

Voith Turbo

VOITH

Installation Manual DIWA .5

Installation Manual | 11 / 2004

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1 General Information

1.1 Safety Instructions

General

Operation, maintenance and repair of the transmission are always subject to the relevant local safety regulations and accident prevention regulations.

These regulations may concern for instance safe handling of hazardous materials, provision and wearing of personal protection equipment or traffic regulations.

Any persons who operate the transmission or who are involved in installation, repair or maintenance must familiarize themselves with the warning notes and precautions described in this document.

Any person involved in operation, installation, repair or maintenance of the transmission must make sure that his or her own personal safety or the safety of other persons is not in danger.

State of the art

This transmission is designed and constructed according to the state of the art in technology and acknowledged safety regulations. Nevertheless, operation, installation, repair and maintenance of the transmission can lead to injury and death of persons or damages to the transmission and other material assets if:

- the transmission is put to a different use than intended,
- the transmission is operated, serviced or repaired by unqualified staff,
- the transmission is modified or reconstructed improperly and/or
- the safety instructions are not observed.

Intended use

The proper use of the DIWA transmission is its application as an automatic drive for busses.

Any use other than this is considered improper. Voith Turbo GmbH & Co. KG does not assume any liability for improper use. The risk lies solely with the user in that case.

The persons in charge, in particular the staff engaged in operation and maintenance, must by all means heed the guidelines for proper and correct usage of the transmission.

Conditions for use

The transmission may be operated only:

- in technically flawless condition,
- for its intended purpose,
- with respect to the safety instructions and the dangers involved and in compliance with the technical manual and other technical documents.

Faults that impair safety must be eliminated at once.

Qualification of personnel

Work on the transmission may only be carried out by staff that is properly trained, instructed and authorized by the operator. The legal minimum age must be observed.

Maintenance and repair require special knowledge and training (e.g. a Voith repair training) and have to be carried out by trained and qualified personnel only.

Personnel that is being trained, instructed, broken in or is currently undergoing a general education may work on the transmission only under the permanent supervision of a person assigned to this purpose.

Responsibilities

The responsibilities of the personnel working at the transmission must be clearly defined and complied with.

Only such personnel as is explicitly ordered to do so may work on the transmission.

Work on the chassis, brakes or steering systems may only be conducted by accordingly qualified personnel.

Unsafe instructions

The personnel working on the transmission must refuse to carry out unsafe instructions given by third persons.

Lifting devices

Use appropriate and technically flawless lifting devices as well as load carrying devices with sufficient load-carrying capacity only.

When replacing the transmission, assemblies or individual parts, these must be carefully attached to lifting devices and secured in a way that excludes any danger.

Never stay or work under suspended loads.

Risk of burns

The oil can become very hot - in extreme cases up to 130 °C.

Improper handling may cause skin burns.

Therefore, allow the transmission to cool down to approx. 60 °C before changing the oil.

Other accident hazards caused by oil

Oil escaping from pipes, seals or O-rings that were improperly installed or are leaking after prolonged running time may cause accidents.

The hydraulic oil in pipes, channels and in the converter can be under high pressure.

Switch off the driving engine before starting maintenance or repair work.

Spare parts

Use only original spare parts for repairs since they only can guarantee that the transmission will comply with the road safety regulations and the technical state upon delivery.

When replacing parts, it is crucial to observe the notes in the spare parts catalogue.

Original spare parts are specially designed for the Voith transmission. Please bear in mind that any parts other than the original spare parts as delivered by Voith have not been tested and released by us. The installation and use of such non-original spare parts may negatively affect the transmission's properties as given by its construction and therefore impair the safety.

Voith does not assume any liability for damages caused by the use of non-original spare parts.

Working on the transmission

Before starting maintenance or inspection at the installed transmission and during installation and removal of the transmission the engine of the bus must be secured against being started.

Before starting maintenance or inspection at the installed transmission and during installation and removal of the transmission the bus must be secured such that it cannot be put in motion, neither deliberately nor accidentally (slope!).

Carry out the prescribed service tasks in regular intervals, timely and using the appropriate operating materials.

The work must be performed in accordance with Voith provisions, e.g. the customer service information that describes improvements and modifications of the transmission to prevent that parts and tools are damaged.

Performing work on the transmission requires a suitable workshop equipment.

After you have worked on the transmission, check all transmission oil lines for leaks, loose connections, chafing and damage. Remove any defects at once.

After you have worked on the transmission, check all seals for leaks.

Retighten all screwed connections that were loosened during work on the transmission to the tightening torques indicated in the technical documents on the transmission.

Cleaning the transmission

Before cleaning the transmission with water or steam jet (high-pressure cleaner) or other cleaning agents, seal any openings into which no water, steam or cleaning agent must penetrate for reasons of safety and functioning.

After cleaning, remove all covers/adhesives completely.

Reconstruction or modification of the transmission

Modifications, attachments or reconstruction to the transmission may not be implemented without approval from Voith Turbo GmbH & Co. KG.

Disposal

Fluids and auxiliary substances (e.g. used oil) and disassembled parts must be disposed of in a safe and environmentally sound manner.

The local regulations and laws on environmental protection and disposal of hazardous materials must be observed.

Towing

Shift transmission to neutral (button N).

Unplug connecting cable between control unit and transmission at the control unit.

If transmission is damaged: Dismantle cardan shaft or stub shaft of rear axle.

If no transmission damage is detected, the vehicle can also be towed with the cardan shaft:

- Max. permissible distance: 10 km
- Max. permissible speed: 30 km/h.

For transmissions with angle drives it is in any case necessary to remove the cardan shaft or stub shaft of the rear axle.

1.2 Signs

	 DANGER DANGER points out an imminent danger to the life and health of persons. If this note is ignored, serious damage to the health and even life-threatening injuries will be the result.
	 WARNING WARNING points out a possible danger to the life and health of persons. If this note is ignored, serious damage to the health and even life-threatening injuries can be the result.
	 CAUTION CAUTION points out a potentially dangerous situation. If this note is ignored, minor injuries or property damage can be the result.
	NOTE Note points out information on proper handling of the transmission. This symbol does not highlight dangerous situations.

	ENVIRONMENT
	Environment points out a potentially harmful situation for the environment owing to operation, maintenance or repair of the transmission.

- ➔ Means: An activity to be performed.
- ↶ Means: The result of an activity.
- Means: Please observe.

2 Transmission Type and Configuration

DIWA - transmission D 864.5 - C 3V T0 R0 W21

Designation	Alternatives	Meaning
DIWA		Bus transmission type "DIWA"
D 864.5	D 854.5	Transmission generation ".5" The transmissions D 864 are generally designed for higher engine output than the transmissions D 854. The last digit before "." (e.g. D 864.5) indicates the number of gears: "4": 4-speed drive
C	D	Drive cover
3	4	Transmission of the input differential: Diff. 3 yields a transmission of 1.43 in 2nd gear, of 1 in 3rd gear, of 0.7 in 4th gear; Diff. 4 yields a transmission of 1.36 in 2nd gear, of 1 in 3rd gear, of 0.735 in 4th gear
V	H, X	Impeller
T0	T2	Turbine
R0	R2	Reverse gear transmission / transmission ratio between output speed n_2 and turbine speed n_{Turbine} :
W21	W18, W22	Output-end angle drive

Rating plate

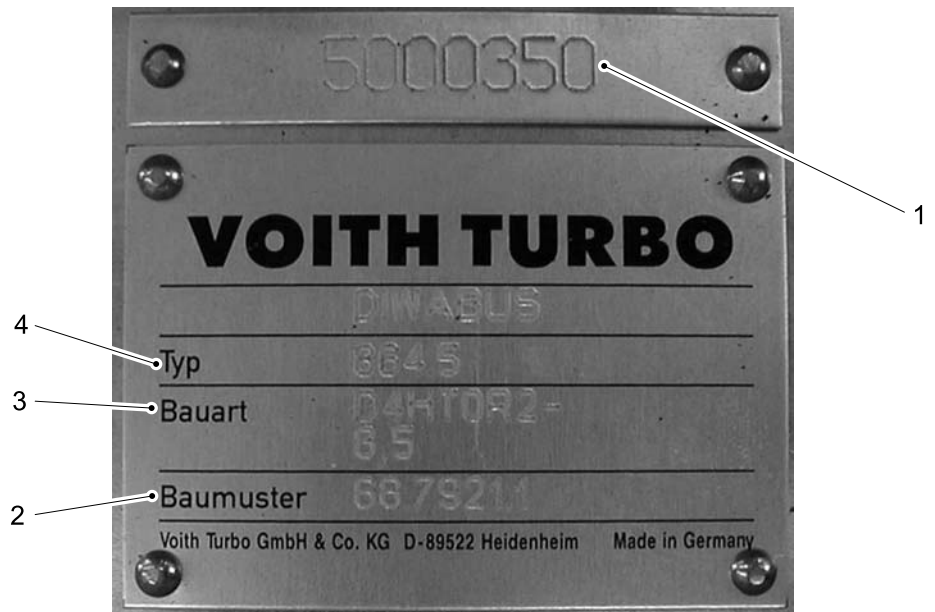


Fig. 1 DIWA .5 rating plate: 1 – Transmission number, 2 – Model, 3 – Configuration, 4 – Transmission type

3 Installation Conditions

	 CAUTION Risk of damages due to incorrect installation Non-observance of the installation conditions can damage the transmission. ➔ Install the transmission only in compliance with the installation conditions.
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Voith does not assume any liability for damages resulting from non-observance of the installation conditions.

3.1 Initial Installation of DIWA .5

Definition of terms

1. The transmission is installed for the first time into a new vehicle type by the OEM.
2. A vehicle is retrofitted with a transmission of a different type or of a different manufacturer.

Specifications

- ➔ Before installing a DIWA transmission for the first time, make sure that the following specifications and conditions are satisfied:
- All documents required for the installation must be at hand such as:
 - Installation drawings
 - Circuit diagram
 - Drawings regarding cable routing and water piping
 - The installation drawings and circuit diagrams must be approved by Voith.
 - Mounting or attaching assemblies to the transmission requires the approval by Voith.
 - The clearances and recesses for the installation and the subsequent maintenance or repair must really exist in the vehicle as described in the installation drawings:

- Basic transmission in general
- Control cover with test ports for checking sensors and oil pressures
- Sensors for speedometer and forward/reverse detection (if available)
- Oil pan and oil filter
- Oil level check (oil dipstick) and oil filler
- Electronic transmission control unit (incl. port for PC diagnostics)
- Gear selector switch
- Brake pedal
- Hand brake switch
- Kickdown switch
- A Voith expert has to be summoned for start-up and initial acceptance test.

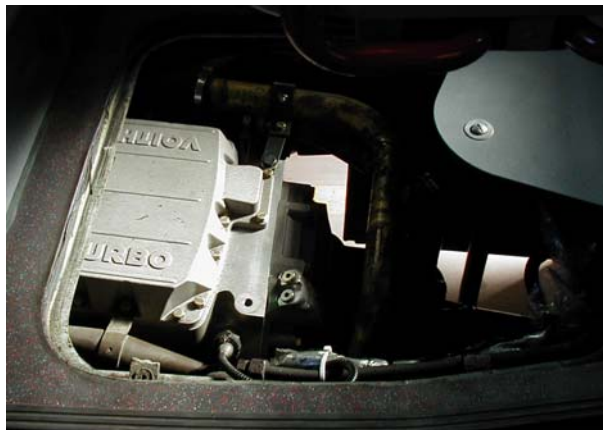


Fig. 2 Poor accessibility of the transmission

3.2 Installation Conditions for the Transmission

Principle

The transmission must be installed according to the specifications in the installation drawings.

Deviations from the horizontal position of more than

- 7° lengthwise and
- 4° crosswise

require the written approval by Voith.

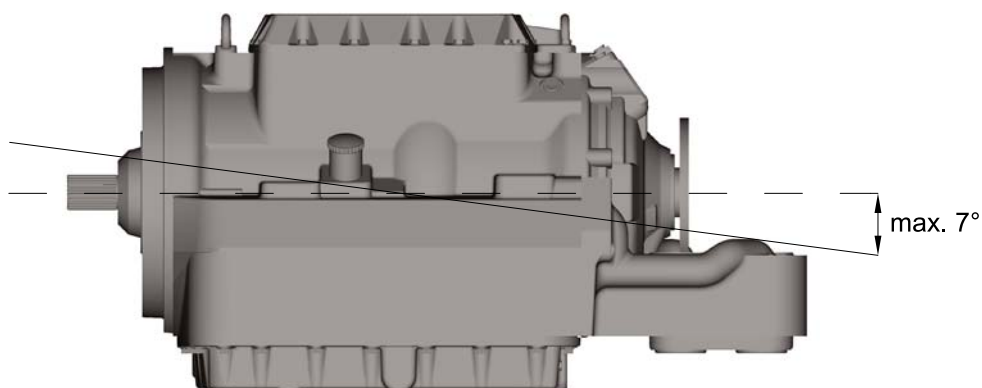


Fig. 3 Allowed position - longitudinal

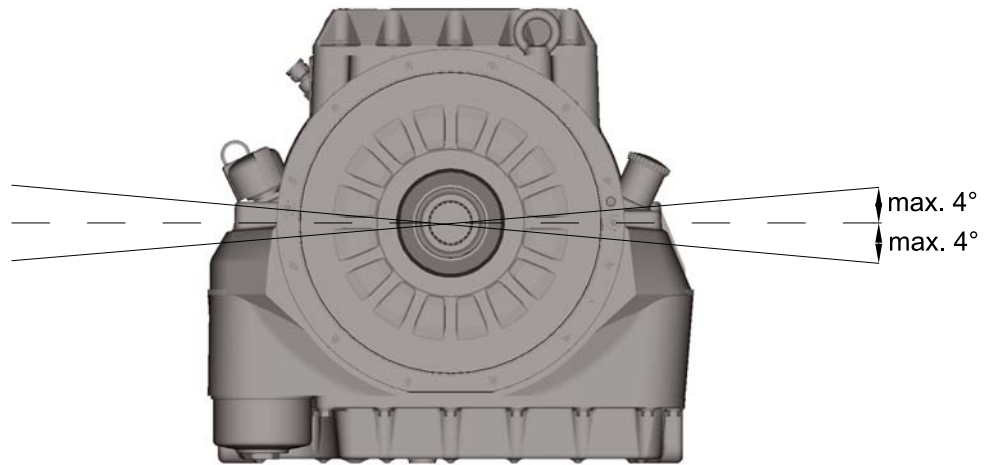


Fig. 4 Allowed position - transverse

All mounting surfaces must be clean and burr-free.

Direct installation

Engine and transmission must be mounted in the vehicle frame without tension and torsion.

Separate installation

The transmission must be suspended elastically on the drive end and output end. Drive-end suspension is achieved by a so-called pilot bearing (bearing inside the flywheel). This bearing must be thoroughly lubricated before being installed. This bearing is not included in the Voith delivery.

3.3 Installation Conditions for Oil Hoses

The following specifications must be observed when installing oil hoses (e.g. for installations with angle drive):

- Install oil hoses over the shortest possible distance.
- Observe a minimum bending radius of **300 mm** .
- After installation, the oil hoses must not suffer from any tension.
- Do not twist oil hoses.
- After installation, oil hoses must not chafe anywhere or suffer any other form of mechanical stress.
- Do not use hose clips to fasten hoses.
- Observe a sufficient distance to heat sources (e.g. exhaust system) when installing hose pipes. A shield is required if the distance is smaller than **100 mm**.
The maximum permissible surface temperature of the hose pipes is 120 °C.

3.4 Installation Conditions for the Electronic Control Unit E 300

The following specifications must be observed when installing the electronic control unit:

- Install the electronic control unit in a splash-proof location only.
 - Observe a sufficient distance to heat sources to prevent the control unit from being destroyed by excessive thermal stress [⇒ Page 41] .
 - Allow for sufficient clearance in horizontal and vertical direction so that testing the device and the cables is possible.
 - Install the control unit only in a way that the sockets are located on the side or the bottom to protect it from condensation water that may penetrate. The degree of protection specified by the OEM depends on the layout of the plugs.
- ☐ Heed the vehicle documentation.

	 CAUTION
	The control unit can be damaged if it is installed or removed while the ignition is on. ➔ Turn off the ignition before installation and removal.

3.5 Installation Conditions for the CAN Gear Selector Switch

The following installation conditions apply for the CAN gear selector switch:

Voltage

Operating voltage	24 V (vehicle electrics)
Voltage range	16 to 32 V
Permissible overvoltage	36 V for 1 hour 45 V for 10 seconds

Temperature

Permissible ambient temperature	-40 °C to +70 °C
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Other

Degree of protection	IP5K0 (installed)
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3.6 Installation Conditions for Cables

The following specifications must be observed when installing cables:

- Install cables over the shortest possible distance.
- Observe a minimum bending radius.
- After installation, the cables must not suffer any tension.
- Do not twist cables.
- After installation, cables must not chafe anywhere or suffer any other form of mechanical stress.
- Observe a sufficient distance to heat sources to prevent the cables from being destroyed by excessive thermal stress.
- Cable plugs must be installed splash-proof.

3.7 Installation Conditions for the Cable Harness

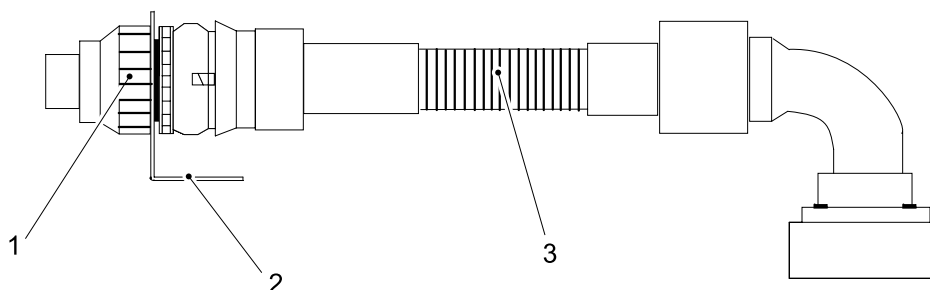


Fig. 5 1 – Plug, 2 – Voith cable clip, 3 - Connecting cable

- The plug (1) of the transmission's cable harness must be fastened to the vehicle chassis. It must not be attached to the transmission.
- If the Voith cable clip (2) is not used, an equivalent fastening device must be employed instead.
- When fastening the plug, make sure that the connecting cable (3) is long enough to compensate for the relative movement between transmission and vehicle chassis.
- After installation, the connecting cable (3) must not suffer any tension.

4 Dimensions

Basic transmission

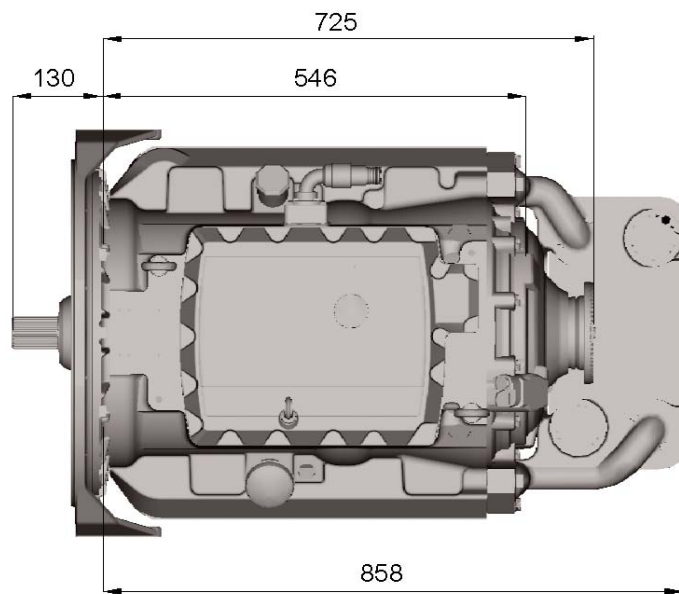


Fig. 6 Top view [mm]

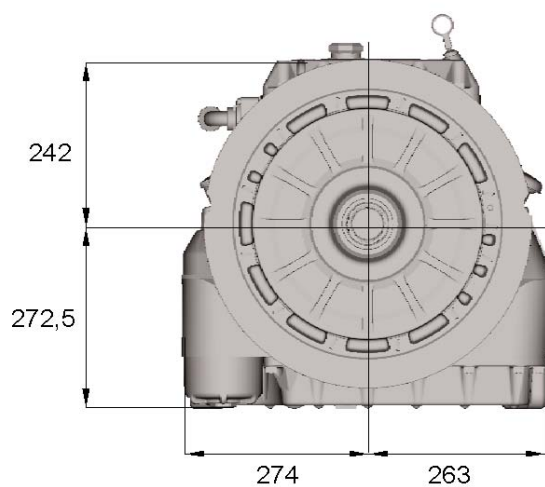


Fig. 7 Front view [mm]

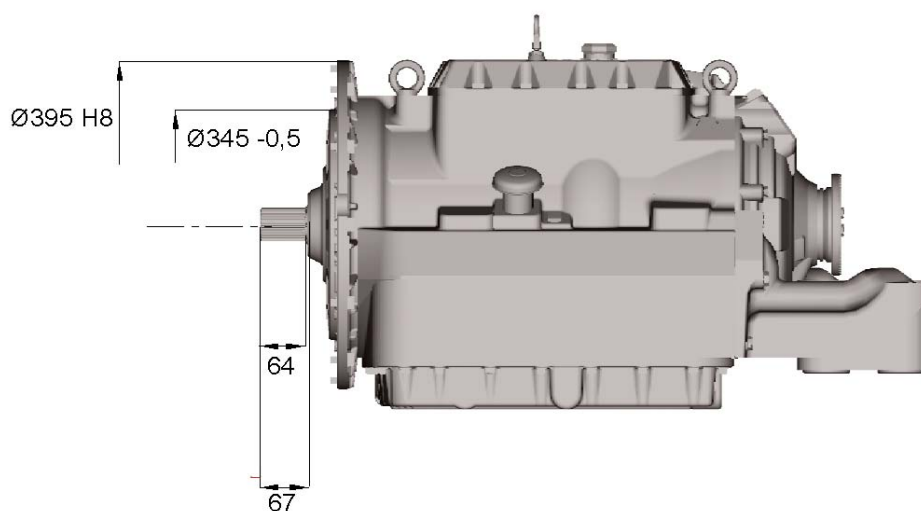


Fig. 8 Side view [mm]

5 Installation Dimensions

5.1 Recess in the Vehicle Floor

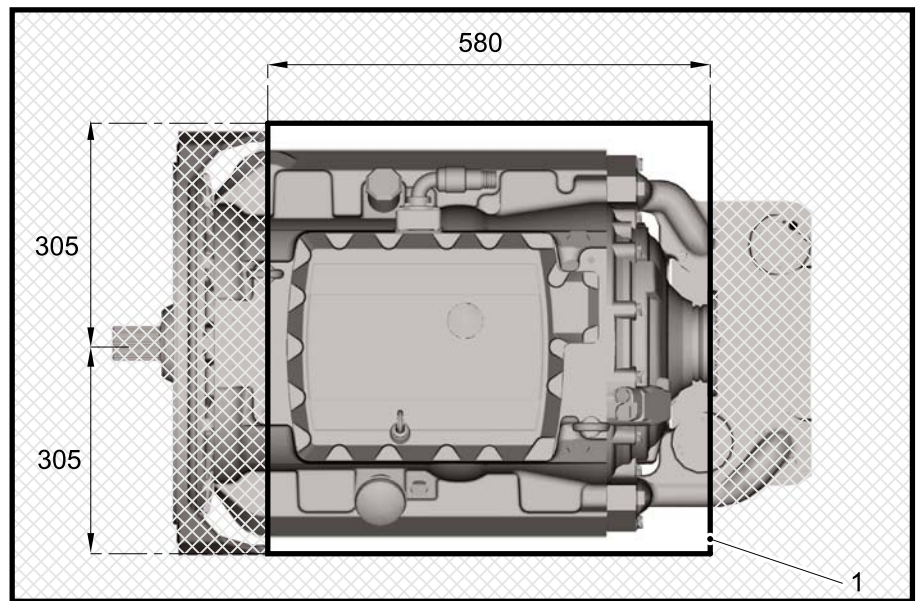


Fig. 9 1 - Recess in the vehicle floor [mm]

5.2 Installation Heights

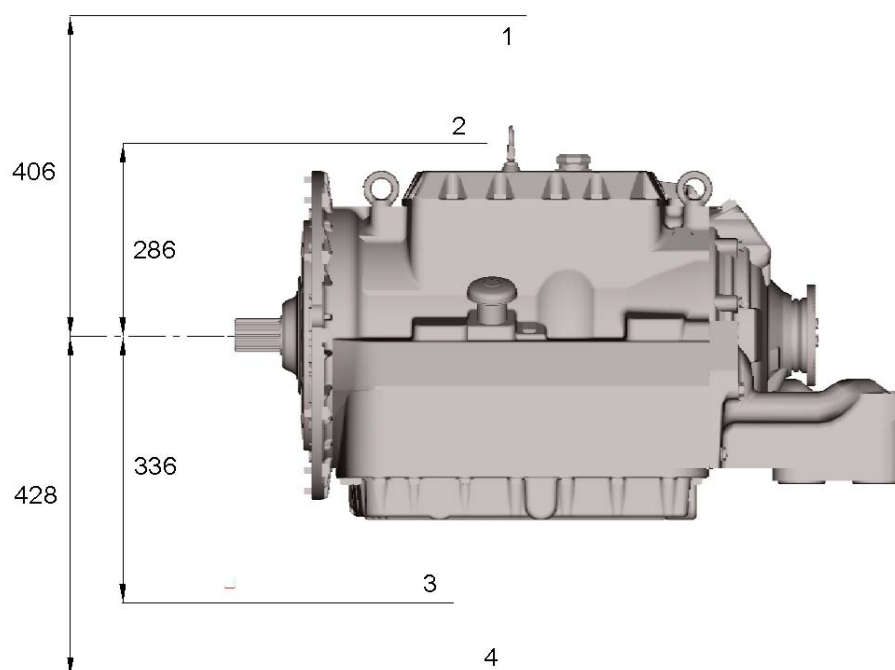


Fig. 10 1 – Oil dipstick, 2 – Control cover, 3 – Oil pan, 4 – Oil filter [mm]

6 Mounting the Transmission to the Engine

6.1 Direct Connection

Driveline

The driveline consists of a hydrodamp that connects the engine flywheel with the transmission input shaft. The hydrodamp is screwed to the engine flywheel either directly or using an intermediate ring if necessary.

The engine case and the transmission case are connected using connecting flanges or suspension flanges.

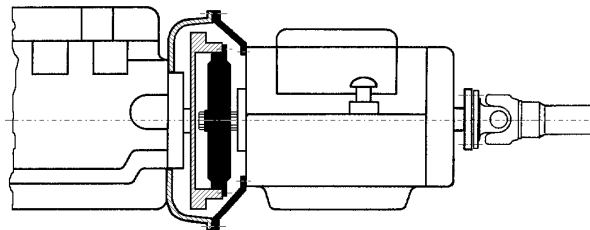


Fig. 11 Direct connection via connecting flange

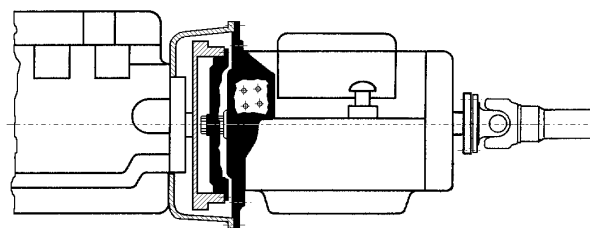


Fig. 12 Direct connection via suspension flange

6.2 Separate Connection

Support

The transmission is supported in the vehicle frame by means of a drive-end suspension flange that must be centered opposite the transmission case. On the output end there are flange faces with threaded holes.

Driveline

The driveline consists of a hydrodamp that connects the engine flywheel with a cardan shaft or an articulated coupling. The hydrodamp is screwed to the engine flywheel either directly or using an intermediate ring.

The stub shaft is suspended in the hydrodamp case and in the engine flywheel. The flywheel's inner bearing (pilot bearing) is not included in the Voith delivery.

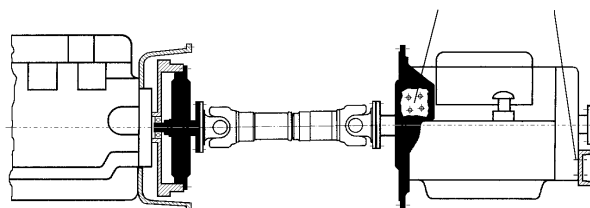


Fig. 13 Separate Connection

7 Installing the Transmission and Components

7.1 Make all necessary preparations for installing the transmission.

- ➔ Before the initial installation, check all relevant installation dimensions in the vehicle frame:
 - Dimensions of the transmission's mounting points
 - Distance between the mounting points of transmission and rear axle
 - Installation position of the transmission (longitudinal or traverse inclination)
- ➔ Check whether in terms of its construction [⇒ Page 8] of the transmission to be installed corresponds to the vehicle configuration, for instance:
 - Differential
 - Pump
 - Turbine
 - Reverse-gear transmission
- ➔ Check whether the electronic control unit installed in the vehicle matches the transmission design.

7.2 Installing the Hydrodamp

- ➔ When installing the hydrodamp for the first time, measure the axial run-out (parallelism) between the mounting face of the flywheel housing and the mounting face of the flywheel.
- ❑ The axial run-out must not exceed 0.1 mm.
- ➔ Measure the radial run-out between the flywheel housing and the flywheel.
- ❑ The radial run-out must not exceed 0.1 mm.

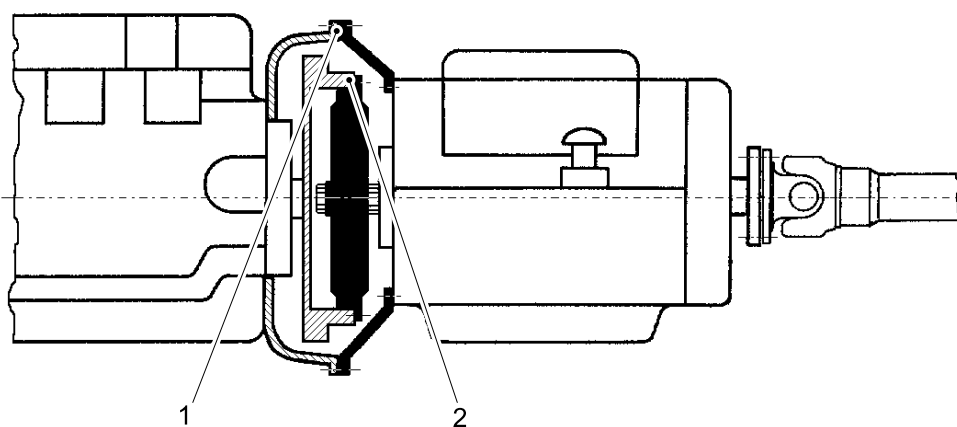


Fig. 14 1 – Flywheel housing, 2 - Flywheel

- ➔ Measure the width of the intermediate ring.
- ❑ The width of the intermediate ring must be greater than the width of the hydrodamp.

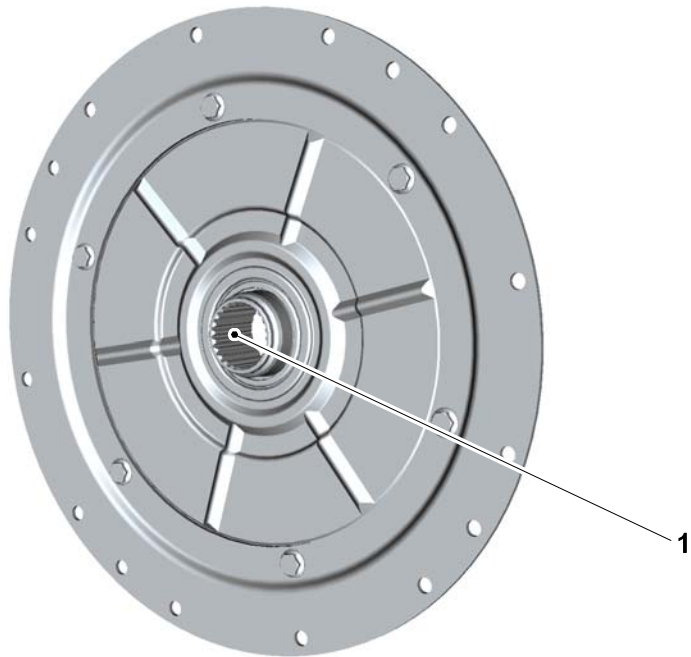


Fig. 15 1 - Spline profile

- ➔ Apply molybdenum disulphide (paste or spray) to the spline profile (1) of the hydrodamp.
- ➔ Use two mounting pins in the positions 2 'o clock and 10 'o clock (at the outer pitch circle) to suspend the hydrodamp and push it into the centering.

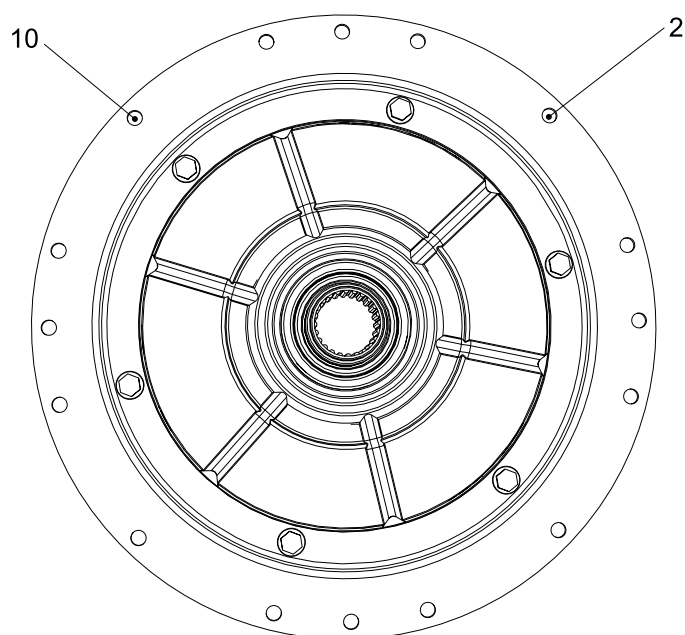


Fig. 16 2 – 2 'o clock position, 10 – 10 'o clock position

- ➔ Tighten any two opposing screws.
- ➔ Unscrew the mounting pins and insert the remaining screws.
- ➔ Tighten screws crosswise.
- ❑ Number and size of the screws and their tightening torque may vary in the different vehicle types.
- ❑ Use only the washers of hardness ≥ 300 HV as specified by Voith.
- 👉 The hydrodamp is fastened to the engine's flywheel by means of the intermediate ring.

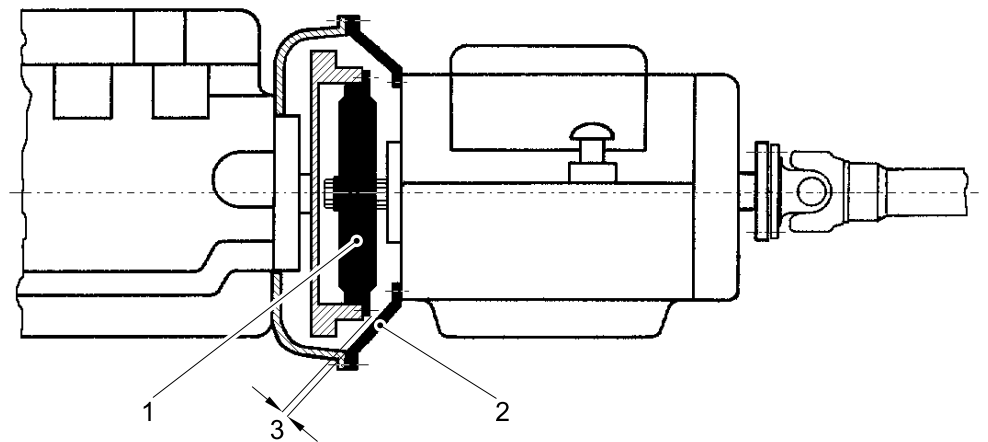


Fig. 17 1 – Hydrodamp, 2 – Connecting flange, 3 – Distance

➔ Measure the distance (3) between the transmission flange or transmission cover and the hydrodamp.

There must be enough clearance to allow the hydrodamp to rotate freely, that is without grazing.

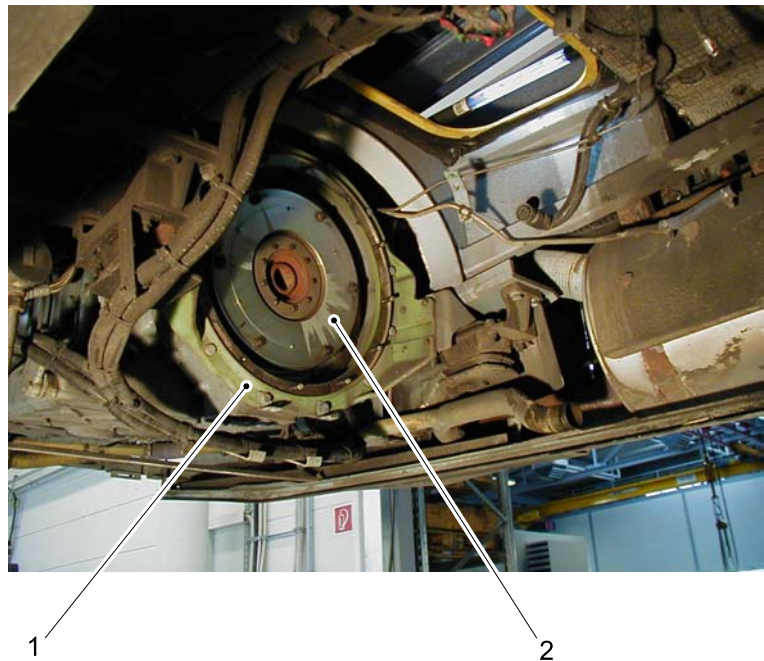


Fig. 18 1 – Suspension flange, 2 – Hydrodamp

	 CAUTION
	Danger due to non-observance of the installation tolerances If the measured values are outside the tolerances in the installation drawings approved by Voith, the transmission may be severely damaged as a consequence. ➔ The specifications made by Voith must be heeded.

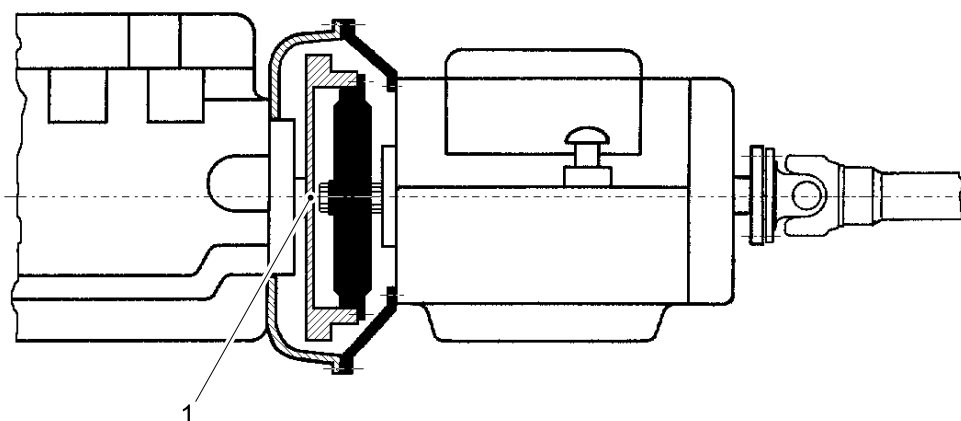


Fig. 19 1 – Position of a pilot bearing

	 CAUTION
	An existing pilot bearing (inner bearing of flywheel) can cause damages at the transmission. If the pilot bearing is not removed, the transmission input shaft might be arrested. The hydrodamp's function to compensate for slight radial and axial run-outs is thus disabled and the transmission input shaft can break during operation. ➔ The pilot bearing must be removed.

7.3 Installing the Transmission

- ➔ Apply molybdenum disulphide (paste or spray) to the toothing of the transmission input shaft.

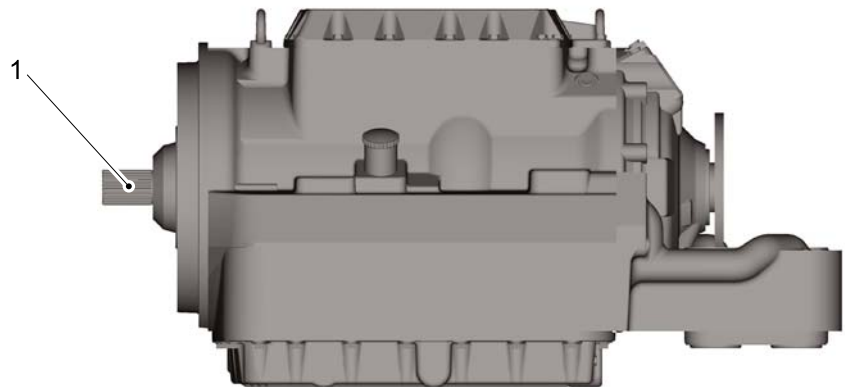


Fig. 20 1 - Transmission input shaft

- ➔ Move the transmission up to the engine.
- ➔ Check whether the flywheel housing is parallel to the drive-end transmission flange.
- ➔ If the toothings of transmission input shaft and the hydrodamp's hub are tooth on tooth, turn the transmission input shaft or crankshaft so that the two toothings mesh.
- ➔ Move transmission input shaft into the hydrodamp.

		CAUTION
	Damages at the hydrodamp	
	Improperly inserting the transmission input shaft can damage the hydrodamp.	
	➔ When inserting the shaft, make sure that the shaft is not jammed.	

- ➔ Move the transmission towards the hydrodamp until it butts against the flywheel housing.
- ➔ Fasten the transmission with screws.
- ❑ Tightening torque of the screws: 46 Nm

- ➔ After the transmission (including the engine) has been installed into the vehicle, check the installation dimensions.

7.4 Installing the Cardan Shaft

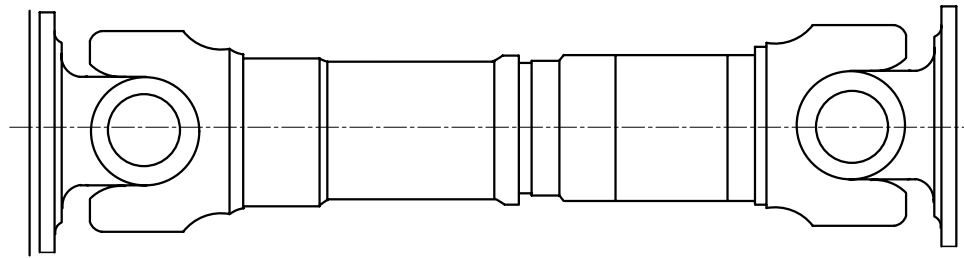


Fig. 21 Cardan shaft

- ➔ Before installing the cardan shaft for the first time, measure or check all relevant installation dimensions:

- Offset (horizontal and vertical)
- Distance
- Parallelism

between the transmission output flange and the drive flange of the rear axle.

- ➔ Compare the measured values with the values in the installation drawings. Inform the OEM of any deviations.
- ➔ Measure the length of the cardan shaft when it is collapsed. Check whether the cardan shaft has the correct length for the specific installation situation.

	CAUTION
	Risk of accident due to a too short cardan shaft The cardan shaft can drop onto the road and cause severe accidents. ➔ A minimum length ($L_{\min}$) of the sliding piece connecting the two parts of the cardan shaft in operation must be observed at all times. Standard value: $L_{\min} \geq 1.5 \cdot \varnothing_{\text{cardan shaft}}$

- ➔ Install the cardan shaft and screw it tight.

- ❑ The installation specifications and safety instructions of vehicle manufacturer and cardan shaft manufacturer must be observed.

	 CAUTION
	Transmission damages due to incorrect installation of the cardan shaft Improper installation of the two cardan shaft ends cause irregular rotations leading to critical torsional vibrations particularly at high speeds. ➔ When assembling the two parts of the cardan shaft, make sure that they are correctly positioned to each other and heed the markings.

7.5 Making Connections

- ➔ Make sure that the heat exchanger is installed in the main cooling water flow in the **reverse flow direction**.
- ❑ Reverse flow means that the transmission oil and the cooling water in the heat exchanger flow in opposite directions.
- ❑ There are labels on the heat exchanger that specify how to make the connections.
 - water out
 - oil in
 - oil out
 - water in
- ➔ Mounting Water Pipes



Fig. 22 Water pipes

➔ Attach the electrical connections such as:

- Speedometer
- Oscillator
- Cable 1.

☐ Make sure that all cable connections have snapped into place and are tightened properly.

➔ Fill in the cooling water [⇒ Page 38] up to the maximum marking.

7.6 Check the Oil Level

➔ Position vehicle horizontally.

➔ Apply parking brake.

➔ Press the N key.

	 CAUTION
	Transmission damages due to missing oil If the engine is started and the transmission has not yet been filled with oil, e.g. after the transmission was repaired, the transmission may take considerable damage as a result. ➔ After the transmission was repaired, check the oil level only when the engine is dead.

➔ You may start the engine and run it at idle speed.

➔ Withdraw oil dipstick (1) from guide tube and clean it.

☐ The guide tube can be mounted to one side of the transmission or on top.

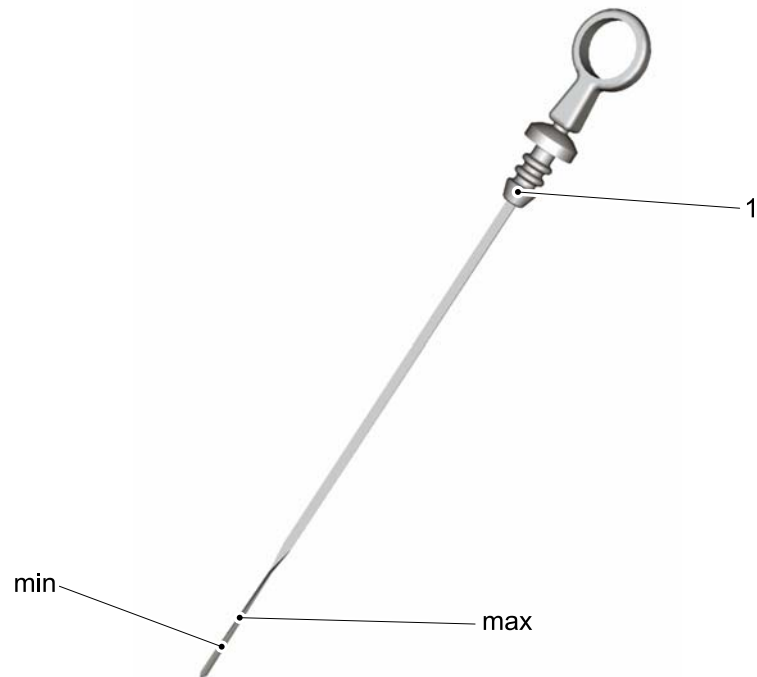


Fig. 23 1 - Oil dipstick

- ➔ Insert oil dipstick (1) briefly and pull it back out.
- ➔ Read off the oil level.

The oil level must reach between the marks "min." and "max." of the oil dipstick.

- ❑ The difference in quantity between the two marks is approximately 2.5 l.

	NOTE Measurement conditions In order to determine the correct value under operating conditions, the oil level must be checked with the engine running and at operating temperature (at least 60 °C). To determine the transmission oil temperature, you can use the cooling water temperature indicator inside the vehicle since the temperatures of transmission oil and cooling water are almost identical. ➔ If the transmission oil temperature is below 60 °C, let the engine run until it has reached operating temperature and recheck the oil level.
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➔ Replenish oil [⇒ Page 34] if necessary.

7.7 Filling the Transmission with Oil

	 CAUTION Transmission damages due to incorrect oil level Too little oil can lead to transmission malfunctioning and damages (disk damage). Too much oil can cause the fuel consumption to increase and oil to escape at the breather. ➔ It is imperative to check the transmission oil level before first starting the engine after transmission installation.
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➔ Fill ATF oil into transmission.

❑ The oil filler can be mounted to one side of the transmission or on top.

Oil quantity

- For oil change: approximately 22 l
- For refill, e.g. after transmission repair: approximately 24-25 l
- No additional oil filling required for ex-works oil filling.

- If the oil level reaches below the min. mark of the oil dipstick, proceed as follows:
Fill oil until the minimum oil level (min. mark) has been reached.

Oil quality

Fill only such oil types into the transmission that are approved in the most recent version of the Voith lubricants list.

- ➔ Check the oil level [⇒ Page 32] after filling in the oil and examine transmission for leaks.

7.8 Checking the Engine Idle Speed

- ➔ Checking the Engine Idle Speed

Voith recommends to set the idle speed to approximately 500 – 700 1/min with the gear engaged.

- ☐ The engine must run smoothly in this condition.

Boundary conditions for the Voith hydrodamp

Number of cylinders	Minimum engine speed [1/min]
6	550
5	600
4	750



CAUTION

Damages of the hydrodamp

The hydrodamp can be damaged if the idle speed setting is incorrect.

- ➔ To avoid damages at the hydrodamp, inform the OEM and have the idle speed adjusted correctly.

7.9 Test Driving

Preparation

	NOTE Different vehicle configurations The components installed in vehicles and the implemented transmission functions vary in the different vehicle types. ➔ Please refer to the vehicle documentation of the OEM (e.g. circuit diagram).
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Use the vehicle or transmission diagnostics (Aladin) to

➔ Read out the identification data of the control unit:

- Current software version
- Current record

➔ Clear the fault memory

➔ Reset the adaptation

➔ Check the signals of the components or digital inputs in the vehicle such as:

- Kickdown switch
- Accelerator pedal
- Hand brake lever and foot brake pedal
- Gear selector switch
- FBAUS
- Brake pressure switch 1
- Brake pressure switch 2

- Shift program selector
- Bus stop brake
- ANS signal
- ➔ Press the button "D" (or any of the buttons "1", "2" or "3") and try to start the engine.
- ❑ The engine must not start under these conditions!

During the test drive

- ➔ Check transmission functions, e.g.:
 - All upshifts and downshifts
 - Function of the converter brake (using the vehicle or transmission diagnostics)
 - Reversing
 - ANS function
 - Measure the stall speed.
- ➔ Check the adaptation or shifting quality of the transmission under partial load and full load.
- ➔ Check the safety functions implemented in the vehicle, e.g.:
 - Engaging a gear in the stationary vehicle only possible with the brake pedal depressed
 - Engaging a gear only possible up to the engine limit speed
- ➔ Reading out and clearing (after elimination of the fault) the fault memory

After the test drive

- ➔ Check the tightness of:
 - Transmission
 - Cooling water connections
- ➔ Check the oil level

8 Cooling Water Quality

	 CAUTION Damages of the heat exchanger due to inappropriate antifreeze and corrosion preventive The heat exchanger can corrode and become leaky as a consequence. ➔ Use only antifreeze and corrosion preventives that are not aggressive on aluminum.
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Water quality requirements

- No floating particles (especially with CU content) in the water
- Pure, entirely demineralised water
- pH-value 6.5 to 8 at 20 °C
- Chloride content max. 75 mg/l
- Sulphate content max. 50 mg/l
- Water hardness 3 to 10 °dH
- Nitrate content max. 50 mg/l
- Nitrite content max. 0 mg/l
- ☐ Drinking water is suitable in most cases.

Mixing ratio

- Water ≤ 64 %
- Antifreeze ≥ 35 %
- Corrosion preventive 1%
- ➔ Use ethylene-glycol based antifreeze.

9 Minimum Bending Radii of Cables

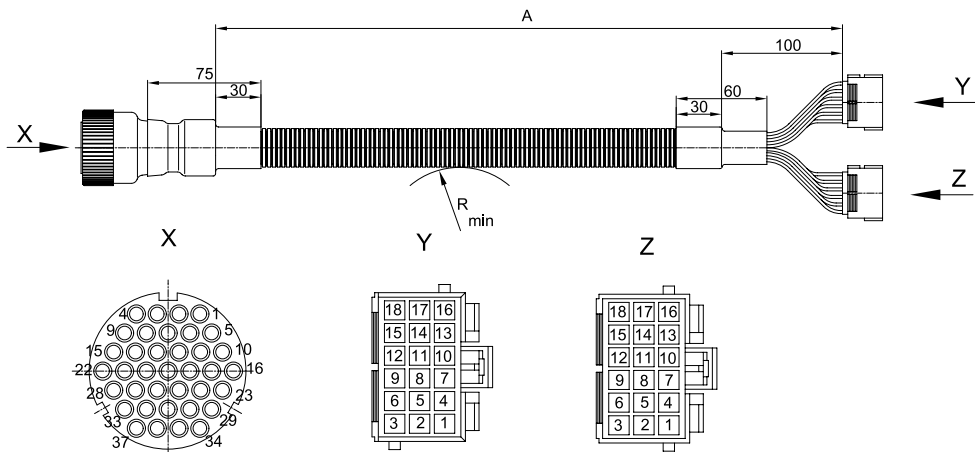


Fig. 24

Connection	Minimum bending radius for flexible installation	Minimum bending radius for inflexible installation
Electronic control to the transmission	min. 5 x the cable outer diameter	min. 3 x the cable outer diameter

Material number	Length "A" [mm]
H68.344320	3 700
150.00044810	4 000
H68.348610	5 600
H68.342720	12 000
H68.310630	14 500
H68.347610	15 500

10 Permitted Temperature Ranges for Cables

Cable	Permitted temperature ranges
Corrugated pipes and electrical lines	-40 °C to +120 °C
Connection of the electronic control system	-40 °C to +80 °C
Connection of the transmission, cable 1, extension	-40 °C to +150 °C
Braided cable sleeveings and electrical lines	-40 °C to +120 °C

11 Permitted Temperature Range for the Electronic Control Unit E 300

Permitted temperature range
-40 °C to +70 °C

12 List of Lubricants

12.1 List of lubricants

Approved lubricants

for Voith DIWA transmissions D 82..., D 85..., D 86..., 502-2, 502-3

The oils marked by an asterisk (*) are only approved for the inline version.

for Voith Midimat transmissions type TA, TM and BR

All ATF oils specified as "Dexron II" are approved.

Oils not approved are those specified as Dexron®III and / or with a five-digit F- or G-code.

Manufacturer	Product name
76Lubricants Co.	76 Multi-Purpose ATF (G-34023)* 76 Super ATF (G-34160)*
Abu Dhabi National Oil Company	ADNOC ATF ADNOC ATF Dexron®III (F-30352)
Addinol Lube Oil GmbH	Addinol ATF D III Addinol D II D
Agip Schmiertechnik	Autol transmission oil ATF III D
Alexandria Company	ACPA 2000
Alexandria Mineral Oils Company (Amoc)	Amoc Power (D-21611)
Allegheny Petroleum Products Co.	Altra Dexron®III (G-34328) / Mercon*
Amoco Petroleum Products	Multi Purpose ATF (F-30323)*
Ampol Refineries Limited	Autotrans Fluid III (F-30737)*
Aral AG	Aral transmission oil ATF 22 Transmission oil ATF 55 (F-30589)

Manufacturer	Product name
Avia Mineralöl AG	Avia Fluid ATF 86
BayWa AG	ATF 3000
Bantleon Ulm	AVIA FLUID ATF 98 (F-30589)
Behran Oil Co.	Behran Automatic ATF(Dexron II D)
Belgin Madeni Yaglar	Lubex ATF II
BP plc.	BP Autran DX II Autran DX III (G-34058) Autran MBX
Bucher + Cie AG	Motorex ATF Dexron IID Motorex ATF Dexron®III Motorex ATF Super Motorex ATF Supersynt Dexron IIE
Caltex Petroleum Corporation	Caltex ATF HDA Caltex ATF HDC Caltex ATF HDE Caltex ATF HDM Caltex Texamatic 1205A Caltex Texamatic 1278 (G-34053) Caltex Texamatic 1322 (G-34054) Caltex Texamatic 7045 Caltex Texamatic 1322S (G-34279)
Castrol Limited	Castrol TQ Dexron III (G-34427)* TQ-D (Europe)
Cepsa Lubricantes S. A.	Cepsa ATF 70 Cepsa ATF 2000 (Dex IIIG)
Chempro SA	Chempro ATF HDM

Manufacturer	Product name
ChevronTexaco Global Lubricants	Chevron ATF Dexron®III (G-34051)* Chevron ATF Mercon V (G-34555) Chevron Supreme ATF (G-34116)* Chevron Supreme ATF (G-34139)* Chevron Synthetic ATF Heavy Duty (G-34090) Havoline® ATF Mercon® / Dexron®III (G-34051)* Havoline® ATF Mercon® / Dexron®III (G-34116)* Havoline® ATF Mercon® / Dexron®III (G-34139)* Texaco Havoline ATF Mercon V (G-34555) Texaco Synthetic ATF Heavy Duty (G-34090)
ChevronTexaco	Texamatic D3 (G-34223)*
Citgo Petroleum Corporation	Citgo Transgard ATF Dexron®III Citgo Transgard ATF Dexron®III (DF-614)*
Coastal Unilube Inc.	Coastal Dexron®III / Mercon
Cofram Lubrifiants	Sintofluid ISO 46-GL4
Cognis Corporation	Emgard 2803 Synthetic ATF (G-34494)
Cyclon Hellas S.A.	ATF Type D
Conoco Phillips Company.	76 Mercon V ATF (H-36011) Conoco Mercon V ATF (H-36011) Kendall Mercon V ATF (H-36011) Phillips Mercon V ATF (H-36011)
De Oliebron B.V.	TOR ATF DMM
Dea Mineralöl AG	Deafluid 3003 (F-30597) Deamatic Deafluid 4011
DE.FI.LU s.r.l.	ATF Dexron II
Delek Ltd.	Delomatic153

Manufacturer	Product name
Delta Petroleum Company, Inc.	Mercon V2000 (G-34095) Dexron®III / Mercon Multi Purpose ATF
Dryden Oil Company	Drydene MP Dexron®III (F-30808) / Mercon* Oilzum MP Dexron®III (F-30808) / Mercon*
Engen Petroleum Ltd.	Engen ATF 22D
Eni S.p.A.	Agip ATF II D Agip ATF D 309 Agip Dexron®III Agip ATF Plus
Ertoil S.A.	Ertoil Transmisiones Automaticas D2
Exxon Mobil Corporation, Fairfax, Virginia, USA	Aamco Synthetic Blend ATF Esso ATF D (21065) Esso ATF D (21638) Esso ATF D2 Esso ATF D3 Exxon Superflow Synthetic ATF Mobil ATF Mobil ATF 220 Mobil 1 Synthetic ATF
FL Group	Tutela GI/A ATF Dexron IID
FL Selenia spa-Villastellone-Italy	Tutela GI/E
Fuchs Europe Schmierstoffe GmbH	Fuchs TITAN ATF 3000 Fuchs TITAN ATF 4000
G.B. Lubricants Ltd.	ATF II
Ginouves Georges SA	Ginouves York 686 (G-34052) Ginouves York 786
Huiles Berliet S.A.	HRD Starmatic 3
Imperial Oil	Esso ATF Dexron®III (G-34024)
International Petroleum	Performance One Dexron®III (F-30383)

Manufacturer	Product name
Ipiranga S. A.	Isamatic III (G-34016)*
Ipiranga	Isamatic 3 (G-34202)*
Italian Petroli s.p.a.	IP Transmission Fluid DX
JB GERMAN OIL	JB GERMAN OIL Hydraulikoeel ATF III
Kluth Mineralölgroßhandlung	Universal ATF-D
Koramo Kolin a.s.	Mogul ATF II Mogul TRANS ATF
Krafft S. A.	ATF (D-21247) ATF Synthetic D3
Kuwait Petroleum R & T B.V.	Kuwaitol ATF Dexron IIIG Q8 Auto 14 Q8 Auto 14 (D-21677) Q8 Auto 14 (D-21883) Q8 Auto 15 (G-34052)
Kuwait Lube Oil Company	AJ Automatic Fluid III
Leprince + Siveke GmbH, Herford	Leprinxol ATF DLZ III* Leprinxol Fluid CN
Liqui Moly GmbH	Liqui Moly ATF III Liqui Moly ATF II D
Lubricating Specialities	Polo Dexron®III ATF (F-30164)
LD Lubrication Dutchmann GmbH	LD ATF Dexron III G DMM
Lubrication Engineers Int. AG	LE 1107 Dexron®III (F-30109)
Lubrication Engineers, Inc.	1107 Automatic Transmission Fluid (G-34185)
Maziva Zagreb d.o.o.	INA ATF Super
Meguín GmbH & Co. KG, Mineralölwerke	Megol Transmission-Fluid ATF III
Modex-Oil	Veco Matic II D
Mohawk Lubricants Ltd.	Mohawk Dexron®III ATF (F-30492) Spartan Dexron®III ATF (F-30492)

Manufacturer	Product name
Mol Hungarian Oil and Gas Co.	Carrier Dexron®III (F-30299) Mol ATF
Morris Lubricants	Morris Liquimatic Super ATF (F-30786)
Motul	Motul Dexron II D Motul Dexron III (G-34291) Motul Dexron®III (F-30601)
Nami Oil Ltd.	Nami Oil ATF (D-21611)
Neste Lubricants Ltd.	Neste ATF X
Norsk Olje A.S.	Automatgirolje II D
Northland Products Company	Northland Dexron®III
Oel-Brack AG	QUAKER STATE ATF Q3 PLUS
Oil Refinery Belgrad	Galaxmatic DAC
Oil Refinery Modrica	Matik DX II
Oil Refinery Novi Sad	ATF II
OK-Lantmännen Smörjoljeproduktion AB	OK Flexmatic
OMV AG	OMV ATF D II D
Opet	ATF Dexron II (D-21247)
Pakelo Motor Oil S.r.l.	Pakelo DX III Fluid (G-34061) Pakelo MTF DX II D
Panolin AG	Panolin ATF Dexron®III (G-34052) Panolin ATF Multi 21996
Paramo a.s.	Gyrol ATF-D III (F-30336)
Pars Enteghal Automatic	Pars ATF (Dexron II D)*
PAZ Lubricants & Chemicals	Pazbo EZF Pazbo Fluid (D 21247)
Pennzoil	ATF 2
Petrobras S. A.	Lubrax OH-49-TDX*

Manufacturer	Product name
Petro Canada Lubricants	Dexron®III (G-34005) / Mercon Dexron®III (G-34006) / Mercon ATF
Petrogal	Galp Transmatic D III Transmatic II D
Petrogal Petroleos de Portugal S.A.	Galp Transmatic D II
Petrol Ofisi A.S.	ATF II
Petronas	Petronas ATF-D3 (F-30734)
Pinnacle Oil Company	All Fleet Multipurpose ATF National Dexron®III / Mercon ATF
Quaker State Corporation	Certified Dexron®III / Mercon ATF Genuine Dexron®III / Mercon ATF Lubriguard Dexron®III / Mercon ATF QuakerState Dexron®III / Mercon ATF Supra Tech Dexron®III / Mercon ATF
Rafineria Nafty Jedlicze S. A.	Hipol ATF II D Hipol ATF III
Redoil Italia S.p.A.	Challoils ATF III (G-34052)
Repsol YPF Lubricantes y Especialidades, S.A.	Repsol Matic ATF Repsol Matic III (G-34061)
Repsol YPF S.A. (Argentina)	Hidro ATF
Rock Oil Company	ATF Type DII
Safety-Kleen Corporation	Performance Plus ATF (G-34287)* America's Choice ATF (G-34287)*
Sakson S.A.	Parnas ATF Super (Dexron II D)
Saudi Arabian Lubricating Oil Co. Jeddah	ATF II D* ATF Dexron®III*
Shell Canada Ltd.	Donax TG (G-34026)

Manufacturer	Product name
Shell International Petroleum Company	Shell Donax TA (D-21610) Shell Donax TA (D-21631) Shell Donax TA (D-21666) Shell Donax TA (D-21774) Shell Donax TG (F-30362) Shell Donax TG (G-34050) Shell Donax TG (G-34078)
Shell Oil USA	Shell Donax TG (F-30666)
Silkolene Lubricants PL	Silktran PSV-ATF
Slovnaft JS Co	Madit Automatic (D-21247)
Société Francaise Hafa	Transmatic (D-22495)
Sonol Israel Ltd.	Sonol ATF D2D
SRS Schmierstoff Vertrieb GmbH	Wintershall ATF III Wintershall ATF D
Statoil Lubricants	Statoil Transway DX III (F-30373) Statoil Transway DX III (G-34049) Transway DX II (D-22079)
Sun Company, INC.	Sunoco Multi Purpose ATF Dexron®III*
Sun Oil Company NV	Sunamatic 149 Sunamatic 153
Suomen Petrooli Oy	Teboil Fluid E
Svenska Statoil AB	Statoil Transway DX II
Syneco S.p.A.	Syneco ATF Dexron III (G-34052)
Tedex Vertriebs GmbH Berlin	Tedex ATF III (G-34198)
Tedex Oil Sp.zo.o.	Tedex ATF III (G-34198)
Terpel Bucaramanga S.A.	Termatic HD

Manufacturer	Product name
Texaco Global Products	Texamatic 4011 Texamatic 4261 Texamatic 4291 Texamatic 7045 Texamatic 7045E Texamatic 7080 Texamatic 9226
Total Lubrifiants S.A.	Elfmatic G3 (G-34079) Elfmatic G 3 Syn (G-34080) Finamatic II D Total Fluide G3 (G-34291) Total Fluide G3 (G-34079) Total Fluide ATD (D-21298) Total Fluide ATF 42 (G-34196) Total Fluide ATX (D-21647) Total Fluidmatic Syn Total Fluide II D (D-20356) Transantar DF 3
Ufaneftechim	Ufalub ATF
Unil Deutschland GmbH, Bremen	Unil Matic CN Unil Matic DLZ III*
Unil Opal	Matic D (D-21610)
Unocal 76 Products Company	Multi Purpose ATF (D-21460) Multi Purpose ATF (D-21647) Multi Purpose ATF (D-21966) Multi Purpose ATF (D-22413)
Valvoline Company	Valvoline Dexron®III (F-30122) / Mercon ATF* Valvoline Dexron®III (F-30135) / Mercon ATF*
Valvoline Deutschland GmbH	ATF Dexron II (E-25106)

Manufacturer	Product name
VEBA Öl AG	Movara ATF Getriebeöl D II-D
Veedol International Limited	Veedol AFX (F-30668) Veedol ATF Dexron®III (F-30521) Veedol ATF-M
Westfalen AG	ATF Dexron D86
Yacco SAF	ATF II (D-22269)
YPF S.A.	ATF D III (G-34016)*
Zeller + Gmelin GmbH & Co	Divinol Fluid III F

Motor oils

only for DIWA 506, 501, 200 S, 502-2, 502-3, 200 D, 145/150 U2, 145 D 2/D 3

These oils can also be used in viscosity SAE 10W.

Manufacturer	Product name
Aral AG	Aral BasicTurboral 20W-20
Avia Mineralöl-AG	Avia Special HDC 20W-20 Avia CFE PLUS 10W-40
BayWa AG	HD Superior 1540
Castrol Ltd.	Castrol RX Super (SAE 15W-40) Castrol CRD Castrol CRD-DB
Chevron Texaco Global Lubricants	Delo 200 Motoroil SAE 20W-20
ENI S.p.A.	Agip Diesel Gamma SAE 10W-20
Enpetrol	Mizar 20W20
ExxonMobil Corporation Fairfax, Virginia, USA	Mobil Delvac 1220
Fuchs	Titan Universal HD SAE 15W-40
Kuwait Petroleum R & T B.V.	EL-3592
Norol	Turbo Motorölje SAE 20 Turbo Motorölje F SAE 15W-40
RFN Cuprum	SAE 15W -40
Shell International Petrol. Comp.	Shell X-100 Motoröl 20W-20
Sonatrach	Chiffa 20
SRS Schmierstoff Vertrieb GmbH	Wintershall Rekord 20W-20
TotalFinaElf S.A. Lubrifiants	Performance 2B SAE 20W-20 Performance 2B SAE 20W-30
Veedol International Ltd.	Veedol Dieselstar SAE 15W-40

12.2 List of lubricants for extended oil change intervals

Approved lubricants for prolonged oil change intervals.

for Voith DIWA transmissions D 82..., D 85..., D 86...

Manufacturer	Product name
Amsoil Inc.	Amsoil ATF
Aral AG	Transmission oil ATF E-S
Avia Mineralöl AG	Avia Fluid ATF 92 S
Bantleon Ulm	Avia Fluid ATF 92 S
BP plc	Autran LTF BP Autran Syn 295 (G-36746)
Bucher + Cie AG	Motorex ATF IIE Synthetic
Castrol Ltd.	Castrol Transmax Z Castrol TransSynd (G-34010)
Cepsa Lubricantes S.A.	CEPSA ATF SYNTHETIC
Dea Mineralöl AG	Deafluid S
Eni S.p.A.	Agip ATF II E
Exxon Mobil Corporation, Fairfax, Virginia, USA	ATF LT 71141 Mobil ATF SHC
FL Group	Tutela Truck ATF 90
Fuchs Europe Schmierstoffe GmbH	Fuchs TITAN ATF 5000 SL
Fuchs Lubricants Co.	Sintofluid III MTA (H-36310)
Ginouves Georges SA	Ginouves York 886
Gulf UK Ltd.	Gulf ATF Synthetic
Kluth Mineralölgroßhandlung	ATF-SLT-Fluid
Kuwait Petroleum R & T B.V.	Q8 Auto 14 Synthetic Q8 Auto 15 ED
Leprince + Siveke GmbH, Herford	Leprinxol Multi Fluid S
Maziva-Zagreb d.o.o.	INA ATF Ekstra

Manufacturer	Product name
Mol Hungarian Oil and Gas Co.	Mol ATF Synt
Neste Lubricants Ltd.	ATF-S II (E 25112)
New-Process AG	ATF Synth
OMV AG	OMV ATF-S
Optimum Oils Ltd	Optisyn ATF (E-25112)
Pakelo Motor Oil S.r.l	Pakelo Auxon II E
Panolin AG	Panolin ATF Synth
Petro Canada Lubricants	Petro-Canada ATF (H-36007)
Rafineria Nafty Jedlicze S. A.	Hipol ATF II E
Repsol YPF Lubricantes y Especialidades, S.A..	Repsol Matic Sintetico (E-25112)
Shell International Petroleum Company	Shell ATF XS Shell Donax TX (G-34077) Shell Donax TX (F-30162) Shell Donax TX (G-32003)
Slovnaft JS Co	Madit Automatic II E
SRS Schmierstoff Vertrieb GmbH	Wintershall ATF Dexron S
Statoil Lubricants	Statoil Syntomatic Statoil TransWay S DX II
Sun Oil Company NV	Sunamatic 154 S
Suomen Petrooli Oy	Teboil Fluid ES-MAX (E-25112)
Texaco Global Products	Texamatic S (E-25453)
Total Lubrifiants S.A.	Elfmatic G2 Syn (E-25116) Finamatic S 6726 Total Fluide Syn FE (E-25218)
Unil Deutschland GmbH, Bremen	Unil Matic S
Valvoline Int. Europe	Valvoline SynPower ATF
Veedol International Ltd.	Veedol ATF Unitrans Z

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