■ CONTROL

1. General

The THS-II system utilizes the following controls.

Item	Outline	
Hybrid Vehicle Control [See page HV-57]	• The hybrid vehicle control ECU calculates the target motive force based on the shift lever position sensor, the degree to which the accelerator pedal is depressed, and the vehicle speed. It performs control in order to create the target motive force by optimally combining MG1, MG2, MGR, and the engine. • The hybrid vehicle control ECU calculates the engine motive force based on the target motive force. The target motive force is calculated based on the requirements of the driver and the vehicle operating conditions. In order to create this motive force, the hybrid vehicle control ECU appropriately controls the ETCS-i (Electronic Throttle Control System-intelligent) system, fuel injection volume, injection timing, and VVT-i (Variable Valve Timing-intelligent) system. • The hybrid vehicle control ECU monitors the conditions of the HV battery and cooling fans to perform control using feedback to keep the HV battery at a predetermined temperature.	
	System Monitoring Control [See page HV-59]	The hybrid vehicle control ECU monitors the SOC of the HV battery and the temperature of the HV battery, MG1, MG2 and MGR, in order to optimally control these items.
	Shut Down Control [See page HV-59]	When the shift lever is in the N position, the hybrid vehicle control ECU performs shut down control to stop driving MG1, MG2 and MGR.
	Motor Traction Control [See page HV-60]	If the drive wheels rotate without traction, the hybrid vehicle control ECU performs motor traction control to restrain the rotation of MG2. This protects the planetary gear unit and prevents MG1 from generating excessive electricity. Motor traction control is also used for MGR.
	SMR (System Main Relay) Control [See page HV-63]	To ensure that it is possible to connect and disconnect the high voltage circuits reliably, the hybrid vehicle control ECU controls the 3 SMRs to connect and disconnect the high voltage circuits from the HV battery. The hybrid vehicle control ECU also uses the timing of the operation of the SMRs to monitor the operation of the relay contacts.
	SOC (State Of Charge) Control [See page HV-65]	The hybrid vehicle control ECU calculates the SOC by estimating the charging and discharging amperage of the HV battery.
	Cooling Fan Control [See page HV-66]	The hybrid vehicle control ECU uses temperature sensors in the HV battery to monitor the temperature of the HV battery. The THS controls HV battery temperature by varying the speed of the three cooling fans that are provided.
	Auxiliary Battery Charging Control [See page HV-67]	The hybrid vehicle control ECU uses the battery temperature sensor in the auxiliary battery to monitor the temperature of the auxiliary battery. The hybrid vehicle control ECU performs charge control based on temperature information from the auxiliary battery.

(Continued)

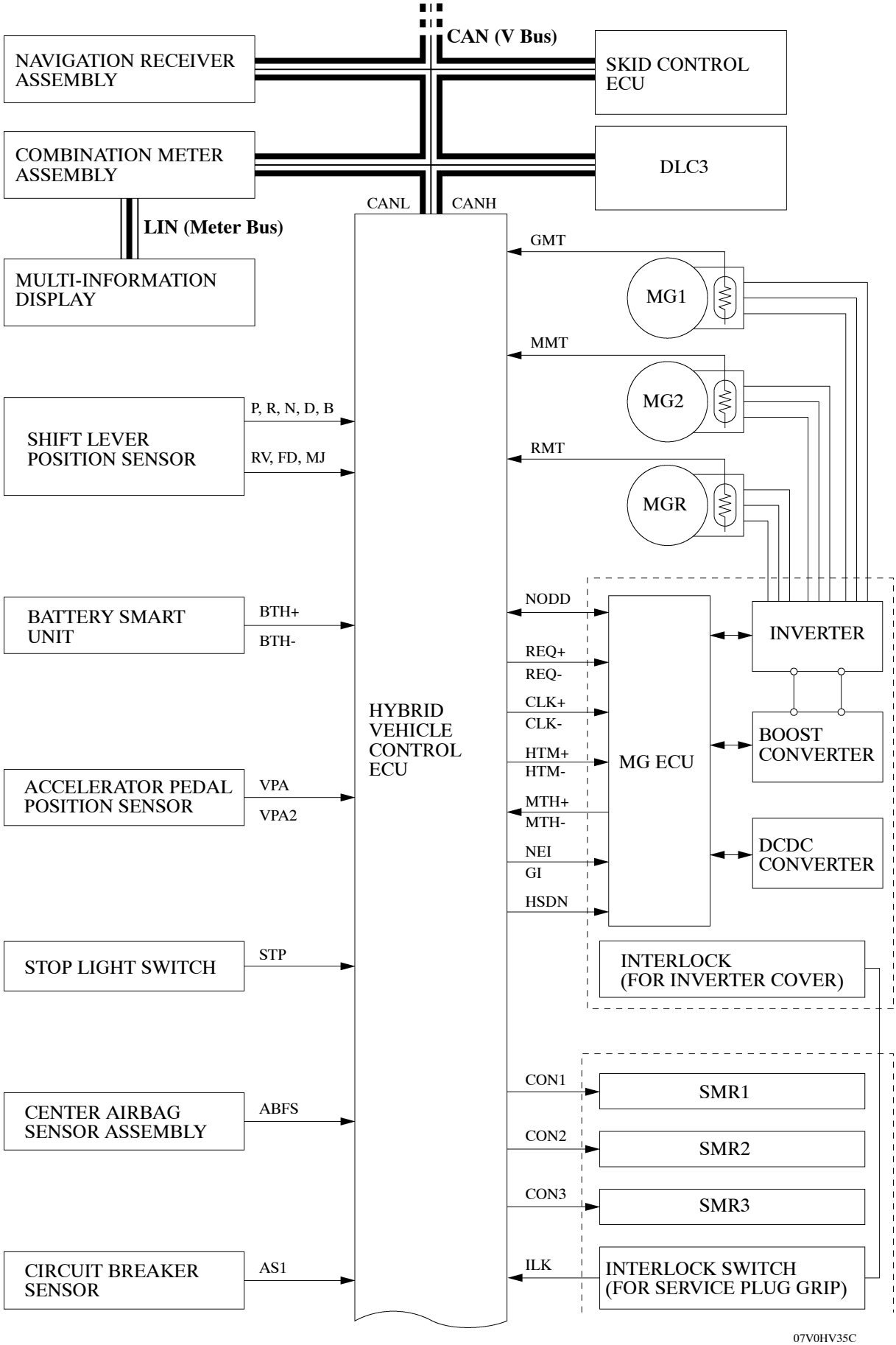
Item	Outline
MG1, MG2 and MGR Main Control [See page HV-68]	• MG1, which is driven by the engine, generates high voltage (alternating current) in order to operate MG2 and charge the HV battery via the inverter. Also, MG1 functions as a starter to start the engine. • MG2, which is driven by electrical power from MG1 and/or the HV battery, generates motive force for the front wheels. • MGR, which is driven by the electrical power from MG1 and/or the HV battery, generates motive force for the rear wheels. • MG2 and MGR generate electricity to charge the HV battery (regenerative braking control) during braking, or when the accelerator pedal is not being depressed. • Resolvers detect the speed and the position of MG1, MG2, and MGR, for use by the hybrid vehicle control ECU. Resolver signals are transmitted to the hybrid vehicle control ECU via the MG ECU. • Temperature sensors mounted in MG1, MG2 and MGR detect the temperature for use by the hybrid vehicle control ECU.
Inverter with Converter Assembly Control [See page HV-70]	• The inverter converts direct current from the HV battery into alternating current for MG1 and MG2, or vice versa, in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU. In addition, the inverter is used to transfer power from MG1 to MG2. • Via the MG ECU, the hybrid vehicle control ECU sends signals to the power transistors on the IPMs in the inverter for switching the U, V, and W phases of MG1, MG2, and MGR, in order to drive MG1 MG2 and MGR. • The hybrid vehicle control ECU shuts down the inverter if it receives an overheat, over-current, or fault voltage signal from the inverter via the MG ECU.
Boost Converter Control [See page HV-71]	• The boost converter boosts the nominal HV battery voltage of DC 288V up to a maximum voltage of DC 650V, in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU. • The inverter converts the alternating current generated by MG1 MG2 or MGR into direct current. The boost converter drops the generated voltage of (up to 650V to approximately DC 288V for the HV battery in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU.
DC-DC Converter Control	• Drops the voltage of DC 288V (nominal) into DC 14V (nominal) in order to supply electricity to body electrical components, as well as to recharge the auxiliary battery (DC 14V). • This converter keeps the auxiliary battery at a constant voltage.
Skid Control ECU Control [See page HV-74]	During braking, the skid control ECU calculates the required regenerative brake force and transmits it to the hybrid vehicle control ECU. Upon receiving this signal, the hybrid vehicle control ECU transmits an actual regenerative brake control value to the skid control ECU. Based on this result, the skid control ECU calculates and executes the required hydraulic brake force.
Battery Smart Unit Control [See page HV-75]	The battery smart unit monitors the insulation of the high voltage electrical system for leakage. In addition, it converts the feedback signals of the cooling fan and the conditions of the HV battery and (which are needed by the hybrid vehicle control ECU to effect SOC control and cooling fan control) into digital signals and transmits them to the hybrid vehicle control ECU.
Shift Control [See page CH-16]	The hybrid vehicle control ECU detects the shift position (P, R, N, D, or B) in accordance with the signals provided by the shift lever position sensor. The hybrid vehicle control ECU controls MG1, MG2, MGR and the engine to match the selected shift position.
During Collision Control [See page HV-76]	During a collision, if the hybrid vehicle control ECU receives an airbag deployment signal from the airbag sensor assembly, or an actuation signal from the circuit breaker sensor located on the inverter with converter assembly, it turns the SMRs (System Main Relay) off in order to shut off the high voltage power supplied to the hybrid system by the battery.
Cruise Control System Operation Control	When the cruise control ECU that is enclosed in the hybrid vehicle control ECU receives a cruise control switch signal, it regulates the hybrid system output to obtain the targeted vehicle speed based on the driver's demand.

(Continued)

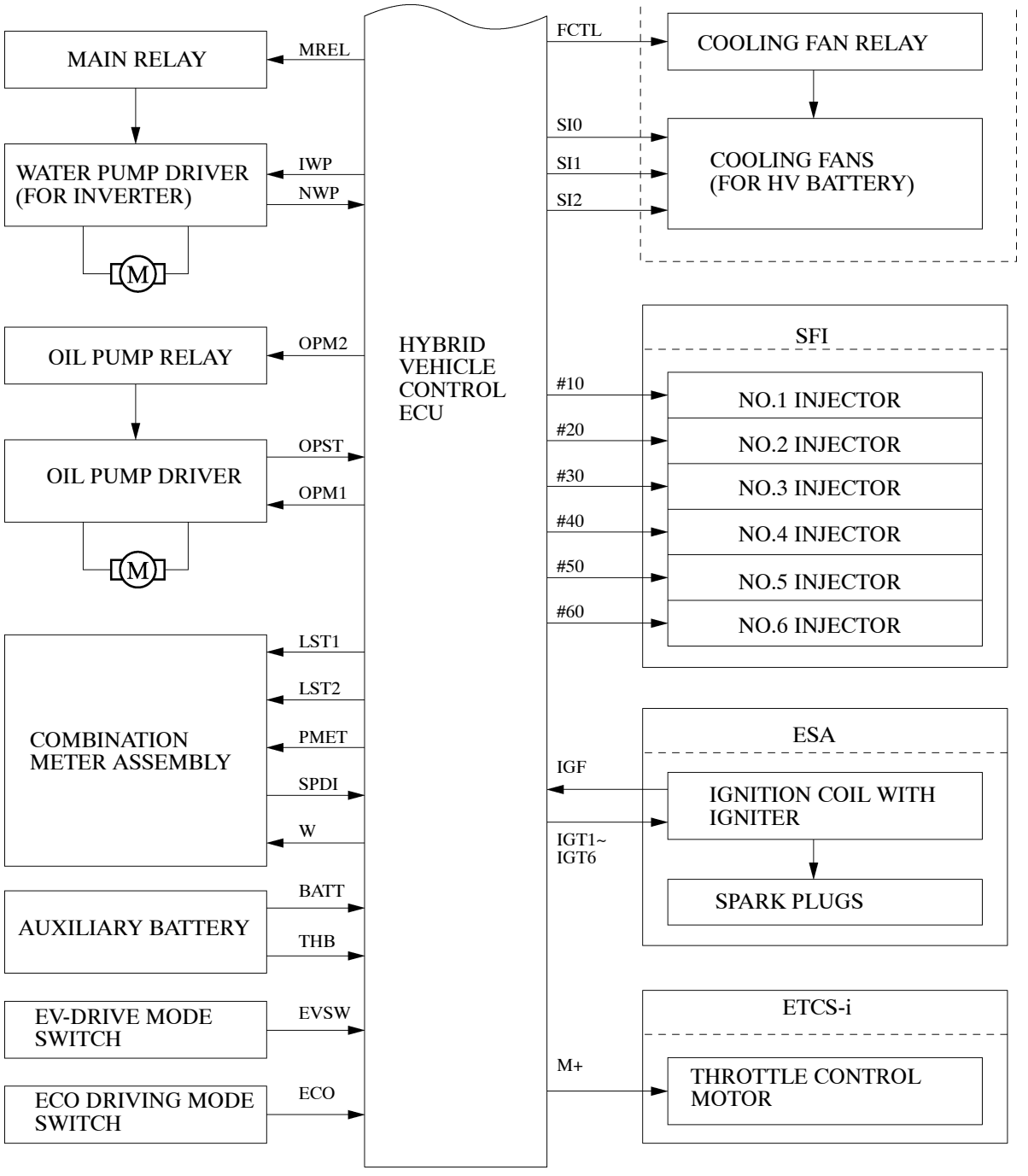
Item	Outline
EV-Drive Mode Control [See page HV-78]	When the EV-drive mode switch is manually operated by the driver, the hybrid vehicle control ECU operates the vehicle to run with only MG2 and MGR if required conditions are satisfied.
Eco Driving Mode Control [See page HV-80]	When the eco driving mode switch is manually operated by the driver, the hybrid vehicle control ECU moderates the response of the accelerator pedal operation to support driving using the variable economy zone.
Indicator and Warning Light Control [See page HV-81]	Illuminates, blinks warning lights, or shows messages on the multi-information display to inform the driver of vehicle conditions or system malfunctions.
Diagnosis [See page HV-85]	When the hybrid vehicle control ECU or MG ECU detects a malfunction, the hybrid vehicle control ECU records the fault and memorizes the information that relates to the fault.
Fail-safe	When the hybrid vehicle control ECU detects a malfunction, it stops or controls the device and other ECUs according to the data already stored in memory.

2. Construction

The configuration of the THS-II system in the vehicle is shown in the following chart.



HV


MAIN RELAY
MREL
WATER PUMP DRIVER (FOR INVERTER)
IWP
NWP
M
OIL PUMP RELAY
OPM2
OIL PUMP DRIVER
OPST
OPM1
M
COMBINATION METER ASSEMBLY
LST1
LST2
PMET
SPDI
W
AUXILIARY BATTERY
BATT
THB
EV-DRIVE MODE SWITCH
EVSW
ECO DRIVING MODE SWITCH
ECO
HYBRID VEHICLE CONTROL ECU
FCTL
COOLING FAN RELAY
SI0
SI1
SI2
COOLING FANS (FOR HV BATTERY)
SFI
#10
#20
#30
#40
#50
#60
NO.1 INJECTOR
NO.2 INJECTOR
NO.3 INJECTOR
NO.4 INJECTOR
NO.5 INJECTOR
NO.6 INJECTOR
ESA
IGF
IGT1~ IGT6
IGNITION COIL WITH IGNITER
SPARK PLUGS
ETCS-i
M+
THROTTLE CONTROL MOTOR

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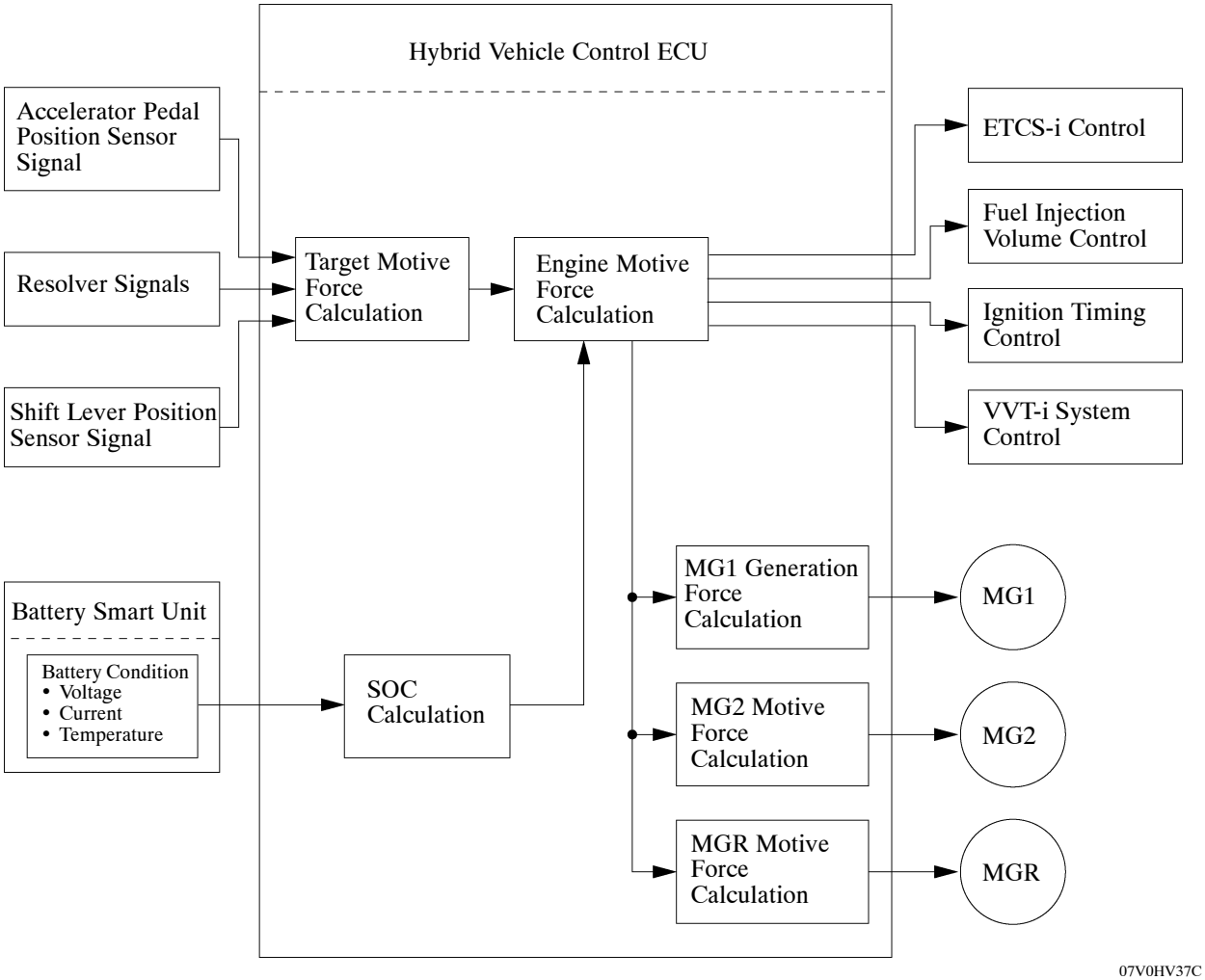
3. Hybrid Vehicle Control

General

- The hybrid vehicle control ECU detects the amount of accelerator pedal depression using the signals from the accelerator pedal position sensor. The hybrid vehicle control ECU receives vehicle speed signals from the MG2 resolver and detects the shift position signal from the shift lever position sensor. The hybrid vehicle control ECU determines the vehicle operating conditions in accordance with this information, and optimally controls the motive forces of MG1, MG2, MGR and the engine. Furthermore, the hybrid vehicle control ECU optimally controls the output and torque of MG1, MG2, MGR and the engine in order to realize lower fuel consumption and cleaner exhaust emissions.
- The hybrid vehicle control ECU calculates the engine motive force based on the calculated target motive force, and by taking the SOC and the temperature of the HV battery into consideration. The value obtained by subtracting the engine motive force from the target motive force is the MG2 and MGR motive force.
- The hybrid vehicle control ECU achieves the required engine motive force by performing ETCS-i control, fuel injection volume control, injection timing control, and VVT-i system control.

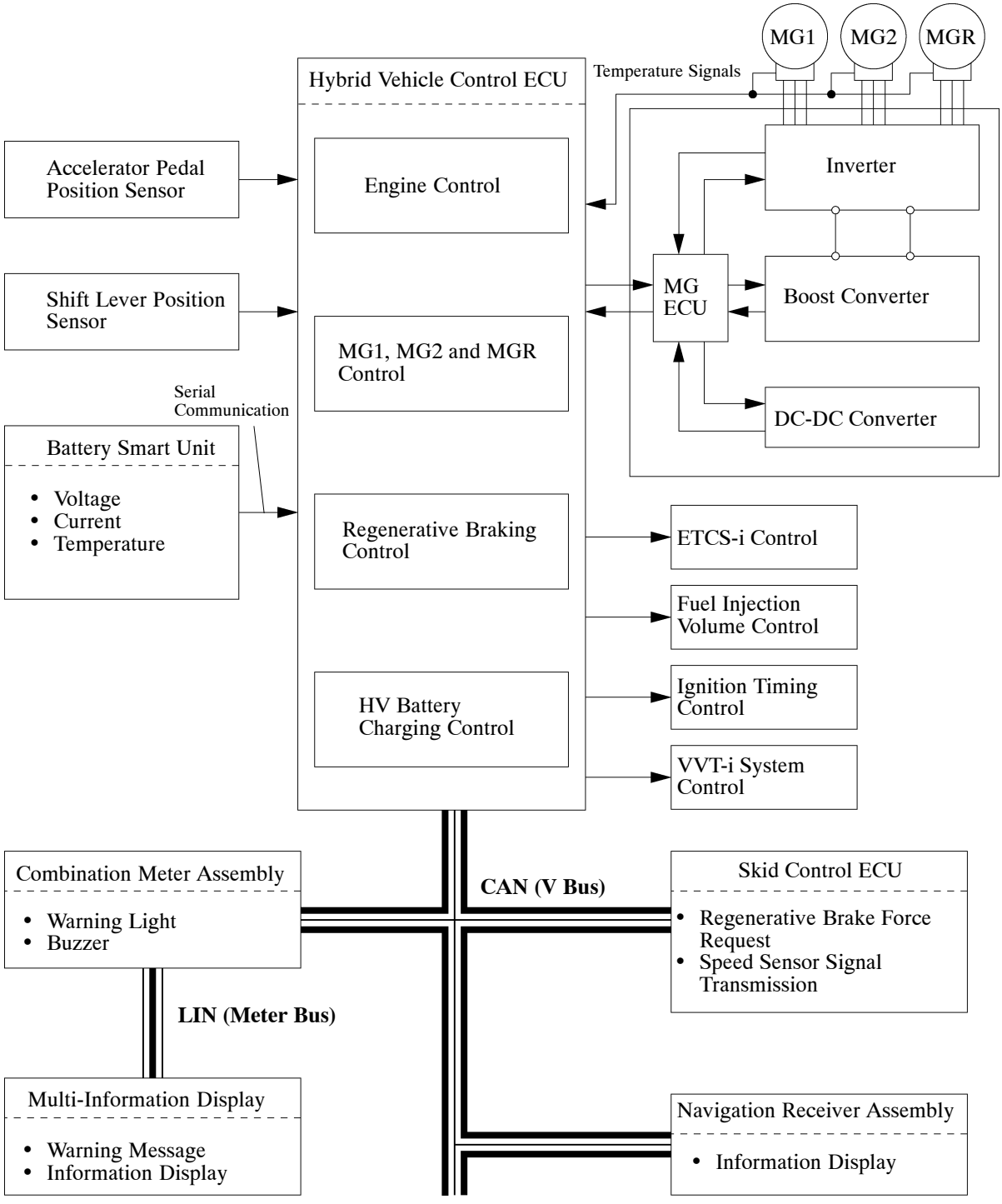
▶ Flow of Motive Force Calculation◀

(Target Motive Force) — (Engine Motive Force) = (MG2 and MGR Motive Force)



HV

System Diagram



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System Monitoring Control

- The hybrid vehicle control ECU constantly monitors the SOC (State Of Charge) of the HV battery. When the SOC is below the lower level, the hybrid vehicle control ECU increases the power output of the engine to operate MG1, which charges the HV battery. When the engine is stopped, MG1 operates to start the engine; then, the engine operates MG1 to charge the HV battery.
- If the SOC is low, or the temperature of the HV battery, MG1, MG2 or MGR is higher than a specified value, the hybrid vehicle control ECU restricts the motive force applied to the drive wheels until the value of the abnormal item returns to normal.

Shut Down Control

Generally, MG1 and MG2 are shut down when the shift lever is in the N position. In order to stop providing motive force, it is necessary to stop driving MG1 and MG2, because MG2 is mechanically joined to the front wheels. MGR will also be shut down at the same time.

However, there are exceptions. The shut down function is canceled in the following conditions:

- During driving, if the brake pedal is depressed and a wheel locks up, the ABS function is activated. After this, low torque is requested from MG2 or MGR to provide supplemental power in order to restart the rotation of the wheel. Even if the shift lever is in the N position at this time, the shut down function is canceled to allow the wheel to rotate. After the wheel rotation has been restarted, the system resumes its shut down function.
- When the vehicle is driven in D or B position and the brake pedal is depressed, regenerative braking occurs. At this time, if the driver moves the shift lever to the N position, the brake hydraulic pressure increases while the request torque of the regenerative brake decreases gradually so as not to create a sluggish brake feel. After this, the system performs the shut down function.
- When the speed of MG1, MG2 and MGR is above a specified threshold, the shut down function is canceled.

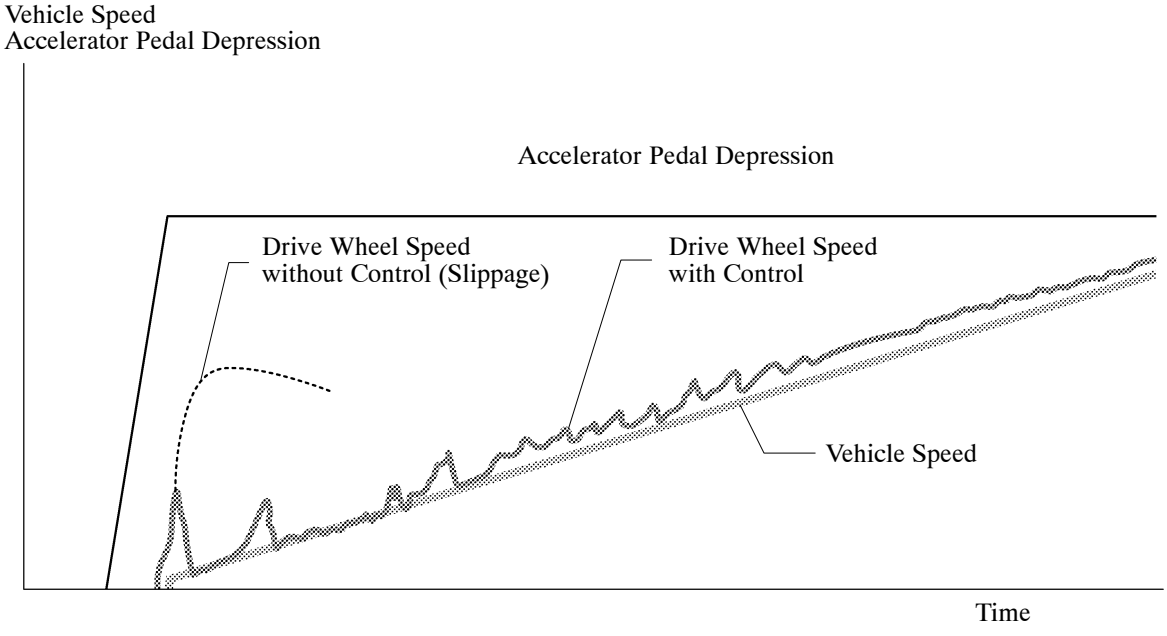
Motor Traction Control

1) General

- If a drive wheels slips while the vehicle is being driven on a slippery road surface, MG2 (which is coupled directly to the wheels) will spin excessively, causing the relative rotational speed of parts of the compound gear unit to increase. This condition could damage the areas that support the parts in the compound gear unit, such as through gear unit parts seizure. In some cases, this condition could cause MG1 to generate an excessive amount of electricity. For this reason, if the hybrid vehicle control ECU determines that MG2 is spinning excessively upon monitoring a sudden change in MG2 rotation speeds by way of its resolver, the hybrid vehicle control ECU applies a brake force to suppress the rotation, in order to protect the compound gear unit.
- Furthermore, if only one of the drive wheels spins excessively, the hybrid vehicle control ECU will monitor the speed difference between it and the other wheels by way of the speed sensors of the respective wheels, and the hybrid vehicle control ECU will transmit a command to the skid control ECU in order to apply the brakes to the wheel that is spinning excessively.

These controls achieve the same effect as the TRAC function of the brake control system.

▶ Image Diagram ◀

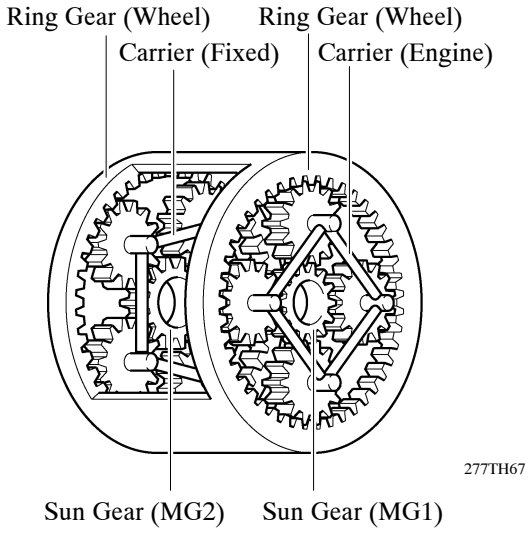


Drive wheel speed behavior when Starting off a snowy road

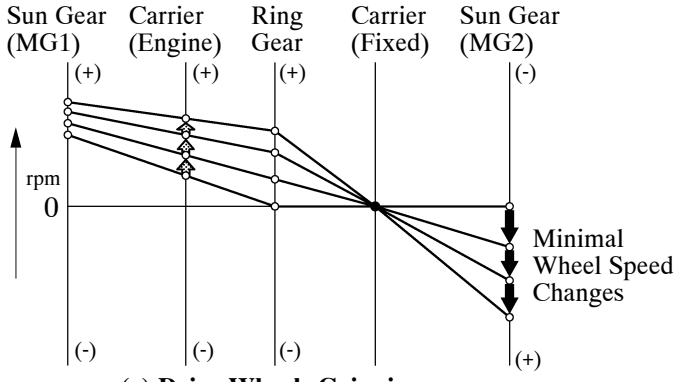
277TH106

2) Operation

- The following describes how excessive rotation is generated. For example, if the drive wheels have normal grip, the change in the rotational speed of MG2 (drive wheels) will be minimal, as shown in Figure (a). Thus, a proper balance is maintained between the drive wheels and the engine with minimal changes in speed, resulting in minimal differences in the relative rotational speeds of the compound gear unit as a whole.
- If the drive wheels lose traction, the rotation speed of MG2 (drive wheels) changes significantly as shown in Figure (b). As a result, difference of the relative rotation speeds in the whole compound gear unit becomes larger, because the engine speed cannot change quickly enough to match the increased speed of MG2.

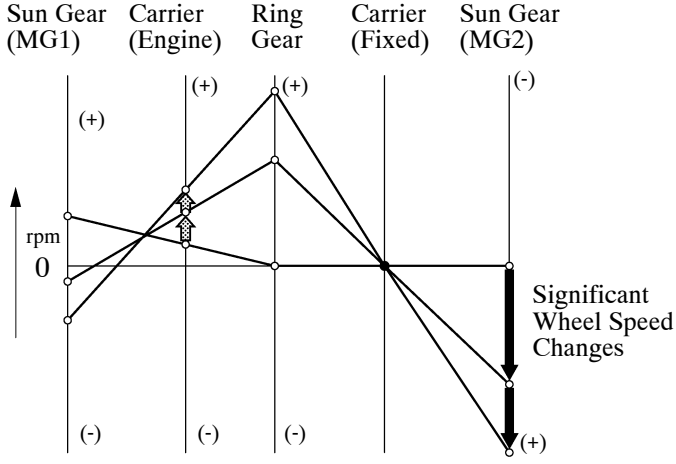


Compound Gear Unit Schematic Diagram



(a) Drive Wheels Gripping

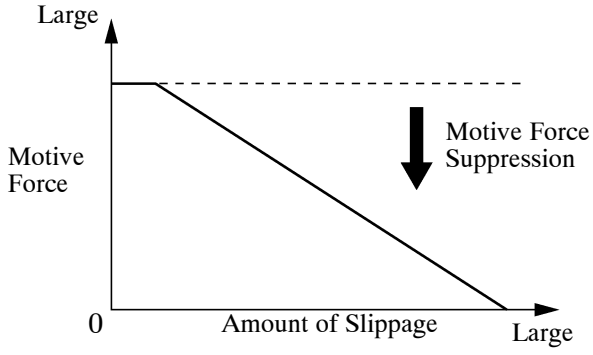
277TH68



(b) Drive Wheels Slipping

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- The hybrid vehicle control ECU monitors for sudden changes in speed through the resolver signals from MG2, (or MGR) in order to calculate the amount of slippage of the drive wheels. The hybrid vehicle control ECU controls the motive force by suppressing the rotation of MG2 (or MGR) in accordance with the calculated amount of slippage.



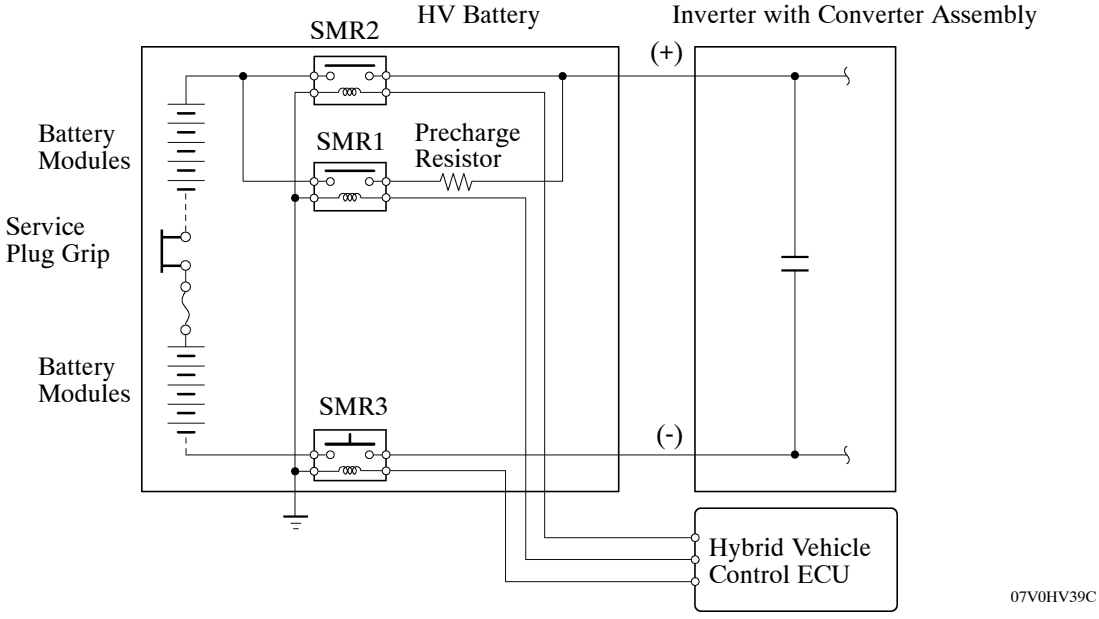
Conceptual Image of Motor Traction Control

SMR (System Main Relay) Control

1) General

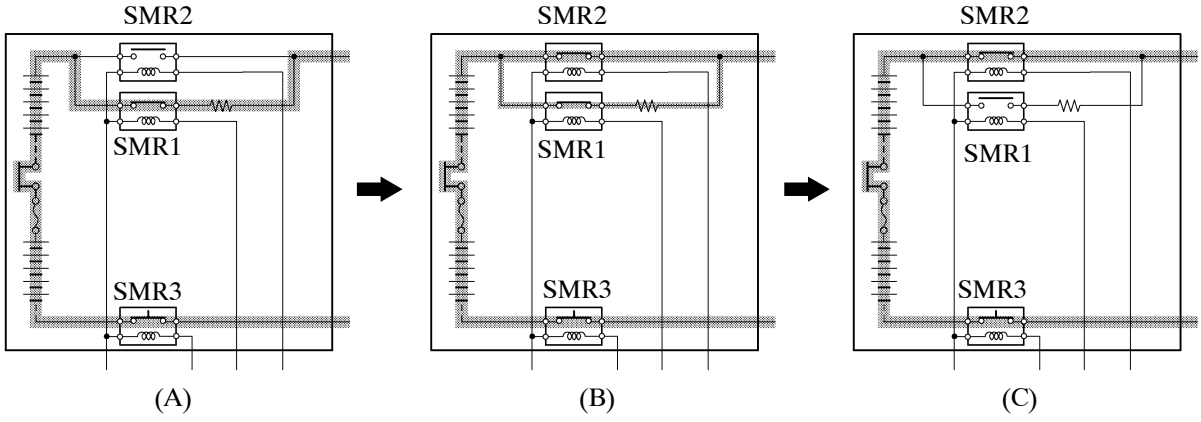
The SMRs are relays that connect and disconnect the power source of the high-voltage circuit upon receiving a command from the hybrid vehicle control ECU. A total of 3 relays, one for the negative side, and two for the positive side, are provided to ensure proper operation.

2) System Diagram



3) Power is turned on

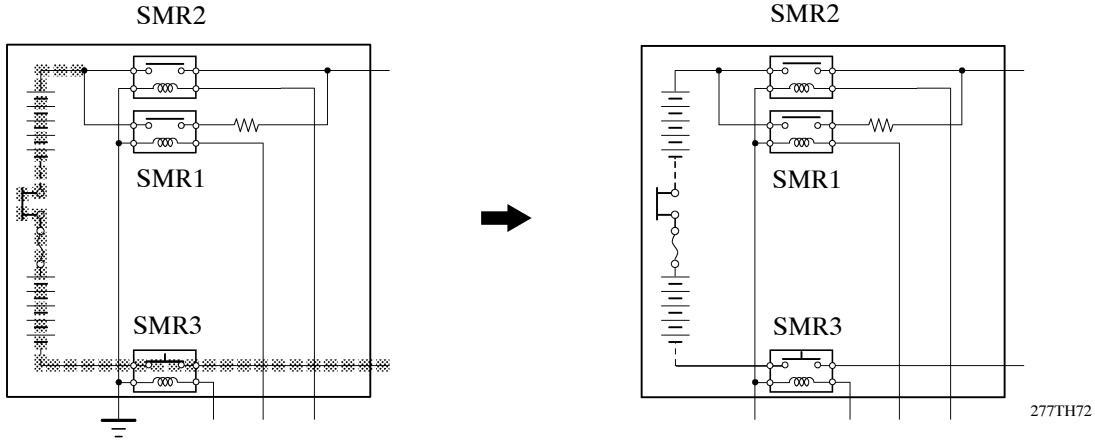
SMR1 and SMR3 turn ON when the circuit is disconnected; subsequently, SMR2 turns ON and SMR1 turns OFF. As the controlled current is initially allowed to pass through a resistor in this manner, the contact point in the circuit is protected from damage that could be caused by a rush current.



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4) Power is turned off

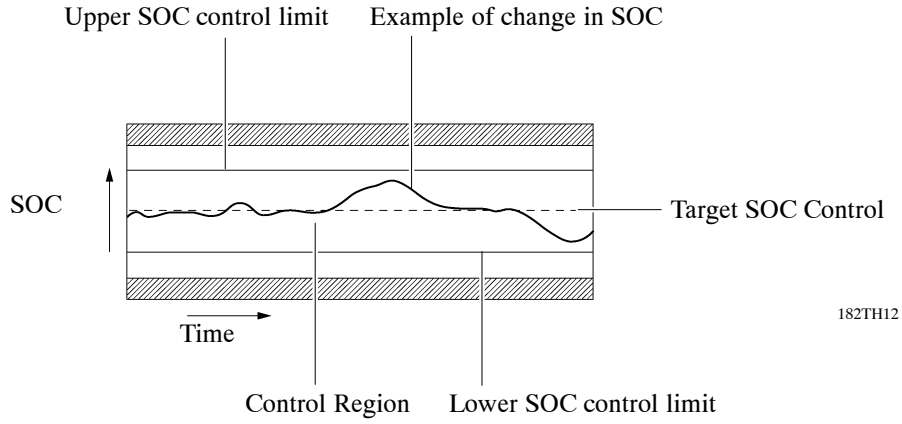
SMR2 and SMR3 turn OFF when the circuit is disconnected, in that order. Then, the hybrid vehicle control ECU verifies that the respective relays have been properly turned off. Accordingly, the hybrid vehicle control ECU is able to determine if SMR2 is stuck.



277TH72

SOC (Stage Of Charge) Control

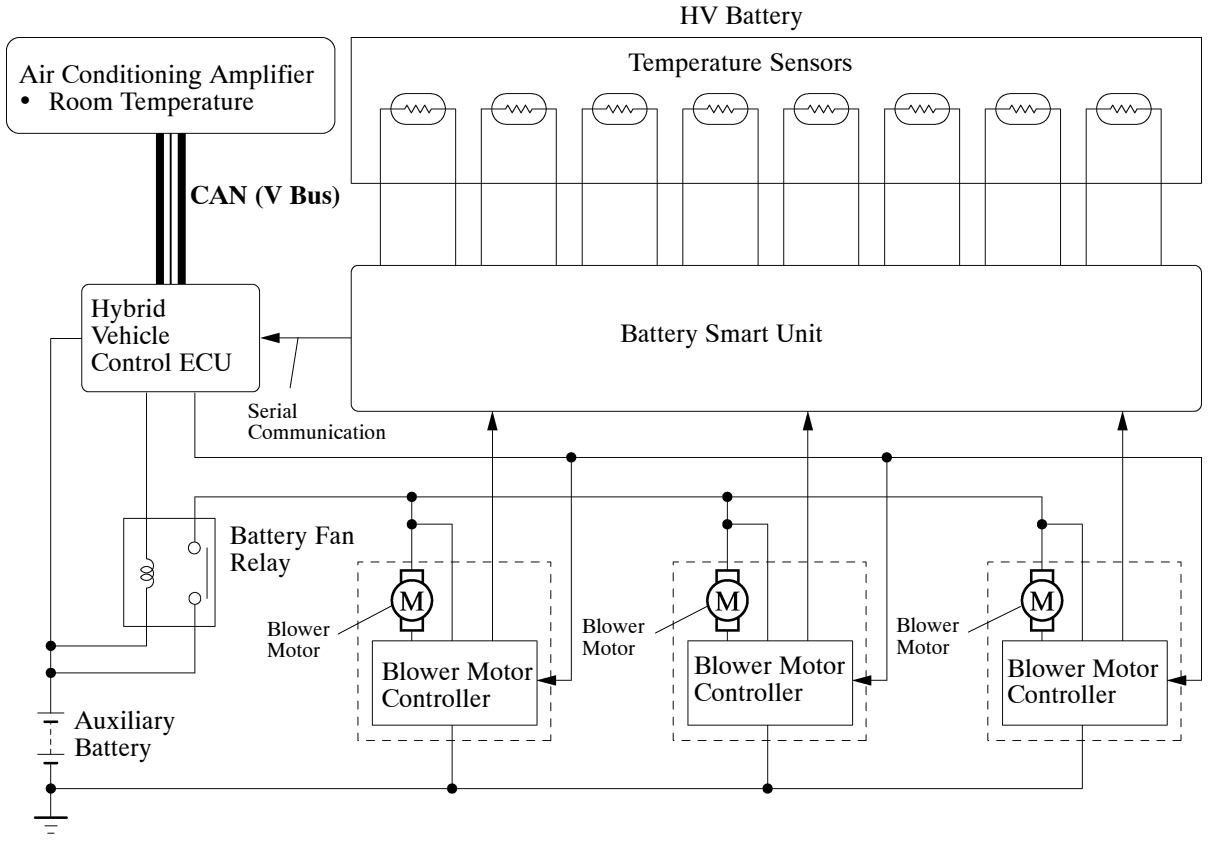
- The hybrid vehicle control ECU calculates the SOC (state of charge) of the HV battery by estimating its charging and discharging amperages, in order to control the SOC. This allows the hybrid system to make control decisions based on the power stored in the battery.
- While the vehicle is in motion, the HV battery undergoes repetitive charge/discharge cycles, as it becomes discharged by MG2 or MGR during acceleration and charged by regenerative braking during deceleration. The hybrid vehicle control ECU calculates the SOC based on the amount of HV battery charge/discharge detected by the current sensor. The hybrid vehicle control ECU constantly performs charge/discharge control based on the calculated SOC value in order to maintain the SOC within its target range.



Cooling Fan Control

- The hybrid vehicle control ECU detects increases in battery temperature via the eight temperature sensors in the HV battery. Then, the hybrid vehicle control ECU steplessly actuates the cooling fans using duty cycle control, in order to maintain the temperature of the HV battery within the specified range.
- While the air conditioning system is operating and cooling down the cabin, and if there is any leeway in the HV battery temperature, the hybrid vehicle control ECU turns the cooling fans off or sets them to a low speed. The purpose of this control is to give priority to cooling down the cabin. If this control was not performed, air taken from the cabin for battery cooling would slow the cooling of the cabin by the air conditioning system.

▶ System Diagram ◀

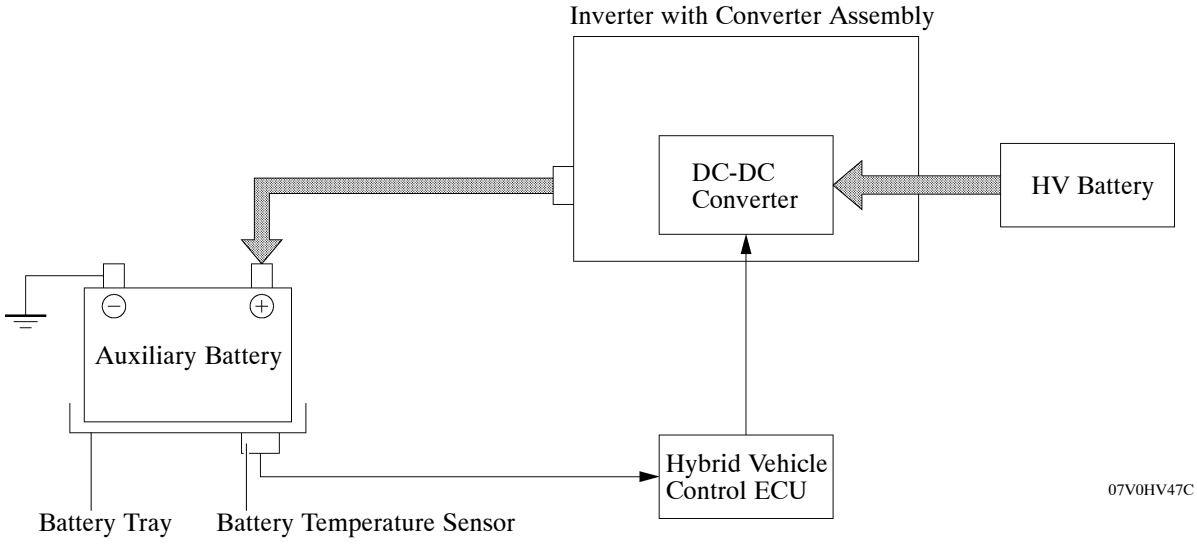


Auxiliary Battery Charging Control

1) General

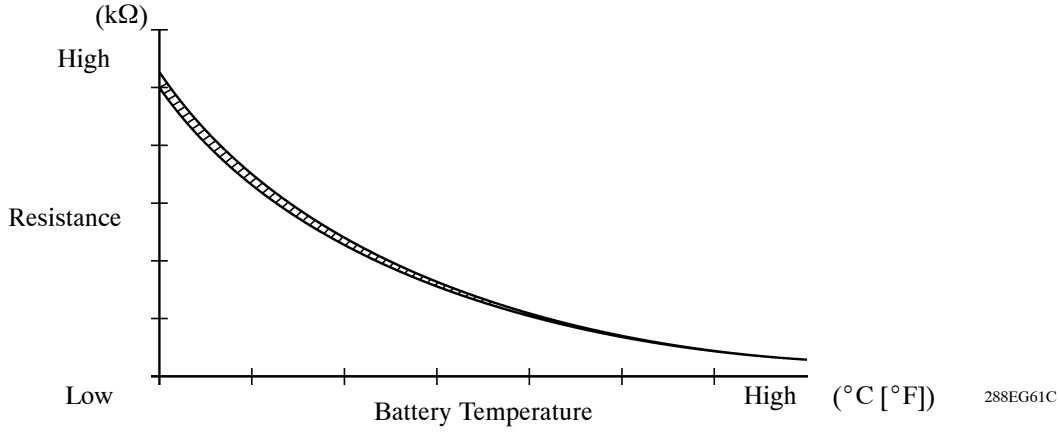
The hybrid vehicle control ECU controls the DC-DC converter in accordance with the signals from the battery temperature sensor of the auxiliary battery, in order to control the charging voltage to the auxiliary battery.

2) System Diagram



Battery Temperature sensor

- The battery temperature sensor (battery thermometer sensor) is located under the battery tray.
- The battery characteristic (battery internal resistance) of taking in current for charging varies according to battery electrolyte temperature. If the battery electrolyte temperature is too low or too high, the battery will degrade more quickly, resulting in premature failure. To prevent this, the battery temperature sensor resistance changes as shown below to allow the hybrid vehicle control ECU to detect the auxiliary battery temperature.



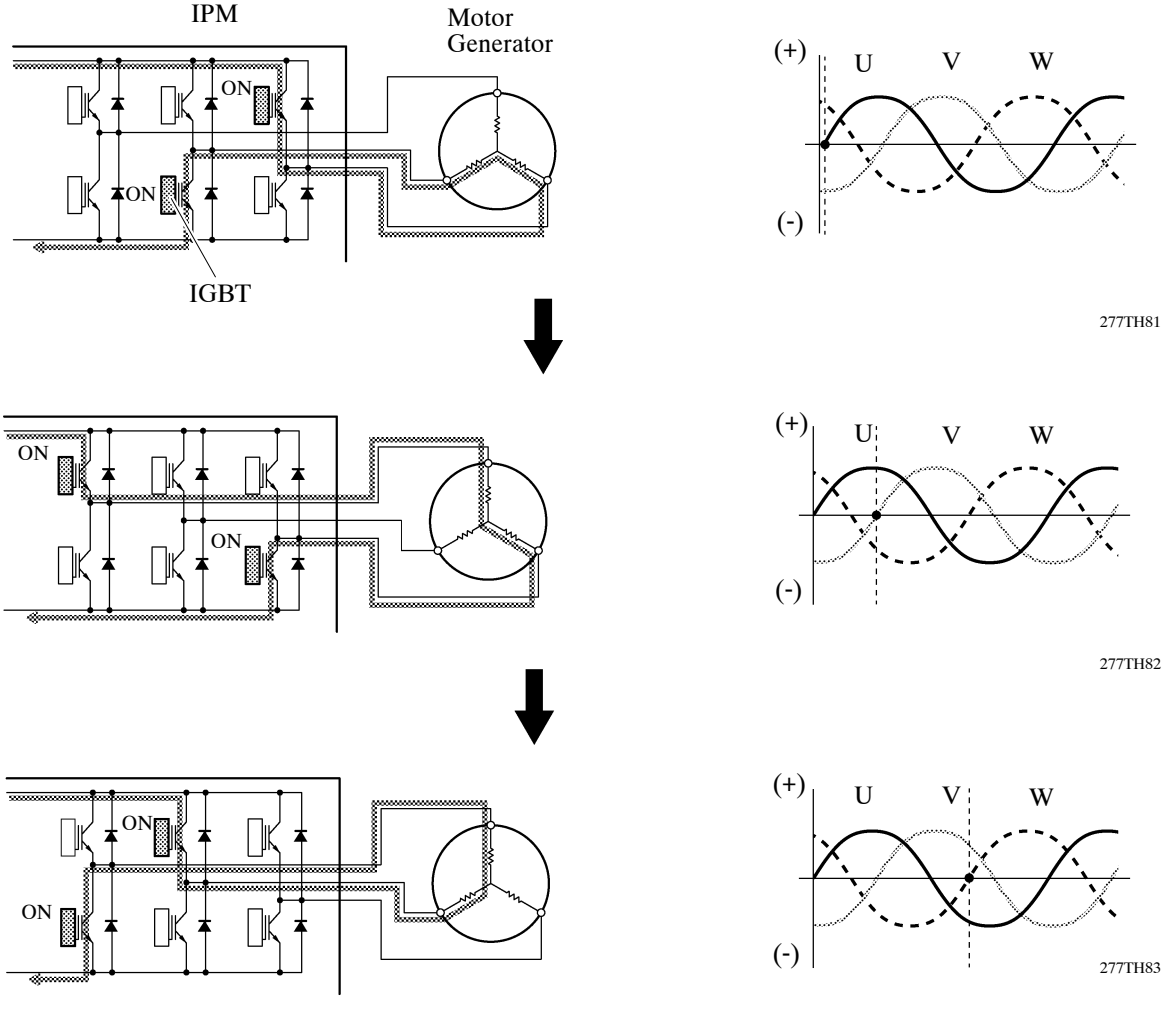
4. MG1, MG2 and MGR Main Control

General

- MG1, which is driven by the engine, generates high voltage (alternating current) in order to power MG2 and charge the HV battery. Also, MG1 functions as a starter to start the engine.
- MG2 is driven by electrical power from MG1 or from the HV battery, and it generates motive force for the front wheels.
- MGR is driven by electrical power from the HV battery and MG1, and it generates motive force for the rear wheels.
- MG2 and MGR generate electricity to charge the HV battery (regenerative brake control) during braking, or when the accelerator pedal is not being depressed.
- The MG ECU, which follows the commands of the hybrid vehicle control ECU, controls MG1, MG2, and MGR via the IPMs (Intelligent Power Modules), for driving the vehicle. 6 IGBTs (Insulated Gate Bipolar Transistors) switch on and off to control each individual motor generator in accordance with operation as either a motor or as a generator.

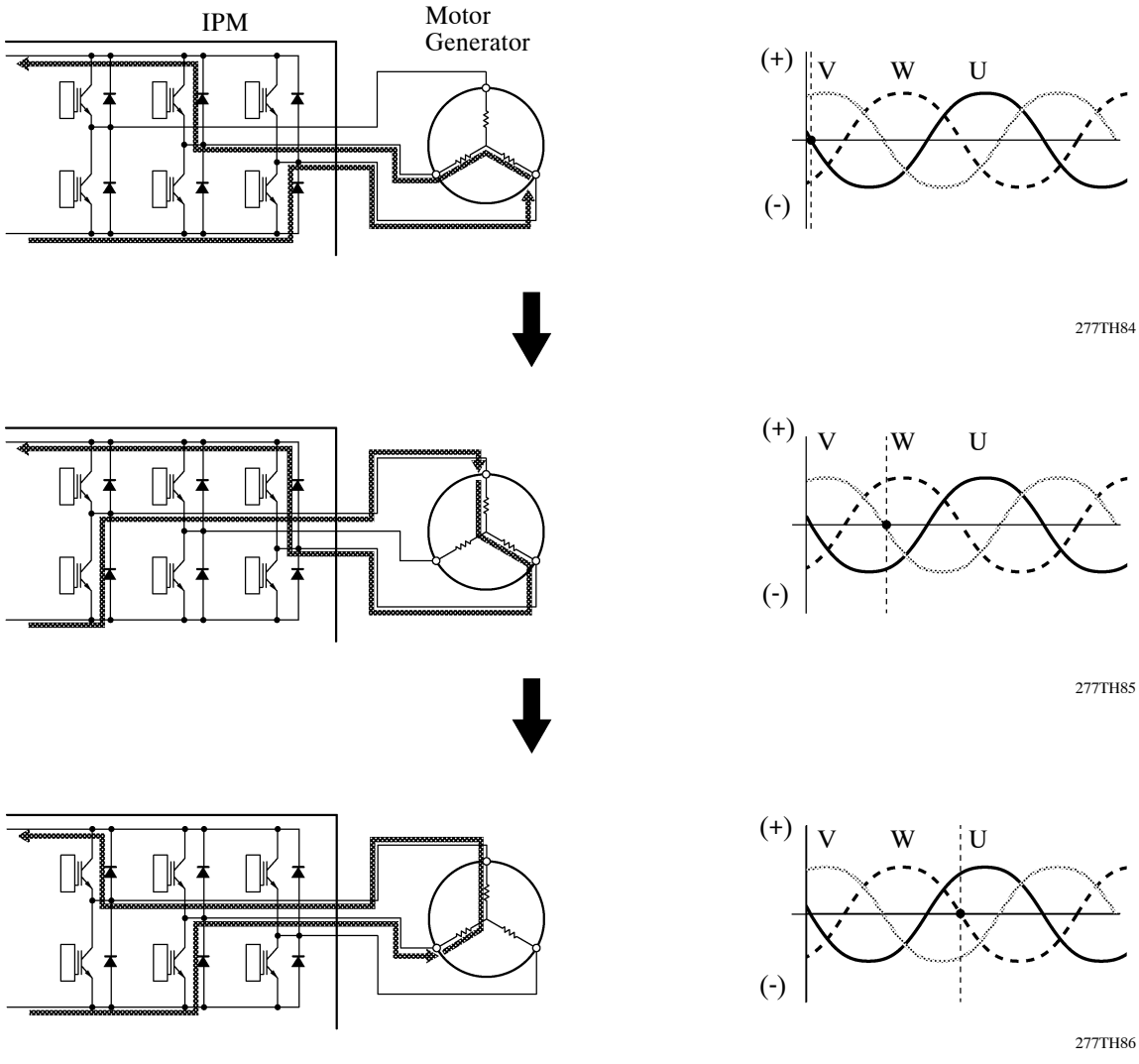
Operation as a Motor

- The illustration below describes the basic control when a motor generator functions as a motor. The IGBTs (Insulated Gate Bipolar Transistors) in the IPM switch on and off to supply three-phase alternating current to the motor.
- In order to create the motive force required of the motor generator as calculated by the hybrid vehicle control ECU, the MG ECU switches the IGBTs on and off and controls the speed, in order to control the speed of the motor generator.



Operation as a Generator

The illustration below describes the basic control used when a motor generator functions as a generator. The current that is generated sequentially by the three phases of the motor, which is driven by the wheels, is utilized to charge the HV battery or drive another motor generator.

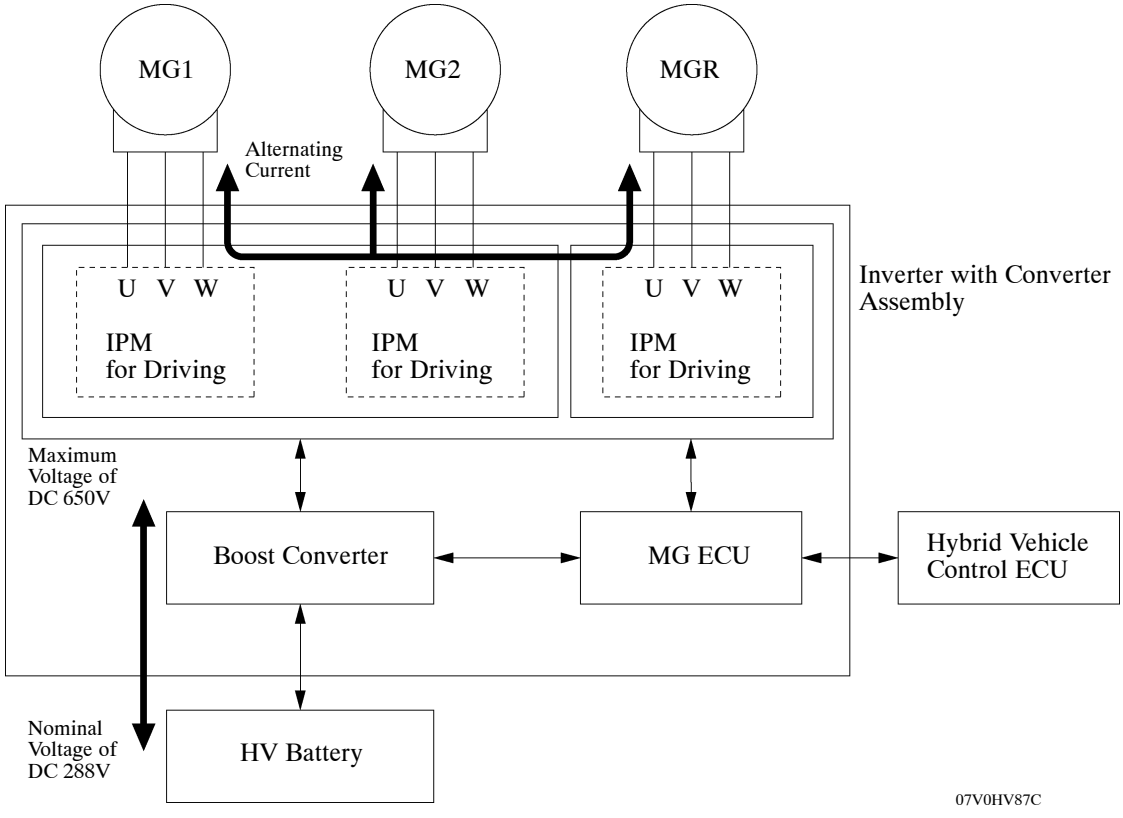


5. Inverter with Converter Assembly Control

General

- The inverter converts the direct current from the HV battery into alternating current for MG1, MG2, and MGR, or vice versa, in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU. In addition, the inverter takes power generated by MG1 and supplies it to MG2 or MGR. However, the electricity generated by MG1 is converted into DC inside the inverter before being converted back into AC by the inverter for use by MG2 or MGR. This is necessary because the frequency of the AC output by MG1 is not appropriate for control of MG2.
- Via the MG ECU, the hybrid vehicle control ECU transmits signals to the power transistors in the inverter for switching the U, V, and W phases of stator coils of MG1, MG2, and MGR based on the rotor position information sent by the MG1, MG2, and MGR resolvers.
- When the shift lever is in the N position, or the hybrid vehicle control ECU has received an over-heating, over-current, or fault voltage signal from the inverter, the hybrid vehicle control ECU transmits a shut down control signal to the inverter, in order to turn off the power transistors to electrically disconnect MG1, MG2, and MGR.

System Diagram

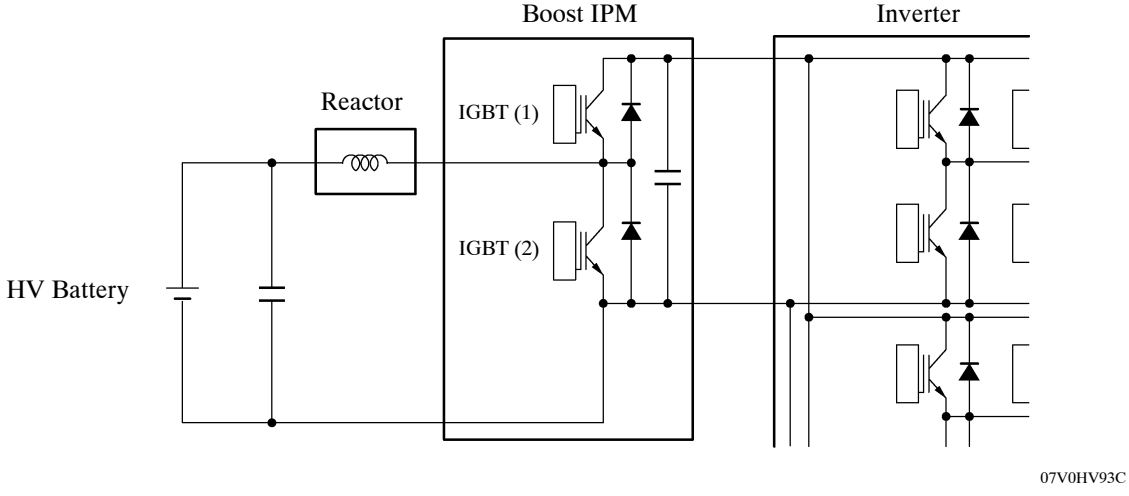


Boost Converter Control

1) General

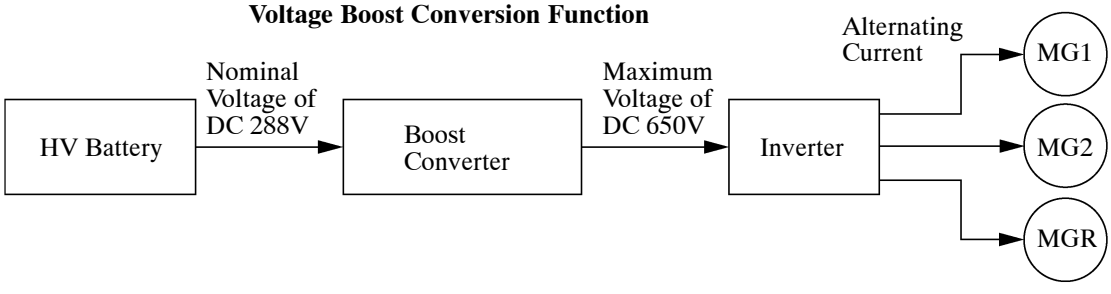
- The boost converter boosts the HV battery voltage of DC 288V (nominal) up to a maximum voltage of DC 650V, in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU.
- The inverter converts the alternating current generated by MG1 MG2 or MGR into direct current. The boost converter drops the voltage of DC 650V (maximum) to DC 288V (nominal) for the HV battery in accordance with the signals provided by the hybrid vehicle control ECU via the MG ECU.
- The boost converter consists of a boost IPM (Intelligent Power Module) with built-in IGBTs (Insulated Gate Bipolar Transistors) that perform switching control, and a reactor.
- The reactor is an electronic component that has characteristics that resist changes in current flow. If a circuit containing a reactor is switched on and then off, the reactor will attempt to maintain current flow after being switched off. At the time of voltage reduction, these characteristics also assist in smoothing the output from the voltage drop IGBT (1). The reactor can be charged quickly by turning on the boost IGBT (2).

2) System Diagram



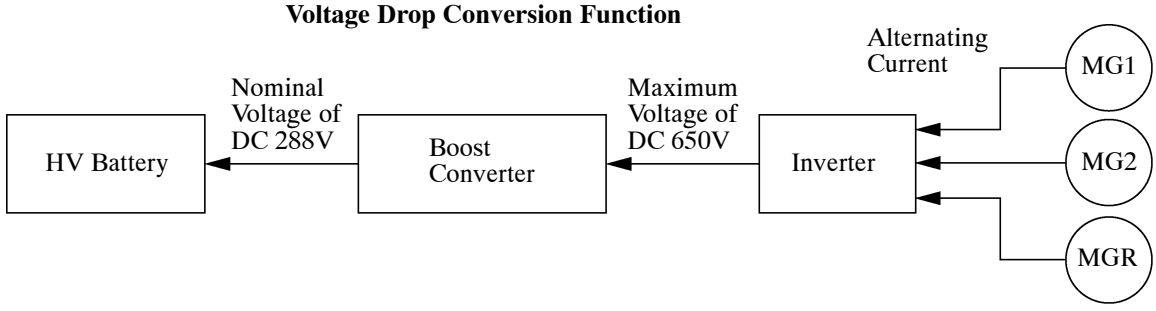
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Voltage Boost Conversion Function



277TH75

Voltage Drop Conversion Function

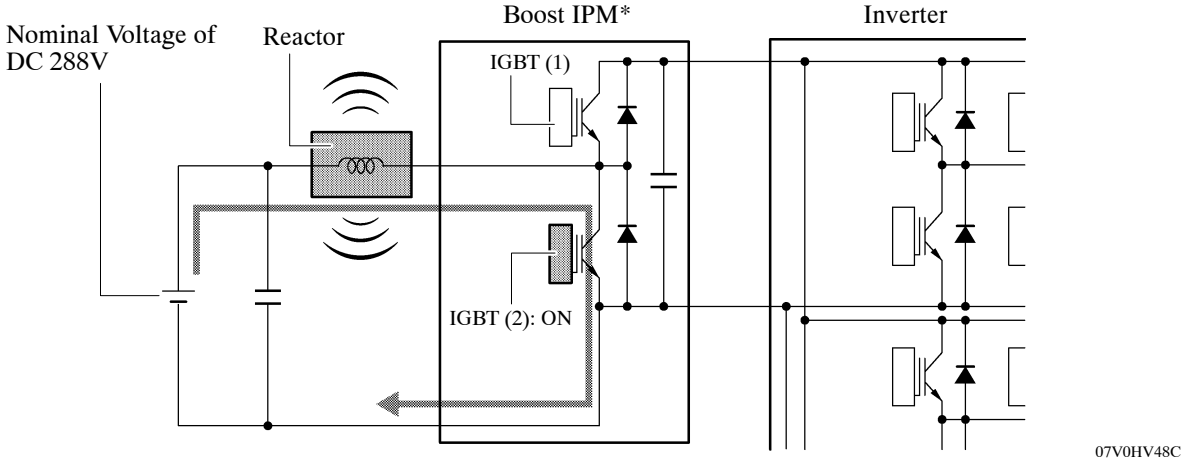


07V0HV90C

3) Voltage Boost Function

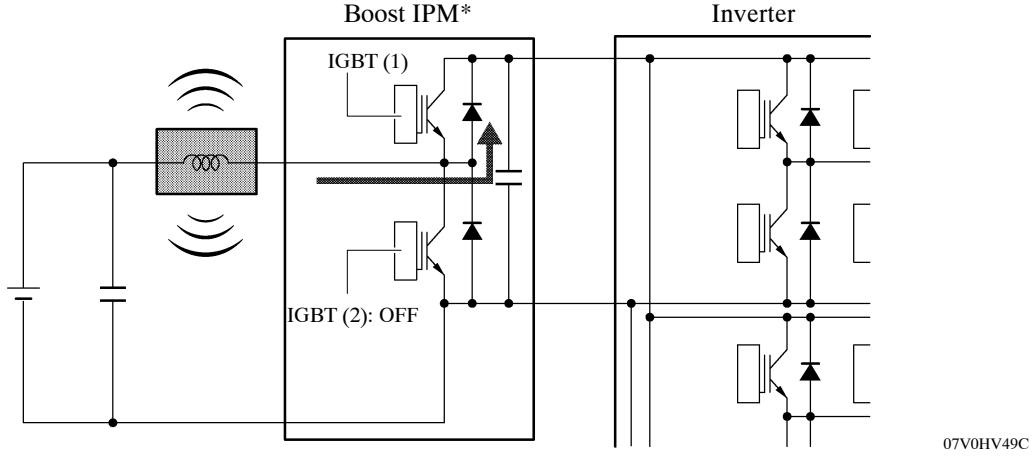
- The boost converter boosts the HV battery voltage from DC 288V (nominal) to a voltage of up to DC 650V as described in the following three steps.

a) The IGBT (2) turns on, causing the electrical power of the HV battery (nominal voltage of DC 288V) to charge the reactor. As a result, the reactor stores power.



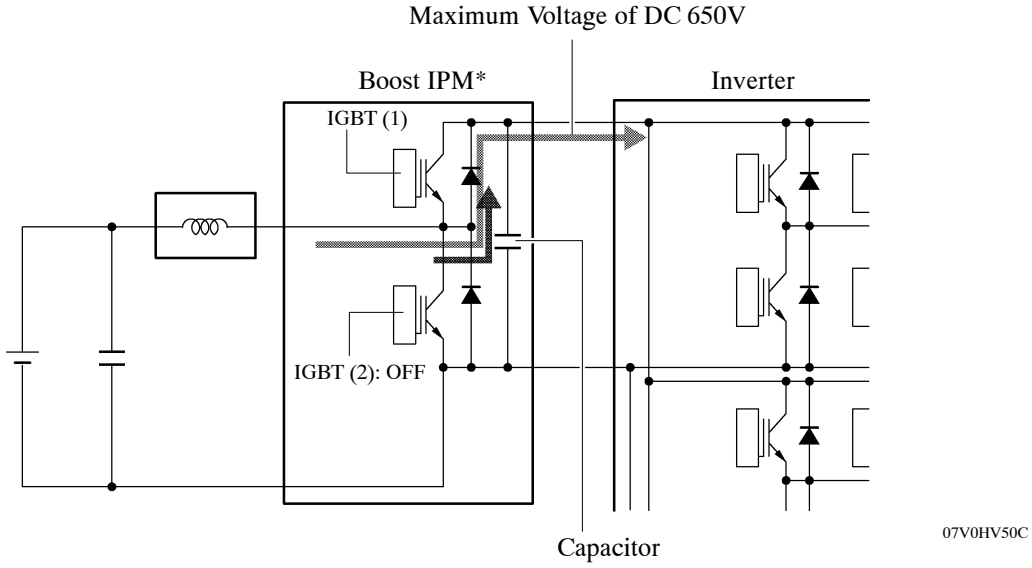
* (1) is the voltage drop IGBT, and (2) is the voltage boost IGBT.

b) In the next stage, the IGBT (2) turns off, causing the reactor to produce an electromotive force (the current continues to flow from the reactor). This electromotive force causes the voltage to rise to a maximum of DC 650V.



* (1) is the voltage drop IGBT, and (2) is the voltage boost IGBT.

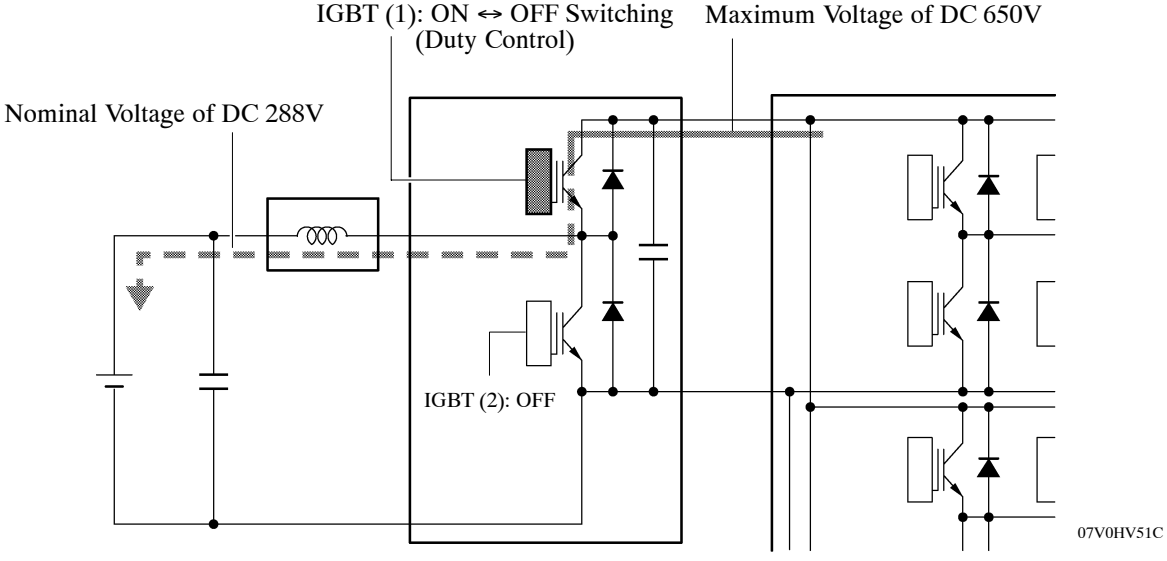
c) Induced by the electromotive force that is created by the reactor, the current that is flowing from the reactor flows into the inverter via the diode and is stored in the capacitors at a boosted voltage.



* (1) is the voltage drop IGBT, and (2) is the voltage boost IGBT.

4) Voltage Drop Function

The alternating current which is generated by MG1 or MG2 for the purpose of charging the HV battery is converted into direct current (maximum voltage approximately 650V) by the inverter. Then, the boost converter is used to drop the voltage to approximately DC 288V. This is accomplished by IGBT (1) being switched on and off using duty cycle control, intermittently interrupting the electrical power provided to the reactor by the inverter.

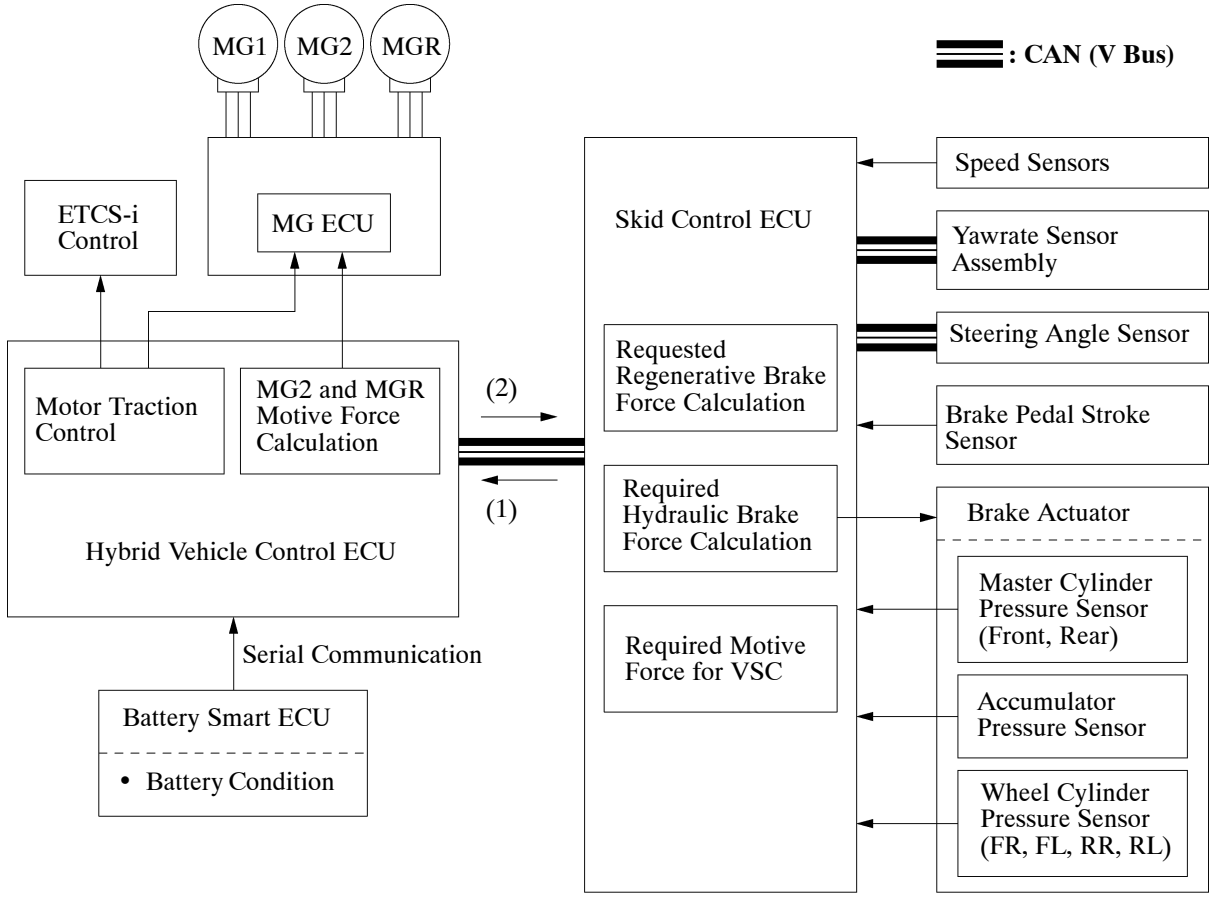


6. Skid Control ECU Control

General

- The skid control ECU calculates the total braking force needed based on the master cylinder pressure in the brake actuator and brake pedal stroke sensor signal generated when the driver depresses the brake pedal.
- After calculating the total brake force required, the skid control ECU sends a request to the hybrid vehicle control ECU. The hybrid vehicle control ECU replies with the amount of regenerative brake force that is possible.
- The hybrid vehicle control ECU uses MG2 and MGR to create minus torque (deceleration force), thus carrying out the regenerative braking.
- The skid control ECU controls the brake actuator solenoid valves and generates wheel cylinder pressure. The pressure that is generated is what remains after the actual regenerative brake control value has been subtracted from the total required braking force.
- The skid control ECU outputs a request to the hybrid vehicle control ECU to limit motive force while the VSC is operating to control wheel spin. The hybrid vehicle control ECU controls the engine, MG1, MG2 and MGR in accordance with the present driving conditions in order to suppress the motive force.

System Diagram



(1): • Requested regenerative brake force
• Required motive force (For TRAC or VSC Function)
(2): • Actual Regenerative Brake Control Value

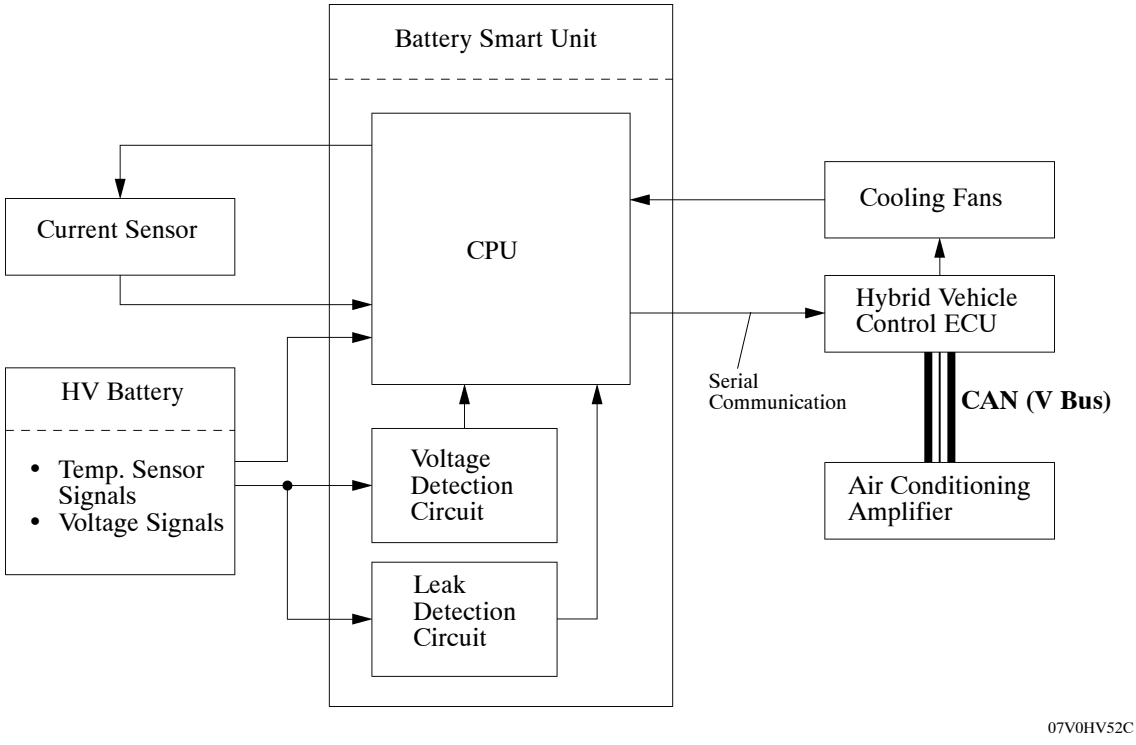
07V0HV89C

7. Battery Smart Unit Control

General

- The battery smart unit converts the HV battery related signals (voltage, current, and temperature) into digital signals, and transmits them to the hybrid vehicle control ECU via serial communication. These signals are needed to determine the charge or discharge values that are calculated by the hybrid vehicle control ECU.
- A leakage detection circuit is provided in the battery smart unit in order to detect any electrical leakage from the HV battery or high voltage circuit. Also, the battery smart unit detects the feedback voltage from the cooling fans, which is needed by the hybrid vehicle control ECU to perform cooling fan control. The battery smart unit converts these signals into digital signals and transmits them to the hybrid vehicle control ECU via serial communication.

System Diagram



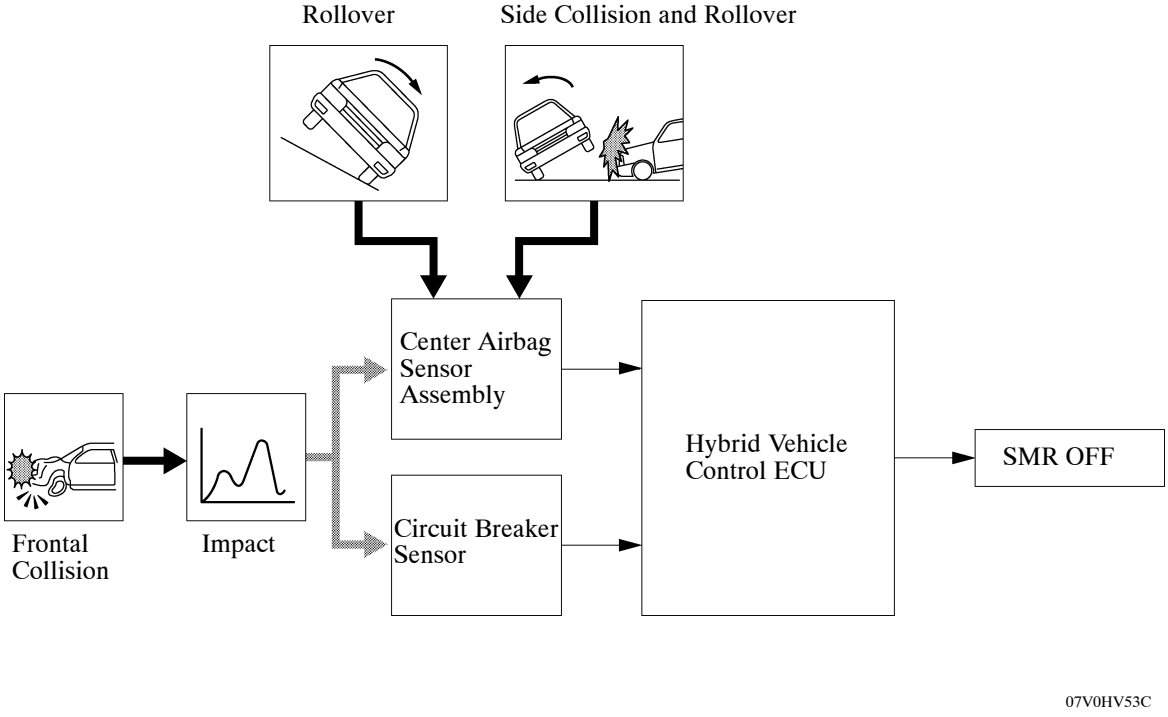
8. During Collision Control

General

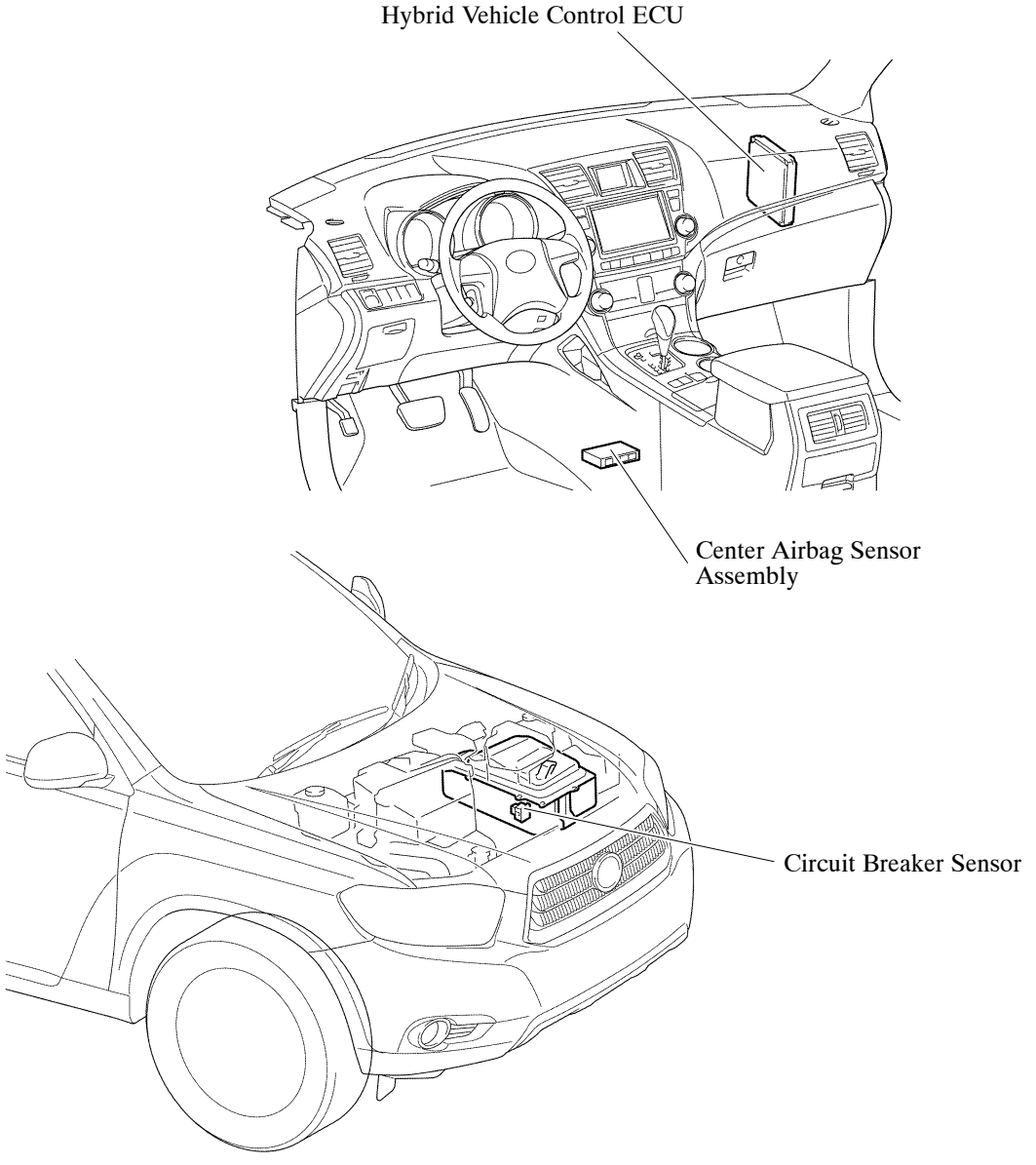
If the vehicle encounters one of the situations described below, the hybrid vehicle control ECU will shut down the power supply by turning the SMRs (System Main Relays) off, for safety.

- The hybrid vehicle control ECU receives an airbag deployment signal from the center airbag sensor assembly during a frontal collision, side collision, or rollover. In the event of a rear collision, the center airbag sensor assembly also sends a signal.
- The hybrid vehicle control ECU receives an actuation signal from the front circuit breaker sensor, which is mounted on the inverter, during a frontal collision.

System Diagram



Layout of Main Components

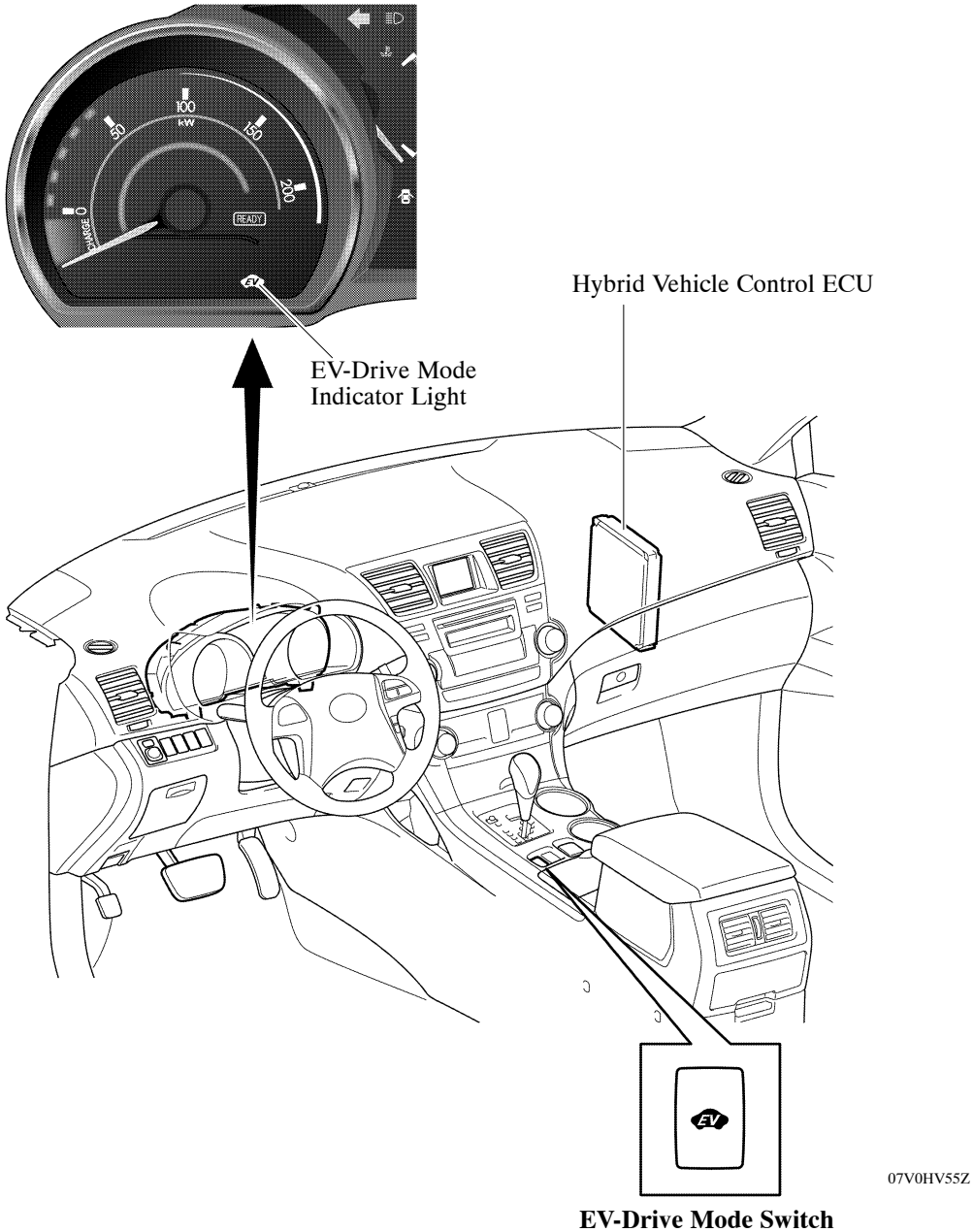


07V0HV54Z

9. EV-Drive Mode Control

General

- To reduce vehicle noise, such as when entering or leaving a garage after midnight or in the early hours of the morning, as well as reduction of emission gasses in the garage, the vehicle can be driven only MG2 and MGR by manually pushing the EV-drive mode switch located on the upper console panel.
- When the EV-drive mode switch is pushed, the EV-drive mode indicator light located in the combination meter will be illuminated.



EV-Drive Mode Switch

Operation

1) General

- When all conditions in the table below are satisfied, pressing the EV-drive mode switch enters the EV-drive mode. If any condition is not satisfied and the EV-drive mode switch is pressed, a message is displayed on the multi-information display to inform the driver that the EV-drive mode switch operation is rejected, and the EV-drive mode cannot be entered.
- The available driving range during the EV-drive mode varies according to the driving conditions and the HV battery charge level. However, it is usually between several hundred meters and approximately 1km (approximately 0.6 miles).

Main EV-Drive Mode Operating Conditions	• The hybrid system temperature is not high. (The hybrid system temperature will be high when the outside air temperature is high or after the vehicle has traveled up a hill or at high speeds.) • The hybrid system temperature is not low. (The hybrid system temperature will be low after the vehicle has been left for a long time when the outside air temperature is low.) • The engine has already warmed-up (engine coolant temperature is 80 °C [176 °F] or more). • The SOC is approximately 50% or more. • The vehicle speed is approximately 40 km/h (25 mph) or less. • The accelerator pedal depression amount is a certain level or below. • The defroster is off. • The cruise control system is not operating.

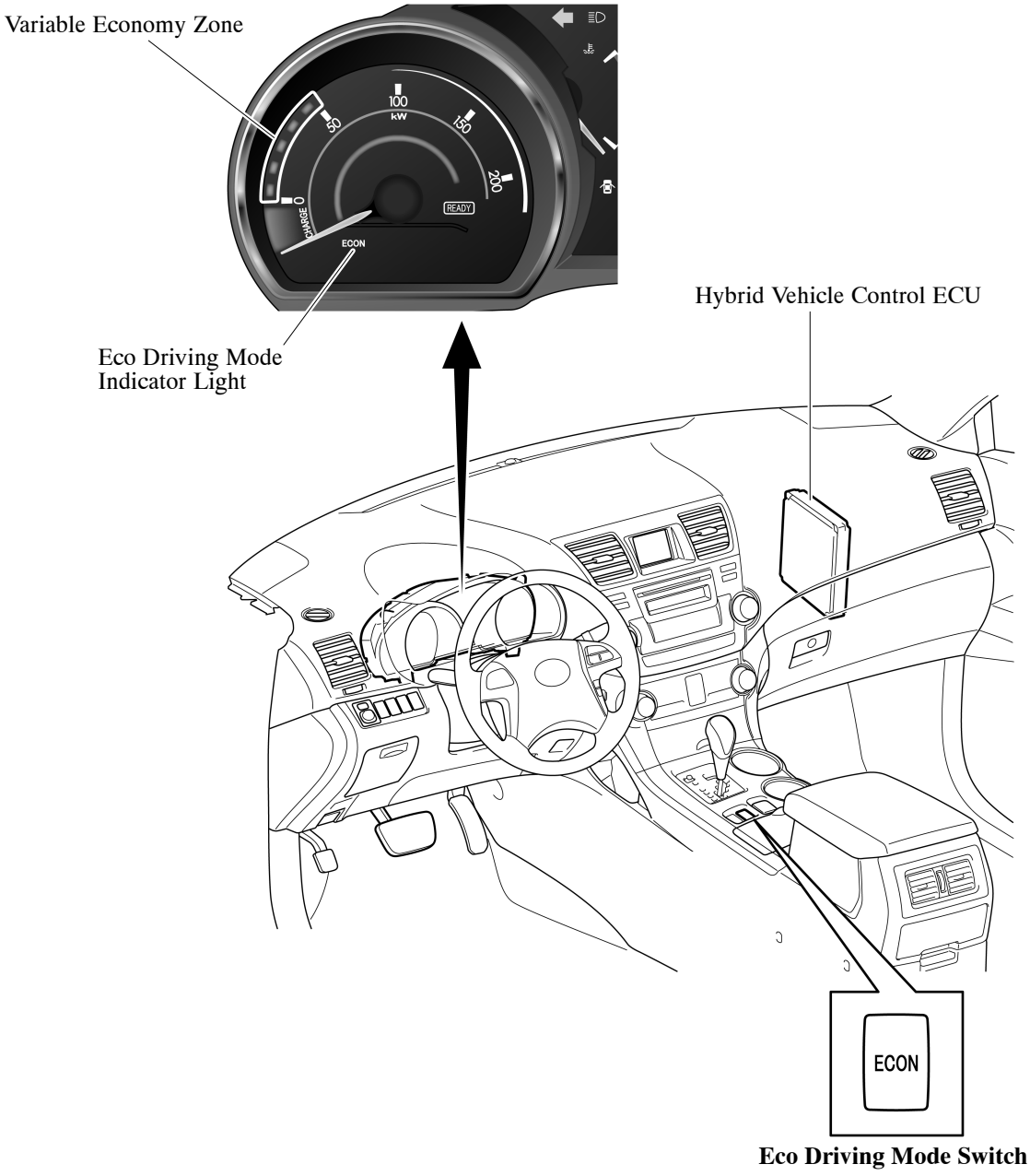
2) Cancel

When EV-drive mode has automatically cancelled, a message is displayed to indicate that EV-drive mode has been cancelled.

10. Eco Driving Mode Control

General

- Pressing the eco driving mode switch on the center console helps enhance fuel economy.
- Eco driving mode control facilitates driving the vehicle in the variable economy zone in the combination meter. For details, refer to Variable Economy Zone on page BE-37.
- The eco driving mode indicator in the combination meter illuminates when the eco driving mode switch is pressed.



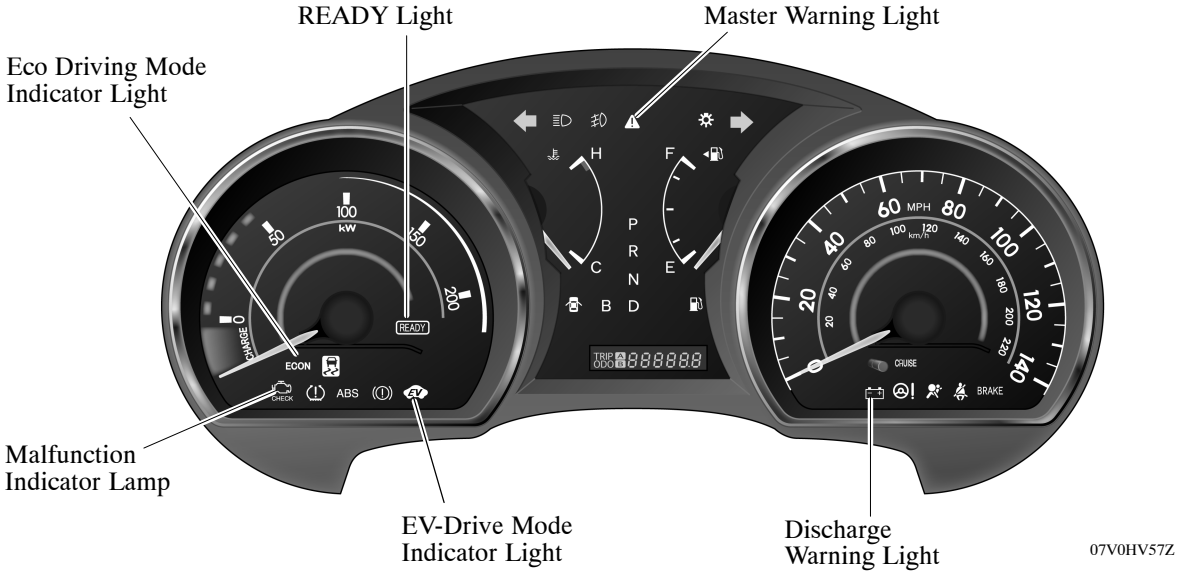
Operation

The characteristics of system output in relation to accelerator operation are specially suited to achieve lower fuel consumption while driving. This helps to reduce the unnecessary consumption of gasoline.

11. Indicator and Warning Light Control

Indicator and Warning Light

The indicator and warning lights associated with the THS-II are described below.

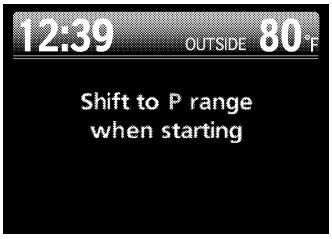
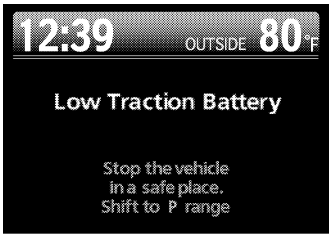
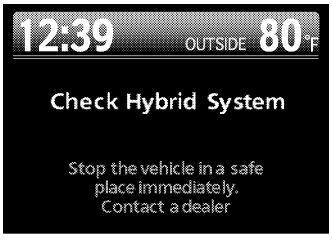


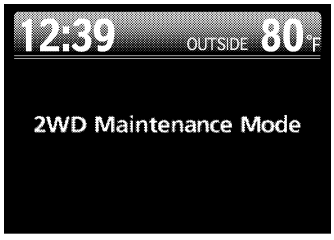
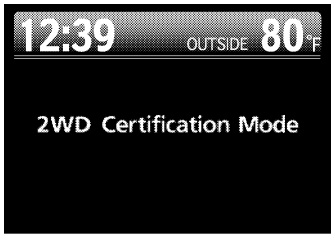
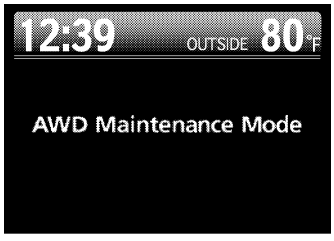
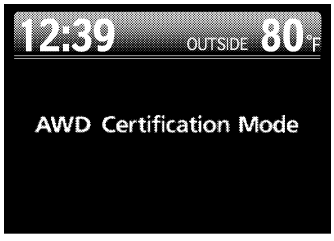
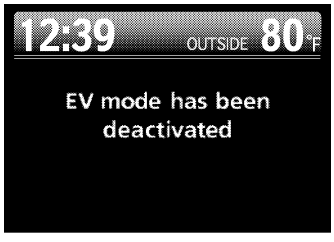
Combination Meter Assembly

Item	Outline
READY Light	This light is used to show the driver that the hybrid system has started. This informs the driver that the vehicle is ready to drive.
Master Warning Light	• In this context, the primary function of this warning light is to inform the driver of a malfunction in the THS-II system or when the SOC of the HV battery is too low. The light illuminates simultaneously with the sounding of a warning buzzer. • Besides the foregoing conditions, this light illuminates and the buzzer sounds to inform the driver in case of an abnormal 4WD system.
Malfunction Indicator Lamp	The Malfunction Indicator Lamp (MIL) turns on when there is a malfunction in the engine control system.
Discharge Warning Light	The discharge warning light turns on when there is a malfunction in the DC 14V charging system (DC-DC converter assembly).
EV-Drive Mode Indicator Light	Informs the driver that the EV-drive mode is entered.
Eco Driving Mode Indicator Light	Informs the driver that the eco driving mode is entered.

Multi-information Display

- The hybrid vehicle control ECU displays messages to inform the driver when a malfunction occurs or electric vehicle drive mode is entered. It also shows system status and appropriate operation to be performed on the multi-information display.
- The master warning light may illuminate or flash and the buzzer built into the combination meter may sound depending on the message displayed on the multi-information display.

Message	Message Content Explanation	Master Warning Light	Buzzer
 07V0HV58C	The shift lever is moved into any position other than P while the READY indicator is flashing.	Flashes	Sounds
 07V0HV59C	SOC drops below a predetermined value (SOC 25% or lower)	Flashes	Sounds
	SOC drops below a predetermined value (SOC 18% or lower)	Flashes	Sounds
 07V0HV60C	THS II system is malfunctioning.	Illuminates	Sounds
 07V0HV61C	The temperatures of any parts related to the THS II system exceed the standard value.	Illuminates	Sounds
 07V0HV62C	The vehicle is in the READY-ON mode, the shift position is in the N, D, or B position, and the driver's door is opened.	Flashes	Sounds

Message	Message Content Explanation	Master Warning Light	Buzzer
 07V0HV63C	2WD Inspection Mode is in use.	-	-
 07V0HV64C	2WD Certification Mode is in use.	-	-
 07V0HV65C	4WD Inspection Mode is in use.	-	-
 07V0HV66C	4WD Certification Mode is in use.	-	-
 07V0HV68C	The EV-drive mode has been cancelled. At this time, the EV-drive mode indicator light flashes 3 times and then goes off. (To inform the driver that EV-drive mode has been cancelled)	-	Sounds
The following messages may be also displayed on the lower part of the screen to provide information about the reason for EV-drive mode deactivation. • Low traction battery • The vehicle speed exceeded the EV range • The accelerator pedal was depressed excessively			

HV

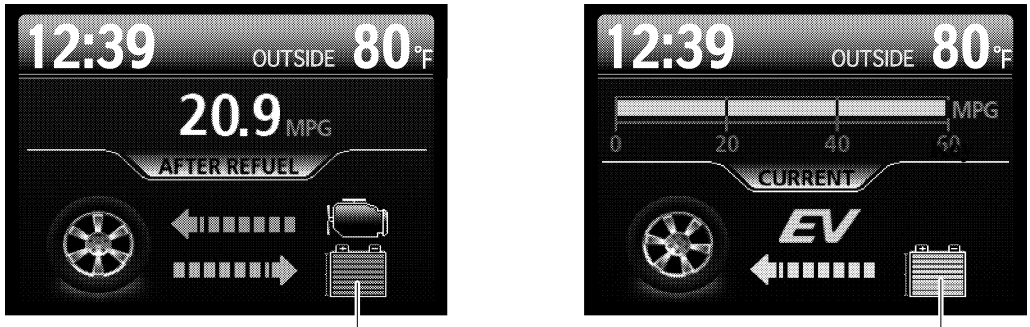
<table>
<tr><th>Message</th><th>Message Content Explanation</th><th>Master Warning Light</th><th>Buzzer</th></tr>
<tr><td>

07V0HV69C</td><td>When EV-drive mode operating conditions are not satisfied, the EV-drive mode switch is pressed.
(EV-drive mode switch operation is rejected.)</td><td rowspan="2">-</td><td rowspan="2">Sounds</td></tr>
<tr><td colspan="2">The following messages may be also displayed on the lower part of the screen to provide information on the vehicle status when the above message is displayed.
• The vehicle is warming up
• Low traction battery
• The vehicle speed exceeds the EV range
• The accelerator pedal is depressed excessively</td></tr>
</table>

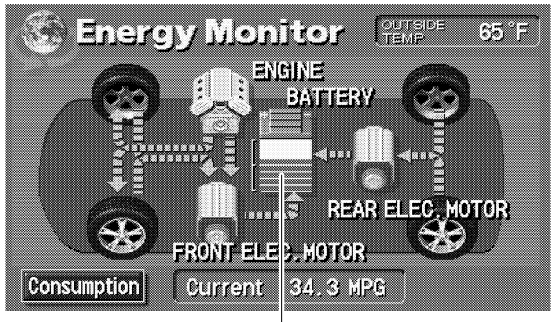
Energy Monitor

The navigation receiver assembly has a function to display the energy flow using a style that differs from the multi-information display. This display also shows the energy flow in the form of an arrow, and shows the SOC (State Of Charge) of the HV battery in 8 levels.

Multi-information Display



Navigation Receiver Display



07V0HV70C

12. Diagnosis

- In the THS-II system, if the hybrid vehicle control ECU or MG ECU detects a malfunction, the hybrid vehicle control ECU records the fault and memorizes the information that relates to the fault.. To inform the driver of the malfunction, the hybrid vehicle control ECU illuminates or blinks the MIL (Malfunction Indicator Lamp), master warning light and displays a message in the multi-information display.
- The hybrid vehicle control ECU will store the respective DTCs of the malfunctions.
- 3-digit information codes (INF codes) have been provided with the conventional DTC as subset of the primary 5-digit code. This enables the troubleshooting procedure to further narrow down a trouble area to identify a problem.
- INF codes can be accessed by viewing the freeze frame data associated with a hybrid system DTC.
- The DTCs can be accessed by using Techstream.

For details, refer to the 2008 HIGHLANDER HYBRID VEHICLE Repair Manual (Pub. No. RM07V0U).