

Transmission (07.00)

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Transmission (07.00)

Automatic Transaxle (07.01)

Description

The ZF 6HP26 automatic gearbox has the following features:

- Six forward speeds / One reverse
- A torque converter with an integral converter lock-up clutch
- Electronic shift and pressure controls
- A single planetary gear set
- A double planetary gear set
- Two fixed multi-disc brakes
- Three multi-plate clutches

All hydraulic functions are directed by electronic solenoids to control:

- Engagement feel
- Shift feel
- Shift scheduling
- Modulated torque converter clutch (TCC) applications
- Engine braking utilizing the coast clutch

The ZF 6HP26 Automatic Transmission is a six speed electronically controlled transmission comprising the basic elements of:

- A Mechatronik module (Transmission Control Module (TCM) and main control valve body assembly)
- A torque converter
- One solenoid valve and six pressure regulators

Gear selection is achieved by the control of the transmission oil flow to operate various internal clutches. The TCM operates the electrical components and provides for the control of gear selection shift pressure which increases refinement and torque converter slip control.

In the event of a system fault the TCM also provides for Failure Mode Effect Management (FMEM) to maintain maximum functional operation of the transmission with a minimum reduction in driver, passenger or vehicle safety. In the event of a total loss of control or electrical power the basic transmission functions Park, Reverse, Neutral and Drive are retained. Also 3rd or 5th gear is retained by the hydraulic system, the gear retained is dependant upon the gear selected at time of the failure.

The transmission also contains turbine and output shaft speed sensors, an internal P, R, N, D selector position sensor, and a transmission oil temperature sensor. The TCM also requires information from the shift selector module to determine when the driver has initiated manual gear selection. The TCM communicates with other electronic control modules by the controller area network (CAN).

The TCM also provides for legislated transmission diagnostics, which meet the requirements of CARB OBDII legislation, monitoring all components, which may effect vehicle emissions. Additional diagnostic functions are also supported to ensure fast repairs of all failures in the service environment.

Engine power transfers to the transmission by a torque converter with integral converter lock-up clutch. Six forward gears and one reverse gear are obtained from a single planetary set followed by a double planetary set also known as lepelletier-type gear sets, these gear sets make it possible to obtain the six forward gears.

Cooling

The Auto transmission has an external cooling circuit which prevents overheating of the transmission oil. A pump mounted in the gearbox, working on engine speed variation, pumps the transmission oil around the radiator and back to the transmission.

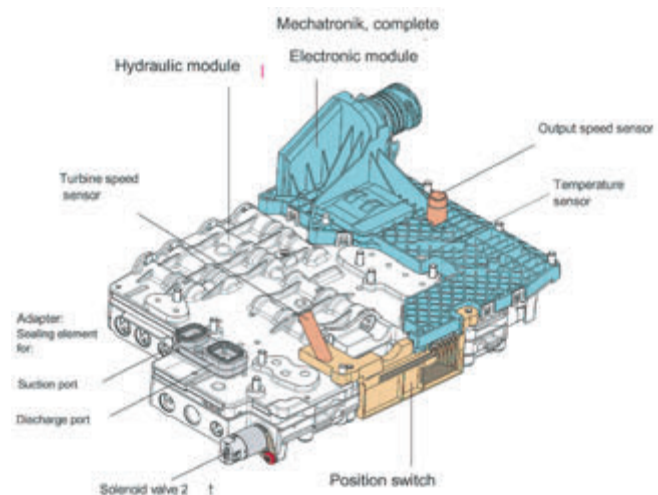
A thermostat (Wax / Poppet type), close to the gearbox inlet / outlet, controls the oil temperature, operating at a range of 74°C - 88°C.

Mechatronic module

The Mechatronik module is located in the sump of the automatic gearbox. It contains electrical actuators and sensors as well as hydraulic valves which, acting in conjunction with the TCM, perform gear changes.

The electromechanical components are arranged in such a way that they may be replaced while the automatic gearbox is installed in the vehicle.

(Refer to 'Automatic Control System (07.05)', page 7-4-1)



Specifications

Gearbox

Type

6 speed ZF 6HP26 automatic transmission and torque converter

Weight

Complete with transmission oil - 89 kg (196.25 lbs) approx.

Control System

Electrohydraulic (Mechatronic)
Controlled on-load shifts
Various shift programs available

Torque Converter

Controlled-slip lock-up clutch in gears 1 - 6 and reverse.

Transmission oil

ATF Shell M1375.4

Transmission Qty. 10 Ltr (17.06 pt. / 10.57 US qts.)

Coolant system Qty. 1.6 Ltr (2.8 pt. / 1.7 US qts.)

The ZF 6HP26 automatic transmission is 'filled for life' at manufacturer and will not normally require any servicing.

Gear Ratios

1st	2nd	3rd	4th	5th	6th
4.17:1	2.34:1	1.52:1	1.14:1	0.87:1	0.69:1
Reverse					
3.40:1					

Maximum Towing Distance

150 km (93 miles) at a maximum speed of 70 km/h (43 mph)

Torque Figures

Description	Nm.	lb. / ft.
Transaxle to Mounting Brackets	20-30	15-22.5
Mechatronics Unit	8	6
Sump	7-9	5.5-7
Gearbox to Differential Adaptor Plate	52-75	38.5-55.5
Subframe cross-member	85	63

Differential

Type

Graziano AM803D

Weight

Complete with differential oil - 47.25 kg (104 lbs) approx

Differential oil

Shell 'Transaxle' oil 75W/90

Gearbox Qty. 1.7 Ltr (3 pt. / 1.8 US qts.)

Coolant system Qty. 0.7 Ltr (1.2 pt. / 0.7 US qts.)

The automatic transaxle differential is 'filled for life' at manufacturer and will not normally require any servicing.

Torque Figures

Description	Nm.	lb. / ft.
Differential Housing Cover (bolts smeared with Loctite 242)	35	26
Output Shaft Cover	10	7.5
Sump Plug	49	36.5
Fill Plug	49	36.5
End Cover	30	22.5

Maintenance

Transmission Oil Check / Top Up

The ZF 6 HP26 automatic transmission is 'filled for life' at manufacturer and will not normally require any servicing.

In the event of a oil leak from the transmission cooling system, the leak must be repaired and then the transmission oil may be replenished as follows:

⚠ Warning ⚠

Observe all transmission oil manufacturers safety instructions when draining and refilling the automatic transmission.

Before doing any work to the transmission oil level setting make sure that:

- The car is on a horizontal ramp
- The rear wheels are standing still for a minimum of 2 minutes before starting the oil level check and during the process, e.g. by applying the hand brake
- The transmission sump temperature is between 30°C-50°C (86°F-122°F) when opening the filling plug and whilst checking oil level
- Positions Reverse and Drive have been engaged for a minimum of 3 seconds with **rear wheels braked** before a setting is carried out
- The TCM is not in limp home mode

1. Remove the rear under tray.

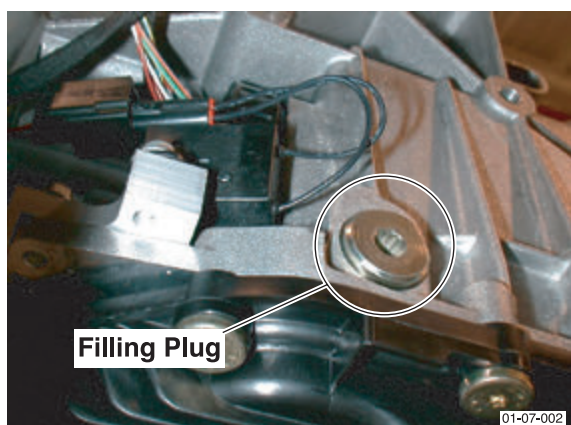
⚠ Warning ⚠

While the engine is running ensure that an exhaust extractor system is attached to the exhaust system.

⚠ Warning ⚠

Do not breathe exhaust fumes. Exhaust fumes contain carbon monoxide. Carbon monoxide is a dangerous gas, which is colourless and odourless and can cause unconsciousness and may be fatal.

2. Remove the RH exhaust pipe.
3. Run the engine between 600 and 750 rpm.
4. Place a suitable container to hold any oil that may come from the opening.
5. Remove the fill plug (rear RH side of the transmission) immediately after starting up the engine.



6. Top up oil level with transmission oil (Refer to 'Specifications', page 7-1-3), until transmission oil drains out of the bore. Stop topping up.
7. Wait until the out coming transmission oil starts dribbling, but at least 1(one) minute or the oil reached 50°C (122°F).
8. Install the fill plug and make sure that the sump temperature has not exceeded 50°C (122°F).
9. Install the RH exhaust pipe. Install the rear under tray.
10. **To ensure that the gearbox and coolant system has been fully charged**, complete a test drive. Ensure that the transmission cooling thermostat fully opens (75°C (167°F)).
11. Check the transmission oil level.

Differential Oil Check / Top Up

The Graziano differential is 'filled for life' at manufacturer and will not normally require any servicing.

In the event of a oil leak from the differential cooling system, the leak must be repaired and then the differential oil may be replenished as follows:

⚠ Warning ⚠

Observe all differential oil manufacturers safety instructions when draining and refilling the differential.

Before doing any work to the differential oil level setting make sure that:

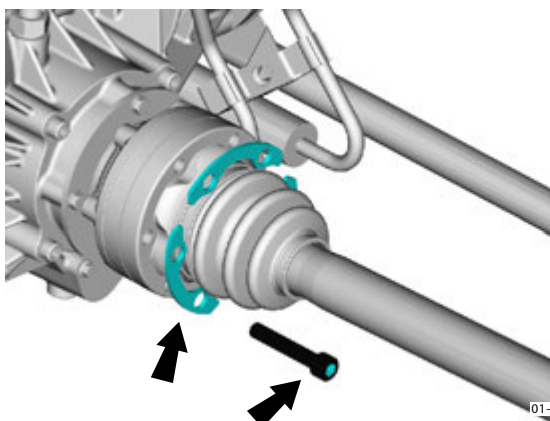
- The car is on a horizontal ramp
 - The rear wheels are standing still for a minimum of 2 minutes before starting the oil level check and during the process, e.g. **by applying the hand brake**
 - Ensure the vehicle has run a short distance to ensure that the differential cooling system has been completely filled
1. Remove the rear under tray.
 2. Place a suitable container to hold any differential oil that may come from the opening.
 3. Remove the fill plug.
With the fill plug removed the differential oil should just 'dribble' from the opening in the side of the differential.
 4. If required fill the differential with the specified oil until oil 'dribbles from the hole (Refer to 'Specifications', page 7-1-3).
 5. Install the rear under tray.

Automatic Transaxle

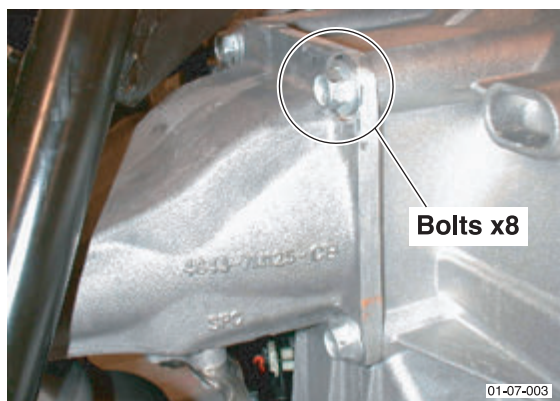
Repair Operation Time (ROT)	
Item	Code
Automatic Transaxle Renew	07.01.AB

Removal

1. Remove the rear subframe complete with the transaxle (Refer to 'Rear Subframe', page 2-1-4).
2. Remove bolts (x6) and washer tabs (x3) from each halfshaft. Discard bolts.
Withdraw the halfshafts.



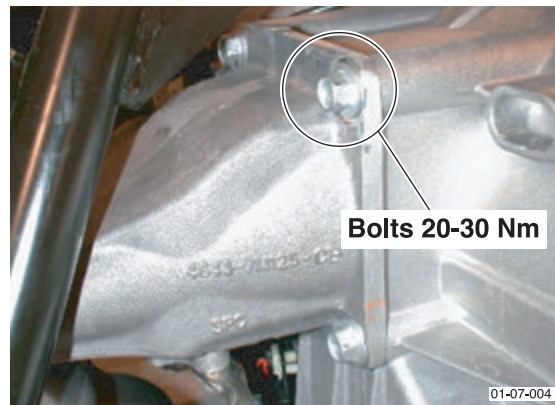
3. Using suitable lifting equipment, i.e. hydraulic ramp and sling, support the transaxle from above.
4. Remove the transaxle from it's mounts.



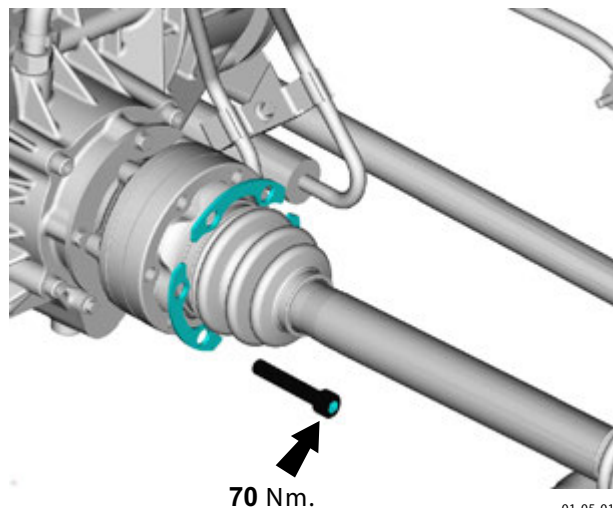
5. Withdraw the transaxle from the subframe.

Installation

1. Using suitable lifting equipment, i.e. hydraulic ramp and sling, place the transaxle to the subframe.
2. Install the transaxle to it's mounting brackets.
Torque bolts (x4) on each mount to **20-30 Nm**.



3. Place the halfshafts up to the differential outputs.



4. Install the washer tabs (x3) and **new** bolts (x6) to each halfshaft. Torque bolts to **70 Nm**.

New bolts should have a thread lock coating.

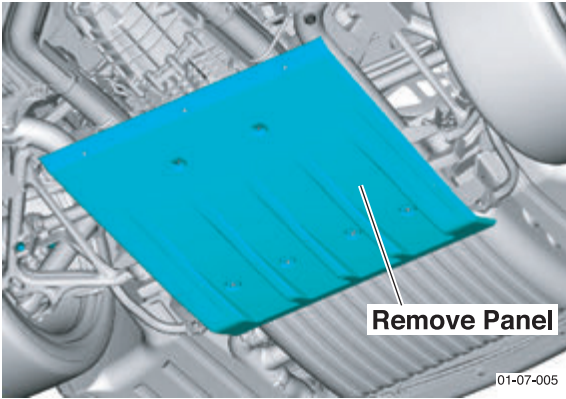
5. If removed. Install the torque converter.
6. Install the rear subframe complete with transaxle to the vehicle (Refer to 'Rear Subframe', page 2-1-4).
7. Top-up the transmission oil (Refer to 'Transmission Oil Check / Top Up', page 7-1-4).
8. Run the engine and place gear selector lever in each position for at least 10 seconds. Stop the engine.
9. Check and, if required, top-up the transmission oil.

Mechatronik Unit

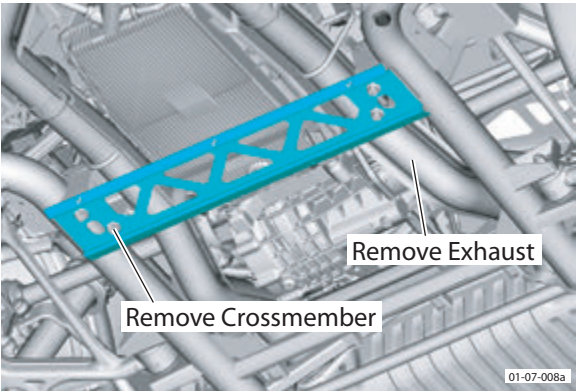
Repair Operation Time (ROT)	
Item	Code
Mechatronik Unit Renew	TBA

Removal

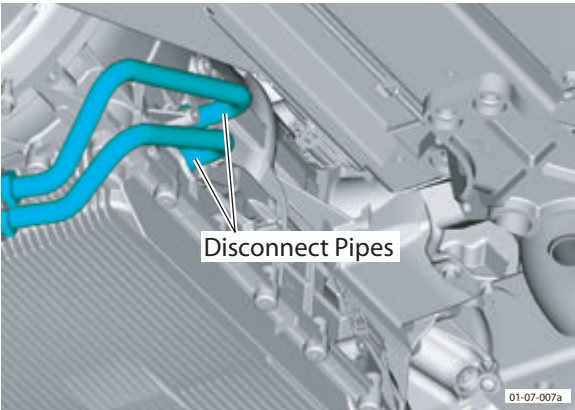
1. Remove the rear undertray.



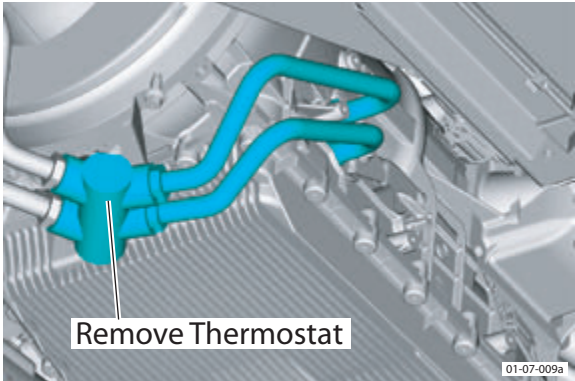
2. Remove the subframe crossmember.



3. Drain the gearbox oil.
4. Remove LH rear exhaust pipe.
5. Disconnect the coolant pipes from the gearbox.



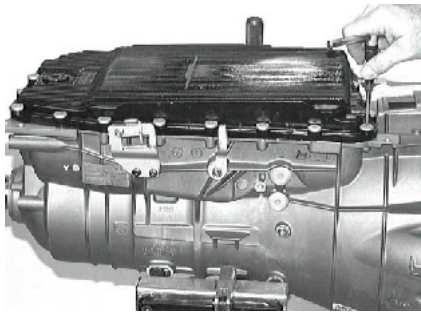
6. Remove the oil thermostat complete with gearbox side coolant pipes (Refer to 'Thermostat (Automatic Gearbox)', page 7-2-2).



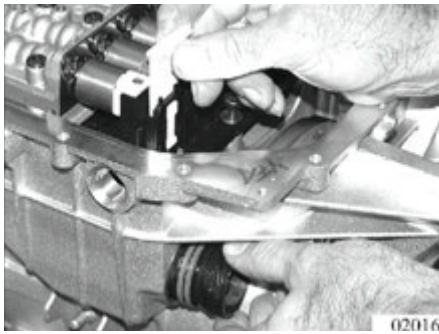
7. Remove the gearbox Capacitor.

The following images are taken from the ZF repair manual.

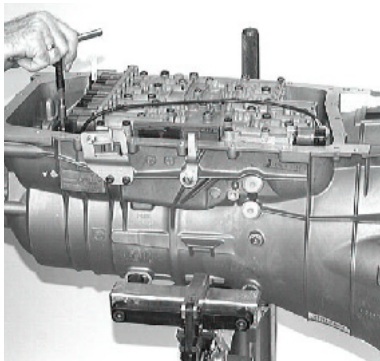
8. Remove screws (x21) that secure the sump. Withdraw the sump. Discard the 'O'-ring seal and the gasket.



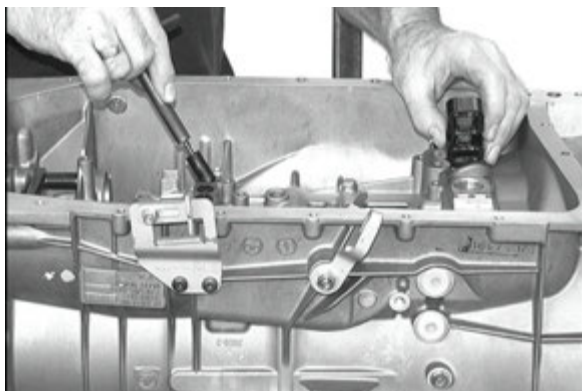
9. Remove the electric socket.



10. Remove screws (x10 large head M6) and lift off the Mechatronik unit.

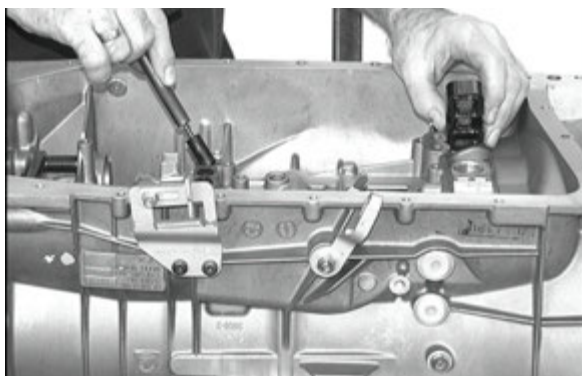


11. Remove the Mechatronik unit seals.

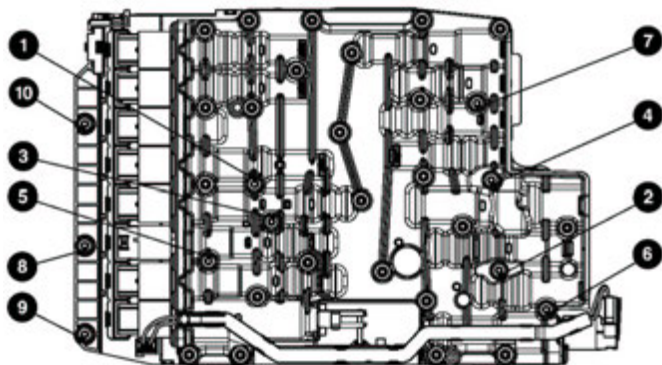


Installation

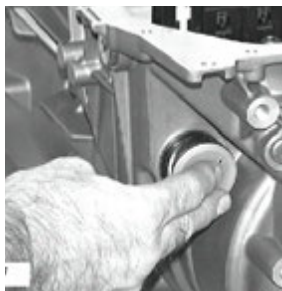
1. Install new Mechatronik unit seals.



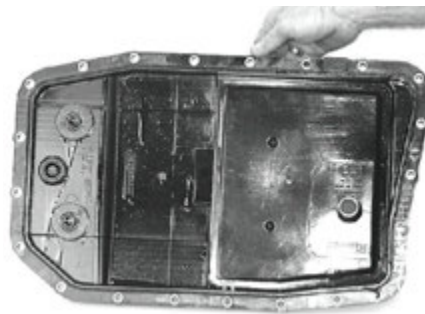
2. Install the Mechatronik unit, press on by hand. Torque bolts, in sequence (detailed below), to **8 Nm**.



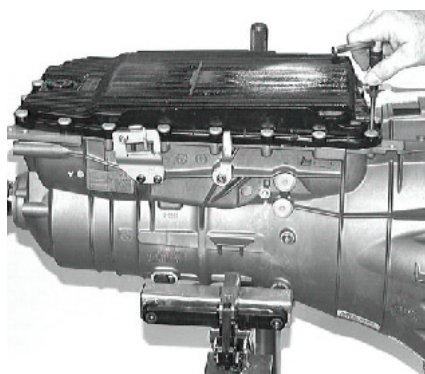
3. Press in the new electric socket with the Mechatronik unit screw plug attached. Secure with the retaining clip.



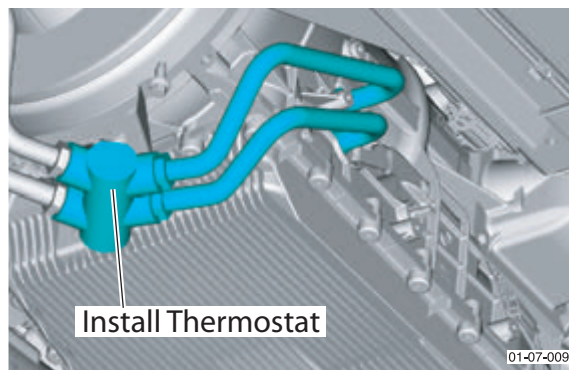
4. Install a new 'O'-ring seal onto stub pipe of the transmission oil filter. Press the new seal into the sump.



5. Install the gearbox capacitor.
6. Install the sump (screws x21). Torque to **7-9 Nm**.

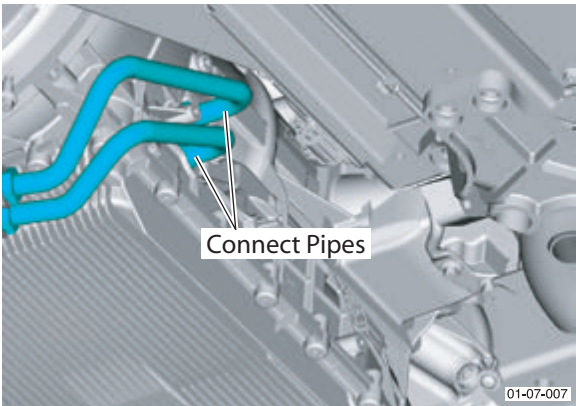


7. Insert a new drain plug. Torque plug to **9 Nm**.
8. Install the oil thermostat complete with gearbox side coolant pipes.

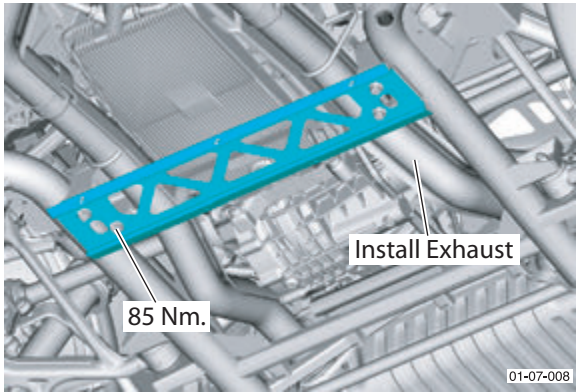


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9. Connect the coolant pipes to the gearbox. Torque bolt to **20-25 Nm**.



10. Install the LH rear exhaust pipe.
11. Install the subframe crossmember. Torque bolts to **85 Nm**.



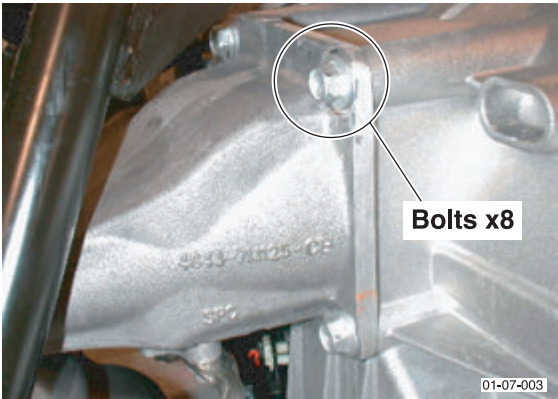
12. Top-up the gearbox oil (Refer to 'Transmission Oil Check / Top Up', page 7-1-4).
13. Run the engine and place gear selector lever in each position for at least 10 seconds. Stop the engine.
14. Check and, if required, top-up the gearbox oil.
15. Install the rear undertray.

Differential

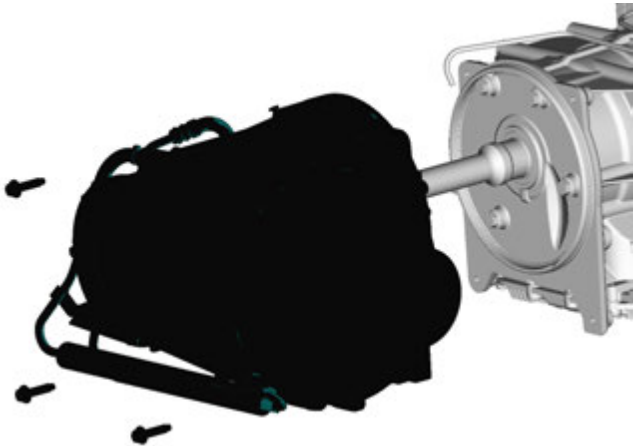
Repair Operation Time (ROT)	
Item	Code
Differential Renew	05.02.AB

Removal

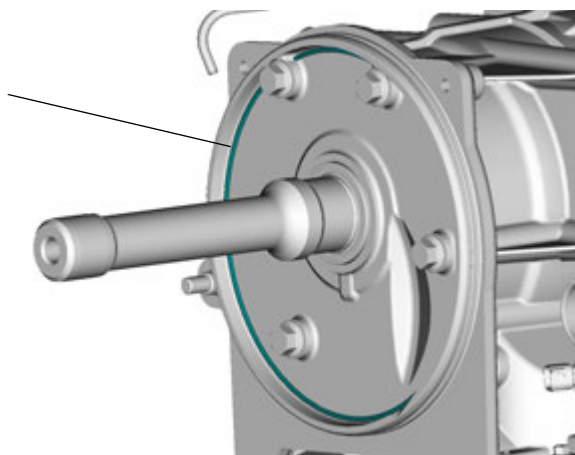
1. Remove the rear subframe complete with the transaxle (Refer to 'Rear Subframe', page 2-1-4).
2. Using suitable lifting equipment, i.e. hydraulic ramp and sling, support the transaxle from above.
3. Remove the transaxle from it's mounts. Withdraw the transaxle from the subframe.



4. Remove the bolts (x4) that secure the differential to the gearbox. Withdraw the differential.



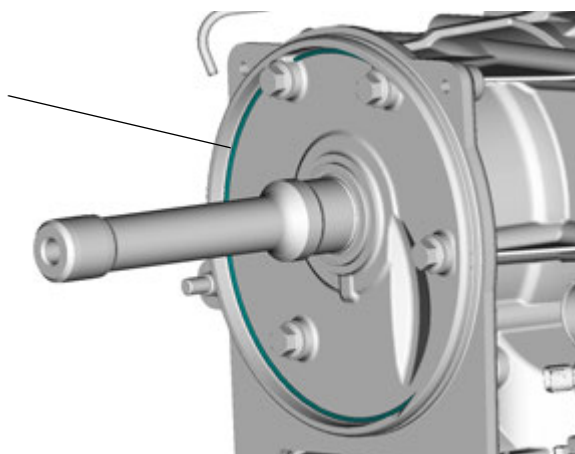
- Remove the 'O' ring.



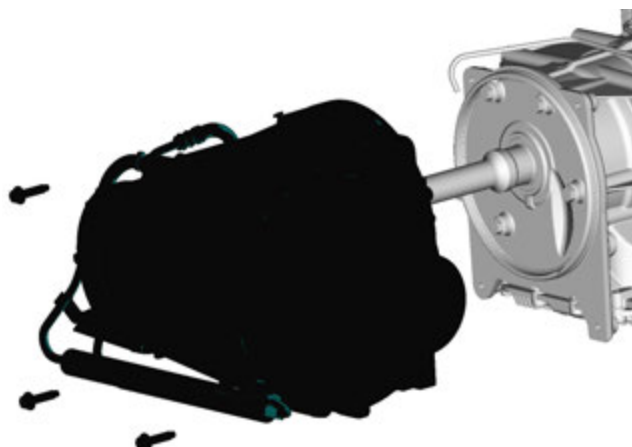
Installation

- Install a new 'O' ring.

Ensure that the 'O' ring is not twisted when installed. Look for the line running along the 'O' ring for guidance.

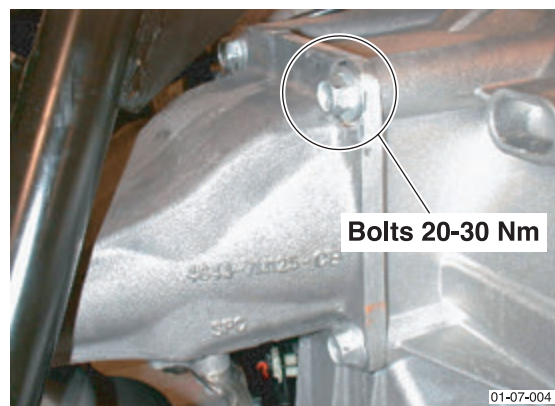


- Install the differential. Torque the bolts to **52-75 Nm**.



- Using suitable lifting equipment, i.e. hydraulic ramp and sling, place the transaxle to the subframe.

- Install the transaxle to its mounting brackets.
Torque bolts (x4) on each mount to **20-30 Nm**.



- If removed. Install the torque converter.
- Install the rear subframe complete with transaxle to the vehicle (Refer to 'Rear Subframe', page 2-1-4).
- Check / Top-up the differential oil (Refer to 'Differential Oil Check / Top Up', page 7-1-4).
- Check and, if required, top-up the transmission oil.

Differential Output Seal (LH)

Repair Operation Time (ROT)	
Item	Code
Differential Output Seal (LH) Renew	TBA

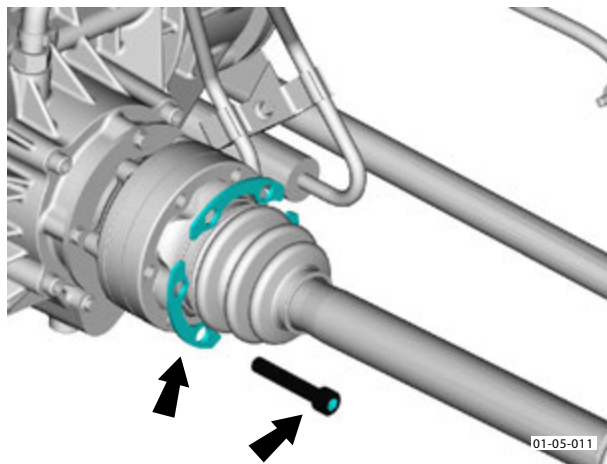
If replacing both LH and RH seals at the same time, change the LH seal first.

When replacing the RH seal the LH output shaft will hold the differential unit in place.

Removal

- Disconnect the vehicle battery.
- Raise the vehicle and make safe.
- Remove the LH road wheel and road wheel arch liner.
- Remove the rear undertray.
- Remove the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
- Remove the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
- Drain the differential oil.

8. Remove the halfshaft bolts (x6) and washers (x3).
Withdraw the halfshaft.



9. Remove bolts (x4).



10. Attach a slide hammer and withdraw the output shaft cover complete with output shaft and bearing. Discard the 'O' ring.

The oil pump impeller ring may come out with the output shaft. Ensure that the oil pump impeller ring is correctly locate on install.

11. Remove the circlip and withdraw the bearing.



12. Remove the seal.

Installation

1. Install a new seal. Push the seal in until it seats against the lip in the casing. Smear the lip with a small amount of grease.
2. Place the output shaft through the seal casing. Install the bearing and circlip.

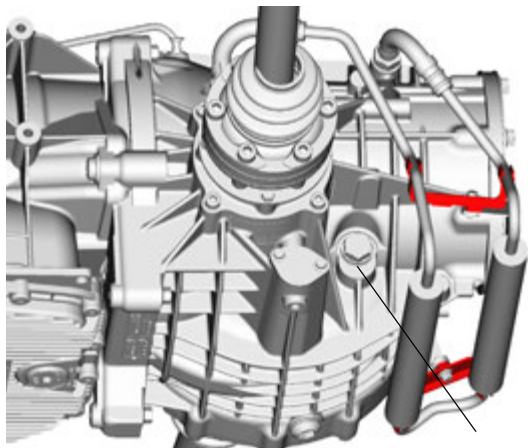


3. Install a new 'O' ring to the seal casting.
4. Install the output shaft cover complete with output shaft and bearing. Install bolts (x4), torque to **10 Nm**.

Insert the output shaft through the inner oil pump ring. Take care to locate the splines of the output shaft through the oil pump inner ring.

5. Install the halfshaft. Torque bolts (x6) to **70.5 Nm**.
6. Install the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
7. Install the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).

8. Ensure the drain plug is installed (Torque **49 Nm.**). Fill the differential with the specified oil (Refer to 'Specifications', page 7-1-3).



10. Remove the circlip. Remove the output shaft complete with bearing.

9. Install the road wheel arch and road wheel (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7).
10. Run the vehicle a short distance to ensure that the differential cooling system has been completely filled. Check / Top if required.
11. Install the undertray.



Differential Output Seal (RH)

Repair Operation Time (ROT)	
Item	Code
Differential Output Seal (RH) Renew	TBA

Removal

1. Disconnect the vehicle battery.
2. Raise the vehicle and make safe.
3. Remove the RH road wheel and road wheel arch liner.
4. Remove the rear undertray.
5. Remove the brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
6. Remove the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
7. Drain the differential oil.
8. Remove the halfshaft bolts (x6) and washers (x3). Withdraw the halfshaft.
9. Remove bolts (x12), attach a slide hammer and withdraw the differential housing cover complete with output shaft. Discard the 'O' ring.



11. Remove the 'O' rings (x2).



3. Install new 'O' rings (x2)



12. Remove the seal.

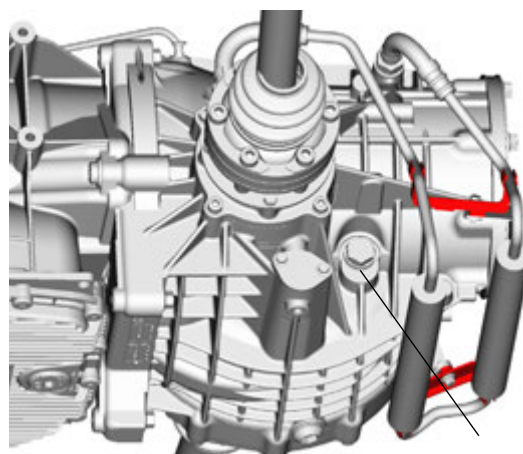


4. Install the differential housing cover. Install bolts, smeared with Loctite 242 (x12). Torque bolts to **35 Nm**.
5. Ensure the drain plug is installed (Torque **49 Nm**). Fill the differential with the specified oil (Refer to 'Specifications', page 7-1-3).

Installation

1. Install a new seal. Push the seal in until it seats against the lip in the casting. Smear the lip with a small amount of grease.
2. Place the output shaft through the differential housing cover. Install the bearing circlip.

Place a support under the casting bearing race and press the output shaft to its seat. Ensure that the bearing race does not move - shims may be disturbed.



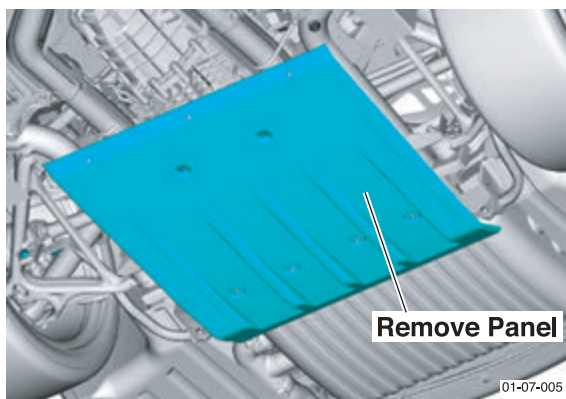
6. Install the halfshaft. Torque bolts (x6) to **70.5 Nm**.
7. Install the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
8. Install the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
9. Install the road wheel arches and road wheels (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7).
10. Run the vehicle a short distance to ensure that the differential cooling system has been completely filled. Check / Top if required.
11. Install the undertray.

Differential Oil Filter

Repair Operation Time (ROT)	
Item	Code
Differential Oil Filter Renew	TBA

Removal

1. Remove the rear undertray.



2. Drain the differential oil.
3. Remove bolts (x2). Withdraw the gauze filter.



Installation

1. Install the oil filter complete with a new 'O' ring. Torque bolts to **5 Nm**.
2. Ensure the drain plug is installed (Torque **49 Nm**.). Fill the differential with the specified oil (Refer to 'Specifications', page 7-1-3).

Run the vehicle a short distance to ensure that the differential cooling system has been completely filled. Check / Top if required.

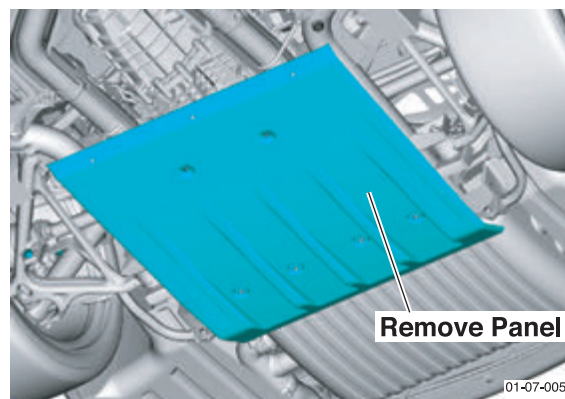
3. Install the undertray.

Differential Speed Sensor

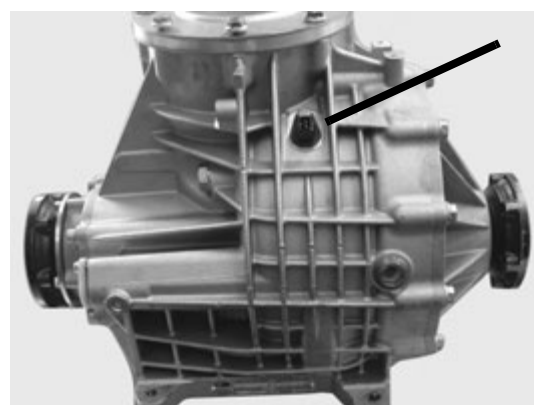
Repair Operation Time (ROT)	
Item	Code
Differential Speed Sensor Renew	TBA

Removal

1. Remove the rear undertray.



2. Place a suitable container to hold any differential oil that may come from the opening.
3. Disconnect the speed sensor. Remove the speed sensor.



Installation

1. Install the speed sensor. Torque bolt to **10 Nm**.
2. Connect the wiring harness plug.
3. Check / Top-up the differential oil (Refer to 'Differential Oil Check / Top Up', page 7-1-4).
4. Install the undertray.



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Transmission (07.00)

Transmission Cooling (07.02)

Specifications

Thermostat	°C	°F
Oil cooler thermostat range (Auto only)	74° - 88°	165° - 190°

Torque Figures

Description	Nm.	lb. / ft.
Cooler Matrix (auto)	8-10	6-7.5
Cooler to subframe (manual)	8-10	6-7.5

Maintenance

Oil Cooler (Automatic Gearbox)

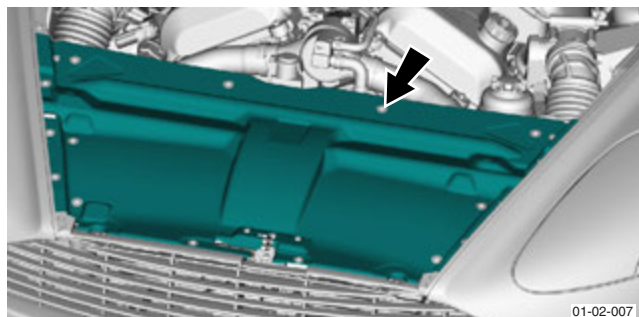
Repair Operation Time (ROT)	
Item	Code
Oil Cooler (Automatic Gearbox) Renew	07.02.AB

Removal

1. Remove the front undertray.

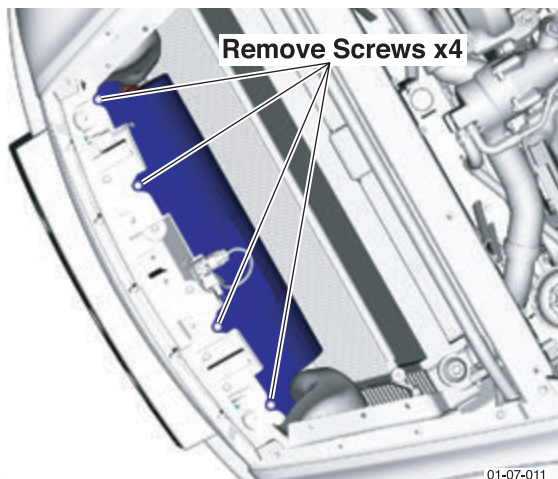
The air intake for the alternator is located in the front under tray.

2. Remove the front bumper (Refer to 'Front Bumper', page 1-13-1).
3. Remove the 'Slam' panel.

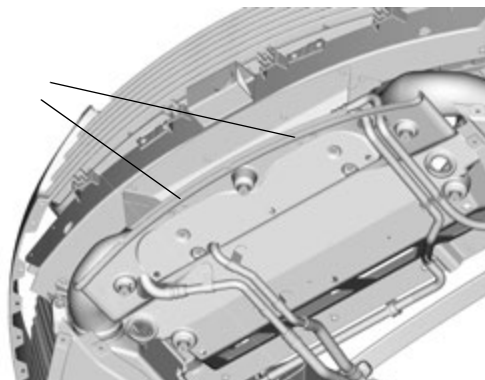


4. Remove screws (x4) that secure the top of the grill divider.

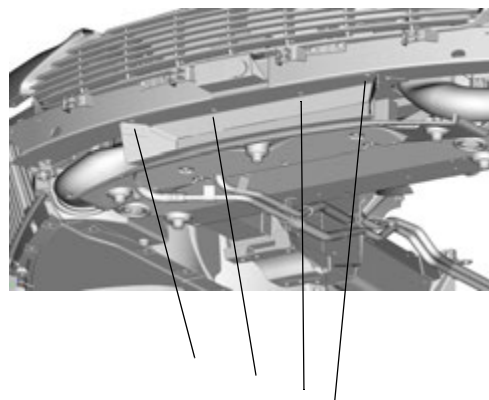
To gain access to the cooler top hose.



6. Remove the PAS cooler securing bolts. Move the PAS cooler to one side.



7. Remove the cooler matrix air duct.



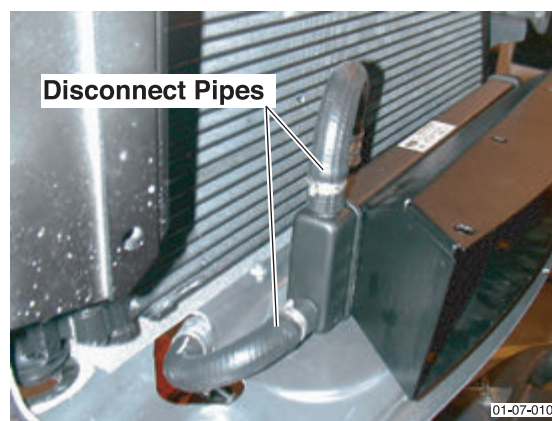
⚠ Warning ⚠

Ensure that the transmission oil has cooled before removing the cooler matrix pipes. The transmission oil operates at very high temperatures.

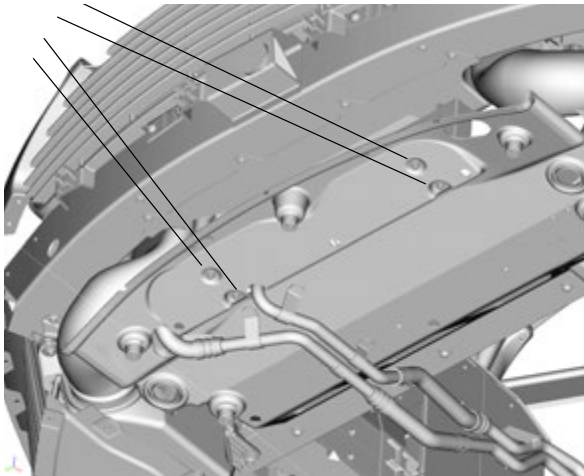
8. Disconnect the cooler matrix pipes (x2). Cap the open ends.

Some transmission oil will drain as the pipes are removed.

The air intake pipe will restrict access to the cooler matrix pipes.



9. Remove bolts (x4) that secure the cooler matrix.
Withdraw the cooler matrix.



Installation

1. Install the cooler matrix. Torque bolts (x4) to **8-10 Nm**.
2. Connect the cooler matrix pipes (x2).

The air intake pipe will restrict access to the cooler matrix pipes.

Access the top cooler matrix pipe through the grill divider.

- Use new 'Oetiker' hose clips when reconnecting hoses.
3. Install screws (x4) that secure the top of the grill divider.
 4. Install the cooler air duct.
 5. Install the PAS cooler.
 6. Install the bumper (Refer to 'Front Bumper', page 1-13-1).
 7. Install the undertray.
 8. Run the engine to prime the cooling circuit.
 9. Check / Top up the transmission oil with the specified transmission oil (Refer to 'Transmission Oil Check / Top Up', page 7-1-4).

Thermostat (Automatic Gearbox)

Repair Operation Time (ROT)	
Item	Code
Thermostat (Automatic Gearbox) Renew	TBA

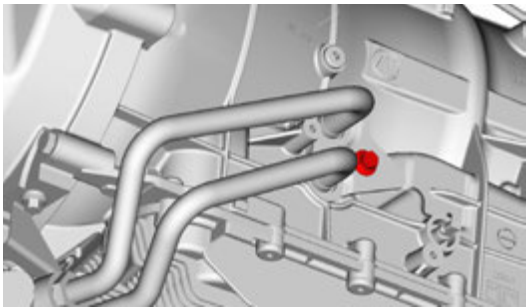
Remove

⚠ Warning ⚠

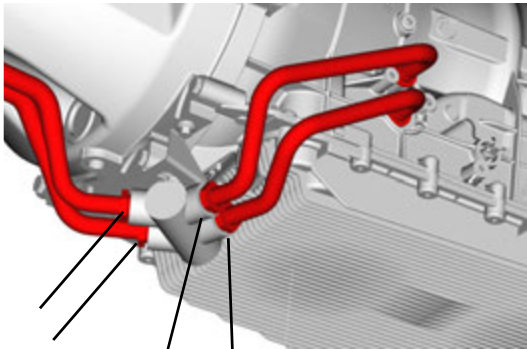
Ensure that the transmission oil has cooled before removing the cooler matrix pipes. The transmission oil operates a very high temperatures.

1. Remove the cooling pipes clamp.

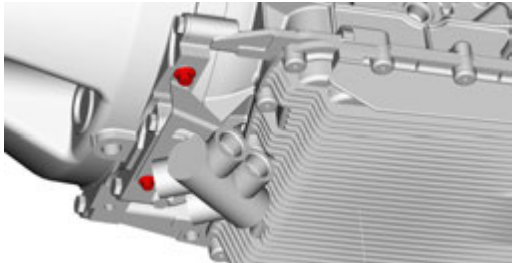
Some transmission oil will start to drip.



2. Remove the gearbox cooling pipes. Plug the open ends.

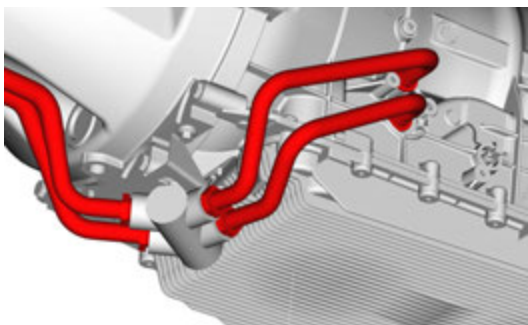


3. Remove the thermostat and bracket assembly from the gearbox.

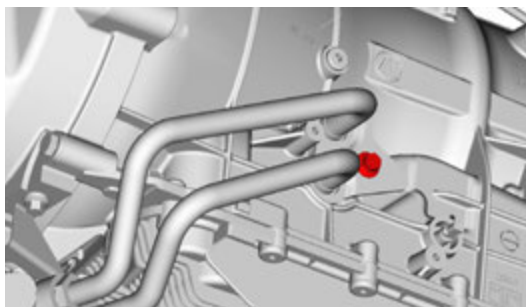


Installation

1. Install the thermostat and thermostat bracket assembly to the gearbox.
2. Connect the cooling pipes. Ensure that the 'O' ring is correctly located in each pipe union.
Torque each union to **20 Nm**.



3. Install the pipe clamp. Torque bolt to **20-25 Nm**.



4. Run the engine to prime the cooling circuit.
5. Check / Top up the transmission oil with the specified transmission oil (Refer to 'Transmission Oil Check / Top Up', page 7-1-4).

Oil Cooler (Automatic Transaxle Differential)

Repair Operation Time (ROT)

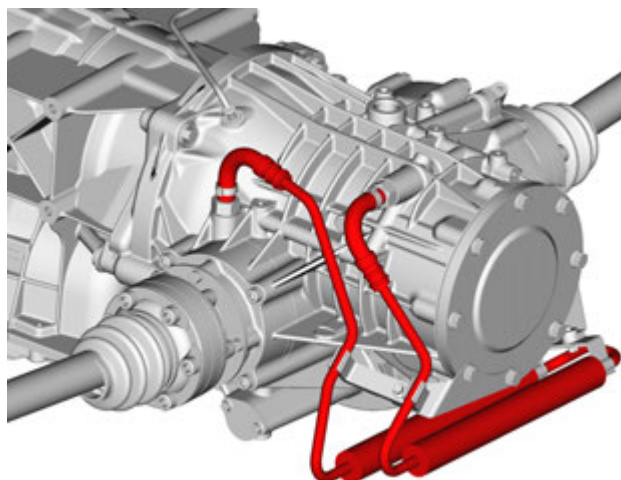
Item	Code
Oil Cooler (Automatic Transaxle Differential) Renew	TBA

Removal

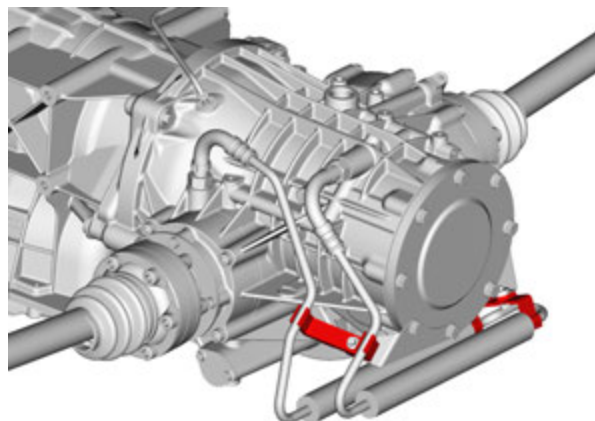
1. Disconnect (quick release) the coolant pipes.

Some transmission oil will start to drip.

Cap the open ends.



2. Remove the bolts (x2) securing the coolant pipes brackets. Withdraw the oil cooler.



Installation

1. With the coolant pipes clipped into their brackets, secure the coolant pipe brackets.
2. Connect the coolant pipes.
3. Run the engine to prime the cooling circuit.
4. Check / Top up the differential with the specified differential oil (Refer to 'Specifications', page 7-1-3).

Oil Cooler (Manual Transaxle)

Repair Operation Time (ROT)	
Item	Code
Oil Cooler (Manual Transaxle Renew	TBA

Removal

1. Disconnect the coolant pipes.

Some transmission oil will start to drip.

Cap the open ends.

Image to Follow

2. Remove bolts (x2) securing the oil cooler to the subframe. Withdraw the oil cooler.

Image to Follow

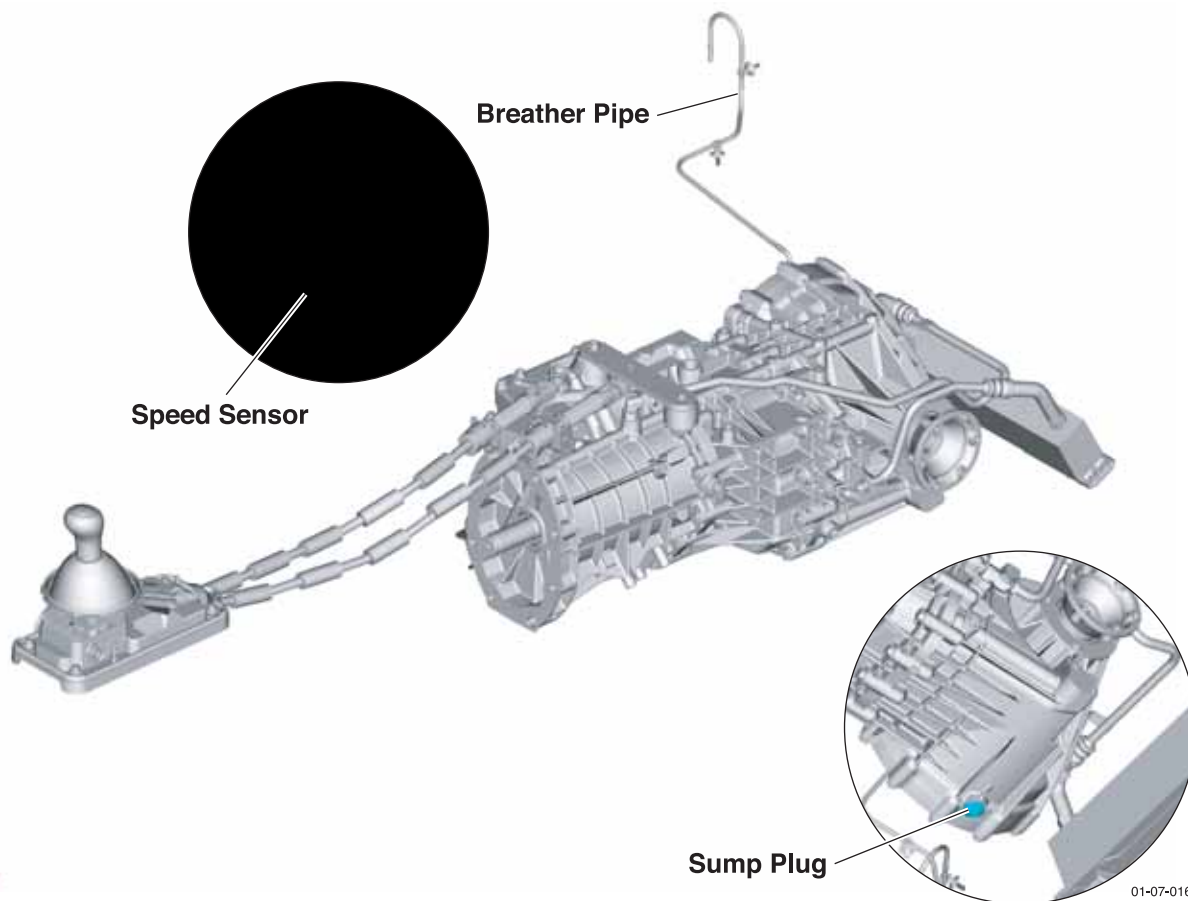
Installation

1. Install the oil cooler to the subframe.
Torque bolts to **8-10 Nm**.
2. Connect the coolant pipes.
3. Run the engine to prime the cooling circuit.
4. Check / Top up the transmission oil with the specified transmission oil (Refer to 'Manual Transmission (07.03)', page 7-3-1).

Transmission (07.00)

Manual Transmission (07.03)

Description



The Graziano AM803T transaxle installed to this vehicle incorporates a six speed transmission, with synchromesh on all gears. Gear selection is by a twin cable system (shift and select) operating an integrated bellcrank and H gate.

Cooling

The manual transaxle has an external cooling circuit which operates continuously by a fixed displacement pump driven by the input shaft.

The cooler is mounted at the rear attached to the subframe.

Specifications

Type

Graziano AM803T transaxle with:

- Integrated Bellcrank Assembly
- Integrated Reverse Switch
- Plate Type Limited Slip Differential

Synchronisers

Triple Cone Syncros on 1st and 2nd, double cone on all other gears incl. reverse.

Lubrication

Forced Lubrication system with integral pump and filter (filter is serviceable item)

Transaxle Oil

Shell Transaxle Oil, Fully Synthetic 75W 90

Transaxle Qty. 4 ltr. (7 pt. / 4.2 US qts.)

Coolant System Qty. 0.5 ltr (0.9 pt. / 0.53 US qts.)

Transaxle + Coolant Qty. 4.5 ltr (7.9 pt. / 4.6 US qts.)

Gear Ratios

1st	2nd	3rd	4th	5th	6th
3.154:1	1.947:1	1.435:1	1.148:1	0.935:1	0.758:1
Reverse					
2.385:1					

Differential Locking Ratio

20% Drive, 60% Coast

Torque Figures

Description	Nm.	lb. / ft.
Speedo sensor to cover plate	7	5.5
Sump plug	49	36.5
LH Output shaft housing	10	7.5
Halfshaft	70	52
Differential Cover	35	26

Maintenance

Oil Check and Top-up

The transaxle is filled for life and would only require checking and topping-up in the event of a oil leak or strip down of the transaxle cooling system.

In the event of a oil leak from the transaxle cooling system, the leak must be repaired and then the transaxle oil may be replenished as follows:

Warning

Observe all transaxle oil manufacturers safety instructions when draining and refilling the manual transaxle.

Before doing any work to the transaxle oil level setting make sure that:

- The car is on a horizontal ramp
 - The engine is not running
 - The rear wheels are standing still for a minimum of 2 minutes before starting the oil level check and during the process, e.g. **by applying the hand brake**
1. Place a suitable container to hold any transaxle oil that may come from the opening.
 2. Remove the fill plug.
With the fill plug removed transaxle oil should just 'dribble' from the opening.
 3. If required fill the transaxle with the specified oil until oil 'dribbles' from the hole (Refer to 'Specifications', page 7-3-2).

Drain / Fill

1. Place a suitable container to hold the transaxle oil.
2. Remove the drain plug. Allow the oil to drain.
3. Disconnect the oil cooling pipes and allow the oil in the cooling system to drain in to the container.
4. Complete with a new sealing washer, install the drain plug. Torque plug to **49 Nm**.
5. Connect the oil cooling system pipes.
6. Fill the transaxle with the correct oil.
7. Run the vehicle a short distance to ensure that the transaxle cooling system has been completely filled. Check / Top-up.

Transaxle

Repair Operation Time (ROT)	
Item	Code
Manual Transaxle Renew	TBA

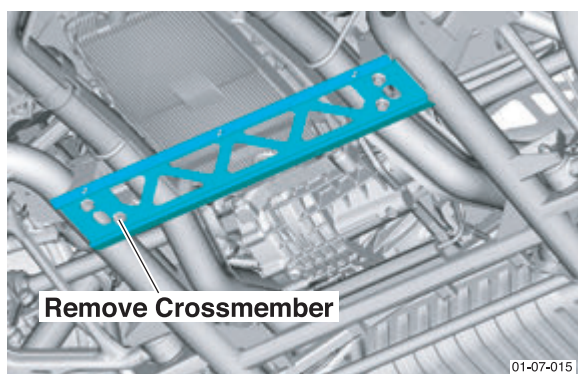
Removal

1. Raise vehicle and make safe.

Caution

On a two post ramp ensure vehicle is 'strapped' to the lift.

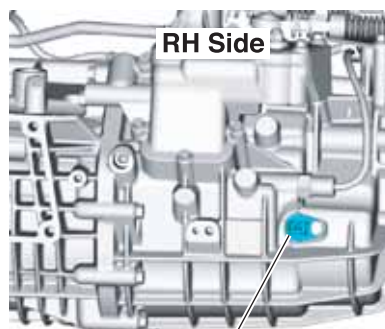
2. Remove both rear road wheels.
3. Remove the silencer and rear LH and RH exhaust pipes.
4. Remove the subframe brace.



5. Remove the halfshafts from the differential.
 - 5.1 Remove bolts (x6) and washer tabs (x3). Discard the bolts.
 - 5.2 Withdraw the halfshafts from final drive.



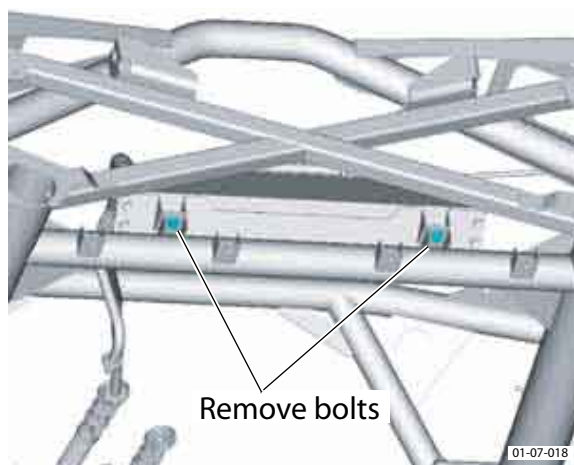
6. Disconnect the wiring harness plugs.



Disconnect the
Wiring Harness
Plugs



7. Remove the bolts that secure the oil cooler to the subframe. Withdraw oil cooler.



8. Disconnect the breather pipe from the transaxle.

The breather pipe should remain in position on the vehicle to avoid being incorrectly route on install.

Image to Follow

9. Using suitable lifting equipment, i.e. hydraulic jack and sling, support the transaxle and remove the bolts (x8 (4 each side)) that secure the transaxle to the mounts (x2). Discard the bolts.

Image to Follow

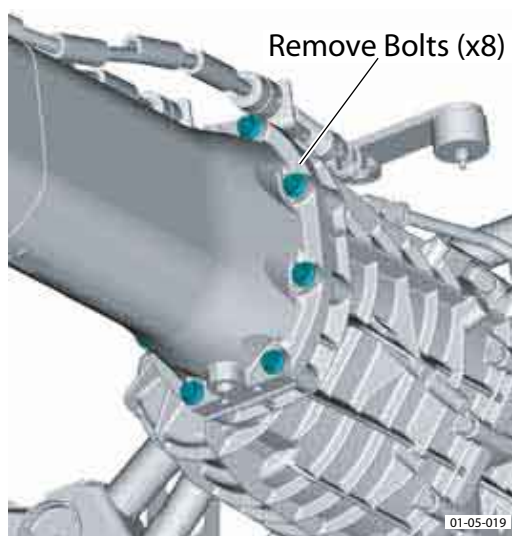
10. Lower the transaxle, using the lifting equipment, and disconnect the gear selector cables.
Use the service tool (Refer to '501-F116 (IP Removal)', page 20-1-8) to remove the horseshoe clips (x2) and lever the cables from the ball joints.

Caution

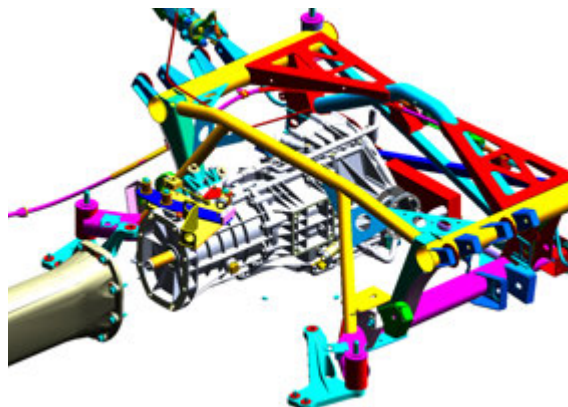
Ensure that the service tool No. TBA is used. There is a risk of bending the end of the cable. Lever cable from ball joint at a point closest to the ball joint.

Image to Follow

11. Disconnect the torque tube from the gearbox.
11.1 Ensure the torque tube is supported.
11.2 Remove bolts (x8).

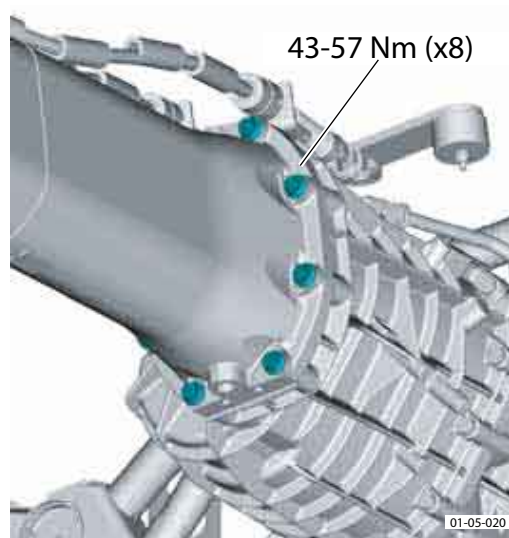


12. Withdraw the transaxle rearwards and manoeuvre transaxle out from rear subframe.



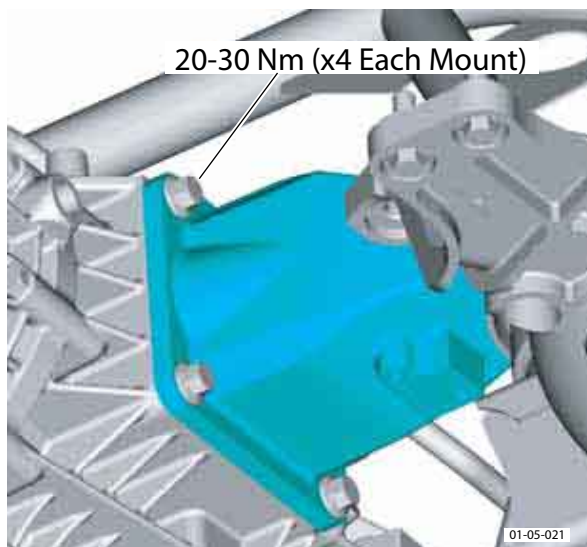
Installation

1. Using suitable lifting equipment, i.e. hydraulic jack and sling, place the transaxle up in the subframe.
2. Manoeuvre the transaxle to up to the torque tube. Install bolts (x8). Torque to **43-57 Nm**.

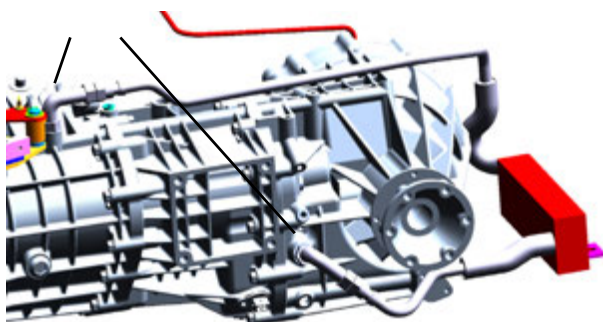


3. Connect the gear selector cables.

4. Install the transaxle to its mountings. Use **new** bolts. Torque bolts (x4 on each mount) to **20-30 Nm**. Remove the support.



5. Install the breather pipe.
6. Install the oil cooler.



7. Install the halfshafts. Torque bolts to **70.5 Nm**.
8. Install the subframe brace. Torque bolts to **85 Nm**.
9. Install the road wheels (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7)).
10. Complete a test drive to ensure correct operation.
11. Check gearbox oil level.

Differential Output Seal (LH)

Repair Operation Time (ROT)

Item	Code
Differential Output Seal (LH) Renew	TBA

If replacing both LH and RH seals at the same time, change the LH seal first.

When replacing the RH seal the LH output shaft will hold the differential unit in place.

Removal

1. Disconnect the vehicle battery.
2. Raise the vehicle and make safe.
3. Remove the LH road wheel and road wheel arch liner.
4. Remove the rear undertray.
5. Remove the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
6. Remove the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
7. Drain the differential oil.



8. Remove the halfshaft bolts (x6) and washers (x3). Withdraw the halfshaft.



9. Remove bolts (x4).



10. Attach a slide hammer and withdraw the output shaft cover complete with output shaft and bearing. Discard the 'O' ring.

11. Remove the circlip and withdraw the bearing.



12. Remove the seal.

Installation

1. Install a new seal. Push the seal in until it seats against the lip in the casing. Smear the lip with a small amount of grease.
2. Place the output shaft through the seal casing. Install the bearing and circlip.



3. Install a new 'O' ring to the seal casting.
4. Install the output shaft cover complete with output shaft and bearing. Install bolts (x4), torque to **10 Nm**.
5. Install the halfshaft. Torque bolts (x6) to **70.5 Nm**.
6. Install the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
7. Install the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
8. Ensure the drain plug is installed (Torque **49 Nm**). Fill the differential with the specified oil (Refer to 'Specifications', page 7-3-2).
9. Install the undertray.
10. Install the road wheel arch and road wheel (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7).
11. Connect the vehicle battery.

Differential Output Seal (RH)

Repair Operation Time (ROT)	
Item	Code
Differential Output Seal (RH) Renew	TBA

Removal

1. Disconnect the vehicle battery.
2. Raise the vehicle and make safe.
3. Remove the RH road wheel and road wheel arch liner.
4. Remove the rear undertray.
5. Drain the differential oil.



6. Remove the halfshaft bolts (x6) and washers (x3). Withdraw the halfshaft.
7. Remove bolts (x12), attach a slide hammer and withdraw the differential housing cover complete with output shaft.



8. Remove the 'O' rings (x2).



9. Remove the circlip. Remove the output shaft complete with bearing.



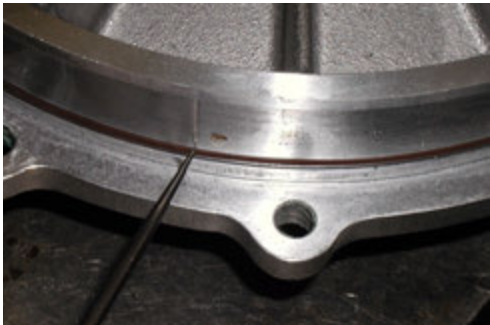
10. Remove the seal.

Installation

1. Install a new seal. Push the seal in until it seats against the lip in the casting. Smear the lip with a small amount of grease.
2. Place the output shaft through the differential housing cover. Install the bearing circlip.

Place a support under the casting bearing race and press the output shaft to its seat. Ensure that the bearing race does not move - shims may be disturbed.

3. Install new 'O' rings (x2)



4. Install the differential housing cover. Install bolts, smeared with Loctite 242 (x12). Torque bolts to **35 Nm**.
5. Ensure the drain plug is installed (Torque **49 Nm**). Fill the differential with the specified oil (Refer to 'Specifications', page 7-3-2).
6. Install the halfshaft. Torque bolts (x6) to **70 Nm**.
7. Install the vertical link (Refer to 'Rear Suspension (04.02)', page 4-3-1).
8. Install the service brake and handbrake calipers (Refer to 'Brake System (06.00)', page 6-1-1).
9. Install the undertray.
10. Install the road wheel arches and road wheels (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7).
11. Connect the vehicle battery.

Differential (Limited Slip)

Repair Operation Time (ROT)	
Item	Code
Differential (Limited Slip) Renew	TBA

Removal

1. Disconnect the vehicle battery.
2. Raise the vehicle and make safe.
3. Remove the RH road wheel and road wheel arch liner.
4. Remove the shear plate and rear undertray
5. Drain the gearbox oil.



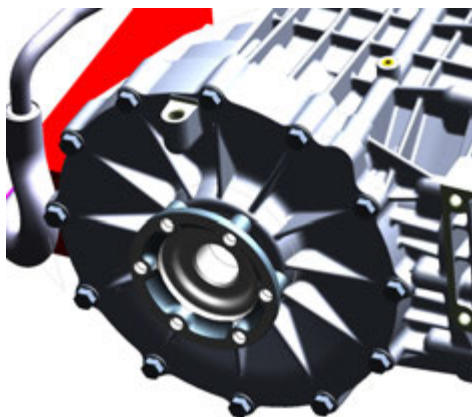
6. Remove the RH rear exhaust pipe (Refer to 'Pipes and Supports (09.03)', page 9-2-1).
7. Remove the RH halfshaft.
 - 7.1 Remove the halfshaft nut.



- 7.2 Remove bolts (x6) and washers (x3).
- 7.3 Withdraw the halfshaft.



8. Remove the differential cover.
 - 8.1 Install service tool (No.) to differential output shaft.
 - 8.2 Remove bolts (x12).



- 8.3 Withdraw the differential cover.
 - 8.4 Discard the 'O' rings (x2).
9. Remove the differential.

The differential may come out with the differential cover or it may remain in the differential housing located on the L/H output shaft.

Installation

1. Insert the differential into the differential housing.
2. Complete with new 'O' rings (x2), install the differential cover. Secure with bolts (x12). Torque bolts to **35 Nm**.
3. Install the halfshaft. Torque bolts (x6) to **70.5 Nm**.
4. Install the exhaust pipe (Refer to 'Pipes and Supports (09.03)', page 9-2-1).
5. Install the undertray and shear panel.
6. Install the road wheel arches and road wheels (Refer to 'Road Wheel Nut Torque Tightening', page 4-5-7).



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Transmission (07.00)

Automatic Control System (07.05)

Transmission controls

Push buttons, mounted on the centre console, are used to select P, R, N and D electrically. The link with the transmission shift console is electric and electronic, via the engine electronics. In addition, gear shifts can be made by using the shift paddles behind the steering wheel ('TouchTronic'). The left paddle is for down-shifts, the right paddle for up-shifts.

Gearbox Modes

Automatic - Button 'D' pressed. Standard drive program (with automatic shifts). Economical use of engine power.

Automatic-Sport - Sport button pressed. Makes full use of the engine power. Moves shifts up to higher engine speeds.

Does not use 6th rear.

TouchTronic - Paddles behind the steering wheel. Manual shifts between all gears (6, 5, 4, 3, 2 and 1). Will auto shift up when engine revs. reach maximum.

TouchTronic-Sport - Manual shifts between all gears with Sport button pressed (6, 5, 4, 3, 2 and 1). Does not auto shift up when engine revs. reach maximum.

Overview of Gearshift Procedures

Park (P)

Select 'P' only with vehicle standing still or moving very slowly (less than 2 km/h). If 'P' is selected without applying the foot brake, the DIM display will read 'PRESS BRAKE PEDAL!'

The 'shift by wire' (SBW) system also includes a mechanical emergency release (Park override) so that the vehicle can be towed away in certain circumstances.

If 'P' is selected from drive position D > 2 km/h, the transmission will read 'CANNOT SELECT PARK AT SPEED'.

Reverse (R)

Select 'R' only when the vehicle is stationary and the engine idling. 'R' can only be engaged if the foot brake has been applied. If 'R' is selected without applying the foot brake, the DIM display will read 'PRESS BRAKE PEDAL!'.

If the vehicle speed is less than approx. 5 km/h (3 mph), 'R' may be selected from 'D', without pressing the brake pedal, to enable a vehicle 'rocking' i.e. to enable vehicle movement out of mud, snow, etc. If 5 km/h (3 mph) is exceeded then the transmission will automatically select 'N'.

Neutral (N)

In neutral, there is no power flow between the engine and the automatic transmission. Apply the handbrake to prevent the vehicle from rolling away when neutral has been selected.

To select 'N' from 'P', the brake pedal must be pressed down, otherwise the DIM display will show 'PRESS BRAKE PEDAL!'. Neutral can be selected from any drive position.

Drive (D)

'D' can only be selected after pressing down the brake pedal. If position 'D' is selected without applying the foot brake, the DIM display will read 'PRESS BRAKE PEDAL!'. From 'D', D-Touch can be selected directly by moving one of the paddles behind the steering wheel.

The standard drive program is in use, with automatic shifts from 1 to 6 and 6 to 1.

The actual gear is added to the 'D' display, for example 'D1' (position D, 1st gear).

If the vehicle speed is less than approx. 5 km/h (3 mph), 'D' may be selected from 'R', without pressing the brake pedal. This enables a vehicle 'rocking' motion, i.e. to enable vehicle movement out of mud, snow, etc.

Drive (D) - Sport

The Sport program is selected at a separate push button on the centre console and must be re-activated each time the engine is started. This is a program that makes full use of the available engine power and moves the shift points farther up the engine-speed scale.

Drive (D) - TouchTronic

Gears are selected by pulling one of the two paddles behind the steering wheel.

Left paddle (-)	Right paddle (+)
Down-shift	Up-shift

The up and down shift points are protected so that the engine cannot over speed. If the '+' paddle is not operated in time, however, the transmission shifts up to the next higher gear when maximum engine speed is reached.

Pull back simultaneously on both paddles to select Neutral.

Drive (D) - TouchTronic-Sport

In contrast to 'D-TouchTronic', no up-shift takes place in 'D-TouchTronic-Sport' when the maximum engine speed is reached. In this mode (manual program / Sport button operated) no up-shift takes place if the '+' paddle is not operated. Engine over speeding will be prevented only by the governed maximum speed limit.

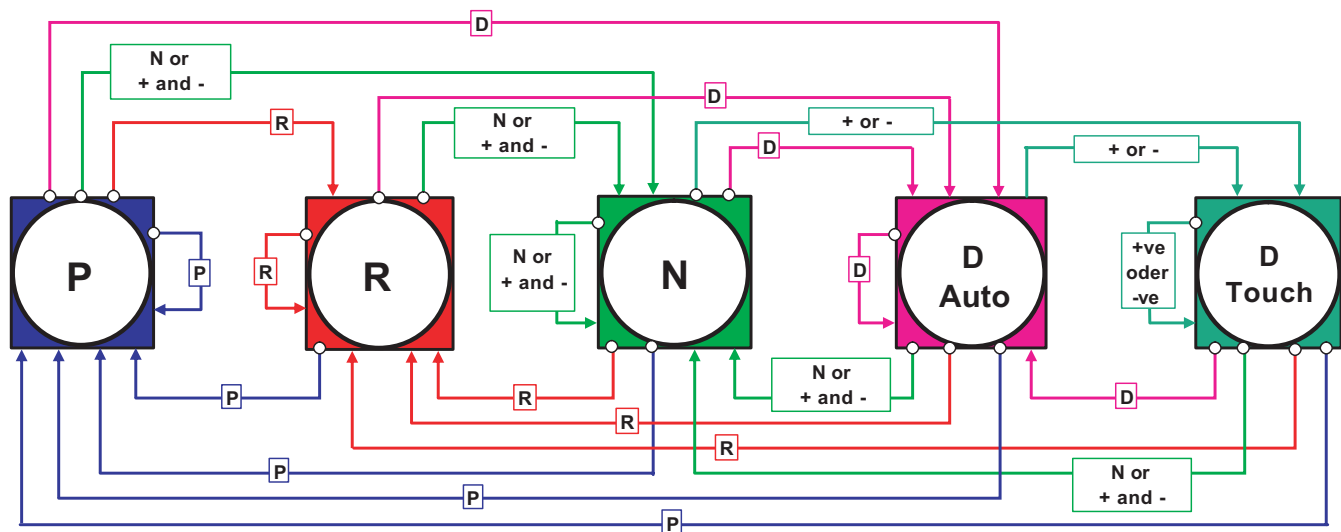
Auto-Park / Auto-Neutral

As safety features, the automatic transmission has 'Auto-Park' and 'Auto-Neutral' strategies. When certain driving situations are encountered, the automatic transmission shifts to the 'P' or 'N' positions.

Driving situations:

- If the engine stops while 'D' or 'R' is selected, but the ignition is on and the vehicle is moving, 'N' will be selected.
- If the engine is stopped and the ignition turned off while in 'D' or 'R', but the vehicle continues to roll, 'P' will be selected if the vehicle's speed is below approx. 10 km/h.
- If the engine is stopped and the ignition turned off in position 'D' or 'R', but the vehicle continues to roll, 'N' is selected above approx. 10 km/h.

This assumes that the vehicle's speed does not rise too high. These functions are performed automatically to ensure that no power can pass through the automatic transmission when the engine is restarted.



Parking Lock

The parking lock is a device that prevents the vehicle from rolling away out of control. It is engaged when 'P' is selected.

The parking lock acts by inserting a pawl into the teeth of the parking lock gearwheel on the transmission output shaft; this prevents the rear road wheels from turning by way of the propeller shaft and final drive.

The parking lock is engaged by a mechanical spring system in the transmission and secured electrically. All drive positions are also selected electrically. The detent disc in the transmission is omitted, and replaced by a parking disc and lock cylinder with solenoid valve (MV3).

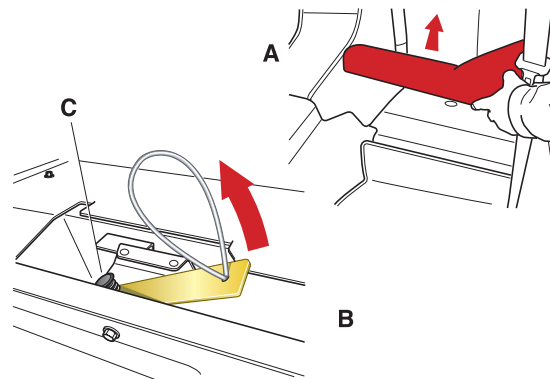
Apply the handbrake before operating the park override. There is the danger that the vehicle will roll, depending on the incline of the road.

After stopping the vehicle apply the handbrake and push back the park override lever.

Overriding the Park Lock

Apply the handbrake. Remove the LH rear seat base (A) and unscrew the two screws that secure the park override lever cover. Remove the cover.

Pull the manual park override lever (B) fully up on the ratchet, fully releasing the parking lock.



After towing or moving the vehicle apply the handbrake. Lift the manual park override lever slightly, press the ratchet release (C) and lower the manual park override lever back to the stop. The parking lock is now engaged. Install the cover and the rear seat base.

The message in the instrument pack must disappear and the position display must change from 'N' to 'P'. Otherwise there is the danger that the vehicle will roll away.

Hydraulic Shift Control Unit

The Hydraulic Shift Control Unit (Mechatronic unit) is a combination of hydraulic and electronic control (TCM) modules, which is located in the transmission, in the oil sump.

This technical principle has the following advantages:

- Minimum tolerances
- Better coordination of gear shifts
- Increased refinement
- Optimised shift quality
- Good reliability, since the number of plug connections and interfaces is reduced

Electrostatic Discharge (ESD)

Caution

When working with the transmission control module (TCM) and main control valve body, all suitable safety precautions must be taken to protect the component against electrostatic discharge (ESD). Failure to follow these instructions may result in component damage.

Make sure all possible safety precautions are taken to protect the TCM and main control valve body unit against ESD.

Personal Wrist-Band Earthing

Earthing (grounding) by means of a wrist band or strap is the most reliable method of diverting electrostatic charges away from working personnel, and should therefore be used wherever possible, particularly if the person concerned is working while seated. The wrist band earthing (grounding) device consists of a bracelet closely attached to the wrist and a spiral earthing (grounding) cable connecting it to the earthing (grounding) contact point. This system must include a quick-release device so that the wrist can be released in the event of danger.

Shoes and Foot Earthing Straps

Electrically conductive shoes should be worn by persons who mainly work standing up or either standing or sitting in ESD protection zones, particularly if wrist band earthing (grounding) is impracticable. The standard calls for ESD shoes to record values between 0 and 35 Megga-ohms (MOhm) resistance. However, for antistatic working shoes resistance values between 0.1 and 1000 MOhm are called for, and a through-conducting resistance for protective shoes of 0.1 to 100 MOhm. A lower limit value of not less than 0.1 MOhm must be maintained on account of the contact voltage risk. For this reason the minimum value has been set contrary to the standard at the higher figure of 0.75 MOhm.

Transmission Control Module (TCM)

The transmission control module (TCM) and its input / output network control the following transmission operations:

- Shift timing
- Line pressure (shift feel)
- Torque converter clutch

The TCM processes signals from the transmission, the engine and the vehicle.

From the signal inputs and the memorised data the control program computes the correct gear and converter lock-up clutch setting and the optimum pressure settings for gear shift and lock-up clutch control.

By means of special output-side modules (power output stages, current regulator circuits), the TCM controls the solenoid valves and pressure regulators and thus influences the hydraulics of the automatic transmission. In addition, the amount and duration of engine interventions are supplied to the engine management by way of the CAN bus.

Caution

Disconnection of other control modules and / or the vehicle battery, may introduce fault codes (DTCs). Following rectification and reconnection, ensure that no induced codes exist in the TCM memory.

Caution

Disconnection of other control modules and / or the vehicle battery, will cause shift adaptations to be lost; this may be apparent by slight shift quality degradation. Shift quality adaptations are made to compensate for changing transmission characteristics over time. Following reconnection, a period of adaptation will be required as the TCM re-learns the transmissions operating characteristics.

Controller Area Network (CAN) Interface

For the TCM to be able to perform shift point and shift quality management a number of external signals are required. For shift point management alone the TCM requires output speed sensor, throttle pedal position, brake pedal status and virtual gear selector position. The controller area network (CAN) bus is used to share information between control modules. The TCM obtains most of its required data over the CAN bus from the electronic engine controls, EMS, Driver inputs and ABS, Instruments pack and diagnostic tools.



TCM Inputs

Input Speed Sensor (ISS)

The input speed sensor provides transmission input shaft speed information. This signal is produced from an inductive pick-up, generating 36 pulses per revolution.

Output Speed Sensor (OSS)

The output speed sensor provides transmission output shaft speed information. This signal is produced from an inductive pick-up, generating 36 pulses per revolution.

Accelerator Pedal Position (APP) Sensor

The accelerator pedal position (APP) sensor is a potentiometer mounted on the accelerator pedal. The APP sensor detects the position of the accelerator pedal and sends this information to the TCM. The APP sensor is used for shift scheduling and TCC lock-up.

Engine Coolant Temperature (ECT) Sensor

The engine coolant temperature (ECT) sensor detects engine coolant temperature and supplies the information to the TCM. The ECT sensor is used to control the torque converter clutch (TCC) operation.

Transmission oil Temperature (TFT) Sensor

A thermistor provides an electrical indication of the oil temperature. The signal is measured as a voltage with reference to analogue ground in the TCM.

Virtual Kickdown Switch

Kickdown is intended to provide maximum vehicle acceleration, via the appropriate downshift(s), when the operator uses full throttle. The kickdown switch provides an electrical signal when the accelerator pedal is fully pressed down. The TCM detects kickdown using the accelerator pedal position.

Position sensor

The TCM uses the position of this switch, housed on the TCM and main control valve body, to determine the selected gear range. Gear selections are sent by CAN to the TCM, which operates the transmission selector shaft between positions Park, Reverse, Neutral and Drive. The TCM detects the driver's choice of manual range selection.

Transmission Range Switch (TRS)

The transmission range switch detects the position of the transmission selector shaft. The switch is supplied as part of a new transmission assembly, mounted on the transmission body. The switch is used to indicate positions of the shaft: Park, Reverse, Neutral, Drive, Fourth, Third and Second.

TCM Monitoring Functions

The TCM monitors all input and outputs to identify possible failures. If a fault is detected the TCM takes the appropriate action to ensure the transmission enters a safe mode of operation, without sacrificing transmission durability or driver safety.

Supply Monitoring

If the battery voltage is either too great or too low, the TCM will detect a fault condition. For the TCM to be able to identify this fault, the engine must be running and the transmission oil temperature sensor must be functioning correctly.

Solenoid Supply Monitoring

While the solenoid operating transistors are being activated, checks are run for open circuits, shorts circuits to ground and short circuits to supply. The monitoring function evaluates the voltage characteristics during the switch on process checking for the above faults. All solenoid outputs are fully protected. The processor and the appropriate fail-safe action taken can quickly identify open and short circuit faults.

Sensor Supply Monitoring

The sensor supply voltage is a stabilized supply. This supply is monitored by the TCM by an Analogue to Digital Converter (ADC). If the voltage is out of the valid tolerance a diagnostic trouble code (DTC) is set and the appropriate fail-safe action is performed.

Electronically Erasable Programmable Read Only Memory (EEPROM) Monitoring

To diagnose errors with the Electronically Erasable Programmable Read Only Memory (EEPROM) the TCM calculates four checksums continuously: If the processor identifies discrepancies in any of the four checksums the TCM will engage 'mechanical' limp-home mode. Diagnosis is only performed during TCM initialization. There is no fail-safe mechanism associated with this function as the EEPROM is mainly used for the storage of fault codes and transmission calibration adoptions. If a fault occurs the TCM is able to perform default action and inform the driver of the problem, this is by the DIM message centre right.

Watchdog Monitoring

Watchdog monitoring has two functions. Firstly, it checks that it is possible to inhibit output control by the activation of the solenoid supply transistor. Secondly, it checks that the safety circuit is functioning correctly. During initialization the watchdog checks that it is possible to inhibit control of the pressure regulator and solenoid valves by switching the solenoid supply transistor. There is a fault if activation of the solenoids cannot be inhibited by the watchdog.

The supply to the solenoids can still be inhibited by the high side switch responsible for control of each solenoid i.e. One safety path is lost.

Temperature Sensor Monitoring

If the temperature of the Mechatronik unit rises above a pre-determined level the TCM will be shut down. Prior to the TCM shutting down the TCM will log a fault code, during shutdown the transmission will enter 'mechanical' limp-home mode. Temperature monitoring is performed by a temperature dependent resistor mounted on the in the TCM.

Transmission oil Temperature Sensor Monitoring

The TCM monitors for faults associated with the transmission oil temperature sensor via open and short circuit fault detection.

The temperature cannot alter by more than a pre-defined differential between any two consecutive measurements. The transmission oil temperature must rise after the engine has been started provided that the oil temperature was low enough to begin with (The vehicle must be driven and the diagnostic test condition met).

Gear Ratio Monitoring

Gear ratio diagnostic checks that each gear ratio is correctly engaged. Also, following a gear shift the diagnostic checks that the transmission has engaged the target gear within the allowed time.

Torque Converter Monitoring

The TCM checks that the torque converter can be locked correctly. If torque converter lock-up does not occur correctly the TCM performs the appropriate fail-safe action of opening the Torque converter clutch.

Plausibility Checking

The TCM detects a fault if an excessive voltage jump is identified between any two consecutive measurements. Also, with the engine started from cold the transmission oil temperature will start to rise. Therefore the Mechatronik unit or transmission oil temperature will also start to rise because the TCM is surrounded by transmission oil. If the engine and output shaft speed is higher than a set threshold for a predetermined length of time without the substrate temperature rising above a set threshold a fault will be detected.

Pressure Regulator/Solenoid Monitoring

Each pressure regulator and solenoid is monitored for open circuits and short circuits. The TCM also checks that the current being delivered to each solenoid valve or pressure regulator is within valid limits. When each solenoid is being driven with minimum current the TCM checks that the current is not above a threshold value. If a solenoid is being driven with maximum current, it checks that the current is not below a valid threshold. If either of these two errors occur a plausibility error is logged and the appropriate fail-safe action is performed.

Output Speed Monitor

It is possible for the TCM to diagnose electrical errors associated with the output speed sensor while the vehicle is stationary as well as moving. Plausibility monitoring is performed on the sensor output when the vehicle is moving.

Input Speed Monitor

It is possible for the TCM to diagnose electrical errors associated with the input shaft speed sensor while the vehicle is stationary as well as moving. Plausibility monitoring is performed on the sensor output when the vehicle is moving.

Position Sensor Monitoring

The TCM can identify position errors with a position switch located within the transmission. If an unrecognized position code is read by the TCM a plausibility fault will be logged.

Torque Converter Lock-up Control

The TCM controls how the torque converter clutch is engaged as a function of the accelerator pedal position, output speed, transmission oil temperature, gear selected and shift program. Lock-up is possible in all forward gears, but usually it is restricted to fourth, fifth and sixth gears. To make use of the comfort enhancing effect of the torque converter, the converter clutch can be disengaged prior to a downshift or up-shift. The torque converter lock up clutch is always modulated to allow for controlled slip, to further improve the shift quality.

Safety Functions

Safety functions are designed to safeguard against inappropriate actions by the operator as well as against system malfunctions. The system prevents reverse gear from being engaged at high forward speeds and prevents manual down shifting at excessive engine speeds.

The functions are not operational in mechanical 'limp-home' mode.

The TCM constantly monitors the transmission for faults. In the event of a problem the TCM will adopt a 'limp-home' mode. If a transmission fault is detected, the PCM generates a DIM warning message.

Safety concept is based on the following:

1. The hydraulic system has 'fail-safe' characteristics regarding its electrical operation, such that should the power supply be lost to the electro-hydraulic actuators, the transmission will initiate a 'limp-home' mode.
2. Recognition of critical shift operation by monitoring the last element in the signal path, i.e. the solenoid valve, and checking by means of redundant measured variables, i.e. engine speed, input speed and output speed.
3. Each time the vehicle is started there is a check on the entire safety hardware and the associated program parts and signal paths. A malfunction in this part of the system, or triggering of the safety circuit, is communicated to the operator through the DIM message centre right.

Limp-home Modes

If a fault is detected in the 'Shift by Wire' system the vehicle will go into 'Limp Home' mode. There are three types of 'Limp Home'.

Electrical - 'Gearbox Fault Reduced Function' will be displayed in the message centre right. Touchtronic and Sport modes will be disabled. Gearshifts will still be possible but shift quality will be degraded.

In certain circumstances 'D' will be restricted to 3rd gear. If travelling at speed 3rd gear will engage when an appropriate speed has been reached.

Reduced Engine Performance - 'Reduced Engine Perform' will display in the message centre right. Engine performance will be restricted.

Mechanical - 'Limphome No Gear Change Possible' will display in the message centre right and a audible warning will sound. If travelling forwards in 'D' or 'D Touch' the vehicle will go into a locked gear (3rd or 5th depending on vehicle speed). If entering mechanical limp home mode in

any position other than 'D' or 'D Touch' (forward gears) the park lock will engage.

Do not attempt to change position while in mechanical limp home mode, i.e. pressing either P, R, N, D or pulling back on both gear shift paddles simultaneously. If this request is detected at a speed below approx. 20 km (12.5 mph) the engine will stop and the parking lock will engage.

At a speed above approx. 20 km (12.5 mph) the request and any other transmission request will be rejected and the vehicle will continue in 3rd or 5th.

Torque Converter Operation

The TCM continually monitors the state of the torque converter.

There are three operating modes for the converter:

Fully open	Torque converter 'disengaged'.
Fully closed	Torque converter 'engaged'.
Slip control	The TCM monitors slip and may apply sufficient pressure to allow a small degree of slip. This mode maximises economy by reducing slip to a minimum whilst providing isolation from drive-line shunt and vibration.

Torque Converter Clutch

Hydraulic Pressure Regulation

The TCM supplies an internally switched +12V supply to No.4 pressure regulator. The regulator is operated by switching the other side of the operating winding to ground. Hydraulic pressure is controlled by 'pulse width modulation' (PWM) of the ground switching signal i.e. the duty cycle: the time that the pressure regulator is switched on.

TCM Supply Voltage

The TCM monitors battery and ignition switched supply voltages.

A permanent supply is used to maintain a battery backed 'memory'. Should this supply be cut, due to battery disconnection or power interruption, the shift quality adaptations (made due to the transmission's changing characteristics over time) will be lost. This will result in a small reduction in shift quality for a period until the shift adaptations are re-learned.

The TCM will adopt 'limp-home' mode as a result of the supply voltage being greater than 16 V or below 7 V with an engine speed of greater than 1600 rpm.

Should the ignition supply be between 7 and 9 volts, the TCM will hold the gear that it has currently selected. If after 2.5 seconds, with the engine speed more than 1600 rpm, the voltage remains at this level, 'limp-home' mode will be adopted. The 2.5 second delay is built in to prevent reaction to a momentary voltage fluctuation.

Shift by Wire

In the shift by wire (SBW) system driver intention is transmitted by electrical signals.

The driver request is transmitted over the CAN and the 'Backup Line PSU'. In general the TCM uses the signal over the CAN, in case of a CAN failure the signal over the backup line is used. The serial backup line is unidirectional.

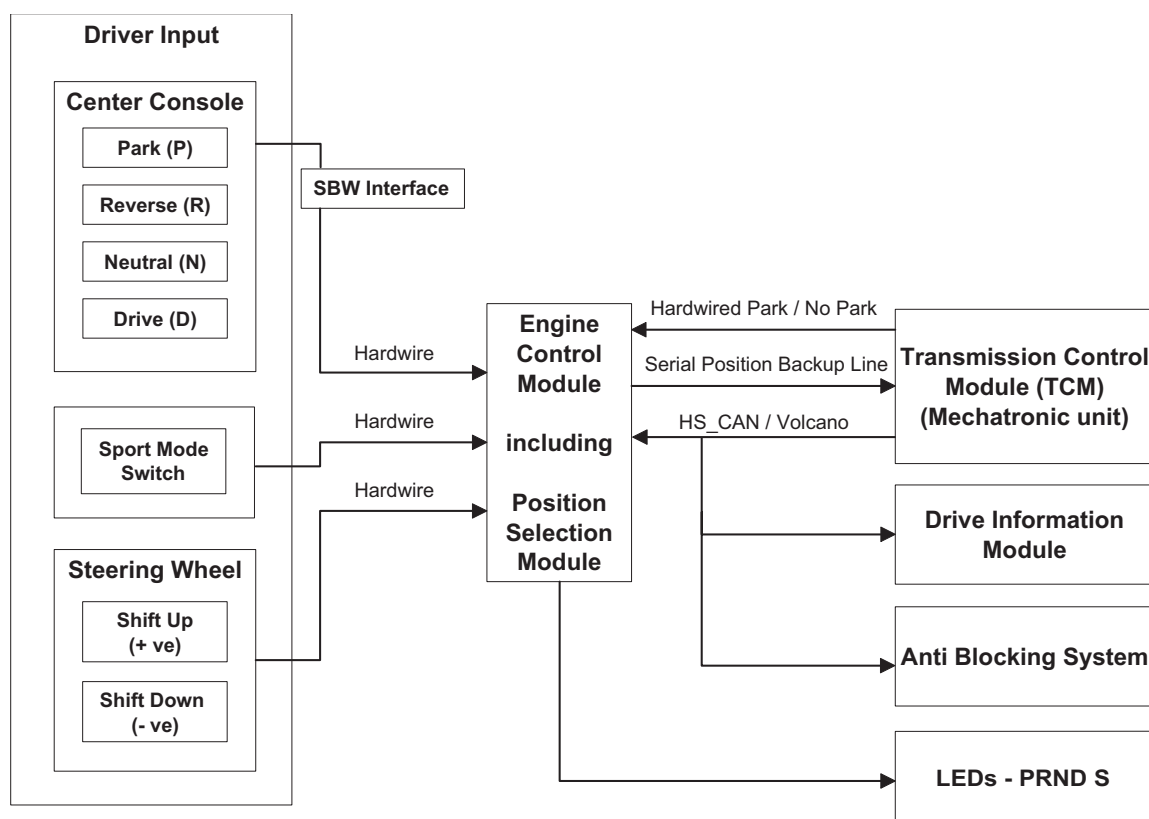
The EMS converts the driver input into an electrical signal which is transmitted to the TCM. The TCM then makes a plausibility check of the driver request. If the conditions (ignition, engine speed, vehicle speed etc.) are fulfilled, the target position is transmitted to the DIM over the CAN.

If required by the TCM the DIM also displays messages to warn the driver and messages to recommend driver actions.

The SBW system provides an emergency disengagement mechanism for the park lock system to enable towing the vehicle (Disengagement of Park in case the engine is not running).

Signal Chain-Basic Example for D-Button operation

1. Driver input - via the SBW interface.
2. The PCM receives the input signal.
3. The PSU performs a diagnostic on the input signal. It then buffers the raw signal from the buttons / paddles and distributes the pressed / no pressed, pulled / no pulled information on CAN.
4. The TCM receives the signal and checks, depending on the current conditions (Transmission state, Engine speed, Vehicle speed etc.), if a change of position is allowed. If yes, the TCM initiates a position change in the gearbox. At the same time the TCM distributes updated position information on CAN.
5. This position information is received by the DIM and the PCM. The DIM illuminates the actual position distributed from the TCM and the PCM illuminates e. g. in addition the drive button light when Drive is distributed from the TCM.



Transmission Plug Pin Assignment

Pin	Assigned to	Notes
1	Series line	Serial Backup Line EMS
2	CAN L	CAN low
3	ISO K	K line (for example application)
4	Not in use	Digital input
5	Not in use	Digital input
6	CAN H	CAN high
7	S4	Heartbeat Supply
8	Not in use	optional input
9	Terminal 15	Wake-up signal, terminal 15 VIGN
10	P signal	P line for starter inhibit
11	S4	Heartbeat
12	not in use	
13	Terminal 31-1	Earth (ground)
14	Terminal 30	Permanent positive (ECS supply voltage)
15	Not in use	
16	Terminal 31-2	Earth (ground) 2

