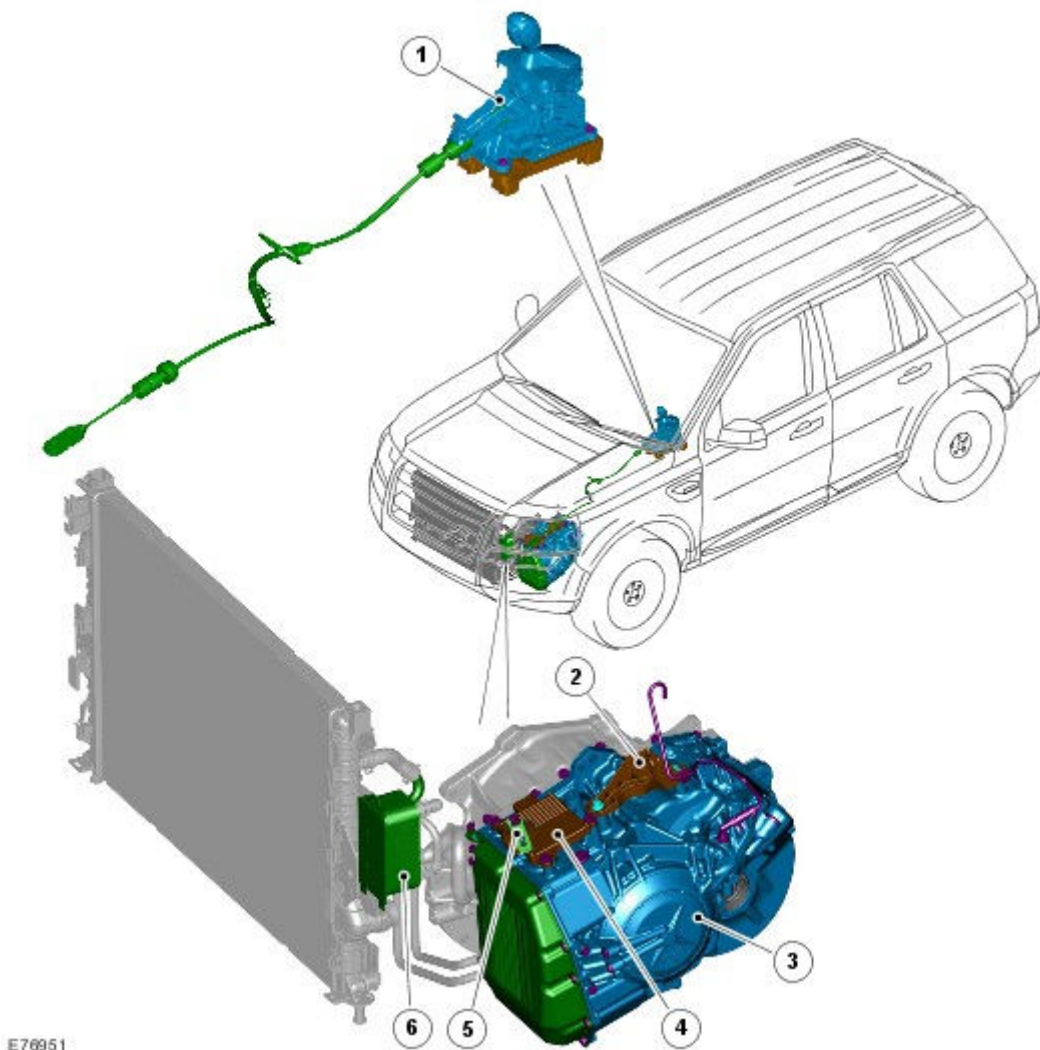


Transmission Description

COMPONENT LOCATION



E76951

Item	Part Number	Description
1		Transmission selector lever assembly
2		Cable bracket
3		Automatic transmission
4		Transmission Control Module (TCM)
5		Lever arm
6		Transmission fluid cooler

OVERVIEW

The AW F21 automatic transmission is a 6 speed, electronically controlled unit manufactured by Aisin AW in Japan. The transmission represents the latest in automatic transmission technology for a transverse, All Wheel Drive (AWD) unit. The transmission features lock-up slip control, 'CommandShift™' functions and automatic and driver selectable modes to give the optimum on and off road performance.

The transmission is controlled by a TCM which contains software to provide operation as a semi-automatic 'CommandShift™' transmission. The TCM allows the transmission to be operated as a conventional automatic unit by selecting P, R, N, D on the selector lever. Movement of the selector lever across the gate to the 'M/S' position puts the transmission into electronic 'Sport' mode. Further movement of the lever in a longitudinal direction to the + or –

position puts the transmission into electronic manual 'CommandShift™' mode. For additional information, refer to [External Controls](#) (307-05 Automatic Transmission/Transaxle External Controls)

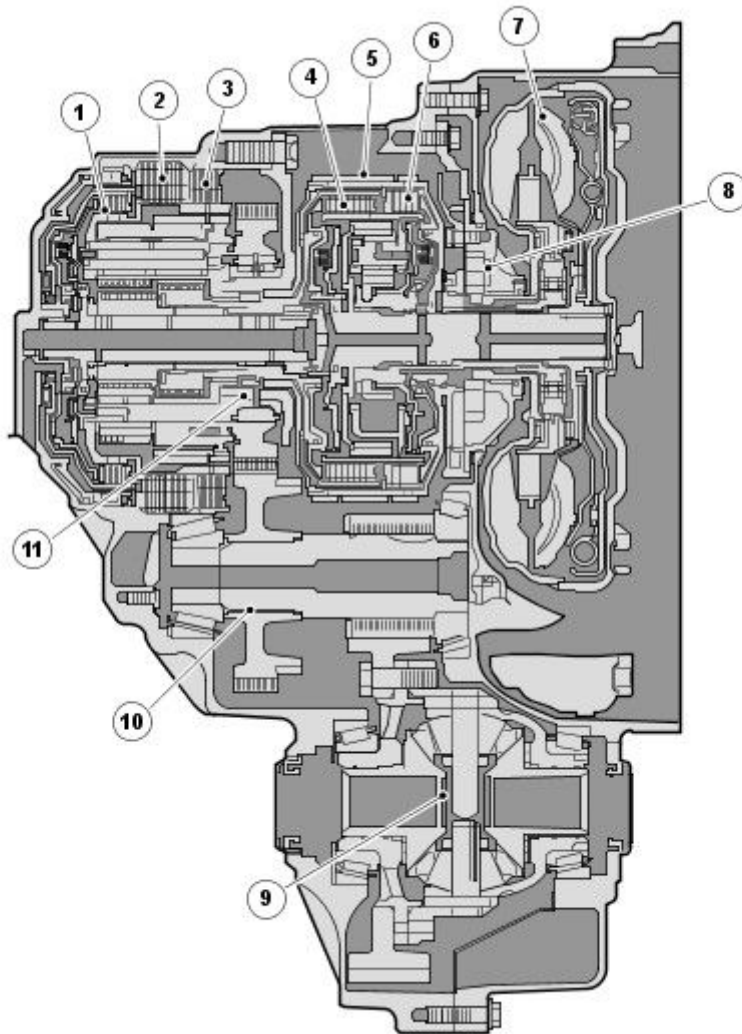
The AW F21 transmission has the following features:

- Designed to be maintenance free
- Torque capacity of 450 Nm
- Transmission fluid is fill for life
- The torque converter features a controlled slip feature with electronically regulated lock-up control on gears 2 to 6
- Shift programs controlled by the TCM
- TCM has an adaptive capability to ensure efficient gear shift quality throughout the service life of the transmission
- Diagnostics available from the TCM via the high speed Controller Area Network (CAN) bus.

TRANSMISSION

The transmission comprises the main casing which houses all of the transmission components. The torque converter is located in a separate converter housing.

AW F21 Automatic Transmission - Sectional View



E83814

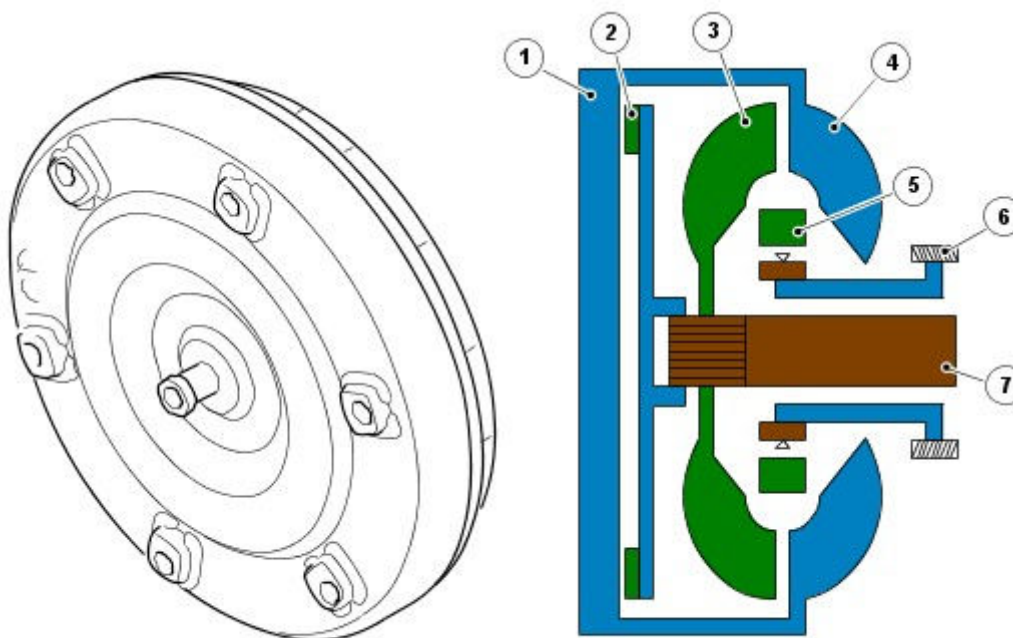
Item	Part Number	Description
1		Clutch - C2
2		Brake - B2
3		One-way clutch - F1

4		Clutch - C1
5		Brake - B1
6		Clutch - C3
7		Torque converter
8		Fluid pump
9		Differential assembly
10		Counter driven gear
11		Counter drive gear

The main casing retains the fluid at the bottom. A combined drain/filler plug is located in the bottom of the casing. The oil level is checked by removing the inner fill plug when the transmission fluid is at a temperature of between 50 to 60°C (122 to 140°F). When the oil flow becomes a drip from the plug hole, the level is correct.

The transmission has a fluid cooler which is located on the Left Hand (LH) end of the radiator. The cooler is connected to the transmission converter housing by 2 pipes. The fluid cooler is connected into the engine cooling system and cools the transmission fluid by heat transfer through the cooler to the engine coolant. For additional information, refer to [Transmission Cooling](#) (307-02 Transmission/Transaxle Cooling)

TORQUE CONVERTER



E83815

Item	Part Number	Description
1		Torque converter housing
2		Lock-up clutch
3		Turbine
4		Impeller
5		Stator
6		Fluid pump
7		Input shaft

The torque converter is the coupling element between the engine and the transmission and is located in the transmission housing, on the engine side of the transmission. The driven power from the engine crankshaft is transmitted hydraulically and mechanically through the torque converter to the transmission. The torque converter is connected to the engine by a drive plate.

The torque converter comprises an impeller, a stator and a turbine. The torque converter is a sealed unit with all

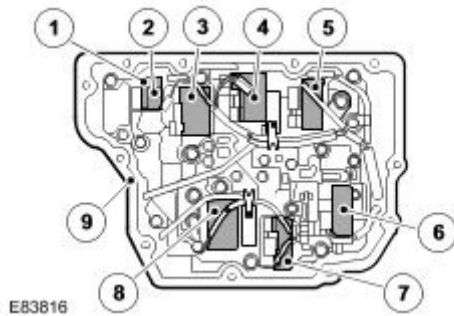
components located between the converter housing cover and the impeller. The two components are welded together to form a sealed, fluid filled housing. With the impeller welded to the converter housing cover, the impeller is therefore driven at engine crankshaft speed.

The torque converter contains a hydraulically operated lock-up clutch which is controlled by the TCM via a solenoid in the valve block which actuates spool valves to control the hydraulic pressure applied to the clutch. This allows the TCM to provide 3 modes of converter operation; unlocked, partially locked and fully locked.

VALVE BLOCK

The valve block is located in a vertical position at the front of the transmission main casing, behind a sealed cover. The valve block contains a number of solenoids, dampers and spool valves to control the transmission operation. The solenoids are controlled by the TCM to provide gear changes and smooth transition between ratio changes.

Solenoids



Item	Part Number	Description
1		3-Way solenoid - S1
2		3-Way solenoid - S2
3		Line pressure control solenoid - SLT
4		Shift control solenoid - SLC2
5		Shift control solenoid - SLC1
6		Lock-up control solenoid - SLU
7		Shift control solenoid - SLC3
8		Shift control solenoid - SLB1
9		Valve block

Shift Control Solenoids - SLC1, SLC2, SLC3, SLB1

The shift control solenoids (SLC1, SLC2, SLC3 and SLB1) are installed on the front valve body. The solenoids respond to inputs from the TCM and control the hydraulic pressure applied to the clutches (C1, C2 and C3) and to the brake B1 to provide smooth shifting. The TCM uses a single or a combination of these solenoids to provide shifts from 1st to 6th gear.

If a solenoid fails, the TCM will remove the current to the shift control solenoids and the transmission will use limp home mode, to prevent damage to the transmission.

Line Pressure Control Solenoid - SLT

The line pressure control solenoid (SLT) is installed on the front valve body. The solenoid is controlled in a linear manner by the TCM which uses throttle opening degree signals and engine torque information from the Engine Control Module (ECM) to determine the solenoid operation. The solenoid controls the line pressure applied to the clutches and brakes to provide smooth shifting.

If the solenoid fails, the TCM will remove the current supplied to the solenoid. Maximum line pressure will be applied to the clutches and brakes unless the failure is due to the solenoid valve sticking, which may result in low line pressure.

Lock-Up Control Solenoid - SLU

The lock-up control solenoid is installed on the front valve body. The solenoid is controlled in a linear manner by the TCM which uses engine speed, throttle opening degree signals and transmission speed sensor signals to determine the solenoid operation. The solenoid controls the amount of lock-up or slip required for the torque converter lock-up clutch.

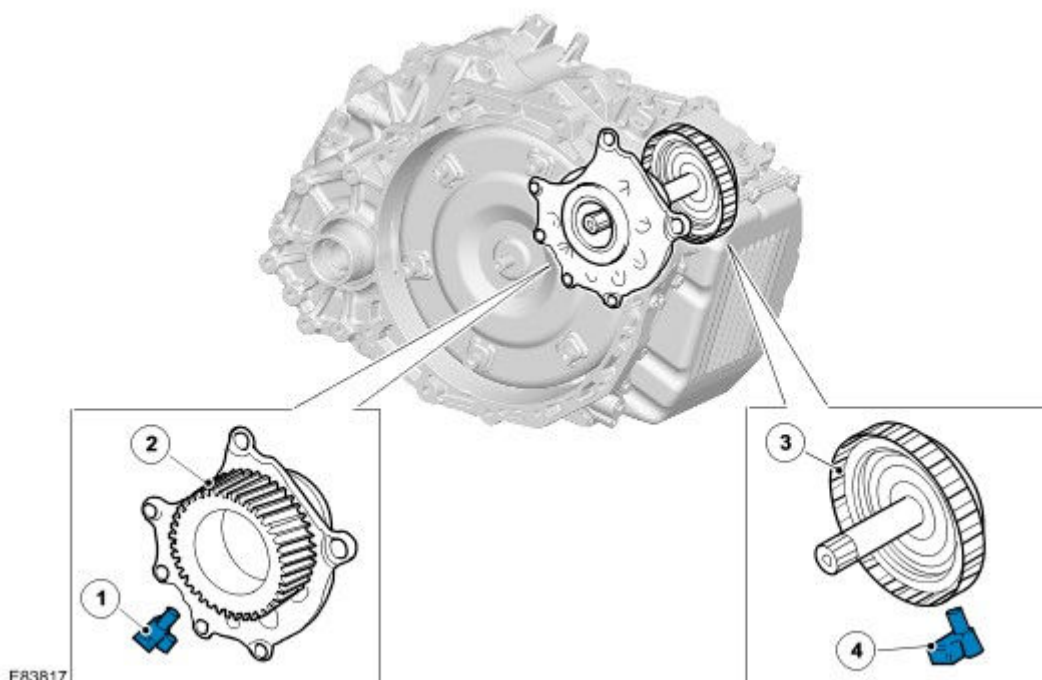
If the solenoid fails, the TCM removes the current supplied to the solenoid which results in no torque converter lock-up being applied.

3-Way Solenoid - S1, S2

The 3-way solenoid (S1) is located on the center valve body and solenoid (S2) is located on the front valve body. The solenoids are on/off solenoids controlled by the TCM. A combination of the 2 solenoids is used to operate either the 1st gear engine braking or enable gear shifts.

If a solenoid fails, the TCM will remove the current supplied to both solenoids.

Speed Sensors



Item	Part Number	Description
1		Speed Sensor (SP) - Output shaft speed
2		Counter drive gear
3		C2 clutch drum
4		Speed sensor (NIN)

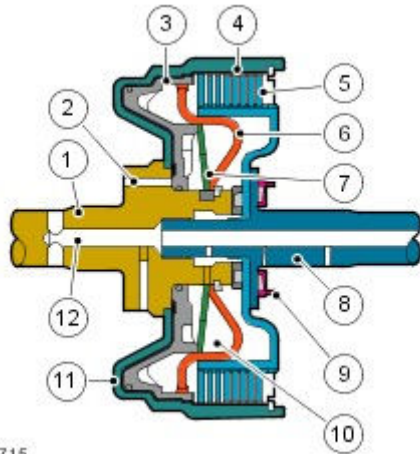
Two speed sensors (NIN and SP) are used in the transmission and are located within the transmission housing. Speed sensor (SP) is located adjacent to the counter drive gear and reads from the gear teeth to provide an output shaft speed signal. Speed sensor (NIN) is located adjacent to the clutch C" drum and reads off teeth on the outer circumference of the drum to provide an input shaft speed. Both speed signals are received by the TCM which uses the 2 signals to calculate engine torque output, shift timing and torque converter lock-up.

Fluid Temperature Sensor

The fluid temperature sensor is integrated into the internal wiring harness within the transmission. It detects the fluid temperature in the hydraulic pressure control circuit and transmits a signal corresponding to the temperature to the TCM. The TCM monitors the temperature and provides smooth gear shifts across a wide range of temperatures.

DRIVE CLUTCHES

Multiplate Drive or Brake Clutch – Typical



E42715

Item	Part Number	Description
1	-	Input shaft
2	-	Main pressure supply port
3	-	Piston
4	-	Cylinder – External plate carrier
5	-	Clutch plate assembly
6	-	Baffle plate
7	-	Diaphragm spring
8	-	Output shaft
9	-	Bearing
10	-	Dynamic pressure equalisation chamber
11	-	Piston chamber
12	-	Lubrication channel

There are three drive clutches and two brake clutches (B2 is a multiplate brake clutch & B1 is a double wrap brake band) used in the AW F21 transmission. Each clutch comprises one or more friction plates dependent on the output controlled. A typical clutch consists of a number of steel outer plates and inner plates with friction material bonded to each face.

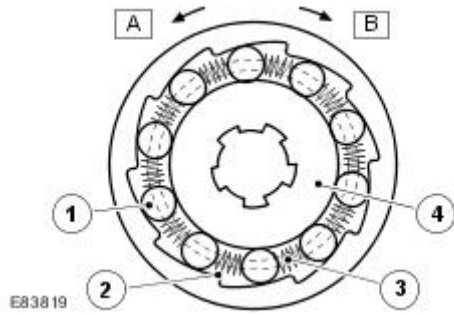
Clutch / Brake	Operation
C1 Clutch	Connects the front planetary carrier to the rear planetary rear sun gear
C2 Clutch	Connects the intermediate shaft to the rear planetary carrier
C3 Clutch	Connects the front planetary carrier to the rear planetary middle sun gear
B1 Brake	Locks the rear planetary middle sun gear
B2 Brake	Locks the rear planetary carrier

The clutch plates are held apart mechanically by a diaphragm spring and hydraulically by dynamic pressure. The pressure is derived from a lubrication channel which supplies fluid to the bearings etc. The fluid is passed via a drilling in the output shaft into the chamber between the baffle plate and the piston. To prevent inadvertent clutch application due to pressure build up produced by centrifugal force, the fluid in the dynamic pressure equalization chamber overcomes any pressure in the piston chamber and holds the piston off the clutch plate assembly.

When clutch application is required, main pressure from the fluid pump is applied to the piston chamber from the supply port. This main pressure overcomes the low pressure fluid present in the dynamic pressure equalization chamber. The piston moves, against the pressure applied by the diaphragm spring, and compresses the clutch plate assembly. When the main pressure falls, the diaphragm spring pushes the piston away from the clutch plate assembly, disengaging the clutch.

One-Way Clutch

One-Way clutch - Typical

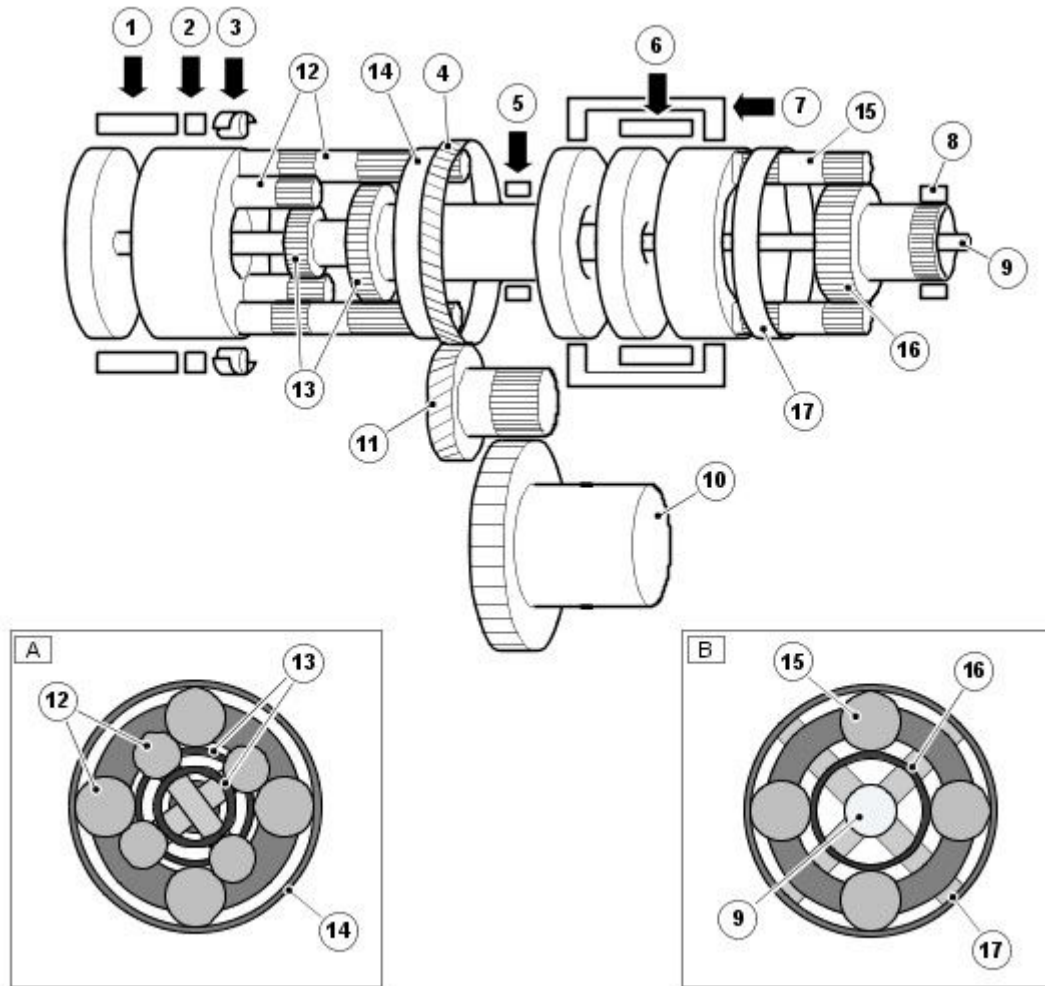


Item	Part Number	Description
1		Roller
2		Cage
3		Spring
4		Inner race

The roller clutch used on the one-way clutch uses parallel rollers, located between the smooth, cylindrical inner race and the inclined cam faces of the clutch body. Springs are used to hold the rollers in position between the two contact faces.

When the clutch is rotated in a clockwise direction, the rollers become trapped between the inner race and the inclined cam faces of the clutch body, providing positive (locked) rotation of the inner race, locking the counter-clockwise rotation of the rear planetary carrier. When the clutch is rotated in a counter-clockwise direction, the rollers are moved away from the inclined cam faces and can rotate freely (unlocked) with the clutch body, providing no drive from the clutch to the rear planetary carrier. In this condition the clutch can rotate freely on the inner race.

PLANETARY GEAR TRAIN



E83818

Item	Part Number	Description
A		Double web planetary gear train - Rear
B		Single web planetary gear train - Front
1		Clutch C2
2		Brake B2
3		Free wheel clutch F2
4		Counter drive gear
5		Brake B1
6		Clutch C1
7		Clutch C3
8		Fluid pump
9		Input shaft
10		Differential gear assembly
11		Counter gear assembly
12		Pinion gears
13		Sun gears
14		Ring gear
15		Pinion gear
16		Sun gears
17		Ring gear

The planetary gear trains used on the AW F21 transmission comprise a single web planetary gear train and a double

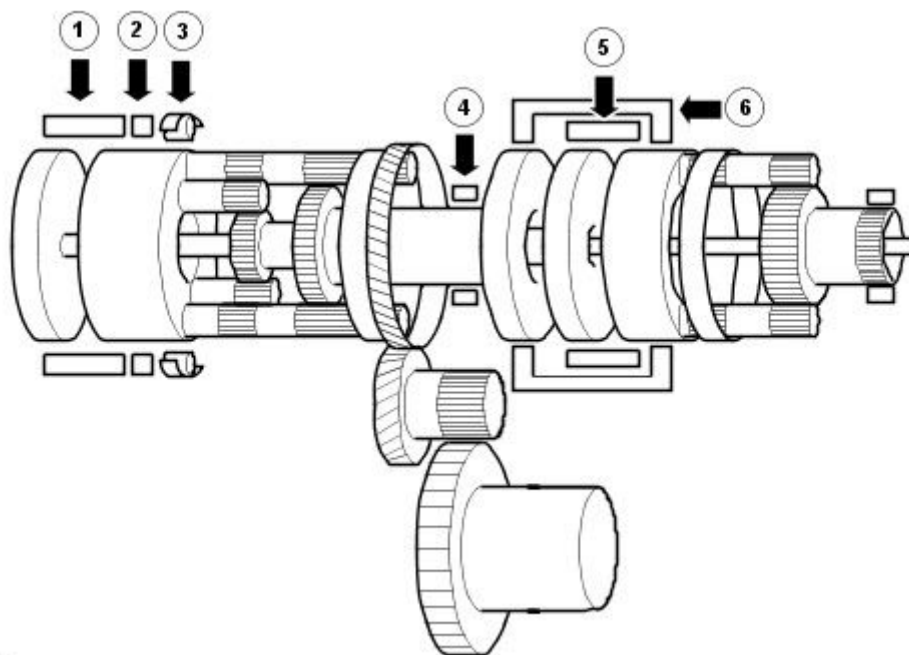
web planetary gear train. These gear trains are known as Ravignaux type gear trains and together produce the six forward gears and the one reverse gear.

Engine torque is transferred, via operation of single or combinations of clutches to the two planetary gear trains. Both gear trains are controlled by reactionary inputs from brake clutches to produce the six forward gears and one reverse gear. The ratios are as follows:

Gear	1st	2nd	3rd	4th	5th	6th	Reverse
Ratio	4.148	2.370	1.556	1.155	0.859	0.686	3.394

POWER FLOWS

Operation of the transmission is controlled by the TCM which electrically activates various solenoids to control the transmission gear selection. The sequence of solenoid activation is based on programmed information in the TCM memory and physical transmission operating conditions such as vehicle speed, throttle position, engine load and selector lever position.



E83820

Item	Part Number	Description
1		Clutch - C2
2		Brake - B2
3		One-way clutch - F1
4		Brake - B1
5		Clutch - C1
6		Clutch - C3

Power Flow - 1st Gear Engine Braking

Solenoid Operation

Transmission Selector Lever Position	Solenoid					
	SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D Engine Brake	-	X	X	X	X	X

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	Engine Brake	X	-	-	-	X	X

X = Operating

When the engine brake is active, driving force is transmitted to the transmission from the road wheels, via the power transfer unit. The rear planetary carrier is locked from clockwise rotation by the one-way clutch (F1) and brake (B2). This results in torque from the wheels being transmitted directly to the engine, providing engine braking.

Power Flow - 1st Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D	1st Gear	-	X	X	X	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	1st Gear	X	-	-	-	-	X

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Rear sun gear Locked: Carrier Output: Ring gear
 - Input: Rear sun gear
 - Locked: Carrier
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates in a clockwise direction along with the planetary pinion gear which also rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis.

The front planetary carrier rotates clockwise in the same direction as the planetary pinion gear. The clutch (C1) is activated and locks the planetary carrier to the rear planetary sun gear.

Rear Planetary Gear Train

The planetary sun gear rotates in a clockwise direction. The planetary short pinion gear rotates in a counter-clockwise direction. The planetary carrier attempts to rotate in the same direction but is restrained by the one-way clutch (F1).

The long pinion gear rotates clockwise on its axis and the middle sun gear rotates counter-clockwise while idling. The ring gear is rotated by the long pinion gear and drives the counter drive gear in a clockwise direction.

The counter driven gear is driven in a counter-clockwise direction which in turn drives the differential ring gear in a

clockwise direction.

Power Flow - 2nd Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D	2nd Gear	-	X	X	-	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	2nd Gear	X	-	-	X	-	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Rear sun gear Locked: Middle sun gear Output: Ring gear
 - Input: Rear sun gear
 - Locked: Middle sun gear
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates in a clockwise direction along with the planetary pinion gear which also rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis.

The front planetary carrier rotates clockwise in the same direction as the planetary pinion gear. The clutch (C1) is activated and locks the planetary carrier to the rear planetary sun gear.

Rear Planetary Gear Train

The planetary sun gear and the carrier rotate in a clockwise direction. The middle sun gear is locked by the brake (B1). The short pinion gears rotate counter-clockwise on its axis and orbits in a clockwise direction. The long pinion gears rotates clockwise on its axis and its orbit.

The ring gear is rotated in a clockwise direction by the long pinion gear. The ring gear and the counter drive gear both rotate in a clockwise direction.

The counter driven gear is driven in a counter-clockwise direction which in turn drives the differential ring gear in a clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow - 3rd Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D	3rd Gear	-	X	-	X	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	3rd Gear	X	-	-	X	-	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Middle sun gear Locked: - Output: Ring gear
 - Input: Middle sun gear
 - Locked: -
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates in a clockwise direction along with the planetary pinion gear which also rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis.

The front planetary carrier rotates clockwise in the same direction as the planetary pinion gear. The clutch (C1) is activated and locks the planetary carrier to the rear planetary sun gear. Clutch (C3) is also activated and locks the carrier to the middle sun gear.

Rear Planetary Gear Train

The planetary short pinion gear and the long pinion gear are engaged which causes both pinion gears to lock due to the different rotational directions. Torque from the sun gear and middle sun gear is transmitted to the planetary ring gear which rotates clockwise in the same direction as the planetary carrier.

The counter drive gear rotates in a clockwise direction with the ring gear.

The counter driven gear is rotated in a counter-clockwise direction which in turn drives the differential ring gear in a clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow - 4th Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2

D	4th Gear	-	-	X	X	-	-
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X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	4th Gear	X	X	-	-	-	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Rear sun gear, Carrier Locked: - Output: Ring gear
 - Input: Rear sun gear, Carrier
 - Locked: -
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates in a clockwise direction along with the planetary pinion gear which also rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis.

The front planetary carrier rotates clockwise in the same direction as the planetary pinion gear. The clutch (C1) is activated and locks the planetary carrier to the rear planetary sun gear. The intermediate shaft rotates in the same direction as the input shaft. Clutch (C2) is also activated rotates in the same direction as the intermediate shaft.

Rear Planetary Gear Train

The planetary carrier rotates in a clockwise direction with the intermediate shaft. The short pinion gear rotates clockwise on its axis and orbits at a faster speed than the sun gear. The long pinion gear rotates counter-clockwise on its axis and orbit. The rotation of the ring gear is in a clockwise direction and is slower than the rotation of the carrier due to the long pinion gear's rotation is counteracted by the planetary carrier.

The counter drive gear rotates in a clockwise direction with the ring gear.

The counter driven gear is rotated in a counter-clockwise direction which in turn drives the differential ring gear in a clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow - 5th Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D	5th Gear	X	-	-	X	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	5th Gear	-	X	X	-	-	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Middle sun gear Locked: - Output: Ring gear
 - Input: Middle sun gear
 - Locked: -
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates in a clockwise direction along with the planetary pinion gear which also rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis.

The front planetary carrier rotates clockwise in the same direction as the planetary pinion gear. The clutch (C3) is activated and locks the planetary carrier to the rear planetary middle sun gear. The intermediate shaft rotates in the same direction as the input shaft. Clutch (C2) is also activated and rotates in the same direction as the intermediate shaft.

Rear Planetary Gear Train

The middle sun gear rotates clockwise in the same direction as clutch (C3). The deceleration of the front planetary gear slows the speed of the input shaft. The intermediate shaft rotates clockwise in the same direction as the input shaft. The planetary carrier also rotates clockwise in the same direction as the intermediate shaft.

The long pinion gear rotates clockwise on its axis and orbit. The carrier rotates faster than the middle sun gear which causes the middle pinion gear to be cancelled out by the speed difference. The middle pinion gear orbits and rotates on its axis in a clockwise direction.

The planetary ring gear rotates in a clockwise direction. The speed of the ring gear is faster than the planetary carrier because the long pinion gear's rotation is combined with the planetary carrier's speed. The counter drive gear rotates in a clockwise direction with the ring gear.

The counter driven gear is rotated in a counter-clockwise direction which in turn drives the differential ring gear in a clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow - 6th Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
D	6th Gear	X	-	X	-	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
D	6th Gear	-	X	-	X	-	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: - Locked: - Output: -
 - Input: -
 - Locked: -
 - Output: -

- Rear planetary gear train Input: Carrier Locked: Middle sun gear Output: Ring gear
 - Input: Carrier
 - Locked: Middle sun gear
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The intermediate shaft rotates clockwise in the same direction as the torque converter. Clutch (C2) locks the intermediate shaft to the rear planetary carrier.

Rear Planetary Gear Train

The planetary carrier rotates clockwise in the same direction as the intermediate shaft. The planetary long pinion gear rotates clockwise on its axis and orbit. The rotational speed of the middle sun gear increases with input shaft speed because it is locked.

The planetary ring gear rotates in a clockwise direction. The speed of the ring gear is faster than the planetary carrier because the long pinion gear's rotation is combined with the planetary carrier's speed. The counter drive gear rotates in a clockwise direction with the ring gear.

The counter driven gear is rotated in a counter-clockwise direction which in turn drives the differential ring gear in a clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow - Reverse Gear

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
R	Reverse Gear - Less than 11 volts	X	X	-	X	-	-
R	Reverse Gear - More than 11 volts	X	X	X	X	-	-

X = Operating

Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1

R	Reverse Gear - Less than 11 volts	-	X	-	X	-	-
R	Reverse Gear - More than 11 volts	-	-	-	-	X	-

X = Operating

The planetary gear trains are in the following conditions:

- Front planetary gear train Input: Ring gear Locked: Sun gear Output: Carrier
 - Input: Ring gear
 - Locked: Sun gear
 - Output: Carrier

- Rear planetary gear train Input: Middle sun gear Locked: Carrier Output: Ring gear
 - Input: Middle sun gear
 - Locked: Carrier
 - Output: Ring gear

Front Planetary Gear Train

The input shaft rotates in a clockwise direction, driven by the torque converter. The planetary ring gear rotates clockwise with the input shaft.

The pinion gear rotates clockwise on its axis and orbit. The planetary sun gear is locked by the fluid pump which causes it to press against the planetary ring gear and orbit the sun gear, rotating on its axis. The planetary carrier rotates clockwise with the pinion gear orbit.

Clutch (C3) is activated and rotates clockwise and locks the planetary carrier to the rear planetary middle sun gear.

Rear Planetary Gear Train

The middle sun gear rotates clockwise with the clutch (C3), but at a lower speed than the input shaft. Brake (B2) is activated and locks the planetary carrier. The long pinion gear rotates counter-clockwise which in turn rotates the ring gear counter-clockwise.

The counter drive gear rotates in a counter-clockwise direction with the ring gear at the same speed.

The counter driven gear is rotated in a clockwise direction which in turn drives the differential ring gear in a counter-clockwise direction.

NOTE:

Engine braking is available when this gear is selected.

Power Flow Neutral

Solenoid Operation

Transmission Selector Lever Position		Solenoid					
		SLC 1	SLC 2	SLC 3	SLB 1	S1	S2
N	Neutral	X	X	X	X	-	-

X = Operating

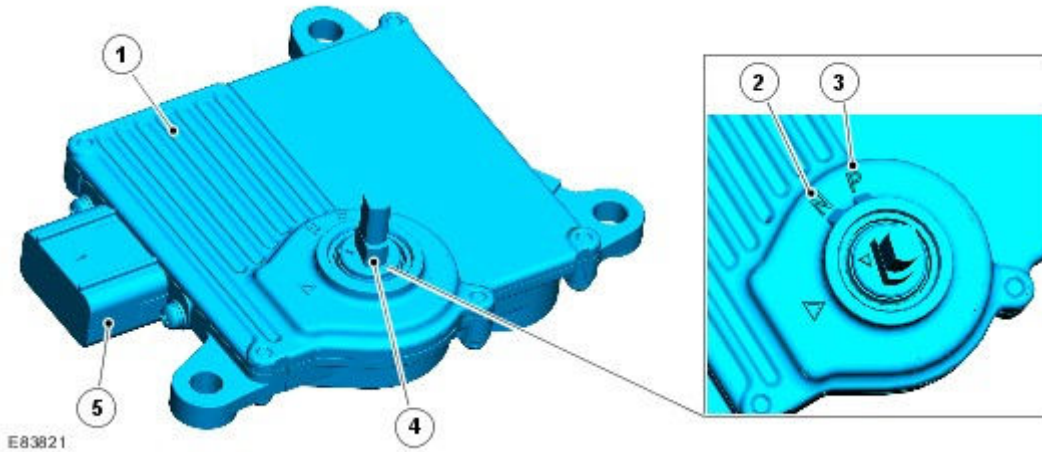
Clutch and Brake Operation

Transmission Selector Lever Position		Clutch			Brake		One-Way clutch
		C1	C2	C3	B1	B2	F1
R	Reverse Gear	-	-	-	-	-	-

X = Operating

In neutral, all the solenoids, except the 3 way solenoids, are energised and the clutches and brakes are all disengaged. This allows rotation from the input shaft to rotate the front planetary gear train without transferring any drive to the differential ring gear.

TRANSMISSION CONTROL MODULE (TCM)



E83821

Item	Part Number	Description
1		TCM
2		'Neutral 'N' position
3		Park 'P' position
4		Position sensor/manual shaft
5		Electrical connector

The TCM is located on the top of the transmission casing and is connected on the high speed CAN bus to send and receive information to and from other system modules.

The TCM outputs signals to operate the transmission solenoid valves to control the hydraulic operation of the transmission.

The ECM supplies the engine management data on the high speed CAN bus system. The TCM requires engine data to efficiently control the transmission operation, using for example; crankshaft torque, engine speed, accelerator pedal angle, engine temperature etc.

The TCM processes signals from the transmission speed and temperature sensors, ECM and other vehicle systems. From the received signal inputs and pre-programmed data, the module calculates the correct gear, torque converter clutch setting and optimum pressure settings for gear shift and lock-up clutch control.

The steering angle sensor and the ABS module also supply data to the TCM on the high speed CAN bus system. The TCM uses data from these systems to suspend gear changes when the vehicle is cornering and/or the Anti-lock Brake System (ABS) module is controlling braking or traction control.

The TCM is positioned over the manual shaft which protrudes through an oil seal on the top face of the main casing. The shaft locates in a rotary position sensor and turns the sensor in the appropriate direction when a selection is made using the selector lever. The rotary position sensor is a Hall effect sensor which outputs a specified voltage relating to the selected selector lever position.

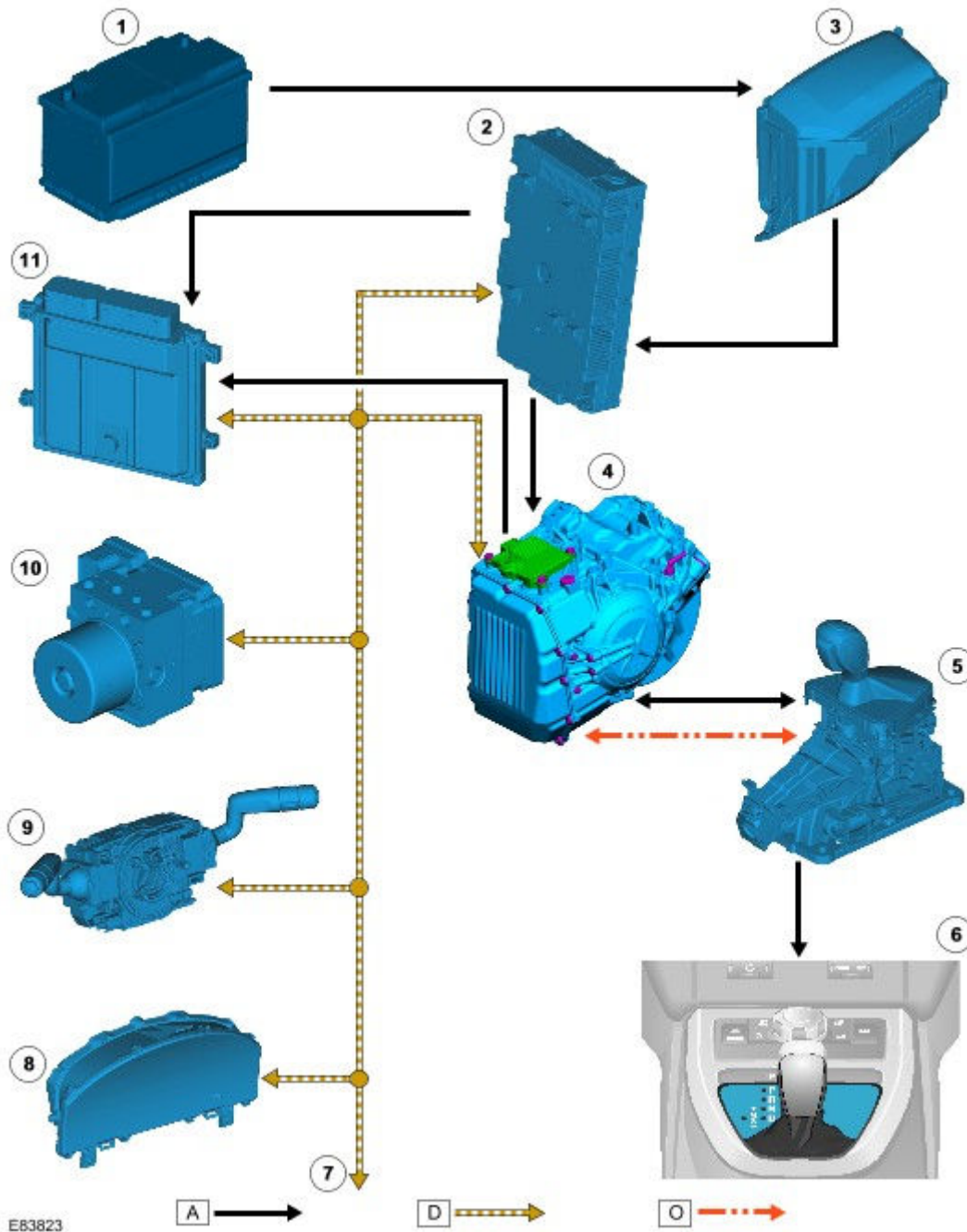
The selector lever is connected to the automatic transmission and the rotary position sensor in the transmission by a Bowden cable. Movement of the selector lever moves the position switch via the Bowden cable and the switch position informs the TCM of the selected position; P, R, N or D. The sport and manual +/- 'CommandShift™' switch passes sport or manual selections to the TCM on a Local Interconnect Network (LIN) bus. The TCM outputs appropriate information on the high speed CAN bus which is received by the instrument cluster to display the gear selection information in the message center.

If the TCM or transmission requires replacement, a setting procedure must be performed using a Land Rover approved diagnostic system to allow the TCM to learn the neutral position of the transmission. The TCM uses the neutral position as a reference point for each of the gear positions P, R, N and D.

CONTROL DIAGRAM

NOTE:

A = Hardwired; D = High speed CAN bus; O = LIN bus



E63823

Item	Part Number	Description
1		Battery
2		Battery Junction Box (BJB)
3		Central Junction Box (CJB)
4		TCM
5		Selector lever
6		Selector lever PRND and M/S Light Emitting Diode (LED) displays
7		High speed CAN bus to other vehicle systems
8		Instrument cluster
9		Steering angle sensor

10		ABS module
11		ECM

INSTRUMENT CLUSTER



E83822

Item	Part Number	Description
1		Malfunction Indicator Lamp (MIL)
2		P R N D display
3		Sport mode display
4		'CommandShift™' transmission status display
5		Message center

The instrument cluster is connected to the TCM via the CAN. Transmission status is transmitted by the TCM and displayed to the driver on one of two displays in the instrument cluster. For additional information, refer to [Instrument Cluster](#) (413-01 Instrument Cluster)

Malfunction Indicator Lamp (MIL)

The MIL is located in the upper left hand corner of the instrument cluster, within the tachometer. Transmission related faults which may affect the vehicle emissions output will illuminate the MIL.

The MIL is illuminated by the ECM on receipt of a relevant fault message from the TCM on the CAN. The nature of the fault can be diagnosed using a Land Rover approved diagnostic system which reads fault codes stored in the TCM memory.

Transmission Status Display

The transmission status display is located on the right hand side of the instrument cluster, in the speedometer LCD display. The display shows the selector lever P R N D position and in the case of manual ('CommandShift™') mode, the selected gear. When the selector lever is moved to the 'Sport' position, 'SPORT' is displayed below the CommandShift™ gear display.

Symbol	Description
P	Park selected
R	Reverse selected

N	Neutral selected
D	Drive selected
1	1st gear selected ('CommandShift™' mode)
2	2nd gear selected ('CommandShift™' mode)
3	3rd gear selected ('CommandShift™' mode)
4	4th gear selected ('CommandShift™' mode)
5	5th gear selected ('CommandShift™' mode)
6	6th gear selected ('CommandShift™' mode)
SPORT	Sport mode selected

Message Center Display

The message center is located below the speedometer and the tachometer at the bottom of the instrument cluster. The message center is a Liquid Crystal Display (LCD) to relay vehicle status information to the driver. For additional information, refer to [Information and Message Center](#) (413-08 Information and Message Center)

CONTROLLER AREA NETWORK (CAN)

The high speed CAN broadcast bus network is used to connect the powertrain modules. The CAN bus is connected between the following electronic units:

High Speed CAN Bus

- TCM
- Instrument cluster
- Steering angle sensor
- Restraints control module
- Engine Control Module (ECM)
- ABS module
- Adaptive Front lighting System (AFS) control module
- Diagnostic socket.

The CAN bus allows a fast exchange of data between modules. The CAN bus comprises two wires which are identified as CAN high (H) and CAN low (L). The two wires are colored yellow/black (H) and yellow/brown (L) and are twisted together to minimise electromagnetic interference (noise) produced by the CAN bus messages. For additional information, refer to [Communications Network](#) (418-00 Module Communications Network)

In the event of CAN bus failure, the following symptoms may be observed:

- Transmission operates in default mode
- Torque converter lock-up clutch control is disabled
- Gear position indication in instrument cluster LCD inoperative (this will also occur with any transmission fault).

DRIVING MODES

A number of different driving modes are available. Some can be selected by the driver and some are automatically initiated by the TCM to adapt to different driving conditions.

- Normal
- Sport
- Manual 'CommandShift™'
- Cooling
- Hill Descent Control (HDC)
- Cruise
- Limp home
- Coast
- Fast off recognition
- Uphill and Trailer
- Downhill
- Wide Throttle
- Terrain Response

- Reverse lock-out

Normal

Normal mode is automatically selected by the TCM when the ignition is switched on. In this mode all automatic and adaptive modes are active. Normal mode uses gear shift and lock-up maps which provide the optimum of fuel consumption, emissions and driveability, depending on the driving style.

If the transmission is operated in sport mode or 'CommandShift™' mode and the selector lever is moved back to the drive 'D' position, then normal mode operation is resumed.

Sport

Sport mode provides enhanced acceleration and responsiveness by the use of sports shift maps. This mode allows the transmission to down shift more readily and hold gears for longer at higher engine speeds.

Manual 'CommandShift™'

Manual 'CommandShift' mode allows the transmission to operate as a semi-automatic transmission. The driver can change up and down the six forward gears with the freedom of a manual transmission.

Shift maps are provided to protect the engine at high speeds. The TCM will automatically change up to a higher gear ratio to prevent engine overspeed and change down to a lower gear ratio to avoid engine laboring and stalling.

When kick-down is requested the TCM shifts down to the lowest available gear. When the vehicle is stationary, the driver can select 1st, 2nd or 3rd to start off.

When moving from a standstill, upshifts can be pre-selected by making '+' selections with the selector lever for the number of upshifts required. The TCM then performs the requested number of upshifts when appropriate shift points are reached. For example; when moving off in 1st gear, if 3 '+' selections are made in quick succession, the TCM will automatically upshift through the gears to 4th gear as the vehicle accelerates, without any further selections being made.

Cooling

Cooling mode is activated when the TCM detects excessively high transmission fluid or engine coolant temperatures. When this mode is active torque converter lock-up is activated earlier to minimize a further rise in fluid and/or engine coolant temperature and assist fluid cooling.

Hill Descent Control (HDC)

The HDC mode assists the ABS module in controlling the downhill speed of the vehicle. When HDC is active, the TCM selects the most appropriate gear for the descent to maximize engine braking.

Maximum engine braking is applied using a shift map which initiates later upshifts and early downshifts.

Cruise

When speed control is activated, the TCM receives a speed control active message on the high speed CAN bus. The TCM activates a speed control map which minimizes up and down shifts.

Cruise mode is active when speed control is selected on and the transmission is in drive 'D', sport 'S', HDC or Terrain Response Grass/gravel/snow program. Unique cruise maps override the current mode to provide a smooth driving feel and mode reselection.

Limp Home

If a transmission fault is detected by the TCM, the TCM adopts a limp home strategy and a message 'TRANSMISSION FAULT LIMITED GEARS AVAILABLE' is displayed in the message center. If the fault has an effect on engine emissions, the MIL in the instrument cluster will also be illuminated.

In limp home mode, P, R and N functions operate normally (if the fault allows these selections) and the TCM locks the transmission in 3rd gear to allow the driver to take the vehicle to a Land Rover dealer or approved repairer. Torque converter lock-up is disabled and reverse-lock-out will not function.

If the vehicle is stopped and subsequently restarted in the limp home mode condition, the TCM operates normally until the fault which caused the condition is detected again.

Coast

Coast mode provides earlier downshifts during coasting dependant on output shaft deceleration rate to improve driveability and refinement by avoiding negative to positive driveline torque reversals transmission during the downshifts.

Fast Off Recognition

Fast off recognition is activated when the TCM detects that the driver has released the accelerator pedal quickly. This is detected by the TCM monitoring for a high level of negative pedal angle from ECM signals on the high speed CAN bus. If this condition is detected, the TCM holds the current gear ratio to allow the driver to complete the manoeuvre without the need for a downshift. The mode can remain active for a predetermined length of time or if the driving style remains passive.

Fast off recognition mode assists vehicle stability and is used in conjunction a lateral acceleration input during cornering to maintain the current gear until the corner is negotiated.

Uphill and Trailer

Uphill and trailer mode can be active when the transmission is operating in normal, sport or Terrain Response modes. When the vehicle is pulling a trailer or driving up an incline, the TCM detects the increased resistance by monitoring engine torque and speed signals received from the ECM on the high speed CAN bus and also transmission output shaft speed sensor signals. Uphill and trailer mode will provide downshifts to prevent a drop in transmission torque output and maintain driving force.

Downhill

Downhill mode can be active when the transmission is operating in normal, sport or Terrain Response modes. When the vehicle is descending an incline the TCM detects a reduction in resistance by monitoring engine torque and speed signals received from the ECM on the high speed CAN bus and also transmission output shaft speed sensor signals. Downhill mode assists engine braking by selecting an appropriate gear reducing the load required on the brakes.

Wide Throttle

Wide open throttle mode operates for part throttle upshifts and kick-down upshifts. It provides consistent wide open throttle upshift performance under all driving conditions. The full engine speed range is used in all driving modes; normal, sport, hill modes and Commandshift. Compensation is used for delays (hydraulic and electronic) in gear change request to gear change start to provide smooth changes and correct shift point correction.

Terrain Response

The Terrain Response system has a unique set of shift maps for each of the Terrain Response programs. These programs override existing modes; for example when HDC is active and the 'Sand', 'Mud and Ruts' or 'Grass/Gravel/Snow' programs are selected, a specific Terrain Response map is used, not the HDC mode shift map detailed previously.

Reverse Lock-Out

If the selector lever is moved from N to R and the vehicle is travelling forwards, reverse selection is prevented if the vehicle speed is 11 km/h (6.8 mph) or more. When reverse lock-out is activated, the clutch (C3) is released without energizing solenoid (SLC3), preventing the transmission from selecting reverse gear.

TRANSMISSION FAULT STATUS

If the TCM detects a fault with the transmission system, it will enter a default (limp home) mode to prevent further damage to the transmission and allow the vehicle to be driven. If possible reverse gear will be available and also 3rd gear only.

When a fault is detected a high speed CAN message is sent from the TCM and is received by the instrument cluster. The instrument cluster illuminates the MIL (if required) and displays an applicable message in the message center. For additional information, refer to [Information and Message Center](#) (413-08 Information and Message Center)

Some transmission faults may not illuminate the MIL or display a fault message, but the driver may notice a reduction in shift quality.

ENGINE SPEED AND TORQUE MONITORING

The ECM constantly supplies the TCM with information on engine speed and torque through messages on the CAN bus. The TCM uses this information to calculate the correct and appropriate timing of shift changes.

If the messages are not received by the ECM, the TCM will implement a back-up strategy to protect the transmission from damage and allow the vehicle to be driven.

In the event of an engine speed or torque signal failure, the transmission will adopt the electrical limp home mode with the transmission operating in a fixed gear.

TOWING FOR RECOVERY



WARNING: Ensure that the remote handset remains docked whilst the vehicle is being towed. Removing the remote handset will engage the steering lock, which will prevent the vehicle from steering correctly. If the engine cannot be run whilst the vehicle is being towed, there will be no power assistance for the steering or brakes. This will result in greater effort being required to steer or slow the vehicle, and greatly increased stopping distances.



CAUTION: The vehicle should only be towed with four wheels on the ground. Towing with two wheels on the ground will result in serious damage to the transmission. The vehicle should only be towed for a maximum of 80 km (50 miles), at a maximum speed of 80 km/h (50 mph). Towing for a greater distance, or at a higher speed may result in serious damage to the transmission.

NOTE:

The recommended recovery method is by trailer or recovery vehicle.

Secure the towing attachment from the recovery vehicle to the front towing eye.

Insert the remote handset in the start control module and switch on the ignition by pressing the start/stop button once.

NOTE:

Leaving the ignition switched on for extended periods will cause the battery to drain.

Apply the foot brake, and move the selector lever to the neutral 'N' position. With the footbrake still applied, release the park brake. If electrical power to the selector is not available, the emergency release lever on the selector lever can be used to release the interlock solenoid.

The vehicle can be towed a maximum of 80 km (50 miles) at a maximum speed of 80 km/h (50 mph).

Park the vehicle on firm, level ground. Apply the park brake and move the selector lever to the park 'P' position.

Switch off the ignition and remove the remote handset.



CAUTION: The vehicle cannot be towed in a reverse direction.