

2006 MINI Cooper S

2006-07 GENINFO Automatic Transmission - Overview - MINI

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MINI GA6F21WA

GA6F21WA 6-SPEED AUTOMATIC GEARBOX

From January 2005, a 6-speed automatic transmission (manufacturer: AISIN AW CO. LTD, Japan) will be used for the first time in the MINI COOPER S and the MINI COOPER S Convertible.

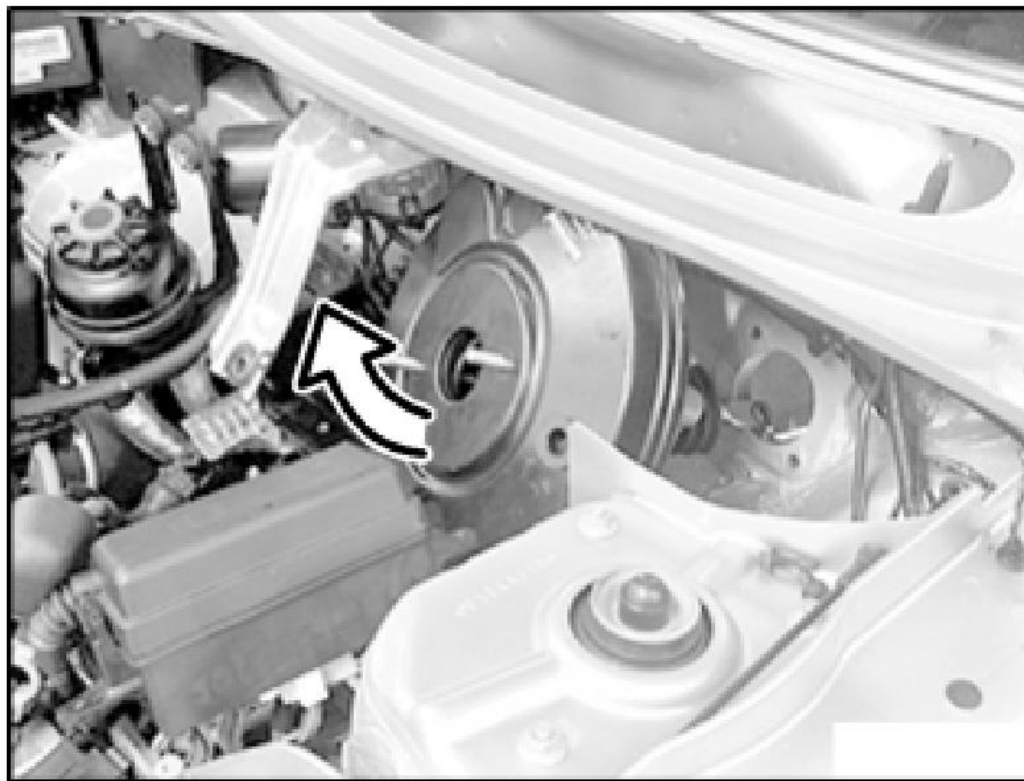
The MINI COOPER will continue to be equipped with the ECVT (electronically controlled continuously variable automatic transmission).

The 6-speed automatic transmission is characterized by its short gearshift times (1/4 second) in conjunction with Agitronic.

Agitronic enables individual gear selection in drive position D by means of shift paddles on the steering wheel. The driver can shift manually in drive position D without having to use the selector lever to switch to Steptronic mode beforehand. There are four innovative shift modes associated with the Agitronic:

DRIVE POSITION SPECIFICATION

Drive Position "D"	Normal	Automatic gear shifting. Perfect combination of comfort, sportiness and fuel consumption.
	Agitronic	Individual gear selection by means of shift paddles on the steering wheel. If there is no acceleration or manual gearshift, the automatic transmission shifts back to the normal drive position D after a short time.
Drive Position "S"	Sport	Automatically provides extremely sporty configuration for maximum agility and ultra-quick response by the car.
	Steptronic	Manual gear shifting by means of shift paddles on the steering wheel or the selector lever without exiting from automatic.



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Fig. 1: ECVT (Electronically Controlled Continuously Variable Automatic Transmission)
Courtesy of BMW OF NORTH AMERICA, INC.

Changes to the Engine and the Vehicle

Extensive changes have been made to the engine and the vehicle for automatic transmission operation:

- Absence of an engine oil cooler. The engine oil cooler can be omitted due to the reduced rpm range of the engine in conjunction with the automatic transmission.
- Adaptation of the coolant lines with a connection for the transmission oil cooler.
- Adaptation of the crankshaft flange to the new flywheel.
- Modification of the engine mounting location. The engine has been moved 7 mm upwards and 10 mm to the right on account of the size of the transmission.
- Transmission mounting with hydro-mounts.
- Use of a suction jet pump. The vacuum pressure for operation of the brake booster may be insufficient in certain operating states. The suction jet pump uses its Venturi effect to boost the vacuum pressure at the brake servo.

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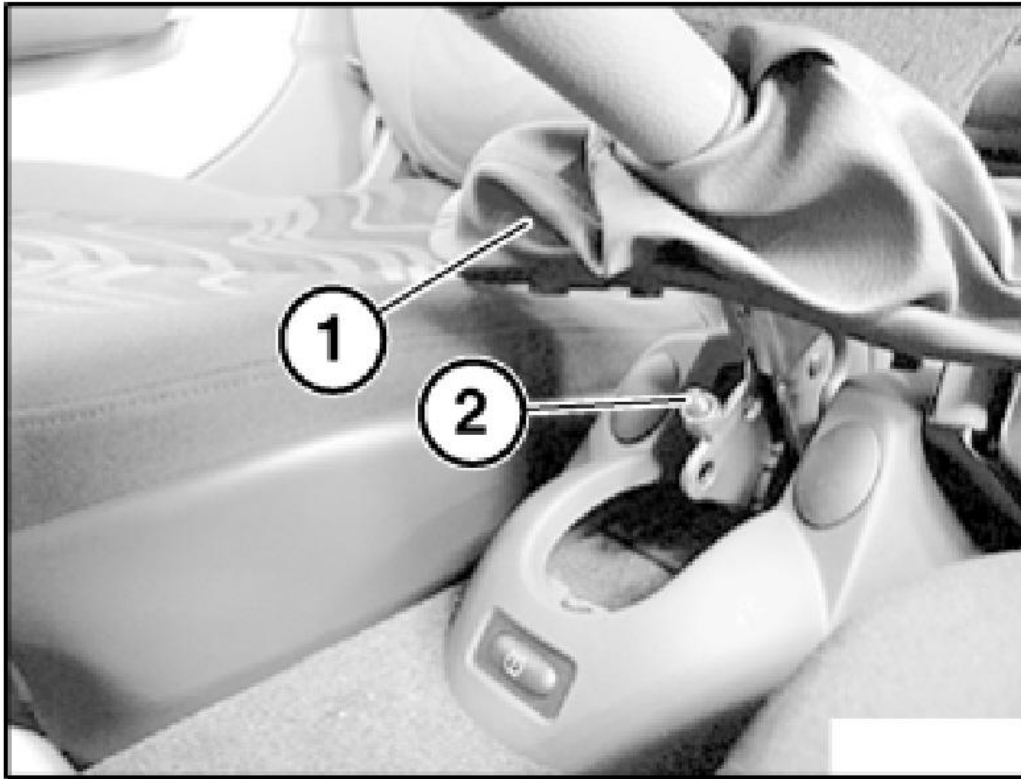
- Air intake duct with a connection for the suction jet pump.
- Adaptation of the exhaust manifold due to the new engine position.
- Extended body wiring harness for transmission control.
- A/C refrigerant lines have been redesigned due to engine mounting change.
- Output shafts adapted to the automatic transmission.
- Modification of the underbody paneling of the engine compartment. The underbody paneling has an air duct for cooling the power steering.

Technical Data

TECHNICAL DATA

Gearbox	6-speed planetary gearbox (6-speed automatic transmission) with hydrodynamic torque converter for front-wheel drive
Transmission Output	max. torque 220 Nm
Transmission Ratios	1st gear: 4.040 4th gear: 1.160 2nd gear: 2.370 5th gear: 0.850 3rd gear: 1.550 6th gear: 0.670 Reverse gear: 3.193
Lever Position	P-R-N-D-M/S and Steptronic
Control	electrohydraulic
Weight	with transmission oil and torque converter: 82.6 kg (63 lbs.)
Towability	50 km at up to 50 km/h
Maintenance	Maintenance-free with life-time oil filling

System Components



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Fig. 2: 6-Speed Automatic Gearbox Components
Courtesy of BMW OF NORTH AMERICA, INC.

Arrangement of components:

1. Multiple pin connector 1 to EGS control unit
2. Multiple pin connector 2 to EGS-control unit
3. Selector lever position switch 7 Selector lever unit
4. Transmission oil cooler
5. Bowden cable
6. EGS control unit

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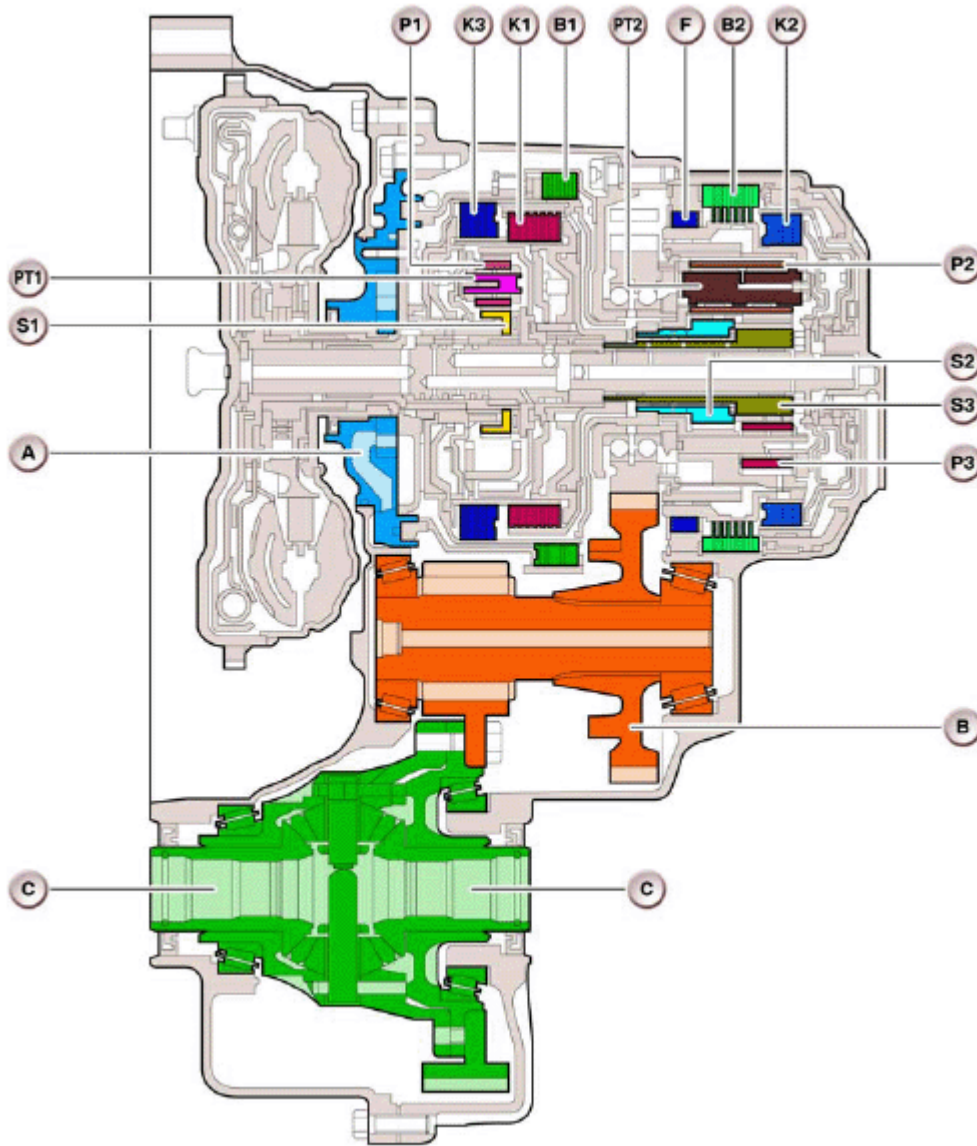


Fig. 3: Section View Of Transmission
 Courtesy of BMW OF NORTH AMERICA, INC.

Section View of Transmission

EXPLANATION CHART

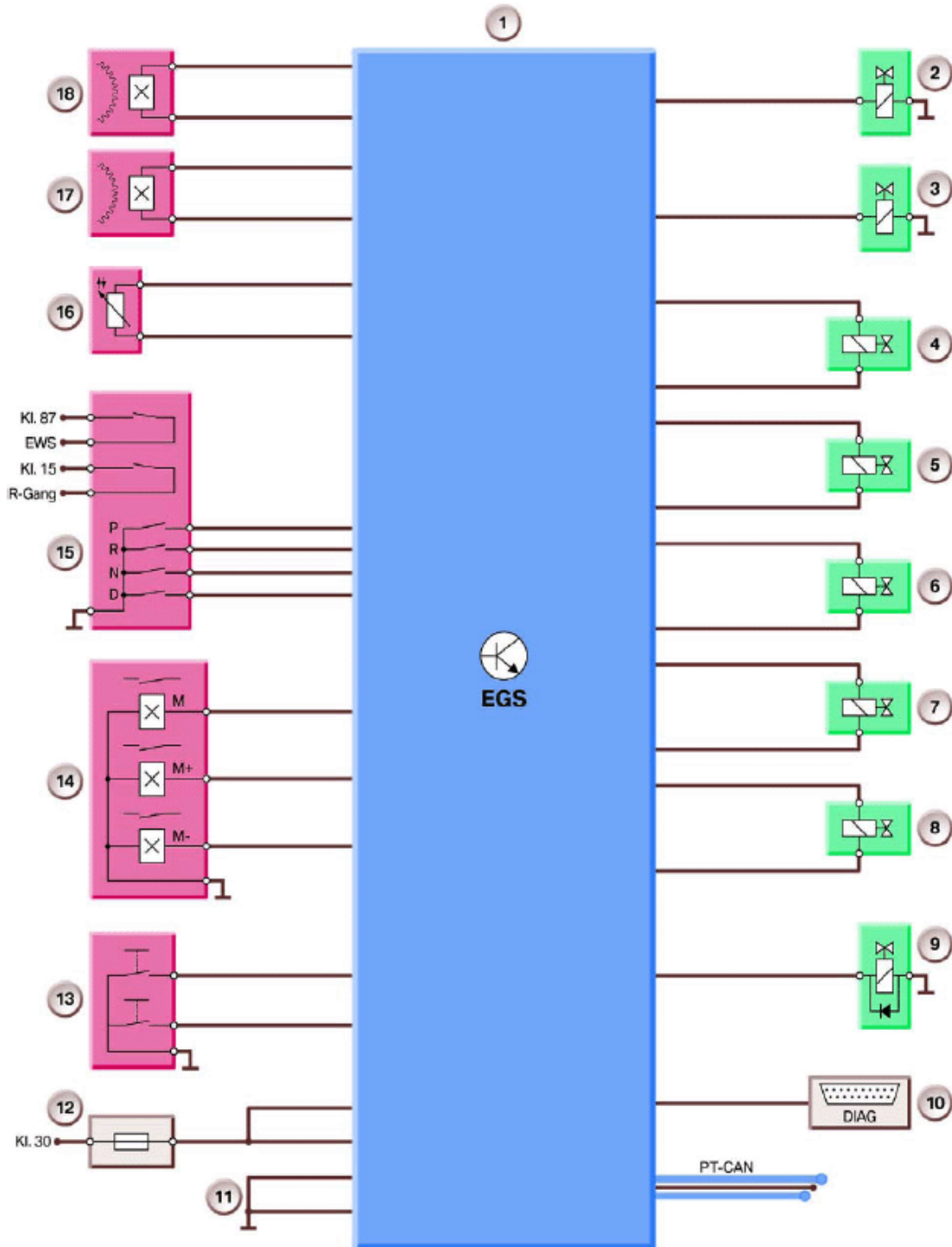
Index	Explanation	Index	Explanation
A	Oil Pump	S1	Sun Gear
B	Intermediate Drive	K1	Multi-plate Clutch
B1	Multi-plate Brake	S2	Sun Gear
B2	Multi-plate Brake	K2	Multi-plate Clutch
C	Output	P3	Planetary Gears S3 Sun Gear
F	Freewheel	K3	Multi-plate Clutch

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PT1	Planet Carrier	P1	Planetary Gears
PT2	Planet Carrier	P2	Planetary Gears

System IPO



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Fig. 4: System IPO Function

Courtesy of BMW OF NORTH AMERICA, INC.

Legend for System IPO

EXPLANATION CHART

Index	Explanation
1	EGS control unit
2-3	Solenoid valves
4-8	Pressure control valves
9	Electromagnet for selector lever interlock (Shiftlock)
10	On-board diagnostics socket
11	Earth connection
12	Fuse
13	Gearshift paddles on steering wheel
14	Switch for sport program and manual gear changes (on selector lever)
15	Selector lever position switch with connectors: <ul style="list-style-type: none">• Terminal 87• Signal for electronic immobilizer (EWS)• Terminal 15• Reversing light control
16	Automatic transmission fluid temperature sensor
17	Engine speed sensor (transmission input speed)
18	Engine speed sensor (transmission output speed)

DESCRIPTION OF COMPONENTS AND OPERATION

Selector Lever

The selector lever has a newly designed selector lever grip. The selector lever mechanism and the arrangement of the drive positions are identical to those of the ECVT (electronically controlled continuously variable automatic transmission).

Selector Lever Positions

The selector lever is used to select drive positions P, R, N, D and M/S.

Selector Lever Position P

The cable and the selector shaft are used to place the automatic gearbox in Park.

Selector Lever Position R

Reverse gear

Selector Lever Position D

Gears 1 to 6 are selected automatically accordance with the shift characteristics in selector lever position D.

Selector Lever Position D (Agitronic)

Gears can also be selected manually with the selector lever in position D: The system switches automatically to manual if the paddles on the steering wheel are operated.

The gears are selected by pushing or pulling on the paddles. The gear selected is engaged as soon as the appropriate rpm and speed are reached.

The gear selected is shown on the instrument cluster display (M1 to M6).

During overtaking or if the car is driven hard, the gear can be changed quickly without first moving the selector lever to the M/S (Steptronic) position. Pulling away is only possible in 1st or 2nd gear.

If the gears are not shifted for more than 6 seconds and the vehicle is not deliberately accelerated, the gears will be shifted automatically again.

Selector Lever Position M/S

Moving the selector lever sideways to the M/S position engages the Sport program. Upshifts are made later in the Sport program, making more sporty driving possible.

To quit M/S mode, you move the selector lever forward (-) or backward (+) or use the paddles on the steering wheel to switch to manual mode (Steptronic). You move the selector lever again or use the paddles on the steering wheel, to select gears manually. The gearbox remains in manual mode until the selector lever is returned to the D position.

Changing gears using the paddles on the steering wheel puts greater pressure on the linkages than does changing gear with the selector lever. Gear changes using the pad-

Selector Lever Position Switch

The selector lever position switch is located on the selector shaft on the transmission housing. It is connected to the selector lever via a cable. The selector lever position switch sends the signals for selector lever positions P, R, N, and D to control the transmission control and the selector lever interlock (Shiftlock) on the EGS control unit.

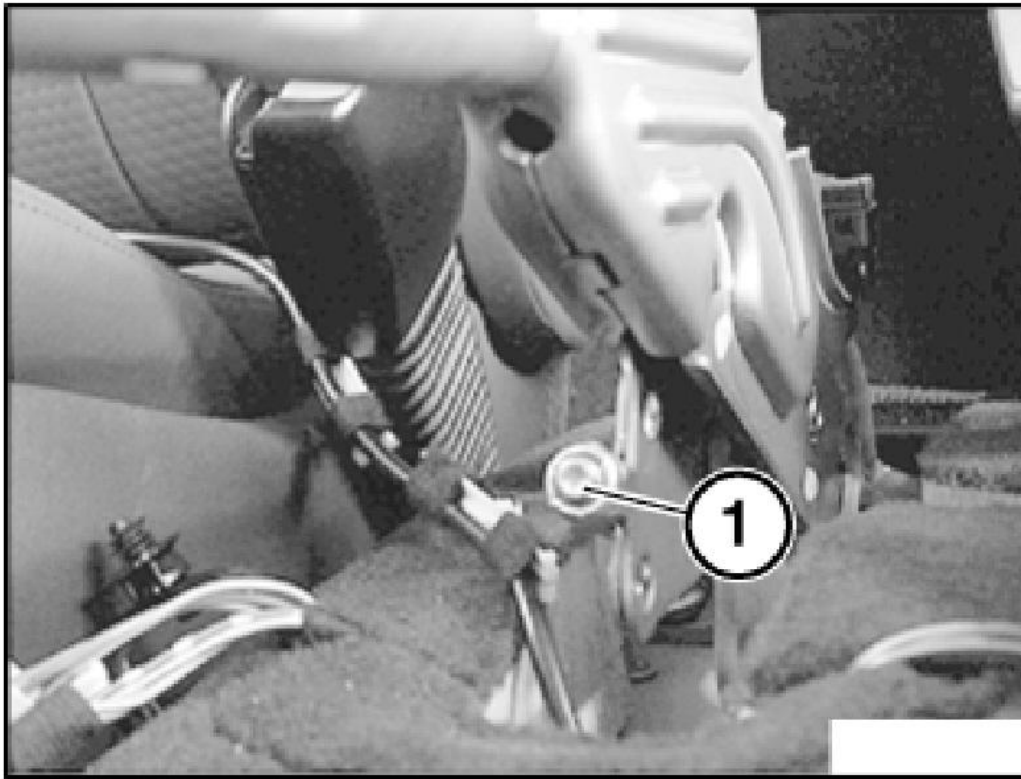
The selector lever position is displayed on the instrument cluster. The display is controlled by the EGS control unit via the Power Train-CAN.

The reversing lights are supplied with 12 V vehicle voltage directly by the selector lever position switch.

The P/N signal for the starter lock comes from the selector lever position switch via a line to the immobilizer

control unit.

The selector lever position switch must be readjusted after replacement and installation of the automatic gearbox. Observe the Repair Instructions.



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Fig. 5: Selector Lever Position Switch
Courtesy of BMW OF NORTH AMERICA, INC.

Selector Lever Interlock (Shiftlock)

The shiftlock prevents the driver pulling away inadvertently by shifting the selector lever by mistake with the engine running. The selector lever is blocked by an electromagnet in positions P and N. Power to the electromagnet is supplied by the EGS from terminal 15 ON.

When the brake pedal is depressed, the power supply is interrupted and the selector lever released. At terminal 15 OFF, the lever can still be shifted to position P and is then locked.

Safety Catch (Interlock)

The ignition key can only be removed with the selector lever in position P. The ignition lock housing has a bowden cable coming from the selector lever.

Starter Lock

The engine can only be started with the selector lever in positions P or N. This information is sent along a separate lead from the selector lever position switch to the electronic vehicle immobilizer (EWS) control module.

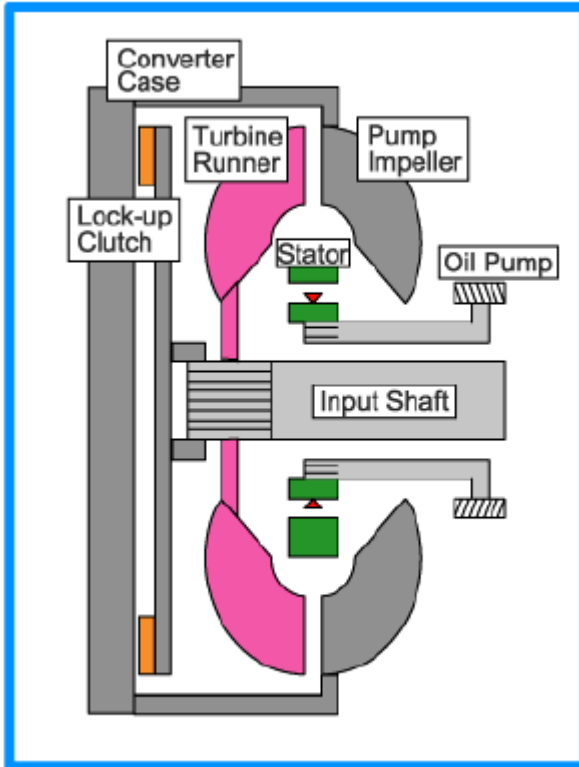
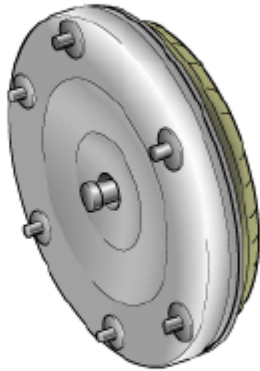
Converter Lockup Clutch

Torque from the engine is transferred to the gearbox by a torque converter fitted with a gradual lockup clutch. The lockup clutch ensures a positive lock between the engine and automatic gearbox, thus reducing consumption.

The converter lockup clutch is closed in gears 2 to 6 as a function of the following factors:

- Accelerator pedal position
- Transmission output speed (locked above 1800 rpm)
- Drive program
- Transmission fluid temperature (always unlocked below 20°C so the that the transmission oil heats up faster).
- Selected gear

Torque Converter



Torque Converter with Lockup Clutch Components

Fig. 6: Converter Lockup Clutch
Courtesy of BMW OF NORTH AMERICA, INC.

Planetary Gear Set

A Lepelletier design planetary gear set is used in the automatic gearbox. This makes for smooth gear changing with only five shift elements and a freewheel.

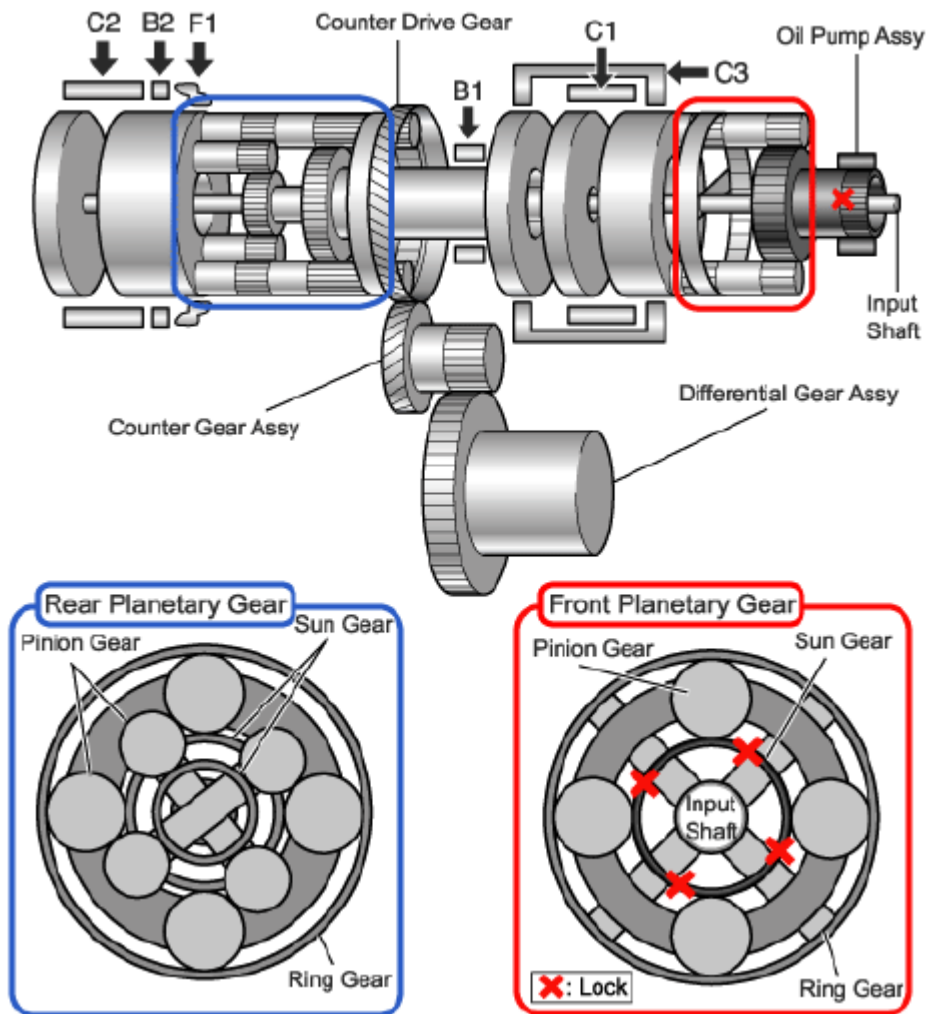


Fig. 7: Planetary Gear Set

Courtesy of BMW OF NORTH AMERICA, INC.

Oil Pump

The automatic gearbox is fitted with an oil pump to supply the necessary hydraulic pressure. The oil pump is driven by the input shaft.

Transmission Oil Cooler

The transmission oil cooler is bolted to the gearbox housing. It connects to the engine coolant circuit via two lines. The transmission oil cooler speeds up transmission oil heating while the engine is warming up. When the engine reaches operating temperature, the coolant reduces the temperature of the transmission oil.

ELECTRONIC GEARBOX CONTROL (EGS)

EGS Control Unit

The EGS control unit is located in the vehicle interior underneath the steering column. Data is exchanged with the following controllers on the Power Train-CAN:

- DME
- DSC (including. ABS / ASC)
- Instrument cluster.

NOTE: The adaptive values must be reset using the BMW diagnosis system after the EGS control unit has been replaced.

Throttle-valve Signal

The throttle-valve signal is the load requirement signal and is needed by the electronics when selecting gears.

Injection Signal

The injection signal is the engine load status signal. It, plus the throttle-valve signal and the pulling-away signal are needed when changing gears.

Engine Intervention

During gear changing, the transmission electronics complement the engine electronics by retarding ignition timing for about 200 ms. This reduces the engine torque momentarily, improves shift quality, the load on the transmission is reduced, and the shift time is reduced.

Kickdown

If the driver presses the accelerator pedal to the floor (kickdown), the full load voltage value of the accelerator pedal module is exceeded.

Once a voltage value set in the engine control unit is reached (4300 mV), this is interpreted by the DME as kickdown, and this information is sent from the DME via the PTCAN to the EGS control unit.

Transmission Input Speed

There is a speed sensor for the transmission input speed on the gearbox input shaft. The speed sensor operates on the Hall principle. The electronic gearbox controller needs to know the exact transmission input speed for the following functions:

- Control, adaptation and monitoring of gear changes
- Control and monitoring of the converter lockup clutch
- Diagnosis of shift elements and plausibility checking of engine and gearbox output speeds.

Gearbox Output Speed

There is a speed sensor for the gearbox output speed on the parking interlock gear. The speed sensor operates on the Hall principle. The electronic gearbox controller needs to know the exact transmission input speed for the

following functions:

- Selection of gear change point
- Diagnosis of shift elements and plausibility checking of engine and turbo unit output speeds.

DSC

The selected gear is limited to 4500 rpm during DSC intervention. Changing gear would have a negative effect on driving stability. The transmission changes up automatically above 4500 rpm to reduce the torque to the wheels. No special winter program is needed in the electronic transmission controller, thanks to DSC control and front-wheel drive.

Transmission Fluid Temperature

The transmission fluid temperature sensor is located in the gearbox oil in the electrohydraulic control gear. Transmission fluid temperature information is needed for the following functions:

- To match the shift pressure (system pressure) and pressure increase and decrease during gear changes
- To activate and deactivate temperature dependent function such as engaging the converter lockup clutch.

Brake Light Switch

The brake-light-switch signal comes from the PT-CAN. It is needed for the operation of the selector lever interlock (shift-lock) and for transmission control (e.g. gradient detection function).

Engine Speed

Engine speed data is needed in the EGS control unit for safety functions, e.g. to prevent downshifting if it could over-rev the engine.

Shift Characteristics

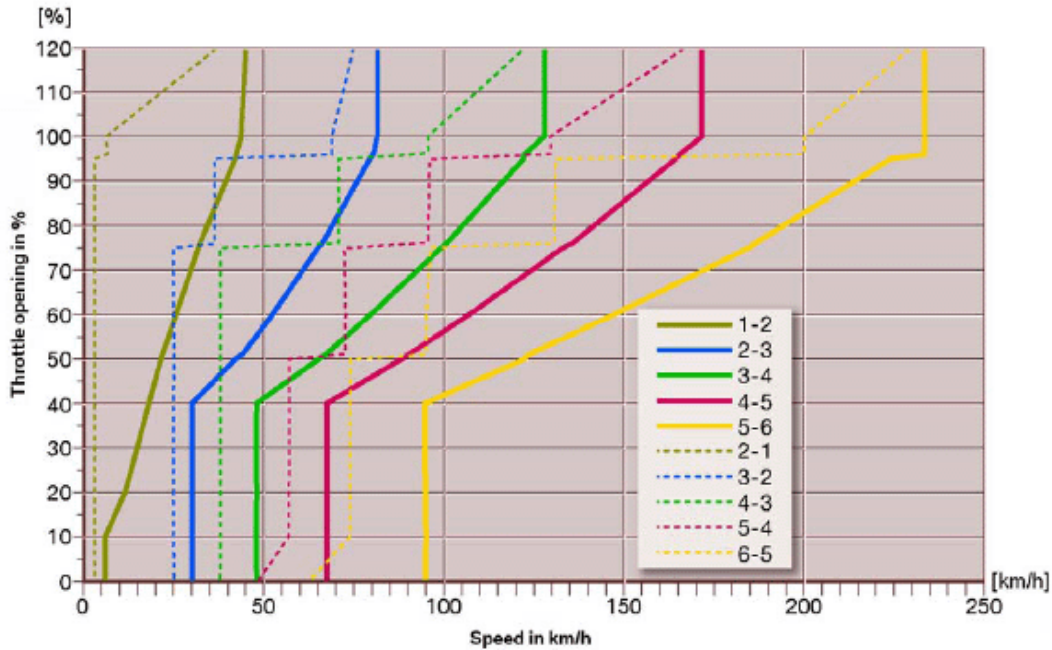
The EGS control unit determines the change-up and change-down points as a function of:

- Driver's desired load (accelerator pedal and throttle-valve position)
- Transmission output speed
- Selector-lever setting
- Kickdown signal

The shift points vary, depending on temperature (temperature sensor in electrohydraulic control gear).

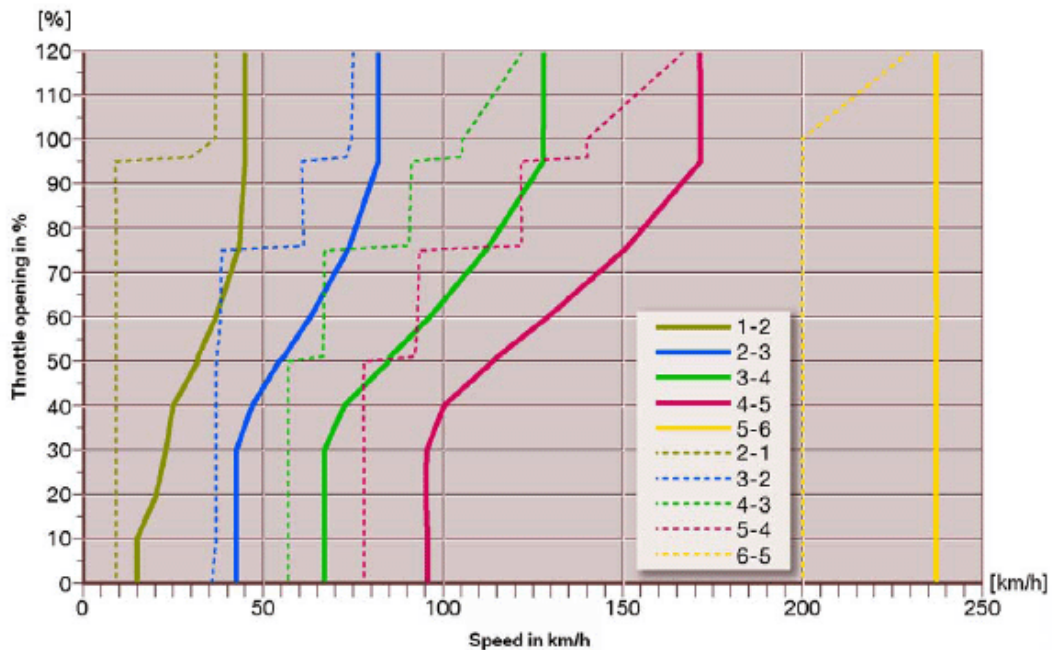
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Shift Characteristics in Drive Position

Fig. 8: Shift Characteristics In Drive Position Graph
Courtesy of BMW OF NORTH AMERICA, INC.

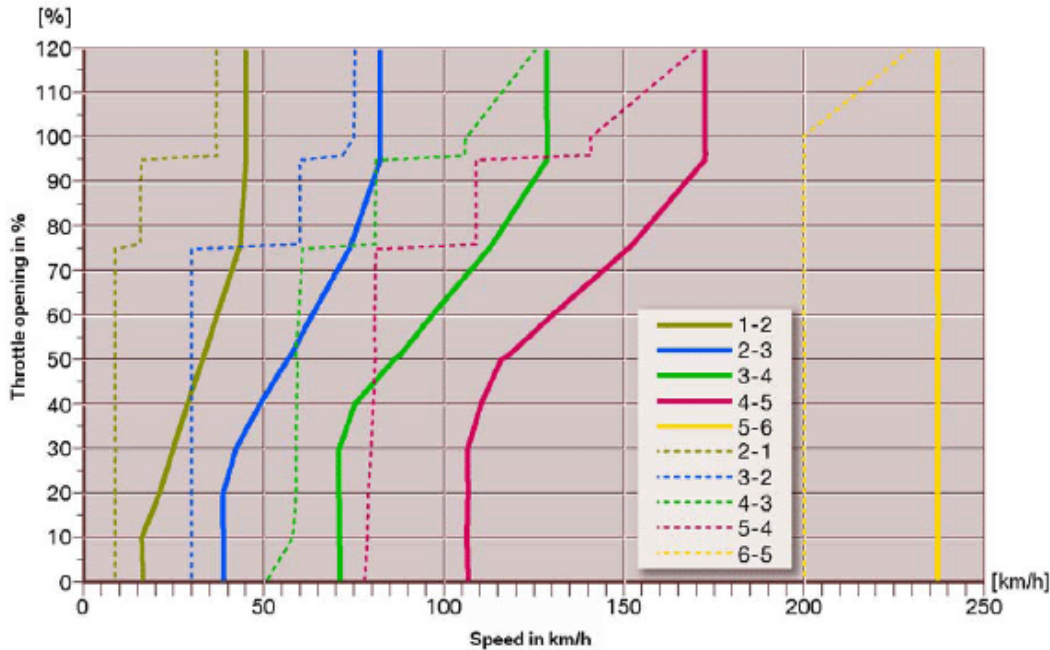


Shift Characteristics in Sport Program

Fig. 9: Shift Characteristics In Sport Program Graph
Courtesy of BMW OF NORTH AMERICA, INC.

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Shift Characteristics During Gradient Detection

Fig. 10: Shift Characteristics During Gradient Detection Graph
Courtesy of BMW OF NORTH AMERICA, INC.

Gradient Detection

The transmission control is fitted with a gradient detection function in shift lever positions D and SD. It detects whether the vehicle is travelling uphill or downhill by comparing the engine torque and the selected gear on the one hand, and wheel speed on the other.

When travelling uphill, the controller selects the gear which best provides the vehicle with sufficient reserves of traction.

When travelling downhill, the gear is held after use of the brake or a manual downshift. The transmission changes down when brake use is detected.

Fast-off Detection

To decelerate, the driver takes his foot off the accelerator pedal and uses the brakes if necessary. Closure of the throttle caused by the change in shift characteristics, tends to make the transmission upshift.

This gear change is not desirable because it hinders the braking effect of the engine. In addition, in many cases, using the brake pedal again shortly after shifting up or down considerably increases shift frequency.

The objective of this function is, therefore, to block upshifting in the circumstances described. The driver's desire to decelerate is detected by very fast return of the pedal into the zero position (Fast-Off). If this action is detected, upshifting is suppressed while the accelerator is in the zero position and the vehicle is moving.

Cornering Detection

Shifting up in corners is prevented above a defined lateral acceleration. The radius of the bend is detected from the differences in speed of the inside and outside wheels. An accurate enough calculation of the lateral acceleration is made by taking the travelling speed into consideration. Identical front wheel tire circumferences are a prerequisite for this calculation.

VALVE BODY

The valve body (electrohydraulic selector unit) is located in the automatic gearbox. It is covered by the transmission oil sump. The valve body sets the drive and brake clutches to the correct hydraulic pressure.

A selector switch is triggered in the valve body by the cable on the selector lever. The gear selector valve regulates the transmission oil (main pressure) as a function of the selector lever position in relation to the corresponding solenoid valves in the transmission.

The following components for transmission control are also located in the valve body:

- Oil temperature sensor
- Solenoid valves (2x)
- Pressure control valves (6x).

The valve body is connected to the EGS control unit by two multiple pin connectors (on the gearbox housing).

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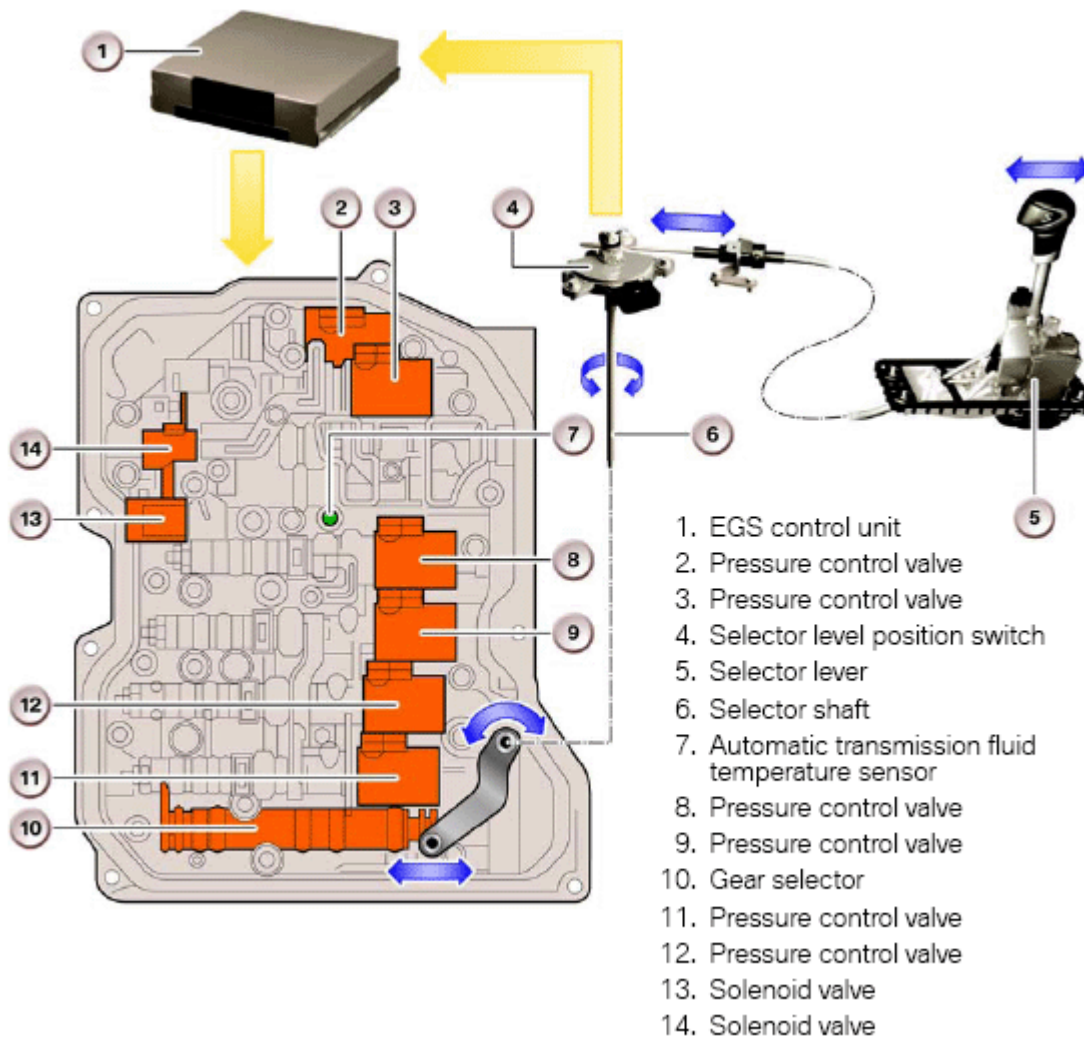


Fig. 11: Valve Body Function

Courtesy of BMW OF NORTH AMERICA, INC.

Automatic Transmission Fluid Temperature Sensor

The automatic transmission fluid temperature sensor is located in the transmission oil in the electrohydraulic selector unit. It is soldered into the transmission wiring harness.

TRANSMISSION OIL TEMPERATURE CHART

Transmission Oil Temperature	10°C	25°C	110°C
Resistance Value	5.62-7.31 (kohms)	3.5 (kohms)	0.22-0.27 (kohms)

Solenoid Valves

There are two solenoid valves (3/2-way valves) in the valve body for sending switching signals such as "Fill clutch" or "Bleed" to the hydraulic controller.

Both solenoid valves are controlled by the EGS controller. They switch either open or closed. First gear or reverse are selected when the valves are activated.

Delivery pressure is blocked in the de-energized state and the working volume connected to zero drain. When current is applied, the delivery pressure is the same as the working pressure and zero drain is blocked.

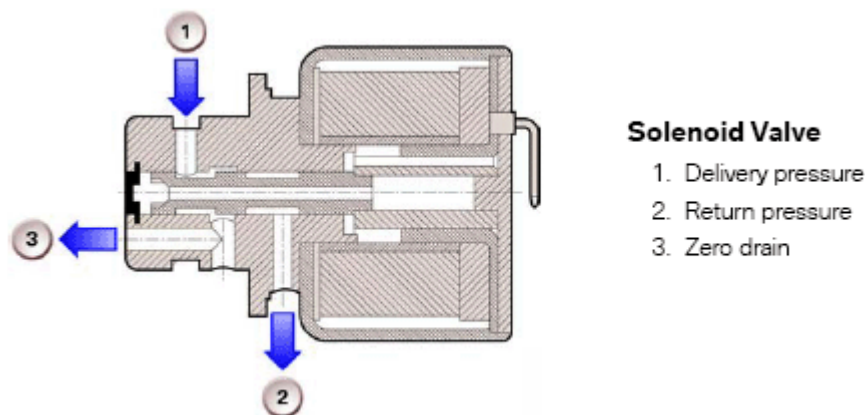


Fig. 12: Solenoid Valves

Courtesy of BMW OF NORTH AMERICA, INC.

Pressure Control Valves

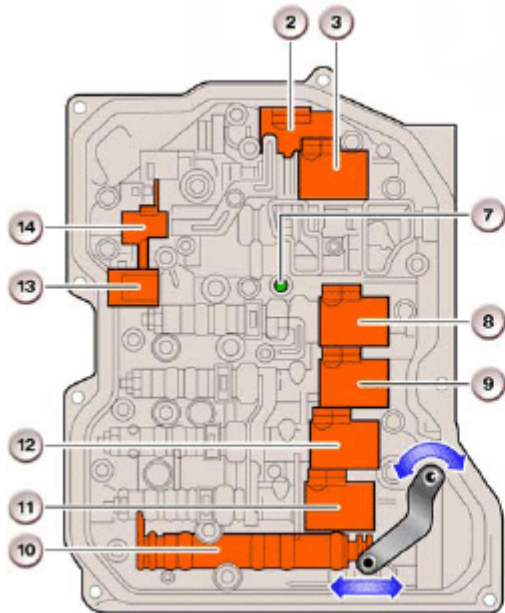
The pressure control valves translate an electrical current into a proportional hydraulic pressure. They are controlled by the EGS control unit and operate the valves associated with the shift elements. They are controlled by a PWM signal (300Hz at 0.1A to 1A).

There are six pressure control valves in the electrohydraulic selector unit. Valves (8, 9, 11, 12) use fluid pressure to control the 3 drive clutches and both brake clutches.

Valve (2) switches the converter lockup clutch.

Valve (3) regulates the oil pressure in the transmission as a function of the throttle-valve-position and engine torque.

The pressure control valves are used to make gear overlap and adaptive pressure control of each clutch possible.



Valve Body

- 2. Pressure control valve
- 3. Pressure control valve
- 7. Automatic transmission fluid temperature sensor
- 8. Pressure control valve
- 9. Pressure control valve
- 10. Gear selector
- 11. Pressure control valve
- 12. Pressure control valve
- 13. Solenoid valve
- 14. Solenoid valve

Fig. 13: Pressure Control Valves

Courtesy of BMW OF NORTH AMERICA, INC.

Overlap Control

Automatic gearboxes differentiate between overlap control and freewheel control. In the case of overlap control, one clutch is partially filled while another is drained. Partial filling is maintained (pressure approximately 1 bar) until a synchronous speed is achieved. After that, the pressure for the clutch being filled can be increased to full.

Freewheel control is only used when changing from first to second gear.

Adaptive Pressure Control

Adaptive pressure control improves shift quality during the life of the vehicle. Slip times are measured during upshifting and compared with a specified value. As soon as a programmed limit value is exceeded, the pressure is first increased, then reduced to the correct value using an approximation technique. This compensates for differences in the friction pad and brings about height matching.

Diagnostics

Faults in the sensors, actuators and the EGS controller are stored in the fault code memory, and can be read using the BMW diagnostic system.

Emergency Operation Program

The solenoid and pressure control valves are no longer controlled by the EGS control unit if a fault occurs. In this case, an emergency operation program is activated and 3rd gear selected to make it possible to continue driving slowly. The display on the instrument cluster shows the letters EP (Emergency Program).

SERVICE INFORMATION**Selector Lever Position Switch**

The selector lever position switch must be readjusted after replacement and refitting of the automatic gearbox.

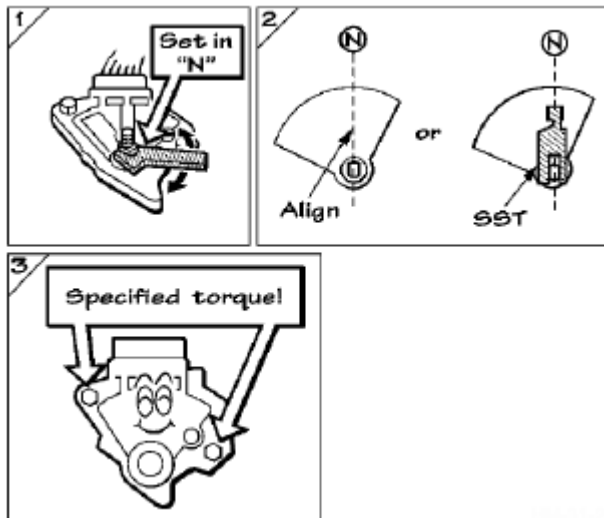


Fig. 14: Selector Lever Position Switch
Courtesy of BMW OF NORTH AMERICA, INC.

Adjustment

1. Place selector lever in vehicle to Neutral.
2. Align the selector switch on the transmission to Neutral.
3. Tighten switch assembly as per tightening torque.

EGS Control Unit

The information on of the transmission control unit can be read as follows:

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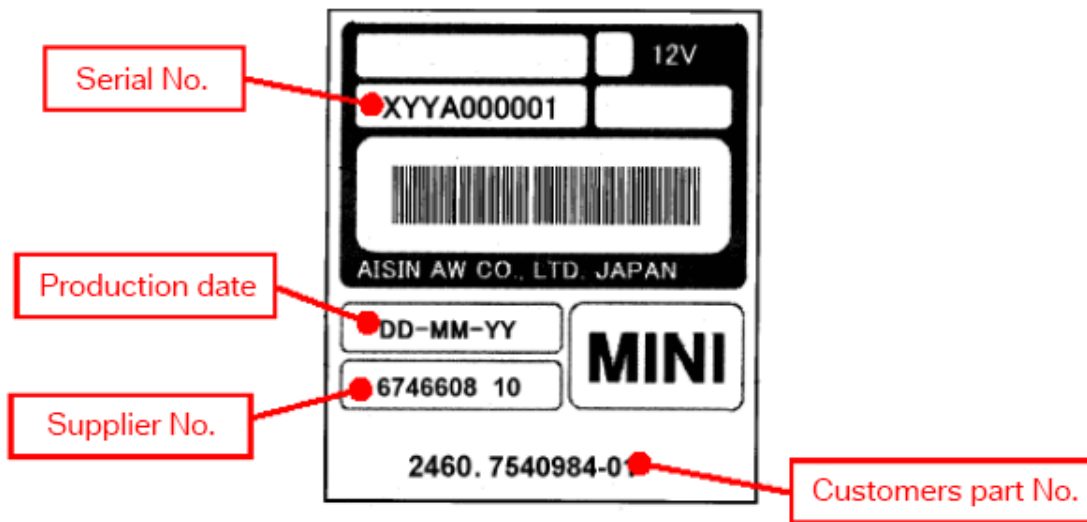


Fig. 15: EGS Control Unit Label
Courtesy of BMW OF NORTH AMERICA, INC.

The adaptive values must be reset using the BMW diagnostic system after the EGS control unit has been replaced.

Transmission

The Aisin transmission has two labels on the side. One label is the factory label from AISIN and the other is the BMW Group label.

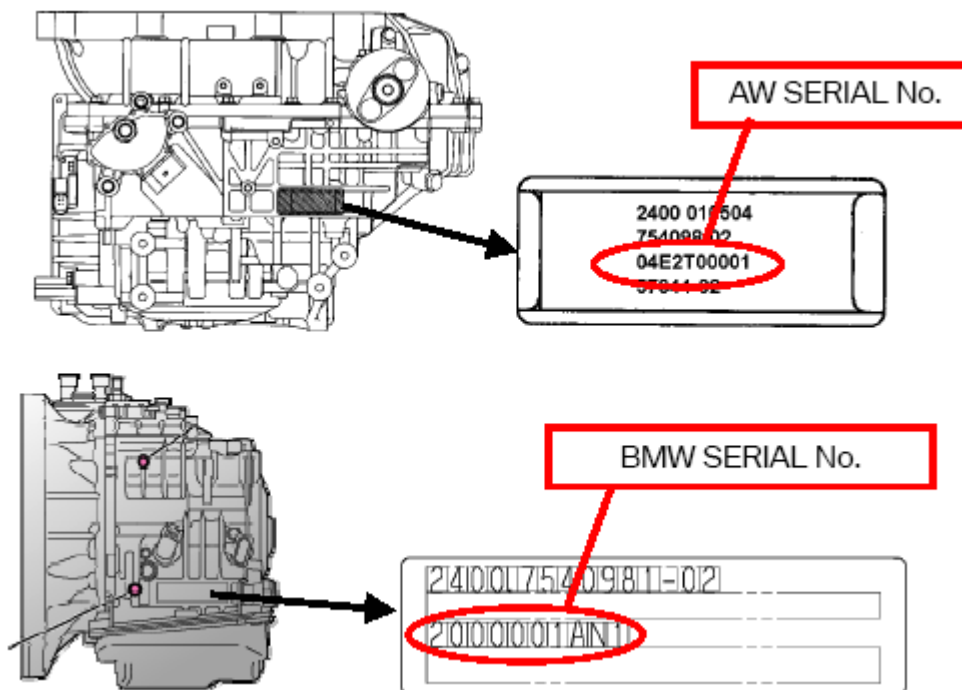


Fig. 16: Transmission Label Location

Courtesy of BMW OF NORTH AMERICA, INC.

The label on the transmission can be interpreted as follows:

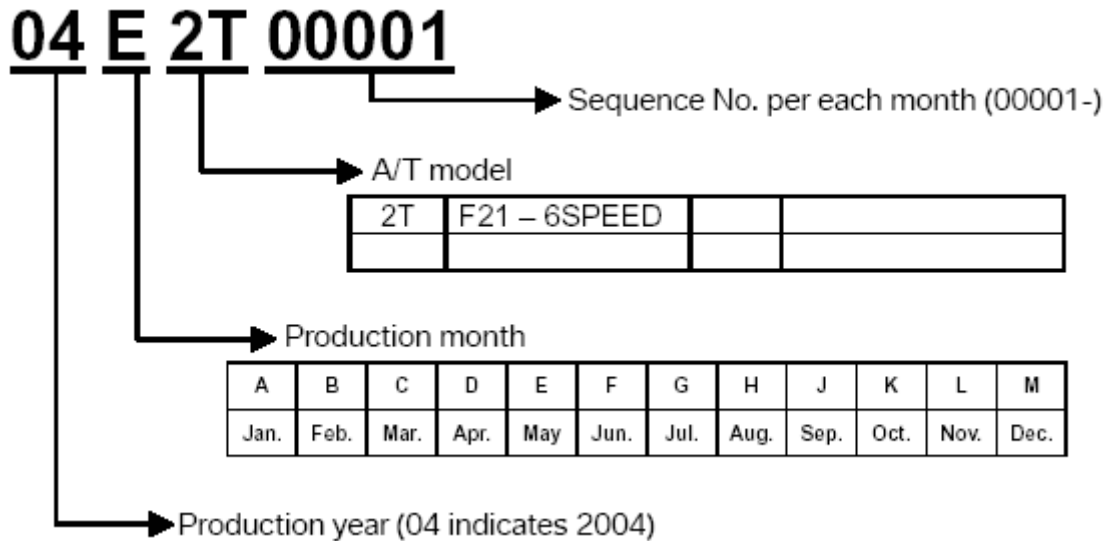


Fig. 17: Transmission VIN Number

Courtesy of BMW OF NORTH AMERICA, INC.

Transmission Fluid

The GA6F21WA transmission is filled with lifetime fluid from the factory. Transmission oil change should only be performed upon technical hotline request. When replacing parts on this transmissions, drain fluid into a clean container and reuse.

The oil used is supplied by ESSO (Exxon) and is labeled JAPAN ESSO JWS-3309 (part number 83 22 7 542 990).

The automatic transmission provides filtered, pressure regulated hydraulic fluid for all of the transmissions functional requirements. All BMW automatic transmissions are designed to operate with specific fluids. Use of non-approved oil will cause malfunctions and irreparable transmission damage which is not covered by BMW warranty.

The transmission fluid provides the following functions:

- Lubricates mechanical components (planetary gears, bearings etc.).
- Removes heat and transfers heat to transmission cooling system. (Heat Exchanger).
- Removes debris and contaminants to sump and filter when circulated.
- Provides a transfer of kinetic energy in the torque converter.
- Allows hydraulic operation of mechanical components (clutches, brakes) via control of the valve body.

Also, transmission fluid has various properties to prevent oxidation and breakdown from heat and friction. Each type of transmission fluid has properties specific for each transmission application.

Fluid level is crucial in the proper operation of an automatic transmission. Improper fluid levels will cause improper operation and eventually irreparable transmission damage.

Improper fluid level can cause:

- A low fluid level can cause an interruption in oil flow during fast acceleration or hard braking which can cause gear shift malfunctions and noises.
- An excessively high fluid level can cause the rotating mechanical components to paddle in the oil. This produces foam which introduces air into the hydraulic system.
- A low fluid level can also cause transmission overheating causing premature transmission failure.

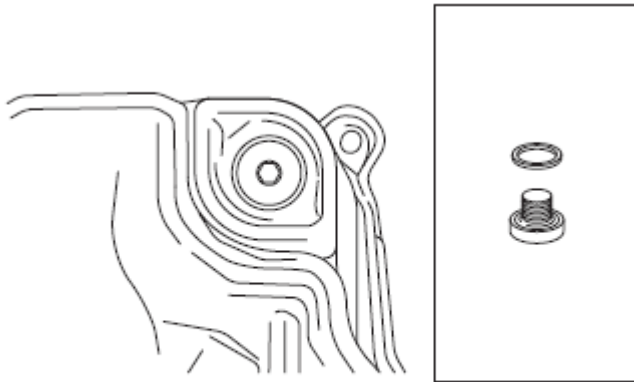
Transmission Fluid Checking Procedures

Transmission fluid checking is accomplished using the DISplus or GT1. The DISplus or GT1 is used to monitor transmission fluid temperature to insure the transmission is not over or under-filled. There is no dipstick, the fluid level is checked by monitoring the overflow coming from the overflow hole while filling via the fill plug.

Transmission fluid should be checked between 35 and 45°C. Use the DISplus and/or GT1 to determine transmission temperature. The transmission temperature information can be found in the diagnosis section under Service Functions.

When checking transmission fluid, observe the following items:

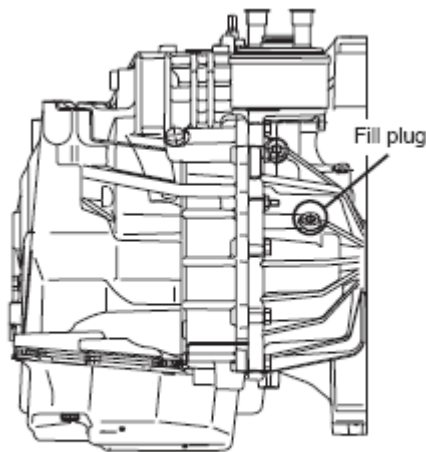
- Transmission in Park
- Parking brake applied
- Vehicle level
- No engine load
- Trans Temp 35-45°C
- Observe correct drain plug torque
- Use correct fluid



Overflow Plug (oil pan)

Fig. 18: Overflow Plug (Oil Pan)

Courtesy of BMW OF NORTH AMERICA, INC.



Fill Plug

Fig. 19: Fill Plug

Courtesy of BMW OF NORTH AMERICA, INC.

Transmission Fluid Checking Procedures (cont.)

1. Park the vehicle on a flat load and lock the tires.
2. Shift the shift lever to "P" range. Do not start engine.
3. Remove the overflow plug and filling plug.
4. Check if automatic transmission fluid drops from the overflow hole.

If Automatic transmission fluid does not drop, additional automatic transmission fluid to be filled until automatic transmission fluid drops.

5. Start the engine.

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6. Check if automatic transmission fluid drops again from the overflow hole.

If Automatic transmission fluid does not drop, additional automatic transmission fluid to be filled until automatic transmission fluid drops.

7. At this point try to maintain automatic transmission fluid in less than 35°C.
8. Shift all range from "P" to "D" with the expenditure of more than 2 seconds per each range and return to "P" after performing the 2 times shifting with foot braking.
9. Check automatic transmission fluid drops from the overflow hole.

If automatic transmission fluid drops: Confirm the automatic transmission fluid at temperature between 35-45°C with oil temperature sensor and wait until automatic transmission fluid does dribble out from overflow plug.

10. Coat a new "O" ring with automatic transmission fluid, and install it to the fill plug.
11. Using a hexagon wrench, install the overflow plug.

NOTE: **Be sure to wipe off spilled automatic transmission fluid completely after tighten fill plug.**