

SYSTEM OPERATION

1. General

The electronic control of the multi-mode manual transmission system has following control.

Control	Outline
Engine Starting Control (See Page CH-29)	The M-MT ECU permits the operation of the starter to start the engine only when the brake pedal is depressed and the shift lever is in the N position.
Vehicle Starting Off Control (See Page CH-30)	When the vehicle starts off in 1st, 2nd, or reverse, the M-MT ECU partially engages the clutch. Thus, it enables the vehicle to start off slowly without requiring the operation of the accelerator pedal.
Shifting Control (See Page CH-31)	<ul style="list-style-type: none"> ● The M-MT ECU effects gear shift control in accordance with the shift lever position and driving conditions by way of the actuators and the ETCS-i control of the engine ECU. ● When the shift lever is in the M position, the M-MT ECU shifts gears to the position selected by the driver. In the M-mode, in order to improve the driving usability and prevent engine stalls, the shifting control shifts the gear down in accordance with the vehicle speed. ● When the shift lever is in the E position, the M-MT ECU selects an optimal gear position that suits the driving conditions.
Kick Down Control* (Only for LHD Model)	This control enables the transmission control ECU to perform downshift when the driver fully depresses the accelerator pedal while driving, in accordance with the actual vehicle speed.
Shifting Control in Uphill/Downhill Traveling (See Page CH-32)	While the vehicle is being driven in the E-mode, this control restricts the 3rd, 4th or 5th upshift or provides appropriate engine braking in order to enable the M-MT ECU to determine whether the vehicle is traveling uphill or downhill.
DTA (Delta Throttle Accelerate) Control (See Page CH-34)	The M-MT ECU determines a sudden ON or OFF operation of the accelerator pedal as request by the driver to accelerate or decelerate, and controls the transmission to downshift or upshift.
Vehicle Stopping Control (See Page CH-34)	<ul style="list-style-type: none"> ● When the input shaft speed decreases to a predetermined level while the vehicle is in motion, the M-MT ECU disengages the clutch to prevent the engine from stalling. ● When the vehicle is stopped and the shift lever is in the E or M position, this control automatically shifts the gears to 1st, thus making it unnecessary for the driver to shift when starting off again.
Parking Control (See Page CH-35)	<ul style="list-style-type: none"> ● When the ignition switch is turned OFF and the shift lever in the R, E, or M position, the M-MT ECU engages the clutch in order to set the transaxle in the gear parking mode. ● When the ignition switch is turned OFF, the M-MT ECU operates the shift lock solenoid to lock the shift lever position. This prevents the shift lever position and the gear position from becoming mismatched.
Retry Control (See Page CH-36)	When shifting is not succeeded to the target gear, M-MT ECU retries gear shifting.

*: Only for E-mode

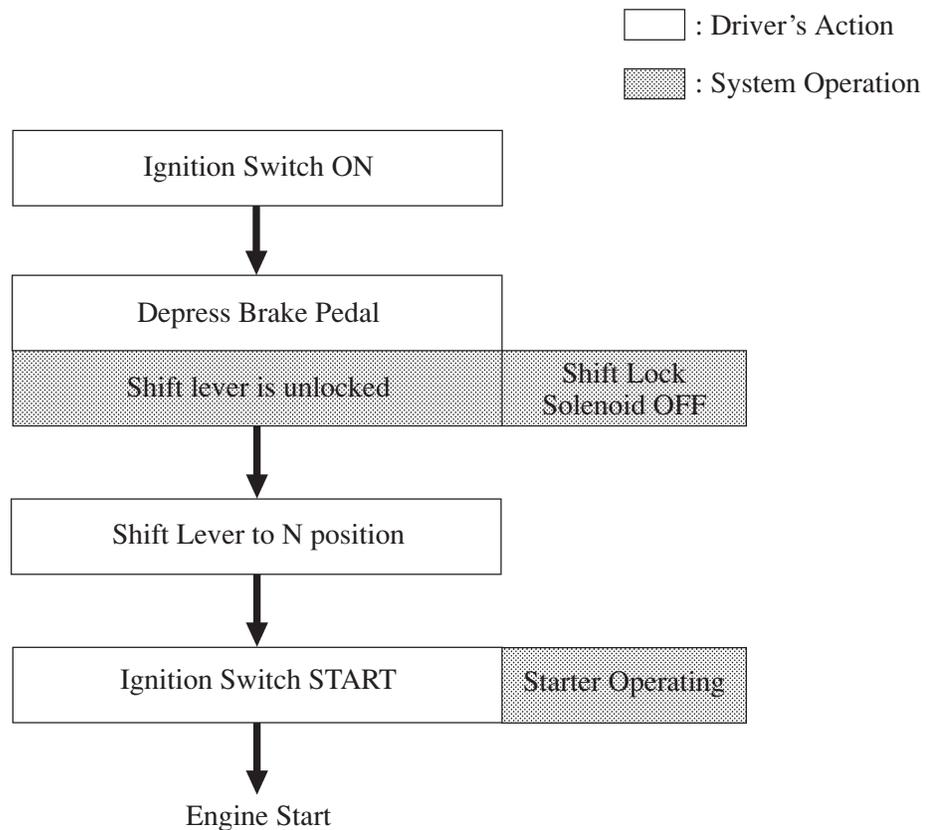
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Control	Outline
Shift Protection Control (See Page CH-37)	To protect the transaxle gears, clutch, and engine, the M-MT ECU restricts shifting control when any of the conditions indicated below occur: <ul style="list-style-type: none"> ● A shift request that could cause the engine to over-rev or under-rev is made. ● A shift request is made to the R position at a vehicle speed that is higher than a predetermined speed. ● A shift request is made to the 1st gear during a low outside air temperature.
Diagnosis (See Page CH-38)	When the M-MT ECU detects a malfunction, the M-MT ECU makes a diagnosis and memorizes the failed section.
Fail Safe (See Page CH-38)	Even if a malfunction is detected in the sensors or actuators, the M-MT ECU effects fail-safe control to prevent the vehicle's drivability from being affected significantly.

2. Engine Starting Control

The M-MT ECU permits the operation of the starter to start the engine only when the brake pedal is depressed and the shift lever is in the N position.

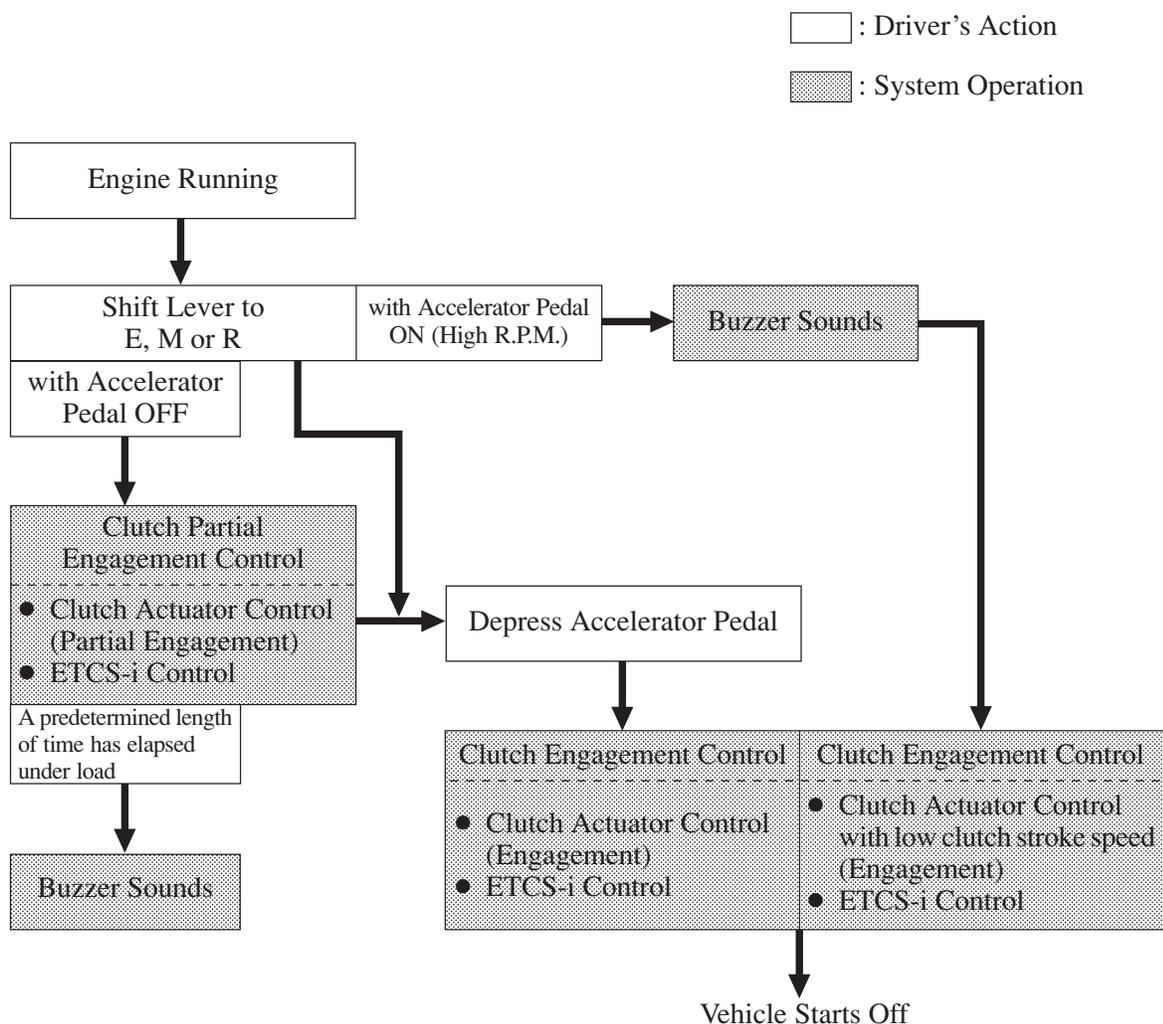
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3. Vehicle Starting Off Control

- When the gear is in the 1st or 2nd position (shift lever in the E or M position) or Reverse (shift lever in the R position), and the brake pedal is released, the M-MT ECU partially engages the clutch via the clutch actuator. To prevent the engine from stalling, the M-MT ECU requests the engine ECU to effect ETCS-i control. As a result, the vehicle can be driven slowly forward without requiring the driver to depress the accelerator pedal. When the driver depresses the accelerator pedal in this condition, the M-MT ECU engages the clutch.
- If the partial engagement condition is prolonged, such as when driving on a hill, the M-MT ECU sounds the built-in buzzer to alert the driver to avoid clutch damage.
- If the shift lever is moved from the N to the E, M, or R position while the engine speed is high*, the M-MT ECU sounds the built-in buzzer to alert the driver. At the same time, the M-MT ECU decreases the clutch stroke speed (the speed of the engagement of the clutch) in order to prevent the vehicle from moving suddenly.

*: The M-MT ECU determines this condition based on the transmission revolution sensor signal, crankshaft position sensor signal, and accelerator pedal position sensor signal.



4. Shifting Control

General

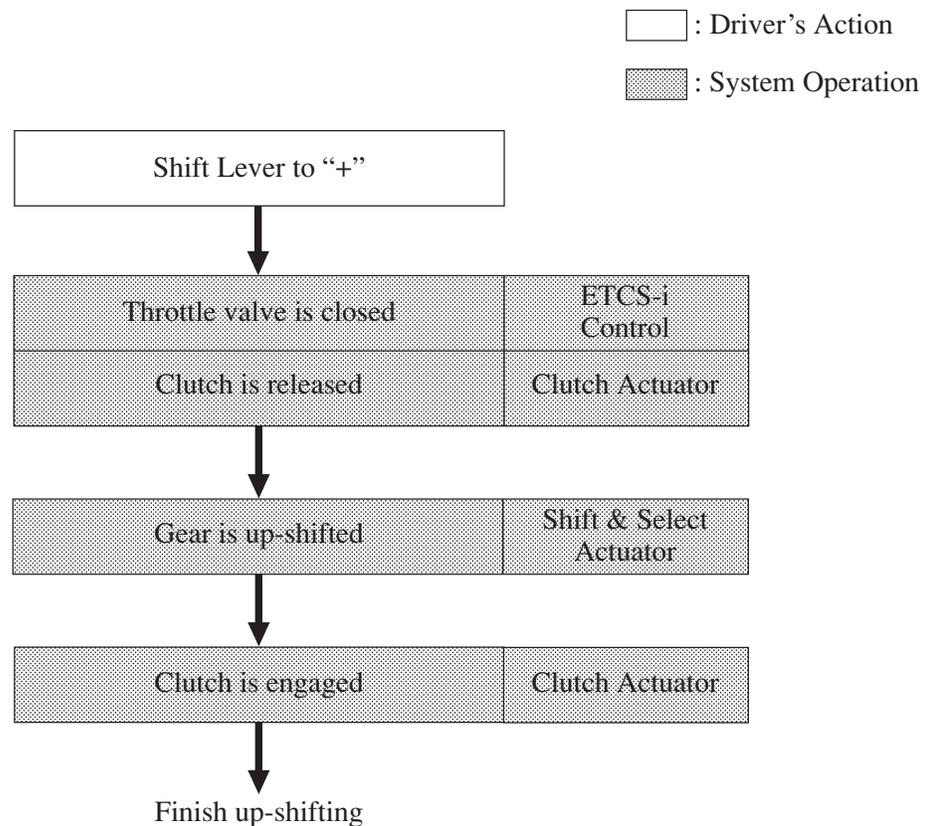
The multi-mode manual transmission system consists of two types of shift modes: the E-mode that shifts automatically to suit the driving conditions; and the M-mode that allows the driver to manually operate the shift lever to shift gears without applying the clutch.

The M-MT ECU shifts gears by operating the clutch actuator and the shift & select actuator in accordance with the shift lever position and the driving conditions. At the same time, it requests the engine ECU to effect ETCS-i control. As a result, smooth shifting control is realized.

- When the shift lever is in the M position, the driver can operate the shift lever in the “+” or “-” direction to enable the M-MT ECU to effect gear shift control.
- When the shift lever is in the E position, the M-MT ECU automatically selects an optimal gear position that suits the driving conditions.

Up-Shifting (M-mode)

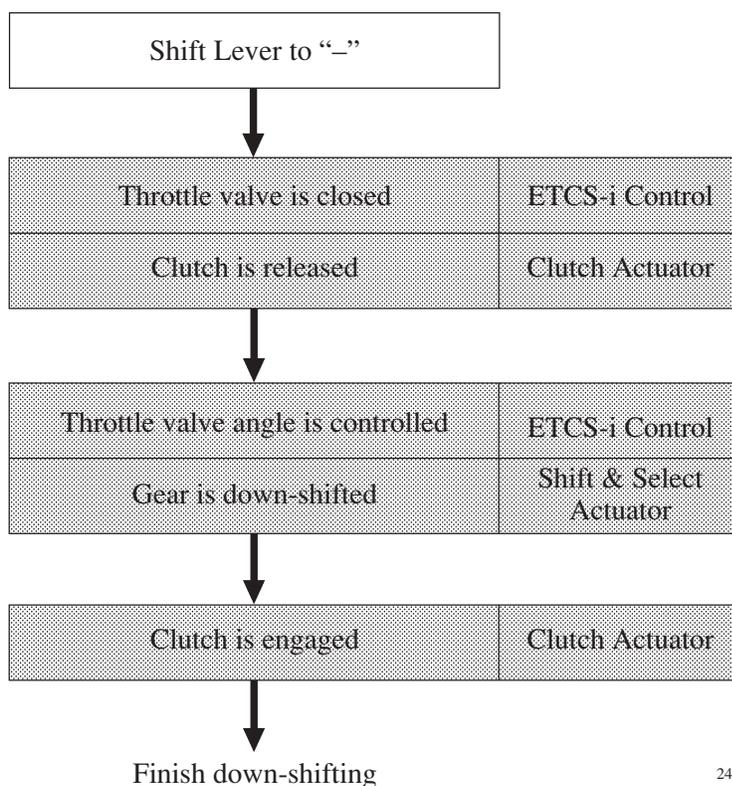
- When the driver moves the shift lever from the M position to the “+” direction, the M-MT ECU releases the clutch by operating the clutch actuator. If the driver is depressing the accelerator pedal at this time, the M-MT ECU prevents the engine from being over-revved by requesting the engine ECU to effect ETCS-i control and close the throttle valve.
- After the clutch release movement has been completed, the M-MT ECU operates the shift & select actuator to shift gears.
- After the gear shift has been completed, the M-MT ECU engages the clutch.



Down-Shifting (M-mode)

- When the driver moves the shift lever from the M position to the “-” direction, the M-MT ECU operates the clutch actuator to release the clutch.
- In the M-mode, in order to improve the driving usability, the shifting control shifts the gear down in accordance with the vehicle speed.
- After the clutch release movement has been completed, the M-MT ECU operates the shift & select actuator to shift gears. At this time, the M-MT ECU requests the engine ECU to effect ETCS-i control.
- After the gear shift has been completed, the M-MT ECU engages the clutch.

□ : Driver’s Action
 ▒ : System Operation



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Automatic Up/Down-Shifting (E-mode)

- When the driver moves the shift lever to the E position, the M-MT ECU calculates an optimal gear position to suit the driving conditions (accelerator pedal position, vehicle speed, etc.), and operates the clutch actuator, shift & select actuator, and ETCS-i control to shift gears (1st ↔ 5th). The control of the actuators and the ETCS-i during upshifting and downshifting is the same as for the M-mode.
- The M-MT ECU determines the driver’s vehicle acceleration request from the accelerator pedal position sensor value, and downshifts to a gear position that suits the vehicle speed if necessary. Thus, the vehicle can be accelerated as requested by the driver, even in the E-mode. In addition, the LHD model has the kick-down function. This function enables the M-MT ECU to perform downshifting when the driver fully depresses the accelerator pedal while driving, in accordance with the actual vehicle speed.

5. Shifting Control in Uphill/Downhill Traveling (E-mode)

General

This control minimizes the shifting of gears when the driver operates the accelerator pedal while driving on a winding road with ups and downs, in order to ensure a comfortable drivability.

Shift Control In Uphill Traveling

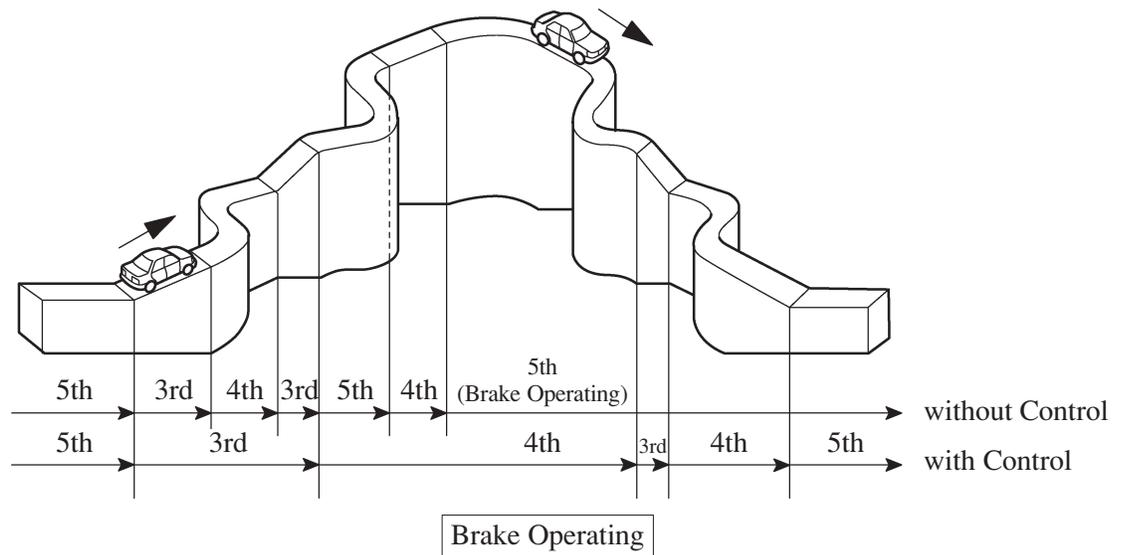
When the M-MT ECU determines that the vehicle is travelling uphill, it controls the upshifting and downshifting of the transmission until it determines that the uphill traveling is over.

Shift Control In Downhill Traveling

When the M-MT ECU determines downhill travel, it shifts down the transaxle from 5th to 4th in accordance with the brake operation signal that is input when the driver operates the brake pedal.

When the M-MT ECU determines downhill travel with a steeper grade, and a brake operation signal is input again, the M-MT ECU shifts the transaxle down from 4th to 3rd.

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Uphill/Downhill Judgment

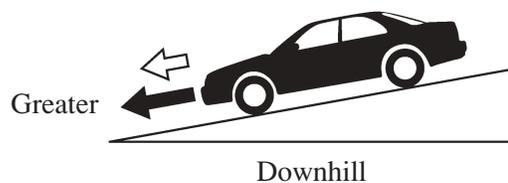
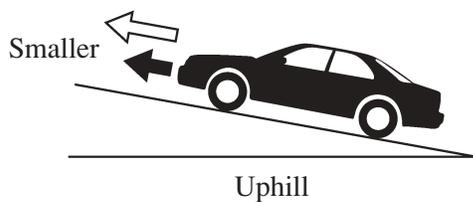
The actual acceleration calculated from the speed sensor signal is compared with the reference acceleration stored in the M-MT ECU to judge uphill or downhill traveling.

Actual acceleration < Reference acceleration

Actual acceleration > Reference acceleration

← Reference acceleration

← Actual acceleration



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6. DTA (Delta Throttle Angle) Control

The DTA control, which operates in the automatic or manual shift mode (E-mode or M-mode), has the following two control functions:

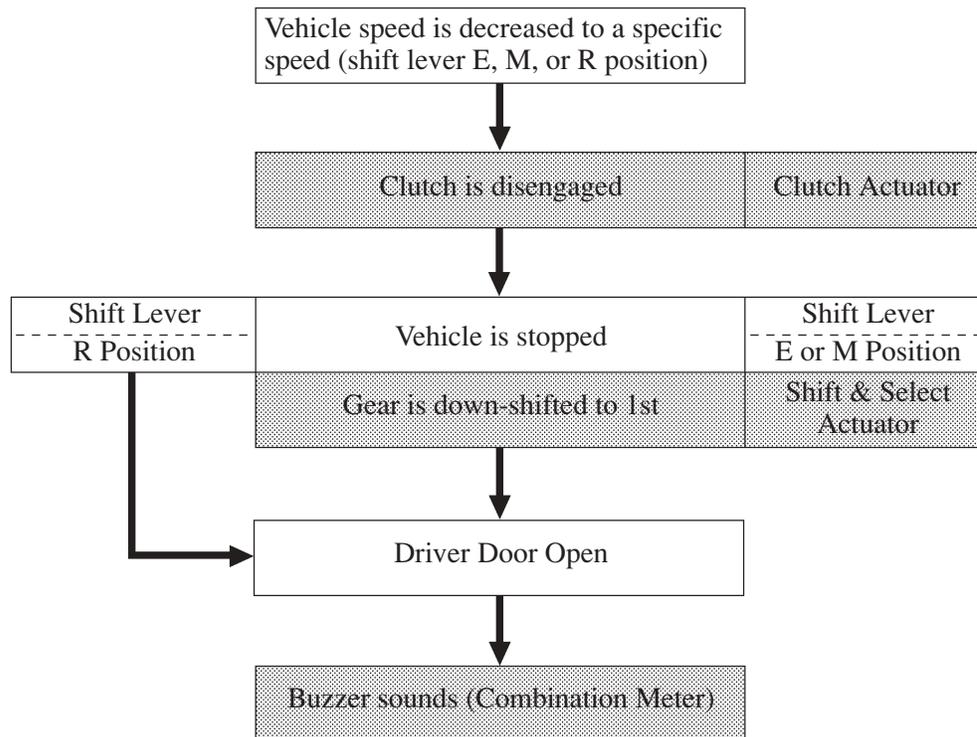
- At sudden acceleration: The transmission control ECU determines, via the accelerator pedal position sensor, a sudden acceleration ON operation as the driver’s request to accelerate, and thus quickens the timing of downshifting.
- At sudden deceleration: The transmission control ECU determines, via the accelerator pedal position sensor, a sudden acceleration OFF operation as the driver’s request to decelerate. Thus, instead of up shifting, it ensures engine braking and also the driving force of the subsequent accelerator ON operation.

7. Vehicle Stopping Control

- When the shift lever is in the E, M, or R position and the vehicle speed is decreased to a specific speed*, the M-MT ECU releases the clutch to prevent the engine from stalling at low speeds.
- In addition, when the vehicle is operating in the E or M position and comes to a stop, the gears shift automatically to 1st gear to improve drivability for starting off again. When the shift lever is in the R position, the gears do not shift automatically when the vehicle is stopped.
- When the vehicle is stopped with its engine running and the driver door is opened with the shift lever in the E, M, or R position, the M-MT ECU sounds the buzzer in the combination meter to alert the driver.

*: Because the M-MT ECU effects this control in accordance with the input revolution sensor signal, this value changes with the gear position.

□ : Driver’s Action
 ▒ : System Operation

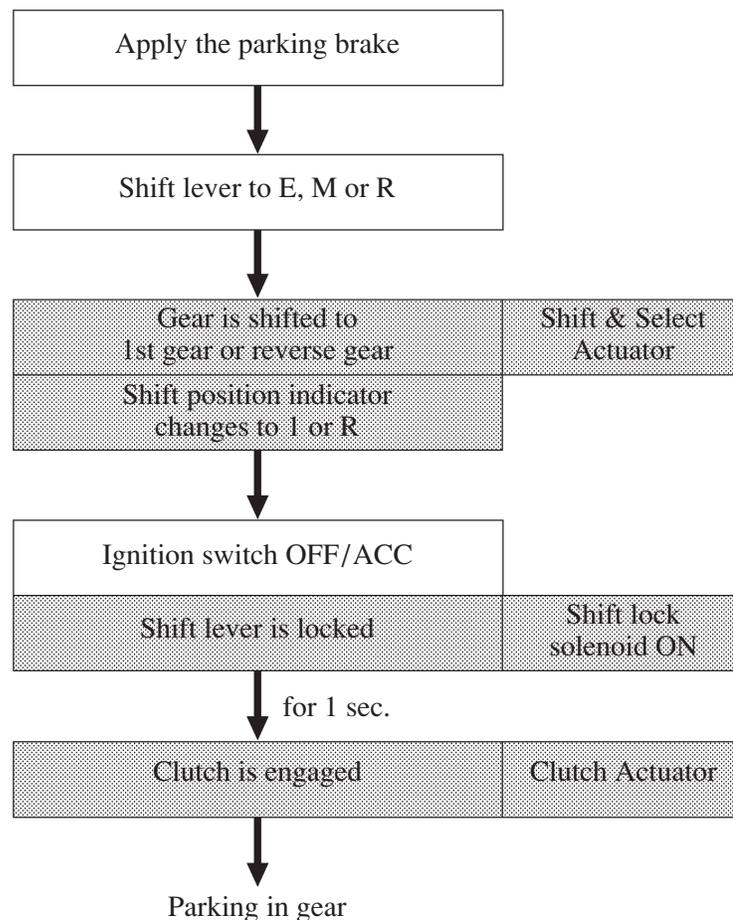


8. Parking Control

- To park the vehicle, the driver apply the parking brake, shift the shift lever to the E, M or R position, verify on the gear position indicator that the shifting has been properly executed, and turn the ignition switch OFF. When the ignition switch is turned OFF, the shift lock mechanism causes the shift lever to lock. Approximately 1 second later, the M-MT ECU engages the clutch. As a result, the transaxle assumes the gear parking mode, with its gears meshed.
- The vehicle can be parked whether the shift lever is in any position, E, M, R, or N. However, when the shift lever is in the N position, the gear parking mode described above cannot be effected because the gears are not meshed. Also, when parking the vehicle using the gear parking mode, turn the ignition switch OFF after the shift position indicator light is indicated “1” or “R”.
- For approximately 5 seconds after the ignition switch has been turned OFF, the driver can verify the gear position on the indicator due to the function of the meter ECU.

□ : Driver's Action

▨ : System Operation



9. Retry Control

When shifting is not succeeded to the target gear, M-MT ECU re-tries gear shifting.

Vehicle Condition	Driver's Action	Retry Operation	Warning
Stopped with Engine OFF	Shift Lever N → E, M or R	If the gears do not shift from neutral to 1st or R position, the M-MT ECU effects the following movements: <ul style="list-style-type: none"> ● Return to neutral position ● Shift to the other gear ● Shift to the 1st or R gear ● If the gears do not shift to 1st or R after the above movements have been repeated a few times, the M-MT ECU stops shifting gears and stands by in the neutral position. 	N range indicator light blinks*
Stopped with Engine Running	Shift Lever N → E, M or R	If the gears do not shift from neutral to 1st or R position, the M-MT ECU effects the following movements: <ul style="list-style-type: none"> ● Return to neutral position ● Clutch is engaged and disengaged once ● Shift to the 1st or R gear ● If the gears do not shift to 1st or R after the above movements have been repeated a few times, the M-MT ECU stops shifting gears and stands by in the neutral position. 	N range indicator light blinks*
			Buzzer in M-MT ECU sounds*
Driving	Up-shifting Down-shifting	If the gears do not shift to the target gear position, the M-MT effects the following movements: <ul style="list-style-type: none"> ● Return to neutral position ● Shifts again to the target gear ● If the gears do not shift to the target gear position after the above movements have been repeated a few times, the M-MT ECU stops shifting gears and stands by in the neutral position. 	N range indicator light blinks*
	Unintended mechanical popping out of the gears.	If the transmission pops out of the gears unintendedly, the M-MT ECU effects the following movements: <ul style="list-style-type: none"> ● Return to neutral position ● Shift to the target gear 	—

*: During retry operation

10. Shift Protection Control

To protect the transaxle gears, clutch, and engine, the M-MT ECU restricts shifting control when any of the conditions indicated in the table below occur:

Driver's Action	System Operation	Warning
Up-shifting that causes the engine to under-rev. (approximately 1,200 rpm or less)	Shifting is rejected	—
Down-shifting that causes the engine to over-rev. (approximately 6,200 rpm or more)*	Shifting is rejected	Buzzer in M-MT ECU sounds once
Moves the shift lever to the R position at a vehicle speed of 6 km/h (4 mph) or more. (E → R, M → R or N → R)	Shifting is rejected	N range indicator light blinks
Downshifts to 1st gear at a low outside air temperature low (Estimated transaxle oil temperature: 0°C or below when driving at speeds over 15 km/h and -25°C or below when driving at speeds over 6 km/h). <ul style="list-style-type: none"> ● Manually downshifts the shift lever in the M-mode. ● Automatically downshifts in the E-mode. 	Shifting is rejected (2nd gear is selected)	—

*: However, it is set at approximately 5,700 rpm when downshifting from 2nd to 1st gear and at approximately 3,400 rpm when downshifting from 3rd to 1st gear.

11. Diagnosis and Fail-Safe

Diagnosis

- When the M-MT ECU detects a malfunction, the M-MT ECU makes a diagnosis and memorizes the failed section. Furthermore, the M-MT warning light and check engine warning light* illuminates, or blinks to inform the driver.
- The M-MT ECU will also store the DTCs (Diagnostic Trouble Codes). The DTCs can be accessed by connecting an intelligent tester II to the DLC3.
- The DTCs cannot be deleted by merely disconnecting the battery terminals. To delete the DTCs, an intelligent tester II must be connected to the DLC3.
- In the M-MT system, the data list can be read and the active test can be performed using the intelligent tester II.

For details refer to the Aygo Repair Manual.

*: Depending on the malfunctions, the check engine warning light illuminates.

Fail-safe

Even if a malfunction is detected in the sensors or actuators, the M-MT ECU effects fail-safe control to prevent the vehicle's drivability from being affected significantly.

► Fail-safe Chart ◀

DTC No.	Malfunction Areas	Fail-safe Functions	Fail-safe Deactivation Conditions
<ul style="list-style-type: none"> ● P0806 ● P0807 ● P0808 ● P0810 ● P0900 	<ul style="list-style-type: none"> ● Clutch stroke sensor or its circuit ● Clutch actuator assembly or its circuit 	<ul style="list-style-type: none"> ● Gear does not change ● Vehicle does not start moving again after stopping 	Either (a) or (b) met: (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Shift lever in N position ● Transmission gear in neutral* ● Vehicle speed less than 9 km/h (5.59 mph) (b) Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0807 ● P0808 ● P0906 ● P0907 ● P0916 ● P0917 	<ul style="list-style-type: none"> ● Clutch stroke sensor or its circuit ● Select stroke sensor or its circuit ● Shift stroke sensor or its circuit 	Limit to 3rd gears or lower	Either (a) or (b) met; (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Shift lever in N position ● Transmission gear in neutral* ● Vehicle speed less than 9 km/h (5.59 mph) (b) Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0905 ● P0906 ● P0907 ● P0909 ● P0910 ● P0915 ● P0916 ● P0917 ● P0919 ● P0920 	<ul style="list-style-type: none"> ● Shift stroke sensor or its circuit ● Shift actuator assembly or its circuit ● Select stroke sensor or its circuit ● Select actuator assembly or its circuit 	<ul style="list-style-type: none"> ● Gear does not change ● Vehicle does not start moving again after stopping 	Either (a) or (b) met; (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Shift lever in N position ● Vehicle speed less than 9 km/h (5.59 mph) (b) Pass condition detected and ignition switch OFF

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DTC No.	Malfunction Areas	Fail-safe Functions	Fail-safe Deactivation Conditions
P0725	Engine speed input circuit	<ul style="list-style-type: none"> ● Convert engine revolution signals into CAN communication signals ● No effect 	Either (a) or (b) met: (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Actual gear position not in neutral (b) Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0500 ● P0715 	<ul style="list-style-type: none"> ● Vehicle speed sensor or its circuit ● Transmission revolution sensor or its circuit 	<ul style="list-style-type: none"> ● Gear does not shift down while driving ● Only possible to drive in 1st or reverse gears after vehicle stops 	Either (a) or (b) met: (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Vehicle speed less than 6 km/h (3.73 mph) ● Accelerator pedal released ● Brake pedal depressed (b) Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0603 ● P0885 	<ul style="list-style-type: none"> ● Transmission control ECU ● Clutch actuator, shift actuator, select actuator power source circuit 	<ul style="list-style-type: none"> ● Gear does not change ● Engine cannot be started ● Transmission control ECU stops engine when vehicle stops 	Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0820 	<ul style="list-style-type: none"> ● Shift lever position sensor or its circuit ● Transmission shift main switch or its circuit 	<ul style="list-style-type: none"> ● Impossible to enter M-mode ● Gear does not shift to 1st or reverse (and forward or backward gears) 	Pass condition detected and ignition switch OFF
<ul style="list-style-type: none"> ● P0335 ● P0339 	Crankshaft position sensor or its circuit	Gear does not change	Pass condition detected and ignition switch OFF
U0100	CAN communication signal circuit	<ul style="list-style-type: none"> ● Gear does not change ● Only possible to drive 1st or reverse gears after vehicle stops 	Either (a) or (b) met: (a) All of following conditions met: <ul style="list-style-type: none"> ● Pass condition detected ● Vehicle stopped ● Accelerator pedal released ● Brake pedal depressed (b) Pass condition detected and ignition switch OFF

*: Transmission gear: Actual transmission gear position

- The transmission control ECU identifies the actual transmission gear position through the signals from the shift stroke sensor and select stroke sensor.
- The transmission control ECU identifies the shift lever position through the signal from the shift lever position sensor.