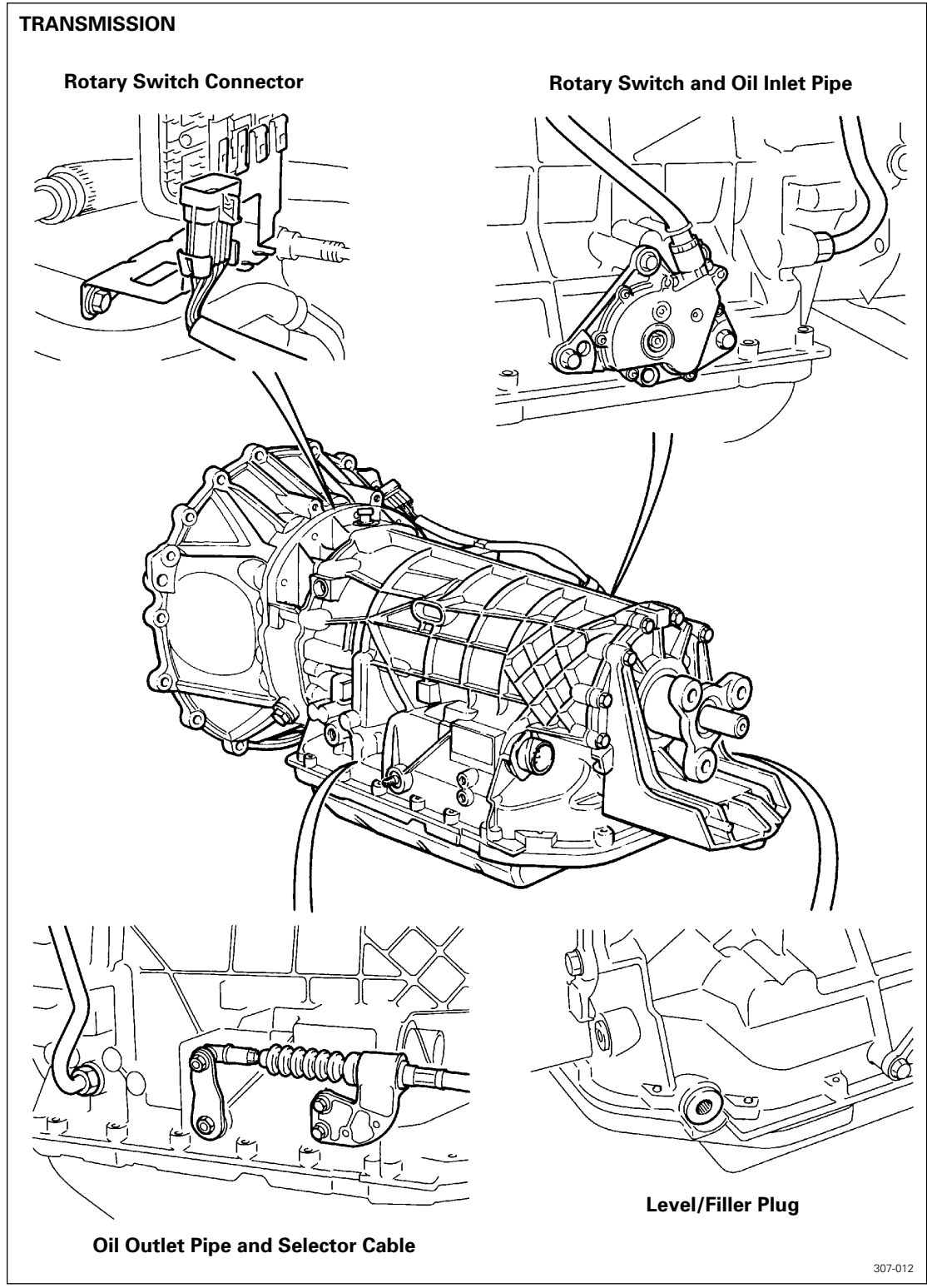


Introduction

The new ZF 5HP24 automatic transmission system features five forward gears and one reverse gear. It also features a filled-for-life oil system. Gearshift management is achieved using a Transmission Control Module (TCM).



Tecnical Data

Transmission weight including fluid and torque converter	95.8 kg (211 lbs)
Oil Type	ATF Esso LT71141
Oil Capacity	10 liters (2.645 US. gals)
Gear Ratios	1st Gear 3.571:1
	2nd Gear 2.202:1
	3rd Gear 1.505:1
	4th Gear 1.000:1
	5th Gear 0.803:1
	Reverse 4.095:1

Gearshifting

Driver gear selection is transmitted from the gear selector lever by cable to a lever fitted to a selector shaft in the transmission casing. This shaft moves the manual valve and the rotary switch. The rotary switch signals all gear positions except D to 4. A separate switch in the driver gear selector mechanism detects movement of the selector between D and 4. The communication of driver gear selection to the TCM is made by the rotary switch. Gear shift points are selected by the TCM in response to output speed, engine load, selector position, accelerator pedal position and driver mode selection. Driver control of the shifting is via the selector lever, throttle pedal position, kickdown switch and mode switch. Two shift modes are available, sport and normal, controlled by the driver from a switch on the gear selector surround. During kickdown, gear upshifts occur at 6800 RPM engine speed.

Mechanical Description

The unit is an oil filled-for-life system therefore no dipstick is fitted to the transmission. A filling/level plug is located at the right-hand side rear of the casing for service oil level checking and replenishment, if required. To achieve effective cooling, the oil is pumped from the transmission casing at the front left-hand side of the casing to the car mounted oil cooler. The oil is returned from the cooler to the inlet connection on the front right-hand side of the casing. The cooler is a plate-type design made from aluminum and is located in the car radiator outlet tank. To detect changes in oil viscosity which occur as the oil temperature changes, an oil temperature sensor is located in the unit casing sump. Also located

in the transmission casing are the input shaft speed sensor (turbine speed) and output shaft speed sensor (vehicle speed). The torque converter is a lightweight unit which, because of its low mass, improves engine responsiveness. The torque converter bell housing is bolted to the transmission casing. Mounting of the transmission is conventional by bolting the torque converter bell housing to the engine. The rear extension housing is bolted to the transmission casing and forms the rear engine/transmission mounting point. It also carries the output shaft oil seal.

The electro-hydraulic module contains three solenoid valves and five pressure regulators for gear shifting. Each of the three solenoid valves control the flow of transmission fluid to the selected clutches. One pressure regulator serves as master pressure control for the entire system and one is used exclusively for torque converter clutch lock-up operation.

Replacement transmission units are shipped complete with the torque converter and housing, extension housing, coupling flange and rotary position switch. They are also fully filled with 10 liters (2.645 US. gals) of oil. Consequently, when undertaking a transmission replacement, oil replenishment should not be necessary. The exterior of the transmission is coated with a non-drip corrosion protection oil, which must not be

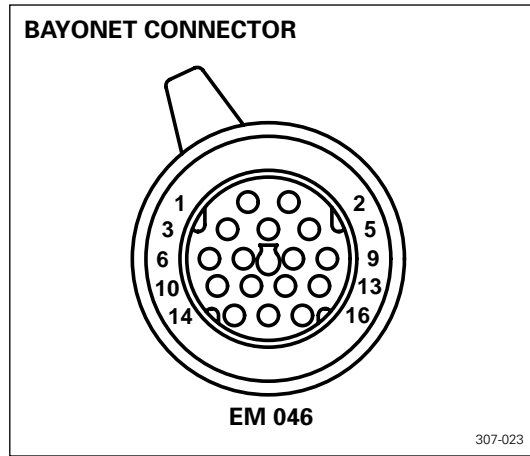
Electrical Description

mistaken for an oil leak.

Electrical Connections

Bayonet Connector

A round, 16-pin, bayonet electrical connector is fitted at the rear left-hand side of the transmission which communicates with the 5 pressure regulators, 3 shift solenoids, oil temperature sensor and the input and output



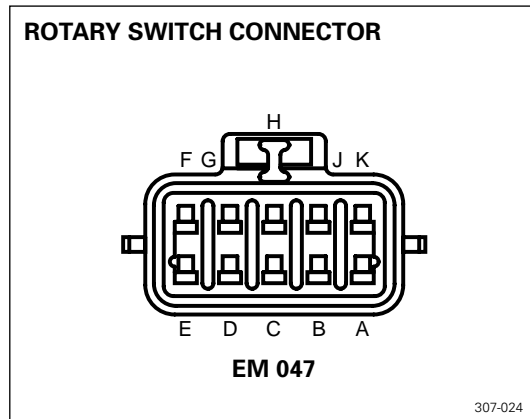
Connector/

Pin	Circuit	Pin	Circuit	Pin	Circuit
shaft speed sensors.					
EM046					
001	Output Speed Sensor (+)	006	Turbine Speed Sensor (-)	012	Solenoid Valves (+)
002	Pressure Regulator 1	007	Pressure Regulator 3	013	Analog Ground
003	Pressure Regulator 2	008	Shift Solenoid 1	014	Oil Temperature Sensor
004	Shift Solenoid Valve 3	009	Shift Solenoid 2	015	Pressure Regulator 5
005	Turbine Speed Sensor (+)	010	Output Speed Sensor (-)	016	Regulator (+)
		011	Pressure Regulator 4		

Rotary Switch Connector

The rotary switch, mounted on the right-hand side of the casing, has a spline arrangement which prevents misalignment with the selector shaft. A locating pin and two bolts secure the rotary switch to the transmission casing. This locates the switch with the transmission casing and the shaft in one place only. The switch requires no other setting up procedure.

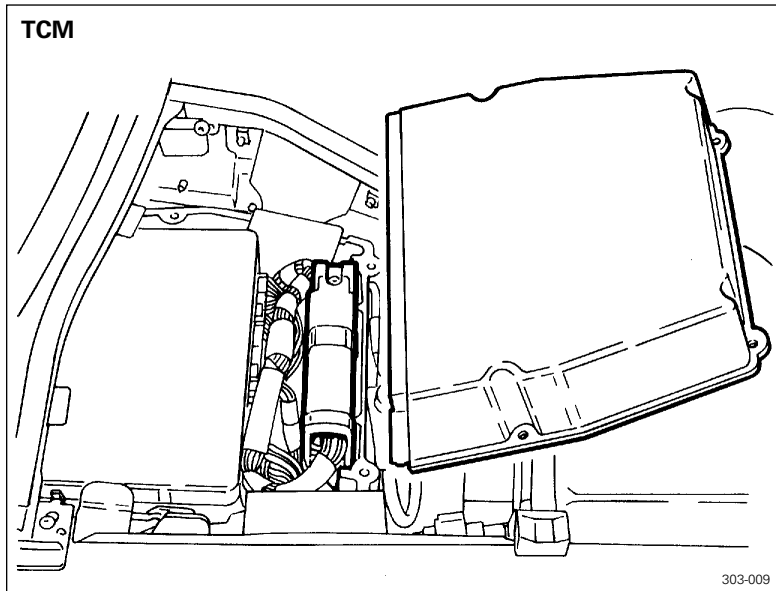
A 10-way connector with flying lead connects the rotary switch to the engine management harness. The connector is retained on a multi-connector bracket bolted to the transmission casing/torque converter housing joint.



Connector/

Pin	Circuit	Pin	Circuit	Pin	Circuit
EMO47					
00A	Position L1	00E	Digital Ground	00J	12V Power Supply
00B	Position L2	00F	Not Used	00K	Park & Neutral Switch
00C	Position L3	00G	Not Used		
00D	Position L4	00H	Not Used		

Transmission Management



The transmission management system uses both analogue and digital signals, to control the operation of the transmission. Digital signals are processed by the TCM to and from the vehicle multiplex network. Other input/output analogue signals are hardwired to the TCM. This information is used primarily by the TCM to decide which shift program to implement, which gear to select and for shift energy management. If a fault occurs, the TCM will take default action and inform the driver via the Message Centre and amber warning light.

Harness Connector

The vehicle harness connector for the TCM is an 88-way latching connector. The TCM is wired to the electrical pressure regulators/solenoids, oil temperature sensor and shaft speed sensors in the transmission casing.

Sport Mode

When sport mode is selected by the driver using the mode switch, the sport pattern is only activated when a set cornering force is achieved, or the kickdown switch is pressed. The vehicle speed and the difference in speeds between the two front wheels is used to calculate the amount of cornering force.

Torque Converter Lock-up

The torque converter lock-up clutch is engaged as a function of throttle position, output speed, oil temperature, gear shift and shift program. Lockup is possible in 2nd, 3rd, 4th and 5th gears but is usually restricted to 4th and 5th gears. During a gear shift the TCM controls the amount of slip of the lock-up clutch to enhance shift quality.

Oil Temperature

When the engine coolant or transmission oil temperature exceeds set thresholds a hot mode program is selected which locks the torque converter clutch, minimising the amount of heat entering the engine cooling system from the transmission oil.

Gear Shift Interlock

Gear shift interlock is controlled by the BPM, part of the SCP network. The gearshift release will only be activated when the ignition is in position II, transmission is in Park and the brake pedal is depressed. Once transmission is out of Park, the brake pedal has no effect on gearshifting and the interlock is disabled.

Reverse Inhibit

Selection of reverse with the vehicle moving forwards above walking pace is electrically inhibited, unless the vehicle is in the default "limp-home" mode.

Kickdown

A floor mounted switch/pedal position sensor signals the TCM to select the lowest gear to give maximum torque for acceleration.

Torque Control

The TCM synchronises the operation of the transmission clutches and invokes shift energy management to control engine output torque during a gear shift (Refer to EMS, page 60).

Traction Mode

The traction program compliments the traction control system and is implemented whenever traction control intervenes to maximize wheel stability.

Cruise Mode

Cruise mode reduces unwanted hunting of the transmission gearshifting and is activated when cruise control is resumed and when the vehicle is cruising near the set speed.

Gradient Mode

The gradient program enhances vehicle performance, driveability and cooling when the vehicle is climbing a gradient.

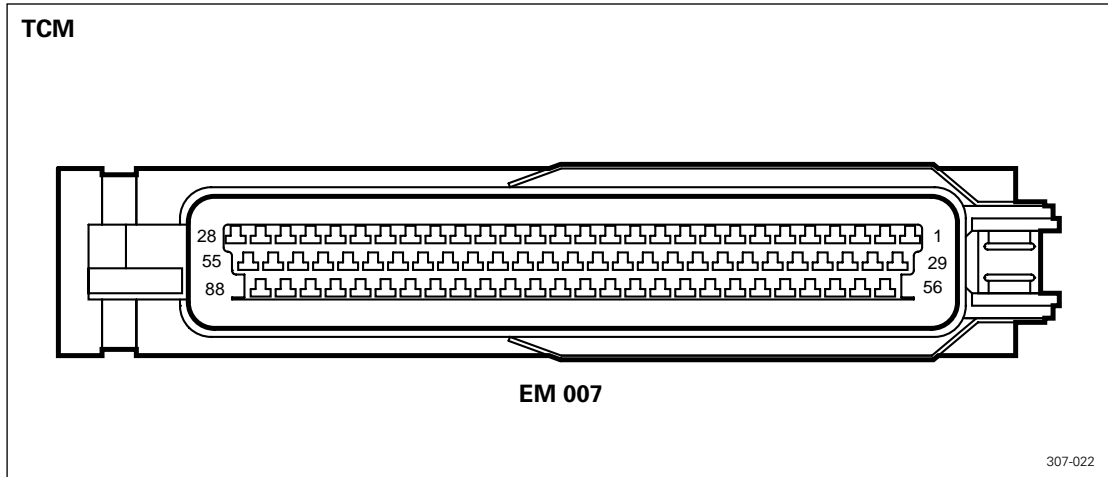
Start Inhibit

The rotary switch also provides the start inhibit function to the ECM, which will not allow an engine start until the gear selector is in either Park or Neutral.

Fault Monitoring/Diagnostics

The TCM constantly monitors the transmission system for faults. In the event of a fault occurring, the transmission is protected by a limp home mode. This mode allows use of P, R, N, and 4. It also signals the ECM to switch on the CHECK ENG (MIL) lamp.

The TCM is able to diagnose faults in components which affect exhaust emissions. Communication with the PDU is through the J1962 connector which allows accurate diagnosis of transmission problems. Additional diagnostic functions facilitate fast repair of faults. All transmission OBDII information is stored for future data analysis in the ECM.



Transmission Control Module Pin Connections

Connector/ Pin Circuit

Pin	Circuit	Pin	Circuit	Pin	Circuit
EM007					
001	Pressure Regulator 2	023	Shield (Input Speed Sensor)	045	Mode Switch Pin A
002	Mode Switch Illumination	024	Not used	046)
003	Not used	025	Not used	047	Not used
004	Pressure Regulator 4	026	Battery Feed	048)
005	Pressure Regulator 1	027	Not used	049)
006	Power Ground	028	Digital Ground	050)
007	Not used	029	Pressure Regulator 3	051	Pressure Regulator 5
008	Position Switch L2	030	Shift Solenoid 1	052	Solenoid valve + ve
009	Position Switch L4	031	Not used	053	Pressure regulator + ve
010	Not used	032	Shift Solenoid 3	054	Fused Ignition + ve
011	Not used	033	Shift Solenoid 2	055	Fused Ignition + ve
012	Mode Switch Pin B	034	Power Ground	056	
013	Drive to Fourth Switch	035	Not used	to	
014	Turbine Speed (-)	036	Position Switch L1	081	Not used
015	Shield (Output Speed Sensor)	037	Position Switch L3	082	CAN Link In - ve
016	Output Speed (+)	038)	083	CAN Link In + ve
017	Not used	039	Not used	084	CAN Link Screen
018	Kickdown Switch	040)	085	CAN Link Out - ve
019	Not used	041)	086	CAN Link Out + ve
020	Not used	042	Turbine Speed (+)	087	Not used
021	Analogue Ground	043	Not used	088	Not used
022	Oil Temp Sensor	044	Output Speed (-)		

Can Messages

Messages on the CAN data bus used or output by the TCM are detailed below:

Note: This list does not include network monitoring or diagnostic related messages.

Message Used by TCM	Source/Used by	Message Produced by TCM
TRACTION STATUS ABS STATUS FRONT LEFT WHEEL SPEED FRONT RIGHT WHEEL SPEED	Brake Control Module	TRANSMISSION INPUT SPEED TRANSMISSION OUTPUT SPEED TORQUE CONVERTER SLIP KICKDOWN SWITCH GEAR POSITION ACTUAL TORQUE CONVERTER STATUS TRANSMISSION SHIFT MAP TRANSMISSION MALFUNCTION TRANSMISSION FAULT CODES
	Instrument Cluster	GEAR POSITION ACTUAL GEAR POSITION SELECTED TRANSMISSION OIL TEMPERATURE TRANSMISSION MALFUNCTION
ESTIMATED ENGINE TORQUE THROTTLE VALVE POSITION ACCELERATOR PEDAL POSITION TORQUE REDUCTION ACKNOWLEDGE ENGINE SPEED CRUISE STATUS BRAKE PEDAL DEPRESSED ENGINE COOLANT TEMPERATURE ENGINE MALFUNCTION	ECM	TORQUE REDUCTION REQUEST TRANSMISSION OVERLOAD TRANSMISSION INPUT SPEED TRANSMISSION OUTPUT SPEED TORQUE CONVERTER SLIP KICKDOWN SWITCH GEAR POSITION ACTUAL TORQUE CONVERTER STATUS GEAR POSITION SELECTED TRANSMISSION SHIFT MAP TRANSMISSION OIL TEMPERATURE TRANSMISSION MALFUNCTION TRANSMISSION FAULT CODES