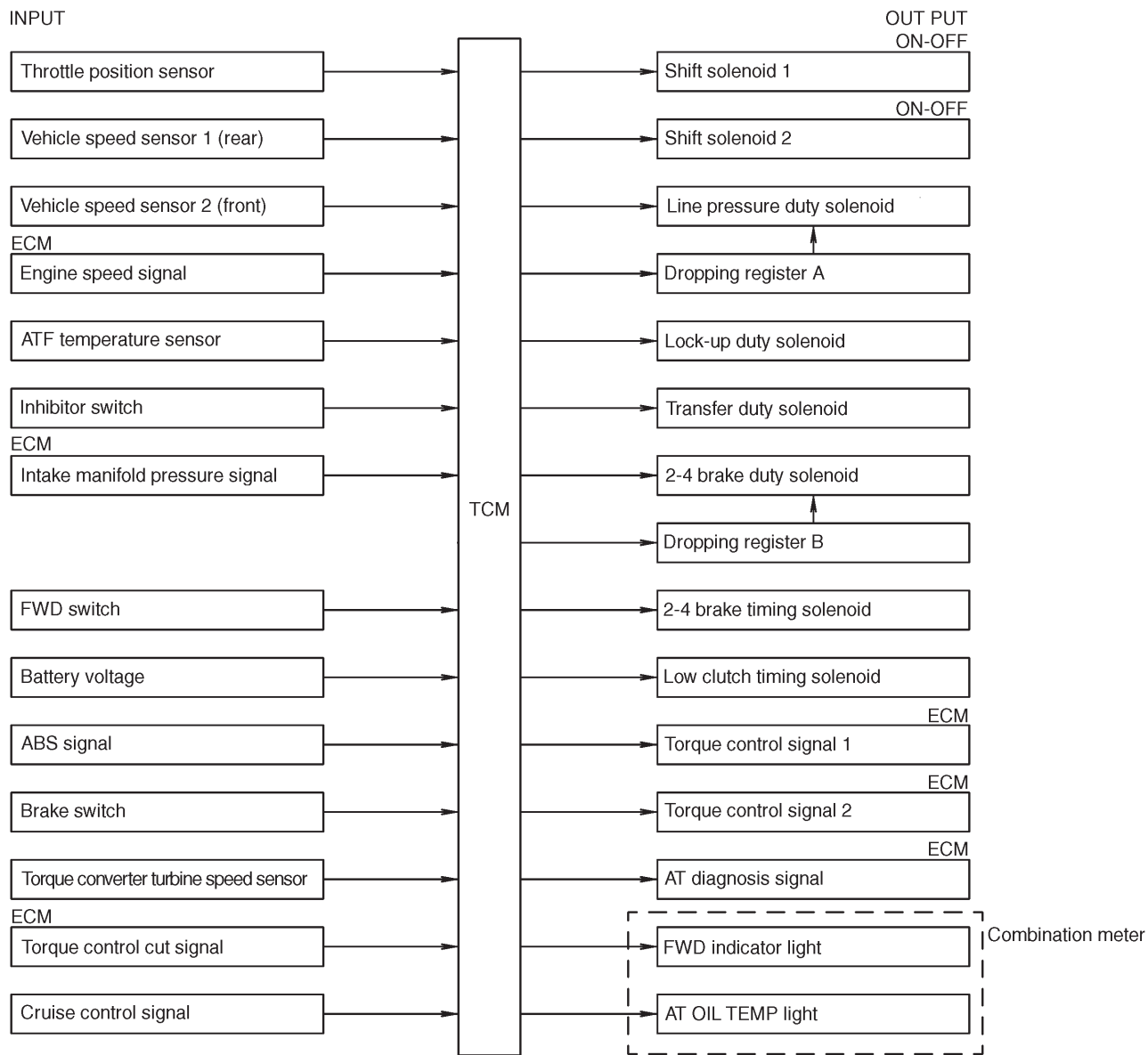


3-2 [M11A0] MECHANISM AND FUNCTION
 11. Electronic-Hydraulic Control System

11. Electronic-Hydraulic Control System

A: GENERAL

The electronic-hydraulic control system consists of various sensors and switches, a transmission control module (TCM) and the hydraulic controller including solenoid valves. The system controls the transmission proper including shift control, lock-up control, timing control, reverse inhibit control, engine control, line pressure control, auto pattern select control and shift timing control. It also controls the AWD transfer clutch. In other words, the system detects various operating conditions from various input signals and sends output signals to shift solenoids 1 and 2, low clutch timing solenoid, 2-4 brake timing solenoid, line pressure, lock-up, transfer and 2-4 brake duty solenoids (a total of eight solenoids).



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MECHANISM AND FUNCTION**[M11B0] 3-2**

11. Electronic-Hydraulic Control System

B: INPUT SIGNAL

Signal name	Major function
Throttle position sensor	Detects throttle position and determines shift point, line pressure and lock-up vehicle speed according to engine load.
Vehicle speed sensor 2 (front) (mounted to transmission)	Detects vehicle speed. This signal is used to control shifting, lock-up, line pressure, and transfer clutch.
Vehicle speed sensor 1 (rear) (mounted to extension case)	Used to control transfer clutch and as backup in case of failure of vehicle speed sensor 2.
Engine speed signal	Detects engine speed. This signal is used for lock-up clutch smooth, control at lock-up.
Inhibitor switch	Used to determine shifting and line pressure for respective ranges "P", "R", "N", "D", "3", "2" and "1".
ATF temperature sensor	Detects ATF temperature. This signal is used for inhibition of lock-up, release of OD and detection of ATF temperature.
FWD switch	Used to change the mode from AWD to FWD. Also used to adapt the vehicle to FWD tester roller. Changeover from AWD to FWD can be accomplished by inserting a fuse into the fuse holder.
ABS signal	When ABS is operating, to optimize ABS control, transfer clutch torque is controlled to eliminate the influence of engine braking and reduce the degree of coupling between front and rear wheels.
Cruise control signal	Detects operation of cruise control, and expands "4th" operating range.
Intake manifold pressure signal	Used to determine line pressure of shift change.
Torque converter turbine speed sensor	Tells the rotation speed of the input shaft. The proportion of this speed to the vehicle speed determines whether shifting should be made or not.
Torque control cut signal	Sent from ECM to TCM to inhibit the torque control.

3-2 [M11C0]**MECHANISM AND FUNCTION****11. Electronic-Hydraulic Control System****C: OUTPUT SIGNAL**

Signal name	Function
Shift solenoids 1, 2	Controls shift stage by turning solenoid ON/OFF. Relationship between solenoid operation and shifting stage is shown in Table below. When shifting, timing is controlled for each solenoid to reduce shock.
Line pressure duty solenoid	Regulates the line pressure according to driving conditions.
Lock-up duty solenoid	Regulates the hydraulic pressure of the lock-up clutch and operates in three modes (open, smooth and lock-up).
Transfer duty solenoid	Regulates the hydraulic pressure of the transfer clutch and controls the driving force to the rear drive shaft.
AT OIL TEMP light	Lights when ATF becomes hot (exceeds a set temperature level). This light is also used for "on-board diagnostics".
2-4 brake duty solenoid	Regulates 2-4 brake duty pressure when 2-4 brake is operated to reduce shifting shocks.
2-4 brake timing solenoid	Switches on or off the pressure acting on 2-4 brake timing valve B to control the release timing of the 2-4 brake
Low clutch timing solenoid	Switches on or off the pressure acting on the low clutch timing valve B to control the release timing of the low clutch. Also switches on or off the pressure acting on the reverse inhibit valve to control the reverse inhibit function.
Torque control signal 1	Reduces engine torque at racing select and gear change.
Torque control signal 2	Reduces engine torque at racing select and gear change.

MECHANISM AND FUNCTION**[M11D0] 3-2**

11. Electronic-Hydraulic Control System

D: CONTROL ITEM

Control item		Description of control		
Transmission control	Gear shift control	Normal shift control ● Normal pattern ● Power pattern	Upshifting and downshifting are set for each range, gear position and pattern according to throttle position and vehicle speed.	
		Control with ABS	Gear is locked in 3rd position when ABS signal enters.	
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.	
	Automatic pattern select control	Power pattern control	Power pattern is selected when throttle opening change speed exceeds the preset value.	
		Normal pattern control	When throttle opening is less than the preset value normal pattern is resumed.	
	Lock-up control	Normal lock-up control	Lock-up ON/OFF is set for 4th gear, gear position, and pattern according to throttle position and vehicle speed. (Basically lock-up is OFF during gear shifting.)	
		Smooth control	Smooth lock-up is performed when lock-up is switched on.	
	Line pressure control	Ordinary control	Line pressure is regulated according to throttle position, vehicle speed and range signals.	
		Shifting control	Line pressure is regulated when shifting to lessen shifting shock.	
		Starting control	Line pressure is at a minimum so as to reduce engine cranking load.	
	Shift timing control	Shift step control	ON/OFF timing for shift solenoid is controlled.	
		Lock-up control	When shifting, the lock-up clutch is temporarily released.	
		Line pressure control	When shifting, line pressure is controlled to the optimum level so as to reduce shifting shock.	
	AWD transfer clutch control	Ordinary transfer control		Transfer oil pressure is regulated according to the throttle position angle and vehicle speed.
		1st range control		Transfer oil pressure is increased.
Slip control		Immediately after detecting a slip, transfer oil pressure is controlled to the same pressure as 1st range. (This control is canceled if $V \geq 60$ km/h (37 MPH), or when throttle is closed fully.)		
Control it turns		Transfer oil pressure is reduced after detecting the turn.		
ABS control		Transfer oil pressure is adjusted to set level immediately after reception of ABS signal.		

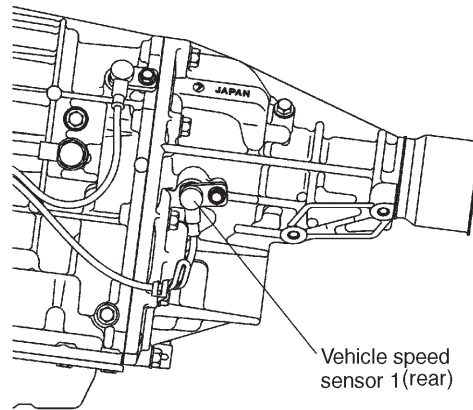
3-2 [M11E0]**MECHANISM AND FUNCTION****11. Electronic-Hydraulic Control System**

E: THROTTLE POSITION SENSOR

The throttle position sensor provides electrical signals corresponding to the throttle position. The throttle position and accelerator depression speed are detected by this throttle position sensor output.

F: VEHICLE SPEED SENSOR 1 (REAR)

The vehicle speed sensor (output shaft rotation sensor) is mounted to the extension case (from the outside of the case). It detects the rear wheel speed based on the peripheral speed of the transfer clutch drum and sends sine wave signals (30 pulses per rotation) to TCM.

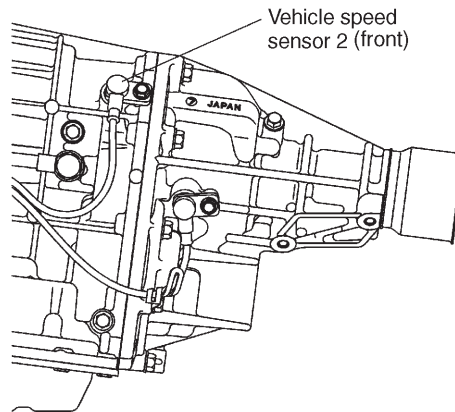


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G: VEHICLE SPEED SENSOR 2 (FRONT)

The vehicle speed sensor (output shaft rotation sensor) is mounted to the transmission case (from the outside of the case). It detects the front wheel speed and sends sine wave signals (16 pulses per rotation) to TCM.

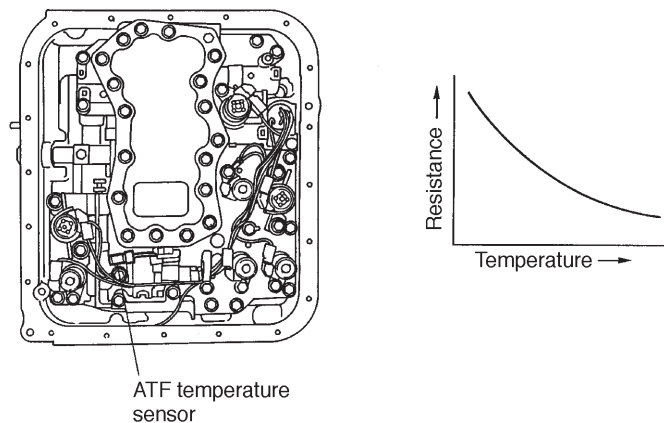
The TCM converts the signals into 4-pulse normal wave signals and outputs them to the engine control module (ECM) and the combination meter.



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H: ATF TEMPERATURE SENSOR

This sensor is mounted to the control valve in the transmission. It detects temperature change as an analog electrical signal. The output characteristics of the sensor are shown below.



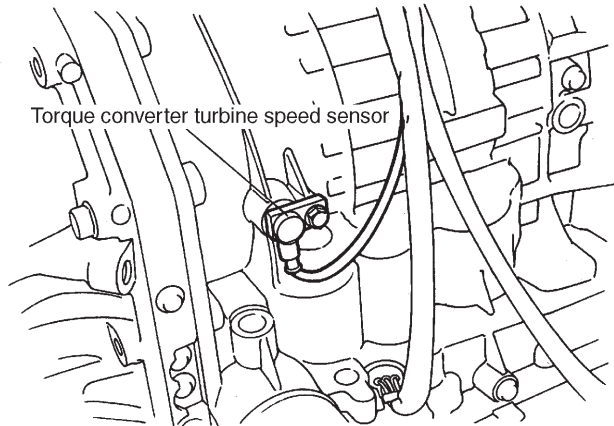
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3-2 [M1110]**MECHANISM AND FUNCTION****11. Electronic-Hydraulic Control System**

I: TORQUE CONVERTER TURBINE SPEED SENSOR

The torque converter turbine speed sensor (output shaft rotation sensor) is mounted to the transmission case (from the outside of the case).

The sensor reads the rotation speed of the periphery of the high clutch drum coupled to the input shaft, and sends sine wave signals (32 pulses per rotation) to the TCM. The TCM calculates the proportion of the input shaft speed to the vehicle speed and determines whether the shifting is to be made or not.



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J: INHIBITOR SWITCH

The inhibitor switch assures safety when starting the engine. This switch is mounted on the right side of the transmission case, and is operated by the range selector lever.

When the selector lever is set to "P" or "N", the electrical circuit is connected in the inhibitor switch and the starter circuit is energized for cranking the engine.

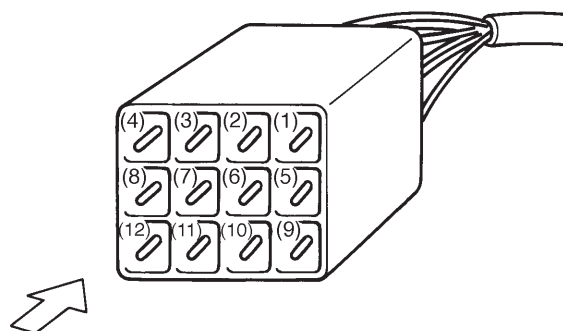
When the selector lever is set to "R", "D", "3", "2", or "1" range, the electrical circuit is disconnected in the inhibitor switch. Hence engine cranking is disabled. In the "R" range, the backup light circuit is completed in the switch, and the backup lights come on.

In addition to the above function, the inhibitor switch incorporates a circuit for detecting the selected range position and sending the range signal to the TCM.

MECHANISM AND FUNCTION

[M11K0] 3-2
11. Electronic-Hydraulic Control System

Inhibitor switch side connector

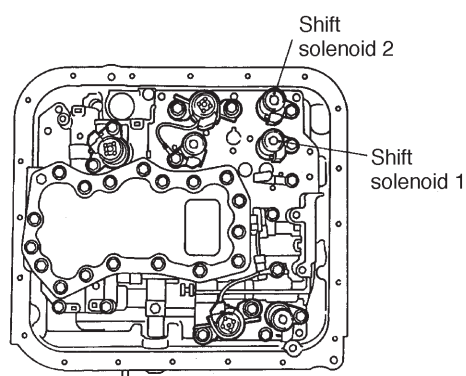


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Range position	Pin No.
P	(4) - (3) (12) - (11)
R	(4) - (2) (10) - (9)
N	(4) - (1) (12) - (11)
D	(4) - (8)
3	(4) - (7)
2	(4) - (6)
1	(4) - (5)

K: SHIFT SOLENOID 1 AND 2

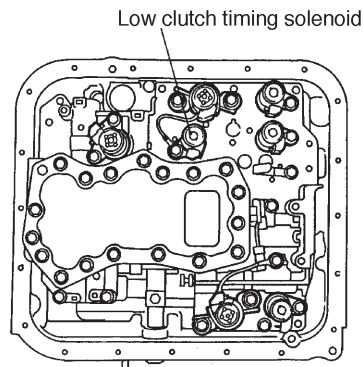
These solenoids are mounted to the control valve. They are turned ON or OFF according to signals sent from the TCM. The gear positions are changed according to the ON and OFF condition of these solenoids.



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3-2 [M11L0]**MECHANISM AND FUNCTION****11. Electronic-Hydraulic Control System****L: LOW CLUTCH TIMING SOLENOID**

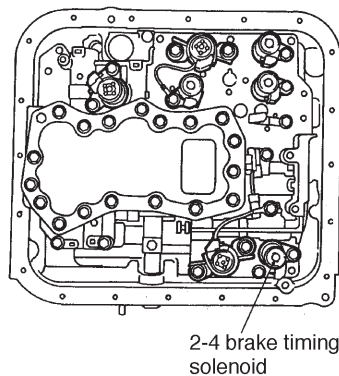
This solenoid is mounted to the control valve, and it is turned ON or OFF according to the signal sent from the TCM. It then controls the low clutch timing valve B and reverse inhibit valve.



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M: 2-4 BRAKE TIMING SOLENOID

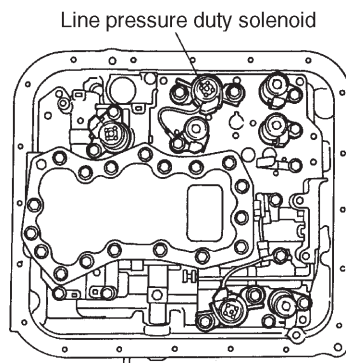
This solenoid is mounted to the control valve, and it is turned ON or OFF according to the signal sent from the TCM. It then controls the 2-4 brake timing valve B for decreasing the change gear shock.



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N: LINE PRESSURE DUTY SOLENOID

This solenoid is mounted to the control valve, and its duty ratio is controlled by the signal sent from TCM. This solenoid then controls the pressure modifier valve and accumulator control valve A to adjust the line pressure to an optimum pressure level suitable for operating conditions.

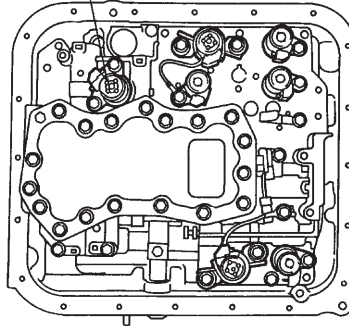


B3H0994G

O: LOCK-UP DUTY SOLENOID

This solenoid is mounted to the control valve, and its duty ratio is controlled by the signal sent from TCM. It then controls the lock-up control valve to provide smooth engagement and disengagement of the lock-up clutch.

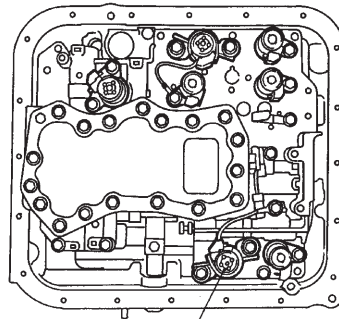
Lock-up duty solenoid



B3H0994H

P: 2-4 BRAKE DUTY SOLENOID

This solenoid is mounted to the control valve, and its duty ratio is controlled by the signal sent from TCM. It modulates the 2-4 brake duty pressure when the 2-4 brake is operated, reducing shifting shocks.

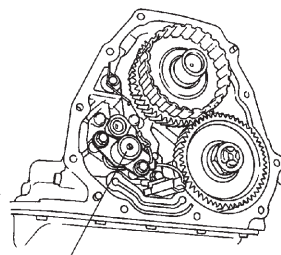


2-4 brake duty solenoid

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Q: TRANSFER DUTY SOLENOID

This solenoid is mounted to the transfer control valve on the rear end of transmission case, and its duty ratio is controlled by the signal sent from TCM. It then controls the transfer control valve for controlling the transfer clutch hydraulic oil pressure.



Transfer duty solenoid

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