

DESCRIPTION AND OPERATION

General overview

Haldex clutches of the 3rd and 4th generations are used in the Ford Kuga.

The development of the third generation Haldex clutch represents a big step forward in modern all-wheel technology. The Haldex clutch is electro-hydraulically controlled. Additional information is taken into consideration during control tasks via the all-wheel drive control unit. Slip alone is no longer decisive for the distribution of the propulsive forces; the vehicle's driving dynamics are also taken into consideration. The control unit accesses the driving-related data via the data bus. With this data, the control unit has all the essential information about speed, cornering, coasting or traction operation, and can optimally react to every driving situation.

Compared with the previous generation, the 4th generation Haldex clutches operate with higher pressure and achieve shorter response times when distributing the drive forces.

Advantages of the Haldex clutch:

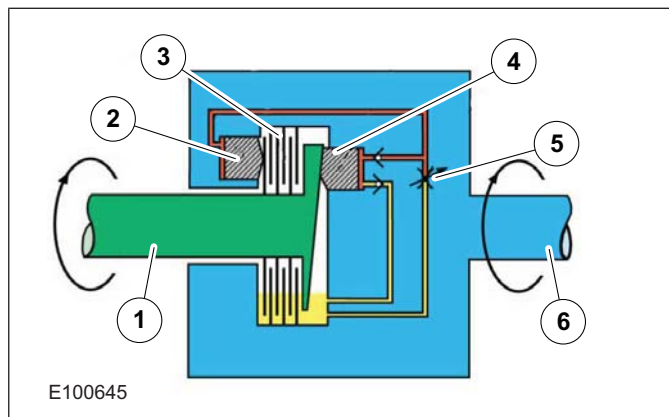
- Permanent all-wheel drive with electronically-controlled multi-plate clutch
- Fast response
- No straining when parking and manoeuvring
- Compatible with different tyres (e.g. emergency spare wheel)
- Fully combinable with driving dynamic control systems

The driveshaft is connected to the input shaft of the Haldex clutch. Within the Haldex clutch, the input shaft is separated from the output shaft to the rear axle differential by means of a multi-plate clutch. Torque is only transmitted to the rear axle differential when the plate assembly of the Haldex clutch is closed.

The multi-plate clutch is electro-hydraulically controlled via the all-wheel drive control unit. For ecological driving, the torque to the rear axle is

reduced to a minimum up to a throttle position of approx. 50%. A prerequisite for this is that there is no difference in speed in the Haldex clutch between the input and output shafts.

Operation



Item	Description
1	Output shaft
2	Working piston
3	Plates
4	Ring piston pump
5	Control Valve
6	Input shaft

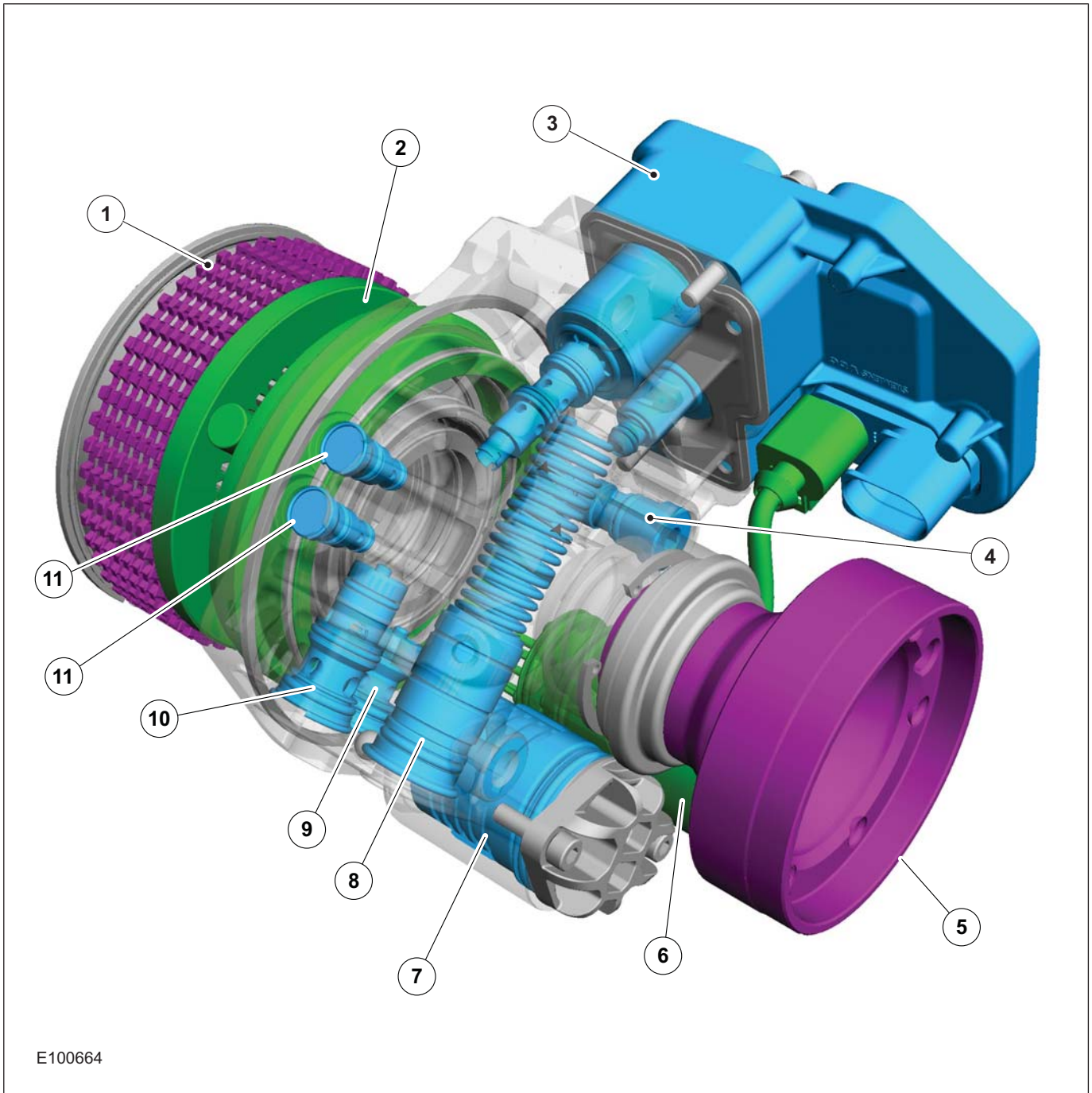
Within the Haldex clutch is a plate assembly and a so-called ring piston pump with a pump plunger and a working piston.

Fluid supply is started if there is a speed difference between the input and output shafts.

This fluid pressure is transmitted to the working piston and in this way the plate assembly is compressed.

Design of the 3rd generation Haldex clutch

DESCRIPTION AND OPERATION



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Item	Description
1	Multiplate clutch
2	Ring piston pump
3	All-wheel drive control unit
4	Pressure relief valve (high pressure)
5	Input shaft

Item	Description
6	Electric feed pump
7	Fluid filter
8	Pressure accumulator
9	Pressure relief valve (low pressure)
10	Preload valve
11	High-pressure valves

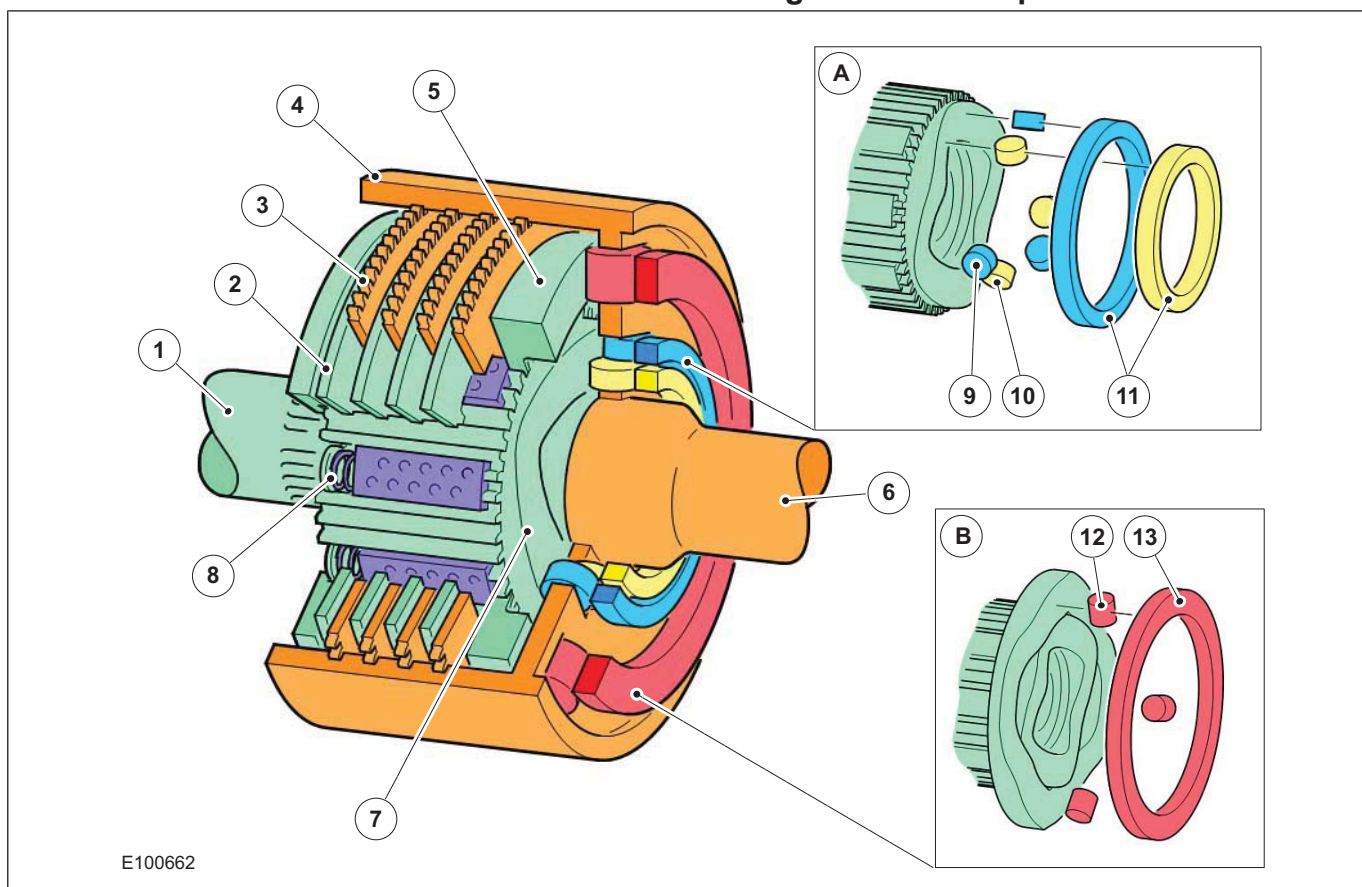
DESCRIPTION AND OPERATION

The Haldex clutch is based on the principle of a simple wet clutch that distributes the torque variably between the front and rear axles.

Three components are linked within the Haldex clutch:

- A mechanical component, comprising input and output shafts, the plate assembly (clutch) as well as the cam plate and the roller bearing.
- A hydraulic component, essentially comprising pressure valves, a pressure accumulator, the control valve, the ring pistons and a fluid filter.
- The electronic control comprises the electric fluid pump and the all-wheel drive control unit with integrated pressure/temperature sensor and an actuator motor for the control valve.

Design of the multi-plate clutch

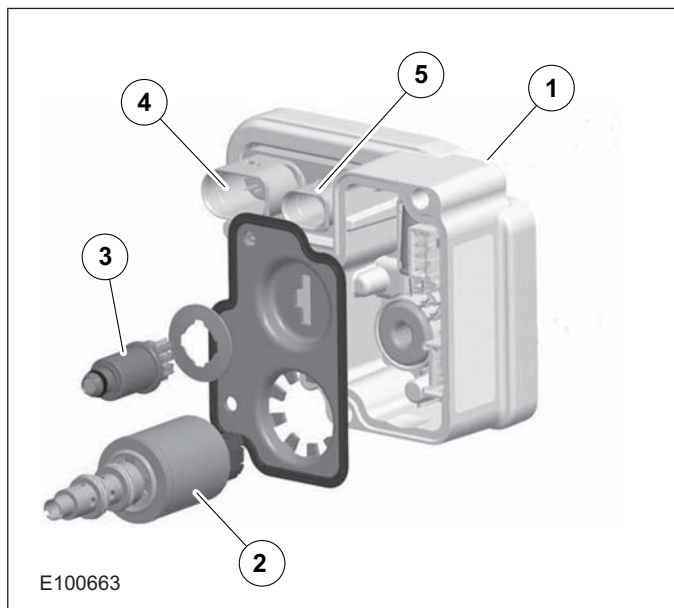


Item	Description
A	Pump plunger assembly
B	Working piston assembly
1	Output shaft
2	Inner plates
3	Outer plates
4	Disc drum
5	Contact plate

Item	Description
6	Input shaft
7	Cam disc
8	Springs
9	Pump plunger roller
10	Pump plunger roller
11	Pump plunger
12	Working piston roller
13	Working piston

DESCRIPTION AND OPERATION

All-wheel drive control unit



Item	Description
1	Electronic Control Unit
2	Control valve
3	Pressure/temperature sensor
4	Electrical connection CAN (controller area network) databus
5	Electric feed pump connection

The all-wheel drive control unit is bolted directly to the housing of the Haldex clutch.

It forms one unit made up of the control valve, a pressure/temperature sensor, and a control module. It receives signals from the PCM and from the ABS control module via the CAN data bus. The control module in the control unit uses these signals to determine the fluid pressure that is needed to actuate the clutch plates depending on the requirement. This determines how much torque should be transmitted to the rear wheels. All-wheel drive is deactivated if a fault occurs in the all-wheel drive control unit.

A preload of approx. 80 Nm is always present at the Haldex clutch.

The temperature sensor of the Haldex clutch is installed near the control valve in the control unit and is surrounded by the hydraulic fluid. The temperature is transmitted to the control module and is used for adaptation to the changing viscosity of the hydraulic fluid. If the hydraulic fluid is cold, the control valve has to be opened slightly more than requested. This allowance has to be reduced as the temperature increases. The normal working temperature of the hydraulic fluid is between +40 °C and +60 °C. If the temperature rises above 100 °C, the clutch is depressurised; if the temperature falls below 95 °C, the clutch is pressurised again. All-wheel drive is deactivated and a diagnostic trouble code set if a fault occurs in the temperature sensor.

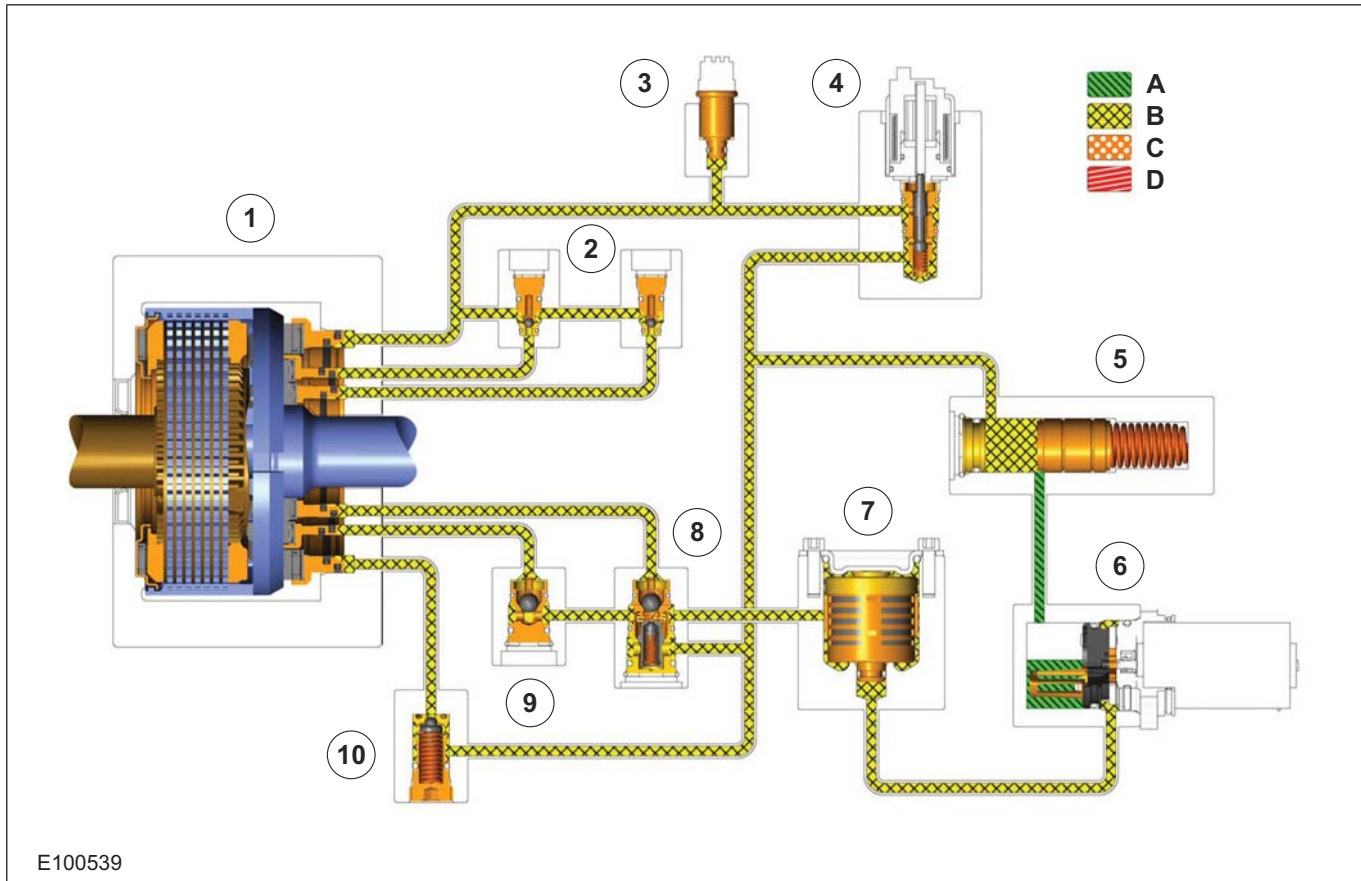
With Haldex Generations I and II, the control valve was actuated via a stepper motor. With Haldex Generation III, the stepper motor has been omitted. The control valve is now actuated via a solenoid valve. The solenoid valve is actuated by the control module in the all-wheel drive control unit by means of pulse width modulation. The pulse width modulation determines the position of the adjustment spindle and thus the opening cross section of the return hole. This is how the pressure at the working piston of the plates is determined. If the return hole is fully closed, maximum pressure is applied to the plates. If the return hole is fully open, the plates are unpressurized.

Electric feed pump

The electric feed pump is installed in the clutch unit. It works according to the gerotor principle. The main purpose of the feed pump is to fill the pressure accumulator and the space behind the pump plunger with hydraulic fluid, thereby ensuring a fast response time of the Haldex clutch. The feed pump used in the third generation is designed to achieve an even higher pressure than the base pressure of 4 bar. It is supplied with current by the control module in the all-wheel drive control unit when the engine is running above approx. 400 rpm.

Pressure control - 3rd generation Haldex clutch

DESCRIPTION AND OPERATION



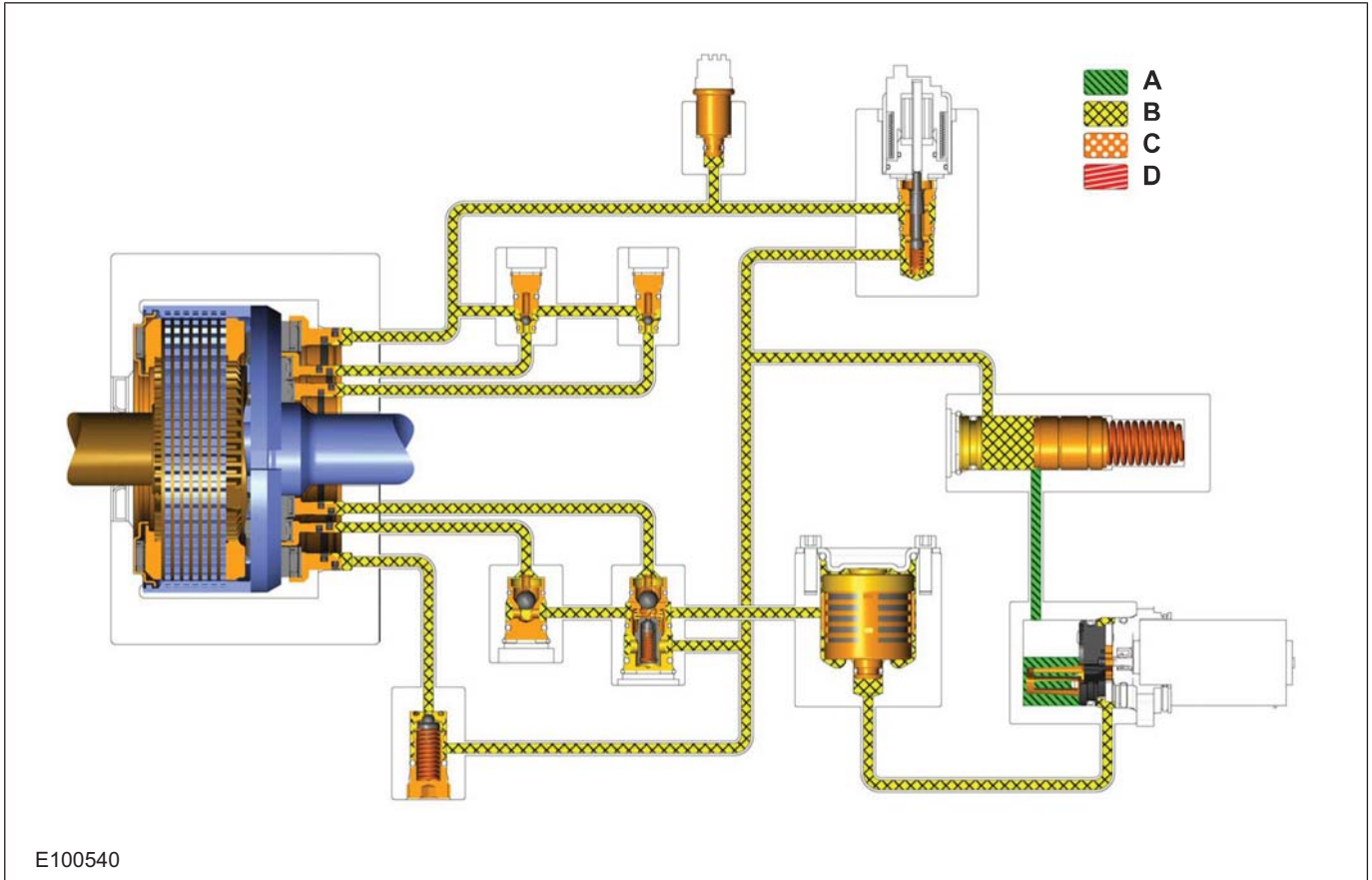
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Item	Description
A	Barometric Pressure
B	Base pressure
C	Increased base pressure (preload)
Drive	Operating pressure
1	Plate assembly and ring piston pump
2	High-pressure valves
3	Pressure Sensor

Item	Description
4	Control valve
5	Pressure accumulator
6	Electric feed pump
7	Filters
8	Preload valve
9	Pressure relief valve (low pressure)
10	Pressure relief valve (high pressure)

Base pressure

DESCRIPTION AND OPERATION



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Item	Description
A	Barometric Pressure
B	Base pressure

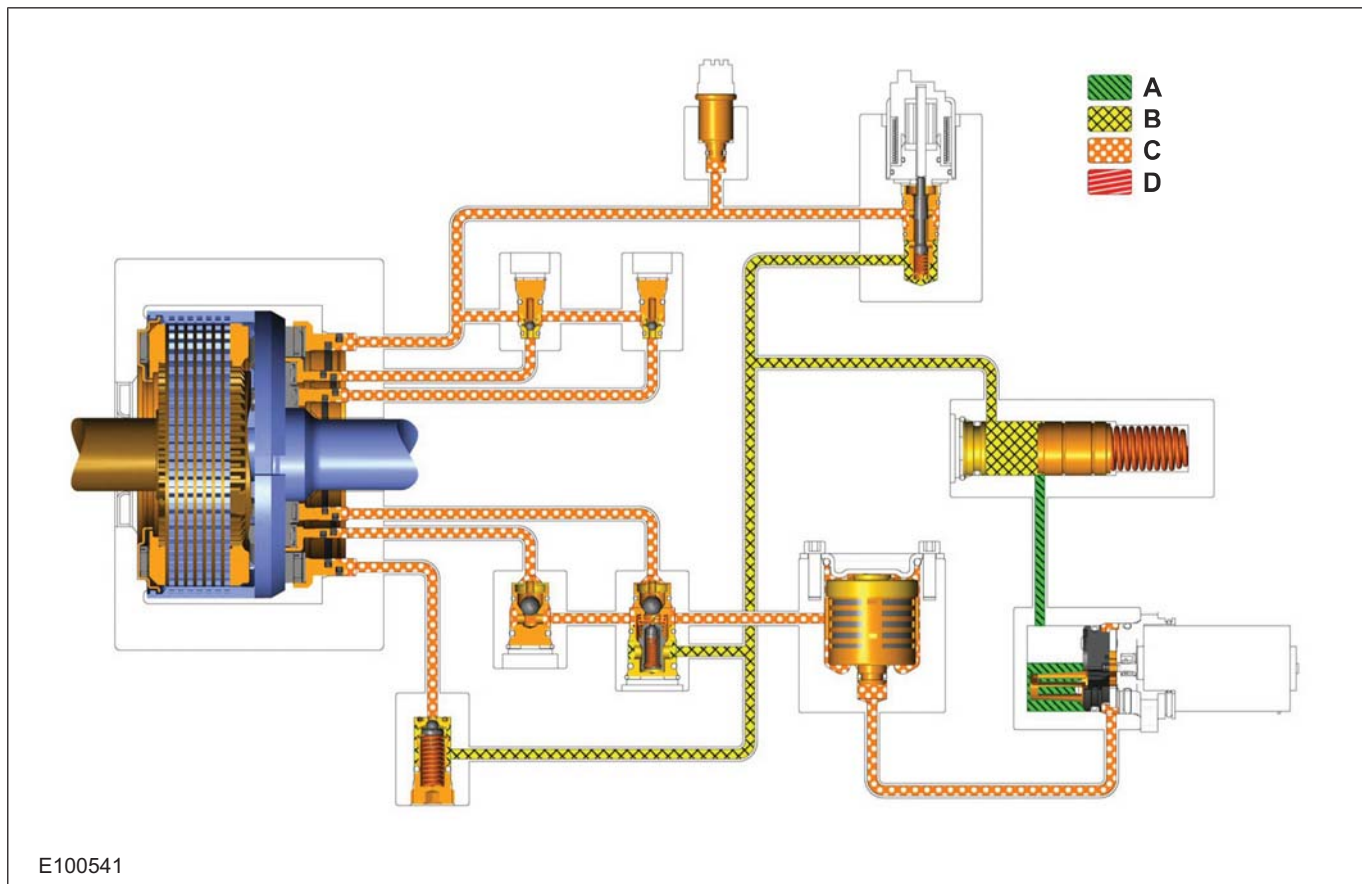
Item	Description
C	Increased base pressure (preload)
Drive	Operating pressure

The hydraulic fluid is drawn from the sump of the hydraulic system and directed through a filter. The feed pump pressurises the system and pumps hydraulic fluid into the pump plungers. This base pressure of 4 bar presses the rollers for the pump plungers against the cam disc. At the same time, hydraulic fluid flows into the working piston. This eliminates the play in the clutch plates. The Haldex clutch can respond quickly and distribute the torque within fractions of a second. The spring force in the pressure accumulator determines the base

pressure of 4 bar and compensates pressure fluctuations. A compensating spring works in the opposite direction and prevents the plate discs becoming blocked by the force of the working piston. This restricts the transferable torque to approx. 7 Nm. This value can, however, deviate slightly due to temperature and/or the difference in speed between the input and output shafts.

Increased base pressure (preload)

DESCRIPTION AND OPERATION



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Item	Description
A	Barometric Pressure
B	Base pressure

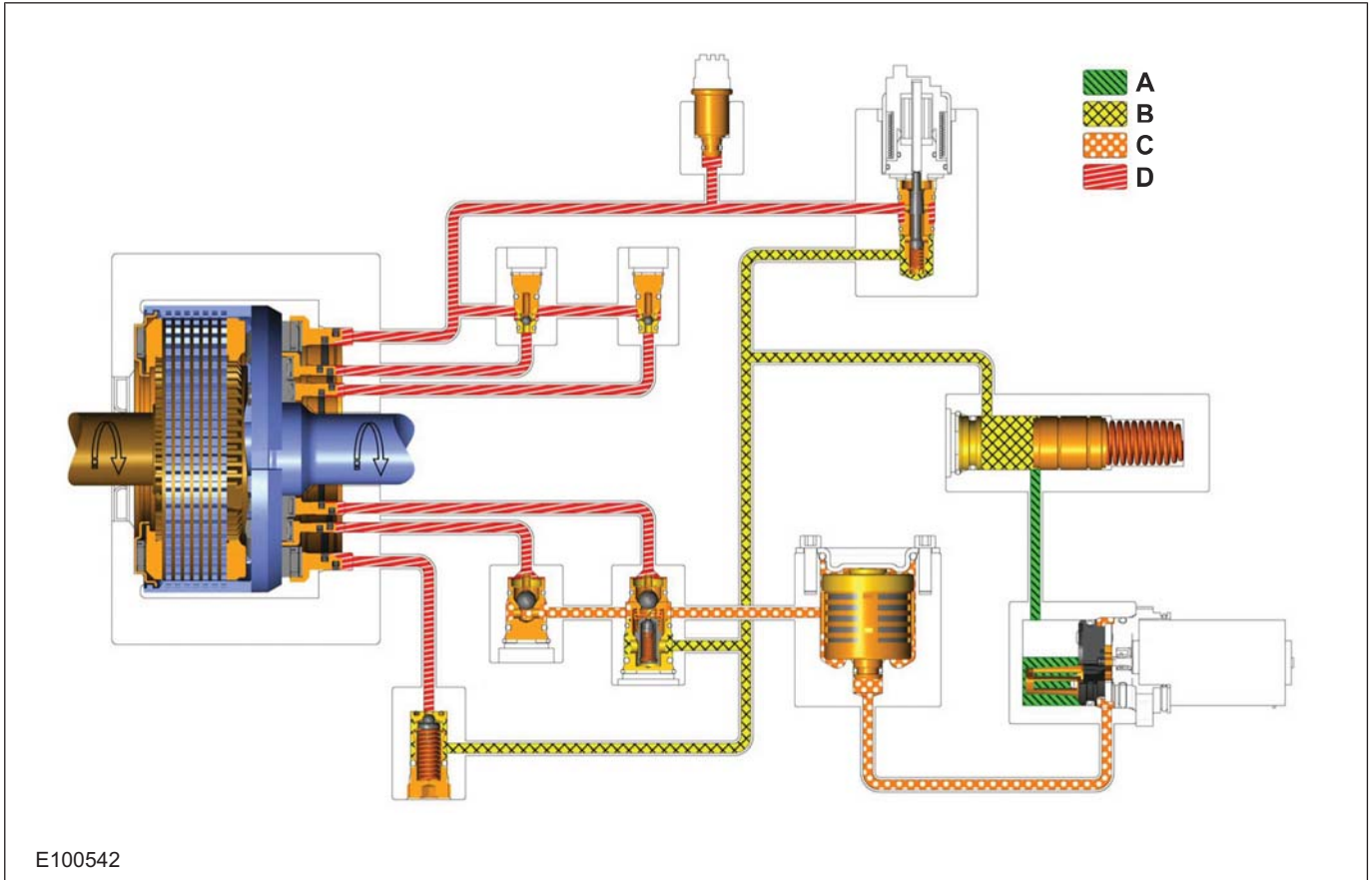
Item	Description
C	Increased base pressure (preload)
Drive	Operating pressure

To ensure very fast torque transmission, a higher voltage is applied to the electric feed pump and the control valve fully closed before the shaft-driven pump is brought into operation. As a result, the maximum pressure is raised above the base pressure, and a torque of up to 80 Nm applied to the multi-plate clutch. This achieves significantly faster pressure build-up than with older systems

(second generation). To protect the pump from overloading, the pressure is restricted to approx. 10 bar by the pressure relief valve. The hydraulic fluid flows back into the sump via the pressure accumulator.

Pressure build-up

DESCRIPTION AND OPERATION



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Item	Description
A	Barometric Pressure
B	Base pressure

Item	Description
C	Increased base pressure (preload)
Drive	Operating pressure

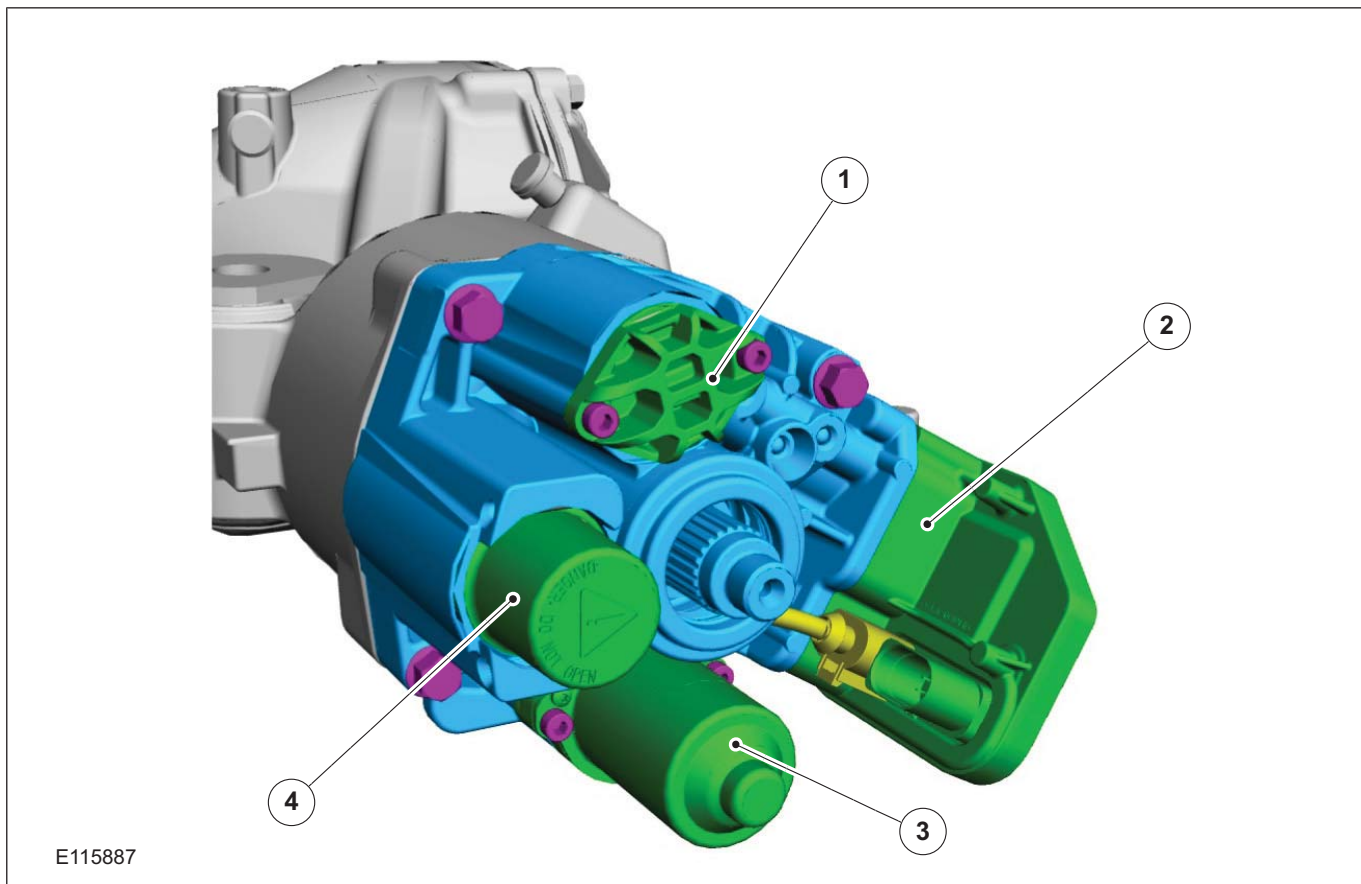
The pump plungers generate the operating pressure that is controlled by the control valve as a function of the difference in speed between the input and output shafts. The control valve works progressively from fully open to fully closed. The fluid pressure can be approx. 67 bar when the control valve is fully open. The maximum pressure

is mechanically controlled by means of the pressure relief valve.

Design of the 4th generation Haldex clutch

General overview

DESCRIPTION AND OPERATION



Item	Description
1	Fluid filter
2	All-wheel drive control unit

Item	Description
3	Electric feed pump
4	Pressure accumulator

The electric feed pump is an axial piston pump which is more robustly designed than the gerotor pump in the 3rd generation Haldex. The higher feed pressure means that the ring piston pump at the clutch plate assembly, the pressure relief valves, preload valve and the high pressure valves are no longer necessary.

The pressure accumulator on the 4th generation Haldex is larger and is designed for the higher pressure.

The 4th generation Haldex has a larger fluid filter which contains a non-return valve.

The all-wheel drive control unit no longer contains a pressure sensor in the 4th generation Haldex.

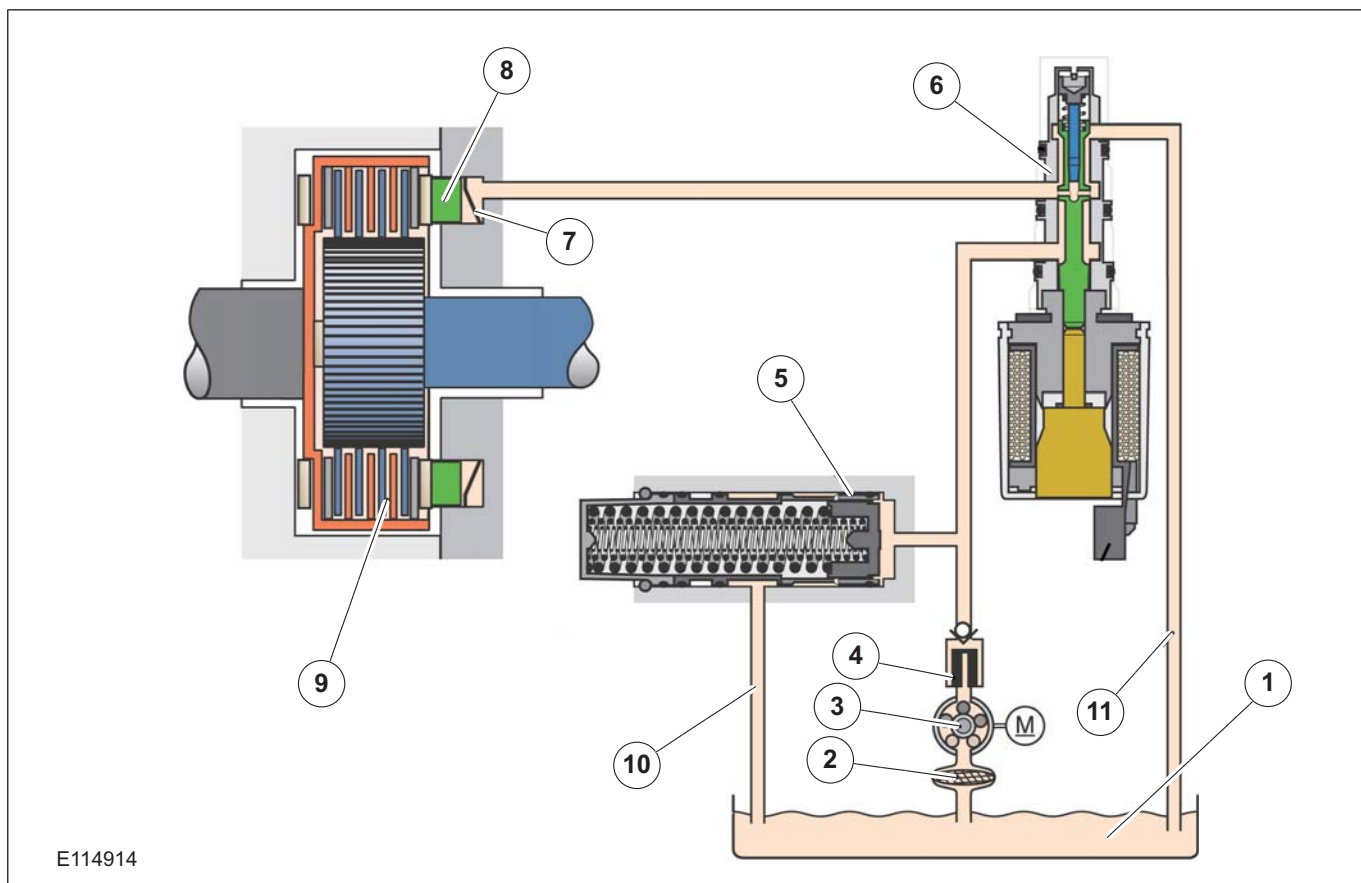
Pressure control - 4th generation Haldex clutch

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Rear Drive Axle/Differential

205-02-16

DESCRIPTION AND OPERATION



Item	Description
1	Haldex clutch fluid
2	Inlet filter
3	Electric feed pump
4	Filters
5	Pressure accumulator

Item	Description
6	Control valve
7	Dished washer
8	Ring piston
9	Clutch plate pack
10	Return pressure accumulator
11	Return control valve

Full torque is available at any time on the 4th generation Haldex clutch because the pressure is not dependent on the difference in the speeds of rotation. This is used for instance to activate the Haldex clutch for better traction when moving off.

On the 4th generation Haldex clutch, the preload function which applied 80 Nm to the plates in the 3rd generation is no longer required.

On request from the control unit and at engine speeds above 400 rpm, the electric feed pump runs and maintains the storage pressure at about 30 bar.

A pressure reducing valve acts as a control valve, allowing the all-wheel drive control unit to control the pressure with much greater precision. The all-wheel drive control unit monitors the position

and function of the control valve. The control valve distributes the pressure, depending on the requirements, across its three outlet openings (storage pressure, working pressure, return).

From the storage pressure (30 bar) and depending on the requirements, the control valve regulates a working pressure of 0 - 17 bar, which is applied to the ring piston. At 17 bar working pressure, the maximum torque of 1000 Nm is transferred to the rear wheels. The all-wheel drive control unit ensures the best possible performance under all driving conditions, for all road conditions and independent of the speed.

GENERAL PROCEDURES

Differential Fluid Level Check

Materials	
Name	Specification
Rear Axle Oil SAE 80W-90 F	WSP-M2C197-A / 4U7J-M2C197-AA

- Material: Rear Axle Oil SAE 80W-90 F (WSP-M2C197-A / 4U7J-M2C197-AA) transmission fluid
 - Correct the rear axle oil level if necessary.
 - 24 ml ~ 1 mm

1. Refer to: **Health and Safety Precautions** (100-00 General Information, Description and Operation).

2.

