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TRANSMISSION IDENTIFICATION - 4HP 22/24 ELECTRONIC

ZF stands for Zahnrad Fabrik - Friedrichshafen, Germany.

A metal plate on the side of the transmission identifies a specific unit as follows:



1043 = Family Type HP 22/24

010 = 4 speed

727 = Specification or Type Number, i.e. specific units used with Land Rover Products - relates to clutch build, planetary ratios, valve block version, etc.

Getriebe Nr. = Serial Number (Gearbox Number)

4 = 4 speed

HP = Hydraulic Planetary

22 = Family IDNm (4.0 Litre)

24 = Family ID (4.6 Litre)

Gear Ratios:

1st gear = 2.48 : 1

2nd gear = 1.49 : 1

3rd gear = 1.00 : 1

4th gear = 0.73 : 1

Reverse = 2.09 : 1



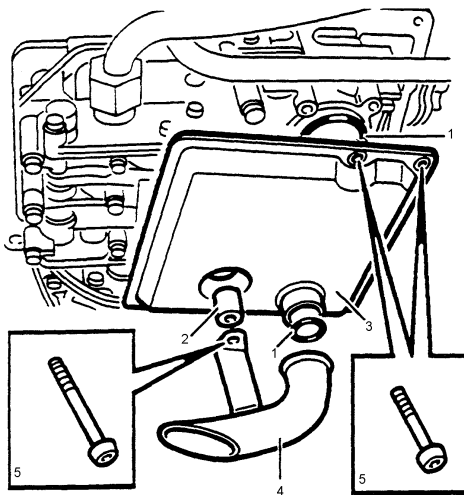
TRANSMISSION SERVICE AND ADJUSTMENTS

Land Rover specifies a complete Automatic Transmission service at the first 30,000 mi (48,000 km) under Normal operating conditions. More frequent servicing should be recommended if a particular vehicle is used continuously in stop and go traffic, off-road extensively or used for frequent towing.

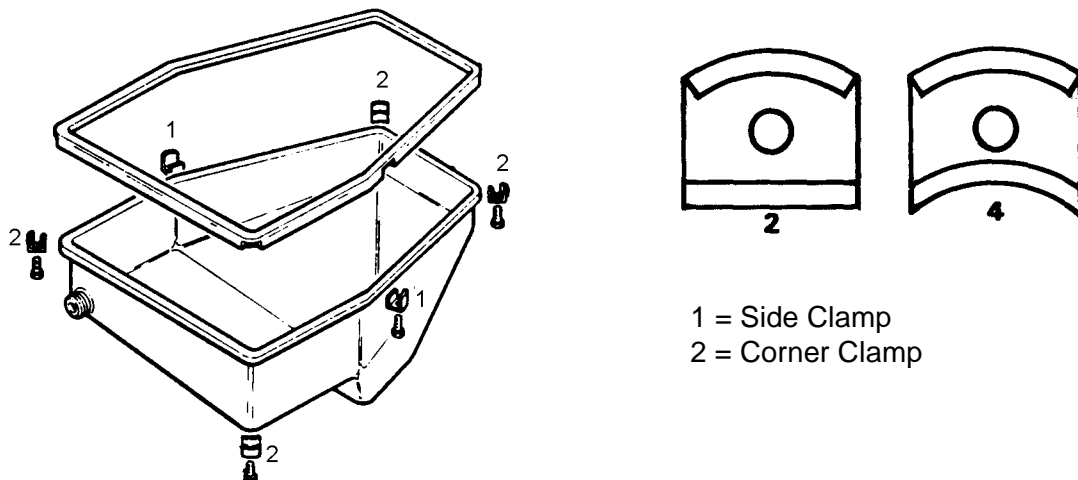
A complete service includes replacing the filter (screen), suction "O" rings, drain plug washer and transmission pan gasket. **Simply draining and refilling the transmission is not sufficient and is not a transmission service.**

Follow the procedure in the Workshop Manual for the specifics of the service procedure:

- 1 - "O" Rings
- 2 - Spacer
- 3 - Filter
- 4 - Pickup
- 5 - Securing bolts



Be sure that the oil pan clamps are correctly placed to avoid leaks and/or pan damage.





TRANSMISSION SERVICE AND ADJUSTMENTS

Transmission Service

Total Fluid Capacity, including Torque Converter:

4HP 22 - 10.25 U.S. qts (9.7 liters)

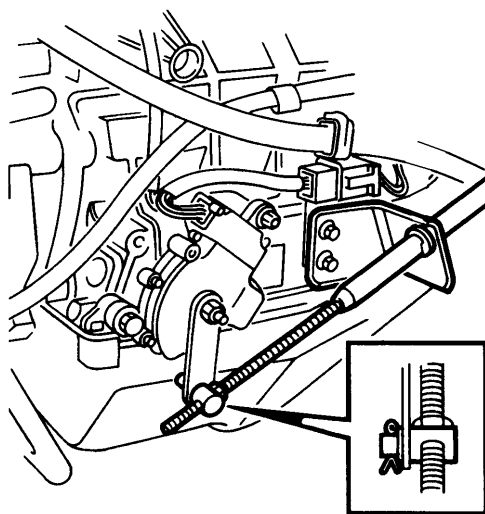
4HP 24 - 11.6 U.S. qts (11 liters)

The refill quantity will vary after a service depending upon drain time. Always check the dipstick with the transmission cold and engine idling in neutral or park. The capacity of the 4HP 24 is greater than the 4HP 22 since it has a larger cooler and torque converter.

In addition, the adjustment of the selector cable needs to be verified during the service/road test.

Selector Cable/Check or Adjust:

- Place the transmission in Park
- Check that the transmission manual valve lever is fully in the Park detent with no preload and the shifter is fully engaged in it's detent within the shift housing.
- Select Drive and Reverse
- Check that the transmission lever is fully in the Drive and Reverse detents in the transmission and the shifter is fully engaged in the Drive and Reverse detents in the shift housing. If not sure, remove the cotter pin and washer and check that the trunnion fits exactly into the manual valve lever hole. If not, loosen the locknut and turn the trunnion 1 revolution in the correct direction recheck.
- Tighten trunnion locknut, replace washer and new cotter pin.





TRANSMISSION SERVICE AND ADJUSTMENTS

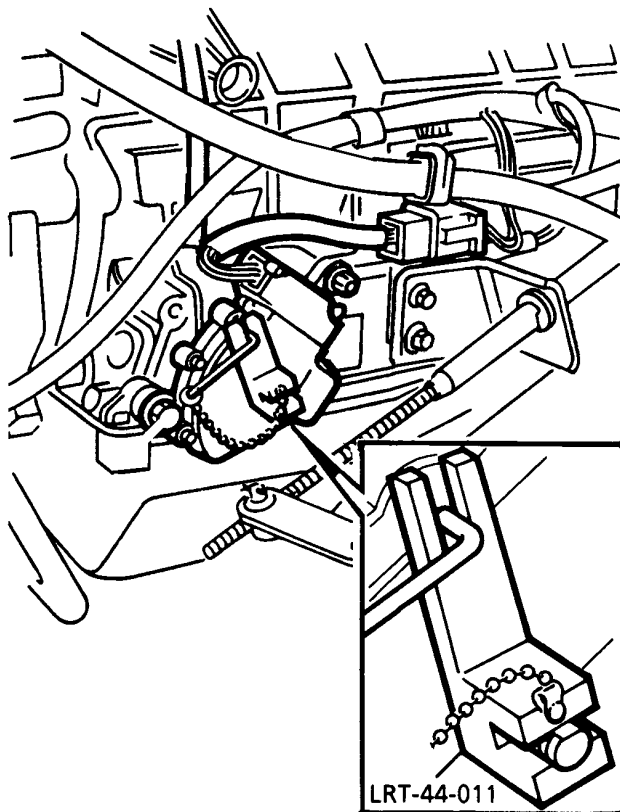
Park Neutral Position Switch (PNPS) - Adjustment

Correct adjustment of the PNPS is critical to ensure that the actual transmission selector lever positions are electrically transmitted to the Transmission Control Module (TCM) and other on-board computers.

A special tool has been developed for this purpose and is used as shown below:

- Set handbrake, select neutral and raise vehicle
- Unscrew nut and pull selector lever and cable from shaft
- Install setting tool LRT-44-011 on shaft
- Install setting pin through slot in tool and into hole in switch. If the pin will not enter the hole, loosen switch mounting hardware.
- Rotate switch such that pin will enter hole.
- Retighten switch
- Remove tool and reinstall selector cable and lever assembly

The same procedure is also used when replacing the PNPS.





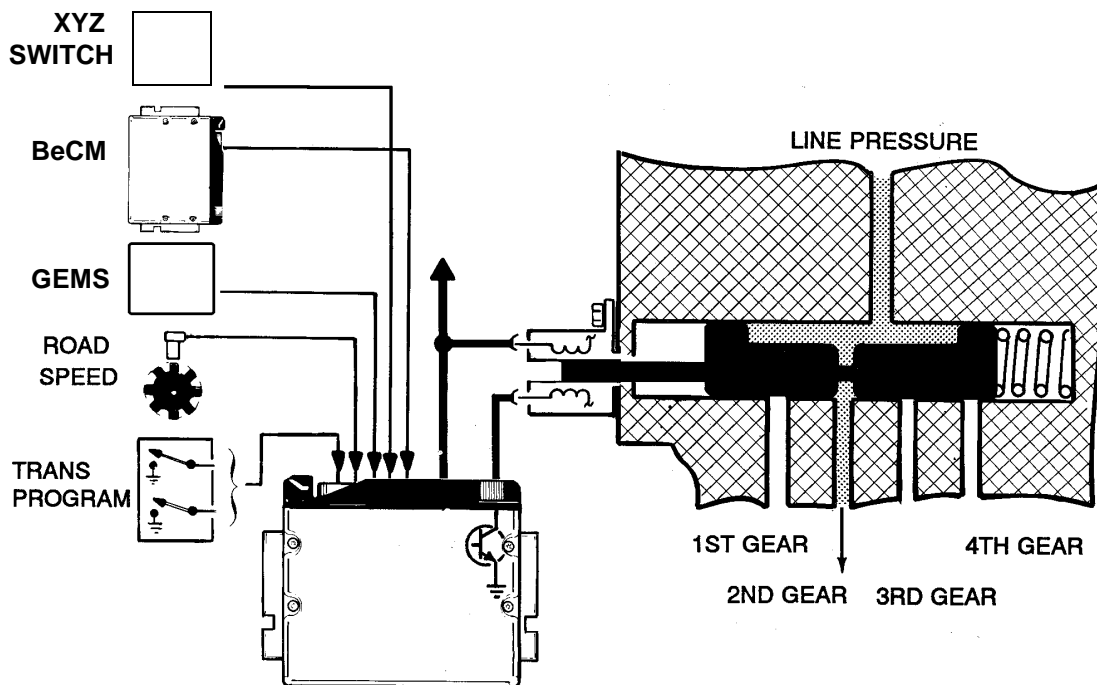
4HP 22/24 E TRANSMISSION OPERATION

Overview

In order to effectively diagnose and repair problems associated with the ZF electronic transmission, it's first necessary to have a good understanding of how they work.

The electronic units are very close cousins to the fully hydraulic models - in fact many of the mechanical components are identical. What sets them apart is how they shift and communicate with other vehicle systems.

In the introduction we covered the basics of electronic shift control and indicated that 4 solenoids in the valve block took the place of the throttle pressure valve/kickdown cable and governor. The 4 solenoids are controlled by an ECU called the transmission control module (TCM) which receives inputs and makes decisions on shiftpoints, torque converter lockup, shift profile, default operation, etc., etc.



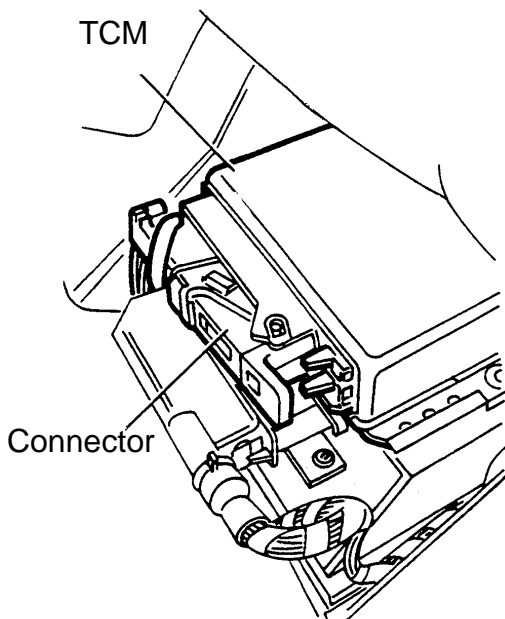
In order to logically review system operation we will begin with the TCM.



4HP 22/24 E TRANSMISSION OPERATION

Transmission Control Module (TCM)

The TCM is located under the driver's seat. To access it or the connector plug, remove the seat base trim panel.



Like all ECU's the TCM receives information from sensors, switches or other ECU's. It makes decisions affecting transmission operation and outputs these decisions to solenoid valves which control shifts, lockup, etc. In addition the TCM outputs to other vehicle ECU's to let them know what the transmission is doing. For instance, during shifts, the TCM will advise the GEMS ECM to reduce engine torque by retarding the ignition timing which provides a smoother shift.

The TCM also contains a "**limp home**" strategy which, if a decision can't be made due to the loss of certain key inputs, the TCM will remove power from all the solenoids which means the transmission will hydraulically:

- Select 3rd gear if the vehicle is stationary
- Select 4th gear if the vehicle is moving



4HP 22/24 E TRANSMISSION OPERATION

Driver Controlled Inputs

The vehicle operator provides the **primary inputs** to the system both mechanical and electronic.

When the driver places his or her foot on the brake, starts the vehicle and shifts from Park to Drive or Reverse, he or she moves a lever which moves the manual valve in the transmission - exactly like the fully hydraulic versions in Classic, Discovery and Defender 90.

What is different is that when the lever is moved, the Park Neutral Position Switch contacts also move informing the TCM, BeCM, H-gate shifter module, and ECM of the gear choice (see page 12 in this section). The shift lever is different, too. It's known as an H-gate shifter and eliminates the need for a separate transfer gearbox lever.

H-Gate Shifter Module

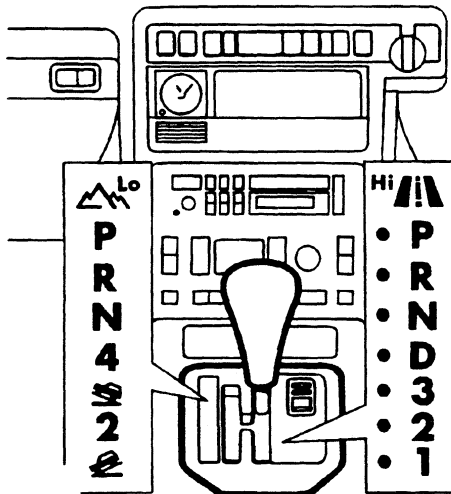
The H-gate module contains a series of lights to indicate gear and range (high or low) selected as well as a mode switch - Manual, Economy, Sport (MES) - which will be detailed later.

If the driver attempts to change from neutral into a gear before the transfer gearbox has fully selected either high or low range a message of "Select Neutral" will appear on the message center.

If the vehicle is moving while the driver attempts to shift ranges, a message of "Slow Down" will appear.



4HP 22/24 E TRANSMISSION OPERATION



H-gate shifter module: interfaces with transfer gearbox ECU (TCU), TCM and BeCM. Further details of the H-gate are found in the (SID) System Information Document section of this book.

Manual, Sport, Economy Switch (MES)

The TCM has the ability to select a shift strategy based in driver input.

In high range the choice is between Economy and Sport. Economy is the default or normal mode whenever the vehicle is switched off and restarted. Sport mode provides more aggressive shifts with less accelerator pedal movement. Any particular gear can be held longer and kickdown occurs earlier in Sport mode.

In low range, the driver can by using the MES switch select a Manual mode. In Manual, the transmission will quickly upshift to the gear selected i.e. 2nd in lever position 2, 3rd in lever position 3, etc. and remain there. It will only shift down to first when the vehicle comes to a stop. The TCM can, however, sense an impending stall and shift down on the roll if necessary.



4HP 22/24 E TRANSMISSION OPERATION

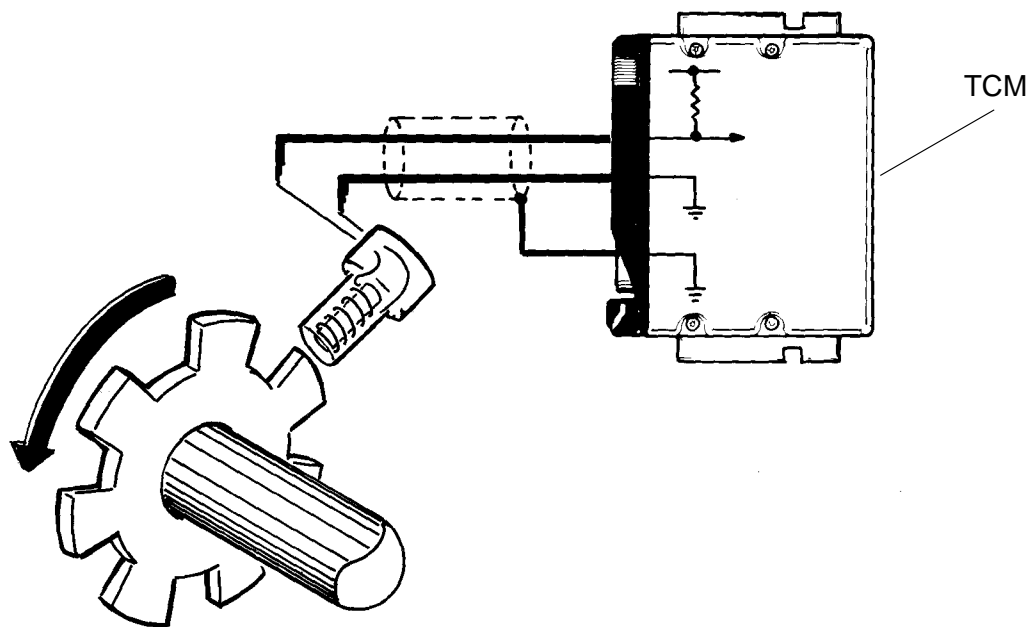
Non-driver Controlled Inputs

The following components provide basic information to the TCM. Detailed troubleshooting and pin out information can be found in the SID section of this book.

Output Shaft Speed Sensor

The output shaft speed sensor is located in the rear of the transmission next to the parking lock assembly. It takes the place of the hydraulic governor and provides the TCM with speed information. The TCM can calculate the difference between input speed and output speed and provide the appropriate gear selection.

The speed sensor - shown below in a simplified diagram - is an A/C generator with shielded wiring to the TCM. Failure of the speed sensor will result in a gearbox default to 3rd or 4th in high range or maintenance of the current gear in low range.





4HP 22/24 E TRANSMISSION OPERATION

Engine Control Module (ECM)

The GEMS ECM provides signals for engine torque, engine speed and throttle angle to the TCM. The TCM then calculates a torque reduction requirement back to the ECM which retards ignition timing to provide a smooth, high quality shift.

BeCM

The BeCM provides several important inputs to the system including power supply via fuses F6 and F3. It also transmits the engine speed signal from the ECM and the diagnostic K and L lines to the DLC under the dash. The BeCM receives the gear selection information from the PNPS and translates it to the message center.

Transfer Gearbox Control Unit (TCU)

The TCU provides a high or low range signal which allows the TCM to select the correct MES switch modes, i.e. Sport or Economy in high, Manual or Economy in low.

Instrument Pack

The instrument pack is linked to the BeCM and indirectly displays MIL illumination on command from the ECM. This is an indirect relationship since the TCM can't directly create a MIL illumination. Three P codes can result from a transmission malfunction.

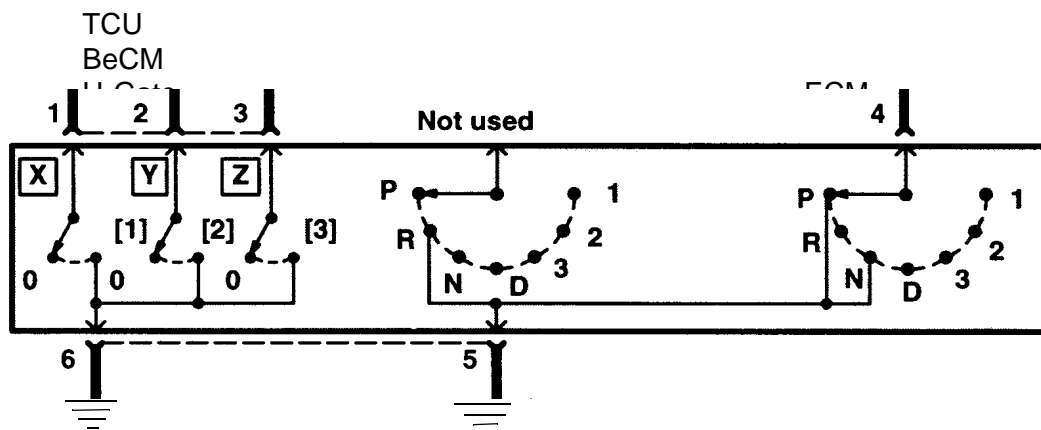


4HP 22/24 E TRANSMISSION OPERATION

Park Neutral Position Switch (PNPS)

The Park Neutral Switch (PNPS) is attached to the left side of the transmission and is multi-functional. It contains 5 separate internal switches. Referring to the diagram below:

- Switches X, Y and Z are connected to the Transmission Control Module (TCM) and inform the TCM of selector lever position - PRND32 or 1. They also provide selector lever position information to the BeCM and H-gate shifter module.
- The middle switch is not used in Land Rover applications.
- The switch at pin "4" is connected to the GEMS ECM. It informs the ECM of transmission no-load status - Park or Neutral.



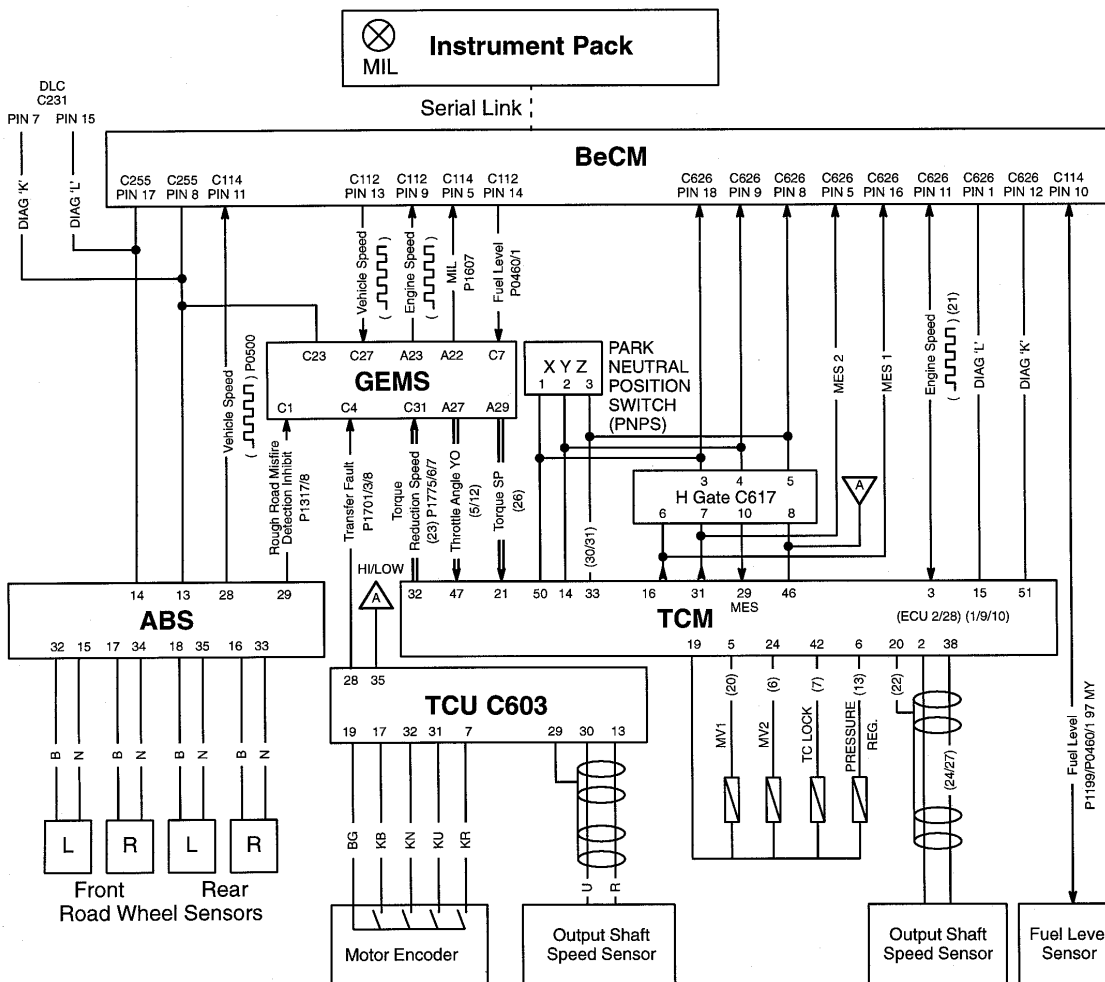
(Wiring is connected to "Fly Leads" not directly to the switch.)

NOTE: Start inhibit and reverse light activation are controlled by the BeCM based on X, Y, Z switch position. A more detailed look at switch operation is provided later in this section.



4HP 22/24 E TRANSMISSION OPERATION

The Big Picture



In the illustration you can see the interrelationships between the TCM and its other inputs. Some are inputs others are outputs - note the arrows. Some components link directly to the TCM others are indirectly linked. Some like the BeCM have both direct and indirect links.



4HP 22/24 E TRANSMISSION OPERATION

Fault Codes

The TCM contains a series of internal Diagnostic Trouble Codes (DTC's) which can provide diagnostic help via TestBook and in some cases cause MIL illumination via the ECM. The TCM by itself cannot illuminate the MIL.

There are a total of 44 unique transmission DTC's and 3 transmission related MIL DTC's or P-codes. The MIL DTC's are:

P-Code	Possible Source	Possible Causes
P1775	Automatic transmission TCM has signaled a fault condition to the ECM.	Automatic transmission TCM sent MIL request Possible wrong ignition retard signal message received
P1776	Automatic transmission TCM ignition retard request duration fault	Automatic transmission TCM fault - too long retard request Driver repeatedly requests shifts which require repeated ignition retard requests and may not be possible
P1777	Automatic transmission TCM ignition retard request line fault	Automatic transmission TCM sends invalid pulse - width - modulated signal. Automatic transmission TCM harness problem: - Open circuit - Short to ground - Short to battery voltage

Please refer to the "Operation Pride" article 1-13 for detailed information on transmission and MIL DTC's. It's in the SID section of this book.



4HP 22/24 E TRANSMISSION OPERATION

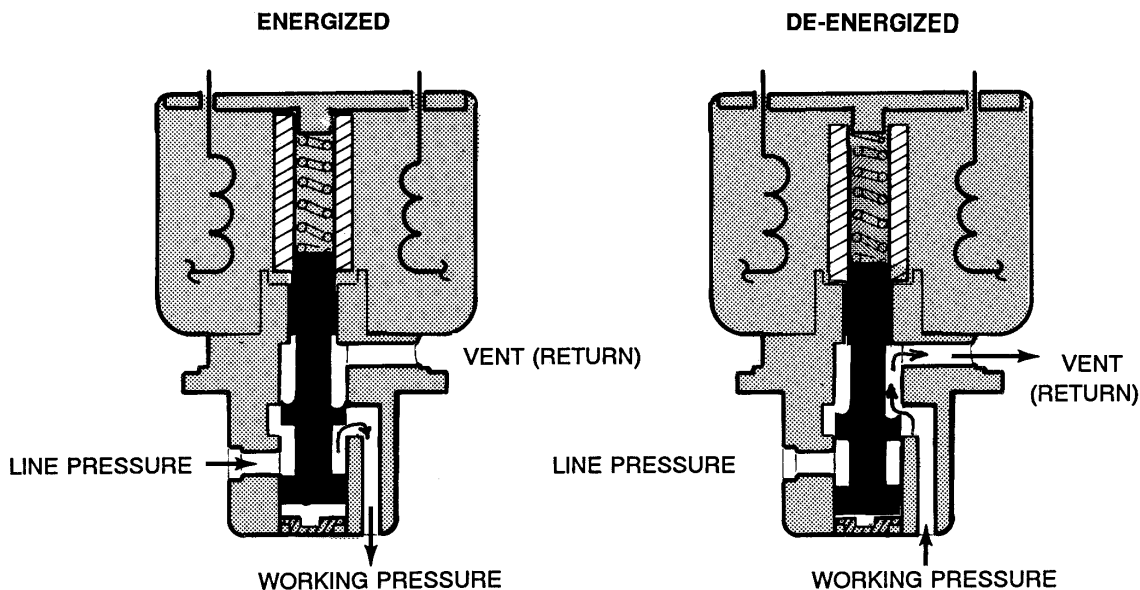
Transmission Control Module Outputs

The TCM provides a series of outputs to solenoids in the transmission and to other vehicle components (such as the BeCM) for information or feedback purposes. We'll take them one at a time.

There are 4 solenoid valves in the transmission, 2 of which are shift solenoids - MV1 and MV2.

They work in conjunction with the hydraulic shift valves to control clutches and clutch brakes and thereby change gears.

In order to select a particular gear the driver first moves the selector lever which positions the manual valve into the desired position - PRND32 or 1. With the engine running, the TCM operates MV1 and MV2 either on or off, together or separately. The valves control hydraulic pressure which moves the shift valves against spring pressure for a particular gear. In the simplified diagram below you can see the operation of a typical solenoid valve both energized and de-energized.





4HP 22/24 E TRANSMISSION OPERATION

Referring to the illustrations on page 14:

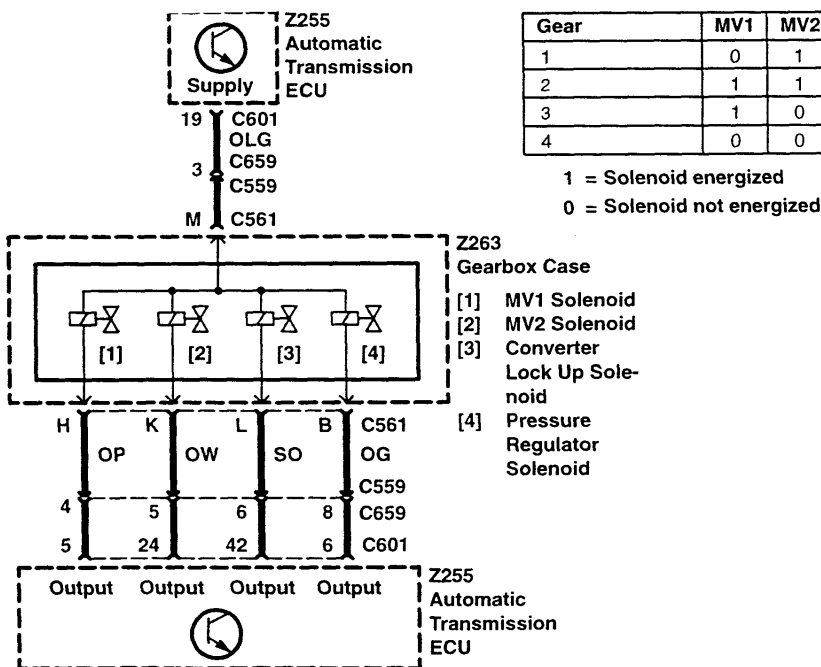
Mainline pressure from the pressure regulator enters on the left port on the valve and if the valve is energized flows across the spool and becomes working pressure. If the valve is not powered the mainline pressure is blocked and the working pressure flows back from the shift valve into the transmission sump.

It's the working pressure which pushes against (or doesn't push against) the end of the shift valves and opposes spring pressure.

The electrical schematic below shows how MV1 and MV2 along with MV3 (T.C. Lockup) and MV5 (Pressure Regulator) are controlled by the TCM.

Note that terminal "M" of connector C561 is common to all 4 valves and is positive. Terminals H, K, L and B are the individual grounds supplied by the TCM to activate each solenoid as required.

The small table at the top, right side of the illustration indicates the electrical "state" (either on or off) of each solenoid for each forward gear. Note that reverse is not impacted by either solenoid directly.





4HP 22/24 E TRANSMISSION OPERATION

Solenoid MV2 is also used to prevent the driver from selecting reverse when the vehicle is moving forward at a speed of 5 mph (8 kph) or greater. This is known as reverse inhibit and prevents damage to the transmission.

Torque Converter Lockup Solenoid - MV3

MV3 controls fluid reversal in the torque converter circuit which applies the torque converter clutch (DDC). Lockup occurs based upon load, gear selection and speed processed by the TCM. Operation of MV3 locks the clutch between 30-45 mph (48-72 kph) in either 3rd or 4th gear. The lockup speed is influenced by whether Economy or Sport have been selected.

Lockup in low range occurs at 2000 rpm with a **closed** throttle. This is useful to know when coasting down a hill as a jolt will be felt at the 2000 rpm threshold as the DDC locks engine and transmission as a unit and provides maximum engine braking.

Pressure Regulator Solenoid - MV5

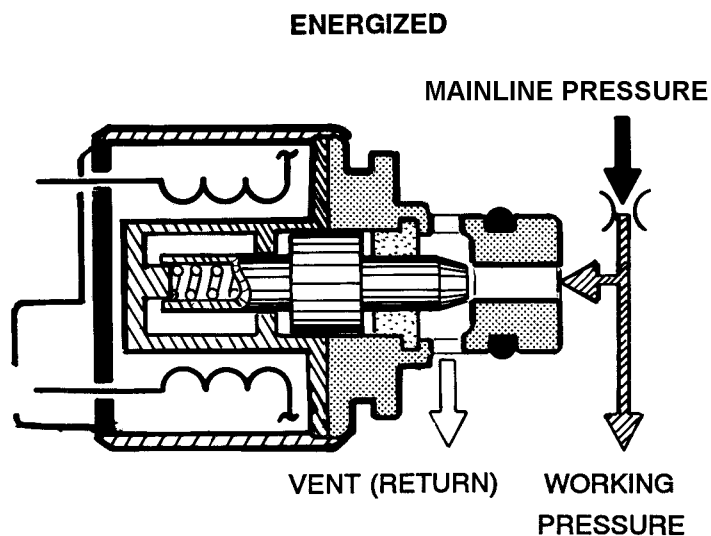
Fluid pressure regulation in the hydraulic ZF transmissions is controlled by a combination of spring pressure and modulator pressure. In the electronic ZF MV5 controls mainline pressure to a degree not possible with hydraulics alone. The electronics allow almost an unlimited range of pressures from very low during light throttle shifts to maximum pressure during hard acceleration.

Operation of the solenoid MV5 is described on the next page.



4HP 22/24 E TRANSMISSION OPERATION

The simplified illustration below shows the pressure regulator solenoid. The solenoid is sprung normally closed. When power is applied the valve opens and some of the mainline pressure bleeds off through the vent reducing actual working pressure. Maximum pressure occurs with the valve deenergized or closed.



The pressure regulator solenoid is **adaptive** and over time will adjust mainline pressure to suit driving style. Sedate driving habits will result in lower pressures than aggressive driving. Lower pressures improve shift qualities but can result in slippage. The ECM constantly monitors clutch slip time and adjusts the pressure accordingly (the ECM is programmed with an "ideal" nominal time). This not only accounts for driving style but also for clutch wear.



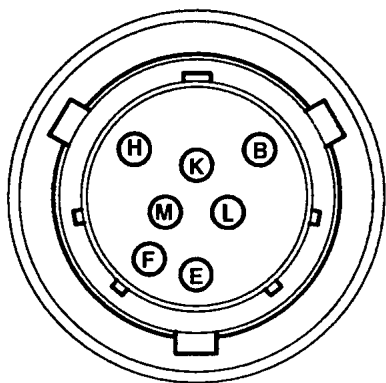
4HP 22/24 E TRANSMISSION OPERATION

Transmission Electrical Connection

The chart below shows a view of the circular plug which electrically connects the transmission to the vehicle. By using a DVOM across the transmission side pins as indicated, you can verify suspected internal faults.

Example: A reading between pin "H" and pin "M" should result in a value of 26 ohms. If you refer to the diagram on page 12 of this book you can see that you have measured the resistance of solenoid MV1's coil.

- B - MV5 Pressure Regulator Solenoid
- E - Road Speed Sensor +VE
- F - Road Speed Sensor -VE
- H - MV1 Solenoid (Shift)
- K - MV2 Solenoid (Shift)
- L - MV3 Solenoid (TC Lock)
- M - Solenoid Supply



TRANSMISSION ELECTRICAL PINOUTS (MATING FACE)

	B	E	F	H	K	L	M
B	-	O/C	O/C	32	32	37	5
E	O/C	-	320	O/C	O/C	O/C	O/C
F	O/C	320	-	O/C	O/C	O/C	O/C
H	32	O/C	O/C	-	53	58	26
K	32	O/C	O/C	53	-	58	26
L	37	O/C	O/C	58	58	-	32
M	5	O/C	O/C	26	26	32	-

- O/C = OPEN CIRCUIT
- FIGURES SHOWN ARE TYPICAL VALUES OF RESISTANCE



4HP 22/24 E TRANSMISSION OPERATION

Solenoid/Clutch Application Chart

The chart on the following page shows which clutches and clutch brakes are applied in different shift lever/gear positions.

Solenoid/Clutch Application Chart

ZF 4HP 22/24 EH Transmission

Lever Position/ Gear	Solenoid Valve			Clutch			Clutch Brake				Unidirectional		
	MV 1	MV 2	MV 3	A	B	C	1	2	3	4	1	2	3
Park/ Neutral		•				•							
Drive- 1ST		•		•		•						•	
Drive- 2ND	•	•		•		•	•	•			•		•
Drive- 3RD	•		•	•	•	•		•					•
Drive- 4TH + LOCKUP			•	•	•			•		•			
1 - 1ST		•		•		•				•			
REVERSE					•	•				•			
REVERSE GEAR INHIBIT		•											

- Indicates component is applied, locked or engaged.



DIAGNOSIS AND TESTING

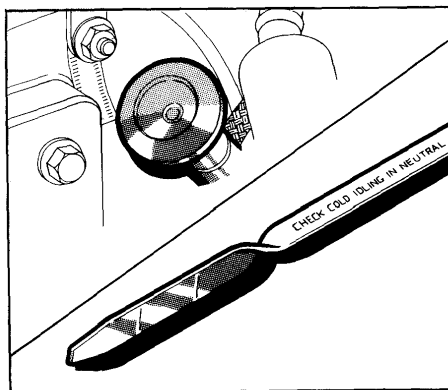
Fluid Analysis

Due to the time and cost associated with either replacing or overhauling an automatic transmission it is vital that a technician performs a complete diagnosis before work begins.

After reviewing the customer complaint, the first thing that a tech will normally do is to check for fluid level and condition. An overfilled transmission will generally do one of two things:

- Shift erratically - caused by fluid foaming and air entering the valve block and clutch circuits.
- "Mysteriously" expel fluid from the dipstick tube especially after a long drive or when towing.

Most service station attendants (where they still exist) and owners have learned to check the fluid level hot - which is INCORRECT for a ZF unit. Level must always be checked cold.



Checking the level hot will make the transmission appear to be overfilled when in fact it is at the correct level. Underfilling is similar to overfilling - fluid foaming and pump cavitation normally result.

Fluid condition is usually judged by color and smell. DEXRON ATF is darker than other types and tends to darken further as it ages. This fact needs to be recognized at the outset to avoid an incorrect diagnosis. The following chart should help with your analysis of ATF.



DIAGNOSIS AND TESTING

Fluid Analysis

COLOR	ODOR	CAUSE/ACTION
Dark Brown, no particles present	Burned smell	Overheated fluid - service transmission
Black or very Dark Brown, particles present	Strong burned smell	Friction materials from clutches. may need trans overhaul or replacement
Foamy - normal color	Normal	Overfilled or underfilled - fluid aerated

Note that a large amount of friction material in the pan or on the filter screen may indicate the need replace the transmission. Simply servicing the transmission invites future problems as the fresh additives can break loose varnish and other residue and cause problems in the valve body.

Normally the torque converter is not drained or serviced. Regular fluid changes keep the additive strength high enough to cope with the several quarts of used fluid in the transmission when it is serviced.

The only practical method of cleaning the torque converter is through specialized flushing equipment at a commercial transmission shop. Never flush a ZF converter with solvent or other cleaning fluids - use only clean ATF. The chemicals in most solvents will damage the bonded lining of the torque converter clutch.



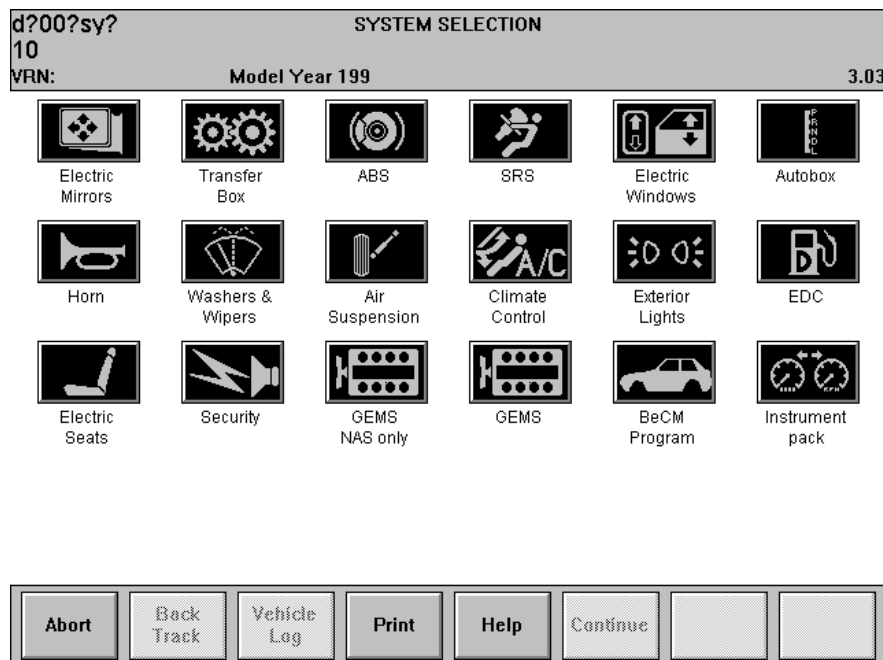
DIAGNOSIS AND TESTING

TestBook Diagnosis

Due to the complexity of the transmission's control circuits and interrelationships with other on-board computers the quickest and most effective method of overall diagnosis is using TestBook.

If the fluid condition and level is ok, connect TestBook up to the vehicles data link connector (DLC) using the blue DLC adaptor.

After logging on and entering the model year and VIN, proceed to the system selection screen and touch **Autobox**.





DIAGNOSIS AND TESTING

Next you will see the “System Diagnostics” screen which gives you four choices. Select the one which is most appropriate to the problem.

Used when you aren't sure of what type the problem is.
(Not available yet for auto trans.)

Used when the message center indicates “Gearbox Fault.”

ddpn0000	AUTO GEARBOX DIAGNOSTICS	
select1		
VRN:	Model Year 199	3.03
SYSTEM DIAGNOSTICS		
GUIDED DIAGNOSTICS		
FAULT CODE DIAGNOSIS		
REAL TIME MONITOR		
SUB-SYSTEM TESTS		
Abort	Back Track	Vehicle Log
Print	Help	Continue
		EXIT

Used during a road test or in the shop to get data on speed, load, throttle angle, etc.

Used when you have an idea what the problem is or the area where it may be.



DIAGNOSIS AND TESTING

Next we have an example of “Fault Code Diagnosis” screens. The message centre indicates “Gearbox Fault.”

ddpnp001	AUTO GEARBOX DIAGNOSTICS						
dispatch_nas							
VRN:	Model Year 199	3.03					
FAULT CODE AND CONDITIONS IDENTIFIED							
<p>Fault Code -06 -- Fault on solenoid valve 1. Possible fault in the wiring associated with solenoid MV1 (pin 5) or fault in the ECM. May result in 1st gear engaging when 2nd is selected, 4th gear when 3rd selected, 2nd gear when 1st selected or 3rd gear when 4th selected</p> <p>The fault status value is 46 (hex) The fault is not exhaust emission relevant The fault is not sporadic The gearbox is in default The fault is not present Short circuit to ground or open circuit detected The number of times that the fault has occurred is 1</p> <p>The freeze frame data is :- Engine Speed 0 RPM Road Speed 0 kph 0 mph</p> <p>Press CONTINUE to proceed.</p>							
Abort	Back Track	Vehicle Log	Print	Help	Continue		

ddpn1006	AUTO GEARBOX DIAGNOSTICS						
startnode							
VRN:	Model Year 199	3.03					
CORRECTIVE SERVICE							
<p>FAULT IDENTIFIER - FMV1 - FAULT CODE NO. 6</p> <p>Fault in circuit which drives the MV1 solenoid</p> <p>Press CONTINUE to proceed to next fault Press MORE DETAIL for guided diagnostics Press TOOLBOX for measurements</p>							
REPAIR DETAILS							
<p>Check the following items</p> <p>P wire, C601 pin 5 short circuit to ground P wire, C601 pin 5 short circuit to supply P wire, C601 pin 5 to P wire, C561 pin H</p>							
Abort	Back Track	Vehicle Log	Print	Help	Continue	More detail	Toolbox

Note how you have three choices on how to proceed: “Continue”, “More Detail” and “Toobox.”



DIAGNOSIS AND TESTING

The menu screen below allows you to select what you want to see in “Real Time Monitor.” Choose the icon which will provide the most information for the problem or problems which you are troubleshooting.

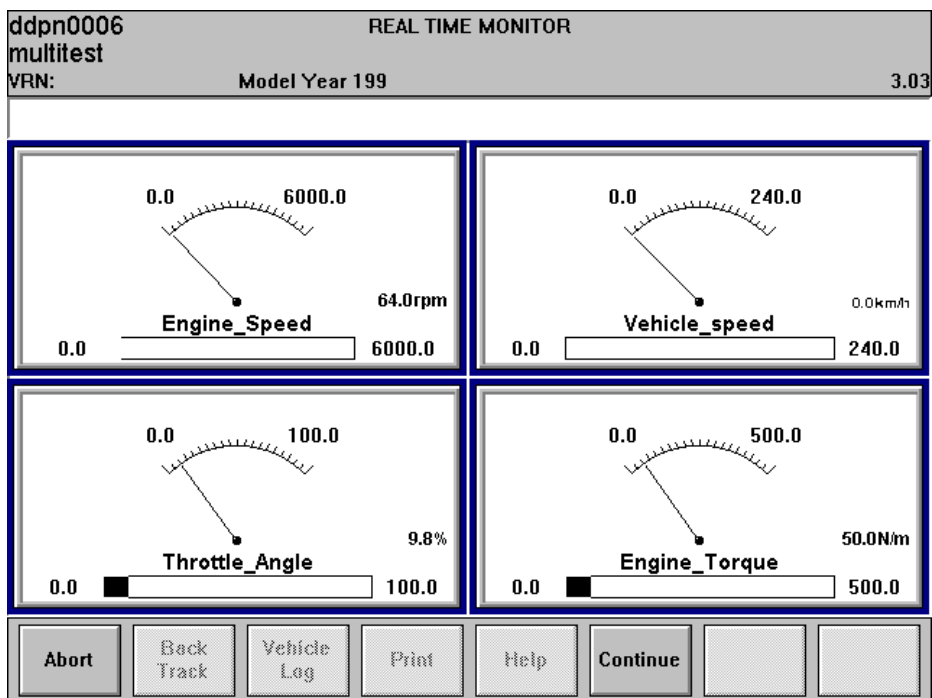
ddpn0007		AUTO GEARBOX DIAGNOSTICS					
real_time_sel							
VRN:	Model Year 199	3.03					
REAL TIME MONITOR							
ENGINE SPEED	THROTTLE ANGLE	MULTIPLE OUTPUTS					
VEHICLE SPEED	GEAR POSITION	ECM Id.					
BATTERY VOLTAGE	HI/LOW RANGE						
ENGINE TORQUE	ENGINE_VEHICLE						
Abort	Back Track	Vehicle Log	Print	Help	Continue		EXIT

As an example we will touch this “button.”



DIAGNOSIS AND TESTING

After pressing the “Multiple Outputs” icon from the Main Menu you see on a real time basis four different measurements, both in analog and digital formats.





DIAGNOSIS AND TESTING

If you decide to use “Sub-System Diagnostics,” here is the menu screen which will appear after you touch the sub-system “button.”

ddpn0011	AUTO GEARBOX DIAGNOSTICS						
startnode							
VRN:	Model Year 199			3.03			
SUB-SYSTEM DIAGNOSTICS							
Gear position switch		Output Solenoids					
Gearbox Mode sense		EMS Interface					
Throttle angle		Shift interlock					
Output shaft Sensor		Erase Faults					
Abort	Back Track	Vehicle Log	Print	Help	Continue		EXIT

Now we'll press the “Output Shaft Sensor” button and receive instructions on what needs to be done in order to test its function, but first we see this screen:

ddpn0000	AUTO GEARBOX DIAGNOSTICS						
startnode							
VRN:	Model Year 199			3.03			
WELCOME							
<p>Auto gearbox diagnostics selected.</p> <p>TestBook will take you through this routine step by step.</p> <p>Carefully follow all instructions.</p> <p>Select HELP where necessary.</p> <p>Press CONTINUE to proceed.</p>							
Abort	Back Track	Vehicle Log	Print	Help	Continue		



DIAGNOSIS AND TESTING

ddpn6008	AUTO GEARBOX DIAGNOSTICS						
startnode							
VRN:	Model Year 199 3.03						
OUTPUT SHAFT SPEED SENSOR							
Switch ignition off							
Refit BeCM Fuse 11							
Switch ignition on							
Ensure message centre displays TRANSFER NEUTRAL							
Apply handbrake							
Select High range and Park							
Press CONTINUE to proceed							
Abort	Back Track	Vehicle Log	Print	Help	Continue		

After pressing "Continue," here's what we see:

Sheet 3 of 3

WORK PROCEDURE:

With the vehicle on a level surface:

1. Install the new dipstick, ensuring that it is the correct version.
 - Replace YELLOW handled dipsticks with BLACK handled dipsticks (GPR33).
 - Replace BLUE handled dipsticks with ORANGE handled dipsticks (PTC1357).
2. With the new dipstick installed, check the level of oil in the transmission. The transmission must be checked while COLD, BUT WITH THE ENGINE IDLING in neutral (set the handbrake). Normally, it will be necessary to partially drain the gearbox and top-up to the correct level on the dipstick, i.e., the mid-point between the two level marks.
3. If the transmission is over-filled, drain off approximately one quart of oil and top-up the transmission to the proper level with new ATF. Never re-use ATF, which could be contaminated.

You can read the speed in either digital or analog format.



DIAGNOSIS AND TESTING

If we decide that we want to test the function of the Park Neutral Position Switch we press the “Gear Position Switch” button on the main menu. Here’s what we’ll see:

ddpn6101		AUTO GEARBOX DIAGNOSTICS	
readp			
VRN:	Model Year 199		3.03
MOVE GEAR SELECTOR TO PARK			
Does the message centre agree with gear selected (PRND321 - disregard Hi/Lo)?	✓		
Does the gear selector illumination (RED dot) agree with gear selected ?	✓		

Abort	Back Track	Vehicle Log	Print	Help	Continue		
-------	------------	-------------	-------	------	----------	--	--

If we cannot answer the question as a “yes” we would touch the “check” mark which would then become an “X.” The diagnostic would then lead us into the resolution of the problem.

If we answer yes to the above questions we would do nothing other than to touch “Continue” and receive instructions on what to do next. Example: The next screen would instruct us to move to the gear selector to reverse.



DIAGNOSIS AND TESTING

Road Test

Due to the ability of TestBook to diagnose faults in the transmissions electronics, a road test only to confirm the complaint is generally needed. Reverse... shift points, T.C. Lock, kickdown, etc. are all determined by the TCM after receiving inputs from sensors and other on-board computers.

A road test can be used to detect mechanical faults which may not be apparent from the Test-Book session. Faults such as a partly plugged filter, clutches worn beyond the ability of the electronics to adapt, noisy planetary gearsets and so forth may be apparent while driving the vehicle but not in the shop.

Remember, TestBook is portable and using the Road Test Power Supply the technician with the help of an assistant can retrieve additional information while on a test drive.

As always... never aggressively drive a vehicle with obvious transmission faults.

As previously mentioned, torque converter lockup can occur in either 3rd or 4th gear at speeds between 30 mph and 45 mph (48-72 kph) and is dependent on load. A quick check of lockup can be made while driving at a steady state in either 3rd or 4th gear.

- Slowly accelerate the vehicle to greater than 30 mph (48 kph)
- Press down the accelerator briefly and observe the tachometer:
 - Tach moves 300-500 rpm but speed remains constant - DDC not engaged.
 - Tach doesn't move - DDC engaged.

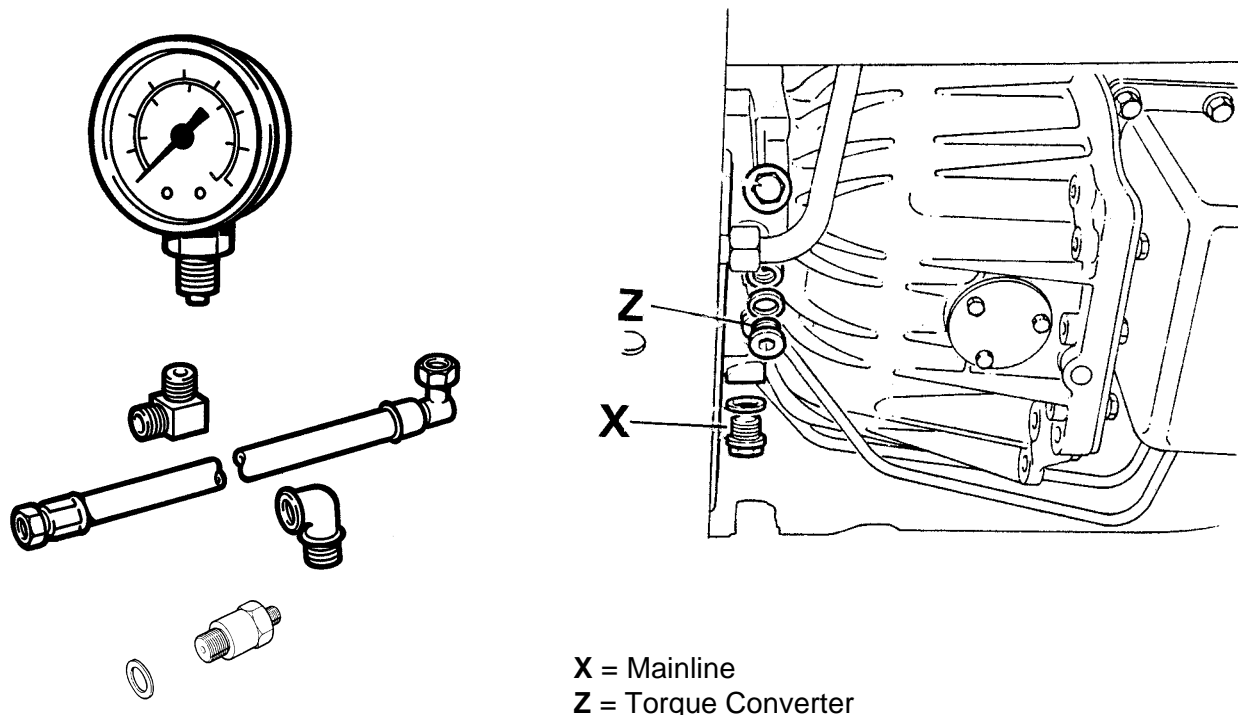


DIAGNOSIS AND TESTING

Pressure Testing

Further analysis of a transmissions condition can be made using a pressure gauge. For ZF transmissions in Land Rover products, the correct tools are:

Pressure Gauge LRT-44-007
Hose and Fittings LRT-44-008
Adaptor/Seal LRT-44-009



X = Mainline
Z = Torque Converter

The pressure gauge can be connected to read either mainline or torque-converter pressure depending on which test port is selected. Testing can be done on the road or in the shop or both.

CAUTION: Make sure that the gauge hose is tied clear of the exhaust or catalyst!

Hook up the gauge adaptor to the appropriate test port or shown in the illustration. Use a 6mm allen socket and replace the sealing washer when done.



DIAGNOSIS AND TESTING

Test Pressures should be as follows:

Mainline Pressures: 150 ± 5 psi (1055 ± 35 kpa) in D, 3, 2, 1 @ 2000 rpm (under load)
0 psi in P, N, R at all speeds

Important: Full mainline pressure will only be seen at "stall" or on a full throttle road test. The TCM reduces mainline pressure during light throttle applications.

Torque Converter Pressure: 100 ± 5 psi (700 ± 35 kpa)
in all gears, park and neutral @ 2000 rpm
0 psi with DDC engaged

Lower than normal mainline pressure can indicate a worn pump, leaking clutch or clutch brake pistons, or more typically a partially clogged filter screen or low fluid level.

Stall Testing

Stall testing is a poorly understood and possibly destructive diagnostic procedure. When performed properly, however, it can provide a great deal of information to the technician.

The "stall" in stall testing occurs when the turbine portion of the torque converter is prevented from turning (stalled) by the vehicle brakes with the vehicle in gear at W.O.T.

A stall test will reveal the following:
Slipping clutches, clutch brakes and unidirectionals
A freewheeling torque converter stator
Weak or poorly tuned engine

Since stall testing is done with the brakes fully locked and zero road speed it will be possible to test the holding/driving power of the components responsible for 1st gear in Drive, 3, 2 and 1 and for Reverse gear. A stall test won't reveal problems with the clutches or clutch brakes specifically responsible for second, third or fourth gear, but by testing 1st and reverse we can confirm or eliminate the following components as being a problem:

- "A" Clutch - used in all forward gears
- "C" Clutch - used in 1st, 2nd, 3rd and Reverse
- CB 3 - used in 1st (selector pos. 1)
- UD 2 - Holding D, 3, 2 positions



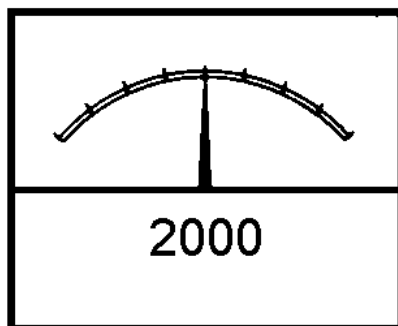
DIAGNOSIS AND TESTING

Stall Test Procedure

Do the following to ensure that the stall test you are performing is accurate and safe.

CAUTION: Never let anyone walk or stand in front of the vehicle while stall testing.

- Make sure the powertrain is at normal operating temperature and that the transmission, coolant and engine oil are topped up.
- Connect TestBook or an accurate tachometer. The vehicle tach is NOT acceptable for stall testing.
- Block the wheels and apply both the hand brake and foot brake firmly.
- Start the engine and place selector in Drive
- Depress the accelerator to the floor and hold until it stabilizes. Release the accelerator and record the rpm. Do not hold the throttle at W.O.T. for more than 5 seconds.
- Shift into neutral and hold at 1000 rpm for 30 - 60 seconds to cool the ATF.
- Repeat in 1st gear lever position 1, record results.
- Cool for 30 - 60 seconds as indicated above.
- Repeat in Reverse gear, record results.



If a stall speed of 2400 rpm or greater occurs, the TCU will default the transmission and illuminate the "gearbox fault" message for the driver. A stall speed this high indicates slipping clutches.

WARNING: A stall test must only be performed in high range.



DIAGNOSIS AND TESTING

The following chart gives you the information needed to analyze stall test results.

RPM	INDICATION
5 %	Clutches holding - normal condition
2400 +	Clutches slipping - repeat in other gears, ranges to isolate
1600 - 1800 rpm	Weak, badly tuned or misfiring engine
5%	Freewheeling stator in T.C.
Loud metallic noise, clicking	T.C. internal problem or drive plate problem

NOTE: A torque converter with a siezed stator will not show up on a stall test. On a road test, however, off line performance will be good but the vehicle will be sluggish at higher speeds and have excessive fuel consumption.

The RPM values shown above will all be somewhat lower at high altitudes (except possibly for slipping clutches).



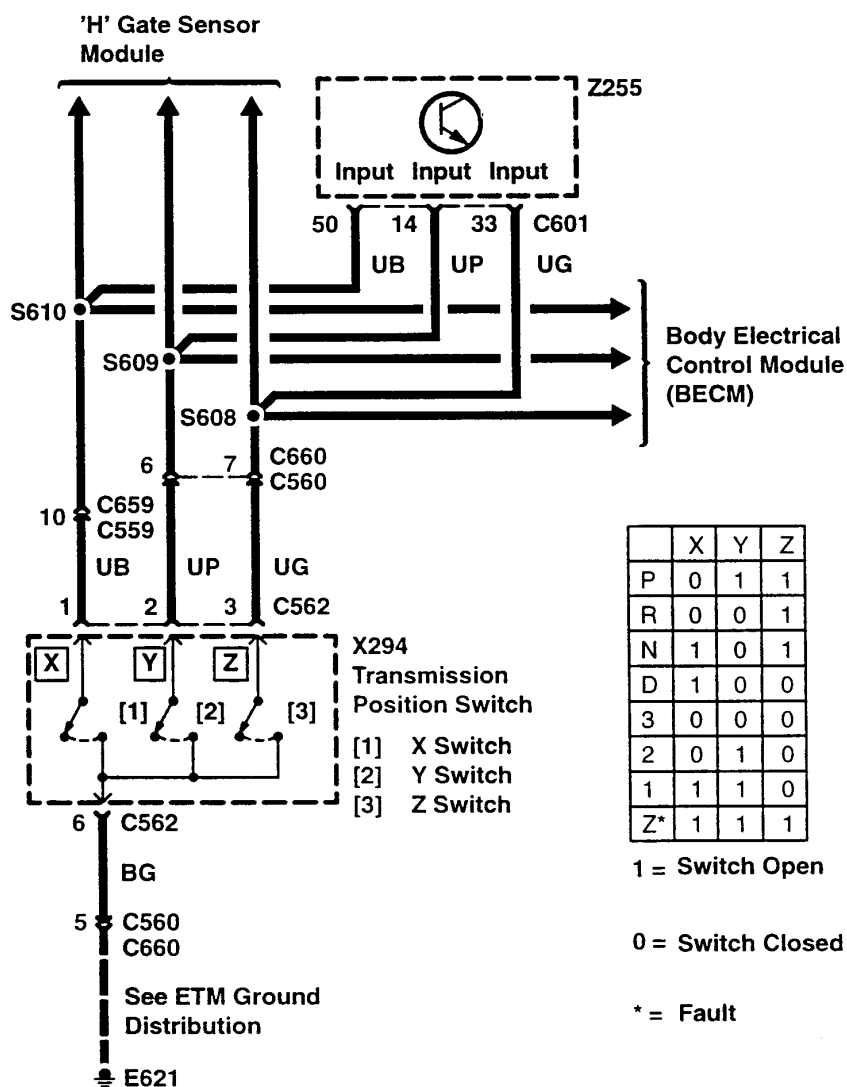
DIAGNOSIS AND TESTING

PNPS - Logic

The PNPS contains five internal switches as shown earlier in this section. Only 3 - the X, Y, Z switches - are connected to the TCM. By analyzing the status of these switches the TCM calculates selector position.

If a fault occurs with the switch the TCM may select a different gear than that requested by the driver. As the shift lever is moved, the TCM will detect the fault and default the gearbox to 3rd (or 4th) gear.

The illustration below shows the interface of the PNPS, TCM, H-gate and BeCM. Note the logic chart.



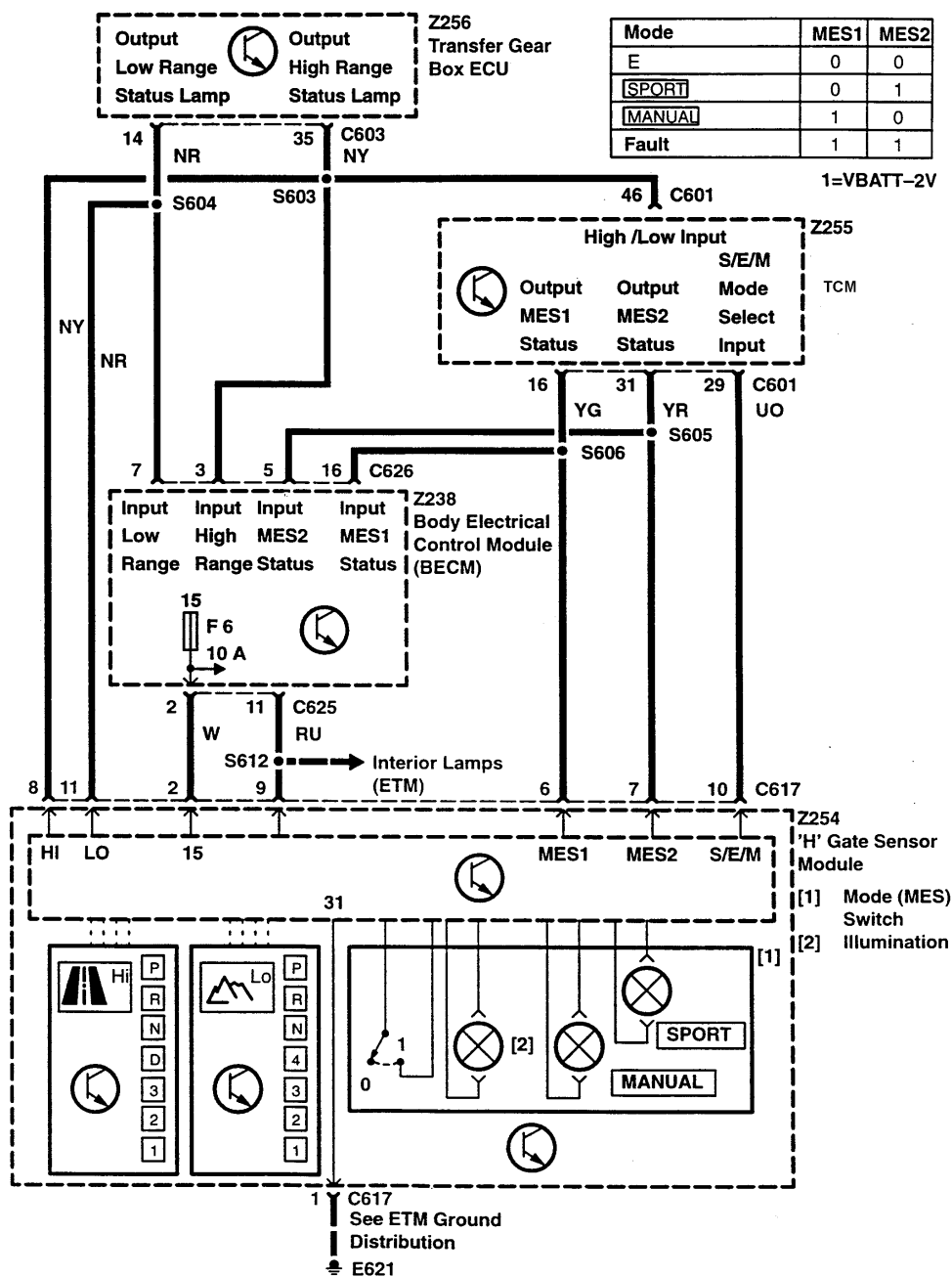
Rev. 6/96



DIAGNOSIS AND TESTING

MES Interface

The following illustration shows the relationship of the H-gate, BeCM, TCM and TCU. The status of the MES1 and MES2 lines indicate to the BeCM which mode (Manual, Economy or Sport) has been selected or if a fault within the transmission has occurred.





REMOVAL AND INSTALLATION

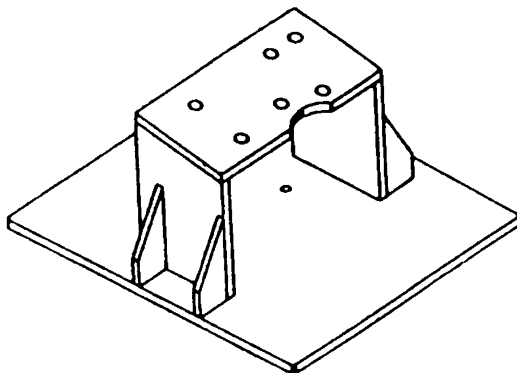
Removal

First, refer to section 44, repair of Range Rover Workshop Manual.

In general terms, it is best to remove the transmission, torque converter and transfer-gearbox as a unit. Since this assembly weighs over 350 lbs. (160 kg) a hydraulic transmission jack is highly recommended.

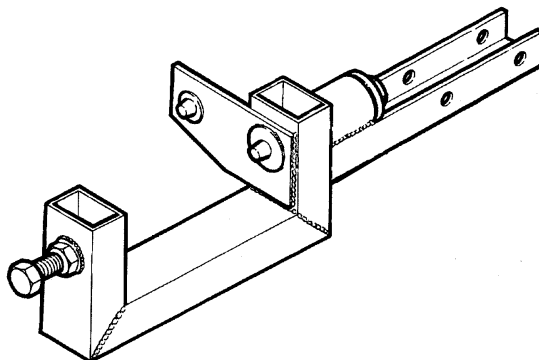
In order to adapt the table of the transmission jack to the transfer gearbox/transmission combination Land Rover supplies premade adaptor plates. They provide a safe means of retaining the assembly while its being lowered and minimize damage to you and the transmission.

Special tool LRT-99-007 is the correct adaptor for Range Rover.



LRT-99-007

With the transmission removed, use special tool LRT-44-505 to support the transmission on an engine stand. This holding fixture allows the unit to be rotated and does not interfere with the removal of any components.



LRT-44-505

Rev. 6/96



REMOVAL AND INSTALLATION

Installation

Installation of the automatic transmission and transfer gearbox combination is essentially the reverse of removal except for some very important checks and adjustments:

Flywheel/Drive Plate

Two different versions of the twin drive plate flywheel exist for Range Rover. One is for the 4.0 engines and the other is for 4.6 applications.

Spacers instead of shims are used to adjust the distance from the rear face of the block to the drive plate.

Spacer Selection

4.0 Engines..... 12mm spacer
4.6 Engines..... 4mm spacer

Refer to TIB 44/03/95/US in the Bulletins/Notes section of this book for details of the two drive plate/torque converter variations.



REMOVAL AND INSTALLATION

Torque Converter

When installing the torque converter onto the transmission stator support, make sure that it is fully inserted and that the pump drive tangs are engaged in the pump. The distance between a torque converter attachment boss to the face of the bell housing is approximately 1 inch (25mm) when the converter is fully seated.

With the bell housing bolted up to the engine block, it should be necessary to slightly pull the converter up to the drive plate.

Oil Cooler

Completely flush out the cooler circuit. If the previous failure left metal particles in the system it may be necessary to replace the cooler.

Final Adjustments

Before returning the vehicle to the customer after the transmission has been replaced, do the following:

- Double Check the cold oil level - if possible after one thermal cycle.
- Selector cable to correctly index in both the transmission and shift housing detents (see p. 3)
- Check the operation of the transfer gearbox
- Thoroughly road test observing shift points, kickdown, lockup, etc.
- Check for leaks.
- Check that no faults are present using TestBook.



4HP 22H REPAIR POLICY

Due to the cost of transmission parts, valve blocks, etc. LRNA has an agreement with ZF North America to supply reasonably priced complete exchange units to retailers. At the time of printing (Spring 1997) a 4HP 22 electronic exchange unit cost approximately \$2600 dealer net (\$3700 MSRP) plus \$500 core surcharge.

During the warranty period, these units must be used when an internal failure has occurred. Due to the limited number of parts available for the electronic unit, exchange is normally the only route.

Customer paid repairs are, of course, at the discretion of the retailer. Whether or not to attempt an overhaul will depend upon the extent of failure. It is best to check the price of the appropriate exchange unit prior to giving the customer his or her options.

Remember....an exchange transmission is complete with torque converter.

When ordering a remanufactured transmission it is important to be specific about the particular vehicle it will be going into. Valve block calibration, clutch pack build and even planetary gear-sets will vary.

On the next page is a list of repairs is from the current Warranty Handbook and specifies which repairs are permitted. In any case the 80% rule applies - if the total repair cost is 80% that of the cost of a repair unit, use the re-man unit.



WARRANTY STATEMENT

The following is a list of repairs dealers are authorized to perform on the automatic transmission. All other defects require replacement of the complete transmission with a Factory Remanufactured unit.

A. Transmission in Vehicle

1. Elimination of Leaks

- ◆ Inhibitor switch
- ◆ Intermediate plate screw plug
- ◆ Selector shaft
- ◆ Oil pan
- ◆ Throttle cable
- ◆ Gearbox extension

2. Elimination of Mechanical Failure

- ◆ Inhibitor switch
- ◆ Oil pan
- ◆ Oil screen
- ◆ Control unit (Valve Body)
- ◆ Dipstick tube seal
- ◆ Shift parts (selector shaft, throttle cam, stop plate, etc.)
- ◆ Gearbox extension
- ◆ Governor housing
- ◆ Throttle cable
- ◆ Governor hub
- ◆ Parking mechanism
- ◆ Breather (complete) or renew 'O'-ring

B. Transmission out of vehicle

1. Elimination of Leaks

- ◆ Torque converter*
- ◆ Pump housing*
- ◆ Pump seal*
- ◆ Between gearbox housing and intermediate plate

2. Elimination of Mechanical Failures

- ◆ Pump*
- ◆ Intermediate plate*

*Not available for Range Rover 4.0SE/4.6HSE

As of 2000 Warranty Policies & Procedures Manual



TOOLS AND TOWING

Special Tools

In order to properly service and repair Land Rover automatic transmissions you will need to use a number of special tools dedicated to the purpose.

Most Land Rover retailers will have the essential Automatic Transmission tools which were shipped as part of their original tool and parts order.

Broken, lost or missing tools can be ordered through the Kent-Moore tool program. A complete list of all necessary tools is included in Section 44 of the specific Workshop Manual being used for the repair.

Towing

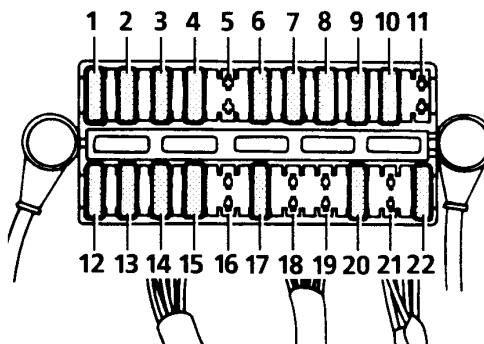
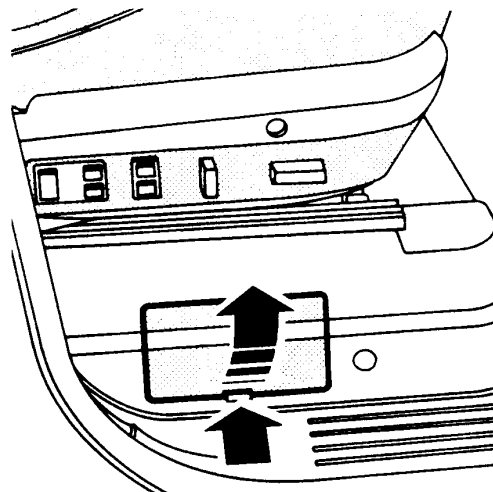
If it is necessary to tow a Range Rover 4.0/4.6 on all four wheels transfer gearbox neutral must be selected.

To select transfer neutral, turn the ignition switch to the off position and remove the ignition key. Insert a 5 amp fuse into position 11 of the BeCM (in-car) fuse box located beneath the right front seat.

When the ignition switch is switched on, transfer neutral will have been selected.

It is essential to remove the fuse from position 11, and reselect high, or low, range before leaving the vehicle. When transfer neutral is selected, the handbrake will not hold the vehicle if the rear wheels are lifted off the ground.

The preferred method for towing is the use of a flat-bed or roll-back truck.



Discovery Series II

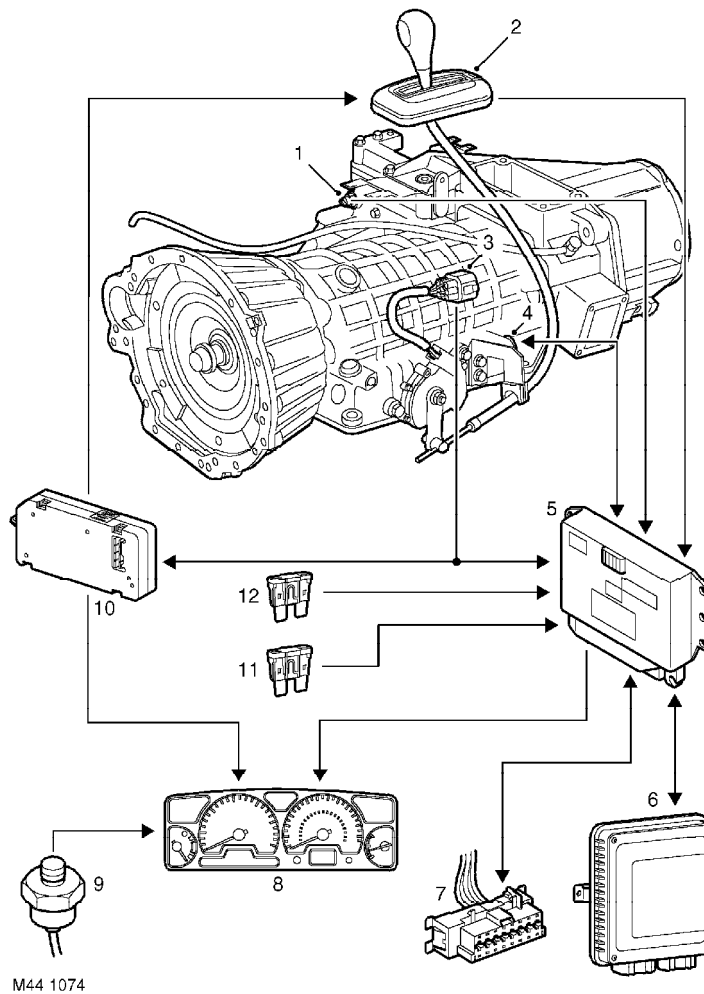
4HP22EH Supplement



1999 MODEL YEAR 4HP22EH AUTOMATIC TRANSMISSION

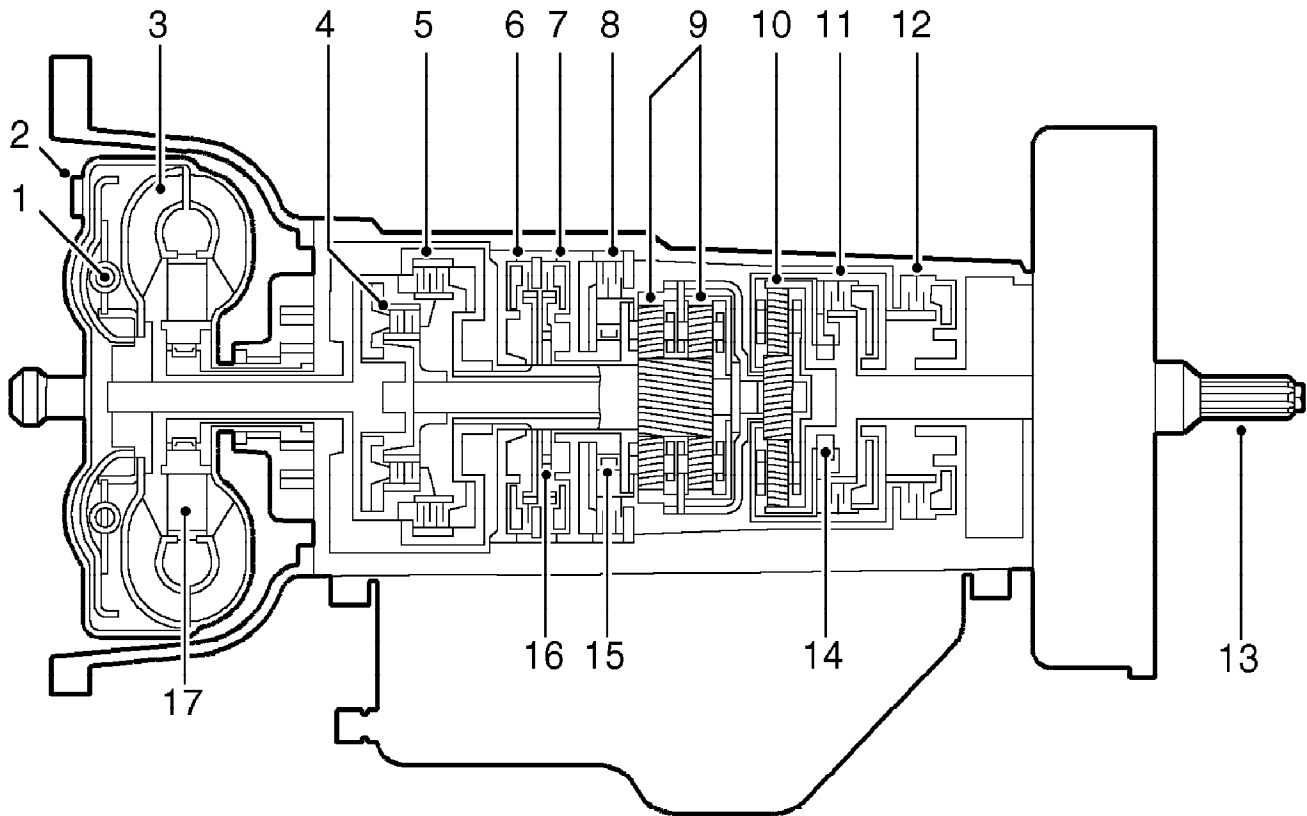
The automatic transmission used on Discovery Series II is the ZF4HP22EH electronically/hydraulically controlled 4 speed gearbox. This gearbox is similar in design mechanically to the automatic transmission used in the pre 1999 model year Range Rover.

The most significant difference between the automatic transmissions used in pre 1999 model year Discoverys and the automatic transmission used in Discovery Series II is the addition of electronic transmission control. In Discovery Series II, gear selection, gear change speeds and torque converter lock up are now controlled electronically/hydraulically, rather than being controlled by mechanical/hydraulic means.



M44 1074

- | | |
|-----------------------------------------|-----------------------------------------|
| 1 Transmission high/low switch | 7 Diagnostic socket |
| 2 Mode switch | 8 Instrument pack |
| 3 Gear position switch connector | 9 Transmission fluid temperature sensor |
| 4 Solenoid valve/speed sensor connector | 10 Body control unit |
| 5 Electronic automatic transmission ECU | 11 Battery power supply |
| 6 Engine control module | 12 Ignition power supply |



M44 1067

- | | |
|-----------------------------|--------------------------------|
| 1. Input/impeller | 10. Epicyclic gear set |
| 2. Converter lock-up clutch | 11. Clutch |
| 3. Turbine | 12. Clutch brake |
| 4. Clutch forward drive | 13. Input to transfer gearbox |
| 5. Clutch reverse drive | 14. Freewheel (one way clutch) |
| 6. Clutch brake | 15. Freewheel (one way clutch) |
| 7. Clutch brake | 16. Freewheel (one way clutch) |
| 8. Clutch brake | 17. Stator and one way clutch |
| 9. Epicyclic gear set | |

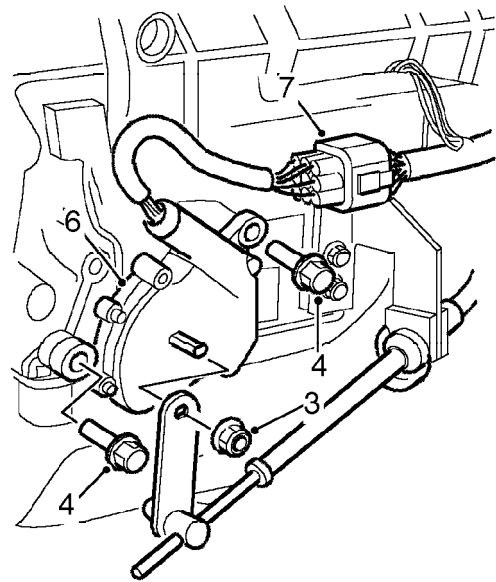
There are a number of advantages provided by an automatic transmission equipped with an electronically/hydraulically control system compared to an automatic transmission featuring a more conventional mechanically governed system. The main advantages are:

- The gear change points of an electronically/hydraulically controlled transmission are more precise and consistent. With mechanical/hydraulic control there is a greater tolerance band regarding the gear change points because of the nature of mechanical components, which are influenced by conditions such as temperature and component wear.
- The automatic transmission system incorporates an output shaft speed sensor which is an input to the transmission control module (TCM). The TCM selects the gears electronically using solenoid valves. The TCM determines which gear to select by monitoring the signals received regarding road speed, throttle angle, engine torque and engine speed.
- The load on the transmission can be reduced by introducing engine intervention when the automatic gearbox changes gear. Rather than operating independently of the engine management system, the transmission TCM is capable of communicating with the engine control module (ECM). In the case of Discovery Series II the ECM requests a percentage reduction of engine torque. This reduction results in an improvement in gear shift quality .

GEAR POSITION SWITCH

The gear position switch is mounted on the side of the transmission and contains internal switches. This switch has four input lines known as the W, X, Y, and Z lines. The gear position switch provides the TCM with the current driver-selected gear position. By analyzing the status of these inputs, the TCM calculates which gear is most suitable for the current conditions.

Range Rover has only three input lines from the position switch: X, Y, and Z. Discovery Series II uses the fourth line for improved electrical diagnostics and better lever position information (intermediate gear lever positions, i.e. to detect when the gear lever is moving between positions). This helps to align mechanical and electrical tolerances.



M44 1060A



DISCOVERY SERIES II

ELECTRONIC CONTROL

The TCM is located under the left hand front seat. Using information from the engine management ECM, together with its own sensors, the TCM selects the most suitable gear.

- The gear is selected depends on certain variables, including:
- Road speed (from output shaft sensor)
- Throttle angle (from engine management)
- Engine Torque (from engine management)
- Altitude (from engine management)
- Selector position (from position switch)

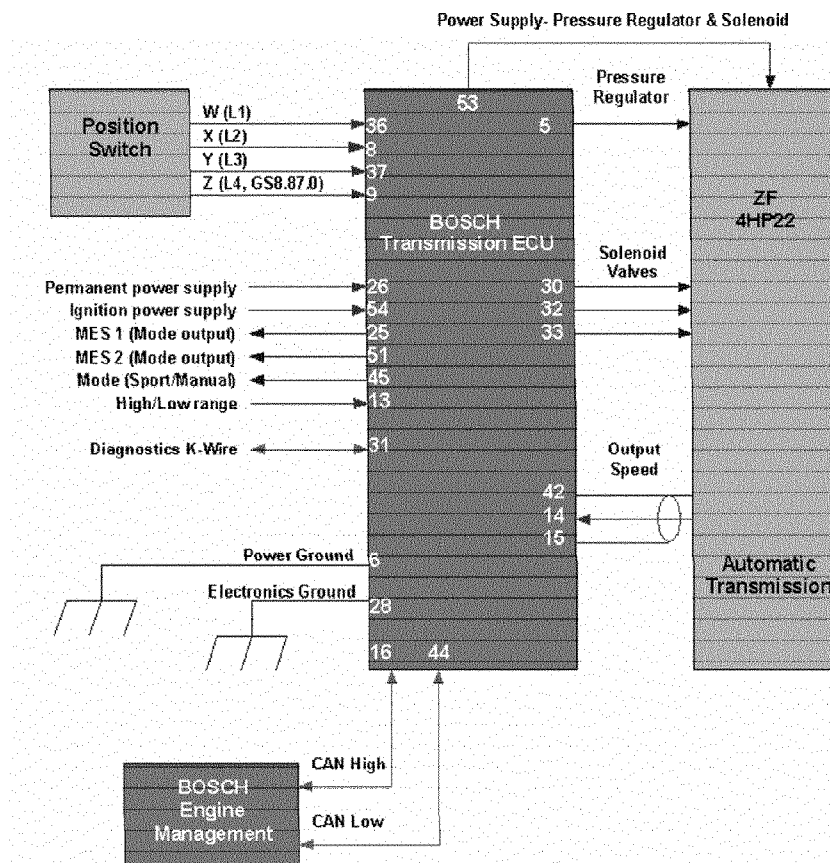
Other factors such as vehicle acceleration are also taken into account when the optimum gear is calculated.

The TCM controls gear selection by directing pressurized transmission fluid to the required clutch assembly. This is achieved by controlling the operation of two shift solenoids incorporated within the valve block.

The TCM controls the gear shift quality by modulating the pressure regulator solenoid. This solenoid is incorporated into the automatic gearbox valve block.

To enhance the quality of the gear changes, the TCM sends a torque reduction signal to the ECM during gear changes. Responding to this signal, the engine management ECM will reduce engine torque to improve shift quality.

The third solenoid valve incorporated into the valve block is the torque converter lock-up solenoid. This solenoid is energized by the TCM when torque converter lock-up is required.





HIGH RANGE

The high range gears should be used for all normal driving, including off-road driving across dry level terrain.

NOTE: If the gear lever is moved from drive to a lower gear while the vehicle is moving at speed, the selected gear will be engaged only when the road speed is reduced to an acceptable level. This prevents the possibility of the engine from over-revving.

LOW RANGE

Low range gears should be selected in any situation where low speed maneuvering is necessary, extreme off-road condition driving is required or hill descent control (HDC) is required. Selection is made via the HI/LO lever situated on the vehicle's center console.

TORQUE CONVERTER LOCK UP

At vehicle pull away and during gear changes, the torque converter will allow a certain amount of slip to occur between the crankshaft drive plate and the input shaft of the gearbox. Incorporated into the design of the automatic transmission system used on Discovery Series II is a lock-up feature, where the TCM will activate the torque converter lock-up solenoid. Discovery Series II will lock the torque converter in all gears, whereas on pre 1999 Range Rover this can only be activated in third and fourth gears. When activated, the torque converter lock-up clutch will be engaged and no slip will be allowed. Direct drive through the torque converter will be provided in this condition.

The torque converter can be locked and unlocked during driving to improve driveability, fuel consumption and gear changing. The torque converter will not be locked until the transmission has calculated that the oil temperature has reached a predetermined temperature. This is calculated from the engine coolant temperature via a software timer within the TCM, as the transmission itself has no temperature sensor. The length of this timer depends on several variables, including the engine coolant temperature during cranking, but is approximately:

<i>Engine ambient temperature</i>	<i>Time taken for oil to warm up</i>
77°F (25°C)	0 minutes
32°F (0°C)	7 minutes
-13°F (-25°C)	12 minutes

When low range is engaged, the torque converter is used to improve the vehicle's off-road capabilities. One example of this is locking the torque converter at 0% throttle. This improves engine braking while negotiating steep gradients. This feature will be active only while there is no danger of stalling the engine.

MODE SELECT

In addition to providing drive, and electronically controlling the gear changes throughout the conventional gear selection range in both high and low ranges, the automatic transmission system featured on Discovery Series II also incorporates a mode select facility. This feature enables the driver to select the gear change strategy that most suits the current driving conditions. The mode switch, situated adjacent to the rear of the automatic selector gate, can be used to select a Sport mode when in high range, and Manual mode when low range is selected.



DISCOVERY SERIES II

Sport mode

Sport mode can be selected by pressing the mode button whenever high range is engaged. Once sport mode has been selected, a dash board lamp will illuminate the letter 'S'. Although automatic gear shifts continue to be controlled by the TCM, they will be made using a different strategy, i.e. remaining in a given gear longer when accelerating, and changing down to a lower gear earlier when decelerating. The characteristics of the transmission while in sport mode help make optimum use of the engine's power. Pressing the mode button for a second time returns the transmission system to its normal operation within the high range.

Manual mode

Manual mode is selected by pressing the mode button whenever low range is selected. With manual mode selected a dashboard lamp will illuminate the letter 'M'. The transmission will function in a similar way to a manual gearbox. In this condition the transmission will change into the selected gear as soon as possible, and then remain in that gear at all speeds, changing down only to prevent engine stall. For example, if the selector position is in "3" while driving in normal modes, gears 1,2 and 3 will be available. However, in manual mode, if position "3" is selected, the transmission will select 3rd gear very shortly after pulling away from rest.

This mode is designed to give improved off road performance, and kickdown is disabled in this mode.

Towing/steep gradients

When the vehicle is normal mode (i.e. high range with sport not selected) the automatic gearbox will select a shift pattern appropriate to the current conditions. If a heavy load is being pulled, a steep gradient is being climbed or both, then the automatic gearbox will use a more aggressive shift pattern, compensating for the

load by using higher engine speeds for any given throttle angle.

Compensation for reduced engine torque

In a similar way to the Towing mode, if the vehicle is producing less torque than would normally be the case (high altitude or very hot air into the engine) then the transmission will hold onto gears longer than would normally be the case. This is a very similar situation to towing, but the performance of the vehicle is reduced due to a lack of engine power, rather than the weight of the vehicle.

Calibration Selection (99MY V8 Range Rover Only)

North American ECU part numbers are different from UK/Euro, and Rest of world. Each ECU contains two calibrations, 4.0l and 4.6l. When an ECU is installed in a vehicle, the correct calibration must be selected, or a gearbox fault will be stored, and "Gearbox fault" will be displayed in the message centre. The vehicle can be driven in this state, and is not in limp home mode. However, vehicles must not be driven for long in this condition.

When the correct calibration is selected (4.0 or 4.6), the fault code memory is deleted automatically. If the ECU is removed from the vehicle, the correct calibration is remembered. For this reason, it is important that if ECU's are swapped between vehicles, the correct calibration must be selected.



FAULT FINDING DIAGNOSTICS

If there is a fault, the automatic transmission will attempt to drive as normally as possible. However, if it is not safe to continue changing gear, a limp home mode will be selected.

Limp home mode differs depending upon the vehicle conditions when the fault is diagnosed. If high range is selected, then the default condition is third, if stationary when the fault occurred and fourth, (if moving) when the fault occurred. If low range is selected, then the system will attempt to maintain the current gear until the ignition supply is removed. This is in case the fault occurs while negotiating a steep gradient.

If there is a fault which either prevents all gears being used or disables the kick-down facility, the sport and manual lights will flash at the same time. This indicates to the driver that the vehicle has entered limp home mode. This mode will continue until the ignition is turned off. When the ignition is turned back on and the engine has been cranked, the TCM will complete a self-test. If the fault has rectified itself the automatic gearbox will resume normal operation and the sport and manual lights will no longer flash. If the fault is still evident, then the vehicle should be taken to the nearest Land Rover dealer as soon as possible for the fault to be investigated and rectified. It is important to appreciate that if a fault has been rectified or is no longer present but the fault code has not been deleted, the sport and manual lights will continue to flash until the TCM has diagnosed the fault is no longer present.

If a fault exists that will not damage the transmission or cause inconvenience to the driver, no warning lights will illuminate but a fault code will be stored. If a driver does notice a slight change with the behavior of the gearbox, this could be due to a fault of this type.

If a transmission fault exists that will increase the emissions of the vehicle, the malfunction indicator lamp (MIL) will illuminate.

If any of the above conditions are true, the software within the transmission TCM will have stored a fault code. After a fault code has been stored and the car has completed 40 warm-ups, (Warm-up is defined as the engine coolant rising by at least 61°F (16°C) and exceeding 158°F (70°C)), then the vehicle fault code will be deleted from memory providing the fault does not reappear during this time. If the fault codes reappear, this counter is reset and requires another 40 warm-ups before the fault is deleted automatically.

If the automatic transmission TCM is found to have been disconnected, the vehicle will have selected an hydraulic limp home mode. Reconnection must occur when the ignition is switched off. If the TCM was disconnected while the ignition was turned on, fault codes will have been stored within the ECM and TCM. These fault codes must be deleted using TestBook.

ENGINE MANAGEMENT FAULTS

Faults can occur with the engine management system which affect the transmissions performance. After the fault has been diagnosed through interrogating the ECM, and has been rectified successfully, the fault must be cleared from the ECM and TCM using TestBook. On V-8 derivatives, if a fault has been stored in the TCM, it will illuminate the MIL (service engine lamp). This will happen only if the fault is emissions-related i.e. torque converter not functioning or 3rd/ 4th gear permanently selected.



DISCOVERY SERIES II

ON BOARD DIAGNOSTIC (OBD) SYSTEM

The TCM communicates with the ECM via a CAN interface. This is used by the transmission for the gearshift torque interface and as a means for transmitting OBD information between the TCM and ECM. The automatic transmission requests the ECM that 'freeze frame' data is stored, and requests MIL activation. If the MIL is illuminated without any fault codes being stored in the ECM, then the automatic transmission is requesting MIL activation. The automatic transmission MIL activation request can be checked with TestBook.

CAN SYSTEM

The controller area network (CAN) is a high speed serial interface for transmitting information between control modules. CAN communications are 'self checked' for errors and if an error is detected, the message is ignored by the receiving control module. Due to the high rate of information exchange, the system has a high degree of latency ('at rest' time, waiting for information to process). This allows for an error to be present without reducing the overall data transfer rate.

Fault code, OBD II (TestBook)	Fault description	Effect	Warning lamp illumination	
			MIL	Sport/Manual
P0705 (14, 23)	* Gear position switch, incorrect outputs	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement	On	On
P0721 (21)	* Downshift safety monitor prevented downshift which would have caused engine overspeed	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P0722 (22)	* Torque converter slipping	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P0731 (29)	* Ratio monitoring, implausible 1st gear ratio	No apparent effect	On	On
P0732 (30)	* Ratio monitoring, implausible 2nd gear ratio	No apparent effect	On	Off
P0733 (31)	* Ratio monitoring, implausible 3rd gear ratio	No apparent effect	On	Off
P0734 (32)	* Ratio monitoring, implausible 4th gear ratio	No apparent effect	On	Off
P0741 (5)	* Torque converter lock-up clutch fault	May affect driveability.	On	Off
P0743 (7, 25)	* Torque converter lock-up solenoid (MV 3), open or short circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement	On	On
P0748 (10, 28)	* Pressure regulating solenoid (MV 4), open or short circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement	On	On
P0753 (8, 26)	* Shift solenoid (MV 1), open or short circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P0758 (9, 27)	* Shift solenoid (MV 2), open or short circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1562 (24)	* Battery supply below 9V while engine running	Maintains current gear in low range, limp home mode in range. Shift pressure to maximum, harsh gear shifts/engagement.	Off	On

DISCOVERY SERIES II



Fault code, OBD II (TestBook)	Fault description	Effect	Warning lamp illumination	
			MIL	Sport/ Manual
P1601 (4)	* ECU, EEPROM checksum	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1606 (3)	* EEPROM	No apparent effect	On	Off
P1606 (6)	* Watchdog	No apparent effect	On	On
P1612 (2)	* Solenoid valves power supply relay, sticking closed or open circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1613 (1)	* Solenoid valves power supply relay, sticking open or short circuit	Limp home mode in low and high ranges. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1705 (39)	Transmission high/low range, implausible input	No apparent effect	On	Off
P1810 (12, 13)	Sport/Manual warning lamp circuit fault	Lamp fails bulb check or is permanently illuminated. No effect on gearbox operation.	On	Off
P1841 (16)	* CAN bus fault	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1842 (15)	* CAN level monitoring	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1843 (17)	* CAN time-out monitoring	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1884 (11)	* CAN message: Engine friction invalid	No apparent effect.	On	Off
P1884 (18)	* CAN message: Throttle position invalid	Substitute throttle angle of 50% adopted. No kickdown. Operates in economy modes only.	On	On
P1884 (19)	CAN message: Engine temperature invalid	Substitute engine temperature derived from other inputs. No apparent effect.	On	Off
P1884 (20)	CAN message: Road speed invalid	No apparent effect.	On	Off
P1884 (33, 34)	* CAN message: Engine torque invalid	Substitute engine torque of derived from other inputs. May affect shift quality.	On	Off
P1884 (35)	* CAN message: Engine speed invalid	Maintains current gear in low range, limp home mode in high range. Shift pressure to maximum, harsh gear shifts/engagement.	On	On
P1884 (37)	CAN message: Engine air intake temperature invalid	No apparent effect.	On	Off
P1844 (38)	Altitude shift control invalid	No reduced torque compensation, possible reduction in performance/ driveability at altitude or high ambient temperatures.	On	Off

* = Emissions (OBD II) relevant

On = MIL illuminates immediately (in all other faults, MIL On = illuminates in the 2nd consecutive drive cycle if fault still present)



DISCOVERY SERIES II

SERVICE MAINTENANCE

The automatic transmission identification number can be found stamped on a plate riveted to the bottom left hand side of the auto transmission casing.

There is no filler/dipstick tube used on the automatic transmission. Discovery Series II uses a filler plug and a drain plug for service maintenance of the transmission fluid.

The procedure for the automatic gearbox drain and refill is as follows:

Drain

1. Position vehicle on ramp.
2. Apply handbrake and position chocks under front and rear wheels.
3. Position container under gearbox.
4. Remove gearbox drain plug and allow oil to drain, discard sealing washer.
5. Refit drain plug using new sealing washer and tighten to 15Nm (11lbf. ft).

Refill

1. Remove filler/level plug and discard sealing washer.
2. Refill gearbox to bottom of filler/level plug hole with correct grade of fluid.
3. Ensure gear lever is in the 'P' position, start engine and move selector lever through all gear positions and back to 'P' position.
4. With the engine idling, continue filling gearbox until a small thread of fluid runs from filler/level orifice.
5. Refit filler / level plug using a new sealing washer and tighten to 22lbf/ft (30 Nm).

The scheduled service requirement for the automatic gearbox, relates to the maintenance of the transmission oil and automatic gearbox oil filter. The oil specified for use is ATF Dexron IID OR III from the approved list. The fluid capacity is 10.25 quarts (9.7 liters) dry fill, refill quantity being dependent upon oil temperature at time of draining and length of time allowed to drain.

Always refer to the current maintenance sheet whenever servicing Discovery Series II , to ensure the correct schedule is always followed.

STALL TESTING

1. Chock the wheels and fully apply the handbrake.
2. Start the engine and run it until it reaches normal operating temperature.
3. Apply the footbrake and select 'D'.
4. Fully depress the accelerator pedal and note the tachometer reading. The figures should be 2200 to 2400 rev/min. Do not carry out stall test for longer than 10 seconds, and DO NOT repeat until 30 minutes have elapsed.
5. A reading below 1300 rev/min indicates a torque converter fault, ie stator free-wheel.
6. A reading between 1300 and 2200 rev/min indicates reduced engine power.
7. A reading above 2400 rev/min (V8) indicates clutch slip.

NOTE: The figures quoted above were measured at sea level with an ambient temperature of 20° C (68° F). At higher altitudes or higher ambient temperatures, these figures will be reduced.