Betriebsanleitung • Operating Instructions

Turbomolecular Drag Pumps

With Magnetic Bearings

TMH 1600M
TMU 1600M

PM 0344 BE/D (0507)

PFEIFFER VACUUM

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Please note: Current operating instructions are available via www.pfeiffer-vacuum.net.

1. Safety Instructions

- ☞ Read and follow all instructions in this manual.
- ☞ Inform yourself regarding:
  - – Hazards which can be caused by the pump;
  - – Hazards which can be caused by your system.
  - – Hazards which can be caused by the media being pumped.
- ☞ Avoid exposing any part of the body to vacuum.
- ☞ Observe the safety and accident prevention regulations.
- ☞ Regularly check that all accident prevention measures are being complied with.
- ☞ Do not operate the turbopump with open high vacuum flange.
- ☞ Do not carry out any unauthorised conversions or alterations to the turbopump.
- ☞ When returning the turbopump observe the shipping instructions.
- ☞ The turbopump must be anchored in accordance with the installation instructions.
- ☞ Do not disconnect the pump cable during operations.
- ☞ When the turbopump is open disconnect the voltage supply to the magnetic bearing.
- ☞ After switching off the turbopump only disconnect the magnetic bearing from the mains once the rotor is at rest.
- ☞ If a heater is in use temperatures of up to 120 °C can be present in the area of the high vacuum flange. Take care to avoid burns!
- ☞ When the temperature management system is in operation, surface temperatures of up to 100 °C can arise on the middle and upper part of the pump. Because even higher temperatures are possible as a result of malfunctions, it is adviseable to take protective measures against accidental touching for temperatures of up to 150 °C.
- ☞ Keep leads and cables well away from hot surfaces (> 70 °C).
- ☞ When working on the turbopump, the high vacuum flange should only be opened once the rotor is at rest.
- ☞ When using sealing gas, the pressure in the hose connection should be limited to 2 bar via the overpressure valve.
- ☞ The unit has been accredited protection class IP 20. When the unit is operated in environments which require other protection classes, the necessary measures must be taken.
- ☞ The housing screws do not loosen, pull tight, remove or replace, since otherwise the guarantee for the security of the turbopump expires.

1.1. For Your Orientation

Instruction in the text

➡ Working instruction: Here, you have to do something.

Symbols used

The following symbols are used throughout in illustrations.

Ⓗ High vacuum flange
Ⓥ Fore-vacuum flange
Ⓕ Venting connection
Cooling water connection
Electric connection
Ⓖ Sealing gas connection
Air cooling

Abbreviations in the text

TMS = Temperature management system
TCM = Magnetic bearing controller
TMP = Turbomolecular pump

Position numbers

The same pump and accessory parts have the same position numbers in all illustrations.

1.2. Pictogram Definitions

Warning!
Danger of burns from touching hot parts.

Warning!
Danger of an electric shock.

Warning!
Danger of personal injury.

Caution!
Danger of damage to the pump or to the system.

Warning!
Danger of injury from rotating parts.

Please note!
Attention to particulary important information on the product, handling the product or to a particular part of the documentation.

Modifications reserved.

2. Understanding The TMH 1600M / TMU 1600M

2.1. Main Features

Turbomolecular Drag Pump TMH 1600M

1 High vacuum flange
2 Fore-vacuum flange
3 Cooling water connection
5 Electric connection
9 Locking screw/sealing gas connection
42 Venting valve

Cooling
Standard: Water cooling
Alternative: Air cooling as an accessory (permissible ambient temperature < 30 °C).

Bearings
High vacuum side: Wear free permanent magnetic bearing.
Fore-vacuum side: Wear free, electromagnetic radial and axial bearings.
In addition: Dry running safety bearings.

Ambient conditions
The turbomolecular pump needs to be installed in compliance with the following ambient conditions:

Installation location:	protected against the weather (rooms within buildings)
Temperature:	+5 °C to +30 °C (with water cooling up to +40 °C)
Relative humidity of the air:	max. 80 % at T ≤ 31 °C up to max. 50% at T ≤ 40 °C
Air pressure:	77 kPa - 106 kPa
Installation altitude:	2000 m max.
Pollution degree:	2
Overvoltage category:	II
Connection voltage:	70 VDC ±5%

Proper use

- The Turbomolecular Pumps TMH/TMU 1600M may only be used for the purpose of generating vacuum.
- The Turbomolecular Pumps TMH/TMU 1600M C (please see the rating plate) are designed to pump corrosive gases and vapours. Where corrosive gas processes are involved, gas bonding and particles which can damage the surfaces of the pump can be produced. The motor and bearing compartments have to be protected with sealing gas.
- The turbopumps may only be used to pump those media against which they are chemically resistant. For other media the operator is required to qualify the pumps for the processes involved.
- If the process produces dust, the maintenance intervals must be specified accordingly and sealing gas must be used.
- If the pump to be operated with more then 50% of the permissible gas load, sealing gas must be used.
- The turbopump may only be operated in conjunction with a Pfeiffer Vacuum Magnetic Bearing Controller TCM 1601 with relevant cables.
- The turbopump must be connected to a backing pump in accordance with Section 3.3.
- The turbopump may only be operated subject to the ambient conditions in accordance with protection class IP 20.

Improper use

The following is regarded, inter alia, as improper:
- The pumping of explosive gases.
- Operating the pumps in areas where there is a danger of explosion.
- Operating the pumps in areas there is a danger of radionactivity.
- The pumping of gases and vapours which attack the materials of the pumps.
- The pumping of corrosive gases without sealing gas.
- The pumping of condensating vapours.
- Operations involving impermissibly high levels of gas loads.
- Operations with improper gas modes.
- Operations involving too high levels of heat radiation power (see Section 8. "Technical Data").
- The use of accessories which are not named in this manual or which have not been agreed by the manufacturer.
- Operating the pump in environments which require a protection class superior to IP 20.

The turbomolecular pumps and flange connections must not be used to tread on when climbing onto the system.

Improper use will cause all claims for liability and guarantees to be forfeited.

2.2. Differences Between The Pump Types

	Rotary vane pump or dry backing pump with p < 0,05 mbar	Diaphragm vacuum pump with p < 5 mbar	Corrosive gas version with rotary vane pump or dry backing pump with p < 0,05 mbar
Stainless steel housing with CF-F	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-8}$ mbar	$< 1 \cdot 10^{-8}$ mbar
Stainless steel housing with ISO-K / ISO-F	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-8}$ mbar	$< 1 \cdot 10^{-8}$ mbar

Abbreviations on the type plate of the pump

TMH 1600**M**: Fully magnetic bearing pump
Suffix"**C**": Surface protection for passive protection of the pump
Suffix "**P**": Purge gas connection for the prevention of the ingress of aggressive gases into the motor and bearing area
Suffix: "**T**": Integrated temperature management system
Suffix "**H**": High level gas throughputs for process technology

2.3. Temperature Management System (TMS)

Pumps with the designation TMH 1600M T/TMU 1600M T (please see the rating plate) can be heated in the area of the pressure stages with the heaters integrated in the casing and temperature sensors up to a maximum of 90 °C.

The connections for heating and sensors are accessible centrally via a separate connection box.

When the TMS is in operation the additional casing heating unit on the turbomolecular pump is not possible.

2.4. Scope Of Delivery

Turbomolekular pump with:
- protecting cover for high vacuum flange,
- protecting cover for fore vacuum flange,
- protecting cover for electric connection,
- protecting cover for venting valve,
- mating plug for venting valve.

3. Installation

3.1. Preparations For Installation

Do not carry out any unauthorised conversions or alterations to the turbopump.

In case the rotor blocks suddenly, torque levels up to **11 400 Nm** can occur which need to be absorbed by the system and the high vacuum flange.

- The maximum permissible rotor temperature of the pump is 120 °C. If the vacuum chamber or parts in the vacuum chamber are heated, the values stated in the technical data relating to the level of heat which may be radiated into the pump must not be exeeded. If necessary, suitable shielding must be fitted in the vacuum chamber before the turbopump (constructional suggestions available on request).
- The temperature of the high vacuum flange must not exceed 120 °C.
- Only remove the blank flange from the high and for-vacuum side immediately before connection.
- Where magnetic fields of > 4 mT are involved suitable shielding must be provided (available on request).
- If the pump is baked out, the heating sleeve and the body of the pump must be insulated to prevent burns from accidental contact.
- Floor mounting of the turbomolecular pump is admissible after consulting the manufacturer.

The person responsible for commissioning must ensure that the installation is carried out in accordance with the legal regulations and the pertinent industrial standards

3.2. Connecting The High Vacuum Side

The utmost cleanliness must be observed when fitting all high vacuum parts. Unclean components prolong the pumping time.
All installations units for the flange must be with installation grease-free, dust free and drying.

Use a Pfeiffer Vacuum splinter shield or protective screen
The use of a Pfeiffer Vacuum splinter shield or protective screen in the high vacuum flange protects the turbopump against foreign bodies coming from the vacuum chamber but does reduce the volume flow rate as followed:

		Reduced volume flow rate [%]				
		N_2	He	H_2	Ar	CF_4
Splinter shield	DN 250	18	6	3	19	23
	DN 200	19	9	5	21	25
Protective screen	DN 250	5	2	1	5	7
	DN 200	5	2	1	6	6

Connecting via a Pfeiffer Vacuum vibration compensator
The high vacuum side can be flanged onto the vacuum chamber either directly or via a Pfeiffer Vacuum vibration compensator (see Section 10. Accessories).

When using a Pfeiffer vacuum vibration compensator, suitable securing needs to be introduced capable of absorbing the energy of the rotor should it suddenly block, since the vibration compensator itself alone cannot absorb the occurring forces. Please consult the manufacturer.

The maximum permissible temperature at the vibration compensator is 100 °C.

Installing the high vacuum flange

- In case the rotor blocks suddenly, torque levels up to **14 100 Nm** can occur which need to be absorbed by the system and the high vacuum flange.
- For installing the turbomolecular pumps to the high vacuum flange, the components listed in the following **must** be used exclusively. Otherwise the turbomolecular pump may twist or tear off.
  The components for installing the tuebopumps are special designs from Pfeiffer Vacuum
- The minimum strength of 170 N/mm^2 of the flange material needs to be observed.

Installation is done as follows:

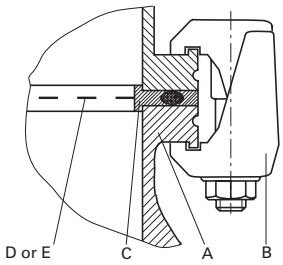
To reliably prevent the pump from twisting if the rotor suddenly blocks, it is absolutely prohibited to secure a pump with an ISO-K flange on a vacuum chamber with an ISO-F flange or vice versa. Both flanges **must be** of the same type. Installation with different flange types is carried out at the user's own risk. Pfeiffer Vacuum shall assume no liability whatsoever for any damage or injuries resulting from this kind of attachment.

ISO-K to an ISO-K flange

The components for installation are enclosed in the appropriate set of mounting material (see sec. 10. Accessories).

Bracket crew

A ISO-K flange
B Bracket screw
C Centering ring, coated
D Splinter shield
E Protective screen



➡ See that the sealing surface is not damaged.
➡ Flange the turbopump according to the drawing and the component parts in your set of mounting material. Use **24 (for DN 200) or 22 (for DN 250)** bracket screws.
➡ Tighten the clamps crosswise in three steps.
Tightening torque: 5 Nm, 15 Nm, 25 ±2 Nm

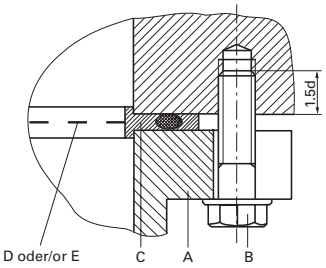
ISO-F to an ISO-F flange

For installing there exist three variants. The components for installation are enclosed in the appropriate set of mounting material (see sec. 11. Accessories).

Variant 1 - Hexagon screw with blind hole

Hexagon srew with blind hole

A ISO-F flange
B Hexagon screw with flange
C Centering ring, coated
D Splinter shield
E Protective screen

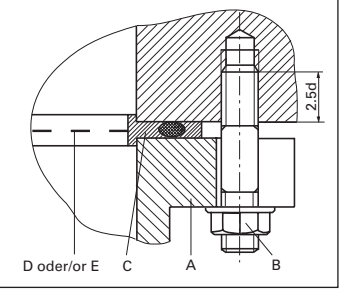


➡ See that the sealing surface is not damaged.
➡ Flange the turbopump according to the drawing and the component parts in your set of mounting material. Use **12** screws.
➡ For a flange material having a strength of > 270 N/mm^2 and with a blind hole the hexagon screw 1,5 d must be screwed in. The hexagon screws must be tightened crosswise in three steps.
Tightening torque: 10 Nm, 20 Nm, 38 ±3 Nm

Variant 2 - Stud screw with blind hole

Stud screw with blind hole

A ISO-F flange
B Stud screw with nut[1)]
C Centering ring, coated
D Splinter shield
E Protective screen



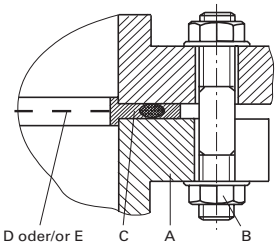
1) Nut with flange.

➡ See that the sealing surface is not damaged.
➡ Flange the turbopump according to the drawing and the component parts in your set of mounting material. Use **12** screws and **12** nuts.
➡ For a flange material having a strength of 170-270 N/mm^2 and a screw-in flange, the stud screw 2,5 d must be screwed in. The nuts must be tightened crosswise in three steps.
Tightening torque: 10 Nm, 20 Nm, 38 ±3 Nm

Variant 3 - Stud screw and clearance hole

Stud screw and clearance hole

A ISO-F flange
B Stud screw with two nuts[1)]
C Centering ring, coated
D Splinter shield
E Protective screen



1) Nut with flange.

➡See that the sealing surface is not damaged.
➡ Flange the turbopump according to the drawing and the component parts in your set of mounting material. Use **12** screws and **24** nuts.
➡ For a flange material having a strength of > 170 N/mm² and a stud screw with clearance hole, the nuts must be tightened crosswise in three steps.
Tightening torque: 10 Nm, 20 Nm, 38 ±3 Nm

CF-F-Flansch

Applications for installing an CF-F to an CF-F flange are "Stud screw with blind hole" and "Hexagon screw and clearance hole". The following items are needed: the particular set of mounting material and a copper seal. Using asplinter shield or protective screen is optional.

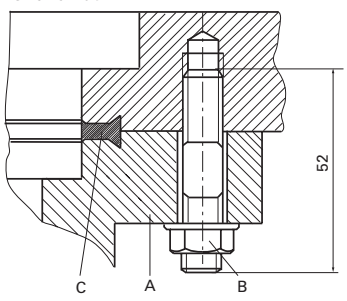
Don't touch the copper seal with bare hands, this may affect the sealings efficiency. See that the sealing lip is not damaged.

Stud screw with blind hole

➡ If used: Insert the splinter shield and protective screen in the high vacuum flange with the clamping lugs downward (towards the pump).
➡ Bring the seal centric into the correct position.
➡ Connect the flanges via **24 (for DN 200) or 32 (for DN 250)** pieces of stud screws (M8) with washers and nuts. The stud screws need to be tightened revolving with a tightening torque of 22 ±2 Nm. Control the torque afterwards, because of the sealing material's flowing a retightening of the screws may be required.

Stud screw with blind hole

A CF-F flange
B Stud screw with washer and nut
C Copper seal

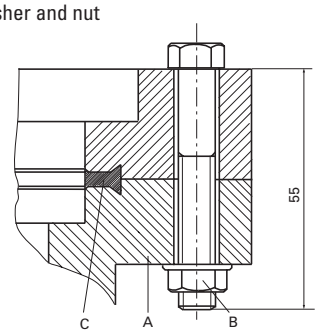


Hexagon screw and clearance hole

➡ If used: Insert the splinter shield and protective screen in the high vacuum flange with the clamping lugs downward (towards the pump).
➡ Bring the seal centric into the correct position.
➡ Connect the flanges via **24 (for DN 200) or 32 (for DN 250)** pieces of hexagon screws (M8) with washers and nuts. The hexagon screws need to be tightened revolving with a tightening torque of 22 ±2 Nm. Control the torque afterwards, because of the sealing material's flowing a retightening of the screws may be required.

Hexagon screw and clearance hole

A CF-F-flange
B Hexagon screw with washer and nut
C Copper seal



The components for installing to an CF-F flange are to be ordered under the following numbers:

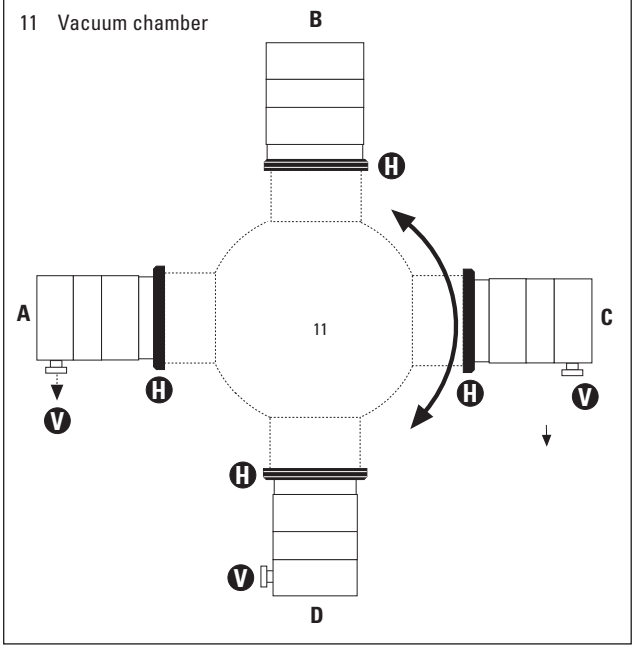
Connection nominal-diameter	Designation	Order-number
DN 200 CF-F/ DN 250 CF-F	Hexagon screw M8 with washer and nut (25 pieces[1)])	PF 505 004 -T
	Stud screw M8 with washer and nut (34 pieces[1)])	PF 507 004 -T
DN 200 CF-F	Copper seal (5 pieces[1)]) or copper seal silvered (5 pieces[1)])	PF 501 420 -T PF 501 520-T
	Splinter shield[2)]	PM 016 321
	Protective screen[2)]	PM 016 342
DN 250 CF-F	Copper seal (5 pieces[1)]) or copper seal silvered (5 pieces[1)])	PF 501 425 -T PF 501 525-T
	Splinter shield[2)]	PM 016 324
	Protective screen[2)]	PM 016 345

1) supplied pieces

Directly Flanging The Pump

Permissible installation positions for the turbopump

11 Vacuum chamber



CAUTION

The maximum loading capacity of the high vacuum flange is 2000 N (equivalent to 200 kg). Asymmetric loading on the high vacuum flange must be avoided.
Shaking the pump can cause overloading on the magnetic bearing; this can lead to activation of the safety bearing. Therefore avoid shaking as far as is possible.
Where incitement from the system is involved, for example via a high vacuum valve, the pump must be secured in such a way that no movement is possible, especially tilting movement.

Where rotary vane vacuum pump backing pumps with installation position A or C are involved the fore-vacuum flange must point downwards.
The use of rotary vane vacuum pumps is not recommended where installation position B has been selected.

CAUTION

No forces from the piping system must be allowed to act on the pump where turbopumps are anchored.
Suspend or support all pipes to the pump.

3.3. Connecting The Fore-Vacuum Side

Recommended Pfeiffer Vacuum backing pump:
- dry compressing diaphragm pump
- for large vacuum chambers UniDry™ 050-3.

Connecting the backing pump
All connections of the fore-vacuum line: With the usual small flange components or hose screw connections.

CAUTION

Be sure to conduct away the exhaust gases from the backing pump. Do not reduce the free cross section of the fore-vacuum flange with following components.

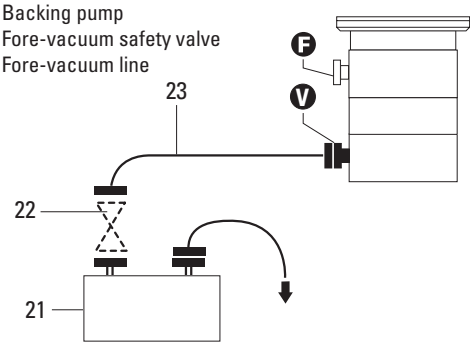
WARNING

The exhausted process gases and vapours can represent a health hazard and can also be environmentally damaging.
Comply with all the gas manufacturer's safety instructions.

➡ Fit the delayed opening fore-vacuum safety valve (e.g. TVV 001, Accessory) in the fore-vacuum line (in Pfeiffer Vacuum rotary vane vacuum pumps already integrated as standard). This prevents the vacuum chamber being ventilated via the backing pump.
➡ With rigid pipe connections: Fit a bellows in the connecting line to reduce vibration.

Connecting the backing pump

21 Backing pump
22 Fore-vacuum safety valve
23 Fore-vacuum line



➡ The electrical connection of the backing pump: Please see the operating instructions for the Magnetic Bearing Controller TCM 1601, PM 0478 BN.

3.4. Connecting The Cooling Unit

The Turbopumps TMH/TMU 1600M are water cooled as standard. The permissible ambient temperature for water cooling is 40 °C.
When operating with reduced levels of gas load, air cooling is possible (please see "Accessories") The permissible ambient temperature with air cooling is < 30 °C and the maximum gas flow and fore-vacuum pressure are reduced compared with water cooling (please refer to Section 8. Technical Data).

Water Cooling

The cooling water can be drawn either
– from the cooling water mains or
– from Recycled Water Cooling Unit TZK in closed circuit.

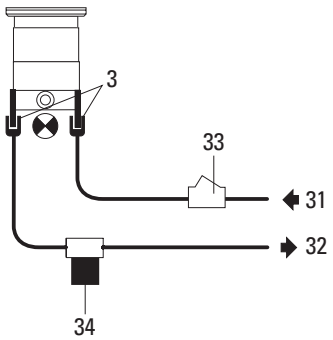
Cooling from the cooling water mains
To prevent deposits collecting in the pump the cooling water must be filtered.
The minimum requirements for the cooling water:
Mechanically clean, optically clear, no turbidity, no sediment, chemically neutral and temperature > dew point.

Oxygen content:	max. 4 mg/kg
Chloride content:	max. 100 mg/kg
Carbonate hardness:	max. 10 ° dH
Consumption of potassium permanganate:	max. 10 mg/kg
Carbon dioxide:	Undetectable
Ammonia:	Undetectable
pH-value:	7 – 9
Max. fore-line over pressure:	max. 6 bar
Minimum flow rate:	see 8. "Technical Data"

Connection to the cooling water mains
➡ Fit the dirt trap (Accessory) in the supply line.
➡ Connect the supply line with hose clips onto one of the two cooling water connections.
➡ Connect Cooling Water Monitor TCW 002 in return line.
➡ Connect the return line to the other cooling water connection of the turbopump.
➡ Tighten all hose clips and check for firm seating of the hoses.
➡ Tighten the hollow screws on the cooling water connection to a torque of 20 Nm.

Cooling from the cooling water mains

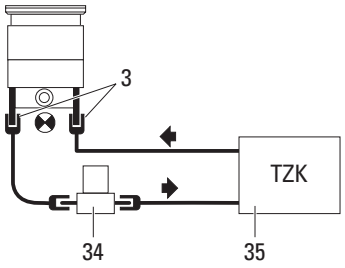
3 Cooling water connection
31 Supply line
32 Return line
33 Dirt trap
34 Cooling Water Monitor TCW 002



Cooling with the Recycled Water Cooling Unit TZK (Accessory)
Dirt traps in the fore-lines are not necessary.
All other steps as for connecting to the cooling water mains.

Cooling with Recycled Water Cooling Unit TZK

3 Cooling water connection
34 Cooling Water Monitor TCW 002
35 Recycled Water Cooling Unit TZK



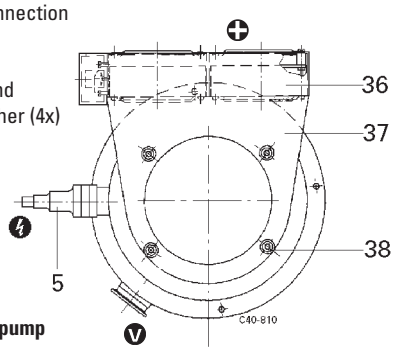
Air Cooling (Accessory)

Air cooling is only permissible where the ambient temperature is < 30 °C.
Ensure that the supply and exhaust air ducts are not restricted.

Fitting the air cooling unit
➡ Place a fluff-free and clean pad on the working surface.
➡ Place the pump on its high vacuum flange (Caution: do not damage the sealed surfaces).
➡ Pull out the synthetic feet from the base of the pump.
➡ Screw air cooling to the holder 37 with 4 srews M8 and spring washers onto the turbopump. The fan have to be installed parallel to the electric connection.

Fitting the air cooling unit

5 Electric connection
36 Fan
37 Holder
38 M8 srew and spring washer (4x)



Underside pump

Electrical connection, air cooling
➡ The electrical connection of the air cooling unit is made on the control line 57 (please see Section 3.8.) on the connecting cable TCM-turbopump (see the operating instructions for the TCM 1601, PM 0478 BN).
Alternatively, either the casing heating unit or the TMS can be connected to the control line. Simultaneous operations of the functions is not possible.

3.5. Connecting The Venting Valve

Uncontrolled venting can cause overloading on the axial bearing resulting in activation of the safety bearing.The TMH/TMU 1600M may only be vented via the venting valve fitted. It must not be replaced by other venting equipment.

Maximum pressure on the venting valve: 1.5 bar absolute.
If a higher venting rate is required further venting components can be opened as soon as the rotation speed of the pump is less than 100 Hz.
If, from the beginning, the pump is to be vented with equipment other than that fitted, the pressure increase on the high vacuum flange must be limited to 2 mbar/s until the rotation speed is less than 100 Hz.

Electrical connection, venting valve
The electrical connection of the venting valve is via the connecting cable magnetic bearing controller - turbopump.

➡ Connect the plug from the cable junction to the venting valve and secure with screw.

Please also refer to the connections diagram for the TCM 1601 in Operating Instructions PM 0478 BN.

3.6. Connecting The Sealing Gas

To protect the pump, particularly where corrosive or dust producing processes are involved, it is necessary to use sealing gas. Connection is made via the sealing gas valve (please see “Accessories”).

For this, please refer to Section 2.1. "Main Features" for the sealing gas connection.

Please refer to Operating Instructions PM 0229 BN for details on installing the sealing gas valve and adjusting the sealing gas flow.

3.7. Connecting The Casing Heating Unit

Final pressures are attained more rapidly when turbopump and vacuum chamber are heated.
The heating duration is dependent on the degree of contamination and on the required final pressure. The heating should last for at least 4 hours.

Where casing heating unit is involved the turbopump must be water cooled.

High temperatures arise when baking out turbopumps and vacuum chambers. There is a danger of burns from touching hot parts, even after the heating has been switched off.
Ideally, the heating sleeve, pump casing and vacuum chamber should be insulated during installation. When baking out do not touch the heating sleeve, pump casing and vacuum chamber.

➡ Screw the heating sleeve tightly onto the casing with the securing screws and fit protection against accidental contact.
➡ Electrical connection, casing heating unit: Please see Operating Instructions PM 0478 BN for the TCM 1601.

3.8. Connecting The Magnetic Bearing Controller

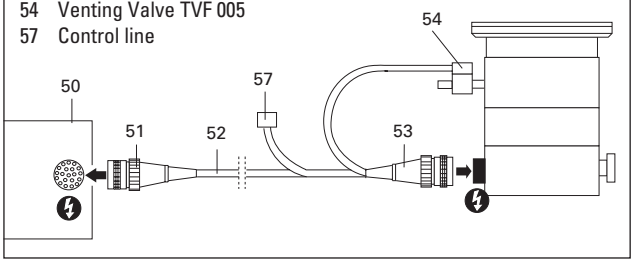
➡ Plug in the connecting cable between the magnetic bearing controller and the turbopump.

CAUTION

Caution! Take care to ensure that the cable plugs are put straight onto the built-in plugs to avoid damage to the connecting points.
For details please refer to the operating instructions for the Magnetic Bearing Controller TCM 1601/PM 0478 BN.

Connecting the magnetic bearing controller with the turbopump

50 Magnetic Bearing Controller TCM
51 Bayonet plug - TCM
52 Connecting cable TCM - TMP
53 Bayonet plug TMP
54 Venting Valve TVF 005
57 Control line



CAUTION

Before disconnecting the plug connection:
- Rotor rotation speed = 0 Hz
- Disconnect the magnetic bearing controller from the mains.

WARNING

Voltages of up to 150 V can be present on the open contacts of a running-down pump.
There is a danger of an electrical shock from touching the contacts.

3.9. Connecting The Temperature Management System (TMS)

Pumps with the designation TMH 1600M T/TMU 1600M T (please see the rating plate) can be heated to a maximum of 90 °C in the Holweck stages range with the heaters and temperature sensors (TMS) integrated in the middle casing. During TMS operations the additional flange heating for the turbomolecular pump is not possible.

PLEASE NOTE

During TMS operations the turbopump must be operated with water cooling.

For connection and operation of the temperature management system (TMS) please refer to operating instructions for the TMS, PM 0517 BN and for the TCM 1601, PM 0478 BN.

Temperature management system

95 Connection box
96 Connecting cable for the heating elements

4. Operations

4.1. Before Switching ON

Turbopump rotors rotate at high speed. When the high vacuum flange is open there is a danger of injury and of damage to the pump caused by objects falling into the pump. Therefore never operate the pump with open high vacuum flange.

When operating with casing heating unit or TMS operations phigh temperatures can arise on the pump surfaces.

➡ Pre-select the required operational functions and parameters on the Magnetic Bearing Controller TCM 1601.
➡ With water cooling: Open cooling water supply and check flow.

4.2. Switching ON

➡ Switch on the magnetic bearing electronic controller with switch S1 on the rear side of the TCM 1601.
➡ Switch on the pumping station with the push button ⏻ on the front panel of the TCM 1601.
– If air cooling is involved the cooling fan is also switched on by the magnetic bearing controller.
– The backing pump is automatically started with the Pumping Station Control Unit TCS 180.
➡ Switch on the backing pump if it is not switched via the pumping station control unit.

Take care when pumping hazardous gases and observe the safety precautions of the gas manufacturer.

4.3. Heating (only for pumps with casing heating unit)

The heating duration is dependent on the degree of contamination and on the required final pressure. The heating should last for at least 4 hours.

Where casing heating unit is involved the turbopump must be water cooled.

➡ Switch on the turbopump heating in the menu of the Magnetic Bearing Controller TCM 1601 (please see Operating Instructions PM 0478 BN for the TCM 1601).

4.4. Operations With The TMS

If the pump is equipped with the temperature management system (TMS) (TMH/TMU 1600M C T, see rating plate), heating is possible in the area of the pressure stages with the heaters integrated in the middle casing part and temperature sensors up to a maximum of 90 °C.

➡ Connect the TMS to the magnetic bearing controller. For connection diagram, function and circuit diagram please refer to the operating instructions for the TMS, PM 0517 BN and for the TCM 1601 PM 0478 BN.
– Condensable media may only be pumped once the selected TMS temperature has been attained.

In order to optimize the performance of the pump in gas load operations and to ensure temperature stability, the rotation speed of the pump in the TMS mode is slightly reduced by activating the TMS heating.
For specific rotation speeds in the TMS mode please refer to Section 8, "Technical Data".

As a matter of principle, TMS heating is only activated on attainment of the rotation speed switchpoint.

4.5. Intermittent Mode Operations Of The Backing Pump

Where Pumping Station Control Unit TCS 180 is in operation there is the option, under certain pre-conditions, to select intermittent mode operations on the diaphragm pump (please refer to the Section "Operations With Pumping Station Control Unit TCS 180 in the TCM 1601 Operating Instructions PM 0478 BN).

If the setting procedure desribed there cannot be executed the guide values
<710: **BkP Poff**> = 150 W und
<711: **BkP Pon**> = 280 W
can be used for the switch on and switch off threshholds.

The TMH 1600M P C H can not be operated in connection with a diaphragm pump.

4.6. Gas Type Dependent Operations

Where high level gas loads and rotation speeds are involved, the resulting friction subjects the rotor to the effect of great heat. To avoid over-heating, a power rotation speed characteristic line is implemented in the TCM 1601; this ensures that where maximum gas loads are involved, the pump will operate at any rotation speed without the danger of damage arising.
The maximum power is dependent on the type of gas. Two characteristic lines are available for any type of gas in order to fully exploit the power potential of the pump:

– "Gas-Mode 0" for gases with molecular mass ≥ 40 as, for example, Argon;
– "Gas-Mode 1" for all lighter gases.

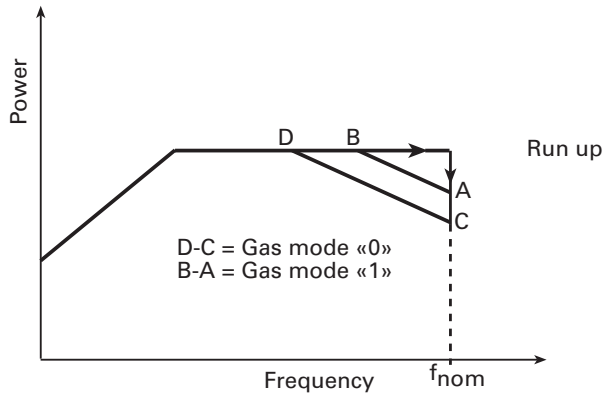
➡ Set the applicable gas mode on the TCM 1601 (please refer to Operating Instructions PM 0478 BN for theTCM 1601).

Pumping gases with molecular mass ≥ 40 with the incorrect gas mode can cause damage to the pump.

For the vertex of the power characteristic line please refer to Section 8. Technical Data.

Maximum power is applied when the pump starts in order to limit the time required. Once the set rotation speed is attained, switching to the selected power characteristic line is automatic.
If the gas dependent maximum power is exceeded, the rotation speed is reduced until equilibrium between the permissible power and gas friction is attained. The power limitation serves to protect the pump against thermal overloading. In order to avoid rotation speed fluctuations it is recommended to set, in rotation speed setting mode, the equilibrium frequency or a somewhat lower frequency.

Gas type characteristic line



4.7. Safety Bearings

Where heavy, external vibration or improper operating is involved, the rotor is supported by an additional, dry-running safety bearing; a clearly audible sound is produced when this happens. The various causes are evaluated as follows:

– Power failure; Display Warning F 007;
  only low level strain on the safety bearing and, with a new safety bearing set, possible 100 times.
– Uncontrolled venting or vibration;
  Malfunction Display E 089;
  medium level strain on the safety bearing, and, with a new safety bearing set, possible 50 times.
– Cable disconnected between the electronics and the pump; Malfunction Display E 082;
  high level strain on the safety bearing, and, with a new safety bearing set, possible 5 times.

If there is a mix of the events referred to above, the criteria for the actual wear of the safety bearing is the sum of the partial wear arising from the individual events.

Please get in touch with your local Pfeiffer Vacuum Service when a safety bearing replacement is required.

4.8. Switching OFF And Venting

When switching off and venting the turbopump please take account of the fact that various venting modes are available (please refer to the operating instructions for the TCM 1601, PM 0478 BN).

➡ Switch off the pumping station with the push button on the front panel of the TCM 1601.
➡ Close the fore-vacuum safety valve (if available). Where Pumping Station Control Unit TCS 180 is involved, the valve closes automatically.
➡ With water cooling: Shut off the water supply.
➡ Shut off the supply of sealing gas if operating with sealing gas.
➡ Do not switch off the TCM 1601 or disconnect from the mains until the rotation speed has reached 0 Hz.

When operating the pump with aggressive gases and their reactive products, the operation of the backing pump and the sealing gas function should be continued for at least 15 minutes in order to protect the bearings and the drive and to ensure the complete pumping out of this media.

4.9. Shutting Down For Longer Periods

Vacuum pumps are sometimes used to pump aggressive or hazardous gases. There is a danger of personal injury resulting from coming into contact with process gases. Before removing a turbopump from the system, first:

– Vent the turbopump with a neutral gas or dry air.
– Ensure that there is no residual process gas in the system nor in the supply lines.

If the turbopump is to be shut down for more than a year:

➡ Remove turbopump from the system.
➡ Close the high vacuum flange and evacuate the turbopump via the fore-vacuum flange.
➡ Vent turbopump via the venting connection with nitrogen or dry air.
➡ Close fore-vacuum connection by blank flanging.
➡ Place the pump vertically on its synthetic feet.
➡ The pump must be stored in buildings within a temperature range of -25 °C to +55 °C.
➡ In rooms with moist or aggressive atmospheres, the turbo-pump must be air-sealed in a plastic bag together with a bag of dessicant.

5. What To Do In Case Of Breakdowns ?

The Magnetic Bearing Controller TCM 1601 contains an integrated malfunction diagnosis system (error code table). The malfunction messages are explained in operating instructions for the TCM 1601, PM 0478 BN and their possible causes are listed.

Problem	Possible causes	Remedy
Pump doesn't start	• Power supply interrupted	• Check fuse in the magnetic bearing controller • Check plug contacts on the magnetic bearing controller • Check supply line
Pump doesn't attain nominal rotation speed within the set start-up time; Pump cuts out during operations	• Fore-vacuum pressure too high • Leak or too much gas	• Check backing pump function • Check seals • Seek leak and repair • Reduce gas load
	• Start-up phase in the magnetic bearing controller set too short • Thermal overloading caused by – flow insufficient – air supply insufficient – fore-vacuum pressure too high – ambient temperature too high	• Increase the start-up phase • Ensure free flow • Ensure adequate air supply • Reduce fore-vacuum pressure • Reduce ambient temperature
Pump doesn't attain final pressure lines or pump	• Pump dirty • Leak in vacuum chamber,	• Bake out pump • If seriously contaminated: Request Pfeiffer Vacuum Service to clean • Seek leak starting with vacuum chamber • Repair leak
Unusual operating noises	• Rotor damaged • Splinter shield (if fitted) not seated firmly	• Inform Pfeiffer Vacuum Service of need for repair • Check seat of splinter shield
	• Pump runs in the safety bearings	• Remove the cause; start the pump again

6. Maintenance

No liability for personal injury nor material damage will be accepted for damages and operational interruptions which have been caused by improper maintenance; in addition, all guarantees become invalid.

Your pump can be cleaned on the spot if it is not very dirty. Please check procedures with your local Pfeiffer Vacuum Service Center.

Your local Pfeiffer Vacuum Service can advise you regarding cleaning procedures and any other maintenance and service work.

7. Service

Do Make Use Of Our Service Facilities
In the event that repairs are necessary a number of options are available to you to ensure any system down time is kept to a minimum:
- Have the pump repaired on the spot by our Pfeiffer Vacuum Service Engineers;
- Return the pump to the manufacturer for repairs;
- Replace the pump.

Local Pfeiffer Vacuum representatives can provide full details.

Before Returning:
➡ Please attach a clearly visible notice "Free of harmful substances" (both on the unit and also on the delivery note and any accompanying letters).

"Harmful substances" are substances and preparations as defined in the current, local, dangerous substances regulations; in the U.S.A. as "materials in accordance with the Code of Federal Regulations (CFR) 49 Part 173.240 Definition and Preparation".
We will carry out the decontamination and invoice this work to you if you have not attached this note. This also applies where the operator does not have the facilities to carry out the decontamination work. Units which are contaminated microbiologically, explosively or radioactively cannot be accepted as a matter of principle.

Fill Out The Declaration Of Contamination
➡ In every case the "Declaration of Contamination" must be completed diligently and truthfully.
➡ A copy of the completed declaration must accompany the unit; any additional copies must be sent to your local Pfeiffer Vacuum Service Center.

Please get in touch with your local Pfeiffer Vacuum representatives if there are any questions regarding contamination.

Decontaminate units before returning or possible disposal. Do not return any units which are microbiologically, explosively or radioactively contaminated.

Returning Contaminated Units
If contaminated have to be returned for maintenance/repair, the following instructions concerning shipping must be followed:
➡ Neutralise the pump by flushing with nitrogen or dry air.
➡ Seal all openings to the air.
➡ Seal pump or unit in suitable protective foil.
➡ Return equipment only in suitable, rugged shipping containers and by complying with the currently valid shipping regulations.

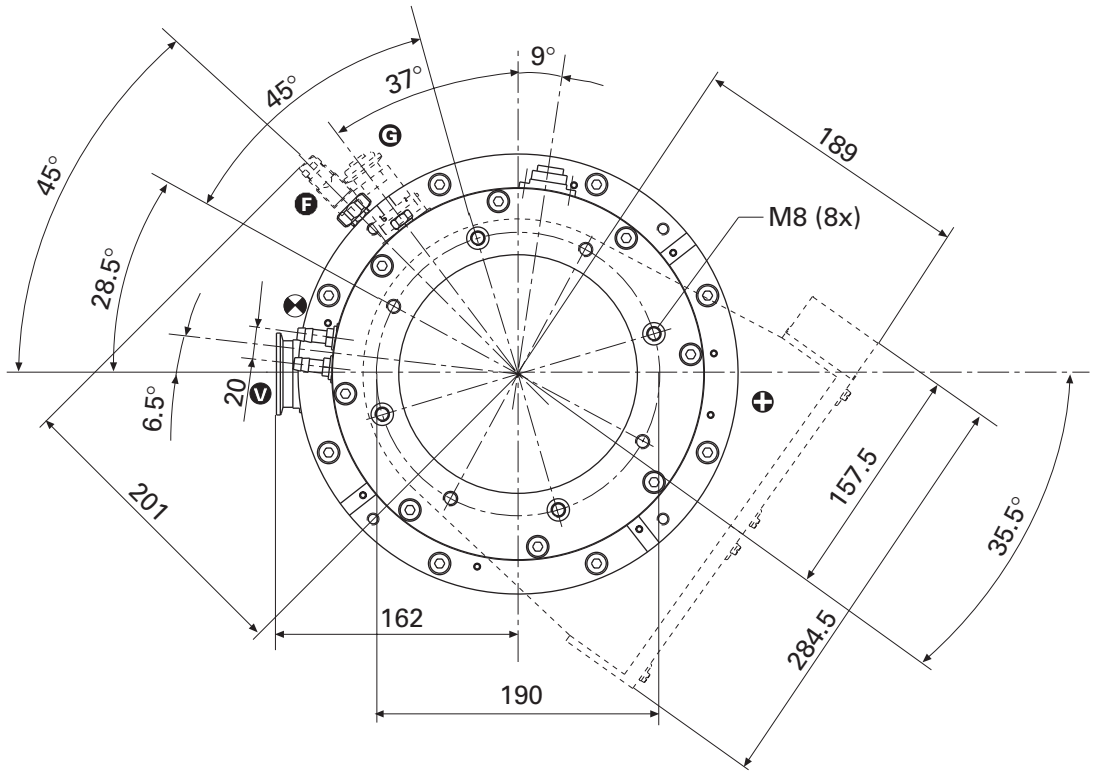
Repair orders are carried out according to our general conditions of sale and supply. If repairs are necessary, please send the pump to your nearest Pfeiffer Vacuum Service Center.

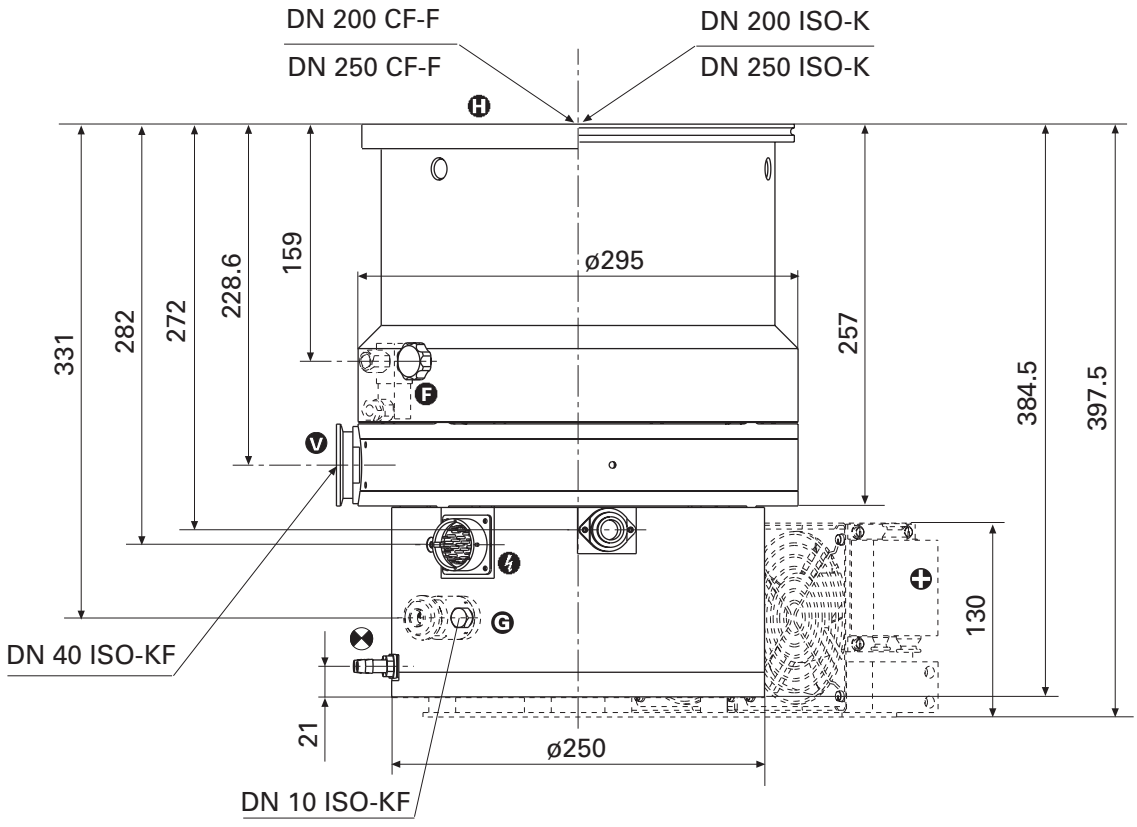
8. Technical Data

Feature	Unit	TMH 1600M TMU 1600M	TMH 1600M TMU 1600M	TMH 1600M H	
Connection nominal diameter:					
Inlet		DN 200 ISO-K	DN 250 ISO-K DN 250 ISO-F	DN 200 ISO-K	DN 250 ISO-K DN 250 ISO-F
		DN 200 CF-F	DN 250 CF-F		
Outlet		DN 40 ISO-KF		DN 40 ISO-KF	
Magnetic bearing controller		TCM 1601		TCM 1601	
Nominal rotation speed without TMS	Hz (1/min)	600 (36 000)		600 (36 000)	
Nominal rotation speed with TMS	Hz (1/min)	550 (33 000)		550 (33 000)	
Standbyrotation speed	Hz (1/min)	400 (24 000)		400 (24 000)	
Start-up time (up to 90% of the nominal rotation speed with TCM 1601) (bis 90 % Nenndrehzahl mit TCM 1601)	min	6		7	
Maximum noise level[1]	dB (A)	55		55	
Final pressure, backing pump	mbar				
Integral leak rate (He)[2]	mbar l/s	$< 2 \cdot 10^{-8}$		$< 2 \cdot 10^{-8}$	
Maximum permissible rotor temperature	°C	120		120	
Permissible heat radiation power	W	27		27	
Volume flow rate (with oil-sealed rotary vane vacuum pump):					
Stickstoff N_2	l/s	990	1400	1000	1400
Helium He	l/s	1050	1180	1100	1230
Wasserstoff H_2	l/s	830	780	750	850
Compression ration for:					
N_2	–	$> 1 \cdot 10^{10}$		$> 1 \cdot 10^{8}$	
He	–	$> 3 \cdot 10^{5}$		$> 3 \cdot 10^{4}$	
H_2	–	$> 1 \cdot 10^{4}$		$> 2 \cdot 10^{3}$	
Critical backing pressure, max.					
N_2 Cooling type: water	mbar	7	10	4	
Gas throughput without TMS operation at nominal rotation speed, max.					
N_2 Cooling type: water	mbar l/s	13	14	18	
Ar Cooling type: water	mbarl/s	7	8	10	
Gas throughput with TMS operation at nominal rotation speed, max[3]					
N_2 Cooling type: water	mbarl/s	7		12	
Ar Cooling type: water	mbarl/s	3,5		5	
Gas throughput at 0,1 mbar intake pressure					
N_2 Cooling type: water	mbarl/s	20		23	
Ar Cooling type: water	mbarl/s	16		20	
Vertex power characteristics line[4]					
A	W / Hz	400/600		400/600	
B	W / Hz	480/400		480/400	
C	W / Hz	360/600		360/600	
D	W / Hz	360/260		360/260	
Theoretical final pressure	mbar	see section 2.2 "Differences Between The Pump Types"		see section 2.2	
Cooling water consumtion with water at 15 °C					
without TMS operation	l/h	20		20	
with TMS operation and gas load	l/h	100		100	
Cooling water temperature	°C	5 - 25		5 - 25	
Permissible ambient temperature with					
air cooling	°C	5 - 30		5 - 30	
water cooling	°C	5 - 40		5 - 40	
Power consumption of:					
casing heating unit	W	170		170	
TMS heating	W	1000		1000	
Permissible magnetic field	mT	4		4	
Protection class		IP 20		IP 20	
Weight	kg	61/63	62/65/64	61	63/65
Shipping and storage temperature	°C	-25 to +55		-25 to +55	
Relative humidity	%	5-85 non-condensing		5-85 nicht betauend	

1) Distance from the pump 1 m
2) Measured at a helium concentration of 20 %, 10 s measurement time
3) Operation with TMS only with water cooling
4) For gas type characteristics line please refer to Section 4.6.

8.1. Dimensions

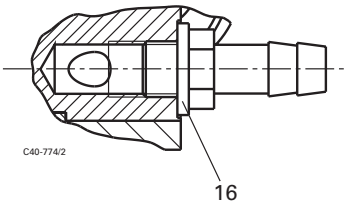




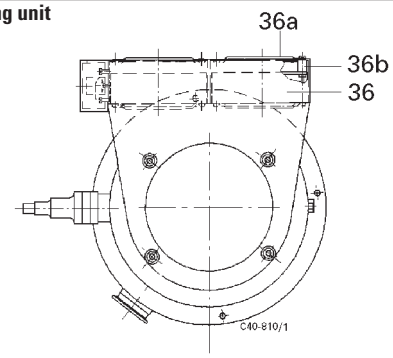
9. Spare Parts

Pos.	Description	Pieces	Size	Number	Comments	Ordering Quantity
	Spare parts TMH/U 1600M					
6	Synthetic foot	4		P 4098 582 FA	see Section 2.1.	
16	USIT ring	2		P 3529 133 -A		
54	Venting Valve TVF 005	1	G 1/8"	PM Z01 135	see Section 2.1.	
97	Temperature sensor, complete	1		PM 073 593 -X	see Section 3.9.	
	Spare parts for the air cooling unit					
36	Fan	1	110 V / 230 V	P 5099 251 -R7		
36a	Finger protection	2		P 5099 251 Z4		
36b	Buffer	4		P 0991 099		

Cooling water connection



Air cooling unit



10. Accessories

Description	Size	Number	Operating Instructions/ Comments	Order Quantity
Magnetic Bearing Controller TCM 1601	90 - 265 V; 50/60 Hz	PM C01 675	PM 0478 BN	
Connecting cable turbopump - TCM	3 m	PM 051 003 -T	other lengths on request	
Pumping Station Control Unit TCS 180	100 - 115/230 V; 50/60 Hz	PM C01 655	PM 0384 BN	
Casing heating unit	230 V AC, Safety plug	PM 016 070 -T	Water cooling required	
	208 V AC, UL plug	PM 016 071 -T		
	115 V AC, UL plug	PM 016 072 -T		
Protective screen	DN 250 CF-F	PM 016 345		
	DN 200 CF-F	PM 016 342		
Splinter shield	DN 250 CF-F	PM 016 324		
	DN 200 CF-F	PM 016 321		
Sealing ring, TMH	DN 200 ISO-K	PF 303 120 -T		
	DN 250 ISO-K	PF 303 125 -T		
Collar flange with retaining ring, TMH	DN 200 ISO-K	PF 307 120 -T		
	DN 250 ISO-K	PF 307 125 -T		
Cu seals (10 pieces), TMU	DN 200 CF	PF 501 420 -T		
(5 pieces)	DN 250 CF	PF 501 425 -T		
Set of screws, TMU	DN 200 CF	PF 505 003 -T		
	DN 250 CF	PF 505 003 -T		
Vibration compensator, TMH	DN 200 ISO-K	PM 006 668 -X		
	DN 250 ISO-K	PM 006 670 -X		
TMU	DN 200 CF-F	PM 006 669 -X		
	DN 250 CF-F	PM 006 671 -X		
Fore-Vacuum Safety Valve TVV 001	115 V	PM Z01 206	PM 0263 BN	
	230 V	PM Z01 205	only with TCS 180	
Drying Unit TTV 001 (filled with zeolite)		PM Z00 121	PM 0022 BN	
Sealing gas valve		PM Z01 142	PM 0229 BN	
Hose nipple for the sealing gas valve	DN 16 ISO-KF-10	PF 144 020		
Components for cooling				
Dirt trap	R 3/8"	P 4161 300 2R		
Recycled Water Cooling Unit TZK 400	230 V, 50 Hz	PM Z01 245	PM 0369 BN	
Set for air cooling	230 V AC, Safety plug	PM Z01 275		
	208 V AC, UL plug	PM Z01 276		
	115 V AC, UL plug	PM Z01 277		
Cooling Water Monitor TCW 002	110 V, 50/60 Hz	PM C00 131	PM 0133 BE	
	220 V, 50/60 Hz	PM C00 130		
	240 V, 50/60 Hz	PM C00 132		
Connection component set for the TCW 002		PM 006 802 -T		
Components for mounting				
Coated centering ring, bracket screws	DN 200 ISO-K	PM 016 410-T		
	DN 250 ISO-K	PM 016 415-T		
Coated centering ring with protective screen, bracket screws	DN 200 ISO-K	PM 016 412-T		
	DN 250 ISO-K	PM 016 417 -T		
Coated centering ring with splinter shield, bracket screws	DN 200 ISO-K	PM 016 411-T		
	DN 250 ISO-K	PM 016 416 -T		
Coated centering ring, hexagonal bolts	DN 250 ISO-F	PM 016 480 -T		
Coated centering ring with protective screen, hexagonal bolts	DN 250 ISO-F	PM 016 482 -T		
Coated centering ring with splinter shield, hexagonal bolts	DN 250 ISO-F	PM 016 481 -T		
Coated centering ring, stud screws	DN 250 ISO-F	PM 016 485 -T		
Coated centering ring with protective screen, stud screws	DN 250 ISO-F	PM 016 487 -T		
Coated centering ring with splinter shield, stud screws	DN 250 ISO-F	PM 016 486 -T		

When ordering accessories and spare parts please be sure to state the full part number. When ordering spare parts please state additionally the unit type and unit number (see rating plate). Please use this list as an order form (by taking a copy).

Declaration of Contamination of Vacuum Equipment and Components

The repair and/or service of vacuum components will only be carried out if a correctly completed declaration has been submitted. Non-completion will result in delay.

The manufacturer could refuse to accept any equipment without a declaration.

This declaration can only be completed and signed by authorised and qualified staff:

1. Description of component:

- Equipment type/model: _____
- Code No.: _____
- Serial No.: _____
- Invoice No.: _____
- Delivery Date: _____

2. Reason for return:

_____

_____

_____

_____

_____

3. Equipment condition

- Has the equipment been used?
  yes ❒ no ❒
- What type of pump oil was used?

  _____
- Is the equipment free from potentially harmful substances?
  yes ❒ (go to section 5)
  no ❒ (go to section 4)

4. Process related contamination of equipment

- toxic yes ❒ no ❒
- corrosive yes ❒ no ❒
- microbiological hazard*) yes ❒ no ❒
- explosive*) yes ❒ no ❒
- radioactive*) yes ❒ no ❒
- other harmful substances yes ❒ no ❒

*) We will not accept delivery of any equipment that has been radioactively or microbiologically contaminated without written evidence of decontamination!

Please list all substances, gases and by-products which may have come into contact with the equipment:

Tradename Product name Manufacturer	Chemical name (or Symbol)	Danger class	Precautions associated with substance	Action if spillage or human contact
1.				
2.				
3.				
4.				
5.				

5. Legally Binding Declaration

I hereby declare that the information supplied on this form is complete and accurate. The despatch of equipment will be in accordance with the appropriate regulations covering Packaging, Transportation and Labelling of Dangerous Substances.

Name of Organisation: _____

Address: _____ Post code: _____

Tel.: _____

Fax: _____ Telex: _____

Name: _____

Job title: _____

Date: _____ Company stamp: _____

Legally binding signature: _____

PFEIFFER VACUUM

Herstellererklärung
Manufacturer´s Declaration

im Sinne folgender EU-Richtlinien:
pursuant to the following EU directives:

- **Maschinen/*Machinery* 98/37/EG**
- **Elektromagnetische Verträglichkeit/*Electromagnetic Compatibility* 89/336/EWG**
- **Niederspannung/*Low Voltage* 73/23/EWG**

Hiermit erklären wir, daß das unten aufgeführte Produkt zum Einbau in eine Maschine bestimmt ist und daß deren Inbetriebnahme so lange untersagt ist, bis festgestellt wurde, daß das Endprodukt den Bestimmungen der EU-Richtlinie 98/37/EG, Anhang II B entspricht.

Wir bestätigen Konformität mit der EU-Richtlinie über elektromagnetische Verträglichkeit 89/336/EWG und der EU-Niederspannungsrichtlinie 73/23/EWG.

We hereby certify that the product specified below is intended for installation in a machine which is forbidden to be put into operation until such time as it has been determined that the end product is in accordance with the provision of EU Directive 98/37/EEC, Annex II B.

We certify conformity with EU Electromagnetic Compatibility Directive 89/336/EEC and EU Low Voltage Directive 73/23/EEC.

Produkt/*Product*:

TMH 1600M

TMU 1600M

Angewendete Richtlinien, harmonisierte Normen und angewendete, nationale Normen:

Guidelines, harmonised standards, national standards in which have been applied:

EN 12100-1
EN 12100-2
EN 294
EN 1012-2
EN 61010-1

Unterschrift/*Signature:*

Pfeiffer-Vacuum GmbH
Emmeliusstrasse 33
35614 Asslar
Germany

(W. Dondorf)
Geschäftsführer
Managing Director

Herst.I/2000

Vacuum is nothing, but everything to us!

Turbo Pumps

Rotary Vane Vacuum Pumps

Roots Pumps

Dry Vacuum Pumps

Leak Test Units

Valves

Flanges, Feedthroughs

Vacuum Measurement

Gas Analysis

System Technology

Service

PFEIFFER VACUUM

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