TO INDEX

F5 TRANSMISSION CONTROL

AUTOMATIC TRANSAXLE (A4B)

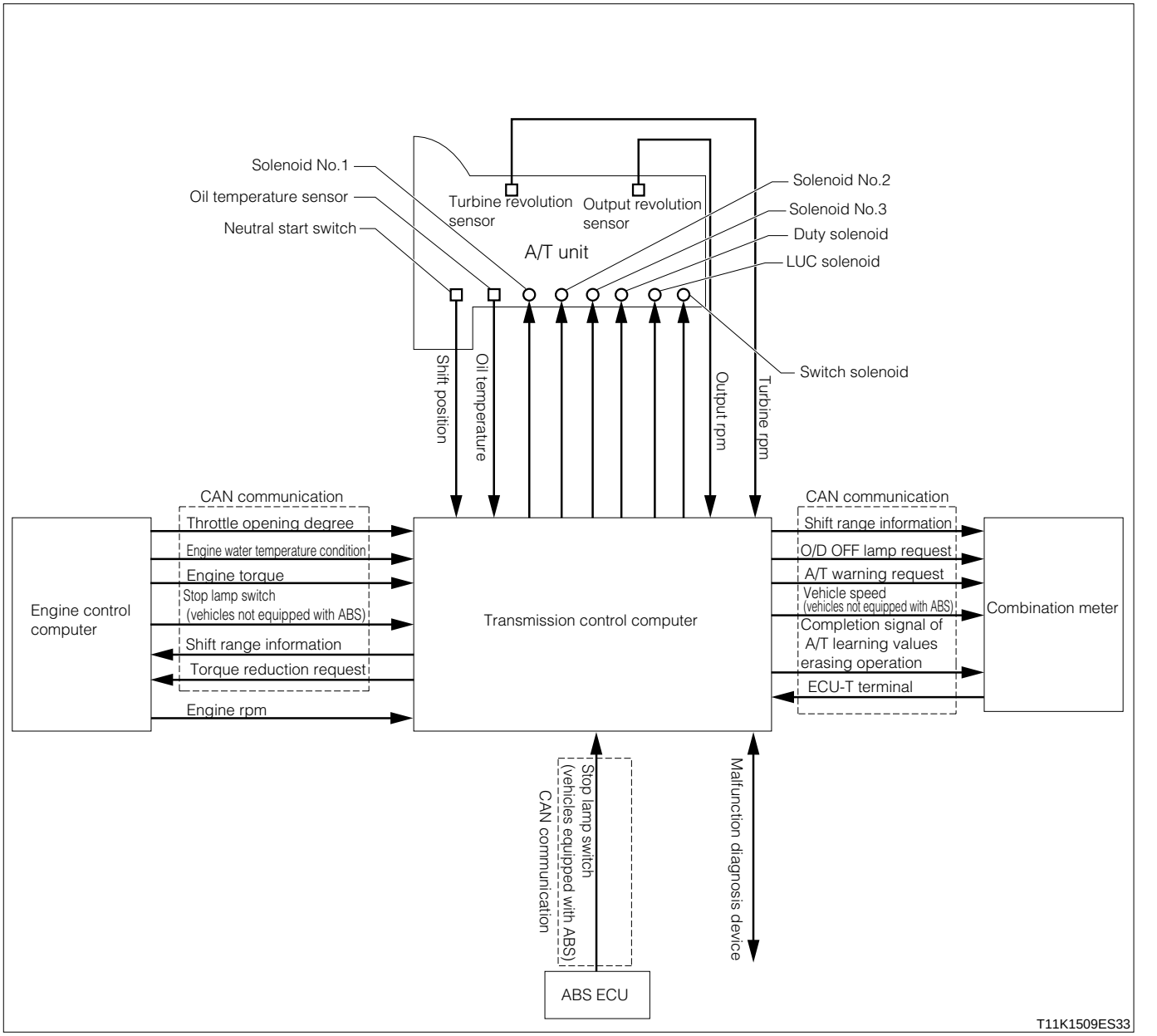
1 OUTLINE

1-1 DESCRIPTION

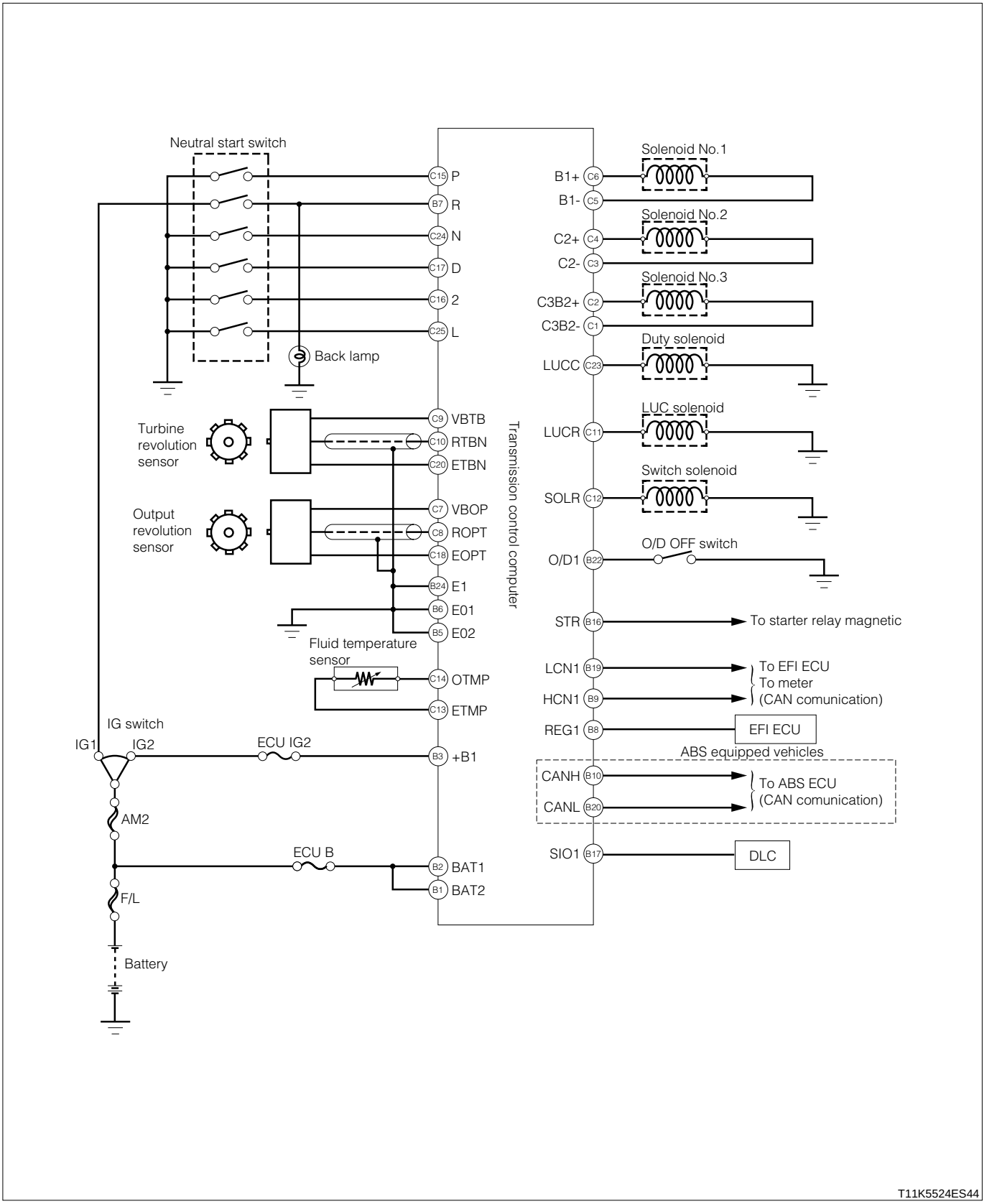
1.The transmission control system consists of the transmission control computer, sensors, switches, solenoid valves, etc. The transmission control system performs the gear shift control, clutch-to-clutch control, lockup control, etc.

2.For cases where the system encounters abnormality, there provided are the diagnosis function that informs the driver or mechanics of the abnormality and the failsafe function that assures the minimum running performance and system protection. Furthermore, for improved serviceability, the system is compatible with the diagnostic tester (DS−21).

1-2 SYSTEM DRAWING

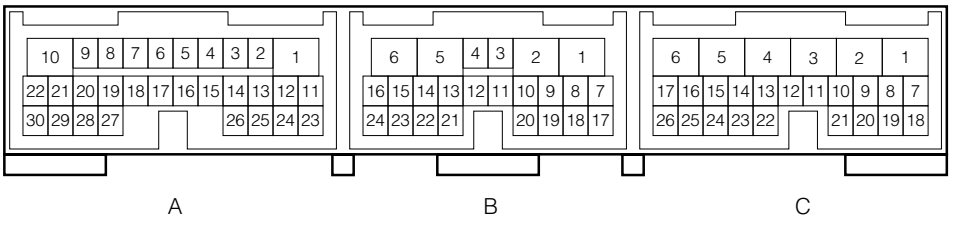


1-3 SYSTEM WIRING DIAGRAM



T11K5524ES44

Transmission control computer terminal name



T11K5006S10

1.Connectors A

This connector is not used.

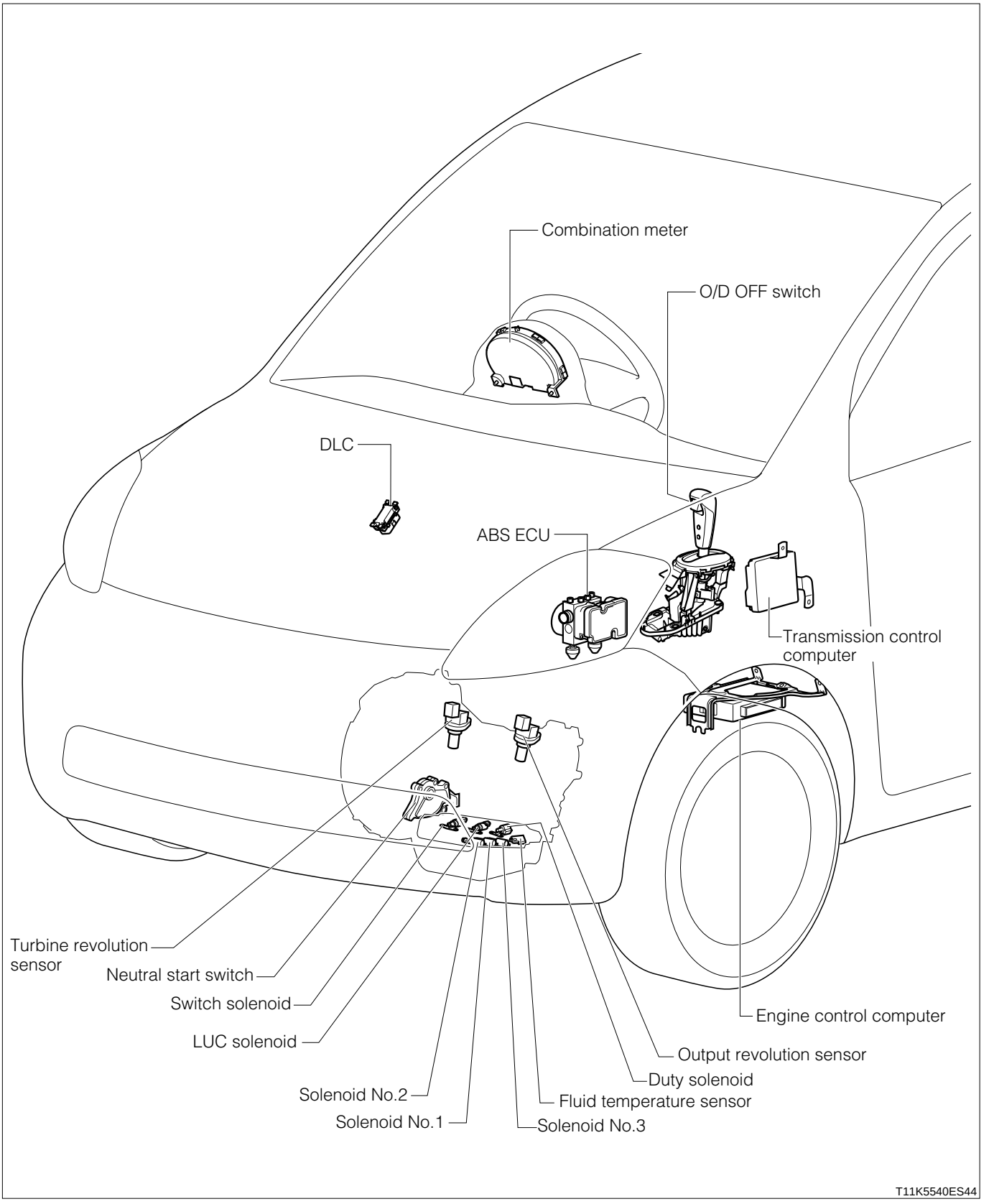
2.Connectors B

Terminal No.	Terminal code	Terminal name	Terminal No.	Terminal code	Terminal name
1	BAT2	Backup power supply	13	—	—
2	BAT1	Backup power supply	14	—	—
3	+B1	ECU power supply	15	—	—
4	—	—	16	STR	Starter relay output circuit
5	E02	A/T power system earth	17	SIO1	Diagnostic tester communication
6	E01	A/T power system earth	18	—	—
7	R	Neutral start switch (R)	19	LCN1	CAN communication LO (1)
8	REG1	Engine revolution speed	20	CANL	CAN communication LO (2)
9	HCN1	CAN communication HI (1)	21	—	—
10	CANH	CAN communication HI (2)	22	O/D1	O/D OFF switch
11	—	—	23	—	—
12	—	—	24	E1	Sensor earth

3.Connectors C

Terminal No.	Terminal code	Terminal name	Terminal No.	Terminal code	Terminal name
1	C3B2−	Solenoid No.3 (−)	14	OTMP	Fluid temperature sensor
2	C3B2+	Solenoid No.3 (+)	15	P	Neutral start switch (P)
3	C2−	Solenoid No.2 (−)	16	2	Neutral start switch (2)
4	C2+	Solenoid No.2 (+)	17	D	Neutral start switch (D)
5	B1−	Solenoid No.1 (−)	18	EOPT	Output revolution sensor earth
6	B1+	Solenoid No.1 (+)	19	—	—
7	VBOP	Output revolution sensor power supply	20	ETBN	Turbine revolution sensor earth
8	ROPT	Output revolution sensor	21	—	—
9	VBTB	Turbine revolution sensor power supply	22	—	—
10	RTBN	Turbine revolution sensor	23	LUCC	Duty solenoid
11	LUCR	LUC solenoid	24	N	Neutral start switch (N)
12	SOLR	Switch solenoid	25	L	Neutral start switch (L)
13	ETMP	Fluid temperature sensor	26	—	—

1-4 LOCATION OF COMPONENTS



2 CONTROL

2-1 RESTRICTIONS ON GEARSHIFTS

2-1-1 DESCRIPTION

1.The transmission control computer determines the optimum gear position and lockup ON/OFF according to the driving condition based on the signals from each sensor and drives each solenoid valve so as to perform gear shifting and lockup control.

2.The gear shifting pattern for each shift range and mode is as follows.

Gear shift and lockup pattern

Gear shift mode		Automatic gear shifting mode
Ⓓ	O/D ON	1⇄2⇄[3]⇄[4]
	O/D OFF	1⇄2⇄[3]←(4)
②		1⇄2←(3)←(4)
Ⓛ		1←(2)←(3)←(4)

·The brackets [ ] indicates that the lockup operation is possible. However, no operation takes place with the transmission fluid temperature is low.

· The parentheses ( ) indicates the low gear inhibitor control during a high-speed running.

2-1-2 DETERMINATION OF GEAR POSITION AND LOCKUP ON/OFF

(1) Automatic gear shifting mode

1.When the shift lever is at the Ⓓ, ② or Ⓛ range, the transmission control computer judges that the mode is the automatic shifting mode and determines the gear position and lock up ON/OFF according to the vehicle speed and throttle opening degree signal, based on the selected gear shift diagram.

2.

(2) Control of prohibition of low speed gear during high speed running

If a request of downshift is received due to the change in the shift range when running at a high speed, the current gear position is retained until the vehicle speed reaches below the set vehicle speed in order to prevent the engine from rotating at an excessively high speed.

(3) Rereverse inhibitor control

In order to avoid danger if the shifting is mistakenly made to Ⓡ range while running forward, the gear position is kept in the neutral position until the speed becomes below the set vehicle speed.

(4) Restrictions on gear shifting during low temperature

When the transmission oil temperature is still low immediately after the vehicle starts running at the time when the temperature is very low, the following restriction is provided for the gear shifting.

Restrictions on gear shifting during low temperature

Transmission oil temperature	Restrictions on gearshifts
Below −10℃	Shift to 3rd is prohibited.
Below 10℃	Shift to 4th is prohibited.

2-1-3 RESTRICTIONS ON GEARSHIFTS

(1) Description

Based on the current gear shift range and the target gear shift range that has been determined, the transmission control computer controls each solenoid valve of such solenoids as the solenoid No.1, solenoid No.2, solenoid No.3, duty solenoid, LUC solenoid and switch solenoid.

The operating condition of each solenoid valve at each gearshift range is as follows.

Solenoid operating table

	Solenoid No.1	Solenoid No.2	Solenoid No.3	Duty Solenoid	LUC solenoid	Switch solenoid
Ⓟrange neutral	×	○	○	○	×	○
Neutral	×	○	○	×	×	○
Reverse	×	○	× 2	×	×	○ 3
4th	○	○	× 2	× 1	× 1	×
3rd	×	×	× 2	× 1	× 1	×
2nd	○	×	○	×	×	○
1st(Ⓓ·②)	×	× 6	○	× 4	×	○ 5
1st(Ⓛ)	×	×	× 6	○	×	○
Remarks	○ = Energized condition, × = Not-energized condition 1: Lockup control condition after engagement○ 2: Line pressure-regulating condition after engagement○ 3: Line pressure-regulating condition after engagement× 4: During line pressure control when vehicle is parked with shift lever placed in D range○ 5: During line pressure control when vehicle is parked with shift lever placed in D range× 6: The control state when the vehicle is stopped is ○.					

(2) Clutch-to-clutch control

For smooth and good responding gearshift, the hydraulic pressures at the disengaging side clutch (brake) and the engaging side clutch (brake) are finely controlled at the same time during the gear shifting transient period, thus preventing the engine from racing and the planetary gear from being interlocked during the gear shifting transient period.

The transmission control computer performs the feedback control for the solenoid valve of the clutches (brakes) at the engaging side and disengaging side based on the engine torque information from the engine control computer and the transmission oil temperature so that the change in the turbine rotation speed may become the target change rate. In this way, the torque fluctuation of the output shaft can be made ideal.

By learning the hydraulic pressure at time of engagement according to the changes of the engine and transmission that occur as the time elapses, the control is automatically compensated, thus preventing changes in shift feeling that take place as the time elapses.

Refer to Page F3-13.

2-2 LOCKUP CONTROL

2-2-1 DESCRIPTION

By directly connecting the lockup clutch completely at the high speed vehicle zone, slipping of the torque converter is eliminated, thus increasing the transmission efficiency.
The ON/OFF of the lockup clutch is performed by controlling the LUC solenoid and duty solenoid.
When the lockup clutch is turned ON, the LUC solenoid is turned ON first. Then, the duty solenoid is controlled, and the hydraulic pressure at the disengagement side is controlled. In this way, the transmission torque capacity of the lockup clutch is controlled at the specified time gradient, thus preventing shocks at the time of actuation.
When the lockup clutch is turned OFF, the hydraulic pressure is applied gradually to the disengagement side by controlling the duty solenoid. When the lockup clutch is turned OFF, the LUC solenoid is turned OFF.

Refer to Page F3-3.

Lockup operation gearshift range

		1st	2nd	3rd	4th
Ⓓrange	Direct connecting control	×	×	○	○

○ = Operative, × = Inoperative

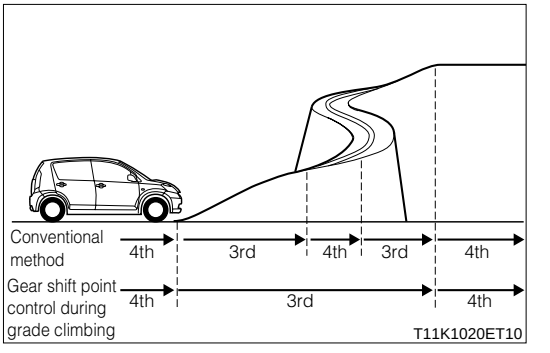
Solenoid operating condition

Lock up clutch	LUC solenoid	Duty solenoid
At time of OFF	×	×
At time of OFF⇄ON (Transient period)	○	◇
At time of ON (Direct connection control)	○	○

○ = Completely-energized condition, ◇ = During duty control, × = Not-energized condition

2-3 UPHILL GEAR SHIFT CONTROL

1. The uphill gear shift control performs control over the upshift to the 4th gear and switching of the lockup zone when driving on the uphill road which has up and down gradients. Thus, comfort driving can be possible during uphill driving without sacrificing fuel economy during running at a flat area.
2. The uphill driving is detected by comparing the vehicle acceleration on the flat road, which is obtained from the throttle opening degree, vehicle speed and gear range, with the actual acceleration obtained from the vehicle speed. If the uphill driving is detected, a gearshift to the 4th gear is prohibited and the lockup zone is switched. This removes frequent gear shifting between the 3rd gear and 4th gear, thus realizing smooth and comfort driving.
3. In order to give priority to the driver's will, the uphill gear shift control is performed only when the shift range is at the Ⓓ range and the O/D is turned ON.



2-4 ELECTRONIC LINE PRESSURE CONTROL

1.For improved fuel consumption, the load of the oil pump is reduced by regulating the line pressure at the time of the 3rd, 4th and reverse gears (after completion of gear shifting) and when the vehicle stops with the shift lever placed in the Ⓓ range.

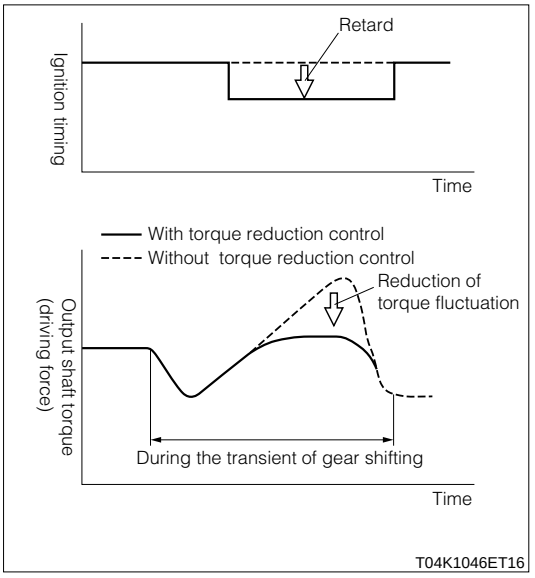
2.At the time of the 3rd, 4th and reverse gears (after completion of gear shifting), the line pressure is regulated according to the turbine torque. Moreover, the line pressure is regulated by the solenoid No. 3.

3.When the vehicle is parked with the shift lever placed in the Ⓓ range, the line pressure drops. Moreover, the drop in the line pressure will be achieved by turning ON the duty solenoid (duty ratio 100%) and turning OFF the switch solenoid.

2-5 TORQUE REDUCTION CONTROL

In order to reduce the fluctuation of the output shaft torque during gearshifts and reduce gear shifting shocks, the engine output torque is temporarily reduced by retarding the engine ignition timing during the gear shifting transient period, thus allowing the gearshift control elements (clutches and brakes) in the transmission to engage smoothly.

The engine timing is retarded when the transmission control computer outputs the torque reduction request signal to the engine control computer.



2-6 SQUIRT CONTROL

When starting off, if the shift lever is switched from Ⓝ range to Ⓓ (Ⓒ, Ⓛ) range with the accelerator fully closed and brake applied, a gearshift to the 2nd gear (N→2nd→1st) is temporarily made, thus avoiding sudden torque change and preventing the vehicle body from moving downward.

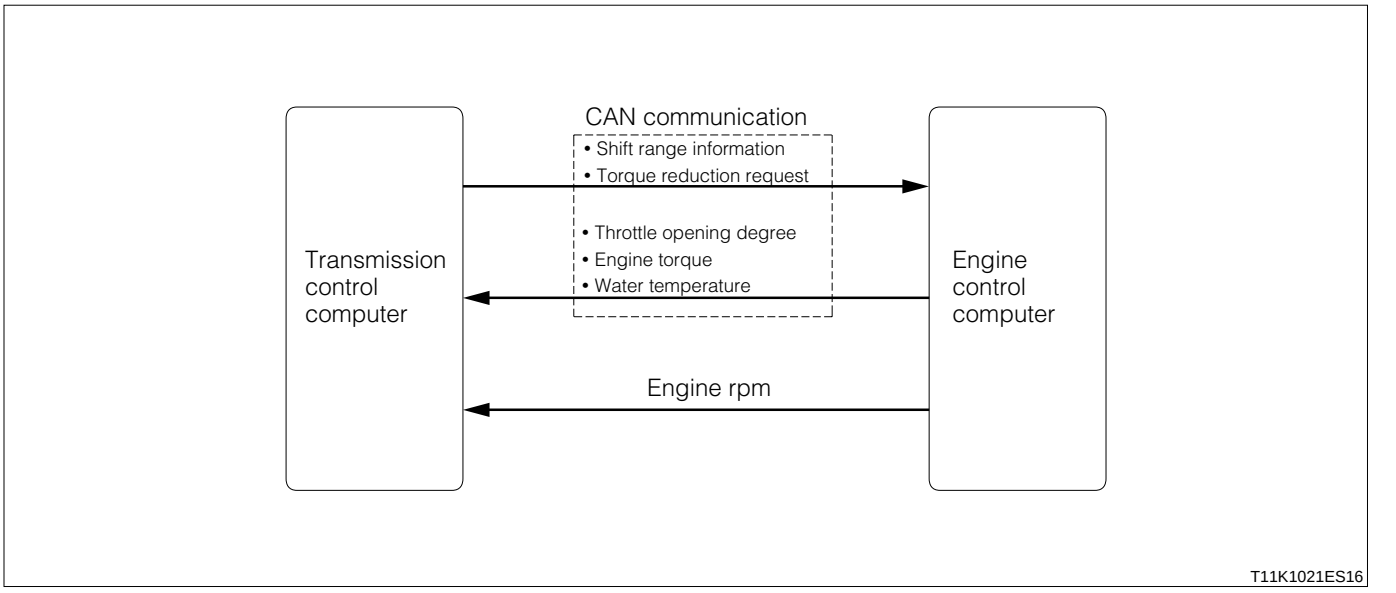
2-7 COMMUNICATION WITH ENGINE CONTROL COMPUTER

1.The transmission control computer performs communication with the engine control computer by means of two CAN communication lines and one serial communication line.

2.With regard to the input/output information by the CAN communication, refer to the section under "CAN communication."

Refer to Page F5-9.

3.The input information by the serial communication includes the engine revolution speed signal.



2-8 CAN COMMUNICATION

1.The transmission control computer performs input/output of some signals by means of the CAN communication for the engine control computer, ABS ECU and combination meter. The transmission control computer sends and receives the information and data for plural items by means of a pair of communication line (twist pair line).

For the details of the CAN communication, refer to the section under "CAN communication system".

Refer to Page L2-1.

2.The input information by the CAN communication with the engine control computer includes the throttle opening degree signal, engine torque signal, engine water temperature condition (warm up condition) signal, and stop lamp switch signal (only vehicles without ABS). The output information includes the shift range information signal, torque reduction request signal, and vehicle speed signal (only vehicles without ABS).

3.As regards the input information by the CAN communication with the ABS ECU, there is information, such as the stop lamp switch signal.

4.The input information by the CAN communication with the combination meter includes the ECU—T terminal signal, etc. The output information includes the shift range information signal, O/D OFF lamp request signal, A/T warning request signal and A/T learning value deletion completion signal.

5.As for the list of principle CAN communication signals, refer to the section under "Communication data of CAN communication system."

Refer to Page L2-10.

2-9 DIAGNOSIS (ONBOARD DIAGNOSIS FUNCTION)

2-9-1 DESCRIPTION

This trouble diagnosis function informs the inspector of abnormality items by means of a computer if abnormality occurs in the input/output sections of the system. The diagnosis items have 25 items, including six solenoid checking items that are done during the normal state. If abnormality takes place, the computer memorizes abnormality items. This memorizing is done directly by the battery power. Therefore, even if the IG switch is set to the ACC or LOCK position, the diagnosis result remains memorized. If abnormality takes place in the important items during running, a warning function will inform the driver of the abnormality.

CAUTION

- Certain items only are not memorized.

2-10 FAIL-SAFE FUNCTION

This is the function which performs controlling to keep the best possible running ability even if abnormality takes place in the input/output signal system of the transmission control computer.
When the system has resumed the normal state after detecting abnormality once, the failsafe function is released, but the diagnosis result remains. (except certain codes)
The warning lamp (O/D OFF lamp) is made to flash while the failsafe function is operating. (except certain functions)

Fail-safe specifications

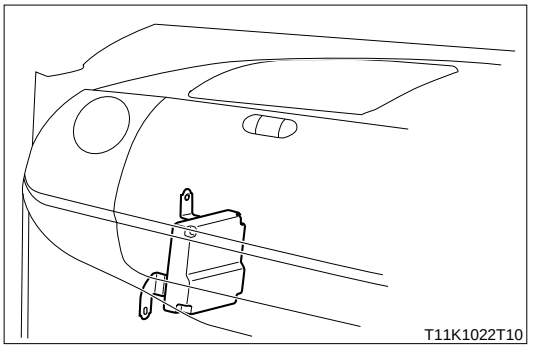
Contents of malfunctions	Contents of fail-safe control	Failsafe control release condition
Battery system power supply abnormality	The gear is fixed to the 3rd gear after malfunction is detected.	After resuming the normal state, released when the IG SW is set once to ACC or LOCK position.
Sensor system power supply abnormality	The gear is fixed to the 3rd gear after malfunction is detected.	After resuming the normal state, released when the IG SW is set once to ACC or LOCK position.
Abnormal engine torque	· The engine torque is set to a constant value. · When a malfunction is detected, a gearshift to the 3rd gear takes place. Then, gear shifting between the 1st — 3rd gears take place according to the vehicle speed and throttle opening angle.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
No turbine rotation input	The gear is fixed to the 3rd gear when malfunction is detected. Then, 1—3 gearshift is performed depending upon the vehicle speed and throttle opening degree.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
Open circuit and short circuit of oil temperature sensor circuit	The gear is fixed to the 3rd gear when malfunction is detected. Then, 1—3 gearshift is performed depending upon the vehicle speed and throttle opening degree.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
Throttle sensor abnormality	· The throttle opening angle is set to a constant value. · When a malfunction is detected, a gearshift to the 3rd gear takes place. Then, gear shifting between the 1st — 3rd gears take place according to the vehicle speed.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
No output rotation input	· When the sensor system is malfunctioning, the gear is set to the one employed at the time of the malfunction detection. Then, when the vehicle stops once, the gear is set to the 1st gear. · When the A/T main body is malfunctioning, the gear is set to the 1st gear.	· When the sensor system is malfunctioning, after it returns to the normal condition, the releasing will take place when the vehicle speed drops to 0 km/h with the shift lever placed in the P or N range. · When the A/T main body is malfunctioning, after it returns to the normal condition, the releasing will take place when the IG SW is set to the "ACC" or "LOCK" position once.
Neutral start switch no input	The normal gear shift control is performed with the shift position set to D range.	The fail-safe function is released when the system returns to the normal condition.
Neutral start switch multiplex input	The normal gear shift control is performed with the shift position set to D range.	The fail-safe function is released when the system returns to the normal condition.

Open wire and short circuit of solenoid No.1 circuit	· The energizing to the solenoid judged to be malfunctioning will be prohibited. · At the time of short circuit, a gearshift to the 3rd gear will take place. Then, gear shifting between the 1st — 3rd gears take place according to the vehicle speed and throttle opening angle, using the normal solenoid. However, in the case of short circuit of the No. 3 solenoid and switch solenoid, the gear will be set to the 3rd gear. · In the case of open wire and when plural solenoids are malfunctioning, the gear will be set to the 3rd gear.	After resuming the normal state, released when the IG SW is set once to ACC or LOCK position.
Open wire and short circuit of solenoid No.2 circuit		
Open wire and short circuit of solenoid No.3 circuit		
Open wire and short circuit of duty solenoid circuit		
Open wire and short circuit of LUC solenoid circuit		
Open wire and short circuit of switch solenoid circuit		
The lockup rotation speed does not match.	The lockup is prohibited.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
Abnormal signal receiving of communication line with EFI	· The throttle opening angle and engine torque are set to constant values. · When a malfunction is detected, a gearshift to the 3rd gear takes place. Then, gear shifting between the 1st — 3rd gears take place according to the vehicle speed.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
Abnormal signal sending of communication line with EFI	· The throttle opening angle and engine torque are set to constant values. · When a malfunction is detected, a gearshift to the 3rd gear takes place. Then, gear shifting between the 1st — 3rd gears take place according to the vehicle speed.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.
No engine rotation input	The gear is fixed to the 3rd gear when malfunction is detected. Then, 1—3 gearshift is performed depending upon the vehicle speed and throttle opening degree.	After resuming the normal state, released at the vehicle speed of 0 km/h in P or N range.

3 COMPONENTS

3-1 TRANSMISSION CONTROL COMPUTER

The transmission control computer is located at the front pillar lower inner panel at the front passenger seat side.



3-2 TURBINE REVOLUTION SENSOR , OUTPUT REVOLUTION SENSOR

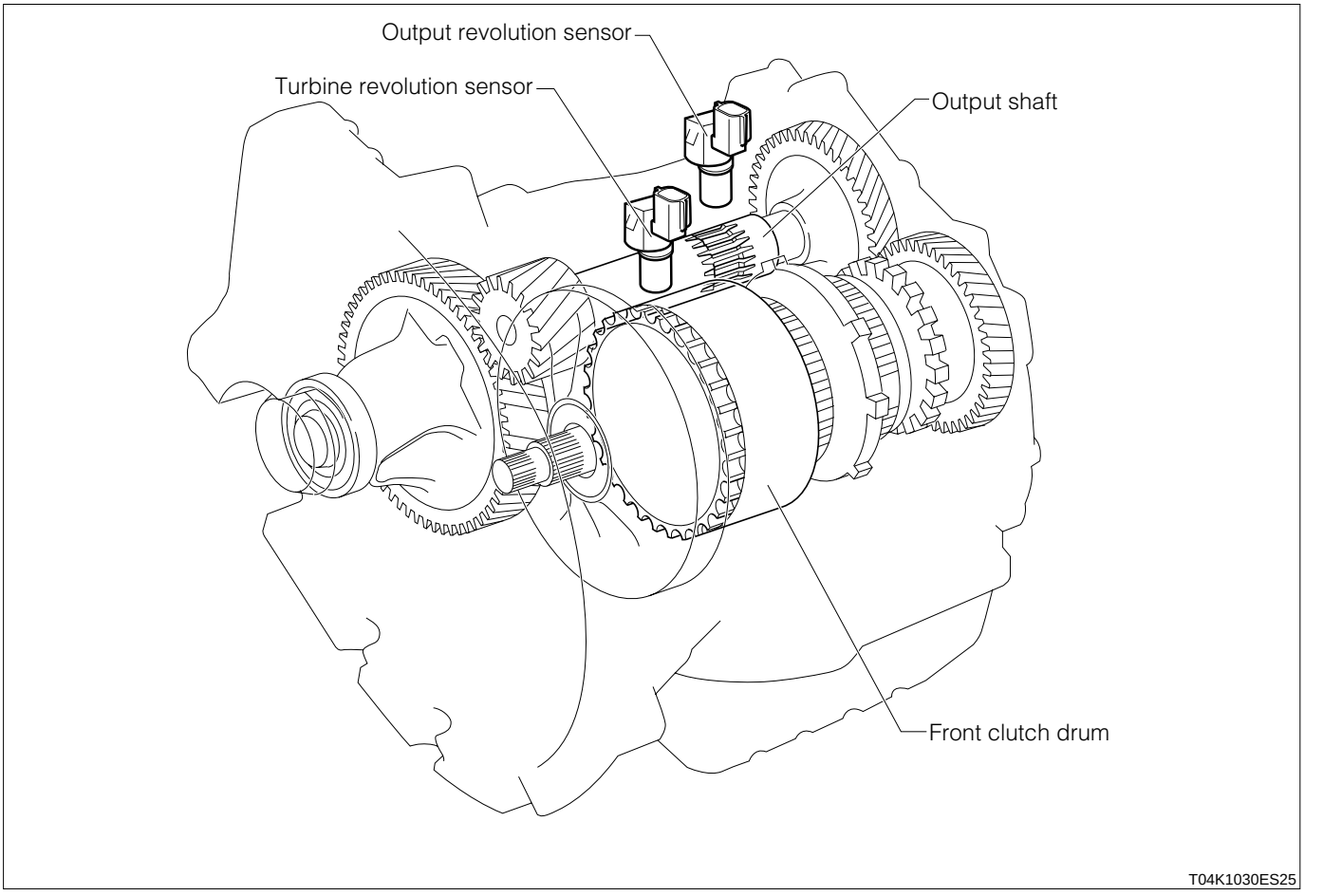
3-2-1 DESCRIPTION

The turbine revolution sensor and output revolution sensor are installed at the upper section of the transaxle case.

The revolution sensor employs the magnetic type revolution sensor which utilizes the Hall element, thus making it possible to detect the rotation speed accurately.

The turbine revolution sensor detects the rotation speed of the front clutch drum (number of sensor rotor teeth: 30).

The output revolution sensor detects the rotation speed of the output shaft (number of sensor rotor teeth: 20).

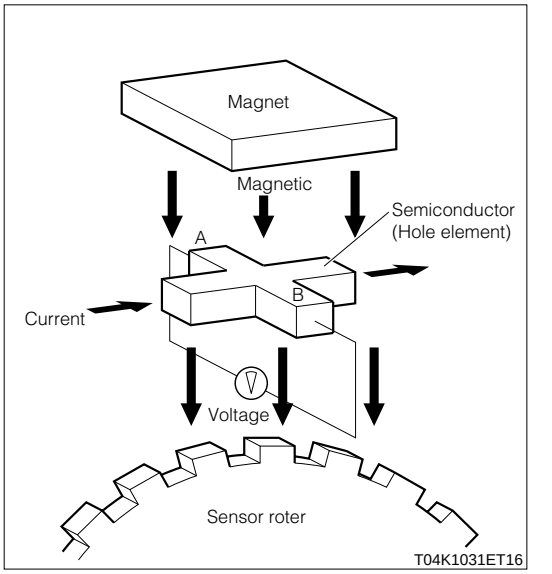


3-2-2 OPERATING PRINCIPLE

The revolution sensor consists of the Hall element and magnet and has a built-in processing circuit.

The Hall element has such characteristics that a voltage is produced in a direction perpendicular to the current and magnetic field (AB in the figure) when a magnetic field in the vertical direction is applied with the current flowing. The produced voltage is proportional to the magnitude of the magnetic field.

The revolution sensor uses this characteristics. Because of the change in magnetic field = change in voltage that is caused by the rotation of the sensor rotor, the transistor in the processing circuit is turned ON and OFF, thus outputting rotation signals (square waves).



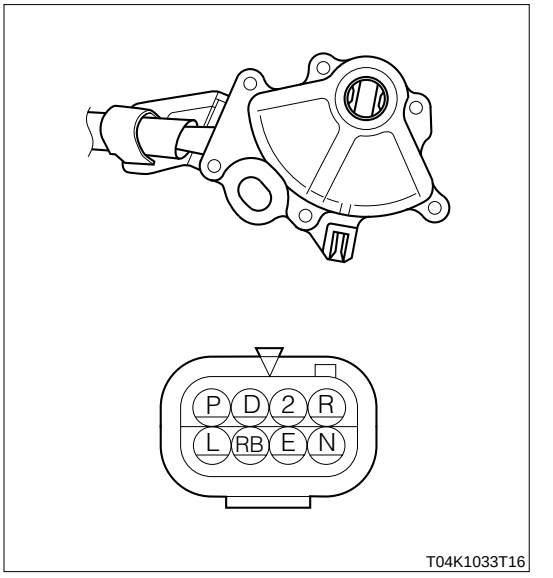
3-3 ENGINE REVOLUTION SPEED SIGNAL

The engine rotation signal is inputted from the engine control computer to the transmission control computer. The signal waveforms are square waves. Six pulses are emitted per engine rotation.

3-4 NEUTRAL START SWITCH

The neutral start switch, which is provided at the transaxle case, detects the shift lever position (P·R·N·D·2·L).

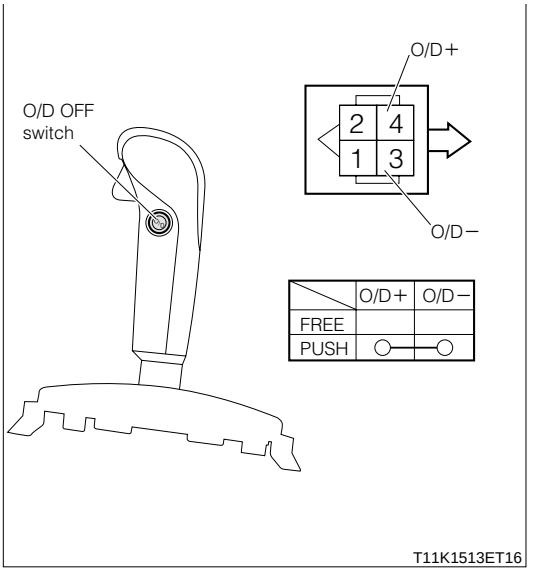
Through the indication at the LCD (liquid crystal display) of the combination meter, the current shift lever position is indicated to the driver.



3-5 O/D OFF SWITCH

The O/D OFF switch is provided at the shift lever knob section.

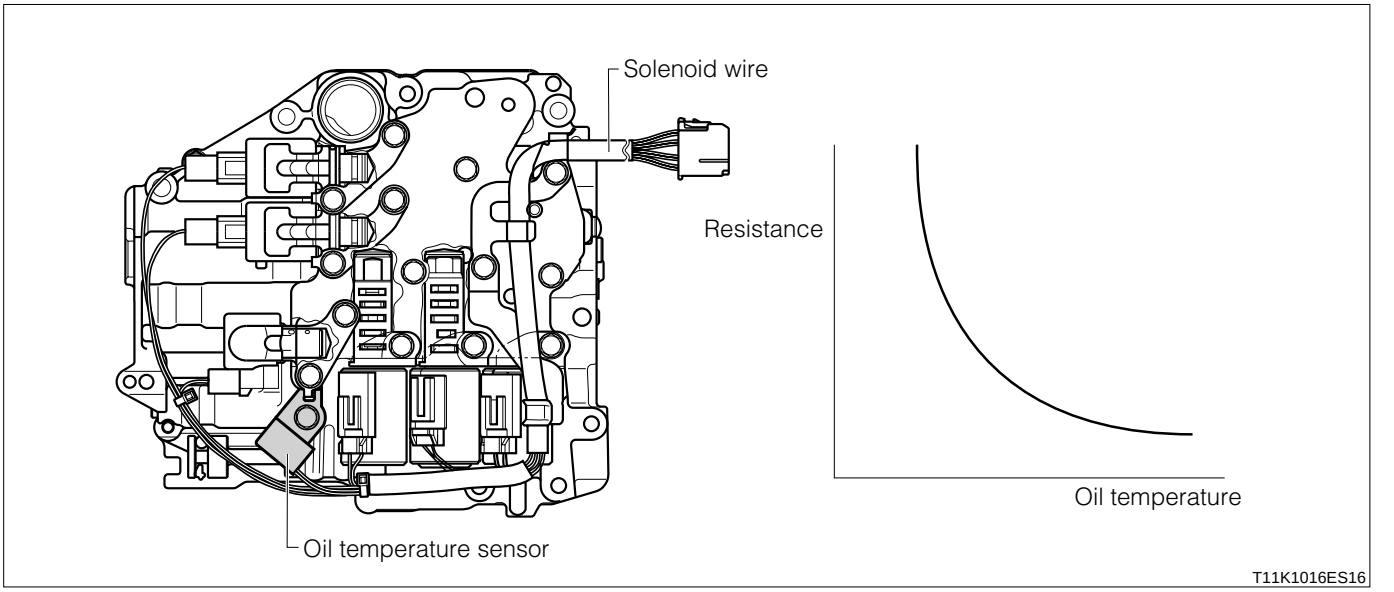
This switch is a pushbutton switch which is turned ON only when it is pressed. Every time it is turned ON, the state changes between the O/D OFF and O/D ON.



3-6 OIL TEMPERATURE SENSOR

The oil temperature sensor is provided at the lower section of the valve body. This sensor senses the transmission oil temperature.

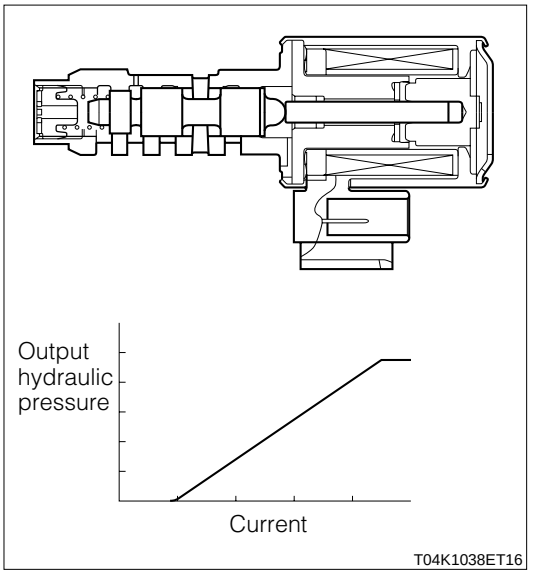
The hydraulic temperature sensor is integral with the solenoid wire.



3-7 SOLENOID NO.1

The solenoid No.1 is a linear type solenoid valve in which the solenoid section is integral with the pressure regulating valve. The plunger at the solenoid section pushes the pressure regulating valve to provide a hydraulic pressure which is proportional to the magnitude of the current.

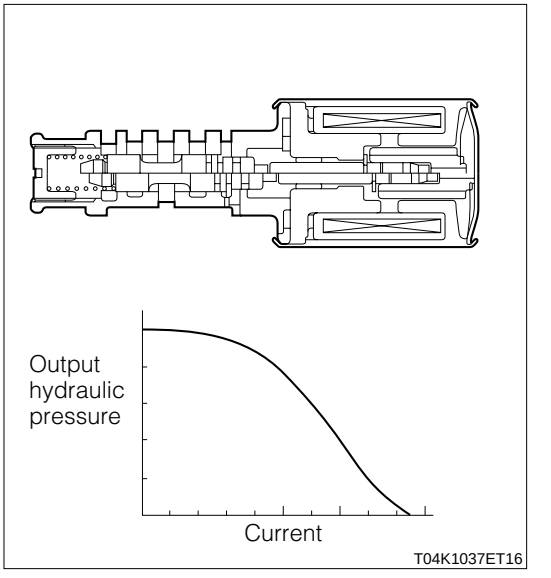
The hydraulic pressure characteristics are the normal close type (the output hydraulic pressure is zero when the current is zero).



3-8 SOLENOID NO.2 , SOLENOID NO.3

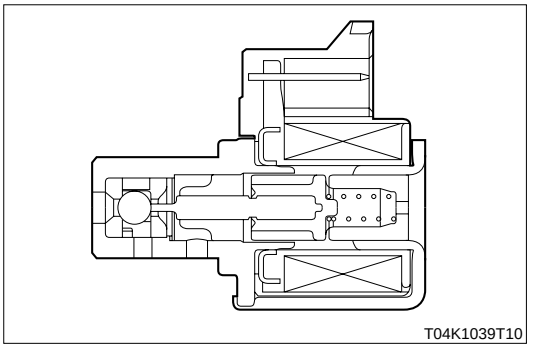
The solenoid No.2 and solenoid No.3 are linear type solenoid valves in which the solenoid section is integral with the pressure regulating valve. The plunger at the solenoid section pushes the pressure regulating valve to provide a hydraulic pressure which is proportional to the magnitude of the current.

The hydraulic pressure characteristics are the normal open type (the output hydraulic pressure is the maximum when the current is zero).



3-9 DUTY SOLENOID

The duty solenoid is a duty type solenoid valve which opens/closes the oil passage by means of the duty signal, thus regulating the pressure.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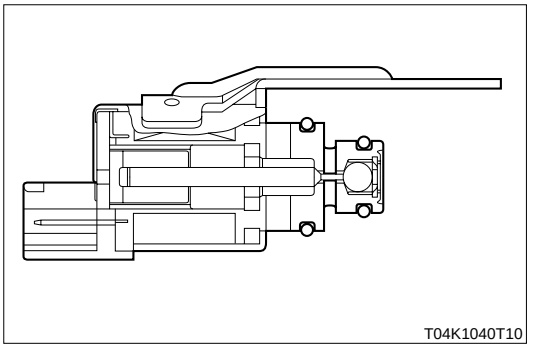
3-10 LUC SOLENOID , SWITCH SOLENOID

Using the three-way ON/OFF switch solenoid valve, the LUC solenoid and switch solenoid open the oil passage to apply the hydraulic pressure when the voltage is turned ON. When the voltage is turned OFF, they close the oil passage and release the hydraulic pressure that has been applied.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