can endanger the emergency response personnel and any crash victims. Since the Sonata Plug-in Hybrid has the ability to shut down the gasoline engine when it is not needed, there will be instances where the vehicle appears to be off because of the absence of engine noise. When in its “ready” mode, the vehicle can move almost silently using the electric motor alone. Responders should approach the vehicle from the sides and stay away from the front or rear as they are both potential paths of travel. Instructions for immobilizing the vehicle are shown below.



Chock the Wheels



Engage Parking Brake



Position the shift lever in park (P)

Disable

The final step in the initial response process, conducted after the vehicle is secured to prevent movement, is to disable the vehicle, its SRS components and the high voltage electrical system. To prevent current flow through the system, use one of the following procedures to disable the vehicle.

I . Disabling the system – Smart Key System and “POWER” START/STOP BUTTON

1. Check the status of the READY light on the instrument panel. If the READY light is illuminated, the vehicle is on.

(Refer to page 6)

- a) If the READY light is NOT illuminated, the vehicle is off, Do not push the “POWER” START/STOP button because the vehicle may restart.

- b) To turn off the system, put the shift lever in the P (Park) position and press the POWER button beside a shift lever.



“POWER” START/STOP Button

Without depressing the brake pedal

Pressing POWER button	Button Position	Vehicle condition
	OFF	Off
One time	ACC	Electrical accessories are operational.
Two times	ON	The warning lights can be checked before the vehicle is started.
Three times	OFF	Off

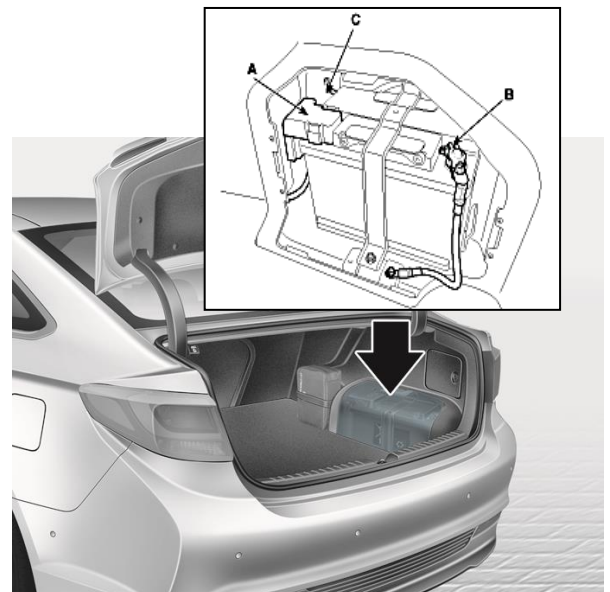
Depressing the brake pedal while a shift lever is in the P (Park) position

Pressing POWER button	Button Position	Vehicle condition
	OFF	Off
One time	–	Ready to drive

2. If necessary, lower the windows, unlock the doors and open the trunk as required, before disconnecting the 12V battery. Once the 12V battery is disconnected, power controls will not operate.
3. Before disconnecting the 12V battery, move the smart key at least 2 meters away from the vehicle to prevent accidental restart.
4. Disconnect the negative (-) 12V battery cable (B), located in the electric motor compartment, to further prevent the risk of accidental restart.



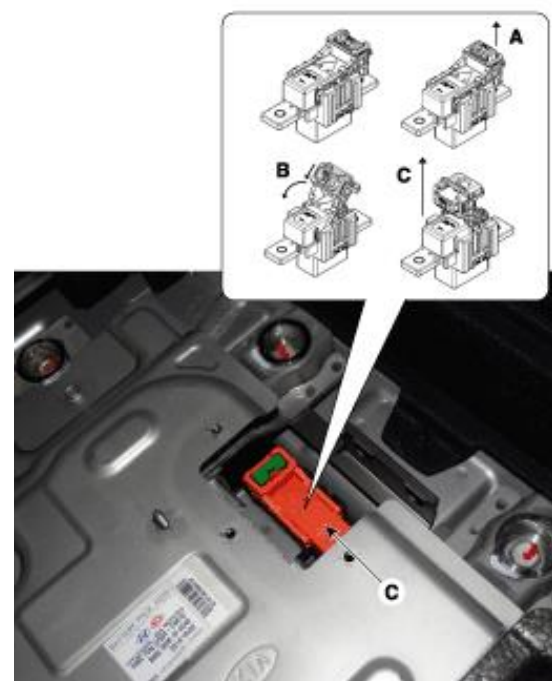
Smart Key



5. Use the following procedure to remove the safety plug and disable the high voltage battery:
 - a) Remove the installation bolts (A), and then remove the safety plug cover(B).
 - a) Remove the safety plug (C) using the following procedure :

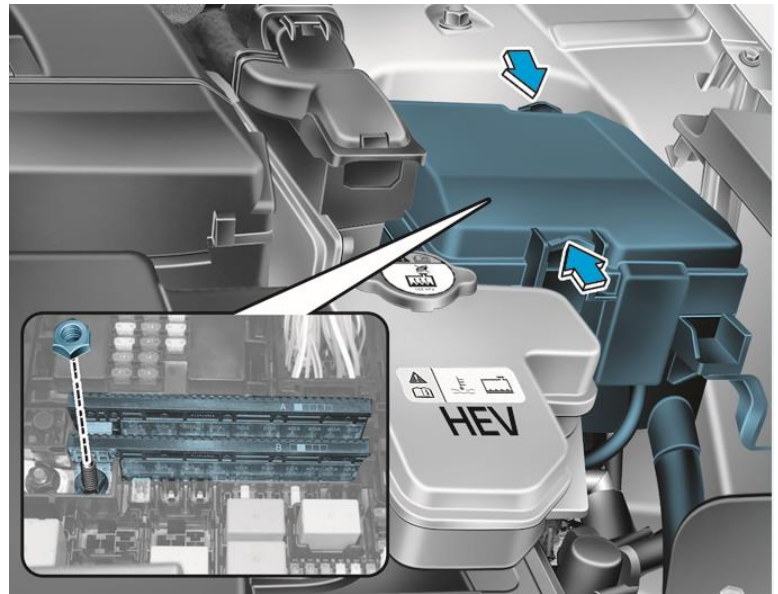


A: Unlock → B: Release → C: Remove



II . Disabling the system – IG Relay Removal (Alternate Method)

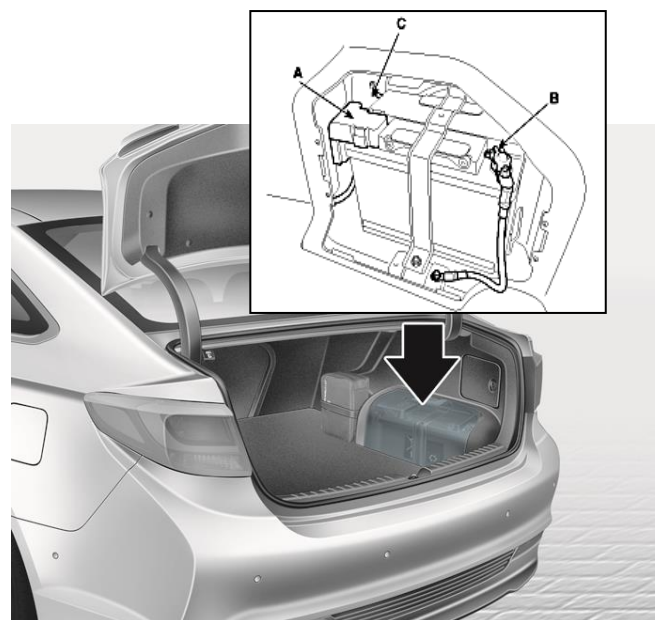
1. Open the hood.
2. Remove the engine compartment fuse box cover.
3. If necessary, lower the windows, unlock the doors and open the trunk as required, before disconnecting the 12V battery. Once the 12V battery is disconnected, power controls will not operate.



Engine compartment fuse box

4. In the event the vehicle cannot be disabled using the “Power” START/STOP Button, pull the IG1, IG2 Relay from the under hood engine compartment room fuse box. If the IG Relay cannot be located, pull out all the fuses and relays in the fuse box.

5. Disconnect the negative (–) 12V battery cable (B), located in the engine compartment room, to further prevent the risk of accidental restart. Before disconnecting the 12V battery (if needed) lower the windows, unlock the doors and open the trunk as required. Once the 12V battery is disconnected, power controls will not operate.

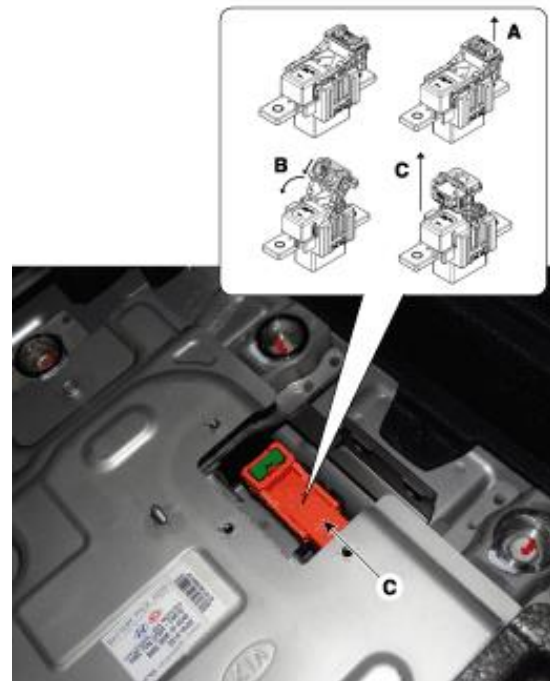


5. Use the following procedure to remove the safety plug and disable the high voltage battery:

a) Remove the installation bolts (A), and then remove the safety plug cover(B).

a) Remove the safety plug (C) using the following procedure :

A: Unlock → B: Release → C: Remove



If both methods of disabling system are unsuccessful, the vehicle is not secured from accidental deployment of airbags and electric shock from high-voltage components.

⚠ WARNING



Electrocution Risk

- Before engaging in emergency response procedures, ensure the vehicle is disabled and wait for more than 5 minutes to allow the capacitor in the high voltage system to discharge to avoid electrocution.
- Exposed cables or wires may be visible inside or outside the vehicle. To prevent injury or death due to electrical shock, never touch the wires or cables before disabling the system,

⚠ WARNING



Explosive

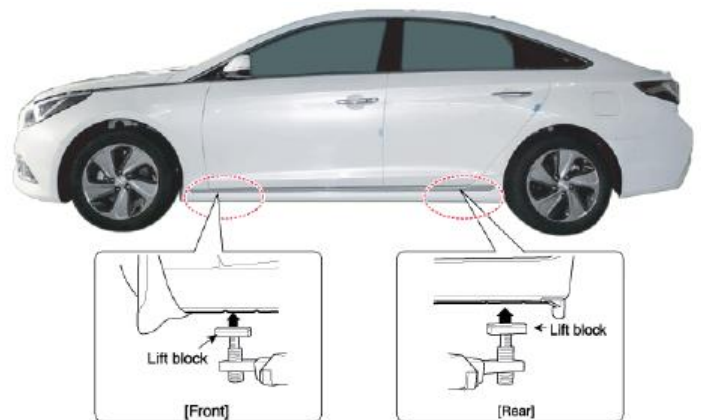
- Unintentional deployment of SRS components can result in serious injury or death.
Do not cut through any component.
- SRS components may remain powered and active for up to 3 minutes after the 12V electrical system is shut off or disabled. Disconnect the battery negative cable and wait for at least 3 minutes before beginning work.

Extraction Operations

The extrication operations for the Sonata Plug-in Hybrid are similar to the conventional vehicle. However, the first responder should pay special attention when they extract occupants in the vehicle. Before extrication operations, the first responders should carry out “Initial Response: Identify, Immobilize and Disable” procedure section in page 17 to 21.

Vehicle Stabilization

Use standard stabilization (cribbing) points, as shown. Always be sure to connect to a structural member of the vehicle and avoid placing cribbing under high voltage cables, fuel lines and other areas not normally considered acceptable.



Extrication tools and procedure

When responding to an incident involving a Sonata Plug-in Hybrid, we recommend that the first responders follow their organization's standard operating procedures for assessing and dealing with vehicle emergencies.

When the first responders cut the vehicle, they should always pay special attention to airbag system, orange colored high voltage cables and other high voltage components to avoid damage to parts which may increase the risks of explosion.

Submersion

Some emergency responses can involve a submerged vehicle. A Sonata Plug-in Hybrid that is submerged does not have high-voltage component on the vehicle's body or framework and is safe to touch, whether it is in water or on land.

In the event the vehicle is submerged or partially submerged, remove the vehicle from the water before attempting to disable the vehicle. Use one of the methods described in sections of page 17 to 21 to disable the vehicle once it has been removed from the water. There is no risk of electric shock from touching the car's body or framework – in or out of the water.

Vehicle Fire

After Initial Emergency Response Procedures have been applied, Firefighting Procedures may begin. Hyundai recommends that each response team follow their own department's standard operating procedures for fighting vehicle fires in combination with the Sonata Plug-in Hybrid specific details that are covered in this section.

Firefighting Operations

If the high-voltage battery pack is either involved in or at risk of being involved in a fire in a Sonata Plug-in Hybrid, strict cautions must be taken while conducting firefighting operations due to following reasons:

- Lithium-ion Polymer batteries contain gel electrolyte that can vent, ignite, and produce sparks when subjected to temperatures above 300°F.
- May burn rapidly with a flare-burning effect.
- A burning battery could release hydrogen fluoride, carbon monoxide, and carbon dioxide gasses. Use NIOSH/MSHA approved full-face self-contained breathing apparatus (SCBA) with full protective gear.

Even if the high-voltage battery pack is not directly involved in a vehicle fire, approach the vehicle very carefully.

Extinguishers

To extinguish a small high-voltage battery fire, the following techniques can be used:

- Dry chemical
- CO₂
- Large amounts of water
- Regular foam

For a large high-voltage battery fire, use these types of extinguishing methods:

- Large amounts of water
- Fog
- Regular foam

Once disabled, there is no risk of electric shock from touching the car's body or framework; therefore, firefighters should not hesitate to pour large amounts of water on the vehicle.

High-Voltage Battery Damage and Fluid Leaks

The HV Battery assembly is enclosed in a sturdy metal case that is rigidly mounted to structural components of the vehicle. This construction helps prevent damage to the HV Battery assembly even in severe crashes. This section provides emergency responders with information regarding how to mitigate the severity of a damaged HV Battery assembly or gel electrolyte spill, however unlikely that might be.

- Cease all smoke, spark, flame activity around the vehicle.
- Electrolyte solution is a skin irritant.
- Do not touch or step on the spilled electrolyte.
- If electrolyte leak occurs, wear appropriate solvent resistant PPE and use oil, sand, or a dry cloth to clean up the spilled electrolyte. Be sure to adequately ventilate the area.

WARNING



Electrocution Risk

- Internal components of HV Batteries are irritants and sensitizers.
 - To avoid contact with these irritants and sensitizers wear positive pressure self-contained breathing apparatus (SCBA) and other personal protective equipment (PPE) designed for use with these types of hazards.
 - Failure to wear proper SCBA and PPE can result in serious injury or death
-
- Electrolyte solution is an eye irritant – If contact with eyes, rinse with plenty of water for 15 minutes.
 - Electrolyte solution is a skin irritant. Therefore, if there is contact with skin, wash off with soap.
 - Electrolyte liquid or fumes that have come into contact with water vapors in the air will create an oxidized substance. This substance may irritate skin and eyes. In these cases, rinse with plenty of water and see a doctor immediately.
 - Electrolyte fumes (when inhaled) can cause respiratory irritation and acute intoxication
- Move to a well ventilated location for fresh air and wash mouth with water. See a doctor immediately.

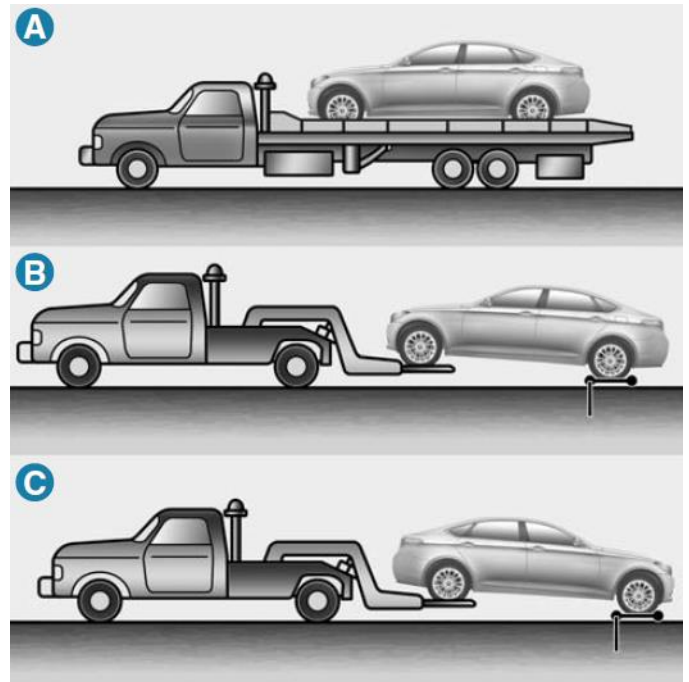
Towing

In the event of an accident, the high voltage system must be disabled. To disable the vehicle, the service plug must be removed from the high voltage battery according to one of the methods described in sections of 17 to 21.

When towing Sonata Plug-in Hybrid vehicle, all wheels should be off the ground and not in contact with the road.

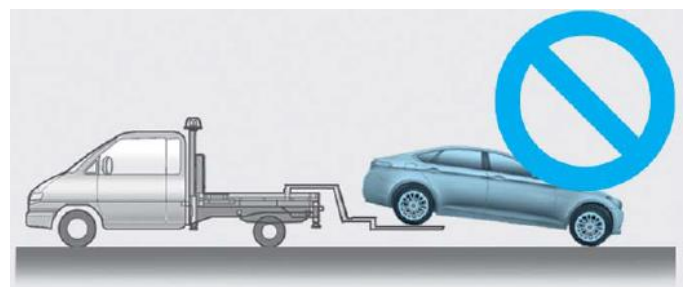
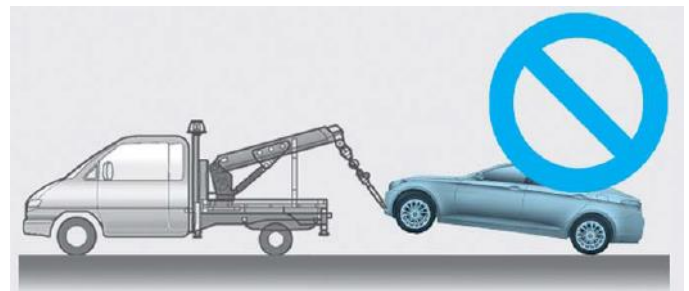
If emergency towing is necessary, we recommend having it done by an authorized Hyundai dealer or a commercial tow-truck service.

The use of wheel dollies or flatbed is recommended.



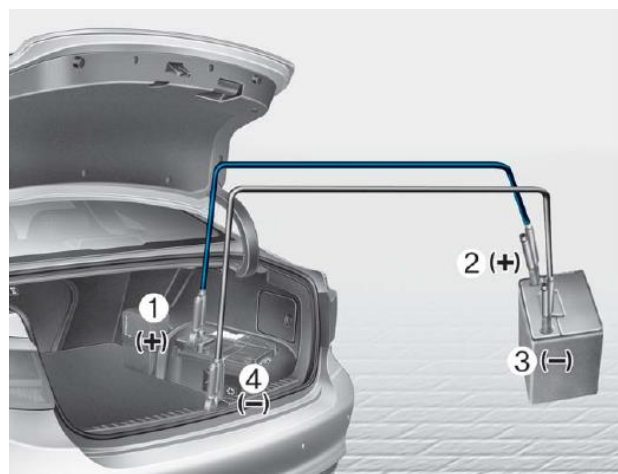
CAUTION!

- Do not tow the vehicle backwards with the front wheels on the ground as this may cause damage to the vehicle.
- Do not tow with sling-type equipment. Use wheel lift or flatbed equipment.
- Never tow the vehicle with the front wheels on the ground (forward or backward), as this may cause damage to the vehicle.



To Jump Start the Car

1. Make sure the booster battery is 12-volt.
2. If the booster battery is in another vehicle, do not allow the vehicles to touch.
3. Turn off all unnecessary electrical loads.
4. First connect one end of a jumper cable to the positive terminal of the discharged battery in the luggage room, then connect the other end to the positive terminal on the booster battery.



Proceed to connect one end of the other jumper cable to the negative terminal of the booster battery, then the other end to a solid, stationary, metallic point away from the battery (for example, the tailgate latch).



CAUTION!

- Do not connect the cables to or near any part that moves when the vehicle is started.
- Do not allow the jumper cables to contact anything except the correct battery terminals or the correct ground.
- Do not lean over the battery when making connections.

5. Start the vehicle with the booster battery, then start the vehicle with the discharged battery.
6. After a few minutes, turn off both of the vehicles.
7. Remove the negative terminal cable first, and then remove the positive terminal cable. If the cause of your battery discharging is not apparent, we recommend that the system be checked by an authorized HYUNDAI dealer or Hyundai Motor America.



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