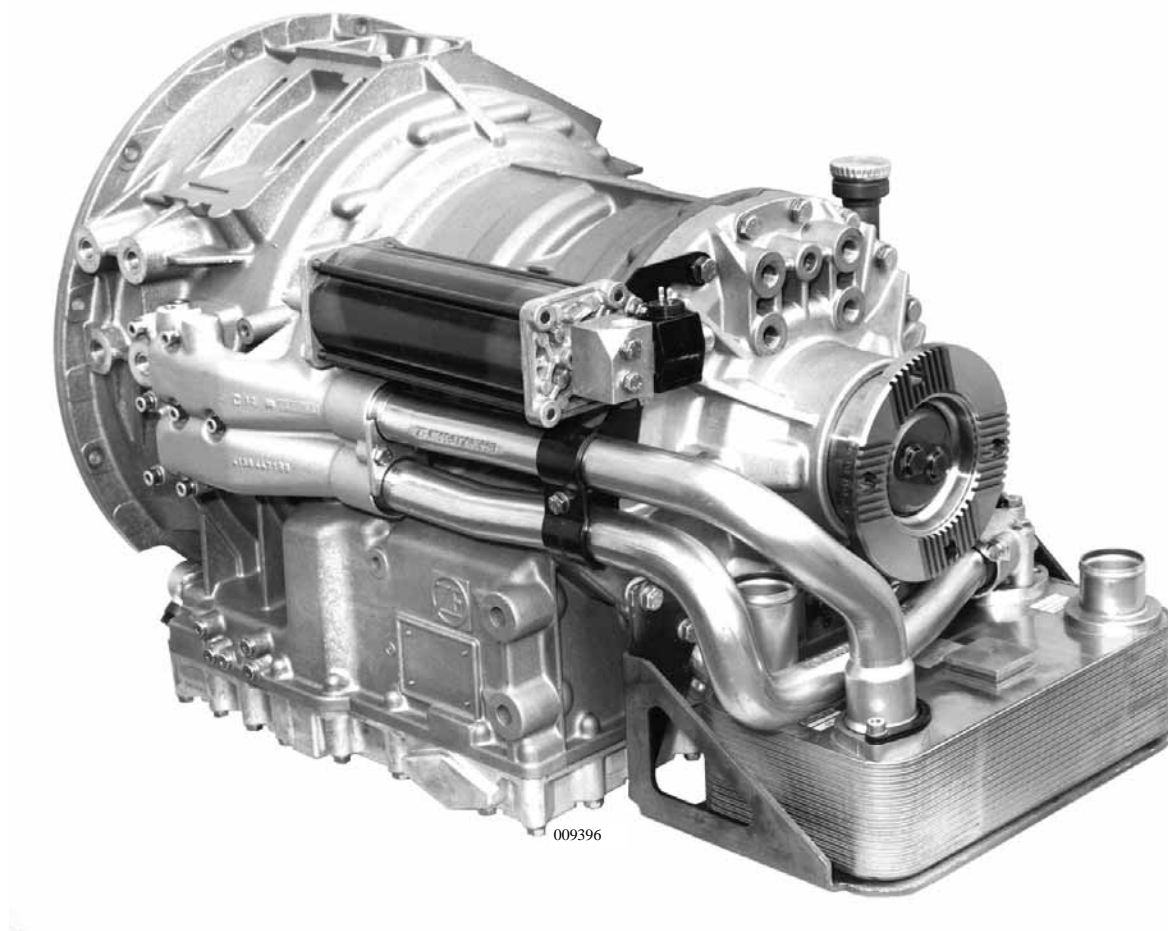


REPAIR MANUAL



ZF-ECOMAT 2

HP 502 / HP 552 / HP 592 / HP 602

Stage 3

4149 751 604

Subject to alterations in design

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This manual is intended for skilled personnel who have been 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 which are not contained in this manual. We therefore 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 courses.

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

1. Well-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 care.

Repair work carried out at ZF service points is guaranteed in accordance with the prevailing contractual conditions.

Damage resulting from work performed by non-ZF personnel in an improper and unprofessional manner, together with follow-on costs caused by such work, is excluded from the contractual guarantee agreement. This also applies where genuine ZF spares have not been used.

ZF FRIEDRICHSHAFEN AG
Division Comm. Vehicle/Special Transmissions
Service Werk 2
Tel.: (0 75 41) 77-0
Fax: (0 75 41) 77-5726

SAFETY NOTICE

Companies who repair 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 and no information about size and weight should be inferred (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 on the input shaft NOR on the output flange.

In any cases of doubt always turn to the the relevant department within ZF After-Sales Services for advice.

After removing the transmission from the vehicle, clean thoroughly before opening.

Pay particular attention to the corners and angles of housings and covers when cleaning.

Parts held on with Loctite can be slightly loosened if warmed with a hot air blower.

CLEANING PARTS

Remove the old remains of gaskets from mating faces. Carefully remove burrs or other similar patches of roughness using an oil-stone

Lube bores and grooves must be free of anti-corrosion agents and foreign matter, check that they can move without encountering any problems.

Carefully cover opened transmissions to prevent the entry of foreign matter.

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

REWORKING

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

If rework is needed on spacer 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 the bearings are fitted while hot, these should be warmed up accordingly (e.g. in a heating cabinet). The temperature should be approx. 85 °C and may not exceed 120 °C. All bearings must be coated with transmission oil after assembly.

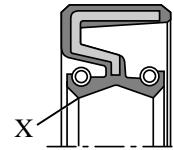
SEALING

If a sealing agent* is to be used for carrying out 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 agent 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 penetrates 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) Duo shaft seals have two packing washers. The dust-proof packing washer (X) must face outwards.



- e) Fill the gap between the packing washers so it is 60% filled with grease (use a 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 (this makes fitting easier). Press in the shaft seal to the correct depth using a punch or suitable plate and make sure the seal remains flat.

LOCKING AGENTS

Locking agents* may only be used in places as specified in the parts list.

Always comply with manufacturer's directions for use when using locking agents (e.g. Loctite).

During assembly, comply with all adjustment data, checking data and tightening torques.

TRANSMISSION OIL

After completing repairs, fill the transmission 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 center. 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

Tightening torques for nuts and bolts, extract from ZFN 148

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

Surface condition of bolts: heat-treated blackened finish and oiled or galvanized and oiled or galvanized, chrome-plated and oiled.

Bolts must be tightened using a calibrated ratchet or torque wrench.

NOTE

Divergent tightening torques are listed separately in the Repair Manual.

Metric coarse pitch thread			
Size	Tightening torque M_A (Nm) for		
	8.8	10.9	12.9
Bolt	8	10	12
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

Metric coarse pitch thread			
Size	Tightening torque M_A (Nm) for		
	8.8	10.9	12.9
Bolt	8	10	12
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

Screw plugs DIN 908, 910 and 7604

The screw plug tightening torques M_A were determined according to DIN 7604, for screwing into steel, grey cast, and aluminium alloys.

The values are based on experience, and are intended as reference values for the mechanic.

The values for the tightening torque M_A shall also be used for screw plugs according to DIN 908 and DIN 910, as the thread geometries are almost identical.

General rule: Screw/bolt class 5, ZFN 148-1
 Screw/bolt material: steel acc. to DIN 7604. Surface condition: as manufactured (without surface protection) and lightly oiled or galvanized, chromated and lightly oiled

Screw plugs (DIN 908, 910, 7604)		
Dimensions	Tightening torque screwed into	
	steel/grey cast	Al alloy
M 8 x 1	20	10
M 10 x 1	25 / 30*	15 / 20*
M 12 x 1.5	35	25
M 14 x 1.5	35	25
M 16 x 1.5	40	30
M 18 x 1.5	50	35
M 20 x 1.5	55	45
M 22 x 1.5	60 / 80*	50 / 65*
M 24 x 1.5	70	60
M 26 x 1.5	80 / 105*	70 / 90*
M 27 x 2	80	70
M 30 x 1.5	100 / 130*	90 / 130*
M 30 x 2	95	85
M 33 x 2	120	110
M 36 x 1.5	130	115
M 38 x 1.5	140	120
M 42 x 1.5	150	130
M 42 x 2	145	125
M 45 x 1.5	160	140
M 45 x 2	150	130
M 48 x 1.5	170	145
M 48 x 2	160	135
M 52 x 1.5	180	150
M 60 x 2	195	165
M 64 x 2	205	175

* DIN 7604 Form C

Union screws DIN 7643

The tightening torques M_A were determined for screwing into steel, grey cast and aluminium alloys.
The values are based on experience and are intended as reference values for the mechanic.

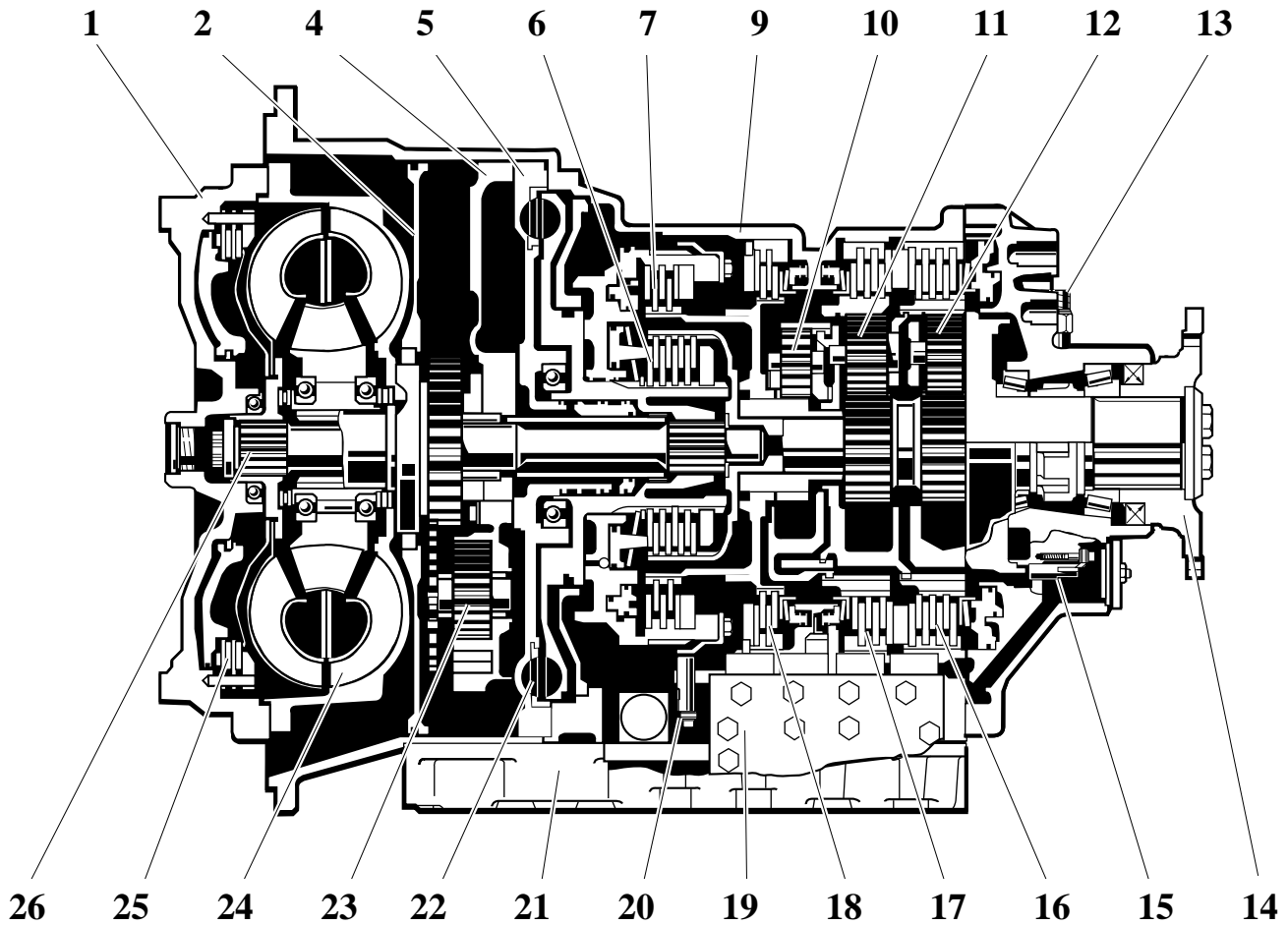
General rule: screw/bolt class 5, ZFN 148-1
 Material 9SMnPb28K acc. to DIN 1651
 Surface conditions: as manufactured (without surface protection) and lightly oiled or galvanized, chromated and lightly oiled

Union screws (DIN7643)		
Pipe outer diameter	Thread	Tightening-torque M_A in Nm
4 - 5	M 8 x 1	30
6	M 10 x 1	35
8	M 12 x 1.5	40
10	M 14 x 1.5	40
12	M 16 x 1.5	45
15	M 18 x 1.5	50
18	M 22 x 1.5	60
22	M 26 x 1.5	90
28	M 30 x 1.5	130
35	M 38 x 1.5	140

Description ZF reference no.	Name	Approx. quantity	Application	Remarks
Grease 0750 199 001	For example: Spectron FO 20		Gen. assembly aid	
Sealing compound 0666 790 017	WEVO-L100		Output flange screw connection	
Jointing compound 0666 690 048	Loctite no.: 648	1 g	Threaded bush on transmission housing	
Sealing band 0634 307 728	Elring Pife/ sold by the meter	300 mm	Oil fill pipe Ecomat 2 transm.	
Surface sealer 0666 790 033	Loctite no.: 574	80 mm ³	Slotted nut on oil fill pipe	
Grease 0671 190 016	Vaseline 8420		Gen. assembly aid	
Operating oil	See TE-ML14 List of lubricants		Gen. assembly aid	

NOTE: Inquire about the size of bundles that can be delivered before placing any orders!

ZF Ecomat 2 transmission,
4-speed version

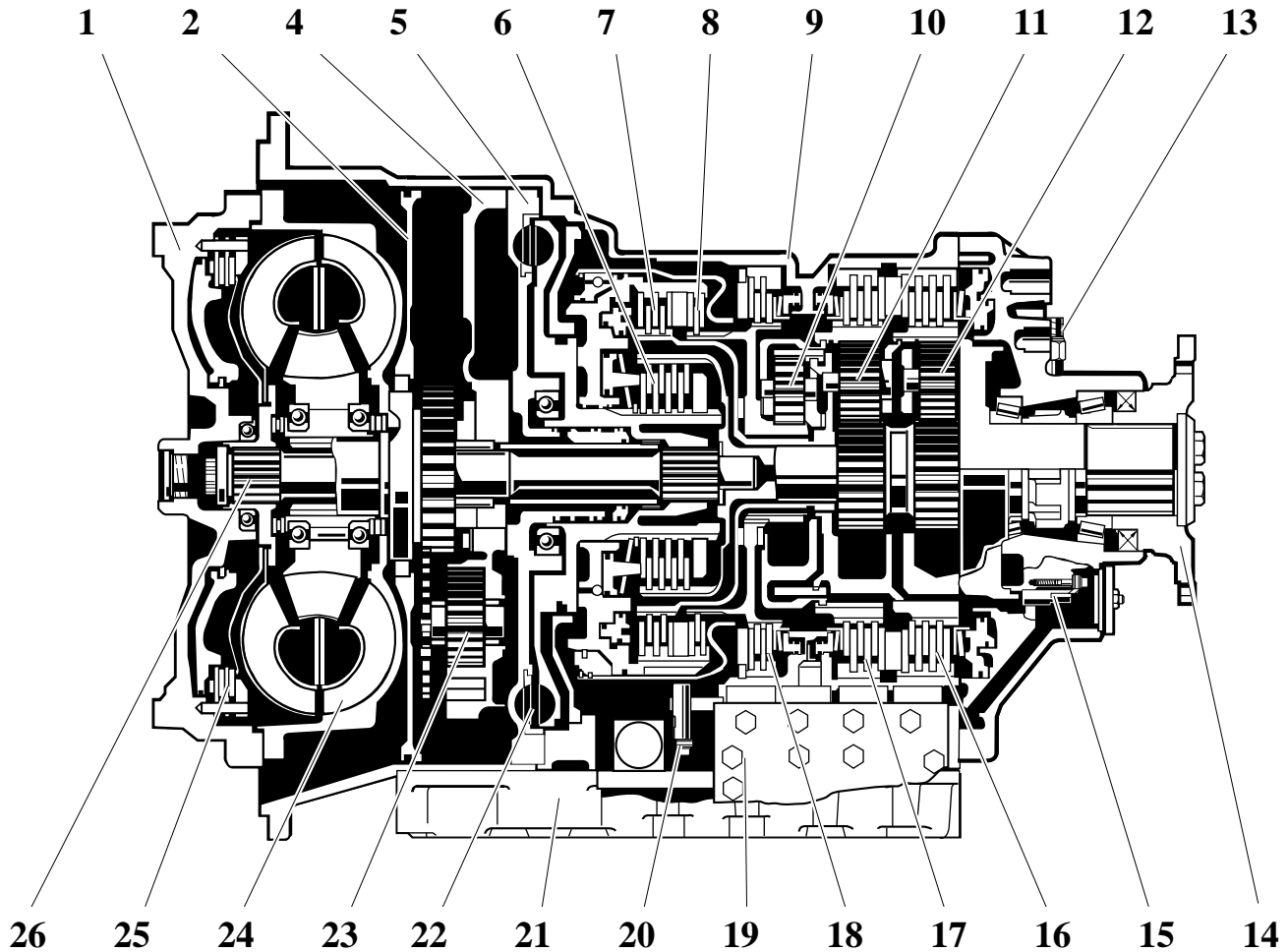


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Key to drawing

- | | | | |
|----|---------------------|----|----------------------------------|
| 1 | Input | 15 | Inductive pickup "output" |
| 2 | Cover plate | 16 | Brake "F" |
| 4 | Control insert | 17 | Brake "E" |
| 5 | Oil feed flange | 18 | Brake "D" |
| 6 | Clutch "A" | 19 | Shift control |
| 7 | Clutch "B" | 20 | Inductive pickup "turbine" |
| 9 | Housing | 21 | Oil pan |
| 10 | Planet gear set I | 22 | Retarder |
| 11 | Planet gear set II | 23 | Primary pump |
| 12 | Planet gear set III | 24 | Converter |
| 13 | Speedo sensor | 25 | Torque converter and clutch "WK" |
| 14 | Output | 26 | Turbine shaft |

ZF Ecomat 2 transmission,
5 & 6-speed version



013467

Key to drawing

- | | | | |
|----|---------------------|----|----------------------------------|
| 1 | Input | 15 | Inductive pickup "output" |
| 2 | Cover plate | 16 | Brake "F" |
| 4 | Control insert | 17 | Brake "E" |
| 5 | Oil feed flange | 18 | Brake "D" |
| 6 | Clutch "A" | 19 | Shift control |
| 7 | Clutch "B" | 20 | Inductive pickup "turbine" |
| 8 | Clutch "C" | 21 | Oil pan |
| 9 | Housing | 22 | Retarder |
| 10 | Planet gear set I | 23 | Primary pump |
| 11 | Planet gear set II | 24 | Converter |
| 12 | Planet gear set III | 25 | Torque converter and clutch "WK" |
| 13 | Speedo sensor | 26 | Turbine shaft |
| 14 | Output | | |



Designation	Dimension	Measuring device	Comments
Converter			
01. Converter installation dimension (depending on version)	2.81 ± 0.02" (71.25 ± 0.5 mm) 3.01 ± 0.02" (77.00 ± 0.5 mm) 3.20 ± 0.02" (81.25 ± 0.5 mm) 3.40 ± 0.02" (86.25 ± 0.5 mm)	Depth gauge	Installation dimensions measured between flange surface on converter and flange surface on transmission housing. Installation dimensions can be adjusted using one or more spacer rings on stator hollow shaft.
02. Converter end play between end face of converter internal sprag race and spacer ring on stator hollow shaft	Between 0.01 and 0.016" (0.3 and 0.4 mm)	Depth gauge	End play can be adjusted using shim on end face of turbine shaft.
03. Disc play of converter lock-up clutch	Between 0.02 and 0.043" (0.5 and 1.1 mm)	Feeler gauge	Disc play is measured between end disc and inner disc.
04. End play on axial bearing in converter	Between 0.004 and 0.01" (0.1 and 0.3 mm)	Measuring bars and depth gauge	Adjusted using shims between housing and turbine wheel flange.
05. Maximum pressure for testing converter for leaks	36 + 7 psi (2.5 + 0.5 bar)	Forcing device 1X56 137 129, compressed air unit 1X56 137 130 and water container	Converter test is performed using air under water.
06. Tightening torque of socket head screws on converter HP 502 / 552 / 592 (M8) HP 592 / HP 602 (M10)	= 26 ft-lbs (35 Nm) = 48 ft-lbs (65 Nm)	Torque wrench	
07. Tightening torque of M16 socket head screw in turbine shaft	Between 133 and 140 ft-lbs (180 and 190 Nm)	Torque wrench and locking device 1X56 137 158	Use counter-support 1X56 137 658 to hold converter.
08. Tightening torque of M33x2 screw plug in converter	Between 140 and 155 ft-lbs (190 and 210 Nm)	Torque wrench	Fit copper sealing ring. Use counter-support 1X56 137 658 to hold converter.
09. Tightening torque of M10x35 hex bolts	50 ft-lbs (68 Nm)	Torque wrench	Only ZFW 380-30 converter.



Designation	Dimension	Measuring device	Comments
Output			
10. Distance between output inductive pickup and end face gearing on planetary carrier	Between 0.02 and 0.027" (0.5 and 0.7 mm)	Depth gauge, measuring rod 1X56 138 149/ 1X56 138 150	Distance can be adjusted using shims.
11. Tightening torque of M6 mounting bolt for inductive pickup	7 ft-lbs (9.5 Nm)	Torque wrench	Do not exceed value.
12. Distance between speedometer pulse generator and toothed ring on output	Between 0.027 and 0.054" (0.7 and 1.4 mm)	Depth gauge	Clearance is set, do not exceed value.
13. Tightening torque of speedo pulse generator	26 ft-lbs (35 Nm)	Torque wrench	Do not exceed value.
14. Installation dimensions of shaft seal in output cover	0.60 ^{-0.04} " (15 ⁻¹ mm)	Depth gauge	Installation dimensions between end face of taper roller bearing inner race and front face of sealing ring can be adjusted using special tool 1X56 136 824. Check again as part of monitoring operat.
15. Preload of taper roller bearing in output cover when cold (approx. 20 °C)	Between 0.002 and 0.006" (0.05 and 0.15 mm) preload 1.3 ft-lbs to 4.7 ft-lbs (1.8 - 6.4 Nm) Roll torque	Adjuster 1P01 136 816, dial gauge and spring balance	Set to 1.8 - 6.4 Nm roll torque of taper roller bearing. Adjusted using spacer washers. Difference between speedometer worm and setting ring = dimension "C". Thickness "S" of spacer washer = C + 0.05 mm.
16. Total end play between sun gear and output	Between 0.02 and 0.03" (0.6 and 0,8 mm)	Measuring bars and depth gauge	Adjusted using shims on output.
17. Installation dimensions of needle bearing in planet carrier III	0.10 + 0.04" (2.5 +1 mm)	Depth gauge	Measured between thrust surface of shim and end face of needle bearing. Correct installation assured if special tool 1X56 137 101 is used.



Designation	Dimension	Measuring device	Comments
18. End play on planet gears in planetary carrier III	Between 0.02 and 0.05" (0.5 and 1.2 mm)	Feeler gauge	Clearance is set, check again as part of monitoring operation.
19. Tightening torque of M6 studs on output cover	Between 3.7 and 5.6 ft-lbs (5 and 7.5 Nm)	Torque wrench	
20. Tightening torque of M6 hex bolts on output cover	5 ft-lbs (6 Nm)	Torque wrench	Do not exceed specified value.
21. Tightening torque of M12 hex bolts on output flange	44 ft-lbs (60 Nm)	Torque wrench	Secure with locking plate. Use special tool 1X56 136 471.
Control unit			
22. Displacement quantities of primary pump tested separately (theoretical value)	approx. 18.5 gal/min (60 l/min)	Graduated vessel and stopwatch	Measured at pump speed n = 1500 rpm. Use SAE 10 W oil at 80 °C. The primary pump is a single-piece part.
23. Distance between spring guide and stator ring guide pin	0.06 + 0.02" (1.6 + 0.5 mm)	Sliding gauge	Adjusted by removing or fitting disc springs. Measurements are taken without pre-tensioning the disc springs.
Clutch carrier			
24. Pressure test (PÜ) for pistons of clutches "A", "B" and "C"	36 + 7 psi (2.5 + 0.5 bar)	Feed bush 1X56 137 128, compressed air unit 1X56 137 130	Pressure test for leakage: Pressure drop of 36 + 7 psi to 20 psi (2.5 + 0.5 bar to 1.4 bar) after cut-off = 10 sec.
25. Disc play on clutch "A"	Between 0.13 and 0.15" (3.2 and 3.7 mm) (HP 502 / HP 552 / HP 592 / HP 602)	Depth gauge	Rectify deviations by fitting steel discs of appropriate thickness.



Designation	Dimension	Measuring device	Comments
26. Disc play on clutch "B"	Between 0.06 and 0.08" (1.6 and 2.1 mm) (HP 502); 0.08 and 0.10" (2.0 and 2.5 mm) (HP 552/592/602)	Feeler gauge	Measured by placing feeler gauge between end disc and outer disc. Rectify deviations by fitting steel discs of appropriate thickness.
27. Disc play on clutch "C"	Between 0.05 and 0.06" (1.2 and 1.7 mm) (HP 502); 0.06 and 0.08" (1.6 and 2.1 mm) (HP 552/592/602)	Feeler gauge	Measured by placing feeler gauge between R gear pot. and outer disc. Rectify deviations by fitting steel discs of appropriate thickness.
28. Run-out of inductive pickup ring when installed	+ 0.008" (+ 0.2 mm)	Dial gauge	Measure from the raised point on the inductive pickup ring. Correct by tapping with plastic-tip hammer
29. Tightening torque of M8 hex bolts on rotor (retarder)	26 ft-lbs (35 Nm)	Torque wrench	
Mechanical transm. section			
30. End play of planetary gears in planetary carrier I	Between 0.02 and 0.05" (0.5 and 1.2 mm)	Feeler gauge	End play is fixed, double-check.
31. Disc play on brake "D"	Between 0.05 and 0.06" (1.2 and 1.7 mm) (HP 502); 0.06 and 0.08" (1.6 and 2.1 mm) (HP 552/592/602)	Feeler gauge	Measure by inserting feeler gauge between end disc and outer disc. Correct deviations by fitting steel discs of appropriate thickness.
32. Installation dimension of needle bearing in input shaft	0.16 + 0.04" (4 +1 mm)	Depth gauge	Measured between thrust face of thrust washer and end face of needle bearing. If punch 1X56 137 101 is used, correct installation is assured
33. End play of planetary gears in planetary carrier III	Between 0.02 and 0.05" (0.5 and 1.2 mm)	Feeler gauge	End play is fixed, double-check.



Designation	Dimension	Measuring device	Comments
34. Disc play on brake "E"	Between 0.11 and 0.13" (2.8 and 3.3 mm) (HP 502 / HP 552 / HP 592 / HP 602)	Feeler gauge	Measure by inserting feeler gauge betw. sealing ring and outer disc. Correct deviations by fitting steel discs of appropriate thickness.
35. Disc play on brake "F"	Between 0.10 and 0.12" (2.6 and 3.1 mm) (HP 502 / HP 552 / HP 592 / HP 602)	Depth gauge	Correct deviations by fitting steel discs of appropriate thickness.
Hydraulic control unit			
36. Distance between inductive pickup - turbine and pulse generator ring	Between 0.02 and 0.03" (0.6 and 0.8 mm)	Depth gauge, measuring rod 1X56 138 149 und 1X56 138 150	Distance can be adjusted using shims.
37 Tightening torque of M6 mounting bolt for inductive pickup	7 ft-lbs (9.5 Nm)	Torque wrench	
Retarder accumulator			
38. Tightening torque of M8 stud bolts on rear cover of retarder accumulator	Between 5.6 and 7.4 ft-lbs (7.5 and 10 Nm)	Torque wrench	Only replace stud bolts with new ones if damaged.
39. Tightening torque of M8 lock nuts on retarder accumulator cover	11 ft-lbs (15 Nm)	Torque wrench	Fit washers.
40. Tightening torque of M12x1.5 screw plug in solenoid valve	18 ft-lbs (25 Nm)	Torque wrench	Fit new copper sealing washer.



Adjustment Data

HP 502 / HP 552 / HP 592 / HP 602

Designation	Dimension	Measuring device	Comments
Other transmission data			
41. Installation dimension of oil filler pipe	1.57 + 0.04" (40 +1.0 mm)	Depth gauge	Measured betw. mating face of transmission housing (oil pan flanging face) and end face of filler pipe. (Use sealing band on pipe)
42. Tightening torque of M30x1.5 slotted nut on oil filler pipe	approx. 60 ft-lbs (80 Nm)	Experience	Secure slotted nut with Loc-tite no. 574.
43. Tightening torque of M22x1.5 oil drain plug in oil pan	37 ft-lbs (50 Nm)	Torque wrench	Fit new copper sealing washer
44. Tightening torque of M10x1 screw plug on pressure measuring ports	9 ft-lbs (12 Nm)	Torque wrench	Fit new copper sealing washer
45. Tightening torque of M10x1 union (hollow) screws in cover plate	approx. 15 ft-lbs (20 Nm)	Torque wrench	Fit new copper sealing washer