05IH3–01

SYSTEM DESCRIPTION

1. GENERAL

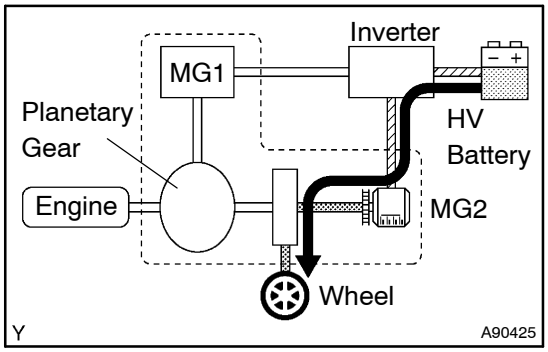
The THS–II control system consists of the following control.

Item	Outline
HV control ECU Control	• The HV control ECU controls the MG1, MG2, engine, regenerative brake control and HV battery SOC. These factors are determined by the shift position, accelerator pedal position and vehicle speed. • The HV control ECU monitors the SOC and temperature of the HV battery, MG1 and MG2, in order to optimally control these items. • When the shift position is in N, the HV control ECU effects shutdown control to electrically stop the MG1 and MG2. • If the drive wheels rotate without traction, the HV control ECU performs the motor traction control that provides a restraint on a rotation of MG2, in order to protect the planetary gear unit and prevent MG1 from generating excessive electricity. • For the purpose of protecting the circuit from high voltage and ensuring the reliability of the circuit shutdown, the HV control ECU effects SMR control through the use of 3 relays to connect and shut down the high–voltage circuit.
ECM Control	The ECM receives the demand power and the target rpm, which were sent from the HV control ECU, and controls the ETCS–i system, fuel injection volume, ignition timing and VVT–i system.
Inverter Control	• In accordance with the signals provided by the HV control ECU, the inverter converts a direct current (HV battery) into an alternating current (MG1 and MG2), or vice versa. In addition, the inverter supplies the AC (MG1) power to the AC (MG2). However, when electricity is supplied from MG1 to MG2 , the electricity is converted into DC inside the inverter. • The HV control ECU sends the signal to the power transistor in the inverter for switching the U, V and W phase of the MG1 and MG2 in order to drive the MG1 and MG2. • The HV control ECU shuts down if it receives an overheating, over–current, or fault voltage signal from the inverter.
Boost Converter Control	• In accordance with the signals provided by the HV control ECU, the boost converter boosts the nominal voltage of DC 201.6 V (for HV battery) up to the maximum voltage of DC 500 V. • The maximum voltage of AC 500 V generated by the MG1 or MG2 is converted into a direct current by the inverter, the boost converter drops the direct current to DC 201.6 V (for HV battery) based on the signals from the HV control ECU.
Converter Control	• DC/DC converter drops the nominal voltage of DC 201.6 V into DC 12 V in order to supply electricity to body electrical components, as well as to recharge the auxiliary battery (DC 12 V). • This converter controls the terminals of the auxiliary battery to a constant voltage.
A/C Inverter Control	A/C inverter converts the nominal voltage of the HV battery from DC 201.6 to AC 201.6 V and supplies power to operate the electric compressor of the A/C system.
MG1 and MG2 Main Control	• MG1, which is rotated by the engine, generates high voltage (maximum voltage of AC 500 V) in order to operate the MG2 and charge the HV battery. Also, it functions as a starter to start the engine. • MG2 primarily provides additional power to the engine in order to increase the overall drive force. During braking, or when the accelerator pedal is not depressed, it generates electricity to recharge the HV battery (regenerative brake system). • Speed sensors detect the speed and position of the MG1 and MG2 and output them to the HV control ECU. • A temperature sensor mounted on the MG2 detects a MG2 temperature and transmits it to the HV control ECU.
Skid Control ECU Control	During braking, the skid control ECU calculates the total braking force and transmits regenerative brake force request to the HV control ECU. Upon receiving this signal, the HV control ECU calculates the regeneration brake demand power value and transmits it to the skid control ECU. Based on this, the skid control ECU calculates and executes the required hydraulic pressure brake force.
Battery ECU Control	The battery ECU effects monitor control to monitor the conditions of the HV battery and cooling fan control to keep the HV battery at a predetermined temperature. Thus, it optimally controls these components.
Shift Control	• The HV control ECU detects the shift position (P, R, N, D, or B) in accordance with the signal provided by the shift position sensor, and controls the MG1, MG2, and engine, in order to create the driving conditions that suit the selected shift position. • The transmission control ECU detects that the driver has pressed the P position switch through a signal provided by the HV control ECU. Then, transmission control ECU operates the shift control actuator in order to mechanically lock the transaxle.

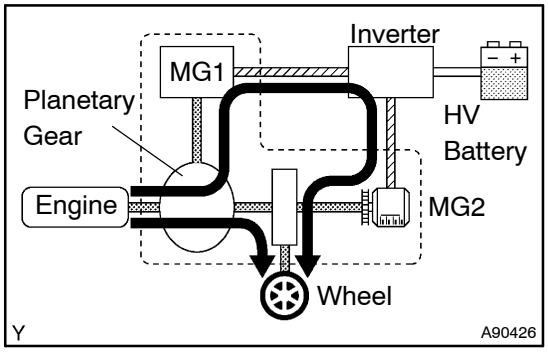
Item	Outline
During Collision Control	At the time of a collision, if the HV control ECU receives an airbag deployment signal from the airbag ECU or an actuation signal from the circuit breaker sensor located in the inverter, it turns OFF the SMR and power switch in order to shut off the entire power supply.
Motor Drive Mode Control	When the EV–drive mode switch located on the instrument panel is manually pushed on by the driver, the HV control ECU operates the vehicle to run with only MG2 if required conditions are satisfied.
Cruise Control System Operation Control	When the cruise control ECU built in the HV control ECU receives a cruise control switch signal, it calculates the cruise control request value, and calculates the motive forces of the engine, MG1, and MG2 to achieve an optimal combination.
Indicator and Warning Lamp Illumination Control	Illuminates or blinks the lamps to inform the driver of the vehicle condition or system malfunction.
Diagnosis	When the HV control ECU detects malfunction, the HV control ECU diagnoses and memorizes values corresponding to the failure.
Fail–Safe	When the HV control ECU detects malfunction, the HV control ECU stops or controls the actuator and ECUs according to the data already stored in its memory.

2. BASIC OPERATION

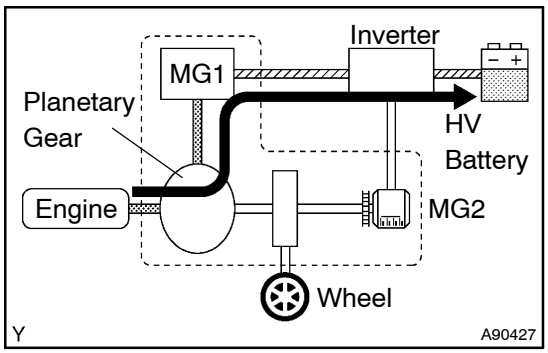
(a) This system controls the following modes in order to achieve the most efficient operations to match the driving conditions:



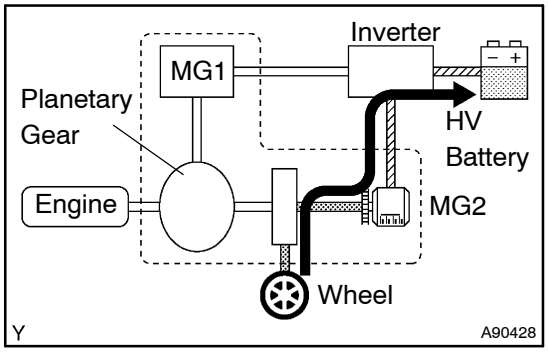
(1) Supply of electrical power from the HV battery to MG2 provides force to drive the wheels.



(2) While the wheels are being driven by the engine via the planetary gear, MG1 is rotated by the engine via the planetary gears, in order to supply the generated electricity to MG2.



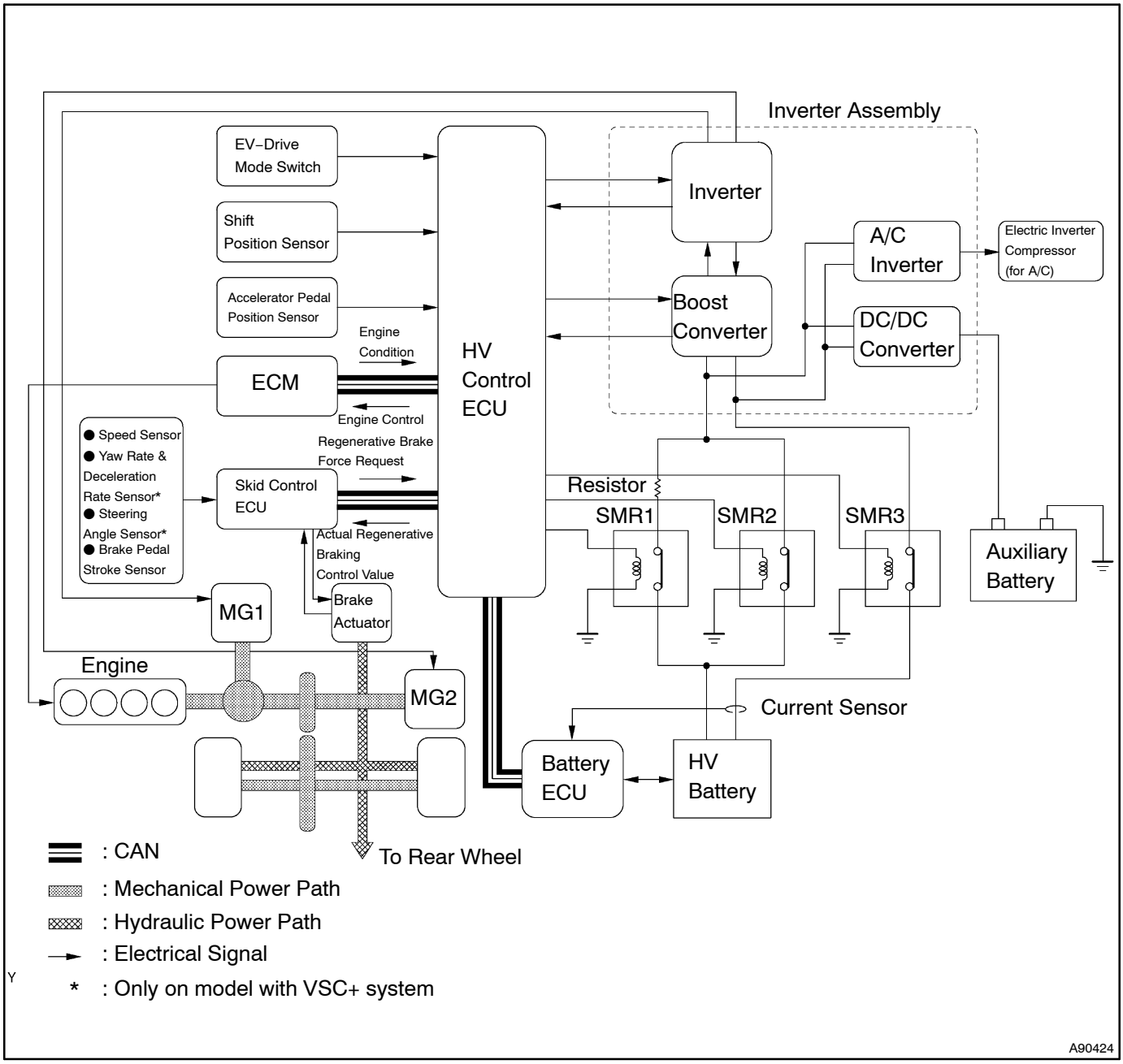
(3) MG1 is rotated by the engine via the planetary gear, in order to charge the HV battery.



(4) When the vehicle is decelerating, kinetic energy from the wheels is recovered and converted into electrical energy and used to recharge the HV battery by means of MG2.

(b) The HV control ECU switches between these modes ((1), (2), (3), (1) + (2) + (3), or (4)) according to the driving condition. However, when the SOC (State of Charge) of the HV battery is low, the HV battery is charged by the engine by turning MG1.
As a result, it achieves far greater fuel economy compared to conventional gasoline engine vehicles, at a reduced level of exhaust gas emissions. Furthermore, this revolutionary power–train has eliminated the constraints that are associated with electric vehicles (such as their short cruising range or their reliance on external recharging units).

3. SYSTEM DIAGRAM



4. FUNCTION OF MAIN COMPONENTS

Item	Outline
MG1	MG1, which is rotated by the engine, generates high–voltage electricity in order to operate the MG2 or charge the HV battery. Also, it functions as a starter to start the engine.
MG2	• Driven by electrical power from the MG1 or HV battery, and generates motive force for the vehicle. • During braking, or when the accelerator pedal is not depressed, it generates electricity to recharge the HV battery (regenerative brake control).
Planetary Gear Unit	Distributes the engine's drive force as appropriate to directly drive the vehicle as well as the generator.
HV Battery	Supplies electric power to the MG2 during start–off, acceleration, and uphill driving. Recharged during braking or when the accelerator pedal is not depressed.
Inverter	Converts the high–voltage DC (HV battery) into AC (MG1 and MG2) and vice versa (converts AC into DC).
Boost Converter	Boosts the nominal voltage of the HV battery from DC 201.6 to DC 500 V and vice versa (drops DC 500 V to DC 201.6 V).
DC/DC Converter	Drops the nominal voltage of DC 201.6 V into DC 12 V in order to supply electricity to body electrical components, as well as to recharge the auxiliary battery (DC 12 V).
A/C Inverter	Converts the nominal voltage of DC 201.6 V of the HV battery to AC 201.6 V and supplies power to operate the electric inverter compressor of the A/C system.
HV Control ECU	Information from each sensor as well as from the ECUs (ECM, Battery ECU, skid control ECU, and EPS ECU) is received, and based on this the required torque and output power is calculated. Sends the calculated result to the ECM, inverter assembly, battery ECU and skid control ECU.
ECM	Activates the ETCS–i (Electronic Throttle Control System–intelligent) in accordance with the target engine speed and required engine motive force received from the HV control ECU.
Battery ECU	Monitors the charging condition of the HV battery.
Skid Control ECU	Controls the regenerative brake that is effected by the MG2 and the hydraulic brake so that the total braking force equals that of a conventional vehicle that is equipped only with hydraulic brakes. Also, performs the brake system control (ABS with EBD, Brake Assist, and VSC+*) conventionally.
Accelerator Pedal Position Sensor	Converts the accelerator pedal position angle into an electrical signal and outputs it to the HV control ECU.
Shift Position Sensor	Converts the shift position into an electrical signal and outputs it to the HV control ECU.
SMR (System Main Relay)	Connects and disconnects the high–voltage power circuit between battery and inverter assembly, through the use of a signal from the HV control ECU.
Interlock Switch (for Inverter Cover and Service Plug Grip)	Verifies that the cover of both the inverter and the service plug grip have been installed.
Circuit Breaker Sensor	The high–voltage circuit is intercepted if a vehicle collision has been detected.
Service Plug Grip	Shuts off the high–voltage circuit of the HV battery when this plug is removed for vehicle inspection or maintenance.

*: Only on model with VSC+ System