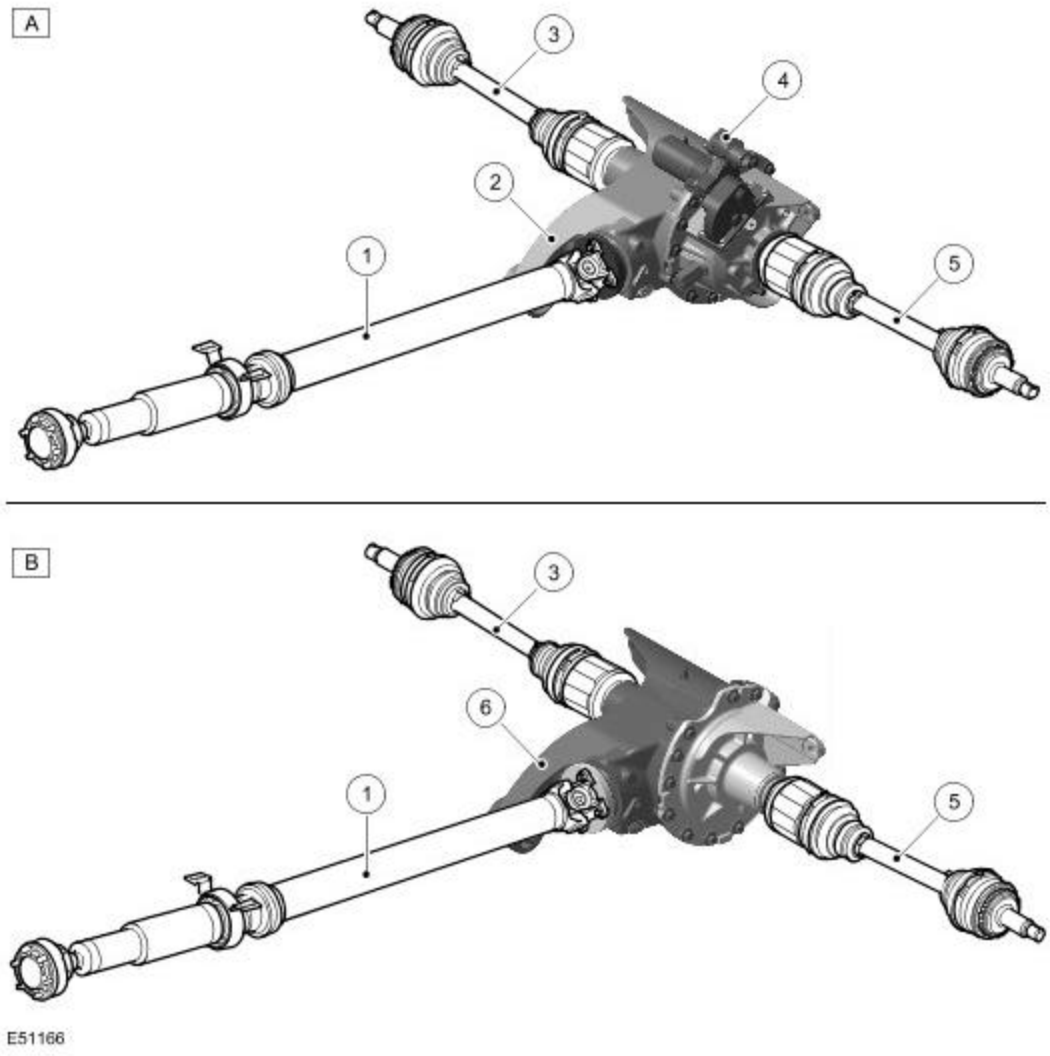
Rear Drive Axle and Differential

GENERAL



Item	Part Number	Description
A	-	Electronic rear differential
B	-	Open rear differential
1	-	Rear driveshaft
2	-	Electronic rear differential
3	-	RH rear drive halfshaft
4	-	Actuator (locking) motor assembly
5	-	LH rear drive halfshaft
6	-	Rear differential

The open rear differential converts the 'angle of drive' through 90° and distributes drive, via the rear drive halfshafts, to the rear wheels.

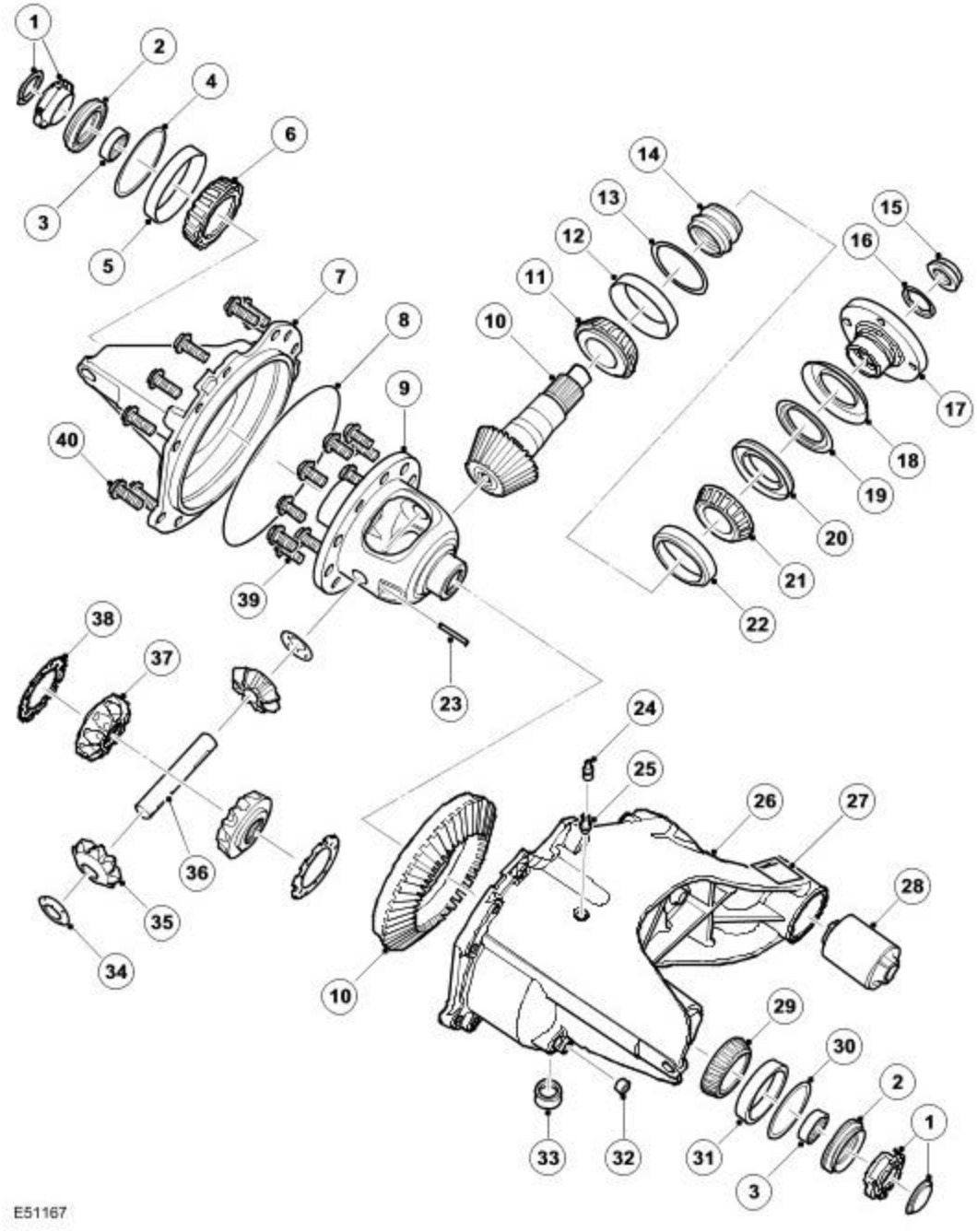
The open rear differential for the V6 and V8 petrol variants has the same output ratio, but the output ratios for the TdV6 diesel are different, depending on whether automatic or manual transmission is fitted.

The open rear differential is located centrally in the rear of the chassis.

The units are mounted to the chassis via rubber bushes and bolts; two mounting points at the rear of the unit and one at the front.

OPEN REAR DIFFERENTIAL ASSEMBLY

Open Rear Differential - Exploded View



Item	Part Number	Description
1	-	Cap
2	-	Seal
3	-	Bearing assembly, without race

4	-	Bearing pre-load spacer
5	-	Bearing
6	-	Roller bearing cup
7	-	Cover
8	-	Seal
9	-	Differential carrier
10	-	Gear and pinion assembly
11	-	Bearing
12	-	Roller bearing cup
13	-	Shim
14	-	Collapsible spacer
15	-	Pinion nut
16	-	Retainer
17	-	Flange
18	-	Outer deflector
19	-	Inner deflector
20	-	Oil seal
21	-	Bearing
22	-	Roller bearing cup
23	-	Roll pin
24	-	Breather cap
25	-	Breather
26	-	Case
27	-	Data location
28	-	Mounting bush
29	-	Bearing
30	-	Bearing pre-load spacer
31	-	Roller bearing cup
32	-	Plug
33	-	Drain plug
34	-	Thrust washer
35	-	Planet gears
36	-	Crosspin shaft
37	-	Sunwheel
38	-	Thrust washer
39	-	Bolt, 10 of
40		Bolt, 12 of

The cast iron casing comprises two parts; a cover and a carrier. The carrier provides locations for all the internal components. The carrier is sealed to the cover via an O-ring seal and secured with twelve bolts. The cover and carrier have cast fins, which assist mobility. A breather tube is fitted to the top of the carrier. This allows a plastic tube to be fitted and routed to a high point under the vehicle body, preventing the ingress of water when the vehicle is wading.

The carrier contains an oil drain plug. The differential unit contains approximately 1.16 litres of oil from a dry fill. If oil is being replaced, a smaller quantity of oil will be required due to residual oil retained in the pinion housing.

The differential is a conventional design using a hypoid gear layout, similar to the front differential. The open rear differential is available in three ratios. V8 petrol engine vehicles use a differential with a final drive ratio of 3.73:1, V6 petrol engine vehicles use a differential with a final drive ratio of 3.73:1 and TdV6 engine vehicles use a final drive ratio of 3.54, for vehicles with automatic transmission and 3.07 for vehicles with manual transmission. Changing the number of teeth between the crown wheel drive gear and pinion gear changes the ratio.

The differential comprises a pinion shaft and hypoid pinion gear and a crown wheel drive gear with an integral cage, which houses two planet gears. Two sun wheels are also located in the cage and pass the rotational drive to the drive shafts.

The pinion shaft is mounted on two opposed taper roller bearings, with a collapsable spacer located between them. The spacer is used to hold the bearings in alignment and also collapses under the pressure applied to the pinion flanged nut. This allows the flanged nut to be tightened to a predetermined torque, which collapses the spacer, setting the correct bearing preload.

The pinion shaft has an externally splined outer end, which accepts and locates the input flange, which is retained by the pinion nut and retainer. The input flange has four threaded holes and mates with the rear drive shaft. Four bolts secure the rear drive shaft to the input flange. An oil seal is pressed into the pinion housing and seals the input flange to the pinion housing. The pinion shaft has a hypoid gear at its inner end, which mates with the crown wheel drive gear.

The crown wheel drive gear is located on the differential case and secured with ten screws. The differential case is mounted on taper roller bearings located in machined bores on each side of the pinion housing. Shims are retained in the casing behind the bearing cups, the shim thickness is selected to apply the correct bearing preload and hypoid backlash.

The differential carrier has a through hole, which provides location for the shaft. The shaft is supported by a sun gear and a needle roller bearing. The shaft is fitted with a snap ring at one end, which locates in a machined groove in the sun gear, locking the shaft in position.

The sun gears are located in pockets in the carrier cage and mesh with the planet gears. Spacers are fitted between the sun wheels and the carrier and set the correct mesh contact between the planet gears and the sun wheels. Each sun wheel has a machined bore with internal splines and machined groove near the splined end. The groove provides positive location for a snap ring fitted to the end of each output flange.

Each output shaft has a spline, which locates in each sun wheel. A snap ring fitted to the splined shaft locates in the groove the sun wheel bore and positively located the output shaft. Oil seals are pressed into each side of the pinion housing and seal the seal the output shaft.

Differential Operation

The operating principles of the front and rear differentials are the same. Rotational input from the drive shaft is passed via the input flange to the pinion shaft and pinion gear. The angles of the pinion gear to the crown wheel drive gear moves the rotational direction through 90°.

The transferred rotational motion is now passed to the crown wheel drive gear, which in turn rotates the differential casing. The shaft, which is secured to the casing, also rotates at the same speed as the casing. The planet gears, which are mounted on the shaft, also rotate with the casing. In turn, the planet gears transfer their rotational motion to the left and right hand sun wheels, rotating the drive halfshafts.

When the vehicle is moving in a forward direction, the torque applied through the differential to each sun wheel is equal. In this condition both drive halfshafts rotate at the same speed. The planet gears do not rotate and effectively lock the sun wheels to the differential casing.

If the vehicle is turning, the outer wheel will be forced to rotate faster than the inner wheel by having a greater distance to travel. The differential senses the torque difference between the sun wheels. The planet gears rotate on their axes to allow the outer wheel to rotate faster than the inner one.

SERVICE

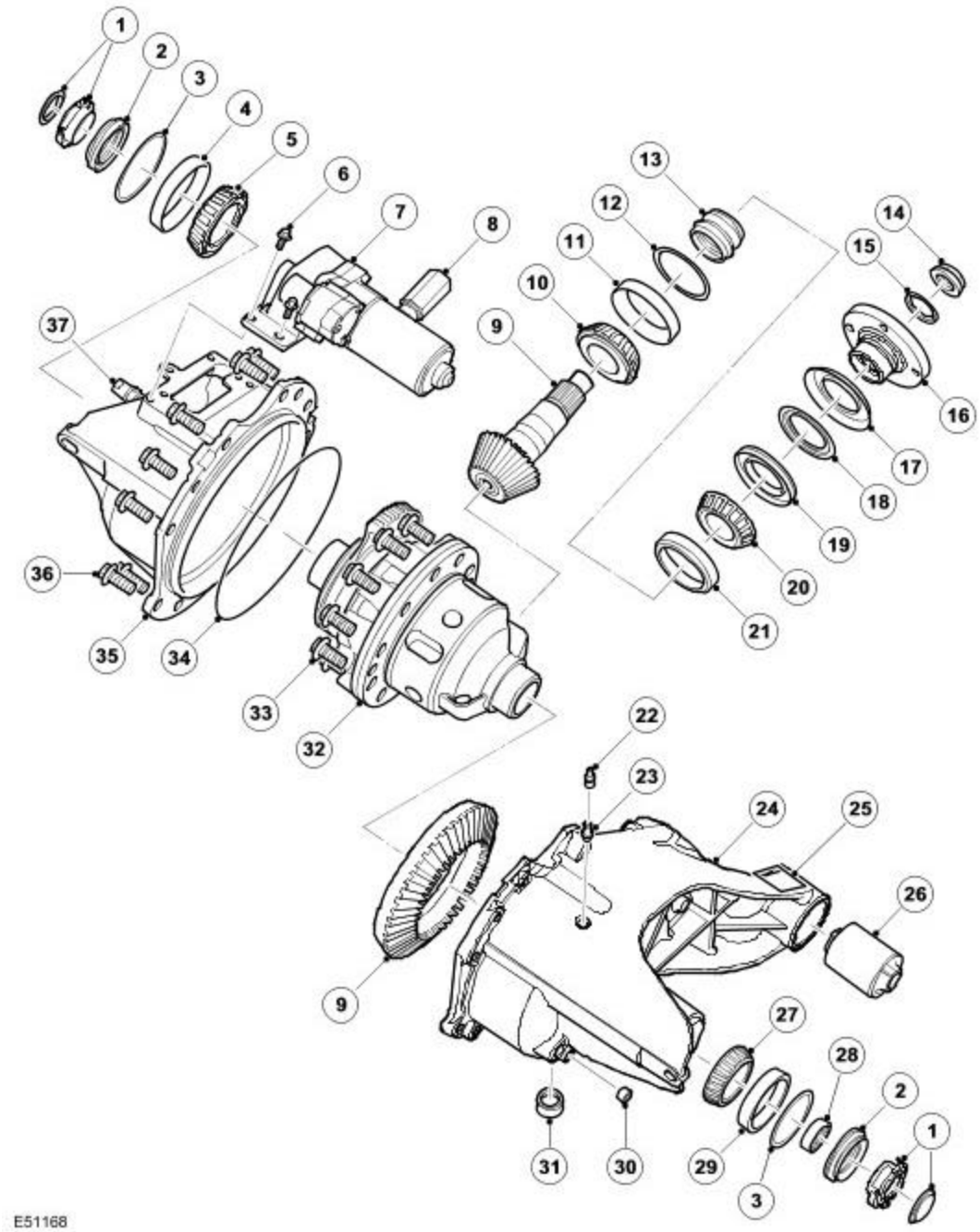
The oil used in the open rear differential is Castrol SAF-XO. The oil contains unique additives, which enhance the differentials operation. No other oil must be used in the open rear differential.

Open Rear Differential Serviceable Components

- Needle roller bearing assemblies
- Halfshaft seals
- Chassis bush/fixings
- Lubricant.

ELECTRONIC REAR DIFFERENTIAL ASSEMBLY

Electronic Rear Differential - Exploded View



Item	Part Number	Description
1	-	Cap
2	-	O ring
3	-	Bearing pre-load spacer
4	-	Bearing
5	-	Bearing cup
6	-	Bolt, 4 of

7	-	Housing and motor assembly
8	-	Damper
9	-	Gear and pinion assembly
10	-	Bearing
11	-	Bearing cup
12	-	Shim
13	-	Collapsible spacer
14	-	Pinion nut
15	-	Retainer
16	-	Flange
17	-	Deflector, outer
18	-	Deflector, inner
19	-	Seal
20	-	Bearing
21	-	Bearing cup
22	-	Breather cap
23	-	Breather
24	-	Case
25	-	Data location
26	-	Mounting bush
27	-	Bearing
28	-	Bearing assembly without race
29	-	Bearing cup
30	-	Filler plug
31	-	Drain plug
32	-	Electronic differential assembly
33	-	Bolt, 10 of
34	-	O ring
35	-	Cover
36	-	Bolt, 12 of
37	-	Temperature sensor

The electronic rear differential has the same functionality as the open rear differential but incorporates a locking feature.

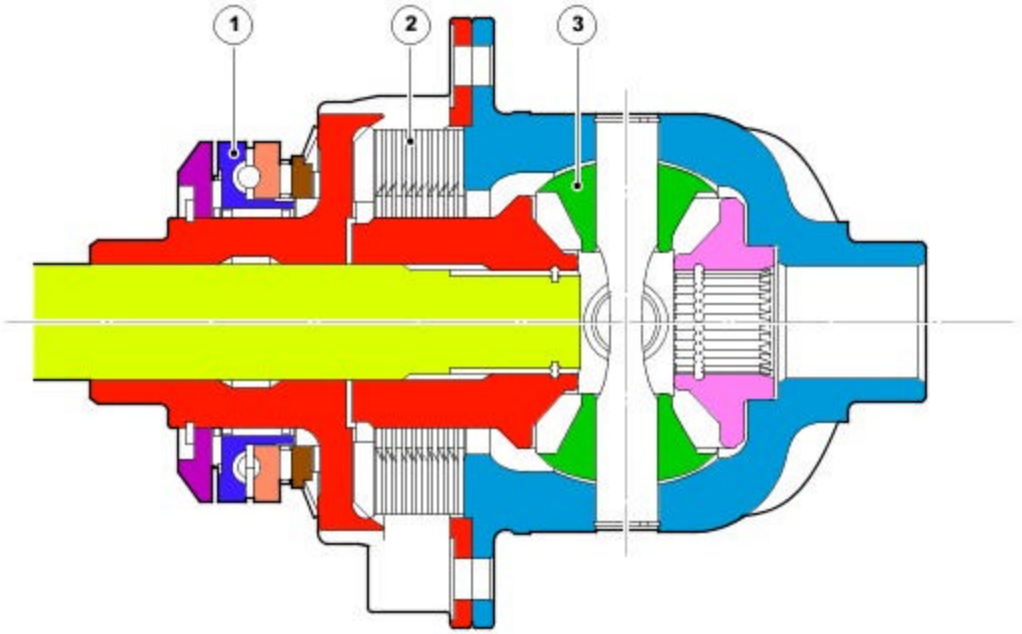
An electronically controlled multi-plate clutch provides a rear differential lock and torque biasing function to give improved traction performance and vehicle dynamic stability.

A strategy, to electronically control the rear differential multi-plate clutch assembly, has been developed to provide:

- a pre-loading function, increasing locking torque with increased driving torque
- a slip controller to increase locking torque under off-road conditions and decrease locking torque for optimum comfort, e.g. parking.

The unit receives a torque input from the transfer box output shaft, which is passed through the unit to two outputs for the rear drive halfshafts.

The unit detects wheel slip via various vehicle system inputs to the electronic rear differential control module and locks the differential accordingly.

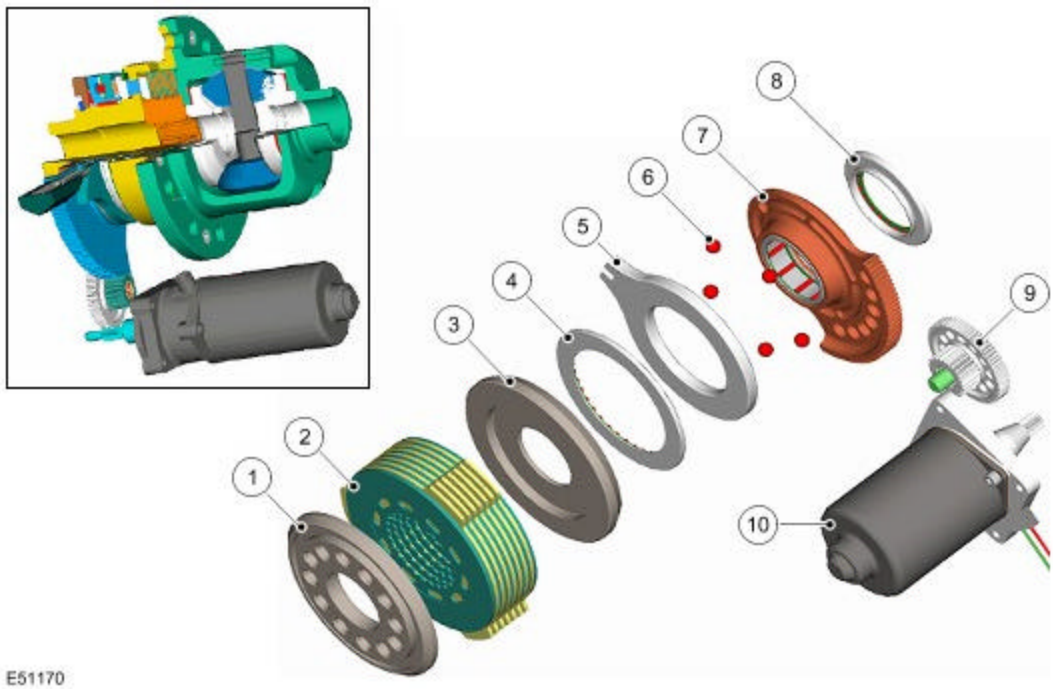


E51169

Item	Part Number	Description
1	-	Actuator
2	-	Clutch pack
3	-	Differential

The electronic rear differential locking and biasing feature is actuated via a DC motor, which is controlled by the electronic rear differential control module, via a Pulse Width Modulation (PWM) signal.

Multi-plate Clutch Assembly



E51170

Item	Part Number	Description
1	-	Pressure disc
2	-	Clutch plate assembly
3	-	Pressure disc
4	-	Thrust race
5	-	Output actuator
6	-	Actuator balls
7	-	Input actuator
8	-	Bearing pre-load spacer
9	-	Reduction gearset
10	-	Actuator motor

The multi-plate clutch assembly for both centre (transfer box) and electronic rear differentials act in a similar way. The aim of the multi-plate clutch assembly is to prevent excessive differential slip and therefore maximise the traction performance of the vehicle. This is fundamentally different from the 'braked' traction control, which can only counter act differential slip when it occurs.

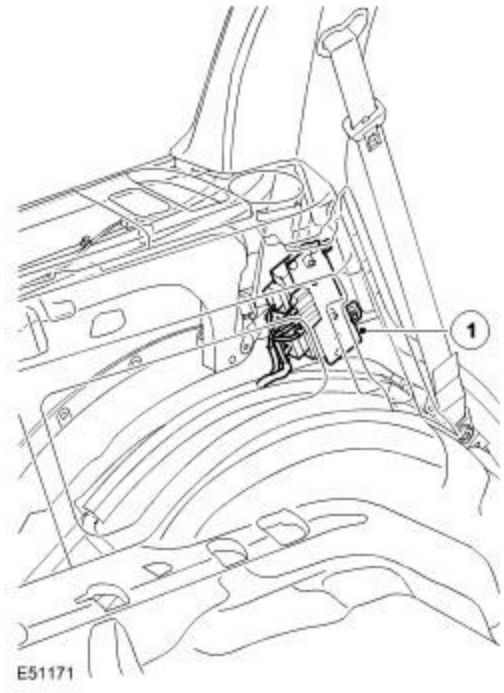
A certain amount of differential slip is required to allow the vehicle to turn corners and to remain stable under control of the Anti-lock Braking System (ABS). The transfer box control module monitors the driver's demands through primary vehicle controls and automatically sets the slip torque at the rear differential via the electronic rear differential control module. The system is completely automatic and does not require any special driver input.

The multi-plate clutch assembly actively controls the torque flow through the rear differential and optimises the torque distribution in the driveline. The clutch assembly biases the torque from the differential to the wheels with the higher grip and prevents the wheels with the lower grip from spinning.

By turning the input actuator disc, via the motor shaft, the output actuator is rotated. This movement acts on 5 balls in a ramp mechanism between the input and output actuators and gives a defined axial movement. The movement forces the pressure disc to induce friction between the sun gear and differential case via the clutch plates supported by the sun gear and the plates supported by the clutch basket on the differential case. This frictional force inhibits the differential rotation; the differential case and left hand differential side gear are locked together.

Electronic Rear Differential Control Module

The electronic rear differential control module controls the multi-plate clutch actuation. The control module is mounted on a bracket located on the LH C-pillar, behind the trim.



Item	Part Number	Description
1	-	Electronic rear differential control module

The control module is connected on the Controller Area Network (CAN) bus and controls the differential operation using CAN messages from other control modules on the network.

The control module uses three connectors for all inputs and outputs. It receives a permanent power supply via a 40A fusible link located in the Battery Junction Box (BJB), and an ignition supply via fuse 24 located in the Central Junction Box (CJB).

The control module memorises the position of the electronic rear differential motor when the ignition is switched off.

The control module controls the closed loop position sensing system within the motor and regulates the power supply to the motor.

If the control module is replaced, T4 must be connected to the vehicle and the electronic rear differential control module self-calibration procedure must be performed. This procedure must also be performed if the motor or differential assembly is replaced.

If a fault occurs with the electronic rear differential, the control module or one of the required input signals, i.e. road speed signal, the control module records an error code and a warning lamp, in the instrument cluster, illuminates permanently.

Electronic Rear Differential Control Module Pin Out Details

Connector C2162

Pin No.	Description	Input/output
1	Not used	-
2	CAN bus low	Input/output
3	CAN bus high	Input/output
4	Not used	-
5	CAN bus high	Input/output
6	CAN bus low	Input/output

Connector C2163

Pin No.	Description	Input/output
1	Not used	-
2	Not used	-
3	Ground	-
4	Ignition feed	Input
5	Not used	-
6	Ground	-
7	Battery feed	Input
8	Battery feed	Input

Connector C2164

Pin No.	Description	Input/output
1	+ve for actuator Hall sensor	Input
2	Not used	-
3	Actuator motor	Output
4	Hall sensor - Signal A	Input
5	Not used	-
6	Not used	-
7	Hall sensor - Signal B	Input
8	Differential oil temperature sensor	Input
9	Not used	-
10	Ground - Hall sensor	-
11	Differential oil temperature sensor	Output
12	Actuator motor	Input
13	Motor temperature sensor	Output
14	Not used	-
15	Not used	-
16	Motor temperature sensor	Input
17	Motor brake solenoid	Output
18	Motor brake solenoid	Input

CAN Bus Messages

The CAN bus is a high speed broadcast network connected between various vehicle control modules. It allows the fast exchange of data between control modules every few microseconds. The bus comprises two wires, which are twisted together to minimise electromagnetic interference (noise) produced by the CAN messages. For additional information, refer to Communications Network (418-00 Module Communications Network)

The electronic rear differential control module is connected on the CAN bus, via the transfer box control module, and controls differential operation using CAN messages from other control units on the network. Wheel speed, steering angle, automatic transmission speed, temperature information, car configuration, axle ratios and mode inputs, are some of the main signals received by the control module.

The control module also sends messages via the CAN bus to tell other control modules on the network, the status of the electronic rear differential. The clutch torque and default mode status are some of the main signals sent out by the control module.

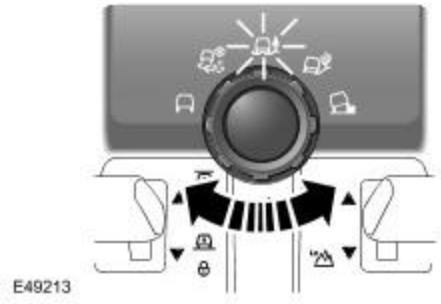
The following table shows the messages that can be displayed in the message centre of a high-line instrument cluster relating to the electronic rear differential:

Message	Description	Chime
'TRANSMISSION OVERHEAT'	Rear differential temperature has reached or is approaching the overheat threshold.	None
'TRANSMISSION FAULT'	Transfer box control module has stopped transmitting CAN bus messages. Defaults to open centre differential.	None
'TRANSMISSION FAULT'	Fault has occurred with electronic rear differential. Stop vehicle at earliest opportunity.	Single

On vehicles fitted with the low line instrument cluster, in place of the message centre there will be a status lamp, which has the following logic:

- Amber - Over temperature
- Red - Failure, stop vehicle

TERRAIN RESPONSE™



The Terrain Response™ system allows the driver to select a program, which will provide the optimum settings for traction and performance for the prevailing terrain conditions.

The system is controlled by a rotary control located on the centre console.

The system uses a combination of vehicle subsystems to achieve the required vehicle characteristics for the terrain selected. The following subsystems form the Terrain Response™ system:

- Engine management system
- Automatic transmission (if fitted)
- Transfer box
- Brake system
- Air suspension.

Each subsystem control module provides a feedback for the selected program so that the Terrain Response™ control module can check that all systems are controlling the system correctly. The exception to this is the electronic rear differential control module which does not provide feedback to the Terrain Response™ system as it is a slave to the transfer box control module. For additional information, refer to Ride and Handling Optimization (204-06 Ride and Handling Optimization)

SERVICE

The oil used in the electronic rear differential is Castrol SAF-Carbon Mod Plus. The oil contains unique additives and friction modifiers, which enhance the differentials operation. No other oil must be used in the electronic rear differential.

Electronic Rear Differential Serviceable Components

- Halfshaft seals
- Needle roller bearing assembly
- Chassis bush/fixings
- Actuator motor
- Temperature sensor
- Control module and bracket
- Lubricant.

DIAGNOSTICS

The electronic rear differential control module can store fault codes, which can be retrieved using T4 or a diagnostic tool using ISO-14229 protocol.

The information is communicated via a diagnostic socket.

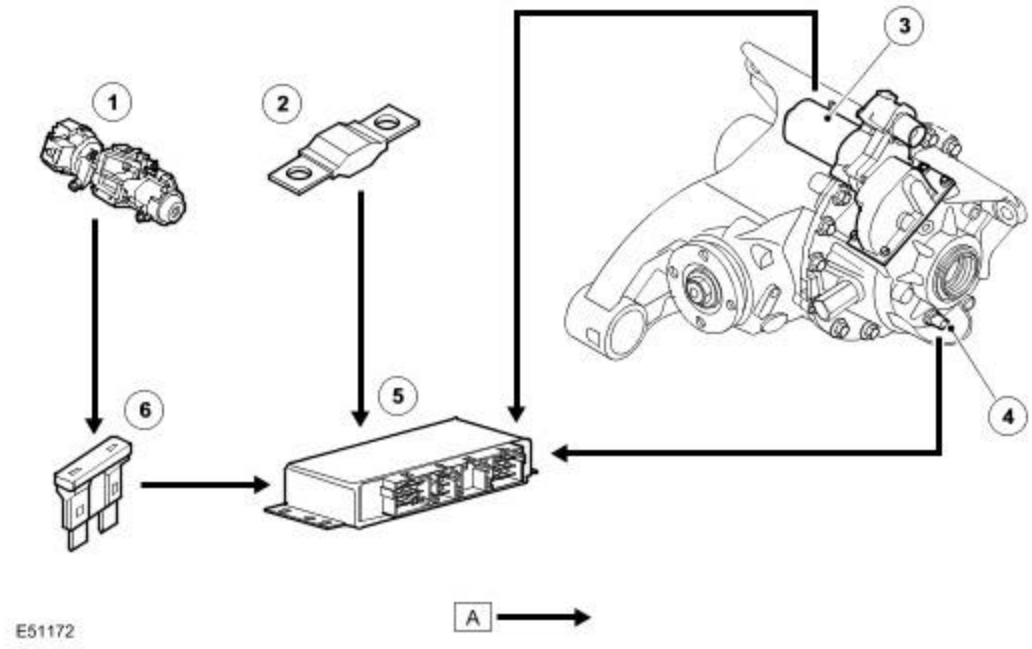
The diagnostic socket allows the exchange of information between the various control modules on the bus systems and T4 or another suitable diagnostic tool. The information is communicated to the socket via the CAN bus. This allows the retrieval of diagnostic information and programming of certain functions using T4 or another suitable diagnostic tool.

The electronic rear differential control module uses Diagnostic Trouble Codes (DTC), which relate to electronic rear differential electrical faults.

ELECTRONIC REAR DIFFERENTIAL CONTROL DIAGRAM

NOTE:

A = Hardwired



Item	Part Number	Description
1	-	Ignition switch
2	-	Fusible link (battery)
3	-	Actuator motor
4	-	Oil temperature sensor
5	-	Electronic rear differential control module
6	-	Fuse (ignition)