

BMW ZF 5-HP-19

By Bob Chernay
Technical Editor

The ZF 5-HP-19 series transmission (See Figure 1) is manufactured in Germany by ZF.

The 5-HP-19 is an electronically controlled five-speed automatic transmission with a converter clutch. Two planetary gearsets, one Ravigneaux gearset and one standard planetary gearset on the output side, four rotating multiple-disc clutches, three multiple-disc brake clutches and one sprag clutch (freewheel) are used to provide the five forward speeds and reverse.

This unit is found in:

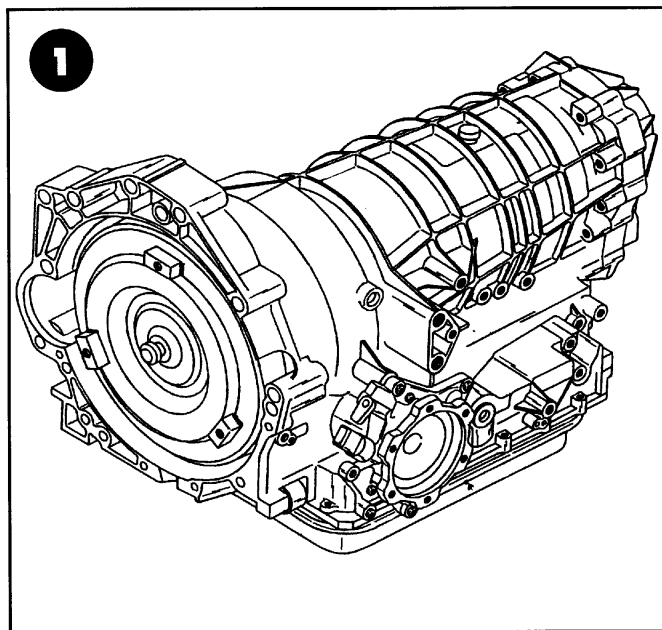
BMW '97-current, 3 Series E46, 5 Series 39, 7 Series E38

Audi '95-current, A4, A8

Audi '97-current, A6

Porsche Boxster 1996-1997

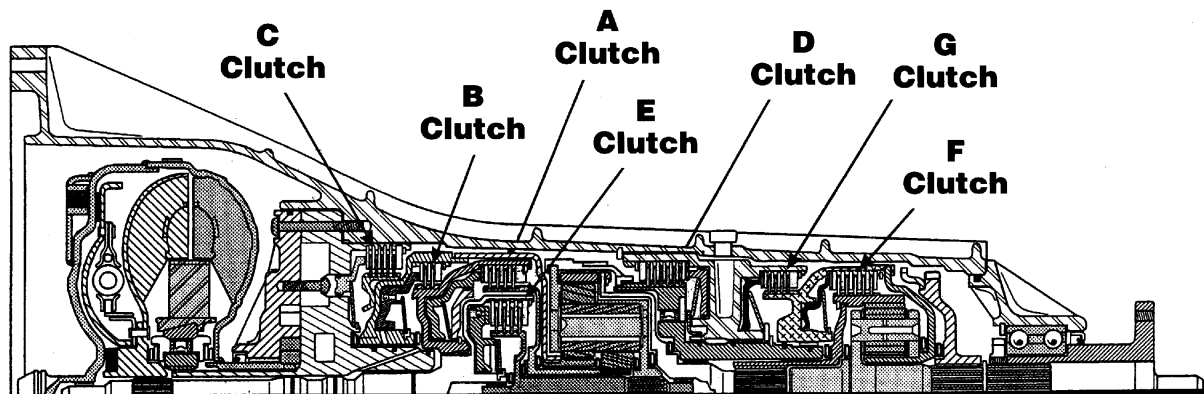
VW Passat '96 - current.



In Figure 2, we have provided a clutch and brake-clutch application chart for the 5-HP-19.

ZF 5-HP-19 Clutch and Brake-Clutch Application Chart

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Range	A Clutch	B Clutch	C Clutch	D Clutch	Low Sprag	E Clutch	F Clutch	G Clutch	Gear Ratio	Conv Clutch
Park								On		
Reverse		On		On				On	4.08	
Neutral								On		
D-1st	On				Hold			On	3.66	
D-2nd	On		On					On	1.99	
D-3rd	On		On				On		1.40	*
D-4th	On					On	On		1.00	*
D-5th			On			On	On		0.74	*

4 Same as above; Automatic Shift 1st thru 4th; 5th gear is inhibited. *

3 Same as above; Automatic Shift 1st thru 3rd; 4th and 5th gears are inhibited. *

2 Same as above; Automatic Shift 1st thru 2nd; 3rd, 4th and 5th gears are inhibited.

*Converter clutch may be On or Off depending on vehicle speed and throttle position.

ZF 5-HP-19 Solenoid Application Chart

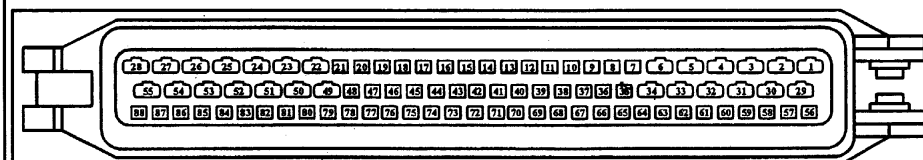
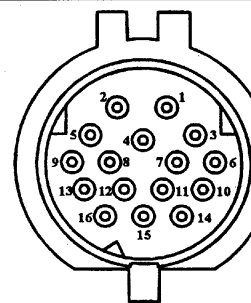
Selector Lever Position	MV 1 Solenoid	MV 2 Solenoid	MV 3 Solenoid	EDS 1 Solenoid	EDS 2 Solenoid	EDS 3 Solenoid	EDS 4 Solenoid	Gear Ratio
Park	On			**				
Reverse	On		⊙	**		*		4.08:1
Neutral	On	On		**		*		
D-1st	On	On		**		*		3.66:1
D-2nd	On	On		**	*	*		1.99:1
D-3rd		On		**	*		■**	1.40:1
D-4th				**			■**	1.00:1
D-5th			■*	**	*		■**	0.74:1
Failsafe (4th)	Off	Off	Off	Off	Off	Off	Off	1.00:1

Solenoid Chart Legend

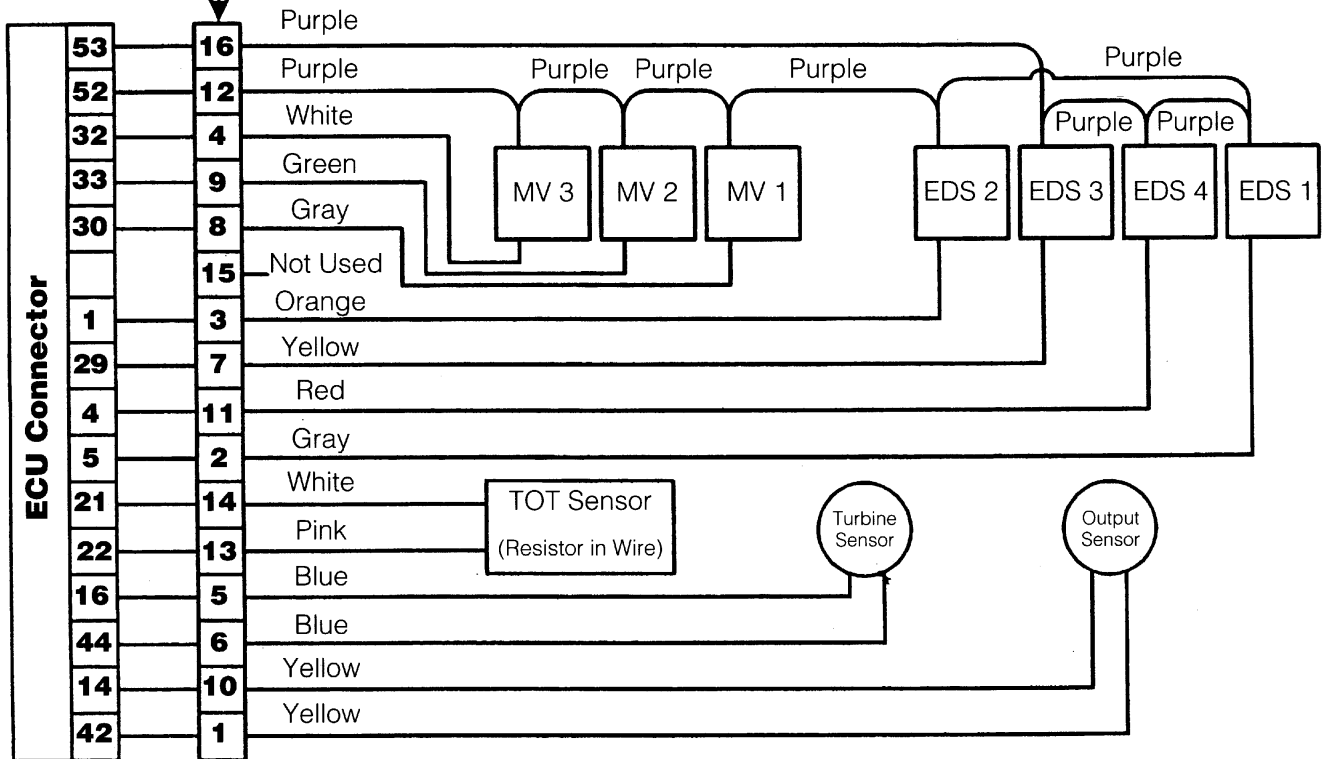
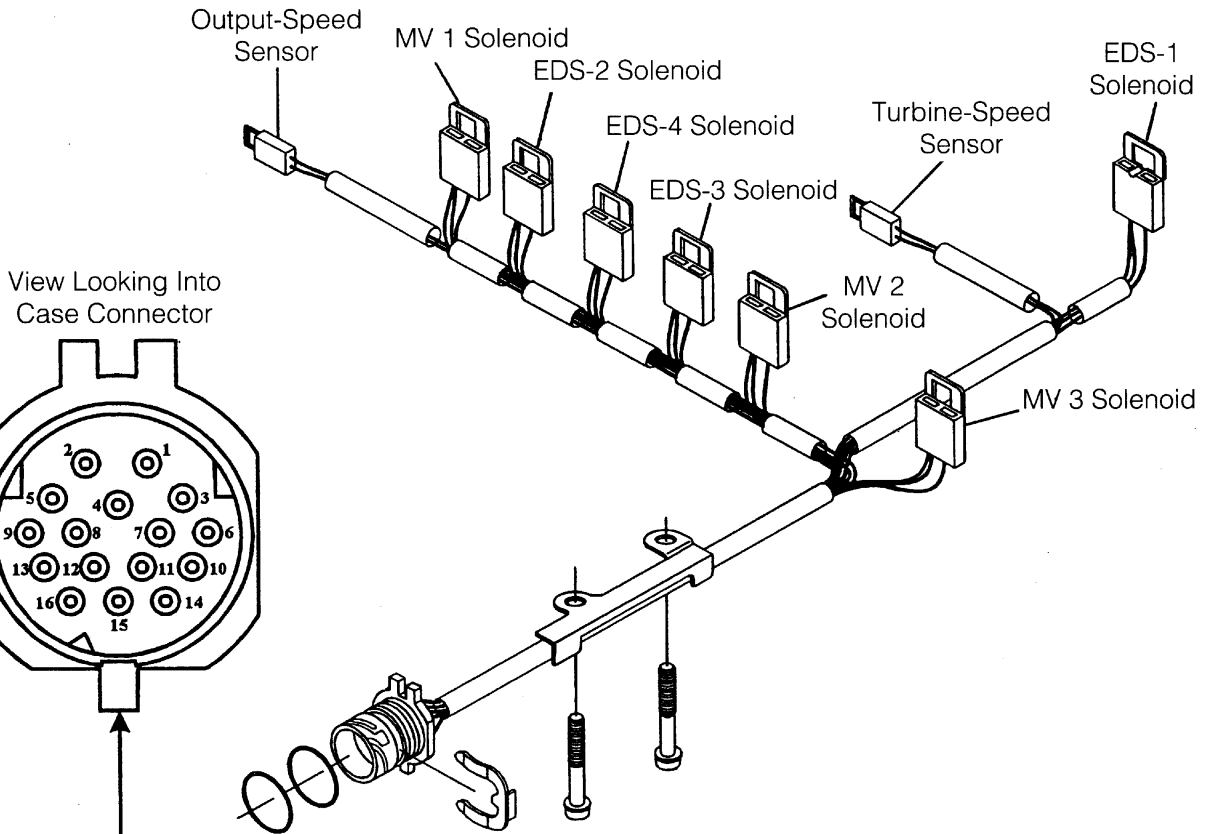
Symbol	Description
On	MV 1, MV 2 and MV 3 solenoids are energized by the Electronic Transmission Control unit and have two functions. They are Open or Closed. Energized (On), there is pressure in circuit.
⊙	MV 3 is turned ON if reverse is selected at a high vehicle speed, to inhibit reverse engagement.
**	EDS 1 is used for line-pressure control only and operates from 0 to 0.8 amps. When the solenoid is OFF (0 amps), pressure is high. EDS 1 pressure is lowered as the solenoid is modulated by the control unit.
*	EDS 2, EDS 3 and EDS 4 solenoids are also pulse modulated but are exactly the opposite of EDS 1 solenoid. When these solenoids are ON, oil pressure in the hydraulic circuit is high, and when they are OFF, pressure in the hydraulic circuit is low.
■*	Solenoid OFF (hydraulic pressure low), then Solenoid ON (hydraulic pressure high).
■**	Solenoid ON briefly (hydraulic pressure high), then Solenoid OFF (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.
■**	EDS 4 Solenoid is used for torque-converter-clutch apply and release only and depends on throttle position and vehicle speed as to its application.

Solenoid and Sensor Resistance Chart

Solenoid	Case Connector Pin Numbers	Control Unit Connector Pin Numbers	Resistance In Ohms
	--+	--+	
MV 1	8 and I2	30 and 52	30-34Ω
MV 2	9 and I2	33 and 52	30-34Ω
MV 3	4 and I2	32 and 52	30-34Ω
EDS 1	2 and I2	5 and 52	5.2-6.8Ω
EDS 2	3 and I2	1 and 52	6.2-7.8Ω
EDS 3	7 and I2	29 and 52	6.2-7.8Ω
EDS 4	11 and I2	4 and 52	6.2-7.8Ω
TOT	I3 and I4	21 and 22	1,000Ω at 25°C
OSS	1 and I0	14 and 42	292-358Ω
TSS	5 and 6	44 and 16	292-358Ω



ZF 5-HP-19 Internal Wire Schematic

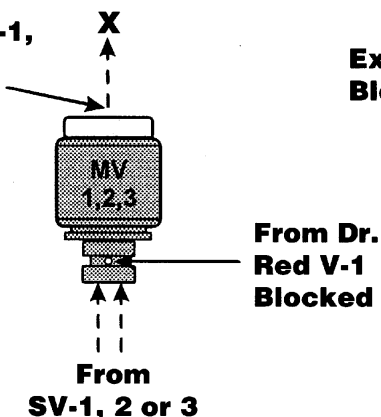
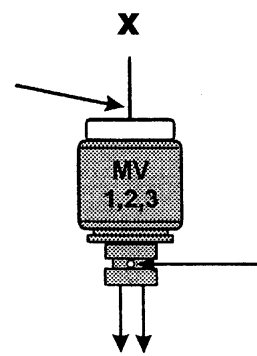


Note: Some internal wire colors may vary.

5**MV 1, 2 and 3 Operation****Solenoid Off****Pressure From SV-1, 2 or 3 Exhausted****Summary:**

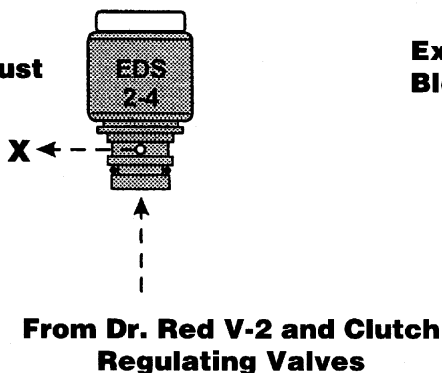
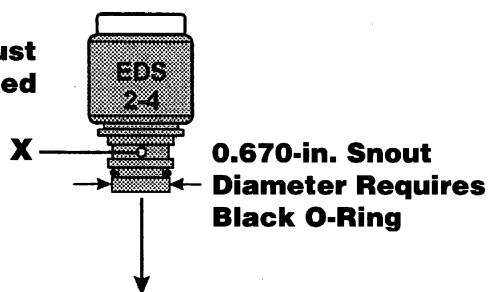
When MV 1, 2 or 3 is OFF, solenoid reducing pressure, from Dr. Red V-1, is blocked by the solenoid, and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.

When MV 1, 2 or 3 is ON, solenoid reducing pressure, from Dr. Red V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.

**Solenoid On****Exhaust Blocked****From Dr. Red V-1 Open****To SV-1, 2 or 3****6****EDS 2, 3 and 4 Operation****Solenoid Off****Exhaust****Summary:**

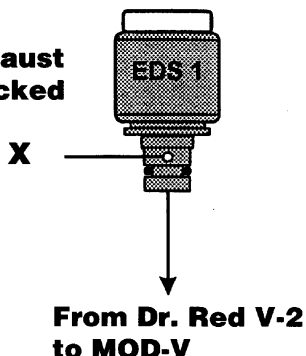
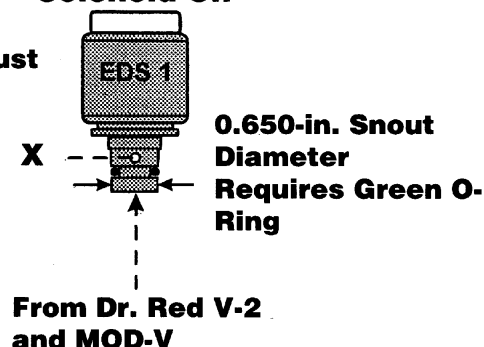
When EDS 2-5 solenoids are OFF they exhaust orificed solenoid reducing pressure from Dr. Red V-2 and the oil pressure from the clutch-regulating valves, releasing them.

When EDS 2- 5 solenoids are ON, the exhaust is blocked by the solenoid, and solenoid reducing pressure from Dr. Red V-2 is applied to operate clutch-regulating valves.

**Solenoid On****Exhaust Blocked****0.670-in. Snout Diameter Requires Black O-Ring****From Dr. Red V-2 to Clutch Regulating Valves****7****EDS-1 Operation (Line-Pressure Solenoid)****Solenoid Off****Exhaust Blocked****Summary:**

When EDS 1 solenoid is OFF, solenoid reducing pressure from Dr. Red V-2 is high to MOD-V valve, which creates high line pressure.

When EDS 1 solenoid is ON, solenoid reducing pressure from Dr. Red V-2 is low to MOD-V valve, which creates low line pressure.

**Solenoid On****Exhaust Open****0.650-in. Snout Diameter Requires Green O-Ring****From Dr. Red V-2 and MOD-V**

Failsafe Operation

When the ECU detects a system fault that could impair normal reliable operation, it interrupts the power supply to pin 12 at the transmission-case connector. The ECU also alerts the driver to any faults

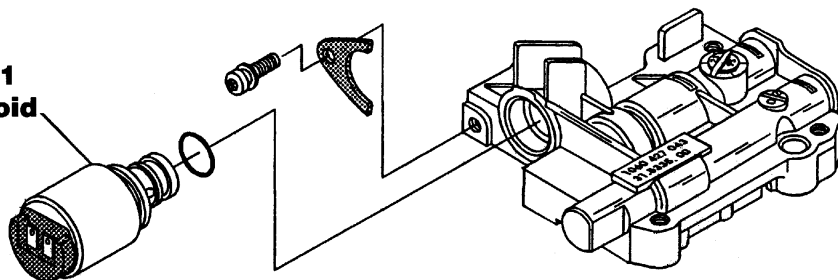
by signaling the vehicle's "check control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

Selector-Lever Position	P R N D 4 3 2
Actual Gear Obtained	P R N 4 4 4 4

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ZF 5-HP-19 Solenoid Identification and Locations

EDS-1 Solenoid



Special Note:

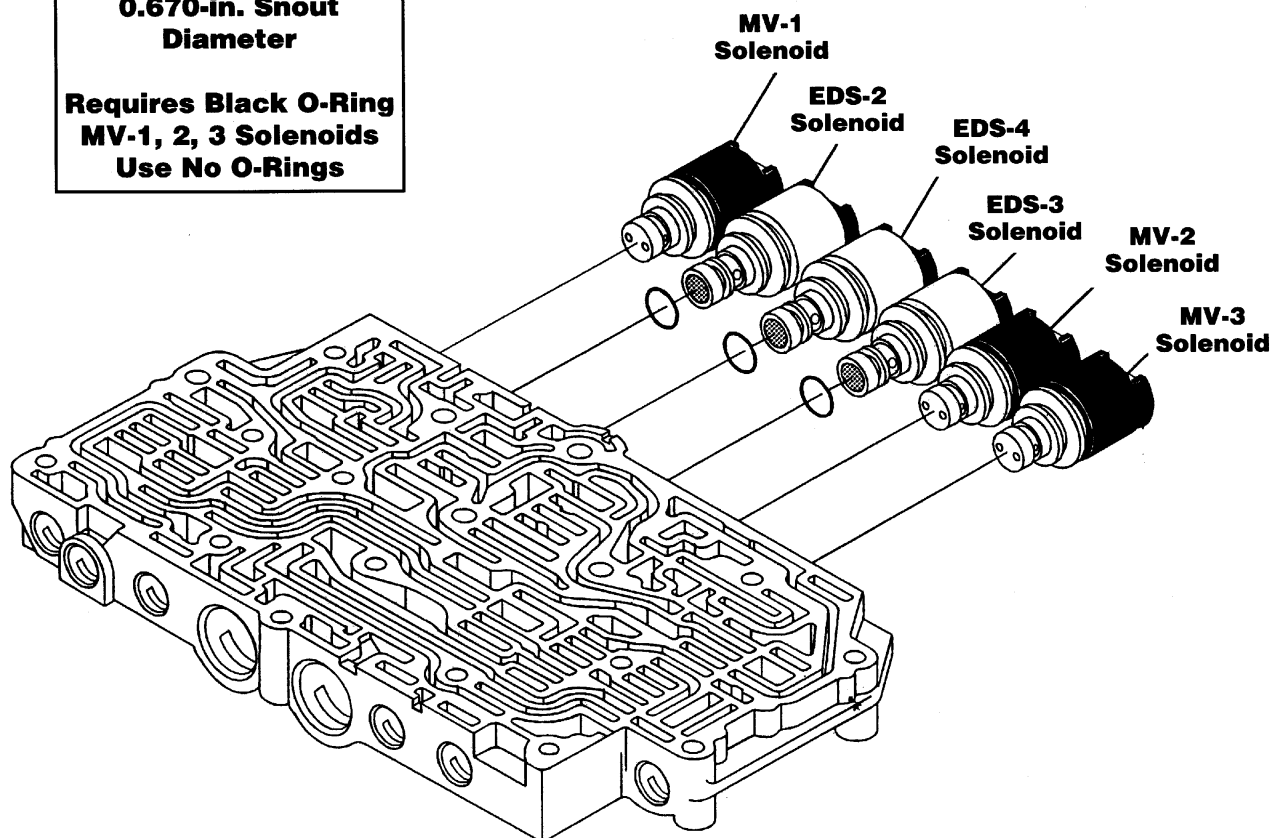
EDS-1 Solenoid
0.650-in. Snout
Diameter

Requires Green O-Ring
EDS-2, 3, 4 Solenoids
0.670-in. Snout
Diameter

Requires Black O-Ring
MV-1, 2, 3 Solenoids
Use No O-Rings

ZF Part Numbers

EDS-1 Solenoid	0501 209 875
EDS-2, 3, 4 Solenoids	0501 208 562
MV-1, 2, 3 Solenoids	0501 313 506



One-Touch Control Versions

Standard versions have a shift quadrant using only the left gate as shown in Figure 3. The versions that are equipped with One-Touch Control, supplied as an option and model dependent, have a two-section shift quadrant, also shown in Figure 3. Positions P, R, N, D, 4, 3 and 2 can be selected in the left-hand gate, and all shifts are automatic, depending on which selection was

maximum fuel economy or a sportier driving style. There are three shift patterns for this purpose.

1. Comfort-oriented, economical driving style
2. Average driving style
3. Sports-oriented, high-performance driving style

When the vehicle is started cold, it starts off in shift

3

Shift Quadrant

(P) = Parking Pawl Engaged

(R) = Reverse Gear

(N) = Neutral

(D) = Automatic shifts 1st through 5th gears.

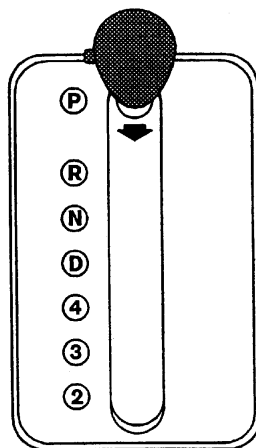
(4) = Automatic shifts 1st through 4th gears.
5th Gear is locked out.

(3) = Automatic shifts 1st through 3rd gears.
4th and 5th gears are locked out.

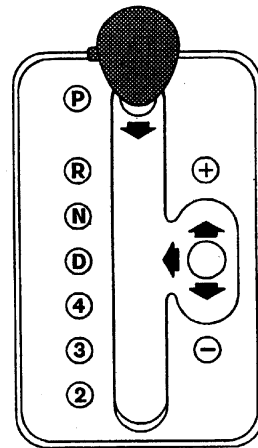
(2) = Automatic shifts 1st through 2nd gears.
3rd, 4th and 5th gears are locked out.

Note: 1st gear, which has an engine-braking effect, is selected electronically, dependent on being in manual position 2 and at a suitable road speed.

Standard Versions



One-Touch Control Versions



made. When the selector lever is placed in the right-hand gate, the transmission can be upshifted manually by tapping the lever in the direction of the Plus symbol, or downshifted manually by tapping the lever in the direction of the Minus symbol. The separate program switch no longer is needed, as functions A and B have replaced it.

Left-Hand Gate = DSP (Dynamic Shift Program)

With the selector lever in the left-hand gate, the DSP looks at the rate of accelerator-pedal movement, engine speed, vehicle acceleration via output speed and other important parameters in the control unit.

The electronic control unit (ECU) includes modules that will automatically modify the transmission's shift characteristics according to driving style and road conditions. These modules effectively replace the program switch.

If the engine temperature is below about 40° C (104° F) when it is started, the ECU control system enters a special warm-up program in order to shorten the catalytic converter's warming-up phase. This warm-up program is terminated after about two minutes of operation.

If the rate of accelerator-pedal movement is varied greatly, the shift points are modified for either

pattern No. 1, provided that the transmission temperature is above 40° C (104° F). This shift pattern places the emphasis on maximum fuel economy. If a more-enthusiastic driving style is required, the ECU detects the accelerator opening and closing more rapidly and switches among the shift patterns, adopting shift pattern 3 where necessary.

If a calmer driving style is resumed, the ECU returns to the lower shift pattern and again places the emphasis on fuel economy.

Right-Hand Gate = Manual Shift Program

When the selector lever is moved to the right-hand gate, the transmission remains in the current gear and can be shifted to a lower or higher gear using the one-touch function.

There are engine-speed limits for each gear, so the transmission can be downshifted only if doing so will not exceed the maximum engine speed. No mandatory upshifts will take place.

If the One-Touch feature is not used when the selector lever is in the right-hand gate, for durability concerns the transmission is allowed to downshift automatically to 1st gear.