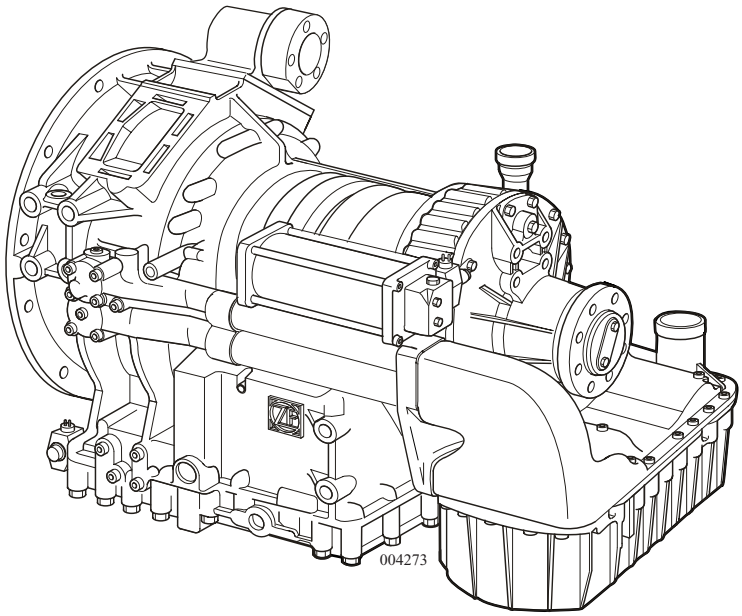
Repair Manual



ZF-ECOMAT®

HP 500 / HP 590 / HP 600
"Long" version
Stage 3

4139 751 621a

Subject to alterations in design

Printed in Germany

Edition: 09.95

4139 751 621a

This repair manual is intended for skilled personnel trained by ZF Friedrichshafen AG to carry out maintenance and repair work on ZF products.

This manual deals with the standard ZF product in accordance with the state of development on the date of issue.

However, due to continuing development of the product, repair work might require work practices and test or adjustment data not contained in this manual.

We recommend that work done on your ZF product is carried out only by skilled mechanics who have had their practical and theoretical knowledge updated on a regular basis at our After-Sales Service training centers.

Service points equipped by ZF Friedrichshafen AG all over the world offer you:

1. Continually trained personnel
2. Specified equipment, e.g. special tools
3. Genuine ZF spares, to our latest specifications

All work performed at these service points is carried out conscientiously and with utmost care.

Repair work carried out at ZF service points is subject to the contractual conditions prevailing in the individual case.

ZF FRIEDRICHSHAFEN AG
C.V./Special Transmissions
Service Plant 2
Tel.: (0 75 41) 77-0
Fax: (0 75 41) 77-5726

Damage resulting from work performed by non-ZF personnel in an improper and unprofessional manner and any consequential costs are excluded from the contractual liability agreement. Exclusion of liability also applies if genuine ZF spares are not used.

In case of doubt always turn to the relevant department within ZF After-Sales Services for advice.
All work on transmissions is to be performed expertly and under clean conditions.
Use specified tools to dismantle and assemble transmissions.

After removing the transmission from the vehicle, clean thoroughly with a suitable cleaning agent before opening.
Pay particular attention to the projections and recesses of housings and covers when cleaning.
Parts joined with Loctite are easier to separate if warmed with a fan heater.

CLEANING PARTS

Remove remains of old gaskets on all seal-faces. Carefully remove burrs or similar patches of roughness using an oil-stone.

Lube bores and grooves must be free of anti-corrosion agents and foreign matter; check for perfect passage.

Carefully cover opened transmissions to prevent foreign matter from entering.

REUSING PARTS

Parts such as ball or roller bearings, multi-discs, thrust washers etc., must be inspected by a competent person, who should decide whether or not they can be re-used. Replace parts which are damaged or have suffered from excessive wear.

GASKETS, LOCKING PLATES

Parts which cannot be removed without being damaged must always be replaced with new parts (e.g. gaskets and locking plates).

SHAFT SEALS

Always change shaft seals with rough, ripped or hardened packing washers. Seal contact surfaces must be totally clean and in perfect condition.

REWORKING

Rework may be carried out on seal contact surfaces using plunge-cut grinding only, never use an emery cloth. Ensure that there are no traces of grinding or riffling.

If rework is needed on distance washers, shims etc. because of clearance settings, ensure that the reworked areas contain no face runout and have the same surface quality.

TRANSMISSION ASSEMBLY

Find a clean site to assemble the transmission. Gaskets are installed without the use of sealing compound or grease. When measuring silicon-coated gaskets, take care **not to include the silicon layer in the measurement.**
During assembly, comply with all adjustment data, checking data and tightening torques in the Repair Manual.

BEARINGS

If bearings are mounted in heated condition, they are to be heated evenly (e.g. heating cabinet).
Temperature should be at ca. 85 °C and must not exceed 120 °C. Each mounted bearing must be oiled with operating oil.

SEALING

If a specific sealing agent* is to be used for sealing, comply with the manufacturer’s directions for use. Apply a thin layer of sealing agent to the surfaces and spread evenly. Do not allow sealing to enter oil ducts and bores. On oil-carrying ducts and bores, wipe off the sealing agent on the surfaces to be sealed near apertures to ensure that no sealing agent enters the oil feeds when the surfaces are sealed.

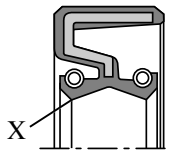
SHAFT SEALS

a) Apply a light coat of sealing agent* on outer edge of shaft seals with “steel surround”.

b) **Never apply sealing agent** to shaft seals with “rubber surround”, but apply a thin coat of Vaseline 8420 to the outer edge or wet with a lubricant, e.g. a water-soluble, concentrated washing-up liquid (e.g. Pril, Coin, Palmolive).

c) Shaft seals with steel and rubber surrounds should be treated on the outer edge of the rubber surround as described above in section b).

d) Dual shaft seals have two sealing lips. The dust-proof sealing lip (X) must face outwards.



e) Fill the gap between the sealing lips so it is 60% filled with grease (e.g. produced by Aral such as Aralub HL2 or by DEA such as Spectron FO 20).

f) If possible, heat shaft seal bores to between 40 and 50 °C (makes fitting easier). Press the seal shaft with mounting or faceplate onto the relevant installation depth plan.

RETAINING AGENTS

Retaining agents* may only be used in places as specified in the parts list.
Always comply with manufacturer’s directions for use when using retaining agents (e.g. Loctite).
During assembly, comply with all adjustment data, checking data and tightening torques.

TRANSMISSION OIL

After completing repairs, fill transmissions with transmission oil. For the procedure and approved oils, refer to the transmission operating manual and List of Lubricants TE-ML (refer to identification plate) which are available from any ZF After-Sales Service Point.
After filling the transmission with oil, tighten the screw plugs at the oil filling point and the oil overflow to the specified torques.

** refer to expendable material*

SAFETY NOTICE

Companies repairing ZF units are responsible for their own work safety.

To avoid injury to personnel and damage to products, all safety regulations and legal requirements which apply to repair and maintenance work must be adhered to.
Before starting work, mechanics must familiarize themselves with these regulations.

Personnel required to carry out repairs on ZF products must receive appropriate training in advance. It is the responsibility of each company to ensure that their repair staff is properly trained.

The following safety instructions appear in this manual:

NOTE
Refers to special processes, techniques, data, use of auxiliary equipment, etc.

CAUTION
This is used when incorrect, unprofessional working practices could damage the product.

⚠ **DANGER**
This is used when lack of care could lead to personal injury or death.

GENERAL INFORMATION

Read this manual carefully before starting any tests or repair work.

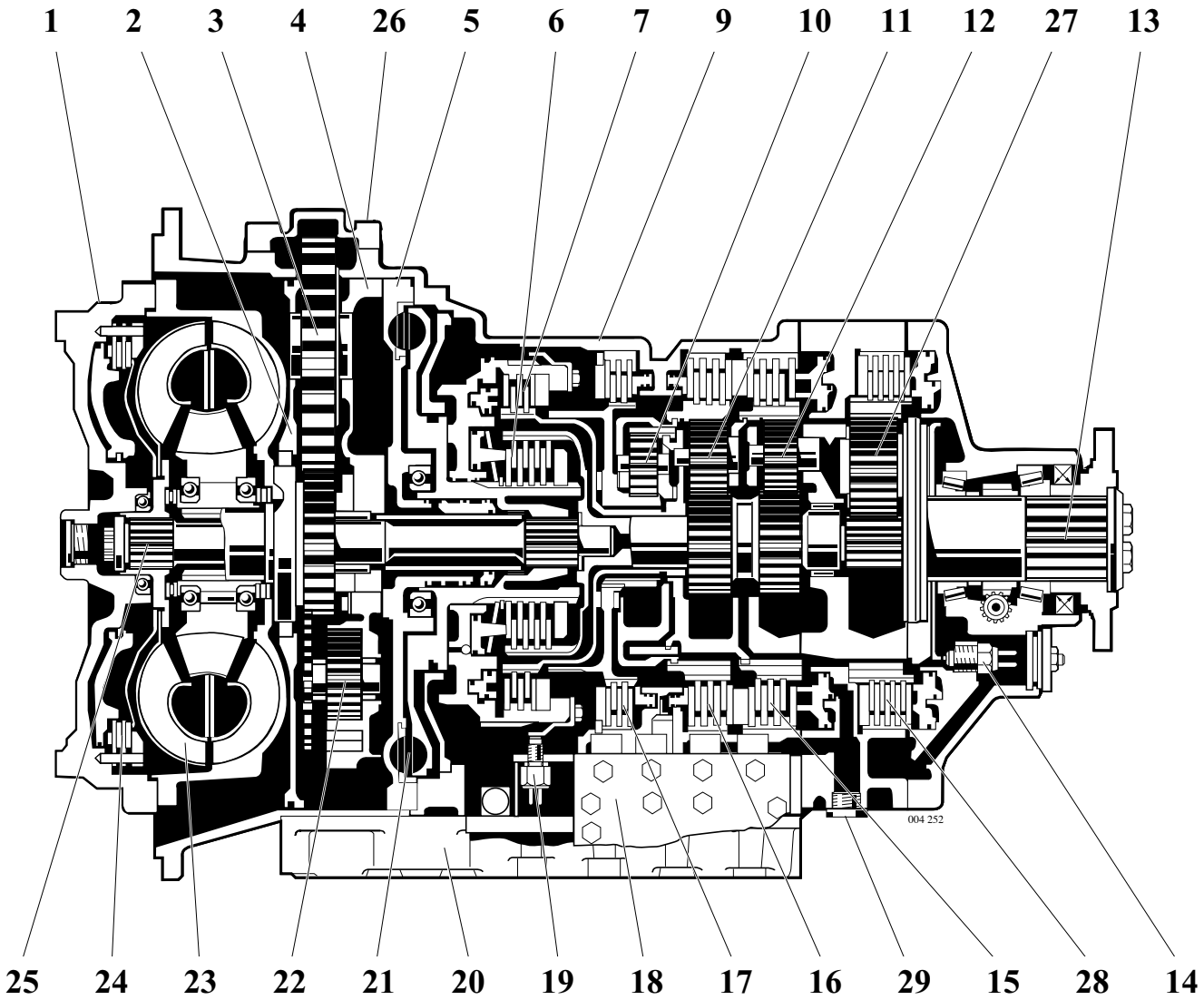
CAUTION
Pictures, drawings and components do not always represent the original object, but are used to illustrate working procedures.
Pictures, drawings and components are not to scale. Conclusions about size and weight should not be drawn (even within a complete illustration).
Always follow the working steps as described in the text.

After completion of repair work and testing, skilled staff must satisfy themselves that the product is functioning correctly.

⚠ **THREATS TO THE ENVIRONMENT !**
Lubricants and cleaning agents must not be allowed to enter the soil, ground water or sewage system.
- **Ask your local environment agency for safety information on the relevant products and adhere to their requirements.**
- **Collect used oil in a suitably large container.**
- **Dispose of used oil, dirty filters, lubricants and cleaning agents in accordance with environmental protection guidelines.**
- **When working with lubricants and cleaning agents always refer to the manufacturer’s instructions.**

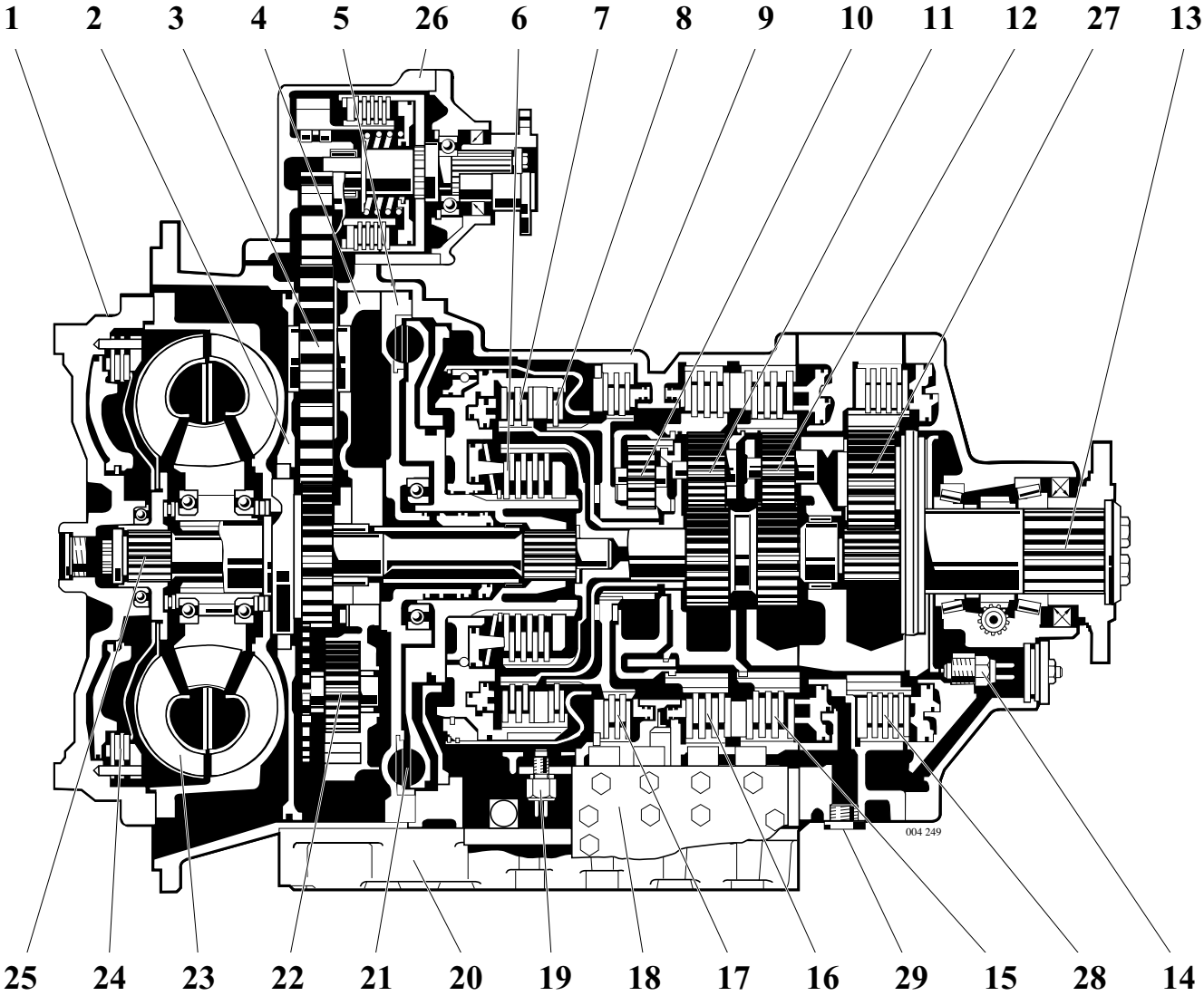
CAUTION
The transmission must NOT be hung by the input shaft NOR by the output flange.

ZF-Ecomat transmission, 5-speed, “long” version



1 Drive flange
2 Cover plate
3 Drive gears for PTO
4 Control element
5 Oil supply flange
6 Clutch “A”
7 Clutch “B”
9 Housing
10 Planetary gear set I
11 Planetary gear set II
12 Planetary gear set III
13 Output flange
14 “Output speed” inductive sensor
15 Brake “F”
16 Brake ”E”
17 Brake ”D”
18 Shift control unit
19 “Turbine” inductive sensor
20 Oil pan
21 Retarder
22 Primary pump
23 Converter
24 Converter lock-up clutch “WK”
25 Turbine shaft
26 Connection for PTO
27 Planet gear set IV
28 Brake “G”
29 Pressure measuring point

ZF-Ecomat transmission, 6-speed, “long” version



1 Drive flange
2 Cover plate
3 Drive gears for PTO
4 Control element
5 Oil supply flange
6 Clutch “A”
7 Clutch “B”
8 Clutch “C”
9 Housing
10 Planetary gear set I
11 Planetary gear set II
12 Planetary gear set III
13 Output flange
14 “Output speed” inductive sensor
15 Brake “F”
16 Brake “E”
17 Brake “D”
18 Shift control unit
19 “Turbine” inductive sensor
20 Oil pan
21 Retarder
22 Primary pump
23 Converter
24 Converter lock-up clutch “WK”
25 Turbine shaft
26 PTO
27 Planetary gear set IV
28 Brake “G”
29 Pressure measuring point

No. of speeds	Transmission type with parts list HP 500	HP 590	HP 600	Transmission	Version
5 speed	4139 008 …	4139 058 …	4139 068 …	5.6 - 1.0	long
6 speed	4139 005 …	4139 055 …	4139 065 …	5.6 - 0.83	long

Long version	A	B_1	B_2	D	E	F_1	F_2	G
5-speed	i = 5.6 to 1							
Reverse			●			●	●	
Neutral								
1st gear	●							●
2nd gear	●					●		
3rd gear	●				●			
4th gear	●			●				
5th gear	●	●						

B_1 = Inner piston area of clutch B

B_2 = Outer piston area of clutch B

F_1 = Outer piston area of brake F

F_2 = Inner piston area of brake F

Long version	A	B	C	D	E	F_1	F_2	G
6-speed	i = 5.6 to 0.83							
Reverse			●			●	●	
Neutral								
1st gear	●							●
2nd gear	●					●		
3rd gear	●				●			
4th gear	●			●				
5th gear	●	●						
6th gear		●		●				

Tightening torques for nuts and bolts, extract from ZFN 148

This standard applies to bolts acc. to DIN 912, DIN 931, DIN 933, DIN 960, DIN 961 and to nuts acc. to DIN 934.
This Standard contains data on tightening torques (M_A) for bolts and nuts in strength categories 8.8, 10.9 and 12.9 and nuts in strength categories 8, 10 and 12.

Surface condition of bolts: thermally blackened and oiled or galvanized and oiled or galvanized, chrome-plated and oiled.

Tighten screws with a calibrated torque spanner.

NOTE
Irregular tightening torques are listed separately in the Repair Manual.

Regular screw thread

Size	Tightening torque M_A (Nm) for		
Bolt	8.8	10.9	12.9
Nut	8	10	12
M 4	2.8	4.1	4.8
M 5	5.5	8.1	9.5
M 6	9.5	14	16.5
M 7	15	23	28
M 8	23	34	40
M 10	46	68	79
M 12	79	115	135
M 14	125	185	215
M 16	195	280	330
M 18	280	390	460
M 20	390	560	650
M 22	530	750	880
M 24	670	960	1100
M 27	1000	1400	1650
M 30	1350	1900	2250

Fine screw thread

Size	Tightening torque M_A (Nm) for		
Bolt	8.8	10.9	12.9
Nut	8	10	12
M 8 x 1	24	36	43
M 9 x 1	36	53	62
M 10 x 1	52	76	89
M 10 x 1.25	49	72	84
M 12 x 1.25	87	125	150
M 12 x 1.5	83	122	145
M 14 x 1.5	135	200	235
M 16 x 1.5	205	300	360
M 18 x 1.5	310	440	520
M 18 x 2	290	420	490
M 20 x 1.5	430	620	720
M 22 x 1.5	580	820	960
M 24 x 1.5	760	1100	1250
M 24 x 2	730	1050	1200
M 27 x 1.5	1100	1600	1850
M 27 x 2	1050	1500	1800
M 30 x 1.5	1550	2200	2550
M 30 x 2	1500	2100	2500

Edition: August 1991 / checked 1997

Description	Dimension	Measuring device	Remarks
Torque converter			
01. Installation depth of torque converter (depending on version)	71.25 ± 0.5 mm 77.00 ± 0.5 mm 81.25 ± 0.5 mm 86.25 ± 0.5 mm	Depth gauge	Installation depth measured from flange surface on torque converter to flange surface on transmission housing. Installation depth can be set using one or more spacer rings on the stator shaft
02. Converter end float between face end of converter one-way clutch inner ring and spacer ring on stator shaft	0.3 bis 0.4 mm	Depth gauge	End float can be set using shim on face end of turbine shaft
03. Disc play of lock-up clutch in converter	0.5 bis 1.1 mm	Feeler gauge	Disc play is measured between end washer and inner disc
04. End float of thrust bearing in converter	0.1 bis 0.3 mm	Measuring strips and depth gauge	Setting is made using shim rings between housing and turbine gear flange
05. Maximum pressure for testing the converter for leaks	2.5 +0.5 bar	Forcing device 1X56 137 129, compressed air unit 1X56 137 130 and water container	The converter is tested using air under water
06. Tightening torque of Allen screws on HP 500 converter (M8) and HP 590/600 converter (M10)	 = 35 Nm = 60 Nm	Torque wrench	For changing screws and new O-ring seal on HP 590/600 converter, see Service Info No.: 06/95.
07. Tightening torque of M16 Allen screw in the turbine shaft	180 to 190 Nm	Torque wrench and locking device 1X56 137 158	Lock converter with brace 1X56 137 658
08. Tightening torque of M33x2 screw plug in converter	190 to 210 Nm	Torque wrench	Attach new Cu seal ring. Lock converter with brace 1X56 137 658
09. Tightening torque of hexagon bolts on the M10x35 end washer (HP 590 / HP 600)	68 Nm	Torque wrench	

Description	Dimension	Measuring device	Remarks
Output			
10. Specified distance between sensing face of inductive sensor and face end of toothed disc (impulse sensor)	0.5 to 0.7 mm	Depth gauge, measuring rod 1P01 137 833	Distance can be set using shim washers
11. End float of speedometer shaft	0.1 to 0.3 mm	Depth gauge	Can also be checked by hand (can be felt)
12. Gear backlash of speedometer shaft	0.1 to 0.2 mm	Experience	Play is specified, to check test by hand (can be felt)
13. Installation depth of shaft seal in output end cover	15^{-1} mm	Depth gauge	Installation depth between face end of tapered roller bearing inner ring and front face of seal ring is set using device 1X56 136 824. Verify to check
14. End float of tapered roller bearing in output end cover when cold (approx. 20 °C)	0.02 to 0.07 mm	Adjuster 1PO1 136 816, dial gauge and tension balance	Rotating resistance of output end cover set to 0.56 to 0.70 Nm. Setting is made using spacing washers. Difference between speedometer worm and setting ring = distance "C". Thickness of spacing washer = C + 0.05 + 0.02 to 0.07 mm
15. Total end float between sun gear and output	0.4 to 0.6 mm	Measuring strips and depth gauge	Setting is made using shims
16. End float between sun gear II/III and sun gear shaft	0.4 to 0.6 mm	Depth gauge	Setting is made using shims
17. Installation depth of needle bearing in planetary carrier IIII	2.5 +1 mm	Feeler gauge	Installation depth between running surface of shim and face end of needle bearing is set when using device 1X56 137 101
18. End float of planetary gears in planet carrier III	0.5 to 1.2 mm	Feeler gauge	Play is set, verify to check

Description	Dimension	Measuring device	Remarks
19. Tightening torque of M6 studs on output end cover	5 to 7.5 Nm	Torque wrench	
20. Tightening torque of M10 studs on output end cover	10 to 15 Nm	Torque wrench	
21. Tightening torque of M5 hex nuts on cover of output	6 Nm	Torque wrench	
22. Tightening torque of inductive sensor (output speed)	max. 50 Nm	Torque wrench	Do not exceed specified value
23. Tightening torque of M12 hexagon bolts on output flange	60 Nm	Torque wrench	Secure with locking plate. Use device 1X56 136 471
24. Tightening torque of speedometer connection piece	ca. 100 Nm	Torque wrench	Attach new Cu seal ring
Control element			
25. Delivery rate of primary pump in independent test (theoretical value)	ca. 60 l/min	Graduated vessel and stop watch	Measured at pump speed n = 1500/min. SAE 10 W oil at 80°C. Primary pump is a one complete unit
26. Distance between spring guide and guide bolts of stator ring	1.6 +0.5 mm	Measuring gauge	Setting is made by removing or attaching the plate springs which are to be installed. Measurements are made without preload on the plate springs
Clutch carrier			
27. Test pressure (PÜ) for the pistons of clutches “A”, “B” and “C”	2.5 +0.5 bar	Feed guide 1X56 137 128 compressed air unit 1X56 137 130	Pressure test for leaks: fall in pressure from 2.5 +0.5 bar to 1.4 bar after locking = 10 sec.
28. Disc play of clutch “A”	3.2 to 3.7 mm	Depth gauge	Deviations can be compensated for by installing steel discs or A pistons of various thicknesses.

Description	Dimension	Measuring device	Remarks
29. Disc play of clutch "B"	1.6 to 2.1 mm in (HP 500) 2 to 2.5 mm in (HP 590/HP 600)	Feeler gauge	Measurement is taken with feeler gauge between end washer and outer disc. Deviations are rectified using steel discs or B pistons of various thicknesses
30. Disc play of clutch "C"	1.2 to 1.7 mm in (HP 500) 1.6 to 2.1 mm in (HP 590/HP 600)	Feeler gauge	Measurement is taken with feeler gauge between R-gear housing and outer disc. Deviations are rectified using steel discs of various thicknesses
31. Concentricity variation of inductive sensor ring in installed position	+ 0.2 mm	Dial gauge	The measurement is taken at the relevant height of the inductive sensor ring. Deviations are corrected carefully using a soft mallet
32. Tightening torque of M8 hex bolts on rotor (retarder)	35 Nm	Torque wrench	
Mechanical transmission part			
33. End float of planetary gears in planet carrier I	0.5 to 1.2 mm	Feeler gauge	Play is specified, verify to check
34. Disc play of brake "D"	1.6 to 2.1 mm	Feeler gauge	Measurement is taken with feeler gauge between end washer and outer disc. Deviations are rectified using outer discs of various thicknesses and/or attaching or removing outer discs
35. Installation depth of needle bearing in drive shaft	4 +1 mm	Depth gauge	Measured between running surface of thrust washer and face end of needle bearing. The installation depth is set if you are using device 1X56 137 101
36. End float of planetary gears in planet carrier II	0.5 to 1.2 mm	Feeler gauge	Play is specified, verify to check

Description	Dimension	Measuring device	Remarks
37. Disc play of brake “E”	2.5 to 3 mm in (HP 500) 3 to 3.5 mm in (HP 590/HP 600)	Feeler gauge	Measurement is taken with feeler gauge between pressure ring and outer disc. Deviations are rectified using outer discs of various thicknesses.
38. Disc play of brake “F”	3.2 to 3.7 mm	Depth gauge	Deviations are compensated for using F pistons and discs of various thicknesses
39. Disc play of brake “G”	2.8 to 3.3 mm / **R** 12 3.2 to 3.7 mm / **R**14/16 3.6 to 4.1 mm / **R** 18	Depth gauge	Disc play depends on the friction coefficient **(R)**; always set in acc. with parts list. Deviations are compensated for using G pistons or discs of various thicknesses
Hydraulic control unit			
40. Specified distance between sensing face of inductive sensor (in duct plate) and bulges around circumference of inductive sensor ring (pulse sensor)	0.6 to 0.8 mm	Depth gauge,measuring rod 1P01 137 833	Distance can be set using shims
41. Tightening torque of inductive sensor (turbine speed)	max. 50 Nm	Torque wrench	Do not exceed specified value
42. Tightening torque of M42x2 screw plug (in duct plate in conical manner)	80 to 100 Nm	Torque wrench	
Retarder accumulator			
43. Tightening torque of M8 studs on rear cover of retarder accumulator	7.5 to 10 Nm	Torque wrench	Studs need only be replaced by new ones if they are damaged
44. Tightening torque of M8 lock nuts on accumulator cover of retarder	15 Nm	Torque wrench	Attach washers

Description	Dimension	Measuring device	Remarks
Miscellaneous transmission data			
45. Tightening torque of M12x1.5 screw plug in solenoid valve	25 Nm	Torque wrench	Attach new Cu seal ring
46. Installation depth of oil fill pipe	40 +1.0 mm	Depth gauge	Measured between the sealing face of the transmission housing (flange surface of oil pan) and front face of fill pipe. Seal threads with sealing tape
47. Tightening torque of M22x1.5 grooved nut in the oil pan	approx. 20 Nm	Experience	
48. Tightening torque of M22x1.5 oil drain screw in oil pan	50 Nm	Torque wrench	Attach new Cu seal ring
49. Tightening torque of M10x1 screw plugs at the pressure measuring points	12 Nm	Torque wrench	Attach new Cu seal ring
50. Tightening torque of M10x1 banjo bolts in the cover plate	approx. 20 Nm	Torque wrench	Attach new Cu seal ring

Part number	Point of installation	No. of turns	Wire diameter in mm	Outer spring diameter in mm	Untensionned length in mm
0732 041 934	Control element, stator ring	13.50	1.40	16.35	56.20
0732 042 114	Control element, main pressure valve	11.50	3.0	22.90	71.14
0732 041 125	Control element, lubrication pressure valve	4.50	2.50	22.94	22.70
0732 041 654	Control element, converter back pressure valve	10.50	2.80	18.70	52.60
0732 041 102	Control element, converter back pressure valve	10.50	2.80	18.40	48.50
0732 040 786	Control element, cooler switch-over valve	14.50	2.50	17.54	67.40
0732 041 373	Shift control, valve blocks	27.50	0.90	5.40	38.40
0732 041 374	Shift control, valve blocks	13.50	1.30	10.53	37.80
0732 041 148	Shift control, valve blocks	14.50	2.10	18.95	63.3
0732 041 095	Shift control, valve blocks	12.50	1.80	18.73	66.90
0732 041 720	Shift control, valve blocks	13.75	2.20	19.41	60.60
0732 041 357	Shift control, valve blocks	14.50	1.80	18.80	79.70
0732 041 199	Shift control, valve blocks	13.50	1.80	18.83	72.90
0732 041 216	Shift control, valve blocks	14.00	2.10	19.19	60.10