

437: Transmission control module (TCM), TF-80SC AWD

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Function**Regulating the solenoids when gearshifting**

Shifting is regulated by the transmission control module (TCM) activating the solenoids in a specific pattern. The solenoids S1, S2, SLC1, SLC2, SLC3 and SLB1 control which gear is engaged. The solenoid SLC1, SLC2, SLC3 (together with solenoid SLT) also control how engagement occurs by adapting hydraulic pressure. The basic parameters for the various shift points are accelerator pedal position and vehicle speed while shift quality is determined by torque control. The pressurizing of clutches and brakes can be adapted by means of

reading off the changes in the rotation speed of the transmission input shaft during the gearshift processes and comparing them with the calculated values in the Transmission Control Module (TCM). Two different shift patterns are available: normal mode and winter mode (selected using the " W" button).

In normal conditions the gearshifts take place at relatively low speeds in order to reduce fuel consumption. With rapid accelerator pedal movements the Transmission Control Module (TCM) automatically changes over to sport mode.

Gearshift patterns

Gear	Activated solenoid					
	S1	S2	SLC1	SLC2	SLC3	SLB1
P	OFF	OFF	ON	ON	ON	ON
R (speed up to 7 km/h / 4 mph)	OFF	OFF	ON	ON	OFF	ON
R (speed above 7 km/h / 4 mph)	OFF	OFF	ON	ON	ON	ON
N	OFF	OFF	ON	ON	ON	ON
1	OFF	OFF	OFF	ON	ON	ON
1^{*)}	ON	ON	OFF	ON	ON	ON
2	OFF	OFF	OFF	ON	ON	OFF
3	OFF	OFF	OFF	ON	OFF	ON
4	OFF	OFF	OFF	OFF	ON	ON
5	OFF	OFF	ON	OFF	OFF	ON
6	OFF	OFF	ON	OFF	ON	OFF

*) with engine braking

Regulating the lock-up function

Regulating the lock-up function takes place by

means of the Transmission Control Module (TCM) activating the lock-up solenoid. The engagement takes place by means of the Transmission Control Module (TCM) controlling the lock-up solenoid linearly and adapting the hydraulic pressure. The basic parameters for engagement are the engine speed, accelerator pedal position and the rotation speed of the transmission input and output shafts. The pressurizing of the lock-up function can be adapted by means of reading off the changes in the rotation speed of the transmission input shaft during the gearshift processes and comparing them with the calculated values in the Transmission Control Module (TCM). Two different lock-up functions are integrated: locked lock-up and slipping lock-up.

Locked lock-up

In normal conditions lock-up takes place at relatively low speeds in order to reduce fuel consumption.

Slipping lock-up

Is a function which provides gentler engagement with dampened vibration and lower noise when using the lock-up gear. When this function is

activated, lock-up is active but not fully applied.

The requirements for the function to be activated include the following:

- gear selector in D or MAN
- gear 2, 3, 4, 5 or 6
- transmission input speed is 1000 rpm
- transmission oil temperature is 20 - 120 °C.

Due to the slipping of the torque converter, between 50-200 rpm, the friction properties of the transmission oil are very important. The transmission oil's properties therefore differ from conventional ATF oil properties. Always use transmission oil specified for this transmission, otherwise the function of the transmission can be impaired.

Gearshift program

Normal program

When driving with normal accelerator pedal application the Transmission Control Module (TCM) uses a preset gearshift program, optimized to shift for economical driving. This gearshift program is designed for "normal" driving which combined provides early upshifting and lock-up. The gearshift program

automatically adapts to different driving cases such as driving uphill with a trailer or driving at high altitude. In addition, transmission oil pressure is adapted to provide gentle engagement of the gears.

Winter program (Winter mode)

Winter mode is selected with the (W) button on the top panel of the gear selector assembly. Winter mode makes it possible to start in a high gear to prevent wheel spin on a slippery surface. The program is also suitable for other difficult situations where the driver wishes to limit gear selection. When the gear position is **D** the vehicle starts in 3rd gear. Automatic shifting takes place between 3rd, 4th, 5th and 6th gear.

When the winter program is selected a W is lit in the combined instrument panel. If kickdown is activated in winter mode then the transmission uses all gears for optimum performance.

Sport mode - Only S60R and V70R

On R-models, the Winter mode function is replaced by Sport mode. Sport mode is activated with button S on the top panel of the

gear selector assembly. The program adapts shift points to provide the best possible performance. Downshifting occurs quicker at lower throttle application. The function can also be activated automatically if the **Advanced** button on the dashboard is pressed.

Other programs

Adaptation

The Transmission Control Module (TCM) monitors each gearshift to achieve consistent and gentle gearshifting in all driving conditions. This is achieved by means of the control module either lowering or raising the hydraulic system pressure which is used during the gearshift itself. The changes in pressure level are stored in the control module memory when the vehicle is shut down, and are retrieved when starting. This provides improved gearshift comfort and improved service life for the transmission. Complete adaptation applies when the following conditions have been fulfilled:

- the position of the accelerator pedal is constant
- oil temperature between 65 °C and 110 °C.

Driving uphill

The Transmission Control Module (TCM) can change the gearshift pattern slightly when driving uphill. This is to avoid close gearshifts.

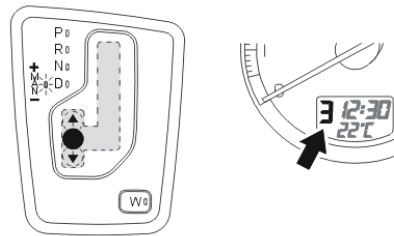
Neutral control (only available on certain models)

This function is activated when the driver stops the car and the car is stationary, at traffic lights for example. The transmission control module (TCM) then disengages the C1 clutch which releases the forward drive of the transmission and reduces the load on the engine. The function improves fuel consumption and reduces vibrations at idle speed. When the driver releases the brake, the C1 clutch engages and drive is resumed.

The following conditions must be met in order for the neutral function to activate:

- gear selector in position D
- oil temperature above + 10 °C
- throttle position less than 3 %
- brake pedal depressed
- speed 0 km/h
- engine speed (RPM) less than 1500 RPM.

Gearshifting with Geartronic



When the gear selector is moved to Geartronic mode (MAN), the automatic transmission is still hydraulically in D. If the gear selector is moved up (+), the gear selector module sends a signal to the transmission control module (TCM) to upshift. If the gear selector is moved down (-), a signal is sent to the transmission control module (TCM) to downshift. When the gear selector is in MAN mode, the driver information module (DIM) will change its symbol from D to the currently engaged gear, such as 3. A signal is also sent to the gear selector module (GSM) to light the LED for MAN and deactivate other LEDs. The transmission control module (TCM) determines whether the shift is possible. The driver information module (DIM) indicates the current gear. If shifting is permitted, the various solenoids are activated in the pattern specific to the relevant gear.

In certain situations however the Transmission Control

Module (TCM) takes over the gearshift decisions. Amongst other things, the following applies:

- When stationary, only gears 1, 2 and 3 can be selected. Gear 4 can be selected at speeds above 40 km/h and gear 5 at speeds above 55 km/h, and gear 6 at speeds above 70 km/h.
- Automatic downshifting takes place on all gears when below a certain speed. Example: Gear 2 is selected. Automatic downshifting then takes place from gear 2 to gear 1 at 2 km/h if the speed before this exceeded 25 km/h. Otherwise gear 2 remains engaged. However, situations can arise where gear 3 remains engaged despite the vehicle stopping.
- A manual upshift is required after an automatic downshift. Kickdown is not available in Geartronic mode (MAN).
- Permitted speeds for the manual downshifts equate to those for kickdown upshifts, i.e. an engine

speed of approx.
6000 rpm.

- If transmission temperature becomes too high then the Transmission Control Module (TCM) takes over the gearshift decisions. The purpose of this is to engage a gear where lock-up is possible at the current speed.
- Lock-up is possible for gears 2, 3, 4, 5 and 6.

Other

- In MAN mode, a signal on gear selector lever position is generated for the gear selector module (GSM) as follows: a Hall sensor is fitted on the printed circuit board for the gear selector module (GSM) for each one of the three gear selector lever positions. A permanent magnet on the gear selector lever acts on the sensor output signals to the control module. The control module can read off the position of the gear selector lever by means of the differences in signal character.

Adaptation data

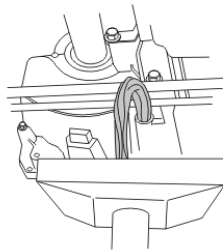
The Transmission

Control Module (TCM) software includes a service for resetting adaptations that can be activated:

- Resetting adaptation - should be performed after replacing an internal component or the whole transmission.

Resetting adaptation is activated via the vehicle communication input.

Gauge for transmission oil data



There is a gauge for transmission oil quality integrated into the software for the Transmission Control Module (TCM). This gauge calculates the time for which the oil exceeds a certain temperature during a certain period. When the gauge reaches the maximum value a diagnostic trouble code (DTC) for oil change is generated in the control module. When replacing transmission oil the gauge must be reset to zero to avoid generating a diagnostic trouble

code (DTC) during incorrect conditions. This applies to changing transmission oil and when changing the oil with a repair. The resetting function is activated via the vehicle communication input.

Emergency mode in the event of a fault

When a fault has arisen in the transmission (permanent fault) and is registered by the Transmission Control Module (TCM), a help program for dealing with the fault is activated. The Transmission Control Module (TCM) then performs certain actions to protect the transmission while maintaining as much driveability as possible. Minor faults do not activate any help programs. There are different programs depending on the type of fault.

- Emergency/limp-home mode
- Failsafe action (temporary action)

Failsafe action is activated upon first detection of the fault, if the fault disappears then the system returns to normal function. Emergency mode is activated with less serious faults and Limp-home mode is activated with the most serious

faults. If the fault disappears (intermittent fault) then the control module returns to normal function as soon as the ignition is next switched on.

The warning lamp in the combined instrument panel comes on, and a text message is displayed in the text window in the combined instrument panel if emergency/limp-home mode has arisen. No text is displayed when the ignition is switched on until the fault has been detected.

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