Functional description

8-speed general
automatic transmissions
passenger cars

This document is a translation of the German original

Contents

Contents

8HP ... - transmission	8-speed automatic transmission with hydrodynamic torque converter and planetary gear sets
ABS	Anti-lock braking system
ASIS	Adaptive shift strategy
ASR	Traction slip control
ATF	Automatic transmission fluid
CAN-Bus	Controller Area Network
CAS	Car access system
DAT	
DDE	Digital electronic engine control (vehicles with petrol engines)
DME	Digital electronic engine control (vehicles with diesel engines)
DR-RED-V	Pressure reduction valve
EDS	Electronic pressure control valve
EDS-SYS	EDS for system pressure
ESD (EGB)	Electrostatically sensitive device
EMF	Electromechanical parking brake
ESD	Electrostatic discharge
ESP	Electronic stability program = Driving dynamics control
FDR	Driving dynamics control
GWK	Controlled lock-up clutch
GWS	Selector lever
HIS	Hydraulic impulse oil storage
HV	Pressure-holding valve
IEP	Integrated electric oil pump
KUE-V	Cooling valve
KV	Clutch valve
MV	Solenoid valve
POS-V	Position valve
PS-ZYL	Parking lock cylinder
PT-CAN Bus	Powertrain CAN Bus CAN Bus drive
PVT	Pressure from torus
PZT	Pressure to torus
RS	Planetary gear set
SDB-V	Lubrication pressure limiting valve
SESP	Spontaneous increase in sportiness
SVF	Spontaneous vehicle deceleration
SV-WD	Converter pressure control valve
SYS-DR.-V	System pressure valve

Abbreviations

SZL	Steering wheel central control
TCU	Transmission control unit
VB-V	Prefilling valve
WD-V	Converter pressure valve
WK	Converter lock-up clutch
WK-FP-V	Converter foot point valve
WK-V	Converter clutch valve
WRH-V	Converter backup valve
WS	Selector slide

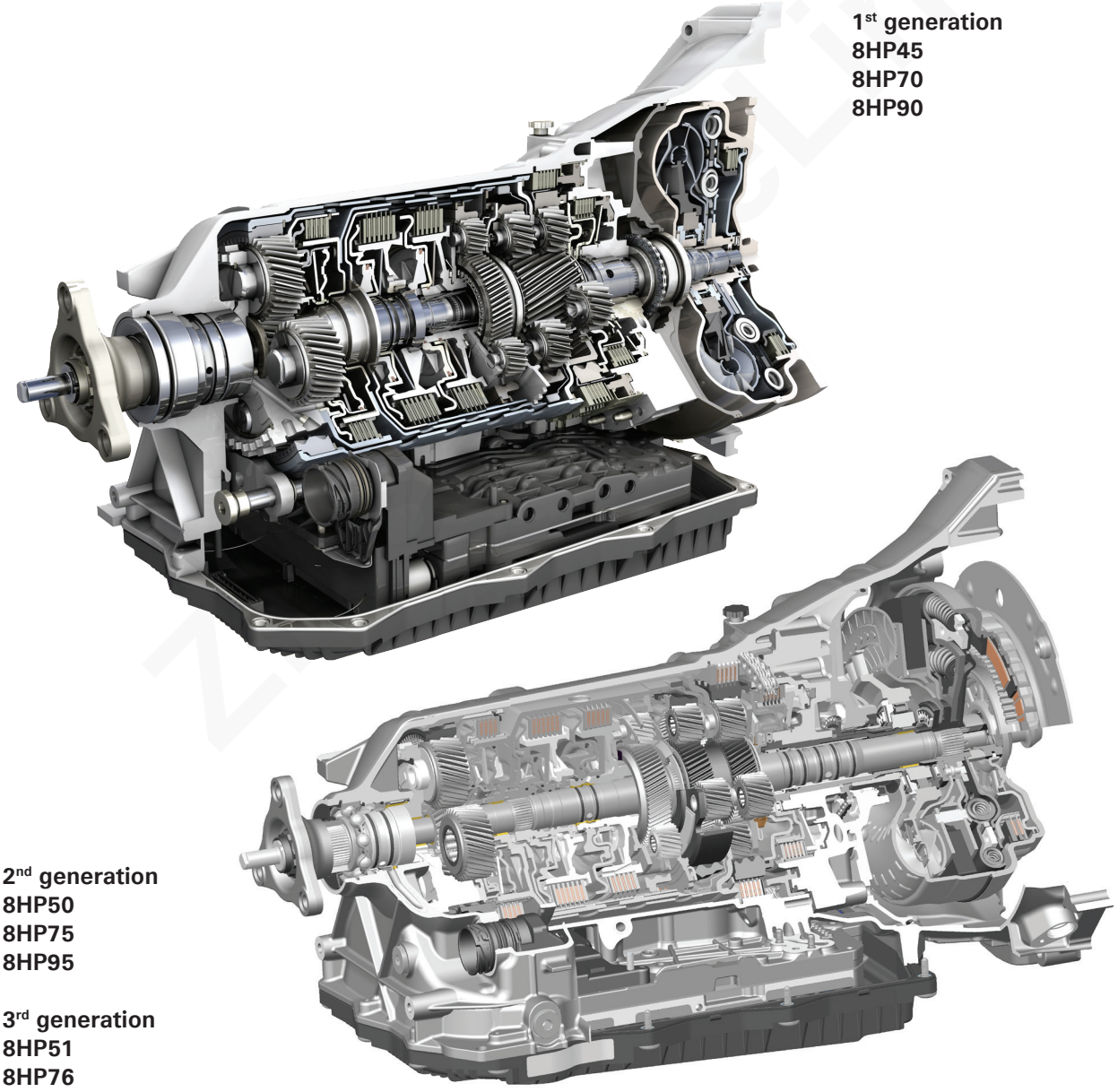
This brief technical description is designed to provide knowledge of the structure, function and components of the 8-speed automatic transmission.

Date of issue of the information: **October 2017**

Changes and additions to the technical data are set out in the relevant current information from “Technical After-Sales”.

Important: This function description does not replace the notes, technical information and rules supplied by the vehicle manufacturer.

ZF Friedrichshafen AG, ZF Aftermarket, Saarbrücken, Germany, Documentation Department

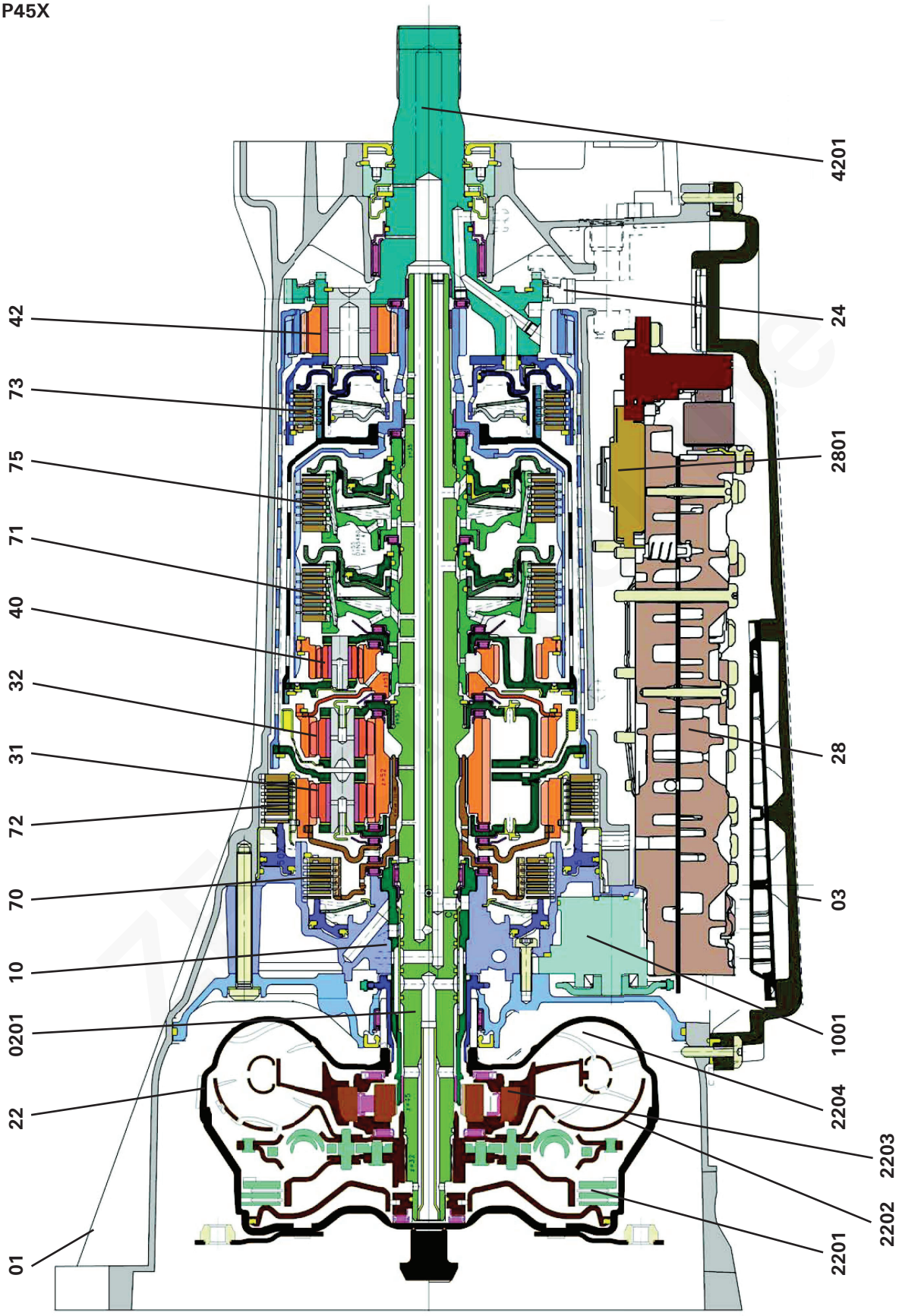


1st generation
8HP45
8HP70
8HP90

2nd generation
8HP50
8HP75
8HP95

3rd generation
8HP51
8HP76

8HP45X


4201
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2801
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1001
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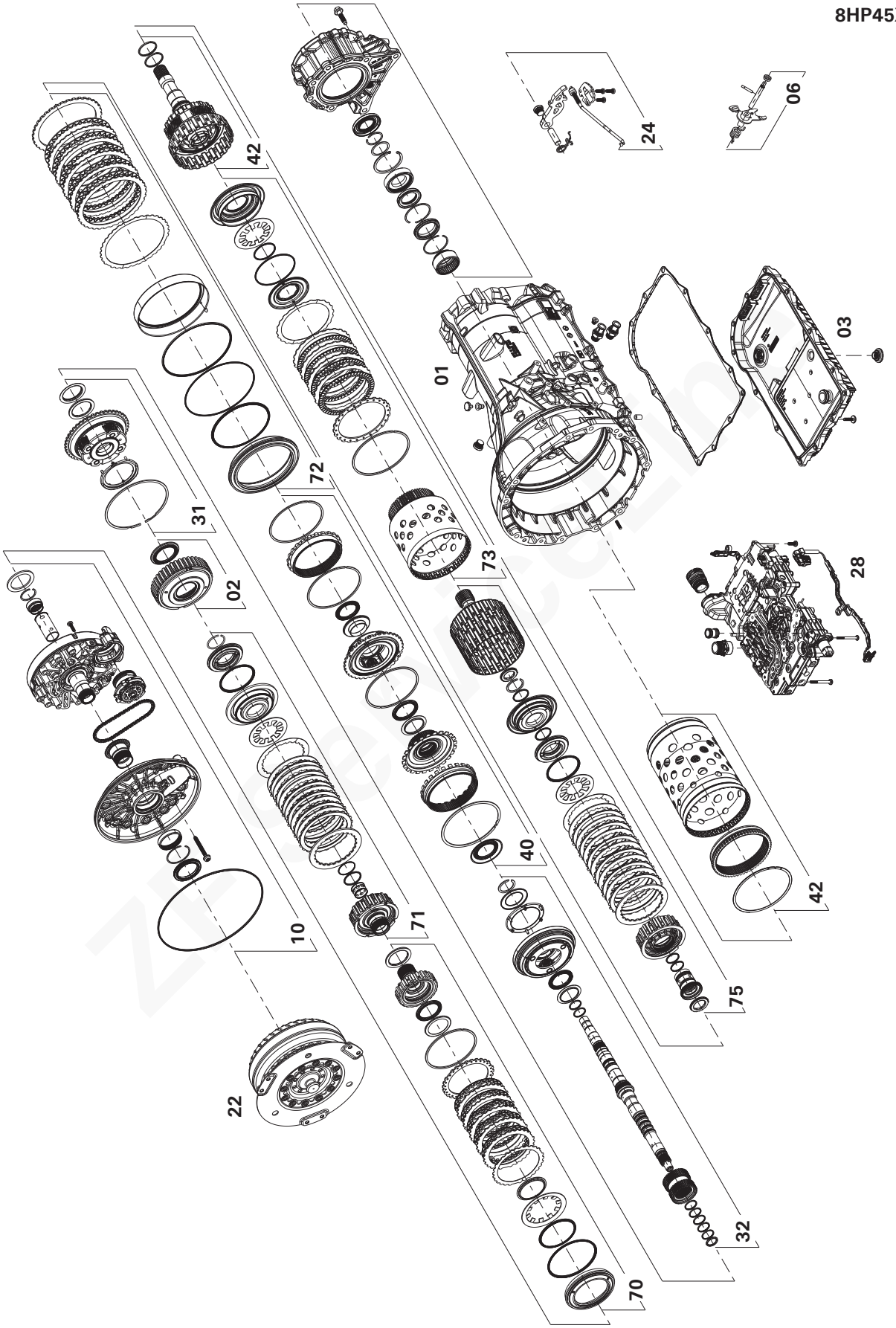
8HP45X



Figures

8HP45X

The figures – sectional and exploded view – of the 8HP45X transmission also apply analogously to the 1st generation 8-speed transmissions when used in vehicles with all-wheel drive.

Legende

01	Transmission housing
02	Drive
0201	Input shaft
03	Oil pan
06	Shift
10	Oil supply
1001	Oil pump
22	Torque converter
2201	Torque converter lock-up clutch
2202	Turbine wheel
2203	Stator
2204	Impeller
24	Parking lock
28	Elektronic hydraulic control unit
2801	Elektronic transmission control unit (TCU)
31	Planetary gearset RS1
32	Planetary gearset RS2
41	Planetary gearset RS3
42	Output shaft with planetary gearset RS4
4201	Output shaft = Planetary gearset RS4
70	Multidisk brake A
71	Multidisk clutch E
72	Multidisk brake B
73	Multidisk clutch D
75	Multidisk clutch C

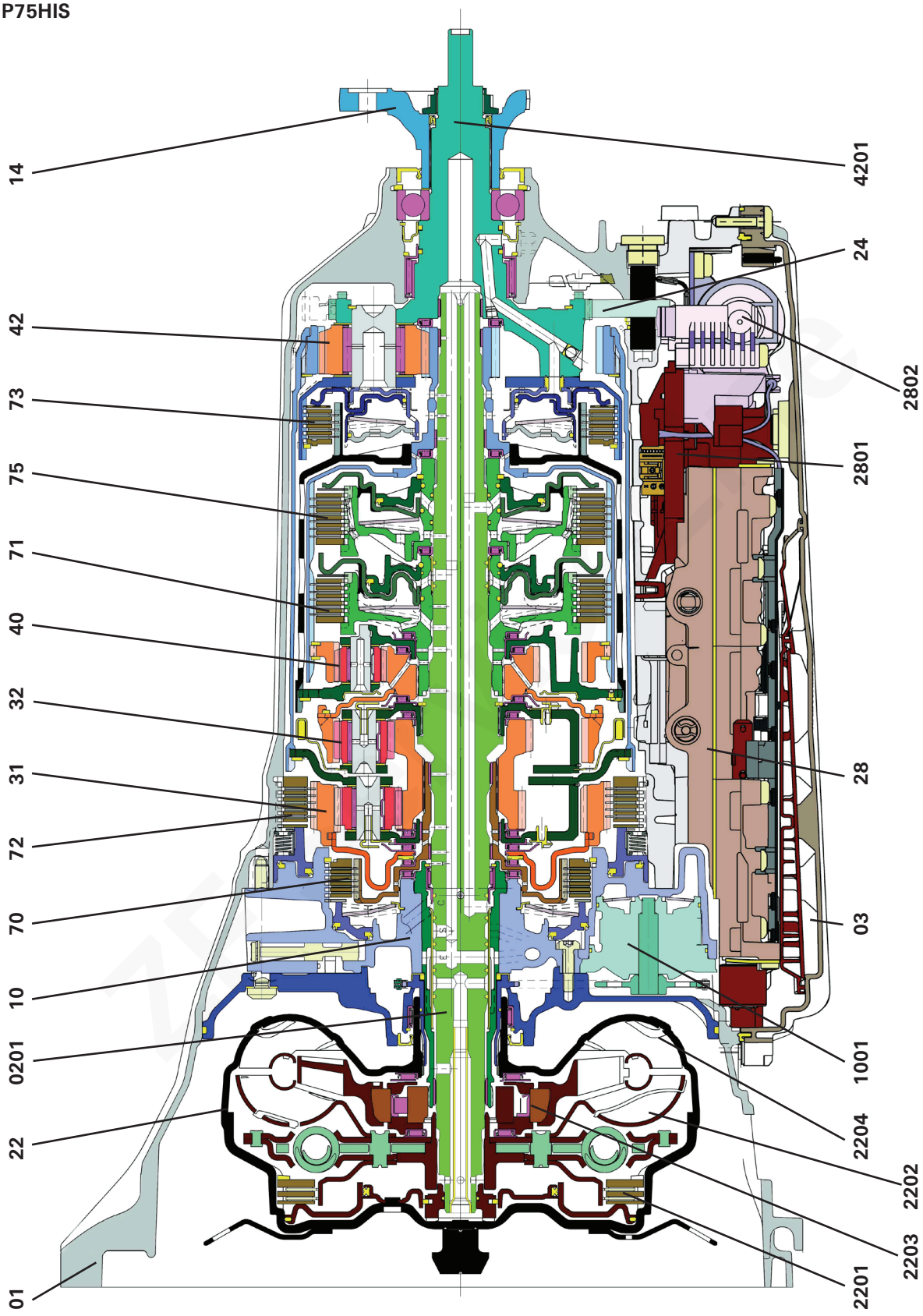
8HP75HIS

The figures – sectional and exploded view – of the 8HP75HIS transmission also apply analogously to the 1st generation 8-speed transmissions when used in vehicles with all-wheel drive.

Legende

01	Transmission housing
14	Output with output flange
02	Drive
0201	Input shaft
03	Oil pan
06	Shift
10	Oil supply
1001	Oil pump
22	Torque converter
2201	Torque converter lock-up clutch
2202	Turbine wheel
2203	Stator
2204	Impeller
24	Parking lock
28	Elektronic hydraulic control unit
2801	Elektronic transmission control unit (TCU)
2802	Hydraulic impulse oil storage (HIS)
31	Planetary gearset RS1
32	Planetary gearset RS2
41	Planetary gearset RS3
42	Output shaft with planetary gearset RS4
4201	Output shaft = Planetary gearset RS4
70	Multidisk brake A
71	Multidisk clutch E
72	Multidisk brake B
73	Multidisk clutch D
75	Multidisk clutch C

8HP75HIS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1001
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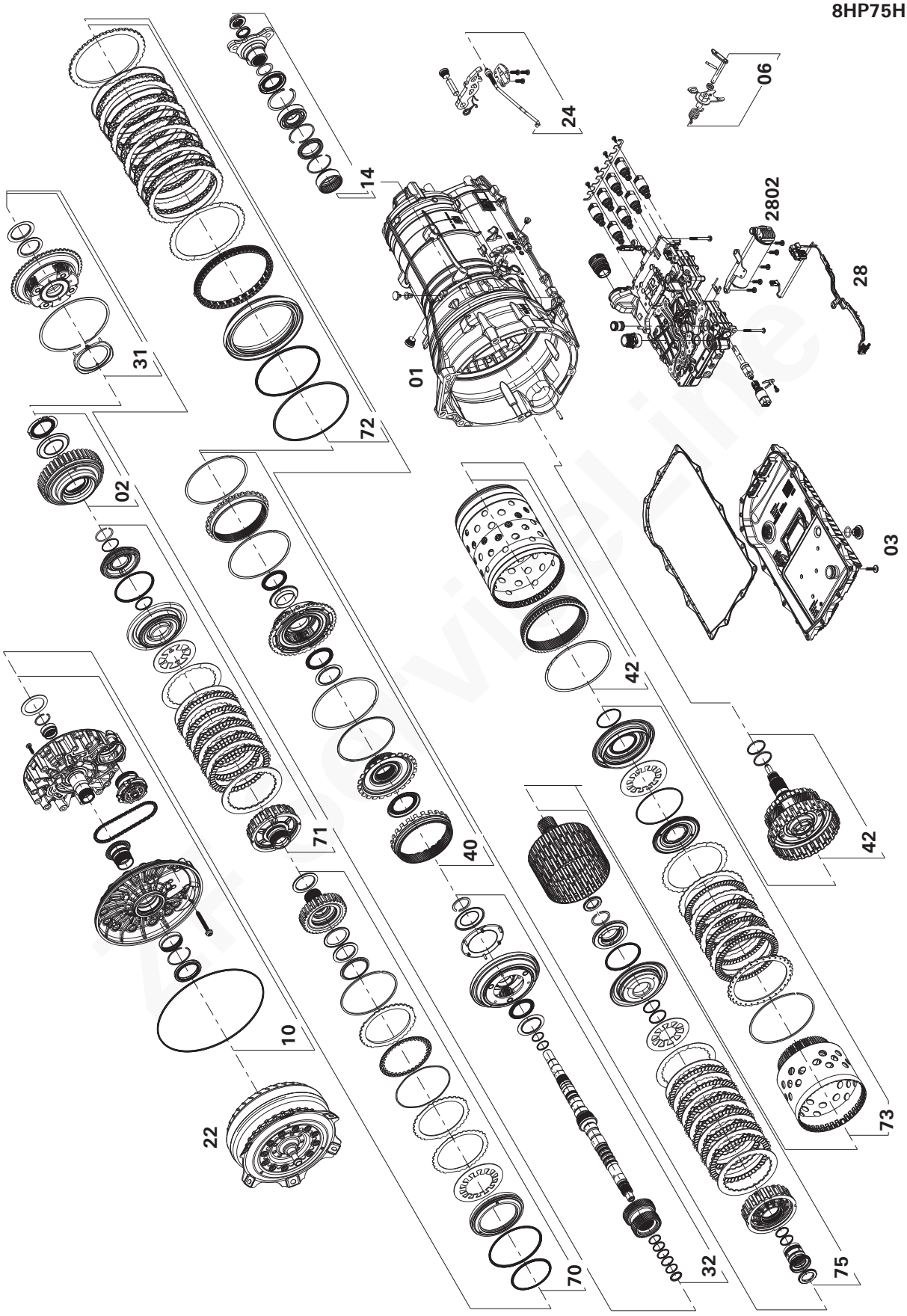
2201

8HP75HIS



Brief description of the 8HP transmission, general

The ZF 8HP ... automatic transmission was developed for vehicles with a transmission input torque of up to 1000 Nm (Newton-meters).

In keeping with the installation position of the engine the transmission is also positioned longitudinally. The mechanics of the automatic transmission operates on the basis of the planetary gear set and has a hydraulic-electronic controller. The hydraulic control unit and the electronic control unit are installed as a single unit in the automatic transmission (mechatronic control unit).

The transmission has a so-called “Stand-By-Control”. That means that instead of allowing the engine to work against the torque converter when the vehicle is at a standstill (“foot on the brake”) the torque converter is decoupled from the driveline so that only a minimal load remains. This produces a further reduction in fuel consumption.

The electronic transmission control unit is based on the newly developed “ASIS” - **A**daptive **S**h**i**ft **S**trategy.

The power is fed into the transmission via a hydrodynamic torque converter (three-line converter; see reference) with an integral lock-up clutch.

The torque transmission capacity is depending on the engine as follows for the various transmissions:

		[petrol / diesel engine]
8HP45	max. input torque	up to 450 Nm / 500 Nm
8HP50	max. input torque	up to 500 Nm / 500 Nm
8HP51	max. input torque	up to 500 Nm / 500 Nm
8HP70	max. input torque	up to 700 Nm / 700 Nm
8HP75	max. input torque	up to 700 Nm / 740 Nm
8HP76	max. input torque	up to 700 Nm / 740 Nm
8HP90	max. input torque	up to 900 Nm / 1000 Nm
8HP95	max. input torque	up to 900 Nm / 1000 Nm

The 8 forwards speeds and the single reverse gear are achieved by linking four single planetary gear sets. The two front planetary gear sets have a joint sun gear and thus form a “Simpson gear train”. The output is always through the planetary carrier of the 4th gear train which also forms the output shaft.

The two front planetary gear sets consist of the following:

1 double sun gear
3 to 5 planetary gears (depending on transmission type and design relative to the torque to be transferred),
1 planet carrier,
1 internal ring gear.

The two other planetary gear sets consist of the following:

1 sun gear,
3 to 4 planetary gears (depending on transmission type and design relative to the torque to be transferred),
1 planet carrier,
1 internal ring gear.

Brief description

The following act as shift elements:

2 multidisk brakes (brake a and brake B)
3 multidisk clutches (clutches C, D and E).

The 8HP51 and 8HP76 transmission series have been significantly improved by a variety of individual measures, such as increasing the transmission spacing and significantly reducing the friction in the central transmission. This contributes to lower fuel consumption in vehicles equipped with these transmissions.

The present technical manual also applies analogously to the 8HP45X, 8HP50X, 8HP51X, 8HP70X, 8HP75X, 8HP76X, 8HP90X and 8HP95X transmissions. These transmissions are intended for use in allwheel drive vehicles and are ready for assembly of a transfer case. The transfer cases are assembled by the customer and contain either a multidisk clutch or an intermediate differential for driving the front axle.

Transmissions that have hydraulic impulse oil storage (HIS, see section “HIS”) enable what is known as the “stop/start function.”

Transmissions equipped with an integrated electric auxiliary oil pump (IEP, see section “Oil supply”) enable the driving condition of “sailing.” The engine and transmission are functionally separated; the engine is switched off or only idles. The vehicle uses its flywheel mass to coast. If the vehicle speed falls below a defined value, the engine is restarted and is coupled to the transmission.

The hydrodynamic torque converter

How the torque converter works

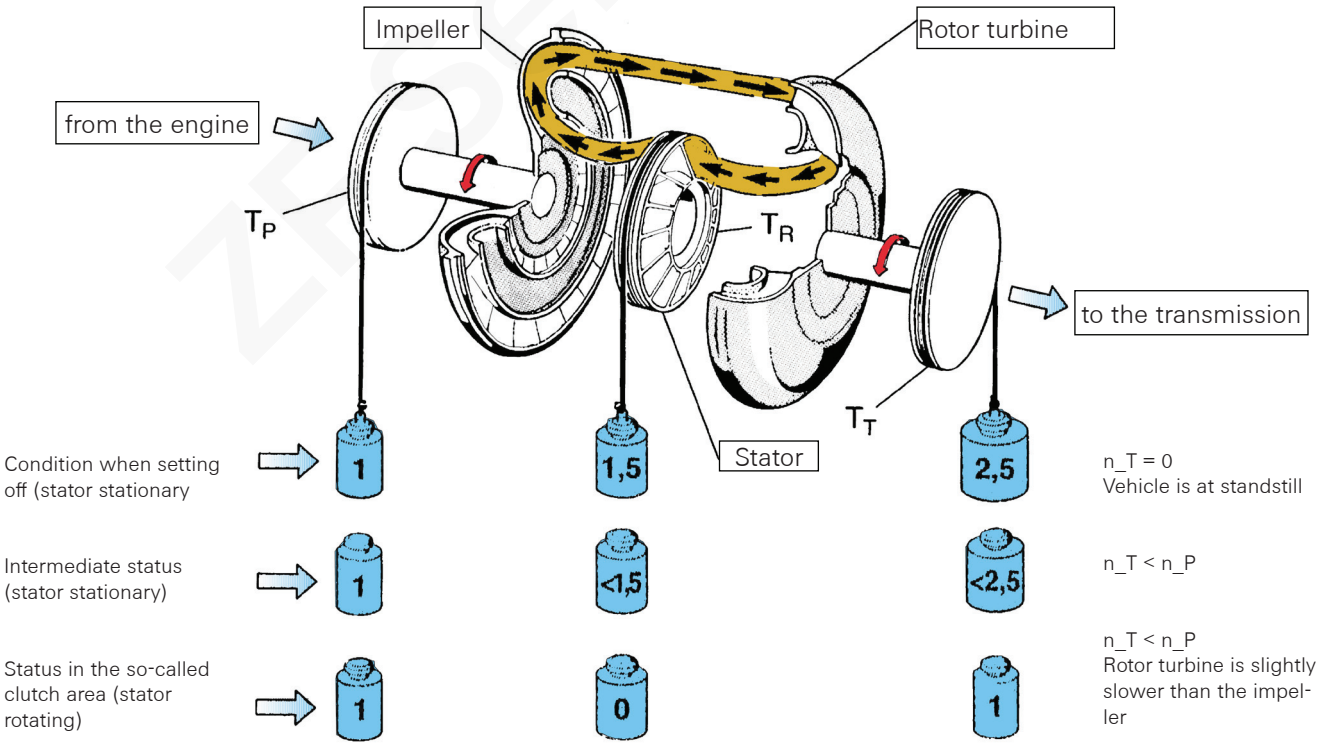
The torque converter consists of the impeller, the rotor turbine, the reaction link (stator) and the oil required for the torque conversion process.

The impeller which is driven by the engine causes the oil in the torque converter to flow in a circular direction. This oil current strikes the rotor turbine where it is deflected in the flow direction. In the hub area the oil leaves the turbine and comes to the reaction link where it is once again deflected and thus fed into the appropriate flow direction towards the impeller.

The change of direction creates a torque at the stator whose reaction torque increases the turbine torque. The ratio of the turbine torque to the pump torque is known as the torque increase. The greater the speed differential between the pump and turbine, the greater the torque increase, and the torque increase reaches its maximum value when the turbine is at a standstill.

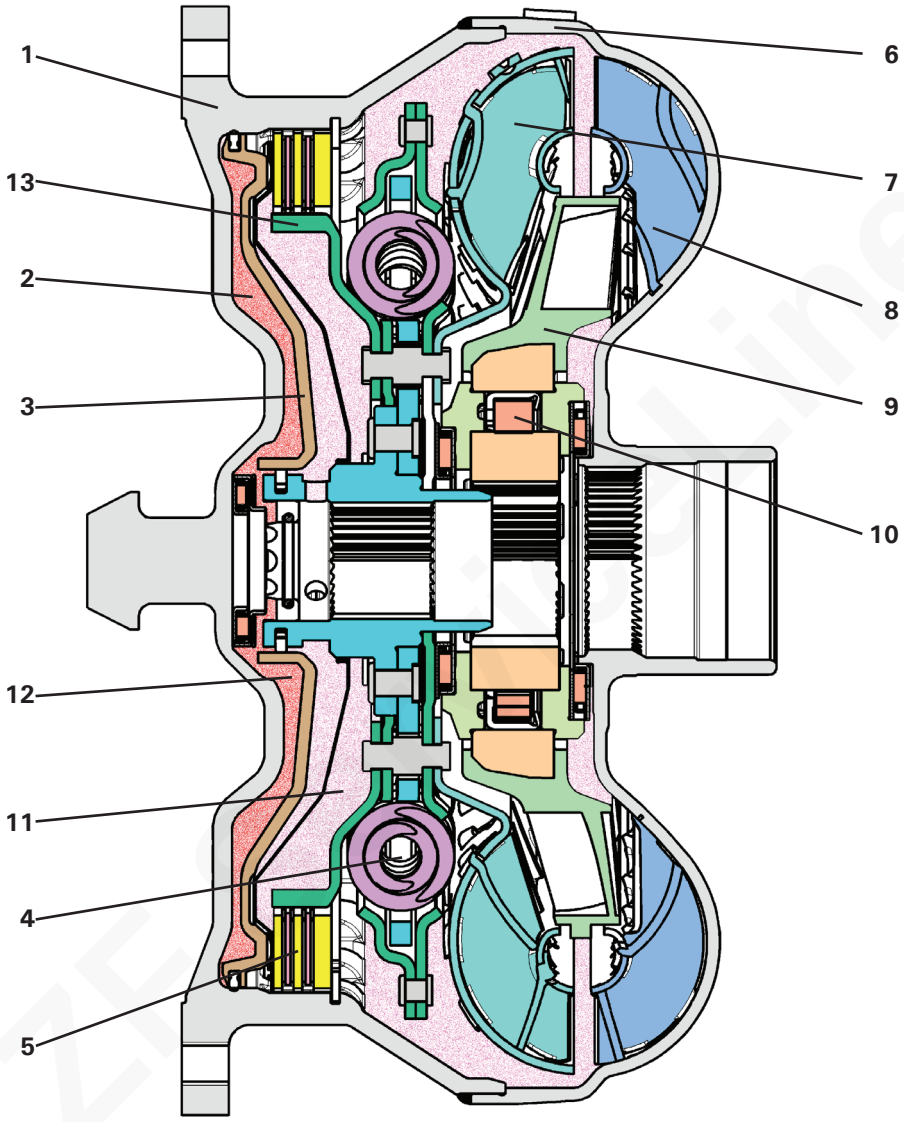
As the turbine speed increases, the torque increase falls. When the turbine speed reaches approx. 85% of the pump speed the torque increase = 1. That means that the turbine torque is equal to the pump torque.

The impeller which is supported towards the transmission housing by the freewheel and the stator shaft now runs freely in the current whilst the freewheel is turned. From this point the torque converter acts purely as a fluid clutch. During the torque conversion process the stator is stopped and is supported towards the housing by the freewheel.



Three-line torque converter 8HP ... with torsional damper

Line 1 = Torque converter input (pump / turbine chamber)
Line 2 = Torque converter output (pump / turbine chamber)
Line 3 = Chamber to apply pressure to the converter lock-up clutch

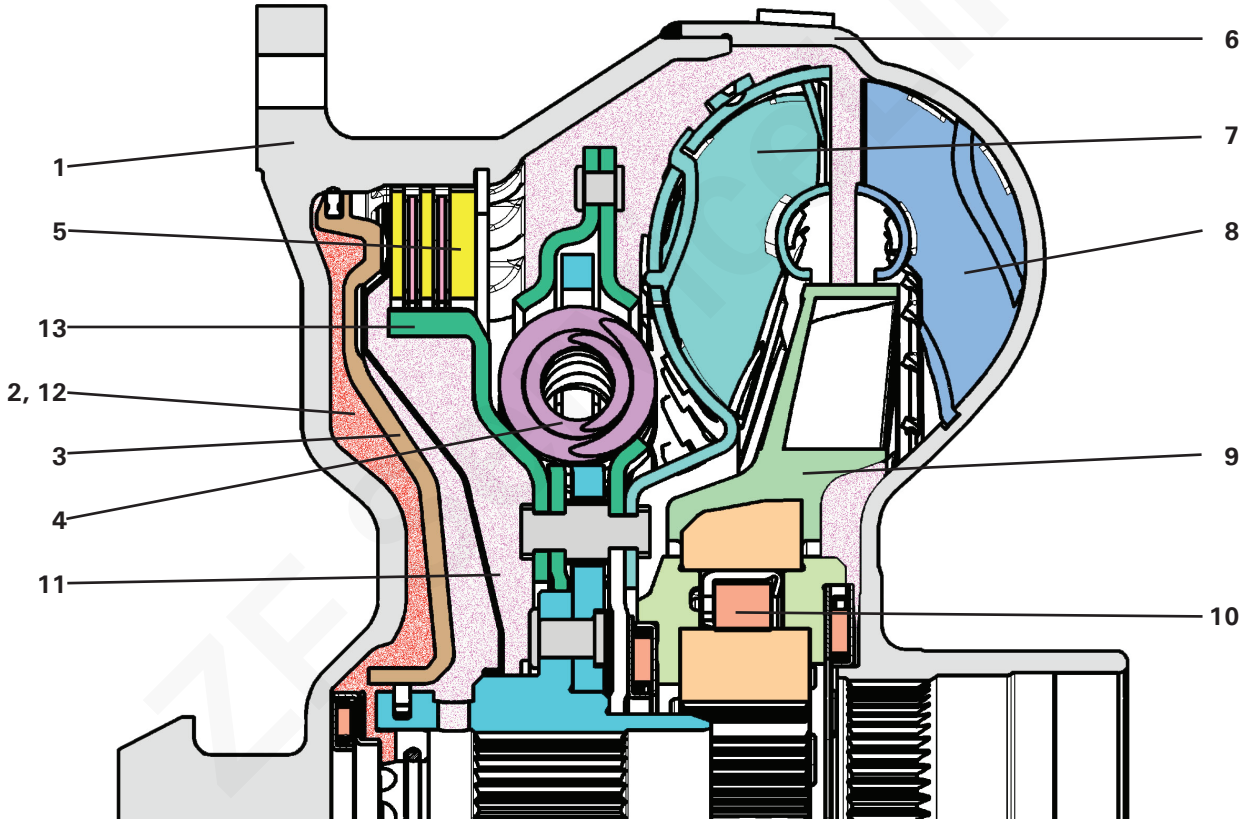


1 Cover / External disk carrier WK (n_mot)
2 Chamber to WK (Converter lock-up clutch)
3 WK piston
4 Torsional damper
5 WK clutch package Lined disk and external disk
6 Converter cover
7 Turbine
8 Pump
9 Stator
10 Stator freewheel
11 Line 1 and 2 (pump and turbine chamber)
12 Line 3 (chamber to apply pressure to the WK)
13 WK internal disk carrier

Converter lock-up clutch (WK)

The converter lock-up clutch (WK) is a device which eliminates slip in the converter and therefore helps to improve fuel consumption.

The type of activation is autarchic. That means that the WK is closed and opened in a controlled fashion independently and decoupled from the turbine chamber. During the control phase a low differential speed is set between the pump and turbine. This prevents the engine rotary oscillations, which are also attenuated by a torsional damper, being transferred into the transmission. This process achieves optimum shift quality and improves the acoustic properties. The pressure control on the WK piston is determined by an electronic pressure control valve (EDS WK; see oil system diagram). The WK can be controlled and closed from 1st to 8th gear at the request of the vehicle manufacturer.

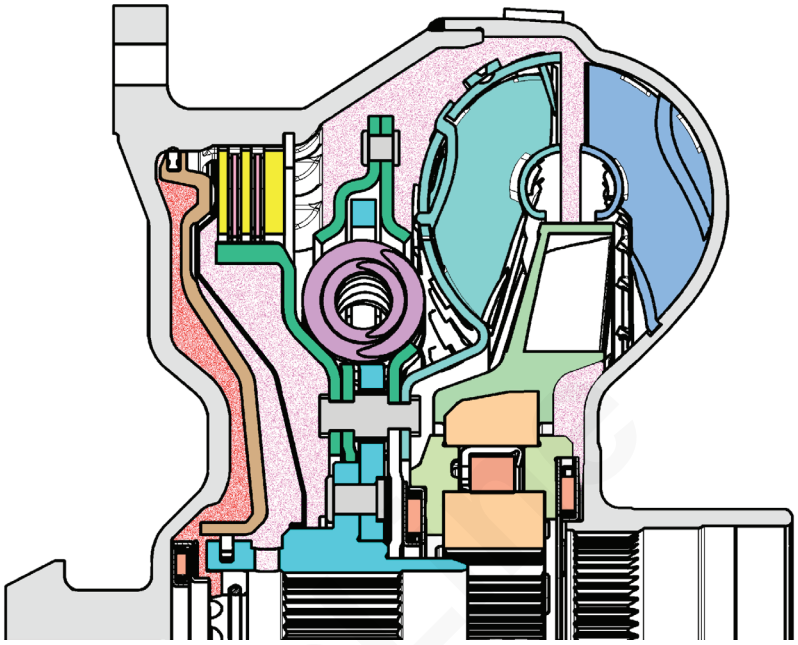


1 Cover / External disk carrier WK (n_mot)
2 Chamber to WK (Converter lock-up clutch)
3 WK piston
4 Torsional damper
5 WK clutch package Lined disk and external disk
6 Converter cover
7 Turbine
8 Pump
9 Stator
10 Stator freewheel
11 Line 1 and 2 (pump and turbine chamber)
12 Line 3 (chamber to apply pressure to the WK)
13 WK internal disk carrier

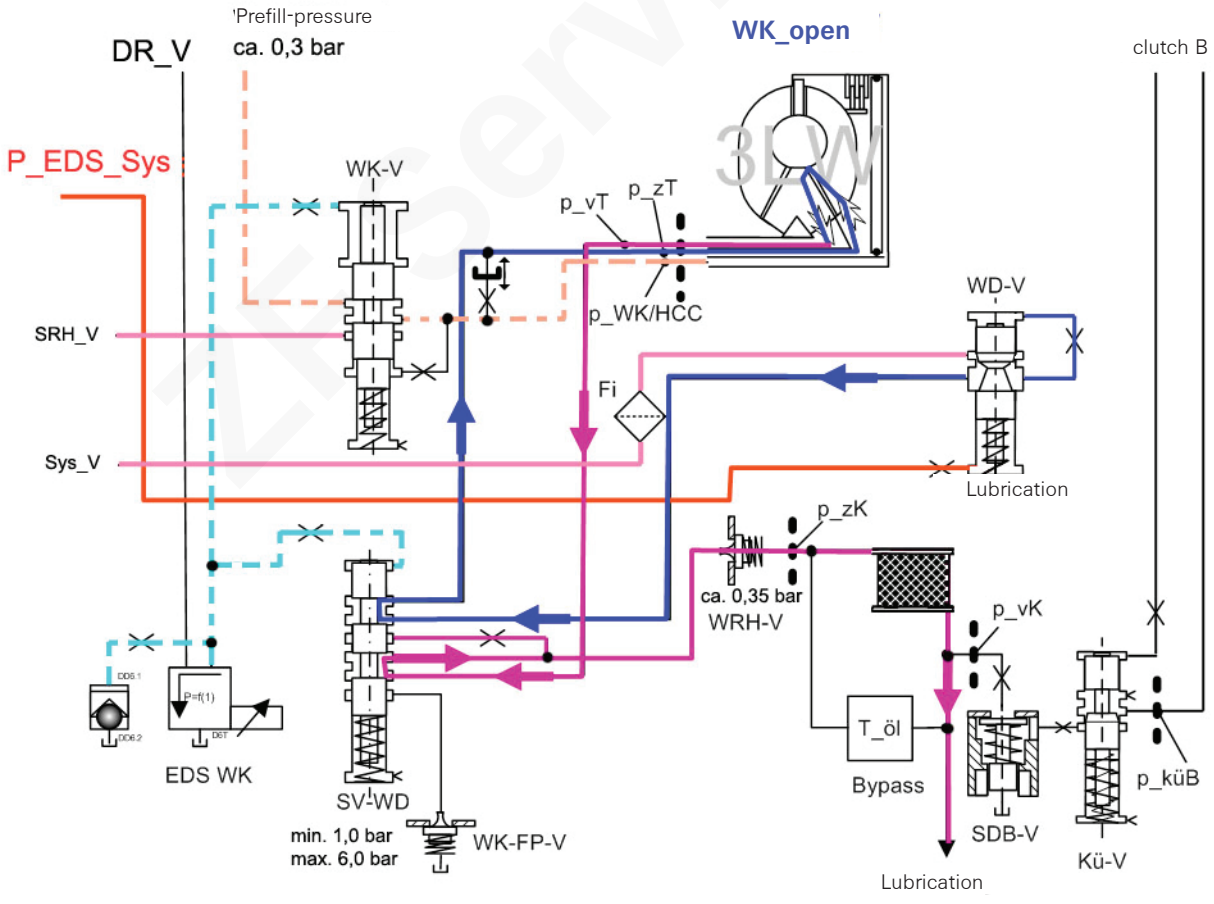
Hydraulic-mechanical action in the torque converter

WK_open n_Mot > n_Turbine

When opened (conversion range) the WK piston (3) has no pressure apart from a prefilling pressure (approx. 0.3 bar). The oil pressure in the turbine chamber pushes the piston into is rest position. A change of flow direction, as in previous versions, does not take place (autarchic clutch using 3-line system). The converter clutch valve (WK_V) and the converter switching valve (SV_WD) are in their rest positions. The oil pressure set by the converter pressure valve (WD_V) can therefore get into the turbine chamber through a switching point on SV_WD. The pressurized oil is fed from the turbine chamber output through a second switching point on the SV-WD into the radiator and for lubrication.

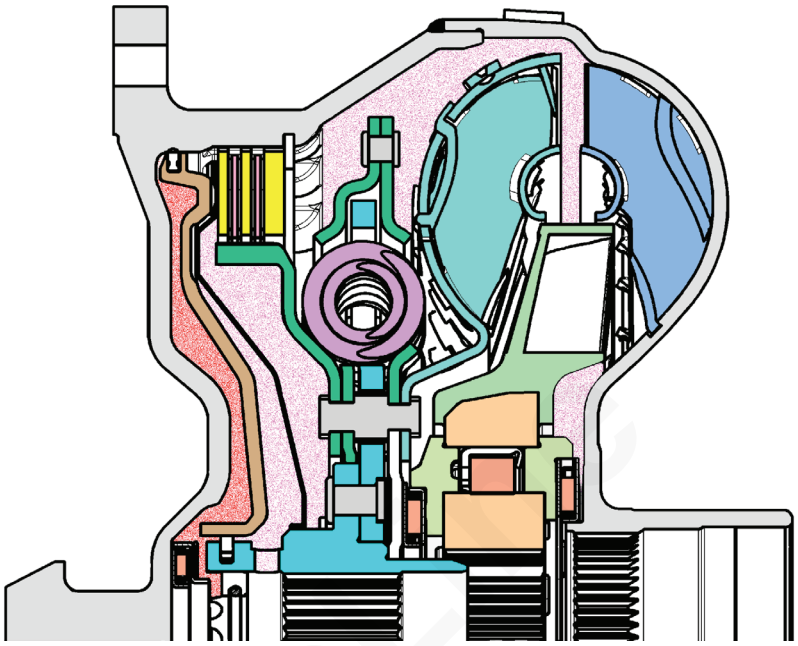


Oil system WK_open

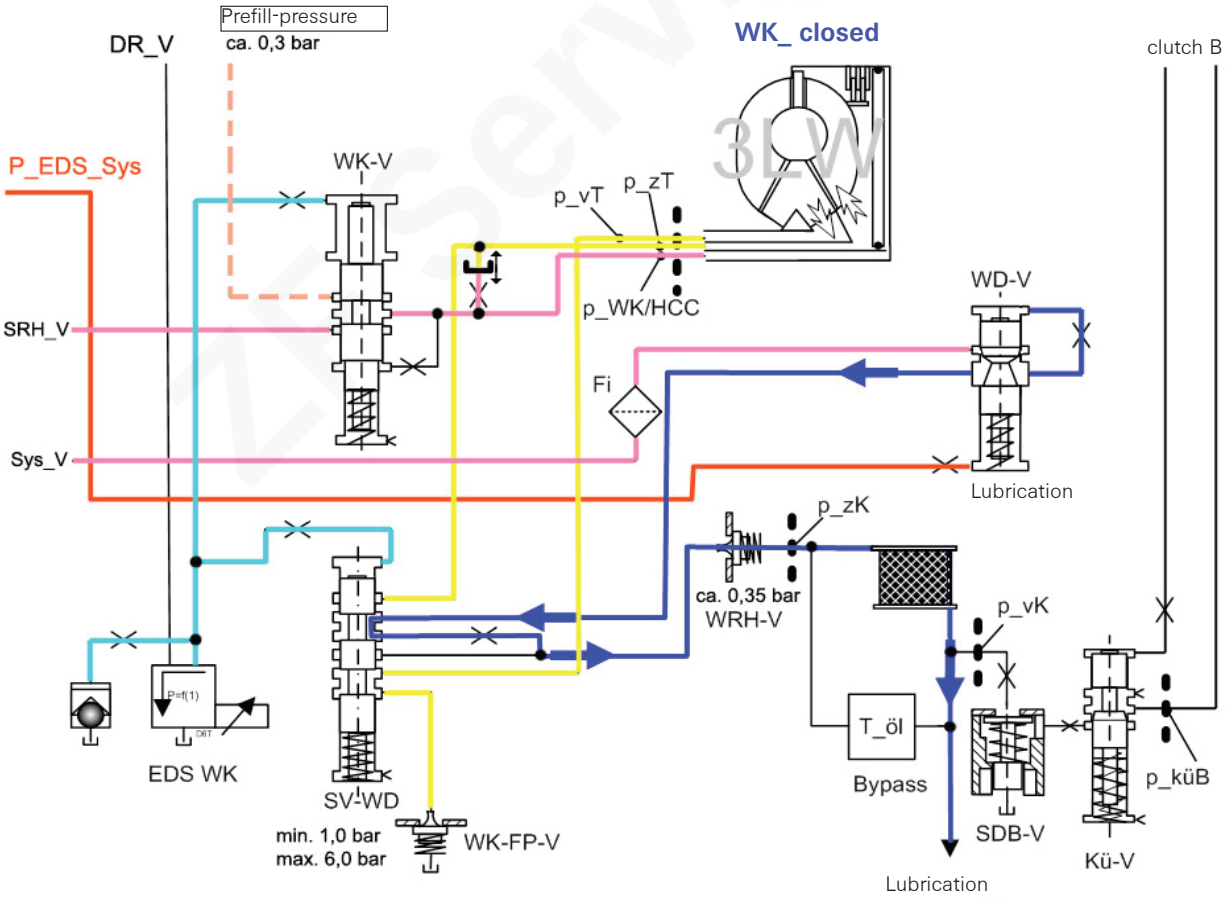


WK_closed n_Mot = n_Turbine

The converter lock-up clutch is supplied with pressurized oil, direct from the converter clutch valve (WK_V). In this situation the turbine chamber is supplied via a bypass from the WK piston chamber to the turbine. The converter switching valve (SV_WD) is switched over. This means that the converter pressure valve (WD_V) does not drain the oil pressure into the converter but direct via the cooler for lubrication.



Oil system WK_closed



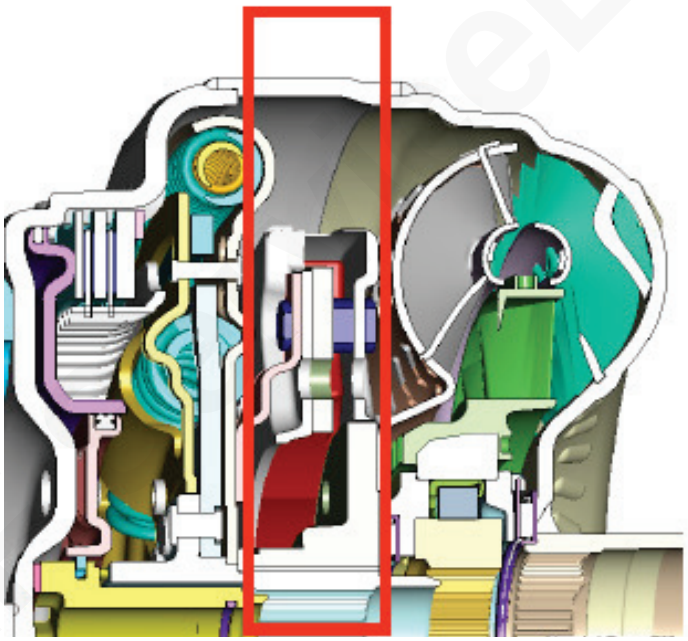
DAT - speed-adaptive vibration damper

The speed-adaptive mass damper dampens the natural frequencies of the combustion engine. Torque converters with speed adaptive mass damper help reduce engine speeds considerably – „downspeeding“. Normal vibration dampers are adjusted to a (/an interfering) frequency and reduce the respective vibrations.

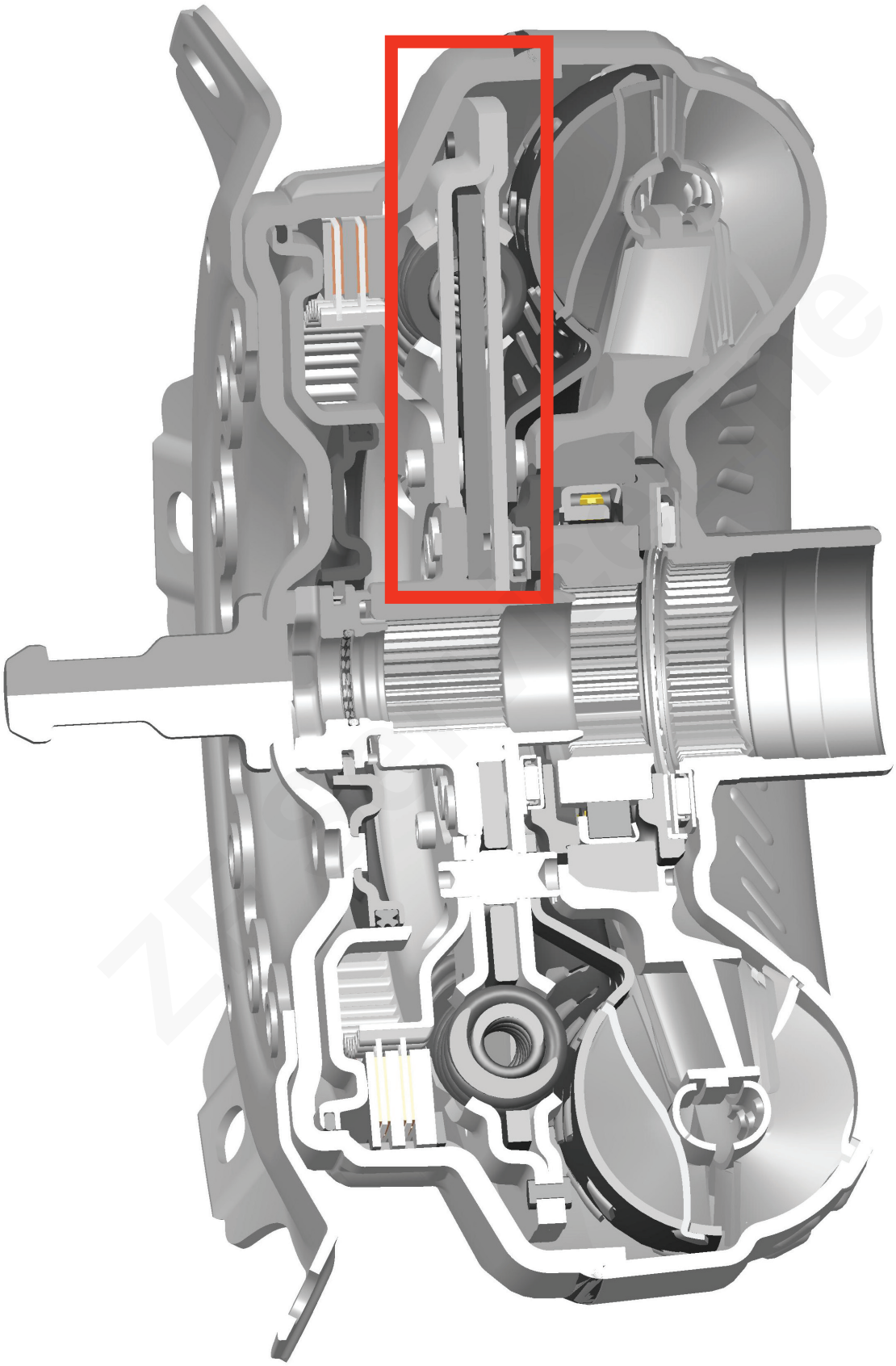
A speed-adaptive vibration damper has a tuning frequency which changes with the speed. It is therefore possible to dampen a specific vibration order over the entire speed range. This behavior is particularly suited to car engines which excite fixed vibration orders. A speed-adaptive mass damper can be implemented using a centrifugal pendulumtype absorber.

DAT1: Starting with the 2nd transmission generation, the 4th order of the torsional vibrations were able to be eliminated by further development of the series design. This leads to optimization of the rotational irregularity in the speed range above 1200 rpm.

DAT2: Starting with the 3rd transmission generation, the DAT connection is also on the secondary side. And that in turn optimizes the torsional vibration behavior in the speed range below 1200 rpm.



DAT - speed-adaptive vibration damper

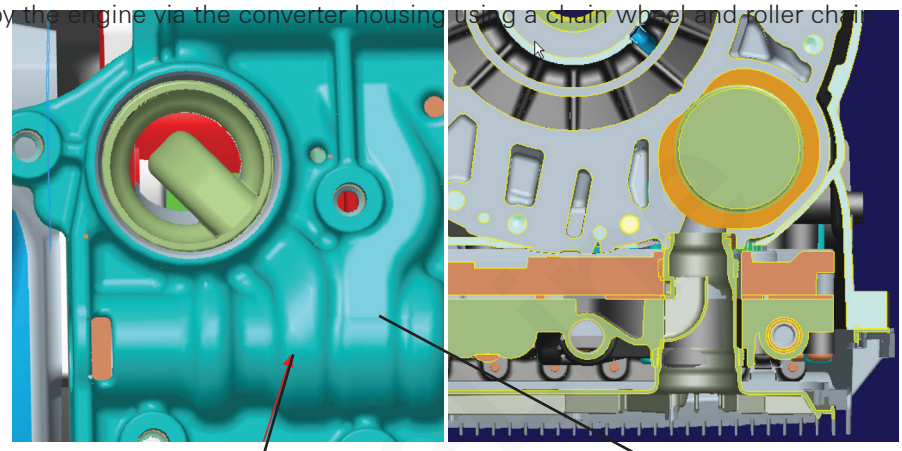


Oil pump (double stroke vane cell pump)

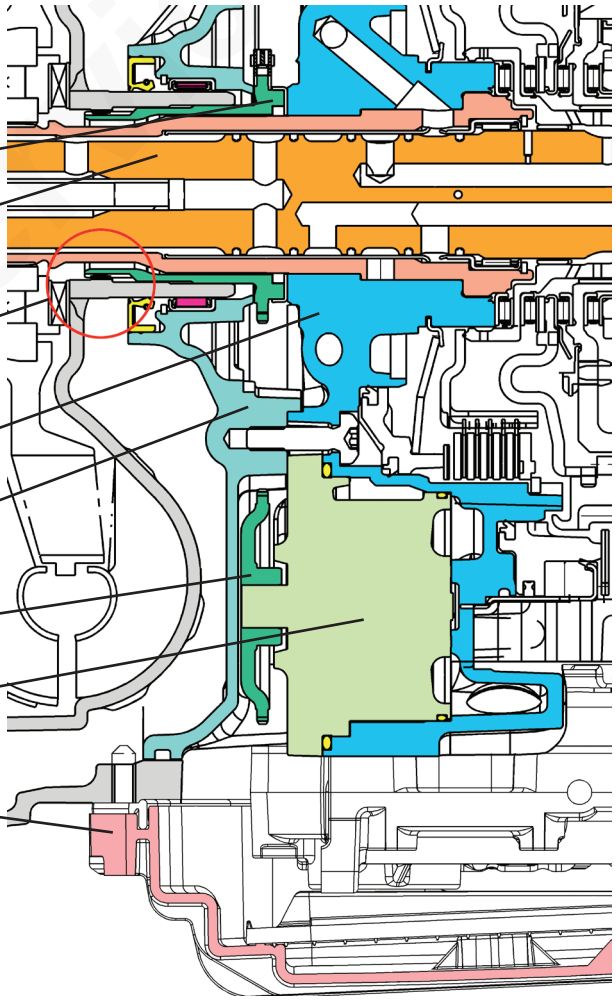
General

The oil pump is a “double stroke vane cell pump” with a capacity of 6.6 up to 42 l/min.

It is located inside the transmission near the centering plate / intermediate plate and supplies the transmission and the hydraulic control unit with oil. The installation position is parallel to the axis on the side above the oil level. It is powered direct by the engine via the converter housing using a chain wheel and roller chain. This bridges the centre distance between the oil pump and drive shaft.
The pump draws the oil in through a filter and feeds the pressurized oil to the system pressure valve in the hydraulic control unit.
This is where the oil pressure is adjusted.
The surplus oil is returned to the intake duct of the oil pump in the correct flow direction.
The energy released by this is used to charge the intake side.
This prevents cavitations and intake noise.



Location of the oil pump



Design

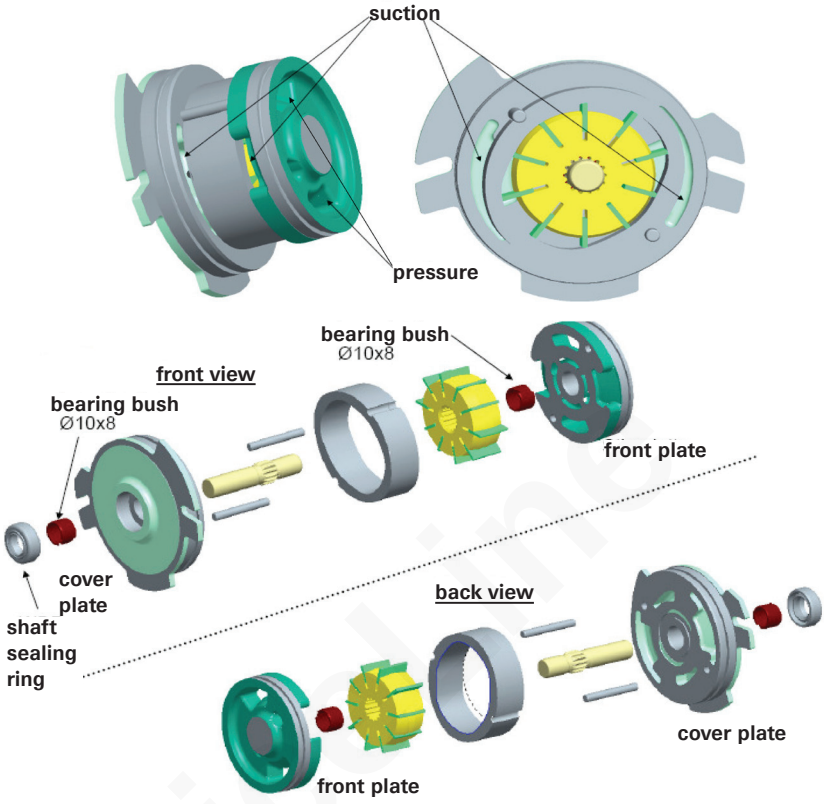
The advantages of the double vane cell pump relate to its small diameter. In the case of the 8HP ... transmission:

approx.Ø 60 mm
approx. 30 mm depth

The large diameter of the converter hub means that a side position adjustment is required (axial offset double stroke vane cell pump).

The pump consists of the following:
- Shaft sealing ring
- Cover with bearing bush
- Rotor cylinder
- Rotor with multidisks (12 vanes)
- Shaft for rotor
- 2 centering pins for rotor cylinder
- End plate with bearing bush
- Chain wheel

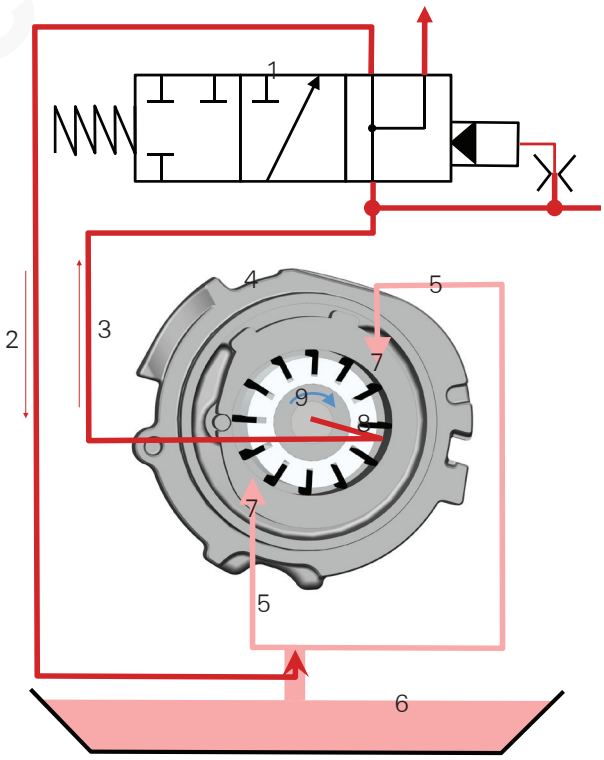
The double vane cell pump including the chain wheel is supplied assembled ready for installation and tested.



Technical data

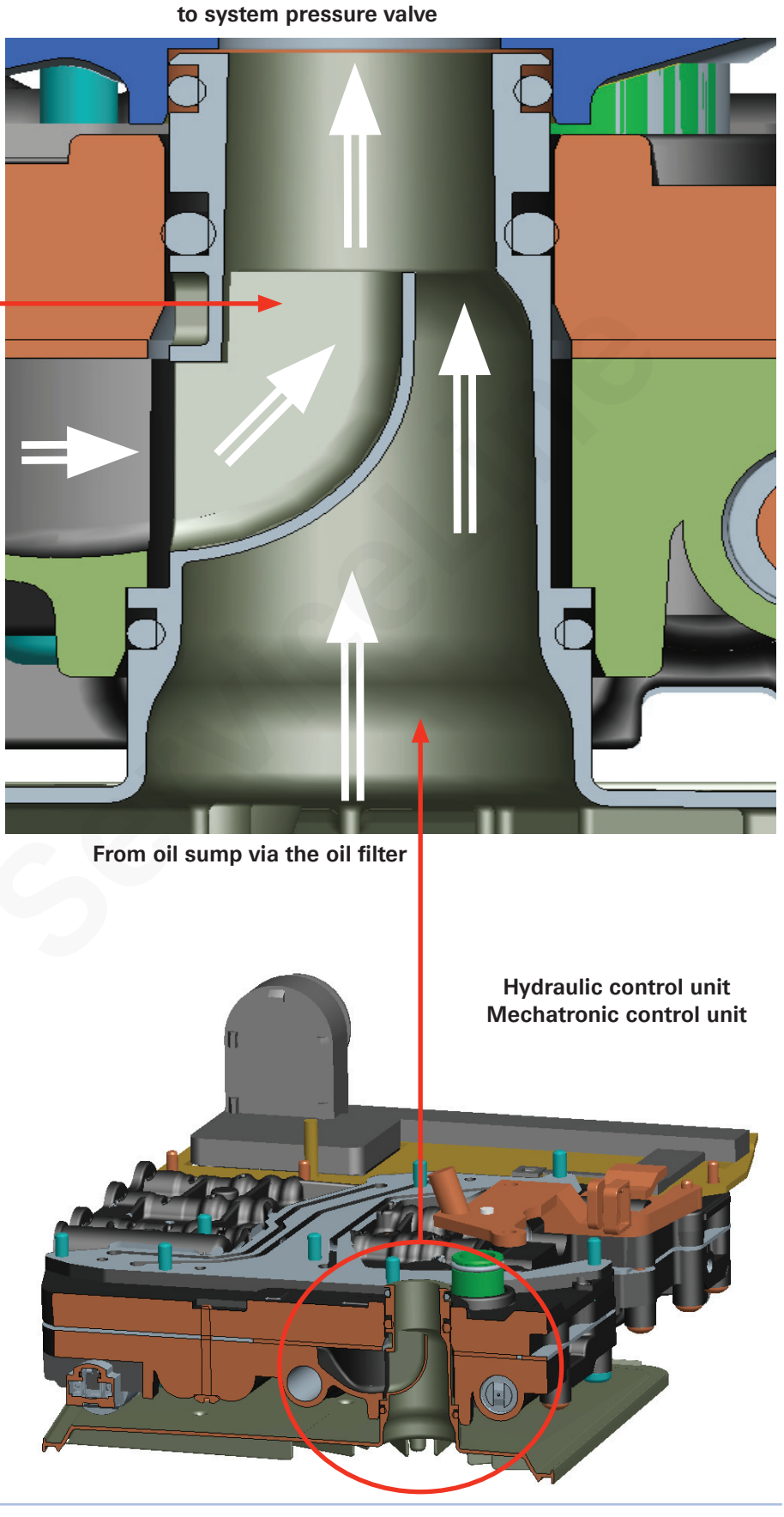
- System pressure	3.5 bar to 19 bar (1st generation) or 22 bar (2nd generation), max. 32 bar
- Oil delivery rate	7 to 22 l/min
- Pump speed	550 to 8600 rpm (depending on the ratio of the chain drive)

For 3rd generation transmissions, the lifting cam of the vane oil pump was reduced to 90%. The use of a new mechatronic control unit with a sliding pressure regulator and reduced internal transmission leakage keeps the total oil pump capacity the same.



1 System pressure valve
2 Return of excess oil
3 Pressure duct
4 Vane cell oil pump
5 Intake runner
6 Oil pan
7 Radial oil inlet
8 Axial oil outlet
9 Pump rotation direction

Pump charging



The pump draws in the oil from the oil sump through an oil filter and feeds it to the system pressure valve. This is where the system pressure is adjusted.

The surplus oil is returned to the intake duct in the correct flow direction. The energy released by this is used to charge the pump.

This is a major contribution to preventing cavitations and noise.

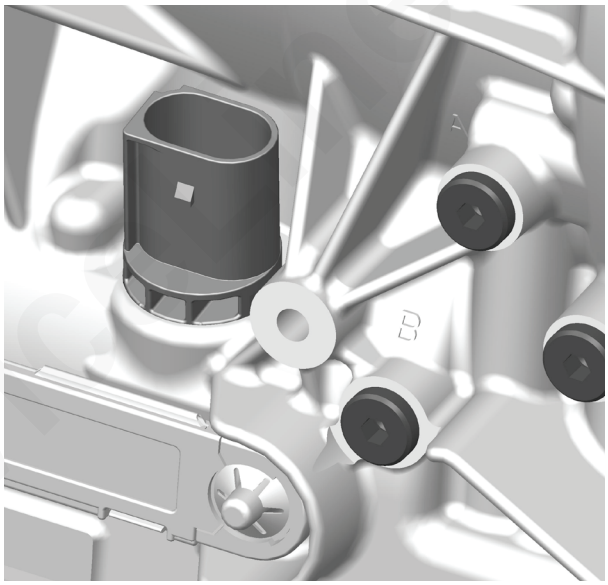
IEP - integrated electric auxiliary oil pump

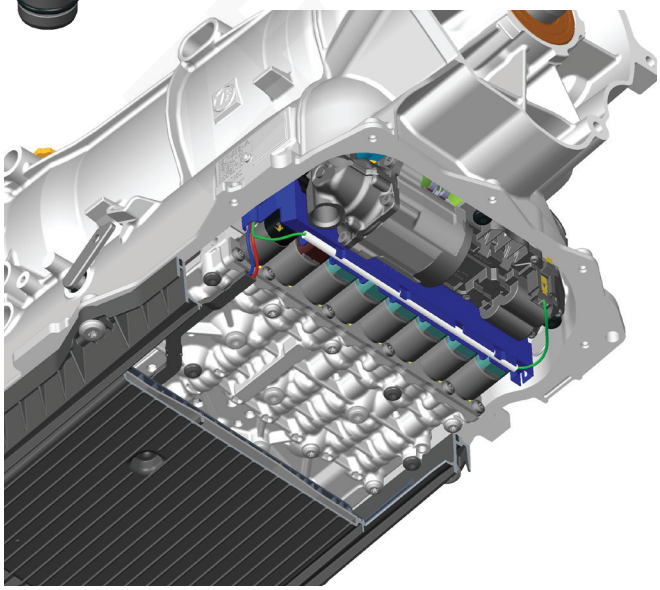
Some applications of the 3rd generation automatic transmission have an integrated electric auxiliary oil pump, which is housed in the oil sump. This is to ensure that oil is supplied to the transmission in operating conditions (e.g., "sailing") in which the oil supply cannot be provided by the conventional transmission oil pump. It supplies the corresponding switching elements with the necessary oil pressure. This allows the switching elements to be closed off. The electric pump is self-sufficient and is connected to the speed range selector module via a separate wiring harness. The wiring harness has two pressure contacts on the pump side and a two-pole plug on the speed range selector module side. Both the pump and wiring harness can be replaced individually.

Technical data:

Supply voltage:	6 to 16 volts (DC)
Operating point 1:	3 bar 5l/min
Operating point 2:	8 bar 8l/min
Operating temperature	
Active:	0°C to + 125°C
Passive:	-40°C to + 140°C

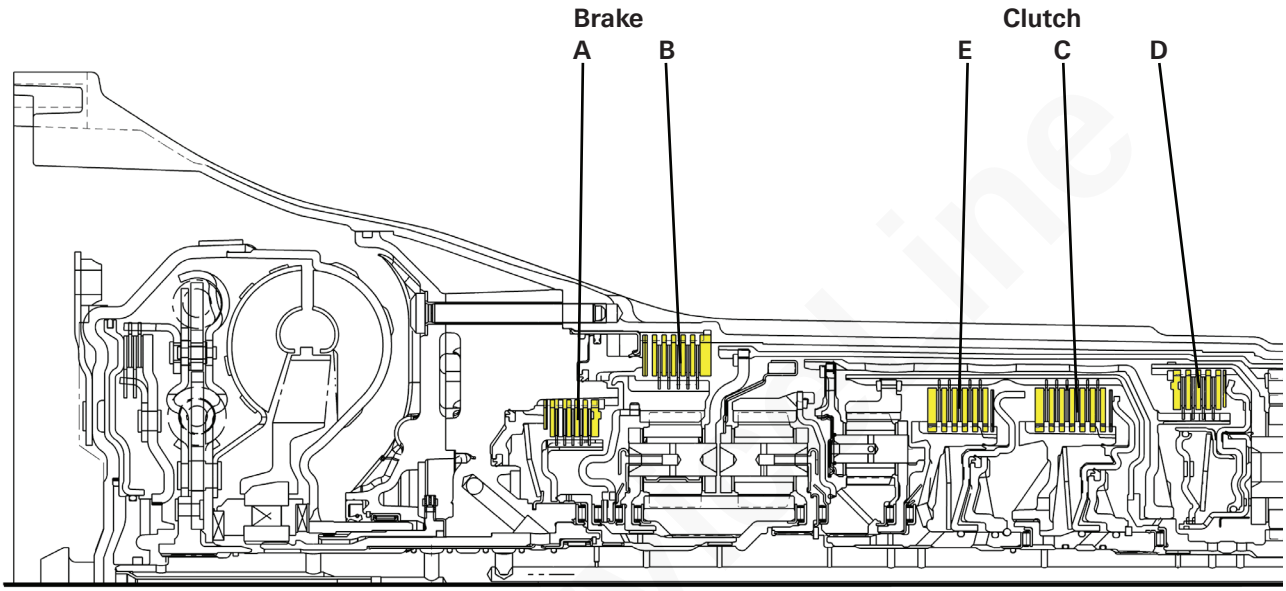
Connection of the IEP





Apart from the converter lock-up clutch (WK) the following act as shift elements:

- **2 fixed multidisk brakes A and B,**
- **3 revolving multidisk clutches E, C and D.**



All upshifts from 1st gear to 8th gear and all downshifts from 8th gear to 1st gear are clutch-to-clutch shifts. . That means that during a shift operation a clutch must remain capable of transfer with reduced main pressure until the other clutch can transfer the current torque.

The shift elements (clutches or brakes) are closed hydraulically. The oil pressure moves between the cylinder and piston which presses the disk package together.

When the oil pressure falls the disk spring on the piston pushes the piston into its initial position.

The piston in transmissions of the 8HP45, 8HP70, and 8HP90 model ranges is hydraulically pressurized both during opening and closing of multidisk brake B (double-acting cylinder). In transmissions of the 8HP50 and 8HP75 model ranges, it is different: In those, multidisk brake B opens via a pack of axial coil springs that are arranged in a ring.

The shift elements are designed to make the shifts under load and without interrupting the traction force.

The multidisk clutches C, D and E feed the engine power into the planetary gear set.
The multidisk brakes A and B support the torque on the transmission housing.

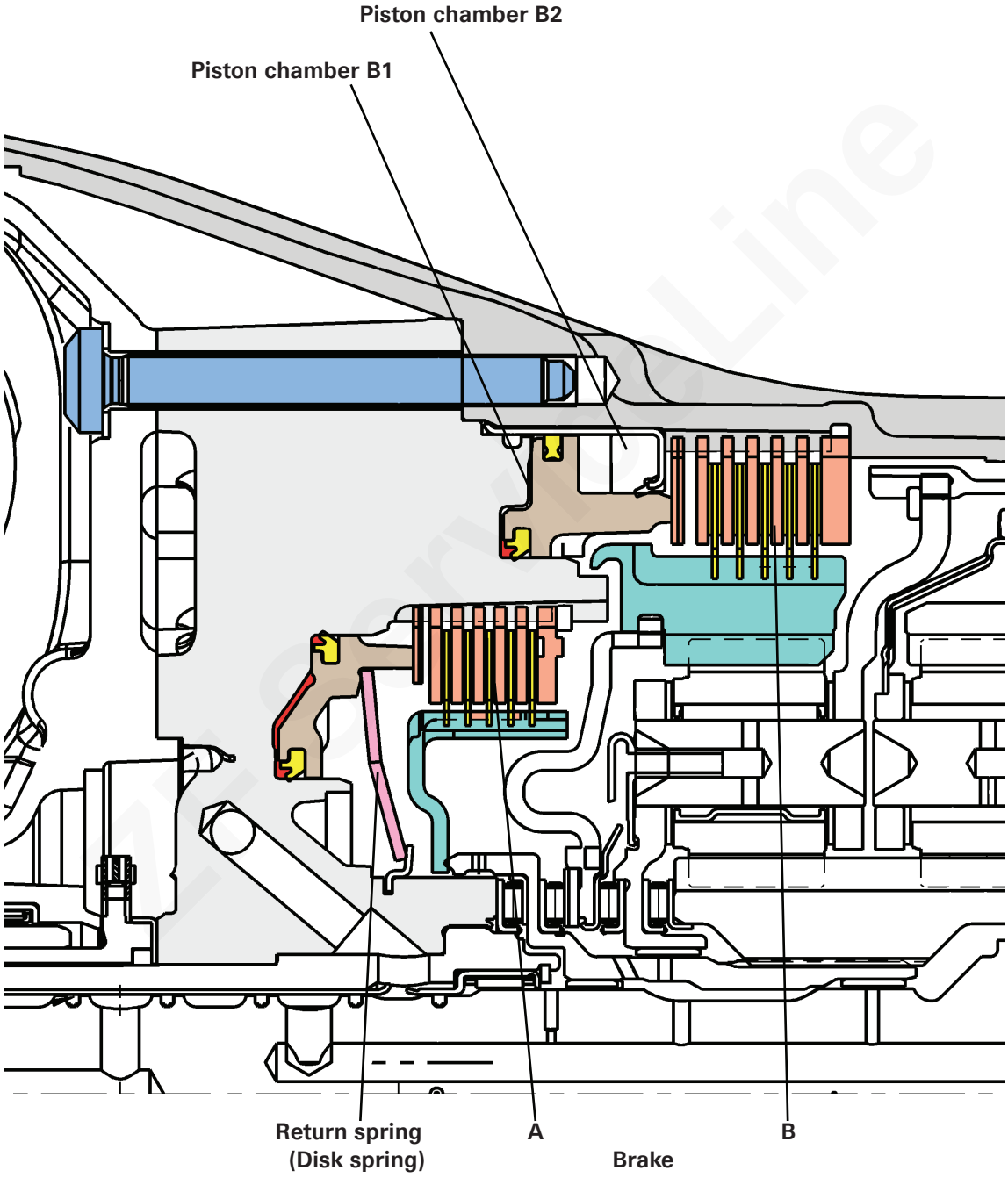
When the various gears are engages there are always three shift elements closed and two shift elements open (see gear description).

8HP45 / 8HP70 / 8HP90 - Multidisk brakes A and B

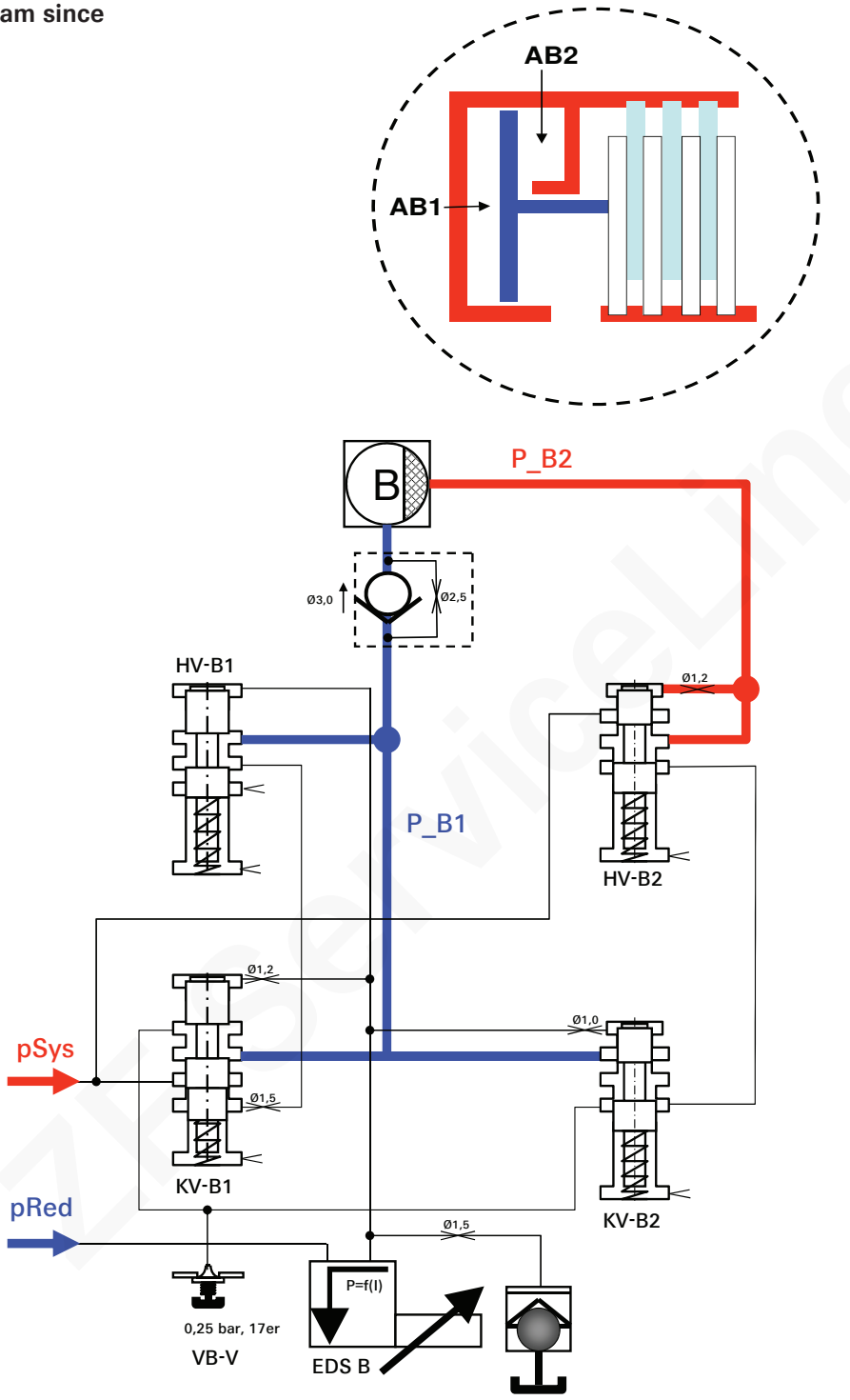
Brake “B” (starting brake B) is designed with two pistons and without a return spring and is actively cooled by the hydraulic control unit (hydraulic module).

The controller for brake “B” is designed such that when the brake is vented in piston chamber “B2” a residual oil pressure remains so that the piston is pushed back into its rest position.

In contrast to brake “B”, brake “A” is designed with one piston and one return spring.

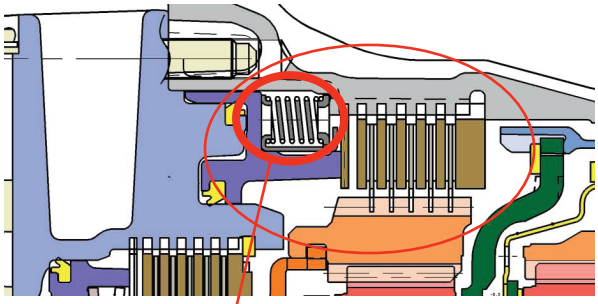


8HP45 / 8HP70 / 8HP90
Brake B diagram since state M-SPT3

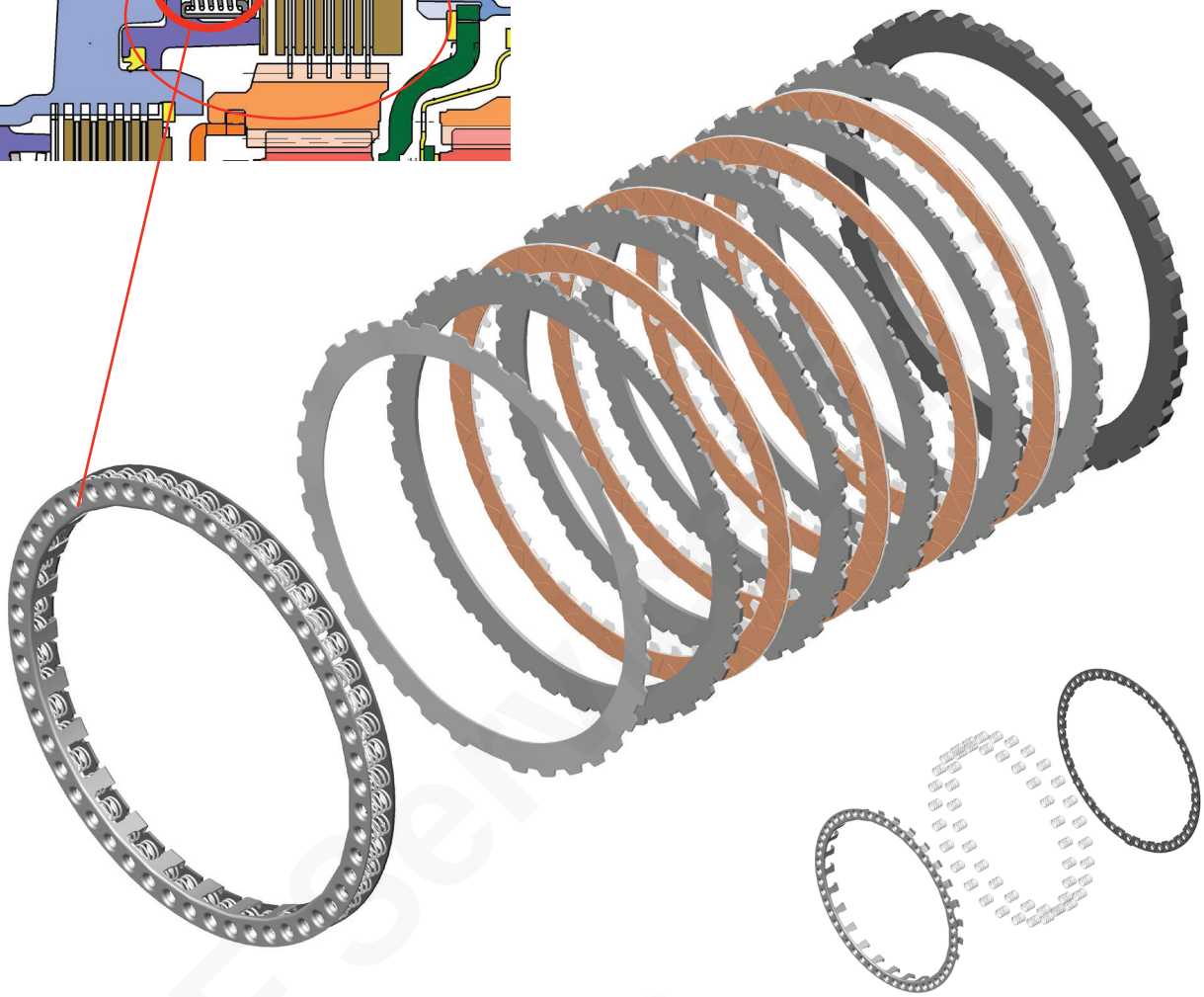


HV-B1	=	Pressure-holding valve brake B1
HV-B2	=	Pressure-holding valve brake B2
KV-B1	=	Clutch valve brake B1
KV-B2	=	Clutch valve brake B2
VB-V	=	Prefilling valve
EDS B	=	Electronic pressure control valve brake B1 / B2
P_B1	=	Oil pressure brake B1
P_B2	=	Oil pressure brake B2

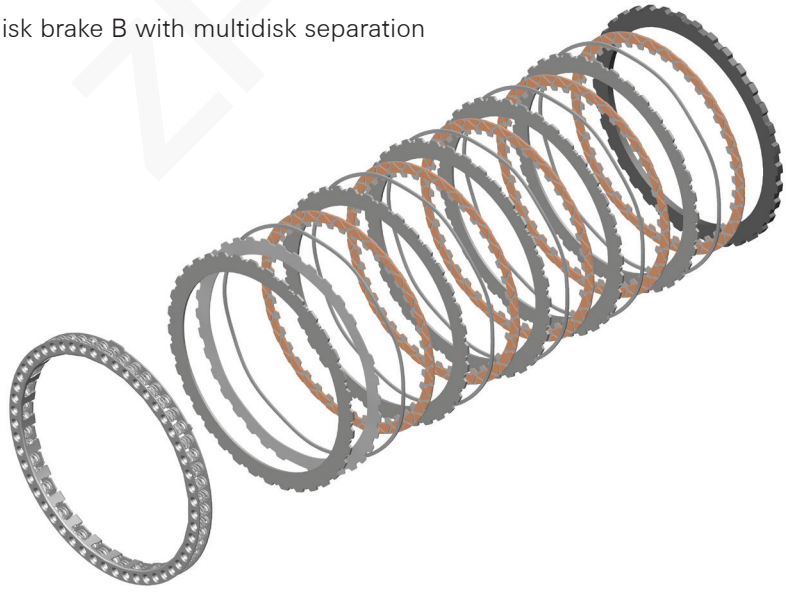
8HP50 / 8HP51 and 8HP75P75 / 8HP76: new piston in multidisk brake B and multidisk separation

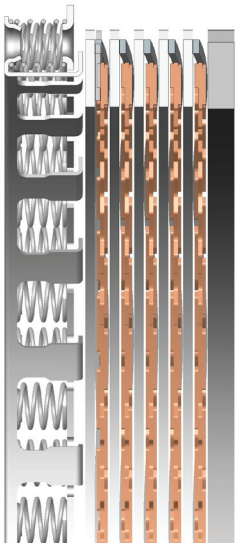


A compression spring pack replaces piston surface B2 of multidisk brake B in the 8HP50 and 8HP75 transmissions.



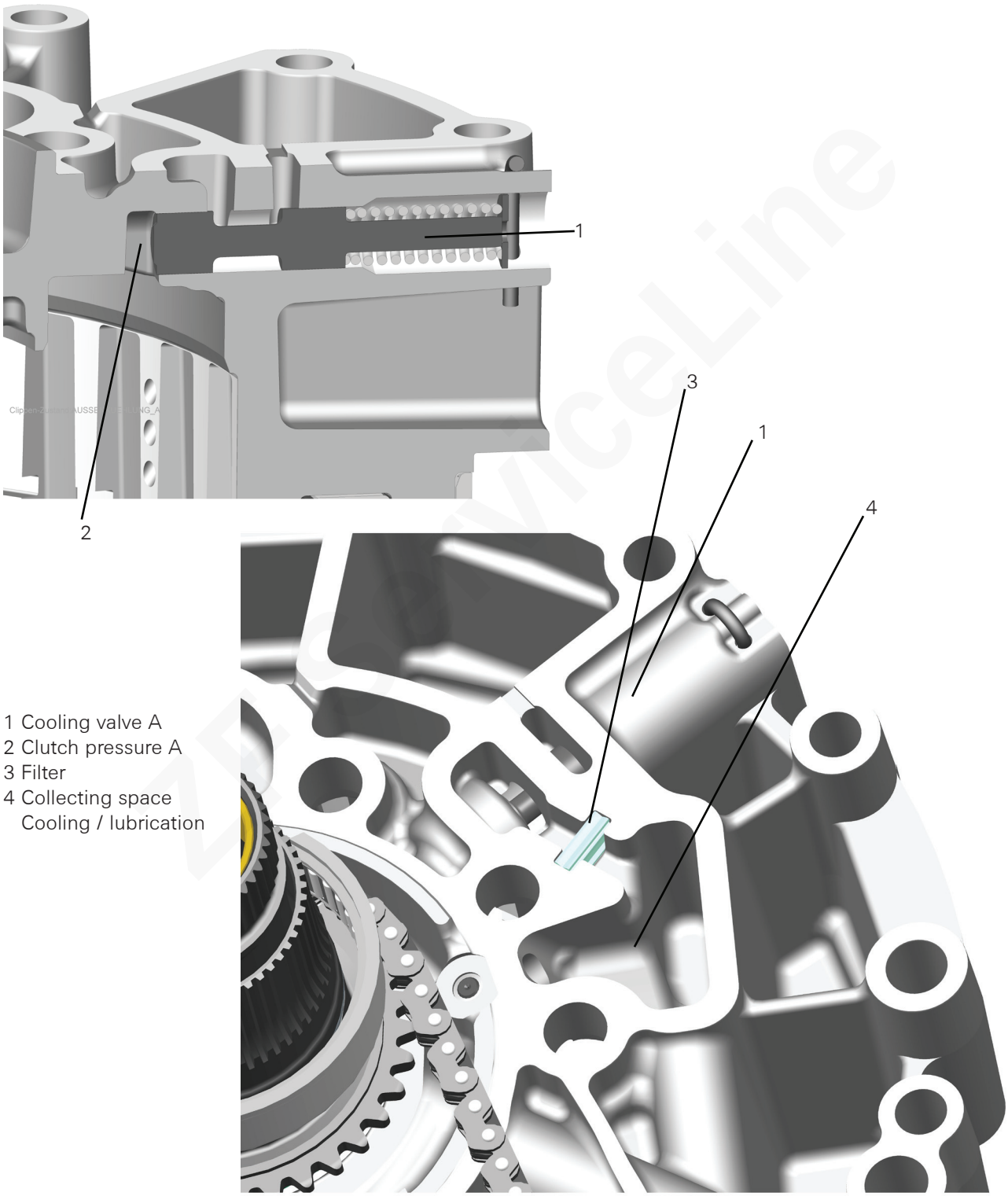
Multidisk brake B with multidisk separation





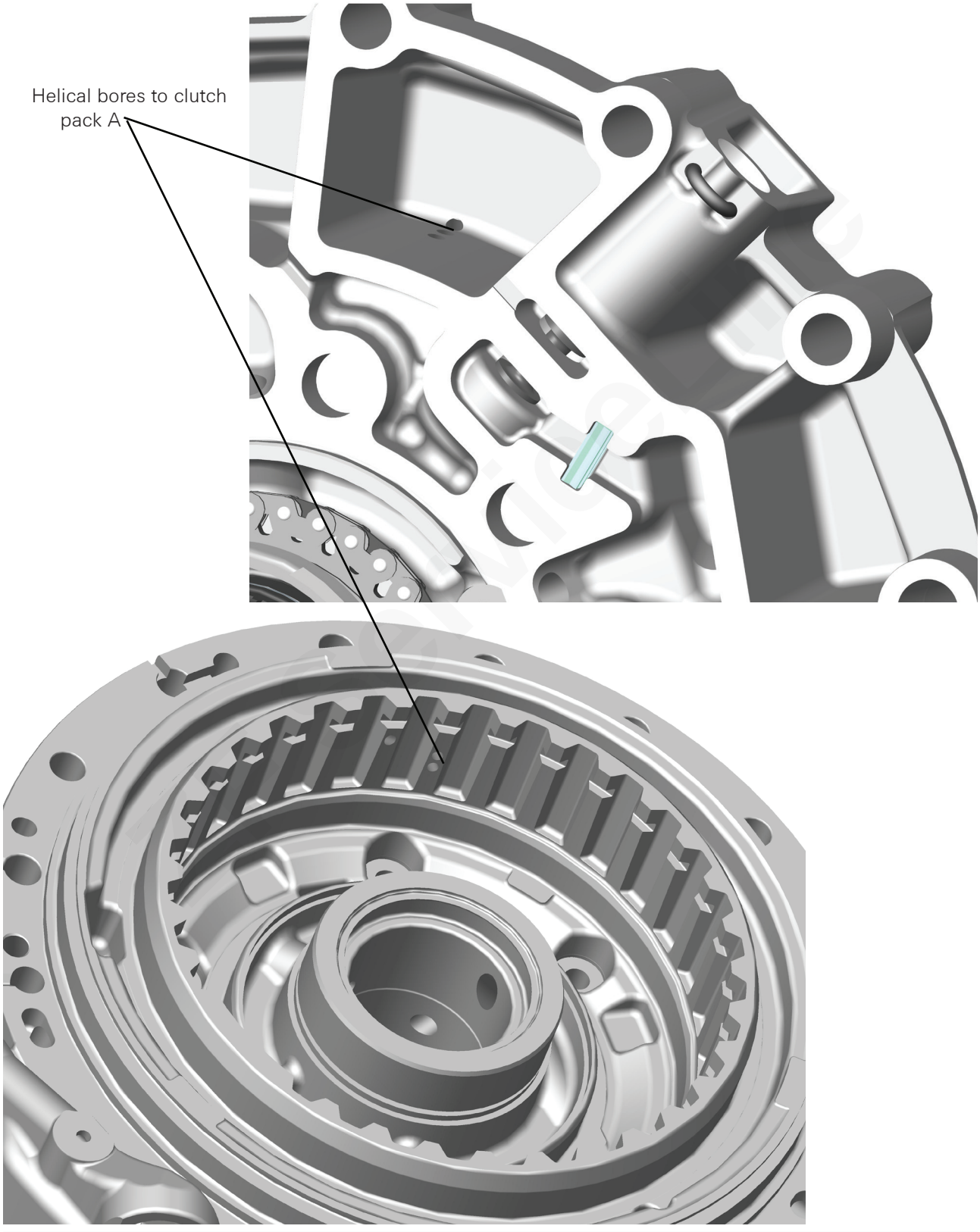
8HP51 and 8HP75 / 8HP76: surface cooling of multidisk brake A

Multidisk brake A is normally cooled from the input shaft with ATF via an orifice plate. When the multidisk brake is closed his cooling mechanism only has a limited effect. For transmission applications subject to high stress, gears 7 and 8 can be provided with an extra cooling option - surface cooling. With a clutch pressure of more than 8 bar a cooling valve opens and thus enables the supply of additional coolant (ATF) to multidisk brake A.



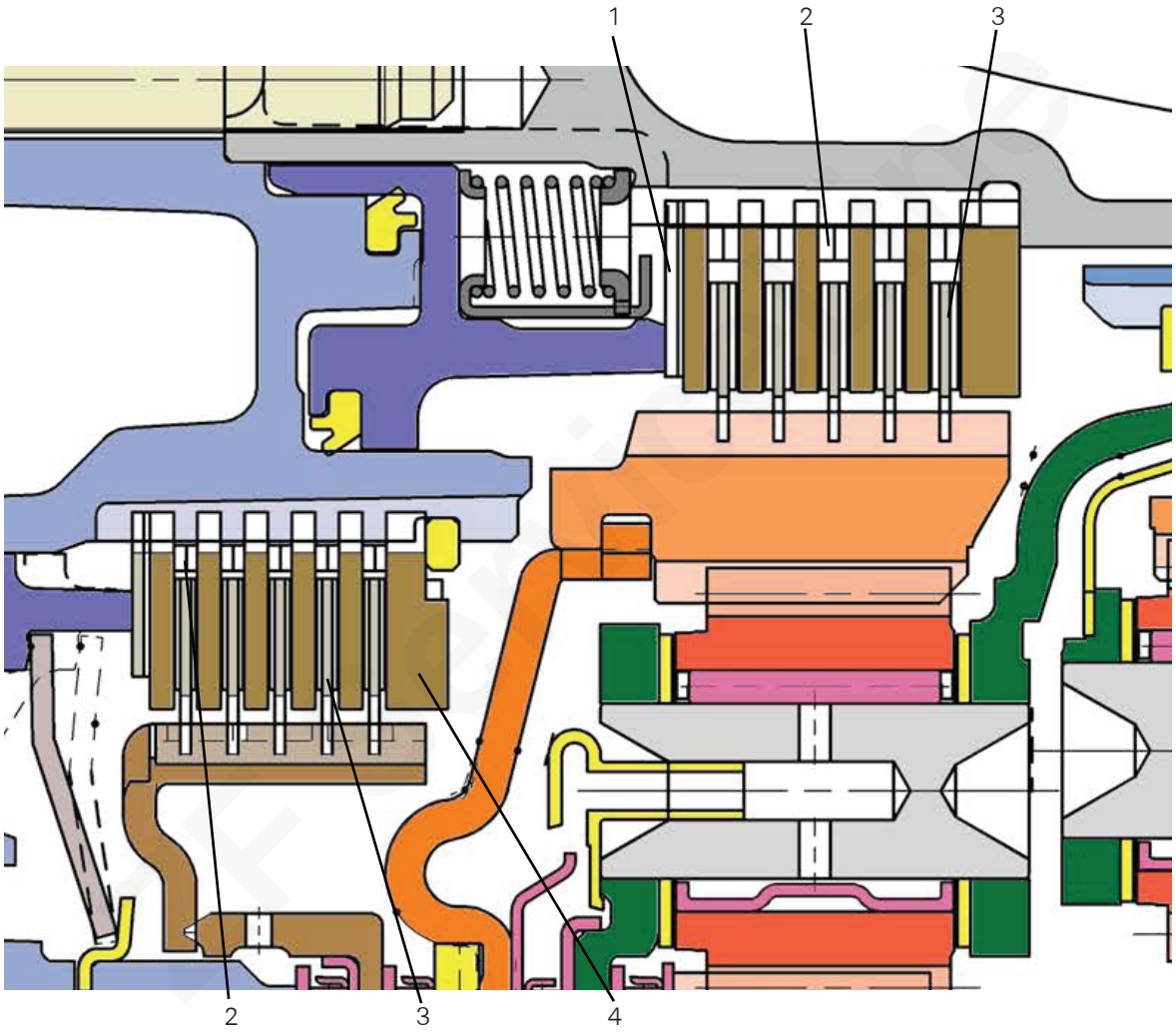
1 Cooling valve A
2 Clutch pressure A
3 Filter
4 Collecting space Cooling / lubrication

8HP51 and 8HP75 / 8HP76: surface cooling of multidisk brake A



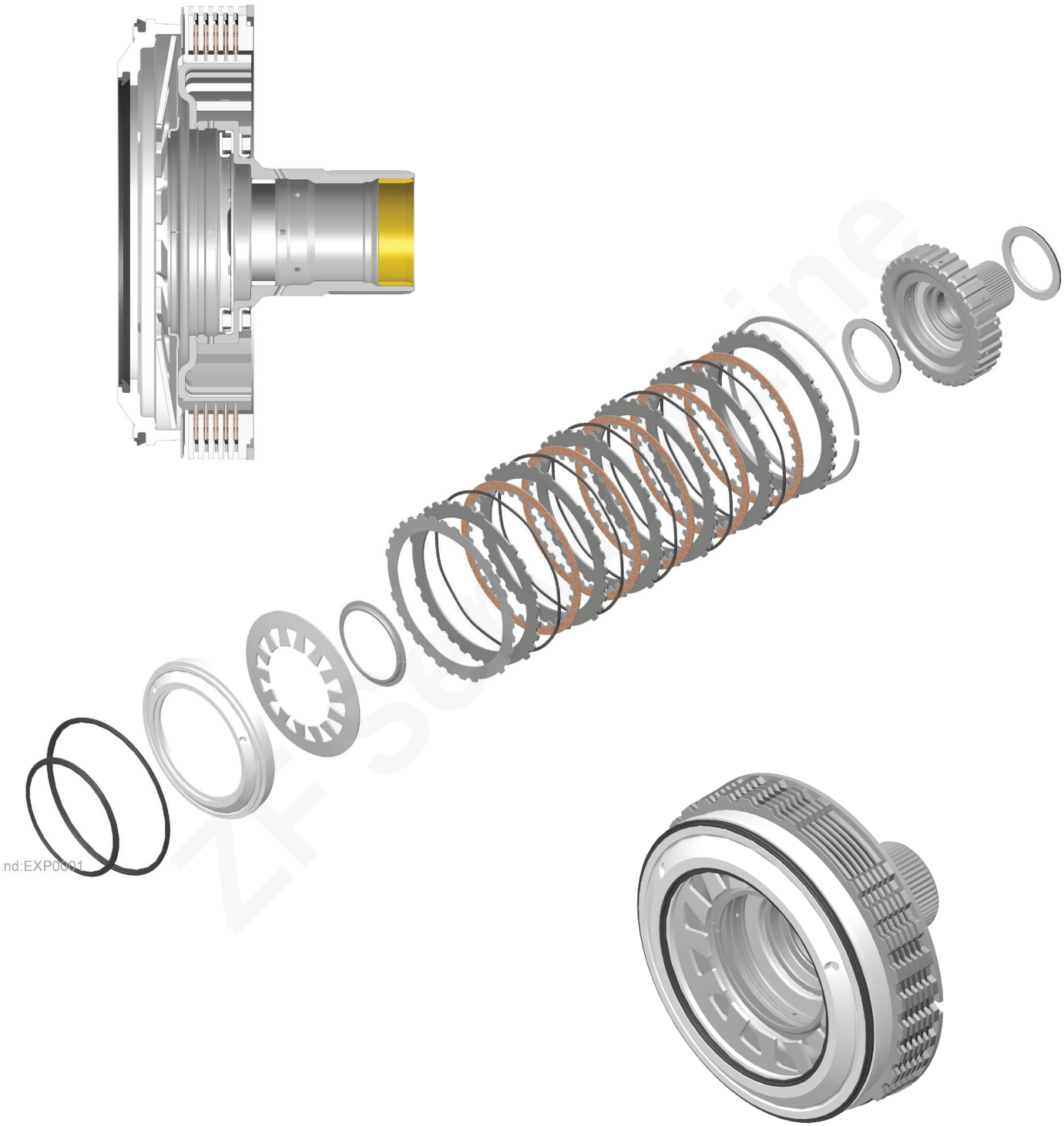
8HP50 / 8HP51 and 8HP75 / 8HP76: multidisk separation in multidisk brakes A and B

So-called spreading wave spring washers are inserted into multidisk brakes A and B in a concentric position to the lined clutch disks. These wave spring washers prevent the multidisks from sticking together due to the cohesion of ATF at the multidisks even when the multidisk brake is open, thus increasing drag losses in the brake. The spreading wave spring washers will keep the lined clutch disks and the steel multidisks at a distance when the brake is open. However, installing spreading wave spring washers reduces the usable friction surface of the lined clutch disks. For that reason, multidisk separation is applied only for transmissions with a comparably low input torque.



1 Adjustment wave spring washer
2 Spreading wave spring washers
3 Corrugated lined clutch disk
4 Stepped end disk

8HP50 and 8HP75: multidisk separation in multidisk brake A



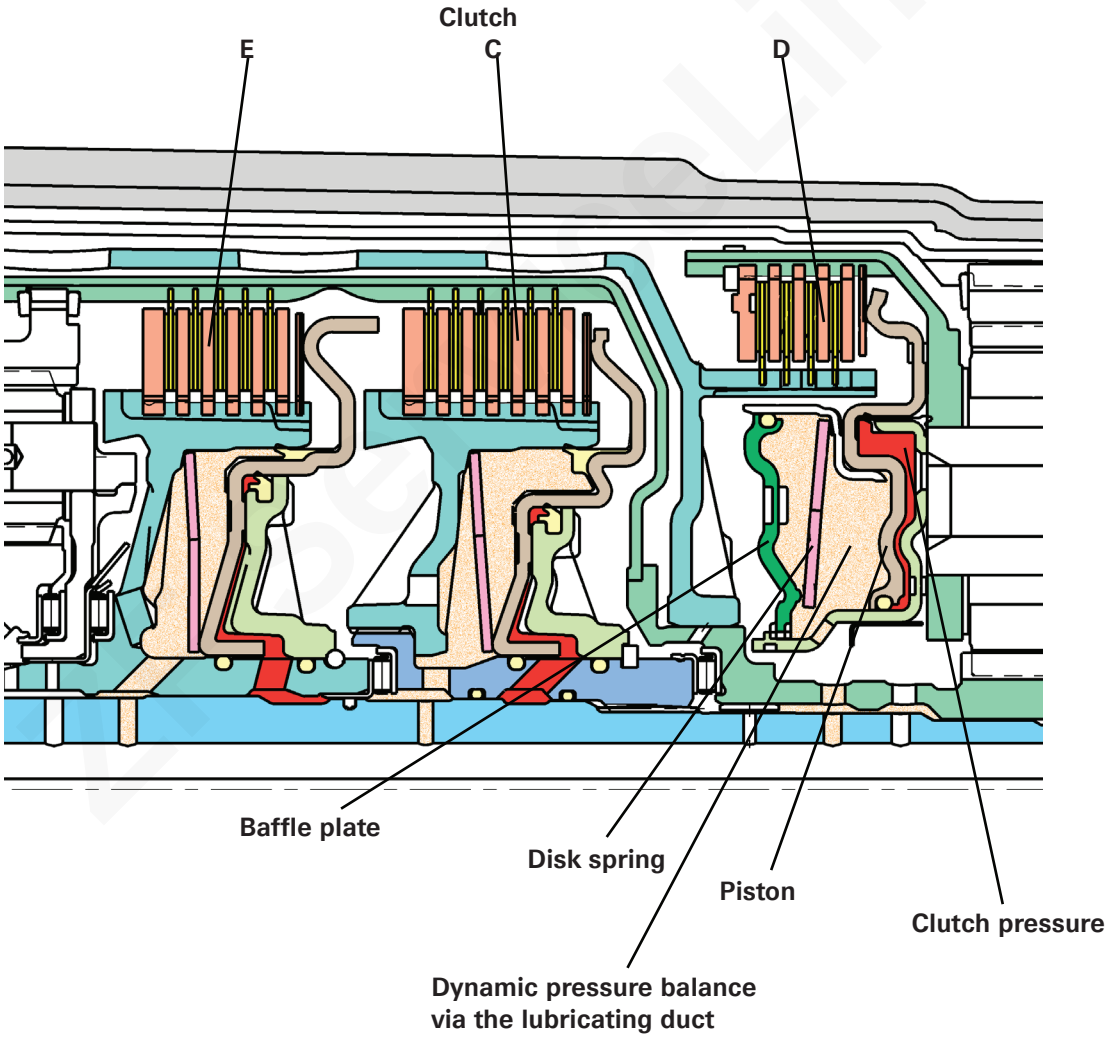
Multidisk clutches E, C and D

Clutches E, C and D are balanced in terms of their dynamic pressure. That means that to avoid speed-dependent pressure increases in the clutch, oil is applied to both sides of the clutch piston.

This balance is achieved by the baffle plate and the non-pressurized oil supply via the lubricating duct. This means that the chamber between the piston and the baffle plate is filled with oil.

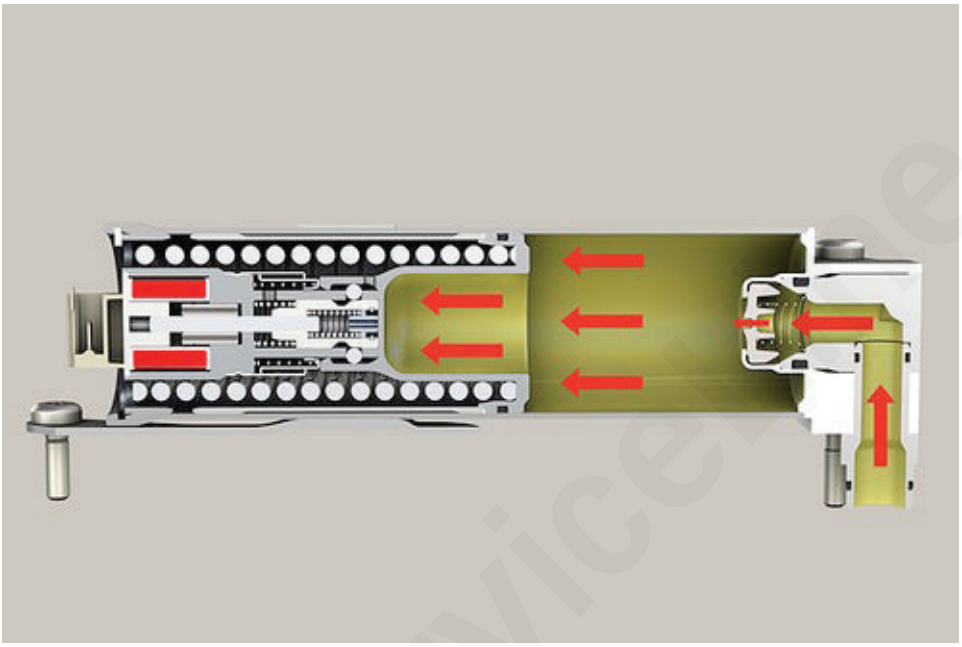
The benefits of this dynamic pressure balancing system include the following:

- Reliable opening and closing of the clutch in all speed ranges
- Improved gearshift comfort.



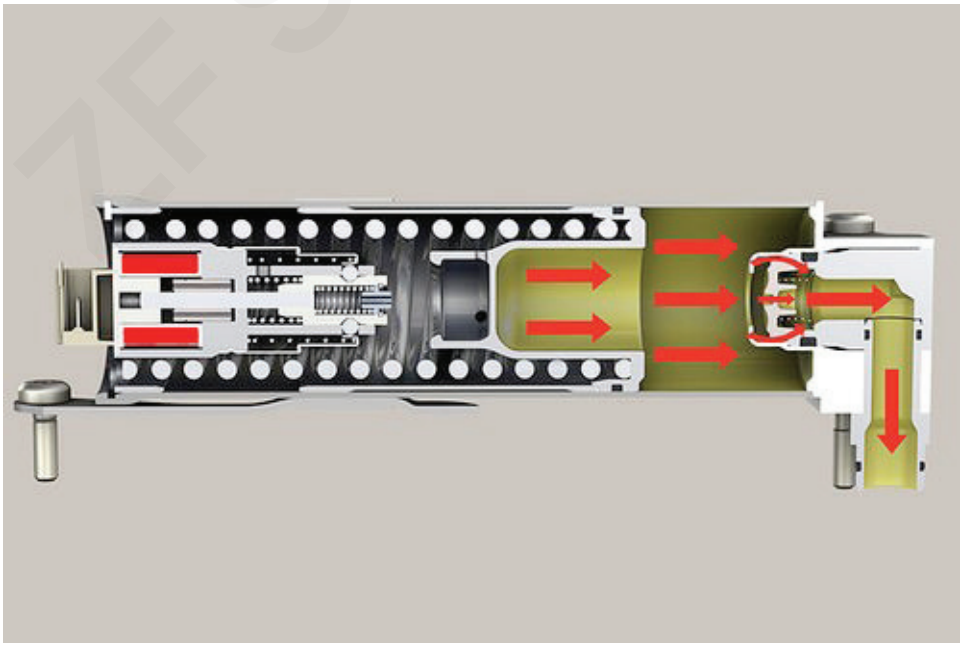
The hydraulic impulse oil storage – HIS

Some customer-specific versions of the new generation 8-speed automatic transmission from ZF will have an integral hydraulic impulse oil storage system. This supplies hydraulic oil to the shift elements of the transmission required for starting. In turn this makes it possible to move off quickly if the engine has been stopped – as required for a start-stop function. The car is ready to move away just 350 milliseconds after the engine has been started.

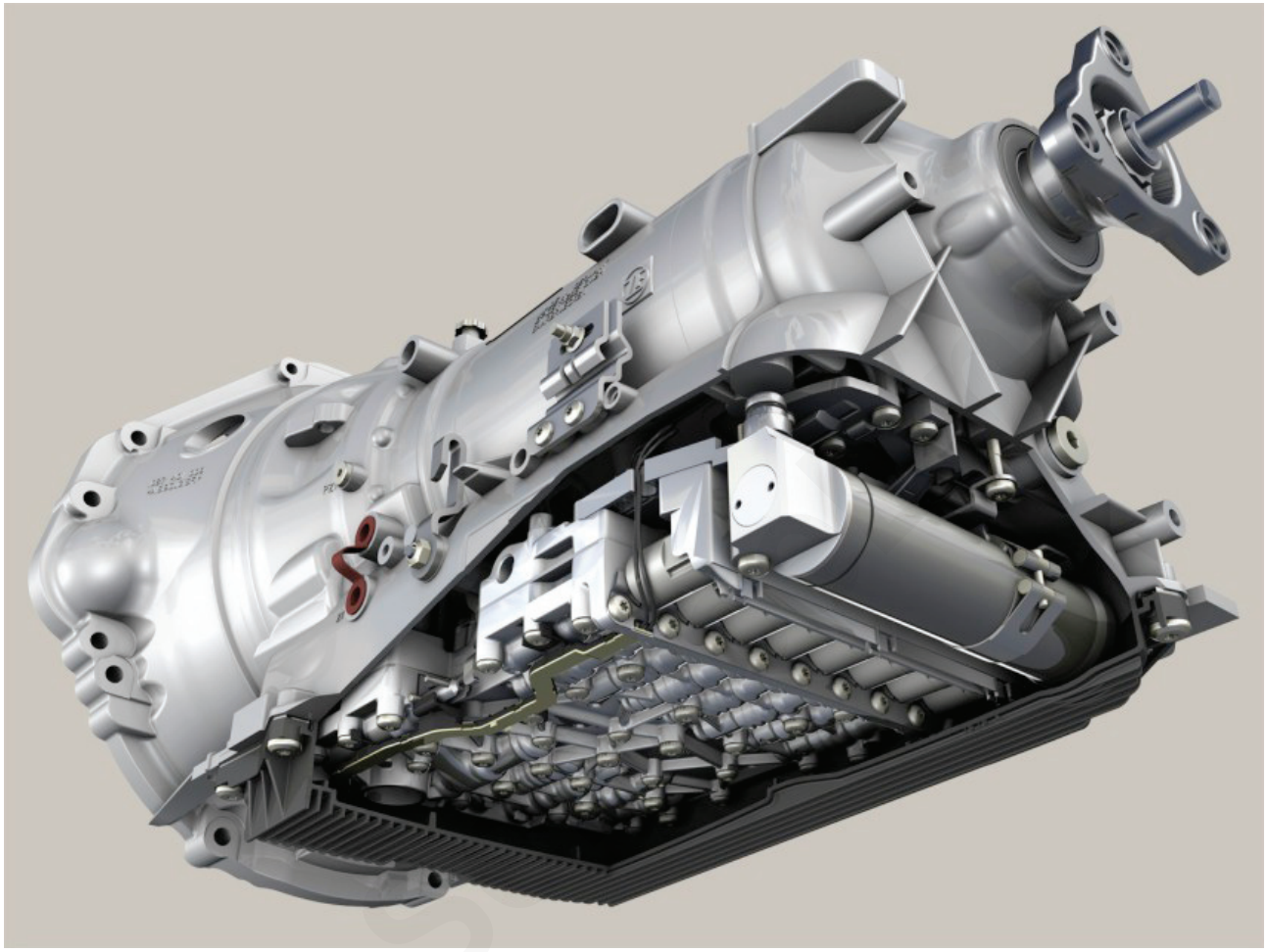


The start-stop function provided by the hydraulic impulse oil storage system means even greater fuel efficiency.

The “HIS” hydraulic impulse oil storage is a spring piston accumulator which fills with oil as the car is being driven, thus tensioning a spring.



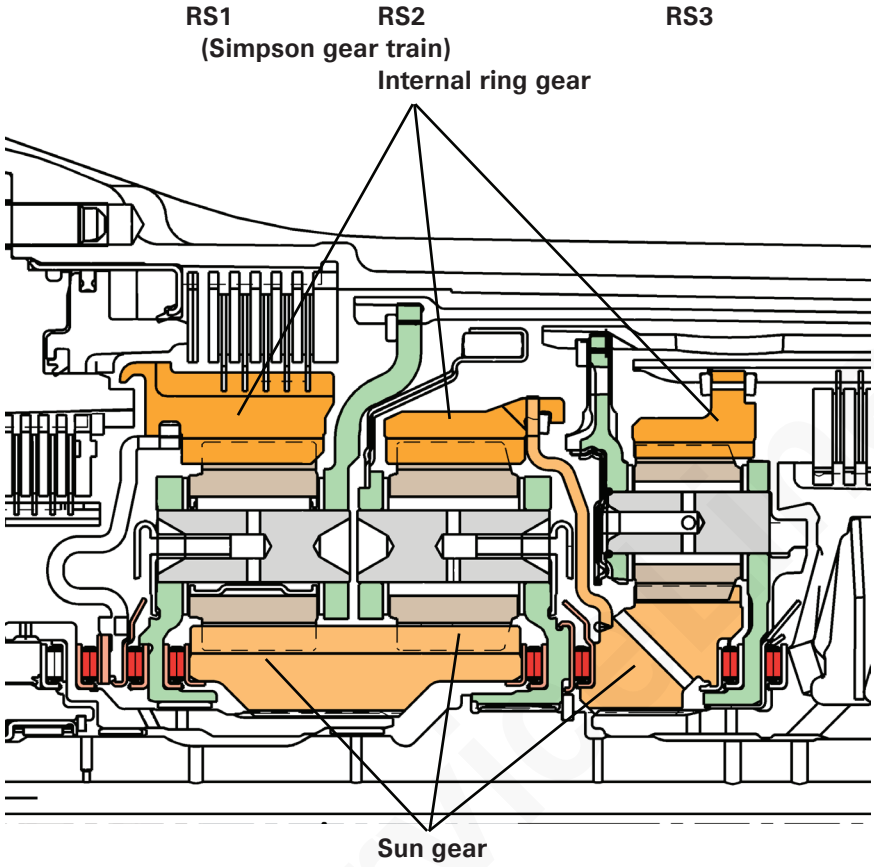
This “reserve” has a capacity of around 100 centiliters which is fed back into the hydraulic system lightning-quick by the spring when the engine is started to supply oil to the shift elements in the transmission required for moving away. This means that the car is ready to move away just 350 milliseconds after the engine has



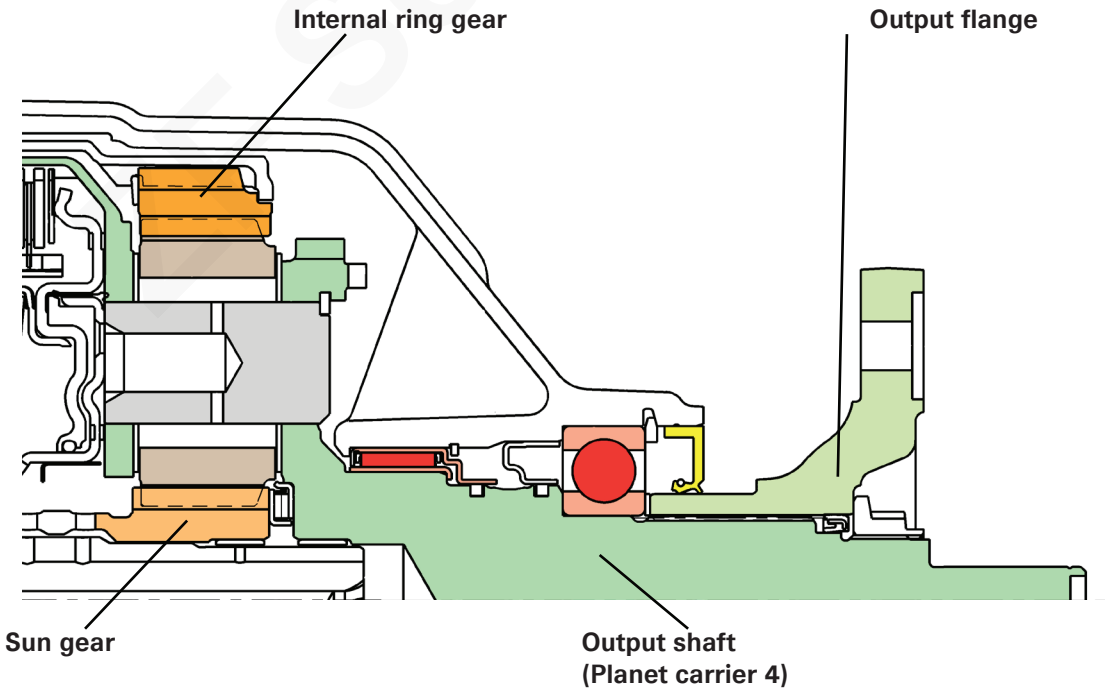
been started. Without the bridging created by the hydraulic impulse oil storage system this would take around 800 milliseconds which would therefore mean a perceptible loss of driving dynamics for the driver.

The component is around 19 centimeters long and has a diameter of five centimeters which means that it can be housed in the conventional installation space for the 8-speed automatic transmission behind the hydraulic control unit.

Simple single-carrier planetary gear train 1, 2 and 3

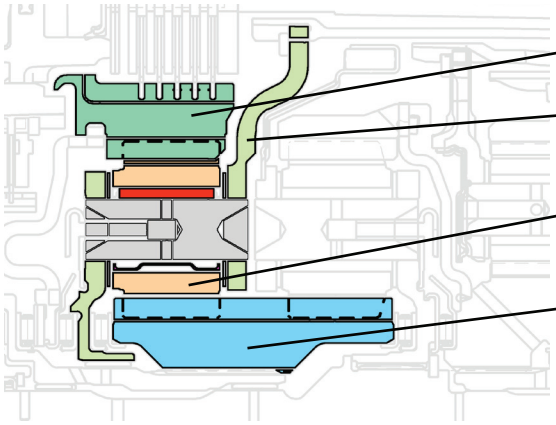


Simple single-carrier planetary gear train 4 with output flange



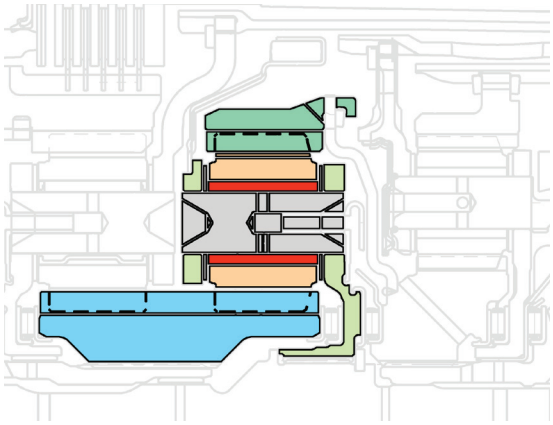
Planetary gearset

RS1

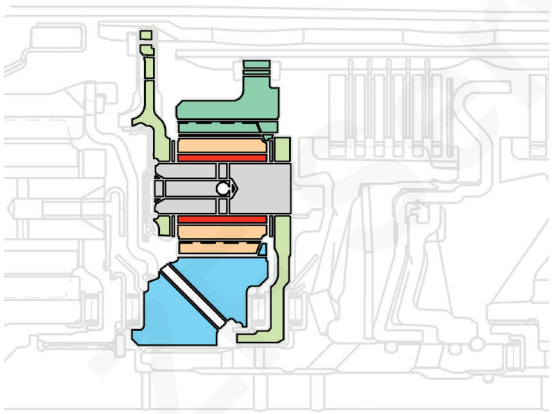


The planetary transmission consists of four gear sets in series. Gears 1 and 2 are interconnected by a joint sun gear (Simpson gear set).

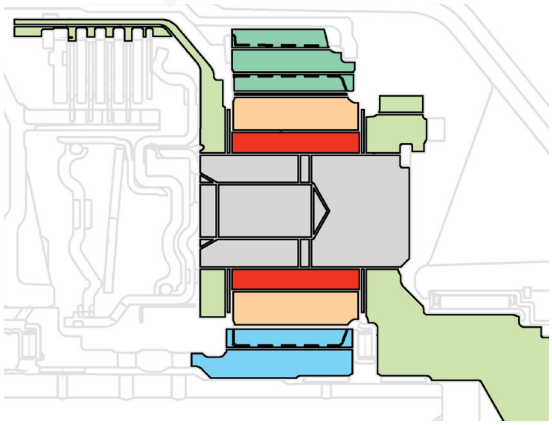
RS2



RS3



RS4



Parking lock

General

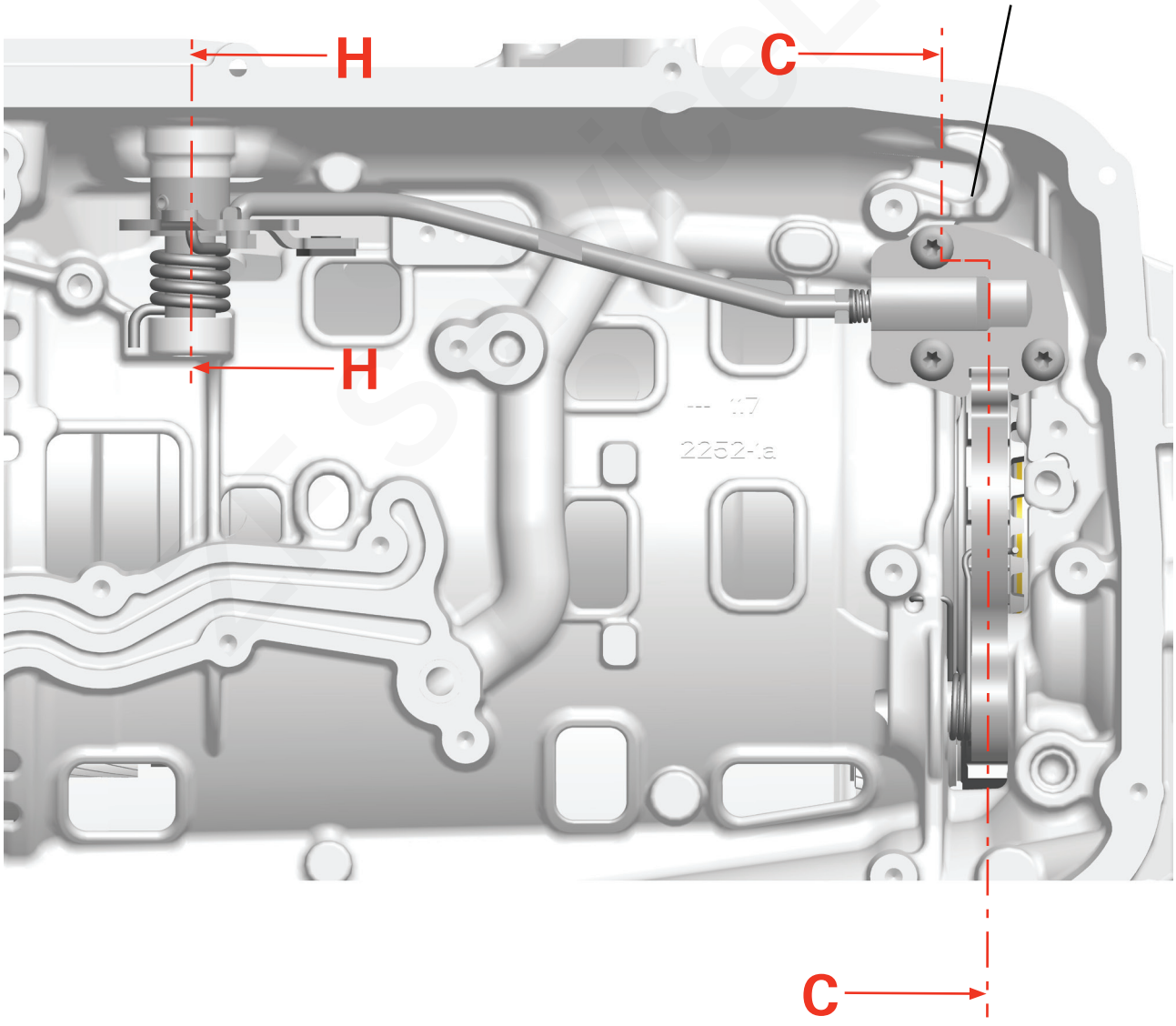
The parking lock is a device that prevents the vehicle from rolling. It is engaged by spring force when the vehicle is at a standstill.

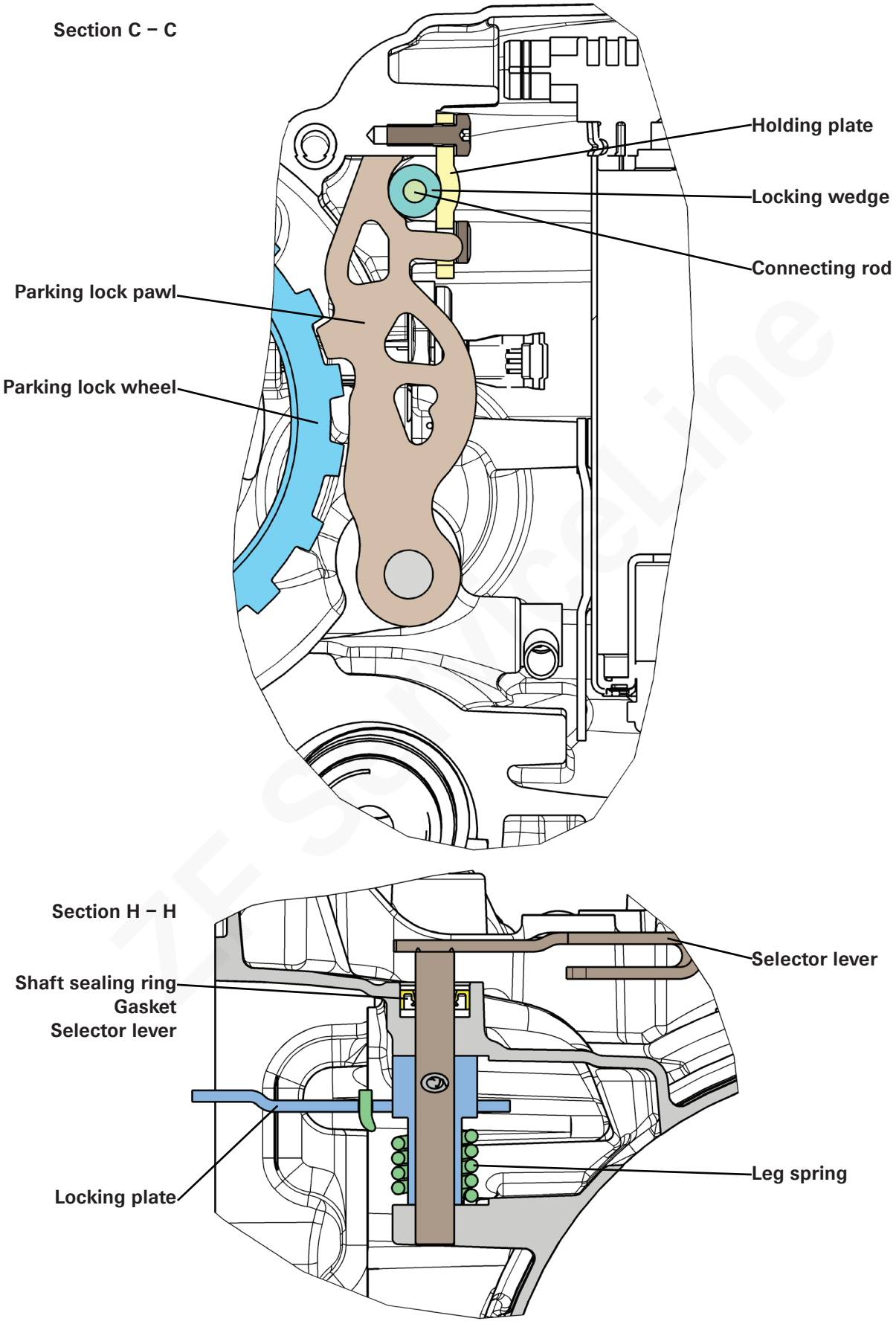
The mechanical version of the parking brake is activated by a Bowden cable from the selector lever unit in the vehicle for the transmission.
The electrical version is activated using a button on the selector lever which actuates a hydraulic cylinder with a solenoid valve in the transmission.

The parking brake locks the transmission output shaft by means of a pawl which engages in the meshing of the parking brake gear. This locks the rear wheels by means of the driveshaft.

Mechanical version

The purely mechanical version of the parking lock is engaged using the selector lever in the car via a Bowden cable to the locking plate in the transmission.

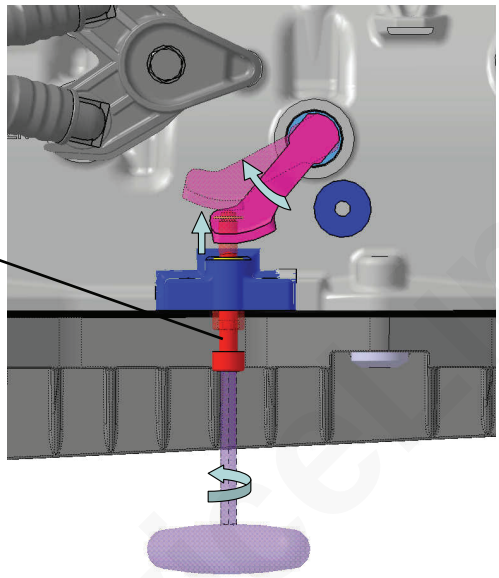



Section C – C
Holding plate
Locking wedge
Connecting rod
Parking lock pawl
Parking lock wheel
Section H – H
Selector lever
Shaft sealing ring
Gasket
Selector lever
Leg spring
Locking plate

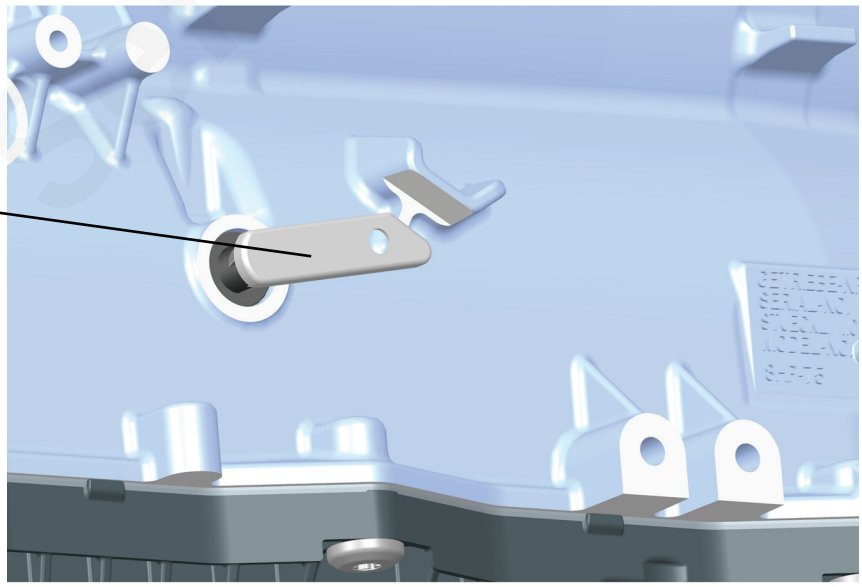
Electrical version (shift by wire)

The electrical version does not have a Bowden cable (mechanical connection between the control element in the vehicle and the automatic transmission). All drive positions and the parking lock function are controlled electrically. The detent disk in the transmission is replaced by a parking disk and a parking lock cylinder with a solenoid valve. The position of the parking lock cylinder is queried by a position sensor and reported to the electronic module.

A customer-specific emergency release (mechanical device using a Bowden cable or release screw) is available for the event of a mal-function.

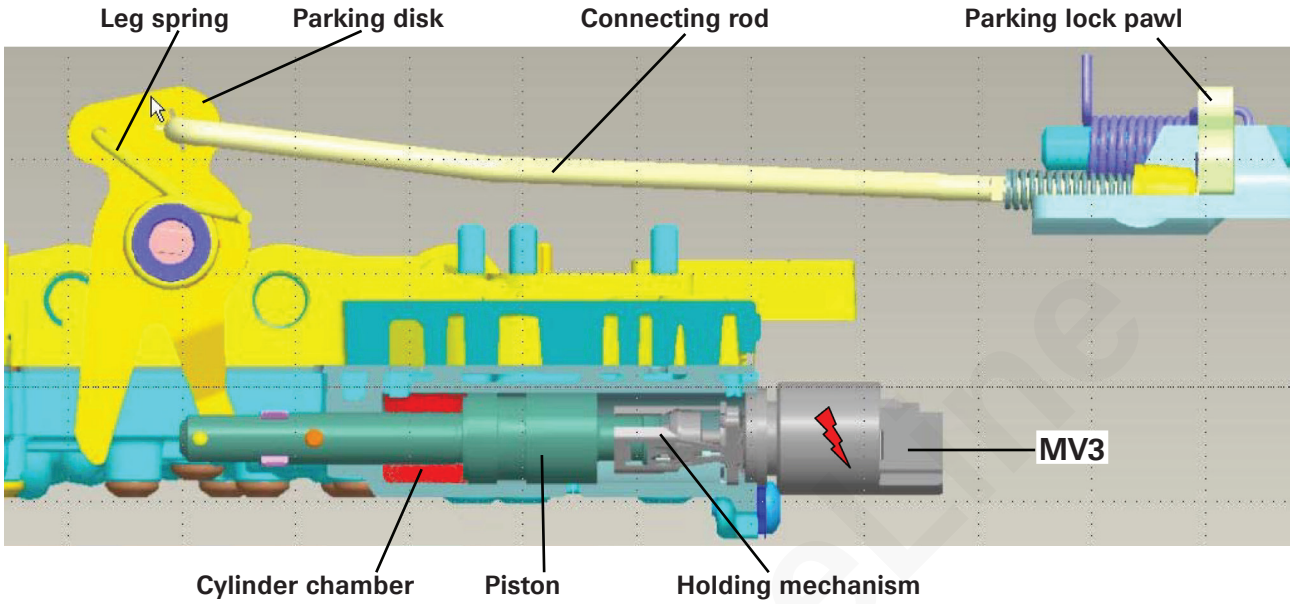


New emergency release for 8HP50 and 8HP75 transmissions.



Function: Parking lock not engaged

Status in the positions R, D and in the various gears



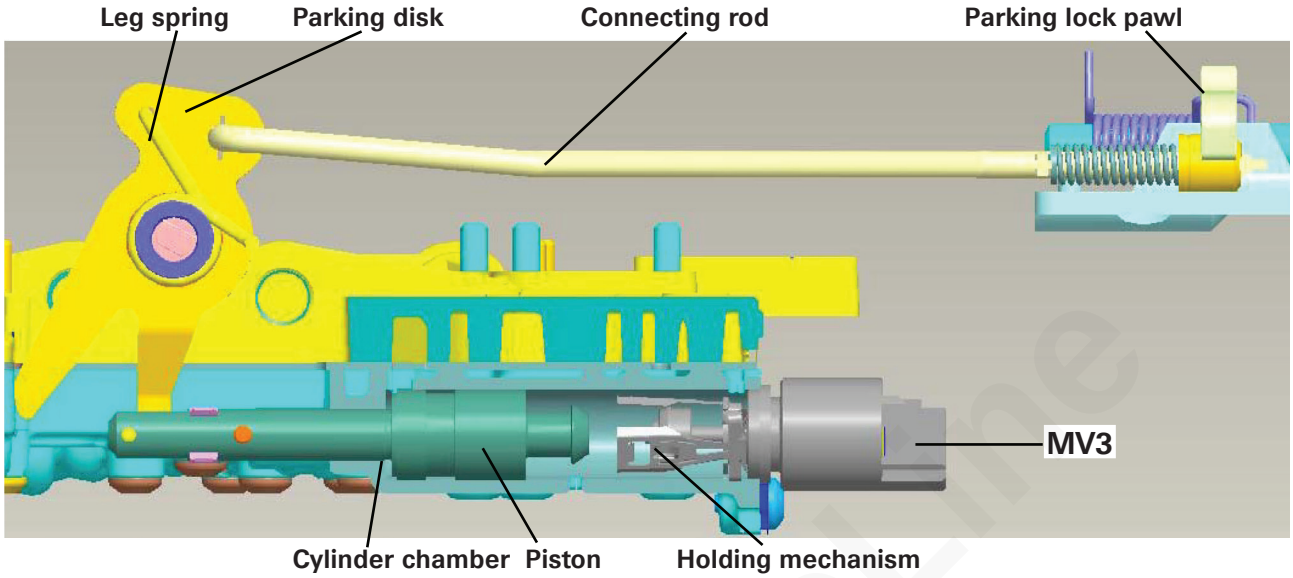
When the parking position is exited the parking lock valve in the hydraulic control unit is moved by MV2 (MV = solenoid valve). The upcoming main pressure is fed into the cylinder chamber of the parking lock cylinder and pushes the piston back against the parking disk against the force of the leg spring. This releases the parking lock. MV3 is actuated and also blocks the parking lock cylinder piston using a mechanism.

Function: Parking lock engaged

When the parking position is selected MV2 and MV3 are shut down. The cylinder chamber is vented and the mechanical interlock of the piston is released. The pretensioned leg spring on the parking disk pushes the piston towards the “Park” position. This engages the parking lock.

An additional Bowden cable or a release screw on the parking disk allows the parking lock to be released manual in certain situations, such as “Power failure in emergency program”.

Status in the position: P - “Park”



Function: Parking lock released (“car wash function”)

When set to position “N” (neutral) and “Engine stopped” the oil pressure in the cylinder chamber is vented. MV3 retains its voltage supply which means that the parking lock cylinder is still held against the parking disk against the tension of the leg spring. This means that the pretensioned leg spring on the parking disk cannot engage the parking lock. The car can therefore still be maneuvered.

There is a time limit on this function due to the strain it places on the battery.

If the transmission is in its emergency program, when the engine is switched off the parking lock (selector lever position “P”) is engaged automatically regardless of the current gearshift position (only with an electronic gearshift).

Status in the position: N – “neutral”

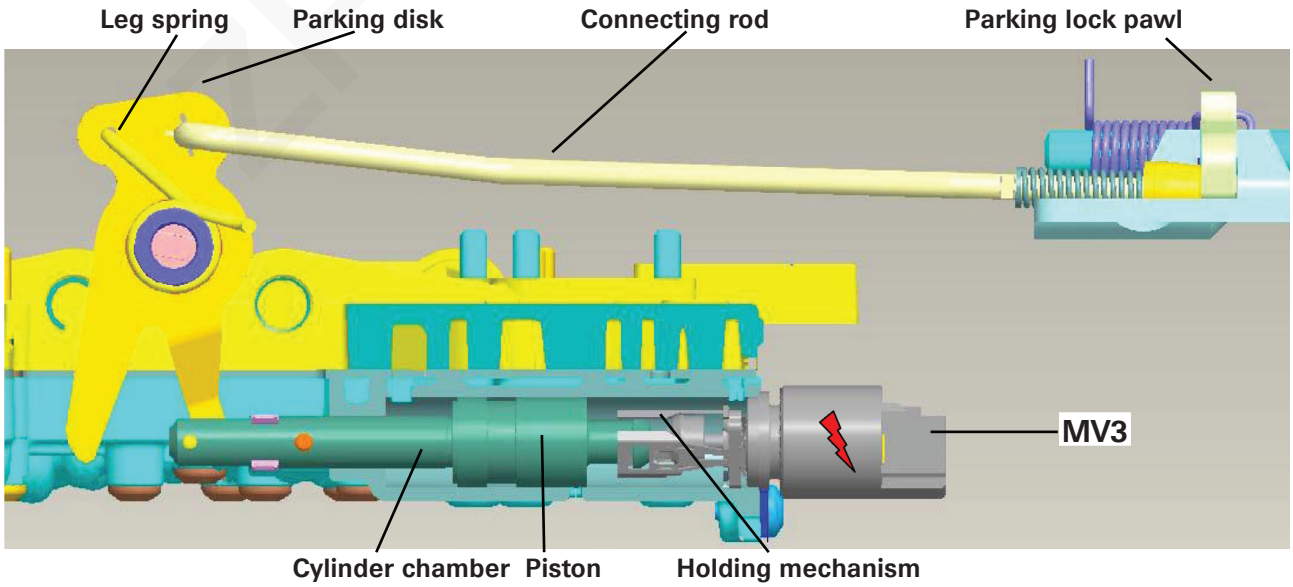


Diagram: Parking lock not engaged

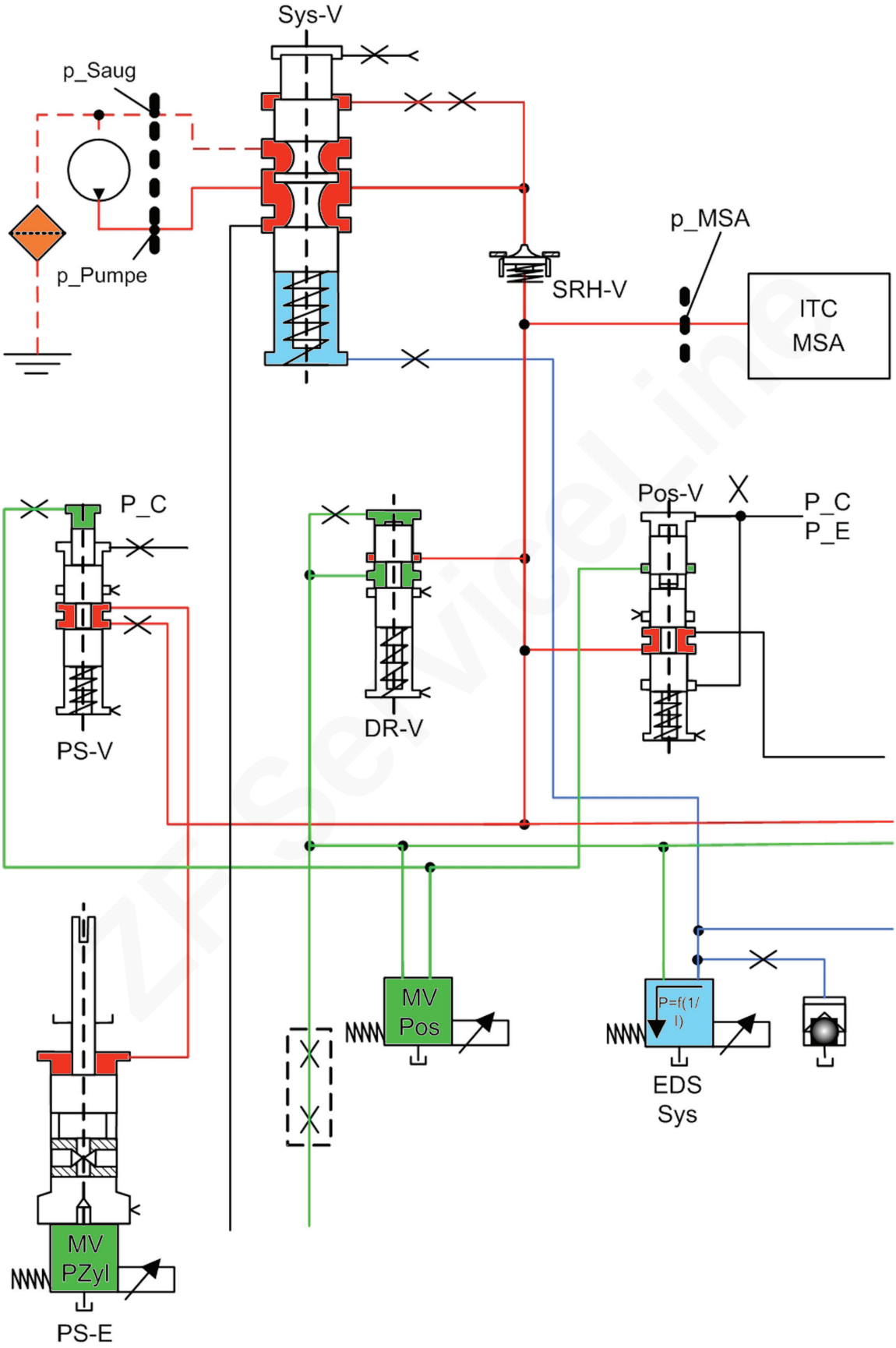
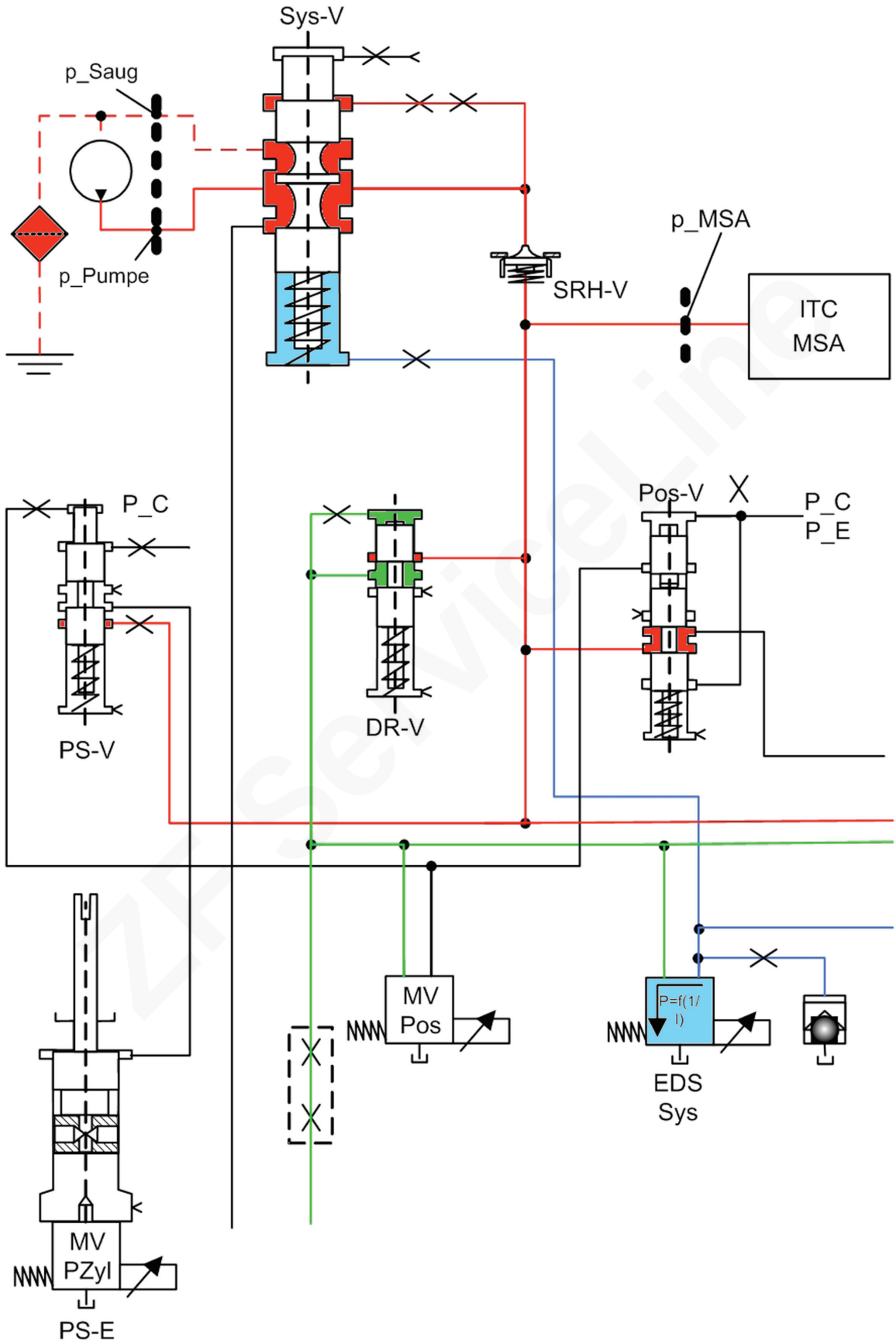
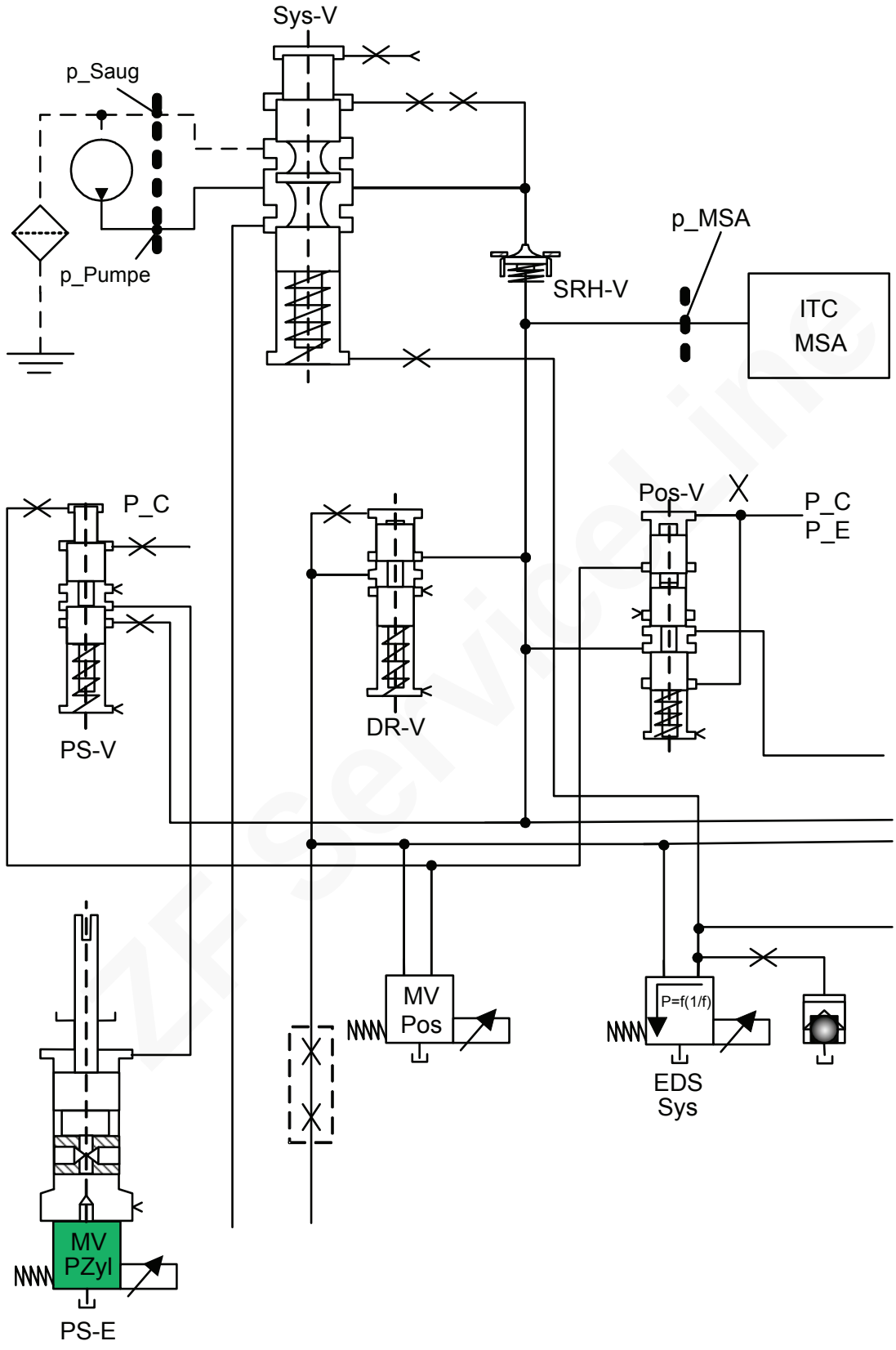


Diagram: Parking lock engaged



Transmission diagram: Parking lock released (“car wash function”)

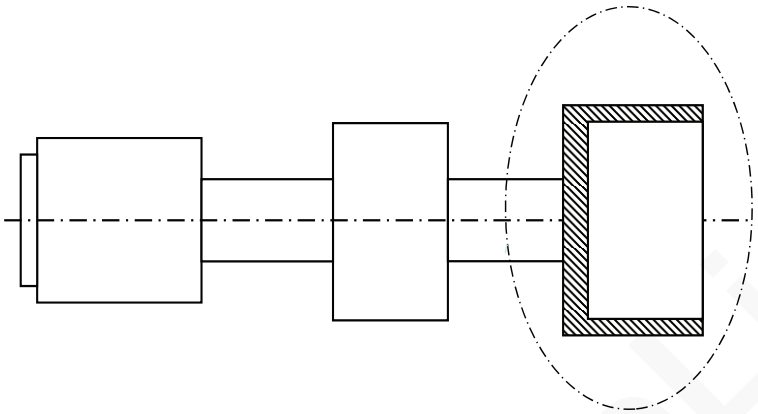


8HP51 and 8HP76 - parking lock

This technical manual is valid for the control unit E26/36 from the MECH-EPT4.0 design status.

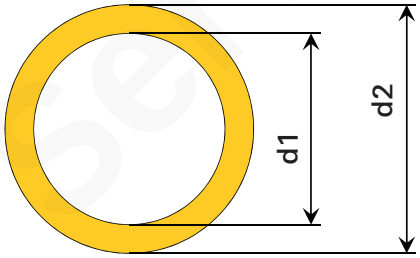
Structural design

The parking brake valve consists of a valve slide with three piston collars, which are designed in the order of diameter on a graduated basis and form different hydraulic pressure surfaces.



Parking lock PS-V plunger

Between two piston collars with different diameters, the hydraulic forces partially cancel each other out because the pressure acting in the intermediate space acts to the same extent on the axially opposite pressure surfaces. Thus, only the differential area of the piston collar with a larger diameter than the effective area for the hydraulic pressure remains.



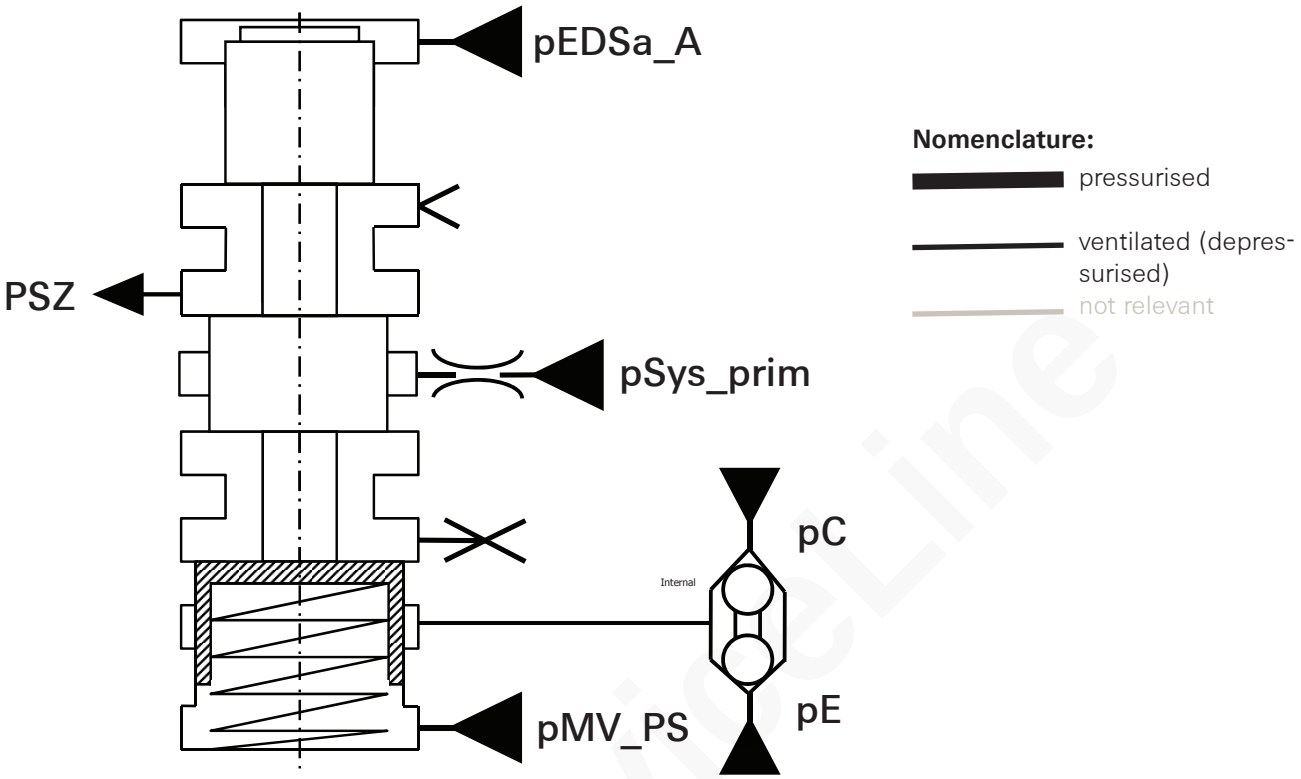
Effective area = differential area

Formation of the differential area due to the differences in diameter

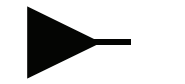
The largest, rightmost piston collar in figure 1 is designed as a hollow body for receiving the valve spring. When pressure is applied, the two differential areas between the respective piston collars produce a force which acts in the direction of the largest piston collar, that is, counter to the spring force.

Parking lock

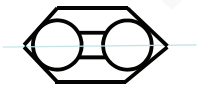
In the following technical manual, a simplified representation of the valve slide in the valve bore is used.



The hydraulic control edges are shown around the plunger from the above figure, with the pressure connections. The following symbols are used here:


Hydraulic energy source


Hydraulic resistance (orifice plate)


Hydraulic OR logic (ball-rocker valve)

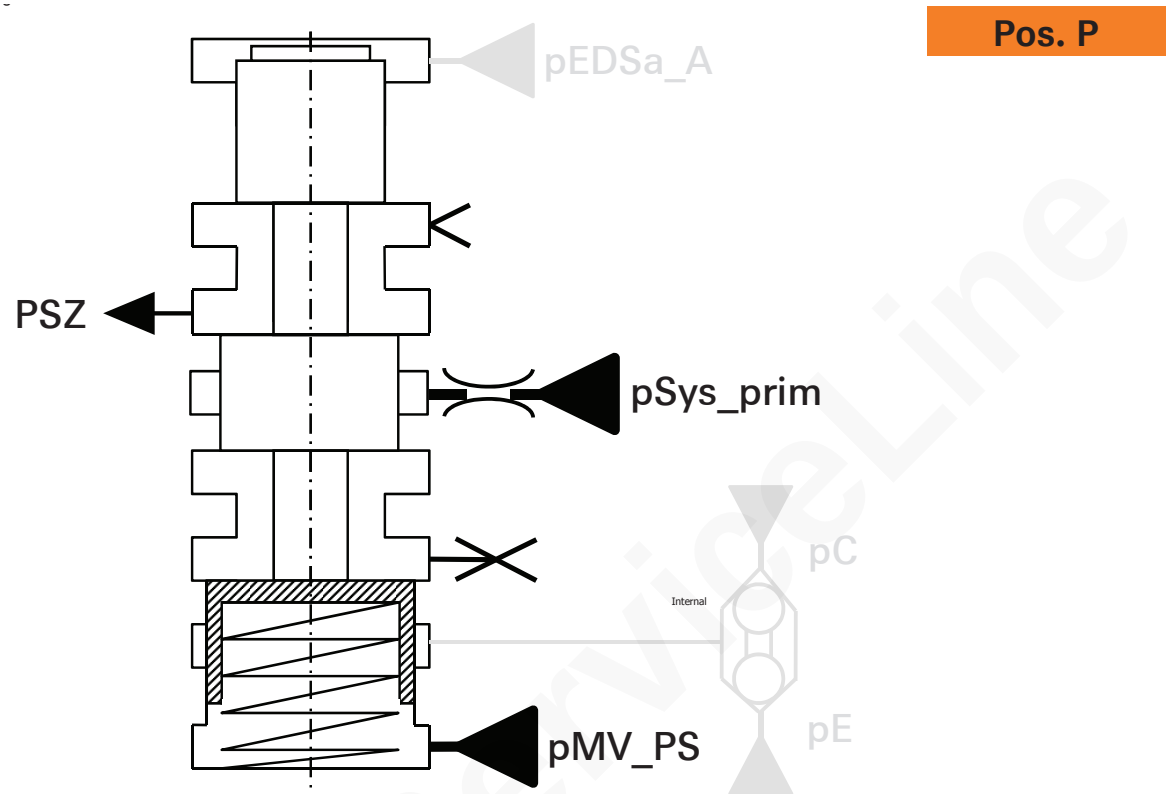

Venting connection for tank


Pressure-tight connection

To display the pressure level at the individual connections, the line representations defined in the nomenclature are used.

8HP51 and 8HP76 - position P – parking lock engaged

In the valve slide starting position, that is, in the non-pressurized state, when the valve is positioned at the upper stop by the spring force, the control edge for the hydraulic pressure is connected to the parking lock cylinder (PSC) with the venting control edge so that the differential area between the small upper piston collar and the central piston collar as well as the PSC does not experience any hydraulic force and the parking lock is engaged via the initial spring tension of the parking lock mechanism.

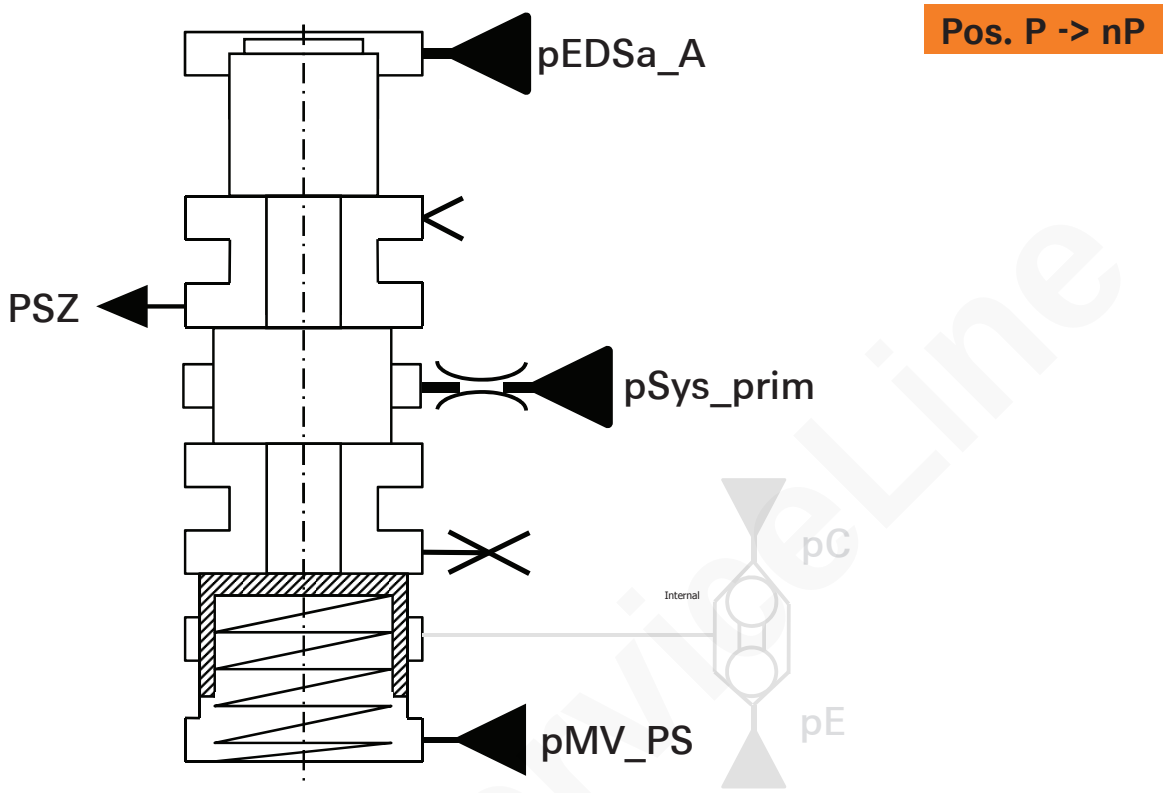


The system pressure placed on the central valve collar via the orifice plate is hydraulically sealed off from the control edges located next to it by the piston collar and thus has no effect. It behaves the same on the clutch pressures of the two clutches C and E, which abut on the large, lower piston collar through a hydraulic OR function. The differential area between the center piston collar and the largest, lower piston collar is vented to the tank and thus free of force.

This valve position is supported by the pressure of the solenoid valve pMV_PS, which acts on the large end face of the lower piston collar. The solenoid valve (SV) switches the system pressure fully to this connection and generates a hydraulic force that acts in the same way as the mechanical spring force on the valve slide. This ensures that the SV pressure always provides the dominant force component for engaging the parking lock, that is, the valve slide always moves in the direction of the starting position even if system pressure is applied incorrectly at the three connections pEDS_A, pC/E and pSys_prim. For this reason, the level of the pressure regulator pressure of clutch A (pEDS_A) is not relevant in this valve position. For reasons of functional safety, however, the pressure regulator pressure pEDS_A may not exceed a defined pressure threshold. The pressure threshold must be so low that when the pressure regulator pressure pEDS_A is present and there is incorrect pressure-free solenoid valve pressure pMV_PS, the PS-V cannot be pushed against the spring force in the direction of position “nicht_P.”

8HP51 and 8HP76 - disengage the parking lock

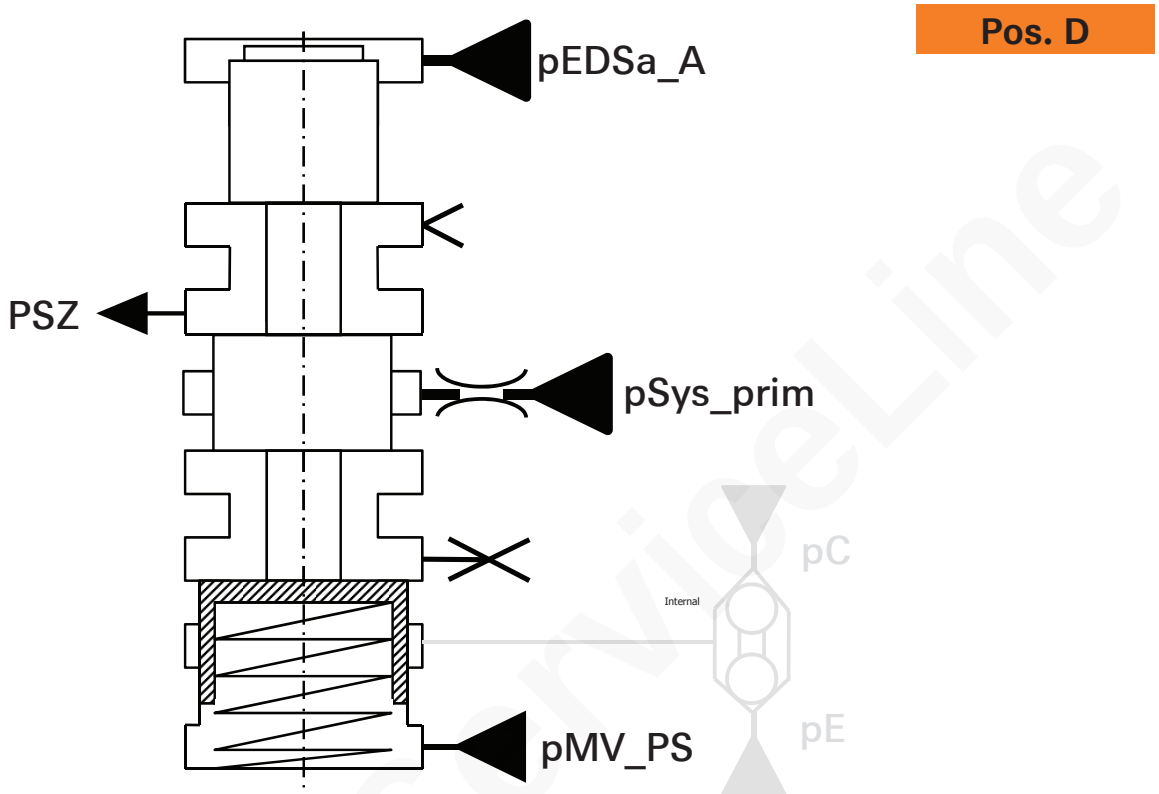
To disengage the parking lock, the PS-V plunger must be moved to the lower position (end position) against the spring force. For this purpose, the solenoid valve pressure pMV_PS is vented and the pressure regulator pressure pEDS_A is set to a pressure value above the threshold value for functional safety.



As soon as the valve slide moves over the control edge of the system pressure connection pSys_prim, the connection of the PSC to the tank is sealed off with the upper piston collar and the system pressure is directed to the PSC. As a result, the PSC is subjected to a hydraulically generated compressive force, which leads to disengagement of the parking pawl.

8HP51 and 8HP76 - position D – keep parking lock disengaged

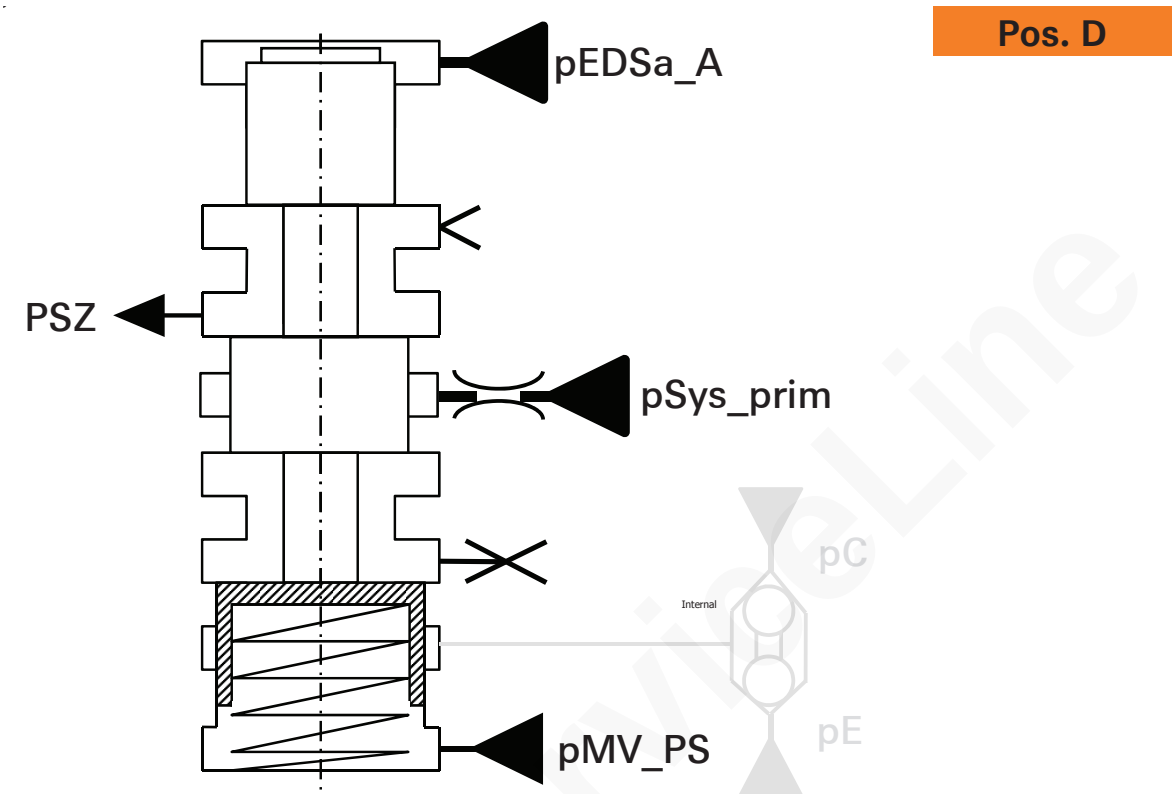
As explained in the previous section, the PSV slide is pushed towards the end position via the pressure regulator pressure of clutch A. In the 8HP transmission, however, there are several gears where the clutch is not involved and thus the pressure regulator pressure is not present. In these cases, the hydraulic force component must be applied elsewhere against the spring force. In figure Pos. D, the PS-V valve is in the end position, and the system pressure is connected via the orifice plate with the pressure chamber between the smallest and the center collar in the direction of PSC. The system pressure now exerts a hydraulic force across the differential



area against the spring force and holds the valve slide in the end position. For this switching state to be maintained, the system pressure must exceed a minimum pressure level, which is above the min. system pressure. However, if the system pressure is lowered in the direction of minimum system pressure, then the missing hydraulic force for holding the valve must be applied via another differential area. For this purpose, an additional hydraulic force is generated on the valve slide via the differential area between the center and the large collar via one of the clutch pressures C or E. Using this wiring logic, the PS-V can be held over all gear positions with the parking lock disengaged.

8HP51 and 8HP76 - engage parking lock

To engage the parking lock, the PS-V slide must be moved to the starting position. For this purpose, pressurization of the solenoid valve alone is sufficient, regardless of the pressure level of the remaining pressures on the valve slide.



[Source: Markus Herrmann – PDCM1 – 60603_He_PS-V_Funktion_E26-36_MECH-EPT4]

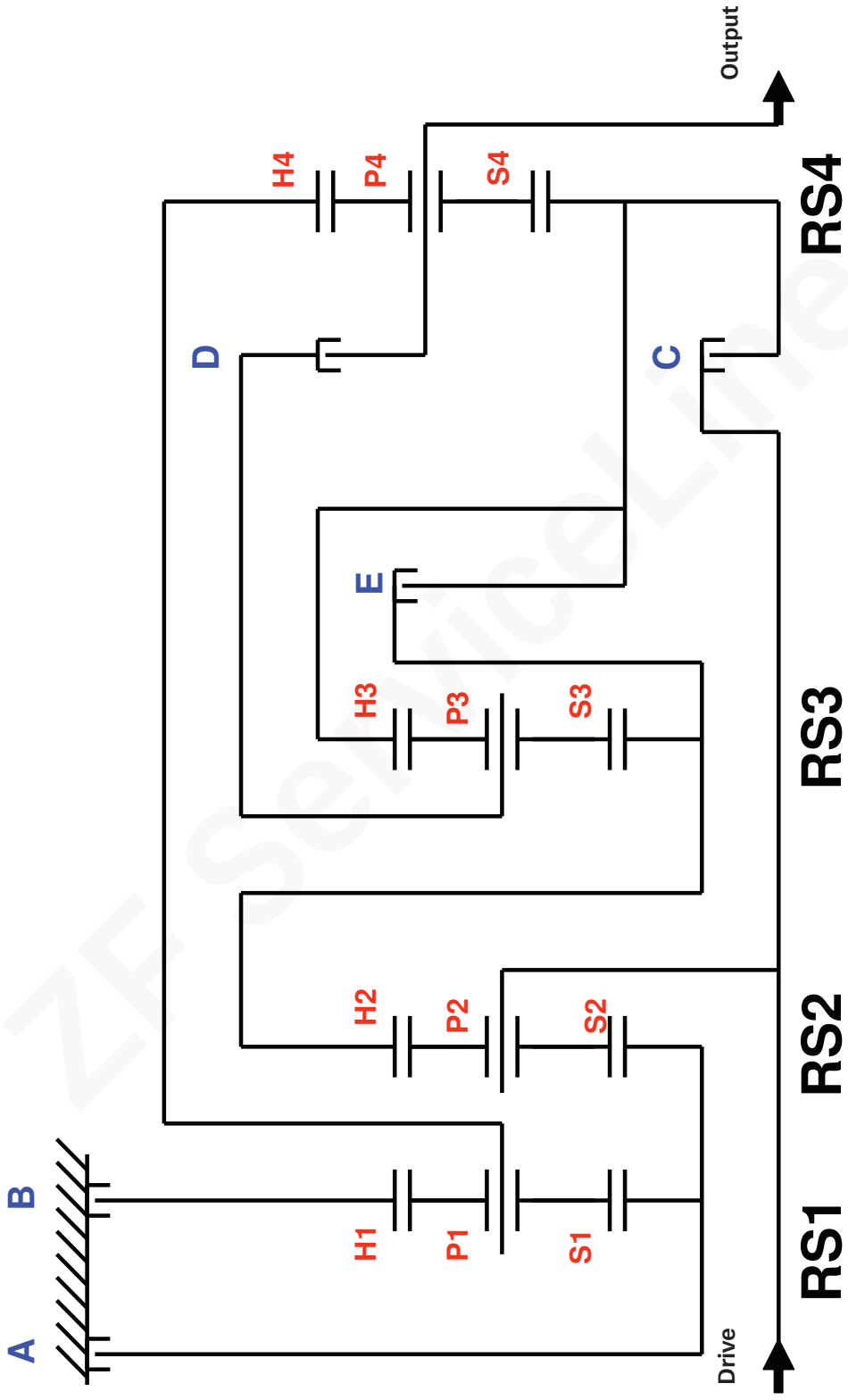
Ratios i

Gang	8HP45	8HP50	8HP51	8HP70	8HP75	8HP76	8HP90	8HP95
1	4,714	5,000	5,250	4,714	5,000	5,500	4,714	5,000
2	3,143	3,200	3,360	3,143	3,200	3,520	3,143	3,200
3	2,106	2,143	2,172	2,106	2,143	2,200	2,106	2,143
4	1,667	1,720	1,720	1,667	1,720	1,720	1,667	1,720
5	1,285	1,314	1,316	1,285	1,313	1,317	1,285	1,313
6	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
7	0,839	0,822	0,822	0,839	0,823	0,823	0,839	0,823
8	0,667	0,640	0,640	0,667	0,640	0,640	0,667	0,640
R	-3,295	-3,456	-3,712	-3,317	-3,478	-3,993	-3,317	-3,478

Gear step

	8HP45	8HP50	8HP51	8HP70	8HP75	8HP76	8HP90	8HP95
1 - 2	1,500	1,563	1,562	1,500	1,563	1,563	1,500	1,563
2 - 3	1,492	1,493	1,547	1,492	1,493	1,600	1,492	1,493
3 - 4	1,263	1,246	1,263	1,263	1,246	1,279	1,263	1,246
4 - 5	1,297	1,309	1,307	1,307	1,310	1,306	1,307	1,310
5 - 6	1,285	1,314	1,316	1,285	1,313	1,317	1,285	1,313
6 - 7	1,191	1,216	1,216	1,191	1,216	1,216	1,191	1,216
7 - 8	1,257	1,285	1,285	1,257	1,285	1,285	1,257	1,285
Total	7,071	7,813	8,203	7,071	7,813	8,594	7,071	7,813

8HP ... schematic diagram



The transmission ratios in the various gears are obtained by the torque being applied by various elements of the planetary gear train whilst other elements are braked. The force is always transferred via the planet carrier of the 4th planetary gear train (see description headed “Power flow in the various gears”).

Gear	Brake		Clutch		
	A	B	C	D	E
1	●	●	●		
2	●	●			●
3		●	●		●
4		●		●	●
5		●	●	●	
6			●	●	●
7	●		●	●	
8	●			●	●
R	●	●		●	

Gear description in 1st gear

In 1st gear, internal ring gear H1 is fixed by the multidisk brake B and the double sun gear S1/S2 via the multi-disk brake A against the housing (blocking position on planetary gear train RS1).

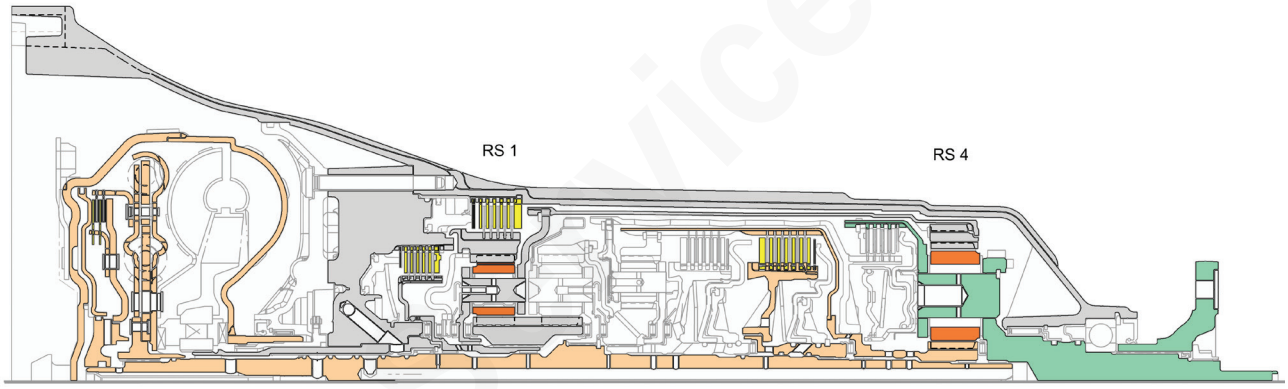
The connection of the planet carrier P1 and internal ring gear H4 means that this internal ring gear is also fixed.

The drive shaft provides the driving force via the closed multidisk clutch C to the sun gear S4. This drives sun gear S4 at the same speed as the turbine.

The fixed internal ring gear H4 means that the planetary gears under the internal ring gear turn and drive the planet carrier P4 in the direction of engine rotation.

Planet carrier P4 also acts as the output shaft.

Active elements in 1st gear with a transmission ratio of i = 4.70



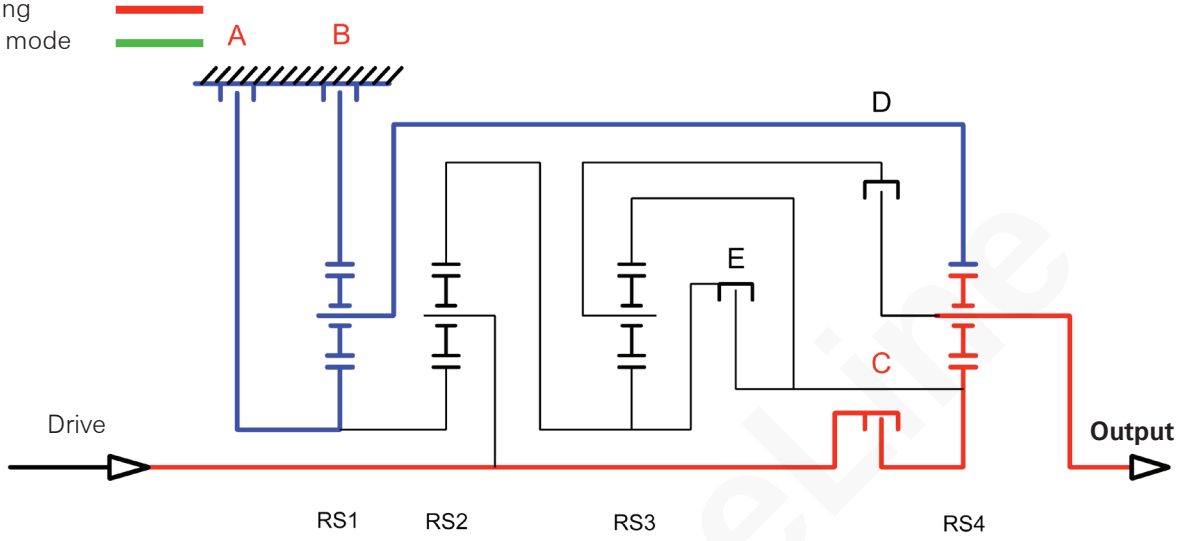
Converter lock-up clutch (WK) closed | **A Brake** | **B Brake** | **C Clutch**

orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

Diagram 8HP...

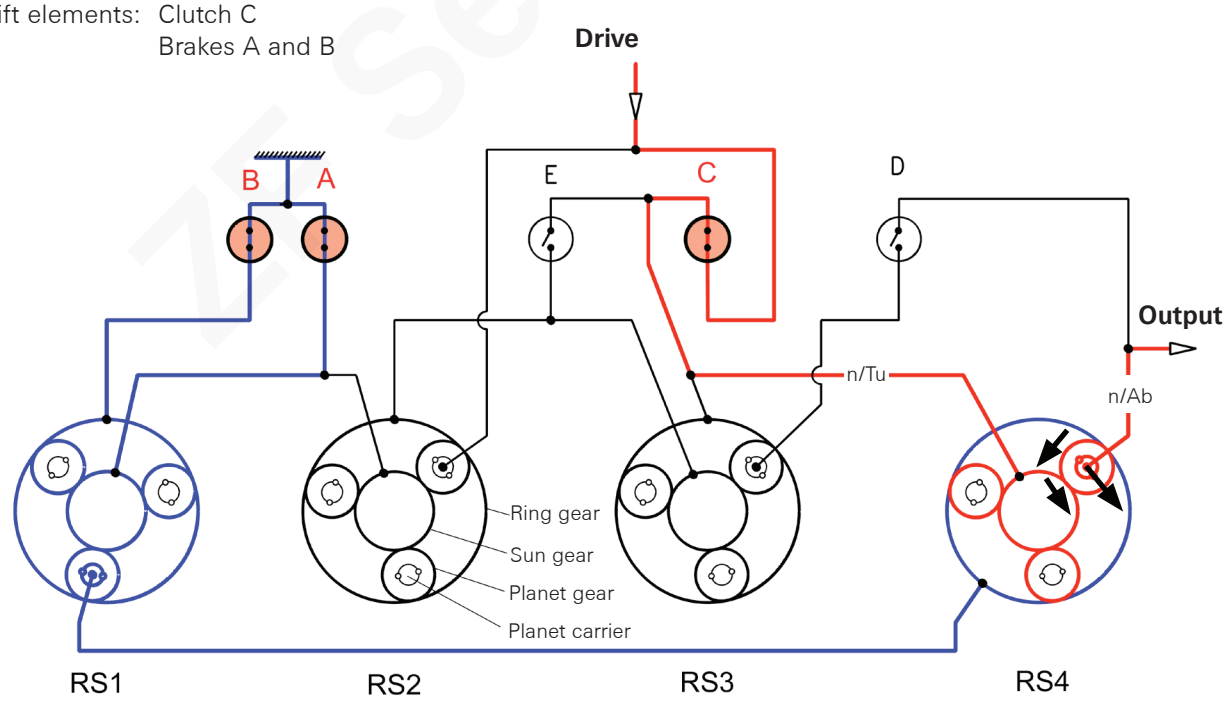
1st gear (i = 4.70)

Legend:
Blocked
Rotating
Block mode



1st gear (i = 4.70)

Shift elements: Clutch C
Brakes A and B



Gear description in 2nd gear

In 2nd gear, internal ring gear H1 is fixed by the multidisk brake B and the double sun gear S1/S2 via the multi-disk brake A against the housing (blocking position on planetary gear train RS1).

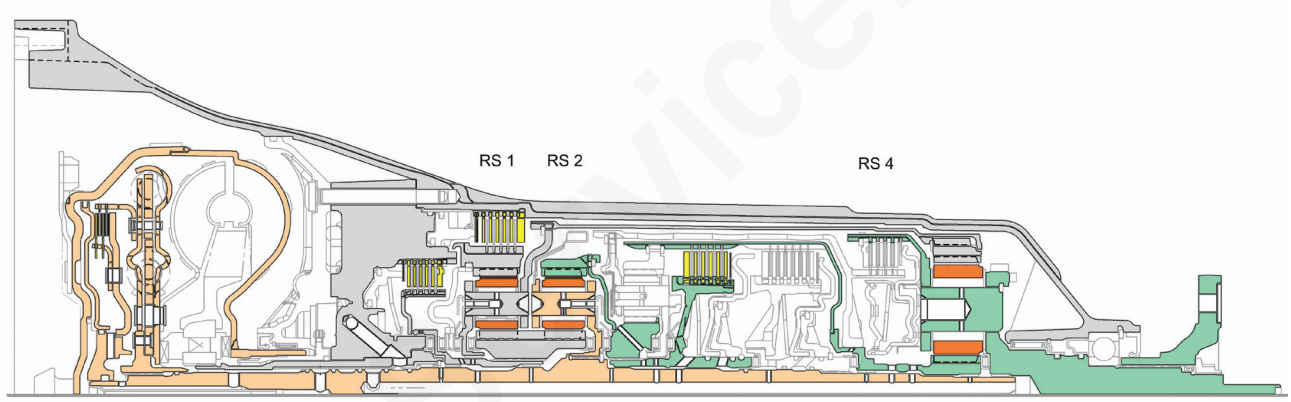
The connection of the planet carrier P1 and internal ring gear H4 means that this gear is also fixed.

The drive shaft provides the driving force which drives the planet carrier P2 at the same speed as the turbine. This rolls over the fixed double sun gear S1/S2. This drives the internal ring gear H2 in the direction of engine rotation which in turn drives the sun gear S4 via the closed multidisk clutch E.

The fixed internal ring gear H4 means that the planetary gears under the internal ring gear turn and drive the planet carrier P4 in the direction of engine rotation.

Planet carrier P4 also acts as the output shaft.

Active elements in 2nd gear with a transmission ratio of i = 3.13



Converter lock-up clutch (WK) closed

A Brake

B Brake

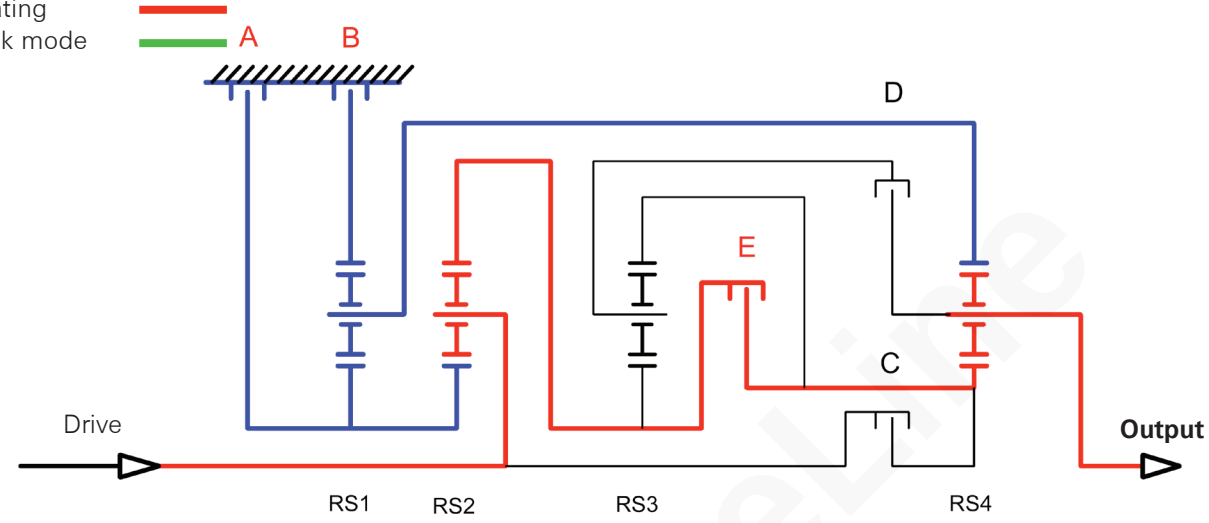
E Clutch

Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

Diagram 8HP...

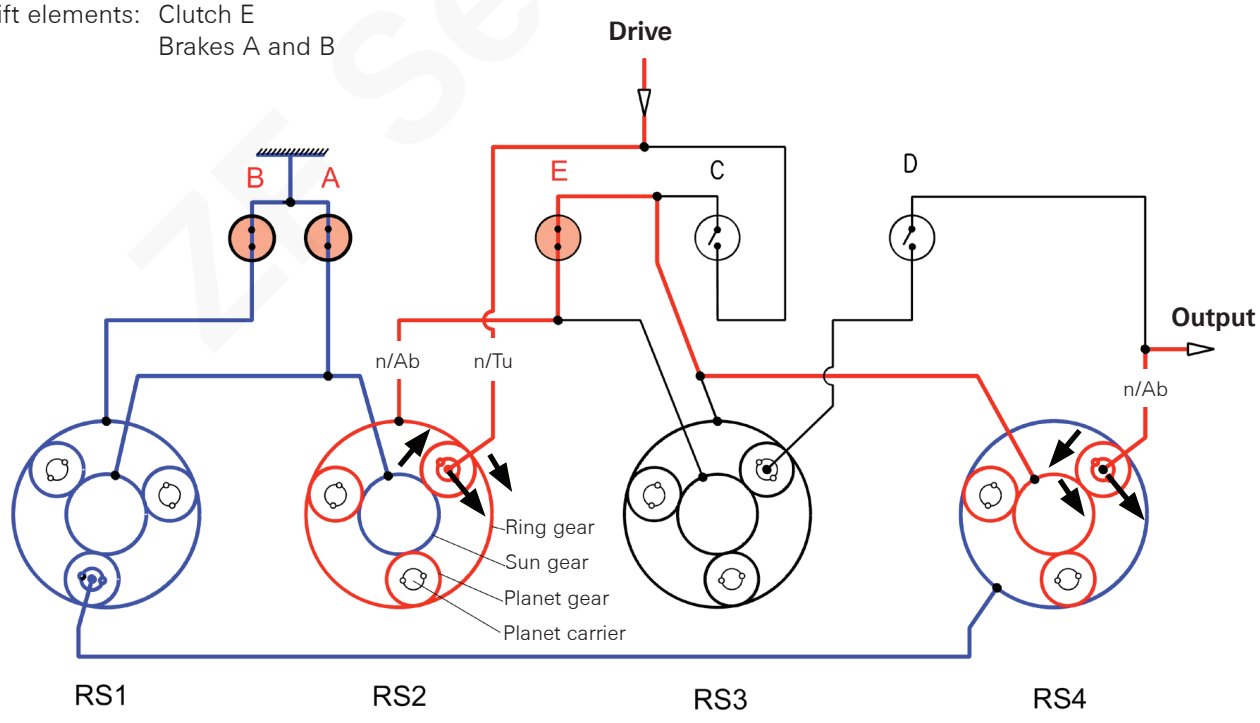
2nd gear (i = 3.13)

Legend:
Blocked
Rotating
Block mode



2nd gear (i = 3.13)

Shift elements: Clutch E
Brakes A and B



Gear description in 3rd gear

In 3rd gear the internal ring gear H1 is fixed against the housing by multidisk brake B.

The drive shaft provides the driving force to the planet carrier P2 and via the closed multidisk clutch C to the sun gear S4. Both are driven at the same speed as the turbine.

The closed multidisk clutch E connects sun gear S4 and internal ring gear H2 and drives them at the same speed in the direction of engine rotation (block mode on planet gear set RS2).

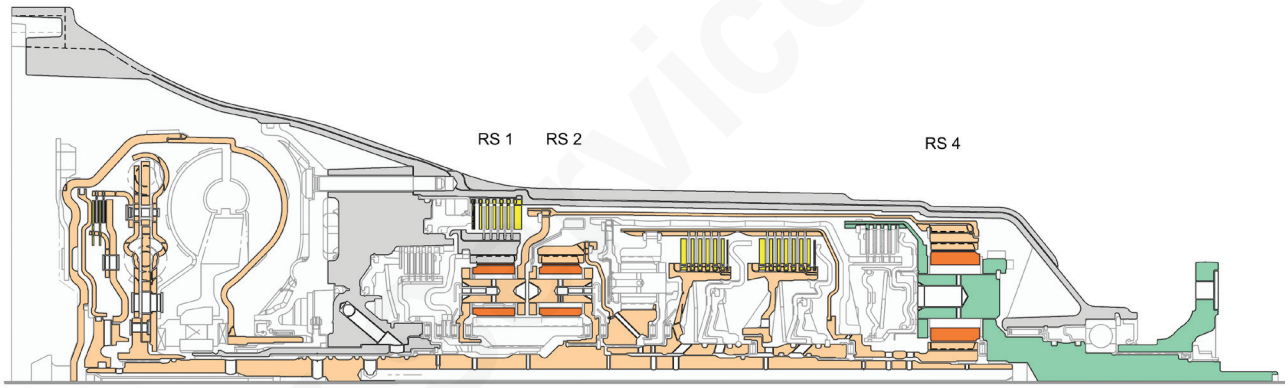
The block position on planetary gear train RS2 means that the double sun gear S1/S2 can drive the planetary gears 1 at the same speed as the turbine which makes them roll under the fixed internal ring gear H1. This drives planet carrier P1 at lower speed in the direction of engine rotation.

The fixed connection between planet carrier P1 and internal ring gear H4 produces the same direction of rotation and speed at internal ring gear H4.

Sun gear S4 drives at the same speed as the turbine which means that planet carrier P4 experiences an increase in speed compared to 2nd gear.

Planet carrier P4 also acts as the output shaft.

Active elements in 3rd gear with a transmission ratio of i = 2.10



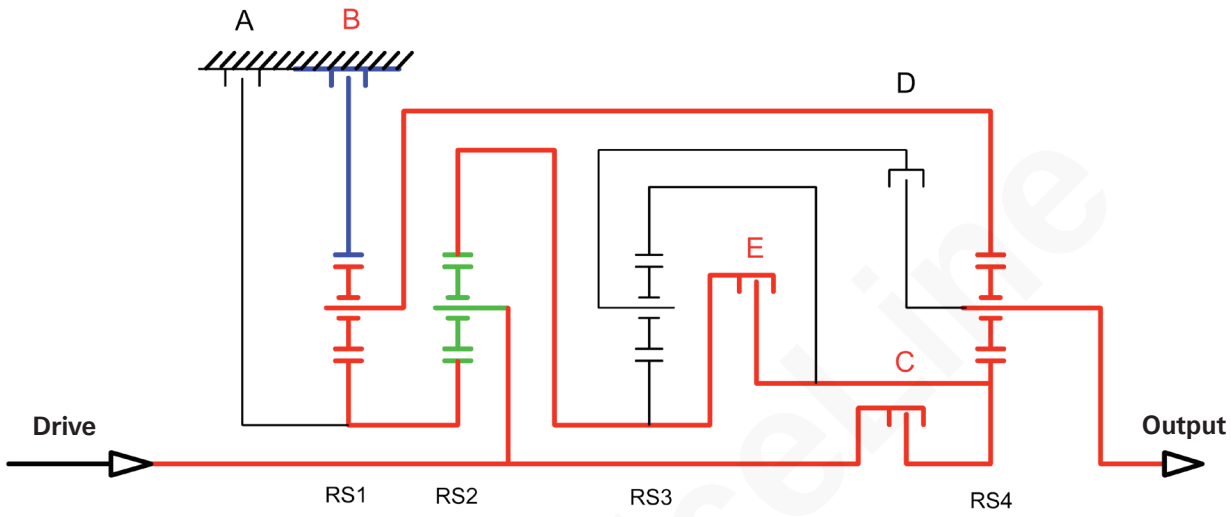
Converter lock-up clutch (WK) closed	B	E	C
	Brake	Clutch	Clutch

Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

Diagram 8HP...

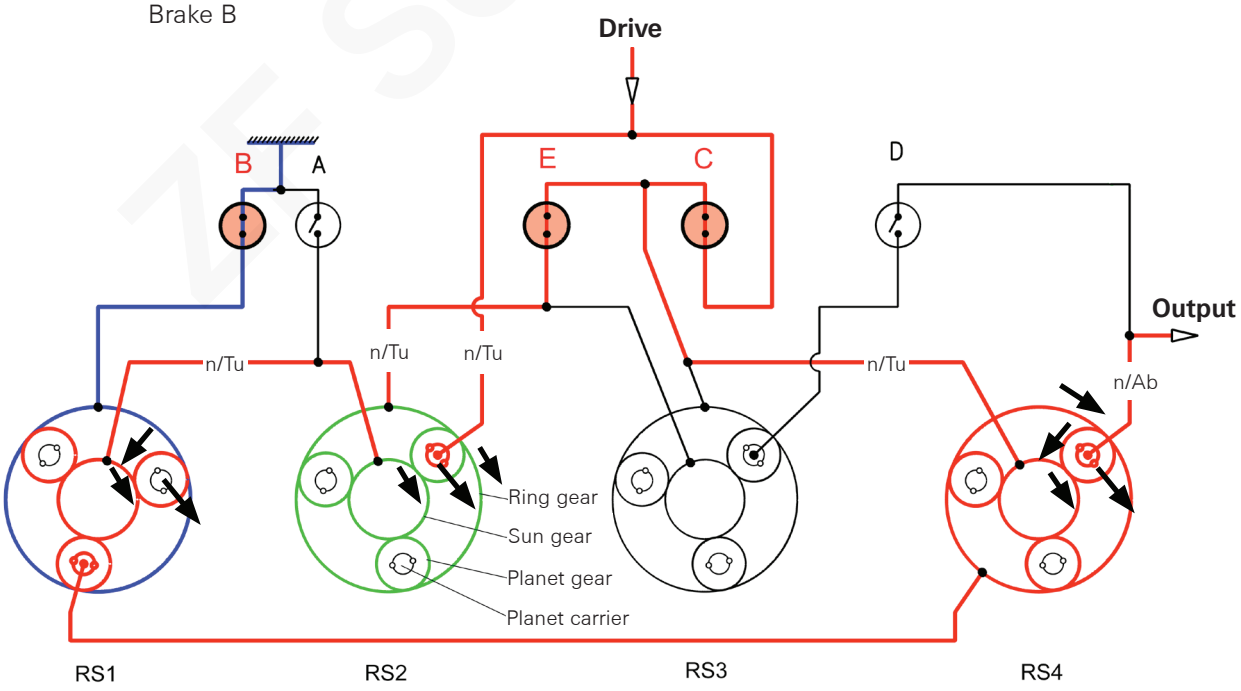
3rd gear (i = 2.10)

Legend:
Blocked
Rotating
Block mode



3rd gear (i = 2.10)

Shift elements: Clutches C and E
Brake B



Gear description in 4th gear

In 4th gear the internal ring gear H1 is fixed against the housing by multidisk brake B.

The closed multidisk clutch E short circuits internal gear H3 and sun gear S3 on the planetary gear train RS3 which produces block mode on planetary gear train RS3.

The closed clutch D produces a fixed connection between planet carrier P3 and the output shaft. This means that planetary gear train RS3 is driven in full at output speed in the same direction as the engine.

The fixed connection of internal ring gear H3 and sun gear S4 and between sun gear S3 and internal ring gear H2 means that internal ring gear H2 and sun gear S4 are also driven at output speed.

The drive shaft provides the driving force to planet carrier P2 which rolls under the internal ring gear H2 which rotates at output speed.

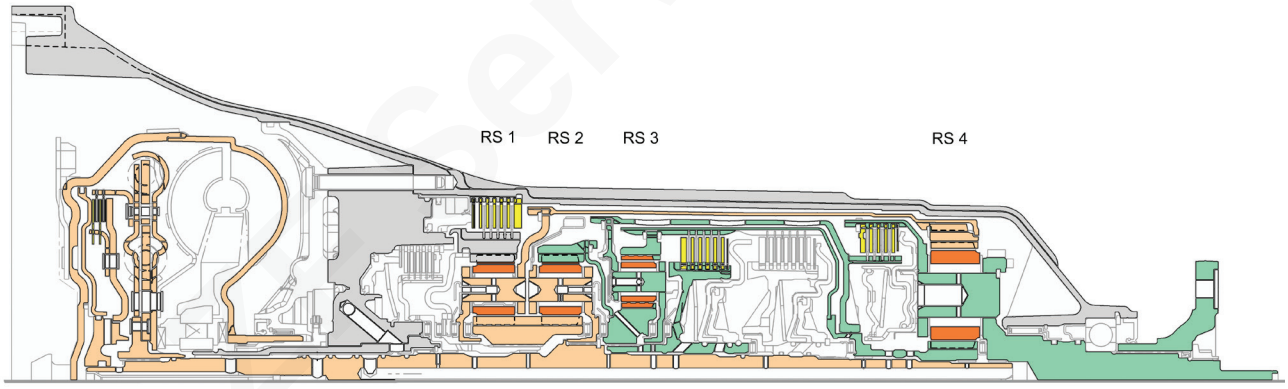
The double sun gear S1/S2 is driven accordingly at the speed of planetary gears 2 which means that planetary gears 1 roll under the fixed internal ring gear H1 and drive the planet carrier P1 in the same direction as the engine.

The planetary gear train RS4 is locked against the output shaft by the connection of the sun gear S and the planet carrier P4. This produces block mode on planetary gear train RS4.

The planet carrier P1 is firmly connected to internal ring gear H4 which means that the planetary gear train is driven as a block.

Planet carrier P4 also acts as the output shaft.

Active elements in 4th gear with a transmission ratio of i = 1.67



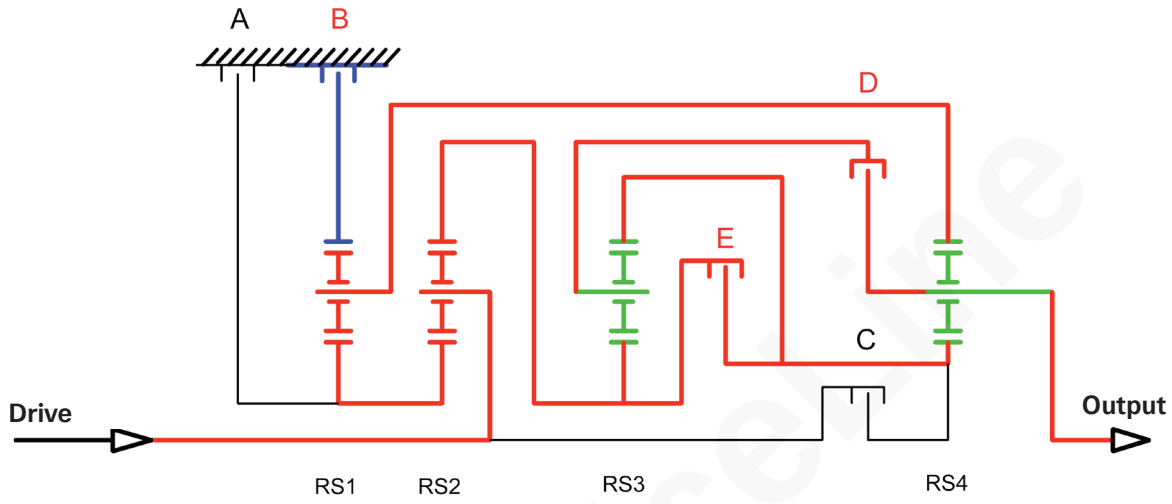
Converter lock-up clutch (WK) closed	**B Brake**	**E Clutch**	**D Clutch**

Orange = **Drive**
Green = **Output**
Grey = **Fixed against the housing**
Red = **Planetary gears**
Yellow = **Brake / clutch**

Diagram 8HP...

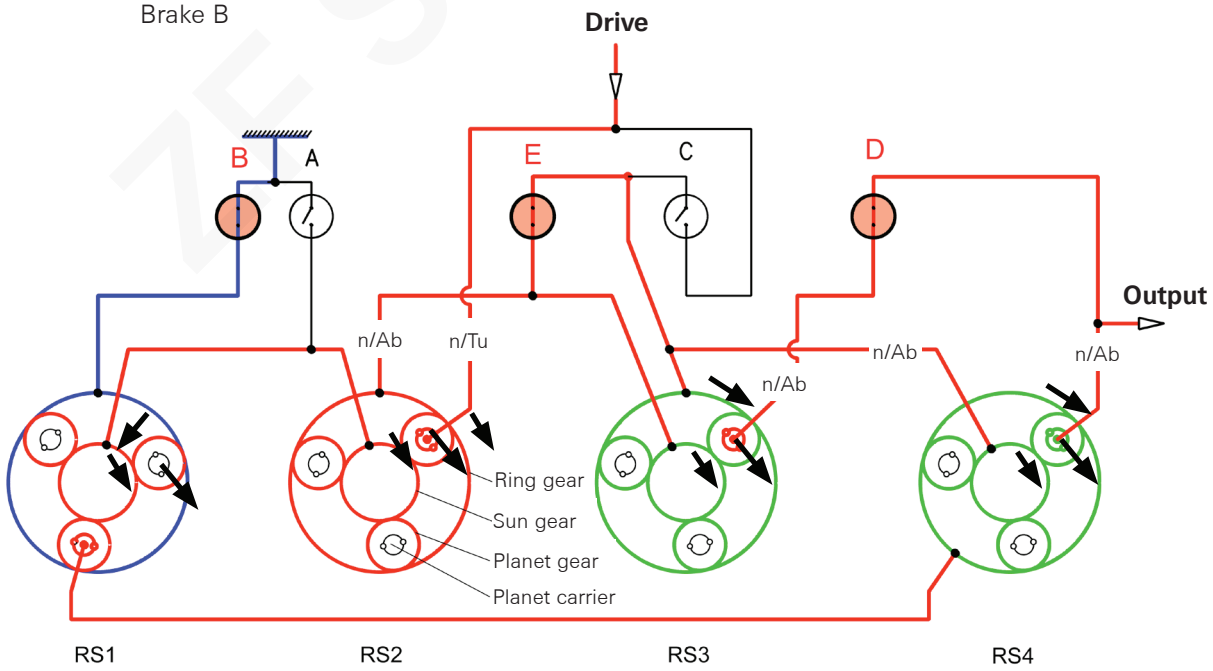
4th gear (i = 1.67)

Legend:
Blocked
Rotating
Block mode



4th gear (i = 1.67)

Shift elements: Clutches D and E
Brake B



Gear description in 5th gear

In 5th gear the internal ring gear H1 is fixed against the housing by multidisk brake B.

The drive shaft provides the driving force to the planet carrier P2 and via the closed multidisk clutch C to the internal ring gear H3 and sun gear S4.

Planet carrier P2, internal ring gear H3 and sun gear S4 are driven in the direction of engine rotation at the same speed as the turbine. The closed multidisk clutch D produces a fixed connection between planet carrier P3 and the output shaft. This drives the planet carrier P3 at output speed in the same direction as the engine so that it rolls under the internal ring gear H3 which is rotating at the same speed as the turbine.
Sun gear S3 is driven in the opposite direction to the engine.

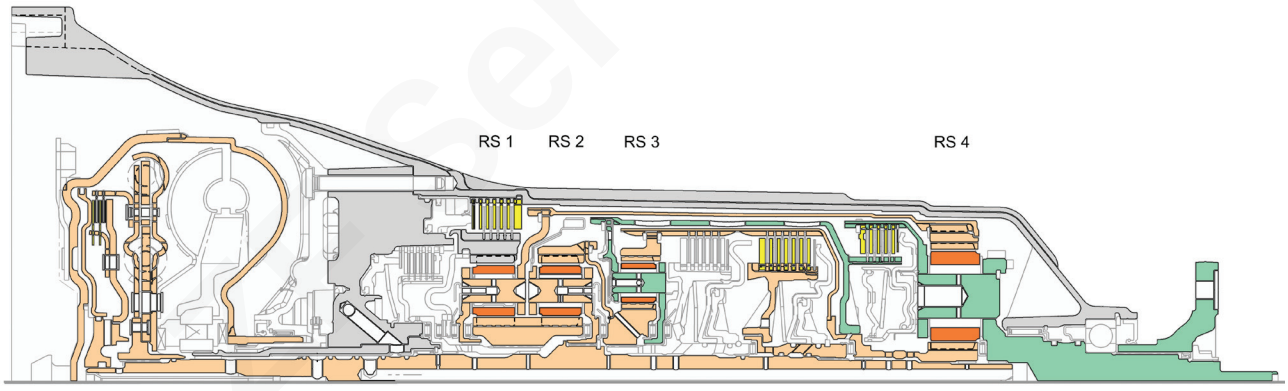
The fixed connection between sun gear S3 and internal ring gear H2 ´rotates internal ring gear H2 in the opposite direction to planet carrier P2 which is driven by the drive shaft.

The double sun gear S1/S2 is therefore driven in the same direction as the engine by planetary gears 2.
This results in planetary gears 1 rolling under the fixed internal ring gear H1 and drive the planet carrier P1 in the same direction as the engine.

Internal ring gear H4 has the same speed due to its fixed connection with planet carrier P1. This produces a speed ratio on planetary gear train RS4 between the sun gear S4 turning at the same speed as the turbine and internal ring gear H4 turning at the same speed as planet carrier P1. This speed ratio produces a resulting peripheral speed of planet carrier P4.

Planet carrier P4 also acts as the output shaft.

Active elements in 5th gear with a transmission ratio of i = 1.29



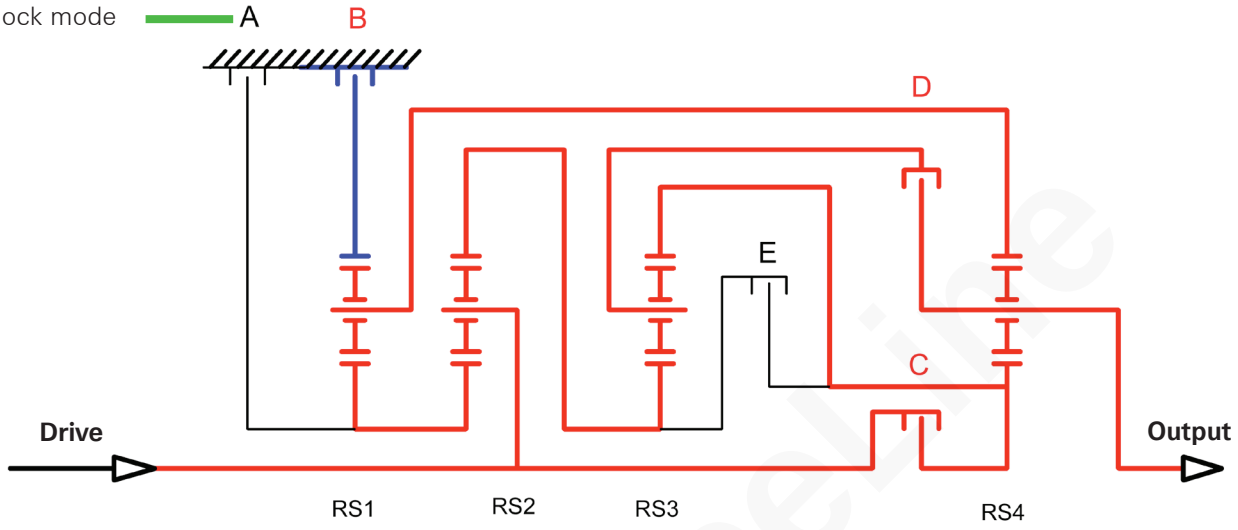
Converter lock-up clutch (WK) closed	B Brake	C Clutch	D Clutch

Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

Diagram 8HP...

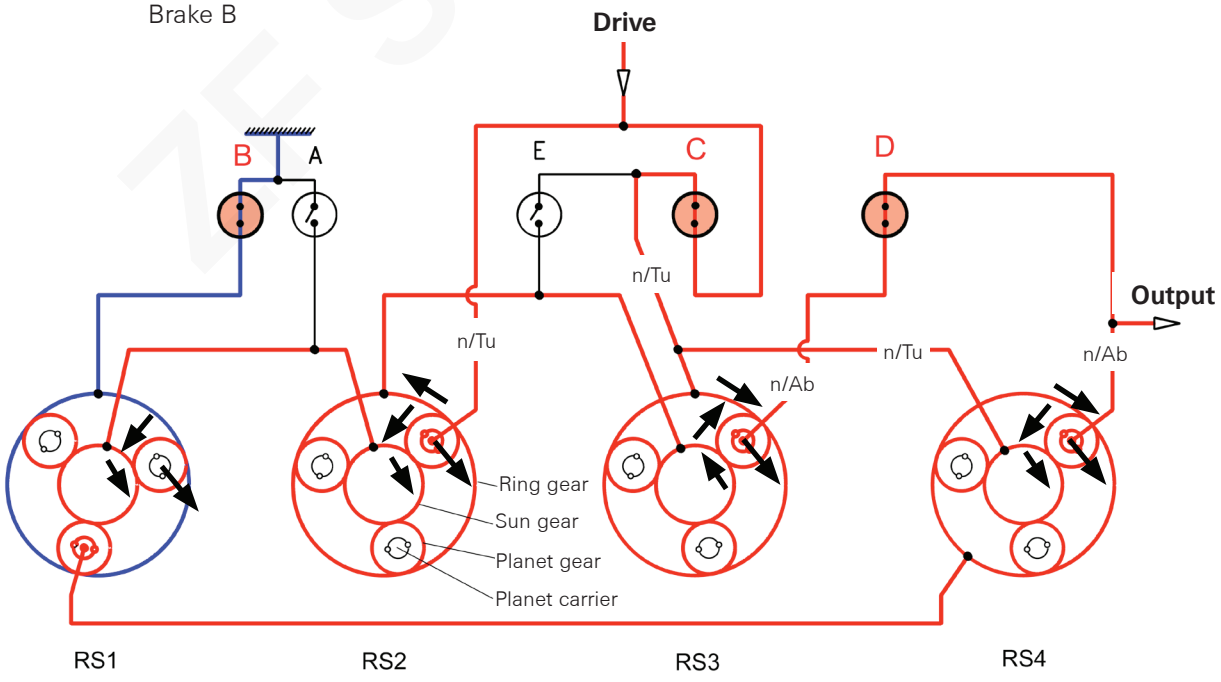
5th gear (i = 1.29)

Legend:
Blocked
Rotating
Block mode



5th gear (i = 1.29)

Shift elements: Clutches C and D
Brake B



Gear description in 6th gear

The driving force from the drive shaft in 6th gear drives the closed multidisk clutches C and E.

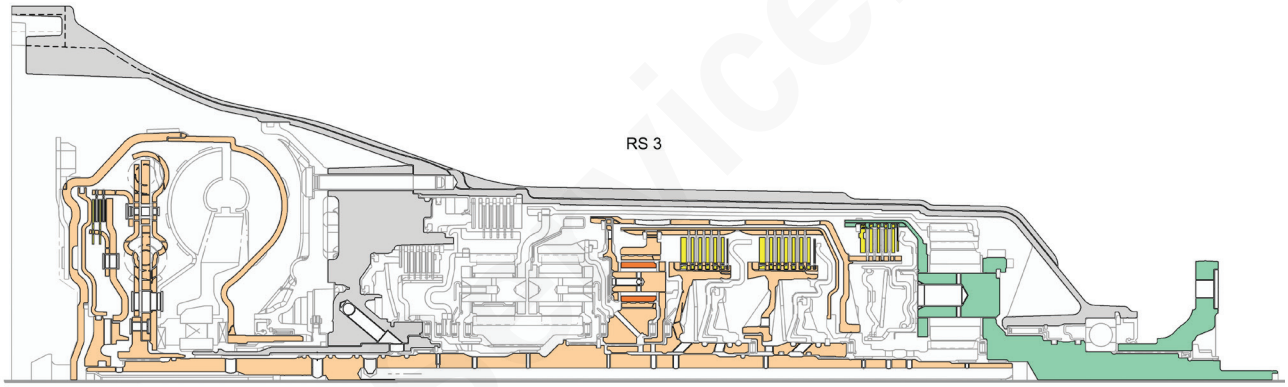
The closed multidisk clutch C initiates the propulsion of the engine into the planetary gear set.

The closed multidisk clutch E short circuits internal ring gear H3 and sun gear S3. Both of these, sun gear S3 and internal ring gear H3 are driven at the same speed as the turbine which produces block mode on planetary gear train RS3.

Planet carrier P3 is connected to planet carrier P4 by the closed multidisk clutch D. This results in the same speed in the same direction as the engine on planet carrier P4.

Planet carrier P4 also acts as the output shaft.

Active elements in 6th gear with a transmission ratio of i = 1.0



Converter lock-up clutch (WK) closed

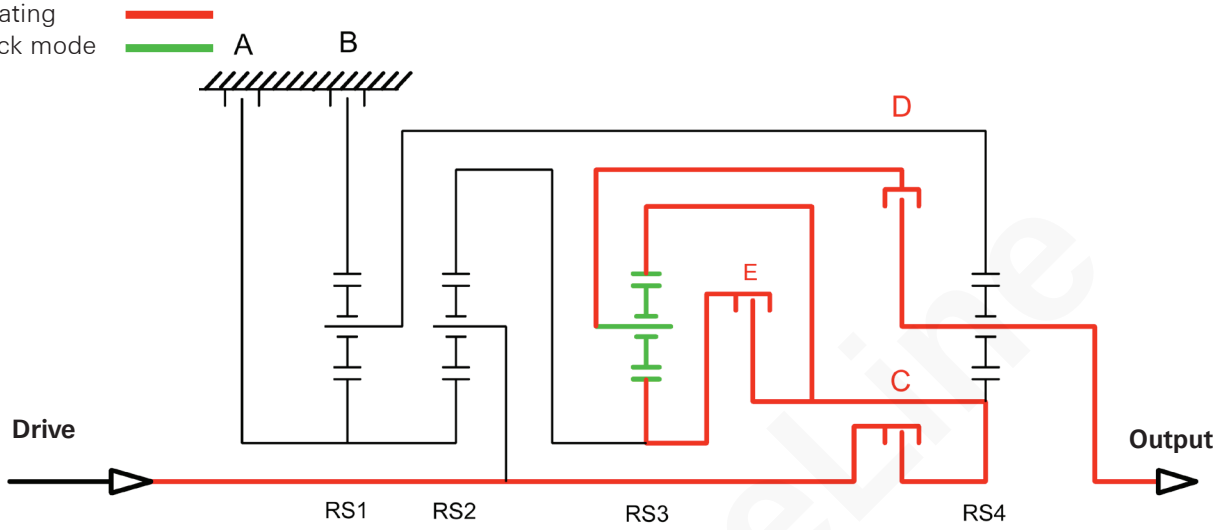
E Clutch **C Clutch** **D Clutch**

Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

Diagram 8HP...

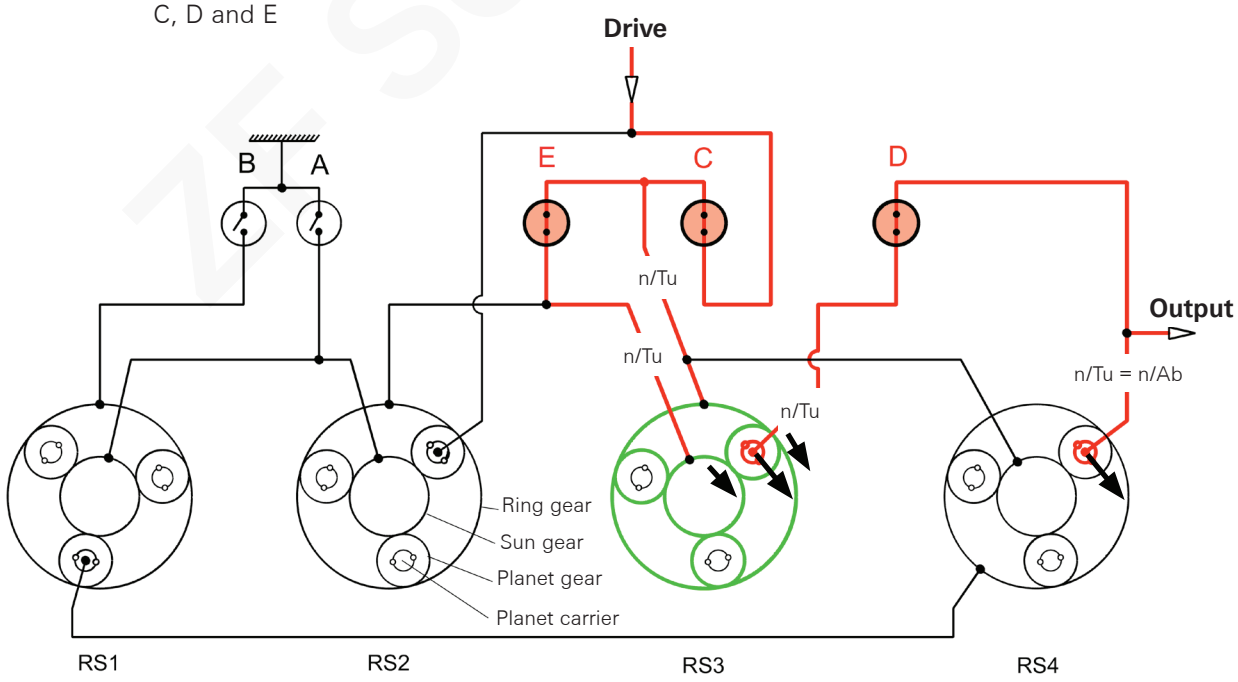
6th gear (i = 1.0)

Legend:
Blocked
Rotating
Block mode



6th gear (i = 1.0)

Shift elements: Clutches
C, D and E



Gear description in 7th gear

In 7th gear the double sun gear S1/S2 is fixed against the transmission housing by the closed multidisk brake A.

The drive shaft provides the driving force to the planet carrier P2 and via the closed multidisk clutch C to the internal ring gear H3. Both, planet carrier P2 and internal ring gear H3, are driven at the same speed as the turbine.

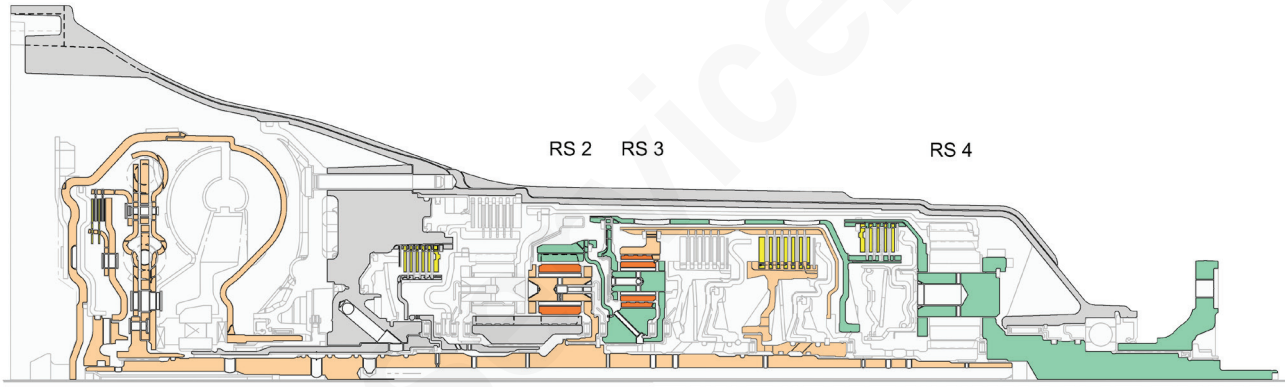
As a result of driving the planet carrier P2 the planetary gears 2 roll over the fixed double sun gear S1/S2 and drive the internal ring gear H2 at the corresponding speed in the same direction as the engine.

The internal ring gear H3 drives planet carrier P3 at the same speed as the turbine and sun gear S3 at a correspondingly higher speed due to the connection with internal ring gear H2. This drives the planet carrier P3 via planetary gears 3 in the same direction as the engine.

Planet carrier P3 has a fixed connection with planet carrier P4 via the close multidisk clutch D which results in the same speed in the same direction as the engine at planet carrier P4.

Planet carrier P4 also acts as the output shaft.

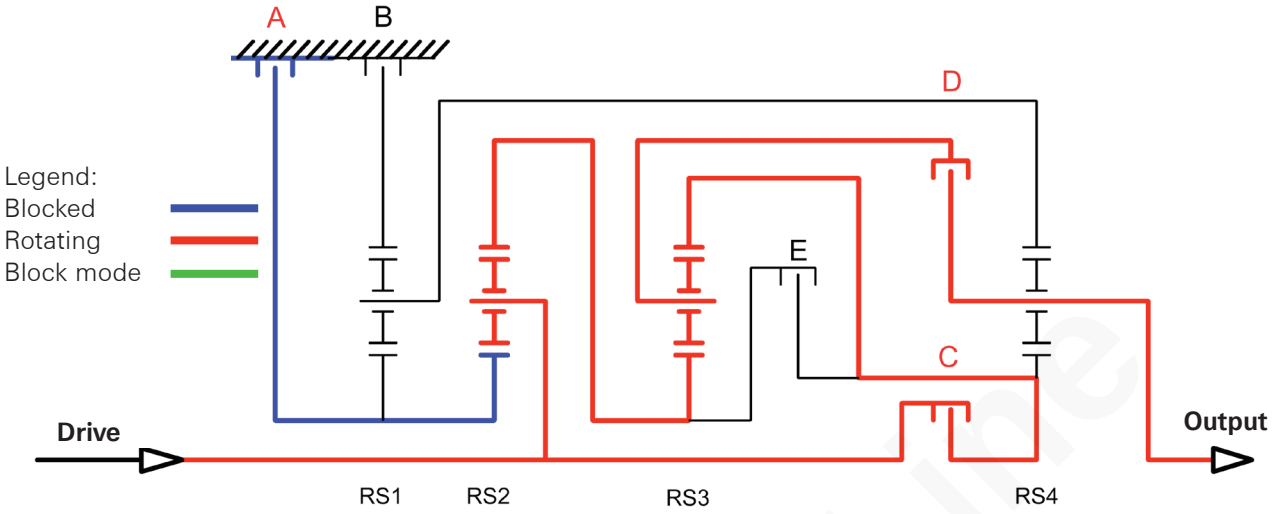
Active elements in 7th gear with a transmission ratio of i = 0.84



Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

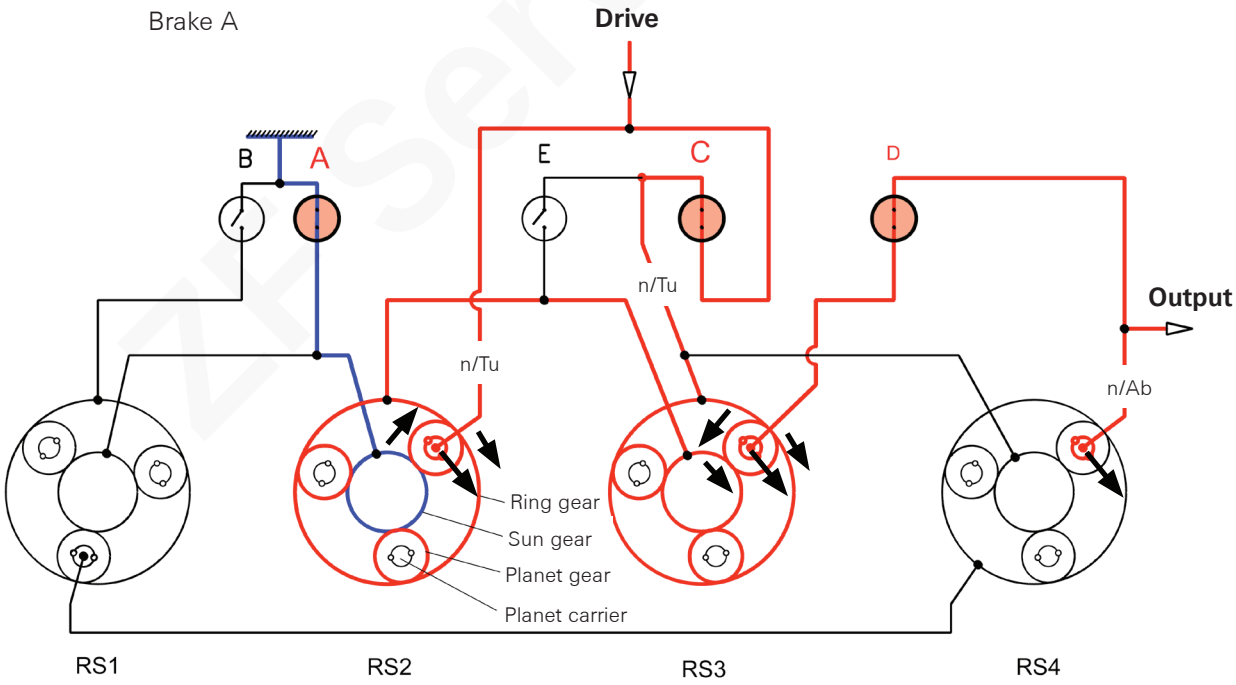
Diagram 8HP...

7th gear (i = 0.84)



7th gear (i = 0.84)

Shift elements: Clutches C and D
Brake A



Gear description in 8th gear

In 8th gear the double sun gear S1/S2 is fixed against the transmission housing by the closed multidisk brake A.

Internal ring gear H3 and sun gear S3 are short circuited by the closed multidisk clutch E which produces block mode on planetary gear train RS3.

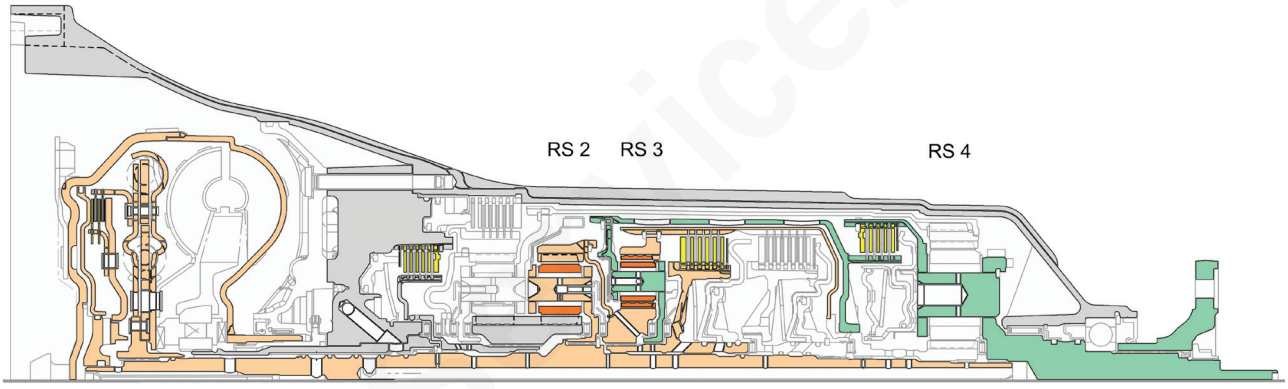
The drive shaft provides the drive direct to planet carrier P2. As a result of driving the planet carrier P2 the planetary gears 2 roll over the fixed double sun gear S1/S2 and drive the internal ring gear H2 at the corresponding speed in the same direction as the engine.

Internal ring gear H2 drives sun gear S3 and internal ring gear H3 via the closed multidisk clutch E (block mode on planetary gear train RS3).

Planet carrier P3 has a fixed connection with planet carrier P4 via the close multidisk clutch D which results in the same speed at planet carrier P4.

Planet carrier P4 also acts as the output shaft.

Active elements in 8th gear with a transmission ratio of i = 0.67



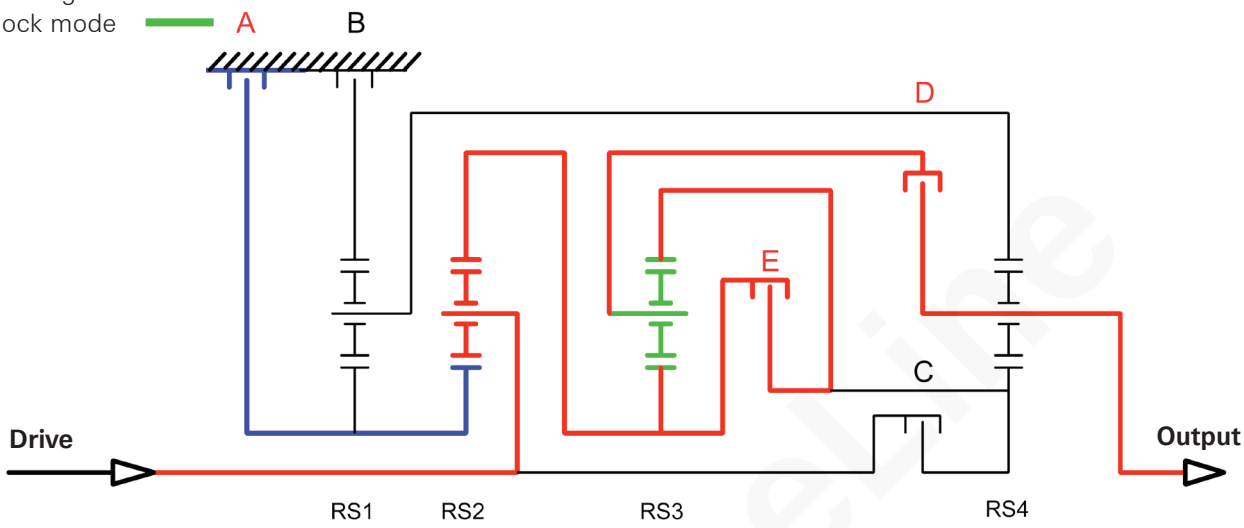
Converter lock-up clutch (WK) closed	**A Brake**	**E Clutch**	**D Clutch**

Orange = **Drive**
Green = **Output**
Grey = **Fixed against the housing**
Red = **Planetary gears**
Yellow = **Brake / clutch**

Diagram 8HP...

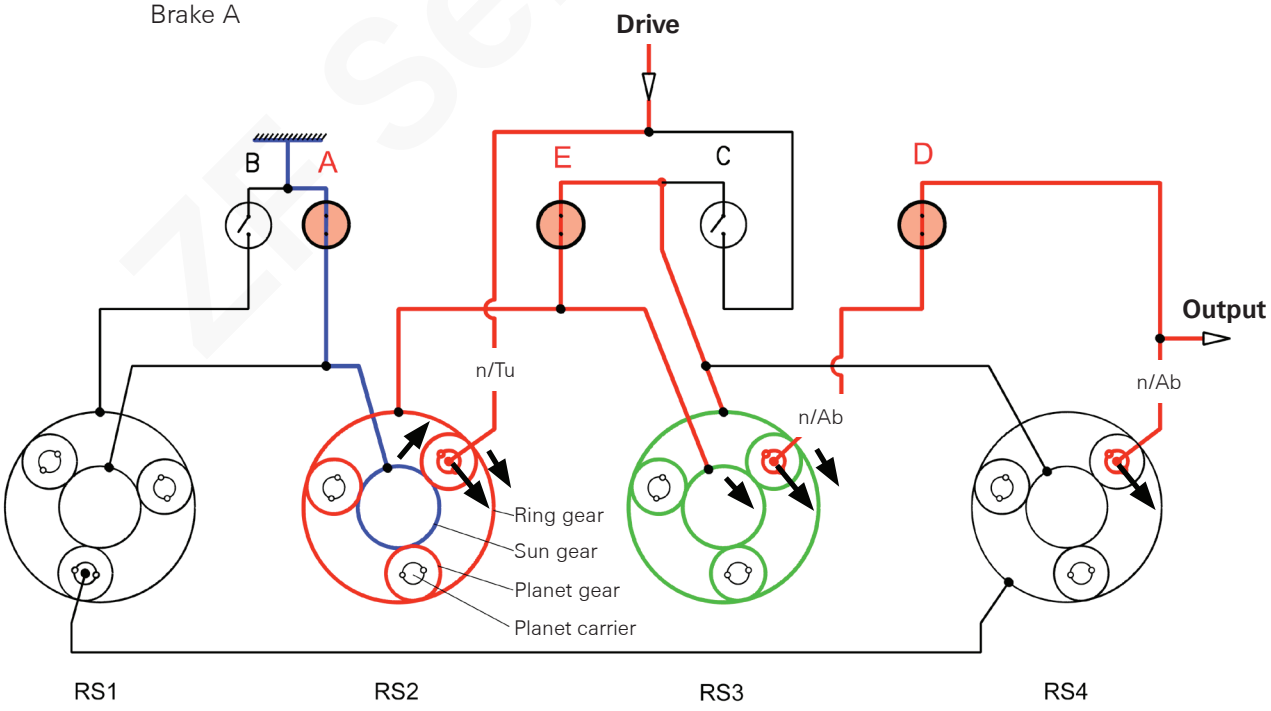
8th gear (i = 0.64)

Legend:
Blocked
Rotating
Block mode



8th gear (i = 0.64)

Shift elements: Clutches E and D
Brake A



Gear description for reverse gear (R)

In reverse gear, the ring gear H1 is secured to the transmission housing using the closed multidisk brake B, and the double sun gear S1/S2 is secured to the transmission housing using the closed multidisk brake A.

The planet carrier P1 is linked with the ring gear H4 and thus is likewise secured to the housing. The planet carriers P3 and P4 are firmly linked to one another by means of the closed multidisk clutch D.

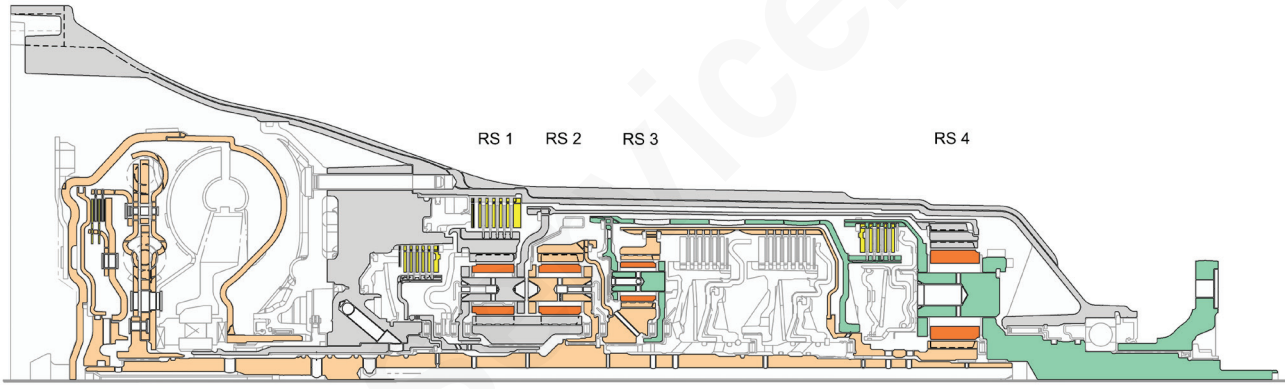
Drive takes place directly from the drive shaft to the planet carrier, whereby planetary gears 2 roll onto the stationary double sun gear S1/S2 and take the internal ring gear H2 in the direction of engine rotation.

The internal ring gear H2 and the sun gear S3 are firmly connected to one another. In this way, the sun gear 3 drives the internal ring gear H3 against the direction of engine rotation. The internal ring gear H3 is firmly connected with the sun gear S4, whereby the same rotational direction is achieved on sun gear S4.

The sun gear S4 drives the planetary gears 4 against the direction of engine rotation, which roll beneath the stationary ring gear H4 against the direction of engine rotation and take the planet carrier P4 with them.

Planet carrier P4 also acts as the output shaft.

Active elements in reverse gear (R) with a transmission ratio of i = 3.297



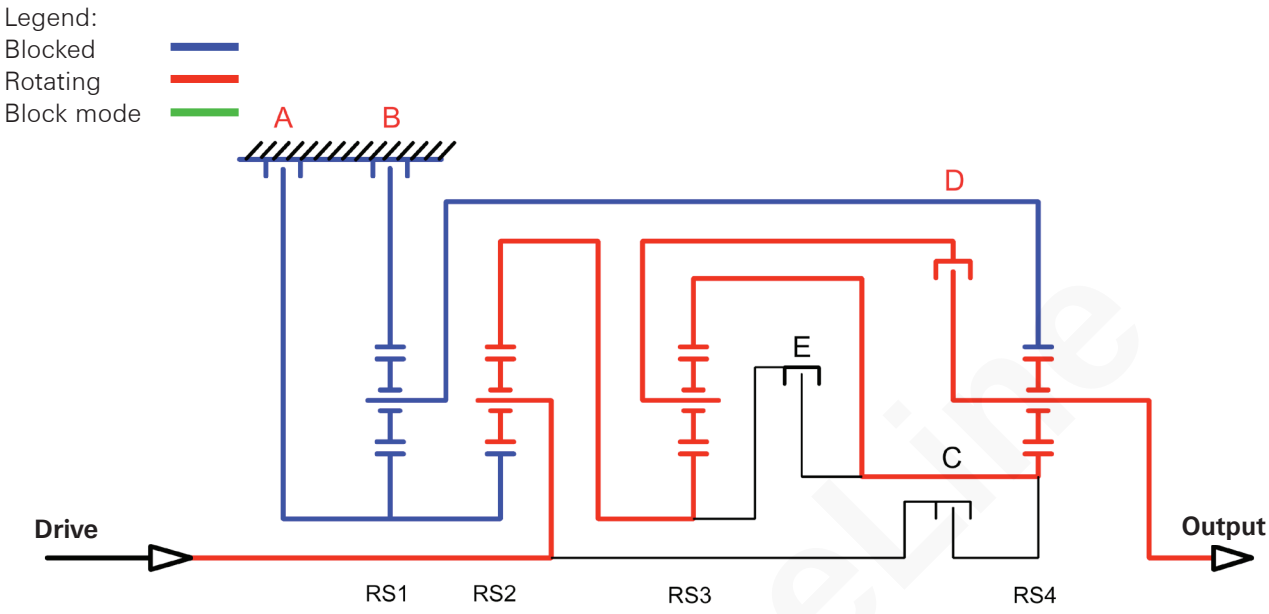
Converter lock-up clutch (WK) open

A Brake **B Brake** **D Clutch**

Orange = Drive
Green = Output
Grey = Fixed against the housing
Red = Planetary gears
Yellow = Brake / clutch

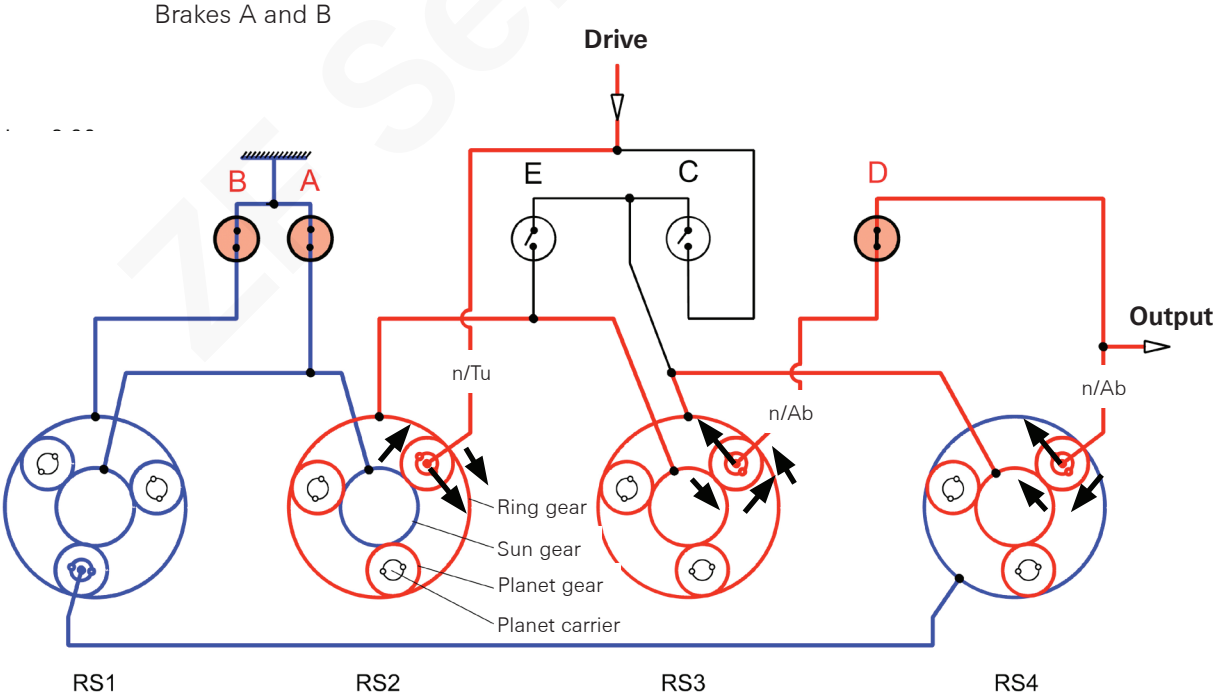
Diagram 8HP...

R gear (i = 3.297)



R-gear (i = 3.297)

Shift elements: Clutch D
Brakes A and B



In handling the mechatronic control unit, for a repair, for example, the appropriate protective measures must be observed, especially for ESD protection.

Please refer to the regulation DIN EN 100015 and the guidelines ESD protection from the technical committee electrostatics VDE / VDI as well as GME, the Society for Micro Electronics.

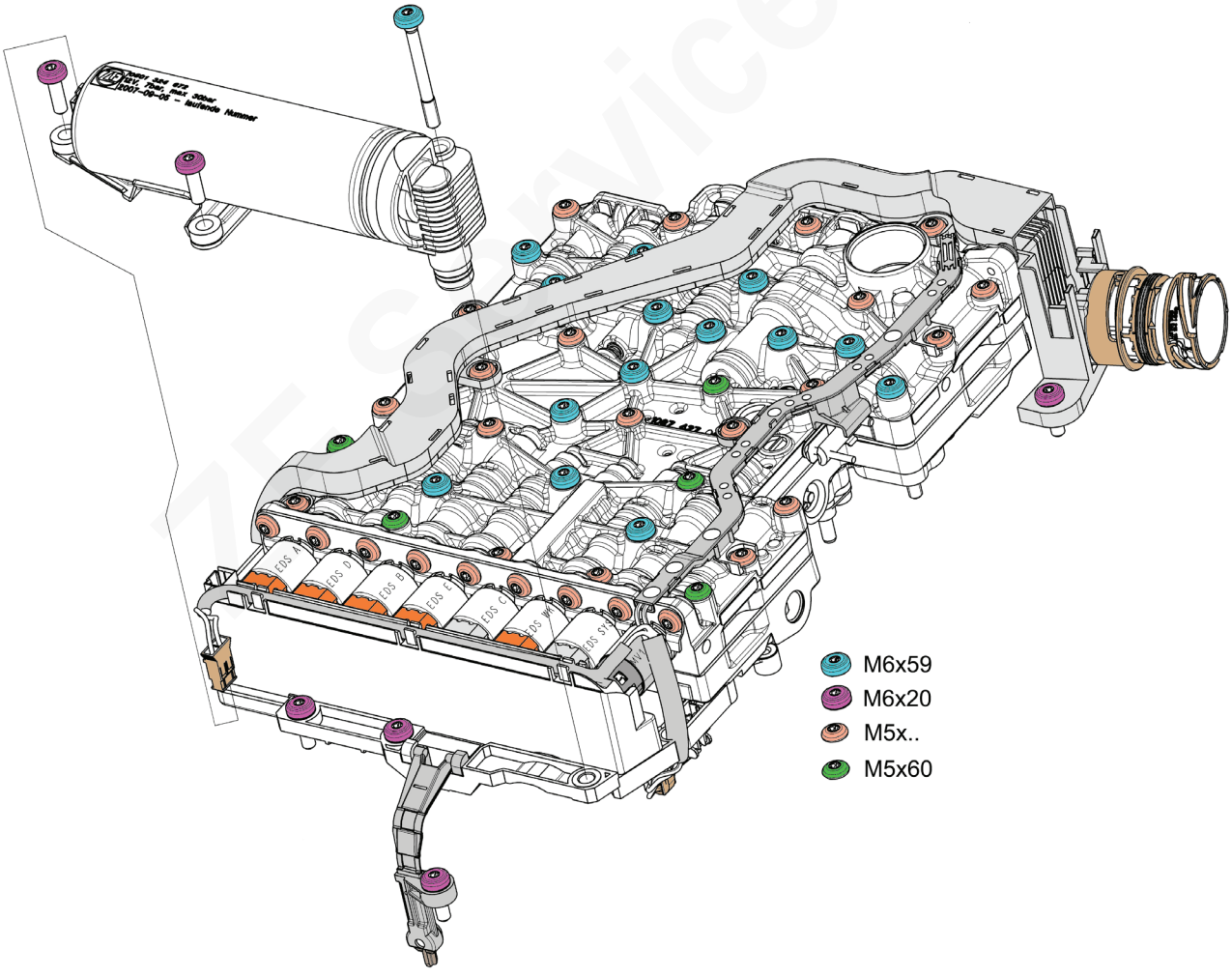
Here are excerpts:

The term “ESD” means **E**lectro**S**tatical **D**ischarge.

A charged person who is not grounded carries a voltage build-up with him, endangering electrostatically sensitive devices, so-called ESD. Thus it is necessary to wear ESD shoes and a closed ESD coat.

Protective measures against damage from electrostatic charges is everyone’s business

- in the acceptance of goods,
- in the goods-receipt inspection,
- in the manufacturing or repair areas (even in case of just a short stay),
- in storage,
- transportation and
- in shipment



What can each individual do?

Always observe personal protective arrangements:
- in the ESD protective zones, always wear an ESD smock and dissipative ESD shoes,
- during seated activities in the ESD protective zones, always wear an anti-static wrist band,
- do not touch any open devices or components without sufficient equipotential bonding.

In ESD protective zones, only use permissible means of transportation and packaging:
- transport boxes,
- component packaging,
- magazine,
- transport cart.

Only use permissible tools:
- grounded soldering irons,
- grounded de-soldering tools,
- permissible auxiliary tools.

Ban all insulating plastic materials from the work area, especially:
- Polyethylene bags
- Polystyrene parts
- Cellophane
- PVC bags, foils, transparent coverings.

The “Siemens Fabrication Guideline F12F1542” and the process description “051 ESD Implementation Instructions” contain detailed instructions.

Assure the greatest possible care is taken everywhere you see this sign:

There are components or assemblies in the vicinity that are sensitive to electrostatic charging.

ESD Protective Zones

An ESD protective zone may take various forms:

Stationary:
- individual workspace,
- workbench, desk,
- warehouse, factory building, office,
- individual shelves or racks
- service,
- customer service,

Personal safety must always be assured with ESD protection. For this reason, directions relating to work safety and especially the DIN VDE 0104 must be observed.

Equipping ESD Protective Zones

An electronic workplace must always be set up as an ESD-protected workplace. The ultimate aim is to strive for a self-contained ESD protected zone.

Minimal equipment, e.g. retrofitting of a workplace

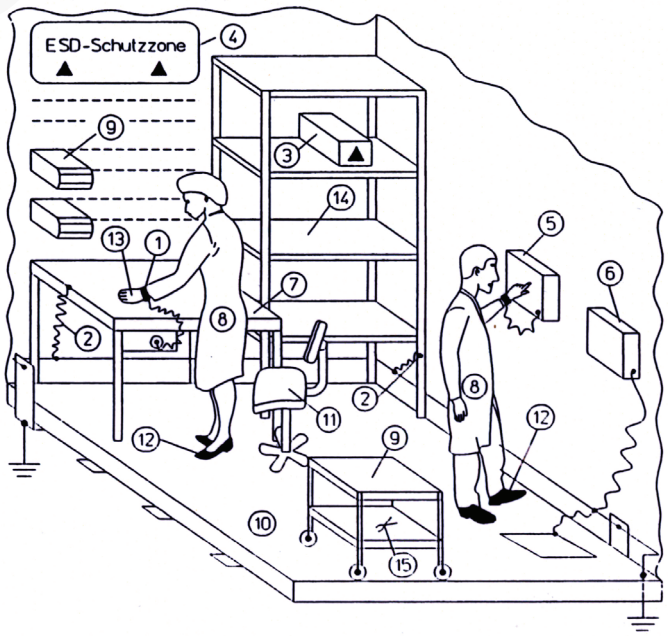
Grounding of a person by means of an antistatic wristband,
Table facing or matting with an equipotential bonding connection.
Protective packaging for electrostatically sensitive components.
The following must be dissipative:

- table facing,
- work clothing,
- transport systems and warehouse boxes.

Optimal equipment, e.g. in case of re-equipping ESD-safeguarded workplaces

Grounding of the person via an antistatic wristband (1),
Work surfaces and shelves connected to equipotential bonding (2),
Protective packaging for electrostatic sensitive components (3),
Demarcation as an ESD protective zone (4),
Test device for personal grounding (antistatic wristband) (5),
Test device for personal grounding (ESD footwear) (6).
The following must be dissipative:

- worktable (7),
- work clothing (8),
- transport systems and warehouse boxes (9).
- floor covering (10),
- chairs (11),
- shoes or foot grounding and (12),
- gloves or gloved finger (if required) (13),
- trays (14),
- tools (15).



Marking "Electrostatically Sensitive Components"

Assemblies with electrostatical sensitive components must carry a note in the form of a warning symbol (→) , which indicates the special handling guidelines.
Self-adhering labels should not be applied directly to the electrostatically sensitive component, because it would thereby be exposed to an impermissibly high electrostatic danger. In these cases, the marking should only be executed on the packaging.

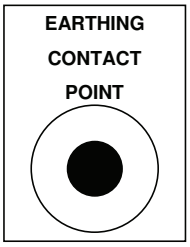
Marking for "ESD Protective Zones"

ESD protective zones must be designated with signs such the adjacent (→) .

The sign must be attached very visibly. The minimum size is 300 mm by 150 mm. The base color is yellow; the writing is in black.

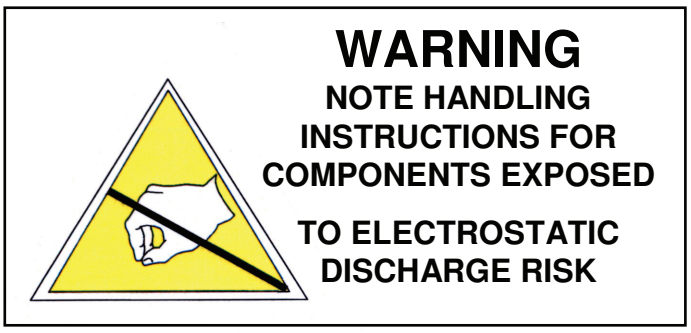
ESD Grounding Devices

All ESD grounding devices that are attached in the ESD protective zones must be marked. Using appropriate symbols, the marking must be provided in a way that the intended use of the ESD protection is obvious. The label must be designed in a way that the purpose of use is clear and that possible additional information does not distract from the basic warning (compare adjacent examples→).



Packaging and Transport Containers

Packaging and transport containers that are used for the pickup and transport of electrostatically sensitive components must be marked with a warning (→). Additionally, leaflets with instructions on the separate handling guidelines should be contained in the transport packaging that, for example, are leaving the manufacturing area.



Documentation

There must be instructions for the user relating to available guidelines on the handling of electrostatically sensitive devices in all the documentation that are necessary for their procurement, specification, design and transfer.

Packaging

In theory, three types of packaging are differentiated. There must be the assurance of ESD protection for directly adjoining packaging in direct contact with electrostatically sensitive components and loose-wrapped packaging especially for the transfer under uncontrolled conditions outside of the ESD protection zones. On the other hand, exterior packaging need offer no ESD protection and should only fulfill any additional requirements, such as physical protection.

Directly adjoining packaging, supporting materials and means of transport used in direct contact with the electrostatically sensitive component must minimize triboelectrostatic charging and assure charge dissipation. That means: They must be **antistatically and electrostatically** dissipating.

Loosely wrapped packaging for the protection of sensitive electrostatically sensitive components (voltage sensitivity up to 4 kV or unknown) must be electrostatically shielded **outside of the ESD protective** zones. When the use is within the ESD protective zones, the requirements can be reduced.

Loose filler must be **antistatically and electrostatically dissipating** if the danger to electronically sensitive components is to be excluded.

A**single bag** can be used as a loosely wrapped as well as a directly adjoining packaging. The requirement is that the inner as well as the outer surface **be electrostatically** dissipating.

Exterior packing material must meet all **additional requirements** for packaging, e.g. physical protection. Electrostatic properties are not required if the ESD protection is assured by the inner packaging. The material, however, must be antistatic if the packaging is to be brought into an ESD protective zone.

Wrist grounding of Persons

Wrist grounding is the most certain method of dissipating electrostatic charge on a person. It should thus be preferred wherever possible and especially during seated activities.

Wrist grounding consists of a band tightly closed around the wrist and a grounding cable (spiral cable), which connects the band with the grounding point. This grounding system must have a fast contact release that frees the wrist first as a priority in case of danger.

The **wristband** must be conductive on the inner side, the outer edge and the outer surface must be insulating, however.

The **ground cable** must consist of an insulated line that withstands a test voltage of 4kV and workplaces with a nominal voltage of up to 250 V. At least one **metal film resistor of 1 MΩ (M-Ohm) and at least 0.25 W capacitance must be integrated into the ground cable according to DIN 45921** Part 107 (2).
This resistance must also **correspond to DIN VDE 0860 (20, 21)** and must not be bridgeable.
The total resistance must not exceed 5 MΩ.

Connectors linking to ground points must not **fit into the plug devices of other systems**, such as alternating current or laboratory plug sockets. For example, suitable push buttons as well as appropriate insulated plug devices meet this requirement. **Banana plugs** across the board and **crocodile clamps** in general (exception: use in service) **are not permitted.** . **Magnets** for connection are**unsuited** for grounding points because they also stick to painted metal surfaces without assuring equipotential bonding.

The entire **leakage resistance of a person** via the wrist grounding, measured from the person's hand to the ground potential, must be **between 0.75 MΩ and 35 MΩ**.

The regulation **"Technical Safety Requirements for Wrist Grounding"** of the fine mechanics and electric technology professional association must be observed.

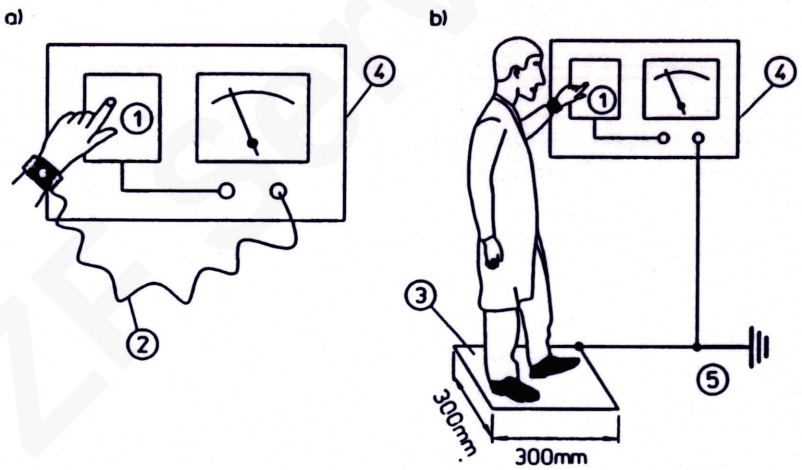
Shoe and Foot Grounding Bands

Dissipative shoes should be worn by persons who work in ESD protective zones mainly in a standing or standing and sitting position if wrist grounding cannot be used. For ESD footwear, the standard calls for values between 0 Ω and 35 MΩ. The requirement for professional shoes is a resistance between 0.1 MΩ and 1000 MΩ are required, however, and between 0.1 MΩ and 100 MΩ for safety shoes. A lower limiting value of at least 0.1 MΩ must be adhered to due to the danger of contact voltage. For this reason, deviating from the standard, the minimum value was set up to 0.75 MΩ.

Foot grounding bands for both shoes are to be provided for temporary use by persons in the ESD protective zones, e.g. visitors. The total **leakage resistance for a person** via the shoes or foot grounding bands, measured from the hand of the person toward the ground potential, must be **in the range from 0.75 M Ω to 35 MΩ** .

Tools

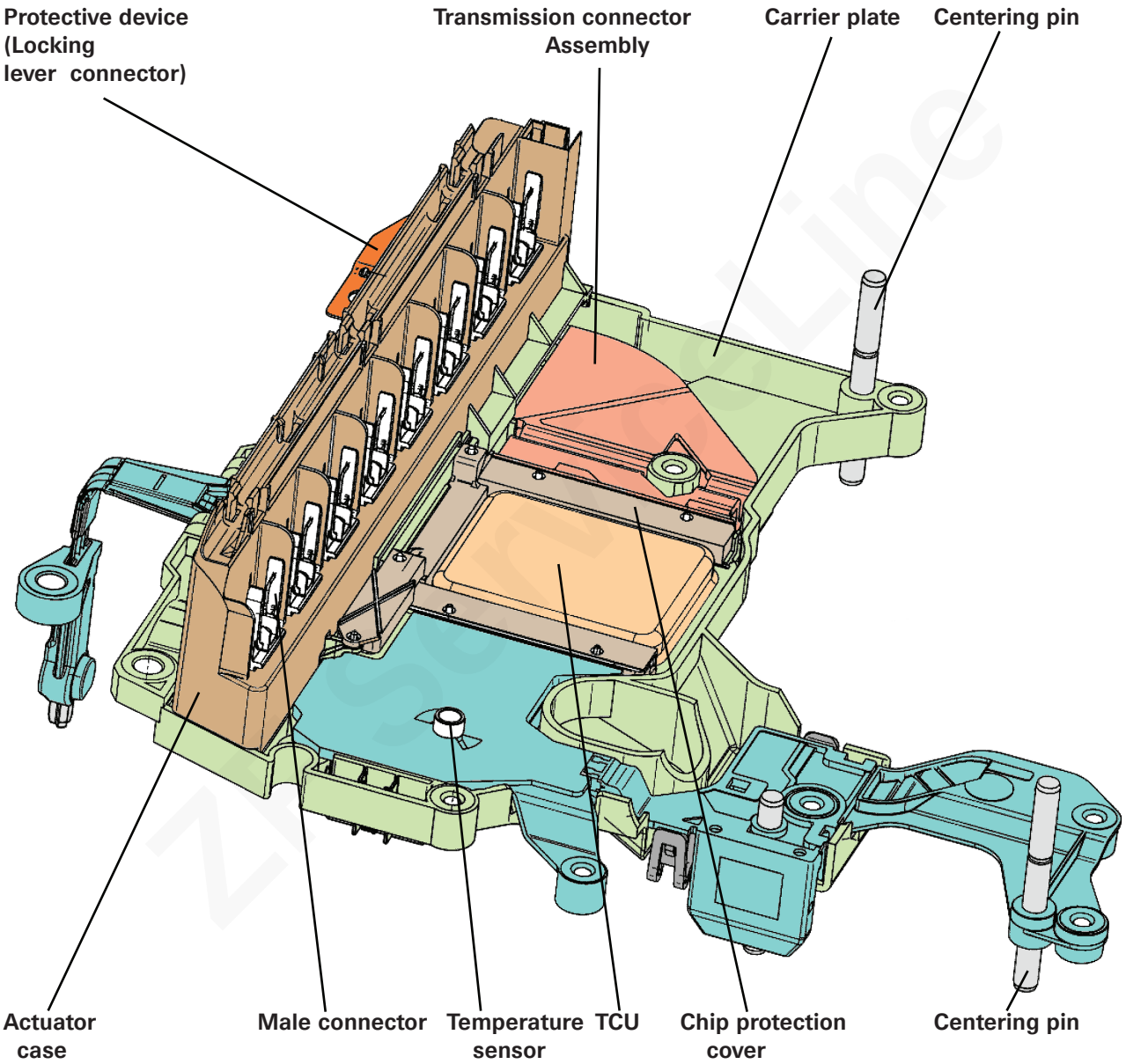
Tools used in a ESD protective zone should consist of **electrostatically dissipative** material insofar as possible.



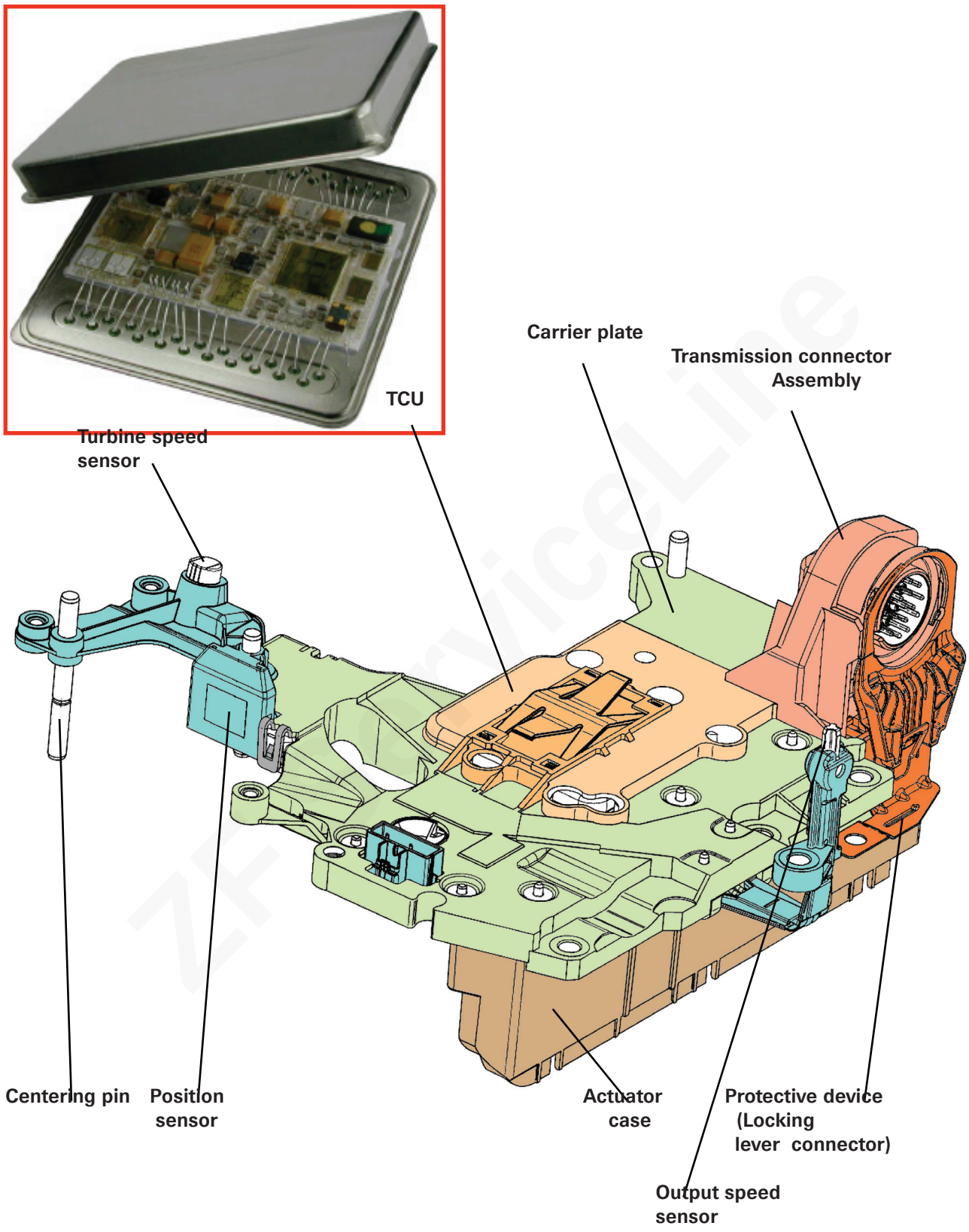
a	in the case of wrist grounding bands	b	in the case of ESD footwear
1	hand plate	3	foot plate
2	wrist grounding band	4	resistance measurement device
4	resistance measurement device	5	ESD grounding device

E-Module - 8HP – top side

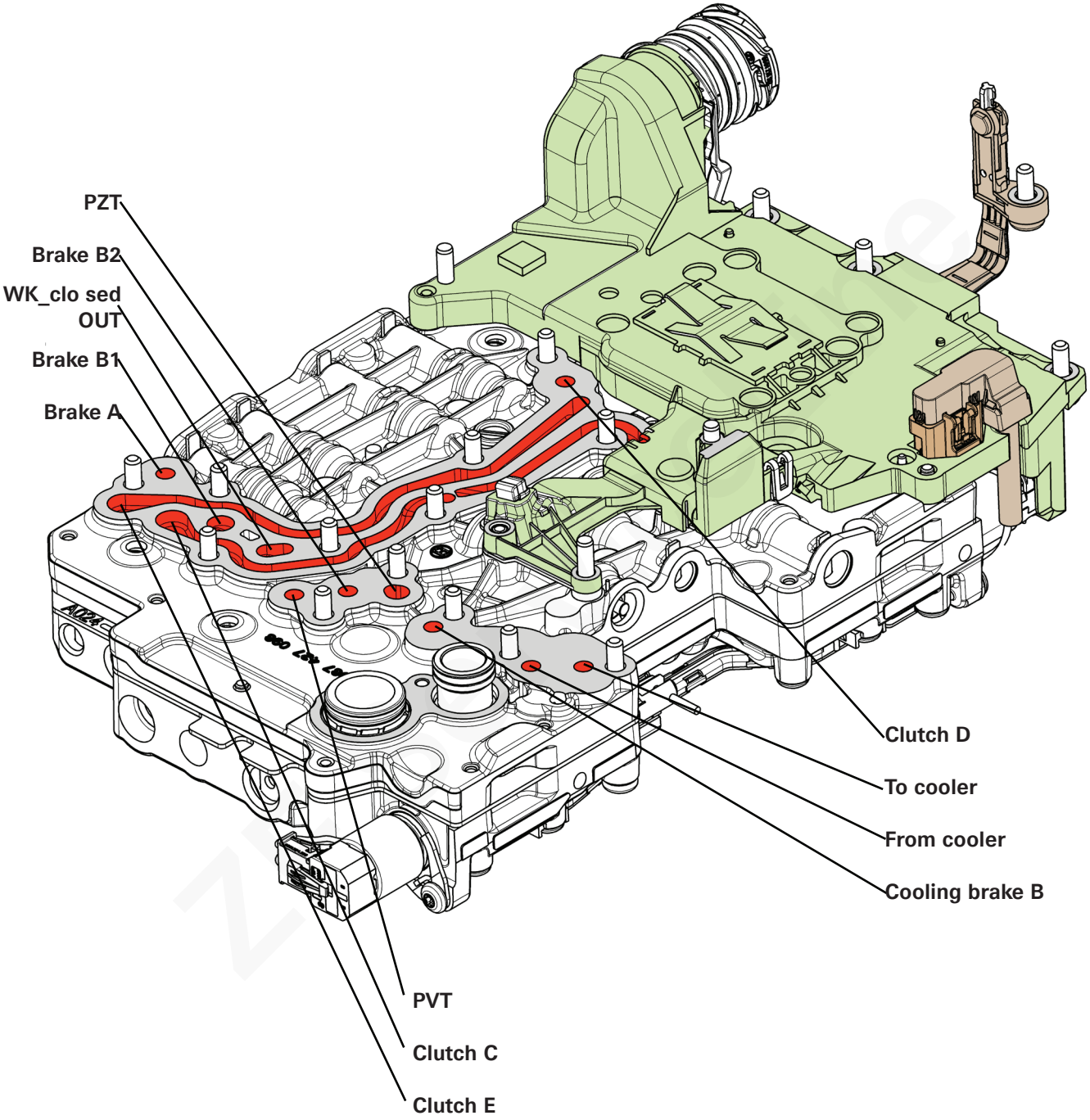
The electronic module (TCU = electronic control unit) processes signals from the transmission, engine and vehicle. Based on the input signals and stored data, the control program computes the right gear and the correct status of the torque converter lock-up clutch (WK) as well as the optimal pressure sequences for the gear and WK regulation. By means of special output building modules (power output stages, current regulator switches), the TCU controls the magnetic valves and pressure regulator, thus influencing the hydraulics of the automatic transmission. In addition, the magnitude and duration of the engine intervention are conveyed to the engine control via the CAN bus.



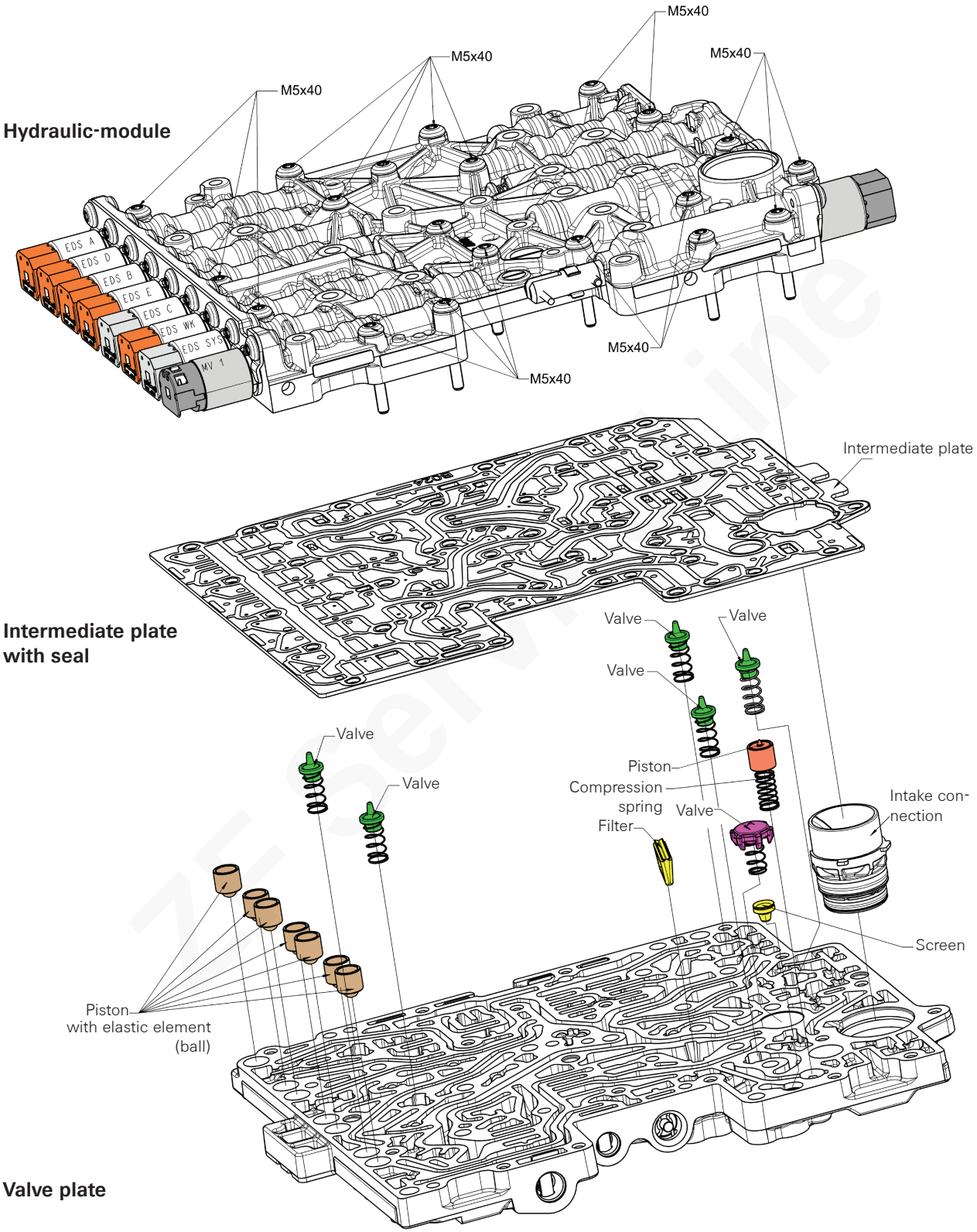
E-Module - 8HP – under side



Position of the pressure channel (Standard)

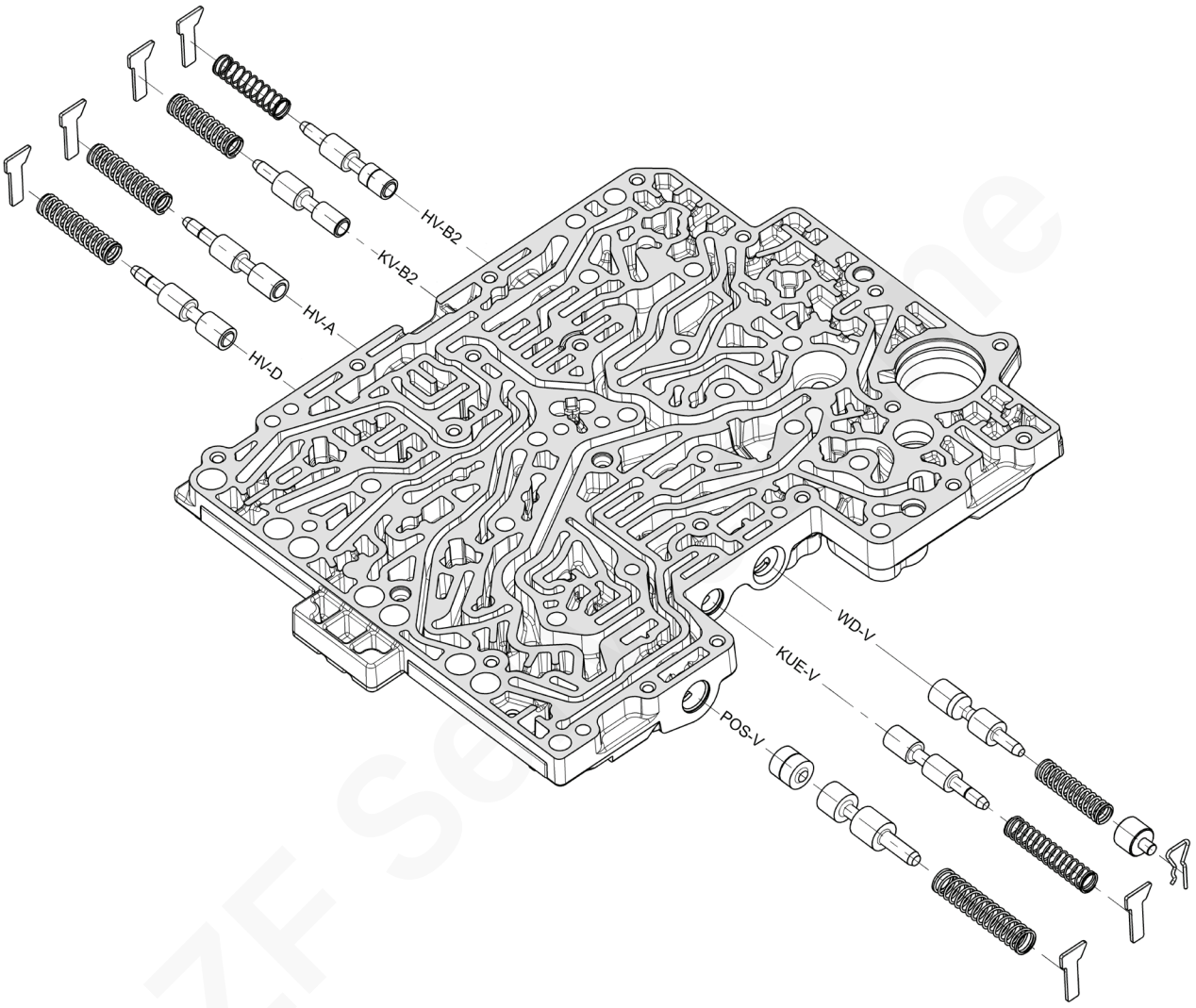


Assembly Sequence for Components (Standard)



Position of the valves in the valve plate (Standard)

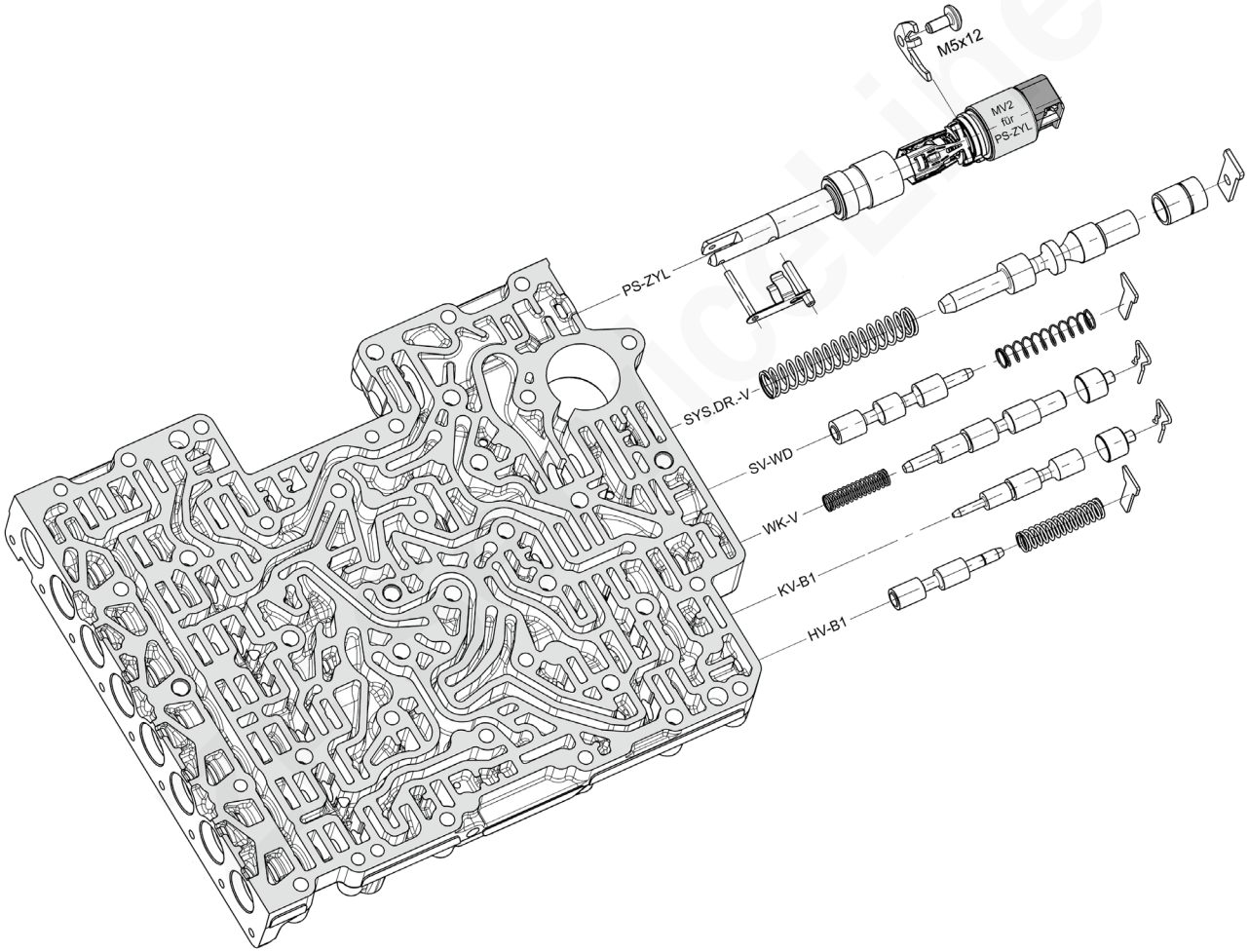
HV-B2 = Pressure-holding valve brake B2
KV-B2 = Clutch valve brake B2
HV-A = Pressure-holding valve brake A
HV-D = Pressure-holding valve clutch D



WD-V = Converter pressure valve
KUE-V = Cooling valve (only for hybrid transmission)
POS-V = Position valve

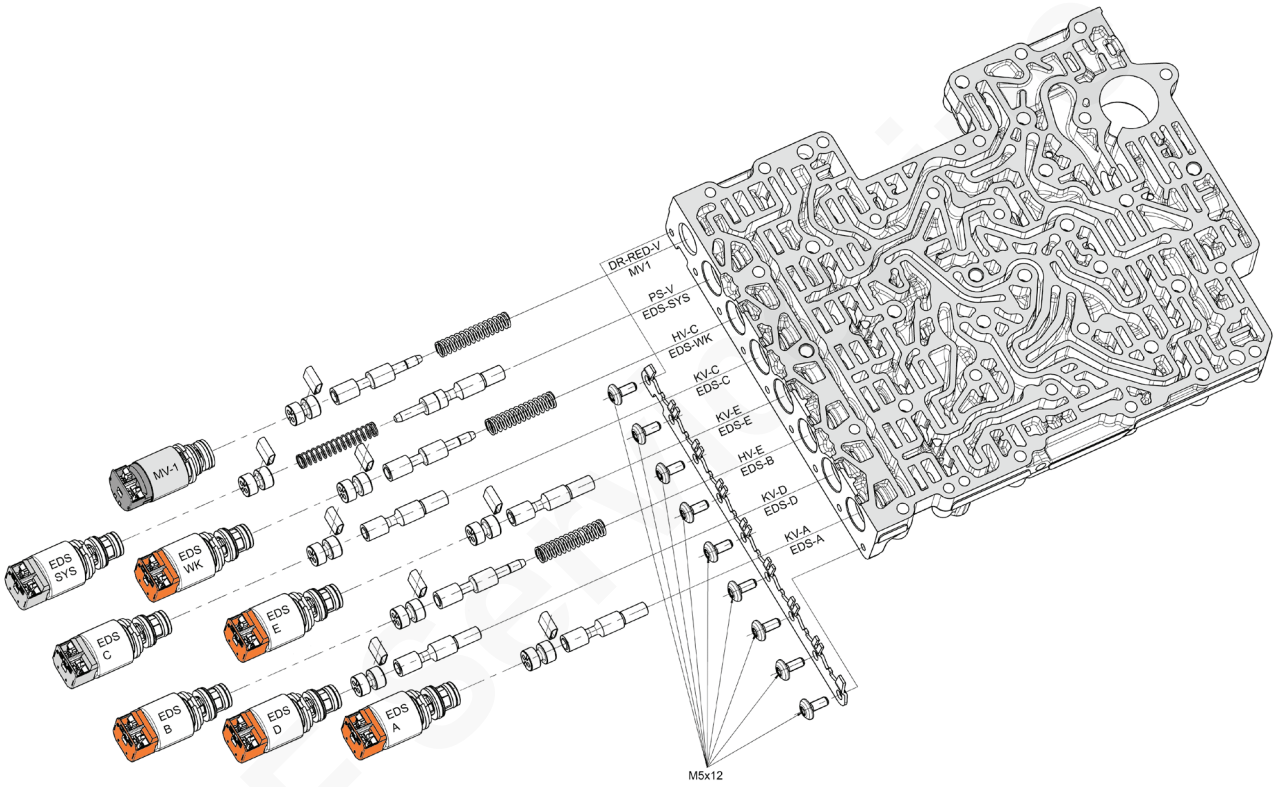
Position of the valves in the valve housing (Standard)

PS-ZYL	=	Park lock cylinder
SYS-DR.-V	=	System pressure valve
SV-WD	=	Control valve converter pressure
WK-V	=	Converter clutch valve
KV-B1	=	Clutch valve brake B1
HV-B1	=	Pressure-holding valve brake B1
MV2 for PS-ZYL =		Solenoid valve 2 for parking lock cylinder



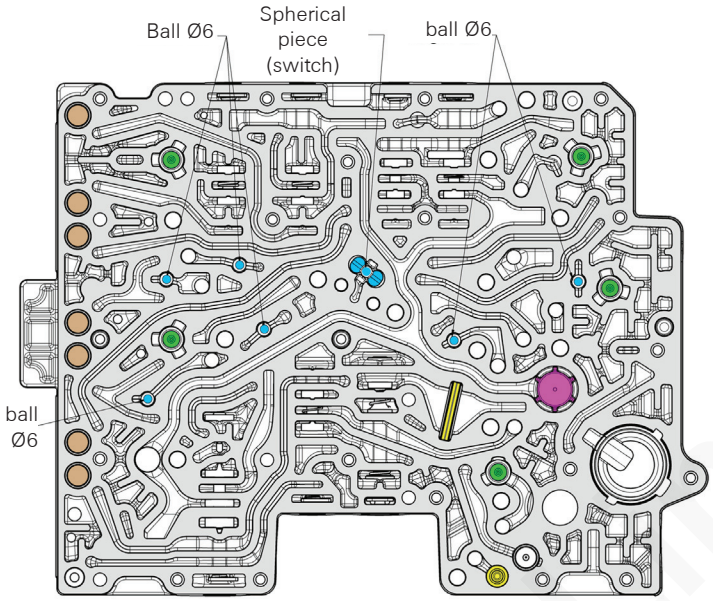
Position of the valves in the valve housing (Standard)

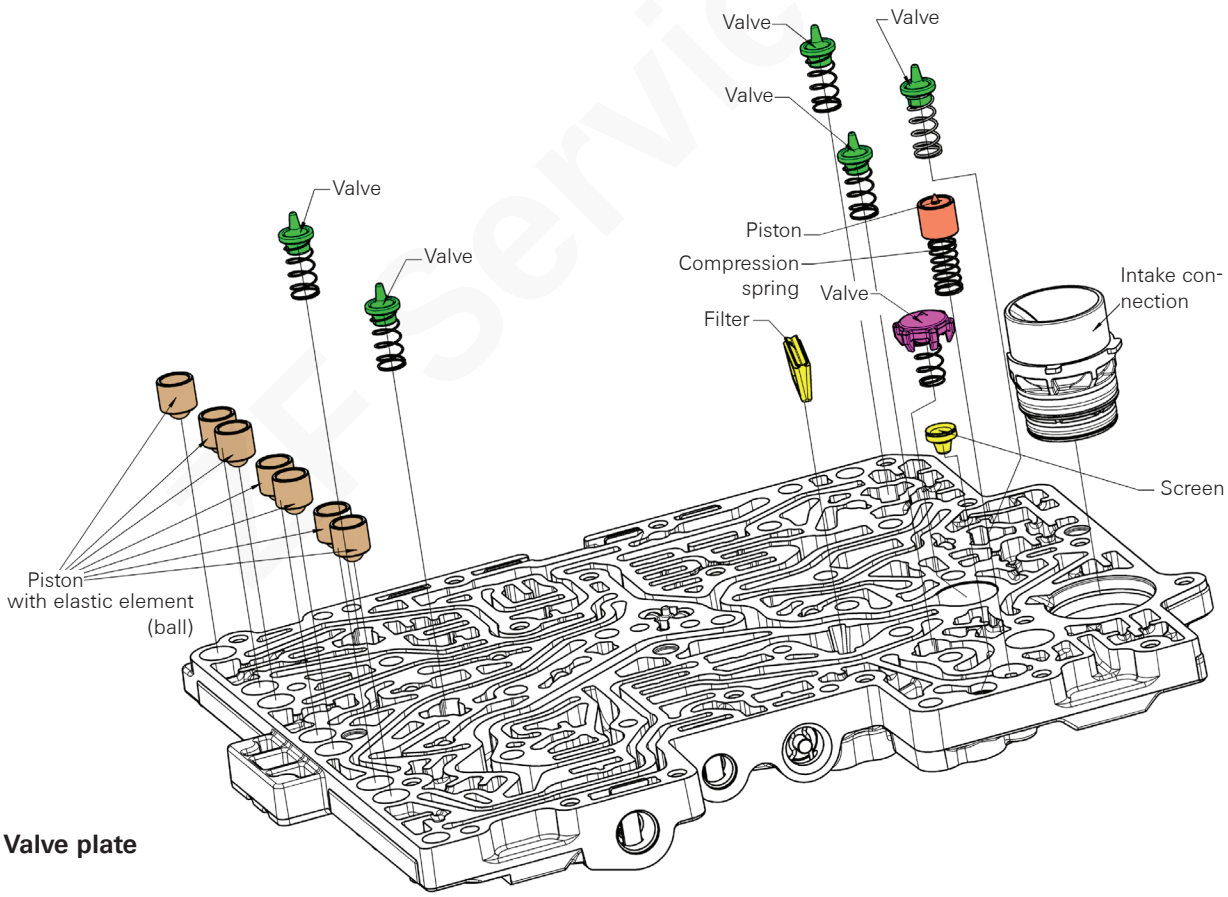
MV1	=	Solenoid valve 1 (position valve)
EDS-SYS	=	Electronic pressure control valve for system pressure
EDS-WK	=	Electronic pressure control valve for lock-up clutch
EDS-C	=	Electronic pressure control valve for clutch C
EDS-E	=	Electronic pressure control valve for clutch E
EDS-B	=	Electronic pressure control valve for brake B
EDS-D	=	Electronic pressure control valve for clutch D
EDS-A	=	Electronic pressure control valve for brake A



DR-RED-V	=	Pressure reduction valve
PS-V	=	Position valve
HV-C	=	Pressure-holding valve clutch C
KV-C	=	Clutch valve clutch C
KV-E	=	Clutch valve clutch E
HV-E	=	Pressure-holding valve clutch E
KV-D	=	Clutch valve clutch D
KV-A	=	Clutch valve brake A

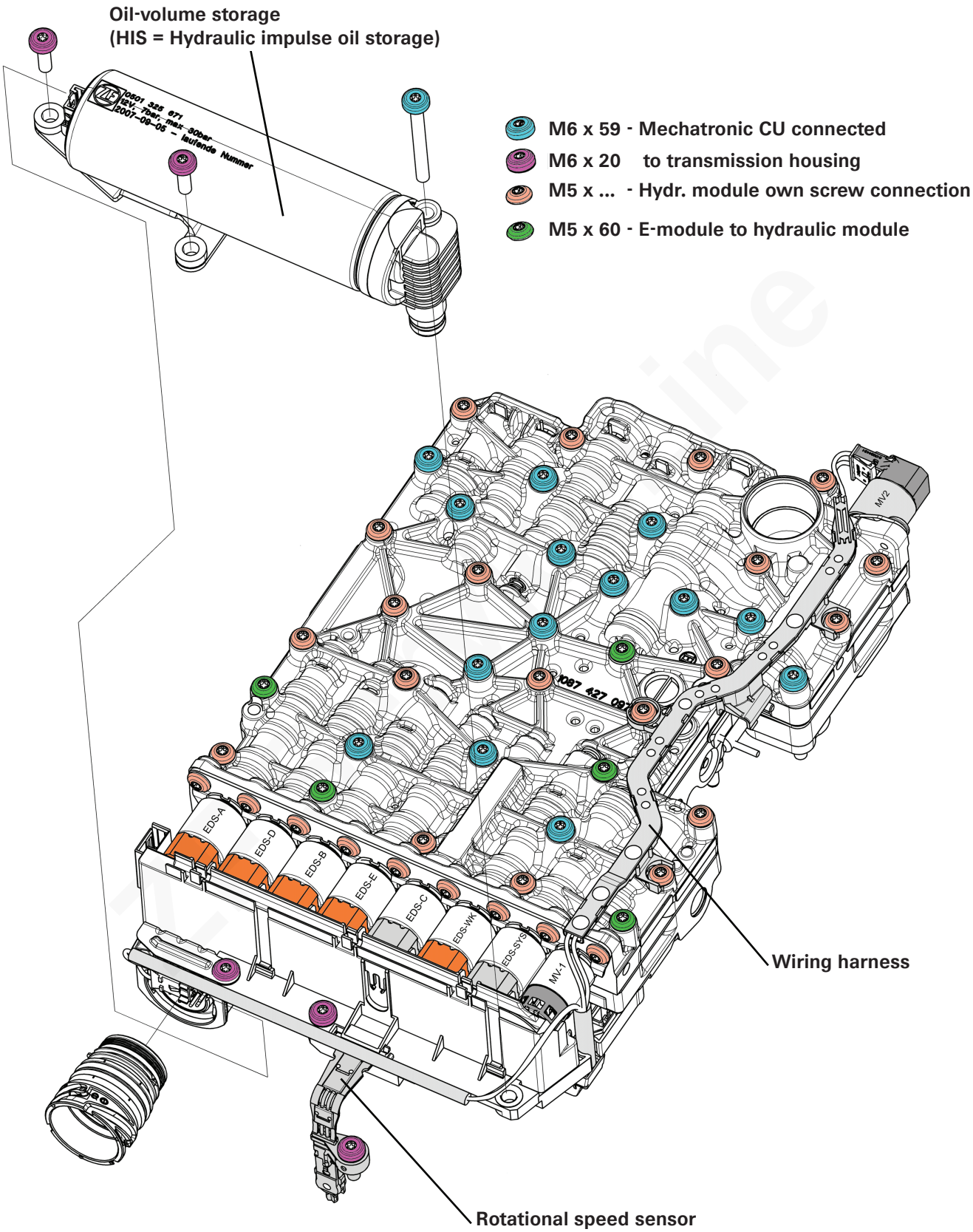
Position of the components in the valve plate (Standard)



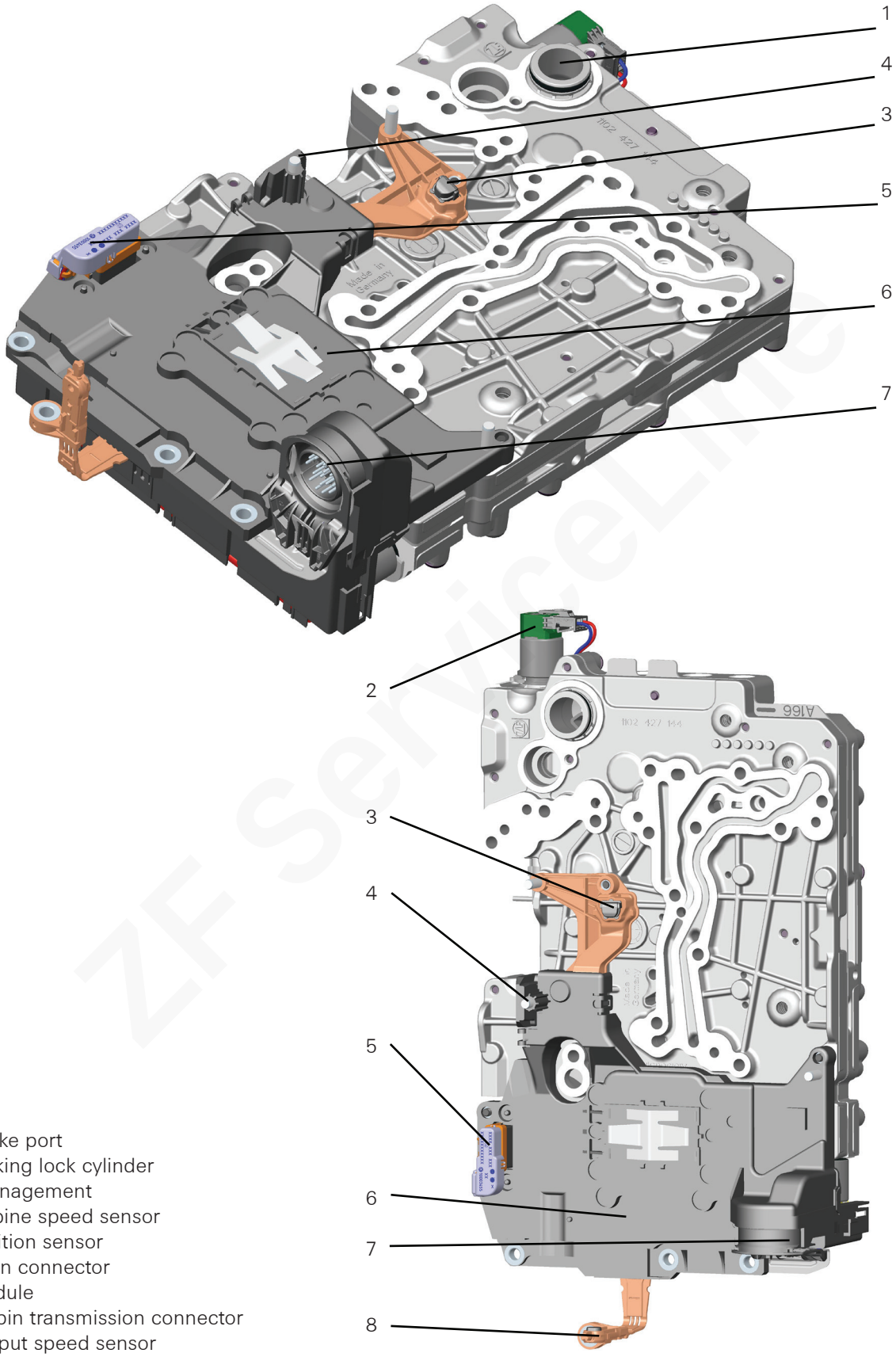


Valve plate

Screw position of the Mechatronic control unit (Standard)

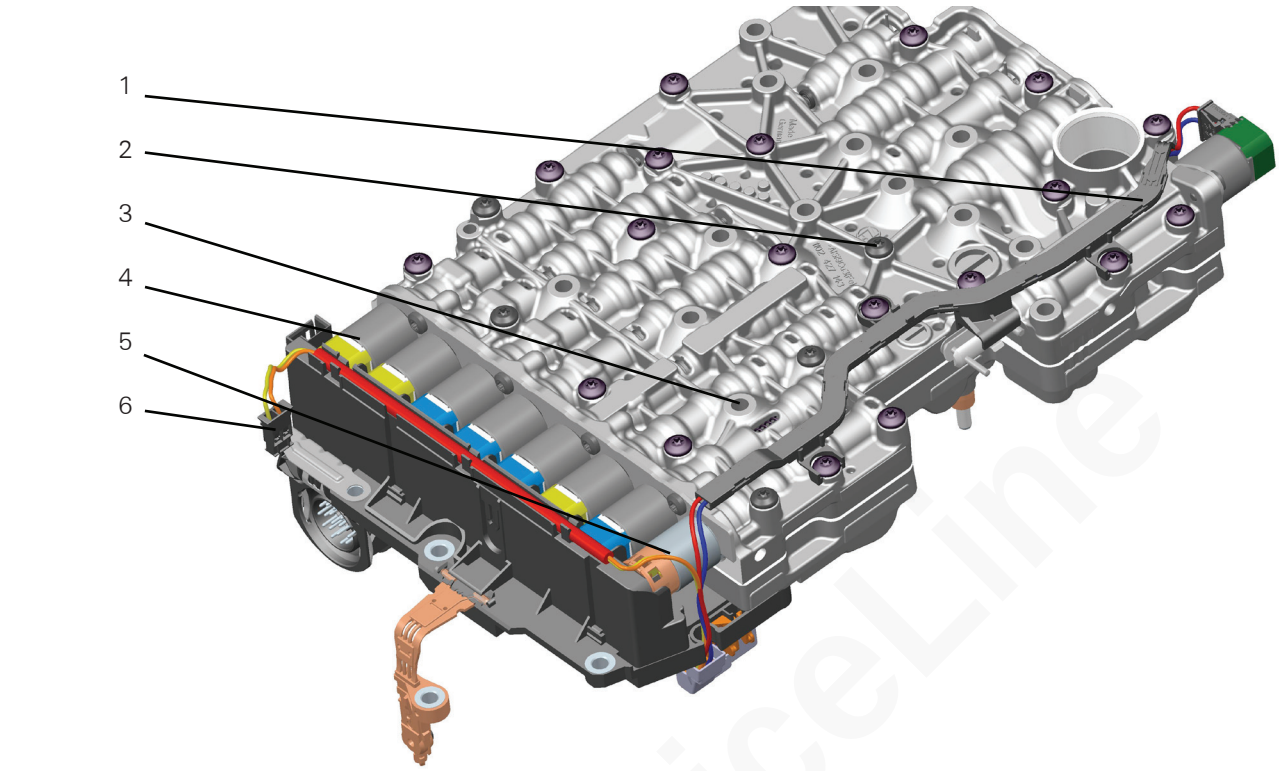


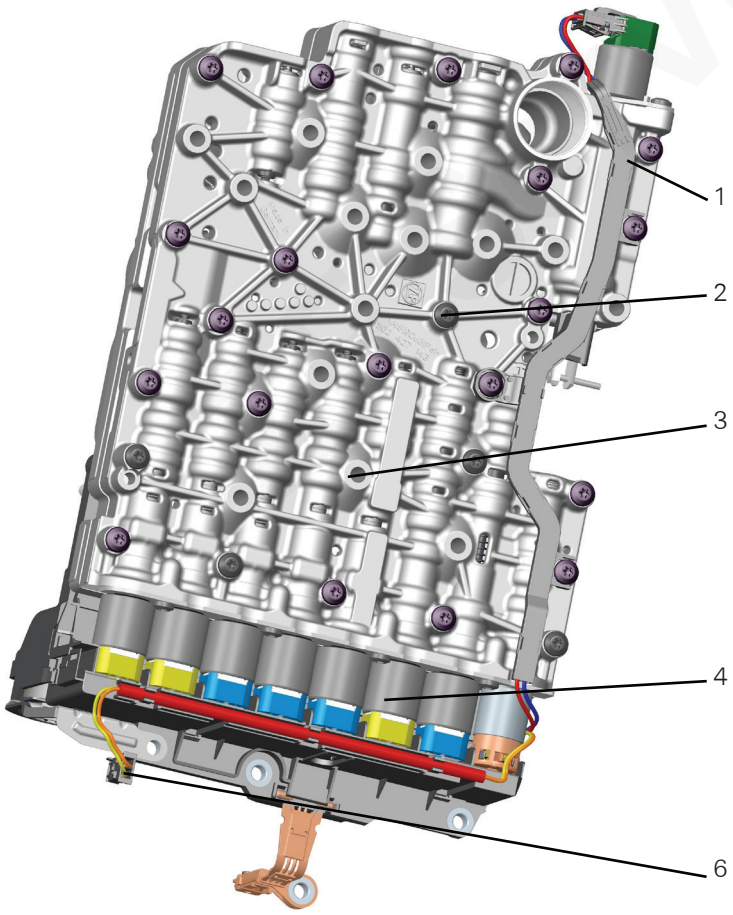
8HP50 and 8HP75: hydraulic control



1 Intake port
2 Parking lock cylinder management
3 Turbine speed sensor
4 Position sensor
5 8-pin connector
6 Module
7 16-pin transmission connector
8 Output speed sensor

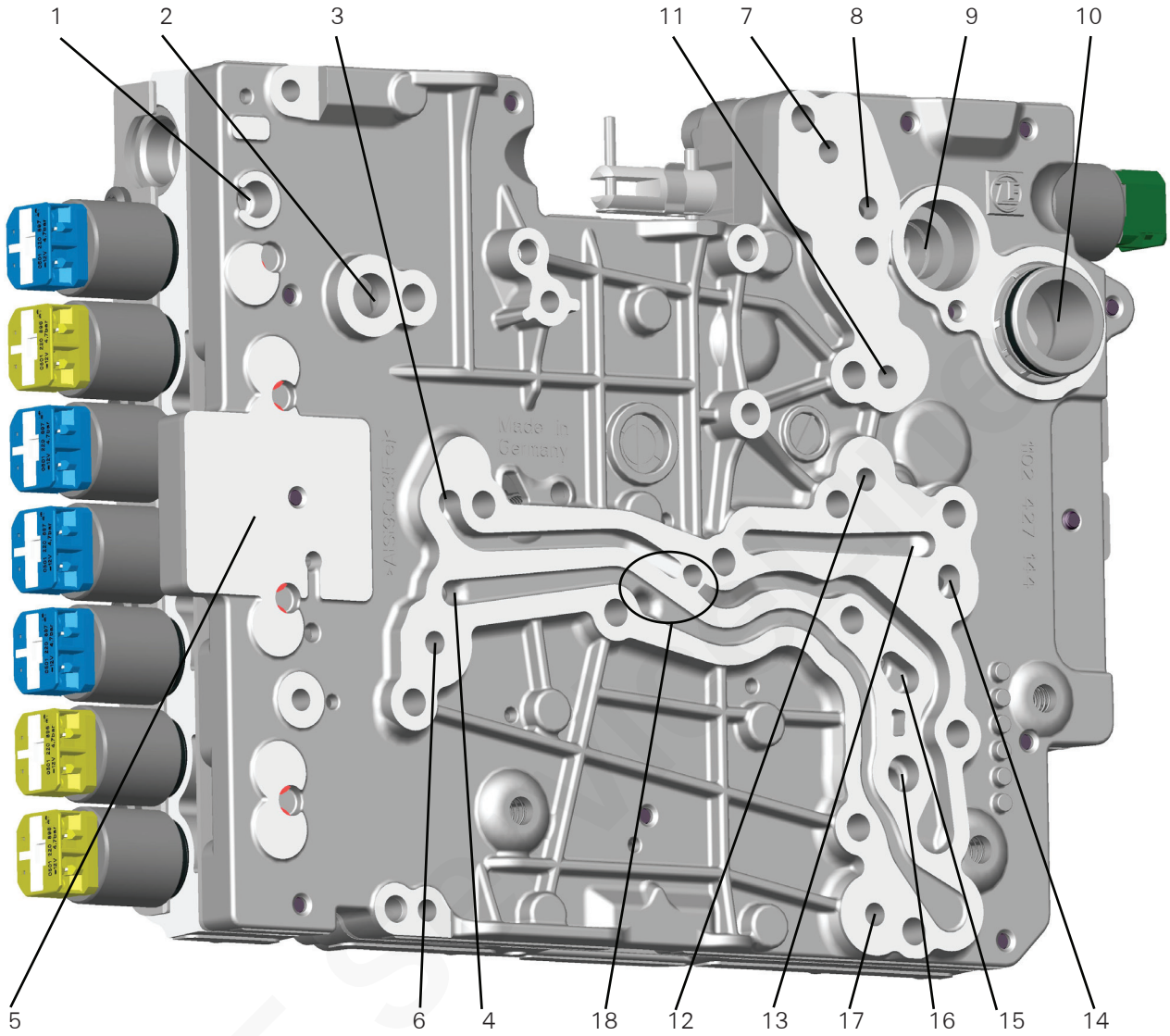
8HP50 and 8HP75: hydraulic control





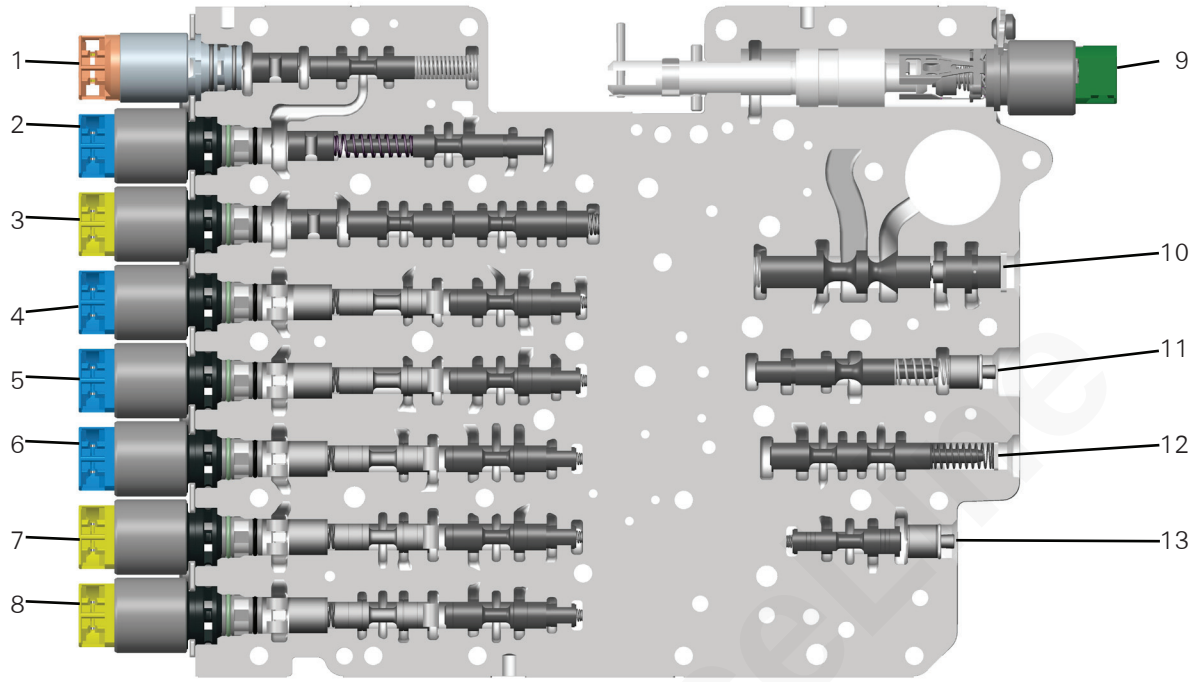
1 Cable duct contacting between solenoid valve and parking lock cylinder
2 M5 hydraulic control unit bolts
3 M6 to transmission housing
4 Pressure regulator
5 Solenoid valve
6 HIS contacting, 2-pin

8HP50 and 8HP75: hydraulic interfaces



1 Thermocouple supply
2 HIS connection
3 Clutch C duct contact
4 Clutch E duct contact
5 Heat sink for ECU
6 Clutch D contact
7 Pump regulating pressure (inoperable)
8 To cooler
9 Pump pressure side
10 Pump suction side
11 From cooler
12 To toroid
13 Inoperable
14 From toroid
15 Torque converter lock-up clutch
16 Clutch B transfer
17 Clutch A transfer
18 Ball rocker valve connection

8HP50 and 8HP75: hydraulic control - a) Pressure regulator and solenoid valve, b) Valve arrangement



1 Solenoid valve SV POS
Pressure control valve PC-V

2 Pressure regulator EPC Sys (fcc)*)
Parking lock valve PL-V

3 Pressure regulator EPC LuC (icc)**)
Position valve POS-V

4 Pressure regulator EPC C (fcc)
Pressure-holding valve PHV-C / clutch valve CV-C

5 Pressure regulator EPC E (fcc)
Pressure-holding valve PHV-E / clutch valve CV-E

6 Pressure regulator EPC D (fcc)
Pressure-holding valve PHV-D / clutch valve CV-D

7 Pressure regulator EPC B (icc)
Pressure-holding valve PHV-B / clutch valve CV-B

8 Pressure regulator EPC A (icc)
Pressure-holding valve PHV-A / clutch valve CV-A

9 Solenoid valve SV parking lock cylinder
Parking lock cylinder Pcyl

10 System pressure valve Sys-V

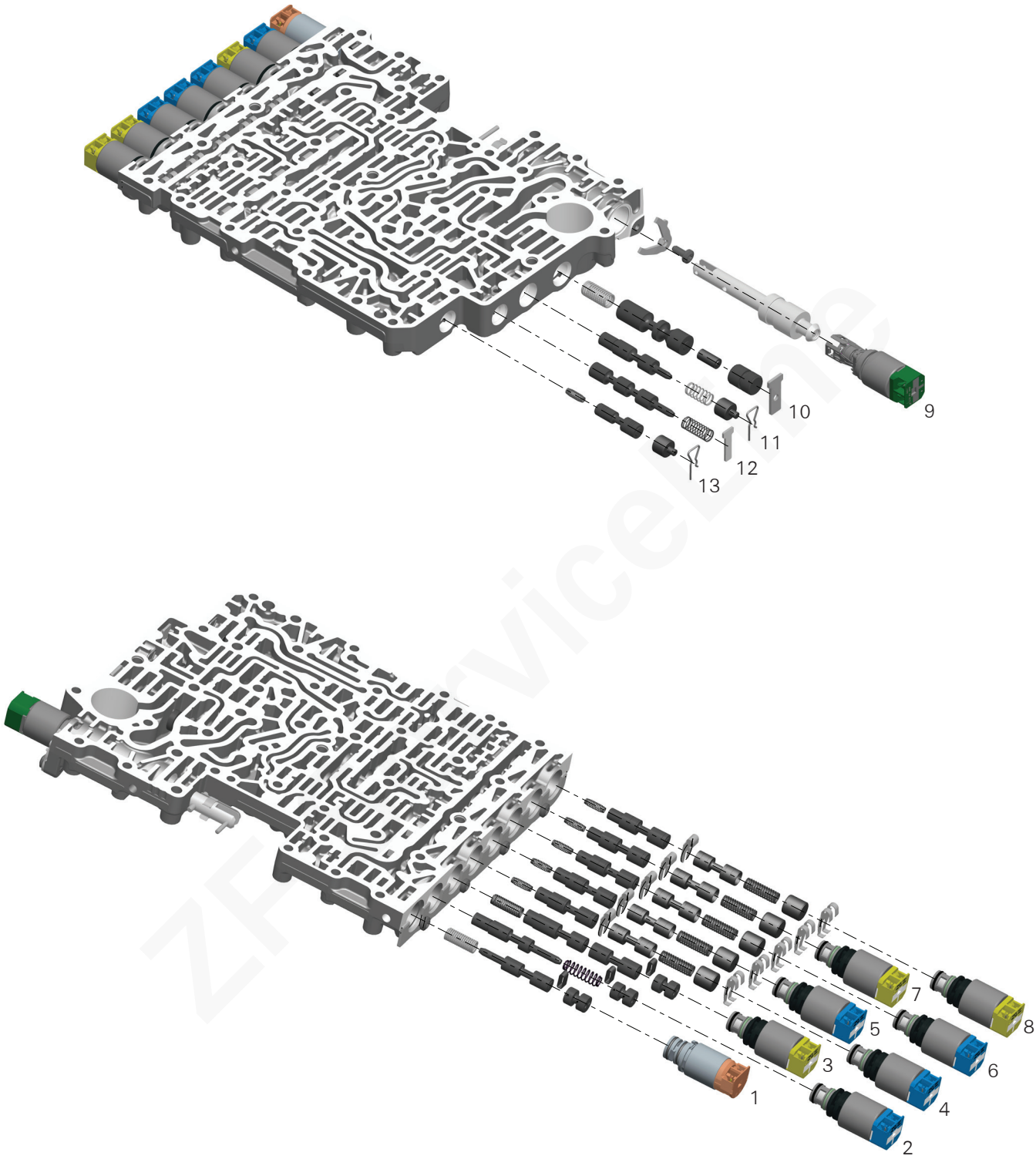
11 Converter pressure valve CP-V

12 Shift valve converter SV-C

13 Converter clutch valve LuCV

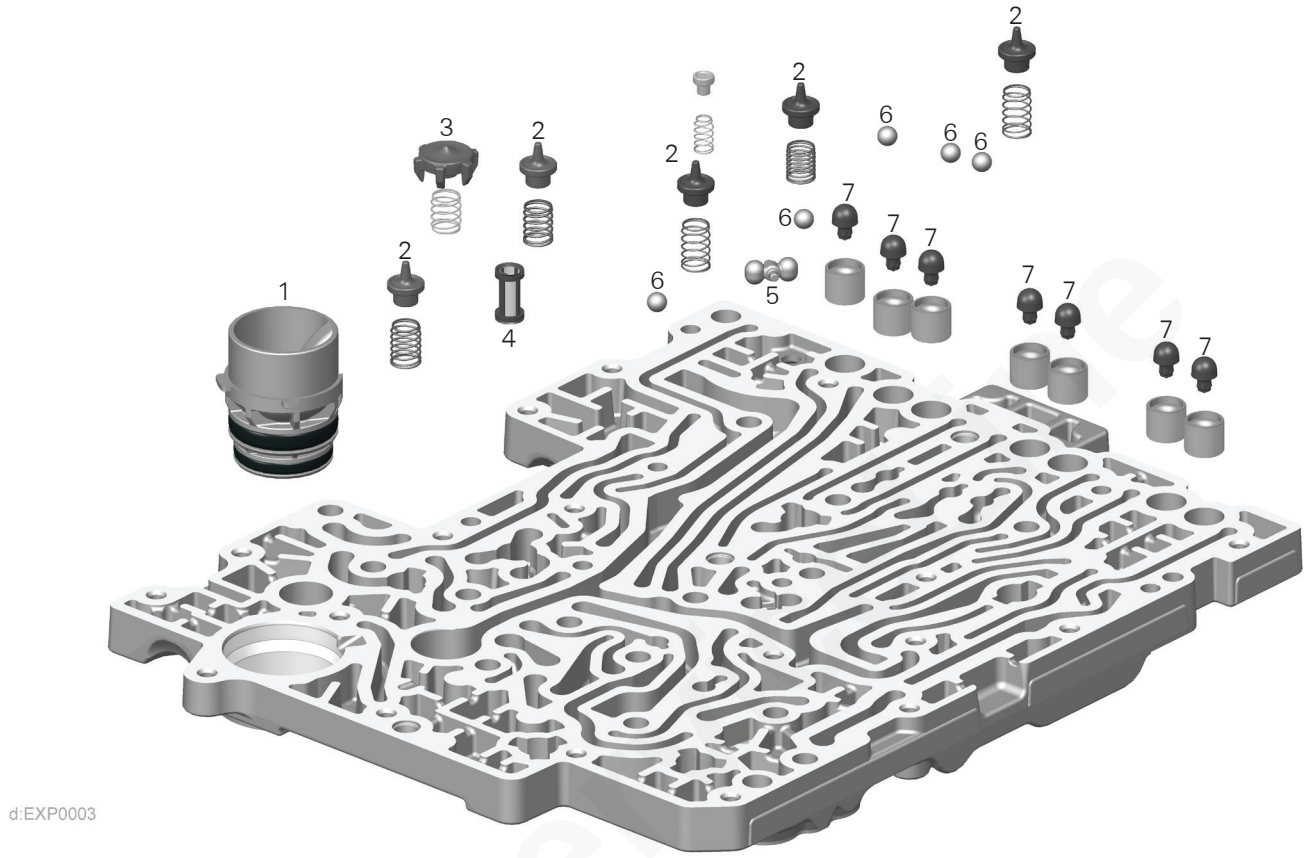
*) (fcc) = falling characteristic curve
**) (icc) = increasing characteristic curve

8HP50 and 8HP75: hydraulic control - a) Pressure regulator and solenoid valve, b) Valve arrangement



For legend, refer to page 79

8HP50 and 8HP75: hydraulic control unit - valve arrangement - Control plate and inserts



No valves

1 Suction adapter

2 Plate valves

3 System pressure backup valve

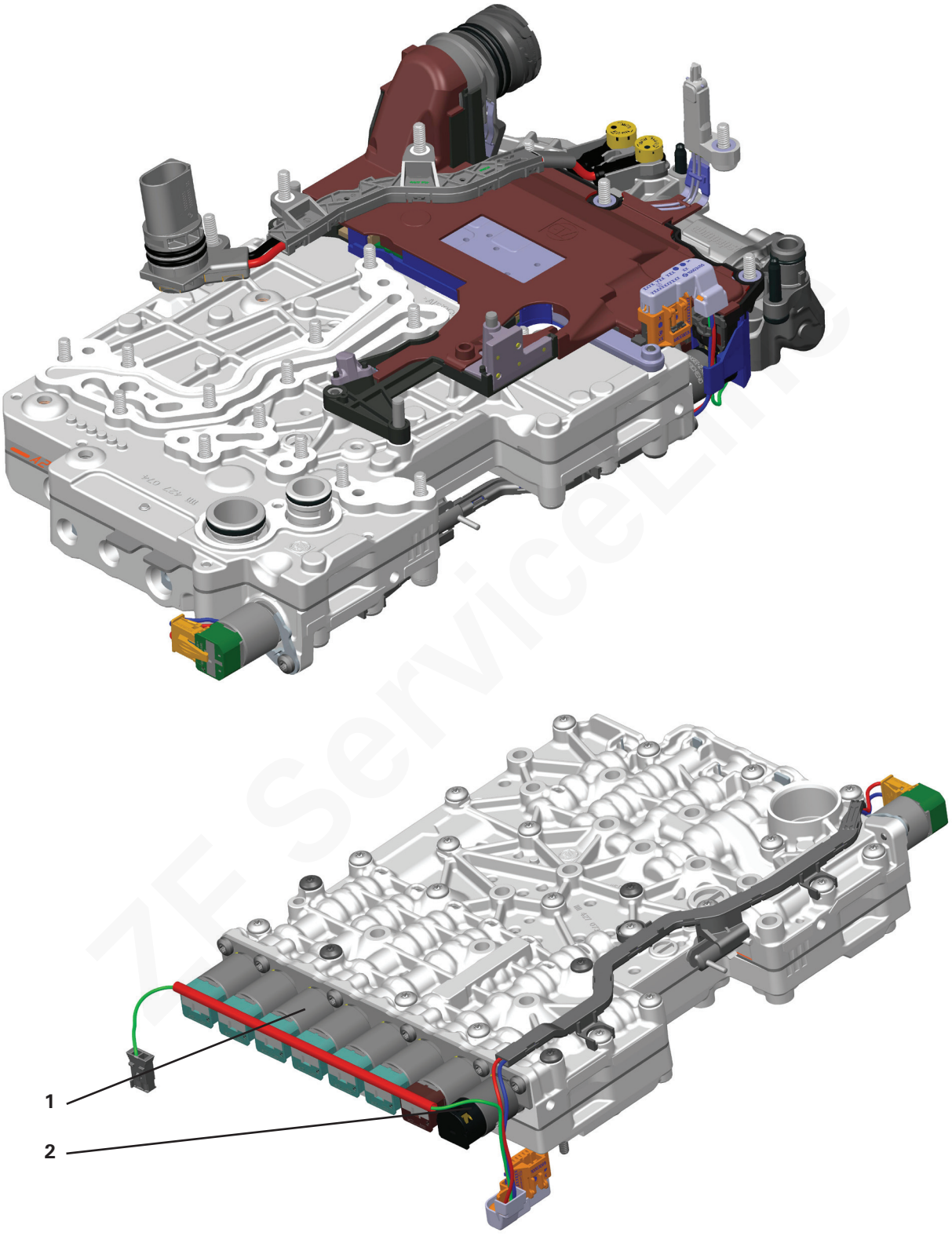
4 Spherical filter secondary ratchet

5 Ball rocker

6 Ball-and-socket bearing

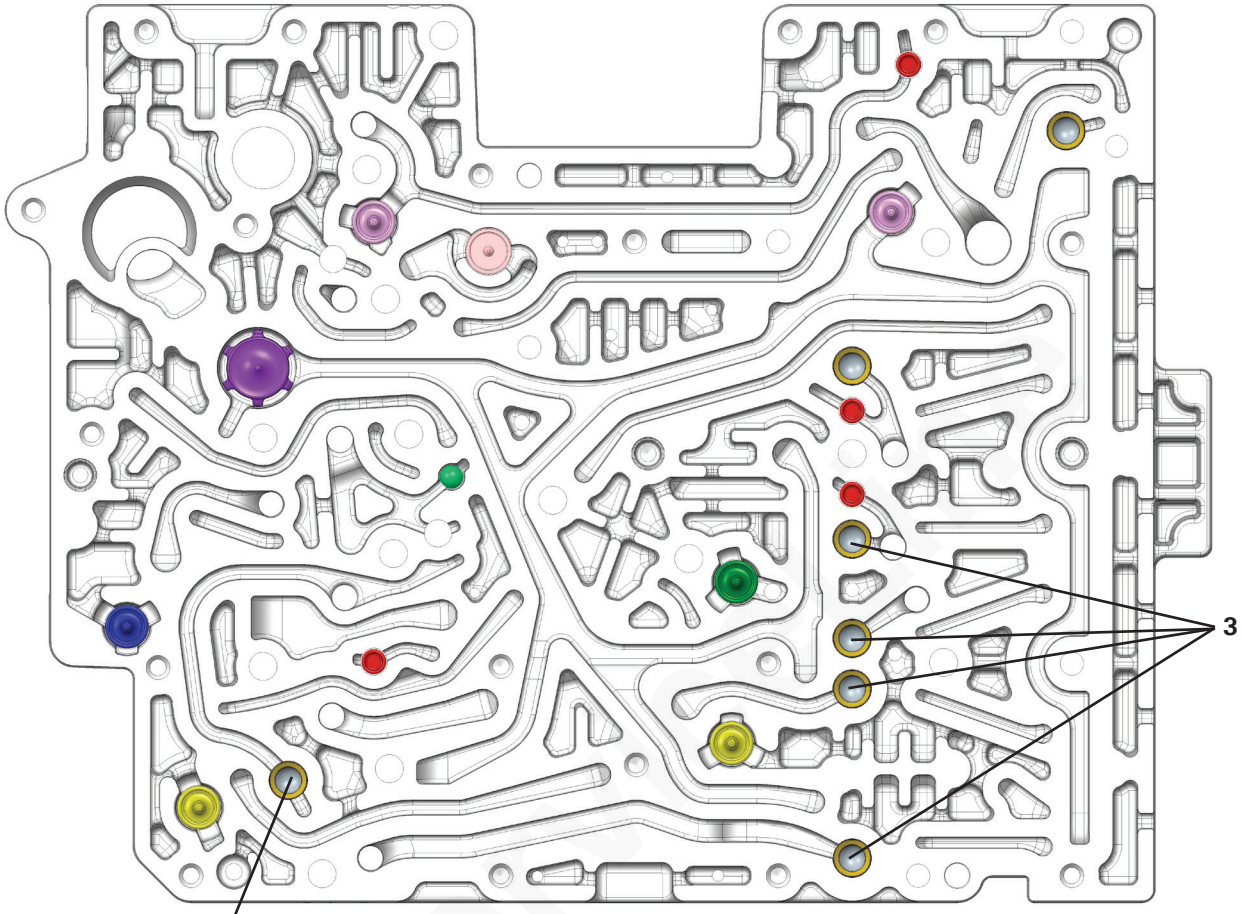
7 Piston

8HP51IEP and 8HP76IEP - Electronic hydraulic control unit

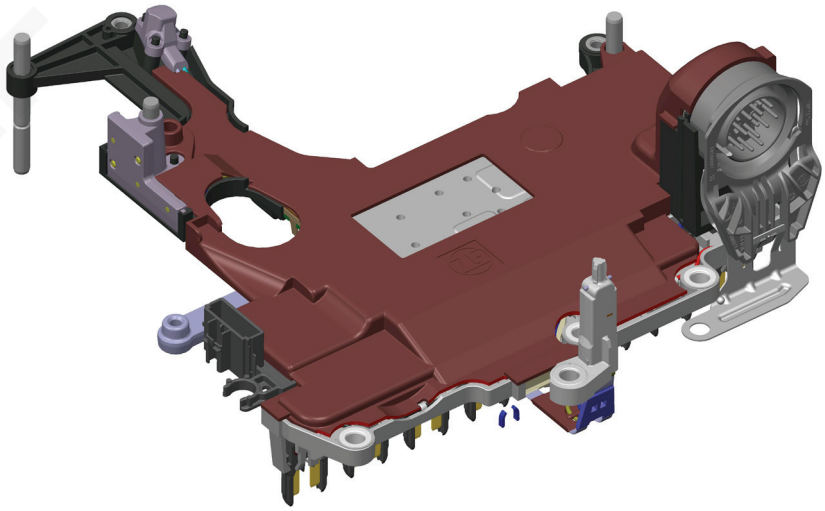


1 Pilot slide pressure regulator
2 25 bar solenoid valve

8HP51IEP and 8HP76IEP - Electronic hydraulic control unit



3 Optional hat filters for the clutches A, B, C, D, E and in p-LuC



Electronic transmission control module from Robert Bosch AG

Signals in transmission control unit

The data that the transmission control unit needs for shifting gears, such as injection time, engine rotational speed, throttle control angle, engine temperature and engine intervention, are conveyed into the transmission control unit by the powertrain CAN Bus. The control of the solenoid valves and the pressure control valves takes place directly from the mechatronic module.

Here are the signals that are sent via the powertrain CAN Bus to the TCU and from the TCU to other control units:

Signals	Sender	Recipient
Transmission selector lever	GWS	TCU
Terminal status	CAS	TCU
Central locking	CAS	TCU
Transmission data	TCU	CAS
Engine data	DME / DDE	TCU
Wheel speed	ESP	TCU
Deceleration demand	EMF	TCU
Display transmission data	TCU	Combi
Check control report	TCU	Combi
Torque demand	TCU	DME
Operating voltage	Power module	TCU
Parasitic load	TCU	Power module

The rotational speeds of the turbine and the transmission output shaft are detected by Hall sensors, which forward the values directly to the mechatronic module. In the same way, the position switch signal goes directly to the electronic module. It is also possible to program the transmission control units using the program code on transmissions of the 8 HP mode line. The programming procedure is mainly identical to the procedure used on 6 HP transmissions, only the functionality of the transmission control units has been adapted.

The transmission control unit uses an internal flash storage (Flash-EEPROM) with 2 MBytes.

After the automatic transmission is replaced or repaired, pressure adaptation must be reset using an appropriate tester. It is then advisable to carry out a test drive in which all the gears are tested (**for more information, see the "ASIS" function description**).

Brief description of the valves (E- and M-shift)

Selector slide valve (WS) – only for M-shift

With the selector slide valve, the driver chooses the drive direction (forwards or reverse), the park position and the neutral (engine in idle) position.

The parking lock cylinder (PS-ZYL) - only for E-shift

The parking lock is electrically engaged by means of the parking lock cylinder (→ park lock).

Parking lock valve (PS-V) - only for E-shift

The parking lock valve has the function of shifting the parking lock cylinder into the park or neutral position. The PS-V is shifted by means of the solenoid valve 1 (MV1).

MV1 active (with current)	=	Neutral position
MV1 inactive (without current)	=	Park position

Pressure-holding valve brakes A, B1 and B2, clutches C, D and E (HV-A, HV-B1, HV-B2, HV-C, HV-D, HV-E)

The pressure-holding valves switch clutch valves. That means: The control mode (control phase) of the clutch valve during shifting is shut off by the pressure-holding valve at the appropriate time, whereby clutch pressure on the system pressure increases. Both valves (clutch and pressure-holding valve) are controlled by the corresponding pressure control valve (EDSx).

Clutch valve brakes A, B1 and B2, clutches C, D and E (KV-A, KV-B1. KV-B2, KV-C, KV-D, KV-E)

The clutch valves are variable pressure reduction valves. They are controlled by the respective electronic pressure control valve (EDSx) and determine clutch pressure during shifting.

Pressure reduction valve (DR.RED.-V)

The pressure reduction valve reduces the system pressure to about 5 bar, which acts upon the downstream pressure control valves (EDS1 - EDS7) and solenoid valves (MV1, MV2). The pressure control valves and solenoid valves need constant inflow pressure to function.

Cooling valve (KUE-V) - in hybrid transmissions

The cooling valve is responsible for cooling brake B. It is activated accordingly by the brake B clutch pressure at the front. In this way, the oil pressure from the lubrication valve can reach brake B and additionally cool and lubricate the disk pack according to the requirements.

Lubrication pressure limiting valve (SDB-V)

The lubrication limiting valve is a variable pressure limiting valve, regulating according to the individual driving situation. The control extends from about 0.3 to about 7 bar. The upper limit prevents the distension of the torque converter.

System pressure valve (SYS.DR.-V)

The system pressure valve is a variable pressure limiting valve and controls the oil pressure that the primary pump produces. The excess oil is directly led back into the intake channel of the oil pump (charging the pump (.) →double vane cell pump).

Converter pressure valve (WD-V)

The converter pressure valve reduces the system pressure and assures the pressure that the converter needs. In addition, the maximum converter pressure is limited, whereby the distension of the converter is avoided. (→ hydraulic mechanical process in converter WK open and WK closed).

Converter clutch valve (WK-V)

The converter clutch valve is controlled, together with the converter pressure switching valve ("converter pressure valve"), by the electronic pressure control valve EDS-WK and correspondingly regulates oil pressure on the WK piston, from "totally open" through "slipping" to "totally closed" (→ hydraulic mechanical process in the converter WK open and WK closed).

Switching valve for converter pressure (SV-WD)

The switching valve for converter pressure ("converter pressure valve") controls the pressure behavior in the converter based on the driving situation (→ hydraulic mechanical process in the converter WK open and WK closed).

Converter foot valve (WK-FP-V)

The converter foot valve prevents pressure in the specified operating situation from falling below about 1 bar when the lock-up clutch (WK) is closed (→ hydraulic-mechanical process in closed converter WK).

Converter backup valve (WRH-V)

The converter backup valve prevents oil pressure in the converter from falling below about 0.35 bar in certain driving situations when the lock-up clutch is open (→ hydraulic-mechanical process in open converter WK).

Position valve (POS-V) -only for E-shift

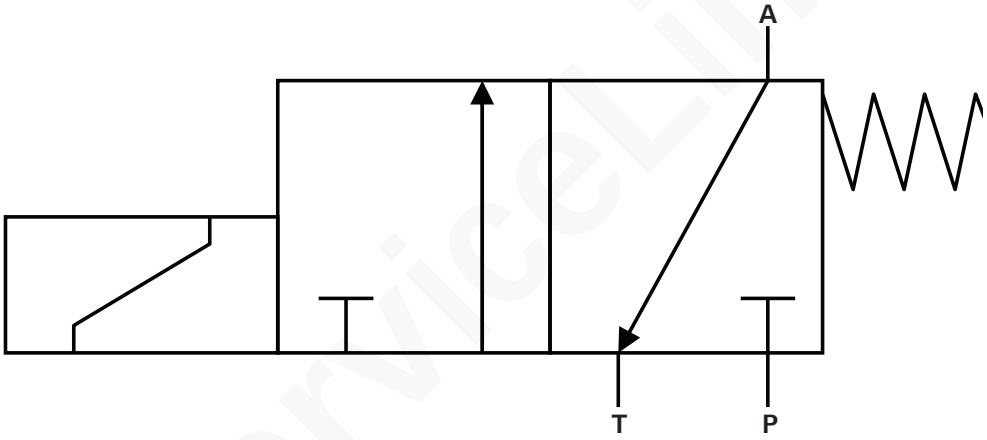
The position valve is the replacement for the selector slide valve and diverts the system pressure to the individual controls for the clutches and brakes. The position valve is switched by means of solenoid valve 1 (E-shift) and held in the respective gear by the two clutches, C and E.

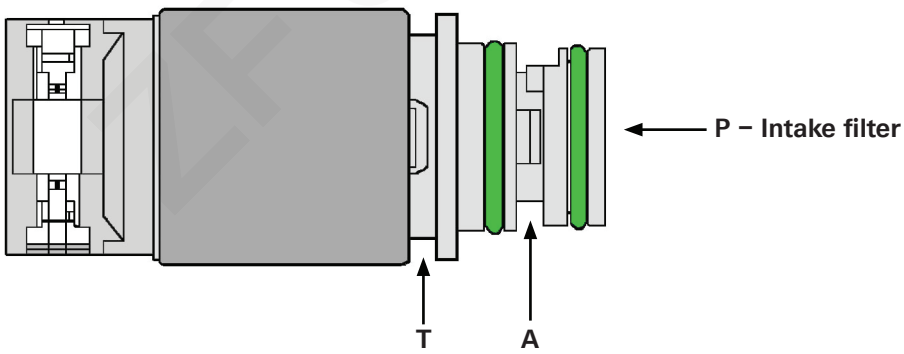
Solenoid valve - MV1 (Position valve)

A 3/2 way solenoid valve (three connections, two shift positions) is built into the hydraulic module. The solenoid valve is controlled by the electronic transmission control (E-module) and has two modes – open and closed. Its purpose is to switch valves. In this case, the MV1 switches the position valve.

Technical data

Operating voltage	< 16 V
Response voltage	> 6 V / 6 bar, 150°C
Dropout voltage	> 5 V / 150°C
Resistance	11 - 1 Ω at +20°C
Flow rate (P → A)	2.3 to 2.9 l/min
Flow rate (A → T)	2.65 to 0.57 l/min
Intake filter	w 150 µm; d 65 µm





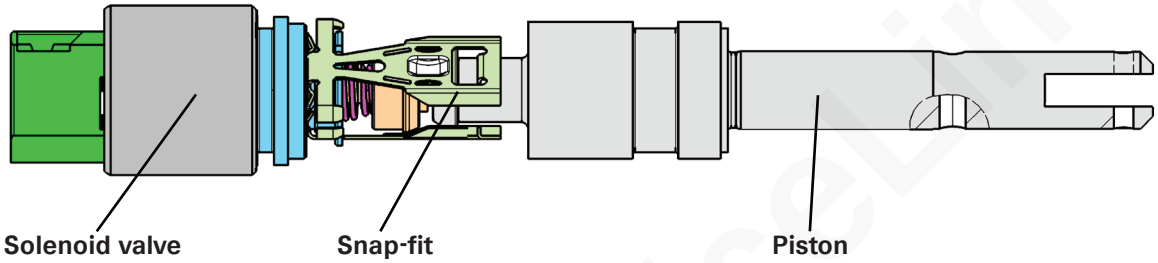
Solenoid valve- MV2 (Parking lock cylinder)

The solenoid valve 2 (MV2) is the electronic component of the electro-hydraulic parking lock cylinder.

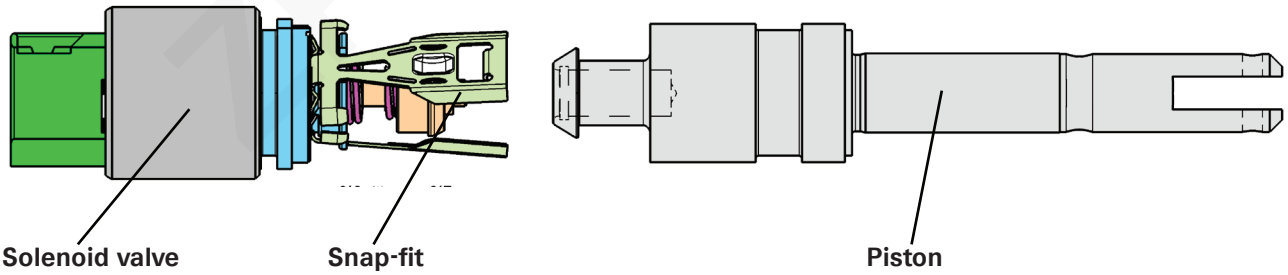
Technical data

Operating voltage	< 16 V
Response voltage	> 8 V / 6 bar, 150°C
Resistance	25 Ω at +20°C

Valve energized = locked (parking lock released)



Valve without current = unlock (parking lock engaged)

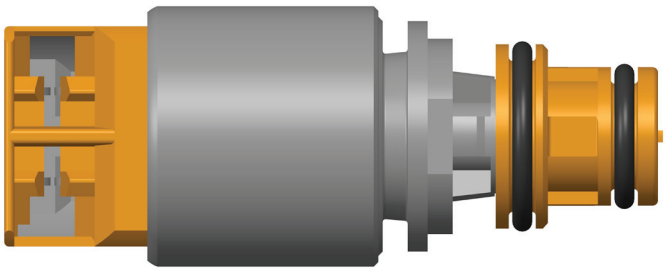


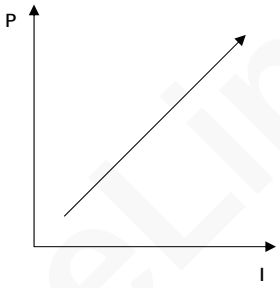
Electronic pressure control valve (EDS)

Electronic pressure control valves convert electric current into a proportional hydraulic pressure. They are controlled by the electronic module and activate the valves that belong to the shift elements.

Two types of electronic pressure control valves are built in:

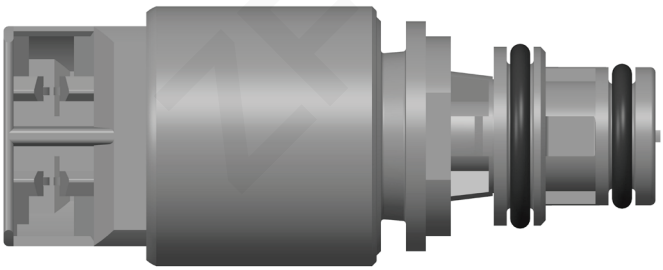
1. pressure control valves with rising characteristic curves (orange cover cap; pressure control range 0 to 4.7 bar)
2. pressure control valve with falling characteristic curve (gray cover; pressure control range 4.7 to 0 bar)

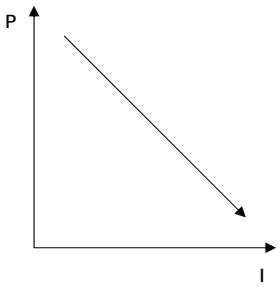




Technical data

Pressure range	as of 0 to 4.7 bar
Operating voltage	12 V
Resistance	5,05 Ω at +20°C
Characteristic curve	rising





Technical data

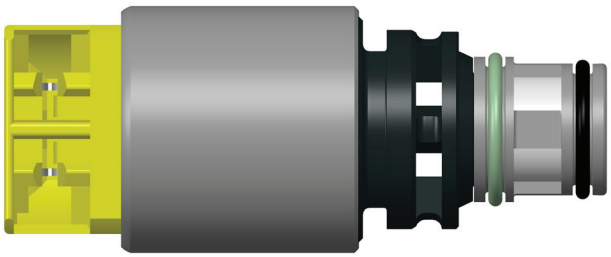
Pressure range	as of 4.7 to 0 bar
Operating voltage	12 V
Resistance	5,05 Ω at +20°C
Characteristic curve	falling

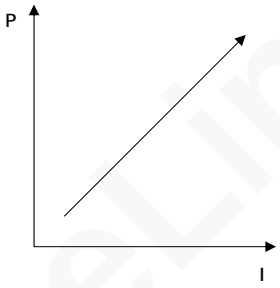
8HP50 and 8HP75: Electronic pressure control valve (EDS)

Electronic pressure control valves convert electric current into a proportional hydraulic pressure. They are controlled by the electronic module and activate the valves that belong to the shift elements.

Two types of electronic pressure control valves are built in:

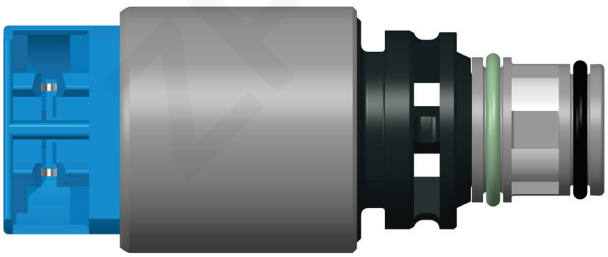
1. pressure control valves with rising characteristic curves (yellow cover cap; pressure control range 0 to 4.7 bar)
2. pressure control valve with falling characteristic curve (blue cover; pressure control range 4.7 to 0 bar)

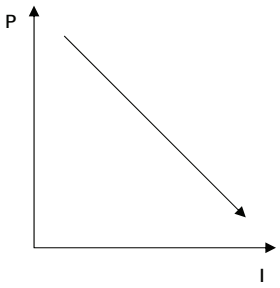




Technical data

Pressure range	as of 0 to 4.7 bar
Operating voltage	12 V
Resistance	5,05 Ω at +20°C
Characteristic curve	rising



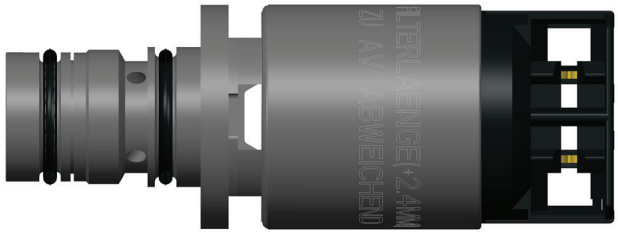


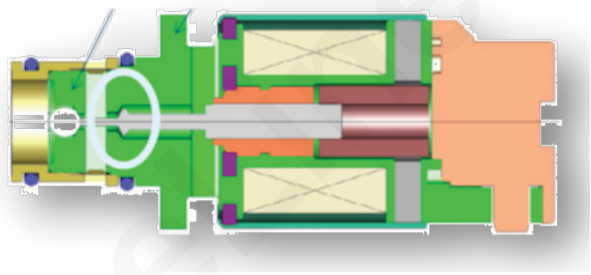
Technical data

Pressure range	as of 4.7 to 0 bar
Operating voltage	12 V
Resistance	5,05 Ω at +20°C
Characteristic curve	falling

8HP51IEP and 8HP76IEP - Electronic hydraulic control unit

25 bar solenoid valve

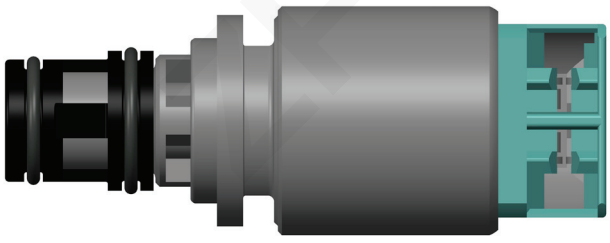


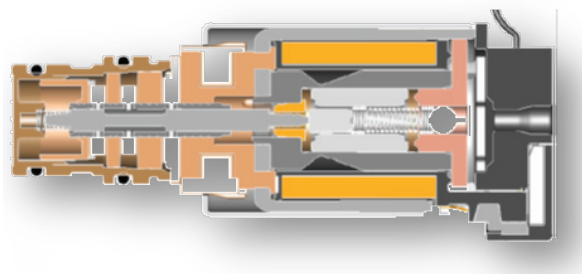


Technical Data

Max. current	1200 mA
Max. supply pressure	pSys (25.0 bar)
Flow rate at cold temperature (-20 >C)	> 1.3 l/min (P → A) > 1.0 l/min (P → T)

Pilot slide pressure regulator

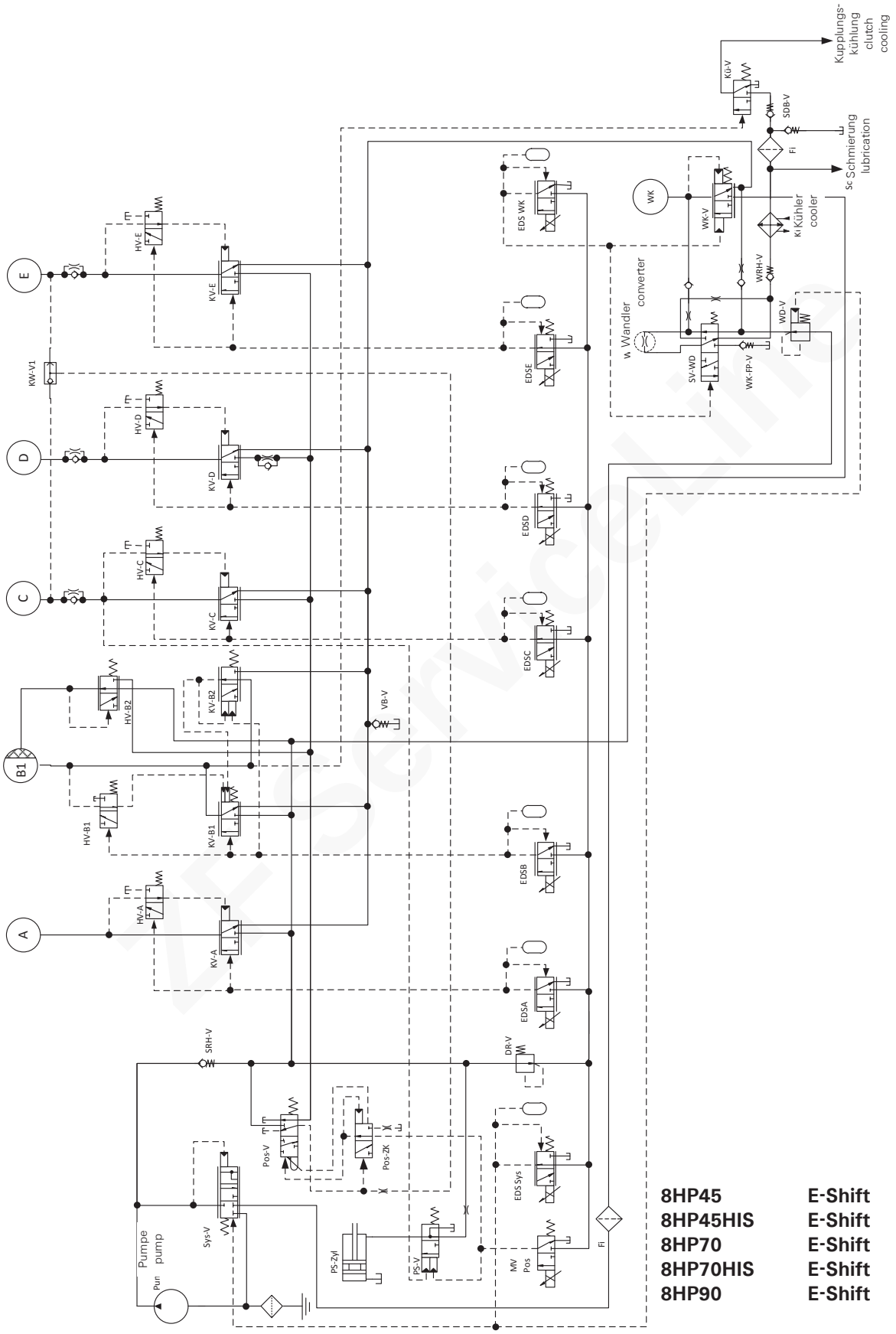




Technical data

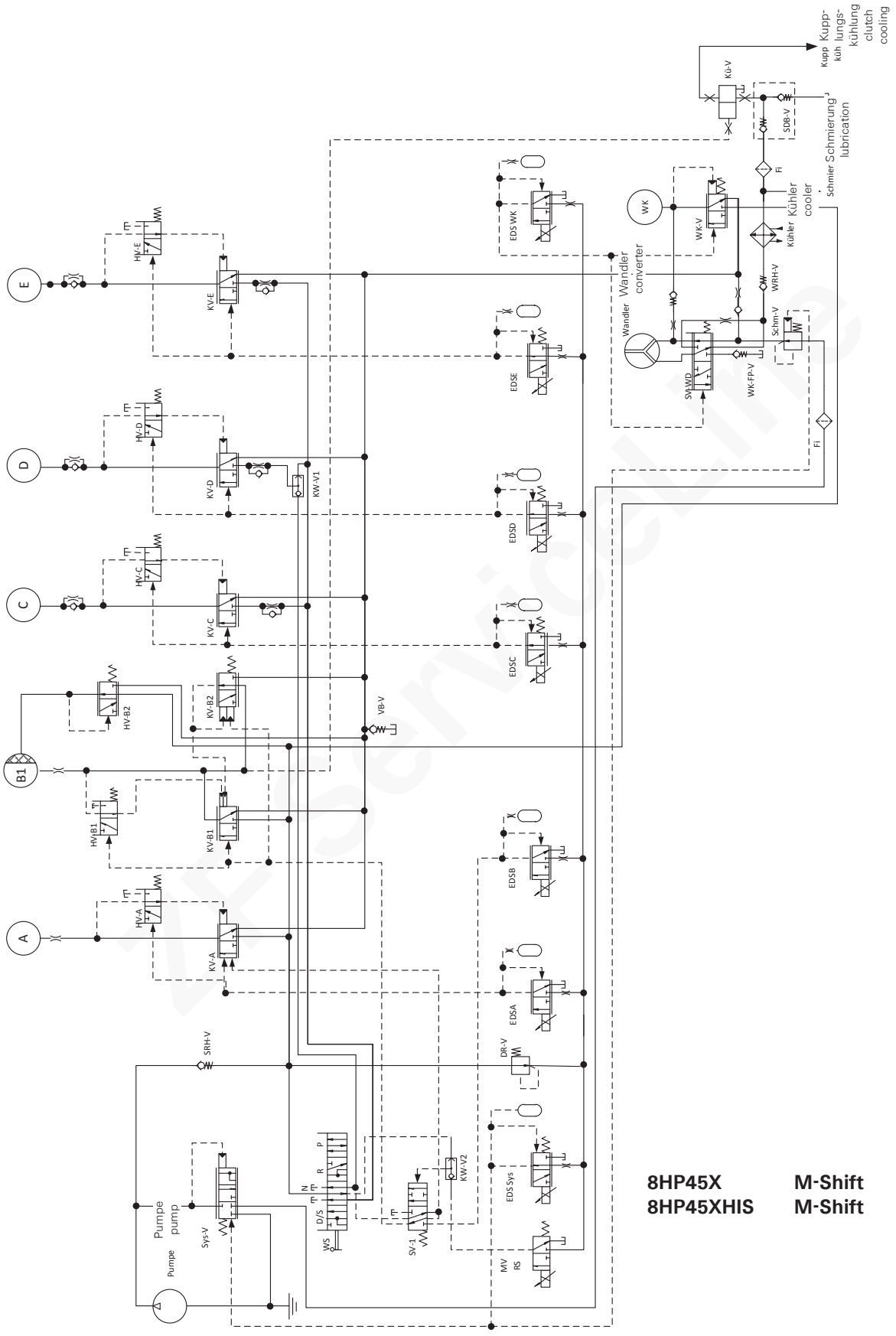
Max. leakage	0.1 l/min permanent
Control pressure	0 ... 12 bar // 8.0 ... 0 bar
Current range	0 ... 1200 mA // 0 ... 850 mA
Follow-on slide	KV (i = 1.8)
Supply pressure	pSys

DIN diagram E26/1



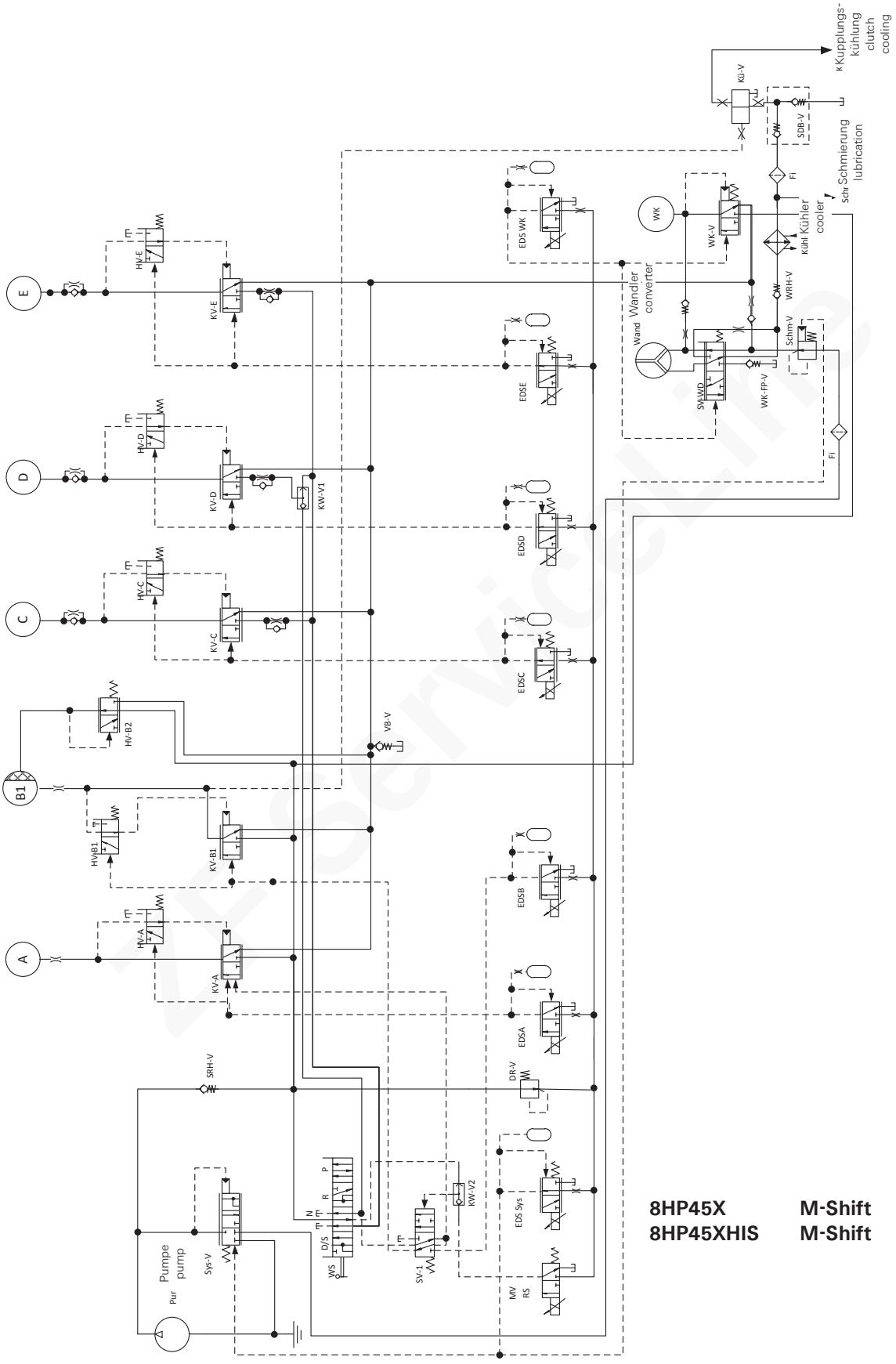
8HP45 E-Shift
8HP45HIS E-Shift
8HP70 E-Shift
8HP70HIS E-Shift
8HP90 E-Shift

DIN diagram E26/2

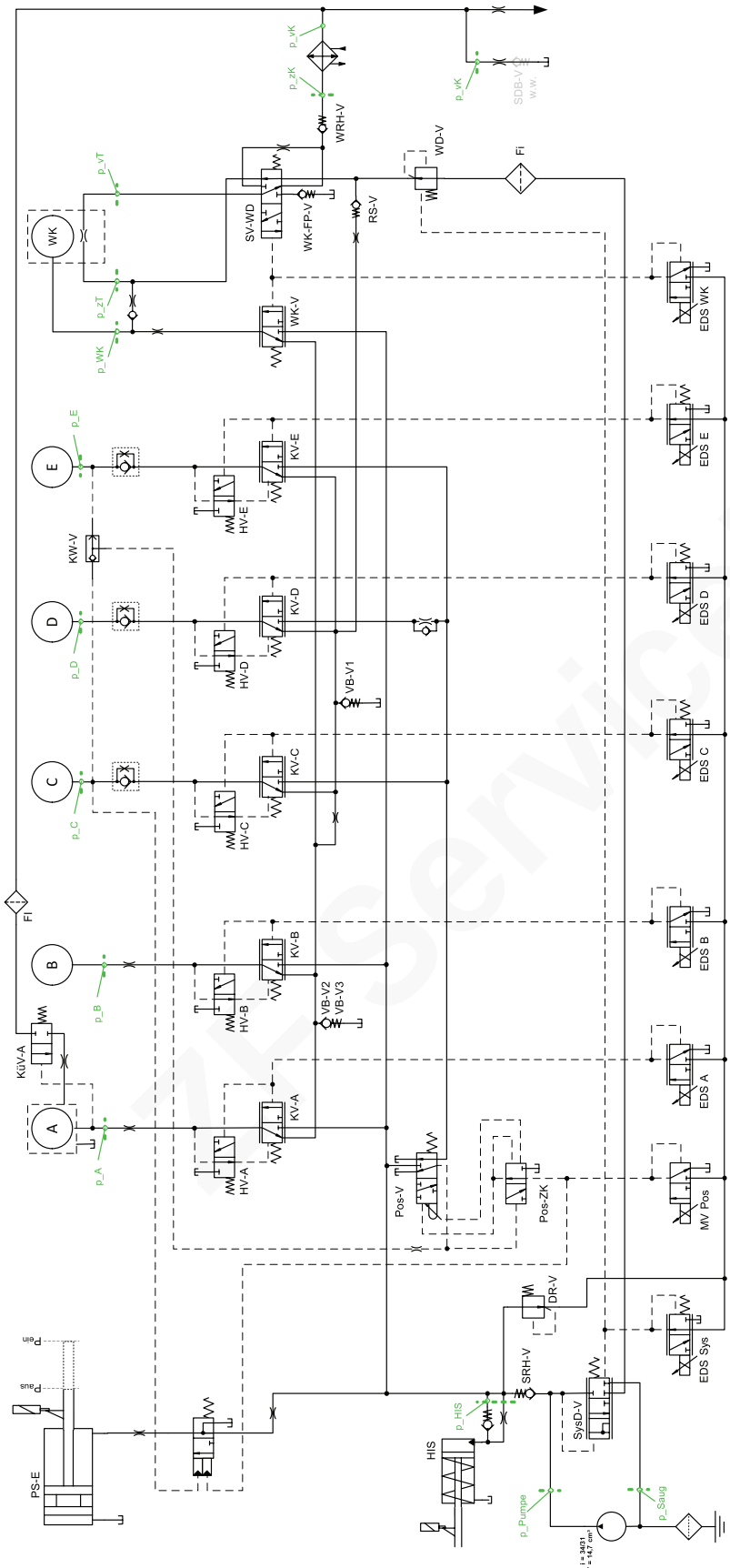


8HP45X M-Shift
8HP45XHIS M-Shift

DIN diagram E26/24



DIN diagram E26/28 - Mech-S 1.0



8HP50HIS **E-Shift**
8HP75HIS **E-Shift**

Brief description

General

The driving strategy software “ASIS” was developed under ZF Friedrichshafen’s own auspices for electronic transmission control. A variety of useful functions are contained in it. There are two basic functions behind the designation

„**ASIS**“ = **A**daptive **S**h**i**ft **S**trategy (adaptable selection of the shift program)

. Gear selection takes place based on the current uphill or downhill stretch being driven. In addition, there is a continual adjustment of the shift program to the individual style of the driver – varying continuously from a very “sporty” to extremely economical manner of driving. A selection of the shift program (e.g. “sport / power” or “ECO”) by means of a switch for choosing a program has been eliminated and is only realized if the customer expressly wants it.

This short description of ASIS will present all its functions and describe its modes of operation. For example, there will be an explanation of what other vehicle systems provide signals and how they are evaluated in the electronic transmission control unit.

A breakdown into 2 groups of functions takes place.

1. Evaluation of the driving style and determination of the driver type.
2. Selection of the driving program based on the driving situation, conditions in the environment and the vehicle load condition.

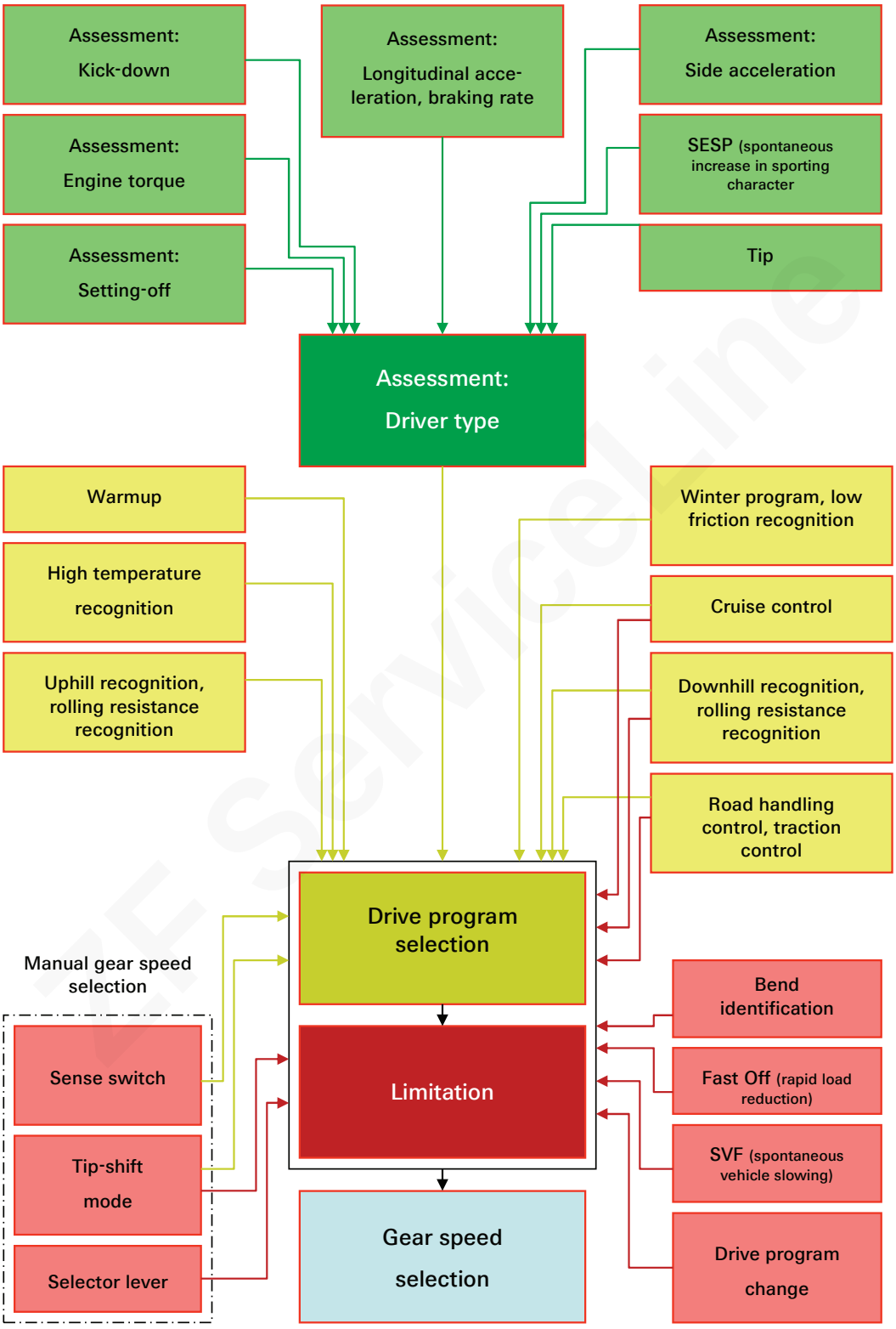
The above-mentioned functions operate in the electronic transmission control unit immediately after starting off, seconds after the information from the other vehicle systems is sent over the CAN-Bus.
The shift program is updated continuously without evaluating long assessment times.
Without deceleration, the sportiness meter is corrected and the uphill and downhill stretches are detected from the time the vehicle starts off (with the engine at operating temperature!).
The result already impacts on the calculation of the next upshift point.

For example: Up-shift 1st. → 2nd gear with an economical shift point.
Up-shift 2nd → 3rd gear appreciably sportier.

The ASIS functions are inoperative if diagnostic or protective functions (e.g. “hot mode”) are active.

Note: Changes and additions must be removed from the respective current Technical Service information.

General functional structure



Drive program selection

In the previous section, there was a description of the evaluation functions by which electronic transmission functions become capable of learning a current driving style. As a result of this driver-type evaluation, there is a sportiness figure between ECO and sport that is used for the selection of the drive or the shift program.

As in various other vehicles with other types of automatic transmissions, the transmission control unit has driving resistance recognition. This basic function is already starting up at the drive-off stage, in the background with a constant calculation of driving resistance. The result is a figure that defines the shift program for uphill, downhill or flat.

There is the choice of one of 15 possible driving programs by means of the sportiness figure and the driving resistance figure (see matrix). Deviating from this matrix of three sporty and five driving resistance categories, environmental conditions (temperature, for example) or driving systems (driving speed governors, for example) can be decisive in the choice of a special driving program.

Warm-up program

The warm-up program is chosen at engine temperatures below 30°C. It is designed to support the heating of the catalytic converter and reduce the emission of pollutants from a cold engine. This temporary driving program uses fuel-efficient shift points to meet this goal. The warm-up program is a static driving program. During the warm-up phase, neither the driver-type evaluation nor the driving resistance recognition is active. The time period for this driving program is longer for diesel vehicles than for those with gasoline engines! An early departure from the warm-up program occurs when driving downhill and – for safety's sake – during downshifting. If the winter sensor was activated before the engine start, and the engine temperature is < 30°C, winter operation is ignored (despite the display).

High temperature

The selection of the high temperature program occurs only when the transmission fluid heats up to a temperature of more than 120°C. Basically, it is a transmission protection program designed to help bring the transmission back from this critical temperature range. If the high temperature program is active, the red transmission check light flashes on the instrument panel! The high temperature program can also be termed static. Neither the driver type evaluation nor the driving resistance calculation is controlling for the position of the shift points. The temperature level is instead. The high temperature driving program has a sporty character, with shift points at relatively high engine rotational speeds. The warming in the torque converter, in particular, is supposed to be reduced due to the early closing of the torque converter lockup clutch. The objective is to have a stiff, nonslip drive for as long as possible and thus cool the transmission fluid.

Incline recognition / Driving resistance recognition

The driving resistance calculation relates to a view of the balance between propulsive force (engine torque) and driving resistance on the driving wheels. The following factors influencing the external driving are taken into consideration:

rolling resistance of the tires
vehicle weight (and inertia)
aerodynamics (= air resistance),
climbing resistance

So it is unnecessary for the driver to intervene while driving uphill or downhill, to possibly up-shift or downshift at a fairly high engine rotational speed.
For example: the prevention of a premature up-shift while going uphill, by activating a limiter, so the driver

can continue driving up the incline in a low gear. This driver’s intervention is not necessary!
Another example is the engine staggering when driving uphill in high gear. The transmission shifts down more readily as throttle is increased to prevent overloading the engine. Do not intervene with the selector lever. Step on the gas instead. In this situation, downshifting occurs earlier than it would on a level surface! Likewise, there is an automatic adjustment in the driving program to current load conditions or even to towing a trailer, solely through the increased driving resistance.

The evaluation of the driver type provides a figure for sportiness, which is assigned to either the S0 = ECO, S2 = MIDDLE to S4 = SPORT.

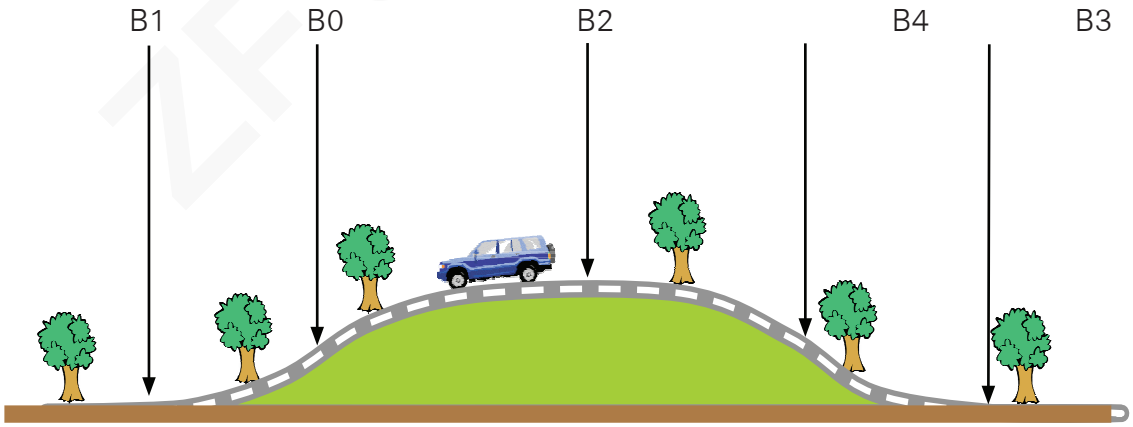
Driving resistance recognition provides a figure for the current driving resistance. This can move between five categories – B0 to B4.

Note: The assignment for a level surface may vary for different applications. So in one instance, level is assigned to incline program B2 and in another instance to incline program B1.

Matrix for driver type evaluation

ECO MIDDLE SPORT

Driving resistance		S0	S1	S2	S3	S4
		RPM	RPM	RPM	RPM	RPM
steep uphill	B4	3000	3500	4000	4500	5000
uphill	B3	2500	3000	3500	4000	4500
level	B2	2000	2500	3000	3500	4000
downhill	B1	1500	2000	2500	3000	3500
steep downhill	B0	1000	1500	2000	2500	3000



Winter recognition (low frictional value recognition)

This function offers the opportunity for higher gears on driving surfaces with low friction coefficients:
- in ice and snow
- in rain
- on loose or soft ground

Thus, starting off is easier. Downshifting, which leads to dangerous driving situations, is avoided.

Cruise control (driving speed controller)

The driver selects the driving program by means of the driving speed controller, or cruise control.
The driving speed that is set is constantly maintained. If the driver activates the resumption of the set speed after braking, engine automatically is given gas and, if necessary, downshifting occurs.
New is the coupling of the driving speed controller with the driving resistance recognition!
In a fixed driving program for cruise control, frequent up- and downshifting (back-and-forth shifting) cannot be avoided, since the topography and the load condition are not captured along with other information. With the ASIS program, maintaining and adjusting driving speed has become even more comfortable, since the current amount of the driving resistance goes into the calculation of the shifting point.

Downhill recognition

As with uphill recognition, the driving resistance calculation relates to the consideration of a balance between propulsive force (engine torque) and the vehicle resistance on the drive wheels.
The following factors influencing external driving resistance are taken into consideration:
- rolling resistance of the tires
- vehicle weight (and inertia)
- aerodynamics (= air resistance),
- Vehicle thrust downhill,
- Actuation of the brake pedal (method of actuation).

Therefore, while driving on a downhill stretch, it is unnecessary for the driver to intervene to possibly introduce downshifting and achieve an additional braking effect by means of the engine.
This occurs via
- the load position of the gas pedal,
- the speed of the vehicle,
- the activation of the brake pedal.

From these signal factors, the electronics recognizes whether and when the appropriate downshift into the next gear down is introduced to support braking power.

Traction control (ASR)

ASR becomes active when wheel spin is recognized. Here there can be a switch into a special shift program designed for the situation, independent of the program priority schedule. The appropriate nominal gear is delivered immediately. At the same time, the program rules out action by the driver.

Driving dynamics control (FDR / ESP)

On the transmission side, the ESP considers the special conditions of driving dynamics control (FDR).
FDR is a control system in the brake system and the drive line that prevents the vehicle’s lateral loss of control.
Other systems are part of this, including:

- Anti-lock braking system (ABS),
- Traction control (ASR),
- Engine management, which regulates intervention into the engine control unit.

ESP makes functions available that the ASR and FDR functions access. Under certain circumstances, they trigger a program change or prevent shifting.

Dynamic stabilization
If the FDR function is active, a measure to prevent shifting can be triggered. Protective measures also prevent impermissible RPMs.

General

During idling RPMs and when vehicle is stopped with drive position “D” engaged, a certain, limited amount of torque is transmitted due to the torque converter. If the brake is not activated, this leads to vehicle “creep.”

In addition, this represents a certain loss of efficiency, since the idle rotational speed must be kept constant through the adjustment of the idle torque (increased quantities of injected fuel). The resulting higher fuel consumption is uneconomical, and the higher brake pedal force (e.g. in stopping the vehicle and in standing at a light) represents a certain reduction in comfort.

Stand-by-control is currently active only in a forward gear and in an ATF temperature range between about 20°C and 120°C.

Function

When the brake pedal is depressed, the stand-by-control function is taken over by the brake “B” control. Stand-by-control refers to the reduction of motor output when the vehicle is stopped and drive position “D” is engaged, by means of the control of brake B’s force flow. The control of stand-by-control takes place through the calculation of the converter torque from the engine rotational speed and the turbine rotational speed (rotational speed differential). In addition, angle of elevation and ATF oil temperature are incorporated.

Example

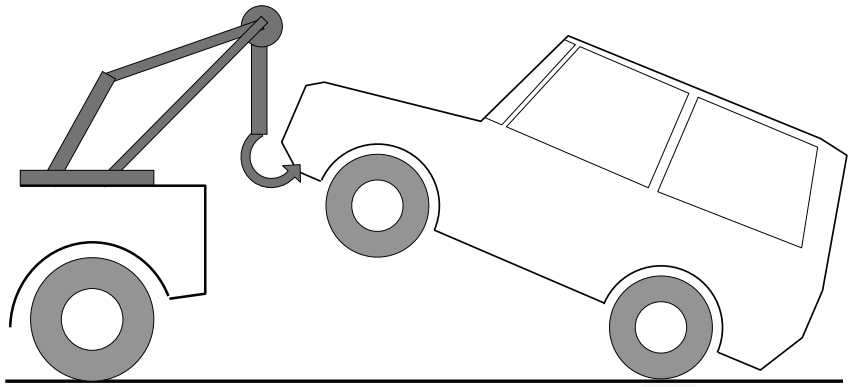
Stand-by-control not active	Stand-by-control active
– vehicle stopped, brake depressed – engine = rotational speed idling – drive shaft stopped	– vehicle stopped, brake depressed – engine = rotational speed idling – drive shaft turns with defined rotational speed
rotational speed differential or slippage amounts to 100%	rotational speed differential or slippage nearly at zero

To assure a delay-free and load-shift-free drive-off, the force flow is not completely interrupted A small amount of converter torque is always transmitted.

If a defined gas pedal value is exceeded or if a transmission output rotation is recognized, the stand-by-control switches off. This likewise occurs with the release of the brake (brake not depressed), independent of other parameters.

Towing in case of break-down

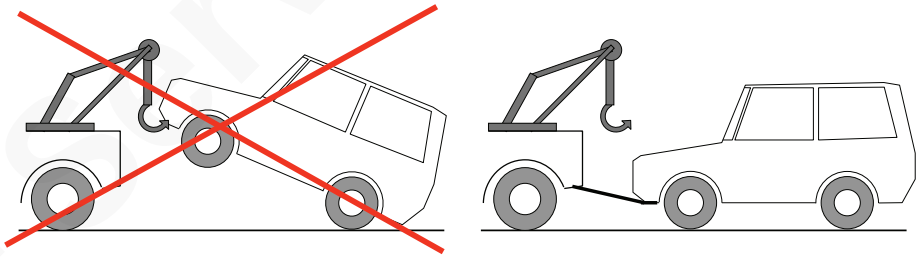
It is essential to observe the information in the operating manual of each particulra vehicle.



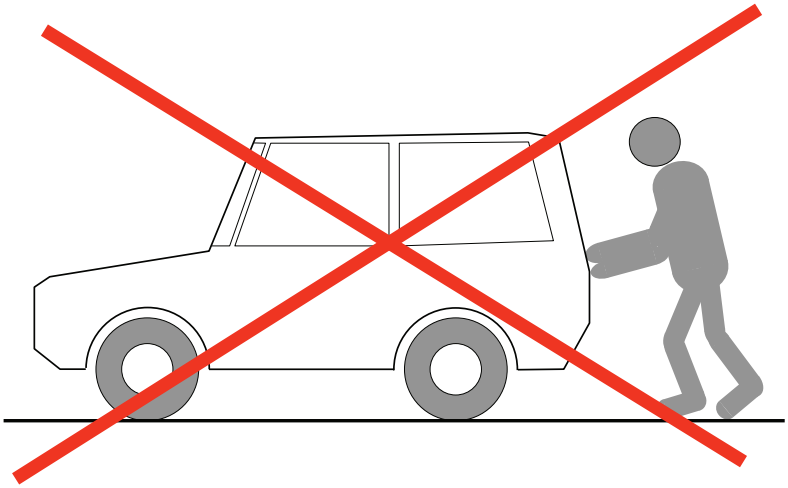
Audi towing
The vehicle can be towed at a maximum vehicle speed of **50 km/h** over a maximum distance of **50 km** using the drive wheels. The transmission must be mechanically unlocked. That means: the parking lock must be released by means of a Bowden cable. The automatic transmission can be seriously damaged if the above-mentioned boundary values are not maintained.

BMW towing
The precondition for towing a vehicle with an unraised drive axle is that the parking lock be opened by means of a Bowden cable emergency release. If this is the case, towing with a maximum speed of **50 km/h** over a maximum distance of **50 km** is possible. The automatic transmission can be seriously damaged if the above-mentioned boundary values are not maintained.
Vehicles on which the parking lock must be opened with an unlocking screw cannot be towed. In case of breakdown, the vehicle must be raised with a crane and delivered to the workshop for repair on a flatbed tow truck.

Four-wheel-driven vehicles
Vehicles with four-wheel-drive must not be towed with one axle lifted.



Pushing
The engine cannot **be started** by pushing the vehicle. That is to say, if the engine is stopped, there is no trans-mission of power from the hydrodynamic coupling of the engine and transmission and the pressure-less shift ele-ments.



Operating instructions for the engagement of the parking lock with depressed foot brake, especially on an incline.

Possible complaint: Discharge impact during unlocking of the parking lock

From: Engaging parking lock without activating the parking brake ahead of time,
Releasing parking brake without unlocking the parking lock ahead of time.

Note: Method for

Parking the vehicle	**Starting the vehicle**
Stepping on the foot brake	Starting the engine
Activating the parking brake	Stepping on the foot brake
Engaging parking lock	Unlocking parking lock
Shutting off engine	Release parking brake

Operating instruction for the engagement of drive position R→P / P→R, R→N / N→R, D→N / N→D or spontaneous (simultaneous) pressing of the accelerator with the selection of position D / R.

Possible complaint: shift impact from manual back-and-forth shifts with the selector lever, one shortly after another (within the shifting process)

Note: Pause a short time (Wait for the respective force locking)

Rocking-free function /Maneuvering function

The “rocking-free” or “rocking-out” of a bogged-down vehicle (e.g. from a snowdrift) is in principle possible through the repeated, fast shifting of the positions **D→R→D**. In the process, it must be assured that the driver does not give the engine too much gas (depending on the vehicle).

If the shifting from **D** to**R** and back takes place within a certain short time span, the transmission control unit recognizes the intention of the driver and releases the selector lever. If the time span is exceeded, the selector lever lock begins to function.

This self-protective function of the transmission prevents the burning-up of the disk clutches under stress during the rocking.

Date	Version	Modification
2011-05-06	D	spelling, diverse
2011-05-06	D	P. 70 - text correction for prozessor flash memory
2011-05-06	D	color correction and margin addition for printing
2011-05-26	E	corrected English pages included
2011-05-26	E	same sites harmonized in functional descriptions “General“ and “All-Wheel“ immage positions / text frames / texts
2011-05-26	E	installation of the FLALL-geartype into the version formerly called “All-Wheel“
2011-09-02	F	towing of vehicles with All-wheel (locking differential!) modified. 08_11_F AG → 09_11_F; correction of the version information, rear cover sheet old: 05/11 - E (files from 2011-08-30); new: 09/11 - F (files from 2011-09-02)
2012-01-27	G	register of modifications added
2012-01-27	G	P. 61 - sensor label added or corrected
2012-01-27	G	P. 62 - sensor label added or corrected
2012-04-12	H	P. 21 - Scheme brake B corrected
2012-04-12	H	P. 22 - Scheme brake B state M-SPT3 added
2012-12-05	I	P. 79 - 84 - Hydraulic control diagrams added
2014-02-13	J	P. 7, 9, 17, 19, 21 - 24, 26, 40, 41, 76 - 81, 88, 92
2016-01-29	K	P. 57, 73
2017-10-10	L	8HP 3rd gen. (8HP51 and 8HP76) added, layout adapted to CI
2018-10-10	M	French version added

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