



Range Rover

Automatic

Transmission

System Information

Document

APPLICABILITY	1995-1997 Range Rover
DATE OF REVISION	1997

Automatic Transmission Diagnostics - System Information

Model: 1995-97 Range Rover

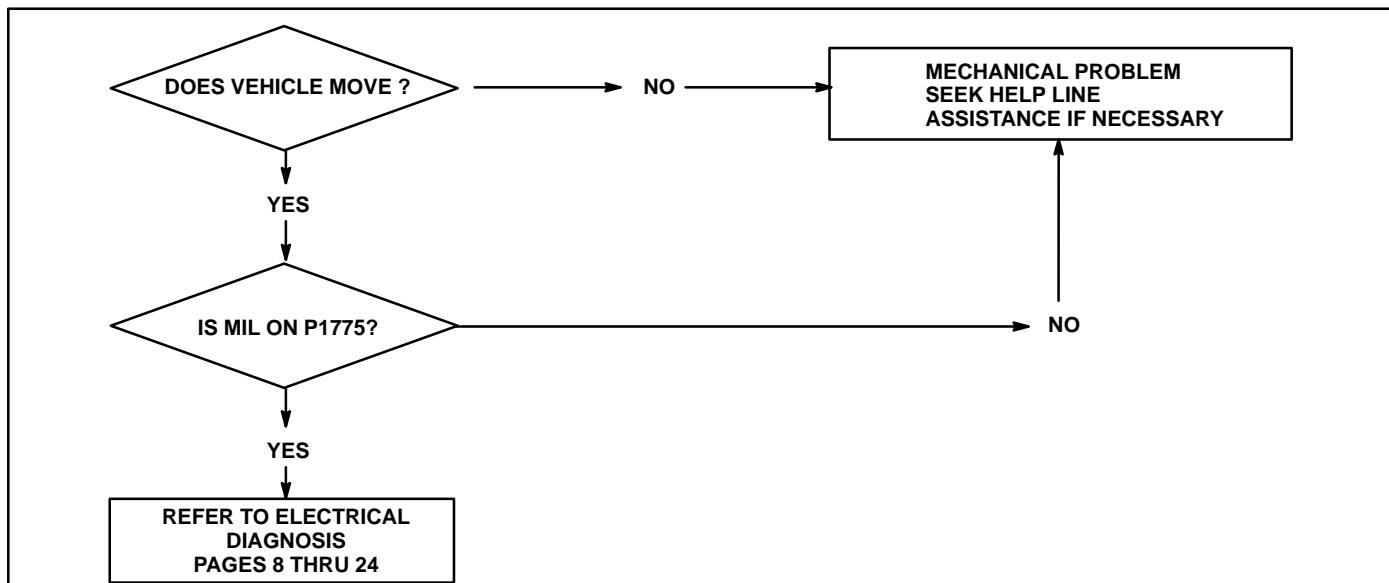
See page 8 for SRO and time for
Electrical Symptom diagnosis

The diagnosis of automatic transmission faults requires that the technician take a systematic approach to the determination of the fault involved. There are two systems involved; the mechanical operation of the transmission and the electronic control of the transmission via the Transmission Control Module (TCM). It is important to realize that a mechanical problem can set a Diagnostic Trouble Code (DTC) and also that an electronic failure can produce a mechanical symptom.

The following flowchart will help to direct you to the area requiring investigation first.

The information following the chart is split into 2 key areas:

- System Information
- Electrical Symptoms



Mechanical Controls

The ZF 4HP22/24 automatic transmission is basically the same as the previous ZF automatic transmission with the addition of electronic control over the pressure regulator, torque converter lockup and shift valves.

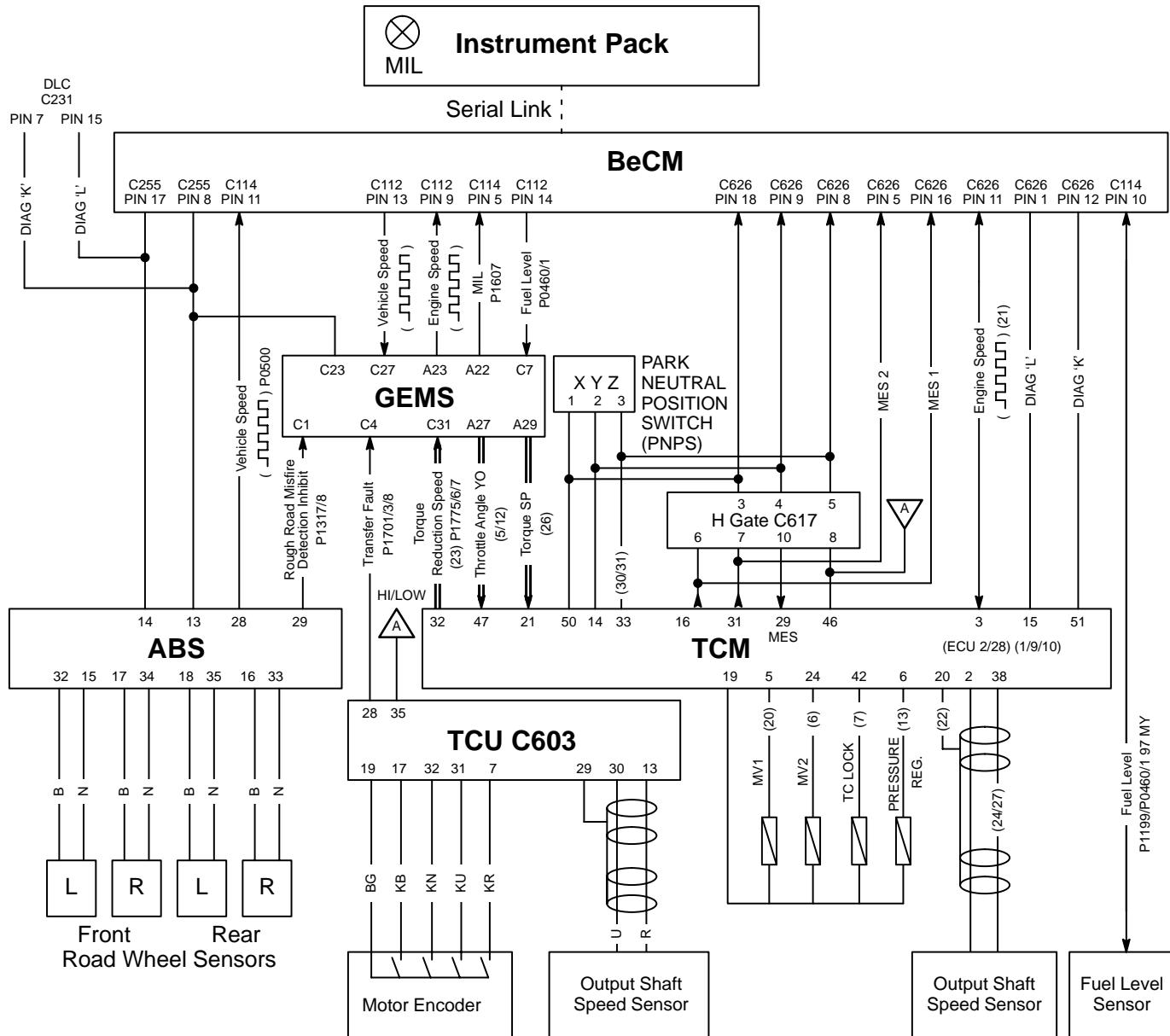
Mechanical selection of Park, Reverse, Neutral and Drive is the same on both Mechanical and Electronic Transmissions. This allows the vehicle to be operated in Limp Home Mode if the electronic controls fail. The mechanical diagnosis of the transmission is the same as before and would require the same repair procedure.

Electronic Controls

Refer to the following schematic to graphically demonstrate the interconnection of the various control units used in the operation of the electronically controlled transmission.

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Schematic 1



Note: A number preceded by a P, for example **P1775**, relates to fault codes stored in GEMS if the signal/component fails.

A number in parenthesis, for example **(23)**, relates to fault codes stored in the TCM if the signal/component fails.



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Economy, Sport and Manual Modes

The TCM has various different driving modes available, with Economy being selected automatically on start up. When the vehicle is in High range, Sport mode can be selected. Sport mode makes gear change much more sensitive to throttle movement, thereby shifting down earlier and holding onto lower gears longer than Economy mode. If the vehicle is in Low range, then the manual mode can be selected. Manual mode will make the transmission change to the gear selected as quickly as possible and hold onto that gear at all speeds, i.e. if "3" is selected, then the gear box will not shift down to "2" or "1" as the vehicle slows down. It will only shift down to prevent the vehicle from stalling.

In addition to the manual mode of operation in low range, the Economy mode is also different than that of the High range Economy mode. This Economy mode has to be different because of the low ratio the transfer box employs, thus causing a torque multiplication, which increases the need to change the shift points and ignition retard points. The shift points will also be modified by the vehicle speed in relation to the engine rpm to ensure shifts at the best points for fuel economy.

Interface with Engine Control Module (ECM), see schematic 1

The TCM takes the engine torque, engine speed and throttle angle signals from the ECM and calculates which gear is required. The TCM then provides outputs to the solenoid valves and sends a torque reduction signal back to the ECM. The ECM then retards the ignition point on each of the cylinders, resulting in a reduction in engine power to produce smoother shifts.

If the TCM detects a fault that affects emissions levels, the TCM has the ability to output a "Check Engine" request to the ECM. The TCM does this by sending a signal to the ECM on the ignition retard request line. When the ECM receives this signal, it knows that it is a request to illuminate the "Check Engine" light and not a ignition retard request. The reason the ECM handles the "Check Engine" request is because the TCM does not have the ability to illuminate a "Check Engine" light directly.

When the ECM receives this signal, it will flag a DTC P1775 immediately and illuminate the "Check Engine" light.

Interface with TCM and Park Neutral Position Switch (PNPS), see schematic 1

The PNPS is mounted on the side of the transmission and contains five internal switches, although only three, known as the "XYZ" switches, are used by the TCM. The other two switches are for reverse selection and start inhibit, neither of which is required by the TCM. By analyzing the status of the "XYZ" switches, the TCM calculates which gear has been selected. If a fault occurs with a switch, the TCM may try to put the transmission into a different gear than requested.



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Interface with Body electronic Control Module (BeCM) , see schematic 1

The BeCM provides power to the TCM via an ignition feed fuse F6 and a permanent feed via fuse F3. In addition to power, the BeCM also routes the engine speed signal that the GEMS ECM outputs and the diagnostic K/L lines that go to the Data Link Connector (DLC). The TCM, ECM, HEVAC, ABS and BeCM are all attached to the same K/L lines in the DLC.

The TCM also uses the Manual Economy Sport (MES) lines to signal to the BeCM what mode of operation it is in. If a fault condition occurs, these lines will remain high (battery voltage minus 2 volts) to indicate to the BeCM that the TCM has encountered some form of failure. The BeCM uses this information to send a "GEARBOX FAULT" message to the instrument pack message center.

The BeCM also receives the gear position switch information to allow it to display the currently selected gear on the message center. However, it too does not need the reverse selection or starter inhibit switch positions as it can determine this information from the status of the "XYZ" switches.

The MES lines are also connected to the H-Gate so that the currently selected gear can be indicated by a "red dot" on the shifter mechanism.

Interface with the Transfer Box Control Unit (TCU) , see schematic 1

The High/Low signal is used by the TCU to select the correct mode on application of the "MES" switch lines, i.e. Economy or Sport modes in High range and Economy or Manual modes in Low range.

Shift points are very different in the Economy mode in the High/Low ranges. In addition, it should also be noted that cruise control does not function when in low range. Cruise control is controlled by the BeCM and not the TCM.

Solenoid Valves

The TCM has control over four solenoid valves: MV1 (shift valve 1), MV2 (shift valve 2), pressure regulator and torque converter lock up.

The power for all the solenoids comes from the TCM via pin 19; this power is controlled by an internal relay. If any fault occurs which needs limp home capability, the TCM will interrupt the power supply. Interrupting the power supply defaults the transmission to third if the vehicle was stationary and fourth if the vehicle was moving. Figure 1 shows the transmission electrical connections and the resistance across all pins. The transmission electrical connector is located on the left hand side of the transmission about 8 inches from the rear of the gear position switches.

Shift Valves

When the driver selects Drive, the TCM controls the gear selection by the use of the two solenoid valves, MV1 and MV2. If a fault occurs in one or both of these valves, then a different gear than the one selected will result. If the TCM defaults the transmission, then the common supply to all the solenoid valves is removed and the transmission mechanically shifts either to third gear, if the vehicle is stationary, or fourth, if moving. MV2 is also used to prevent the driver from selecting reverse when the vehicle is moving at more than 8 km/h (5 mph) and from disengaging at reverse speeds greater than 6 km/h (4 mph). This is known as "Reverse Safety" and will not be available if MV2 is non-operational or the transmission is defaulted. Figure 1 shows the transmission electrical connections and the resistance across all pins.

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Pressure Regulator Solenoid

The gear shift quality is controlled by modulating the pressure regulator, which is controlled by the TCM. The solenoid is powered closed, so that if a failure occurs, then the regulator will allow default gear change. Figure 1 shows the transmission electrical connections and the resistance across all pins.

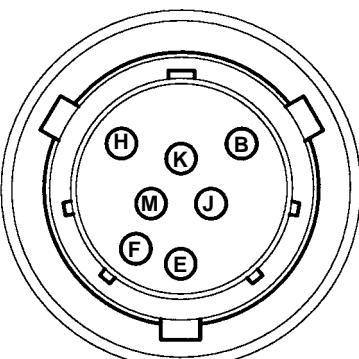
Torque Converter Lock-Up Solenoid

The torque converter slips to allow smooth operation of the transmission. Lock-up occurs when the vehicle reaches a speed of 48-72 km/h (30-45 mph), depending on model year, in either third or fourth gears. Figure 1 shows the transmission electrical connections and the resistance across all pins.

Output Shaft Speed Sensor

The automatic transmission system incorporates an output shaft speed sensor which is an input to the TCM. This is a two wire shielded input and enables the TCM to compare input shaft speed (engine speed) with the output shaft speed.

This comparison is used to determine which gear is currently selected and allows the TCM to accurately determine the upshift/downshift points and the duration of the shift, ensuring smooth gear shifts under all conditions. Figure 1 shows the transmission electrical connections and the resistance across all pins.

 <p>TRANSMISSION ELECTRICAL PINOUTS (MATING FACE)</p>	<p>1</p> <p>B -PRESSURE REGULATOR E -ROAD SPEED SENSOR +VE F -ROAD SPEED SENSOR -VE H -MV1 SOLENOID K -MV2 SOLENOID L -MVWK SOLENOID M -SOLENOID SUPPLY</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th><th>B</th><th>E</th><th>F</th><th>H</th><th>K</th><th>L</th><th>M</th></tr> </thead> <tbody> <tr> <td>B</td><td>-</td><td>O/C</td><td>O/C</td><td>32</td><td>32</td><td>37</td><td>5</td></tr> <tr> <td>E</td><td>O/C</td><td>-</td><td>320</td><td>O/C</td><td>O/C</td><td>O/C</td><td>O/C</td></tr> <tr> <td>F</td><td>O/C</td><td>320</td><td>-</td><td>O/C</td><td>O/C</td><td>O/C</td><td>O/C</td></tr> <tr> <td>H</td><td>32</td><td>O/C</td><td>O/C</td><td>-</td><td>53</td><td>58</td><td>26</td></tr> <tr> <td>K</td><td>32</td><td>O/C</td><td>O/C</td><td>53</td><td>-</td><td>58</td><td>26</td></tr> <tr> <td>L</td><td>37</td><td>O/C</td><td>O/C</td><td>58</td><td>58</td><td>-</td><td>32</td></tr> <tr> <td>M</td><td>5</td><td>O/C</td><td>O/C</td><td>26</td><td>26</td><td>32</td><td>-</td></tr> </tbody> </table> <p style="text-align: center;">- O/C = OPEN CIRCUIT - FIGURES SHOWN ARE TYPICAL VALUES OF RESISTANCE</p>		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	-
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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	-																																																										

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GEMS CONNECTOR LAYOUT

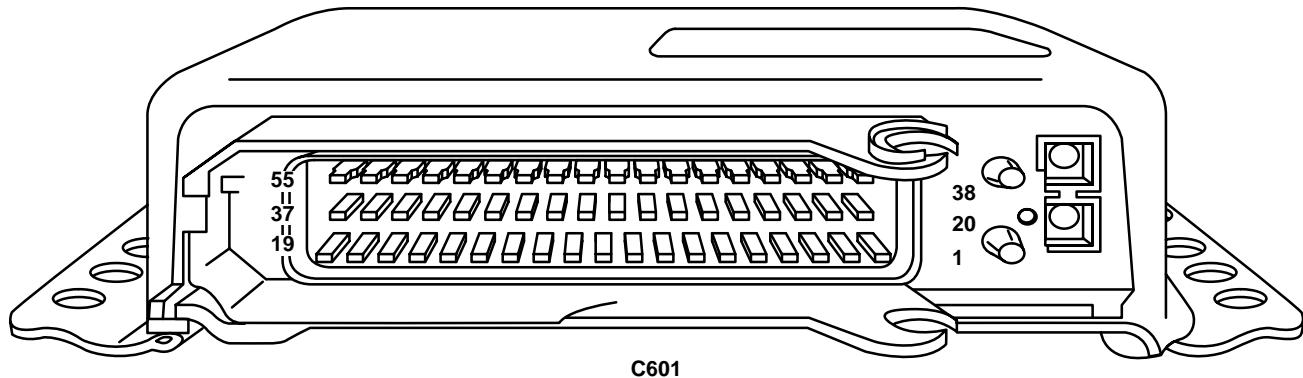
CONNECTOR B (POWER)
C509 (18-BLACK)
CONNECTOR C (INPUTS)
C507 (36-RED)
CONNECTOR A (OUTPUTS)
C505 (36-BLACK)

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	Coil Driver Cyls 5&8	1	Rough Road Detected	1	A/C Grant
2	—	2	Cam Sensor	2	Fuel Used
3	—	3	—	3	Condenser Cooling Fan
4	TPS 5V Supply	4	Low Range Detected	4	—
5	Ground	5	—	5	—
6	—	6	—	6	Canister Vent Solenoid (97.5 MY)
7	Main Relay Supply	7	Fuel Level	7	—
8	Ignition Sense	8	HO2S Bank B Upstream	8	—
9	Ground	9	—	9	—
10	Ground	10	Knock Sensor Ground	10	—
11	Crank Sensor Neg	11	Knock Sensor A	11	Injector, Cyl 3
12	Crank Sensor Pos	12	Knock Sensor B	12	—
13	Coil Driver Cyls 2&3	13	Air Temperature	13	Injector, Cyl 1
14	Coil Driver Cyls 1&6	14	Coolant Temp	14	—
15	Coil Driver Cyls 4&7	15	Throttle Position	15	IACV-D
16	Ground	16	Mass Air Flow	16	IACV-B
17	Main Relay Control	17	HO2S Bank A Downstream	17	Injector, Cyl 6
18	—	18	Park/Neutral	18	Injector, Cyl 8
		19	—	19	Purge Valve
		20	Diagnostic L Line	20	—
		21	Heated Front Windshield	21	Oxygen Sensor Heater Upstream
		22	—	22	MIL
		23	Diagnostic K Line	23	Engine Speed output
		24	—	24	Fuel Pump
		25	—	25	—
		26	Immobilization	26	—
		27	Vehicle Speed	27	Throttle Position (PWM)
		28	A/C Request	28	Oxygen Sensor Heater Downstream
		29	Condenser Cooling Fan Request	29	Engine Torque (PWM)
		30	Fuel Pressure (97.5 MY)	30	Injector, Cyl 4
		31	Ignition Retard Request (PWM)	31	—
		32	O2 Sensor Ground	32	Injector, Cyl 7
		33	HO2S Bank B Downstream	33	Injector, Cyl 5
		34	HO2S Bank A Upstream	34	IACV-C
		35	Fuel Temp	35	IACV-A
		36	Sensor Ground	36	Injector, Cyl 2

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TCM CONNECTOR LAYOUT



PIN	FUNCTION	PIN	FUNCTION
1	Ignition Supply	29	MES Mode Select
2	Vehicle Speed Sensor Positive	30	—
3	Engine Speed	31	MES 2
4	—	32	Torque Reduction Request (PWM)
5	Solenoid Valve MV2	33	Gear Position Switch - Z Line
6	Pressure Regulator Solenoid	34	—
7	Digital Ground	35	—
8	—	36	—
9	—	37	—
10	—	38	Vehicle Speed Sensor Negative
11	—	39	Permanent 12V Supply
12	—	40	—
13	—	41	—
14	Gear Position Switch-Y Line	42	Torque Convertor Solenoid
15	Diagnostic L Line	43	—
16	MES 1	44	—
17	—	45	—
18	—	46	Transfer Box High/Low
19	Solenoid Valves Supply	47	Throttle Position Input (PWM)
20	Earth (Screens)	48	—
21	Engine Torque (PWM)	49	—
22	—	50	Gear Position Switch - X Line
23	—	51	Diagnostic K Line
24	Solenoid Valve MV2	52	—
25	—	53	—
26	Power Ground	54	—
27	—	55	—
28	—		



Automatic Transmission Diagnostics - Electrical Symptoms SRO/Time:
 Model: 1995-97 Range Rover 19.22.97 - TestBook hookup access codes,
 compete DTCR and diagnostic drive cycle "B"
 per bulletin W96-007 1.05 hrs.

TestBook

1. Hookup TestBook and follow directions to retrieve fault codes in line with service bulletin W96-007.
2. Complete a DTC report and fax to LRNkA.
3. Follow diagnostic directions from TestBook in order to locate problem.
4. Use the following information to help investigate the fault condition.

DTC	DTC NAME	FAULT DESCRIPTION	OBD MONITORING CONDITIONS	TRIP OCCURRENCES TO MIL	GEARBOX FAULT MESSAGE	LIMP HOME DEFAULT
1	FTGR	Solenoid supply malfunction	Run engine above 1600 rpm for more than 1 sec. Switch engine off	2	Y	Limp home in third if stationary, fourth if moving.
2	FEPROM	TCM data corrupted	Run engine for more than 180 secs.	1	Y	Limp home in third if stationary, fourth if moving.
5	FDKI	Throttle angle malfunction	Start engine and run at idle.	2	Y	Substitute throttle angle of 30%
6	FMV1	Shift solenoid A malfunction	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.
6	FMV1	Shift solenoid A electrical short	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.
7	FMV2	Shift solenoid B malfunction	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.
7	FMV2	Shift solenoid B electrical short	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.
9	FPRGANGZ1	Mode output 1	Operate Mode switch in high and low range with the ignition on	N/A	N	No default condition
10	FPRGANGZ2	Mode output 2	Operate Mode switch in high and low range with the ignition on	N/A	N	No default condition
12	FDKT	Throttle angle electrical short	Start engine and run at idle.	2	Y	Substitute throttle angle of 30%
13	FMVWK	TCC circuit output state does not match command state	Drive vehicle at a steady speed of 55 mph (88.5 kph) or above.	2	Y	Limp home in third if stationary, fourth if moving.
20	FPLUSMV	Solenoid supply malfunction	Run engine above 1600 rpm for more than 1 sec. Switch engine off	1	Y	Limp home in third if stationary, fourth if moving.
21	FN_MOT	Engine speed signal high out of range	Start engine	1	Y	Limp home in third if stationary, fourth if moving.
21	FN_MOT	Engine speed, no signal	Drive vehicle above 10 mph (16 kph).	1	Y	Limp home in third if stationary, fourth if moving.
22	FDR	Pressure control regulator malfunction	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.
22	FDR	Pressure control regulator electrical short	Drive through all gear ranges.	2	Y	Limp home in third if stationary, fourth if moving.



Automatic Transmission Diagnostics - Electrical Symptoms

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DTC	DTC NAME	FAULT DESCRIPTION	OBD II MONITORING CONDITIONS	TRIP OCCURRENCES TO MIL	GEARBOX FAULT MESSAGE	LIMP HOME DEFAULT
23	FME	Engine torque reduction	Drive through all gear ranges.	2	Y	Poor shift quality – maximum pressure on shifts
24	FRSS	Output speed sensor signal out of range	Drive vehicle and accelerate to force a downshift.	2	Y	Limp home in third if stationary, fourth if moving.
26	FT_T	Engine torque signal out of range	Start engine and run at idle.	2	Y	Poor shift quality – maximum pressure on shifts
27	FFSTBR	Output speed sensor, no signal	Drive forward at an rpm greater than 2200.	2	Y	Limp home in third if stationary, fourth if moving.
28	FEPROM	TCM data corrupted	Run engine for more than 180 secs.	1	Y	Limp home in third if stationary, fourth if moving.
30	FPOS	Gear position switch inaccurate while running	Start engine. Operate gear selector momentarily through all ranges.	2	Y	Limp home in third if stationary, fourth if moving.
31	FPOSST	Gear position switch inaccurate while starting	Start engine. Operate gear selector momentarily through all ranges.	2	Y	Limp home in third if stationary, fourth if moving.
40	FGANG1 (97 MY)	First gear ratio incorrect	Drive vehicle forward, held in first gear to above 2500 rpm.	2	N	Limp home in third if stationary, fourth if moving.
41	FGANG2 (97 MY)	Second gear ratio incorrect	Drive vehicle forward and ensure all upshifts occur	2	N	Limp home in third if stationary, fourth if moving.
42	FGANG3 (97 MY)	Third gear ratio incorrect	Drive vehicle forward and ensure all upshifts occur	2	N	Limp home in third if stationary, fourth if moving.
43	FGANG4 (97 MY)	Fourth gear ratio incorrect	Drive vehicle forward and ensure all upshifts occur	2	N	Limp home in third if stationary, fourth if moving.
44	FWK (97 MY)	TCC gear ratio incorrect	Drive vehicle forward and ensure converter lockup occurs in 3rd and 4th.	2	N	Limp home in third if stationary, fourth if moving.

Note: Limp home mode differs depending upon the selected range of the transfer box. If High range is selected, then the default condition is third if stationary and fourth if moving when the fault occurred.

Low range default conditions will vary depending on the fault. If a fault occurs while in Low range, change to High range and verify that the fault can be induced.

FAULT	CORRECTIVE ACTION	TRIP OCCURANCES TO MIL	CHECK ENGINE
Transfer Box Fault – Low Range Status – High Range Status	Check for correct range change occurring	N/A	N
GEMS Faults – P1775 – P1776 – P1777	Check wiring between TCM, GEMS or BECM	1 2 1	Y Y Y



Automatic Transmission Diagnostics - Electrical Symptoms

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TCM FAULT CODE DIAGNOSIS

CODE: 01 FTGR, Solenoid supply malfunction

EFFECT: Limp home in third or fourth

DESCRIPTION

This fault code is associated with the internal relay of the TCM. This relay provides a means of interrupting power to the solenoids, allowing the transmission to revert to a mechanical default condition. The relay and associated circuitry is tested once during initialization and whenever a hardware reset occurs. When the ignition is first switched on, the TCM carries out an initialization routine. During this routine the processor drives the relay ON and then tests for the supply voltage on the output via a feedback path. If the supply voltage is not seen within a specific time, a fault is flagged; the TCM will run in default mode and code 01 will be stored.

A set time after the relay is turned on, it is turned off and the processor then tests for the supply voltage again. If voltage is still present, the TCM will then run in default mode and code 01 will be stored.

Note: The ignition supply voltage must be greater than 8V for a fault code to be stored.

CAUSE

The internal relay contacts may be damaged or the relay may not be responding to its control signals.

REPAIR

Check pin 19 for battery voltage once pin 1 has received battery voltage with the ignition on. If no voltage is present on pin 19 and the relay can not be heard "clicking", then a new TCM is required.

If this fault is permanently flagged, the TCM should be replaced taking care to obtain the correctly programmed TCM.

CODE: 02 FEPROM1, TCM data corrupted

EFFECT: Limp home in third or fourth

DESCRIPTION

On each power-up, the TCM analyzes its internal Read Only Memory (ROM) and checks that its contents are correct by calculating the contents for a specified length and comparing this value with the checksum value stored in ROM. When the two disagree on three attempts, the TCM will flag a code 28. The ROM contains the program which runs the TCM and calculates the upshift and downshift points together with all the diagnostics on the TCM and its associated sensors.

The TCM will also analyze its Electrically Erasable Programmable Read Only Memory (EEPROM). This area of memory is kept alive even when the TCM is disconnected to determine if the stored conditions for freeze frame and stored DTC's are correct.

When the checksum values for this area of memory also disagree, then the TCM will flag a code 2.

CAUSE

The TCM data has become corrupted and the information it contains cannot be relied upon.



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REPAIR

Renew the TCM and verify that everything works correctly.

CODE: 05 FDKI, Throttle angle malfunction

EFFECT: Substitute throttle angle of 30%

DESCRIPTION

Incorrect TPS information from the ECM can result in erratic shifts or no kickdown. This information is transmitted to the TCM in the form of a Pulse Width Modulation (PWM) signal. This signal should normally have a duty cycle of 5% to 94%.

CAUSE

This fault will be flagged if the duty cycle is outside of the 5% to 94% range for more than 50 ms with the engine rpm greater than 580 rpm. Intermittent connections at either the ECM, TCM or in-line connectors C551 and C659 can be the cause of this fault.

REPAIR

Verify that the TPS signal to the ECM is good; if not, then false signals will also be sent to the TCM. Check the following connectors for any sign of loose connections or terminals backing out:

- ECM connector C505 pin 27.
- TCM connector C601 pin 47.
- In-line connectors C551 pin 5 and C659 pin 7.

CODE: 06 FMV1, Shift solenoid A malfunction

EFFECT: Limp home in third or fourth

DESCRIPTION

A different gear may be encountered momentarily, i.e.:

- First gear is engaged when second is selected.
- Second gear engages when first is selected.
- Third gear engages when fourth is selected.
- Fourth gear engages when third is selected.

CAUSE

Open circuits or shorts in the wiring of the MV1 solenoid

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the MV1 solenoid.

See figure 1 for assistance with the transmission connector pinouts and resistance of the solenoid.



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CODE: 07 FMV2, Shift solenoid B malfunction

EFFECT: Limp home in third or fourth

DESCRIPTION

A different gear may be encountered momentarily, i.e.:

- First gear engages when fourth is selected.
- Second gear engages when third is selected.
- Third gear is engaged when first is selected.
- Fourth gear engages when first is selected.
- Reverse gear does not engage.

CAUSE

Open circuits or shorts in the wiring of the MV2 solenoid

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the MV2 solenoid.

See figure 1 for assistance with the transmission connector pinouts and resistance of the solenoid.

CODE: 09 FPRGANGZ1, Mode output 1

EFFECT: No noticeable effect

DESCRIPTION

Because the MES lines are an output to the BeCM they do not create a failure mode in the TCM. The following symptoms may be evident if the MES lines fail open or are shorted.

- Sport is recognized by the BeCM as a fault.
- Economy is recognized by the BeCM as low range manual.
- Manual is recognized by the BeCM as Economy.

CAUSE

Open circuits or shorts in the wiring of the MES lines from the TCM to BeCM.

REPAIR

Verify that the MES lines have good continuity and no shorts are evident.



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CODE: 10 FPRGANZ2, Mode output 2

EFFECT: No noticeable effect

DESCRIPTION

Because the MES lines are an output to the BeCM they do not create failure mode in the TCM. The following symptoms may be evident if the MES lines fail open or are shorted.

- Sport is recognized by the BeCM as a fault.
- Economy is recognized by the BeCM as low range manual.
- Manual is recognized by the BeCM as Economy.

CAUSE

Open circuits or shorts in the wiring of the MES lines from the TCM to BeCM.

REPAIR

Verify that the MES lines have good continuity and no shorts are evident.

CODE: 12 FDKT, Throttle angle electrical short

EFFECT: Substitute throttle angle of 30%

DESCRIPTION

Incorrect TPS information from the ECM can result in erratic shifts or no kickdown. This information is transmitted to the TCM in the form of a Pulse Width Modulation (PWM) signal. This signal should normally have a duty cycle of 5% to 94%.

CAUSE

This fault will be flagged if the duty cycle is outside of the 5% to 94% range for more than 50 ms with the engine rpm greater than 580 rpm. Intermittent connections at either the ECM, TCM or in-line connectors C551 and C659 can be the cause of this fault.

REPAIR

Verify that the TPS signal to the ECM is good; if not, then false signals will also be sent to the TCM. Check the following connectors for any sign of loose connections or terminals backing out:

- ECM connector C505 pin 27.
 - TCM connector C601 pin 47.
 - In-line connectors C551 pin 5 and C659 pin 7.
-



Automatic Transmission Diagnostics - Electrical Symptoms

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CODE: 13 FMVWK, TCC output state does not match command state

EFFECT: Limp home in third or fourth

DESCRIPTION

- TCC does not engage in third or fourth gears.
- TCC does not disengage causing vibrations at lower engine speeds and stalling when coming to a stop.

CAUSE

Open circuits or shorts in the wiring of the TCC solenoid.

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the TCC solenoid.

See figure 1 for assistance with the transmission connector pinouts and resistance of the solenoid.

CODE: 20 FPLUSMV, Solenoid supply malfunction

EFFECT: Limp home in third or fourth

DESCRIPTION

Problems encountered with gearboxes selecting limp home mode and having stored code 20 are an indication that the control unit is receiving insufficient battery voltage to enable the solenoid supply rail, pin 19.

To get this fault, the internal relay must have already energized, which means that the TCM supply voltage must be greater than 10.5V at ignition switch on. However, during cranking this voltage may drop and adversely affect the solenoid supply line. Communications problems may also be evident with the TCM and Gear box. Fault messages with no codes stored can occur.

CAUSE

Insufficient voltage to pin 1 during cranking or normal operation.

REPAIR

Check BeCM supply studs for battery voltage, (located on the side of the BeCM next to the fuses). Ensure that the voltage at these studs is the same as the voltage at the battery terminals. If not, investigate chassis grounds for looseness, corrosion or wiring problems and ensure the BeCM supply stud connections are electrically good.

Locate BeCM connector C625 pin 3 and do a voltage drop test from this pin to the battery supply stud with the NLG wire attached to it (just to the left of the fuses). If more than 0.3 volts are dropped across these connections, then there is an internal problem with the BeCM. Replace BeCM.



Automatic Transmission Diagnostics - Electrical Symptoms
Model: 1995-97 Range Rover

CODE: 21 FN_MOT, Engine speed, no signal

EFFECT: Limp home in third or fourth

DESCRIPTION

Can be caused by the engine stalling out while in gear, or by CPS signals not being reliably received by the ECM.

CAUSE

This fault is flagged if the engine exceeds 6100 rpm for more than 300 ms. In addition, if the engine speed drops below 95 rpm and the selected gear is not Park or Neutral while the output speed sensor signal is greater than 300 rpm, then the fault will be flagged if its duration is longer than 200 ms.

REPAIR

Verify that the CPS is not loose in its mounting on the block and its electrical connections are good. Check that the engine speed signal is being received by the TCM from the ECM via the BeCM. Failure of the BeCM can result in the loss of this signal.

Check BeCM connections C625 pin 11 and C112 pin 9 for signs of a signal.

CODE: 22 FDR, Pressure control regulator

EFFECT: Limp home in third or fourth

DESCRIPTION

Harsh shifts as maximum pressure is applied due to lack of pressure regulation.

CAUSE

Open circuits or shorts in the wiring of the TCC solenoid.

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the pressure regulator solenoid. See figure 1 for assistance with the transmission connector pinouts and resistance of the solenoid.

CODE: 23 FME, Engine torque reduction

EFFECT: Poor shift quality - Maximum pressure on shifts

DESCRIPTION

This output from the TCM is a PWM signal that has an idle duty cycle of 17% (ignition retard inactive) and a normal driving duty cycle of 20% to 90% (ignition retard of 0 to 27.8 degrees). Extreme cold conditions and immediate start/drive away with transmission still cold can sometimes induce Code 23.

Harsh shifts due to no ignition retard control.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

CAUSE

Signal from TCM to ECM being sent for too long or outside normal limits.

REPAIR

Check the following connectors for any sign of loose connectors or terminals backing out.

- ECM connector C507 pin 31.
- TCM connector C601 pin 32.
- In-line connectors C551 pin 4 and C659 pin 9.

CODE: 24 FRSS, Output speed sensor, signal out of range

EFFECT: Limp home in third or fourth

DESCRIPTION

This fault is only tested during a downshift and therefore the engine must be in a forward gear, i.e. D, 3, 2. If the engine speed is above a defined threshold during the shift for a duration of 50 ms or more, then the fault will flagged.

Erratic, harsh, or elongated shifts can be a result of this fault.

CAUSE

The output speed sensor provides the information necessary for the TCM to calculate the pressure needed for any shift and also for the length of the shift. The TCM compares the engine speed to output speed for a measure of slip.

Mechanical slip due to excessive internal wear on the clutches can also cause a large difference between engine speed input and output speed.

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the output speed sensor.

See figure 1 for assistance with the transmission connector pinouts and resistance of the output speed sensor.

Verify the mechanical condition of the transmission and check transmission fluid for contamination.

CODE: 26 FT_T, Engine torque signal out of range

EFFECT: Poor shift quality - Maximum pressure on shifts

DESCRIPTION

The ECM provides the TCM with an indication of the torque the engine is currently producing. Incorrect information can affect both the timing and the length of the shifts. The torque signal is also needed to determine the amount of torque reduction required by the TCM for smooth shifts.

Erratic, harsh or elongated shifts can result.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

CAUSE

The ignition retard line from the ECM to the TCM will have a PWM signal to identify any ignition retard requests during normal operation of the TCM.

This line will also indicate a fault condition when the TCM sends a PWM of less than 10% or greater than 93% and the engine speed is above 448 rpm

REPAIR

Check the following connectors for any sign of loose connectors or terminals backing out.

- ECM connector C505 pin 29.
- TCM connector C601 pin 21.
- In-line connectors C551 pin 5 and C659 pin 1.

CODE: 27 FFSTBR, Output speed sensor, no signal

EFFECT: Limp home in third or fourth

DESCRIPTION

By comparing the engine speed while in gear and checking for the signal from the output speed sensor, it can be determined if the sensor is operational. The diagnostic monitors for zero rpm from the sensor while the engine speed is above 2000 rpm and a forward gear is selected. If the fault condition lasts for 50 ms, then the fault will be flagged.

The engine speed and torque are used by the TCM to determine input shaft speed. When the torque converter locks up, engine speed equals input speed.

Erratic, harsh or elongated shifts can result.

CAUSE

The output speed sensor provides the information necessary for the TCM to calculate the pressure needed for any shift and also for the length of the shift. The TCM compares the engine speed to output speed for a measure of slip. Mechanical slip due to excessive internal wear on the clutches can also cause a large difference between engine speed input and output speed.

REPAIR

Check the continuity of the wiring from the TCM to the transmission connector and also the resistance of the output speed sensor. Check output sensor screen wires for shorts to output sensor wiring.

See figure 1 for assistance with the transmission connector pinouts and resistance of the output speed sensor. Verify the mechanical condition of the transmission and check transmission fluid for contamination.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

CODE: 28 FEPROM, TCM data corrupted

EFFECT: Limp home in third or fourth

DESCRIPTION

On each power-up the TCM analyzes its internal Read Only Memory (ROM) and checks that its contents are correct by calculating the contents for a specified length and comparing this value with the checksum value stored in ROM. When the two disagree on three attempts, the TCM will flag a code 28. The ROM contains the program which runs the TCM and calculates the upshift and downshift points together with all the diagnostics on the TCM and its associated sensors.

The TCM will also analyze its Electrically Erasable Programmable Read Only Memory (EEPROM), which is an area of memory that is kept alive even when the TCM is disconnected. This memory is used to determine that the stored conditions of freeze frame and DTCs are correct.

The same conditions apply for flagging a fault in the EEPROM as in the ROM.

CAUSE

The TCM data has become corrupted and the information it contains cannot be relied upon.

REPAIR

Renew the TCM and verify everything works correctly.

CODE: 30 FPOS, Gear position switch inaccurate while running

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation the gear position is read from the XYZ switches. This information is also read by the BeCM so it can enable/disable cranking and display the currently selected gear on the message center.

If the lever position does not return the correct selection then the BeCM, TCM and H-GATE will receive incorrect information.

If the wiring between the XYZ switches and the TCM is good but the wiring between the XYZ switches and the BeCM or H-GATE is faulty, no fault code would set but a gear indication problem would exist.

The table on the following page helps to identify the reaction of the BeCM, TCM and H-GATE to false information from the XYZ switches.

The first column is the reaction to the system when Park is selected, the second when Reverse is selected and so on.

Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

Status	P	R	N	D	3	2	1
Normal	P	R	N	D	3	2	1
X o/c	Z	N	N	D	D	1	1
Y o/c	P	P	Z	1	2	2	1
Z o/c	P	R	N	N	R	P	Z
X s/c gnd	P	R	R	3	3	2	2
Y s/c gnd	R	R	N	D	3	3	D
Z s/c gnd	2	3	D	D	3	2	1
X s/c bat	Z	N	N	D	D	1	1
Y s/c bat	P	P	Z	1	2	2	1
Z s/c bat	P	R	N	N	R	P	Z

Note: **Bold** selections indicate a failure condition, Z is an open circuit condition on all switch positions and is not normally seen.

The TCM will store fault 30 when a fault condition has been seen for more than 50 ms.

CAUSE

The status information from the XYZ switches is incorrect due to either an open circuit switch or shorts in the wiring from the switches.

A misadjusted mechanical selector can cause the switch position to be different from the mechanically selected position.

REPAIR

Check the gear position on the PRNDL, message center and from the gearbox diagnostic in the real time monitor section on TestBook.

Verify they all return the same information as the lever is moved through all possible combinations.
Check mechanical selector for correct positioning.

CODE: 31 FPOSST, Gear position switch inaccurate while starting

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation the gear position is read from the XYZ switches. This information is also read by the BeCM so it can enable/disable cranking and display the currently selected gear on the message center.

The TCM will check the probability of this fault once only during cranking, when the engine speed exceeds a specific threshold (96 rpm). If during this time the TCM detects anything other than Park or Neutral for more than 50 ms, then a fault code 31 will be stored.

CAUSE

The status information from the XYZ switches is incorrect due to either an open circuit switch, or shorts on the wiring from the switches.

A misadjusted mechanical selector can cause the switch position to be different from the mechanically selected position.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

REPAIR

Check the gear position on the PRNDL, message center and from the gearbox diagnostic in the real time monitor section on TestBook.

Verify they all return the same information as the lever is moved through all possible combinations.
Check mechanical selector for correct positioning.

CODE: 40 FGANG1, First gear ratio incorrect (97 MY onwards)

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation, the TCM will monitor the input speed and output speed to determine if the transmission is operating in the gear selected. The TCM will compare the ratio between the calculated input speed and the output speed with the value for first gear stored in ROM. If this value is incorrect, the TCM will store code 40 for a first gear ratio fault.

CAUSE

Selected transmission gear has an incorrect ratio compared to its known value. See mechanical diagnosis.

Incorrect input/output shaft speeds being sensed.

REPAIR

Transmission may need replacing.

Check input/output speed signals for correct operation.

CODE: 41 FGANG2, Second gear ratio incorrect (97 MY onwards)

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation, the TCM will monitor the input speed and output speed to determine if the transmission is operating in the gear selected. The TCM will compare the ratio between the calculated input speed and the output speed with the value for second gear stored in ROM. If this value is incorrect, the TCM will store code 41 for a second gear ratio fault.

CAUSE

Selected transmission gear has an incorrect ratio compared to its known value. See mechanical diagnosis.

Incorrect input/output shaft speeds being sensed.

REPAIR

Transmission may need replacing.

Check input/output speed signals for correct operation.

Automatic Transmission Diagnostics - Electrical Symptoms
Model: 1995-97 Range Rover

CODE: 42 FGANG3, Third gear ratio incorrect (97 MY Onwards)

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation, the TCM will monitor the input speed and output speed to determine if the transmission is operating in the gear selected. The TCM will compare the ratio between the calculated input speed and the output speed with the value for third gear stored in ROM. If this value is incorrect, the TCM will store code 42 for a third gear ratio fault.

CAUSE

Selected transmission gear has an incorrect ratio compared to its known value. See mechanical diagnosis.

Incorrect input/output shaft speeds being sensed.

REPAIR

Transmission may need replacing.

Check input/output speed signals for correct operation.

CODE: 43 FGANG4, Fourth gear ratio incorrect (97 MY onwards)

EFFECT: Limp home in third or fourth

DESCRIPTION

During normal operation, the TCM will monitor the input speed and output speed to determine if the transmission is operating in the gear selected. The TCM will compare the ratio between the calculated input speed and the output speed with the value for fourth gear stored in ROM. If this value is incorrect, the TCM will store code 43 for a fourth gear ratio fault.

CAUSE

Selected transmission gear has an incorrect ratio compared to its known value. See mechanical diagnosis.

Incorrect input/output shaft speeds being sensed.

REPAIR

Transmission may need replacing.

Check input/output speed signals for correct operation.

CODE: 44 FWK, TCC gear ratio incorrect (97 MY onwards)

EFFECT: Limp home in third or fourth

At predetermined speeds, the TCM will lock the converter clutch via the TCC solenoid; this occurs in third and fourth gears thereby giving a direct drive through the transmission. Once the converter is locked up, the TCM will compare the input speed and output speed of the transmission and verify if the gear ratio is the same as the one stored internally. If not, the TCM will store code 44.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

CAUSE

TCC is not operating mechanically or has insufficient pressure to actuate. See mechanical diagnosis.

Incorrect input/output shaft speeds being sensed.

REPAIR

Transmission may need replacing.

Check input/output speed signals for correct operation.

TRANSFER BOX CONTROL UNIT (TCU) INDICATES LOW RANGE PERMANENTLY

EFFECT: No sports mode, shifts rough

DESCRIPTION

TCM assumes that low range is selected permanently. Shifting to low range does not alter the TCM's shifting behavior, i.e. economy mode has different shift pattern and sport mode would be manual mode.

CAUSE

TCU failure causing open circuit fault on the input to the TCM for range selected.

REPAIR

If the shift into low range does not take place, check TCU Connector C603 pin 35 and TCM connector C601 pin 46 for 0V in high range and greater than 10V when in low range. Check the TCU for signs of overheating or a burning smell, if evident replace the TCU. Make sure the motor is in good condition before powering up with the new TCU as a failed motor will damage the new TCU.

TRANSFER BOX CONTROL UNIT (TCU) INDICATES HIGH RANGE PERMANENTLY

EFFECT: No manual mode in low range

DESCRIPTION

TCM assumes that high range is selected permanently. Shifting to low range does not alter the TCM's shifting behavior, i.e. economy mode has different shift pattern and manual mode would be sport mode.

CAUSE

TCU failure causing short to ground fault on the input to the TCM for range selected.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

REPAIR

If the shift into low range does not take place, check TCU connector C603 pin 35 and TCM connector C601 pin 46 for 0V in high range and greater than 10V when in low range. Check the TCU for signs of overheating or a burning smell. If evident, replace the TCU. Make sure the motor is in good condition before powering up with the new TCU as a failed motor will damage the new TCU.

GEMS P1775 code

EFFECT: "CHECK ENGINE" light on

DESCRIPTION

This code confirms the existence of a stored TCM fault code.

The fault is flagged when the Pulse Width Modulation (PWM) signal on the ignition retard line has a duty cycle of between 10% and 14% for 100 ms or longer.

CAUSE

If the fault is permanent and not intermittent, then the ignition retard value can be viewed by Test-Book through the Real Time Monitoring section under the Switches and Status icon. A normal value of 17% should be shown if the fault is not present at the time of viewing. A value of 10% - 14%, for example 12%, would indicate that the TCM fault is currently present.

REPAIR

Diagnose the TCM, retrieve the fault codes and follow the diagnosis for the stored faults.

GEMS P1776 code

EFFECT: "CHECK ENGINE" light on

DESCRIPTION

The ignition retard line from the ECM to the TCM will have a PWM signal to identify any ignition retard requests during normal operation of the TCM.

The values for this signal are:

- 17% to indicate ignition retard is not active.
- 20% to 90% to indicate 0 to 27.8 retard.

CAUSE

During normal operation if the ignition retard request exceeds 4 seconds, then P1776 will be flagged.

This can also be caused by a variety of electrical connector/terminal problems between the ECM and TCM.



Automatic Transmission Diagnostics - Electrical Symptoms

Model: 1995-97 Range Rover

REPAIR

Check the following connectors for any signs of loose connectors, lack of terminal tension, water ingress, terminals backed out or dirt/corrosion on the terminals:

- In-line connector C551 (near coil pack) pins 4, 5 and 6
- ECM connectors C505 pins 27 and 29 and C507 pin 31

If nothing was found during this inspection and the fault is still present, check in-line connector C659 pins 1, 7 and 9 under the center console for any similar connector problems.

GEMS P1777 code

EFFECT: "CHECK ENGINE" light on

DESCRIPTION

The ignition retard line from the ECM to the TCM will have a PWM signal to identify any ignition retard requests during normal operation of the TCM.

This line will also indicate a fault condition when the TCM sends a PWM of less than 10% or greater than 93%.

CAUSE

This can also be caused by a variety of electrical connector/terminal problems between the ECM and TCM.

REPAIR

Check the following connectors for any signs of loose connectors, lack of terminal tension, water ingress, terminals backed out or dirt/corrosion on the terminals:

- In-line connector C551 (near coil pack) pins 4, 5 and 6
- ECM connectors C505 pins 27 and 29 and C507 pin 31

If nothing was found during this inspection and the fault is still present, check in-line connector C659 pins 1, 7 and 9 under the center console for any similar connector problems.

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<i>ZF</i>	-	<i>4HP22EH</i>	-	<i>4.0l V8 vehicles</i>
		<i>4HP24</i>	-	<i>4.6l V8 vehicles</i>
<i>BOSCH</i>	-	<i>GS8.87.0</i>	-	<i>99MY Discovery Series II</i>
		<i>GS8.87.1</i>	-	<i>99MY Range Rover</i>

4 Speed Electronic Automatic Transmission System

APPLICABILITY:	99MY Discovery Series II - 4.0 Petrol and 2.5 Turbo Diesel 99MY Range Rover - 4.0l and 4.6l Petrol Vehicles 99MY Range Rover Diesel transmissions are not covered by this document
DATE:	19 th May 1998

System Information Document

[ZF_4SPD\Project_Specs]

[Revision: 2.3]

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System Information Document

[ZF_4SPD\Project_Specs]

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1 Introduction

1.1 General

This document is intended to be a guide to the BOSCH Transmission controllers for the ZF 4 Speed Automatic Transmission unit incorporating the Torque Converter (4HP22). The information contained within gives the outline functionality, architecture and electrical specification. There should also be enough information to diagnose any system fault, which is complemented with a fault diagnosis tree.

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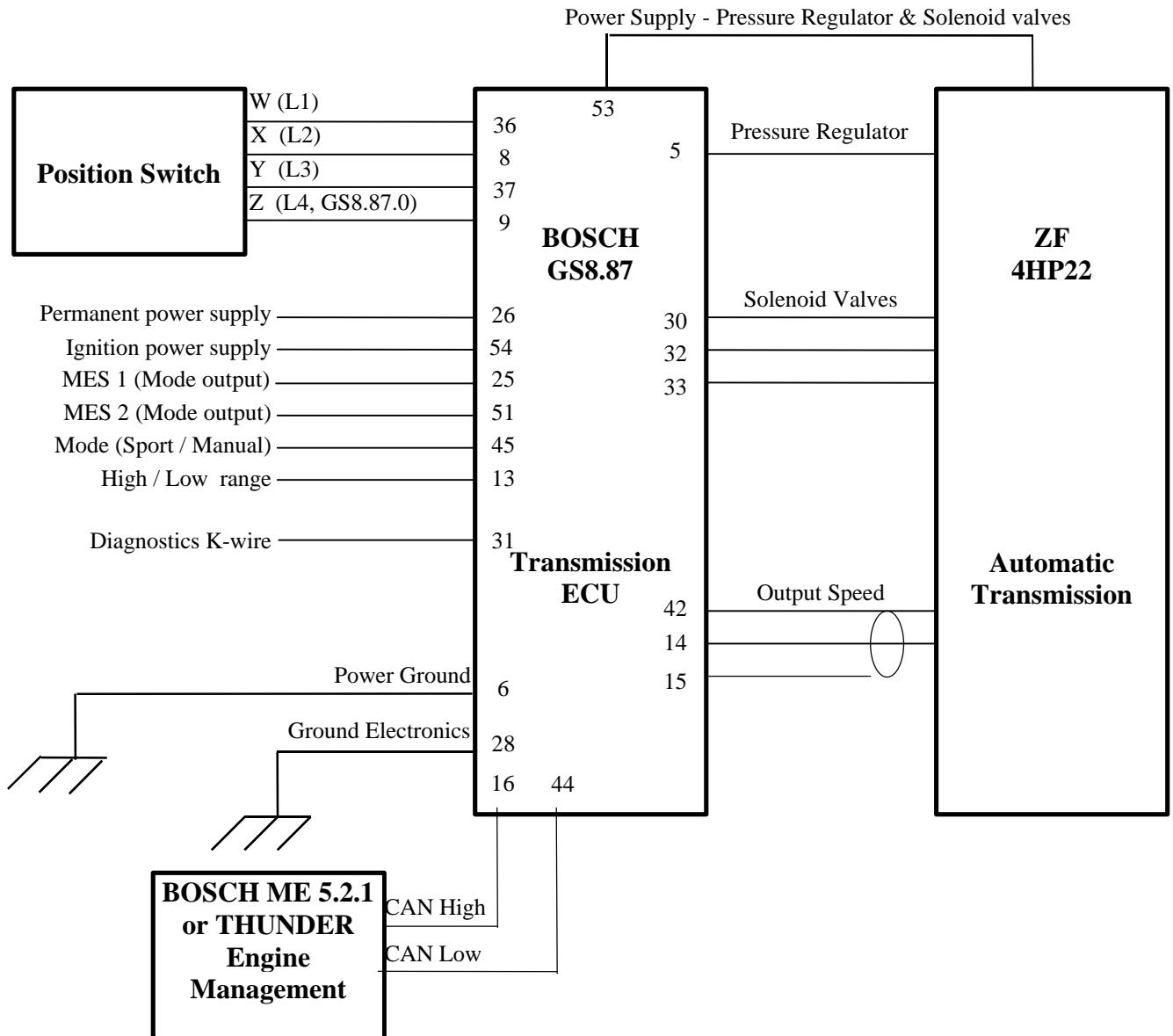
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2 Vehicle Interface requirements

2.1 Block Diagram

The Diagram below shows a summary of the vehicle architecture with reference to the Automatic Transmission Controller. For more detail, please refer to the following pages.



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2.2 Interface specification

2.2.1 Gear Shift Solenoids

2.2.1.1 Pin 5 - Pressure regulator

The purpose of the Pressure regulator is to generate modulation pressure for the gearbox clutches. The pressure regulator is mounted between the common output supply (pin 53) and pin 6. It is driven by a pulse width modulated power signal that is generated and regulated in the CG202 ASIC.

+

The pulse width modulated signal frequency f_0 is generated permanently; the free running duty cycle corresponds to the minimal current and the maximal modulation pressure

- Component

- Type	2/2-way relief jet with falling characteristic line; the control edge is closed when the valve is without power supply.
- Coil resistance R	$5.5\Omega \pm 6\% @ 20^\circ C$
- I_max	700mA mean value
- I_min	150mA mean value
- Chopper frequency	1000Hz $\pm 50\text{Hz} @ +25^\circ C$

- Control Unit

- Interface characteristic	current regulated, chopped output stage, pulse width modulated.
- Current range	$145\text{mA} \leq I_{\text{min}} \leq 175\text{mA} @ +25^\circ C$
- Current range	$680\text{mA} \leq I_{\text{max}} \leq 720\text{mA} @ +25^\circ C$
- Reference point	Pin 6 (power ground)
- Recommended wire size:	1.0mm^2

The ASIC status output is fed back to the processor for diagnostic purposes. See the diagnostic specification for details.

2.2.1.2 Pin 30 (MV1), 32 (MV3, lockup), 33 (MV2) - Solenoid valves 1,2 and 3

The purpose of solenoid valves 1 and 2 is to switch the hydraulic valves and thus control the hydraulic logic for gear selection. Solenoid valve 3 is to lock the torque converter.

The solenoid valves are mounted between the common output plus supply (pin 53) and their corresponding control pin. The solenoid valves are activated if the output control pins are drawn to ground.

- Component

- Type	3/2-way valves, inlet closed without power supply
- Coil resistance	$R_{20} = 32.5\Omega \pm 2\Omega$
- Operating voltage range	$9.5V \leq U \leq 14V$
- Drop off current	$I < 30\text{mA} @ P_o = 4.5 \text{ bar} \pm 0.1 \text{ bar}$
- Temperature range	-30°C to +150°C under test conditions

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- Control unit

- | | |
|----------------------------|-----------------------------|
| - Interface characteristic | Power output |
| - Output voltage low | $U_{sat} \leq 1V$ at $I=1A$ |
| - Reference point | Pin 6 (power ground) |
| - Recommended wire size: | 1.0mm ² |

The output voltages of Pin30, Pin32 and Pin33 are fed back over a resistor network to the processor for diagnostic purposes. During initialisation and operation the output signal is toggled periodically for a short time in order to enhance the diagnosis of the outputs.

2.2.1.3 Pin 53 - Power supply to Pressure regulator

When an ignition supply is available at the controller, pin 53 is a permanent power supply to the pressure regulator and the solenoid valves. This power supply can be switched off with hardware and software in the event of a failure in the transmission electrical system.

- Recommended wire size: 1.5mm²

2.2.2 Controller power supply

2.2.2.1 Pin 6 - Power ground

Permanent connection from the ECU to 0V. This is used for driving the Solenoid valves and the Pressure regulator.

- Recommended wire size: 1.5mm²

2.2.2.2 Pin 28 - Electronics ground

Permanent connection from the ECU to 0V. This is used for driving the electronics within the controller.

- Recommended wire size: 1.5mm²

2.2.2.3 Pin 26 - Permanent ignition supply

Permanent connection to 12V required. This is essential in order to allow storage of data for adaptive pressure control.

- Recommended wire size: 0.5mm²

2.2.2.4 Pin 54 - Ignition supply

Connection to +12V when the ignition is switch on. This is the main feed to the controller, allowing the transmission system to operate. It is essential that this supply is switch on at exactly the same time the engine management system receives an ignition supply. This is to ensure serial communications can be established between the two controllers.

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If the battery supply is different from that expected, the following details the functionality of the transmission controller:

Voltage	System behaviour
16.0 - 26.0	Jump start; excess voltage without damage, limphome mode, output stages for solenoid valves and pressure regulator switched off (max 1min at 40°C).
9.0 - 16.0	Voltage range for normal operation of the EAT with CAN-Bus corresponding to the specification.
6.5 - 9.0	Operation of the EAT with diagnostic functions and CAN-Bus enabled, limp home mode, output stages for solenoid valves and pressure regulator switched off.
3.0 - 6.5	Under voltage with data retention in SRAM, limp home mode, unreliable communication over the CAN bus.
0 - 3.0	Undervoltage without reliable function
-14 - 0	Reversed polarity without damage (-14V max 1 min at 25°C)
- Recommended wire size: 1.5mm ²	

2.2.3 Serial information - inputs

2.2.3.1 Pins 16 and 44 - CAN information from Engine management system

Both Discovery Series II and 99MY Range Rover vehicles use a CAN specification owned by ZF called CAN 22H. This communication protocol operates at 500kBit/sec. Both the engine management system and the transmission controller should be fitted with 120Ω terminating resistors. For more information on the CAN bus, please refer to the CAN specification.

2.2.4 Serial information – outputs

2.2.4.1 Pins 16 and 44 - CAN information sent to Engine Management system

See section the relevant section - CAN information from the Engine management system.

2.2.5 Digital inputs

2.2.5.1 Pins 8, 9, 36, 37 - Position switch

The position switch is the electrical input to the Transmission ECU regarding the drivers requested gear. It is not however, exactly the same as the gear which the Transmission may have selected. The transmission assumes a new selector position has been selected after it has recognised a stable input / code from the position switch lines for a filter time TPO_FILT.

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Discovery Series II (GS8.87.0):

A 12V supply is required to the position switch whenever there is an ignition feed to the Transmission controller. If this is not realised, the transmission will be unable to function correctly and so limphome mode will permanently be selected. The movement of the gear lever will make or break with 4 different sliding contacts. This creates a coded representation of the selected gear. These 4 wires go directly to the Transmission ECU (Terminals L1, L2, L3 and L4) where they are decoded. The software will then decide if the selected gear can be safely engaged without damage to the Transmission and Engine.

- Component

- Type	Make contact to +12V
- Location	Gearbox, assembled together with the switch block
- Positions	Mechanical P R N D 3 2 1 Hydraulic P R N D 1 Electrical P R N D 3 2 1 Z

- Control Unit

- Interface characteristic	Digital input, active high
- Threshold U_low to U_high = <6.0V, label U_OS_AD	
- Threshold U_high to U_low =>2.0V, label U_US_AD	
- Hysteresis	U_low to U_high >= U_high to U_low + 0.5V
- Input circuit	(1.15 +/- 0.2) kΩ (pull down to Ground)
- Input current	12.2 mA; input shorted to U_batt = 14V, R_in = 1.15 kΩ
- Reference point	U_batt, pin 54

- Coded position inputs (a 1 represents a high potential, pulled high by the position switch)

Position Switch	ECU Pin	P	Z1	R	Z1	N	Z2	D	Z3	3	Z4	2	Z4	1
Line 1 (W)	36	1	1	0	1	1	1	1	1	0	0	0	0	0
Line 2 (X)	8	0	1	1	1	1	0	0	1	1	0	0	0	0
Line 3 (Y)	37	0	0	0	0	1	1	1	1	1	1	0	1	1
Line 4 (Z)	9	0	0	0	0	0	0	1	1	1	1	1	1	0

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99MY Range Rover (GS8.87.1):

The position switch feed must be attached to ground at all times. If this is not realised, the transmission will be unable to function correctly and so limp home mode will permanently be selected. The movement of the gear lever will make or break with 3 different sliding contacts. This creates a coded representation of the selected gear. These 4 wires go directly to the Transmission ECU (Terminals L1, L2 and L3) where they are decoded. The software will then decide if the selected gear can be safely engaged without damage to the Transmission and Engine.

- Component

- Type	Make contact to Ground
- Location	Gearbox, assembled together with the switch block
- Positions	Mechanical P R N D 3 2 1 Hydraulic P R N D 1 Electrical P R N D 3 2 1 F

- Control Unit

- Interface characteristic	Digital input, active low
- Threshold U_low to U_high=<6.0V, label U_OS_AD	
- Threshold U_high to U_low=>2.0V, label U_US_AD	
- Hysteresis	$U_{low} \text{ to } U_{high} \geq U_{high} \text{ to } U_{low} + 0.5V$
- Input circuit	(1.21 +/- 0.2) kΩ (pull up to U_batt)
- Input current	-11.2 mA; input shorted to Ground, $R_{in} = 1.21 \text{ k}\Omega$
- Reference point	Digital ground, pin 28
- Coded position inputs (a 0 represents a low potential, pulled low by the position switch)	

Position Switch	ECU Pin	P	R	N	D	3	2	1
Line 1 (W)	36	0	0	1	1	0	0	0
Line 2 (X)	8	1	0	0	0	0	1	1
Line 3 (Y)	37	1	1	1	0	0	0	1

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2.2.5.2 Pin 13 - High / Low range input

Discovery Series II (GS8.87.0):

The high / low range switch is electrically connected both to the transfer box and the EAT. It sets the transmission ratio of the transfer box and indicates the selected range to the EAT.

The closed switch indicates Low range, and open switch indicates high range. After a change of the signal (a rising or falling edge), the EAT retains the signal value before the change for the applicable time THL_WAIT.

- Component

- Type Make contact to ground
- Location Centre console
- Switch open High range
- Switch closed (to ground) Low range

- Control Unit

- Interface characteristic Digital input, active low
- Threshold U_low to U_high=< 6.0V, U_OS_AD
- Threshold U_high to U_low=> 2.0V, U_US_AD
- Hysteresis U_low to U_high => U_high to U_low +0.5V
- Input circuit (1.2 +/- 0.2) kΩ (pull up to Ubp)
- Input current -10mA, input grounded, U_batt = 14V, R_in = 1.2kΩ
- Reference Digital ground, pin 28

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99MY Range Rover (GS8.87.1):

The high / low range switch on 99My Range Rover is a component of the H-gate. It is electrically connected to the transfer box; the input signal to the EAT is generated in the control unit of the transfer box.

A constant high signal indicates Low range, a constant low signal indicates high range. When the range is changing from Low range to High range, the transfer box ECU sends a periodic pulse whilst in the neutral position.

After a change of the signal (ie a rising or falling edge), the EAT retains the signal value before the change for the applicable time THL_WAIT.

- Component

- | | |
|------------------------------|--------------|
| - Type | Active low |
| - Location | Transfer box |
| - Signal open circuit / high | Low range |
| - Signal active / low | High range |

- Control Unit

- | | |
|---|---|
| - Interface characteristic | Digital input, active low |
| - Threshold U_low to U_high=< 6.0V, U_OS_AD | |
| - Threshold U_high to U_low=> 2.0V, U_US_AD | |
| - Hysteresis | U_low to U_high => U_high to U_low +0.5V |
| - Input circuit | (1.2 +/- 0.2) kΩ (pull up to Ubp) |
| - Input current | -10mA, input grounded, U_batt = 14V, R_in = 1.2kΩ |
| - Reference | Digital ground, pin 28 |

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2.2.5.3 Pin 45 - Driver mode request

Discovery Series II (GS8.87.0):

The program selector is used to select shift strategies depending on the setting of the High/Low range switch. The strategies can be selected independently for High range and Low range. After ignition on and after changing between High range and Low range, the EAT assumes a default shift strategy (normal mode).

The number of implemented shift strategies can be individually set for High range and Low range by the label KPG_MAX

The program selector is a push button that is debounced and latched by software in the EAT. The EAT changes the shift strategy after it has recognised the stable input voltage U_low for the time period TPG_FILT

- Component

- Type	Make contact to ground
- Max bounce time	<= 50ms
- Location	facia or centre console
- Positions	Toggle between shift strategies
- Switching function	Normal - Sport (high range), Normal - Manual (low range)

- Control Unit

- Interface characteristic	Digital input, active low
- Threshold U_low to U_high=< 6.0V, U_OS_AD	
- Threshold U_high to U_low=> 2.0V, U_US_AD	
- Hysteresis	U_low to U_high => U_high to U_low +0.5V
- Input circuit	(1.2 +/- 0.2) kΩ (pull up to Ubp)
- Input current	-10mA, input grounded, U_batt = 14V, R_in = 1.2kΩ
- Reference	Digital ground, pin 28

99MY Range Rover (GS8.87.1):

The purpose of the program selector is to select shift strategies depending on the setting of the High / Low range input. The strategies can be selected independently for High Range and Low Range. After ignition on and after changing between high range and low range, the EAT assumes a default shift strategy (normal mode).

The number of implemented shift strategies can be inndividually set for high range and Low range by the label KPG_MAX.

The program selector is a switch that is debounced and latch internally. The EAT changes shift strategy after it has recognised a stable input voltage for a time period TPG_FILT.

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- Component

- Type Make contact to ground
- Max bounce time $\leq 50\text{ms}$
- Location H gate
- Positions Toggle between shift strategies
- Switching function
 - Switch open, signal high = Normal
 - Switch closed, signal low = Sport (high range)
 - Switch closed, signal low = Manual (low range)

- Control Unit

- Interface characteristic Digital input, active low
- Threshold $U_{\text{low}} \text{ to } U_{\text{high}} = < 6.0\text{V}$, $U_{\text{OS_AD}}$
- Threshold $U_{\text{high}} \text{ to } U_{\text{low}} = > 2.0\text{V}$, $U_{\text{US_AD}}$
- Hysteresis $U_{\text{low}} \text{ to } U_{\text{high}} = > U_{\text{high}} \text{ to } U_{\text{low}} + 0.5\text{V}$
- Input circuit $(1.2 \pm 0.2) \text{ k}\Omega$ (pull up to U_{bp})
- Input current -10mA , input grounded, $U_{\text{batt}} = 14\text{V}$, $R_{\text{in}} = 1.2\text{k}\Omega$
- Reference Digital ground, pin 28

2.2.6 Digital outputs

2.2.6.1 Pin 25 and 51 - MES lines 1 and 2

The MES signal lines drive lights in the instrument pack that display the selected shift strategy and the EAT's fault state. Pin 51 and Pin 25 are open drain outputs. The following table shows the switching function; a “0” represents a low output, a “1” represents a high output voltage.

	MES 1 - Pin 51	MES 2 - Pin 25
Normal	1	1
Sport	0	1
Manual	1	0
Fault	0	0

- Component

- U_{low} $U < 1.2\text{V}$
- U_{high} $U > U_{\text{batt}} - 3.0\text{V}$
- R to U_{batt} $1.0\text{k}\Omega$

- Control unit

- Interface characteristics Digital output / open drain, active low
- U_{low} $\leq 1.0\text{V} @ I = 30\text{mA}$
- U_{high} $\geq U_{\text{batt}} - 2.0\text{V}$ at $I \leq 0.5\text{mA}$
- R to U_{batt} $1.21 \text{ k}\Omega$

N.B. After reset and igniton on, the MES lines display “Normal” as the default strategy.

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2.2.7 Analogue inputs

2.2.7.1 Pins 14,15,42 - Output shaft speed sensor

The transmission output shaft speed is captured by an inductive sensor that is mounted at a magent wheel with 36 teeth. The signal is transmitted to the EAT over a shielded 2-wire connection.

- Component (inductive sensor)

- location	Gearbox housing
- output	36 pulses per revolution
- f_min	102Hz (170 rpm)
- f_max	5.0kHz (8333 rpm)
- sensor voltage U_i_{min}	0.7 Vs at 102Hz (peak voltage)
- sensor voltage U_i_{max}	1.3 Vs at 102Hz (peak voltage)
- sensor distance	0.85mm
- load resistance	$R_1 = 20k\Omega$

- Control unit

- Interface characteristic	Frequency input
- R_{in} Pin 14 to Pin 42	$20k\Omega$
- sensitivity U_{min}	1.2Vss (peak to peak) @ 100 Hz
- sensitivity U_{max}	200 Vss @ 100 Hz
- f_max	6.0 kHz

- Rotational limit

- n_min	170 rpm
- n_max	8333 rpm
- Switching voltage of input	$(U @ \text{Pin } 42 - U @ \text{Pin } 14) / 2$

- Signal processing in the EAT

- The EAT calculates the mean period time over one program loop.

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2.2.8 Diagnostic interface

2.2.8.1 Pin 31 - Diagnostic line (K line)

The K line is the main interface between the on board electronic control units and external diagnostic devices as customer specific testers, Scantool, development tools or end of line programmers.

Customer specific testers are used to read diagnostic data from the fault memory, to manipulate diagnostic data and / or manipulate other data like country variants or calibration data. Scantools are used to access the OBDII relevant entries in the fault memory and to manipulate them.

Development tools are used to display and to manipulate random data of the EAT including the fault memory.

- Component

The physical and transfer layer must be compatible to ISO9141 and ISO9141 CARB. The EAT supports the application and protocol layer of ISO9141 CARB. Other customer specific protocols can be implemented.

- Control unit

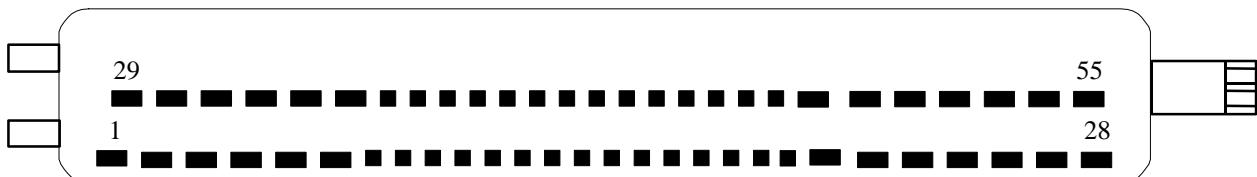
- interface characteristic	Digital input / output
- signal form	Square wave
- voltage levels	compliant to ISO 9141
- input resistance	compliant to ISO 9141
- data transfer rate	10.4 kBaud for CARB diagnostics Other supported protocols, see relevant specification.

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2.3 ECU Connector Pin-out



Pin	Function	Wire Colour	Pin	Function	Wire Colour
1	Not used		29	Not used	
2	Not used		30	Solenoid Valve 1; MV1	
3	Not used		31	K Line (Diagnostic line)	
4	Not used		32	Solenoid valve 3; MV3	
5	Pressure regulator		33	Solenoid valve 2; MV2	
6	Power Ground		34	Not used	
7	Not used		35	Not used	
8	Position Switch Line 2 (X)		36	Position Switch Line 1 (W)	
9	Position Switch Line 4 (Z) (GS8.87.0 only)		37	Position Switch Line 3 (Y)	
10	Not used		38	Not used	
11	Not used		39	Not used	
12	Not used		40	Not used	
13	High / Low Range Input		41	Not used	
14	Output speed sensor -		42	Output speed sensor +	
15	Output speed sensor screen		43	Not used	
16	CAN – High		44	CAN – Low	
17	Not used		45	Mode Switch	
18	Not used		46	Not used	
19	Not used		47	Not used	
20	Not used		48	Not used	
21	Not used		49	Not used	
22	Not used		50	Not used	
23	Not used		51	MES Line 1	
24	Not used		52	Not used	
25	MES Line 2		53	Supply, Solenoids & PR	
26	Permanent Battery Supply		54	Ignition Battery Supply	
27	Not used		55	Not used	
28	Electronic Ground				

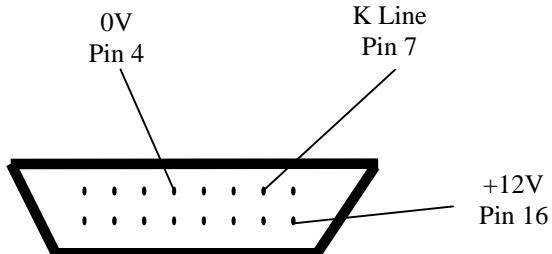
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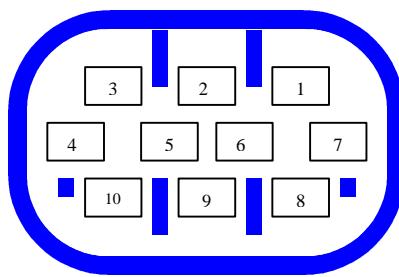
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2.4 Vehicle connector pin outs

2.4.1 Diagnostic Connector



2.4.2 Harness to Position switch (mounted on Transmission)



1	-	12V supply
2	-	Line 1
3	-	Line 2
4	-	Line 3
5	-	Line 4
6	-	
7	-	
8	-	
9	-	
10	-	

2.4.3 Harness to Solenoid Valves (mounted on Transmission)

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3 Description of Functionality

In an Electronic Automatic Transmission, the hydraulic valve block is replaced with an Electronically controlled hydraulic valve block. This allows the shift points and valve pressures to be calibrated individually for every possible situation. The result is an improvement in shift quality, and increased torque capacity and more flexibility of shift patterns.

The Electronic Control Unit is programmed with software which monitors all the relevant electrical inputs required to decide what type of shift should be made. As well as this information, several special features exist within the software to improve the drivability and functionality of the Vehicle.

3.1 Special features

3.1.1 Sport Mode.

In order to activate the sport mode, the “mode” button must be pressed whilst the vehicle is in high range. This will make the vehicle more responsive to accelerator pedal movement, changing down gears sooner than would be the case in the default normal mode.

3.1.2 Manual Mode.

In order to activate the manual mode, the “mode” button must be pressed whilst the vehicle is in low range. This mode is designed to give improved off road performance. If the vehicle is in manual mode, the position of the selector will reselect the gear engaged, rather than the maximum gear required. For example, if the selector position is in “3” whilst 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. Kickdown is disabled in this mode.

3.1.3 Towing / Driving up steep gradients

When the vehicle is in its normal default mode (ie, High range with sport not selected) the transmission will select a shift pattern appropriate to the current conditions. If either a heavy trailer is being pulled, or a steep gradient is being climbed, the transmission will hold onto gears longer than would normally be the case to aid performance and drivability.

3.1.4 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.

3.1.5 Calibration Selection (99MY V8 Range Rover Only)

ECU part numbers differentiate between North America, UK/Euro and Rest of world. Each ECU contains two calibrations, 4.0l and 4.6l. When an ECU is fitted to 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 state.

When the correct calibration is selected (4.0l or 4.6l), 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.

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4 Fault finding

If there is a fault with the transmission, a substitute function will be activated which will allow the vehicle to be driven in some manner whilst attempting to protect the transmission. Depending on the fault, the substitute function activated may or may not be noticeable to the driver.

Abnormal gear shifting

If a fault exists that will not damage the transmission, cause inconvenience to the driver or increase the emmissions output of the vehicle by 15%, there will be no warning lights illuminated but a fault code will be stored. If a driver does notice the vehicle is behaiving differently, this could be due to a fault of this type.

Sport and Manual lights flashing together

If something has happend which will effect the performance of the transmission, the Sport and Manual lights will flash at the same time. This indicates a fault code has been stored. If this happens to a customer, the first thing the customer should attempt is to turn off the ignition, and re-start the vehicle. If the lights continue to flash, the car should be taken to the nearest Land Rover dealer as soon as possible.

If both lights are flashing, the transmission will have selected a limp-home mode. Although the vehicle will drive, damage to the transmission may occur if the fault is not corrected. When the vehicle is in this state, special care should be taken when selecting position D. In absolutly no circumstances should the vehicle be moving backwards when position D is selected.

4.1 Fixing faults

If either of the above conditions are true, the transmission controller should have stored a fault code. The following is recommended as the order in which abnormal transmission behaviour should be investigated.

4.1.1 The transmission ECU is disconnected

The automatic transmission ECU is located under the left hand front of seat of 98MY and later Discovery vehicles. On vehicles prior to this model year, the transmission is hydraulic and therefore has no controlling electronics.

If the ECU has been disconnected, the transmission will have selected a hydraulic limp-home. The ECU should be connected whilst the ignition is off.

4.1.2 The transmission has diagnosed a fault.

If the software within the transmission ECU has diagnosed there is something wrong with the system, a fault code will be stored. If the diagnosed fault is currently active (ie, the transmission can currently not fucntion correctly), the Sport and Manual lights will flash together. After a fault code has been stored and the car has completed 40 journeys and the fault has not happend again, the fault code will be deleted from memory.

If a fault is stored, the vehicle must be interogatted using a TestBook. The following page lists each fault code and its effect on the transmission system.

4.1.3 Power to the ECU has been lost or K line not connected.

If the transmission ECU is connected, but the TestBook cannot communicate with the ECU, then the power supply to the ECU may have been lost or the K line is not connected. In this instance, the following sequence of events should be followed.

- A) Turn the ignition to the off position.
- B) Disconnect the transmission ECU.
- C) Test the voltage at Pin 26 with a volt meter. This should read greater than 10V.
- D) Measure the resistance to ground with a digital volt meter or equivalent, of pins: 6 and 28. The resistance should be less than 100 ohms.
- E) Turn the ignition to position II (normal running position).
- F) Test the voltage at Pin 54 with a volt meter. This should read greater than 10V.

If the above is completed with no strange reading, the ECU's power supply is OK. The only possibility is the Diagnostic connector is not attached to the ECU. To check for this:

- G) Measure the resistance between pin 31 of the ECU connector, and pin 7 of the vehicle diagnostic connector (see drawing later). This should be less than 10 ohms.

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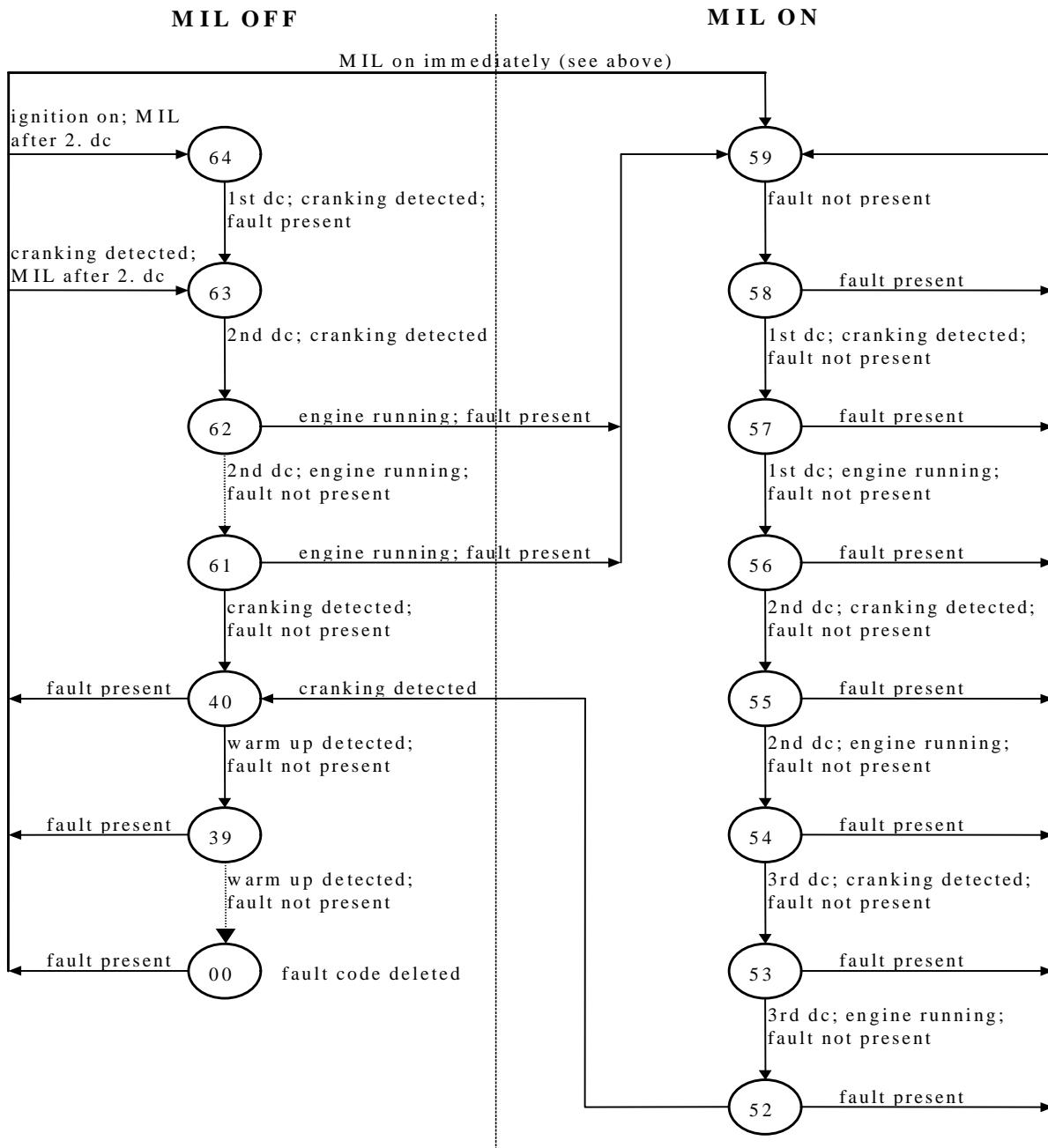
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4.2 MIL light illumination (N.A.S. vehicles only)

The illumination of the MIL (Check engine light) is controlled by the following counter. This counter is only applicable for MIL (emissions) related faults. Any faults which prevent the gearbox from requesting the MIL light will automatically illuminate the MIL light immediately.

Definition of a Warmup: Engine Coolant temperature rises by 16°C and exceeds 72°C.



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5 Fault codes

5.1 Ambient conditions stored

The following lists all fault codes, together with the associated CARB P code, a description and the ambient conditions saved with each fault code. The ambient conditions must be multiplied by the following conversion factors in order to calculate the ambient conditions present when the fault was diagnosed.

Please note. The ambient conditions stored with each fault are those at the time of the first occurrence of the fault and are not updated if the fault re-occurs. The ambient conditions stored with each fault may change prior to volume. This will not effect TestBook, as the ambient conditions of each fault are referenced in the diagnostic protocol.

Variable	Scaling factor	Description
AN6	1 Volt = 4.65 ₁₀	Solenoid valve 1 voltage
AN7	1 Volt = 4.65 ₁₀	Solenoid valve 2 voltage
AN8	1 Volt = 4.65 ₁₀	Solenoid valve 3 voltage
AN9	1 Volt = 4.65 ₁₀	MES1 voltage
AN11	1 Volt = 4.65 ₁₀	MES2 voltage
MMM	2 Nm = 1 ₁₀	Engine torque
N_MOT	32 rpm = 1 ₁₀	Engine speed
UBATT	1 Volt = 9.8 ₁₀	Battery voltage
VGT_\$X	1 km/h = 1 ₁₀	Output shaft speed
YPO_Old	L1=Bit 0, L2 = Bit 1 etc	Position switch L1 - L4 inputs

5.2 Fault codes descriptions

For the recommended method to diagnose each of the fault codes, please refer to the last section in this document, Fault tree analysis.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
1	Transmission relay control (Relay sticks, short circuit)	P1613	AN6	AN7	UBATT

The transmission controllers supply to the power outputs is faulty. This could be due to a problem in the harness (short circuit to 12V of a power output stage), or an internal ECU fault.

Diagnostic operates: Initialisation; approximately 60ms after ignition is switched on.

Normal operation;

Conditions to be met to run Diagnostic: None

Time between fault present & fault stored: 10ms max

Variables used by the diagnostic: Status of Watchdog circuit, Status of Highside switch

Will limp home mode be selected: Yes

Conditions to be met to clear the fault: Ignition to be switch on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
2	Transmission relay control (Relay sticks, open circuit)	P1612	AN6	AN7	UBATT

The transmission controllers supply to the power outputs is faultly. This could be due to a problem in the harness (short circuit to 0V), or and internal ECU fault.

Diagnostic operates: Initialisation; approximately 200ms after ignition is switched on

Battery voltage > 10.5V

Conditions to be met to run Diagnostic: 60ms max.

Time between fault present & fault stored: Status of Watchdog circuit, Status of Highside switch

Variables used by the diagnostic: Yes

Will limp home mode be selected: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
3	EEPROM communication fault	P1606	N_MOT	VGT_\$X	MMM

The ECU cannot communicate with part of its internal memory, ie ECU fault

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 1 second
 Variables used by the diagnostic: Internal communication between the Processor and the memory
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
4	EEPROM checksum fault	P1601	N_MOT	VGT_\$X	MMM

The software within the transmission control unit is not recognised. Part of the software is programmed to recognise if any changes to the software or calibration have been made. If this is the case, the transmission will select limphome.

Diagnostic operates: Normal operation
 Conditions to be met to run Diagnostic: Initialisation complete
 Time between fault present & fault stored: Max. 1 minute.
 Variables used by the diagnostic: Function of all data stored on EPROM
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition switched on whilst fault not present, engine cranked

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
5	Torque converter lock-up clutch monitoring	P0741	N_MOT	VGT_\$X	MMM

The software has detected a potential problem with the torque converter system.

Diagnostic operates: When the Torque converter is locked
 Conditions to be met to run Diagnostic: No Engine speed, Output shaft speed or gear ratio faults active.
 Time between fault present & fault stored: 5 seconds max.
 Variables used by the diagnostic: Engine Speed, Output shaft speed, Throttle angle, selected gear.
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition switched on whilst fault not present, engine cranked

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
6	Watchdog check	P1606	N_MOT	VGT_\$X	MMM

Internal ECU fault.

Diagnostic operates: Initialisation; approximately 70ms after ignition on.
 Conditions to be met to run Diagnostic: Normal operation;
 Time between fault present & fault stored: None
 Variables used by the diagnostic: 60ms max.
 Will limp home mode be selected: Status of Highside switch, Status of Watchdog circuit.
 Conditions to be met to clear the fault: Yes
 Ignition switched on whilst fault not present, engine cranked

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
7	Solenoid valve lockup clutch check (short circuit to +)	P0743	N_MOT	AN8	UBATT

The transmission ECU has diagnosed a short circuit to 12V of pin 32.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Torque converter unlocked
 Time between fault present & fault stored: 10ms
 Variables used by the diagnostic: Voltage at Pin 32
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Initialisation complete, engine cranked, diagnostic runs & fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
8	Solenoid valve 1check (short circuit to +)	P0753	N_MOT	AN6	UBATT

The transmission ECU has diagnosed a short circuit to 12V of pin 30.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Solenoid valve 1 = off
 Time between fault present & fault stored: 10ms
 Variables used by the diagnostic: Voltage at Pin30
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Initialisation complete, engine cranked, diagnostic runs & fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
9	Solenoid valve 2check (short circuit to +)	P0758	N_MOT	AN7	UBATT

The transmission ECU has diagnosed a short circuit to 12V of pin 33.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Solenoid valve 2 = off
 Time between fault present & fault stored: 10ms
 Variables used by the diagnostic: Voltage at Pin 33
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Initialisation complete, engine cranked, diagnostic runs & fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
10	Pressure regulator check (short circuit to +)	P0748	N_MOT	VGT_X	UBATT

The transmission ECU has diagnosed a short circuit to 12V of pin 5.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 150ms
 Variables used by the diagnostic: Voltage at Pin 5
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Initialisation complete, engine cranked, diagnostic runs & fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
11	CAN message MD_REIB invalid (FFh)	P1884	N_MOT	VGT_X	MMM

The CAN message from the engine management controller which informs the transmission of the engine friction is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: No CAN timeout or CAN level fault stored
 Time between fault present & fault stored: Filter time 2.5s
 Variables used by the diagnostic: CAN message MD_REIB from engine management controller
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Engine started with fault no present

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
12	MES line 1 fault	P1810	N_MOT	AN9	UBATT

One of the wires which drives the sport and manual lights in the instrument pack has an electrical fault.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 1 s
 Variables used by the diagnostic: Voltage at 51
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition on with fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
13	MES line 2 fault	P1810	N_MOT	AN11	UBATT

One of the wires which drives the sport and manual lights in the instrument pack has an electrical fault.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 1 s
 Variables used by the diagnostic: Voltage at pin 25
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition on with fault not present

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
14	Position switch monitoring (permanent)	P0705	N_MOT	YPO_OLD	UBATT

The position switch is the electrical input to the transmission controller of the driver selected PRiNDle position. The fault means the ECU has recognised an electrical code from this switch which does not represent a valid position.

The fault can be due to 3 reasons. Firstly, one or more of the wires to the position switch has become open circuit or short circuit to 0V or 12V. Secondly, the 12V supply from the body control unit to the position switch has been removed whilst the ignition is in position II (in extreme circumstances, this may be possible whilst the vehicle is cranking). Thirdly, the position switch is worn, or has water / dirt ingress. In the last case, the position switch must be changed. The following table indicates the voltages which should be seen by the ECU in each selector position, whilst the ignition is on.

98MY Discovery selector codes. (A Z* code in this table represents an intermediate selector position.)

Position Switch	ECU Pin	Selector Position												
		P	Z1	R	Z1	N	Z2	D	Z3	3	Z4	2	Z4	1
Line 1 (W)	36	12V	12V	-	12V	12V	12V	12V	12V	-	-	-	-	-
Line 2 (X)	8	-	12V	12V	12V	12V	-	-	12V	12V	-	-	-	-
Line 3 (Y)	37	-	-	-	-	12V	12V	12V	12V	12V	12V	-	12V	12
Line 4 (Z)	9	-	-	-	-	-	-	12V	12V	12V	12V	12V	12V	-

99MY Range Rover selector codes.

Position Switch	ECU Pin	Selector Position						
		P	R	N	D	3	2	1
Line 1 (W)	36	0V	0V	>	>	0V	0V	>
Line 2 (X)	8	>	0V	0V	0V	0V	>	>
Line 3 (Y)	37	>	>	>	0V	0V	0V	0V

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 100 ms
 Variables used by the diagnostic: W,X,Y, (Z) digital inputs
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
15	CAN level monitoring	P1842	N_MOT	VGT_\$X	MMM

The CAN protocol is not compatible between the engine and transmission controller.

Diagnostic operates: On arrival of first CAN message from the Engine Management Controller
 Conditions to be met to run Diagnostic: Ignition on
 Time between fault present & fault stored: 1.5 s
 Variables used by the diagnostic: CAN_STAND = 22H (CAN message)
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
16	CAN bus monitoring	P1841	N_MOT	VGT_\$X	MMM

Messages being transmitted on the CAN bus are being corrupted.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 300 ms
 Variables used by the diagnostic: None
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
17	CAN timeout monitoring	P1843	N_MOT	VGT_\$X	UBATT

There has been no communication from the engine management controller over the CAN serial link for a specified time.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 1 s
 Variables used by the diagnostic: Time since last CAN message received
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
18	CAN message WFPDK (Throttle angle) is invalid (FFh)	P1884	N_MOT	VGT_\$X	MMM

The CAN message WFPDK indicates to the transmission controller the driver demand (ie accelerator pedal position).

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10ms
 Variables used by the diagnostic: Throttle angle signal on CAN
 Will limp home mode be selected: No, substitute throttle angle, Gearbox lights to indicate Kick down not available
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
19	CAN message T_MOT invalid (FFh)	P1884	N_MOT	VGT_\$X	MMM

The CAN message T_MOT (engine temperature) from the engine management controller is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: Engine temperature signal via CAN
 Will limp home mode be selected: No, substitute engine temperature used.
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
20	CAN message V3 (road speed) invalid (FFh)	P1884	N_MOT	VGT_X	MMM

The CAN message V3 (Velocity) from the engine management controller is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10ms
 Variables used by the diagnostic: CAN message V3
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
21	Downshift safety monitoring	P0721	N_MOT	VGT_X	MMM

The transmission control unit has prevented a gear shift which would have caused an engine overspeed.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Transmission not in Limp Home
 Time between fault present & fault stored: 10ms max.
 Variables used by the diagnostic: Engine Speed, Target gear
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
22	Stall speed monitoring	P0722	N_MOT	VGT_X	MMM

The torque converter has appeared to slip more than the specified amount.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 40 ms
 Variables used by the diagnostic: Engine Speed, gear selected, Output shaft speed.
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
23	Position Switch during cranking (99MY Range Rover only)	P0705	N_MOT	YPO_Old	UBATT

The engine speed has exceeded its maximum speed.

Diagnostic operates: During cranking only
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: Engine speed, selector position, road speed ?
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
24	Battery supply check	P1562	N_MOT	MMM	UBATT

Whilst the engine is running, the battery supply has fallen to below 9V.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Engine speed > 996 rpm
 Time between fault present & fault stored: 300 ms
 Variables used by the diagnostic: Engine speed, battery supply voltage
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
25	Solenoid valve for TC (short circuit to - or open circuit)	P0743	N_MOT	AN8	UBATT

Pin 32 (Solenoid valve for torque convertor lockup) is either short circuit to 0V or open circuit.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Torque converter = locked
 Time between fault present & fault stored: 20 ms
 Variables used by the diagnostic: Status of torque converter drive, Battery voltage
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
26	Solenoid valve 1 (line short circuit to - or open circuit)	P0753	N_MOT	AN6	UBATT

Pin 30 (Solenoid valve 1) is either short circuit to 0V or open circuit.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Solenoid valve 1 = on
 Time between fault present & fault stored: 20ms
 Variables used by the diagnostic: Status of Solenoid valve 1, Battery voltage
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
27	Solenoid valve 2 (line short circuit to - or open circuit)	P0758	N_MOT	AN7	UBATT

Pin 33 (Solenoid valve 2) is either short circuit to 0V or open circuit.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: Solenoid valve 2 = on
 Time between fault present & fault stored: 20 ms
 Variables used by the diagnostic: Status of Solenoid valve 1, Battery voltage
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
28	Pressure regulator (line short circuit to - or open circuit)	P0748	N_MOT	VGT_X	UBATT

Pin 5 (pressure regulator) is either short circuit to 0V or open circuit.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 20 ms
 Variables used by the diagnostic: Status of low side pressure regulator driver
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
29	Gear ratio monitoring, 1st gear	P0731	N_MOT	VGT_X	MMM

Ratio of engine speed to output shaft speed whilst 1st gear is engaged is out of range.

Diagnostic operates: NAS vehicles only, Continuously
 Conditions to be met to run Diagnostic: 1st gear selected, gear shift not in progress
 Time between fault present & fault stored: 800 ms
 Variables used by the diagnostic: Engine Speed, Engine Torque, Output shaft speed, Selected gear
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
30	Gear ratio monitoring, 2nd gear	P0732	N_MOT	VGT_\$X	MMM

Ratio of engine speed to output shaft speed whilst 2nd gear is engaged is out of range.

Diagnostic operates: NAS vehicles only, Continuously
 Conditions to be met to run Diagnostic: 2nd gear selected, gear shift not in progress
 Time between fault present & fault stored: 800 ms
 Variables used by the diagnostic: Engine Speed, Engine Torque, Output shaft speed, Selected gear
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
31	Gear ratio monitoring, 3rd gear	P0733	N_MOT	VGT_\$X	MMM

Ratio of engine speed to output shaft speed whilst 3rd gear is engaged is out of range.

Diagnostic operates: NAS vehicles only, Continuously
 Conditions to be met to run Diagnostic: 3rd gear selected, gear shift not in progress
 Time between fault present & fault stored: 800 ms
 Variables used by the diagnostic: Engine Speed, Engine Torque, Output shaft speed, Selected gear
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
32	Gear ratio monitoring, 4th gear	P0734	N_MOT	VGT_\$X	MMM

Ratio of engine speed to output shaft speed whilst 4th gear is engaged is out of range.

Diagnostic operates: NAS vehicles only, Continuously
 Conditions to be met to run Diagnostic: 4th gear selected, gear shift not in progress
 Time between fault present & fault stored: 800 ms
 Variables used by the diagnostic: Engine Speed, Engine Torque, Output shaft speed, Selected gear
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
33	CAN message MD_IND invalid, indicated by F_TL_MES	P1884	N_MOT	VGT_\$X	MMM

The CAN message from the engine management controller which informs the transmission of the engine torque is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: CAN message F_TL_MES
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
34	CAN message MD_IND invalid (FFh)	P1884	N_MOT	VGT_\$X	MMM

The CAN message from the engine management controller which informs the transmission of the engine torque is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: CAN message MD_IND
 Will limp home mode be selected: No, substitute engine torque used.
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

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Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
35	CAN message N_MOT invalid, indicated by F_N_MOT	P1884	N_MOT	VGT_\$X	MMM

The CAN message from the engine management controller which informs the transmission of the engine speed is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: CAN message F_N_MOT
 Will limp home mode be selected: Yes
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

99MY Range Rover only, Discovery Series II dummy code.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
36	Transmission calibration selection incorrect / invalid	P1602	N_MOT	VGT_\$X	MMM

An ECU has been fitted to a vehicle an not had the correct calibration selected, or no calibration has been selected.

Diagnostic operates: During initialisation
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: Tune select status
 Will limp home mode be selected: No, default shift maps used (normally 4.0l calibration)
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
37	CAN message T_ANS invalid (FFh).	P1884	N_MOT	VGT_\$X	MMM

The CAN message which informs the transmission of the air intake temperature is invalid.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: CAN message T_ANS
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
38	CAN message FHOEHE invalid (FFh).	P1884	N_MOT	VGT_\$X	MMM

The CAN message used to control the special altitude shift patterns is not correct.

Diagnostic operates: Continuously
 Conditions to be met to run Diagnostic: None
 Time between fault present & fault stored: 10 ms
 Variables used by the diagnostic: CAN message FHOEHE
 Will limp home mode be selected: No
 Conditions to be met to clear the fault: Ignition to be switched on whilst fault not present, engine cranked.

Fault	Description	CARB	Ambient 1	Ambient 2	Ambient 3
39	Range switch plausibility error	P1705	N_MOT	VGT_\$X	MMM

The input received from the range switch input cannot be correct. This may be due to not moving the lever fully, not necessarily a faulty switch

Diagnostic operates:
 Conditions to be met to run Diagnostic: Road speed > 5km/h
 Time between fault present & fault stored: 50 ms
 Variables used by the diagnostic: O/P shaft speed, Road speed (V3), Range Switch status
 Will limp home mode be selected:
 Conditions to be met to clear the fault:

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5.3 Impact on the system of each fault

Settings are those for Range Rover, 99MY (Software release L944e1414, 4.0l & 4.6l V8, NAS only)

		Priority		Control				Byte 2 – Protection & Default			Byte 1 – Protection & Default																				
Fault Number		Priority Byte	Control Byte	Byte 1 - Protection & default	Byte 2 - Protection & default	Priority level (0 – 7, Bits 5 – 7	MIL on with activation of substitute function	Diagnostic function enable	Delete error after 40 warm-up cycles	Fault is CARB relevant	Filtering depends on time	Filter counter not changed if test not fulfilled	After cranking, return to normal function if fault still present	Not used	Return to normal function in operation if error not present	Limphome	Max pressure	Flash Sport and Manual lights (Gearbox fault message in RR)	No Kickdown	Substitute throttle angle	Use calculate range, not Range switch input	Substitute engine temperature	Only E program allowed	Substitute engine torque	No adaptive pressure control	No adaptive shift point control	Maintain current gear in low range / Limphone in High	No CAN communication	No gear and lockup diagnostics	Don't change status of MES line driver outputs	No Hot / High shift point & pressure adaption
1	224	244	32	7	7			1	1	1	1	1	1																		
2	224	244	32	7	7			1	1	1	1	1	1																		
3	225	244	0	0	7	1		1	1	1	1	1	1		1																
4	224	240	32	7	7			1	1	1	1	1	1																		
5	96	244	32	0	3			1	1	1	1	1	1		1																
6	224	244	32	7	7			1	1	1	1	1	1		1																
7	96	252	32	7	3			1	1	1	1	1	1		1																
8	96	252	32	7	3			1	1	1	1	1	1		1																
9	96	252	32	7	3			1	1	1	1	1	1		1																
10	96	252	32	7	3			1	1	1	1	1	1		1																
11	96	244	164	0	3			1	1	1	1	1	1		1																
12	0	212	64	0	0			1	1		1	1	1																		
13	0	212	64	0	0			1	1		1	1	1																		
14	224	252	40	6	7			1	1	1	1	1	1																		
15	224	244	56	6	7			1	1	1	1	1	1																		
16	224	228	40	6	7			1	1	1		1	1																		
17	224	236	40	6	7			1	1	1		1	1																		
18	96	244	166	156	3			1	1	1	1	1	1																		
19	96	212	0	64	3			1	1		1	1	1																		
20	96	212	0	0	3			1	1		1	1	1																		
21	96	244	40	6	3			1	1	1	1	1	1																		
22	96	244	40	6	3			1	1	1	1	1	1																		
23	96	244	40	6	3			1	1	1	1	1	1																		
24	96	244	40	6	3			1	1	1	1	1	1																		
25	96	252	32	7	3			1	1	1	1	1	1																		
26	96	252	32	7	3			1	1	1	1	1	1																		
27	96	252	32	7	3			1	1	1	1	1	1																		
28	96	252	32	7	3			1	1	1	1	1	1																		
29	96	244	32	0	3			1	1	1	1	1	1																		
30	96	244	32	0	3			1	1	1	1	1	1																		
31	96	244	32	0	3			1	1	1	1	1	1																		
32	96	244	32	0	3			1	1	1	1	1	1																		
33	96	244	164	0	3			1	1	1	1	1	1																		
34	96	244	165	0	3			1	1	1	1	1	1																		
35	96	244	40	6	3			1	1	1	1	1	1																		
36	96	244	0	4	3			1	1	1	1	1	1																		
37	96	212	128	0	3			1	1		1	1	1																		
38	96	212	128	0	3			1	1		1	1	1																		
39	0	0	0	0	0																										

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6 General information

6.1 Dimensions and fixing details

The transmission controller ECU is located under the front left had seat, under a black metal bracket. To remove the ECU, a medium sized philips screwdriver is required, together with 8mm and 10mm sockets, a short (40mm) extension and a 1/4 inch drive socket.

The trim surrounding the base of the seat must first be removed. This sometimes requires the panel on the left of the seat to be removed. After this has been done, remove 3 x 10mm screws which hold down the bracket. When these have been removed, disconnect the ECU from the harness (ensure the ignition is off). The bracket can now be removed from the vehicle. Remove the ECU from the bracket using an 8mm socket.

Approximate ECU dimensions:



6.2 Voltage requirements

Voltage	System behavior
16.0 - 26.0	Jump start; excess voltage without damage, limp home mode, output stages for solenoid valves and pressure regulator switched off (max 1min at 40°C).
9.0 - 16.0	Voltage range for normal operation of the EAT with CAN-Bus corresponding to the specification.
6.5 - 9.0	Operation of the EAT with diagnostic functions and CAN-Bus enabled, limp home mode, output stages for solenoid valves and pressure regulator switched off.
3.0 - 6.5	Under voltage with data retention in SRAM, limp home mode, unreliable communication over the CAN bus.
0 - 3.0	Undervoltage without reliable function
-14 - 0	Reversed polarity without damage (-14V max 1 min at 25°C)

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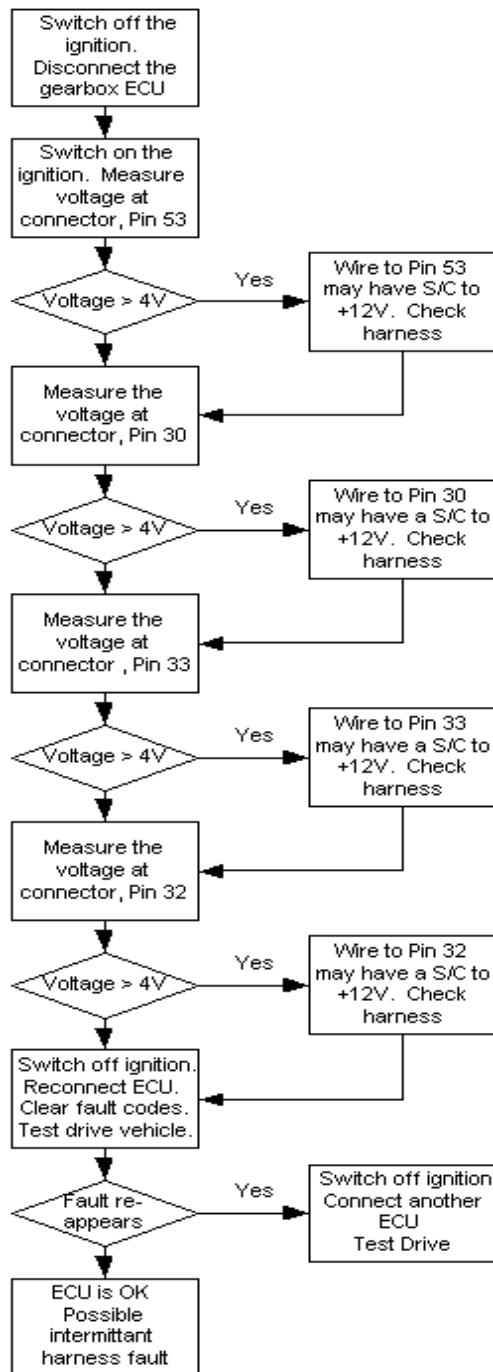
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7 Fault tree analysis

The following pages are a guide to fixing faults with the electronic automatic transmission. In order to solve fault, the fault trees indicate the most logical way a problem should be approached. If the fault tree indicates the transmission or controller is faulty, the transmission electronics department should first be consulted.

In the instance, somebody will look at the car, and if nothing is deemed to be faulty with the electronics, the Transmissions department will check the condition of the gearbox. If both the transmission and the controller are deemed to be OK, the diagnosis will have to be further investigated by Transmission Electronics.

7.1.1.1 Fault code 1 – Transmission relay control (Sticks S/C)

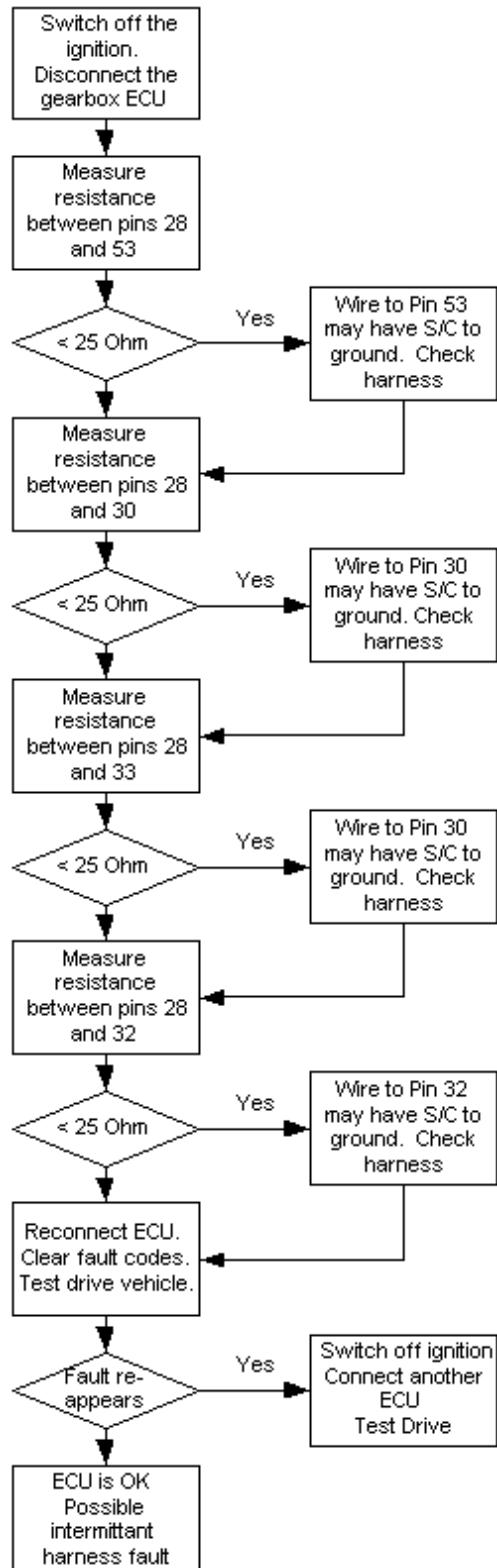


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7.1.1.2 Fault code 2 – Transmission relay control (Permanent O/C)

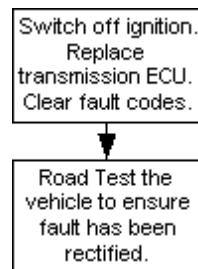


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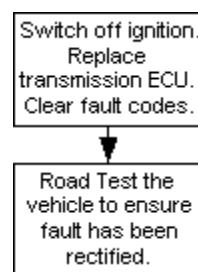
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7.1.1.3 Fault code 3 – EEPROM communication fault



7.1.1.4 Fault code 4 – EPROM checksum fault

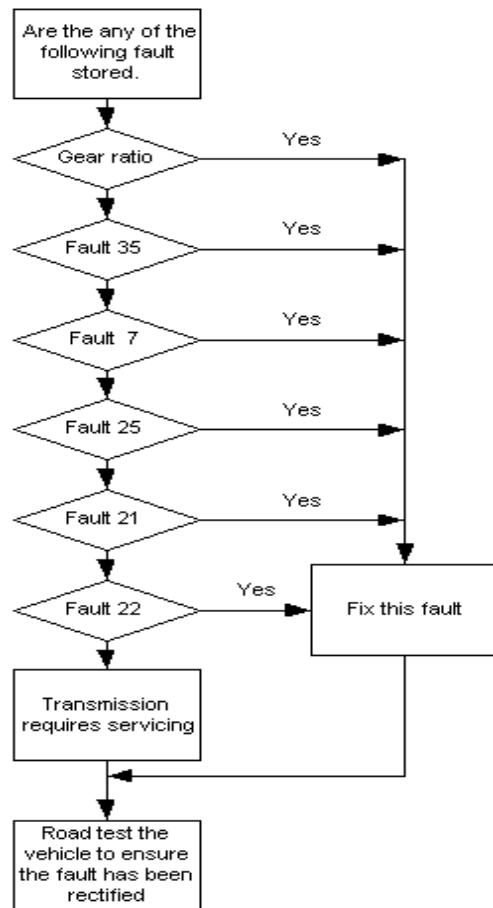


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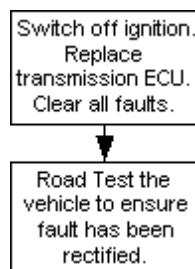
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7.1.1.5 Fault code 5 – Lockup clutch monitoring



7.1.1.6 Fault code 6 – Watchdog Check

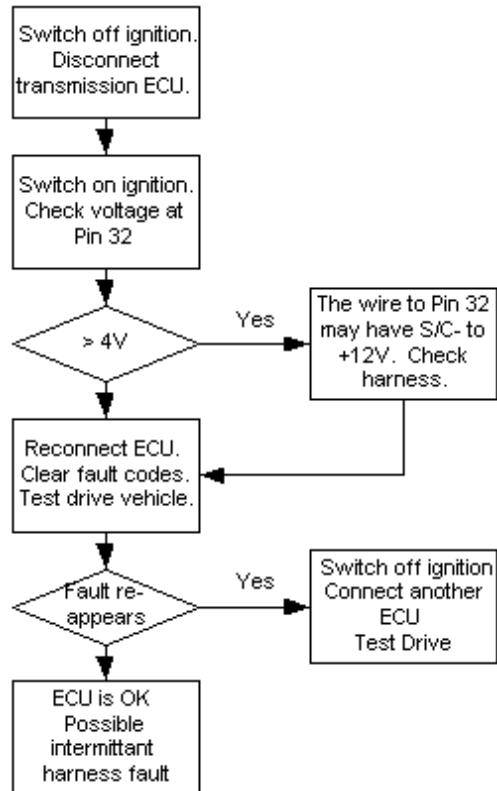


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7.1.1.7 Fault code 7 – Solenoid valve lockup clutch S/C +12V

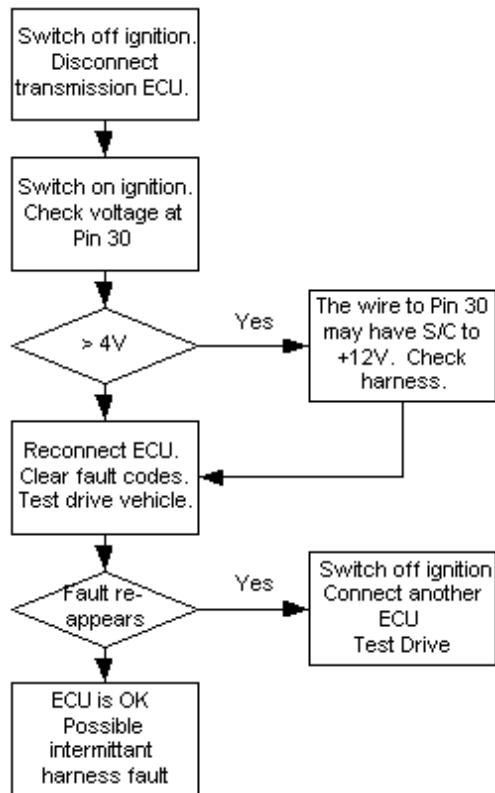


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7.1.1.8 Fault code 8 – Solenoid valve 1 S/C +12V

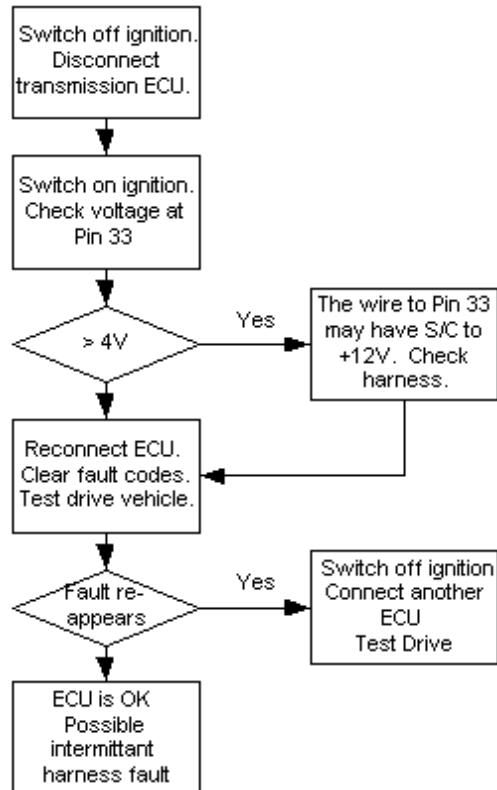


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7.1.1.9 Fault code 9 – Solenoid valve 2 S/C +12V

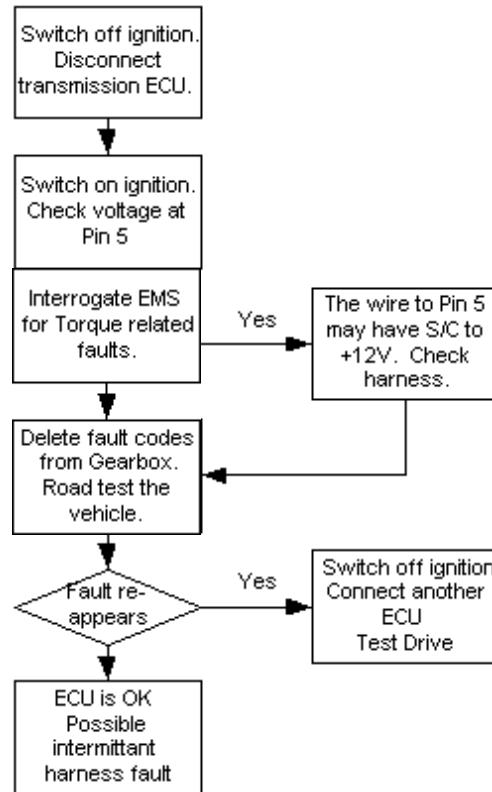


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7.1.1.10 Fault code 10 – Pressure regulator S/C +12V



7.1.1.11 Fault code 11 – CAN message MD_REIB invalid (FFh)

7.1.1.12 Fault code 12 – MES line 1, Electrical fault

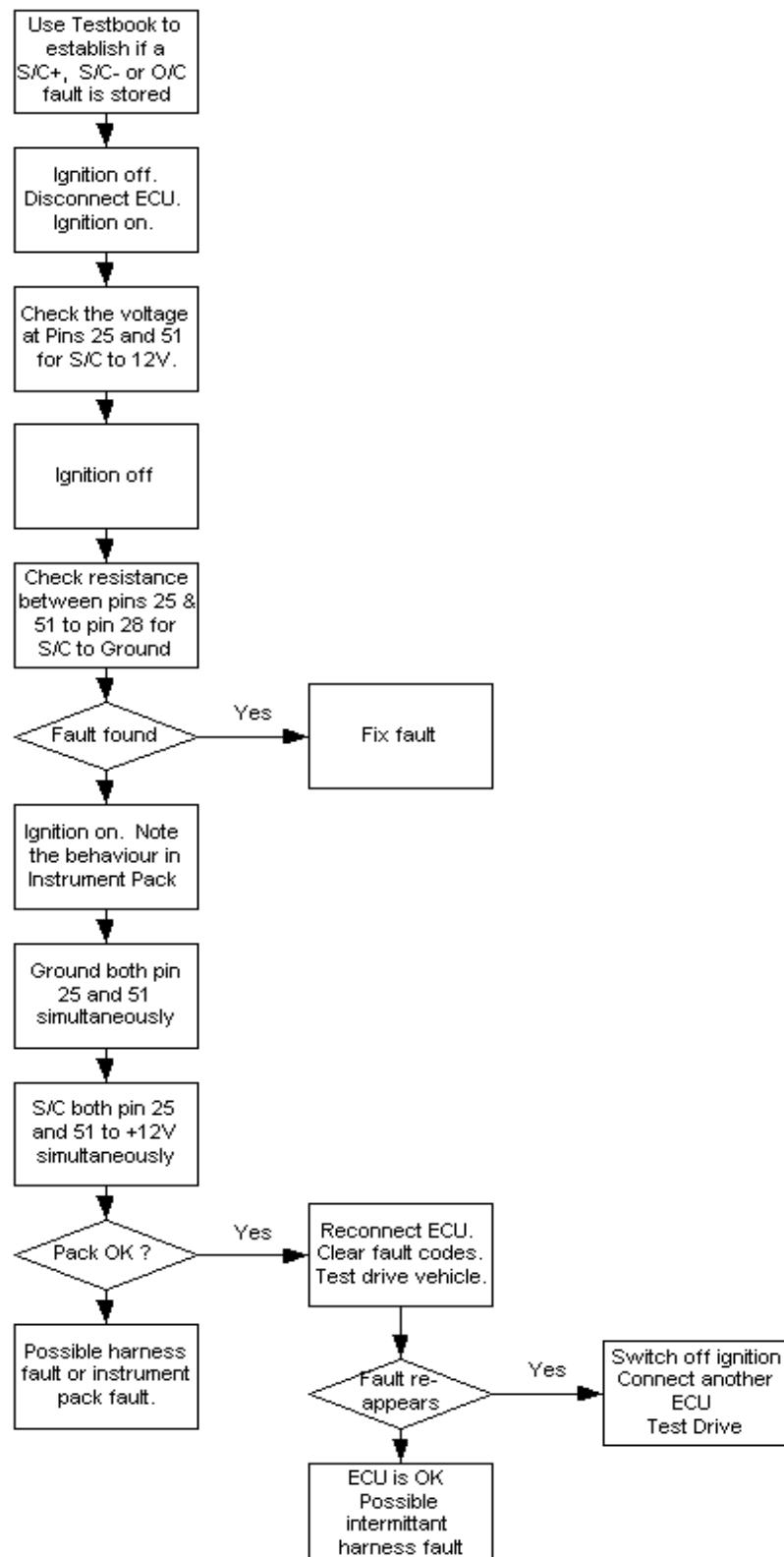
See below, Fault code 13 MES line 2, Electrical fault for details.

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7.1.1.13 Fault code 13 – MES line 2, Electrical fault

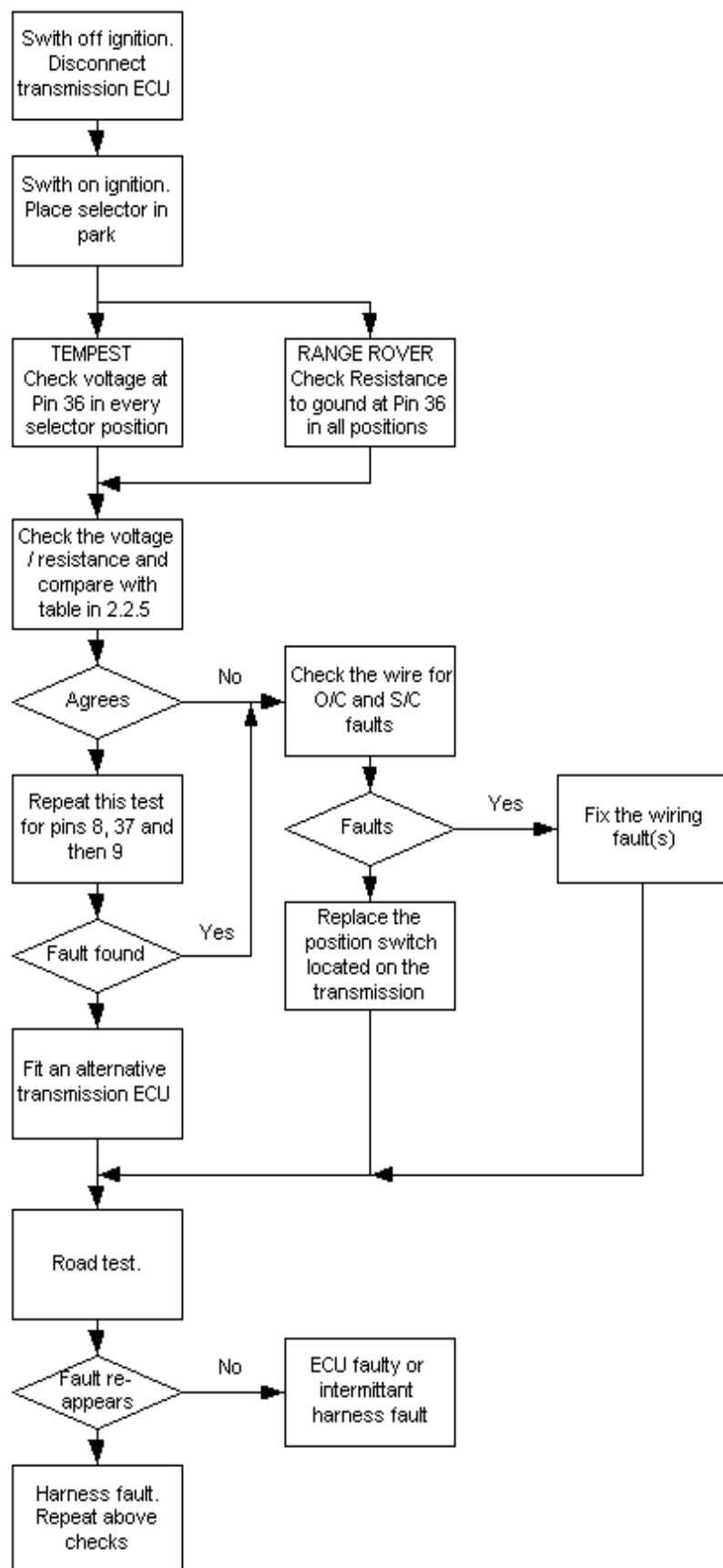


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7.1.1.14 Fault code 14 – Position switch monitoring (Permanent)

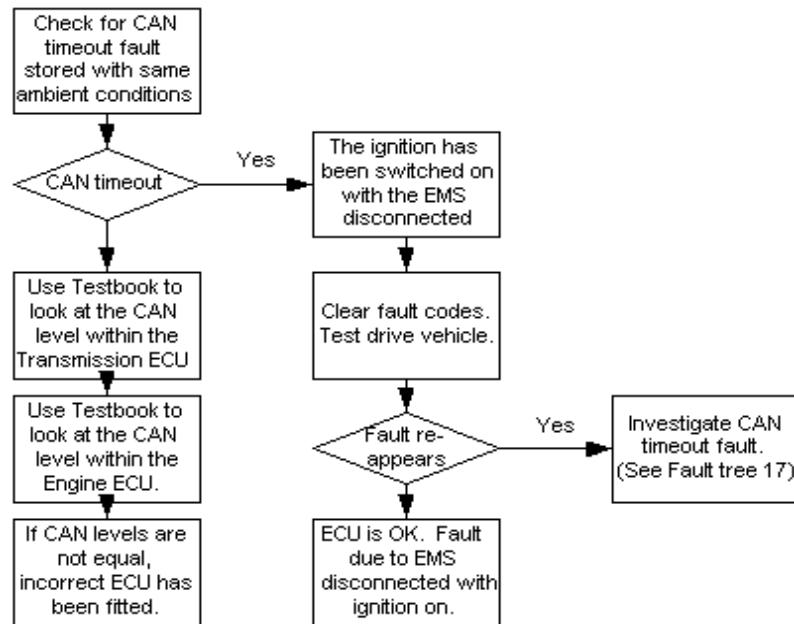


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7.1.1.15 Fault code 15 – CAN level invalid



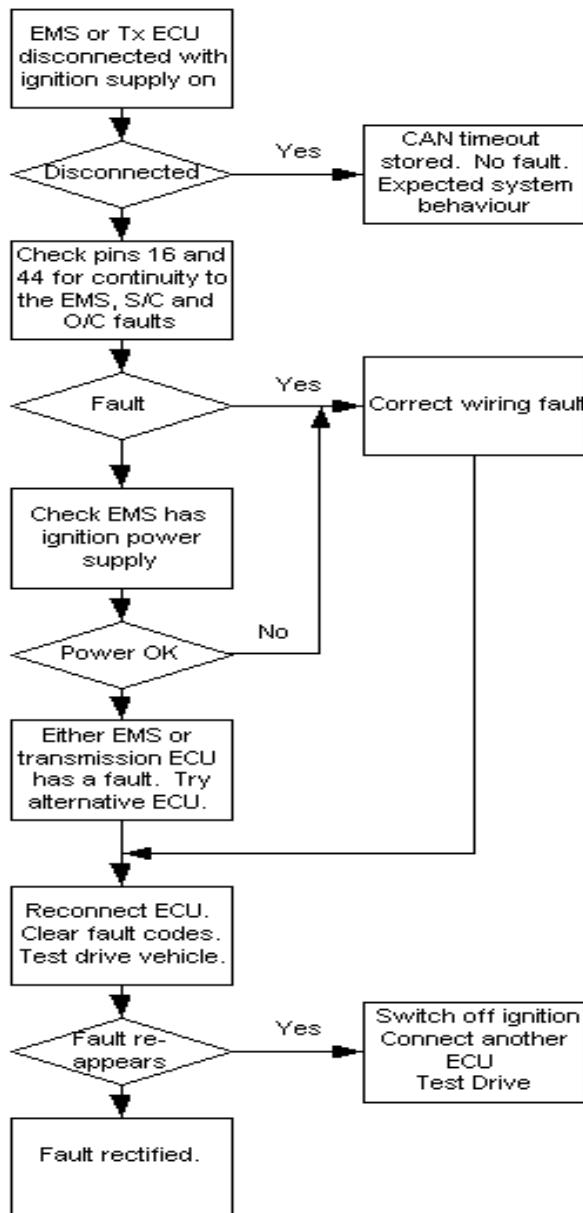
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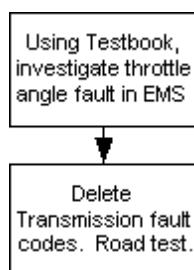
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7.1.1.16 Fault code 16 – CAN bus fault – See following, CAN timeout

7.1.1.17 Fault code 17 – CAN timeout fault



7.1.1.18 Fault code 18 – CAN message DKI fault (Throttle angle)

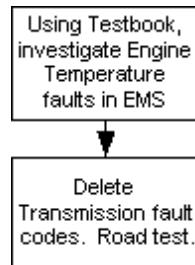


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7.1.1.19 Fault code 19 – CAN message T_MOT (Engine temperature)



7.1.1.20 Fault code 20 – CAN message V3 (Road speed)



7.1.1.21 Fault code 21 – Downshift safety monitoring

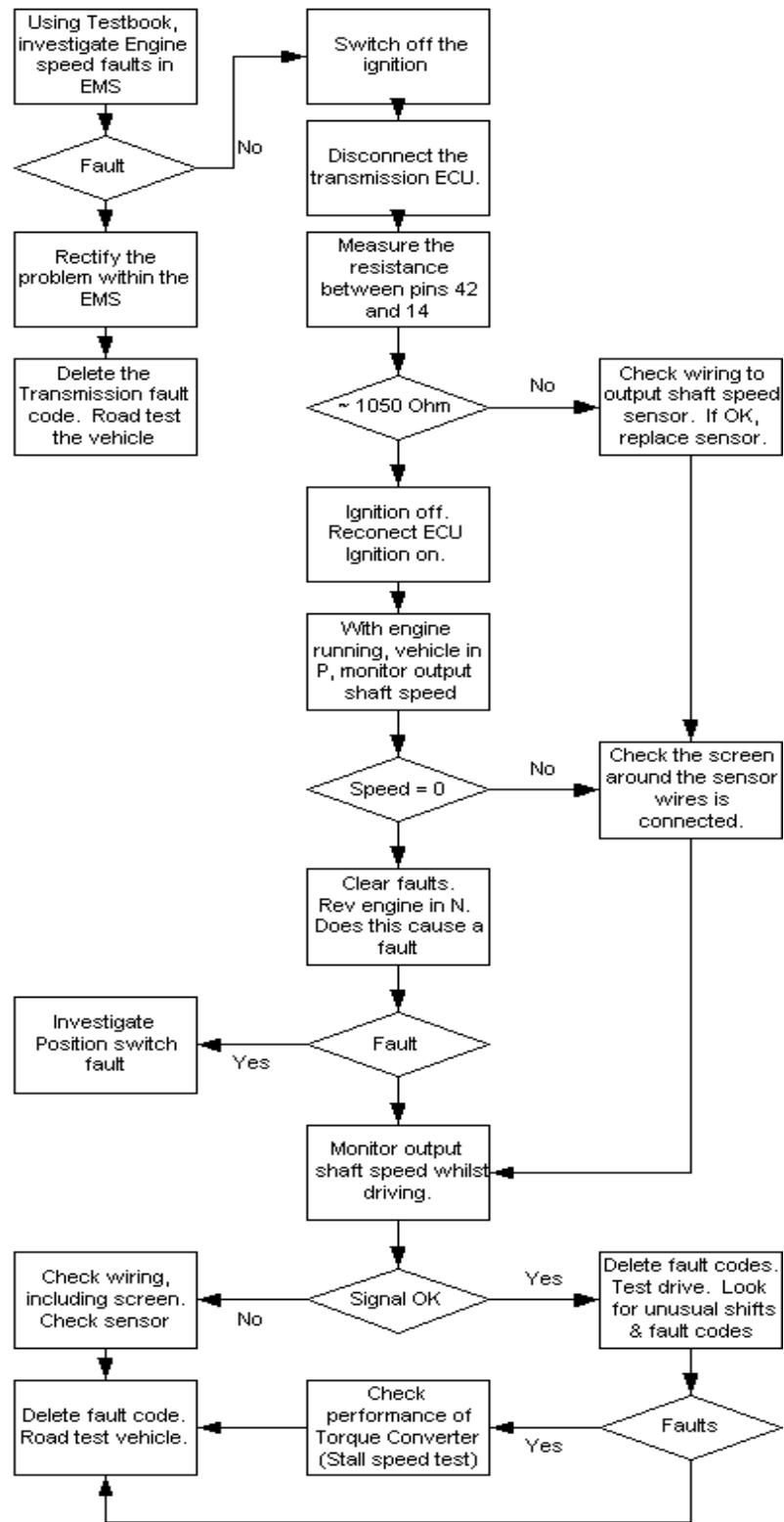
Work through the Stall speed monitoring flowchart. Depending on Ambient conditions, these fault codes may refer to the same failure.

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7.1.1.22 Fault code 22 – Stall speed monitoring

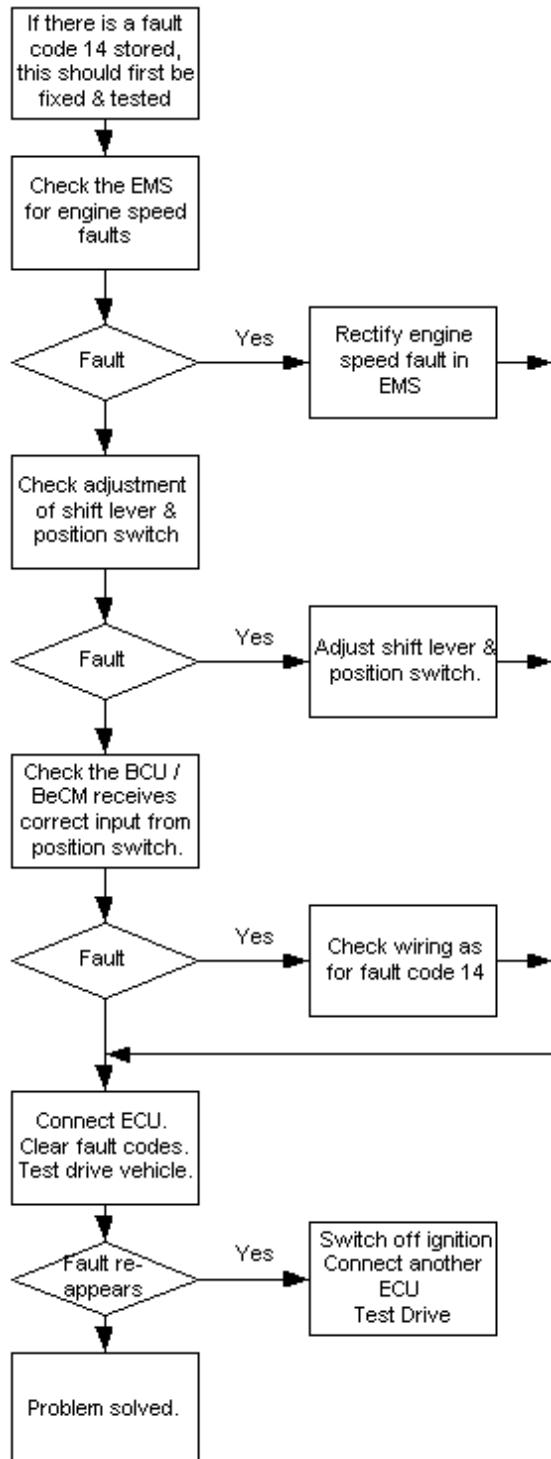


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7.1.1.23 Fault code 23 – Position switch during cranking (99MY Range Rover only)

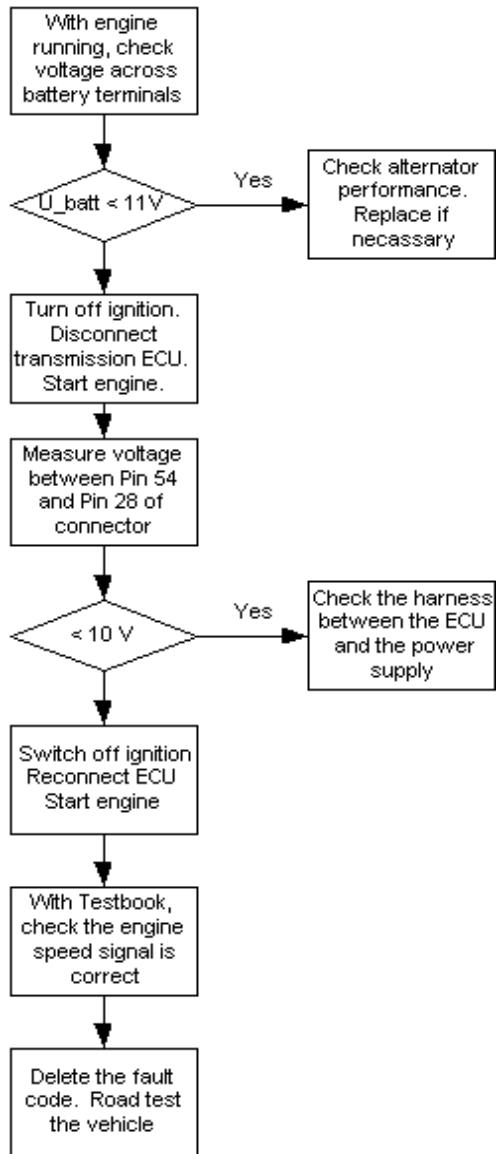


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7.1.1.24 Fault code 24 – Battery supply check



7.1.1.25 Fault code 25 – Solenoid valve lockup clutch S/C- or O/C

Carry out tests as for fault code 28 but substitute Pin 32 in place of pin 5

7.1.1.26 Fault code 26 – Solenoid valve 1, S/C- or O/C

Carry out tests as for fault code 28 but substitute Pin 30 in place of pin 5

7.1.1.27 Fault code 27 – Solenoid valve 2, S/C- or O/C

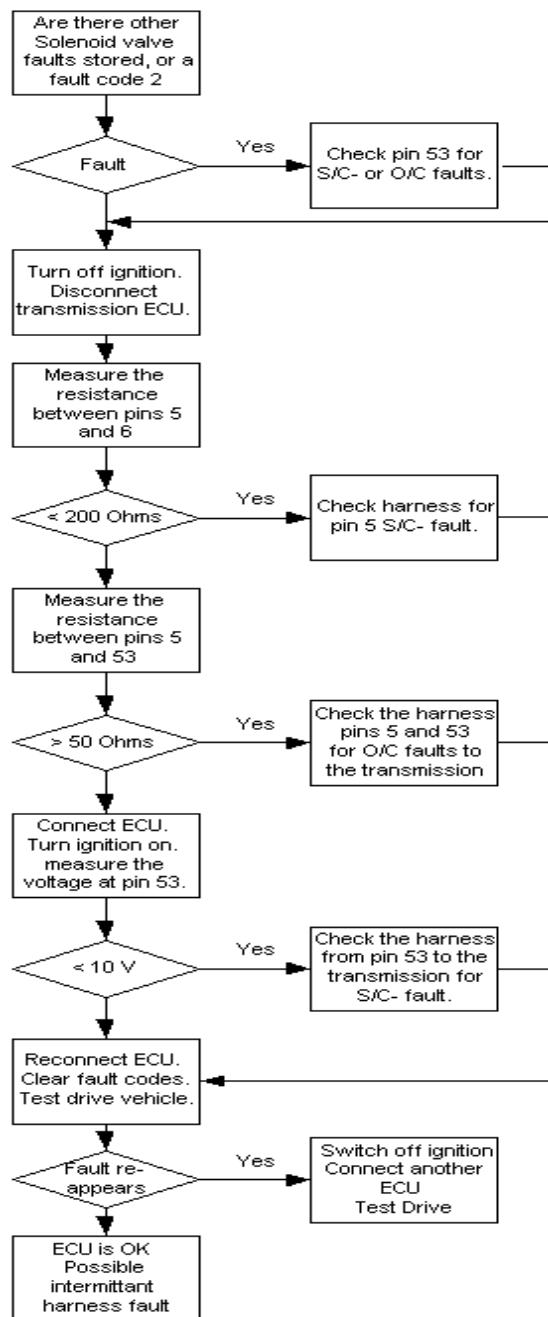
Carry out tests as for fault code 28 but substitute Pin 33 in place of pin 5

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7.1.1.28 Fault code 28 – Pressure regulator S/C- or O/C



7.1.1.29 Fault code 29 – Gear ratio 1st

See gear ratio 4th (fault code 32)

7.1.1.30 Fault code 30 – Gear ratio 2nd

See gear ratio 4th (fault code 32)

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7.1.1.31 Fault code 31 – Gear ratio 3rd

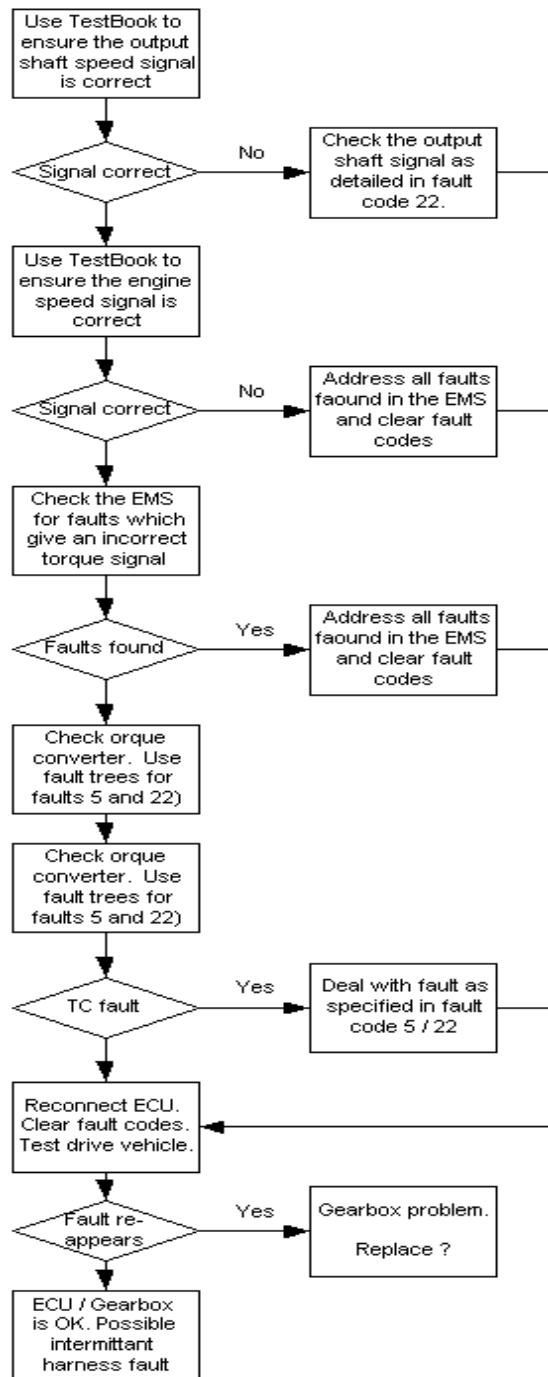
See gear ratio 4th (fault code 32)

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7.1.1.32 Fault code 32 – Gear ratio 4th



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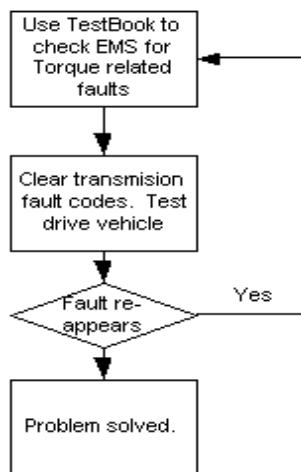
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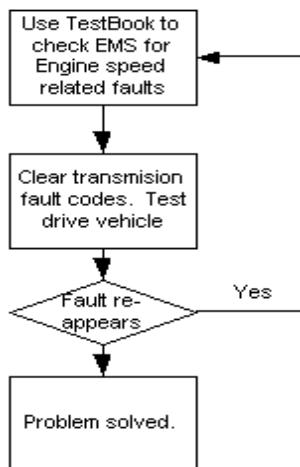
7.1.1.33 Fault code 33 – CAN message MD_IND invalid (indicated by F_TL_MES)

See fault code 34

7.1.1.34 Fault code 34 – CAN message MD_IND invalid (FFh)



7.1.1.35 Fault code 35 – CAN message N_MOT invalid (indicated by F_N_MOT)



7.1.1.36 Fault code 36 – Transmission calibration selection incorrect / invalid

Use Testbook to select the correct calibration from the transmission ECU (4.0l or 4.6l)

7.1.1.37 Fault code 37 – CAN message T_ANS invalid (FFh)

Check the EMS for faults which prevent it from transmitting the air inlet temperature.

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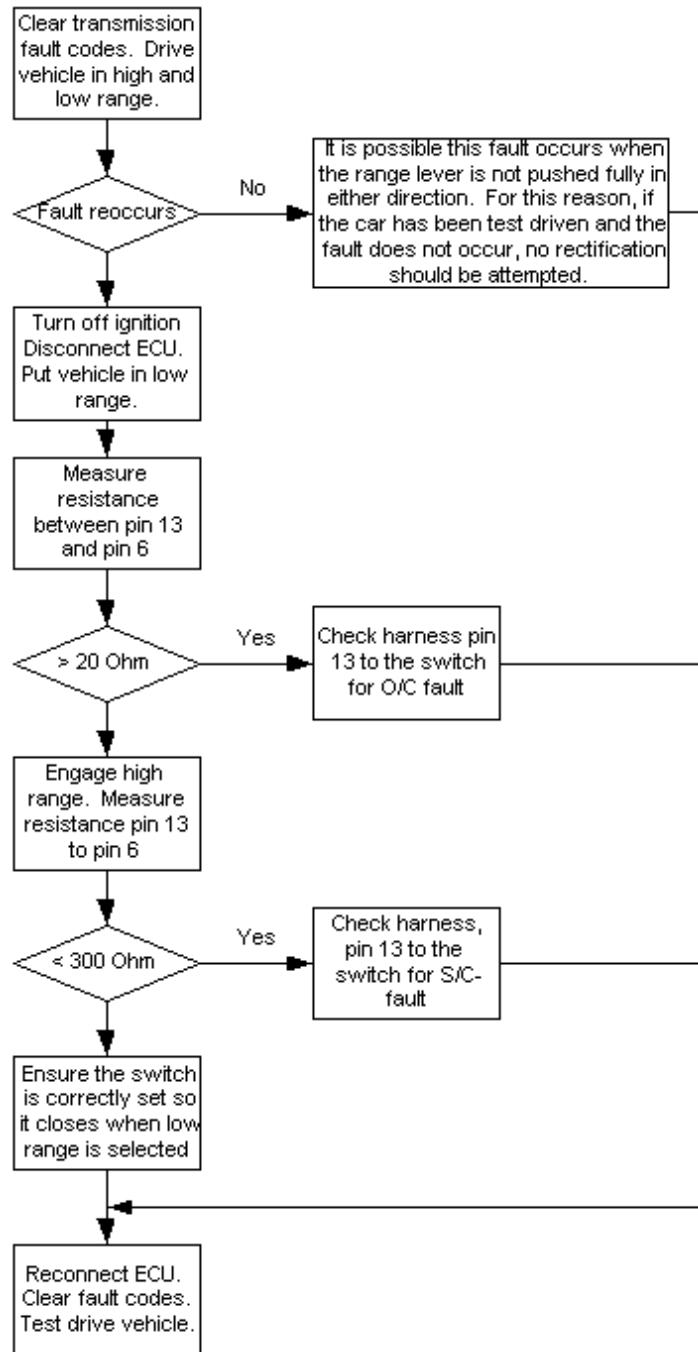
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7.1.1.38 Fault code 38 – CAN message FHOEHE invalid (FFh)

Check the EMS for faults which prevent it from transmitting the calculate altitude (air density).

7.1.1.39 Fault code 39 – Range switch plausibility



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SEALANTS, ADHESIVES AND LUBRICANTS

No sealants or adhesives are used for automatic transmission assembly.

Gaskets are installed dry.

Lip seals should be dipped in ATF before installation. Clutch linings should be soaked in ATF for at least one-half hour before assembly.

Use petroleum jelly to retain torrington bearings in place during assembly. Do not use ordinary grease.

Never use rags or wiping cloths during transmission assembly. Lint from the rags can block tiny passages in the valve body. Use compressed air or lint free synthetic wipes.

Most Land Rover service literature specifies Dexron IID as the correct ATF type. Since IID is no longer commonly available, use Dexron III/Mercon.

Synthetic ATF is not recommended for Land Rover automatic transmissions.