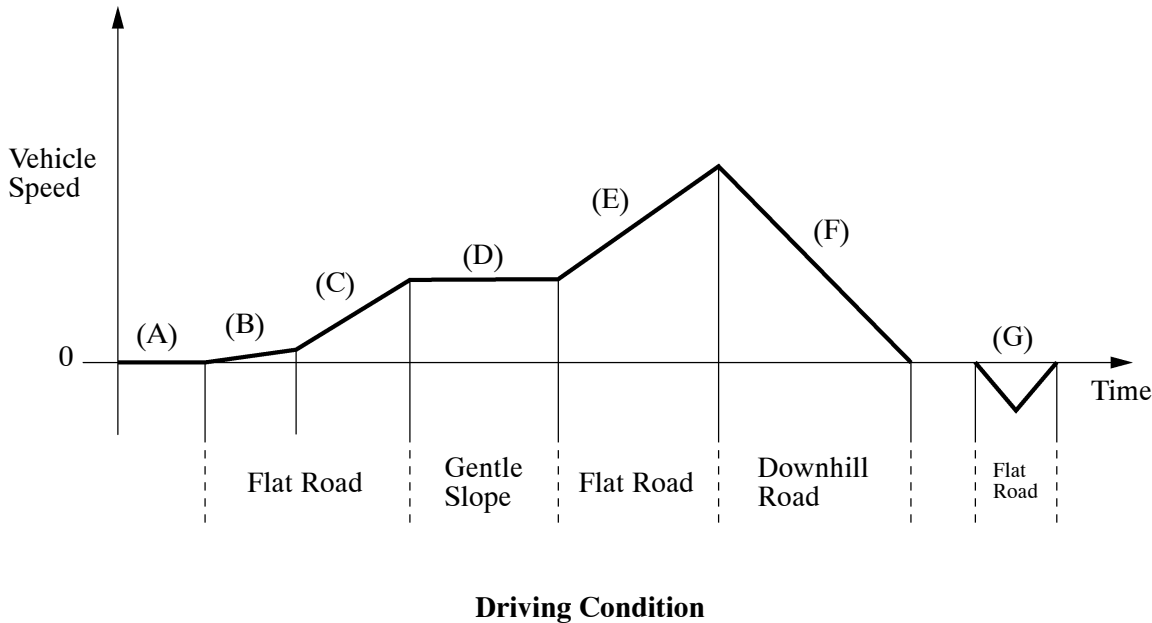


■ SYSTEM OPERATION

1. General

- The THS-II system uses the two types of motive forces, the engine and MG2, and uses MG1 as a generator. The system optimally combines these forces in accordance with the various driving conditions.
- The THS ECU constantly monitors the SOC condition, the HV battery temperature, the water temperature, and the electrical load condition. If any one of the monitoring items fails to satisfy requirements when the READY indicator is ON and the shift position is in the "P" position, or the vehicle is driven in reverse, the THS ECU demands to start the engine to drive MG1, and then charges the HV battery.
- The THS-II system drives the vehicle by optimally combining the operation of the engine, MG1, and MG2 in accordance with the driving conditions listed in the table below.
- Furthermore, on this model, MGR drives the rear wheels in accordance with the driving conditions of the vehicle, thus enhancing its driving force.



277TH14

(A) READY ON state (See Page TH-14)

(B) Starting (See Page TH-16)

(C) During slight acceleration with engine (See Page TH-19)

(D) During low load and constant-speed cruising (See Page TH-20)

(E) During full throttle acceleration (See Page TH-21)

(F) During deceleration driving (See Page TH-22)

(G) During reverse driving (See Page TH-24)

2. How to Read a Nomographic Chart

- The nomographic chart below gives a visual representation of the planetary gear's rotational direction, rotational speed, and power balance. In the nomographic chart, the rpm of the gears used in the power split planetary gear unit and the rpm of the gears used in the motor speed reduction planetary gear unit each maintain relationships indicated by direct lines.
- This nomographic chart describes the charging or generating conditions of MG1 and MG2, their direction of rotation, and torque conditions as indicated in the table below.

Condition	Rotation Direction of Ring Gear	Torque Condition	Nomographic Chart Example
Discharging	Forward Revolution	Plus Direction Torque	277TH15
	Reverse Revolution	Minus Direction Torque	278TH17
	Reverse Revolution	Plus Direction Torque	278TH18
Charging	Forward Revolution	Minus Direction Torque	277TH17

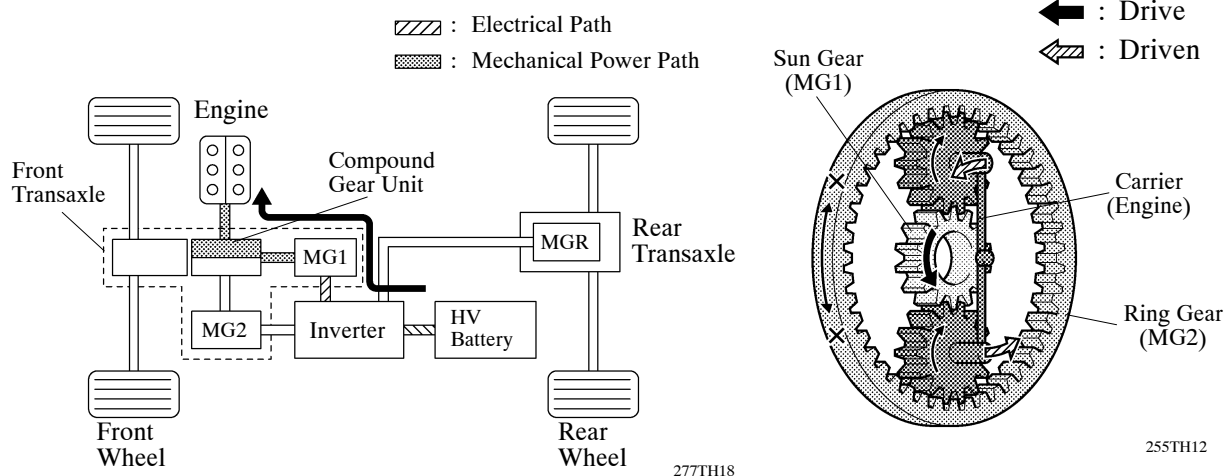
3. READY ON State/(A)

- On the RX400h, even if the driver turns on the ignition switch and the READY indicator turns ON, the engine will not start when the proper engine coolant temperature, SOC conditions, battery temperature and electrical load conditions have been met. In this state, the engine, MG1, MG2 and MGR are all stopped.
- After driving, if the driver stops the vehicle and moves the shift position to the “P”, the THS ECU will continue to operate the engine for a predetermined length of time and will bring the engine to a stop, provided that the proper engine coolant temperature, SOC conditions, battery temperature and electrical load conditions have been met. At this time, the engine, MG1, MG2 and MGR are all stopped.

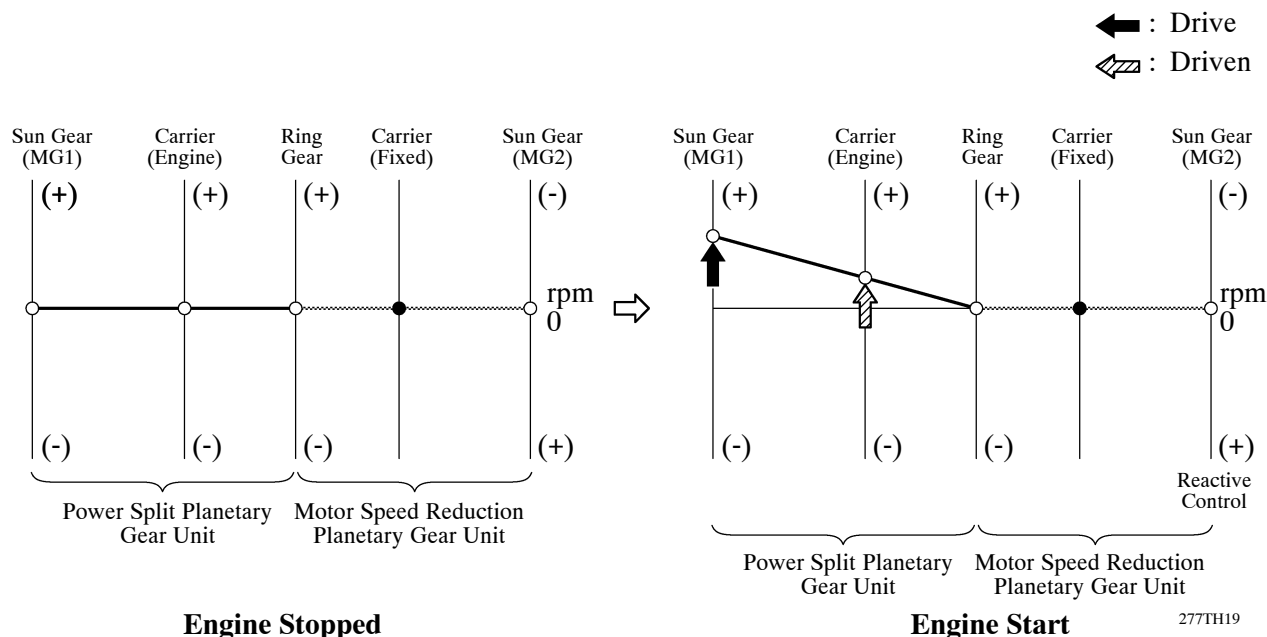
Engine Start

- If any one of the items monitored by the THS ECU is outside the relevant specifications when the READY indicator is ON and the shift position is in the “P” position, the THS ECU activates MG1 to start the engine.
- During this operation, to prevent the reactive force of the sun gear of MG1 from rotating the ring gear of MG2 and driving the drive wheels, an electrical current is applied to MG2 in order to apply a brake. This function is called “reactive control”.

► Power Split Planetary Gear Operation ◀

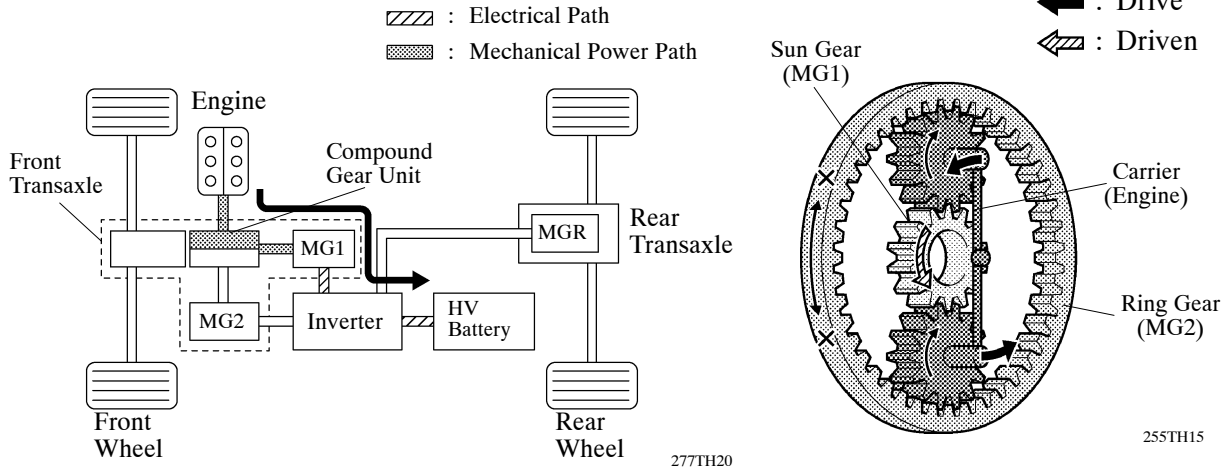


► Nomographic Chart of Planetary Gear Unit ◀

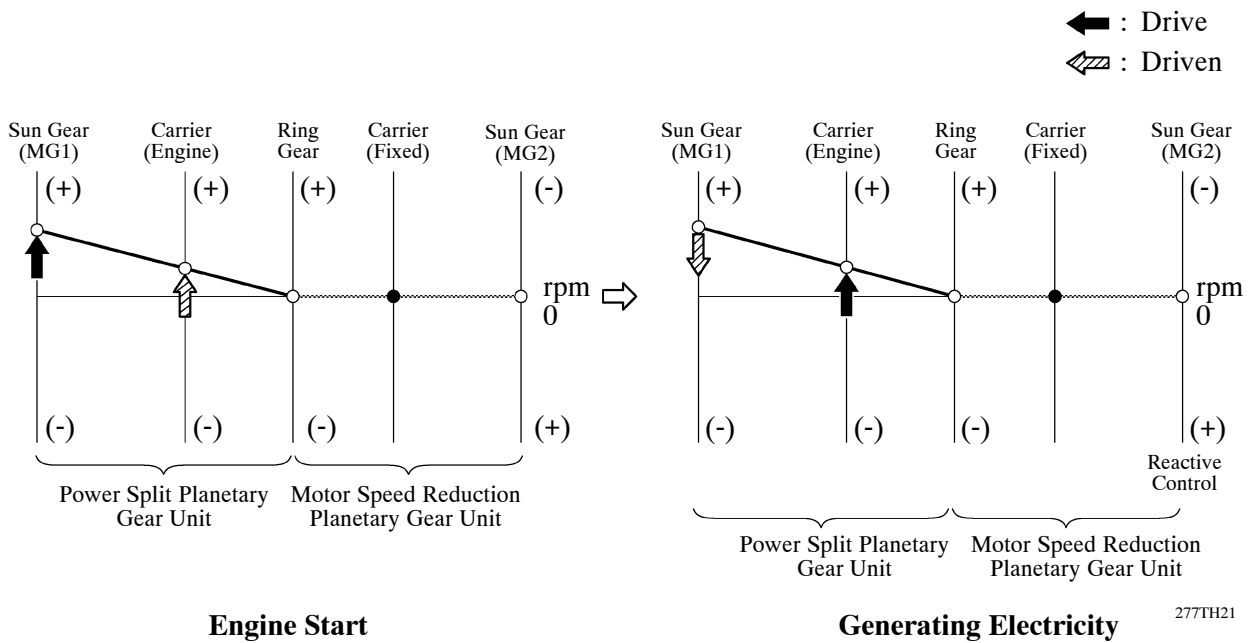


- In the next state, the engine that is running starts to operate MG1 as a generator, which starts to charge the HV battery.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀

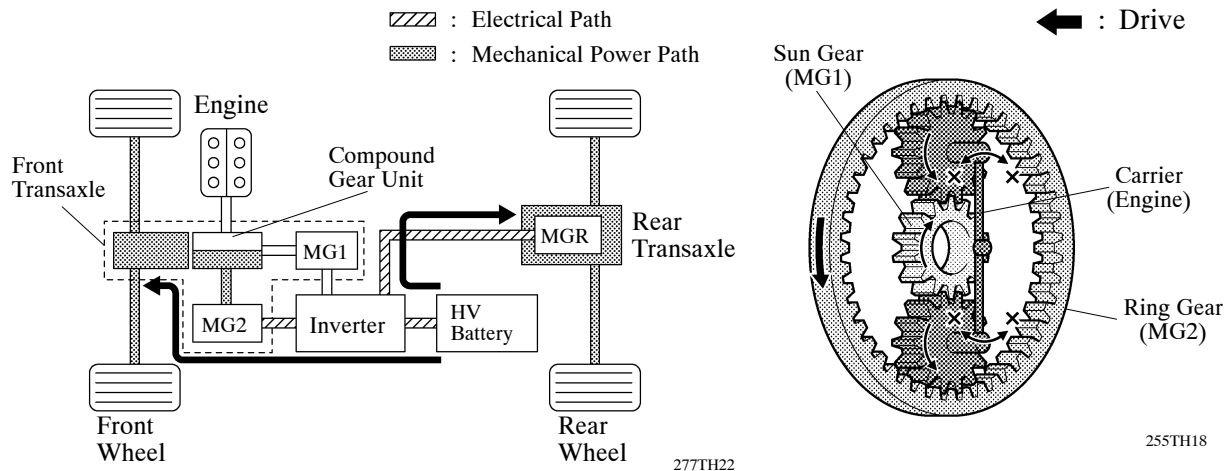


4. Starting/(B)

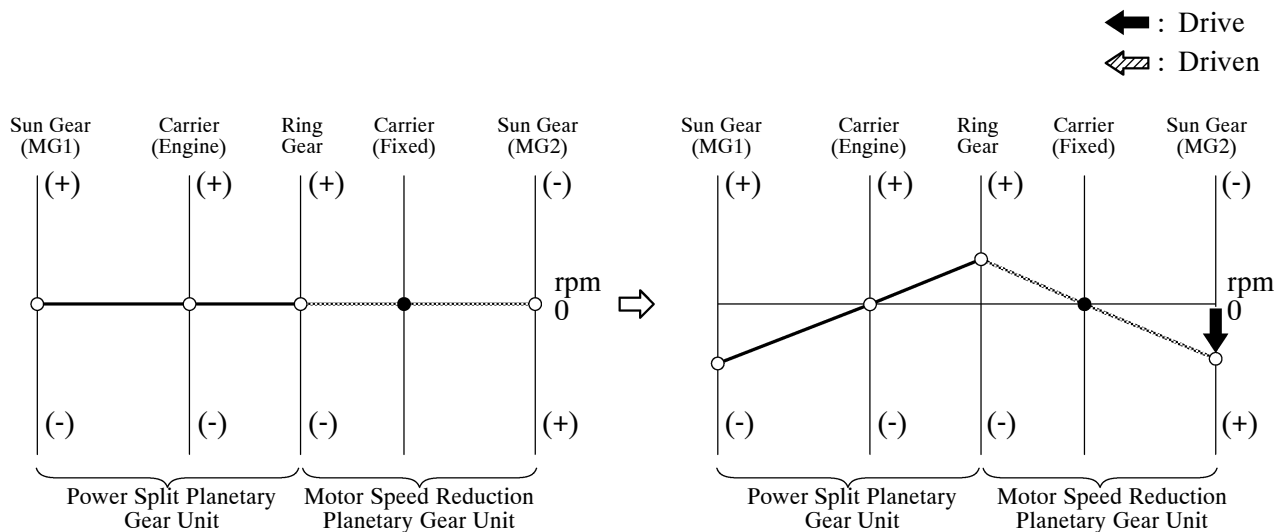
Driving with MG2 and MGR

When the vehicle is started off, the vehicle operates powered only by MG2 and MGR. At this time, the engine remains stopped, and MG1 is spinning in the opposite direction without generating electricity.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀



Vehicle Stopped

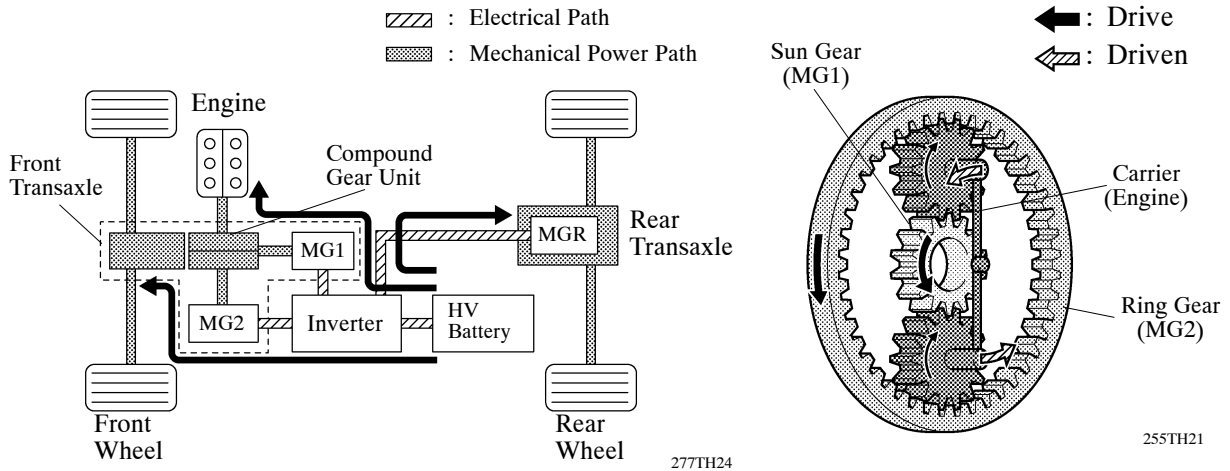
Vehicle Starting Off

278TH06

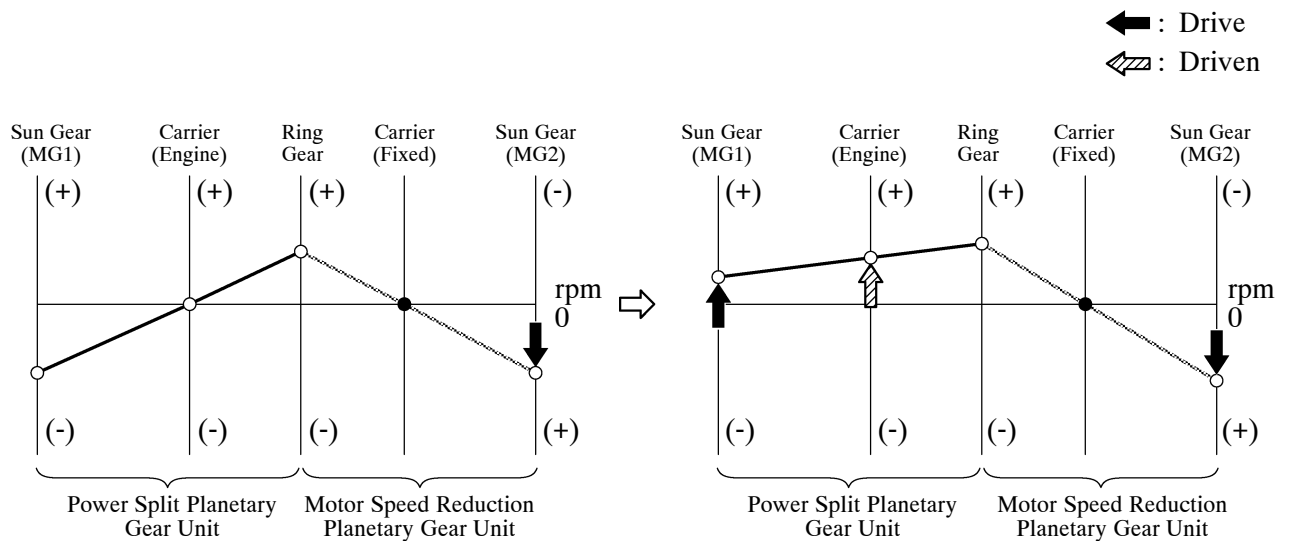
Engine Start

- If the required drive torque increases when running with MG2 and MGR only, MG1 will be activated to start the engine. If, also, any one of the items monitored by the THS ECU such as the SOC condition, the battery temperature, the engine coolant temperature and the electrical load condition deviates from the specified level, MG1 will be activated to start the engine.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀



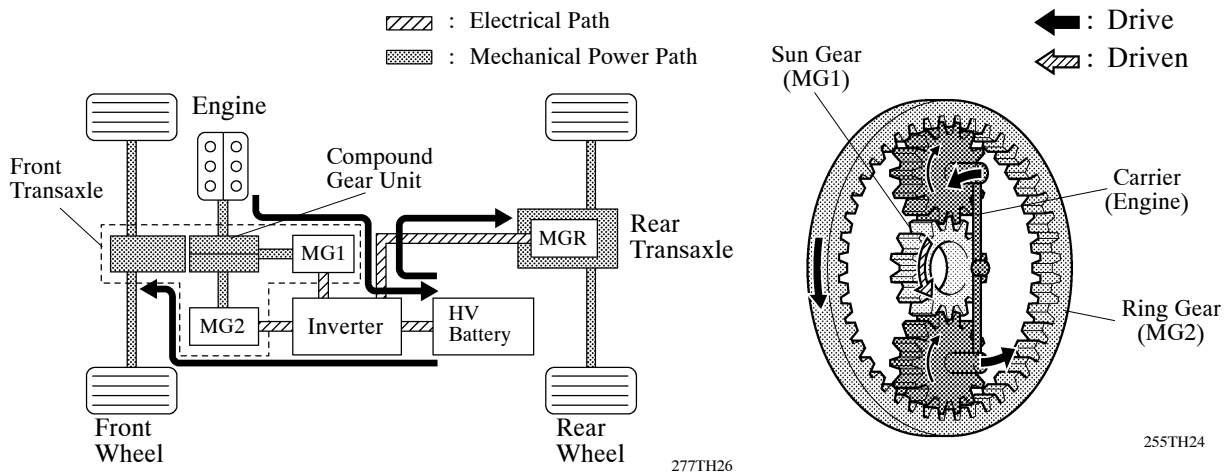
Vehicle Starting Off

Engine Start

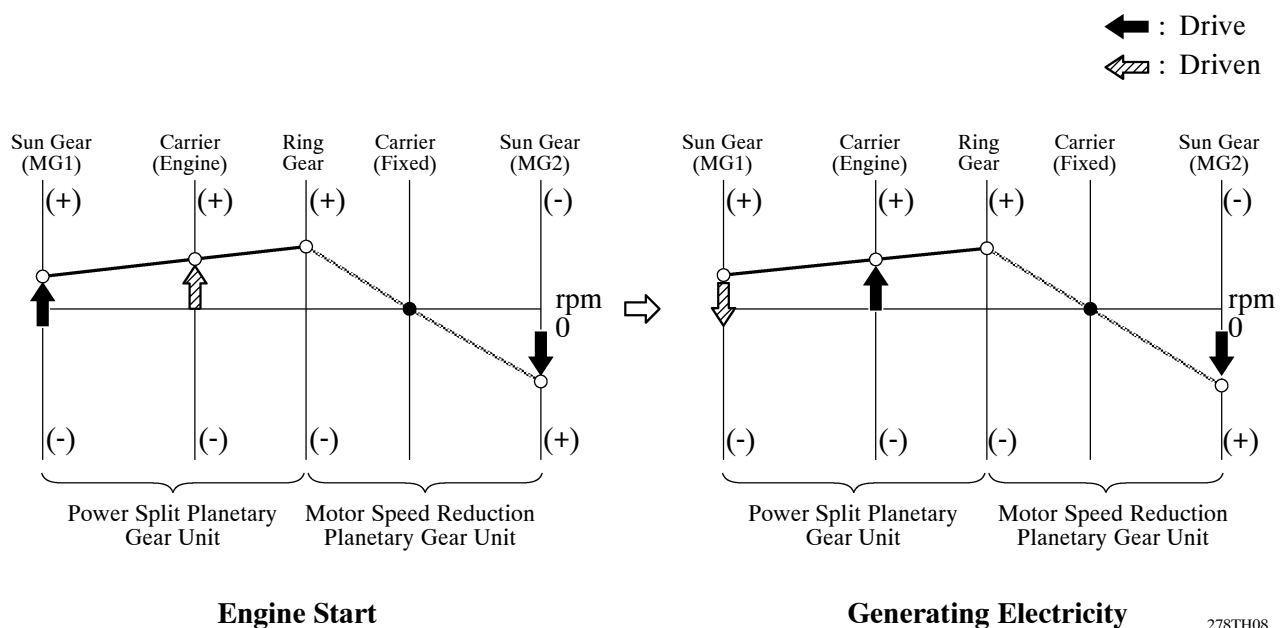
278TH07

- In the next state, the engine that has been started will operate MG1 as a generator, in order to start charging the HV battery. If the drive torque requirement increases, the system directly uses the electrical power that is generated by MG1 to start driving MG2, in order to transfer to the “During Acceleration with Engine” mode.

► Power Split Planetary Gear Operation ◀



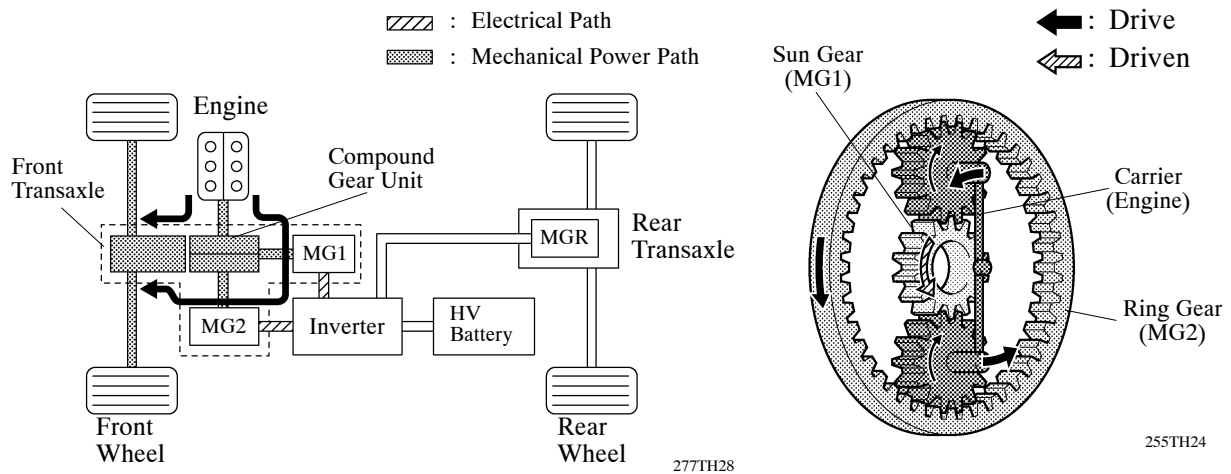
► Nomographic Chart of Planetary Gear Unit ◀



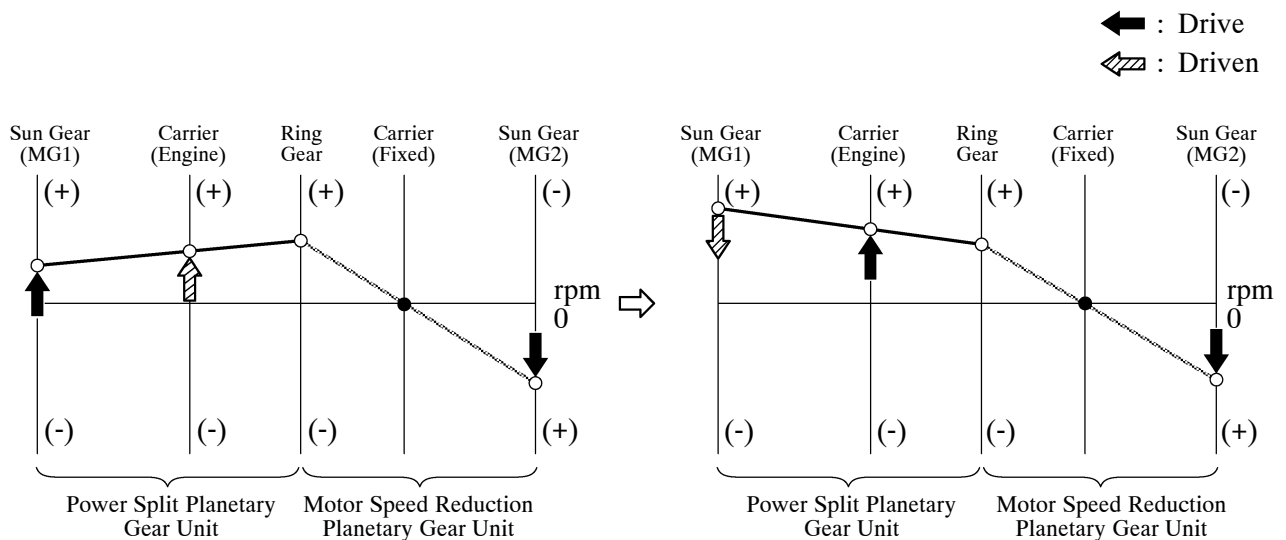
5. During Acceleration with Engine/(C)

- When the vehicle is during acceleration with engine, the motive force of the engine is divided by the planetary gears. A portion of this motive force is output directly, and the remaining motive force is used for generating electricity through MG1. Through the use of an electrical path of an inverter, this electrical force is sent to MG2 to be output as the motive force of MG2.
- On this model, MGR stops in the “During Acceleration with Engine” mode, in order to make fuel economy a priority.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀



Engine Starts while Driving with MG2

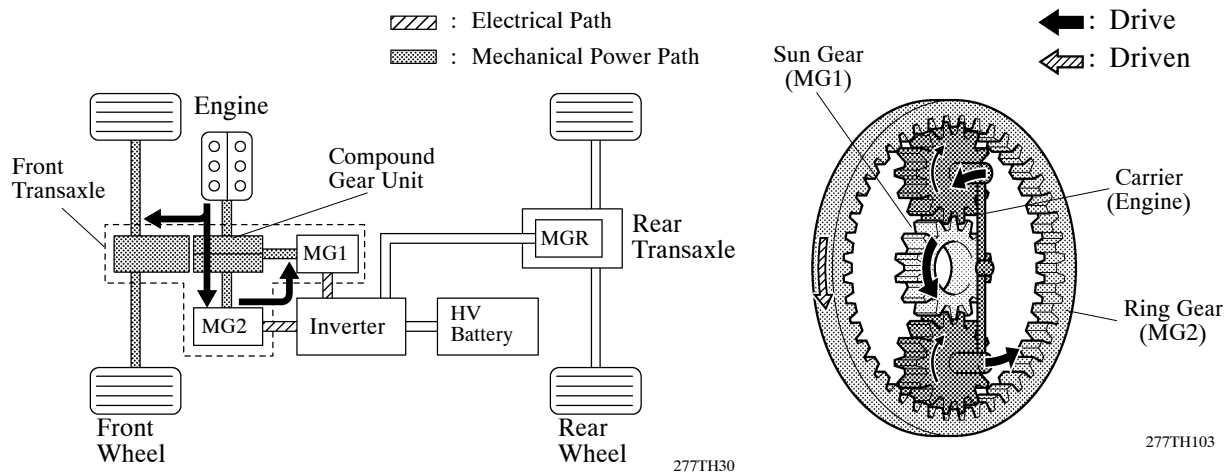
Normal Driving with Engine

278TH09

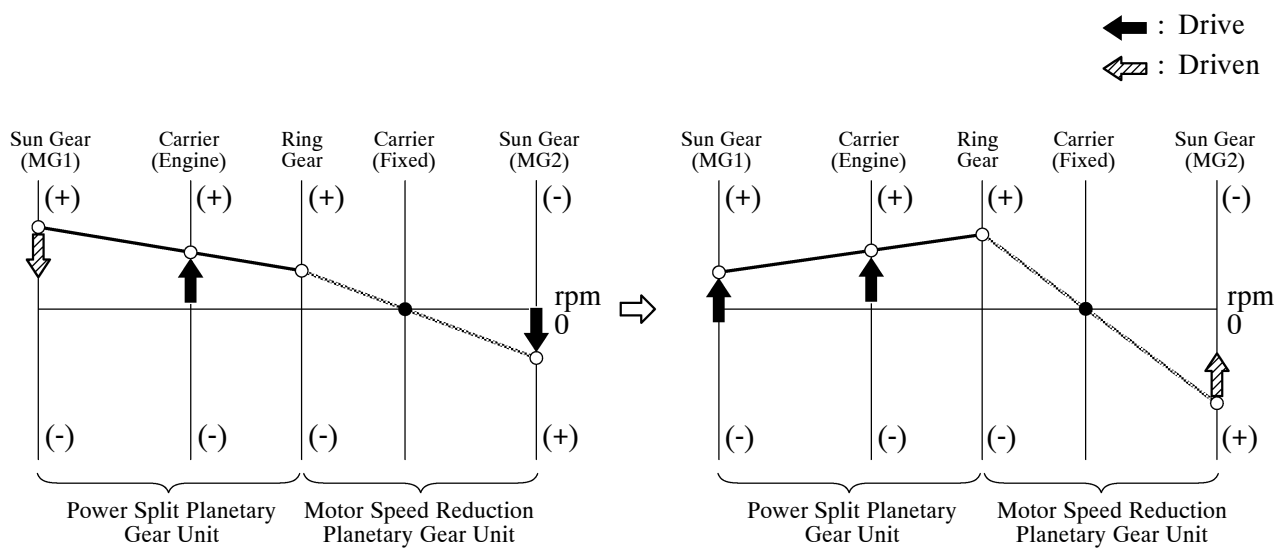
6. During Low Load and Constant-Speed Cruising/(D)

- When the vehicle is operating in the low-load, constant speed cruising mode, the planetary gears split the motive force of the engine two ways: one to directly drive the wheels, and the other to drive MG2. MG2, which is driven by the engine, functions as a generator to generate electricity and drive MG1. As a result of MG1 being driven, the compound gear unit attains an optimum gear ratio, which enables the vehicle to maintain a constant speed. In addition, fuel economy is improved by regulating the engine speed in order to make the engine run more efficiently.
- On this model, MGR stops in the low-load, constant speed cruising mode, in order to make fuel economy a priority.

► Power Split Planetary Gear Operation ◀



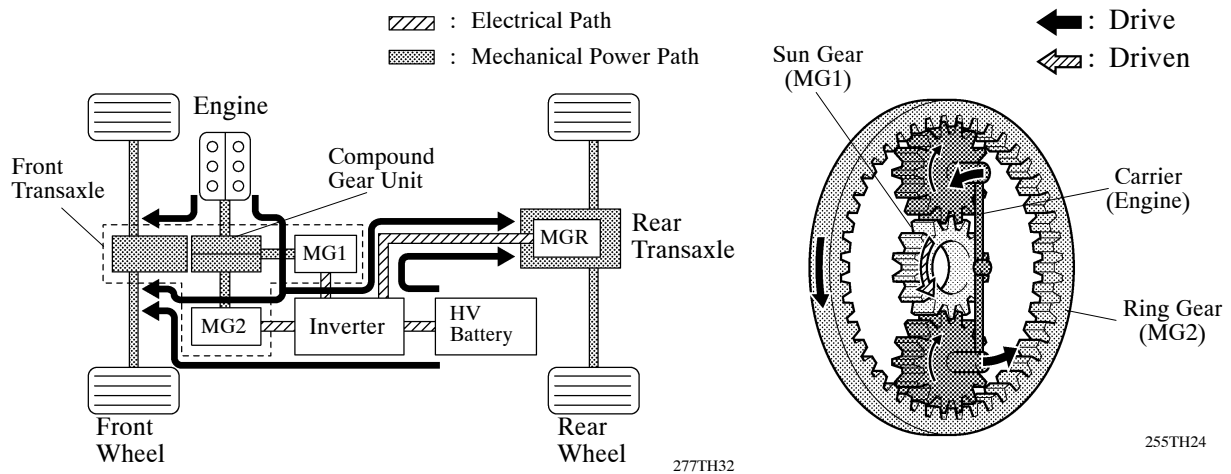
► Nomographic Chart of Planetary Gear Unit ◀



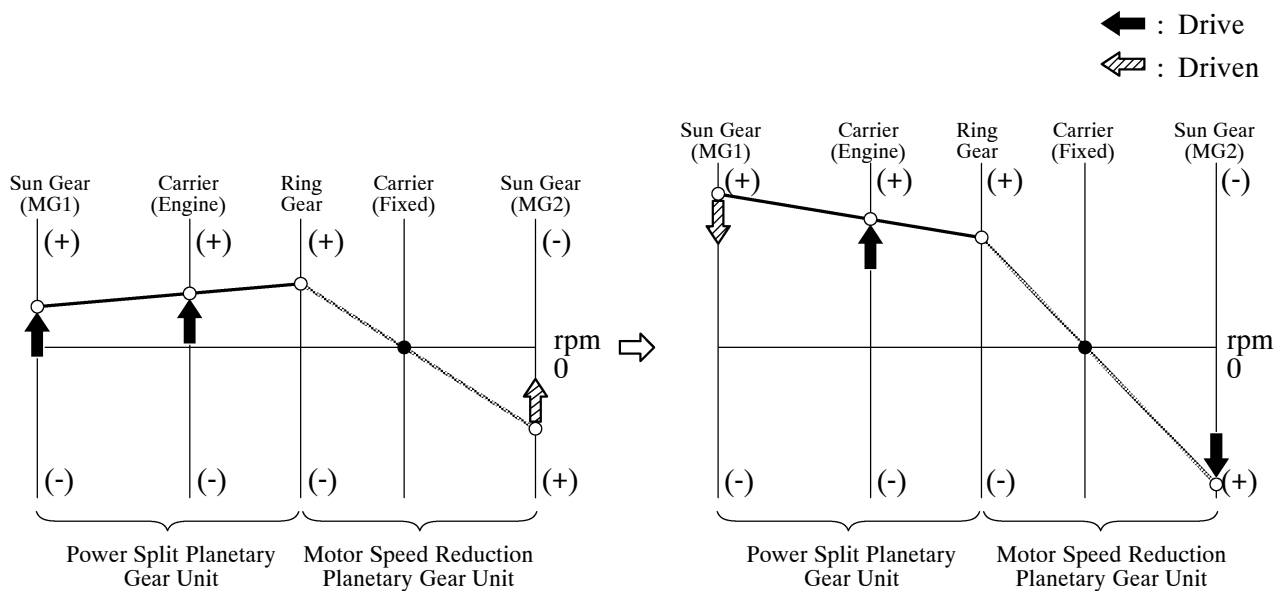
7. During Full Throttle Acceleration/(E)

- When the vehicle transfers from the low load cruising to the full-throttle acceleration mode, the system will add the electrical force of the HV battery to the motive force of MG2.
- On this model, MGR operates during full throttle acceleration and drives the rear wheels, in order to make acceleration performance a priority.
- Since the HV battery has a limited capacity, when the SOC (state of charge) status falls below a certain level, the electrical force supplied by the HV battery is suspended.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀

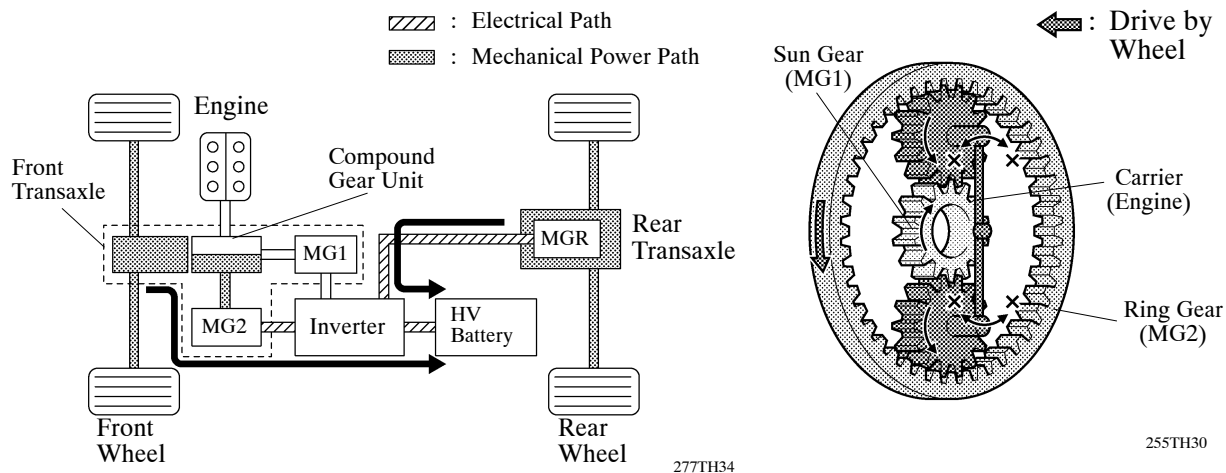


8. During Deceleration Driving/(F)

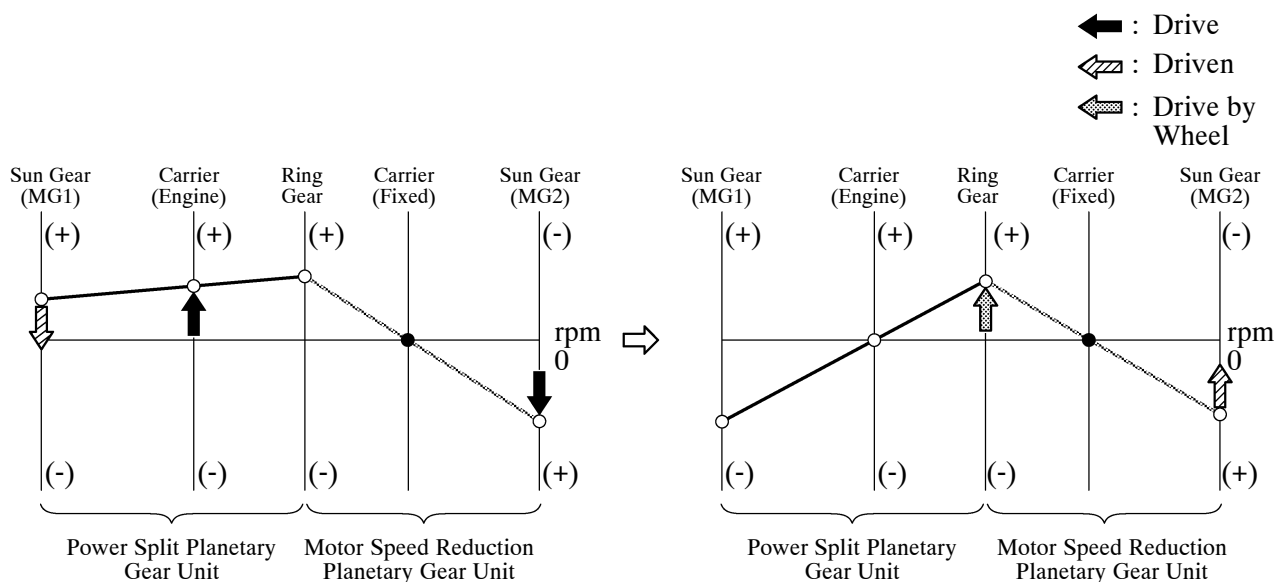
Deceleration in “D” Range

- While the vehicle is being driven with the shift position in the D, and decelerates, the engine turns OFF and the motive force will be zero. At this time, the wheels drive MG2 and MGR, causing MG2 and MGR to operate as a generator and charge the HV battery.
- If the vehicle decelerates from a higher speed, the engine will maintain a predetermined speed without stopping, in order to protect the planetary gear unit.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀



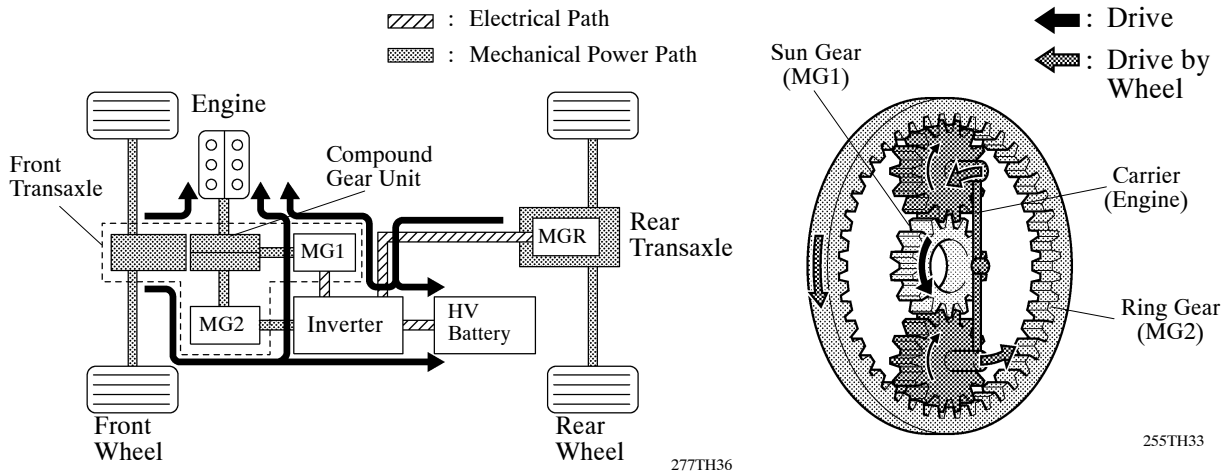
Low Load and Constant-Speed Cruising

Deceleration Driving

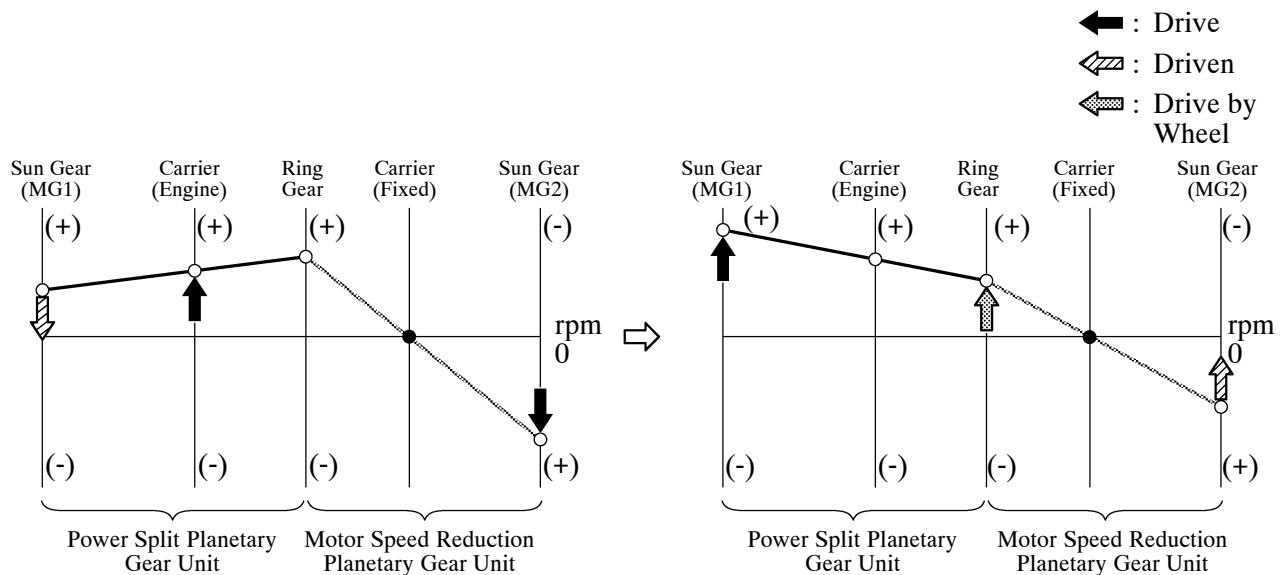
Deceleration in “B” Range

While the vehicle is being driven with the shift position in the B, and decelerates, the wheels drive MG2 and MGR, causing MG2 and MGR to operate as a generator, charge the HV battery, and supply electrical power to MG1. Accordingly, MG1 maintains the speed of the engine and applies an engine brake. At this time, the fuel to the engine is cut.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀



Low Load and Constant-Speed Cruising

Deceleration Driving

278TH13

During Braking

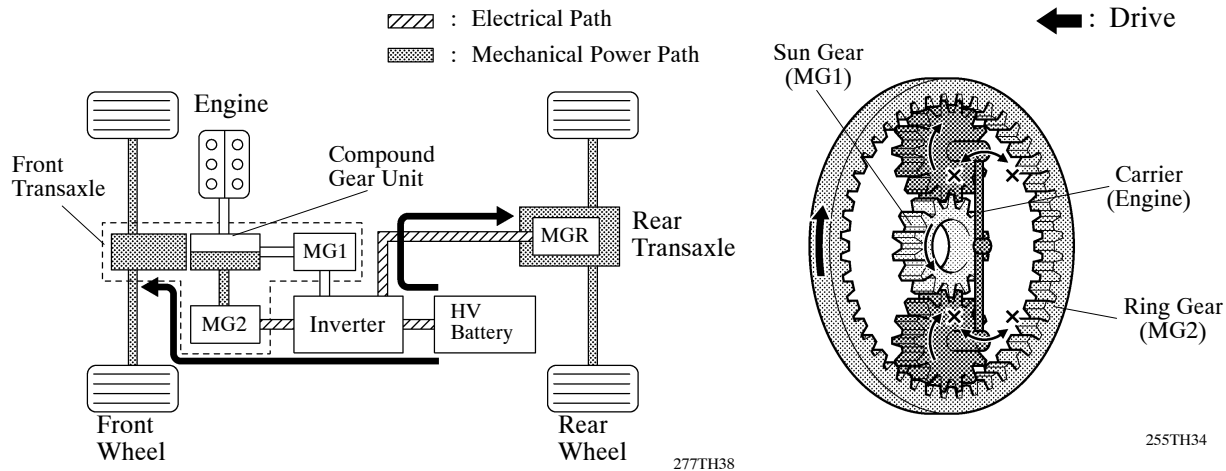
While the vehicle is decelerating, if the driver presses the brake pedal, the skid control ECU calculates the required regenerative brake force and sends a signal to the THS ECU. Upon receiving this signal, the THS ECU increases the regenerative force within a range that suits the required regenerative brake force. As a result, MG2 and MGR will be controlled to generate an ample amount of electricity.

9. During Reverse Driving/(G)

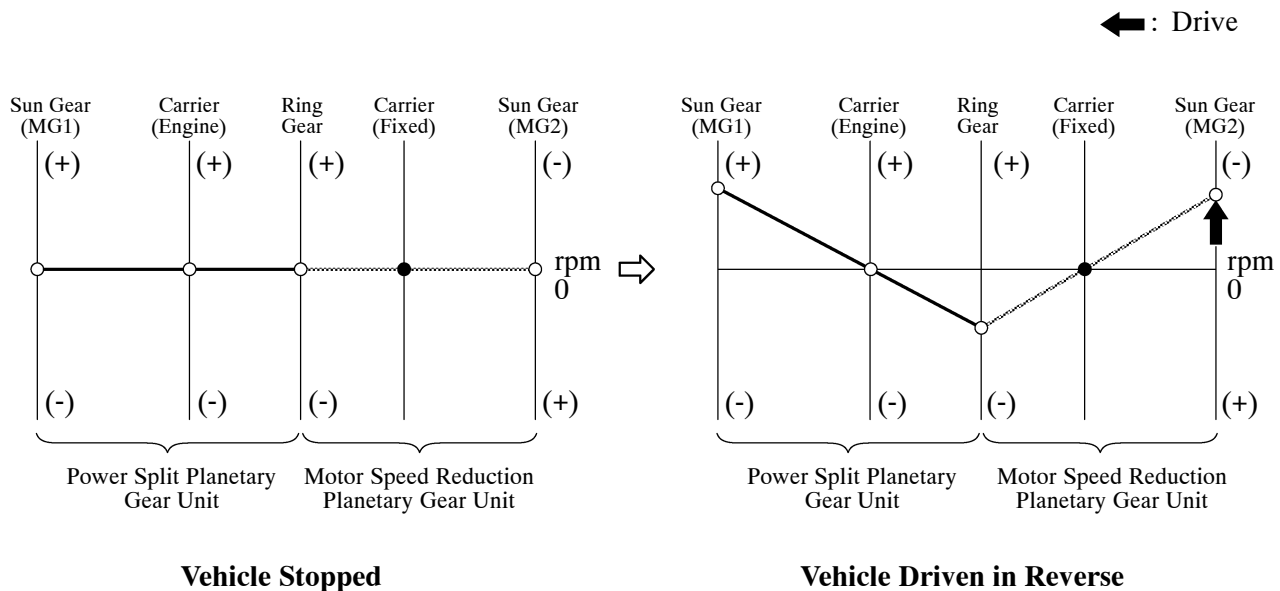
Driving with MG2 and MGR

While the vehicle is being driven in reverse, its power is delivered by MG2 and MGR. At this time, MG2 and MGR is spinning in the opposite direction, the engine remains stopped, and MG1 is spinning in the normal direction without generating electricity.

► Power Split Planetary Gear Operation ◀



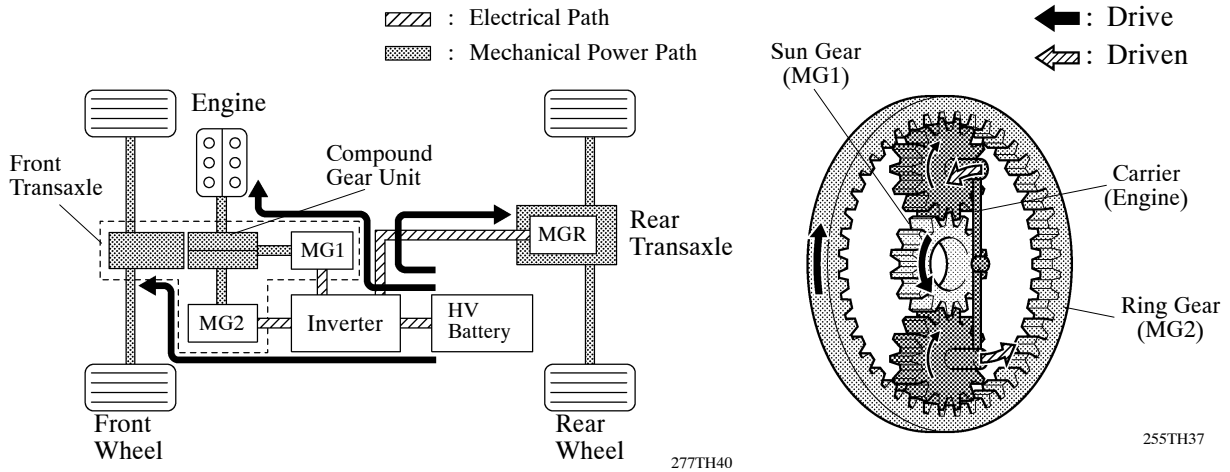
► Nomographic Chart of Planetary Gear Unit ◀



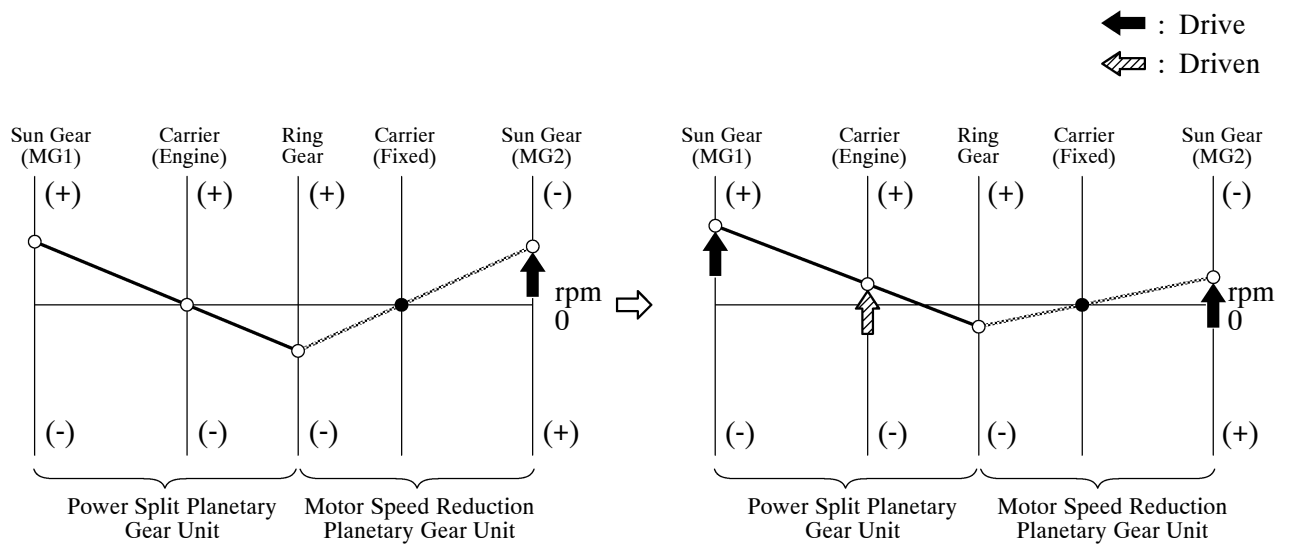
Engine Start

- If, when running with MG2 and MGR only, any one of the items monitored by the THS ECU such as the SOC condition, the battery temperature, the engine coolant temperature and the electrical load condition deviates from the specified level, MG1 will be activated to start the engine.

► Power Split Planetary Gear Operation ◀

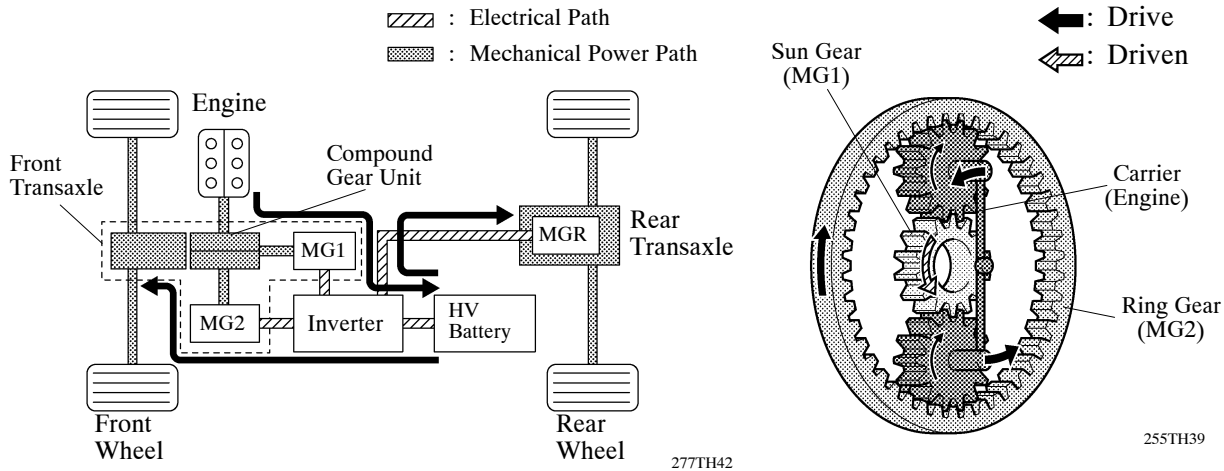


► Nomographic Chart of Planetary Gear Unit ◀



- In the next state, the engine that has been started will operate MG1 as a generator, in order to start charging the HV battery.

► Power Split Planetary Gear Operation ◀



► Nomographic Chart of Planetary Gear Unit ◀

