



OPERATING INSTRUCTIONS



Translation of the original instructions

CALIBRATION SYSTEM PRO

for calibration of vacuum gauges



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1 About this manual

1.1 Validity

This operating manual is for customers of Pfeiffer Vacuum. It describes the functioning of the designated product and provides the most important information for safe use of the unit. The description follows applicable EU guidelines. All information provided in this operating manual refers to the current state of the product's development. The documentation remains valid as long as the customer does not make any changes to the product.

Up-to-date operating instructions can also be downloaded from www.pfeiffer-vacuum.com.

Applicable documents

Calibration system BASIC	Operating Instructions
Operating instructions for vacuum gauges	see product descriptions *
Declaration of conformity	Part of these operating instructions
Operating instructions for components:	
Operating instructions "HiPace 80 with TC 110"	PT 0208 BN *
Operating instructions "TC 110"	PT 0204 BN *
Operating instructions "DCU 110"	PT 0250 BN *
Operating instructions "HiPace Air Cooling Unit"	PT 0500 BN *
Operating instructions "DUO 3"	PD 0060 BN *
Operating instructions "OME 16 M "	PK 0213 BN *
Operating instructions "PKR 360"	BG 5164 BN *
Operating instructions "TPG 361"	BG 5195 BN *
Operating instructions "EVN 116"	BP 5005 BN *
Operating instructions "AVC 016 SA"	BP 5261 BN *

* also available at www.pfeiffer-vacuum.de

Variants

These operating instructions are valid for components with the following part numbers:

Part number	Designation	Difference
PS A30 110	Calibration system PRO	Nominal diameter (DN) of the flange connections on the vacuum chamber (see p. 33, chap. 11.2)
PS A30 111	Calibration system PRO	

The part number is given on the rating plate of the unit.

1.2 Conventions

Safety instructions

The safety instructions in Pfeiffer Vacuum operating instructions are the result of risk evaluations and hazard analyses and are oriented on international certification standards as specified by UL, CSA, ANSI Z-535, SEMI S1, ISO 3864 and DIN 4844. In this document, the following hazard levels and information are considered:

DANGER
Imminent danger Indicates an imminent hazardous situation that will result in death or serious injury.
WARNING
Possibly imminent danger Indicates an imminent hazardous situation that can result in death or serious injury.
CAUTION
Possibly imminent danger Indicates an imminent hazardous situation that can result in minor or moderate injury.

NOTICE**Command or note**

Command to perform an action or information about properties, the disregarding of which may result in damage to the product.

Pictographs

Prohibition of an action to avoid any risk of accidents, the disregarding of which may result in serious accidents



Warning of a displayed source of danger in connection with operation of the unit or equipment



Command to perform an action or task associated with a source of danger, the disregarding of which may result in serious accidents



Important information about the product or this document

Instructions in the text

→ Work instruction: here you have to do something.

Abbreviations

ATM:	Atmospheric Pressure
DCU:	Display Control Unit
GAV:	Gas dosing valve mit separate shut-off valve
TC:	Turbo Control (Electronic Drive Unit)
TPS:	Turbo Power Supply (Power Supply Pack)
UUC:	Unit Under Calibration
UUT:	Unit Under Test
VAC:	High vacuum
[P:000]:	Parameter of the electronic drive unit with number

1.3 References for standards and guidelines**ISO 3567****Calibration of vacuum gauges by direct comparison with a reference gauge**

This standard defines the physical, technical and metrological conditions, which must be fulfilled, when vacuum gauges are calibrated by direct comparison with a reference gauge.

DAkkS-DKD-R 6-2**Calibration of measuring equipment for vacuum**

This directive determines the minimum requirements for the calibration of measuring equipment. It does not replace the necessary work instructions for DAkkS calibrations. The parts of this directive contain the details for calibration of various kinds of vacuum gauges.

1.4 Liability and warranty

Pfeiffer Vacuum takes no responsibility or warranty if the user or third parties:

- disregard this document,
- use the product improperly,
- does any kind of modifications on the product (conversions, changes, etc.), which are not documented in the corresponding product documentations,
- operates the product with accessories, which are not documented in the corresponding product documentations.

The responsibility associated with the process used media is with the operator.

1.5 Target groups

These operating instructions are aimed at operators of the calibration system and at technically qualified personnel with experience in calibration of vacuum gauges.

2 Safety

2.1 Safety precautions

The unit is manufactured according to the latest state of the art and the recognized safety rules. However, improper use can cause danger to life of the operator or third parties or can cause damage to the unit and other material.

Information requirements



Information requirements regarding possible risks

Every person, who does installation, operation or maintenance on the calibration system, must read, understand and obey the safety relevant parts of these operating instructions.

→ The operator is obligated to indicate risks to every user, which come from the vacuum pump, the pumped medium or the complete calibration system.

Operation of accessories



Installation and Operation of Accessories

Pfeiffer Vacuum pumps can be equipped with various adapted accessories. Installation, operation and maintenance of connected devices are described in detail in the operating instructions of the single devices.

→ Refer to chapter "Accessories" for information about order numbers of components.
→ Only use original accessories.

Risk of improper changes

Improper changes can have extensive consequences:

- dangerous electrical malfunctions can occur.
 - mechanical malfunctions can occur and the safety of the unit can be affected.
- Do not modify the unit.

General safety instructions

- Do not expose any body parts to the vacuum.
- Observe all safety and accident prevention regulations.
- Regularly check the proper observance of all safety measures.
- Always ensure a safe connection to the protective earthing conductor (PE, protection class I).
- Do not loosen any plug connection during operations.
- Wait for the rotor to reach standstill before performing work on the high vacuum flange.
- Keep leads and cables well away from hot surfaces (> 70 °C).
- Never fill or operate the calibration system with cleaning agent.
- Do not operate the calibration system with open high vacuum flange.
- Do not carry out any unauthorised modifications or conversions to the pumps.
- The unit has been accredited with protection class IP 20. Take necessary measures when installing into ambient conditions, which afford other protection classes.
- Note the shipping instructions, when returning the unit.
- Ensure the proper filling of the backing pump with operating fluid and lubricant.

Risk of contamination

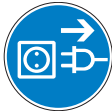


WARNING
<p>Contamination of the calibration system by contaminated devices Contact with hazardous substances can cause health hazard.</p> <ul style="list-style-type: none"> → Do not contaminate the calibration system by the use of contaminated devices. → In case of a contamination take appropriate safety measures to prevent health risks from hazardous substances. → Decontaminate concerned parts before doing any maintenance.

Risk of electrical power



WARNING
<p>Danger of electric shock The calibration system is only de-energized with the power plug disconnected.</p> <ul style="list-style-type: none"> → Switch off the master switch and disconnect the power plug before you do any work. → Prevent the unit from unintentional energizing and switching-on.



WARNING
<p>Danger of electric shock In case of defect, the parts connected to the mains supply are under voltage.</p> <ul style="list-style-type: none"> → Always keep the mains connection freely accessible so that you can disconnect it at any time.



WARNING
<p>Danger due to lack of power disconnection device Pump and electronic drive unit are not equipped with a power disconnection device. Installation of a user-supplied power disconnection device in accordance with SEMI-S2.</p> <ul style="list-style-type: none"> → Fit a circuit breaker with an interruption rating of min. 10,000 A.



WARNING
<p>Danger of unsafe electrical installation Safe operation after installation is the responsibility of the operator.</p> <ul style="list-style-type: none"> → Do not independently modify or change the pump and electrical equipment. → Make sure that the system is integrated in an emergency off safety circuit. → Consult Pfeiffer Vacuum for special requirements.



Risk of contamination



NOTICE
<p>Protect vacuum components against contamination Dirt and damages affect the function of the calibration system.</p> <ul style="list-style-type: none"> → Keep the calibration system and the gauges connected and in operation in order to keep the calibration system clean and efficient. → Pay attention to cleanliness and damage protection when operating vacuum components. → Ensure clean, greaseless and dry connection flanges.



**NOTICE****Risk of damage to the turbo pump because of contamination**

No parts, particles or dusts may get into the calibration system.

- Only remove blank flanges from the vacuum chamber for connection of vacuum gauges!

Risk of incorrect handling

**NOTICE****Risk of damaging vacuum gauges**

The calibration system or vacuum gauges can be damaged by incorrect handling during the calibration process.

- Obey the operating instructions of the vacuum gauges before the calibration.

**NOTICE****Process stability due to constant rotation speed of the turbo pump**

Inconstant rotation speed of the turbo pump can lead to negative influence on the calibration process.

- Make sure, that the rotation speed of the turbo pump remains stable throughout the whole calibration process and does not decrease below the nominal value.
- Obey the operating instructions of the display control unit DCU 110 regarding the speed control of the turbo pump.

Risk of overpressure during venting

**DANGER****Danger of excessive pressure in the vacuum chamber**

For the connection of nitrogen or other pressurized gases to the vacuum chamber, additional measures are necessary, to prevent a venting of the vacuum chamber to pressures > 500 hPa (relative pressure).

- Install a safety valve to the vacuum chamber.
- Contact Pfeiffer Vacuum for selecting an appropriate safety valve.

**NOTICE****Damage to vacuum gauges by venting**

Some vacuum gauges must be switched off before venting them to atmospheric pressure to prevent damage.

- Obey the operating instructions of the used vacuum gauges.

**NOTICE****Damage by excessive pressure in the vacuum chamber**

Excessive pressure in the vacuum chamber can cause damage to connected components and vacuum gauges.

- Do not vent the vacuum chamber in excess of atmospheric pressure.
- Connect a safety valve to the vacuum chamber.



NOTICE
<p>Risk of excessive inlet pressure at the turbo pump</p> <p>The turbo pump can be damaged by a high rate of pressure rise during venting. When the turbo pump is running, do the following:</p> <ul style="list-style-type: none"> → Do not disconnect the vacuum gauges or blank flanges from the vacuum chamber. → Switch off the turbo pump and let it reach standstill (0 Hz). → Set the gas flow to the minimum on the gas dosing valve before you open the internal shut-off valve. → Do not open the butterfly valve as long as the pressure in the vacuum chamber is >1 hPa. → If you use pressurized venting gas, maintain the allowed rate of pressure rise, because the gas flow of the venting gas supply rises in accordance with the inlet pressure. → Restart: Reduce the pressure in the calibration system with the backing pump to ≤ 22 hPa.



NOTICE
<p>Risk of overpressure in the calibration system with pressurized gas connection</p> <p>The max. permitted pressure at the inlet of the gas dosing valve is 500 hPa (relative pressure).</p> <ul style="list-style-type: none"> → Install a safety valve on the vacuum chamber. → Use a pressure reducer. → Set the inlet pressure on the pressure reducer to < 500 hPa (relative pressure). → Close the gas dosing valve, when normal atmospheric pressure has been reached in the vacuum chamber. → Avoid venting with pressure higher than normal atmospheric pressure. → Close the pressurized gas supply again after venting.

Correction factors for Pirani vacuum gauges



NOTICE
<p>Correction factors for Pirani vacuum gauges</p> <p>The applicable correction factors for Pirani vacuum gauges are given in the related operating instructions, in order to convert the indicated equivalent nitrogen pressure into the correct pressure for the measured gas.</p> <ul style="list-style-type: none"> → Take and obey the correction factors given in the operating instructions of the vacuum gauges.

2.2 Protective equipment

Determined situations concerning the handling of vacuum pumps require wearing of personal protective equipment. The owner, respectively the employer are obligated to provide an adequate equipment to any operating persons.



DANGER
<p>Danger to health by hazardous substances during maintenance or installation</p> <p>Depending on the process vacuum pumps, components or operating fluids can be contaminated by toxic, reactive or radioactive substances.</p> <ul style="list-style-type: none"> → Wear adequate protective equipment during maintenance and repairs or in case of reinstallation.



WARNING	
Danger from falling parts	<p>If you transport the unit by hand, parts can fall or slip and can thus cause danger.</p> <ul style="list-style-type: none"> → Always transport the unit with 2 persons two-handed. → Wear safety shoes with toe protection according to EN 347.



CAUTION	
Risk of injury through hot surfaces	<p>Vacuum pumps can become hot during operation.</p> <ul style="list-style-type: none"> → Allow the pump to cool before maintenance and repairs. → If necessary wear protective gloves according to EN 420.

2.3 Proper use



NOTICE	
EC conformity	<p>The manufacturer's declaration of conformity becomes invalid if the operator modifies the original product or installs additional components.</p> <ul style="list-style-type: none"> → Following installation into a plant and before commissioning, the operator must check the entire system for compliance with the valid EU directives and reassess it accordingly.

- The calibration system is intended for test, adjustment and calibration of vacuum gauges.

2.4 Improper use

Improper use voids any liability and warranty. Examples of improper use is any use for purposes that are different from the above.



Closure seal	<p>The product is sealed at the factory. Damaging or removal of a closure seal leads to the loss of liability and warranty entitlements.</p> <ul style="list-style-type: none"> → Do not open the product within its warranty period! → For process-related shorter maintenance intervals please contact the Pfeiffer Vacuum Service.
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2.5 Requirements for the operator

Safety conscientious work behaviour

- Only operate the unit in perfect technical condition.
- Only operate the unit in its intended use and safety consciously. Always be aware of dangers and obey these operating instructions.
- Fulfill the following regulations and supervise their adherence:
 - Intended use
 - General safety and accident prevention regulations
 - International, national und local valid standards and directives
 - Additional regulations related to the unit itself
- Only use original parts or parts which have been approved by Pfeiffer Vacuum.
- Keep these operating instructions available at the place of installation.

Qualification of personnel

Worksteps described in these operating instructions may only be carried out by personnel, who have the suitable technical qualification and have the necessary experience or have been trained by the operator respectively.

- Instruct technical personnel on the unit.
- Personnel to be instructed must only work on or with the unit with supervision by experienced personnel.
- Only allow instructed personnel to work with the unit.
- Make sure, that authorized personnel have read and understood these operating instructions as well as all further applicable documents before starting with the work, especially the safety instructions, maintenance instructions and overhaul instructions.
- Manage all responsibilities and the supervision of the personnel.

2.6 Requirements for the user

- Read, understand and obey these operating instructions and instructions made by the operator, especially the safety instructions and warnings.
- Only do the work with the help of the complete operating instructions and the further applicable documents.
- If you have any questions regarding operation or maintenance of the unit, which are not answered in these operating instructions, please contact the Pfeiffer Vacuum field service.

3 Transport and storage

3.1 Transport



WARNING

Danger from falling parts

If you transport the unit by hand, parts can fall or slip and can thus cause danger.

- Always transport the unit with 2 persons two-handed.
- Wear safety shoes with toe protection according to EN 347.

NOTICE

Damage due to transport

The unit can be damaged during transport in an unsuitable packing.

- Only transport the unit in its original packing.
- Keep the original packing.

- Only transport the calibration system by hand with 2 persons and two-handed.
- Always transport the calibration system upright and preferably plain.
- Keep the original protective caps and blank flanges.

3.2 Transportation lock

The backing pump of the calibration system is protected against damage during transport.

- Follow instructions concerning the installation location!
- Before putting into operation loosen the backing pump's transportation lock device at the installation location.

3.3 Storage



NOTICE

Damage due to improper storage

Improper storage increases the desorption rate and/or leads to mechanical damage of the unit.

- Keep the vacuum connections closed with protective caps at all times.
- Observe the permitted storage temperature and the ambient conditions.

- Store the calibration system in a cool, dry and dust-free place.
- Close the flanges with the original protective caps and blank flanges.
- Close further connection ports by using the corresponding protective covers.
- Store the calibration system only indoors at temperatures of between -10 °C to +40 °C (preferably at room temperature of 20°C).
- In rooms with humid or aggressive atmosphere or during long-term storage: Store the calibration system together with a desiccant (e.g. silica gel) shrink-wrapped in an air-tight plastic bag.

4 Product description

4.1 Product identification

To correctly identify the product when communicating with Pfeiffer Vacuum, always have the information from the rating plate available.

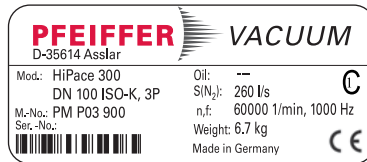


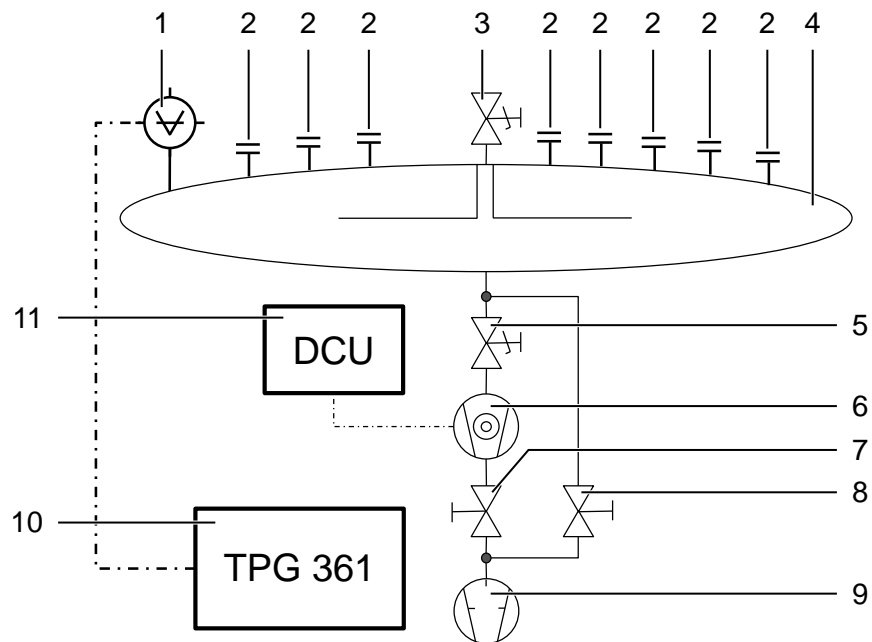
Fig. 1: Example for a rating plate

Scope of delivery

Calibration system BASIC, inclusive

- Calibration recipient
- Turbo pump HiCube 80
- Rotary vane pump DUO 3
- Control unit DCU 110
- Calibration set consisting of
 - Display unit TPG 361
 - Pirani/Cold cathode transmitter PKR 360
 - DKD Certificate
- GAV EVN 116
- Manually actuated valve AVC 016 SA
- Butterfly valve
- Mains cable
- Adapter attachment
- Operating instructions (incl. turbo pumping station HiCube 80 Eco and single components)

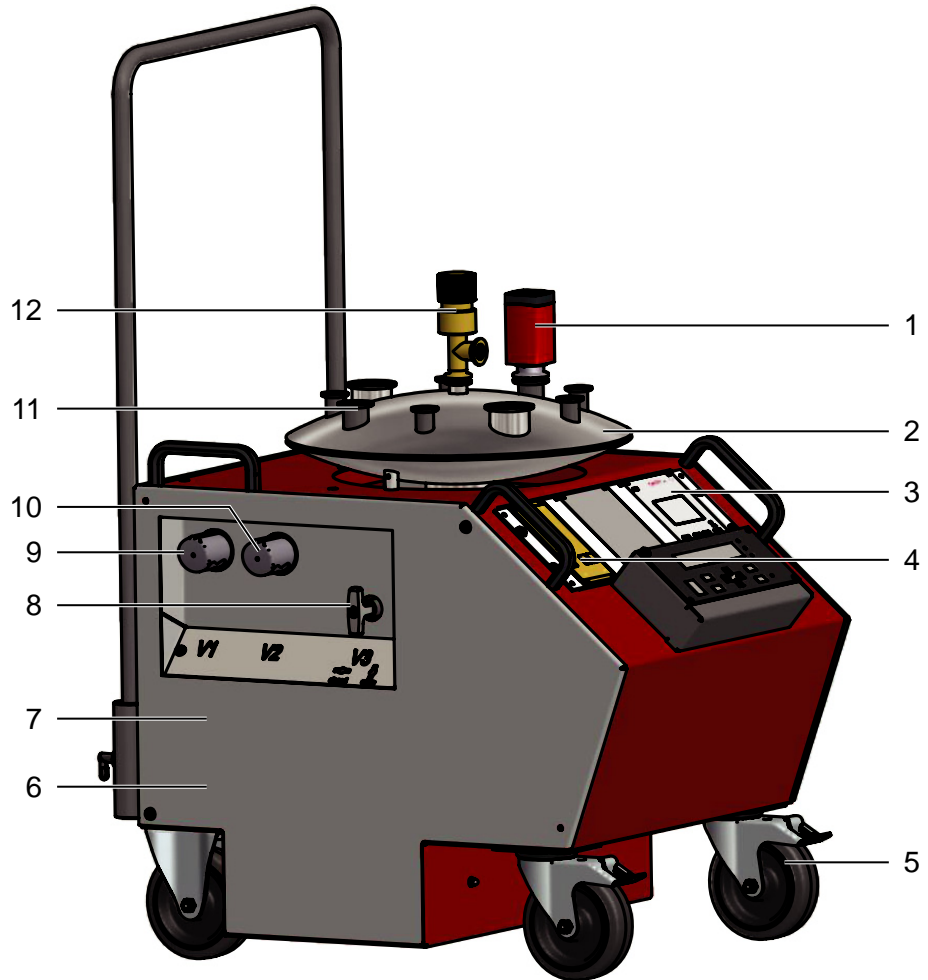
4.2 Vacuum layout



1 - Pirani/Cold cathode transmitter (PKR 360)	7 - Valve V2
2 - Flange connections for vacuum gauges	8 - Valve V1
3 - GAV (EVN 116)	9 - Backing pump (DUO 3)
4 - Vacuum chamber (figure exemplified)	10 - Display control unit (DCU 110)
5 - Butterfly valve	11 - Display unit (TPG 361)
6 - Turbo pump (HiPace 80)	

4.3 Structure

Controls and components



1 - Pirani/Cold cathode transmitter (PKR 360)	7 - Turbo pump (HiPace 80)
2 - Vacuum chamber (figure exemplified)	8 - Butterfly valve V3
3 - Display control unit (DCU 110)	9 - Valve V1 (AVC 016 M)
4 - Electronic drive unit (TC 110)	10 - Valve V2 (AVC 016 M)
5 - Roll wheels (4x) with clip breaks (2x)	11 - Flange connections for vacuum gauges
6 - Backing pump (DUO 3)	12 - GAV (EVN 116)

Description

The calibration system consists of a turbo pump HiCube 80, a backing pump DUO 3 and a vacuum chamber, mounted on a mobile housing. The vacuum chamber can be closed off from the turbo pump with the butterfly valve. With the two manually actuated valves in the bypass the backing pump could be connected directly with the vacuum chamber and/or the fore-vacuum line of the turbo pump.

The calibration system can be switched on and off with the master switch. The display control unit (3) takes over the control and monitoring.

The backing pump (6) generates the necessary fore-vacuum for the turbo pump.

On top of the vacuum chamber are - depending on the unit model - several flange connections with different nominal diameters for vacuum gauges (11). They are closed with blank flanges ex works.

The centrally positioned GAV (12) on the vacuum chamber is for central manual gas inlet regulation. The Pirani/cold cathode transmitter (1) on the vacuum chamber controls the calibration system.

The vacuum chamber can be closed off from the turbo pump with the manual butterfly valve. The T handle indicates the valve position.

The electronic drive unit (4) is supplied with power by the power supply pack and is an inherent part of the turbo pump. It is for inducement, monitoring and control of the turbo pump. The turbo pump is additionally equipped with a venting valve, which vents the turbo pump automatically in case of deactivation or a power cut-off.

The HiPace air cooling unit cools the turbo pump during operation. Additionally, the pumping station is equipped with a housing fan.

4.4 Range of application

The calibration system must be installed and operated in the following ambient conditions.

Installation location	weather protected (indoors)
Protection category	IP 20
Protection class	I
Ambient temperature	+5 °C to +30 °C with convection cooling without gas throughput +5 °C to +35 °C with air cooling +5 °C to +40 °C with water cooling
Relative humidity	max. 80 %, at T ≤ 31 °C, up to max. 50 % at T ≤ 40 °C
Atmospheric pressure	750 hPa - 1060 hPa
Installation altitude	2000 m max.
Degree of pollution	2
Permissible surr. magnetic field	≤ 3.3 mT
Overvoltage category	II
Connection voltage TC 110	24 V DC ± 5 %



Remarks to ambient conditions

The specified permissible ambient temperatures apply to operation of the turbopump at maximum permissible fore-vacuum pressure or at maximum gas throughput depending on the cooling method. The turbopump is intrinsically safe by a redundant temperature monitoring.

- By reducing the fore-vacuum pressure or gas throughput, the turbopump can be operated at higher ambient temperatures.
- If the maximum permissible operating temperature of the turbopump is exceeded, the electronic drive unit reduces drive power first and switches off then, if necessary.

5 Installation

5.1 Preparatory work

The installation location should be chosen so that components which need servicing are freely accessible at all times. No special foundation or base is necessary for installation. The unit must not be used outdoors.

Prerequisites

- The ambient conditions specified for the area of use

- Level, vibration-free surface
- Distance to side walls or adjacent devices: at least 50 cm

Selecting an installation site

- Ensure sufficient cooling for the pumping station.
- Use suitable shielding if the maximum permitted surrounding magnetic fields are exceeded.
- If the process results in high temperatures, install suitable shielding to ensure that the radiated heat output does not exceed the permissible values.
- Secure the pumping station at the final installation site with the clip breaks.

5.2 Connecting accessories



Installation and operation of accessories
 Pfeiffer Vacuum pumping stations can be equipped with a series of adapted accessories. The installation, operation, and maintenance of connected devices are described in detail in the operating manuals of the individual components.
 → Information about approved accessories see chapter "Accessories".
 → Use original accessories only.



NOTICE

Note the factory settings
 The accessory connections on the turbopump have been preconfigured at the factory. If the control lines on the connector are mixed up, this can cause the pumping station to malfunction or fail.



Accessory connector for the electronic drive unit TC 110

- Pfeiffer Vacuum accessory devices can be connected to the electronic drive unit TC 110 only by using the appropriate connection cable or adapter.
- Use Pfeiffer Vacuum display and control devices or a PC to configure the desired accessory output via RS-485.
- See the operating manual for the "Electronic Drive Unit TC 110."

5.3 Connecting to the mains power supply



WARNING

Danger to life from electric shock due to unsafe electrical installation
 The device uses mains voltage as the electrical supply. Unsafe or unprofessional electrical installation can lead to life-threatening situations.
 → Ensure that the system is integrated in an emergency-off safety circuit.
 → Do not perform any unauthorized conversions or modifications to the device.

- Connect the mains cable to the mains.
- Always ensure a secure connection to the protective earth (PE) (protection class I).

6 Operation

This chapter contains a description of all necessary steps to do a calibration with the calibration system.

6.1 Handling of the calibration system

You can use the calibration system for various purposes:

- Analysis of vacuum gauge malfunctions and verification of characteristics
- Adjustment of vacuum gauge range limits
- Calibration of vacuum gauges

Analysis

You can analyse UUT of process systems which have malfunctions.

The process vacuum system, in which you use the UUT, does not have to be blocked or switched off for this.

The small volume and the high pumping speed allow quick pressure changes in the calibration system.

Because of that you can check the UUT at the crucial operating pressures quickly.

Adjustment

The measuring range limits of vacuum gauges can shift in the course of their service life. Some types of vacuum gauges require occasional adjustment of their measuring range limits, for example

- Pirani gauges at ATM and VAC,
- Diaphragm gauges at zero of scale.

You can easily establish the required pressure conditions for this adjustment with the calibration system, compared to many process vacuum systems.

Calibration

Calibrating a UUC means the comparison of the UUC with a reference gauge.

The calibration can cover the entire range of measurement of the UUC or a limited range of interest.

The reference gauge has been calibrated before in a calibration process with a smaller measurement uncertainty.

The calibration chain is thereby linked to a national metrological laboratory, which provides standards with the lowest possible measurement uncertainty.

In commercial documents (catalogs, brochures) the measurement uncertainty is frequently denoted as accuracy.

You must do a careful consideration of the required accuracy of the UUC in order to choose the appropriate reference gauge.

In general, capacitance diaphragm gauges (Pfeiffer Vacuum ActiveLine types CMR, CCR) offer the highest accuracy as long as you use these gauges in the pressure decade below full scale.

For verification of a UUC a reference gauge of the same type is sufficient in most cases.

6.2 Requirements for a calibration

Before you can start a calibration, you must fulfil the the following 5 requirements:

Base pressure < calibration pressure

For a calibration according to ISO 3567 the base pressure p_0 of the calibration system must be lower than the lowest calibration pressure p_{\min} .

The following applies: p_0 is lower than p_{\min} divided by 10 ($p_0 < p_{\min}/10$)

Ambient temperature constant at 23°C

The ambient temperature must be at 23°C ($\pm 3^\circ\text{C}$).

Temperature changes of more than $\pm 1^\circ\text{C}$ during the calibration can lead to non-negligible measuring uncertainty.

Vacuum gauges at operating temperature

All UUC must be at operating temperature.

- UUC (thermally stabilized): min. 3 hours operating time
- UUC (not thermally stabilized): min. 30 minutes operating time

Thermal stability of the components

The calibration system and all components used during the calibration procedure need to be thermally stable.

To meet this requirement, all components must be located in a room with constant temperature for at least 2 hours prior to the calibration.

Zero adjustment <ZERO> and offset correction

To achieve the best possible result, every calibration requires a preceding zero adjustment and an offset correction of all vacuum gauges (*see p. 23, chap. 6.5*).

6.3 Preparation of the calibration system

Connection / exchange of vacuum gauges

Before you can connect vacuum gauges, the calibration system must be switched off, this means:

- The calibration system is in starting position (see p. 26, chap. 6.7)

Proceed as follows to connect vacuum gauges:

- Disconnect and remove the blank flanges from the flange connections of the vacuum chamber.
- Connect respectively exchange the UUC.
- Connect respectively exchange the reference gauge(s) if necessary.
- Start the calibration system (see p. 22, chap. 6.4).



Do not remove blank flanges unnecessarily

Blank flanges, sealings and the flanges on the vacuum chamber can get dirty.

- Keep not used flange connections on the vacuum chamber closed.
- Keep blind flanges and protect them against dirt.



Extended calibration range

You can connect additional reference gauges in order to achieve a higher accuracy or to extend the calibration range.

Connection of the nitrogen supply



NOTICE

Nitrogen reduces the adsorption of water in the vacuum system

A reduced adsorption of water in the vacuum system allows shorter pumping times. Therefore we recommend:

- Connect the inlet of the GAV to a nitrogen supply (N₂ 99,9% or better).
- Use nitrogen for the gas flow during the dynamic calibration.
- Use nitrogen to vent the vacuum chamber.



CAUTION

Danger when using other gases than nitrogen

Improper usage of other gases may result in health hazard and injuries.

- Observe the inlet pressure at the vacuum chamber of max. 500 hPa (relative pressure).
- Obey all safety instructions of the gas producer.
- Obey the relevant regulations regarding the gases you use.
- Comply with safety measures.



NOTICE

Danger of overpressure in the calibration system by pressurized gas connection

The max. permitted pressure at the inlet of the gas dosing valve is 500 hPa (relative pressure).

- Connect a safety valve to the vacuum chamber.
- Use a pressure reducer.
- Set the inlet pressure at the pressure reducer to < 500 hPa (relative pressure).
- Close the gas dosing valve when normal atmospheric pressure has been reached in the vacuum chamber.
- Do not vent with pressures higher than normal atmospheric pressure.
- Switch off the pressurized gas supply subsequently.

6.4 Starting the calibration system



Parameter set and Pfeiffer Vacuum display control unit

Pfeiffer Vacuum display control units DCU show the basic parameter set by default. Furthermore the DCU contains parameters, which are not positioned in the electronic drive unit.

- Parameter **[P:794]** = 1 (Display of all available parameters).

Before you can start the calibration system, the calibration system must be switched off and all vacuum gauges must be connected, this means:

- The calibration system is in starting position (see p. 26, chap. 6.7)
- The vacuum gauges (UUC) and the reference gauge(s) are connected to the vacuum chamber
- Not used flange connections on the vacuum chamber are closed

Proceed as follows to start the calibration system:

- Close the butterfly valve.
- Open valve V1 (valve between backing pump and vacuum chamber).
- Open valve V2 (valve between backing pump and turbo pump).
- Switch on the calibration system at the master switch.
- Switch on the pumping station at the DCU 110.
- Check the pressure of the Pirani/Cold cathode transmitter PKR at the integrated display unit TPG 361.
- When the pressure inside the vacuum chamber is < 1 mbar, close valve V1 and open the butterfly valve.
- Await the run-up of the turbo pump.

The calibration system is now ready for operation.



Automatic venting in case of mains power failure

In case of a mains power failure the calibration system will be vented automatically and time-delayed by the integrated venting valve of the turbo pump. The venting valve will open automatically as soon as the rotation speed of the turbo pump falls below the pre-set threshold limit for venting.

6.5 Zero adjustment <ZERO> and offset correction

Prior to a calibration you must perform a zero adjustment <ZERO> of all UUC and the reference gauge(s).

After the zero adjustment of a UUC with analog output (e.g. Pfeiffer Vacuum ActiveLine gauges), you must also adjust the zero of the DCU 110 (offset correction).

→ Refer to the operating instructions of the used vacuum gauges and the DCU 110 for the correct procedures and the necessary base pressures.

Before you can do the zero adjustment, the calibration system must have been started, this means:

- The calibration system is ready for operation (see p. 22, chap. 6.4).



Reaching the calibration pressure

A clean vacuum system should reach the pressure range of 10^{-6} hPa in a reasonable time. This is sufficient for the adjustment of all Pirani gauges.



Zero adjustment with PKR 360

You can use the pressure value of the Pirani/Cold cathode transmitter PKR 360 (scope of delivery) as reference gauge for the zero adjustment.

Proceed as follows to do the zero adjustment <ZERO> and the offset correction:

- Close the GAV to achieve an acceptable base pressure p_0 .
- Do the zero adjustment <ZERO> and the offset correction for all UUC and the DCU 110.
- Start the calibration of the UUC without any major delays to minimize measurement uncertainties by zero drift*.

* Drift designates a slow change of the metrological characteristics of a vacuum gauge.

6.6 Calibration of vacuum gauges

In general

You must start the calibration with the lowest pressure and then proceed to the highest pressure.

- Start the calibration of the UUC without any major delays after the zero adjustment <ZERO> to minimize measurement uncertainties by zero drift.
- For best accuracy: Note down the values of the UUC and the reference gauge simultaneously during the calibration process.
- In case of a reference gauge combination: Read the value of the reference gauge with the best accuracy in each pressure range.

Examples for measurement accuracies of the recommended reference gauges are shown in the appendix. (see p. 35, chap. 12.1)

Choosing a method and reference gauges

You must choose the method with dynamic or static direct comparison according to the pressure range.

- Pressure range < 0,1 hPa: do the dynamic direct comparison.
- Pressure range > 0,1 hPa: do the static direct comparison.

Pressure range	Method	Reference gauge (recommended)
< 0,1 hPa	dynamic direct comparison	CMR 375 Capacitance Full-Scale Gauge (Pfeiffer Vacuum ActiveLine) (Pressure range from 10^{-4} to 10^{-1} hPa)
		> 0,1 hPa
> 0,1 hPa	static direct comparison	CMR 363 Capacitance Full-Scale Gauge (Pfeiffer Vacuum ActiveLine) (Pressure range from 10^{-2} to 10 hPa)
		CMR 361 Capacitance Full-Scale Gauge (Pfeiffer Vacuum ActiveLine) (Pressure range from 1 to 1000 hPa)

Dynamic direct comparison

The following requirements must be fulfilled for the dynamic direct comparison:

- General requirements for a calibration are fulfilled (see p. 20, chap. 6.2).
- The calibration system is ready for operation (see p. 22, chap. 6.4).
- The zero adjustment <ZERO> and the offset correction have been done (see p. 23, chap. 6.5).

Proceed as follows for the dynamic direct comparison:



Extend the working range of the turbo pump

You may move the butterfly valve successively to an almost closed position to extend the working range of the turbo pump to higher pressures. Thus it works as a throttle to reduce the effective pumping speed of the turbo pump.

- Open the butterfly valve completely.
- Pump down the vacuum chamber to a pressure at least one decade lower than the lowest pressure of the intended calibration range.
- Carefully open the GAV to create a gas flow.
- Adjust the gas flow, so that the first calibration pressure is reached (indicated by the reference gauge).
- Start with the lowest pressure value and increase the pressure successively.

- Read the pressure values of the UUC and the reference gauge as soon as the pressure has stabilized.
 - For best results: Read the values of the UUC and the reference gauge simultaneously.
- For UUC with logarithmic output characteristics (e.g. Pirani, hot and cold cathode gauges):
 - Note down three to four values per decade (e.g. 1, 2, 5, ... or 1, 2, 4, 7, ...)
 - This will result in evenly spread data points over the whole range.
- For UUC with linear output characteristics:
 - Note down the values, which cover the range of interest.
- Record the data in a calibration report (see p. 27, chap. 6.8).

Static direct comparison

The following requirements must be fulfilled for the static direct comparison:

- General requirements for a calibration are fulfilled (see p. 20, chap. 6.2).
- The calibration system is ready for operation (see p. 22, chap. 6.4).
- The zero adjustment <ZERO> and the offset correction have been done (see p. 23, chap. 6.5).

Proceed as follows for the static direct comparison:

- Open the butterfly valve completely.
- Pump down the vacuum chamber to a pressure at least one decade lower than the lowest pressure of the intended calibration range.
- Close the butterfly valve in order to achieve a static pressure without gas flow in the vacuum chamber.
- Open the GAV slowly to adjust the required calibration pressure.
 - The pumping station does not generate a gas flow when the butterfly valve is closed.
- Close the GAV slightly as soon as the pressure in the vacuum chamber approaches the target value (indicated by the reference gauge).
- Close the GAV completely.
 - The pressure may still rise by a small amount.
- Read the pressure values of the UUC and the reference gauge as soon as the pressure has stabilized.
 - For best results: Read the values of the UUC and the reference gauge simultaneously.
- For UUC with logarithmic output characteristics (e.g. Pirani, hot and cold cathode gauges):
 - Note down three to four values per decade (e.g. 1, 2, 5, ... or 1, 2, 4, 7, ...)
 - This will result in evenly spread data points over the whole range.
- For UUC with linear output characteristics:
 - Note down the values, which cover the range of interest.
- Record the data in a calibration report (see p. 27, chap. 6.8).

6.7 Switching off the calibration system



DANGER

Danger of excessive pressure in the vacuum chamber

For the connection of nitrogen or other pressurized gases to the vacuum chamber, additional measures are necessary, to prevent a venting of the vacuum chamber to pressures > 500 hPa (relative pressure).

- Install a safety valve to the vacuum chamber.
- Contact Pfeiffer Vacuum for selecting an appropriate safety valve.



Parameter set and Pfeiffer Vacuum display control unit

Pfeiffer Vacuum display control units DCU show the basic parameter set by default. Furthermore the DCU contains parameters, which are not positioned in the electronic drive unit.

- Parameter **[P:794]** = 1 (Display of all available parameters).

Proceed as follows to switch off the calibration system:

- Close the butterfly valve.
- Vent the turbo pump with the automatic venting function of the DCU 110.
 - Enable venting with parameter **[P:012]**
 - Select the venting mode with parameter **[P:030]**
- Switch off the calibration system on the DCU 110.
- Switch off the calibration system at the master switch.
- Vent the vacuum chamber manually with the GAV.
- Close the GAV as soon as atmospheric pressure has been reached.
 - Do not vent the vacuum chamber to higher pressures than atmospheric pressure.
- Close the separate shut-off valve of the GAV.
- Set the gas flow to minimum on the GAV.
- Shut off the nitrogen supply.
- Allow the turbo pump to come to a standstill (0 Hz).
- Close valve V2 (valve between backing pump and turbo pump).

Starting position

After you have switched off the calibration system, the following starting position has been reached:

- The turbo pump is in standstill (0 Hz).
- The vacuum chamber is vented.
- The bypass line is vented.
- V1 (valve between backing pump and vacuum chamber) is closed.
- V2 (valve between backing pump and turbo pump) is closed.
- The butterfly valve is closed.
- The GAV is closed (with gas flow set to minimum).

6.8 Interpretation of the data

After you have completed the calibration process, you must compare the measured values with the accepted tolerances of the vacuum gauges (UUC) for each pressure range.

→ Refer to the operating instructions of the vacuum gauges (UUC) for the tolerances.

It is helpful to create a spreadsheet to display the measured pressure data and the calculated deviations automatically in a diagram.

Calibration report

An example for a calibration report:



Calibration report

Unit under calibration: ActiveLine CMR363
 Test equipment: Calibration System Basic
 Ambient temperature (°C): 23

Type: ActiveLine CMR363
 Art.No.: PT R24 611
 S.No.: 123456789

Reference gauges

Reference 1: CMR 375 Art.No. PT R25 141
 S.No.: 123456789 DAkkS-No.: 1234/D-K-12345-01-00/2016-12

Reference 2: PCR 280 Art.No. PT R26 855
 S.No.: 123456789 DAkkS-No.: 1234/D-K-12345-01-00/2016-12

Target pressure	Reference gauge	Unit under calib.	Deviation
1,00E-04	9,93E-05	1,02E-04	2,76%
2,00E-04	1,99E-04	2,09E-04	4,99%
4,00E-04	4,01E-04	4,23E-04	5,53%
7,00E-04	6,99E-04	7,33E-04	4,97%
1,00E-03	1,00E-03	1,03E-03	2,52%
2,00E-03	2,00E-03	2,03E-03	1,53%
4,00E-03	4,00E-03	4,04E-03	0,94%
7,00E-03	7,00E-03	7,06E-03	0,82%
1,00E-02	1,00E-02	1,01E-02	0,79%
2,00E-02	2,00E-02	2,01E-02	0,77%
4,00E-02	4,00E-02	4,03E-02	0,73%
7,00E-02	7,00E-02	7,04E-02	0,59%
1,00E-01	1,00E-01	1,00E-01	0,48%
2,00E-01	2,00E-01		-
4,00E-01	4,00E-01		-
7,00E-01	7,00E-01		-
1,00E+00	1,00E+00		-
2,00E+00	2,00E+00		-
4,00E+00	4,00E+00		-
7,00E+00	7,00E+00		-
1,00E+01	1,00E+01		-
2,00E+01	2,00E+01		-
4,00E+01	4,00E+01		-
7,00E+01	7,00E+01		-
1,00E+02	1,00E+02		-
2,00E+02	2,00E+02		-
4,00E+02	4,00E+02		-
7,00E+02	7,00E+02		-
9,00E+02	9,00E+02		-
1,00E+03	1,00E+03		-

Calibration technician: _____
 Name, Forename

Date: 12.09.2015

Calibration according to ISO 3567:

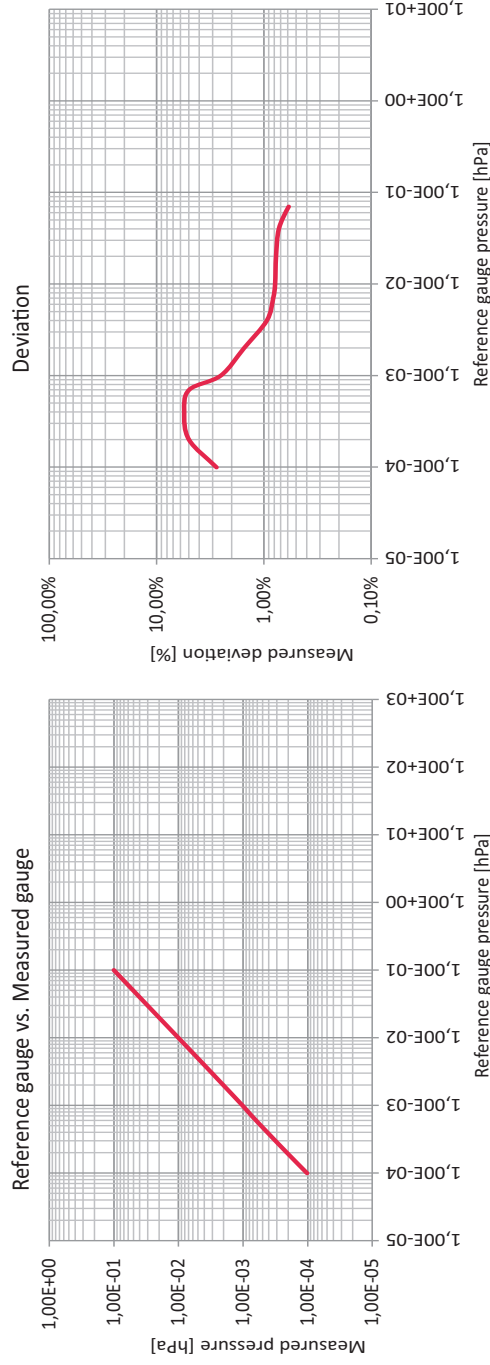
Vacuum gauges - Calibration by direct comparison with a reference gauge

Page 1 of 2



Calibration report

Unit under calibration	ActiveLine CMR363	Calibration System Basic
Type:	PT R24.611	23
Art.No.:	123456789	Test equipment:
S.No.:		Ambient temperature (°C):



Calibration technician: _____ Date: 12.09.2015
 Name, Forename

7 Maintenance / replacement

7.1 General maintenance information



WARNING

Danger to life from electric shock during maintenance and service work

The device is completely free of voltage only if the mains plug is removed.

- Switch off the master switch and disconnect the mains plug before all work.
- Secure the device against being switched on again accidentally.



WARNING

Health risks and environmental damage from contaminated parts

Contaminated parts can be harmful to health and environment.

- Inform yourself about possible contamination before you start working on the product.
- Adhere to the relevant regulations when you handle contaminated parts and obey the safety precautions.

7.2 Maintenance intervals and responsibilities

- Carry out the required maintenance on the components of the pumping station in accordance with the instructions in the individual operating manuals.
- Clean the pumping station externally with a lint-free cloth and a little industrial alcohol.
- Shorter maintenance intervals are required for extreme loads or unclean processes. Clarify with Pfeiffer Vacuum service.
- For all other cleaning, maintenance, or repair work, contact your Pfeiffer Vacuum service point.

8 Decommissioning

8.1 Shutting down for extended periods

Procedure for a prolonged shutdown of the turbopumping station

- Replace the operating fluid reservoir of the turbopump.
- Close the flange openings using the original protection covers.
- Store the pumping station only indoors at temperatures between -10 °C and +40 °C.
- In rooms with humid or aggressive atmospheres: Hermetically seal the pumping station in a plastic bag together with a desiccant.

8.2 Re-commissioning



NOTICE

Damage to the turbopump due to excess age of the operating fluid after re-commissioning

The operating fluid in the turbopump has a limited shelf life. Old operating fluid can cause the ball bearings to fail and damage the turbopump.

- Ensure that the operating fluid is suitable for use: max. 2 years without operation, Max. 4 years in total following periods of operation and non-operation.
- Follow the maintenance instructions and inform Pfeiffer Vacuum.

Procedure for re-commissioning the pumping station

- Check the pumping station for contamination and moisture.
- Clean the pumping station externally with a lint-free cloth and a little industrial alcohol.
- If necessary, arrange for Pfeiffer Vacuum Service to clean the pumping station completely.
- If necessary, arrange maintenance of the pumping components by Pfeiffer Vacuum Service.
- Installation and commissioning in accordance with manual.

8.3 Disposal



WARNING

Health risks and environmental damage from contaminated parts

Contaminated parts can be harmful to health and environment.

- Inform yourself about possible contamination before you start working on the product.
- Adhere to the relevant regulations when you handle contaminated parts and obey the safety precautions.

- Dispose of substances in accordance with the applicable local regulations.

9 Malfunctions

9.1 General

Malfunctions on the pumping station are usually caused by faults on individual components. LEDs on the turbopump and backing pump show the operating states for the respective device.

- The DCU display and control unit displays basic operating states for the pumping station.
- The DCU shows operating faults by outputting an error code on the display.

9.2 Troubleshooting

Problem	Possible causes	Remedy
Pumping station will not start up. None of the LEDs on the DCU is illuminated.	• Electrical supply interrupted	<ul style="list-style-type: none"> • Check the supply lines of the pumping station. • Check the 24 V output voltage on the "DC out" terminal of the power supply unit. • Check the plug contacts on the power supply unit. • Check the connection cable between the power supply unit, backing pump, and turbopump.
	• Incorrect operating voltage	<ul style="list-style-type: none"> • Apply the correct operating voltage. • Observe the type plate.
	• No operating voltage applied	<ul style="list-style-type: none"> • Apply the correct operating voltage.
	• Electronic drive unit defective	<ul style="list-style-type: none"> • Replace the drive electronics in accordance with the turbopump operating manual • Call Pfeiffer Vacuum Service
Pumping station is not achieving the required final pressure.	• Condensate in the backing pump	<ul style="list-style-type: none"> • Open the gas ballast valve on the backing pump
	• Gas ballast valve open	<ul style="list-style-type: none"> • Close the gas ballast valve on the backing pump

10 Service

Pfeiffer Vacuum offers first-class service!

- Operating fluid and bearing change on the spot by Pfeiffer Vacuum FieldService
- Maintenance / repair in the nearby ServiceCenter or ServicePoint
- Fast replacement with exchange products in mint condition
- Advice on the most cost-efficient and quickest solution

Detailed information, addresses and forms at: www.pfeiffer-vacuum.com (Service).

Maintenance and repair in the Pfeiffer Vacuum ServiceCenter

The following steps are necessary to ensure a fast, smooth servicing process:

- Download the forms "Service Request" and "Declaration on Contamination".¹⁾
- Fill out the "Service Request" form and send it by fax or e-mail to your Pfeiffer Vacuum service address.
- Include the confirmation on the service request from Pfeiffer Vacuum with your shipment.
- Fill out the declaration on contamination and include it in the shipment (required!).
- Dismantle all accessories.
- Drain the operating fluid (applies for turbopumps with pumping speed > 700 l/s).
- Leave electronic drive on the pump.
- Close the flange openings by using the original protective covers.
- If possible, send pump or unit in the original packaging.

Sending of contaminated pumps or devices

No units will be accepted if they are contaminated with micro-biological, explosive or radioactive substances. "Hazardous substances" are substances and compounds in accordance with the hazardous goods directive (current version). If pumps are contaminated or the declaration on contamination is missing, Pfeiffer Vacuum performs decontamination at the shipper's expense.

- Neutralise the pump by flushing it with nitrogen or dry air.
- Close all openings airtight.
- Seal the pump or unit in suitable protective film.
- Return the pump/unit only in a suitable and sturdy transport container and send it in while following applicable transport conditions.

Exchange unit

The factory operating parameters are always preset with exchange units. If you use changed parameters for your application, you have to set these again.

Service orders

All service orders are carried out exclusively according to our repair conditions for vacuum units and components.

¹⁾ Forms under www.pfeiffer-vacuum.com

11 Technical data and dimensions

11.1 General

Basic principles for the Technical Data of Pfeiffer Vacuum Turbopumps:

- Recommendations of PNEUROP committee PN5
- ISO 21360; 2007: "Vacuum technology - Standard methods for measuring vacuum-pump performance - General description"
- ISO 5302; 2003: "Vacuum technology - Turbomolecular pumps - Measurement of performance characteristics"
- Ultimate pressure: using a test dome and a 48 hrs. period of baking out
- Gas throughput: water cooling; backing pump = rotary vane pump (10 m³/h)
- Cooling water consumption: at max. gas throughput, cooling water temp. 25 °C
- Integral leak rate: using a Helium concentration of 100 %, period 10 s
- Sound pressure level: Distance 1 m to the pump

Conversion table: pressure units

	mbar	bar	Pa	hPa	kPa	Torr mm Hg
mbar	1	$1 \cdot 10^{-3}$	100	1	0.1	0.75
bar	1000	1	$1 \cdot 10^5$	1000	100	750
Pa	0.01	$1 \cdot 10^{-5}$	1	0.01	$1 \cdot 10^{-3}$	$7.5 \cdot 10^{-3}$
hPa	1	$1 \cdot 10^{-3}$	100	1	0.1	0.75
kPa	10	0.01	1000	10	1	7.5
Torr mm Hg	1.33	$1.33 \cdot 10^{-3}$	133.32	1.33	0.133	1

1 Pa = 1 N/m²

Conversion table: gas throughput units

	mbar·l/s	Pa·m ³ /s	sccm	Torr·l/s	atm·cm ³ /s
mbar·l/s	1	0.1	59.2	0.75	0.987
Pa·m ³ /s	10	1	592	7.5	9.87
sccm	$1.69 \cdot 10^{-2}$	$1.69 \cdot 10^{-3}$	1	$1.27 \cdot 10^{-2}$	$1.67 \cdot 10^{-2}$
Torr·l/s	1.33	0.133	78.9	1	1.32
atm·cm ³ /s	1.01	0.101	59.8	0.76	1

11.2 Technical data

Parameter	PS A30 110	PS A30 111
Connection for gauge	4x DN 16 ISO-KF, 2x DN 25 ISO-KF, 1x DN 40 ISO-KF, 1x DN 40 CF	5x DN 16 ISO-KF, 2x DN 25 ISO-KF, 2x DN 40 ISO-KF
Pumping speed for N ₂	67 l/s	67 l/s
Pumping speed backing pump at 50 Hz	2.5 m ³ /h	2.5 m ³ /h
Ultimate pressure	$<1 \cdot 10^{-7}$ hPa	$<1 \cdot 10^{-7}$ hPa
Power consumption	230 VA	230 VA
Mode of operation	Manual	Manual
Gas inlet	DN 16 ISO-KF	DN 16 ISO-KF
Accuracy	Depending on the used reference gauges	Depending on the used reference gauges
Gas flow max.	$5 \cdot 10^{-6} - 1 \cdot 10^3$ hPa l/s	$5 \cdot 10^{-6} - 1 \cdot 10^3$ hPa l/s
Weight	52 kg	52 kg
Cable length	3 m	3 m
Measurement range max.	$1 \cdot 10^3$ hPa	$1 \cdot 10^3$ hPa
Measurement range min.	$1 \cdot 10^{-4}$ hPa	$1 \cdot 10^{-4}$ hPa
Voltage: Range	115 V, 50/60 Hz; 230 V, 50/60 Hz	115 V, 50/60 Hz; 230 V, 50/60 Hz
Material	Stainless steel, gas bead blasted	Stainless steel, gas bead blasted

11.3 Dimensions

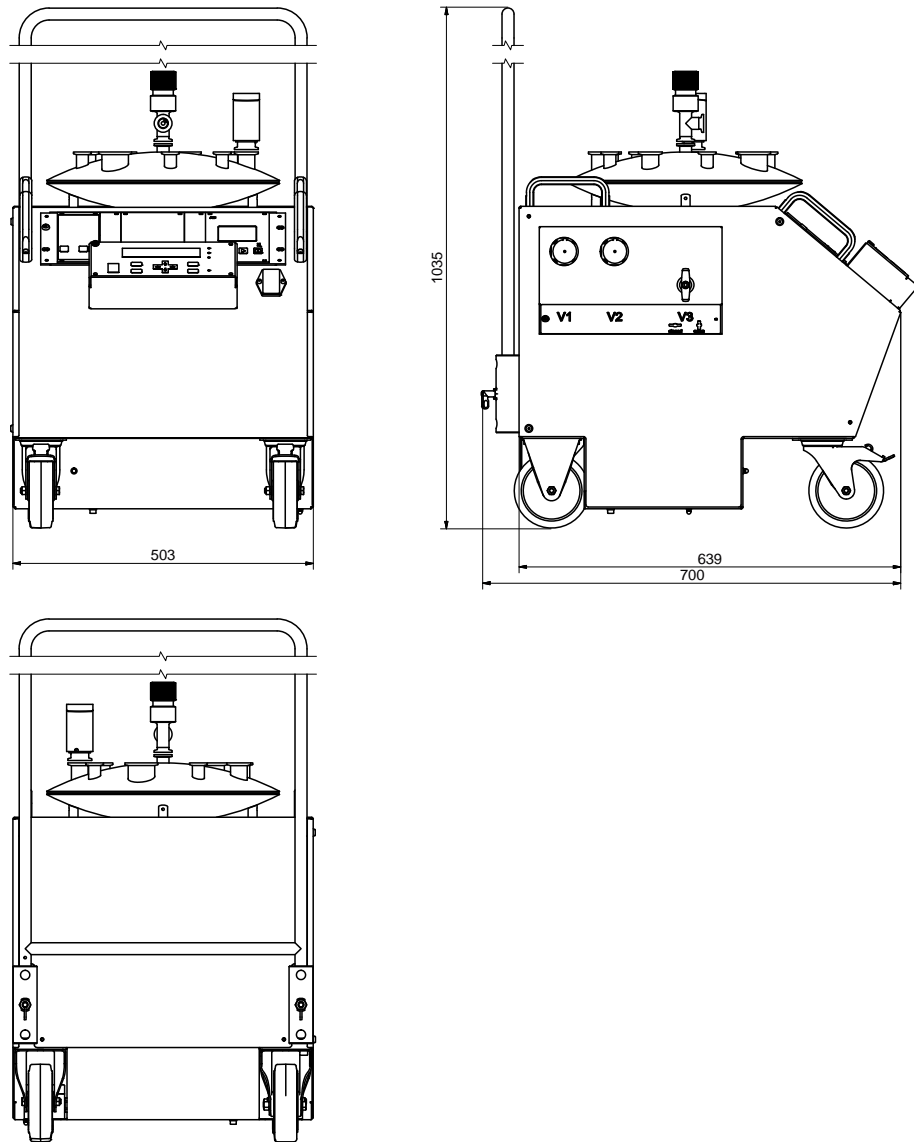
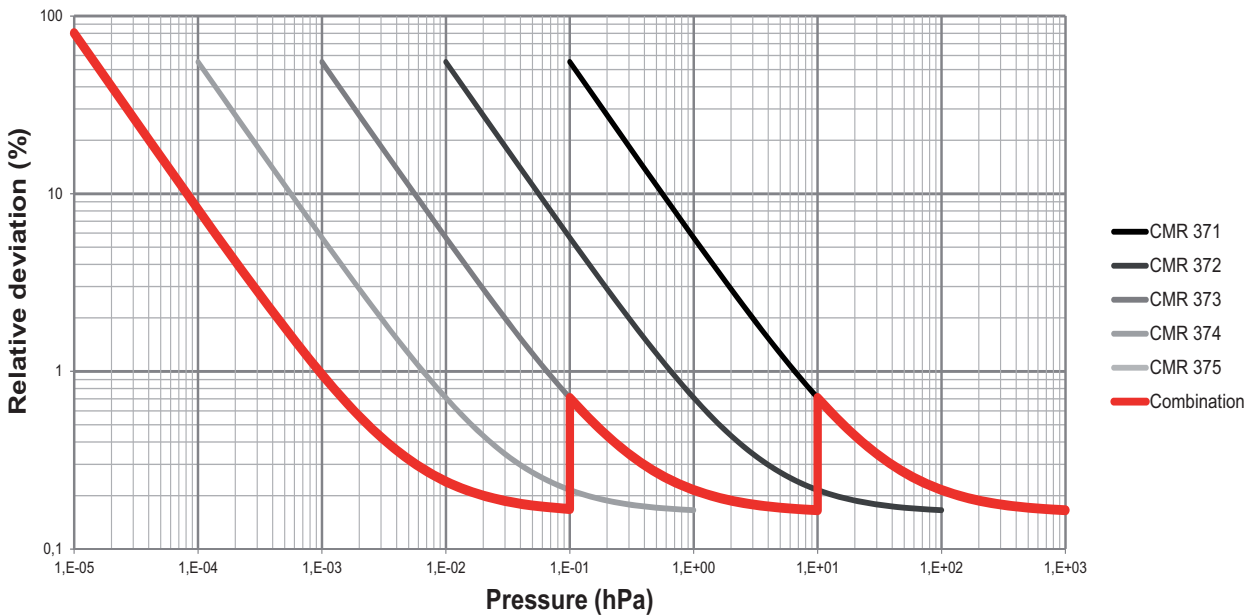
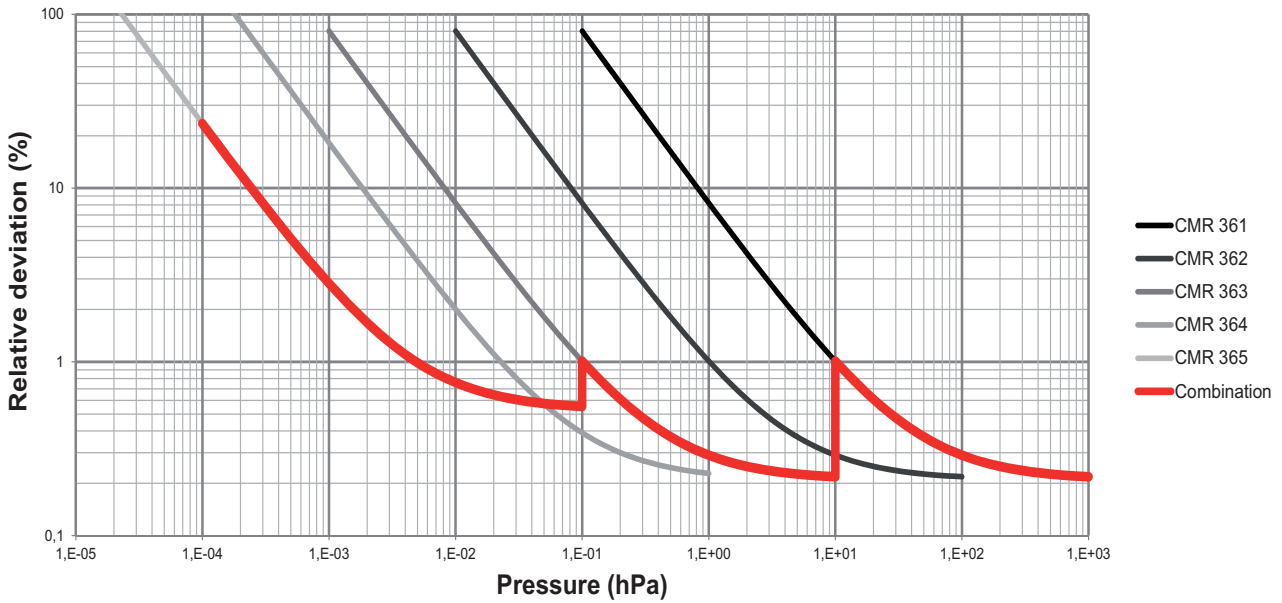


Fig. 2: Dimensions (The flange connections are exemplified.)

12 Appendix

12.1 Examples for measurement accuracies

Examples for measurement accuracies with three different capacitance gauges CMR 36x respectively CMR 37x as reference gauges (upper range values 1000 hPa, 10 hPa and 0,1 hPa).





Declaration of conformity

We hereby declare that the product cited below satisfies all relevant provisions according to the following **EC directives**:

- **Machinery 2006/42/EC (Annex II, no. 1 A)**
- **Electromagnetic Compatibility 2014/30/EU**

The agent responsible for compiling the technical documentation is Mr. Andreas Würz, Pfeiffer Vacuum GmbH, Berliner Straße 43, 35614 Asslar.

Calibration system

Pro

Harmonised standards and national standards and specifications which have been applied:

EN ISO 13857:2008	Safety distances
EN ISO 12100:2010	Safety of machinery (General principles for design)
EN 61000-6-2:2005	EMC (Generic standard: Immunity standard for industrial environments)
EN 61000-6-4:2007/A1:2011	EMC (Generic standard: Emission standard for industrial environments)
EN 60204-1:2006/A1:2009	Safety of machinery (Electrical equipment)

Signature:

Pfeiffer Vacuum GmbH
Berliner Straße 43
35614 Asslar
Germany

(Dr. Ulrich von Hülsen)
Managing Director

2016-12-16

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