The Vacuum Technology Book

PFEIFFER VACUUM

Volume 1

New developments

HiPace™

These turbopumps are picking up the pace in vacuum technology! Faster. Higher. Stronger.

Page 332

HiPace™ MC

Magnetically levitated turbopumps with integrated drive electronics.

Page 412

PentaLine™

The new generation two-stage rotary vane pump.

Page 214

HenaLine™

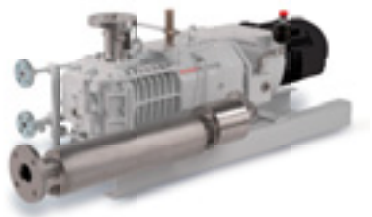
Single-stage rotary vane pumps for low and medium vacuum applications.

Page 190

OktaLine™

Roots pumps for every low and medium vacuum application.

Page 264



HeptaDry™

The dry screw pump. Optimum ultimate pressure. Absolutely oil-free. Cool running.

Page 316

PrismaPlus™

The new mass spectrometer. Modular design. Intelligent software. Wide range of applications.

Page 552

HiQuad™

New high-end mass spectrometer. Fast, flexible and easy to operate.

Page 560

Valves

Electromagnetically, electropneumatically and manually actuated.

Page 674

Dear Customers and Prospective Customers,

As a technology leader, Pfeiffer Vacuum develops high-performance, dependable products for generating and measuring vacuum. In addition, we also engineer and manufacture complete vacuum systems for you.

Your concrete needs enjoy top priority at Pfeiffer Vacuum. And this is why we offer you a complete, balanced and innovative product portfolio. With our standard products, our customer-specific solutions and, last but not least, our excellent service, we thus assist you in satisfying your individual requirements.

We are committed to two factors for our joint success: Global customer intimacy and high-technology that offers the utmost quality and perfection. And our end-to-end product line is what defines the way we see ourselves: As a competent, forward-looking, honest partner to you in developing, manufacturing and delivering the products you need.

This book symbolizes our pioneering vacuum technology and provides you with more than just an overview of our product portfolio, which represents unrivaled German engineering achievements. It also affords insights into the major fundamentals of vacuum technology and advises you in selecting a cost-effective solution for your specific needs.

We hope that this Vacuum Technology Book will spark your interest and look forward to constructive, successful collaboration with you.

Yours sincerely

Dr. Matthias Wiemer,
Managing Director

Yours sincerely

Manfred Bender,
CEO

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Vacuum is nothing, but everything to us.
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Vacuum Technology
Know-how
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Vacuum generation

Rotary vane pumps
This product line includes HenaLine™ single-stage rotary vane pumps as well as DuoLine™ and PentaLine™ two-stage rotary vane pumps
Page 186

Roots pumps
This product line includes OktaLine™ standard, magnetically coupled and explosion hazard-protected OktaLine™ pumps
Page 264

Dry pumps
In addition to diaphragm pumps, this product line also includes HeptaDry™ screw pumps, XtraDry™ piston pumps, as well as the OnTool™ Booster side channel pump that compresses against atmosphere
Page 294

Turbopumps
This product line includes the HiPace™ series of hybrid and fully magnetically levitated pumps, as well as pumps for corrosive gas applications
Page 332

Vacuum analysis and measurement

Measurement and control units
This product line includes analog (ActiveLine) and Digital (DigiLine) equipment, as well as equipment for research & development applications (ModulLine)
Page 450

Mass spectrometers
This product line includes the PrismaPlus™ and HiQuad™ mass spectrometers for residual gas analysis
Page 546

Leak detectors
This product line includes the SmartTest helium leak detector with a selection of various backing pumps
Page 570

Installation elements

Components and feedthroughs
This product line includes ISO-KF, ISO-K, ISO-CF/FR flange components, as well as rotary, linear motion, coaxial and electric feedthroughs
Page 600

Valves
This product line includes manually, electropneumatically and electromagnetically actuated valves, as well as special valves
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Appendix
System solutions, figures, data, facts, product index
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The Company

Vacuum is nothing but everything to us.

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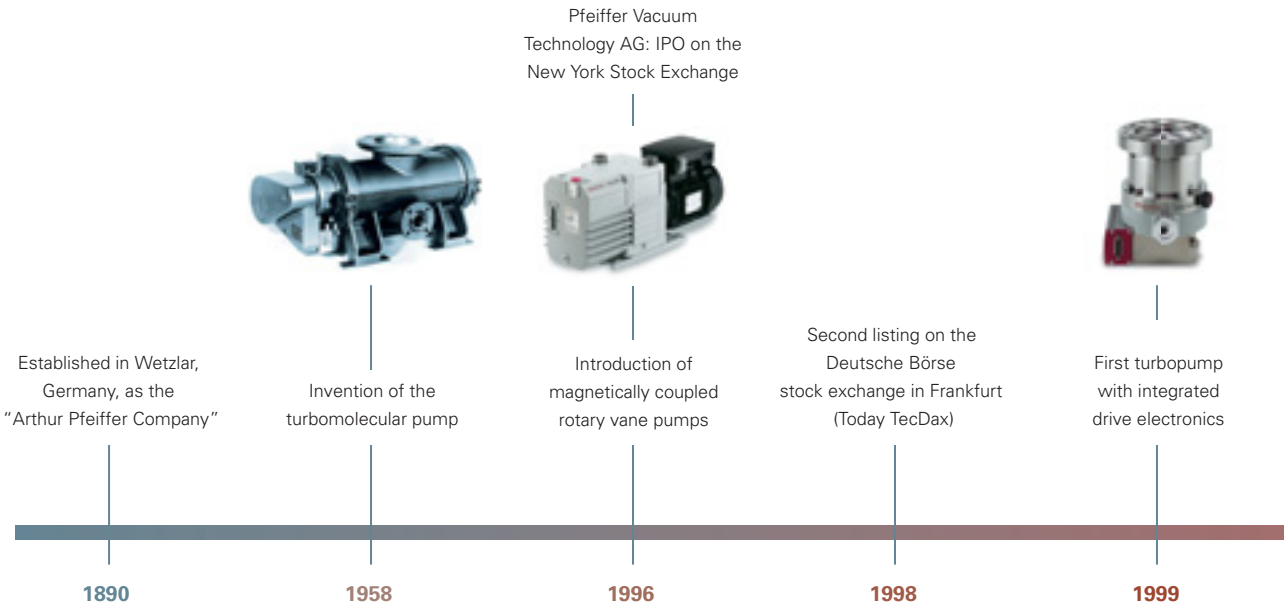
Pfeiffer Vacuum – Milestones



Pfeiffer Vacuum – Your ideal partner

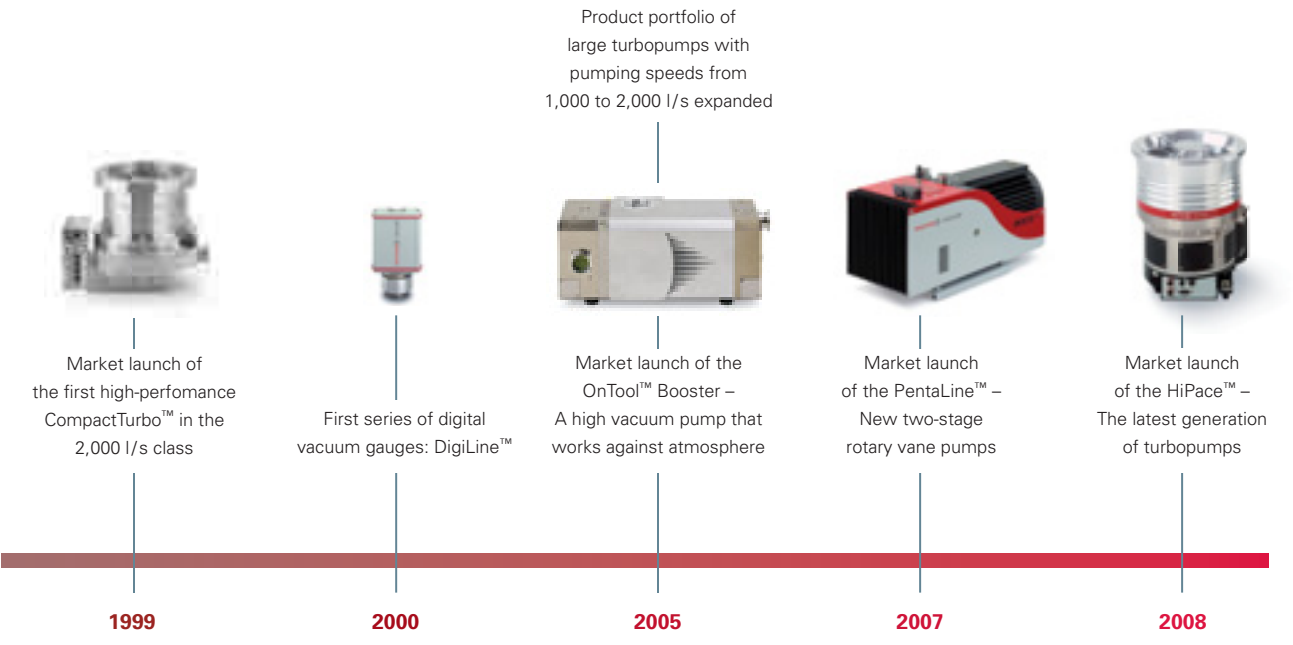
Our name stands for innovative solutions, reliable high-technology products, as well as first-class service.

For some 120 years, we have been setting milestones in vacuum technology with our products. Our comprehensive portfolio of products and services ranges from individual components right through to complex vacuum systems. As a leading supplier, we offer the right solution for every application.

Quality and worldwide service play a crucial role in this connection. With the invention of the turbopump, we set new standards in vacuum technology many years ago. And Pfeiffer Vacuum is the world market leader in this field.

With a close-knit global sales and service network, we are always nearby. A long and successful track record of customer- and application-specific experience makes Pfeiffer Vacuum your ideal partner.

High-quality, dependable products. First-class service. Competent advice. These are our strengths!



Advantages at a glance

- A leading manufacturer in the field of vacuum technology for around 120 years
- World market leader with more than 280,000 turbopumps sold
- Strong investments in research & development
- An independent, innovative company
- A full line of products, ranging from individual components right through to complex vacuum systems
- Worldwide on-site service
- Very high standard of quality

Quality management:
Certified under ISO 9001

Environmental management:
Certified under ISO 14001

Modern vacuum technology

Vacuum generation

Turbopumps

Rotary vane pumps

Dry pumps

Roots pumps

Vacuum analysis and measurement

Mass spectrometers

Leak detectors

Vacuum measurement and control equipment

Installation elements

Components

Valves

Vacuum systems

Leak detection systems

Vacuum pumping stations

Vacuum produces pressure conditions that are similar to those that prevail in outer space and are indispensable for manufacturing any number of high-tech products and articles that are used in daily life. The production of solar cells, semiconductors and insulated glazing, as well as coating high-stress, mechanical tools or even eyeglasses, are but a few examples of applications for vacuum technology. Vacuum also plays a major role in environmental technology, analytical applications, the automotive industry, as well as research & development.

A steady stream of new high-growth applications and markets stems from Pfeiffer Vacuum's position as a leading manufacturer of components and systems for vacuum generation, measurement and analysis. Many forward-looking ideas would not be feasible without the products from Pfeiffer Vacuum.

Quality

More than 280,000 turbopumps from Pfeiffer Vacuum are in service throughout the world. They are running trouble-free for up to 200,000 hours. Products from Pfeiffer Vacuum are employed in a wide variety of industries. They accompany the International Space Station (ISS) in space, for example, or assure the vacuum required for wafer production. These are applications in which quality always plays a crucial role.

Our products are constantly being optimized – through close collaboration with customers from a wide variety of industries, through modern development work and through the tremendous enthusiasm and commitment of our people. That enables us to satisfy the high demands of the market.

This is documented by numerous distinctions like the R&D 100 Award or being honored by the Technical University of Aachen (RWTH).

Markets

Analytical industry

In analyzing gases, it is possible to assure and reproducibly create the conditions required for complex, highly sensitive physical-chemical processes in the field of process technology. Pfeiffer Vacuum is responding to the trend toward small, integrated devices that range all the way to portable systems with compact turbopumps that offer pumping speeds of up to 700 liters per second in combination with dry backing pumps and digital measurement equipment.

The fields of application include mass spectrometry in the pharmaceutical, medical, environmental and biotechnology industries, as well as electron microscopy in the semiconductor industry. Further fields of application are the automotive industry, refrigeration and air conditioning technology, vacuum and overpressure technology, as well as the packaging industry.

Semiconductor industry

The term semiconductor is used to denote solid-state electronic components, such as transistors or microprocessors. These semiconductor modules are used, for example, in computers, mobile phones, digital cameras, MP3 and DVD players, flat panel displays, flash memories, automobiles and household electronics. Pfeiffer Vacuum offers turbopumps, backing pumps, pumping stations and measurement equipment for the following applications: Coating, CVD processes, lithography, etching and implantation processes. Further application options include process chamber transfer, wafer transport or electron microscopy (SEM and SLM).

Coating

Modifying the properties of surfaces is the key to improving the functionality, appearance and serviceability of numerous products. Optical and mechanical properties are modified through the application of thin layers in the nanometric to micrometric ranges. It is also possible to produce conductive or decorative coatings. Fields of application include the production of architectural glass, eyeglass lenses, flat panel displays and solar cells, as well as gear coating. Pfeiffer Vacuum supplies a complete product portfolio for coating systems. In addition to individual components, we also offer pumping stations that are customized for your specific needs.

Industry

Quality demands are steadily rising in connection with the manufacture of industrial products, with vacuum technology taking on increasing significance in this connection. Requirements with respect to quality assurance and environmental protection can be satisfied superbly with know-how and products from Pfeiffer Vacuum. Emission reductions, such as in the automotive industry, for example, are being achieved with the aid of vacuum technology. Pfeiffer Vacuum offers a complete product portfolio that is geared to the needs of industry for applications from the fields of metallurgy, leak detection, freeze- and vacuum-drying, as well as electron beam welding and general vacuum applications.

Research & development

Research laboratories at universities, major research centers and industrial research facilities in Europe, the United States, Asia and other parts of the world rely upon the quality and dependability of our products. Moreover, such products as turbopumps, leak detectors and mass spectrometers from Pfeiffer Vacuum are also employed in connection with research into renewable energies.

Pfeiffer Vacuum online

Internet
In addition to the latest information about the company, as well as detailed product and investor relations pages, Pfeiffer Vacuum's Internet presence also offers a number of further online services. These include the Contact rubric, an easy-to-use selection aid, our tradeshow calendar, our extensive press archive, as well as numerous download offerings, such as photos, brochures and operating instructions. In addition to the German- and English-language versions, additional versions in Spanish, French, Portuguese and Russian are also available.

Online catalog
The Pfeiffer Vacuum online catalog not only offers a wealth of product information, such as technical data, product illustrations, dimensional drawings and characteristic curves, it also features a user-friendly menu system with direct interactive selection. Further comfort functions, such as product comparisons and product inquiries, round out the online version of the catalog.

Service

Flexible service for your application.

First-class service for high-quality products.
Responsive. Dependable. Cost-effective.
Long service life of vacuum components coupled with only low downtimes are your clear expectations. We satisfy your requirements with powerful products and outstanding service.

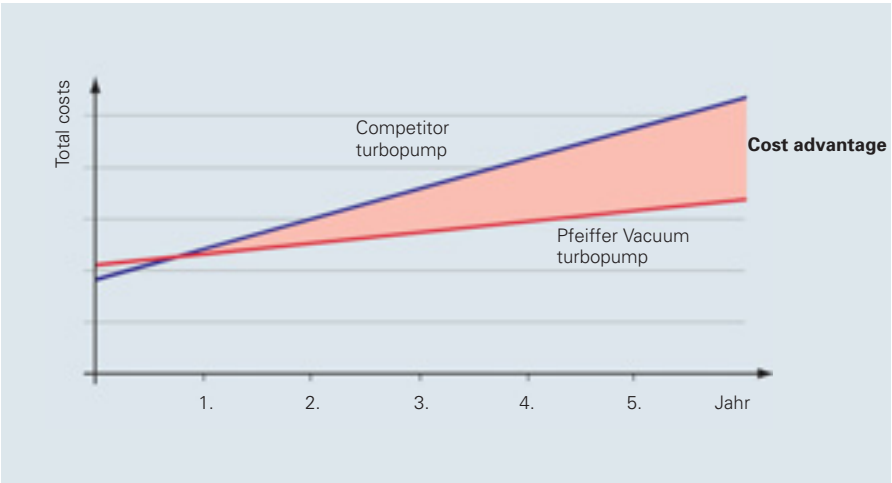
Our professional sales and service engineers stand ready to provide you with active assistance worldwide. Pfeiffer Vacuum offers an end-to-end portfolio of products and services, ranging from spare parts right through to service agreements: The modular service system, geared precisely to your needs.

We are the only manufacturer of turbopumps that is able to perform bearing changes on site. These savings of time and money are an invaluable advantage, and not just in plant engineering. One-stop shopping for products and service.

Service

Service offerings at a glance

- Fast, competent service worldwide
- On-site bearing changes
- Maintenance and repairs at our service locations
- On-site start-up of components and systems
- Replacement products and spare parts
- Application training for dependable operation
- Service agreements that are geared to customer needs



In addition to the cost of acquisition, total cost of ownership throughout the life of the product is also contingent upon operating and maintenance expenses.

Training

Service begins early on at Pfeiffer Vacuum.
In thinking about service, what often first comes to mind are repairs, spare parts or failures. But prevention takes top priority in our thinking! In addition to sound advice, what prevents a "worst case scenario" from ever happening in the field of service are training and maintenance, first and foremost. Our offerings include customer training courses on vacuum technology and our products. And regular training for our service engineers keeps them state of the art.

Spare parts

We install the same parts as in our new products!
Pfeiffer Vacuum uses only genuine spare parts that satisfy our high quality requirements. Please use only genuine parts in repairing and maintaining our backing pumps.

They assure longer service life and prevent costly consequential damage.
Please also use only genuine spare parts in maintaining our turbopumps, and take advantage of our service for repairs. Our professional service team stands ready to provide you with active support!

Maintenance

Downtime when you can afford it.
Regular maintenance safeguards against sudden, unexpected failures. Maintenance means: Maximum uptime. Maintenance when you can afford it – scheduled to fit in with your specific operations. When professionally maintained with genuine spare parts, our products are characterized by very long service life – even under the most punishing operating conditions.
Your advantage: Pfeiffer Vacuum is the only manufacturer of turbopumps that is able to change bearings on site!

Exchange

Components at a fair price!
Working exchange:
If regular equipment maintenance is needed, but the timing or on-site conditions are not convenient.

Standard exchange:
If a unit has failed and downtime has to be avoided.
In both cases, what you get are units that

- Feature state-of-the-art technology and engineering
- Are tested just the same as a new unit

Standardized service offerings

We insist on identical standards everywhere throughout the world! This is why we have certified each and every service location as either a ServiceCenter or ServicePoint. Because customer intimacy and competence are top priorities at Pfeiffer Vacuum.

ServiceCenter:

- Rotor-stator replacement
- Repair
- Maintenance

ServicePoint:

- Maintenance
- Repair

Service

Training

Vacuum seminars for first-class products – Know-how that's state of the art

We place particular emphasis on an intensive and comprehensive training program. Because: Every company is only as good as its people! We conduct regular seminars to assure that our excellently trained service engineers are always state of the art.

Our customers have differing needs. This is why in addition to our standard seminars we also offer customer-specific training at our Training Center in Asslar or – if you wish – on-site at your facility.

Our trainers impart to you the knowledge, skills and abilities you need for handling vacuum components and systems.

You'll receive intensive advice about application options, the use and operation of our products, as well as preventive maintenance.

We offer training that supports you and moves you forward in your fields of work. With their know-how, enthusiasm and commitment, our professional trainers stand ready to provide you with active support worldwide!

What you get from us are high quality products, first-class service and state-of-the-art training! Pfeiffer Vacuum can provide you with comprehensive training offerings that are geared to your individual needs.
We're setting standards – in technical training as well!

Training offerings at a glance

- Standard seminars and customer-specific training
- Know-how that is state of the art
- Practical exercises in small groups
- At the Training Center in Asslar or on-site at your facility
- One-stop shopping for products, service and training

Training content – Fundaments of vacuum technology

Vacuum generation
Turbopumps
Rotary vane and Roots pumps
Dry pumps
Pumping stations

Vacuum measurement
Total pressure measurement
Fundamentals of mass spectrometry
Partial pressure measurement

Leak detection
Fundamentals of leak detection
Helium leak detectors

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1 Introduction to Vacuum Technology

1.1 General

1.1.1 What is vacuum?

A vacuum is defined as a diluted gas, or the corresponding state at which its pressure or density is lower than that of the ambient surrounding atmosphere. Because atmospheric pressure fluctuates locally over the Earth's surface and lessens as altitude above sea level increases, it is not possible to specify a general upper limit for the vacuum range.

1.1.2 Overview of vacuum

Consequently, in order to achieve a vacuum it is necessary to generate a pressure in a vessel that is lower than the ambient pressure. Due to the Earth's gravity, atmospheric pressure varies with altitude in accordance with the barometric altitude formula:

Formula 1-1
Barometer formula

$$p = p_0 \cdot \exp\left(-\frac{g \cdot \rho_0 \cdot h}{V_0 \cdot p_0}\right)$$

Where:
Atmospheric pressure at sea level p_0 = 1,013 mbar
Earth acceleration g = 9.81 m/s^2
Density of air at sea level at 0 °C ρ_0 = 1.293 kg/m^3.

Combining the constants yields::

Formula 1-2
Barometer formula number

$$p = p_0 \cdot \exp\left(-\frac{h}{8{,}005\ m}\right)$$

If $p = p_0/2$ and the formula is solved for h, the result is the half altitude value $h_{1/2}$ = 5,548 m. In other words: Atmospheric pressure declines by one half every 5.548 km.

At the cruising altitude of a passenger jet, i.e. at approximately 10 km above the surface of the Earth, atmospheric pressure has already decreased to 290 mbar. Weather balloon data are measured at an altitude of approximately 30 km at a pressure of 24 mbar. The pressure levels prevailing at these altitudes can still be categorized as being in the low vacuum range, which will be discussed in greater detail below. An even greater distance from the Earth's surface, finally, brings us to satellite orbits at an altitude of 250 km, where the pressure has now decreased to 10^{-5} – 10^{-6}. What prevails farther out in space is an ultra high vacuum of less than 10^{-14}.

Practical utilization of pressure differentials to exert a force is meaningful in the 1,000 to 1 mbar range. In this application range, vacuum is indicated in % of atmospheric pressure.

Various aids are required in order to achieve pressures on Earth that are similar to the natural vacuum that prevails in space. These differing pressure ranges can be achieved through the use of vacuum pumps.

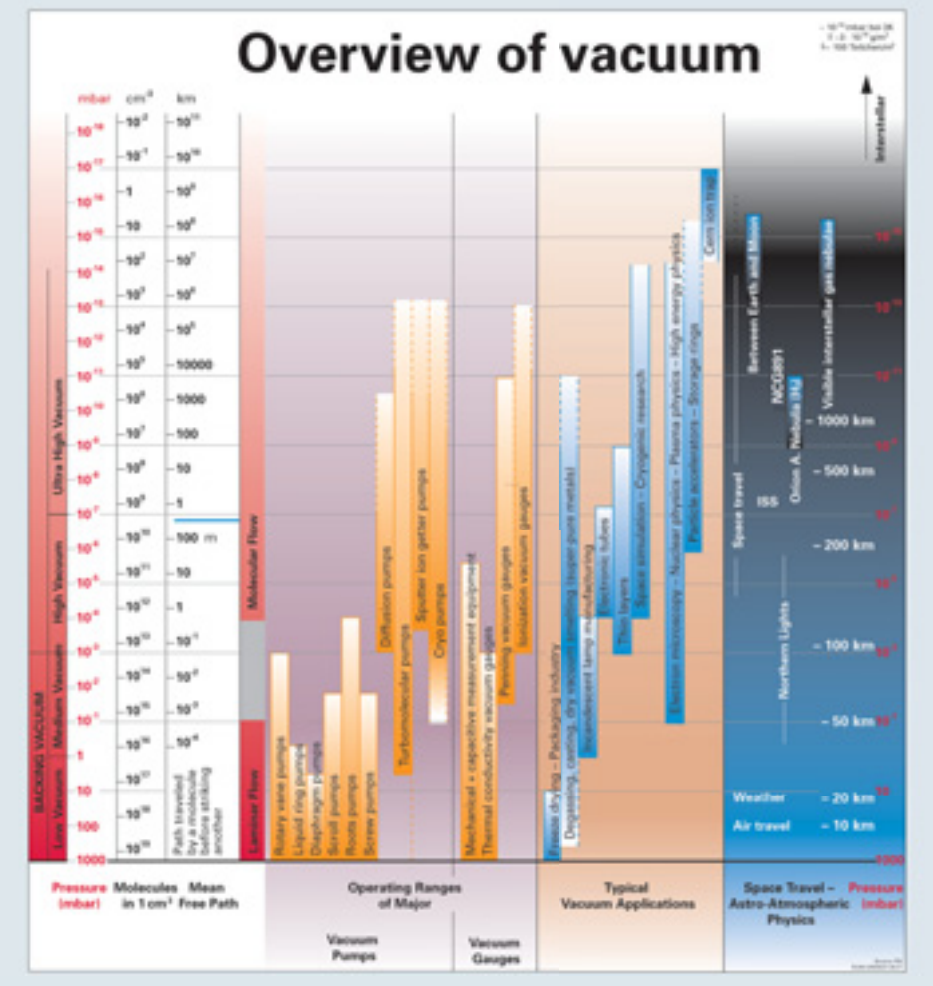


Figure 1.1: Overview of vacuum

Source: Paul Scherer Institut, CH

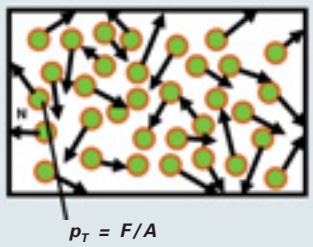
1.2 Fundamentals

1.2.1 Pressure

Any gas enclosed within a volume is always uniformly distributed. The individual gas particles are constantly moving back and forth at high-speed within the volume; upon striking the vessel wall, they exert a force F on surface A due to pulse transmission. The pressure p that is exerted on the wall is defined as

Formula 1-3
Definition of pressure

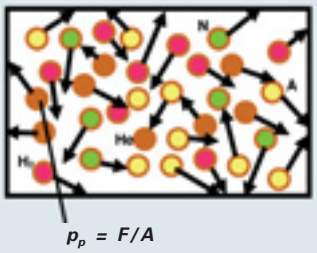
$$p = \frac{F}{A}$$



- Pressure in vessel
- One gas, e.g. nitrogen N_2
- Various gases, e.g. air

Figure 1.2: Definition of total pressure

If the gas is made up of different types of gases, each of these gases will exert a pressure that corresponds to its concentration; this is called partial pressure. The sum of all partial pressures equals the total pressure. Air is a good example of this: In addition to its main constituents of nitrogen, oxygen and water vapor, air also contains many trace gases.



- Partial pressure
- Sum of partial pressures of all gases present equals total pressure
- All gases present evidenced through mass spectrometry

Figure 1.3: Definition of partial pressure

Table 1.1: Total pressure and composition of air at 20 °C and 50 % relative humidity

Gas	Partial Pressure / mbar
Nitrogen	781.8
Oxygen	209.7
Water vapor	12
Argon	9.34
Carbon dioxide	$3.3 \cdot 10^{-1}$
Neon	$1.82 \cdot 10^{-2}$
Helium	$5.23 \cdot 10^{-3}$
Krypton	$1.15 \cdot 10^{-3}$
Hydrogen	$4.94 \cdot 10^{-3}$
Xenon	$8.7 \cdot 10^{-5}$
Total pressure	1,013

The pressure range of vacuum comprises the interval of 0 – 1 bar. A distinction is made between the following pressure ranges:

Table 1.2: Pressure ranges/Molecular number density

Pressure Range	Pressure / mbar	Molecular Number Density / cm^{-3}
Low vacuum	10^{3} – 10^{0}	$2.65 \cdot 10^{19}$ – $2.65 \cdot 10^{16}$
Medium vacuum	10^{0} – 10^{-3}	$2.65 \cdot 10^{16}$ – $2.65 \cdot 10^{13}$
High vacuum	10^{-3} – 10^{-7}	$2.65 \cdot 10^{13}$ – $2.65 \cdot 10^{9}$
Ultra high vacuum	10^{-7} – 10^{-12}	$2.65 \cdot 10^{9}$ – $2.65 \cdot 10^{4}$

In accordance with Formula 1-3 for pressure definition, the SI unit Pa = N/m² will be used for this purpose. Also customary in actual practice are the units of pressure shown in the conversion table below. It is very customary to use mbar as a unit of pressure.

Table 1.3: Conversion table for units of pressure

	Pa = N/m²	bar	mbar	µbar = dyn/cm²	Torr = mm Hg	micron µ = mTorr	atm	at	mm WS	psi = lbf/inch²	psf = lbf/ft²
Pa	1	$1 \cdot 10^{-5}$	$1 \cdot 10^{-2}$	10	$7.5 \cdot 10^{-3}$	7.5	$9.87 \cdot 10^{-6}$	$1.02 \cdot 10^{-5}$	0.102	$1.45 \cdot 10^{-4}$	$2.09 \cdot 10^{-2}$
bar	$1 \cdot 10^{5}$	1	$1 \cdot 10^{-3}$	$1 \cdot 10^{6}$	750	$7.5 \cdot 10^{5}$	0.987	1.02	$1.02 \cdot 10^{4}$	14.5	$2.09 \cdot 10^{3}$
mbar	100	$1 \cdot 10^{-3}$	1	1,000	0.75	750	$9.87 \cdot 10^{-4}$	$1.02 \cdot 10^{-3}$	10.2	$1.45 \cdot 10^{-2}$	2.09
µbar	0.1	$1 \cdot 10^{-6}$	$1 \cdot 10^{-3}$	1	$7.5 \cdot 10^{-4}$	0.75	$9.87 \cdot 10^{-7}$	$1.02 \cdot 10^{-6}$	$1.02 \cdot 10^{-2}$	$1.45 \cdot 10^{-5}$	$2.09 \cdot 10^{-3}$
Torr	$1.33 \cdot 10^{2}$	$1.33 \cdot 10^{-3}$	1.33	1,330	1	1,000	$1.32 \cdot 10^{-3}$	$1.36 \cdot 10^{-3}$	13.6	$1.93 \cdot 10^{-2}$	2.78
micron	0.133	$1.33 \cdot 10^{-6}$	$1.33 \cdot 10^{-3}$	1.33	$1 \cdot 10^{-3}$	1	$1.32 \cdot 10^{-6}$	$1.36 \cdot 10^{-6}$	$1.36 \cdot 10^{-2}$	$1.93 \cdot 10^{-5}$	$2.78 \cdot 10^{-3}$
atm	$1.01 \cdot 10^{5}$	1.013	1,013	$1.01 \cdot 10^{6}$	760	$7.6 \cdot 10^{5}$	1	1.03	$1.03 \cdot 10^{4}$	14.7	$2.12 \cdot 10^{3}$
at	$9.81 \cdot 10^{4}$	0.981	981	$9.81 \cdot 10^{5}$	735.6	$7.36 \cdot 10^{5}$	0.968	1	$1 \cdot 10^{-4}$	14.2	$2.04 \cdot 10^{3}$
mm WC	9.81	$9.81 \cdot 10^{-5}$	$9.81 \cdot 10^{-2}$	98.1	$7.36 \cdot 10^{-2}$	73.6	$9.68 \cdot 10^{-5}$	$1 \cdot 10^{-4}$	1	$1.42 \cdot 10^{-3}$	0.204
psi	$6.89 \cdot 10^{3}$	$6.89 \cdot 10^{-2}$	68.9	$6.89 \cdot 10^{4}$	51.71	$5.17 \cdot 10^{4}$	$6.8 \cdot 10^{-2}$	$7.02 \cdot 10^{-2}$	702	1	144
psf	47.8	$4.78 \cdot 10^{-4}$	0.478	478	0.359	359	$4.72 \cdot 10^{-4}$	$4.87 \cdot 10^{-4}$	4.87	$6.94 \cdot 10^{-3}$	1

1.2.2 General gas equation

The following applies for gases: A volume of 22.414 liters (mol volume) at a temperature of 273.15 K (standard temperature = 0 °C) and a pressure of 101,325 pa (standard pressure) contains 6.02 times 10^{23} particles (Avogadro's number). The mass of the gas thus enclosed is its molecular weight in grams.

The general gas equation describes the state of a gas as a function of pressure, temperature and volume.

Formula 1-4
General gas equation

$$p \cdot V = \frac{m}{M} \cdot R \cdot T = n \cdot V \cdot k \cdot T$$

Thus:

Formula 1-5
Gas pressure

$$p = n \cdot k \cdot T$$

Where:

p = pressure [Pa; N/m²]
V = volume [m³]
m = mass [kg]
M = molar mass [kg/kmol]
R = general gas constant R = 8.314510 kJ/(kmol K)
T = thermodynamic temperature [K]
n = molecular number density [1/m³]
k = Boltzmann's constant k = $1.380 \cdot 10^{-23}$ J/K

1.2.3 Molecular number density

As can be seen from Formula 1-4 and Formula 1-5 pressure is proportional to molecular number density. Due to the high number of molecules per unit of volume at standard conditions, it follows that at a pressure of 10^{-12} mbar, for example, 26,500 molecules per cm³ will still be present. This is why it is not possible to speak of a void, or nothingness, even under ultra high vacuum.

1.2.4 Thermal molecular velocity

Gas molecules in a vessel move back and forth in different directions and at different speeds. Their velocity distribution corresponds to a bell curve having its peak at the most probable velocity

Formula 1-6
Probable velocity

$$c_w = \sqrt{\frac{2 \cdot R \cdot T}{M}}$$

The mean thermal velocity is

Formula 1-7
Mean velocity

$$\bar{c} = \sqrt{\frac{8 \cdot R \cdot T}{\pi \cdot M}}$$

The following table shows values for selected gases.

Table 1.4: Molar masses and mean thermal velocities of various gases

Gas	Molar Mass / (g / mol)	Mean Velocity / (m / s)	Mach Number
H_2	2	1,762	5.3
He	4	1,246	3.7
H_2O	18	587	1.8
N_2	28	471	1.4
Air	29	463	1.4
Ar	40	394	1.2
CO_2	44	376	1.1

1.2.5 Mean free path

The mean free path is the mean path length that a molecule traverses between two successive impacts with other molecules. It depends upon molecular diameter d_m and temperature T in accordance with the following equation

Formula 1-8
Mean free path

$$\bar{l} \cdot p = \frac{k \cdot T}{\pi \cdot \sqrt{2} \cdot d_m^{\,2}}$$

and is of significance for the various flow types of a gas in a vacuum.

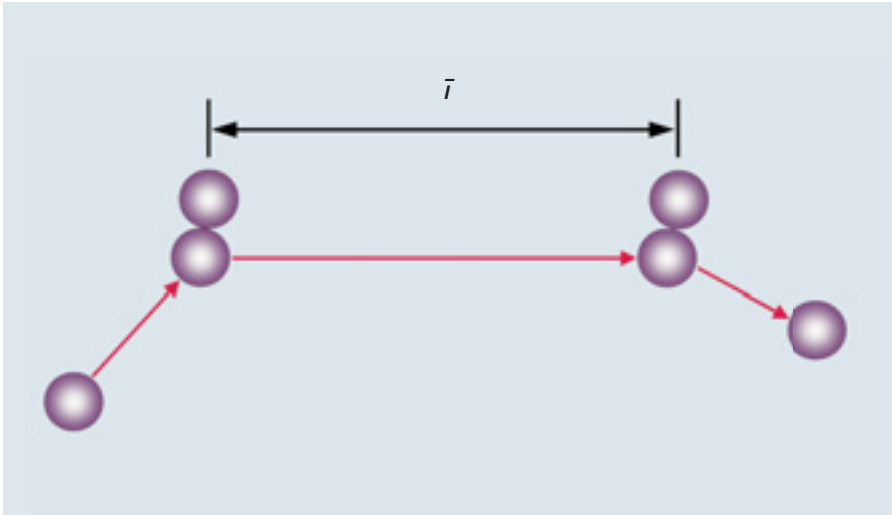


Figure 1.4: Mean free paths

The table [1] below shows the product $\bar{l} \cdot p$ for various gases at 0 °C.

Table 1.5: Mean free paths of various gases at 0 °C

Gas	$\bar{l}p$ / (m · Pa)	Gas	$\bar{l}p$ / (m · Pa)
H_2	$11.5 \cdot 10^{-3}$	Xe	$3.6 \cdot 10^{-3}$
N_2	$5.9 \cdot 10^{-3}$	Hg	$3.1 \cdot 10^{-3}$
He	$17.5 \cdot 10^{-3}$	CO	$6.0 \cdot 10^{-3}$
Ne	$12.7 \cdot 10^{-3}$	CO_2	$4.0 \cdot 10^{-3}$
Ar	$6.4 \cdot 10^{-3}$	HCl	$4.4 \cdot 10^{-3}$
Air	$6.65 \cdot 10^{-3}$	NH_3	$4.3 \cdot 10^{-3}$
Kr	$4.9 \cdot 10^{-3}$	Cl_2	$2.8 \cdot 10^{-3}$

1.2.6 Types of flow

A distinction is made between three types of flow in a vacuum. The types of flows described below will occur as a function of pressure, mean free path and component dimensions *d*.

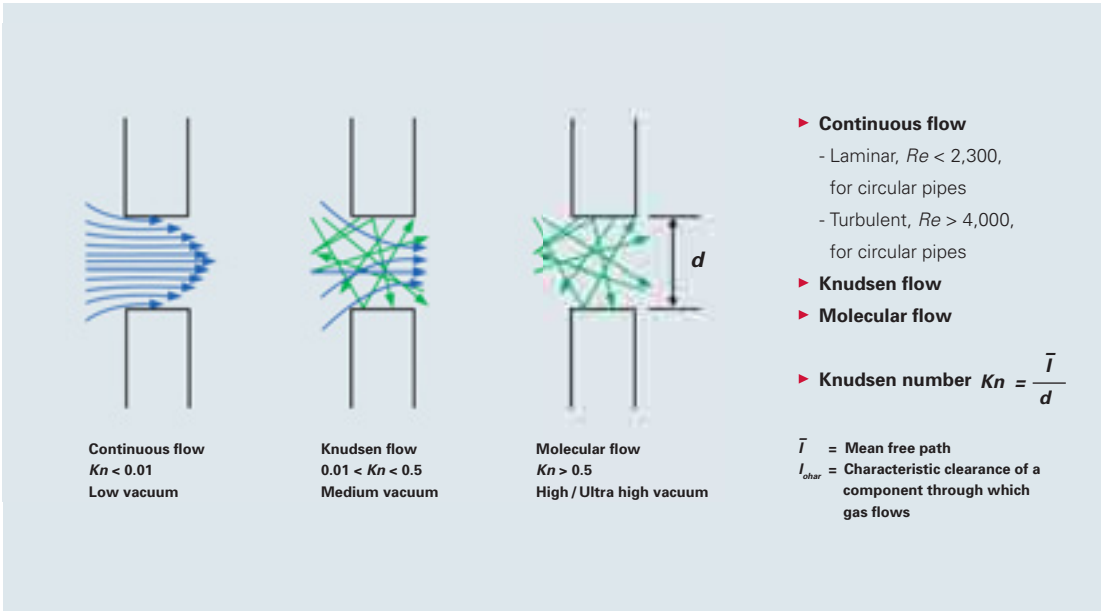


Figure 1.5: Types of flow in a vacuum

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

Continuous flow in low vacuum, $p = 10^3 - 10^0$ mbar, where $\bar{l} << d$

What characterizes continuous flow, as well as viscous flow, is frequent contact between gas molecules, yet less frequent contact with the walls of the vessel. In this case, the mean free path of the gas molecules is significantly shorter than the dimensions *d* of the vacuum equipment.

The dimensionless Knudsen number *Kn* is defined as the ratio between mean free path and component diameter

Formula 1-9
Knudsen number

$$Kn = \frac{\bar{l}}{d}$$

In this case, *Kn* is < 0.01. In addition, the term viscous flow is used if the product of pressure *p* and diameter *d* of the components through which gas is flowing is $p \cdot d \geq 6 \cdot 10^{-1}$ mbar · cm for air.

In the case of viscous flow, a distinction is made between laminar and turbulent flow. Laminar flow prevails at low flow speeds. At higher flow speeds, this changes to a turbulent flow [2]. The occurrence of turbulent flow is contingent upon the Reynolds number

Formula 1-10
Reynolds number

$$Re = \frac{\rho}{\eta} \cdot v \cdot d$$

Where is:
ρ = density [kg/m³]
η = viscosity [Pas]
v = flow velocity [m/s]
d = tube diameter [m]

Up to values of *Re* < 2,300 the flow will be laminar, and where *Re* > 4,000 the flow will be turbulent. In vacuum systems, the lines are dimensioned in such a manner that turbulent flow occurs only briefly at relatively high pressures, as the high flow resistance that occurs in this process necessitates that the pumps produce higher volume flow rates.

Knudsen flow in medium vacuum, $p = 10^{0} – 10^{-3}$ mbar, mit $\bar{l} \leq d$
If the Knudsen number is between 0.01 and 0.5, this is termed Knudsen flow. Because many process pressures are in the medium vacuum range, this type of flow occurs with corresponding frequency. Since this is a transitional flow, this range is transited relatively quickly when pumping down vacuum chambers. This means that the influence of this conductivity on pump-down times is correspondingly low. It is a complicated endeavor to perform a precise calculation of conductivity where the flow range is still laminar and yet already molecular, and this will not be discussed here. A simple approximation for the Knudsen range can be obtained by adding the laminar and molecular conductivities. Figure 1.7 shows the conductivities of round, one meter long tubes of differing diameters in all three flow ranges.

Molecular flow in high vacuum, ($p = 10^{-3} – 10^{-7}$ mbar), where $\bar{l} > d$ and in ultra high vacuum ($p < 10^{-7}$ mbar), mit $\bar{l} >> d$
At Knudsen numbers of *Kn* > 0.5 molecular interaction virtually no longer occurs. What prevails is molecular flow. In this case, the product of pressure *p* and component diameter *d* is $p \cdot d \leq 1.3 \cdot 10^{-2}$ mbar · cm.

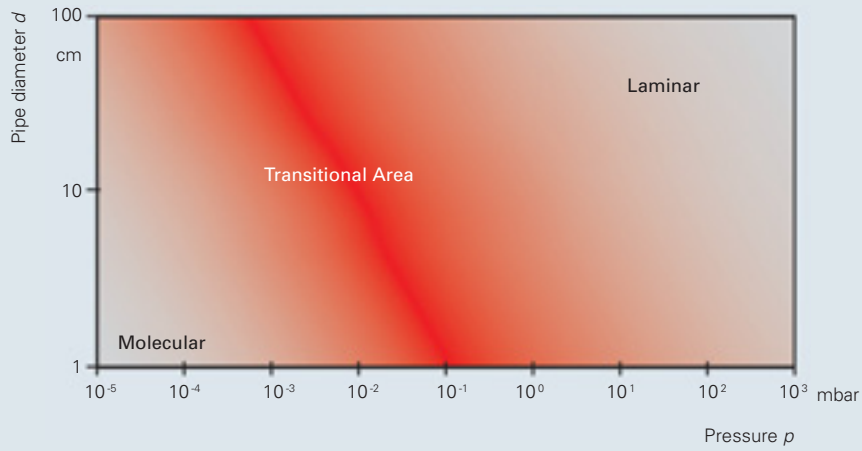


Figure 1.6: Flow ranges in vacuum

1.2.7 pV flow

Dividing the general gas equation by time t yields the gas flow

Formula 1-11
pV flow

$$q_{pV} = \frac{p \cdot V}{t} = \frac{m \cdot R \cdot T}{t \cdot M}$$

This is also referred to as pV flow. As can be seen from the right-hand side of the equation, a constant mass flow is displaced at constant temperature *T*.

Vacuum pumps, particularly positive displacement pumps, have a constant volume flow rate of

Formula 1-12
Definition of volume flow rate, or pumping speed

$$S = \frac{dV}{dt}$$

over a given inlet pressure range; i.e. they displace a constant volume flow. Multiplying the volume flow rate by the inlet pressure yields the throughput of a pump

Formula 1-13
Vacuum pump throughput

$$q_{pV} = S \cdot p = \frac{dV}{dt} \cdot p$$

Throughput is the gas flow transported by a vacuum pump.

Table 1.6: Conversion table for units of flow, length and temperature

	Pa m³/s = W	mbar l/s	Torr l/s	atm cm³/s	lusec	sccm	slm	Mol/s
Pa m³/s	1	10	7.5	9.87	$7.5 \cdot 10^{3}$	592	0.592	$4.41 \cdot 10^{-4}$
mbar l/s	0.1	1	0.75	0.987	750	59.2	$5.92 \cdot 10^{-2}$	$4.41 \cdot 10^{-5}$
Torr l/s	0.133	1.33	1	1.32	1,000	78.9	$7.89 \cdot 10^{-2}$	$5.85 \cdot 10^{-5}$
atm cm³/s	0.101	1.01	0.76	1	760	59.8	$5.98 \cdot 10^{-2}$	$4.45 \cdot 10^{-5}$
lusec	$1.33 \cdot 10^{-4}$	$1.33 \cdot 10^{-3}$	10^{-3}	$1.32 \cdot 10^{-3}$	1	$7.89 \cdot 10^{-2}$	$7.89 \cdot 10^{-5}$	$5.86 \cdot 10^{-8}$
sccm	$1.69 \cdot 10^{-3}$	$1.69 \cdot 10^{-2}$	$1.27 \cdot 10^{-2}$	$1.67 \cdot 10^{-2}$	12.7	1	10^{-3}	$7.45 \cdot 10^{-7}$
slm	1.69	16.9	12.7	16.7	$1.27 \cdot 10^{4}$	1,000	1	$7.45 \cdot 10^{-4}$
Mol/s	$2.27 \cdot 10^{3}$	$2.27 \cdot 10^{4}$	$1.7 \cdot 10^{4}$	$2.24 \cdot 10^{4}$	$1.7 \cdot 10^{7}$	$1.34 \cdot 10^{6}$	$1.34 \cdot 10^{3}$	1

	cm	inch	ft
cm	1	0.394	0.033
inch	2.54	1	0.083
ft	30.48	12	1

	K	°C	F
K	1	K - 273.15	9/5 K - 459.67
°C	°C + 273.15	1	9/5 °C + 32
F	5/9 (F + 459.67)	5/9 (F - 32)	1

°C	100	80	60	40	20	0	-20	-40
F	212	176	140	104	68	32	-4	-40

1.2.8 Conductivities

Generally speaking, vacuum chambers are connected to a vacuum pump via piping. Flow resistance occurs as a result of external friction (gas molecules/wall surface) and internal friction (gas molecules/gas molecule „viscosity"). This flow resistance manifests itself in the form of the volume flow rate, or pumping speed. In vacuum technology, it is customary to use the reciprocal, the conductivity of piping *L*, instead of flow resistance *W*. This is expressed in [l/s] or [m³/h].

Gas flowing through piping produces a pressure differential Δp at the ends of the piping. The following equation applies:

Formula 1-14
Definition of conductivity

$$q_{pV} = L \cdot \Delta p$$

The conductivity of a line is $L = 1/W$.

Analogously to Ohm's Law $I = \frac{1}{R} \cdot U$ q_{pV} represents flow I, L represents the reciprocal of resistance $1/R$ and Δp epresents voltage U. If the components are connected in parallel, the individual conductivities are added:

Formula1-15
Parallel connection conductivities

$$L_1 + L_2 + \ldots L_n = L_{ges}$$

and if connected in series, the reciprocals are added:

Formula 1-16
Series connection conductivities

$$\frac{1}{L_1} + \frac{1}{L_2} + \ldots + \frac{1}{L_n} = \frac{1}{L_{ges}}$$

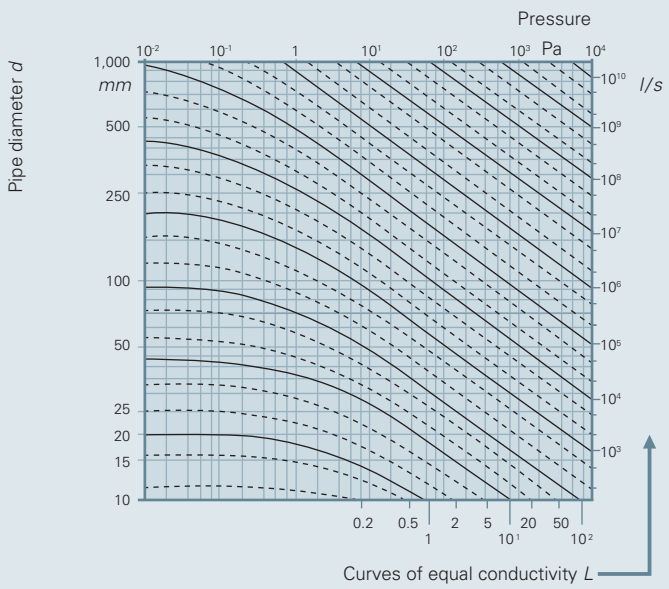


Figure 1.7: Diagram for determining pipe conductivities

Source: Pupp / Hartmann, Vakuumtechnik, Grundlagen und Anwendungen, Hanser Verlag

The conductivities of pipes and pipe bends will differ in the various flow ranges. In the case of continuous flow, they are proportional to the mean pressure $\bar{p}$ and in the case of molecular flow they are not a function of pressure. Knudsen flow represents a transition between the two types of flow, and the conductivities vary with the Knudsen number. Since this range is passed through relatively quickly when generating a vacuum, reference is made to the applicable literature [2].

The conductivities of orifices and long round pipes for the laminar and molecular flow ranges are presented briefly below.

The following Formula 1-14 fundamentally applies for conductivity $L = \frac{q_{pV}}{\Delta p} = \frac{q_{pV}}{p_1 - p_2}$

Orifices are frequently encountered in vacuum systems. Examples include constriction of cross sections in valves, ventilation systems or orifices in measuring domes that are used to measure volume flow rate. Similarly, orifice resistance must also be taken into consideration in connection with pipe openings in vessel walls.

Blocked flow

Let us consider venting of a vacuum chamber. When the venting valve is opened, ambient air flows into the vessel at high velocity at a pressure of p_1 It reaches maximum sonic velocity, and the volume flowing through it q_{pV} is not a function of the vessel's interior pressure p_2. The following applies for air:

Formula 1-17
Blocking

$$q_{pv} = 15.6 \cdot d^2 \cdot p_1 = 15.6 \frac{l}{s} \cdot \left(\frac{d}{cm}\right)^2 \cdot p_1$$

Gas dynamic flow

If the pressure in the vessel now rises beyond the critical pressure [2], gas flow is reduced and we obtain:

Formula 1-18
Gas dynamic flow

$$q_{pv} = A \cdot \sqrt{\frac{\pi}{4}} \cdot \bar{c} \cdot p_1 \cdot \psi\left(\frac{p_2}{p_1}\right)$$

$\psi(p_2/p_1)$ [3] is termed the outflow function and is shown in the following diagram (figure 1.8).

Molecular flow

If an orifice connects two vessels in which molecular flow conditions exist ($\bar{l} >> d$), the following will apply for orifice conductivity:

Formula 1-19
Orifice conductivity

$$L_{Bm} = \frac{\bar{c}}{4} \cdot A$$

Accordingly, the following applies for flow:

Formula 1-20
Orifice flow

$$q_{pv} = A \cdot \frac{\bar{c}}{4} \cdot (p_1 - p_2)$$

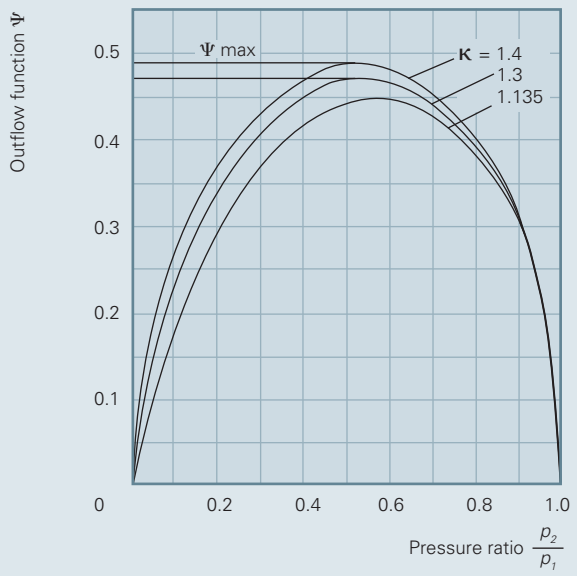


Figure 1.8: Outflow function for gas dynamic flow

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

Let us now consider specific pipe conductivities. On the one hand, this would be laminar flow in a long pipe having a round cross section:

In the case of laminar flow, the conductivity of a pipe is proportional to the mean pressure $\bar{p}$:

Formula 1-21
Laminar pipe flow

$$L_{Rl} = \frac{\pi \cdot d^4}{256 \cdot \eta \cdot l} \cdot (p_1 + p_2) = \frac{\pi \cdot d^4}{128 \cdot \eta \cdot l} \cdot \bar{p}$$

On the other, there would be molecular flow in a long pipe having a round cross section: In the molecular flow range, conductivity is constant and is not a function of pressure. It can be considered to be the product of the orifice conductivity of the pipe opening L_{Rm} and passage probability P_{Rm} through a component:

Formula 1-22
Molecular pipe flow

$$L_{Rm} = L_{Bm} \cdot P_{Rm}$$

Passage probability P_{Rm} can be calculated for different pipe shapes, bends or valves using Monte Carlo computer simulation. In this connection, the trajectories of individual gas molecules through the component can be tracked on the basis of wall collisions.

The following applies for long round pipes $P_{Rm} = \frac{4}{3} \cdot \frac{d}{l}$.

Multiplying this value by Orifice Conductivity Formula 1-19 yields

Formula 1-23
Molecular pipe conductivity

$$L_{Rm} = \frac{\bar{c} \cdot \pi \cdot d^3}{12 \cdot l}$$

L_{Rm} = pipe conductivity [m³/s]
d = pipe diameter [m]
l = pipe length [m]
$\bar{p}$ = $(p_1 + p_2)/2$ pressure [Pa]
p_1 = pressure at piping inlet [Pa]
p_2 = pressure at piping outlet [Pa]
η = viscosity of the gas [Pa · s]
$\bar{c}$ = thermodynamic gas temperature [m/s]

Figure 1.7 [5] shows curves of identical conductivities L as a function of mean pressure $\bar{p}$ and piping diameter d of one meter long pipes. At lower pressures, the conductivities are constant, and at high pressures they increase proportionately with mean pressure $\bar{p}$. The bends in the curves represent the Knudsen flow range.

1.3 Disturbing side effects

1.3.1 Contamination

Vacuum chambers must be clean in order to reach the desired pressure as quickly as possible when they are pumped down. Typical contaminants include oil and grease on screws and seals, process reaction products or condensed vapors, particularly water that is adsorbed on the walls of the vessel. Consequently, it is necessary to ensure that the components are clean when installing vacuum equipment. All components attached in the vacuum chamber must be clean and grease-free. All seals must also be installed dry. If high or ultra high vacuum is to be generated, clean gloves must be worn during the assembly process.

1.3.2 Condensation and vaporization

All substances can occur in a liquid, solid or gaseous state. Their aggregate status is a function of pressure and temperature. Liquids are transformed into their gaseous state through vaporization, solids through sublimation. The separation of liquids or solids out of the gaseous phase is termed condensation. Since normal room air contains approximately 10 g of water vapor per m³, condensed water vapor is always present on all surfaces.

Adsorption on surfaces is especially pronounced due to the strong polarity of the water molecules. Natural fibers, in particular, such as paper, contain large quantities of water that escape during drying processes under vacuum. Cooled condensers are used to separate the water vapor in this connection. Even some metals (Cd, Zn, Mg) can vaporize in noticeable quantity at temperatures of several 100 °C. Consequently, use of these metals is avoided in plant construction.

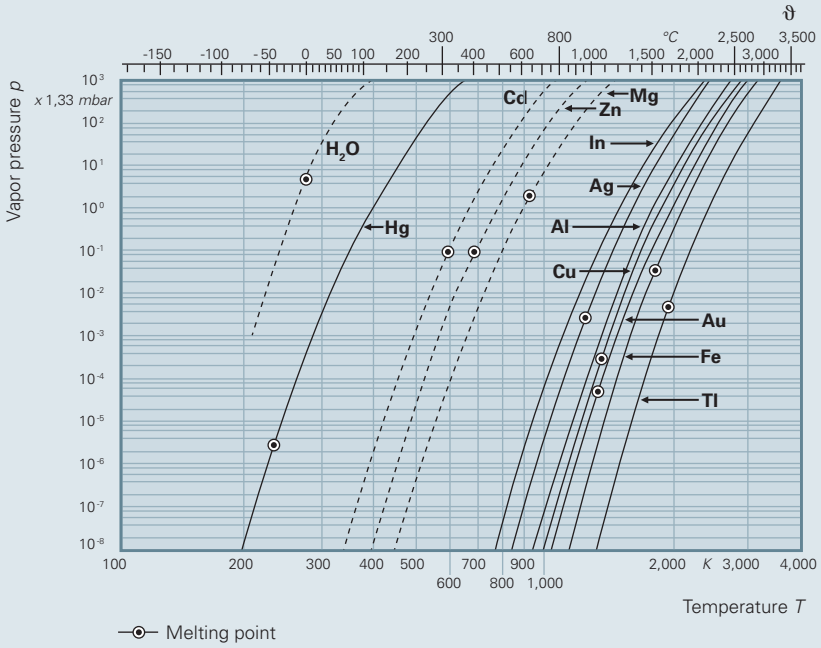


Figure 1.9: Vapor pressure curves of various substances

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

1.3.3 Desorption, diffusion, permeation and leaks

In addition to water, other substances (oil) can be adsorbed on surfaces. Substances can also diffuse out of the metal walls, which can be evidenced in the residual gas. In the case of particularly rigorous requirements, stainless steel vessels can be baked out under vacuum, thus driving the majority of the volatile components out of the metal walls.

Desorption

Gas molecules, (primarily water) are bound to the interior surfaces of the vacuum chamber through adsorption and absorption, and gradually desorb again under vacuum. The desorption rate of the metal and glass surfaces in the vacuum system produces a gas yield that is a function of time, however. A good approximation can be obtained by assuming that after a given point in time $t > t_0$ the reduction will occur on a linear basis over time. t_0 is typically assumed to be one hour.

The gas yield can thus be described as:

Formula 1-24
Desorption

$$Q_{des} = q_{des} \cdot A \cdot \frac{t_0}{t}$$

In this formula, q_{des} is the surface-based desorption rate of the material, A the interior surface area of the vacuum chamber, t_0 the start time and t the duration.

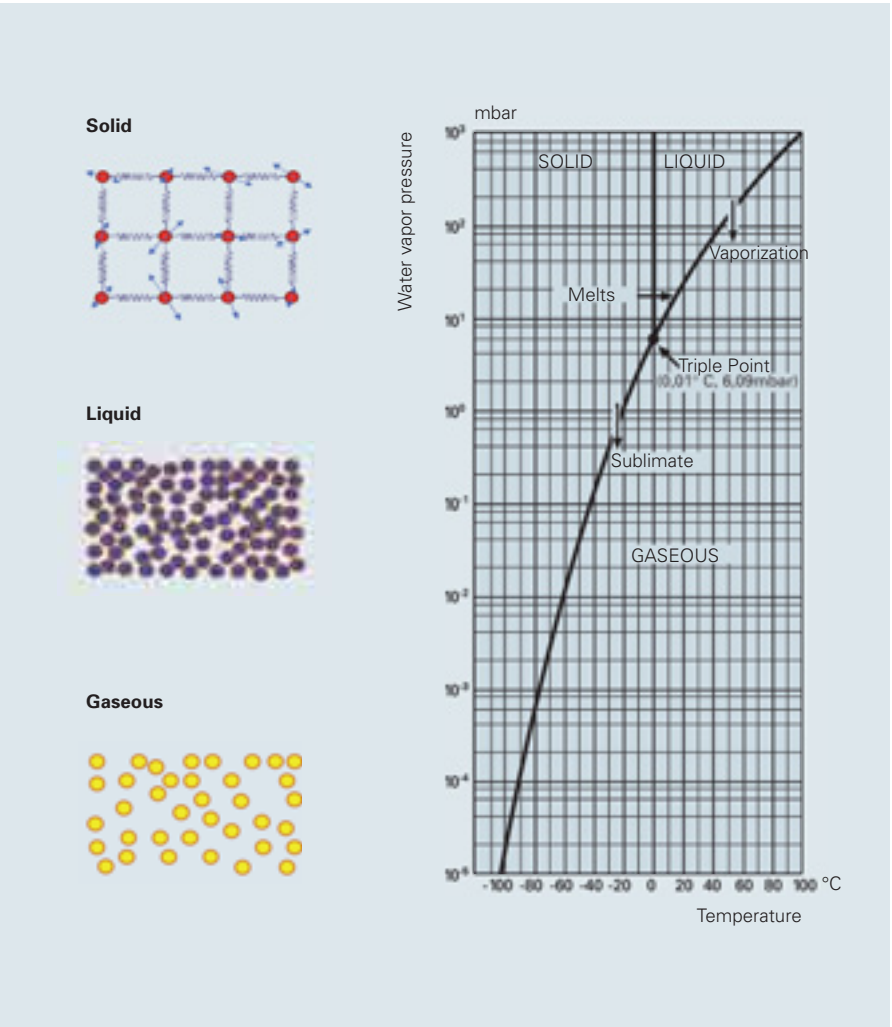


Figure 1.10: Saturation vapor pressure of water

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

Diffusion with desorption

At operation below 10^{-6} mbar, desorption of plastic surfaces, particularly the seals, assumes greater significance. Plastics mainly give off the gases that are dissolved in these plastics, which first must diffuse on the surface.

Following extended pump downtimes, desorption from plastics can therefore dominate the metal surfaces. Although the surface areas of the seals are relatively small; the decrease in the desorption rate over time occurs more slowly in the case of metal surfaces. As an approximation it can be assumed that the reduction over time will occur at the square root of the time.

The gas produced from plastic surfaces can thus be described as:

Formula 1-25
Desorption from plastic material

$$Q_{diff} = q_{diff} \cdot A_d \sqrt{\frac{t_0}{t}}$$

where A_d denotes the surface area of the plastics in the vacuum chamber and q_{diff} denotes the surface area-specific desorption rate for the respective plastic. At even lower pressures, similar effects also occur with metals, from which hydrogen and carbon escape in the form of CO and CO_2 and can be seen in the residual gas spectrum. Formula 1-25 also applies in this regard.

Permeation and leaks

Seals, and even metal walls, can be penetrated by small gas molecules, such as helium, through diffusion. Since this process is not a function of time, it results in a sustained increase in the desired ultimate pressure. The permeation gas flow is proportional to the pressure gradient p_0/d (d = wall thickness, p_0 = atmospheric pressure = ambient pressure) and to the permeation constants for the various materials k_{perm}.

Formula 1-26
Permeation

$$k_{perm} \cdot Q_{perm} = k_{perm} \cdot A \cdot \frac{p_0}{d}$$

Permeation first manifests itself at pressures below 10^{-8} mbar.
Q_l denotes the leakage rate, i.e. a gas flow that enters the vacuum system through leaks at a volume of V. The leakage rate is defined as the pressure rise Δp over time Δt:

Formula 1-27
Leakage rate

$$Q_l = \frac{\Delta p \cdot V}{\Delta t}$$

If a vessel is continuously pumped out at a volume flow rate S, an equilibrium pressure p_{gl} will be produced. Throughput Formula 1-13 is equal to the leakage rate $Q_l = S \cdot p_{gl}$. A system is considered to be adequately tight if the equilibrium pressure p_{gl} is approximately 10 % of the working pressure. If, for example, a working pressure of 10^{-6} mbar mbar is attained and the vacuum pump that is being used has a pumping speed of 100 l/s, the leakage rate should not be more than 10^{-5} mbar l/s. This corresponds to a leak of approximately 20 · 20 µm² in size. Leakage rates Q_l of less than 10^{-8} mbar l/s can usually be easily attained in clean stainless steel vessels. The ultimate pressure achievable after a given period of time t primarily depends upon all of the effects described above and upon the pumping speed of the vacuum pump. The prerequisite is naturally that the ultimate pressure will be high relative to the base pressure of the vacuum pump.

The specific pressure components for a given pumping time t can be calculated by using

Formula 1-28
Ultimate pressure (t)

$$Q_{des}(t) + Q_{diff}(t) + Q_{perm} + Q_l = p(t) \cdot S$$

and by solving the equations for t. The achievable ultimate pressure is the sum of these pressures.

1.3.4 Bake-out

The following prerequisites must be satisfied in order to achieve lower pressures (< 10^{-8} mbar):

- The base pressure of the vacuum pump should be a factor of 10 lower than the required ultimate pressure
- Stainless steel vacuum recipients and components must be used
- Metallic seals (CF flange connections) are required
- Pump and equipment must be baked out
- Leaks must be avoided and eliminated prior to activating the heater (use helium leak detectors!)
- Clean work is a must, i.e. all parts must be thoroughly cleaned and must be installed with grease-free gloves

Bake-out significantly increases desorption and diffusion rates, and this produces significantly shorter pumping times. Bake-out temperatures of up to 300 °C are used. The instructions of the pump manufacturers relating to maximum bake-out temperatures and maximum permissible radiation levels in the pump flange must be observed.

Following installation the equipment is switched on, and after reaching a pressure of $p < 10^{-5}$ mbar the heater is then switched on. During the heating process, all gauge heads must be operated and degassed at intervals of 10 hours. In the case of stainless steel vessels and the use of metallic seals, bake-out temperatures of 120 °C and heating times of approximately 48 hours are sufficient for advancing into the pressure range of 10^{-10} mbar. Bake-out should be continued until 100 times the expected ultimate pressure is attained. The heaters for the pump and vacuum chamber are then switched off. After cool-down, the desired ultimate pressure will probably be achieved. In connection with pressures $p < 5 \cdot 10^{-10}$ mbar and large interior surface areas, it will be advantageous to use a titanium sublimation pump that pumps the hydrogen escaping from the metals at a high volume flow rate.

1.3.5 Residual gas spectrum

When working in ultra high vacuum, it can be important to know the composition of the residual gas. The percentages of water (M = 18) and its fragment HO (M = 17) will be large in the case of vacuum chambers that are not clean or well heated. Leaks can be identified by the peaks of nitrogen (M = 28) and oxygen (M = 32) in the ratio of $N_2/O_2 = 4/1$.

Hydrogen (M = 2), water (M = 17 and 18), carbon monoxide (M = 28) and carbon dioxide (M = 44). will be found in well-heated chambers. No hydrocarbons will be found when using turbomolecular pumps. They are very effectively kept out of the chamber due to the high molecular masses and the resulting high compression ratios. A typical residual gas spectrum for a clean vessel evacuated by a turbomolecular pump is shown in Figure 2.22.

1.3.6 Venting

To avoid undesired contamination, vacuum chambers should be vented with dry nitrogen instead of air. This prevents water vapor from depositing on the vessel walls, which would be difficult to desorb in connection with the subsequent evacuation.

2 Vacuum Generation

2.1 Pump principles and vacuum pump performance data

2.1.1 Classification of vacuum pumps

In connection with vacuum pumps, a distinction is made between gas-displacement vacuum pumps and gas-binding vacuum pumps. While gas-displacement vacuum pumps can be used without limitation, gas-binding vacuum pumps have a limited gas absorption capacity and must be regenerated at certain process-dependent intervals.

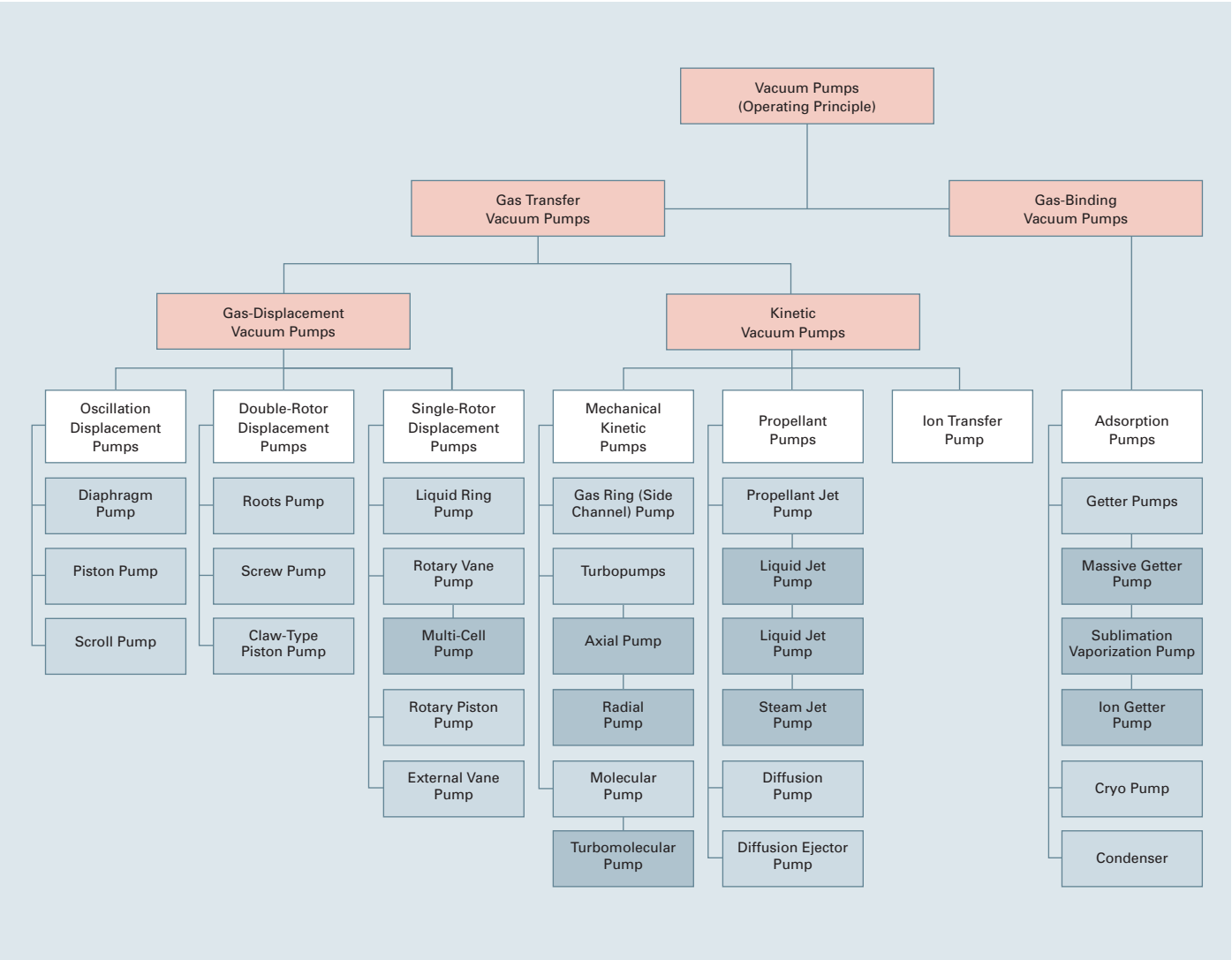


Figure 2.1: Overview of vacuum pumps

Gas-displacement pumps, which are also referred to as gas transfer pumps, are classified either as positive displacement pumps or kinetic vacuum pumps. Positive displacement pumps displace gas from sealed areas to the atmosphere or to a downstream pump stage. Kinetic pumps displace gas by accelerating it in the pumping direction, either via a mechanical drive system or through an aligned vapor stream that is condensed at the end of the pumping section. Gas-binding vacuum pumps either bind the gas to an especially active substrate through gettering or condense the gas at a suitable temperature.

2.1.2 Pumping speed and throughput

Pumping speed $S = \frac{dV}{dt}$ (Formula 1-12) is the mean volume flow through the cross section of the inlet port of a vacuum pump. In the volume flow rate diagram, it is applied as a factor of the inlet pressure of the pump. The pump's maximum achievable pumping speed is always referred to as its rated pumping speed. Determination of the pumping speed is described in base standard ISO 21360-1. Pumping speed is indicated in m^3/s. The units of m^3/h, l/s and l/min are also customary.

Throughput $q_{pV} = S \cdot p = \frac{dV}{dt} \cdot p$ (Formula 1-13) denotes the gas throughput in a vacuum pump as a function of inlet pressure. It is indicated in Pa · l/s or mbar · l/s. In the case of pumping stations that consist of gas-displacement pumps, the throughput of all pumps will be the same.

2.1.3 Ultimate pressure and base pressure

Ultimate pressure pe is the lowest pressure that is asymptotically approached by the pressure of a blank-flanged vacuum pump under defined basic conditions without gas inlet. If a pump is operated at ultimate pressure, the usable pumping speed will be zero, as only its own back-flow losses will be displaced. Ultimate pressure is a theoretical value. Today, base pressure is specified instead of ultimate pressure. The conditions for achieving base pressure are specified in standard ISO 21360-1. As the base pressure must be attained within a specified period of time, it is usually higher than the ultimate pressure.

2.1.4 Compression ratio

The maximum pressure ratio between discharge pressure p_2 and intake pressure p_1 is referred to as the compression ratio:

Formula 2-1
Compression ratio

$$K_0 = \frac{p_2}{p_1}$$

In the case of blank-flanged inlet ports, the compression ratio is measured through gas inlet on the discharge side.

2.1.5 Pumping speed of pumping stages connected in series

Let us consider a vacuum pump having a pumping speed S_0 and a compression ratio K_0. The pump has backflow losses through gaps having conductivity L_R. Let inlet pressure be p_1 and discharge pressure p_2. An additional pump having a pumping speed S_v is connected on the outlet side.

The pumping station will displace the following volume of gas:

Formula 2-2
Pump combination gas flow

$$q_{pV} = p_1 \cdot S = p_2 \cdot S_v = S_0 \cdot p_1 - L_R \cdot (p_2 - p_1)$$

Where $L_R << S_0$, backflow conductivity L_R is:

Formula 2-3
Backflow conductivity

$$L_R = \frac{S_0}{K_0}$$

and the real compression ratio is:

Formula 2-4
Real compression ratio

$$K = \frac{p_2}{p_1} = \frac{S}{S_v}$$

Using the above formulas, it therefore follows that the pumping speed S of a two-stage pumping station will be:

Formula 2-5
Recursion pumping speed

$$S = \frac{S_0}{1 - \frac{1}{K_0} + \frac{S_0}{K_0 \cdot S_v}}$$

This formula can also be used as the recursion formula for multiple pumping stages that are connected in series by starting with the pumping speed S_v of the last stage and inserting the K_0 and S_0 of the preceding stage.

2.1.6 Gas ballast

Means through which air or another non-condensing gas is admitted into a vacuum pump are referred to as gas ballast. If the pump is displacing vapor that would condense in the pump at the corresponding temperatures without gas ballast, the gas ballast enables the outlet valve to open before the vapor condenses, and the vapor is discharged together with the ballast gas. Both atmospheric air as well as selected inert or process gases are used as ballast gas. The use of the gas ballast increases the attainable base pressure of a vacuum pump slightly. Consequently, for gas ballast vacuum pumps the base pressure is specified both with and without gas ballast.

2.1.7 Water vapor tolerance / water vapor capacity

Water vapor tolerance p_{w0} is the highest water vapor pressure with which a vacuum pump can continuously intake and displace pure water vapor under standard ambient conditions (20 °C, p_0 = 1,013 mbar). It can be calculated from pumping speed, gas ballast volume, relative humidity and saturation vapor temperature and is indicated in mbar [7].

Formula 2-6
Water vapor tolerance

$$p_{w0} = \frac{q_{pB} \cdot (p_s - p_l)}{S \cdot (\alpha \cdot p_0 - p_s)}$$

DIN 28426 describes the use of an indirect process to determine water vapor tolerance. Water vapor tolerance increases at higher pump outlet temperature and greater gas ballast volume q_{pB}. It declines at higher ambient pressure.

Without gas ballast, a vacuum pump having an outlet temperature of less than 100 °C would not be capable of displacing even small amounts of pure water vapor. If water vapor is nevertheless pumped without gas ballast, the condensate will dissolve in the pump oil. As a result, the base pressure will rise and the condensate could cause corrosion damage.

Water vapor capacity

Formula 2-7
Water vapor capacity

$$c_{w0} = p_{w0} \cdot S$$

is the maximum volume of water that a vacuum pump can continuously intake and displace in the form of water vapor under the ambient conditions of 20 °C and 1,013 mbar.

2.1.8 Sealing gas

When pumping corrosive process gas, there is a risk that the gas might attack parts of the pump. To counter this danger, sensitive parts, e.g. bearings, must be protected by a continuous flow of inert gas. A special gas inlet system is installed in the pumps for this purpose, through which gas flows into the pumping system via the bearings. In this connection, it is necessary to ensure that the base pressure does not increase excessively.

2.2 Rotary vane vacuum pump

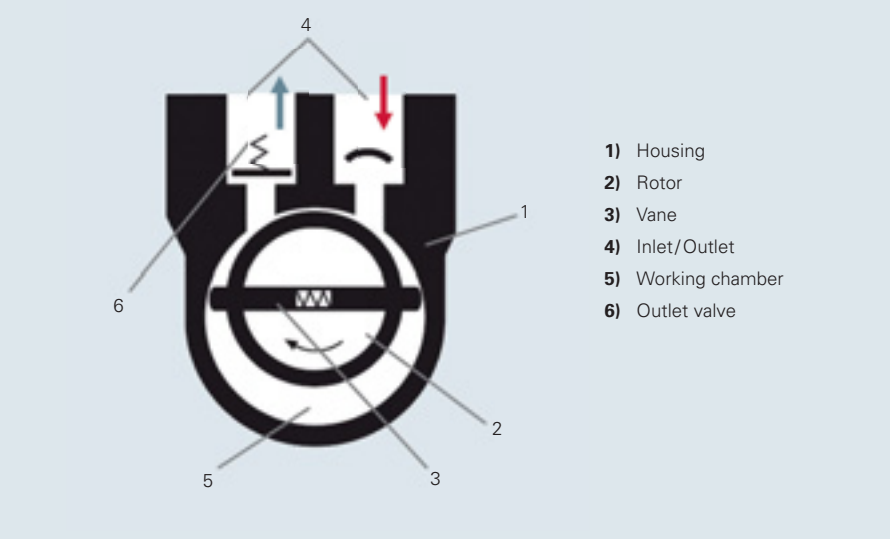


Figure 2.2: Operating principle of a rotary vane pump

2.2.1 Design / Operating principle

A rotary vane vacuum pump is an oil-sealed rotary displacement pump. The pumping system consists of a housing (1), an eccentrically installed rotor (2), vanes that move radially under spring force (3) and the inlet and outlet (4). The outlet valve is oil-sealed. The inlet valve is designed as a vacuum safety valve that is always open during operation. The working chamber (5) is located inside the housing. Rotor and vanes divide the working chamber into two separate spaces having variable volumes. As the rotor turns, gas flows into the enlarging suction chamber until it is sealed off by the second vane. The enclosed gas is compressed until the outlet valve opens against atmospheric pressure. In the case of gas ballast operation, a hole to the outside is opened, which empties into the sealed suction chamber on the front side.

Operating fluid, oil

Pump oil, which is also called as operating fluid, has multiple tasks to perform in a rotary vane pump. It lubricates all moving parts, fills both the harmful space under the outlet valve as well as the narrow gap between inlet and outlet. It compresses the gap between the vanes and the working chamber and additionally ensures an optimal temperature balance through heat transfer.

Multi-stage pumps

Rotary vane vacuum pumps are built in single- and two-stage versions. Two-stage pumps achieve lower ultimate pressures than single-stage pumps. Moreover, the effects of the gas ballast on the ultimate pressure are lower, as the ballast gas is only admitted in the second stage.

Vacuum safety valve

Depending upon the type of pump in question, rotary vane vacuum pumps can be equipped with a vacuum safety valve. The vacuum safety valve disconnects the pump from the vacuum recipient in the event of intentional or unintentional standstill, and uses the displaced gas to vent the pumping system in order to prevent oil from rising into the recipient. After switching on the pump, it opens after a delay once the pressure in the pump has reached the approximate pressure in the recipient.

2.2.2 Application notes

Rotary vane vacuum pumps can be employed universally throughout the entire low and medium vacuum ranges. Either a single- or double-stage pump can be used, depending upon the pressure range in question. Ideal operating conditions always exist if the medium to be pumped down will not condense at pump operating pressure and atmospheric pressure.

Vapors

Vapors that can condense entirely or partially in the pump during the compression phase must also be displaced for distillation and drying processes. Here, opening the gas ballast valve helps to displace the vapor through the pump without condensation. However vapor compatibility is not always sufficient to prevent condensation. Condensates mix with the oil and cause ultimate pressure to increase and diminish the lubricating capacity of the operating fluid. These factors can cause corrosion inside the pump.

Filters

Within certain limits, filters and separators can protect the vacuum pump against wear and corrosion. Separators that are filled with paper filter inserts (STP), Raschig rings (STR) or additionally with cyclone (STZ) bind dust. Activated carbon filters (FAK) bind inorganic vapors, and Fuller's earth filters (FBL) can be connected upstream for absorption of organic vapors. The fillings are replaceable. Inflowing hydrocarbons (oil vapor) can be catalytically incinerated in the heated catalytic trap (URB), and zeolite traps adsorb various vapors. When saturated, they can be regenerated by baking them out. Condensates can be collected in the condensate separator (KAS) and drained manually. Chemical oil filters (OFC) clean the pump oil with the aid of the oil pump that is integrated in the rotary vane pump.

At high gas throughputs and in connection with gas ballast operation, oil mist is entrained out of the pump. 4 ml of oil loss at a throughput of 1 bar · m³ gas can be assumed. The oil vapor can be separated in an oil mist separator (ONF) and returned to the pump's oil circulation system by means of an additional return line.

However if substances are also displaced that chemically attack the pump oil or that have such low vapor pressure that condensation in the pump cannot be avoided, in spite of gas ballast and the above-mentioned accessories, a different type of backing pump should be selected.

2.2.3 Portfolio overview

Pfeiffer Vacuum rotary vane pumps are available as single- and two-stage versions.

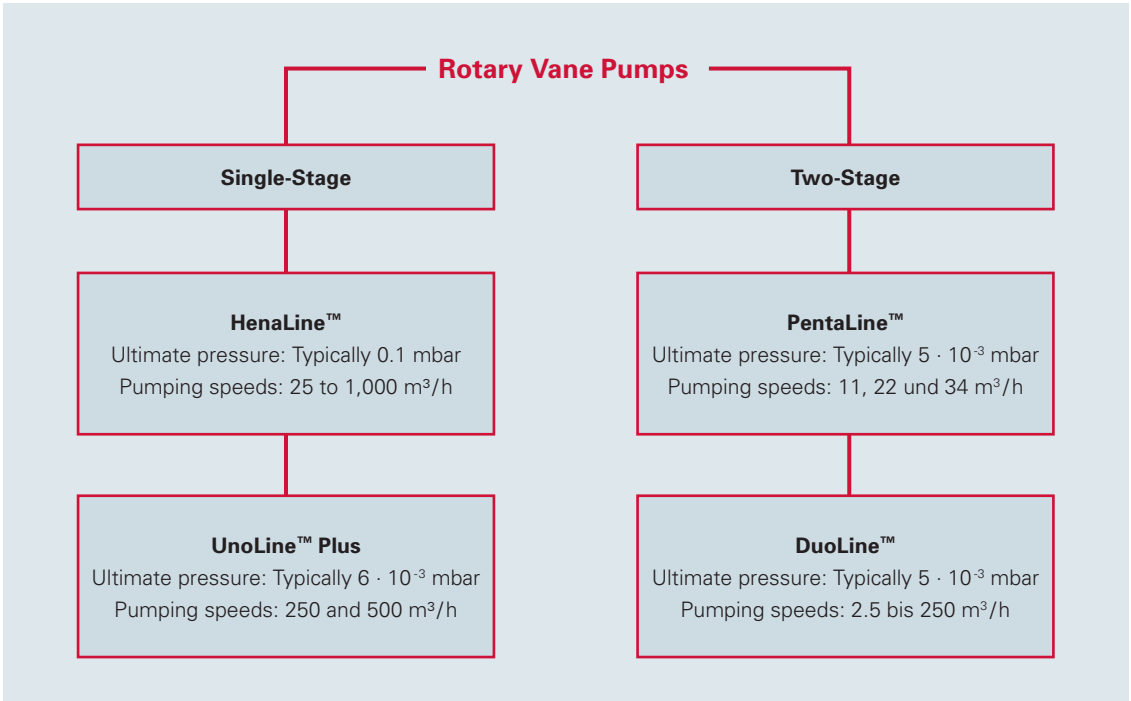


Figure 2.3: Pfeiffer Vacuum rotary vane pumps

2.2.3.1 Single-stage rotary vane vacuum pumps

HenaLine™

HenaLine single-stage, oil-sealed rotary vane vacuum pumps generate a vacuum having volume flow rates of 25 to 1,000 m^3/h at ultimate pressures of up to 0.1 mbar. They can be universally employed in many industrial and research environments. They can either be operated as a stand-alone pump or integrated into pumping stations.

With appropriate accessories, these pumps are also suitable for use under the harshest operating conditions, i.e. at high inlet pressures as well as in cycle-mode operation. Oil mist filters, oil return systems and vacuum safety valves are all integrated as standard equipment. In addition to preventing pollution of the ambient air, they also protect the pump and the system. A gas ballast valve enables pump-down of water vapor and other process vapors.

Table 2.1: HenaLine™ performance data

Model	Pumping Speed	Ultimate Pressure	Applications
Hena 25	25 m^3/h	0.1 mbar	Suitable for electron beam welding, incandescent light bulb manufacturing, surface coating, vacuum drying, leak detection, metallurgy, gas recovery, load lock applications, simulation chambers
Hena 60	60 m^3/h	0.1 mbar	
Hena 100	100 m^3/h	0.1 mbar	
Hena 200	200 m^3/h	0.1 mbar	
Hena 300	300 m^3/h	0.1 mbar	
Hena 400	600 m^3/h	0.1 mbar	
Hena 630	630 m^3/h	0.1 mbar	
Hena 1000	1,000 m^3/h	0.4 mbar	

UnoLine™ Plus

UnoLine Plus pumps can be optimally employed for industrial applications, first and foremost. These rotary vane vacuum pumps have proven track records as both stand-alone and backing pumps for Pfeiffer Vacuum Roots pumps. An ultimate pressure of approximately $6 \cdot 10^{-2}$ mbar can be attained. These pumps are water-cooled and extremely insensitive to dust and dirt.

They are equipped with an oil regeneration system. Condensates, contaminants and dust particles can be separated from the operating medium, collected in the vapor separator and drained. The adjustable cooling water controller enables the UnoLine Plus pumps to maintain the required operating temperature. These pumps are equipped with gas ballast in order to pump down vapors.

Table 2.2: UnoLine™ Plus performance data

Model	Pumping Speed	Ultimate pressure	Applications
BA 251	250 m^3/h	$6 \cdot 10^{-2}$ mbar	Suitable for all industrial applications, e. g. metallurgy, transformer drying, coating, chemistry
BA 501	500 m^3/h	$6 \cdot 10^{-2}$ mbar	

2.2.3.2 Two-stage rotary vane vacuum pumps

Two-stage rotary vane pumps are suitable for applications in the low and medium vacuum ranges to a pressure of 10^{-3} mbar. They are equipped with a vacuum safety valve that prevents oil contamination in the recipient. Integrated gas ballast means allow condensable vapors to be pumped down.

PentaLine™

The pumps in the PentaLine series are characterized by their innovative drive concept. These pumps are powered by an electronically controlled brushless DC motor whose rotor sits directly on the rotor shaft of the pumping system. The pumps are supplied with alternating current via an electronic inverter. Voltage ranges of 100 – 120 volts and 200 – 240 volts can be selected by means of a selector switch. Their advantages include high energy efficiency with approximately 25 % lower energy consumption than conventional rotary vane pumps, and the pump's hermetic seal without shaft feedthrough.

If maximum pump performance is temporarily not required, the RPM of the pump can be reduced to the standby mode for additional energy savings of 50 %. Thanks to this new drive concept, it is possible to avoid the high startup currents that typically occur when the pump is cold, even with asynchronous motors. In addition to the above-mentioned gas ballast, the PentaLine pumps can be operated with temperature control to increase water vapor tolerance. The functions of Pump ON, Standby ON and Enhanced Water Vapor Tolerance ON can be selected by means of a PLC-compatible interface or a remote connection.

Table 2.3: PentaLine™ performance data

Model	Pumping Speed	Ultimate Pressure	Applications
Penta 10	11 m³/h	$5 \cdot 10^{-3}$ mbar	Ideally suited for turbopump pumping stations, analysis, industrial applications, research and development, coating
Penta 20	22 m³/h	$5 \cdot 10^{-3}$ mbar	
Penta 35	34 m³/h	$5 \cdot 10^{-3}$ mbar	

DuoLine™

DuoLine rotary vane vacuum pumps are powered by AC or DC motors, depending upon the size of the pump. In addition to the standard models, the following designs are also available: Magnetically coupled pumps (Duo M series) and corrosive gas pumps, both with and without magnetic coupling (Duo MC series).

Table 2.4: DuoLine™ performance data

Model	Pumping Speed	Ultimate Pressure	Applications
Duo 2.5	2.5 m³/h	$6 \cdot 10^{-3}$ mbar	Suited for Turbopump pumping stations, analysis, research and development, coating
Duo 35	35.0 m³/h	$3 \cdot 10^{-3}$ mbar	
Duo 120	120.0 m³/h	$6 \cdot 10^{-3}$ mbar	
Duo 255	250.0 m³/h	$5 \cdot 10^{-3}$ mbar	

Duo M series

M series pumps are equipped with a magnetic coupling with can. This wear-free sealing concept hermetically seals the pumps, making them clean and environmentally friendly. The magnetic coupling minimizes maintenance and thus results in significant savings.

Table 2.5: Duo M series performance data

Model	Pumping Speed	Ultimate Pressure	Applications
Duo 5 M	5 m³/h	$5 \cdot 10^{-3}$ mbar	Ideally suited for turbopump pumping stations, analysis, research & development, coating, non-explosive toxic gases
Duo 10 M	10 m³/h	$5 \cdot 10^{-3}$ mbar	
Duo 20 M	20 m³/h	$5 \cdot 10^{-3}$ mbar	
Duo 35 M	35 m³/h	$3 \cdot 10^{-3}$ mbar	
Duo 65 M	65 m³/h	$3 \cdot 10^{-3}$ mbar	

Duo C series and MC series

The C series pumps are suitable for corrosive gas applications. In contrast to standard pumps, they have a special gas ballast valve, through which inert gas can be admitted into the pump. In addition, the pumps are equipped with special vanes that are especially resistant to chemicals. All corrosive gas pumps are ready for operation with chemical-resistant F4 or F5 (perflourpolyether) operating fluids. The Duo MC pumps are especially suitable for pumping toxic gases, because the hermetically sealed magnetic coupling prevents gas from reaching the outside.

Table 2.6: Duo C series and Duo MC series performance data

Model	Pumping Speed	Ultimate Pressure	Applications
Duo 5 MC	5.0 m³/h	$5 \cdot 10^{-3}$ mbar	Suitable for corrosive gas applications, chemical labs, toxic non-explosive gases
Duo 10 MC	10.0 m³/h	$5 \cdot 10^{-3}$ mbar	
Duo 20 MC	20.0 m³/h	$5 \cdot 10^{-3}$ mbar	
Duo 2.5 C	2.5 m³/h	$6 \cdot 10^{-3}$ mbar	Suitable for corrosive gas applications, chemical laboratories
Duo 35 C	35.0 m³/h	$3 \cdot 10^{-3}$ mbar	
Duo 65 C	65.0 m³/h	$3 \cdot 10^{-3}$ mbar	
Duo 120 C	120.0 m³/h	$3 \cdot 10^{-3}$ mbar	

2.2.3.3 Operating fluid selection

Because operating fluid comes into contact with the medium to be pumped, it is exposed to the influences of the medium in question. Consequently, operating fluid should be selected on an individual basis in accordance with the respective application. Pfeiffer Vacuum offers four different types of operating fluids that are suitable for all major applications. The pumps are factory-set for the respective operating fluid.

The ultimate pressures of the rotary vane vacuum pumps that are specified in the catalog can only be ensured when using the operating fluid recommended by Pfeiffer Vacuum. The manufacturer cannot accept any liability for damage attributable to the use of other operating fluids. Different types of oil should never be mixed. Some oils do not mix and can thus cause damage to the pumping system.

Table 2.7: Oil types for backing pumps and Roots pumps

P3	**High quality mineral oil for standard applications** Extremely low vapor pressure Achievable ultimate pressure: $< 1 \cdot 10^{-3}$ mbar Max. operating temperature: 95 °C **For pumping down:** Air, inert gases, noble gases
D1	**Diester oil for standard and special applications** Achievable ultimate pressure: $< 5 \cdot 10^{-2}$ mbar Max. operating temperature: 120 °C **For pumping down:** Air, inert gases, noble gases, oxygen, weakly aggressive and organic solvents
F4 (for pumps < 20 m³/h) **F5** (for pumps > 20 m³/h)	**Perfluorpolyether for special applications** Achievable ultimate pressure: $< 1 \cdot 10^{-3}$ mbar Max. operating temperature: 120 °C **For pumping down:** Oxygen, ozone, halogens, organic and inorganic solvents, HCl, BF_3, HF, fluorine

2.2.3.4 Accessories

Dust separators (STP, STR, STZ)

If the process produces dust, the pump must be installed downstream from a dust separator. Different versions are available, depending upon the degree of contamination of the pumped-down gases and molecule size.

Condensate separator (KAS)

Condensates can form in the inlet and outlet lines of a vacuum system when pumping down vapors. To protect the pump against these condensates, we recommend providing a condensate separator in both the inlet and outlet lines.

Oil mist separator (ONF)
Oil mist separators are mounted on the outlet port of rotary vane vacuum pumps. They prevent the air from being contaminated by the oil mist that the pump discharges in greater or lesser quantities, depending upon operating pressure. The filter consists of cylindrical filter elements and an aluminum housing with oil collection chamber.

Oil return system (ORF)
The ORF oil return system was developed for collecting and returning pump oil mist. It helps to reduce operating costs, particularly when special oils are being used for fluorine and nuclear technology applications. In this process, the oil accumulating in the ONF is collected in a container and returned into the vacuum pump by a feed pump.

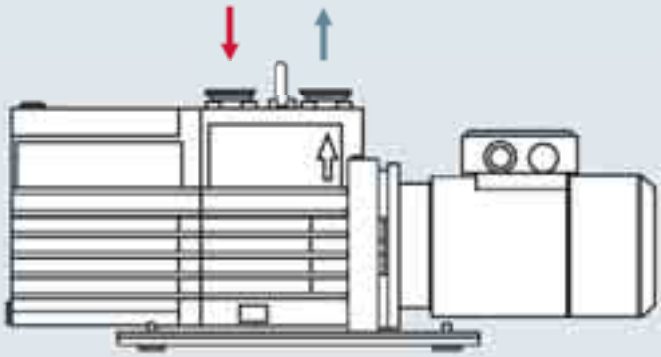
Zeolite trap (ZFO)
A zeolite trap uses adsorption to prevent the backflow of hydrocarbons from rotary vane vacuum pumps to downstream high vacuum components. The adsorption agent can be regenerated by baking it out at 300 °C. The regeneration intervals will depend upon the process in question.

Catalytic trap (URB)
A catalytic trap prevents the backflow of hydrocarbons from single- or two-stage rotary vane vacuum pumps. This is accomplished through catalytic incineration of hydrocarbons at an operating temperature of 250 °C to form CO_2 and water vapor. The oxygen that is admitted into the process chamber through periodic venting suffices for self-regeneration. This means that the regeneration intervals are independent of the process in question. Water cooling is required for direct installation of the traps on the inlet ports and/or for use on single-stage rotary vane pumps.

Activated carbon filters (FAK)
Activated carbon filters are used if there are accumulations of H_2S, HCN, Hg, NH_3 or SO_2 vapors, nitrous gases, as well as vaporous solvents, acids and alkaline solutions. The activated carbon filters come supplied with a filling. This filling is replaceable. The service life of the filling is dependent upon the process in question.

Bleaching earth filter (FBL)
A bleaching earth filter protects both the rotary vane vacuum pump and the operating fluid by adsorbing organic vapors. The bleaching earth filling is replaceable. The service life of the filling is dependent upon the process in question. This filter is used in petrochemical, plastics and resin chemistry applications if there are accumulations of peroxides, hydroperoxides and polycondensation.

Chemical oil filter (OFC)
Chemical oil filters are interposed in the oil circulation systems of rotary vane pumps. These oil filters filter out dust or particulate matter reaching the operating fluid from the process. In addition, chemical oil filters adsorb corrosive substances from the operating fluid. This reduces pump wear.



Inlet

Application: Protects pump and operating fluid

Dust separators (STP, STR, STZ)

- Prevents dusts from entering the pump
- STP single-stage filter with cyclone and paper element
- STR two-stage filter with cyclone and oil-wetted fillers
- STZ two-stage filter with cyclone and paper element

URB catalytic trap

- Prevents pump oil backflow to vacuum recipient
- Operates through catalytic incineration

ZFO zeolite trap

- Prevents oil backflow
- Zeolites bind backflowing pump oil
- Can be regenerated by means of optional heating rod

Outlet

Application: Prevents pump oil mist from escaping to the environment

ONF oil mist separator

- Prevents oil mist from reaching the atmosphere
- Degree of filtration with clean filter > 99.98 %

ORF oil return system

- Returns oil to pump from ONF oil mist separator

KAS condensate separator

- At inlet and outlet: Prevents condensates from entering the pump
- Separator for condensed vapors
- Sight glass for monitoring condensate level
- Drain plug for draining condensate

Figure 2.4: Accessories for rotary vane pumps

2.3 Diaphragm vacuum pumps

2.3.1 Design / Operating principle

Diaphragm vacuum pumps are dry positive-displacement pumps. Their operating principle is explained in Figure 2.5. A crankshaft-driven connecting rod (4) moves the diaphragm (1) that is tensioned between head cover (2) and housing (3). The space between the head cover and the diaphragm forms the suction chamber (5). Diaphragm pumps require inlet valves and outlet valves (6) to achieve aligned gas displacement. Pressure-controlled shutter valves made of elastomer materials are used as valves. Because the suction chamber is hermetically sealed off from the drive by the diaphragm, the pump medium can neither be contaminated by oil nor can aggressive media corrode the mechanics. The harmful space between the outlet valve and the suction chamber results in only a limited compression ratio. This means that an ultimate pressure of only approximately 70 mbar can be attained with a single pump stage. Connecting multiple pumping stages in series can reduce ultimate pressure to 0.5 mbar. Lower pressures cannot be achieved, as in this case there is no longer sufficient force to open the inlet valve. The principle of the diaphragm pump is particularly well suited for low pumping speeds of up to approximately 10 m^3/h.

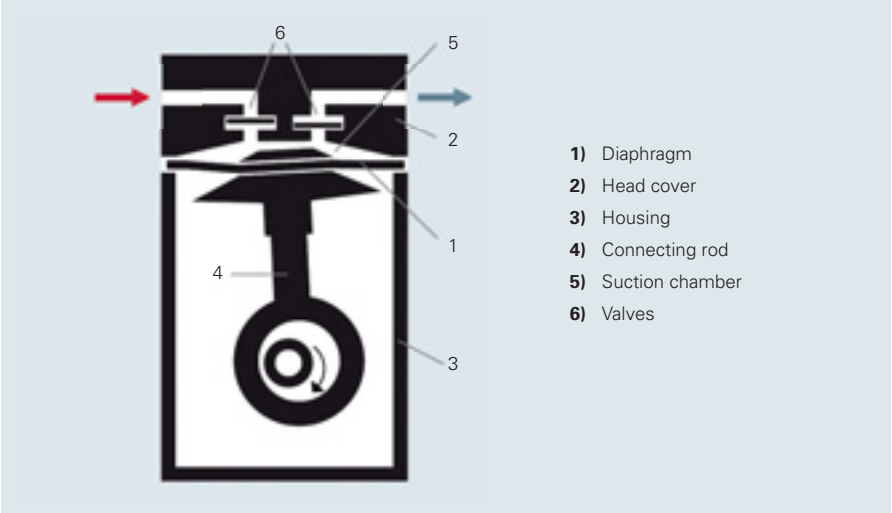


Figure 2.5: Operating principle of a diaphragm pump

2.3.2 Application notes

Their hydrocarbon-free suction chambers make diaphragm pumps particularly well suited as dry backing pumps for turbomolecular pumps with Holweck stage. Even two-stage diaphragm pumps that can reach an ultimate pressure of approximately 5 mbar can be used as backing pumps for Holweck turbopumps. Their clean vacuum is particularly valued for analytical applications. Diaphragm pumps, too, do not displace water vapor without gas ballast. Even the low volumes of water vapor that desorb from the walls of high vacuum equipment can allow the ultimate pressure of a diaphragm pump to increase dramatically. However some diaphragm pumps are equipped with a gas ballast valve that operates in accordance with a patented process.

For this purpose, gas is admitted into the connection channel between the first and second stages of two-stage diaphragm pumps, and communicates with the suction chamber of the first stage via a small hole. If greater volumes of moisture accumulate and diaphragm pumps without gas ballast are being used, suitable separators or cooling traps must be connected upstream to prevent significant condensate formation in the pump. However the ultimate pressure will nevertheless increase.

2.3.3 Portfolio overview

Diaphragm pumps from Pfeiffer Vacuum are available in a variety of versions. They differ in terms of their ultimate pressures and pumping speeds. The pumping speeds of the pumps are between 6 and 160 l/min (0.36 – 9.6 m³/h). Ultimate pressures of less than 4 mbar for two-stage pumps and less than 0.5 mbar for four-stage pumps can be attained. Pumps that feature corrosive gas design with coated diaphragms and corrosion-resistant housings are available for pumping corrosive gases.

Table 2.8: Diaphragm pump performance data

Model	Pumping Speed	Ultimate Pressure	Applications
MVP 006-4	0.28 m³/h	≤ 2.0 mbar	Small turbopump pumping stations (ideal with HiPace 10 and HiPace 80), mobile analysis devices
MVP 015-2	0.9 m³/h	≤ 3.5 mbar	Turbopump pumping stations, leak detectors, research laboratories, analytical applications, chemistry
MVP 015-4	0.9 m³/h	≤ 0.5 mbar	
MVP 040-2	2.3 m³/h	≤ 4.0 mbar	
MVP 070-3	3.8 m³/h	≤ 1.0 mbar	
MVP 070-3 C	3.4 m³/h	≤ 1.5 mbar	Corrosive gas applications requiring a hydrocarbon-free vacuum
MVP 160-3	9.6 m³/h	≤ 2.0 mbar	Turbopump pumping stations, leak detectors, research laboratories, analysis, chemistry
MVP 160-3 C	8.3 m³/h	≤ 2.0 mbar	Corrosive gas applications requiring a hydrocarbon-free vacuum

The designations for the pumps are selected in such a manner as to indicate the number of pumping stages and the pumping speed. Corrosive gas pumps have the letter C as a suffix to the model designation.

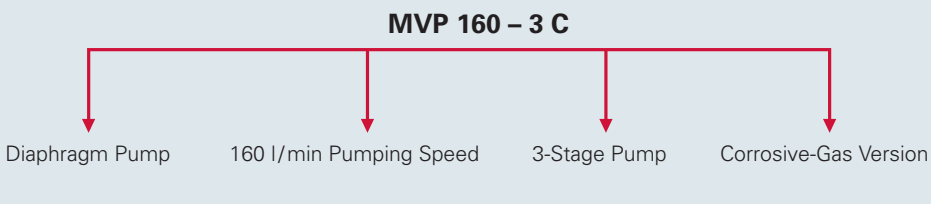


Figure 2.6: Diaphragm pump model designations

2.4 Piston vacuum pumps

2.4.1 Design / Operating principle

The operating principle of piston vacuum pumps is one of the oldest in the history of vacuum generation. Its principle is that of the classical positive-displacement pump. Otto von Guericke, the father of vacuum technology, used a pump incorporating this design for his experiments.

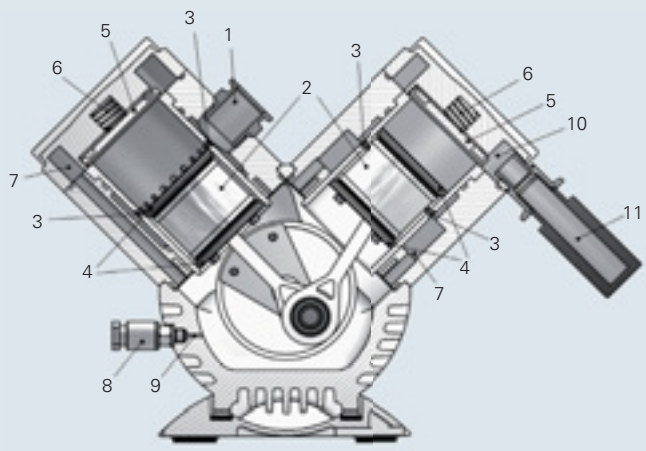


Figure 2.7: Operating principle of a piston pump

Like diaphragm pumps, classical piston vacuum pumps are equipped with an inlet valve and an outlet valve. The arrangement of these valves produces a dead volume above the piston in the cylinder head, which limits the maximum compression ratio. Moreover, ultimate pressure is limited by the force that must be applied to open the inlet valve. These two disadvantages are avoided through the special design of the piston pump described below.

New material pairings enable operation without oil between the piston seals (4) and the cylinder wall. Since the entire cross section of the cylinder is formed as an outlet valve plate (5), the harmful space (dead volume) between the piston (2) and the cylinder head tends toward zero.

A crankshaft-driven connecting rod moves a piston up and down in a cylinder. The inlet flange (1) communicates with the swept volume via the intake holes (3) when the piston (2) is in its bottom-most position. As the piston moves upward, the inlet holes (3) close off again, and the incoming gas is compressed. After reaching the opening pressure, the valve plate (5) lifts and the gas flows to the inlet holes (3) of the second stage via the overflow channel (7) and the crankcase housing. The second seal (4) prevents the inlet channel from communicating with the crankcase during the compression stroke. The second stage operates in the same manner as the first, and discharges the gas to the atmosphere via the outlet channel (10) and the silencer (11).

Gas ballast air can be admitted to the crankcase via the gas ballast valve and the throttling port behind it in order to displace water vapor though the pump without condensation (see also 2.1.6, Gas ballast).

In the case of dry piston pumps, wear occurs on the piston seals during operation, particularly at high average piston speeds. Once the required inlet pressure is reached, seal wear can be significantly reduced by lowering the RPM.

2.4.2 Applications

Dry piston pumps have higher pumping speeds than those offered by diaphragm pumps, and are used where a clean, hydrocarbon-free vacuum is required when operating near ultimate pressure. Eliminating the inlet valve enables lower base pressures to be reached than with diaphragm pumps. Like all true positive-displacement pumps, piston pumps have the same pumping speed for all gases.

Piston pumps are suitable for use as dry backing pumps for turbomolecular pumps. However to prevent enrichment of hydrogen and water vapor in the backing vacuum area of the turbo-pump, they must be operated with gas ballast if necessary. Piston pumps are particularly well suited for analytical applications and for leak detectors (see also 5.2, Design of a helium leak detector). If the test specimens are directly evacuated by the backing pump for leak detection, they cannot be contaminated with oil vapor when a dry backing pump is used.

Piston pumps are not suitable for pumping corrosive or abrasive media.

2.4.3 Portfolio overview

Pfeiffer Vacuum offers two piston vacuum pumps, the single-stage XtraDry 250-1 and the two-stage XtraDry 150-2. These pumps differ in terms of their pumping speeds and ultimate pressures. In particular, the two-stage XtraDry is characterized by:

- Low base pressure: p_b = 0.1 mbar
- Gas ballast
- Automatic speed reduction near base pressure

Table 2.9: XtraDry™ piston pump performance data

Model	Pumping Speed	Ultimate Pressure	Applications
XtraDry™ 150-2	7.5 m³/h	0.1 mbar	Dry backing vacuum without condensate and dust accumulation
XtraDry™ 250-1	13.0 m³/h	7.0 mbar	

2.5 Screw vacuum pumps

2.5.1 Design / Operating principle

Two parallel bearing-supported, intermeshing screw rotors (3) having opposite threads synchronously and contactlessly counter-rotate in a cylindrical housing (2) that tightly encloses them, and together form a multi-stage pump.

Because of the counter-mesh of the two rotors, the volumes sealed in each thread are advanced along the rotors to the outlet (4). The pump has no valves at either inlet (1) or outlet. When a displacement volume reaches the outlet opening, the pressure is equalized with the atmosphere. This means that atmospheric air flows into the displacement volume and is then discharged again as the rotor turns. This pulsing gas flow generates a high level of dissipated energy and heats the pump. The dissipated energy can be minimized by means of internal compression. This internal compression is achieved by reducing the thread pitch in the direction of the outlet. The gaps between housing and rotors, as well as between the rotors relative to one another, determine the achievable ultimate pressure of a screw pump. The geometry and the resulting configuration of the gap in connection with the mesh between the rotors also significantly influence ultimate pressure.

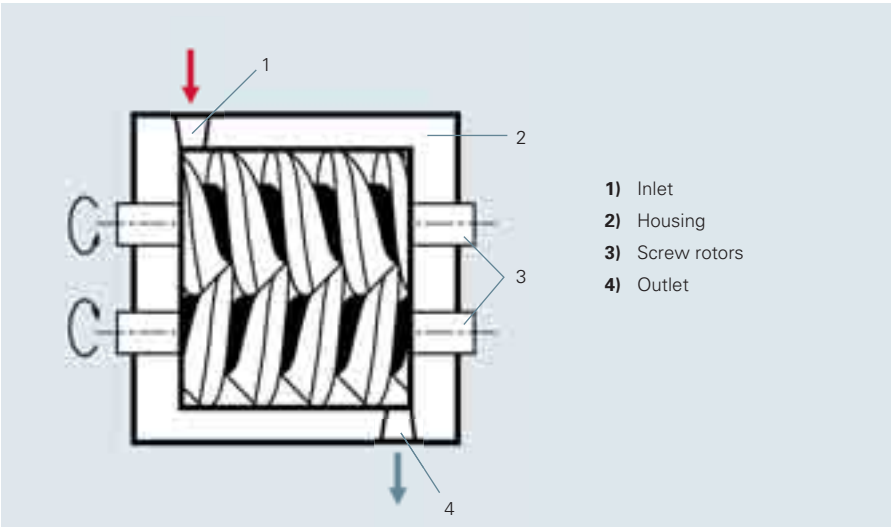


Figure 2.8: Operating principle of a screw pump

Because the dissipated energy that is generated by the pulsing gas flow heats the pump on the outlet side, cooling is required at precisely this location. The gap between housing and rotors is a function of the temperature differential between the warmer rotors and the cooled housing. The amount of heat produced and the temperature are a function of the inlet pressure range. Temperatures are lowest at high inlet pressures (nearly atmospheric), as virtually no compression work is performed here and the displaced air transports sufficient heat out of the pump. In addition, the high gas flow also prevents oscillation of the gas in the last stage. During operation at ultimate pressure ($p < 1$ mbar), the oscillation of the atmospheric air produces higher temperatures at the outlet area, since no gas is passing through the pump, and no heat is thus being transported out of the pump.

HeptaDry pumps are dry screw pumps with internal compression. The screw rotors have a symmetrical geometry with variable pitch. These pumps do not have an end plate with control openings; instead, the gas is discharged axially against atmospheric pressure. Because of the internal compression, the volume of pulsing gas is low.

This results in lower power consumption, quiet operating, uniform temperature distribution within the pump and low cooling water consumption. This makes these pumps extremely cost-effective, in spite of their robust design.

Figure 2.9: HeptaDry™ rotors

2.5.2 Application notes

In recent years, screw pumps have been replacing oil-lubricated rotary vane pumps in the high pumping speed segment (100 – 600 m^3/h)

Their advantages include:

- No lubricant in the gas displacement area
- No contamination of the medium to be pumped
- Higher efficiency thanks to internal compression
- Lower ultimate pressure $p_B < 10^{-1}$ mbar
- Virtually constant pumping speed between 1 and 1,000 mbar
- Good liquid and particulate matter tolerance
- Bearings and seals are protected through low gas pulsation as a result of internal compression
- High-quality axial face seals
- Low noise level thanks to standard-feature silencers and outlet valve
- Temperature-regulated cooling
- Low energy consumption
- Extensive use of standard components
- Mounted ready for connection on a frame with vibration dampers
- Ideal backing pump for Roots pumps

This makes HeptaDry screw pumps very well suited for chemical applications or processes that generate dust, e.g. for semiconductor production, or if significant volumes of condensate are produced.

In connection with thermostatic cooling, the water flow volume will depend upon the following parameters: Inlet pressure, gas type, rotary speed and pump size. Because of the water-flow cooling, virtually no heat is dissipated to the atmosphere. This can ease the heat load on any existing air conditioning systems and reduce their energy consumption.

Overview of primary applications:
- Drying, freeze-drying
- Coating
- Electron beam welding
- Metallurgy
- Load locks
- Chemistry

2.5.3 Portfolio overview

HeptaDry pumps are dry screw pumps for applications in the low and medium vacuum ranges where high volume flow rates are required. The pumping speeds of this product line range from 100 to 600 m^3/h. Ultimate pressures of under 0.1 mbar are attained.

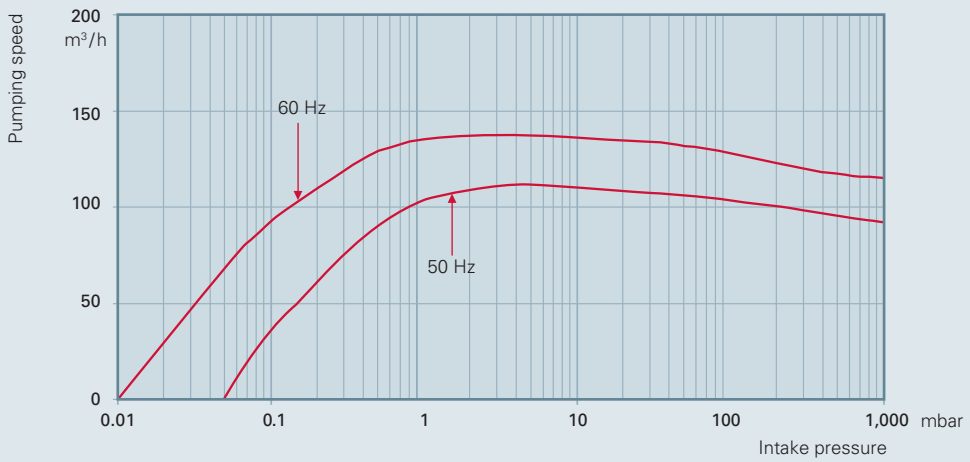


Figure 2.10: HeptaDry™ operating range

Regardless of the model in question, HeptaDry pumps can be continuously operated in the operating range shown in Figure 2.10. Their effective pumping speed declines in the $p < 1$ mbar pressure range due to the ever-stronger backflow between the individual sealed volumes within the pump. See also Formula 2-5. There is a similar reason for the decrease in pumping speed toward high pressure, as in this case the gas is compressed to pressures in excess of atmospheric pressure through internal compression, and consequently backflow increases significantly due to the high differential pressure.

The standard equipment that comes with the pumps includes: Inlet sieve, water-flow cooling with thermostatic valve and thermometer, silencer with non-return valve and frame-mounted design with vibration dampers.

The pumps are driven by a three-phase, temperature-monitored asynchronous motor that is suitable for 50 and 60 Hz (3,000 or 3,600 rpm). Coupling, bearings and flanges are standard components.

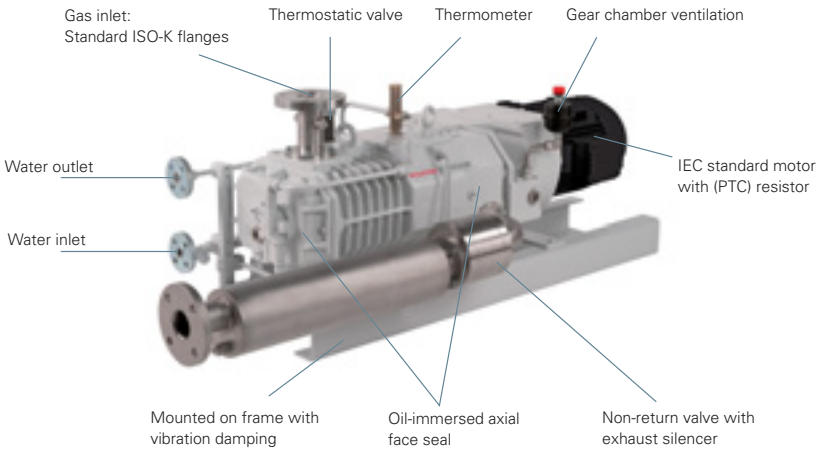


Figure 2.11: HeptaDry™ with connections and accessories

Table 2.10: HeptaDry™ series connections

Model	Intake Connection DN	Exhaust connection DN	Water DN
Hepta 100	63 ISO-K	40 PN 16	15 PN 10
Hepta 200	63 ISO-K	50 PN 16	15 PN 10
Hepta 300	63 ISO-K	50 PN 16	15 PN 10
Hepta 400	100 ISO-K	80 PN 16	15 PN 10
Hepta 600	100 ISO-K	80 PN 16	15 PN 10

Table 2.11: HeptaDry™ performance data

Model	Pumping Speed / (m³ / h)	Ultimate Pressure / mbar	Motor rating / kW
Hepta 100, 50 Hz	110	< 0.05	3.0
Hepta 100, 60 Hz	130	< 0.01	4.0
Hepta 200, 50 Hz	220	< 0.05	5.5
Hepta 200, 60 Hz	265	< 0.01	7.5
Hepta 300, 50 Hz	320	< 0.05	7.5
Hepta 300, 60 Hz	410	< 0.01	9.2
Hepta 400, 50 Hz	350	< 0.05	7.5
Hepta 400, 60 Hz	420	< 0.01	9.2
Hepta 600, 50 Hz	525	< 0.05	11.0
Hepta 600, 60 Hz	630	< 0.01	15.0

The HeptaDry line is rounded out by the RevoDry 50. The RevoDry 50 is available either as an S version or a P version with a variety of accessories. It, too, is a dry pump with a pumping speed of 50 m^3/h.

Please note the following in connection with pumps that are supplied in the standard scope of delivery:

- They are not suitable for pumping toxic, flammable and/or explosive gases
- They are not suitable for corrosive gases
- No foreign matter
- No deposit-forming media
- Limited entrainment of fluid (surge fluid)
- Permissible inlet temperature between 70 and 200 °C as a function of inlet pressure
- Coolant limits must be observed: Temperature 10 – 25 °C, pressure 3 – 6 bar
- Not gas tight

2.6 Roots vacuum pumps

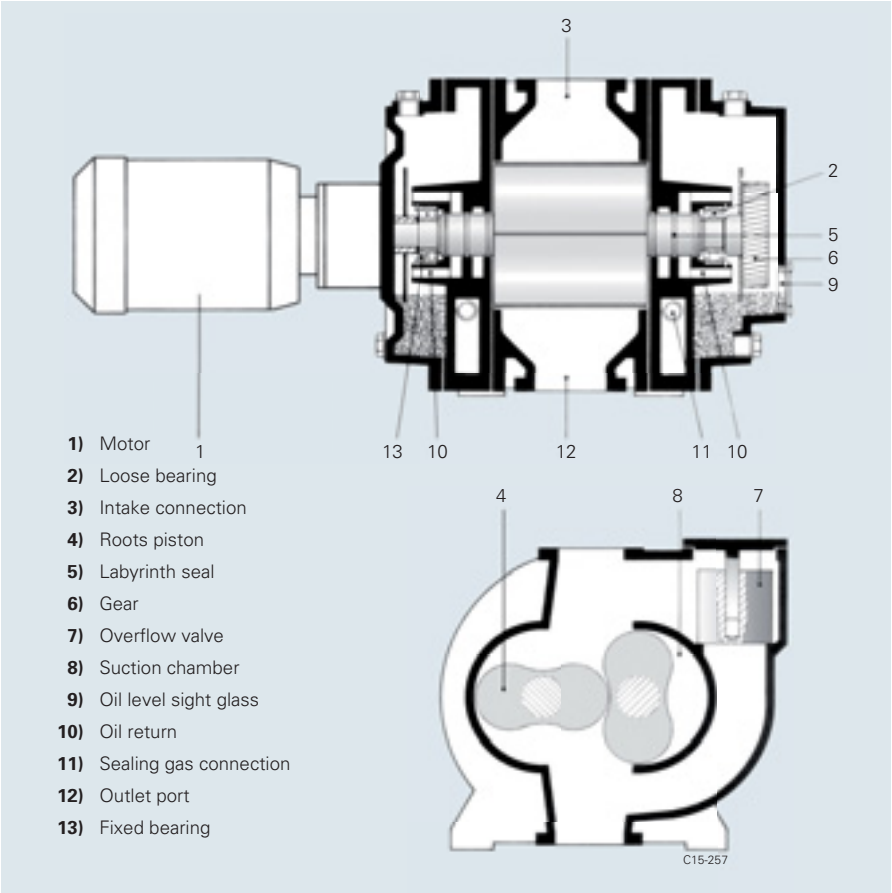


Figure 2.12: Operating principle of a Roots pump

2.6.1 Design / Operating principle

Roots vacuum pumps belong to the category of technically dry-running rotary displacement vacuum pumps. They are also termed Roots pumps or Roots blowers.

Operating principle

In a Roots pump, two synchronously counter-rotating rotors (4) rotate contactlessly in a single housing (Figure 2.12). The rotors have a figure-eight configuration and are separated from one another by a narrow gap. Their operating principle is analogous to that of a gear pump having one two-tooth gear each that pumps the gas from the inlet port (3) to the outlet port (12). One shaft is driven by a motor (1). The other shaft is synchronized by means of a pair of gears (6) in the gear chamber. Lubrication is limited to the two bearing and gear chambers, which are sealed off from the suction chamber (8) by labyrinth seals (5). Because there is no friction in the suction chamber, a Roots vacuum pump can be operated at high rotary speeds (1,500 - 3,000 rpm). The absence of reciprocating masses also affords trouble-free dynamic balancing, which means that Roots vacuum pumps operate extremely quietly in spite of their high speeds.

Design

The rotor shaft bearings are arranged in the two side pieces. They are designed as fixed bearings on one side and as sliding internal rings on the other in order to enable unequal thermal expansion between housing and piston. The bearings are lubricated with oil that is displaced to the bearings and gears by splash disks. The driveshaft feedthrough to the outside is sealed with radial shaft seal rings made of FPM that are immersed in sealing oil. To protect the shaft, the sealing rings run on a protective sleeve that can be replaced when worn. If a hermetic seal to the outside is required, the pump can also be driven by means of a permanent-magnet coupling with can. This design affords leakage rates Q_l of less than 10^{-5} mbar · l/s.

Pump properties, heat-up

Since Roots pumps do not have internal compression or an outlet valve, when the suction chamber is opened its gas volume surges back into the suction chamber and must then be re-discharged against the outlet pressure. As a result of this effect, particularly in the presence of a high pressure differential between inlet and outlet, a high level of energy dissipation is generated, which results in significant heat-up of the pump at low gas flows, which in and of itself transports low quantities of heat.

The rotating Roots pistons can only be provided with relatively weak cooling by comparison with the housing, as there are no contacting surfaces other than the front side. Consequently, they expand more than the housing. To prevent contact or seizing, the maximum possible pressure differential, and thus dissipated energy, is limited by an overflow valve (7). It is connected to the inlet side and the pressure side of the pump-through channels. A weight-loaded valve plate opens when the maximum pressure differential is exceeded and allows a greater or lesser portion of the intake gas to flow back from the pressure side to the inlet side, depending upon the volume of gas encountered. Due to the limited pressure differential, simple Roots pumps cannot discharge against atmosphere and require a backing pump. However Roots vacuum pumps with overflow valves can be switched on together with the backing pump, even at atmospheric pressure, thus increasing their pumping speed right from the beginning. This shortens evacuation times.

Backing pumps

Rotary vane pumps, rotary piston pumps or screw pumps can be used as backing pumps: These kinds of pump combinations can be employed for all applications in the low and medium vacuum ranges involving high pumping speeds. Liquid ring pumps can also be used as backing pumps.

Gas-cooled Roots pumps

To allow Roots vacuum pumps to work against atmospheric pressure, some models do not have overflow valves with gas cooling (Figure 2.13). In this case, the gas that flows from the outlet flange (6) is re-admitted into the middle of the suction chamber (4) through a cooler (7). This artificially generated gas flow cools the pump, enabling it to compress against atmospheric pressure. Gas entry is controlled by the Roots pistons, thus eliminating the need for any additional valves. There is no possibility of thermal overload, even when operating at ultimate pressure.

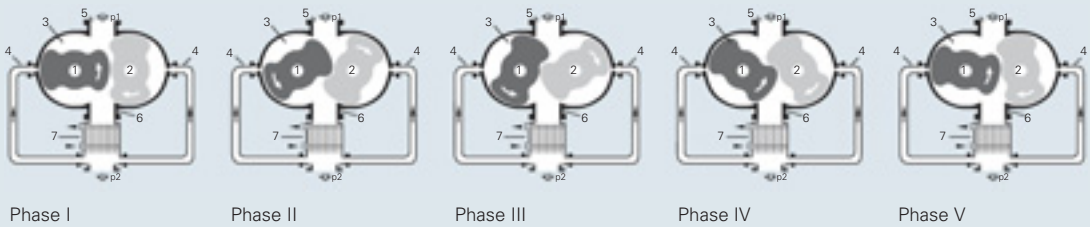


Figure 2.13: Operating principle of a gas-cooled Roots pump

Figure 2.13 shows a cross section of a Roots vacuum pump. The direction of gas flow is vertical from top to bottom, enabling the liquid or solid particles entrained in the inlet flow to flow off downward. In phase I, the chamber (3) is opened by the rotation of the pistons (1) and (2). Gas flows into the chamber through the inlet flange at pressure p_1. In phase II, the chamber (3) is sealed off against both the inlet flange and the pressure flange. The inlet opening (4) for the cooling gas is opened by the rotation of the pistons. In Phase III, the chamber (3) is filled at the outlet pressure p_2, and the gas is advanced toward the pressure flange. Initially, the suction volume does not change with the rotary movement of the Roots pistons. The gas is compressed by the inflowing cooling gas. The Roots piston now continues to rotate (phase IV), and this movement pushes the now compressed gas over the cooler (7) to the discharge side (Phase V) at pressure p_2.

Gas-cooled Roots pumps can be used in the inlet pressure range of 130 to 1,013 mbar. Because there is no lubricant in the suction chamber, they do not discharge any mist or contaminate the medium that is being pumped. Connecting two of these pumps in series enables the ultimate pressure to be reduced to 20 to 30 mbar. In combination with additional Roots vacuum pumps, the ultimate pressure can be reduced to the medium vacuum range.

Pumping speed and compression ratio

The characteristic performance data of Roots pumps are: The pumping speed $S_{th} = S_0$, which is the volume flow rate the pump displaces without counter-pressure, and the (no-load) compression ratio $K_m = K_0$ without gas displacement, which is a function of the exhaust pressure p_2. Pumping speeds range from 200 m³/h to several thousand m³/h. Typical K_0 values are between 10 and 75.

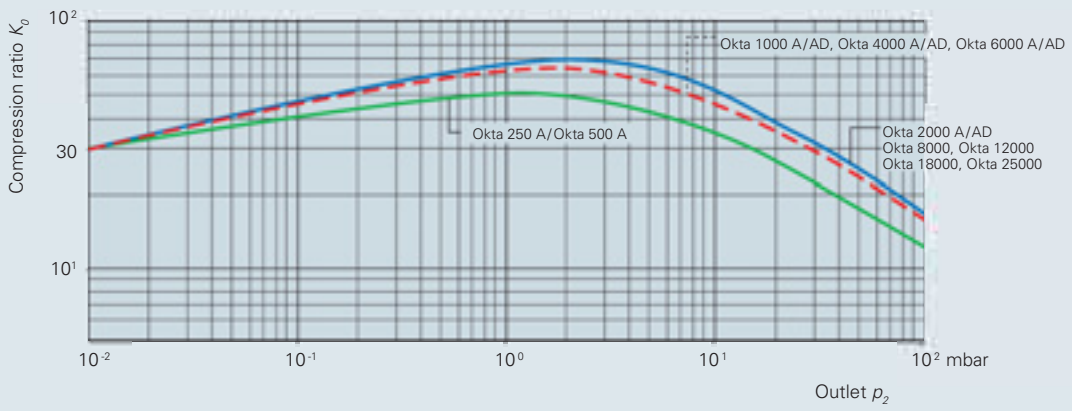


Figure 2.14: No-load compression ratio for air with Roots pumps

The compression ratio is negatively impacted by two effects:

- By the backflow into the gaps between piston and housing
- By the gas that is deposited on the surfaces of the piston on the outlet side and is re-desorbed after rotating toward the suction side

In the case of outlet pressures of 10^{-2} to 1 mbar, molecular flow prevails in the seal gaps, which results in less backflow due to their lower conductivities. However the volume of gas that is pumped back through adsorption, which is relatively high by comparison with the pumped gas volume, reduces the compression ratio.

K_0 is highest in the 1 to 10 mbar range, since molecular flow still prevails due to the low inlet pressure in the pump's sealing gaps, and backflow is therefore low. Because gas transport through adsorption is a function of pressure, it is less important than the pressure-proportional gas flow that is transported by the volume flow.

At pressures in excess of 10 mbar, laminar flow occurs in the gaps and the conductivities of the gaps increase significantly, which results in declining compression ratios. This effect is particularly noticeable in gas-cooled Roots pumps that achieve a compression ratio of only approximately $K_0 = 10$.

The gap widths naturally have a major influence on the compression ratio. However to avoid piston scraping they should not be smaller than certain minimum values due to the thermal expansion of the pistons and the housing.

2.6.2 Calculations

Power requirements of a Roots vacuum pump

A Roots vacuum pump is a pure positive-displacement pump without internal pre-compression. Consequently, its power input P, as well as the pressure differential Δp between inlet side connection and pressure side connection S_0, are proportional.

Formula 2-8
Roots pump power input

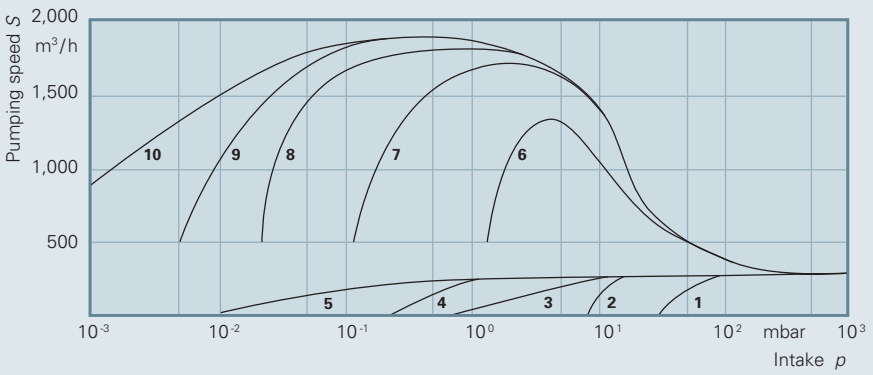
$$P = \frac{S_0 \cdot \Delta p}{\eta_{mech}}$$

S_0 = pumping speed of a Roots vacuum pump without counter-pressure, in m³/s
Δp = pressure differential between inlet-side connection and pressure-side connection, in Pa
η_{mech} = mechanical efficiency of the pump (approximately 0.85 for Roots vacuum pumps)
P = power requirement or motor rating, in W

Although the mechanical losses are low, it is advisable to use contactors in the control cabinet for heavy-duty start-up. After power-up, the power requirement in the medium vacuum range is low.

All further calculations relating to the pumping speeds of pumping stations and pump-down times are provided in Chapter 7: Configuration.

2.6.3 Application notes



1) Liquid ring pump (S = 250 m³/h)
2) Liquid ring pump with gas jet (S = 250 m³/h)
3) Single-stage rotary vane pump with gas ballast (S = 250 m³/h)
4) Liquid ring pump with gas jet (S = 250 m³/h) and upstream Okta 250 Roots pump (S = 250 m³/h)
5) Single-stage rotary vane pump without gas ballast (S = 250 m³/h)
6) – 10) Okta 2000 Roots pump with vacuum pumps analogous to 1) – 5)

Figure 2.15: Pumping speeds of pumping stations with Okta 2000 and various backing pumps

Due to their low compression ratios, Roots pumps must always be operated as pump combinations for vacuum generation. Their achievable final pressures will be a function of the ultimate pressures of the selected backing pumps. Due to gas transport through adsorption, it is no longer practical to use Roots pumps in the range below 10^{-4} mbar. The behavior of the pumping speed and ultimate pressure of pumping stations with various backing pumps is shown in Figure 2.15. The curves clearly show that the pumping speed of this kind of pump combination rises by a factor of 8 and its ultimate pressure reduces by a factor of 15 relative to the backing pump.

2.6.3.1 Backing pump selection

Rotary vane pumps

If there will be no negative impact on function due to the process, a rotary vane vacuum pump is the most cost-effective backing pump for a Roots vacuum pumping station. Rotary vane vacuum pumps have ultimate pressures of around $p < 1$ mbar over a broad pressure range at constant pumping speed. A Roots vacuum pumping station achieves ultimate pressures of approximately 10^{-2} mbar with the gas ballast valve open.

Water vapor can be extracted with these kinds of pumping stations, as well as many solvent vapors and other vapors that have sufficiently high vapor pressures and do not chemically decompose the pump oil (alcohols, halogenated hydrocarbons, light normal paraffins, etc.).

Liquid ring vacuum pumps

Liquid ring vacuum pumps are a suitable solution for extracting vapors that chemically attack and decompose the backing pump oil or that have such low pressure that condensation in the backing pump cannot be avoided, in spite of gas ballast. However they will only achieve an ultimate pressure that is determined by the vapor pressure of the operating fluid. If 15 °C water is used, an ultimate pressure of approximately 20 mbar can be expected at the liquid ring vacuum pump, and it is then already working in the cavitation area.

A cavitation-free liquid ring vacuum pump working through the addition of air achieves an ultimate pressure of approximately 25 to 30 mbar, and a combination of Roots pump and liquid ring pump reaches approximately 1 mbar. A liquid ring pump should not be used with fresh water when evacuating environmentally harmful substances. In this case, a closed circulation system must be provided to advance a suitable operating fluid over a cooled heat exchanger in order to extract the heat of compression.

Liquid ring vacuum pump with gas jet device

The combination of Roots vacuum pump, gas jet device and liquid ring vacuum pump achieves an ultimate pressure of 0.2 mbar. If lower pressures need to be achieved, an additional Roots vacuum pump must be connected upstream.

Gas-cooled Roots vacuum pumps

Since Roots vacuum pumps are technically dry pumps, their employment is advisable when pumps with liquid-tight suction chambers cannot be used.

Their applications include:

- Extracting and compressing helium on cryostats
- Extracting and compressing SF_6
- Clean recovery of a wide variety of gases and vapors in a wide variety of processes, e.g. distillation
- Evacuating molecular sieves, etc.
- Pumping down and displacing toxic substances in closed circulation systems
- Evacuating extremely large-volume vessels

Roots pumping stations with gas-cooled Roots pumps can be configured with a wide variety of inlet characteristics. In extreme cases, it is possible to achieve a virtually constant pumping speed throughout the entire pressure range of 1 bar to 10^{-3} mbar, and the individual pump stages can be selected in the ratio of 2:01 to 3:01.

To do this, however, the Roots vacuum pumps must be equipped with correspondingly powerful motors, and outlet valves to the atmosphere must be provided instead of overflow valves.

Screw pumps

With the HeptaDry screw pumps, a complete line of technically dry pumps is available that offer pumping speeds of 100 to 600 m^3/h. As stand-alone pumps (see also Figure 2.10), they cover an extensive pressure range in the low and medium vacuum segments. Due to their internal compression, they can work continuously with relatively low drive power throughout the entire inlet range of 0.1 to 1,000 mbar. In combination with OktaLine Roots pumps, it is even possible to achieve ultimate pressures of $5 \cdot 10^{-3}$ mbar.

2.6.4 Portfolio overview

Roots pumps are offered in four versions:

- Standard pumps with shaft seal rings and cast iron housing (A series)
- Hermetically sealed standard pumps with magnetic coupling and cast-iron housing (AM series)
- Roots pumps for potentially explosive environments (ADx series)
- Roots pumps for potentially explosive environments and for displacement of explosive gases (ATEx series)

Table 2.12: OktaLine™ performance data

Model	Pumping Speed S_0	Maximum Differential Pressure	Maximum Compression Ratio K_0	Applications
Okta 250	270 m^3/h	75	50	Suitable for industrial/chemical applications:
Okta 500	490 m^3/h	75 (ADEx: 53)	50	E.g. oil regeneration, transformer drying, steel
Okta 1000	1,070 m^3/h	45 (ADEx: 30)	63	degassing, freeze-drying, leak detection systems,
Okta 2000	2,065 m^3/h	35 (ADEx: 20)	70	metallurgy, packaging industry, electron beam welding
Okta 4000	4,050 m^3/h	25 (ADEx: 20)	63	Suitable for large-area coating:
Okta 6000	6,075 m^3/h	20	63	E.g. photovoltaics, wear protection, glass coating
Okta 8000	8,000 m^3/h	27	70	Suitable for research & development:
Okta 18000	17,850 m^3/h	10	70	E.g. accelerators, simulation chambers

2.6.4.1 Standard pumps

The performance data of the standard pumps (A series) are shown in Table 2.12. These performance data also apply to all other series. The maximum differential pressures are a function of the overflow valves. In the ADEx series, these maximum differential pressures are smaller than for the other series in order to satisfy the temperature requirements specified by the ADEx guidelines and are shown in parentheses in the table. The housings for these pumps are manufactured of cast iron and are tested at 1 bar overpressure. The seal to the atmosphere consists of radial shaft seal rings. The standard pumps are characterized by their robust, compact design as well as by their high compression ratios, which result in high pumping speeds for the pump combination, even with small backing pumps, and thus afford short pump-down times. The vertical direction of flow renders this pump largely insensitive to dusts and liquids.

2.6.4.2 Standard pumps with magnetic coupling

The AM series can be used for processes that place the most rigorous requirements on sealing and require the longest service intervals. For the most part, this series is identical to the A series, however it is additionally characterized by a hermetically sealed magnetic coupling instead of radial shaft seal rings. This means that it is virtually wear-free in operation. The integral leakage rate of the pump is $Q_l < 1 \cdot 10^{-5}$ mbar l/s.

This precludes the possibility of oil leaks, nor is there any exchange between process gas and the environment. AM series standard pumps are suitable for all applications shown in Table 2.12. In addition, however, these pumps can also be employed in industrial / chemical applications for pumping toxic gases, as well as for superclean gas applications: e.g. for CVD and PVD processes in the semiconductor industry or for evacuating load locks / transfer chambers and for the production of flat screens. The AM series is available in sizes that range from 250 m^3/h to 6,000 m^3/h.

2.6.4.3 Explosion-protected pumps

The ADx and ADEx series are available for processes in potentially explosive environments, or for evacuating explosive gases..

PTFE-sealed ADx series pumps with pumping speeds from 500 to 4,000 m^3/h are made of nodular graphite cast iron 40.3 and are supplied either with or without ATEX motor. Although they are not suitable for pumping explosive gases, they can be operated in potentially explosive environments. They satisfy the explosion protection requirements specified in Directive 94/9/EG (–(i)/II 3G II BT3 (o).

ADEx series pumps are identical to the ADx series pumps. They are equipped with an ATEx coupling, an integrated ATEx temperature sensor and can be supplied either with or without ATEx motor (EEx de IIC T4). From 800 mbar onward, they can be switched on without bypass line, which eliminates valves. They satisfy the explosion protection requirements specified in Directive 94/9/EG (II 2G IIB T3 (i) (o)).

Generally speaking, additional measures and/or components are required for safe pump operation, such as start-up and shut-down procedures, special backing pumps, flashback arrestors and pressure sensors. The entire plant must naturally be designed and operated in accordance with the respective explosion-protection regulations. Both series of pumps are available in pumping speeds that range from 500 to 4,000 m^3/h.

Gas-cooled Roots pumps

Upon request, the gas-cooled Roots pumps described in Section 2.6.1 can also be supplied in sizes ranging from 500 m^3/h (18.5 kW drive power) to 12,000 m^3 (200 kW drive power).

2.6.4.4 Pumping stations

Pfeiffer Vacuum offers its CombiLine standard pumping stations with single- and two-stage backing pumps:

Roots pumping stations WU … with single-stage HenaLine/UnoLine Plus rotary vane pumps with an ultimate pressure of $p < 5 \cdot 10^{-2}$ mbar. They are cost-effective and suitable for the following applications:

- Evacuating load lock chambers (e.g. electron beam welding, coating)
- Helium leak detection
- Vacuum drying and degassing, metallurgy, (e.g. hardening, sintering, soldering, casting, smelting)

Roots pumping stations WD … with RevoDry 50 or HeptaDry dry screw pumps with an ultimate pressure of $p < 5 \cdot 10^{-4}$ mbar for the following applications:

- Backing pump station for high vacuum pumps
- Coating (e.g. wear protection, decorative coatings, thermal protection coatings, optical coatings)
- Metallurgy (e.g. hardening, sintering, soldering, casting, smelting, degassing)

Roots pumps WH … with RevoDry 50 or HeptaDry dry screw pumps with an ultimate pressure of $p < 1 \cdot 10^{-2}$ mbar for the following applications:

- Coating (solar industry, metalizing, surface treatment)
- Degassing steel and plastics
- Vacuum drying, workpiece cleaning
- Leak test systems
- Freeze drying

2.6.5 Accessories

Splinter shield inserts are offered as accessories for all OktaLine series Roots pumps.

The following oils for lubricating the gearing and the bearings are available as lubricants (Table 2.7):

- Mineral oil P3 (in 0.5 l to 200 l containers)
- Perflourpolyether F5 (in 0.5 l to 50 l containers)
- Diester oil D1 (in 0.5 l to 200 l containers)

Caution: Different kinds of oil should not be mixed. The pumps are prepared for one of these types of oil at delivery.

Since many Roots pumps are installed in pump combinations, it is possible to integrate the following accessories on an as-needed basis:

- Electrical controllers
- Measuring instrumentation for temperature and pressure
- Pressure regulation means
- Heat exchangers and condensers

- Soundproofing encapsulation for indoor and outdoor installation
- Silencers
- Dust separators
- Flushing devices
- Vibration isolation
- Liquid separators
- Gear chamber extraction
- Sealing gas supply

Measurement connections
In the case of many Roots pumps, it is possible to use the measurement connections on the inlet and pressure sides of the pump. To do this, the existing locking screws can be replaced with small ISO KF flange unions. This enables connection of appropriate temperature sensors and pressure sensors for monitoring the pump.

Sealing gas connection
When pumping solvents or reactive gases, the risk exists that the lubricant will be significantly diluted as a result of condensation. Reactive gases or vapors can also attack parts of the gear chamber. For the most part, this risk can be avoided by admitting a sealing gas in the area of the shaft feedthrough between working space and gear chamber. Inert gases, mostly nitrogen (N_2), are used as the sealing gas.

Gear chamber extraction
In the case of all processes in which large Roots vacuum pumping stations must reach certain pressures in short cycle times (fast evacuation), it is practical to pump down the gear chambers of a Roots pump via an oil separator, by means of a separate vacuum pump in each case. This prevents gas from flowing out of the gear chamber and into the suction chamber, thus enabling the desired working pressure to be reached faster. The desired working pressure will determine whether it is possible to connect the gear chamber toward the backing-vacuum side of the Roots pump.

Flushing devices
A flushing device can be used for processes in which deposits form in the suction chambers. The design of this device will be coordinated individually with the customer on the basis of the specific requirements. The flushing device for standard pumps requires the use of sealing gas to prevent the flushing liquid from reaching the bearings or gear chambers.

Surface protection
If the media to be pumped down are corrosive, components that come into contact with the product can be provided with durable surface protection. The plasma-polymer thin-layer system consists of a bonding agent layer, a corrosion-protection layer and a non-stick coating. The thickness of the layer is less than 1 µm. Upon request, the pump chamber can be phosphated, vented with nitrogen and vacuum sealed in order to provide short-term surface protection, e.g. for warehousing and shipment.

Seals
Roots vacuum pumps come factory-equipped with O-rings made of FPM. For special applications, all pumps can be equipped with the specific O-rings or seals that are required for the respective application.

2.7 Side channel high vacuum pumps

2.7.1 Design / Operating principle

The side channel high vacuum pump is a vacuum pump that works from atmosphere to the high vacuum range. The pump uses two operating principles to do this. In the upper pressure range (laminar flow range), the pump primarily works in accordance with the principle of a side channel vacuum pump, while working as a Holweck vacuum pump in the lower pressure range.

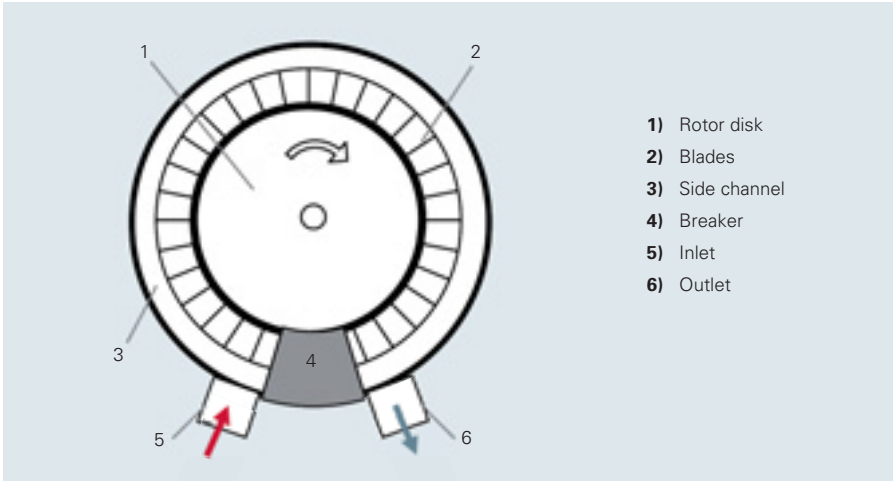


Figure 2.16: Operating principle of a side channel vacuum pump

The pumping system in a side channel vacuum pump (Figure 2.16) consists of a rotor disk (1) having blades (2) that are arranged on the outer perimeter and a ring-shaped working chamber, the side channel (3). The side channel is narrowed to the disk profile at one point by a breaker (4).

The pumping effect occurs through a helical flow from the inlet to the outlet that is produced by the blades of the rotating rotor. This results in a pressure differential between inlet (5) and outlet (6). Lower ultimate pressures can be attained by connecting multiple pumping stages in series. At pressures of between 1 and 20 mbar, the pump leaves the laminar flow range, and a Holweck stage (Figure 2.21) takes over displacement of the gas.To adapt to the pressure of the side channel pump stages, which is still quite high, the Holweck channels are small on the vacuum side and the gap is narrow. Larger channel cross sections are used toward the suction side in order to increase the pumping speed.

2.7.2 Application notes

This kind of pump is particularly well suited for generating clean high vacuum. It works completely dry, as it only has one oil-lubricated bearing on the atmosphere side. It is ideally suited for fast evacuation of load locks or transfer chambers, since no backing pumps or bypass lines are required. The pump can be used either as a stand-alone pump or as a backing pump for turbopumps. Corrosive gases, condensates and particulate matter cannot be pumped due to the narrow gaps.

2.7.3 Portfolio overview

Pfeiffer-Vacuum offers a dry side channel high vacuum pump in the form of the OnToolBooster 150:

Table 2.13: OnTool™ Booster performance data

Model	Pumping Speed in m^3/h	Base Pressure in mbar	Compression Ratio	Applications
OnTool™ Booster 150	130	$1 \cdot 10^{-5}$	10^8	Load locks, backing pumps for turbopumps

2.8 Turbomolecular pumps

2.8.1 Design / Operating principle

The turbomolecular pump was developed and patented at Pfeiffer Vacuum in 1957 by Dr. W. Becker. Turbomolecular pumps belong to the category of kinetic vacuum pumps. Their design is similar to that of a turbine. A multi-stage, turbine-like rotor with bladed disks rotates in a housing. Interposed invertedly between the rotor disks are bladed stator disks having similar geometries.

Bearings

Mounting the rotors by means of two ball bearings would be problematic, since the lubricants require that both bearings be arranged on the backing-vacuum side, and the rotor, with its high mass, can only be supported by bearings on one side (floating).

Hybrid bearing support offers advantages in this regard with respect to rotor dynamics. In this case, an oil-lubricated ball bearing sits on the end of the shaft on the backing-vacuum side, and the high vacuum side is equipped with a maintenance- and wear-free permanent magnetic bearing that centers the rotor radially. A small dry safety bearing is arranged within the magnetic bearing stator. During normal operation, a journal rotates freely within this bearing. In the event of strong radial shocks, it stabilizes the rotor and rotates only briefly. If the rotor is out of balance, the bearings on both ends of the shaft will generate significantly lower bearing-stressing vibration forces than in the case of a floating bearing. Moreover, this enables the larger of the two bearings on the drive shaft, whose size allows only limited rotor speeds, to be eliminated.

So-called 5-axis magnetic bearings are used in large pumps. The rotor is levitated axially through digital electronic control via distance sensors and electromagnets, and in two radial directions each at both shaft ends. Electronic balance compensation and the absence of mechanical contact between rotor and housing keep the vibration generated by the pump low. In addition to the absence of oil on the backing-vacuum side, as well, freedom from wear and maintenance is another advantage. In the event of a power failure, the magnetic bearings are supplied with electricity through the rotational energy of the pump.

This enables power failures to be easily bridged for several minutes. Should the power failure be of longer duration, the rotor will safely come to a stop at only very low speed through the use of an integrated safety bearing. If the electronics are defective or if there is significant ingress of air, the rotor will be braked without damage with the aid of safety bearings.

Motors / Drives

Brushless DC motors that afford rotational frequencies of up to 1,500 Hz (90,000 rpm) are used to drive the rotors. This enables the blade velocities that are necessary for pumping the gases to be achieved.

Today, the drives are typically attached directly to the pumps. Power that is generated by external power supply units is supplied at 24 VDC or 48 VDC. In the case of large pumps, the drives are supplied directly from the rectified mains voltage.

2.8.1.1 Turbomolecular pump operating principle

The pumping effect of an arrangement consisting of rotor and stator blades is based upon the transfer of impulses from the rapidly rotating blades to the gas molecules being pumped. Molecules that collide with the blades are adsorbed there and leave the blades again after a certain length of time. In this process, blade speed is added to the thermal molecular speed. To ensure that the speed component that is transferred by the blades is not lost due to collisions with other molecules, molecular flow must prevail in the pump, i.e. the mean free path length must be greater than the blade spacing.

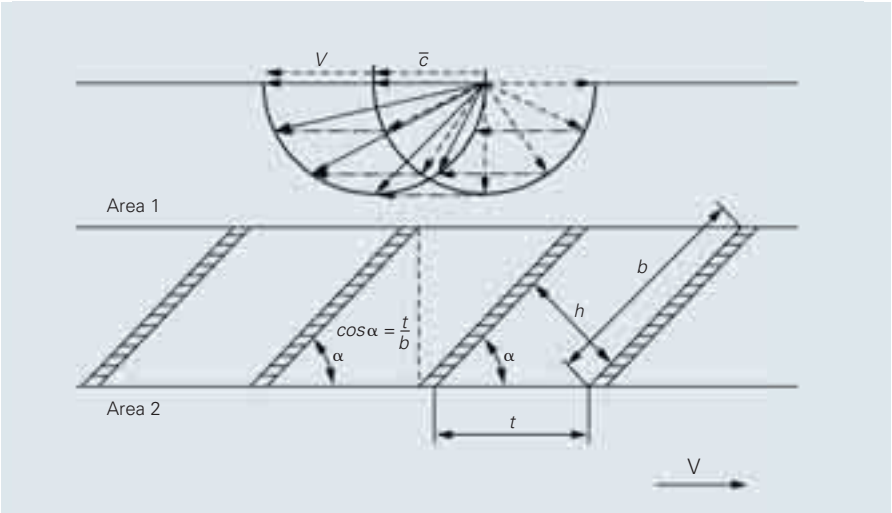


Figure 2.17: Operating principle of a turbomolecular pump

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

In the case of kinetic pumps, a counter-pressure occurs when pumping gas; this causes a backflow. The pumping speed is denoted by S_0. The volume flow rate decreases as pressure increases and reaches a value of 0 at the maximum compression ratio K_0.

Compression ratio

The compression ratio, which is denoted K_0, can be estimated according to Gaede's considerations [9]. The following applies for visually dense blade structure (Figure 2.17).

Formula 2-9
Turbopump K_0

$$K_0 = exp\left(\frac{v}{\bar{c} \cdot g \cdot t \cdot sin\alpha}\right)$$

The geometric ratios are taken from Figure 2.17. The factor g is between 1 and 3 [10]. From the equation, it is evident that K_0 increases exponentially with blade velocity v as well as with $\sqrt{M}$ because

$\bar{c} = \sqrt{\frac{8 \cdot R \cdot T}{\pi \cdot M}}$ (Formula 1-7).

Consequently, the compression ratio for nitrogen, for example, is significantly higher than for hydrogen.

Pumping speed

Pumping speed S_0 is proportional to the inlet area A and the mean circumferential velocity of the blades v, i.e. rotational speed [9]. Taking the blade angle α into account produces:

Formula 2-10
Turbopump pumping speed

$$S_0 = \frac{1}{2} \cdot A \cdot v \cdot sin\alpha \cdot cos\alpha$$

Taking the entry conductivity of the flange into account, $L_{Bm} = \frac{\bar{c}}{4} \cdot A$ (Formula 1-19) as well as the optimal blade angle of 45°, produces the approximate effective pumping speed S_{eff} of a turbopump for heavy gases (molecular weight > 20) in accordance with the following formula:

Formula 2-11
Turbopump S_{eff}

$$S_{eff} = \frac{S_0 + L_{Bm}}{S_0 \cdot L_{Bm}} = \frac{A \cdot v}{4 \cdot \left(\frac{v}{\bar{c}} + 1\right)}$$

Dividing the effective pumping speed by the bladed entry surface of the uppermost disk and taking the area blocked by the blade thickness into consideration with factor d_f ~= 0.9 provides the specific pumping speed of a turbopump for nitrogen, for example (curve in Figure 2.18):

Formula 2-12
Specific pumping speed

$$S_A = \frac{S_{eff}}{A} = \frac{d_f \cdot v}{4 \cdot \left(\frac{v}{\bar{c}} + 1\right)}$$

In Figure 2.18, the specific pumping speed d_f = 1 in l/(s · cm²) is plotted on the ordinate and the mean blade speed on the abscissa $v = \pi \cdot f \cdot (R_a + R_i)$. Moving up vertically from this point, the point of intersection with the curve shows the pump's maximum specific pumping speed S_A. Multiplying this value by the bladed surface area of the inlet disk: $A = (R_a^2 - R_i^2) \cdot \pi$, yields the pumping speed of the pumps and enables it to be compared with the catalog information.

The points plotted in Figure 2.18 are determined by Pfeiffer Vacuum on the basis of the measured values of the indicated pumps. Points that are far above the curve are not realistic.

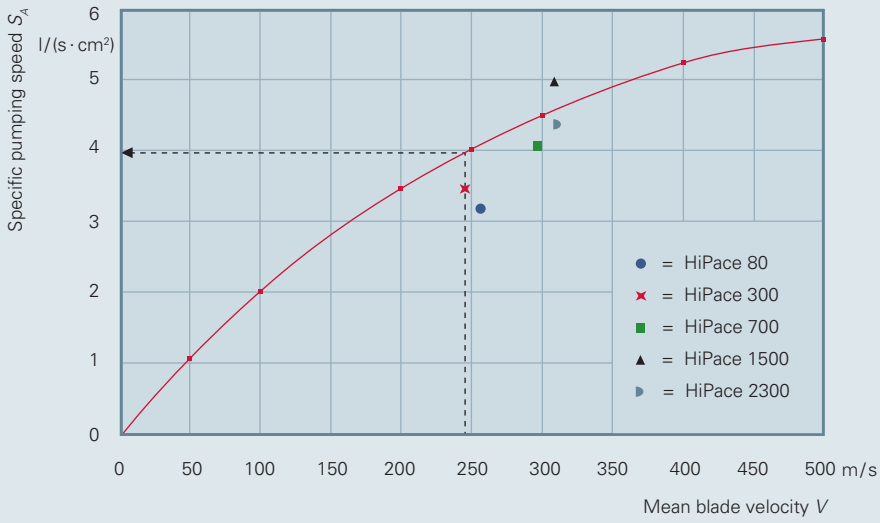


Figure 2.18: Specific turbopump pumping speeds

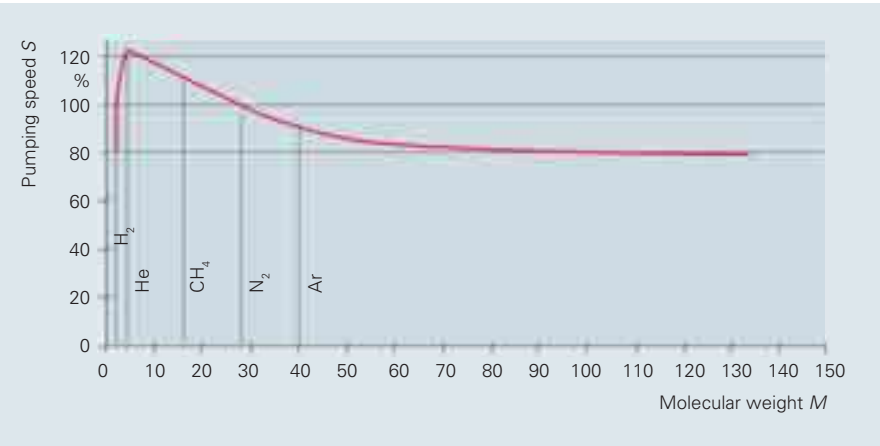


Figure 2.19: Pumping speed as a function of molecular weight

The pumping speeds (l/s) thus determined still tell nothing about the values for light gases, e.g. for hydrogen. Pump stages having differing blade angles are normally used in a turbopump to optimize the maximum pumping speed for hydrogen. This produces pumps with sufficient compression ratios for both hydrogen (approximately 1,000) and nitrogen, which should be 10^9 due to the high partial pressure in the air. In the case of pure turbomolecular pumps, backing-vacuum pressures of approximately 10^{-2} mbar are required due to their molecular flow.

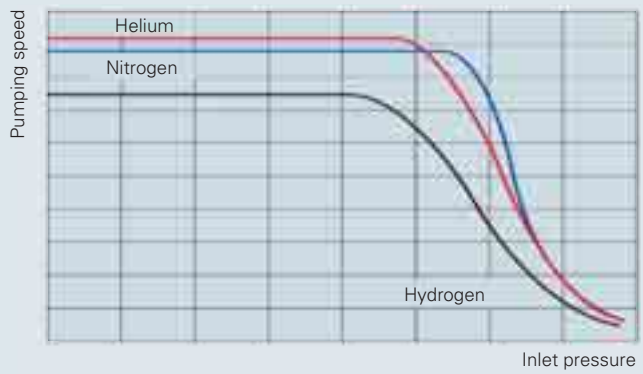


Figure 2.20: Pumping speed as a function of inlet pressure

2.8.1.2 Holweck stage operating principle

A Holweck stage is a multi-stage Gaede's type molecular pump [10] having a helical pump channel. Due to the rotation of the rotor, gas molecules entering the pump channel receive a stimulus velocity in the direction of the channel. Backflow losses occur through gaps between the webs that separate the Holweck channels from one another and the rotor. The gap widths must be kept small to minimize backflow. Cylindrical sleeves (1) that rotate about helical channels in the stator (2) are used as Holweck stages. Arranging stators both outside as well as inside the rotor enables two Holweck stages to be easily integrated within one and the same pump.

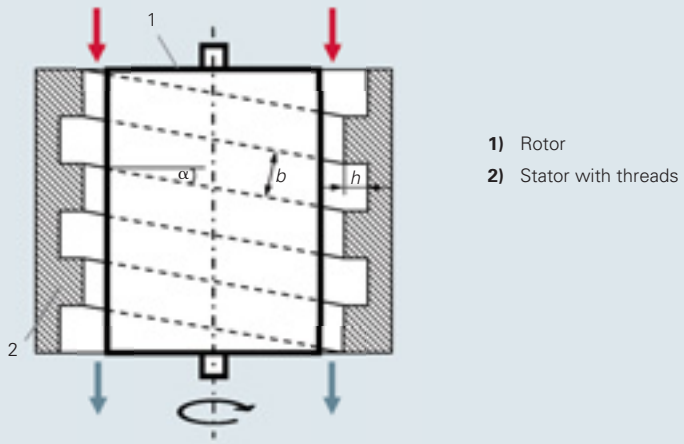


Figure 2.21: Operating principle of a Holweck stage

The pumping speed S_0 of the Holweck stages is equal to:

Formula 2-13
Holweck stage pumping speed

$$S_0 = \frac{1}{2} \cdot b \cdot h \cdot v \cdot \cos\alpha$$

Where $b \cdot h$ is the channel cross section and $v \cdot \cos\alpha$ the velocity component in the channel direction.

The compression ratio increases exponentially as a function of channel length L and velocity $v \cdot \cos\alpha$ [4]:

Formula 2-14
Holweck stage compression ratio

$$K_0 = \frac{v \cdot \cos\alpha \cdot L}{\bar{c} \cdot g \cdot h} \quad \text{mit } 1 < g < 3$$

The values yielded by this formula are much too large, because backflow over the web from the neighboring channel dramatically reduces the compression ratio, and this influence is not taken into account in Formula 2-14.

In order to use small dry backing pumps, e.g. diaphragm pumps having ultimate pressures of less than 5 mbar, turbopumps are today equipped with Holweck stages. These kinds of pumps are termed turbo drag pumps. Since the Holweck stages require only low pumping speeds due to the high pre-compression of the turbopump, the displacement channels and, in particular, both the channel height as well as the clearances to the rotors can be kept extremely small, thus still providing a molecular flow in the range of 1 mbar. At the same time, this increases the compression ratios for nitrogen by the required factor of 10^3. The shift of the compression ratio curves to higher pressure by approximately two powers of ten can be seen from Figure 2.22.

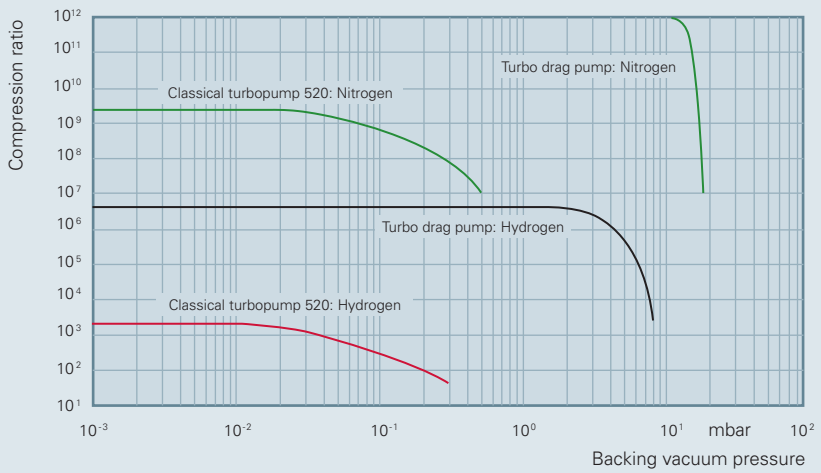


Figure 2.22: Compression ratios of pure turbopumps and turbo drag pumps

2.8.1.3 Turbopump performance data

Gas loads

The gas loads $q_{pV} = S \cdot p = \frac{dV}{dt} \cdot p$ (Formula 1-13), that can be displaced with a turbomolecular pump increase proportionally to pressure in the range of constant volume flow rate, and in the declining range reach a maximum that also is a function of the size of the backing pump. The maximum permissible gas loads depend upon the type of cooling and gas in question.

Displacing heavy noble gases is problematic, because they generate a great deal of dissipated energy when they strike the rotor; and due to their low specific heat, only little of it can be dissipated to the housing. Measuring the rotor temperature and reducing the RPM enables the pump to be operated in the safe range. The technical data for the turbopumps specify the maximum permissible gas loads at nominal RPMs for hydrogen, helium, nitrogen and argon.

Critical backing pressure

Critical backing pressure is taken to mean the maximum pressure on the backing-vacuum side of the turbomolecular pump at which the pump's compression decreases. This value is determined as part of the measurements for determining the compression ratio in accordance with ISO 21360-1 by increasing the backing-vacuum pressure without gas inlet on the intake side. In the technical data for turbomolecular pumps, the maximum critical backing pressure is always specified for nitrogen.

Base pressure, ultimate pressure, residual gas

In the case of vacuum pumps, a distinction is made between ultimate pressure and base pressure (see also 2.1.3). While the pump must reach base pressure pb within the prescribed time under the conditions specified in the measurement guidelines, ultimate pressure pe can be significantly lower. In the HV range, base pressure is reached after 48 hours of bake-out under clean conditions and with a metallic seal. What is specified as the base pressure for pumps with aluminum housings is the pressure that is achieved without bake-out and with clean FPM seals.Corrosive gas-version pumps have a higher desorption rate, which can temporarily result in higher base pressures due to the coating on the rotor surface.

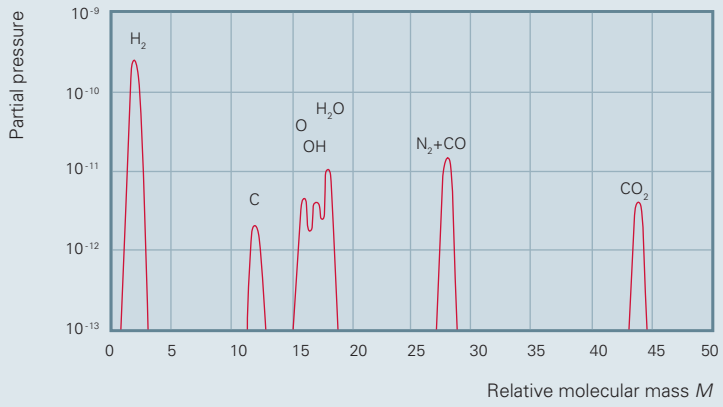


Figure 2.23: Typical residual gas spectrum of a turbomolecular pump

Dividing the backing pressure by the compression ratio yields the ultimate pressure.

Formula 2-15
Ultimate pressure

$$p_e = \frac{p_v}{K_0}$$

Whether ultimate pressure will be achieved will hinge upon the size and cleanliness of both the equipment and the pump, as well as upon the bake-out conditions. After extreme bake-out (to 300 °C) only H_2, CO and CO_2 will be found in the residual gas. These are gases that are dissolved in the metal of the recipient and continuously escape.

The gas ballast in the backing pump that is being used should be activated occasionally to prevent hydrogen from accumulating in the backing-vacuum area. In many cases, the actual ultimate pressure will be a factor of the desorption conditions on the high vacuum side of the turbopump and its pumping speed, and not the compression ratios of the pumps.

2.8.2 Application notes

Generating clean vacuum

Turbopumps are suitable for generating clean vacuums in the range of 10^{-3} to 10^{-10} mbar. Thanks to their high compression ratio, they reliably keep oil from the inlet area of rotary vane pumps away from the recipient. Models with stainless steel housings and CF flanges can be baked out. This makes these pumps ideally suited for research and development applications where contamination of the residual gas is undesirable. Turbopumps can be used for evacuating large vessels, with rotary vane pumps being employed as backing pumps. In the case of turbo drag pumps, even two-stage diaphragm pumps will suffice as backing pumps; however due to their lower pumping speed, it will take them a great deal of time to pump down larger vessels. The gas throughput of the combination will also be highly restricted by the diaphragm pump.

However this combination is an extremely cost-effective solution for a dry pumping station. It is often used in connection with differentially pumped mass spectrometers. Pumping stations consisting of a backing pump and a turbopump do not require valves. Both pumps are switched on at the same time. As soon as the backing pump has reached the necessary backing-vacuum, the turbopump quickly accelerates to its nominal speed and quickly evacuates the vessel to a pressure of $p < 10^{-4}$ mbar with its high pumping speed. Brief power failures can be bridged by the high rotational speed of the rotor. In the case of longer power failures, both the pump and the recipient can be vented automatically if the RPMs decline below a minimum speed.

The effects that play a role in evacuating vessels are described in Chapter 7. Dimensioning issues as well as calculation of pump-down times are also presented in that chapter.

Evacuating load lock chambers

Evacuating load-lock chambers definitely requires clean handling when transferring the workpieces to be treated in a vacuum process. If these items are channeled in from atmospheric pressure, the chamber should first be pre-evacuated via a bypass line. The running turbopump is then connected between the backing pump and the chamber via valves.

Analytical applications

In many cases, mass spectrometers are used in analysis devices today. Fluids are often injected and evaporated in the inlet chamber of the vacuum system. Pressure is reduced in several stages, and the individual chambers are isolated from one another by orifices. Since each chamber must be pumped, the objective is to combine the gas flows via taps on the turbopump through skillful combination of backing pumps and turbopumps. Specially modified turbopumps with taps are used for series applications.

Helium leak detectors, too, are equipped with turbopumps. In this case, the counter-flow principle is often used; i.e. a mass spectrometer is arranged on the high vacuum side of the pump. Due to the lower compression ratios of turbopumps for helium than for nitrogen or oxygen, the pump acts as a selective amplifier for the helium partial pressure.

Pumps with high gas loads in vacuum processes

The turbopump offers two advantages when pumping high gas loads for vacuum processes: It generates clean vacuum at the beginning of each process step, and can then pump down process gas without any harmful backflow. In the second step, the primary objective is to maintain the given pressure at which the desired vacuum process should run. In this process, gas throughputs and working pressure will be determined by the application in question; i.e. a given volume flow rate will be pumped at a given gas throughput. Moreover, it should be possible to quickly achieve clean intermediate vacuum when changing workpieces. Since these are conflicting requirements, a turbopump of sufficient size for the required gas throughput and the required intermediate vacuum will be selected. The process pressure will be regulated via an inlet (butterfly) valve. An example of how to dimension this kind of pumping station is shown in Chapter 7. The maximum permissible gas loads specified in the technical data should be taken to mean permissible continuous loads. This applies subject to the assurance of sufficient cooling in accordance with the specification and a backing pressure that is less than 50 % of the critical backing pressure.

Pumping corrosive and abrasive substances

When pumping corrosive gases, measures must be taken to protect the motor/bearing areas and the rotor, in particular, against corrosion. To do this, all surfaces that come into contact with corrosive gas are either provided with a coating or made from materials that can withstand attacks by these gases. A defined inert gas flow is admitted into the motor/bearing area in the backing-vacuum via a special sealing gas valve. From there, the gas flows through labyrinth seals to the backing-vacuum area, mixes with the corrosive gas and is pumped down together with the corrosive gas.

The blades can wear mechanically should dust accumulate; this could necessitate repairs and replacement of the rotor. It should also be noted that deposits can be expected to form in the pump, which will necessitate shorter service intervals. In particular, it is necessary to ensure that deposits in the pump do not react with the moisture in the air to become aggressive substances. Consequently, the pumps should be vented with dry inert gases only, and should be fitted with sealed backing-vacuum and high vacuum flanges. Turbopumps for these applications are always classical turbopumps without a Holweck stage, as the narrow gaps and pump channels in the Holweck stage would quickly clog with dust deposits and the rotor would seize.

2.8.3 Portfolio overview

Als führender Hersteller von Turbomolekularpumpen bietet Pfeiffer Vacuum mechanisch gelagerte und magnetisch gelagerte Baureihen an.

2.8.3.1 Mechanical-bearing turbopumps

In the case of HiPace turbopumps with oil-lubricated ball bearings on the backing-vacuum side and permanent magnet-bearings on the high vacuum side, a distinction is made between the following turbopump series:

- HiPace turbo drag pumps with Holweck stages offering pumping speeds of less than 1,000 l/s with ISO-K flanges to generate high vacuum for standard applications, or
- with bakeable CF flanges to generate ultra high vacuum
- Classical HiPace turbopumps offering pumping speeds of over 1,000 l/s with ISO-K flanges to generate high vacuum for standard applications, or
  with bakeable CF flanges to generate ultra high vacuum
- Classical HiPace-C turbopumps with coating and sealing gas system for corrosive gas applications

Classical HiPace-C turbopumps offering pumping speeds of less than 1,000 l/s but with coating and sealing gas system for corrosive gas applications are available upon request.

Figure 2.24: Standard HiPace™ turbopumps

The advantages and disadvantages of classical turbopumps and turbo drag pumps are shown in the table 2.14.

Table 2.14: Comparison between turbopumps and turbo drag pumps

Characteristic	Advantages	Disadvantages
Pure turbo stages	▸ Insensitive to particulate matter, dust and condensates ▸ High gas loads possible ▸ Robust/High flood rates possible	▸ Lower compressions ▸ Lower backing vacuum tolerance ▸ Larger backing pump with base pressure < 0.1 mbar required
Turbo stages and drag stages (Holweck)	▸ Higher compressions ▸ Higher backing vacuum tolerance ▸ Smaller backing pump with base pressure > 1 mbar can be used	▸ Sensitive to particulate matter, dust and condensates ▸ Lower gas loads (narrow gap)

2.8.3.2 Magnetic-levitation turbopumps

With their high pumping speeds of over 1,500 l/s, magnetic-levitation turbopumps require large backing pumps. Since diaphragm pumps with base pressures of over 1 mbar are out of the question, these turbopumps are not equipped with Holweck stages. These pumps, too, are available as:

- Classical HiPace turbopumps offering pumping speeds of over 2,000 l/s with ISO-K flanges to generate high vacuum for standard applications, or
- with bakeable CF flanges to generate ultra high vacuum
- Classical HiPace-C turbopumps with coating and sealing gas system for corrosive gas applications

Figure 2.25: HiPace™ MC magnetic-levitation turbopump

Table 2.15 below contains the performance data for the standard pumps. All other series are modifications of these standard models and essentially offer the same performance data.

Table 2.15: HiPace™ performance data

Model	Pumping Speed for N_2	Compression Ratio N_2	Applications
HiPace™ 10	11.5 l/s	$3.0 \cdot 10^7$	Analytical applications, leak detectors, gas flow control systems, incandescent and fluorescent lamp manufacturing
HiPace™ 80 (DN 40)	35.0 l/s	$> 1.0 \cdot 10^{11}$	Analytical applications, research & development, coating, semiconductor manufacturing
HiPace™ 80 (DN 63)	67.0 l/s	$> 1.0 \cdot 10^{11}$	
HiPace™ 300	260.0 l/s	$> 1.0 \cdot 10^{11}$	
HiPace™ 400	355.0 l/s	$> 1.0 \cdot 10^{11}$	
HiPace™ 700	685.0 l/s	$> 1.0 \cdot 10^{11}$	
HiPace™ 1200	1,250.0 l/s	$> 1.0 \cdot 10^8$	Glass coating, solar cell manufacturing, surface finishing, CVD, PVD/sputtering, ion implantation, plasma physics, space simulation
HiPace™ 1500	1,450.0 l/s	$> 1.0 \cdot 10^8$	
HiPace™ 1800	1,450.0 l/s	$> 1.0 \cdot 10^8$	
HiPace™ 2300	1,900.0 l/s	$> 1.0 \cdot 10^8$	
HiPace™ 2400 MC	2,100.0 l/s	$> 1.0 \cdot 10^9$	Coating industry, semiconductor manufacturing, research & development
HiPace™ 3400 MC	2,950.0 l/s	$> 1.0 \cdot 10^9$	

The base pressures of standard pumps with ISO-K flanges are: $p_b < 1 \cdot 10^{-7}$ mbar. Equipped with CF flanges, these pumps can attain base pressures of $p_b < 5 \cdot 10^{-10}$ mbar after bake-out.

2.8.3.3 Controls, displays and drives

A variety of controls, displays and drives are available for operating turbopumps in different applications; they are shown in the table 2.16.

The numbering used below is based upon Figure 2.26 (Accessories for turbopumps).

HiPace Models 10 to 300 (1a) are equipped with attached drive TC 110 (1b). They require a supply voltage of 24 VDC. Integrated power supplies TPS 110/111 or 180/181 (2c) or power supply modules DCU 110 or DCU 180 (2a) with DCU 002 display control unit are available for off-line operation. HiPace Models 400 and 700 are equipped with the TC 400 drive.

The TC 400 can be operated either with 24 VDC or 48 VDC, depending upon the pump that is connected. The supply voltage of 48V can be provided by the TP 400 integrated power supply or the DCU 400 power supply module. The large HiPace 1200 to 2300 pumps are powered by the attached TC 1200, which is supplied directly from the mains.

All HiPace 10 to 700 pumps can also be supplied without attached drive (e.g. for radioactive environments). The TCP 350 drive with integrated power supply and with DCU 002 (2b) for control is used for operation.

The magnetic-levitation HiPace 2400 MC and 3400 MC are controlled by the TM 3000 operating unit. The 140 V supply voltage can be provided by the TPS 1400 power supply module. Alternatively available is the attached OPS 900 (Onboard Power Supply) power supply that mounts beneath the base plate of the pump.

The DCU 002 (2b) can be connected to the RS 485 interface for operation and for setting various parameters. The HPU 001 handheld programming unit can also be connected; this unit can also be used to store parameter records and enter them in multiple pumps. A USB converter (5b) can also be used to connect a PC (5a) to the RS 485 interface in order to execute programming and switching functions or to transfer status displays.

In addition, Profibus DP and DeviceNet converters are available for integrating the pumps into appropriate plant control systems.

The major switching functions can also be executed via a remote control plug with the aid of switches. Moreover, some status displays can be taken from relay outputs.

A selector switch can be used to select pump operation either by means of this approach or via the serial interface.

Table 2.16: Drives and power supplies

● Recommended + Always with OPS (Onboard Power Supply)	Drives					Power Supplies			Display Units	
	TC 110 24 V	TC 400 24/48 V	TC 1200 90–240 V	TM 3000 140 V	TCP 350 with DCU 90–240 V	Integrated TPS power supply	Power supply module with DCU	Attached OPS power supply	HPU 001 handheld programming unit	DCU Power supply module
HiPace™										
HiPace™ 10	●					●	●		●	●
HiPace™ 80	●				●	●	●		●	●
HiPace™ 300	●	●			●	●	●		●	●
HiPace™ 400		●			●	●	●		●	●
HiPace™ 700		●			●	●	●		●	●
HiPace™ 1200			●					+	●	●
HiPace™ 1500			●					+	●	●
HiPace™ 1800			●					+	●	●
HiPace™ 2300			●					+	●	●
HiPace™ 2400 MC				●		●		●	●	
HiPace™ 3400 MC				●		●		●	●	

2.8.3.4 Accessories

Figure 2.26: Accessories for turbopumps

In addition to the electrical operating devices described above, various accessories are also available for special applications. Some DCU power supplies enable a TPR 280 vacuum gauge to be connected in order to measure pressures in a vacuum system.

With the aid of the „backing pump“ relay box (6) the DCU power supply (2a) can be converted to a pumping station controller that can switch on both turbopump (1a) and backing pump simultaneously.

Either a fan (4), or water cooling (3) for high gas loads, can be attached to cool the pumps.

An electric vent valve (8) vents the turbopumps if the RPM declines below a given speed. In the event of a brief power failure, the vent valve will remain closed to maintain the vacuum. The pumping station will then re-start immediately when mains voltage is restored. However this necessitates a backing pump with a safety valve that will close automatically in the event of a power failure.

For UHV applications, a heater (9) can be connected to the pump that switches on automatically after a preselected RPM is attained, and switches off when RPM decreases.

Electromagnetic sealing gas valves (7b) with matching throughputs, as well as sealing gas throttles (7a) for pumps of various sizes, are available for corrosive gas pumps.

3 Vacuum Measuring Equipment

Pressure is defined as force per unit of area: p = F/A (Formula 1-3), where *F* is force and *A* the area to which the force is applied. The SI unit of pressure is 1 N/m² = 1 Pa. Other frequently-used units of pressure are: 1 mbar = 100 Pa and 1 torr = 133,322 Pa. If pressure is measured via the force that is exerted on an area, it is termed a pressure measurement that is independent of the type of gas in question.

Pressure measurement on the basis of force reaches its limits at pressures of less than 1 mbar, because the exerted forces become too small. Consequently other processes must be used. The thermal conductivity of the enclosed gas can be used, for example, or the gas molecules can be ionized, the ion streams flowing between electrodes measured.

A spinning rotor gauge (SRG), a so-called gas friction gauge, is used for calibration purposes [11]. A sphere is magnetically suspended in the vacuum and caused to rotate rapidly, at which point the drive is then de-energized. The pressure of the type of gas that is present can be calculated from the decrease in rotational frequency due to gas friction. These devices measure pressures *p* of more than 10^{-7} mbar. Calibrated spheres can be used as a transfer standard.

3.1 Fundamentals of total pressure measurement

In vacuum technology, no one measurement method covers the entire pressure range. It is therefore necessary to use different sensors. The criteria for selecting a pressure sensor are based upon various conditions:

- The pressure range to be detected
- Gas composition: Inert or corrosive
- Required accuracy and repeatability
- Environmental conditions, such as radioactivity

3.1.1 Direct, gas-independent pressure measurement

Diaphragm vacuum gauges

In the case of a diaphragm vacuum gauge, pressure is measured in accordance with the definition. A pressure *p* is exerted on a diaphragm having a defined area *A* and deflects the diaphragm proportionally to the pressure. A sensor measures the deflection. Piezo-resistive or capacitive sensors receive the pressure signal and convert it into an electrical signal.

Piezo-diaphragm vacuum gauges

A simple and extremely robust method involves the use of a piezo-resistive pick-up. The design is shown in Figure 3.1. A diaphragm is arranged over a well-evacuated volume having a reference pressure p_0, into which the expansion measurement resistances are diffused. The measured change in resistance as a result of diaphragm deflection serves as a parameter for the pressure. This pick-up is characterized by its insensitivity to gas inrush and its high accuracy.

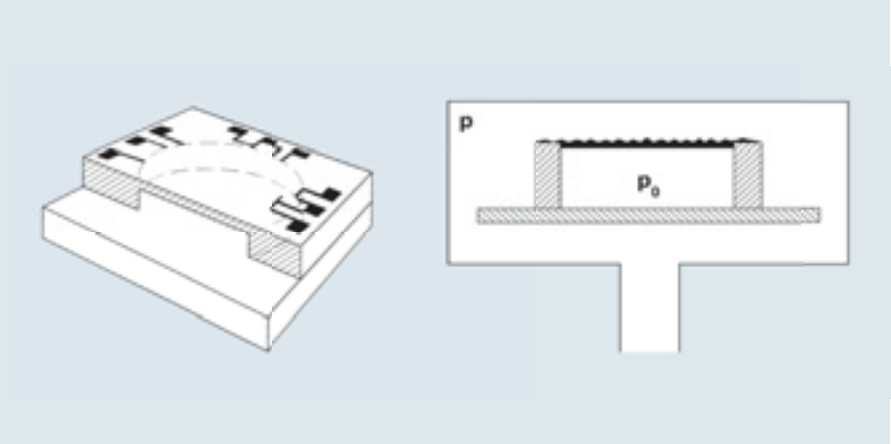


Figure 3.1: Design of a diaphragm vacuum gauge

Source: Wutz, Handbuch der Vakuumtechnik, Wiesbaden 2006, p. 453

Capacitive diaphragm vacuum gauges

In a capacitive vacuum gauge (Figure 3.2), deflection of the diaphragm is measured as the change in capacity of a plate capacitor that is formed by the diaphragm and a fixed counter-plate in a well-evacuated space having a pressure p_0. The diaphragm is comprised either of ceramic with a vacuum-metalized coating or of stainless steel. This method and diaphragms of varying sensitivity can be used to perform measurements of four decades each. The lower measurement limit is 10^{-5} mbar.

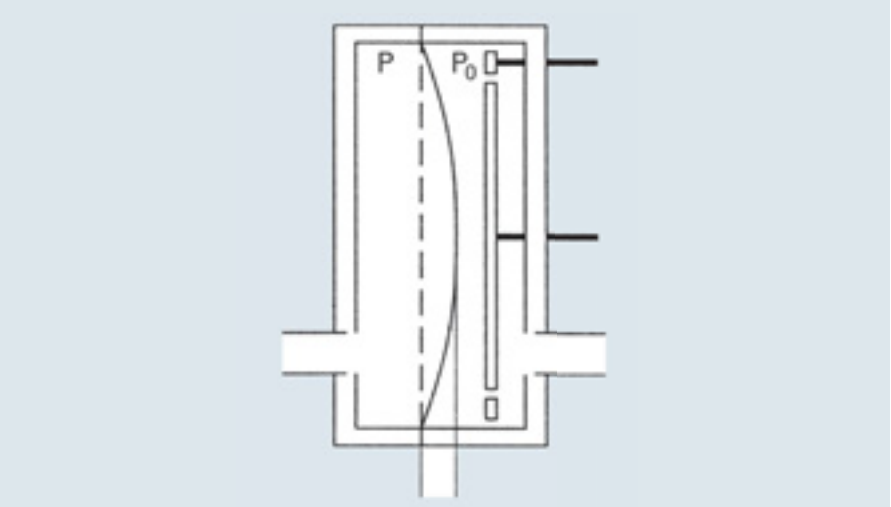


Figure 3.2: Design of a capacitative diaphragm vacuum gauge

Source: Wurz, Handbuch der Vakuumtechnik, Wiesbaden 2006, p. 459

The limiting effects are:

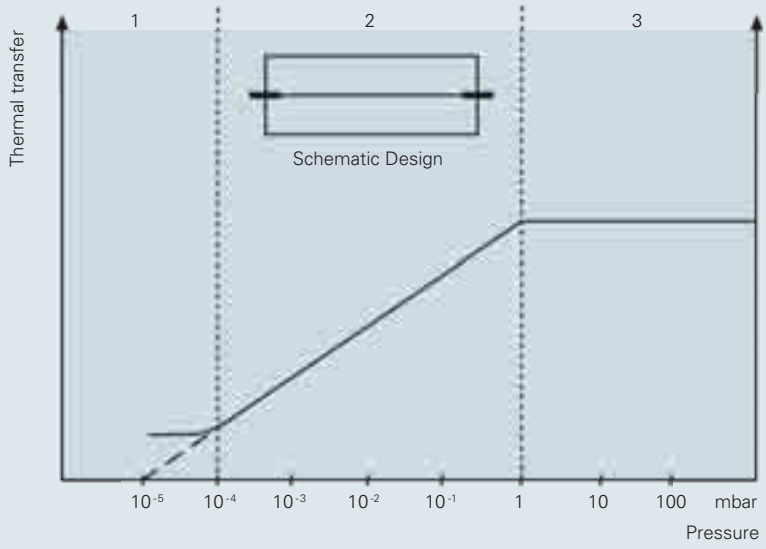
- Change in clearance within the pressure transducer due to the influence of temperature
- Decreasing forces acting on the diaphragm at low pressures

The influence of temperature can be eliminated through electronic compensation of a known temperature drift or by means of an installed heater that maintains the sensor at a constant temperature. The influence of temperature can be further minimized through the use of ceramic diaphragm material.

3.1.2 Indirect, gas-dependent pressure measurement

At extremely low pressures, the influence of the force on a diaphragm becoming negligible. This is why pressure is determined by means of the molecular number density, which is proportional to pressure. The status equation that applies for an ideal gas is: $p = n \cdot k \cdot T$ (Formula 1-5). Thus, pressure is proportional to molecular number density where temperature T is identical. This formula is satisfied for the pressures that prevail in vacuum technology. Various physical effects, such as thermal transfer, ionization capacity or electrical conductivity, are measured for this purpose. These values are a function of both pressure as well as molecular weight. This results in a pressure measurement that produces differing results for different heavy gases.

Pirani (thermal transfer) vacuum gauges



1) Thermal transfer to the ends through radiation and thermal conductivity
2) Pressure-dependent thermal transfer through gas
3) Thermal transfer through thermal radiation and convection

Figure 3.3: Operating principle of a Pirani vacuum gauge

Source: Inficon 2000-2001 Catalog, p. 82

A Pirani vacuum gauge utilizes the thermal conductivity of gases at pressures *p* of less than 1 mbar. Wire (usually tungsten) that is tensioned concentrically within a tube is electrically heated to a constant temperature between 110 °C und 130 °C by passing a current through the wire. The surrounding gas dissipates the heat to the wall of the tube. In the molecular flow range, the thermal transfer is the molecular number density and is thus proportional to pressure. If the temperature of the wire is kept constant, its heat output will be a function of pressure. However it will not be a linear function of pressure, as thermal conductivity via the suspension of the wire and thermal radiation will also influence the heat output.

The limiting effects are:

- Thermal conductivity will not be a function of pressure in the range of 1 mbar to atmospheric pressure (laminar flow range)
- The thermal conductivity of the gas will be low relative to the thermal transfer over the wire ends at pressures below 10^{-4} mbar, and will thus no longer influence the heat output of the wire. Consequently, the measurement limit is approximately at 10^{-4} mbar
- Thermal radiation will also transfer a portion of the heat output to the wall of the tube

Figure 3.4 shows the different curves for various gases between 1 mbar and atmospheric pressure. While good linearity can still be seen for nitrogen and air, significant deviations are indicated for light (He) and heavy gases (Ar).
In the case of gas-dependent measuring methods, it is also common to speak of the nitrogen equivalent that is displayed.

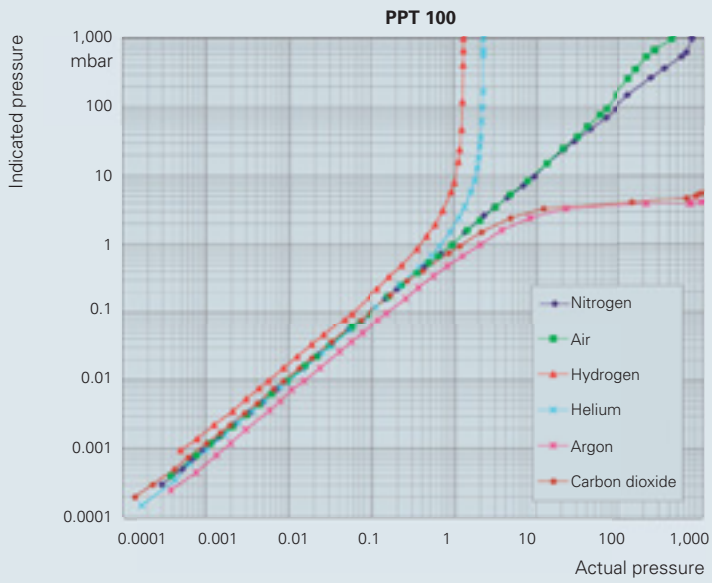


Figure 3.4: Pirani vacuum gauge curves

Cold cathode ionization vacuum gauges

Cold cathode ionization vacuum gauges essentially consist of only two electrodes, a cathode and an anode, between which a high voltage is applied via a series resistor. Negatively charged electrons leave the cathode because of the high voltage, moving at high velocity from the cathode toward the anode. As they travel this path, they ionize neutral gas molecules, which ignites a gas discharge. The measured gas discharge current (Figure 3.5) is a parameter for pressure. However only few molecules are ionized with straight electron trajectories, which results in lower sensitivity and interruption of the gas discharge at approximately 1 mbar.
A design that avoids this disadvantage is the inverted magnetron after Hobsen and Redhead. A metal pin (anode) is surrounded by a rotationally symmetrical measurement chamber (cathode) (Figure 3.5). An axially magnetized, cylindrical, permanent-magnet ring is placed on the exterior of the measurement chamber to generate a magnetic field within the chamber.

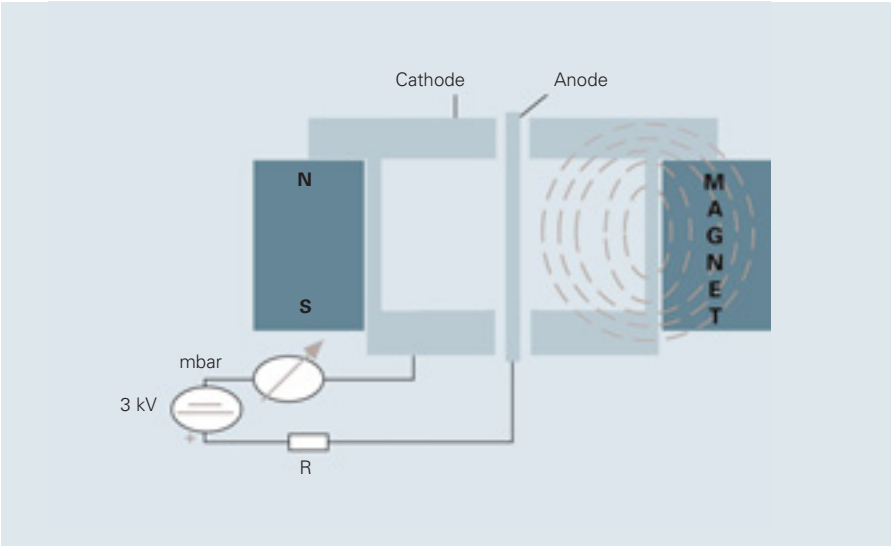


Figure 3.5: Design of an inverted magnetron

The electrons travel through the magnetic field on spiral trajectories (Figure 3.6). The electron paths extended in this manner increase the probability of collisions with the gas molecules and ensure that sufficient ions are generated to maintain the gas discharge, even at pressures of less than 1 mbar. The pressure reading will depend upon the type of gas in question due to the different ionization probabilities of the various gases. For example, a lower pressure will be indicated for helium than for air.

Cold cathode vacuum gauges can be easily contaminated under the following conditions:

- If the device is activated at pressures p of more than 10^{-1} mbar
- Argon is often used for applications in sputtering systems. This results in sputtering of the cathode, as well, which can cause short circuits and thus failures of the gauges
- Gases are also gettered on the surfaces of the cathode. This produces a pumping effect that will falsify the measurement signal.

When installing the gauge in a vacuum system, it is necessary to take the magnetic field into consideration, as it can interfere with sensitive equipment.

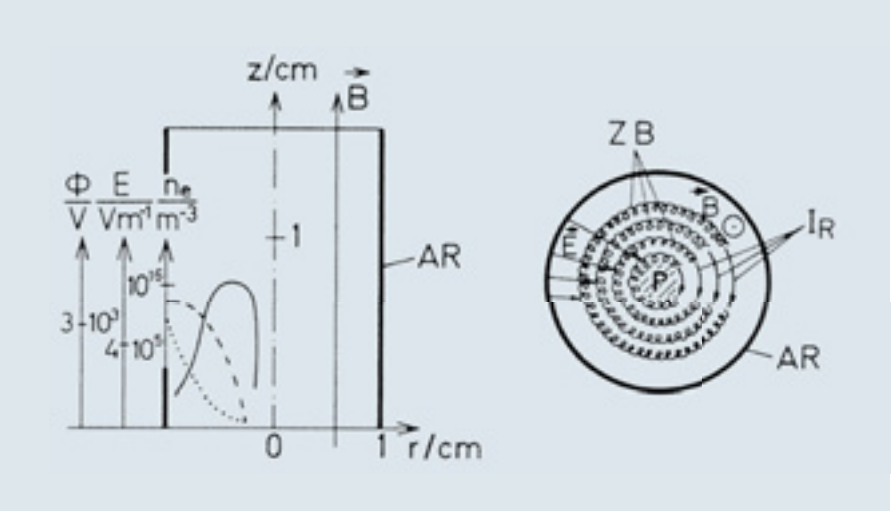


Figure 3.6: Operating principle of an inverted magnetron

Source: Jousten (publisher) Wutz, Handbuch Vakuumtechnik, Vieweg Verlag

Hot cathode ionization vacuum gauges

In this case, as opposed to cold cathode ionization vacuum gauges, electrons are generated with the aid of a heated cathode. Figure 3.7 shows the design of a gauge after Bayard–Alpert. A thin wire is arranged in the middle of the cylindrical, lattice-shaped anode; this wire serves as the ion collector. A voltage of approximately 100 V is applied between anode and cathode. This accelerates all emitted electrons toward the anode. The emission current is measured in the anode circuit, which can be set by means of the heat output of the cathode. As they travel toward the anode, gas molecules that strike the collector, which has the potential of the cathode, are ionized by electron collisions. The measured collector current is a parameter for pressure. Since the emission current is proportional to the ion current, it can be used to set the sensitivity of the gauges.

Pressures can be accurately measured to $1 \cdot 10^{-10}$ mbar with Bayard-Alpert sensors.

Measuring errors result from the pumping effect of the sensor, as well as from the following two limiting effects:

- **X-ray braking radiation** Electrons that strike the anode cage cause x-rays to be emitted, some of which strike the collector. This x-ray effect causes the collector to emit photo-electrons that flow off toward the anode. The resulting photoelectron current increases and falsifies the pressure-dependent collector current. Consequently the collector wire should be selected as thin as possible so that it collects only little x-ray radiation.
- **ESD ions** ESD (electron stimulated desorption) means that gas molecules deposited on the anode cage are desorbed and ionized by electrons. These ions also increase the pressure-proportional ion current.

A hot cathode vacuum gauge also measures independently of the type of gas in question. However the measurement results are significantly more accurate than those obtained with a cold cathode ionization vacuum gauge.

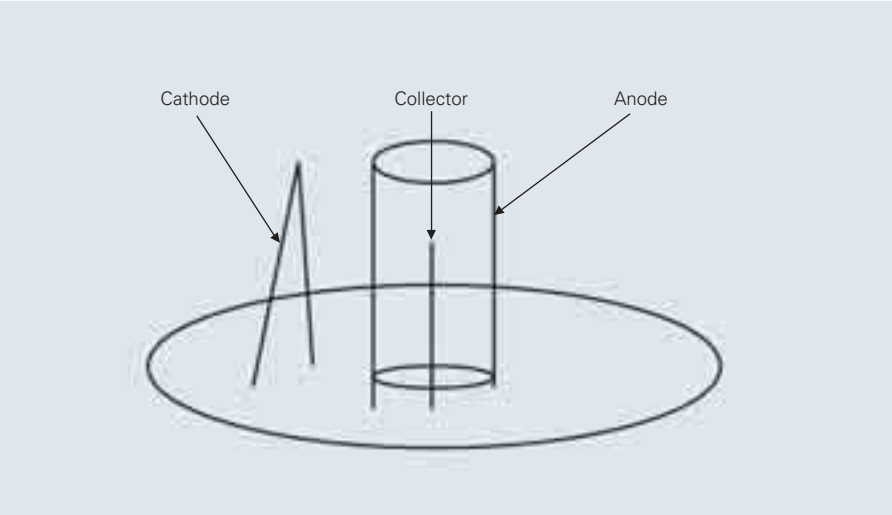


Figure 3.7: Design of a Bayard-Alpert vacuum gauge

3.2 Application notes

The following conditions must be observed in selecting and installing the measurement devices:

- Appropriate selection of the installation location due to potential pressure gradients in the recipient
- Potential pumping effect of the sensors
- Sputter effect of cold cathode gauges
- Strong magnetic and electrical fields
- Bake-out of the equipment and the gauges when generating ultra high vacuum
- Selection of switching points for ionization gauges in such a manner as to avoid contamination

Cold cathode gauges can be easily removed and cleaned in the event of contamination. Bayard-Alpert immersion measurement systems can also be cleaned, with any defective components, such as heating filaments, anode gates or collectors, being replaced. Contaminated anode gates and collectors can cause significant measurement errors due to the charging effects.

3.2.1 Measurement ranges

Pointer-type vacuum gauges are used in the pressure range from 1,000 - 1 mbar; however these gauges offer only limited accuracy and can only be read directly at the point of installation. Diaphragm vacuum gauges are used to obtain more accurate measurements.

Pirani thermal conductivity vacuum gauges are used between 1 and 10^{-4} mbar. It is also possible to use special „high-pressure“ hot cathode ionization vacuum gauges at pressures *p* of less than 10^{-2} mbar.

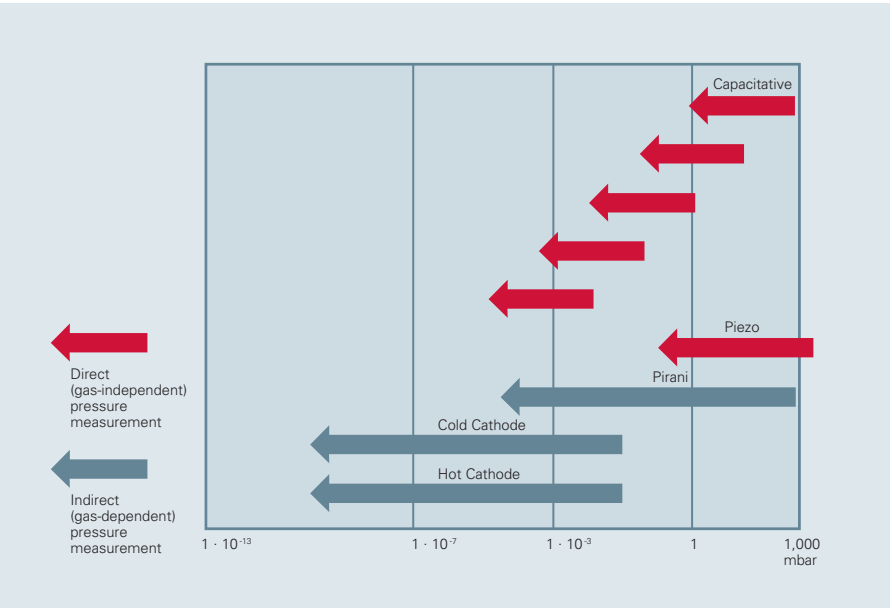


Figure 3.8: Pressure measurement ranges and measurement principles

Either cold cathode ionization vacuum gauges, or ionization vacuum gauges after Bayard-Alpert in the case of clean conditions and rigorous accuracy requirements, are used for pressures of less than 10^{-3} mbar. It is always meaningful to use a combination of measuring sensors that covers the entire pressure range in use.

In the case of diaphragm vacuum gauges and Pirani vacuum gauges, pressure switch points are generated in order to not activate ionization vacuum gauges until sufficiently low pressure prevails, thus protecting them against contamination or burn-out of the heated cathode. Consequently, combination sensors are also offered, which are described below.

3.2.2 Transmitters

Transmitters are measuring sensors that output the measured pressure either in the form of an analog measurement signal (0 - 10 V) or a digital signal to a standardized interface. They must be supplied with a direct-current voltage (e.g. 24 V). Power supplies that display the measured values are also offered for the transmitters.

3.2.3 Vacuum gauges

Vacuum gauges are connected to control units via cables; the control units afford power supply, analysis and display of the measured data. These devices usually also have analog voltage outputs.

Table 3.1: Transmitters and vacuum gauges

Sensor Design	Designation
Vacuum sensor with adapted electronics Input: Feed voltage (e.g. 24 V) Output: Analog signal (e.g. 0-10 V) or Digital signal (RS-232, -485, Profibus, DeviceNet)	Transmitter
Vacuum sensor connected to required feed and analysis electronics via cable	Measurement gauge

3.2.4 Combination sensors

Combination sensors combine two sensors in one and the same measurement cell and offer the following advantages:

- Broader measurement range
- Only one measured value output
- Sensitive high vacuum sensors are protected against being activated at excessive pressure
- Only one connection flange is required

The various combinations are described in connection with the individual series.

3.3 Portfolio overview

3.3.1 Product lines

Pfeiffer Vacuum offers transmitters in the form of single or combination sensors, as well as conventional gauges.

3.3.1.1 DigiLine™

DigiLine sensors are supplied with 24 VDC. The measured values are output via an RS-232 or RS 485 digital interface. The various application options are described in Figure 3.9.

Individual transmitters can be operated and their measured values displayed by means of the DPG 101 controller. The DPG 109 can supply up to nine transmitters Transmitter signals can also be directly displayed and processed on a PC or PLC by means of the DokuStar Plus software. With the aid of converters, the RS-485 signal can be converted to a fieldbus signal (Profibus-DP or DeviceNet), thus enabling it to be used in plant control systems with a field-bus controller that enables especially simple and cost-effective cabling.

Table 3.2: Pressure sensor selection table

● Recommended ▲ Possible	Measurement Range			Application					
		max. (mbar)	min. (mbar)	Vacuum furnaces	Sputtering	Vaporization chambers	Reactive processes	Load locks	Accelerators
Transmitters / Measurement Gauges									
DigiLine™									
Digital piezo transmitter	CPT 100	2,000	1	▲	▲	▲	▲	▲	
Digital Pirani transmitter	PPT 100	1,000	$1 \cdot 10^{-4}$	●	▲	●	▲	●	
Digital piezo/Pirani transmitter	RPT 100	1,200	$1 \cdot 10^{-4}$	●	▲	●	▲	●	
Digital Pirani/cold cathode transmitter	MPT 100	1,000	$5 \cdot 10^{-9}$	●	●	●	●	▲	▲
Digital Pirani/Bayard-Alpert transmitter	HPT 100	1,000	$1 \cdot 10^{-9}$	▲	●				
ActiveLine									
Active piezo transmitter	APR 250	1,100	$1 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 260	1,100	$1 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 262	2,200	$2 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 265	5,500	0,5	▲	▲	▲	▲	▲	
	APR 266	11,000	1	▲	▲	▲	▲	▲	
	APR 267	55,000	5	▲	▲	▲	▲	▲	
Active capacitative transmitter	CMR 361	1,100	$1 \cdot 10^{-1}$	▲	●	●	●		
Temperature compensated	CMR 362	110	$1 \cdot 10^{-2}$	▲	●	●	●		
	CMR 363	11	$1 \cdot 10^{-3}$	▲	●	●	●		
	CMR 364	1.1	$1 \cdot 10^{-4}$	▲	●	●	●		
	CMR 365	0.11	$1 \cdot 10^{-5}$	▲	●	●	●		
Temperature regulated	CMR 271	1,100	$1 \cdot 10^{-1}$	▲	●	●	●		
	CMR 272	110	$1 \cdot 10^{-2}$	▲	●	●	●		
	CMR 273	11	$1 \cdot 10^{-3}$	▲	●	●	●		
	CMR 274	1.1	$1 \cdot 10^{-4}$	▲	●	●	●		
	CMR 275	0.11	$1 \cdot 10^{-5}$	▲	●	●	●		
Active Pirani transmitter	TPR 280	1,000	$5 \cdot 10^{-4}$	●	▲	▲		▲	
	TPR 281	1,000	$5 \cdot 10^{-4}$	●	▲	▲	▲	▲	
Active Pirani/capacitative transmitter	PCR 260	1,500	$5 \cdot 10^{-4}$	●	▲	▲		●	
Active cold cathode transmitter	IKR 251	0.01	$2 \cdot 10^{-9}$	▲	▲	●	▲		
	IKR 261	0.01	$2 \cdot 10^{-9}$	▲	▲	●	▲		
	IKR 270	0.01	$5 \cdot 10^{-11}$	▲	▲	●	▲		
Active Pirani/cold cathode transmitter	PKR 251	1,000	$5 \cdot 10^{-9}$	▲	▲	▲	▲		
	PKR 261	1,000	$5 \cdot 10^{-9}$	▲	▲	▲	▲		
Active hot cathode transmitter	IMR 265	1,000	$2 \cdot 10^{-6}$	▲	●	▲			
Active Pirani/Bayard-Alpert transmitter	PBR 260	1,000	$5 \cdot 10^{-10}$	▲	▲	▲	▲		
ModulLine									
Pirani pressure gauge	TPR 010	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	▲	▲	▲
	TPR 017	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	▲	▲	●
	TPR 018	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	●	▲	●
Cold cathode pressure gauge	IKR 050	$5 \cdot 10^{-3}$	$2 \cdot 10^{-9}$	▲	▲	●	▲		●
	IKR 060	$5 \cdot 10^{-3}$	$1 \cdot 10^{-10}$	▲	▲	●	▲		●
	IKR 070	$5 \cdot 10^{-3}$	$1 \cdot 10^{-11}$	▲	▲	●	▲		●

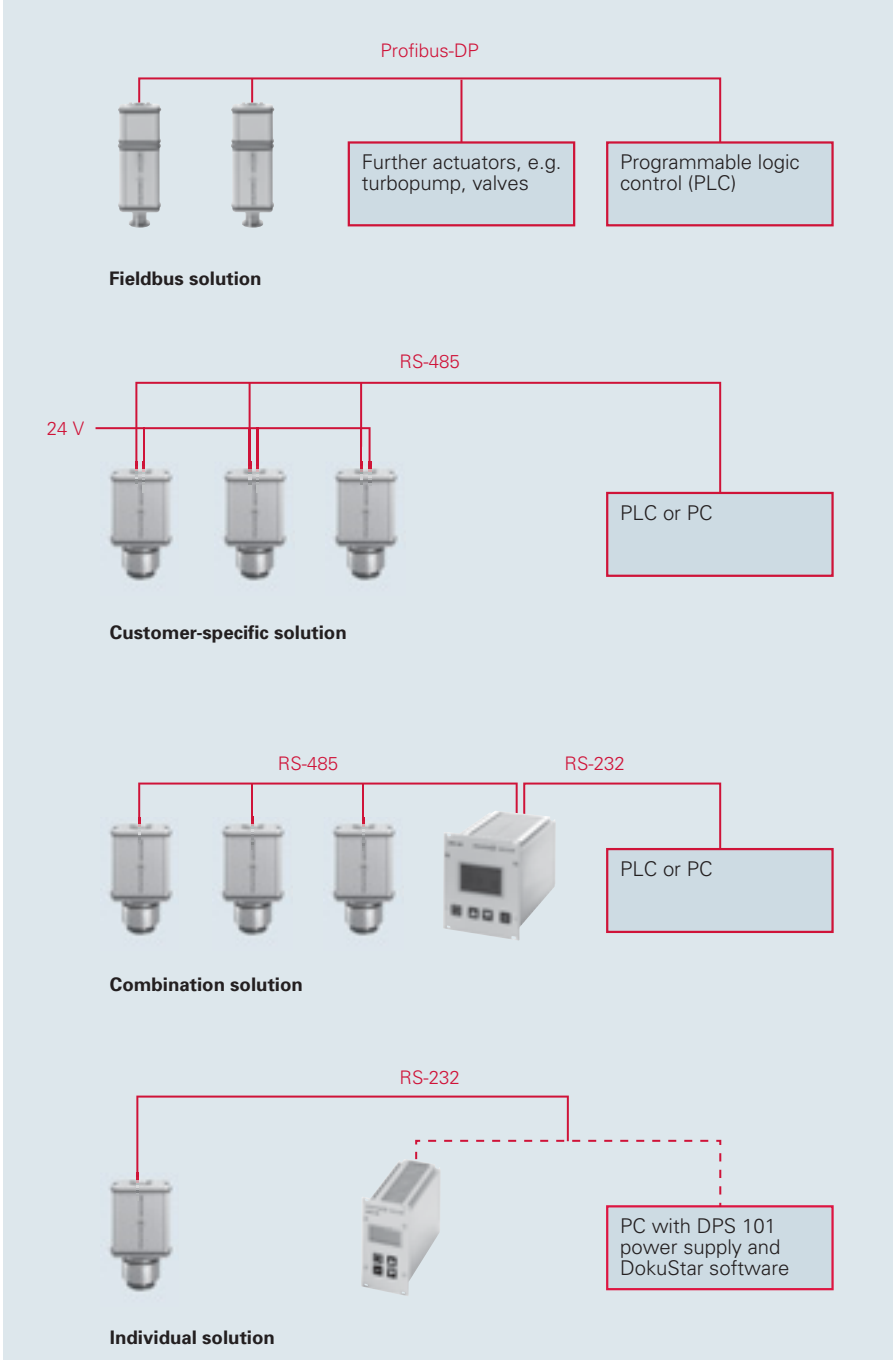


Figure 3.9: DigiLine™ application concepts

DigiLine sensors offer the following advantages:

- Freely combinable components
- Measured values are transmitted directly; no curve correction is required
- Secure data transmission thanks to digital signals
- Reversible RS 232/RS 485 serial interface
- Data can be analyzed directly on a PC with DokuStar Plus software
- Can be integrated into a plant control system by means of a fieldbus converter
- Simple calibration
- Suitable for industrial use

Single-sensor transmitters are available in the form of a **CPT 100 piezo-diaphragm system** (2,000 – 1 mbar) and a **PPT 100 Pirani system** (1,000 – 10^{-4} mbar).

The following combination sensors are available in the DigiLine series:

- **RPT 100 piezo-Pirani combination.** Since the thermal conductivity effect for the Pirani vacuum gauge is not a function of pressure, a diaphragm vacuum gauge is used for pressures p of over 1 mbar. This affords good accuracy throughout the entire measurement range from 1,200 to $1 \cdot 10^{-4}$ mbar, enabling processes to be controlled by means of this gauge
- **MPT 100 Pirani-cold cathode combination.** This combination covers the pressure from 1,000 to $5 \cdot 10^{-9}$ mbar. The gas discharge of the cold cathode measuring sensor is range initiated by the pressure that is measured with the Pirani sensor. Using this process prevents inadvertent activation of the cold cathode at excessive pressure, thus avoiding contamination.
- **HPT 100 Pirani/Bayard-Alpert combination.** This covers a pressure range from 1,000 to $5 \cdot 10^{-10}$ mbar. Pressure monitoring by the Pirani sensor protects the hot cathode gauges against operating at excessively high temperatures and prevents burn-out of the hot cathode. This enables extremely long cathode service life to be achieved.

3.3.1.2 ActiveLine

The ActiveLine family includes three control units and eight transmitters.

The APR piezo transmitters cover five measurement ranges from 55 bar to 0.1 mbar with six transmitter models.

Capacitive CMR diaphragm-type transmitters are available in the form of both temperature-compensated and temperature-regulated versions, in four or five measurement ranges each from 1,100 – 10^{-5} mbar. The use of diaphragms of differing thicknesses results in the following categories:

- 1,100 to 10^{-1} mbar
- 110 to 10^{-2} mbar
- 11 to 10^{-3} mbar
- 1.1 to 10^{-4} mbar
- 0.11 to 10^{-5} mbar

These ceramic-technology capacitive diaphragm vacuum gauges from Pfeiffer Vacuum have a proven track record in many, even corrosive applications.

The electrodes (anode, cathode, collector) in the sensor of the IMR 265 hot cathode transmitters are designed with extremely small clearances between one another.

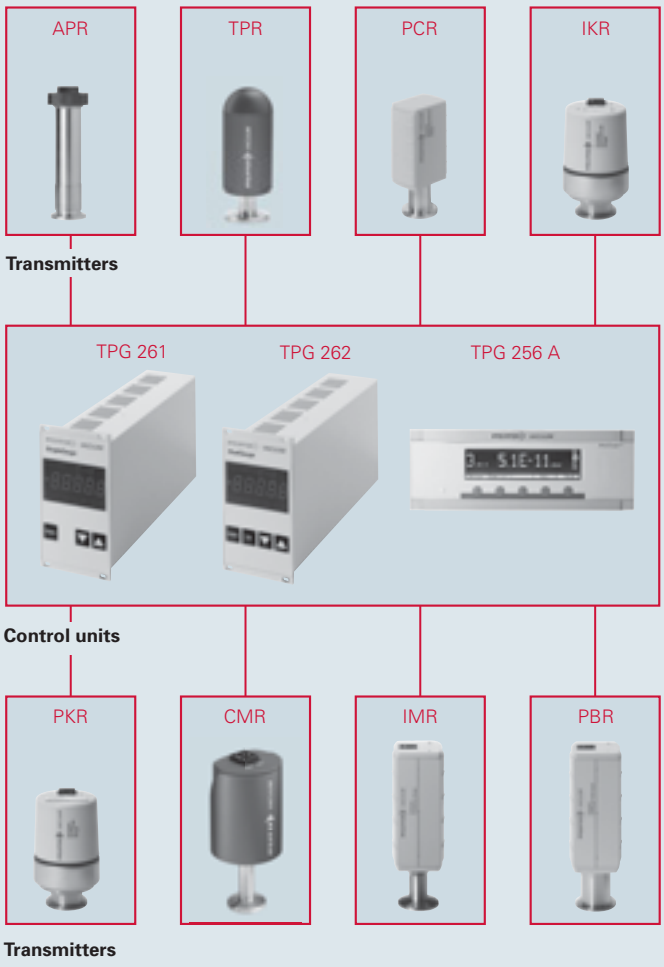


Figure 3.10: ActiveLine application concepts

Molecular flow therefore prevails, even at pressures *p* of less than 10^{-2} mbar, enabling ion currents there to be measured. An additional advantage is its lower sensitivity to contamination than the Bayard-Alpert design. Moreover, there are two TPR Pirani transmitters and three IKR cold cathode transmitters with measuring ranges from 0.01 to $5 \cdot 10^{-11}$ mbar.

The TPR 280 Pirani vacuum gauges can also be connected to DCU pumping station display control units, thus providing a pressure reading at no additional expense.

The following combination sensors are available:

- **PCR 260 capacitive diaphragm-Pirani combination transmitter** with a measurement range from 1,500 bis $5 \cdot 10^{-4}$ mbar
- **PKR 251 and 261 Pirani-cold cathode combination transmitters** with measurement ranges from 1,000 bis $5 \cdot 10^{-9}$ mbar
- **PBR 260 Pirani/Bayard-Alpert combination transmitter** with a measurement range from 1,000 bis $5 \cdot 10^{-10}$ mbar.

ActiveLine transmitters offer the following advantages:

- There are three control units for one, two or six transmitters
- Any transmitter can be operated with any control unit
- Uniform connection cable

3.3.1.3 ModulLine

The ModulLine series includes three TPR Pirani vacuum gauges with a measurement range from 1,000 to $8 \cdot 10^{-4}$ mbar and three IKR cold cathode measuring tubes with measurement ranges from $5 \cdot 10^{-3}$ to 10^{-11} mbar. Because these vacuum gauges do not contain any electronics, they are suitable for use in high-radiation environments.

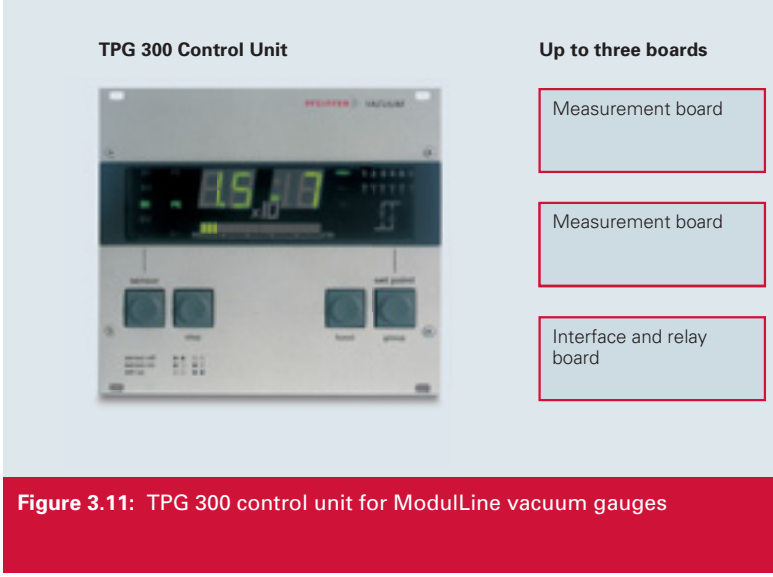


Figure 3.11: TPG 300 control unit for ModulLine vacuum gauges

A TPG 300 with the following features serves as the control unit:

- Two measurement boards can be inserted, as well as
- An RS-232/RS-485 interface board with relay outputs
- Connection of up to four vacuum gauges
- Fieldbus connection is possible

4 Mass Spectrometers and Residual Gas Analysis

4.1 Introduction, operating principle

Mass spectrometry is one of the most popular analysis methods today. A mass spectrometer analyzes the composition of chemical substances by means of partial pressure measurement.

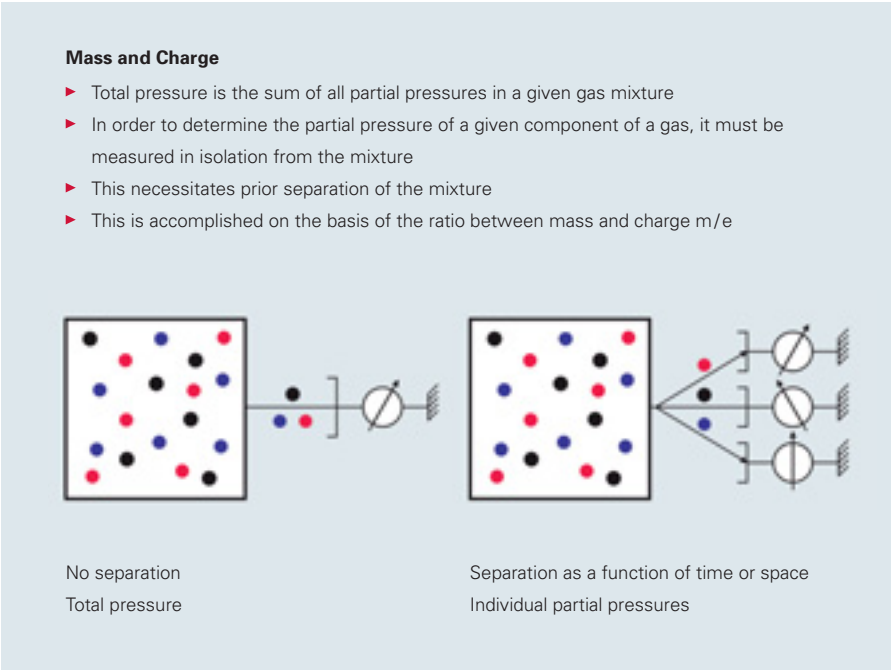


Figure 4.1: Total and partial pressure measurement

Source: Pupp / Hartmann, Vakuumtechnik, Grundlagen und Anwendungen, Hanser Verlag

Analyses are typically performed in the field of research & development and in the production of products that are used in daily life:

- Analysis of products from the chemical industry
- Drug development
- Doping tests
- Quality assurance of food products
- Monitoring semiconductor production processes
- Isotope analysis

Gaseous or liquid substances that vaporize under vacuum are admitted to a mass spectrometer. The gas is diluted by being partially pumped down to a low pressure (molecular flow range) in a vacuum chamber and ionized through electron bombardment. The ions thus generated are introduced to a mass filter and separated on the basis of their charge-to-mass ratio.

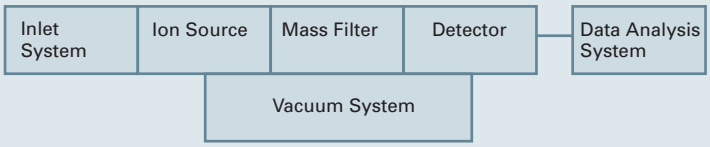


Figure 4.2: Components of a mass spectrometer

Figure 4.2 shows the typical structure of a mass spectrometer system:

- The substances to be analyzed are admitted into a vacuum chamber through the **inlet system** via a capillary or metering valve, for example, and then
- Partially pumped down to the system's working pressure

The actual analyzer is located in the vacuum and consists of the following components:

- The **ion source** ionizes neutral gas particles, which are then
- Sorted in the **mass filter** on the basis of their mass-to-charge ratio *m/e*
- The ion current is measured using a Faraday **detector** or a secondary electron multiplier (SEM) after the ions have left the separating system. The measured current is a parameter of the partial pressure of the respective gas molecules or a parameter of fractals that may possibly have been generated in the ion source
- A **data analysis system** processes the ion currents measured with the aid of the detector and presents these currents in various forms. Today, data analysis software programs are capable of supporting the user in interpreting mass spectra.

Mass spectrometers differ as a result of the wide variety of available versions. The main difference consists of the separating systems. The following four types of mass filters are in widespread use today:

- **Sector field devices** use the deflection effect of a magnetic field on moving charge carriers
- Time-of-flight mass (TOF) spectrometers utilize the differing velocities of molecules of equal energy for separation
- In ion traps, the trajectories of the ions are influenced by a high-frequency field
- Quadrupole mass spectrometers utilize the resonance of moving ions in a high-frequency field (similar to ion traps)

Our discussion will be confined to sector field mass spectrometers and quadrupole mass spectrometers, as these are the mass spectrometers that are most widely used in the field of vacuum technology.

4.1.1 Sector field mass spectrometers

Because of their simple, robust design, sector field mass spectrometers are used for helium leak detectors, where only little demands are placed on resolution.

The operating principle of sector field mass spectrometers is shown in Figure 4.3.

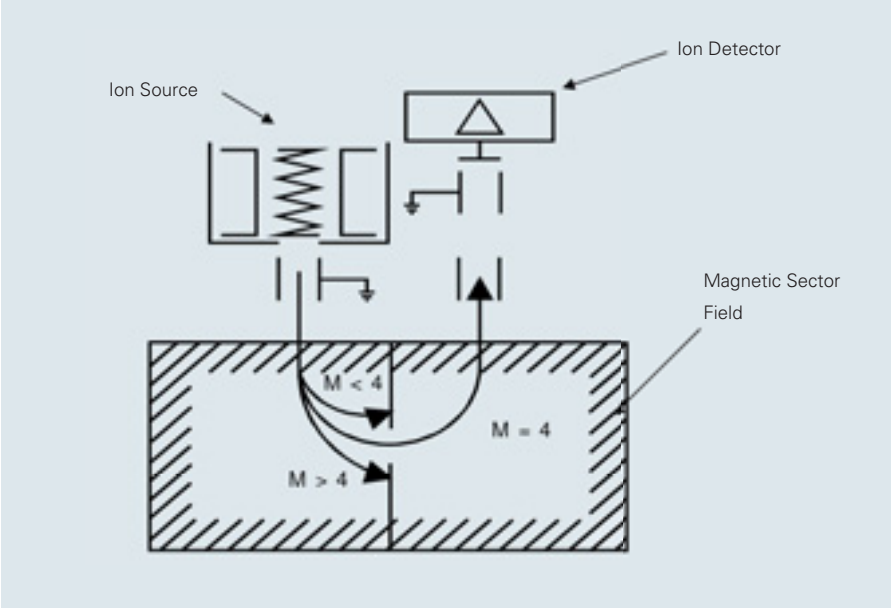


Figure 4.3: Operating principle of a sector field mass spectrometer

Neutral gas molecules are ionized in an ion source through electron bombardment. The electrons thus generated are accelerated into the magnetic sector field with the aid of an electrical voltage. The magnetic field is homogeneous in the area of the trajectories of the ions and is positioned perpendicular to the image plane. Helium ions having a mass of 4 amu are able to pass through a slot to reach the detector. All other molecules are unable to pass through the slot and are re-neutralized. The ion current measured for helium is proportional to the helium partial pressure.

4.1.2 Quadrupole mass spectrometers (QMS)

4.1.2.1 Quadrupole mass filter

The filter system of a quadrupole mass spectrometer consists of four parallel rods arranged in the form of a square. Each pair of opposite rods in Figure 4.4, designated (+) or (-), is connected with the other. Voltage

Formula 4-1
Quadrupole deflection voltage

$$U_1 = U + V \cdot \cos \omega t$$

is applied between the two pairs of rods.

At this point, only a brief phenomenological description of the operating principle will be provided. Reference is made to the literature for a detailed presentation [14, 15, 16].

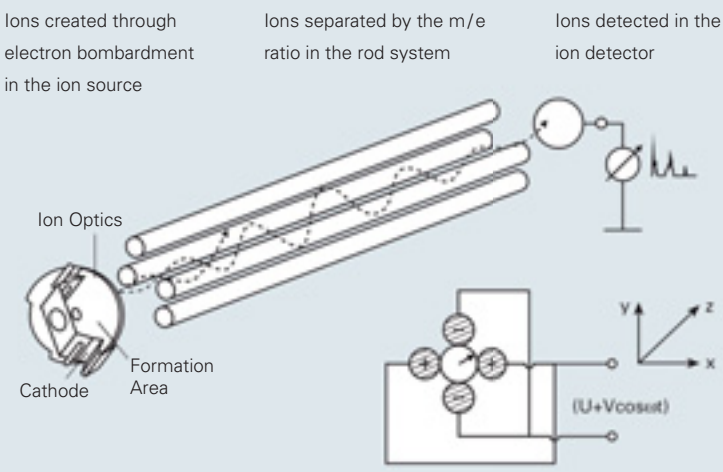


Figure 4.4: Operating principle of a quadrupole mass spectrometer

Ideal quadrupole fields require rods that have a hyperbolic profile. In actual practice, however, round rods are used, with the rod radius being equal to 1.144 times the field radius r_0. An electrical quadrupole field is formed between the rods. Ions of varying mass are shot axially into the rod system at approximately equal energy and move through the rod system at uniform velocity. The applied quadrupole field deflects the ions in the X and Y directions, causing them to describe helical trajectories through the mass filter. To solve the movement equations, the dimensionless variables

Formula 4-2
Stability parameter a

$$a = \frac{8 \cdot e \cdot U}{m \cdot r_0^2 \cdot \omega^2}$$

and

Formula 4-3
Stability parameter q

$$q = \frac{4 \cdot e \cdot V}{m \cdot r_0^2 \cdot \omega^2}$$

are introduced to obtain Mathieu's differential equations. Their solutions yield the stable area with oscillation amplitudes of less than r_0 beneath the triangle formed by the two solubility curves in Figure 4.5. The values $a_p = 0.23699$ and $q_p = 0.706$ apply for the apex of the triangle. All solutions outside result in increasing oscillation amplitudes and thus in neutralization of the ions on the rods of the quadrupole filter.

Dividing the two equations by one another yields: $\frac{a}{q} = 2\,\frac{U}{V}$.

This is the pitch of the so-called load line of the mass filter.

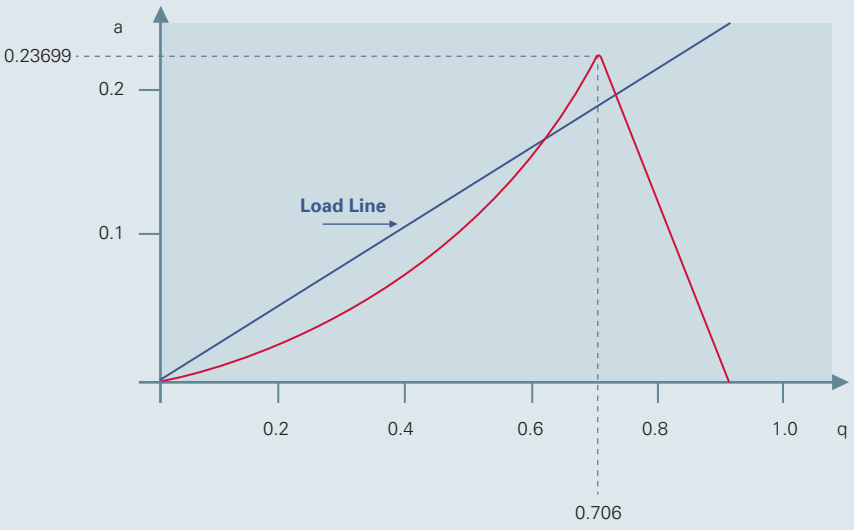


Figure 4.5: Stability diagram of a quadrupole filter

From Figure 4.5, it can be seen that:

- All ions whose parameters a and q are located in the triangle above the load lines will reach the detector
- The ions will only reach the detector under voltage conditions $\frac{U}{V} = \frac{a_p}{2 \cdot q_p} < 0.1678$.

Introducing the ratio between the atomic mass unit 1 amu = $1.66055 \cdot 10^{-27}$ kg and the elementary charge $e = 1.602 \cdot 10^{-19}$ A · s $\frac{m_{amu}}{e} = 1.0365 \cdot 10^{-8} \frac{kg}{A \cdot s}$ and multiplying it by the dimensionless mass number M of the corresponding ion yields the following conditions for U and V for the apex of the stability triangle:

Formula 4-4
Stability condition U

$$U = 1.2122 \cdot 10^{-8} \frac{kg}{A \cdot s} \cdot M \cdot r_0^2 \cdot f^2$$

and

Formula 4-5
Stability condition V

$$V = 7.2226 \cdot 10^{-8} \frac{kg}{A \cdot s} \cdot M \cdot r_0^2 \cdot f^2$$

With the DC voltage de-energized, $U = 0$, all trajectories of the ions where q < 0.905 will be stable; according to Formula 4-5, these will all be masses where

Formula 4-6
High-pass condition

$$M > \frac{1.0801 \cdot 10^7 \cdot V}{r_0^2 \cdot f^2} \cdot \frac{A \cdot s}{kg}$$

The filter thus acts as a high pass. As HF amplitude (V) increases, ever-heavier types of ions become unstable, starting with the light masses, and are thus sorted out. This operating mode produces an integral spectrum.

The shot conditions are crucial for transmission of ions through the filter.
Ions parallel to the rod system must be shot in within the following diameter:

Formula 4-7
Shot orifice

$$D = \frac{1}{2} \cdot r_0 \cdot \frac{M}{\Delta M}$$

The maximum shot angle must satisfy the condition:

Formula 4-8
Shot angle

$$tg\psi < 11.85 \cdot \frac{r_0^2}{L^2}$$

and the energy must be as uniform as possible. The advantages of the Pfeiffer Vacuum ion sources described in 4.1.4.1 translate into high transparency and thus high sensitivity.

In order for the amplitudes of the unstable ions to become large enough to strike the rods, where they are neutralized, these ions must perform a minimum number of oscillations in the separating field. The following equation applies for the maximum acceleration voltage in the Z direction:

Formula 4-9
Maximum acceleration voltage U_{zmax}

$$U_{zmax} \approx 4.2 \cdot 10^{-6} \frac{kg}{A \cdot s} \cdot L^2 \cdot f^2 \cdot M \cdot \frac{\Delta M}{M}$$

In practical operation, the ratio U/V is activated as a function of the mass number in such a manner that the actual resolution $\Delta M/M$, does not remain constant, but that instead the line width ΔM remains constant. This means that resolution increases proportionally to the mass number. Due to Formula 4-5 (V is proportional to M), the quadrupole (as opposed to the sector field mass spectrometer) produces a linear mass scale.

One point of major significance for a QMS is the required HF power. If C is used to designate the entire capacity of the system and Q to designate the factor quality of the power circuit, the required HF power

Formula 4-10
HF power

$$N_{HF} \approx \frac{C}{Q} \cdot M^2 \cdot f^5 \cdot r_0^4$$

will increase with high powers of f and r_0. An enlargement of field radius r_0 will lessen the occurring relative mechanical tolerances, thus resulting in improved behavior. Essentially, it is advantageous to select f_0 and r_0 as large as possible. However there are limits in this regard due to the associated increase in HF power (Formula 4-10). While extending the rod system permits a lower operating frequency, the size of a production unit should not exceed certain dimensions.

The required mass range and desired resolution are governed by the dimensions of the filter and the selection of the operating frequency. Devices with 6, 8 and 16 mm rod diameters and appropriately matched electronics are available to satisfy the respective requirements.

What follows is a brief digression on the relationship between resolution and mechanical precision. Let us consider a quadrupole mass filter that works at the apex of the stability diagram; i.e. that works at high resolution.

$U = 1.2122 \cdot 10^{-8} \frac{kg}{A \cdot s} \cdot M \cdot r_0^2 \cdot f^2$ Formula 4-4 applies for the DC amplitude

and Formula 4-5 $V = 7.2226 \cdot 10^{-8} \frac{kg}{A \cdot s} \cdot M \cdot r_0^2 \cdot f^2$ for the AC amplitude.

Here, M designates the mass of the ion, r_0 the field radius and f the frequency at which the filter is operated. We are making the idealized assumption that both voltages U and V, as well as frequency f, can be set and maintained "as precisely as desired."

What follows from this is: $M = c_k \cdot \frac{1}{r_0^2}$ (c_k is a constant), and following differentiation and division by M, the filter scatter caused by r_0 is:

Formula 4-11
Scatter

$$\frac{dM}{M} = \frac{-2 \cdot dr_0}{r_0}$$

Let us assume that the field radius r_0 changes by $\Delta r_0 = 0.03$ mm over the length of the mass filter. Now let us consider the effect of this change on scatter $\Delta M/M$ for two mass filters of different sizes. For optimal transmission, the resolution set on the spectrometer (we select: $\Delta M/M = 1/100$) must be greater than the scatter generated by the fluctuation of r_0:

$$\frac{\Delta M}{M} > \frac{-2 \cdot \Delta r_0}{r_0} \quad .$$

For a filter (a) having a field radius of 3 mm, this results in $\Delta M/M = 0.02$, i.e. a contradiction; and for a filter (b) having a field radius of 12 mm, this results in $\Delta M/M = 0.005$, i.e. coincidence with the above condition. In other words: If a resolution of $\Delta M/M = 0.01$ has been set for both filters, most of the ions will not be able to pass through the filter in case (a). In the case of the larger filter (b), all ions will be able to pass through the filter, since the set resolution is greater than the scatter.

Although this simplified error calculation does not nearly take into account all of the effects that can contribute to transmission, it does teach several fundamental relationships:

- The field radius must be maintained significantly better than 1% over the entire length of the filter, depending on the selected mass range. Fluctuations in the field radius will lead to transmission losses
- The larger the dimensions of the rod system are selected, the lower the influence of the absolute mechanical tolerances will be

- The higher the mass range, and if differentiation between adjacent masses is still to be made, the stricter will be the requirements relating to the relative accuracy of the mass filter. In this simple picture, the required relative accuracy is scaled linearly with the mass range

Summary

A quadrupole mass filter is a dynamic mass filter for positive and negative ions. The mass scale is linear to the applied amplitude of the HF voltage. Mass resolution can be conveniently and electrically set by means of the ratio between the DC voltage *U* and the high-frequency voltage amplitude *V*. Due to their small dimensions and light weight, quadrupole mass spectrometers are suitable both as pure residual gas analyzers and, in higher-quality design, as sensors for gas analysis.

4.1.2.2 Ion sources

Before gases can be analyzed in a mass filter, they must first be ionized in an ion source by means of electron bombardment.

Electrons are emitted from an electrically heated cathode (filament). A voltage is applied between anode and cathode, which accelerates the electrons. Neutral gas molecules that are present in the formation space between anode and cathode are ionized by collisions between electrons, forming single and multiple positive ions. The energy of the colliding ions exerts a significant influence on both the number and type of ions that will be formed.

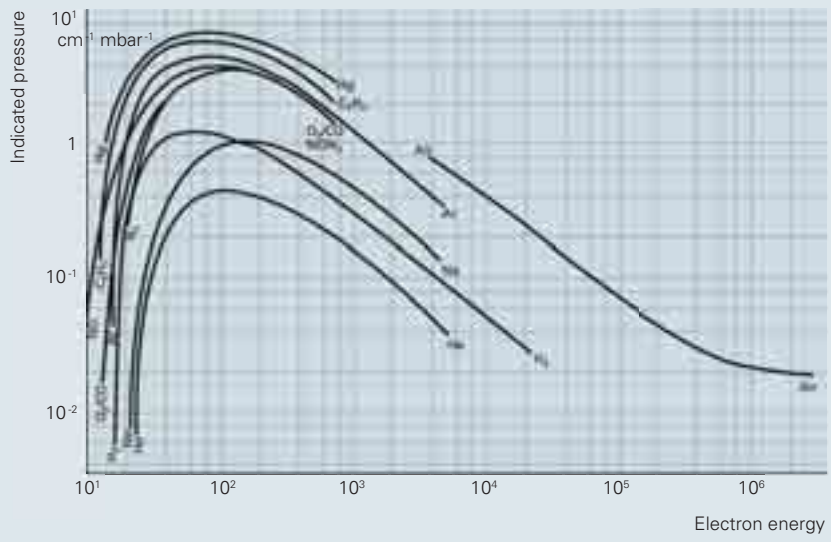


Figure 4.6: Ion density as a function of electron energy

Source: Pupp / Hartmann, Vakuumtechnik, Grundlagen und Anwendungen, Hanser Verlag

Ionization of the neutral particles commences at a minimum electron energy of between 10 and 30 eV (appearance potential). The number of formed ions quickly increases as electron energy rises (acceleration voltage), reaches a maximum at 50 to 150 eV depending upon the type of gas in question, and slowly declines again as energy continues to rise. Since the yield in ions, and thus the sensitivity of the mass spectrometer, should be as large as possible, electron energies between 70 and 100 eV are typically used.

The ion current I_{K+} of a gas component K can be calculated from the following relationship:

Formula 4-12
Ion current

$$I_{K+} = i_ \cdot l_e \cdot s \cdot p_K$$

Where:
$i_$ = electron current (emission current), in A
l_e = mean path length of the electrons, in cm
s = differential ionization effect cross section K, in 1/(cm · mbar)
p_K = partial pressure of the gas component K, in mbar

Many types of ions are formed when ionizing complex molecules. In addition to single- and multiple-charge molecule ions (ABC_+, ABC_{++}) fractal ions also occur:

- $ABC^+ + 2e^-$
- $ABC^{++} + 3e^-$
- $AB^+ + C + 2e^-$
- $BC^+ + A + 2e^-$
- $A^+ + BC + 2e^-$
- $C^+ + AB + 2e^-$
- $B^+ + A + C + 2e^-$

In addition to these types, it is also possible for recombination ions, such as AC^+, to form. The occurrence and relative frequency of individual types of ions are characteristic of a certain type of molecule and serve as an important aid in identifying the molecule, and thus as an aid in qualitative gas analysis. Figure 4.7 shows the fragment ion distribution (cracking pattern or fractal pattern) of the simple molecule CO_2, recorded at 70 eV of electron energy.

Selection of the ion source and the optimal filament material is based upon the requirements imposed by the measurement task. Applications often impose contradictory requirements on the ion source. In order to achieve optimal results, the ion source must be matched to the task at hand. This has resulted in the development of different types of ion sources that can almost all be equipped with cathodes made of rhenium (Re), tungsten or yttriated iridium (Y_2O_3/Ir).

T-cathodes are preferred in the UHV range or where the vapor pressure of Re could have a disturbing effect. However the brittleness of tungsten cathodes due to the tungsten/carbon/oxygen cycle must be taken into account; i.e. due to the formation of W_2C. Yttriated iridium is increasingly being used today instead of the pure metal cathodes that were used in the past. The advantages offered by these cathodes are significantly lower operating temperature and relative insensitivity to air inrush. Consequently, the preferred fields of implementation for these cathodes are analysis of temperature-sensitive substances, e.g. metal-organic compounds, or analysis of contaminants in gas mixtures containing a high concentration of oxygen.

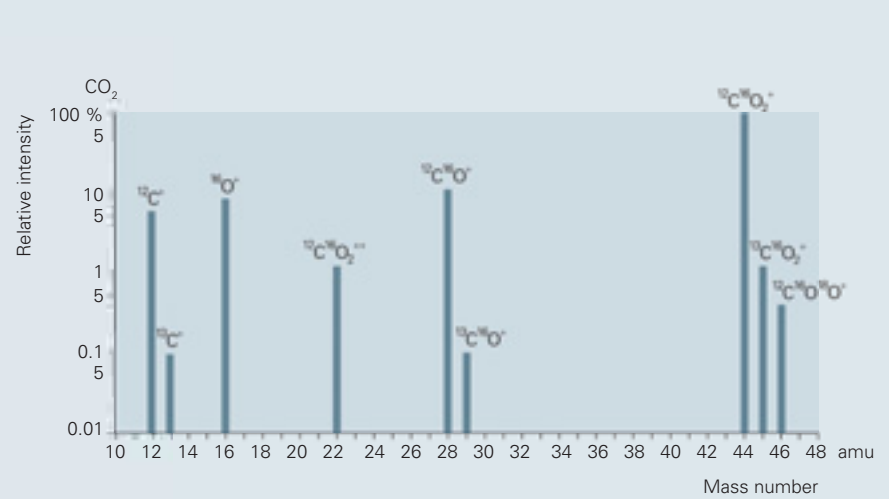


Figure 4.7: Fractal ion distribution of CO_2

Table 4.1: Filament materials and their employment

Material	Temperature	Applicable Gases	Remarks
Y_2O_3/Ir	1,300 °C	Inert gases, Air/O_2, NO_x, SO_x	Short service life with halogens, insensitive to high O_2 concentrations, generates some CO/CO_2 from O_2 or H_2O background
W	1,800 °C	Inert gases, H_2, halogens, freons	Short service life with O2 applications, generates some CO/CO_2 from O_2 or H_2O background, C causes brittleness
Re	1,800 °C	Inert gases, hydrocarbons, H_2, halogens, freons	Service life around three months due to vaporization of the material, used in connection with hydrocarbons

The various ion sources are described below on the basis of their attributes and fields of application. What all ions have in common is that they can be electrically biased up to 150 V. This avoids signal background due to ESD ions. This technology will be explained in detail later.

Axial ion source

This ion source is characterized by its extremely robust mechanical design and high sensitivity. It is primarily employed for residual gas analysis in high vacuum systems due to its open construction. Figure 4.8 shows a schematic diagram of an axial ion source.

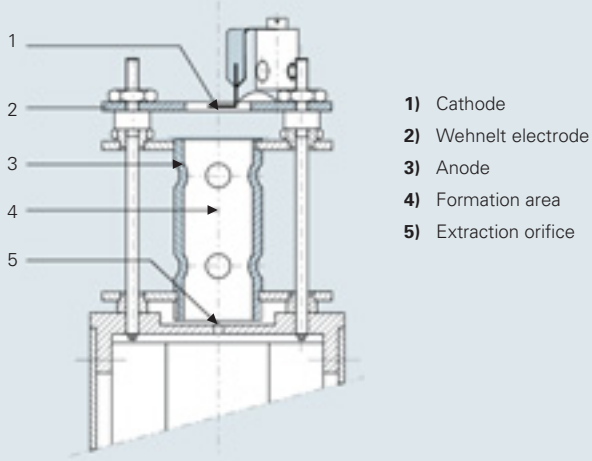


Figure 4.8: Section through an axial ion source

The cathode (1) is arranged within a hole in the Wehnelt electrode (2) and is connected with this electrode on one side. The electrons accelerated toward the anode (3) ionize gas molecules in the formation area (4). The positive ions reach the mass filter through the extraction orifice (5). Due to its relatively open construction, only minor falsification occurs through desorption and surface reactions.

Lattice ion source

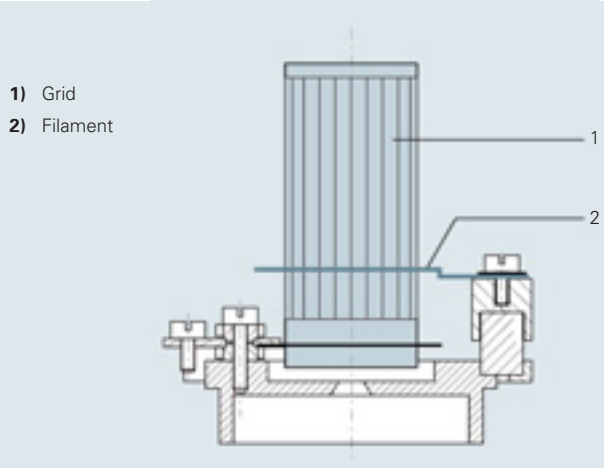


Figure 4.9: Lattice ion source

A lattice ion source is used to examine residual gas in UHV or even XHV applications. Its extremely open construction and the selection of materials ensure extremely low internal gas emission. This ion source is equipped with two tungsten filaments that can be heated simultaneously for degassing. If work is to be performed at temperatures below 10^{-11} mbar, rod systems that have been highly degassed especially for this purpose would be used. Measurements in the pressure range below 10^{-10} mbar can be falsified by so-called EID (electron impact desorption) ions. These (H^+, O^+, F^+, Cl^+) ions are directly desorbed by electron bombardment of surfaces, often with a high yield. EID ions come from adsorbed coatings that originate earlier in the history of the UHV equipment or the ion source, and usually have an initial energy of several eV. This attribute is utilized by skilled selection of the field axis voltage to suppress the EID ions relative to ions from the gas phase having energy of approximately eV, (Figure 4.10).

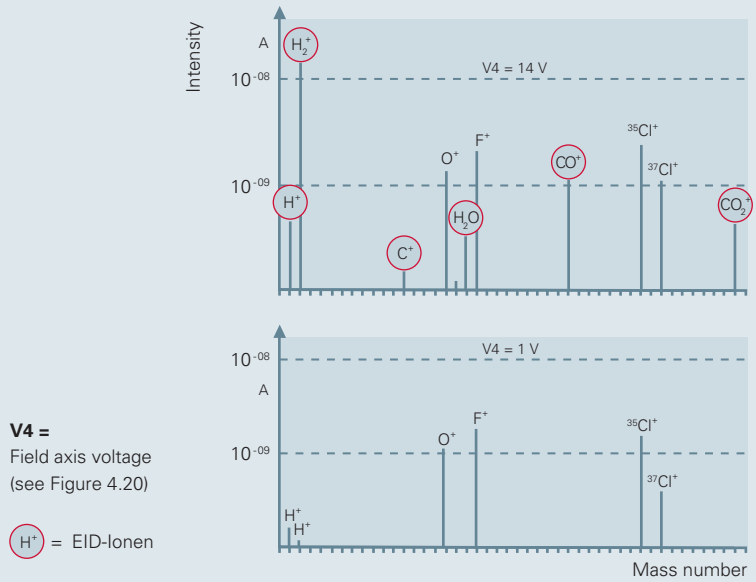


Figure 4.10: Discrimination of EID ions

Crossbeam ion source

A crossbeam ion source (Figure 4.11) allows direct passage of molecular beams perpendicular and parallel to the system axis. The system emits electrons with pre-selectable energy (90 – 120 eV) into the formation area (3), from either the left or the right filament (1). The Wehnelt cylinder (4) at filament potential prevents the electrons from scattering to the environment. Because the electron energy can be set within broad limits, this ion source can be used to determine the appearance potential. The crossbeam ion source very precisely maintains the shot conditions of the ions into the mass filter.

Crossbeam ion sources are used for diagnosing bundled molecular beams. In this process, the molecular beam is shot into the formation area perpendicular to the axis of the plane of projection (Figure 4.11). After passing through the ion source (7), un-ionized neutral gas molecules are either channeled into a pump or into a cold trap for condensation. Mass spectrometers with this type of ion source are also used as „rate meters“ for molecular beam epitaxy.

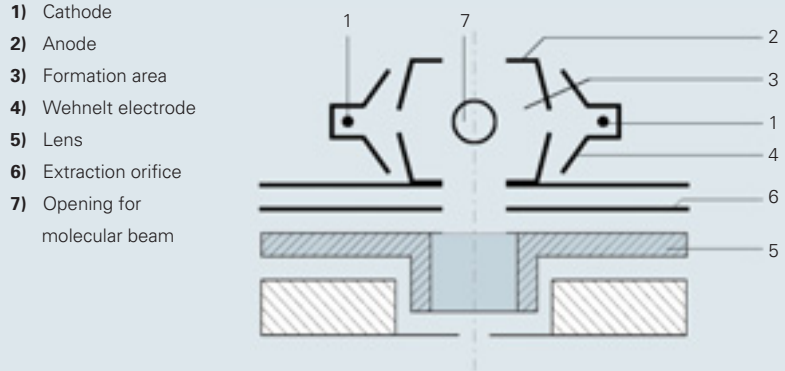


Figure 4.11: Crossbeam ion source

Gas-tight ion sources

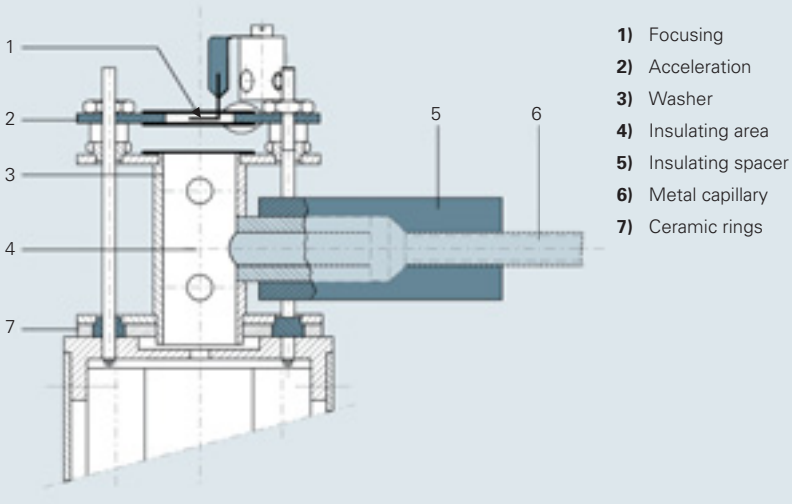


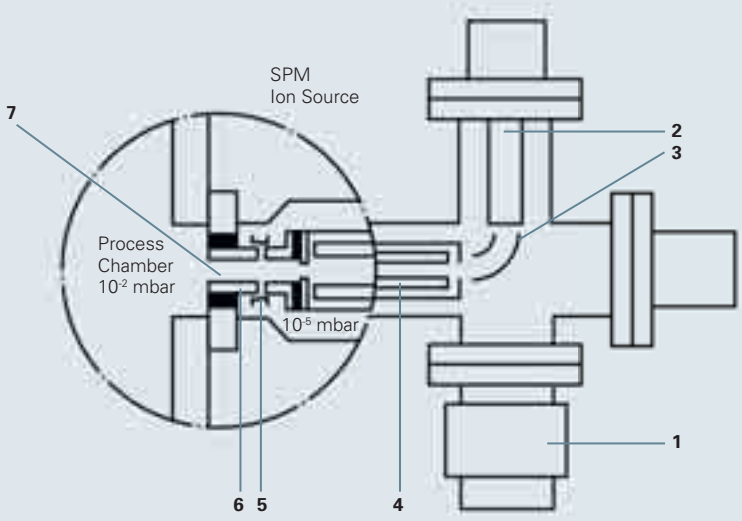
Figure 4.12: Gas-tight axial ion source

Some of the above-described ion sources are also available in gas-tight versions. Gas-tight ion sources are used if only small quantities of gas samples are available, or if the signal background generated by residual gas needs to be effectively suppressed. In this connection, the gas inlet system (e.g. a heated capillary) and the ion source must be matched to one another. The inflowing gas volume will determine the pressure in the formation area, which can be a multiple of the pressure in the surrounding vacuum chamber, by means of the conductivity of the ion source. The operating principle will now be presented using an axial ion source by way of example (Figure 4.12).

The gas to be analyzed is introduced directly into the formation area via a metal capillary (6) that is at ground potential and an insulating spacer (5). The conductivity to the vacuum chamber is approximately 1 l/s.

Sputter process monitor (SPM) ion source

In this ion source, the formation area (7) communicates directly with the process chamber. The analyzer is equipped with a small turbopumping station (1), which also evacuates the cathode space (5) to approximately 10^{-5} mbar. Electrons are shot into the formation area (7) from the low pressure side through small holes in order to ionize them.



1) Turbomolecular pump for differential pumping
2) Secondary electron multiplier (SEM)
3) Deflection unit
4) Quadrupole mass filter
5) Heating filament
6) High-conductivity piping to process
7) Formation area

Figure 4.13: Sputter process monitor (SPM) ion source

The ions thus formed are also extracted to the mass filter through a small opening to the low-pressure side. This ion source offers two crucial advantages for examining the composition of the gas in sputtering processes. On one hand, the analysis is performed at an ion source pressure that is up to three orders of magnitude higher; i.e. a higher concentration of residual gas can be tolerated in the vacuum chamber. On the other hand, the hot filament is not in direct contact with the sputtering process. This avoids contamination by the hot cathode for sensitive processes.

Standard PrismaPlus™ ion source

The PrismaPlus mass spectrometer from Pfeiffer Vacuum is equipped with this robust and highly sensitive ion source. It is an ion source that is especially suitable for residual gas analysis. Its design is comparable to that of a lattice source; like the lattice ion source, it has two cathodes, thus affording particularly secure operation. Both an open version as well as a gas-tight version with gas inlet in the axial direction are available.

Open Design **Gas-Tight Design**

Figure 4.14: PrismaPlus™ ion source

All ion sources described here ionize by means of electron collision. The ion sources can be categorized into two groups:

- Open ion sources are used if the process gas is to be analyzed and additional pressure reduction is not required
- Closed ion sources are used in analytical applications, for example, in order to require only small volumes of gas or to increase sensitivity relative to the substrate of the vacuum system

Closed ion sources are used in combination with a differentially pumped system (Figure 4.13) in order to analyze higher-pressure gases.

4.1.2.3 Detectors

The ions that are separated in the rod system on the basis of their mass-to-charge ratio can be electrically detected by means of various types of detectors:

- By means of a Faraday cup for direct measurement of the ion current using an electrometer amplifier
- Using a secondary electron multiplier (SEM) of discrete design with individual dynodes
- By means of a continuous secondary electron multiplier (C-SEM)

Detector selection will primarily be based upon requirements that relate to detection sensitivity, detection speed and signal-to-noise ratio. However it will also be governed by other application-specific requirements that relate to stability, thermal and chemical resistance, as well as space requirements.

Faraday cup

In the simplest case, the ions strike a Faraday collector (Faraday cup), where they emit their electrical charge.

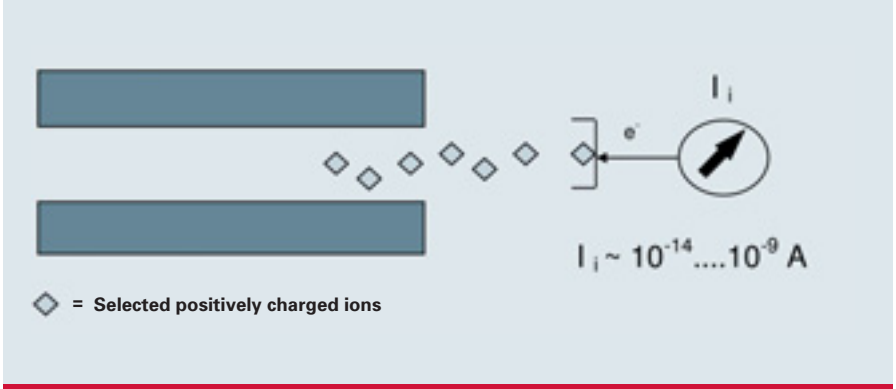


Figure 4.15: Operating principle of a Faraday Cup

The resulting current is converted to a voltage that is proportional to the ion current by means of a sensitive current/voltage inverter (electrometer amplifier). Because it is necessary for the input resistance R of the current amplifier to be extremely high, time constants $\tau = R \cdot C$ where $0.1\ s < \tau < 100\ s$ occur together with the capacities C of the measurement lead. Depending upon the time constant, the measurement limit is between $1 \cdot 10^{-16}$ and $1 \cdot 10^{-14}$ A.

In addition to its simple, robust design, a Faraday detector is characterized by its long-term stability and its ability to withstand high temperatures. To keep the time constants small and to avoid other interfering effects, the electrometer amplifier is connected directly to the analyzer and its output signal is supplied directly to the data analysis system. This is why the Faraday Cup is also present in all Pfeiffer Vacuum mass spectrometers. It is only suitable for detecting positive ions.

If extremely small ion currents are to be measured or if an extremely high measuring speed is required, physical pre-amplifiers, so-called secondary electron multipliers, are used.

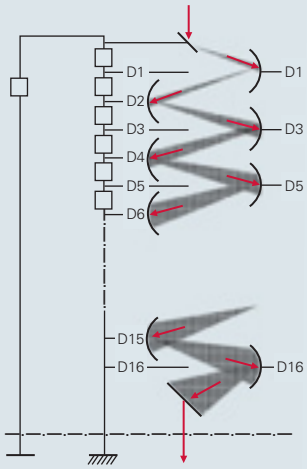


Figure 4.16: Secondary electron multiplier (SEM)

Figure 4.16 shows the design of such an amplifier. Cylindrically shaped pieces of sheet metal (dynodes) are coated with a layer that affords a low level of electron work function. Depending upon its kinetic energy, an ion or an electron generates multiple secondary electrons upon striking this layer. Connecting multiple stages in series produces an avalanche of electrons from a single ion. Positive voltages of approximately 100 V are applied between the dynodes to accelerate the electrons. Technical implementation of this arrangement is produced by supplying a high voltage (approximately 3,000 V) to it by means of a resistance chain, with the individual dynodes being connected to the taps of this voltage. The positive high-voltage pole is grounded to keep the escaping electrons at approximately ground potential. These types of arrangements produce current amplification factors of 10^7.

A secondary electron multiplier offers the following advantages over a Faraday cup:

- It dramatically increases the sensitivity of the instrument, affording sensitivity increases of up to 10 A/mbar
- This means that lower partial pressures can be scanned at shorter intervals of time with the downstream electrometer amplifier
- The signal-to-noise ratio is significantly higher than that of an electrometer amplifier, which means that the detection limit can be lowered by several orders of magnitude. This applies only if a lower dark current (noise portion) is also flowing in the SEM at high amplification. An increase in sensitivity in its own right is of little value

However an SEM also has disadvantages:

- Its amplification can change due to contamination or a chemical change in the active layer
- The number of electrons (conversion factor) that generate a colliding ion (approximately 1 to 5 electrons) will be a factor of the ion energy (mass discrimination)

Amplification changes as a result of this effect. Consequently, it must be calibrated from time to time. Changes in amplification can easily be adjusted by modifying the high voltage. The conversion factor can be kept constant by supplying the first dynode with a separate high voltage that seeks to equal the energy of the various ions.

Table 4.2: Detectors and their attributes

	PrismaPlus™	HiQuad™ with SEM 217	HiQuad™ with SEM 218
Detectors	**Faraday / C-SEM**	**Faraday / SEM**	**Faraday / SEM with conversion dynode**
Maximum possible pressure, Faraday	10^{-3} mbar	10^{-4} mbar	10^{-4} mbar
Maximum possible pressure, SEM/C-SEM	10^{-5} mbar	10^{-5} mbar	10^{-5} mbar
Maximum measuring speed/amu	2 ms	125 µs	125 µs
Bake-out temperature (max)	300	400	400
Counting operation	No	Yes	Yes
Detection of positive ions	Yes	Yes	Yes
Detection of negative ions	No	Yes	No
Counter option	No	Yes	Yes

Extremely fast measurements are possible with the aid of secondary electron multipliers. As can be seen from Table 4.2, the measuring speeds are significantly higher than with a Faraday cup.

In addition to operation as current amplifiers, discretely designed SEMs are also suitable as ion counters. Extremely low count rates of 1 ion per 10 s can be attained with this configuration. High count rates are also possible, producing an extremely broad dynamic range by comparison with operation as a current amplifier.

In the counting mode, the speed of the SEM serves as the upper limit of the dynamic range. With a pulse width of 20 ns, non-linearity begins at a count rate of 10^6 events per second. Given its pulse width, the SEM must be suitable as a counter.

What all secondary electron multipliers have in common is that they are restricted to operating at pressures of less than 10^{-5} mbar. At pressures of more than 10^{-5} mbar, the layer of water on the dynodes can lead to pyrolysis in operation, and thus to premature aging. Due to the high voltages involved, gas discharges that could destroy the SEM can occur at high pressures.

A C-SEM (Figure 4.17) is a continuous secondary electron multiplier, in which ions trigger an electron avalanche through secondary electron emissions. It consists of a glass tube whose interior is coated with a conductive layer that has high resistance and a low work function. High voltage is applied to the layer in order to obtain a uniform voltage gradient throughout the length of the tube. Ions from the quadrupole system are routed to the conversion dynode and generate secondary electrons that trigger an electron avalanche in the tube. Current amplification factors of 106 are attained at an amplification current of 2.5 kV.

Here, too, amplification and dark current govern the signal-to-noise ratio, and the maximum current/dark current ratio of 10^6 the current amplification factor. Thanks to a C-SEM arrangement that is slightly offset relative to the axis of the quadrupole, both a Faraday cup as well as a C-SEM can be used next to one another in the analyzer, with changeover from one detector to the other even being possible when necessary.

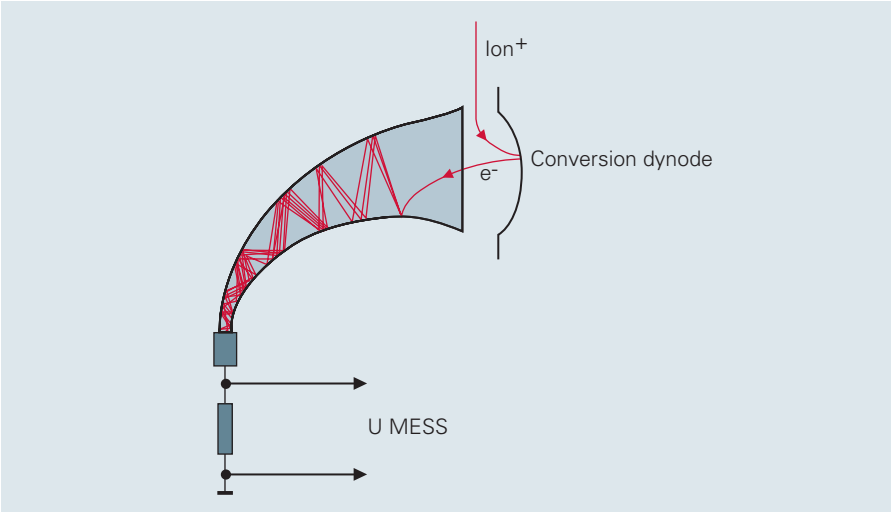


Figure 4.17: Operating principle of a C-SEM

4.1.2.4 Vacuum system

Pressures of less than 10^{-4} mbar are required for operation of quadrupole mass spectrometers. This necessitates an appropriate pumping station with pressure monitoring. In order to perform gas analysis with optimal sensitivity, only a low a base pressure is necessary and the residual gas should only contain unavoidable partial pressures stemming from desorption from the walls of the equipment. Residual gas spectra of this type and low base pressures are best attained with turbo drag pumping stations (Figure 2.22). An additional total pressure gauge protects the mass spectrometer against being energized at excessively high pressures.

When setting up such a system, attention must be paid to meaningful arrangement of gas inlet, valves, pumps and measurement instruments in order to avoid falsification stemming from unfavorable flow conditions. A separate pumping station that evacuates the measurement system is often required during the course of vacuum processes that run at high pressure. Small pumping stations with turbo drag pumps and diaphragm pumps are used for this purpose.

4.1.2.5 Inlet system

Many vacuum technology processes that are monitored by mass spectrometers occur in pressure ranges of more than 10^{-4} mbar. Gases to be analyzed must also be relieved from atmospheric pressure to pressures of less than 10^{-4} mbar. Differing pressure reducing procedures are used, depending on the pressure gradient in question.

Gas mixtures should be admitted to the mass spectrometer without de-mixing if possible:

- At pressures p of more than 10 mbar, pressure is reduced by means of a (heatable) capillary, in which laminar flow prevails, with a downstream gas inlet valve. Under some circumstances, pressure reduction by means of an additional pump will be necessary upstream of the valve

- At pressures p of less than 10 mbar, pressure is reduced by means of an orifice and with a mass spectrometer that is differentially pumped by means of a turbomolecular pump
- At pressures p of less than 10^{-4} mbar, the mass spectrometer can be installed directly in the process chamber with an open ion source

Table 4.3: Various gas inlet systems and their attributes

Inlet System	Pressure Range	Product Example	Characteristics
No pressure reduction	10^{-12} to 10^{-4} mbar	PrismaPlus QMG 220, HiQuad QMG 700	A further pressure range can be covered with various ion sources
SPM ion source	10^{-9} to 10 mbar	PrismaPlus SPM 220, HiQuad SPM 700	Special ion source for analyzing sputter processes. This system analyzes the unfalsified state of the plant by means of pressure reduction
Capillary inlet	700 to 1,100 mbar, as a function of capillary length and upstream orifice	OmniStar, ThermoStar, GES 020 and GES 010 inlet system	Differentially pumped inlet system, low mass discrimination, not suitable for changing inlet pressures
Orifice inlet	0,1 to 10 mbar, as a function of orifice diameter	PrismaPlus HPA 220	Orifices with diameters of 0.01 to 0.5 mm,simple, robust design, mass discrimination, changing inlet pressure possible with various orifice diameters, not suitable for fast-changing gas compositions
Metering valve	0,1 to 1,000 mbar	HPA 220 PrismaPlus, UDV 040 to 146 metering valves	Metering valves are suitable for gas inlet throughout a very broad measurement range, differentially pumped valves also enable analysis of rapidly changing gas compositions
Pressure-regulated gas inlet	10^{-3} to 1,000 mbar	EVR 016 with RVC 300, OmniStar with pressure-regulated inlet	Differentially pumped inlet system, comprising a control loop with regulating valve and pressure measurement, relatively large dead volume, long gas changing times

4.1.3 Application notes

Mass spectrometer analysis is every bit as varied as vacuum applications. The above-described gas inlet systems with heated capillaries are used for gas analysis in the pressure range of up to 1 bar. Gas flows can be channeled directly to gas-tight ion sources in order to reduce the background noise of the vacuum environment. Gas beams are passed through crossbeam ion sources, with the beam either falling directly into a vacuum pump or condensing in a cooling trap.

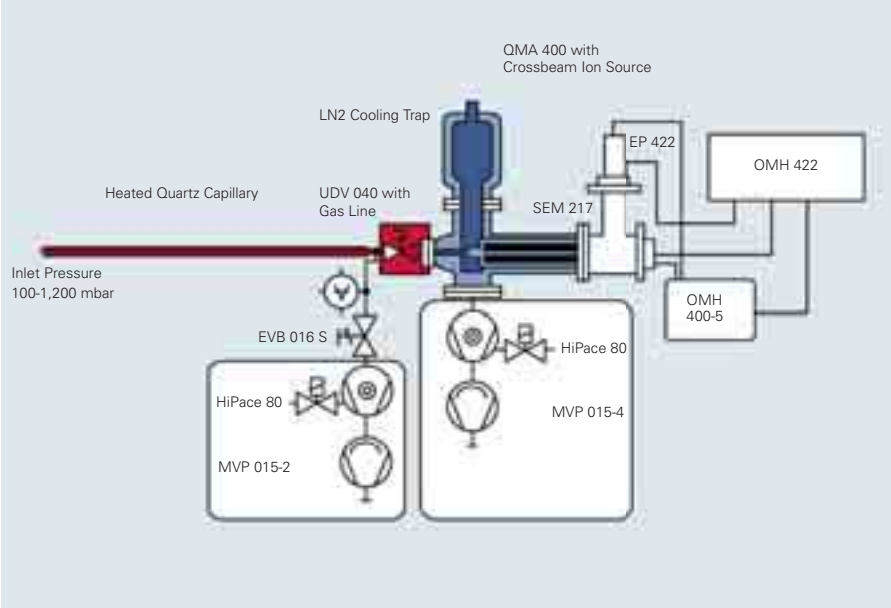


Figure 4.18: Quadrupole mass spectrometer with gas inlet system, crossbeam ion source and cooling trap

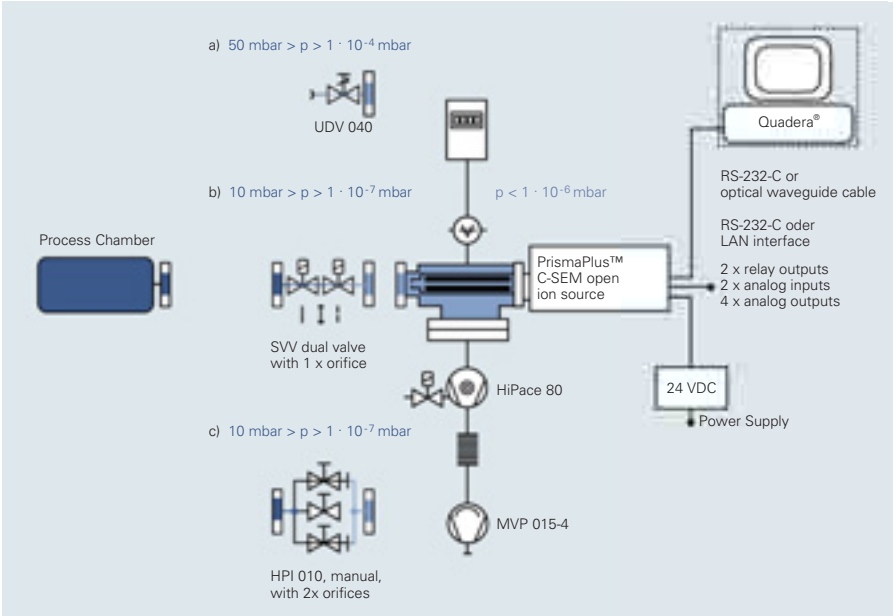


Figure 4.19: Differentially pumped quadrupole mass spectrometer with various gas inlets

In the pressure range of less than 10 mbar (etching, sputtering or other coating processes), the gas is admitted into the mass spectrometer via an orifice or a valve. A turbopump is attached to the measuring system for pressure reduction. There are special versions for corrosive gases.

Open ion sources are used at extremely low pressures, particularly in the UHV range. Due to the low gas densities, secondary electron multipliers (SEM) that are arranged perpendicular to the axis of the quadrupole must be used as detectors. To improve the signal-to-noise ratio, a turbopump that pumps down the inflowing neutral particles is attached opposite the SEM.

Secondary ion mass spectrometry (SIMS) represents a special case. In this process, ions are shot onto surfaces that generate positively or negatively charged secondary ions, which are detected directly by a QMS without an ion source. The measuring arrangement described in the preceding section is used in this case as well.

4.1.4 Portfolio

Pfeiffer Vacuum offers two basic mass spectrometer models:

- The compact PrismaPlus with a 6 mm rod system and a length of 100 mm, and
- The high-resolution HiQuad with mass filter diameters of 8 mm and 16 mm and a length of 300 mm

PrismaPlus™

This is a compact device whose entire electronics are attached to the analyzer and can be removed for bake-out. The PrismaPlus unites the following features:

- Mass ranges of 100, 200 and 300 amu
- A Faraday cup and a C-SEM are available as detectors
- Can be equipped with a variety of ion sources and filaments
- The analyzer can be baked out at up to 150 °C

The PrismaPlus is used as a standalone device, and can also be integrated into modules and analysis systems.

HiQuad™

These devices offer the utmost in accuracy and unite the following features:

- The 1–16 amu, 1–128 amu, 1–340 amu, 1–300 amu, 1–512 amu, 1–1,024 amu and 1–2,048 amu mass ranges can be covered by various models
- There are various mass filters with rod diameters of 6 mm, 8 mm molybdenum, 8 mm stainless steel and 16 mm molybdenum
- Virtually all of the above-described ion sources can be combined with the analyzers
- There are ion optics for analyzing neutral particles as well as both positive and negative ions (SIMS)
- All types of detectors, i.e. Faraday cup, Faraday cup and SEM, Faraday cup and C-SEM, as well as ion counters, are available in various arrangements
- These mass spectrometers can be integrated into analysis systems with the aid of input/output modules

Modules

Modules are special process monitoring or gas analysis devices that are equipped with various gas inlet systems and attached turbo drag pumps for evacuating the analyzer:

- The HPA 220 high-pressure analyzer, based upon the PrismaPlus
  Process pressure up to 5 mbar
- The SPM 220 sputter process monitor, based upon the PrismaPlus
  Process pressure up to 10^{-2} mbar or 10 mbar
- The SPM 700 sputter process monitor, based upon the HiQuad
  Process pressure same as SPM 220
- The EPD 700 is used to detect positive ions when etching in the gaseous phase and is based upon the HiQuad, Process pressure up to 10^{-2} mbar

Benchtop mass spectrometers

There are complete systems for process pressures of 1 bar; they are based upon the PrismaPlus:

- The OmniStar GSD 320 O with one gas inlet is used for quantitative gas analysis at atmospheric pressure with heated and temperature-regulated gas inlet systems
- The ThermoStar GSD 320 T is designed to be coupled with thermal scales

These devices, or elements of them, are installed in complete devices by OEM customers.

4.1.4.1 Advantages of Pfeiffer Vacuum mass spectrometers

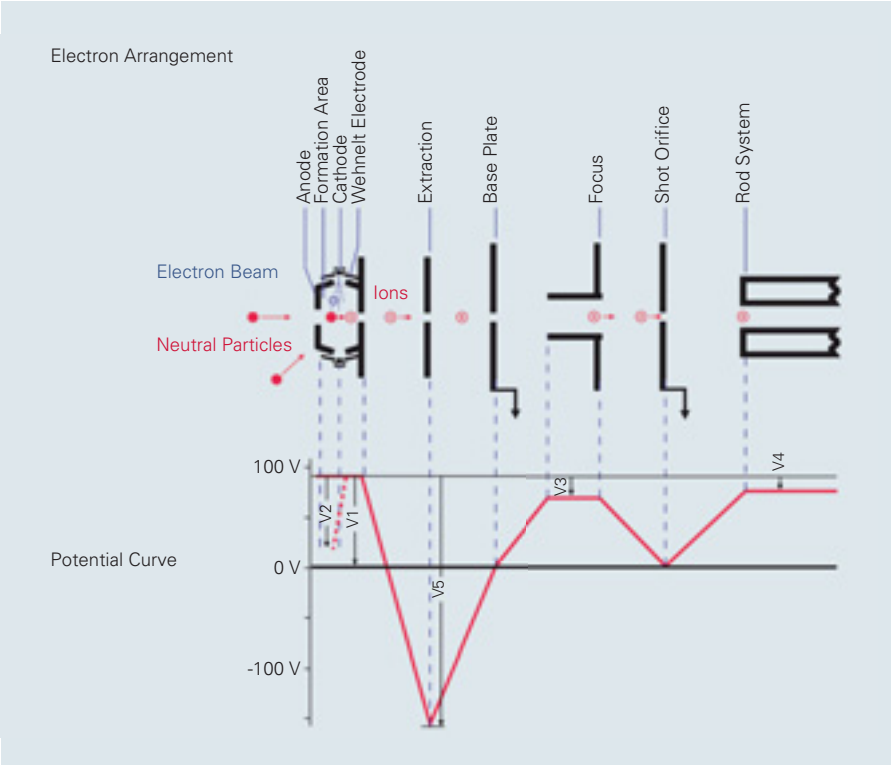


Figure 4.20: Potential curve in an electrically biased ion source

The potential curve in a Pfeiffer Vacuum ion source is shown in Figure 4.20. The heated, electron-emitting cathode has a potential of approximately 20 V. The Wehnelt electrode is typically connected to the positive pole of the cathode and prevents electrons from being scattered in the vicinity of the ion source. An anode voltage V_2 of 80 V accelerates the electrons into the formation area (100 V), where they ionize penetrating neutral gas molecules. The ions are accelerated through an orifice at a potential V_5 of -150 V, and are again decelerated to V_3 = 80 V by the focusing electrode. The shot orifice accelerates the ions once more before they then enter the mass filter and are decelerated by the field axis potential V_4 = 85 V at an energy of approximately 15 eV (difference between formation area and field axis).

The Pfeiffer Vacuum PrismaPlus and HiQuad mass spectrometers are characterized by their above-described electrically biased ion source and their field axis technology.

Electrically biased ion source

In many quadrupole mass spectrometers, the cathode is grounded or even has a negative potential. The cathode (filament) accelerates the emitted electrons to the formation area (anode), where they ionize neutral gas particles, which are then extracted in the mass filter. Given these field conditions, however, electrons can also strike other surfaces in the vacuum, where they trigger electron stimulated desorption (ESD) ions. This results in undesirable background noise and can cause considerable gas eruptions when the filament is energized if there are highly-populated surfaces in the recipient.

Pfeiffer Vacuum ion sources have a positive potential (approximately 10 – 100 V). Electrons emitted from them are repelled from all surfaces having a negative potential and are thus kept away from these surfaces to avoid triggering interfering ESD ions.

Field axis technology

The ions formed in the ion source are accelerated toward the mass filter at high kinetic energy. As a result, the ions cannot be influenced by the peripheral or interference fields, and initially move toward the mass filter at high energy. This enables optimal shot conditions to be achieved in the quadrupole field, even without the pre-filters that are required with other mass spectrometers. The mass filter, itself, is appropriately biased to the field axis voltage, which decelerates the ions to a kinetic energy of approximately 15 eV again upon entering the filter. This energy – which the industry terms the field axis voltage – together with the mass of the ions determines the velocity of the ions, and thus their time of flight in the mass filter. The favorable shot conditions thus produced result in a high transmission of ions through the mass filter over a broad mass range, thus producing the high sensitivity of the entire system.

SEM: 90 degrees off axis

An additional advantage of Pfeiffer Vacuum mass spectrometers is the arrangement of the secondary electron multiplier (SEM), which is offset by 90° relative to the filter axis ("SEM: 90 degrees off axis").

If the SEM (4.1.2.3) is arranged in the axial direction behind the mass filter, all colliding particles (neutral particles, ions, electrons, photons) will generate secondary electrons and thus contribute to the background signal.

This is why the ions escaping from the filter are deflected by 90 degrees and then accelerated to the first dynode of the SEM. Neutral particles and photons are not deflected at all by the electrical deflection unit, and electrons are deflected to a much greater extent than ions. This means that almost all of the ions that are allowed through the filter will strike the amplifier, which significantly improves the signal-to-noise ratio.
Except for a few special versions, HiQuad analyzers are equipped with "90 degrees off-axis SEMs."

In the PrismaPlus, an axial C-SEM is offered as a current amplifier. In this case, too, the ions exiting the mass filter are deflected slightly toward the C-SEM, and in a weakened state are thus separated from the undesired particles.

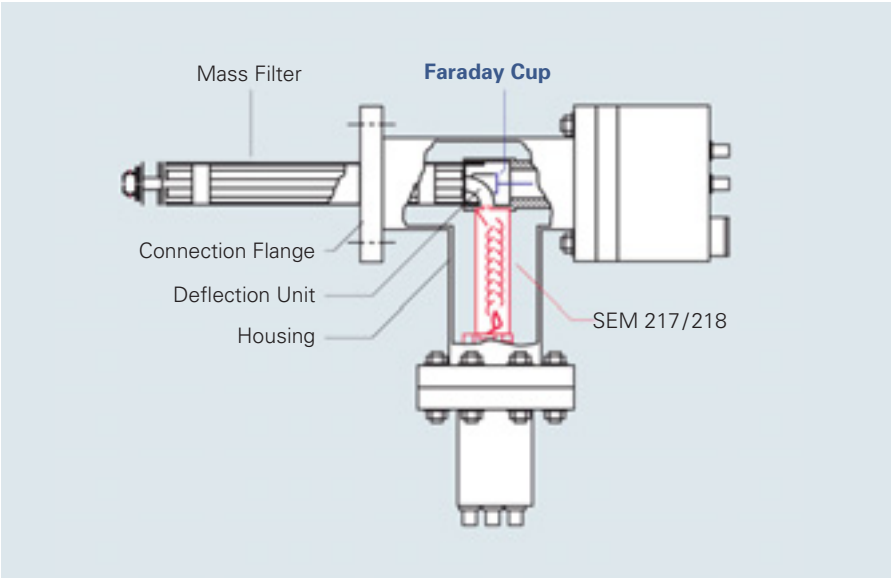


Figure 4.21: Design of the detectors in a QMA 400 HiQuad™ analyzer with Faraday cup and SEM

Mass discrimination
If ions strike the first dynode of the SEM with different pulses, differing quantities of secondary electrons will be generated. The conversion rate at the amplifier is a function of mass. This effect is called mass discrimination, and is less pronounced with an SEM of discrete design than with a C-SEM. Mass discrimination can be reduced by accelerating the ions to a high energy before they strike the conversion dynode.

Summary
Both a stable HF supply as well as a mechanically precise filter are necessary in order to achieve maximum possible transmission over a broad mass range with a pre-selected mass resolution. A biased ion source with suitably selected field axis technology, as well as the "90 degrees off-axis" arrangement of the SEM considerably improve the signal-to-noise ratio.

Mass discrimination in an SEM or a C-SEM can be reduced with the aid of a conversion dynode to which a high voltage is applied.

Quadrupole mass spectrometers differ from other designs through the following attributes:

- Compact dimensions and light weight
- Linear relationship between mass and HF voltage amplitude
- High sensitivity
- Large signal-to-noise ratio
- High measuring speed and repeat rate
- Broad dynamic range (up to 10 decades)
- Any installation orientation
- No magnetic field interference

With these advantages, the quadrupole mass spectrometer has become the most widely used mass spectrometer.

4.1.4.2 Data analysis systems

The electrical control units of Pfeiffer Vacuum mass spectrometers do not include any operating or display possibilities. Consequently, operation, data analysis, display and data storage are performed on a PC with the „Quadera" software.

Pfeiffer Vacuum's Quadera mass spectrometer software is a modular system. Quadera can be used with the PrismaPlus and HiQuad devices, which are equipped with newly developed electronics. The PC can be connected to the Prisma or HiQuad mass spectrometers via an Ethernet.

To perform certain measurement tasks, the PC transfers parameter records to the mass spectrometer in order to set the device. The data read out during or after the measurement is transferred back to the computer, where it can be analyzed, displayed or stored.

The following data are typically displayed:

- Mass spectra with adjustable mass range, and linearly or logarithmically calibrated for concentration
- Display of the chronological sequence of partial pressures
- Bar graph measurements to reduce the volume of data

Typical measuring tasks, such as residual gas analysis or leak detection, are pre-programmed and can be launched with a mouse click.

If quantitative analysis is to be performed, the mass spectrometer must be calibrated beforehand. If this involves recurring processes, such as calibration with subsequent quantitative analysis, these processes can be programmed by means of „visual basic for applications." Programming skills are not required, as pre-engineered modules are available for this purpose.

To solve complicated measurement tasks, a library containing fractal ion distributions for several frequently occurring gases and compounds is available in the Quadera software. However these and other distributions obtained from spectra libraries can only be viewed as guideline values, as they are influenced by various parameters, such as ionization energy, temperature or the transmission characteristics of the mass analyzer.

In analyzing mixtures containing multiple gas components, the problem of overlapping ion currents of differing origin on the same mass numbers is one that frequently occurs. There are mass numbers whose intensity is produced exclusively by a single gas component (e.g. argon on mass number 40, oxygen on mass number 32, carbon dioxide on mass number 44 and water on mass number 18).

In the case of other mass numbers, the overall intensity of the detected ion current is governed by the overlapping of different concentrations of fractal ions from diverse gas components. Depending upon the composition and concentration ratios in the gas mixture to be analyzed, suitable algorithms and calibration procedures must also be formulated for the measurement task in question.

Through the admission of suitable calibration mixtures having non-overlapping components, the respective calibration factors must be determined for each individual gas component on all overlapping mass numbers prior to performing quantitative gas analyses. The concentration or the partial pressure can then be determined for these gases within the framework of a matrix calculation. These kinds of matrix calculations and the required gas-specific calibration routines are supported by the Quadera mass spectrometer software.

5 Leak Detection

5.1 General

5.1.1 Leaks and leak detection

What is a leak? A leak, also referred to as leakage, enables a substance to flow toward a pressure gradient. Expressed in simpler terms, leaks are small holes through which gases or liquids flow from the side of higher pressure to the side of lower pressure. This can involve simple, harmless leaks, such as a dripping water faucet, or hazardous toxic substances that escape through leaks.

Any number of technical products will not function, or will not function for an adequate period of time, if they have leaks. Examples include: The refrigerant circulation system in refrigerators, air conditioning systems in cars, automobile tires, automotive fuel tanks or home fuel oil tanks, as well as distillation systems in the chemical or pharmaceutical industries. In many cases, the leak-tightness of machines and systems in the production process is an indispensable prerequisite for the quality of the manufactured products.

Returning to the original definition of a leak, we thus find that it is impossible to completely prevent substances from flowing through a wall. The term „tight" therefore refers to the requirements of the respective machine, plant or vessel, and must be quantified accordingly.

5.1.2 Leakage rate

Let us consider a bicycle tube having a volume V = 4 l. It has been inflated to a pressure of three bar, and without any additional inflation should have a maximum pressure loss of Δp = 1,000 mbar after time t (30 days).

The leakage rate has already been defined in 1.3.3: $Q_l = \frac{\Delta p \cdot V}{\Delta t}$ (Formula 1-27).
Or to illustrate: The leakage rate of a vessel having a volume of 1 liter is 1 mbar · l/s if the interior pressure increases or decreases by 1 mbar in 1 second. Please refer to Table 1.6 for conversion to other customary units. Inserting the values for our bicycle tube then yields the permissible leakage rate:

$$Q_l = \frac{1{,}000 \text{ mbar} \cdot 4\ l}{30 \cdot 24 \cdot 3{,}600\ s} = 1.5 \cdot 10^{-3} \frac{\text{mbar} \cdot l}{s}$$

and we find that the bicycle tube with this leakage rate is sufficiently tight.

These kinds of leakage rates can be found by means of the well-known bubble test method (Figure 5.1).

Now let us consider a refrigerator in which a loss of 10 g of refrigerant having a molecular weight of 102 g/mol, i.e. around 2.24 bar · l, is allowable over a ten-year period. This results in a permissible leakage rate of

$$Q_l = \frac{2.24\ l \cdot 1{,}000 \text{ mbar}}{10 \cdot 365 \cdot 24 \cdot 3{,}600\ s} = 7.1 \cdot 10^{-6} \frac{\text{mbar} \cdot l}{s}$$

These kinds of leakage rates can only be localized and quantified by means of extremely sensitive measuring methods, for example with mass spectrometry and test gases that are not present in the atmosphere.

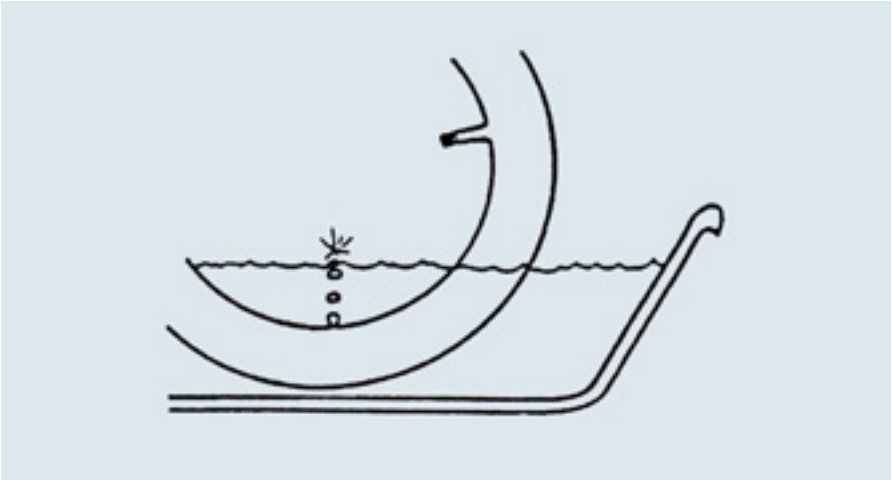


Figure 5.1: Bubble leak test for a bicycle tube

5.1.3 Test gases

The test gases that are used for leak detection (also called tracer gases) should satisfy the following prerequisites:
They should

- Be non-toxic to humans, animals and the environment
- Not displace air, as hazardous situations, such as suffocation, could otherwise occur
- Be inert, i.e. slow to react, and should neither react chemically nor be flammable
- Not be present in air, if possible. Only with a gas that is present in the smallest possible concentration in the ambient air is it possible to detect even the smallest leaks
- Cannot be mistaken for other gases

The test gas helium satisfies all of these requirements. As a noble gas, it is not capable of chemically reacting. Only 5 ppm of it is present in atmospheric air, thus enabling even the smallest leakage to be detected. Since it is lighter than air, it thus does not pose a health hazard.

5.2 Leak detection with helium

Mass spectrometers that are set to helium's atomic weight of 4 are used to detect the pre-sence of helium. Mass spectrometers operate only in the molecular flow range, i.e. under vacuum at pressures p of less than 10^{-4} mbar. Sector field devices are used for reasons of cost and because of their robust design.

The operating principle of these devices is described in 4.1.1.

5.2.1 Design of a helium leak detector

Helium counterflow leak detectors are designed in accordance with the schematic diagram in Figure 5.2. A mass spectrometer MS is mounted on the intake flange of a turbomolecular pump. A backing pump S_v evacuates the turbomolecular pump via valve V_2.

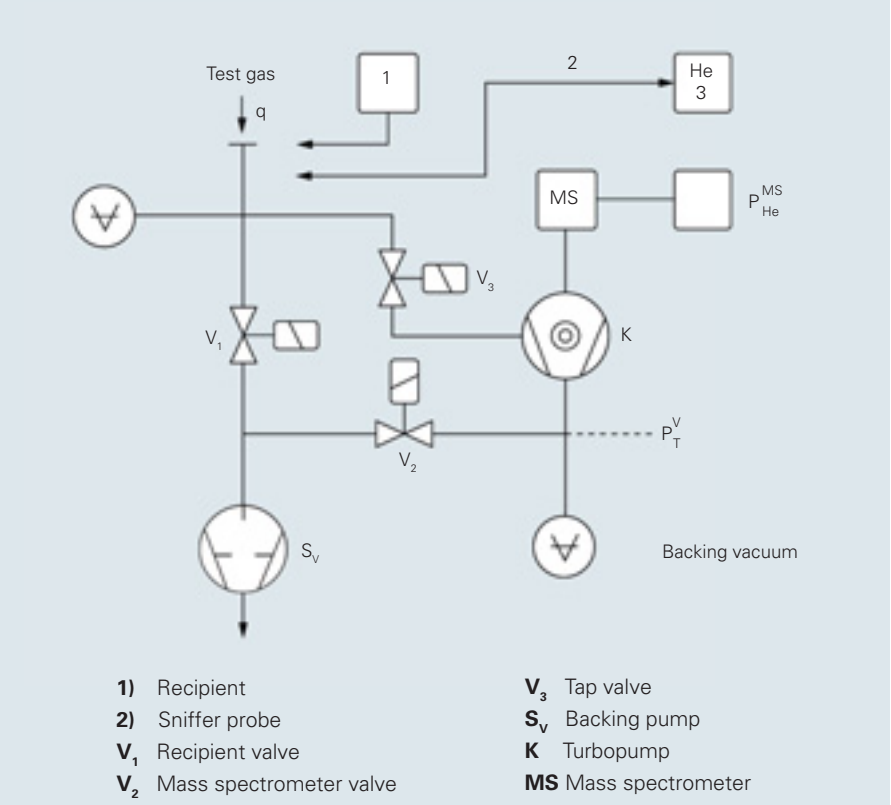


Figure 5.2: Schematic diagram of a helium counterflow leak detector

A workpiece 1 is evacuated via the test gas connection with valve V_1 open. Valves V_2 and V_1 are connected in such a manner that the required backing vacuum pressure of the turbopump always takes priority over evacuation of the workpiece. Once the workpiece is evacuated, it can be connected to the backing vacuum, or to a tap on the turbomolecular pump via valve V_3. Depending upon the pressure range in question, helium is now sprayed onto the workpiece from the outside and together with the ambient air penetrates into the workpiece through leaks. The helium present in the residual gas flows counter to the pumping direction through valves V_1 and V_2 and through the turbopump to mass spectrometer MS, where it is detected. The differing compression ratios of the turbopump for helium and air, which differ by multiple powers of ten, are utilized in this regard. While the high compression ratio of the turbopump keeps air away from the mass spectrometer, the helium arrives there at a relatively high partial pressure. The turbopump thus acts as a selective amplifier for helium.

This is why a mass spectrometer enables helium to be detected in the workpiece even at pressures of less than 1 mbar. Several powers of ten of the helium partial pressure, and thus a leakage rate range of between 10 and 10^{-8} mbar l/s, can be covered by means of various taps on the turbopump (V_3), as well as by operating it at different speeds that exponentially influence the compression ratio. A pressure of 10^{-3} mbar must be attained in the workpiece for the highest sensitivity stage of the leak detector (inlet via V_3).

Because of the upstream turbopump, the mass spectrometer always operates at an extremely low total pressure, and is thus well protected against contamination and failure.

5.2.2 Test methods

A distinction is made between two methods of leak detection:

- Local leak detection, which is used to find leaks
- Integral leak detection, where the leakage rate of workpieces is typically determined for quality assurance purposes

Leak detectors are equipped for two operating methods:

- The pump-down method, in which the workpiece is evacuated and helium exerts its effect from the outside
- The sniffer method, in which the workpiece is filled with a helium overpressure Δp of more than 100 mbar, and the escaping helium is sucked into the leak detector via a sniffer valve (capillary, metering valve) and detected

5.2.3 Calibrating the leak detector

The leak detector must be calibrated in order to determine leakage rates. This is done by means of a commercial test leak, a small helium-filled vessel with a shut-off valve that emits the defined quantity of gas. This is usually integrated into the leak detector or connected to the intake side of it. For calibration, an appropriate working cycle is often built in that automatically performs the calibration.

To obtain precise measurements, the device should be calibrated before each use. To test large workpieces for which additional vacuum pumps are in use, it is advantageous to use an external test leak. The measurement accuracy can be a function of where the test leak is attached. Consequently, it is necessary to take flow conditions within the vacuum area into consideration.

5.2.4 Local leak detection

Local leak detection is used to identify leakage in a workpiece.

Under the pump-down method, the workpiece (vessel) is connected to the leak detector, and helium is briefly sprayed onto a suspicious area by means of a spray gun. If the pressure in the workpiece is in the molecular flow range, i.e. less than 10^{-3} mbar, there will be an immediate display as a result of the high velocity of the helium atoms. At higher pressures, particularly in the laminar flow range that starts at 1 mbar, the display speed will be much slower and will be governed by the pumping speed of the leak detector's backing pump.

Under the sniffer method (Figure 5.3), the workpiece (3) is filled with a helium overpressure. A sniffer probe (2) is connected to the test gas connection. The helium that escapes through leaks in the workpiece can be detected by sniffing with the probe.

Individual leaks can be identified using local leak detection. However the sum of all leakage cannot be determined. That is why this process offers only limited suitability for providing a GO/NO GO indication for quality assurance purposes.

Sniffer Leak Detection	Vacuum Leak Detection
Sniffing the helium-filled workpiece	Sprayed with helium
Overpressure-proof workpiece	Vacuum-proof workpiece
Detection limit $5 \cdot 10^{-8}$ mbar l/s	Detection limit $5 \cdot 10^{-12}$ mbar l/s

Figure 5.3: Local leak detection by means of the sniffer and vacuum methods

5.2.5 Integral leak detection

Integral leak detection is used to determine the total of all leaks (total leakage) in the workpiece. Here, too, the pump-down method and the sniffer method can be used.

Under the pump-down method, a workpiece is enclosed, filled with helium and the surrounding vessel evacuated. Or the workpiece is evacuated (vacuum system) and the surrounding space is filled with helium. In this connection, the enclosure can be a plastic film, or it can be a rigid vessel for commercial test systems. Under the sniffer method, the workpiece (e.g. an automotive fuel tank) is filled with helium and a given volume of gas is evacuated from the surrounding vessel through the leak detector's sniffer probe (Figure 5.4). The best result that can be obtained using the sniffer method is general confirmation that the workpiece is tight. However this method is not suitable for quantitative integral leakage rate measurement.

A pressure differential $\Delta p = p_1 - p_2 = 100$ mbar is sufficient when testing with an overpressure in the workpiece. Assuming laminar flow at the leak for the leakage rate $Q_{l\Delta p}$ thus determined, this can be converted to value Q_l for vacuum measurement at outside atmospheric pressure p_0, in accordance with the following formula:

Formula 5-1
Leakage rate conversion with differential pressure measurement

$$Q_l = \frac{Q_{l\Delta p} \cdot p_0^2}{p_1^2 - p_2^2}$$

This conversion formula is derived from Formula 1-14 and Formula 1-21.

Sniffer Leak Detection	Vacuum Leak Detection
Overpressure-proof workpiece	Vacuum-proof workpiece
Use of a sniffer probe	Workpiece filled with helium
Detection limit $5 \cdot 10^{-8}$ mbar l/s	Detection limit $5 \cdot 10^{-12}$ mbar l/s

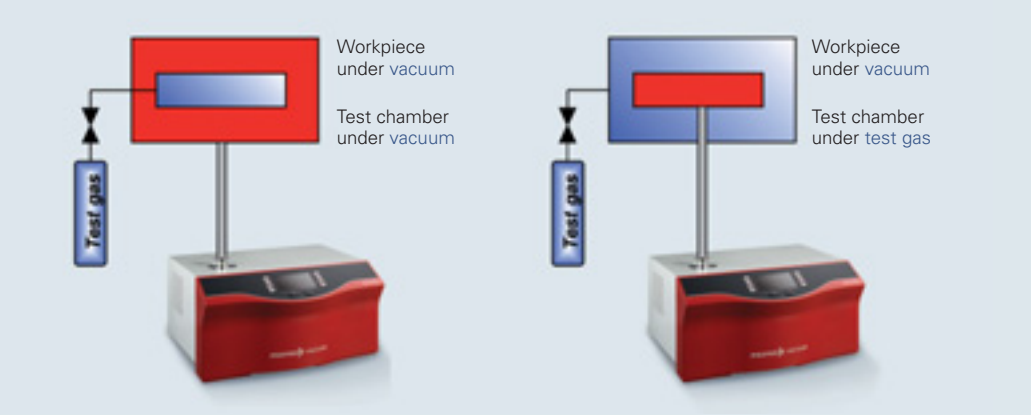


Figure 5.4: Integral leak detection by means of the sniffer and vacuum methods

5.3 Application notes

Prior to beginning any leak detection process with helium, the user must clarify several fundamental questions:

- Is the workpiece vacuum-proof?
- Is the workpiece overpressure-proof?
- Is the total leakage rate of the workpiece to be determined?
- Is only the location of the leakage to be determined or should it be quantified?

An appropriate test method can be selected from among the methods indicated under 5.2.2 to 5.2.5.

Leak detection with helium

The leak detector must be calibrated prior to beginning. A helium test leak integrated in the Pfeiffer Vacuum SmartTest leak detector is used for this purpose. The calibration routine is started at the touch of a button and runs automatically. Following calibration, the leak detector is ready for use. For leak detection under the vacuum method, the best option is to use an audible indicator, where the frequency of the signal tone rises as the leakage rate increases, thus eliminating the need for a second person to read the display while the workpiece is being sprayed.

The following must always be observed when using helium as the test gas:

- Helium is lighter than air. So when helium is used in the atmosphere, the leak detection process should always begin at the highest point of the workpiece
- Excessive amounts of the test gas should not be sprayed, as this can increase the concentration of helium in the ambient air, which would constantly simulate leaks that do not exist

- Because helium accumulates in the backing pump, in the exhaust space and in the oil, and can return to the backing vacuum area from these points, the gas ballast in the backing pump must be energized if there are high leakage rates. This usually occurs automatically when the higher measuring ranges are selected in the leak detector. The gas ballast must be energized manually if auxiliary pumps are being used

Under the vacuum method, it is necessary to generate sufficiently good vacuum to allow the leak detector to be operated at maximum sensitivity.

Additional vacuum pumps (auxiliary pumps) with high pumping speeds must therefore often be used for large workpieces. In this case, the leak detector should be connected directly to the recipient pump ports for the large vacuum pump, or at least directly adjacent to them.

When the auxiliary pump is running, the measured leakage rate must be increased by the pumping speed ratio between the auxiliary pump and the leak detector in order to determine the leakage rate.

When working with the sniffer valve, the pressure in the vessel must be at least 100 mbar higher than the ambient pressure. Due to strong mixing with the air, the sensitivity of the sniffer method is lower than that of the vacuum method. Moreover, the delayed reaction of the leak detector to the inflowing helium must also be taken into consideration.

5.4 Portfolio

Table 5.1: SmartTest leak detector selection table

● Suitable
▲ With test chamber
■ External backing pump, S > 10 m³/h
✖ External backing pump, S < 10 m³/h

		Workpiece Use		Workpiece Volume		Detectable Leak Rate, in mbar l/s		Remarks
		Vacuum	Overpressure	> 20 l	< 20 l	< 1 · 10⁻⁷	> 1 · 10⁻⁷	
Leak Detector	**Mode**							
SmartTest HLT 550	Vacuum	●	▲	■	✖	●	●	External vacuum pump
	Sniffer		●	●	●		●	required
SmartTest HLT 560	Vacuum	●	▲		●	●	●	Rotary vane pump
	Sniffer		●	●	●		●	S = 5 m³/h
SmartTest HLT 565	Vacuum	●	▲	●	●	●	●	Rotary vane pump
	Sniffer		●	●	●		●	S = 30 m³/h
SmartTest HLT 570	Vacuum	●	▲		●	●	●	Dry backing pump
	Sniffer		●	●	●		●	S = 2 m³/h
SmartTest HLT 572	Vacuum	●	▲		●	●	●	Dry backing pump
	Sniffer		●	●	●		●	S = 7.5 m³/h
SmartTest HLT 575	Vacuum	●	▲	●	●	●	●	Dry backing pump
	Sniffer		●	●	●		●	S = 26 m³/h

Pfeiffer Vacuum offers the "SmartTest" leak detector with the following equipment:

- Counterflow leak detector with turbopump and sector field mass spectrometer
- Calibration leak with automatic calibration
- Sniffer probe
- Digital display with automatic measurement range selection
- Audible leakage indication via the pitch of a signal tone
- Various types of backing pumps

The SmartTest HLT 550 permits any suitable backing pump to be connected, making it ideally suited for integration into leak detector systems.

Figure 5.5: SmartTest HLT 560 leak detector

The SmartTest HLT 560 (Figure 5.5) is a helium leak detector with an integrated rotary vane pump offering a pumping speed of 5 m^3/h. With this configuration, leak detection in the vacuum mode is also possible within a reasonable period of time for larger workpieces (Table 5.1). The HLT 560 can naturally also be used in the sniffer mode when attached to vessels that are charged with helium.

The SmartTest leak detector is mounted on a trolley together with larger backing pumps. The following versions are available:

- With a 30 m^3/h rotary vane pump
- With dry backing pumps of various sizes if an oil-free environment is required (Figure 5.6)
- With a bypass option enabling large vessels to be pre-evacuated by means of an additional backing pump. During this phase, an upstream valve isolates the leak detector from the workpiece, thus preventing contamination of the leak detector
- With remote control and sniffer probe as accessories

The versions described here are shown in Table 5.1.

Figure 5.6: SmartTest leak detector, HLT 572 with bypass and dry backing pump XtraDry™

6 Valves and Components

6.1 General

A vacuum system includes a variety of different components, such as recipients, vacuum pumps, measurement instruments, shut-off devices, filters, separators, etc., that must be joined together to form a unit. A distinction is made between detachable connections, which are equipped with seals, and non-detachable connections. The various types of connections that have to be taken into consideration in configuring a system and selecting components for it are described and presented in the sections below.

6.2 Seals

When vacuum technology components are detachably joined, seals must be used to prevent ambient air from flowing into the vacuum. There are different designs for this purpose, depending upon the application and pressure range in question.

O-rings / round rubber rings

O-rings are the most frequently used of all seals. O-rings are available in a variety of materials, usually elastomers with hardness ranging from 65 to 80 Shore. Their suitability as good vacuum seals stems from their ability to adapt to the minute unevenness of the mating surfaces. The surface of the o-ring must be free of releasing grease or talcum, smooth and crack- or scratch-free. In the low vacuum range the o-ring can be coated with a thin film of a low vapor pressure grease (silicon grease, Fromblin grease or mineral oil-based grease), depending upon the application in question. In the case of dry installation, particular attention must be paid to surface quality, the cleanliness of the mating surfaces as well as to the sealing material. The cross section diameter (thickness) of the o-rings can be 2 to 12 mm. 5 mm thicknesses are used for many joints, while rings with thicknesses of 8, 10 or even 12 mm are used only for very large seals. The o-rings should be seamlessly pressed. The parting line of the compression molding die is in the plane of the cross section diameter and is usually removed by abrasion.

Generally speaking, o-rings are used as static seals. If dynamic stress is involved, precision o-rings that are manufactured especially for this purpose should be used. A discussion on how to dimension the grooves for this purpose will not be presented here. O-rings can also be used in axial or radial grooves, in addition to being employed in conjunction with centering rings or sealing washers. In most cases, o-rings are placed in grooves and pressed between flanges, with one flat flange and one grooved flange typically being used. The grooves must be carefully dimensioned in accordance with the following criteria:

- Compression, i.e. the ratio (width/height)-1, should be a maximum of 30 % for o-ring thicknesses (cross sections) of less than 3 mm, and 20–15 % for thicknesses of 5–10 mm
- The groove fill factor should be between 79 and 91 %
- The inside diameter of the groove should be equal to or only slightly larger than the inside diameter of the o-ring
- The outside diameter of the groove may be larger than the outside diameter of the o-ring in its compressed state

If these conditions are maintained, the seals can be reused multiple times without any problem. If the groove is overfilled, the o-rings will be damaged and the flange might even bend, because the ring material is non-compressible. The table below shows groove dimensions, with the inside diameter of the groove and the inside diameter of the o-rings being equal.

Table 6.1: O-ring groove dimensioning table for axial, static seals

Thickness ∅	Tolerance +/-	Groove Width	Tolerance +/-	Groove Depth	Tolerance +/-	Mean Compression	Max. Fill Factor
1.00	0.08	1.45	0.05	0.70	0.05	30.0 %	86.3 %
1.20	0.08	1.65	0.05	0.85	0.05	29.2 %	88.4 %
1.50	0.08	2.00	0.05	1.10	0.05	26.7 %	86.3 %
1.60	0.08	2.10	0.05	1.20	0.05	25.0 %	85.3 %
1.78	0.08	2.30	0.05	1.30	0.05	27.0 %	88.5 %
2.00	0.10	2.50	0.10	1.50	0.05	25.0 %	90.3 %
2.20	0.10	2.80	0.10	1.65	0.05	25.0 %	88.0 %
2.40	0.10	3.00	0.10	1.80	0.05	25.0 %	89.1 %
2.50	0.10	3.10	0.10	1.90	0.05	24.0 %	88.4 %
2.62	0.10	3.20	0.10	2.00	0.05	23.7 %	89.2 %
3.00	0.13	3.70	0.10	2.30	0.05	23.3 %	87.3 %
3.35	0.13	4.10	0.10	2.60	0.05	22.4 %	86.4 %
3.50	0.13	4.30	0.10	2.70	0.05	22.9 %	86.4 %
3.53	0.13	4.30	0.10	2.80	0.05	20.7 %	84.7 %
4.00	0.15	5.00	0.10	3.20	0.05	20.0 %	81.4 %
4.50	0.15	5.50	0.10	3.60	0.05	20.0 %	83.0 %
5.00	0.15	6.00	0.10	4.00	0.05	20.0 %	84.3 %
5.34	0.15	6.50	0.10	4.30	0.05	19.5 %	82.3 %
6.00	0.15	7.20	0.10	4.90	0.10	18.3 %	83.0 %
7.00	0.14	8.50	0.10	5.80	0.10	17.1 %	80.4 %
8.00	0.14	9.50	0.10	6.70	0.10	16.3 %	81.0 %
10.00	0.14	12.00	0.10	8.50	0.15	15.0 %	79.0 %

To facilitate assembly, the diameter of the o-ring groove is usually selected somewhat larger than the diameter of the o-ring. This keeps the o-ring in the groove during assembly. There is no problem in stretching an o-ring by 5 % in length, however not more than 10 %. If the o-ring is used on a centering ring, e.g. in ISO-K and ISO-KF flange connections, the centering ring must be designed in such a manner that it properly positions the o-ring, supports it and limits its compression. There are centering rings that have inner support rings, outer support rings (for overpressure applications), as well as inner and outer rings.

To seal screws, e.g. oil filler screws or oil drain plugs, the o-ring is installed in an angular position. The thread has a 45° chamfer at the upper end, into which the o-ring is inserted. Here, too, the fill factor should be 79–91 %, as in the case of axial installation. The o-ring is then compressed by surface of the screw. The o-ring should be lubricated for this installation method to prevent it from being damaged when the screw is tightened.

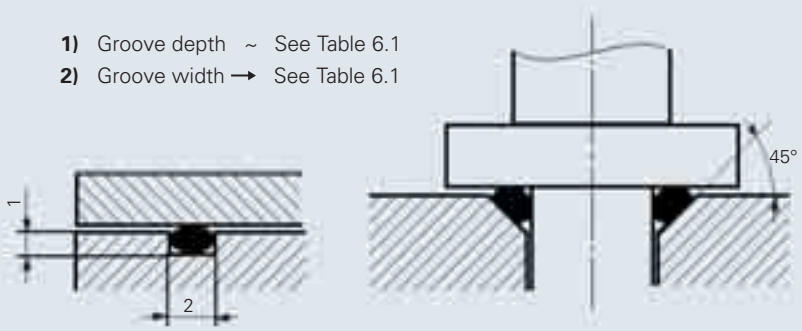


Figure 6.1: O-ring in groove and corner positions

Centering ring with elastomer o-ring (ISO-KF)

Centering ring with elastomer seal and outer ring (ISO-K)

Figure 6.2: Centering rings

Trapezoid seals

Elastomer seals having a trapezoid configuration or a similar cross section are used for valve seats and for the covers and doors of large vacuum chambers, for example, where they are tightly fitted to prevent them from being pulled out when the valve plate lifts or the chamber door is opened. Since enormous surface loads can occur in connection with large chamber dimensions, deformation of the seals is kept within the desired limits by attaching spacers in applications that involve large chamber doors.

Flat seals should be avoided wherever possible in the field of vacuum technology, because it is difficult to achieve the pressure required for the sealing material to fill our all surface unevenness.

Figure 6.3: Trapezoid seal with spacer

Shaft seal rings / cap seals

Radial shaft ring seals or cap seals are used to seal rotating shafts (Figure 6.4). In this connection, care should be taken to assure that only shaft seal rings with a metal ring that is fully coated in rubber are used. While these seals are quite tight in the static state, the fact must be taken into consideration that their leakage rate will be significantly higher when the shaft is in motion. Cap seals are only suitable for slow-running feedthroughs, e.g. for manually rotated feedthroughs.

Metal seals

Metal seals must be used instead of elastomer seals in high-temperature applications (e.g. baking out vacuum chambers), for high radiation loads and wherever very low permeation rates are the priority. Materials that are frequently used for metal seals are copper, aluminum, indium and in some cases silver and gold. Gold, silver and indium are usually used as wire seals; in addition to wire form, aluminum can also used as a profile seal. In the case of all metal seals, care must be taken to ensure that the specific contact forces (up to 6000 N per cm of seal length) are maintained.

Cut-edge seals made of copper are used for UHV systems. They are placed between Conflat® flanges. Silver-plated copper gaskets are used for temperatures of over 200 °C. In this case, the silver coating serves as a diffusion barrier against atmospheric oxygen to prevent the copper from oxidizing. Metal seals can be used only once. Indium is also employed as a metal seal, where it is placed between smooth flanges in the form of a wire. Although its ease of welding and its malleability are advantages, its low melting point prevents it from being baked out at high temperatures. In addition to temperature resistance, there can be other reasons for using metal is used as a seal material, e.g. resistance to radioactivity.

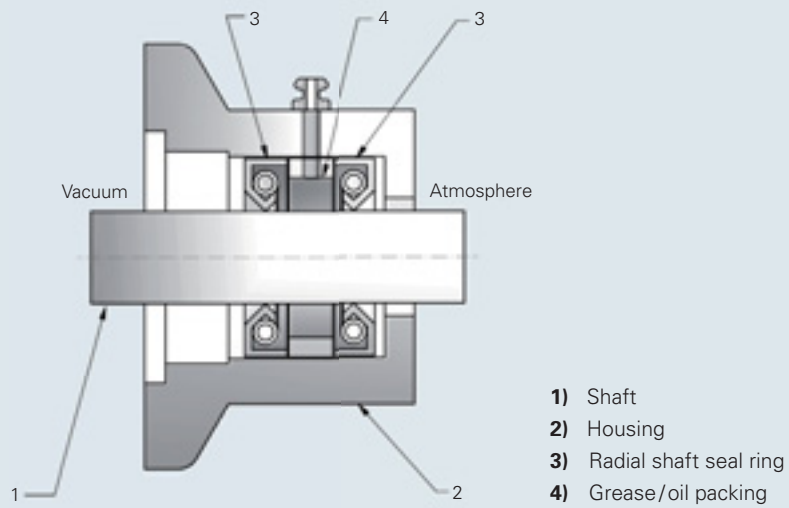


Figure 6.4: Rotary feedthrough with radial shaft seal ring

Greases, oils

Greases are still being used as a full-fledged sealing material only in the field of glass technology or as a makeshift solution for slightly damaged seals. In addition to its use as a seal in oil-tight vacuum pumps, oil is being used virtually only as an aid in sealing detachable connections in the low and medium vacuum ranges.

Table 6.2: Comparison of sealing materials

Material	Pressure / Length	Maximum Temperature
CR (Neoprene)	1 N/mm	100 °C
FPM	1 N/mm	150 °C
Indium	7 N/mm	100 °C
Aluminum	30 – 200 N/mm	200 °C
Copper	150 – 600 N/mm	450 °C
Gold	100 – 500 N/mm	800 °C

6.3 Detachable joints

The individual components of a vacuum system, e.g. pumps, valves, measurement instruments, vacuum chambers, etc., are connected with one another either directly or by means of hoses or piping. The joints between these components must be vacuum-tight and detachable. In configuring a vacuum system, however, as few detachable joints as possible should be used, as they represent a significantly more frequent source of potential leakage than non-detachable joints.

Piping and piping components made of aluminum, plain steel and stainless steel are used as connection elements. Metal hoses made of stainless steel are preferable to thick-walled rubber or thermoplastics for flexible joints, and they are a strict necessity from the lower medium vacuum range onward. To reduce the wide variety of existing dimensions and shapes, internationally valid series of nominal diameters have been specified. The series of nominal diameters that originated with the PNEUROP manufacturers' association and which were later adopted by the ISO is:

- 10 - 16 - 25 - 40 - 63 - 100 - 160 - 250 - 400 - 630 - 1,000 and is supplemented by the auxiliary series 20 - 32 - 50 - 80 - 125 - 200 - 320 - 500 - 800

Small flanges

The small flange connection (ISO-KF in accordance with ISO 2861/I/DIN 28403), consisting of two flat flanges having tapered rear sides, a centering ring, a sealing ring and a circlip (clamp), is available in nominal diameters of DN 10, 16, 25, 40 and 50 ISO-KF, whereby DN 50 ISO-KF comes from the auxiliary series and is being used more and more rarely today. An adaptation of components with one of the old nominal widths, 20 and 32, can be adapted by means of a reducing centering ring, or by means of an old DN 25/20 ISO-KF or DN 40/32 ISO-KF outside centering ring. Small flanges can also be held against flat surfaces by means of claws (Figure 6.5).

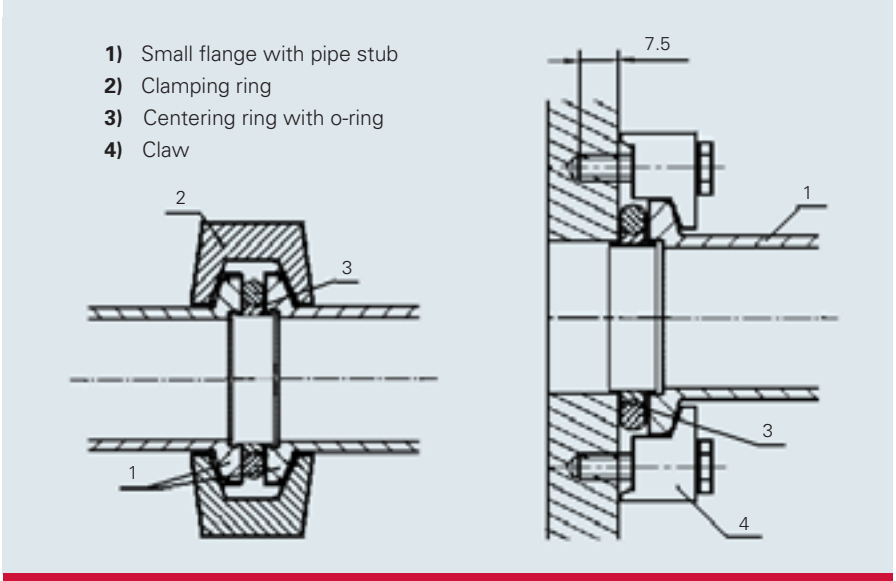


Figure 6.5: Small flange connection

Fixed flanges and clamping flanges

Standard ISO 1609.4/DIN 28404 specifies fixed flanges for nominal diameters of DN 10 – 1,000 ISO-F and clamping flanges for nominal diameters of DN 10 – 630 ISO-K. The small flange components are usually preferred for nominal diameters of DN 10 – 50. As in the case of small flanges, fixed and clamping flanges with centering rings have a seal between the flat mating surfaces of the flanges. The flanges are fastened by means of special clamps (clamping flanges) or by means of screws or pins (fixed flanges). By using a collar flange that is held in a groove on the clamping flange by means of a retaining ring or claws, it is also possible to connect clamping flanges to fixed flanges. When installing turbomolecular pumps with clamping flanges, the manufacturer's special instructions in the operating manuals must be observed for reasons of safety.

1) Clamping flange
2) Clamp
3) Collar flange
4) Fixed flange
5) Base plate/ housing wall
6) Claw
7) Circlip

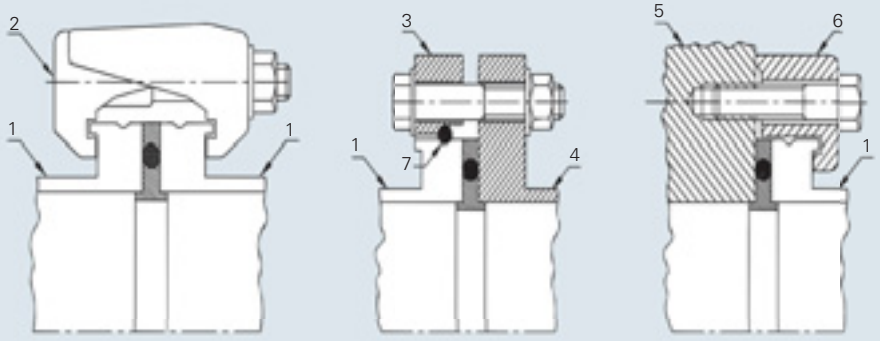


Figure 6.6: Clamping and fixed flange connections

DIN flanges

Since fixed and clamping flange connections are not designed for overpressure applications and because there are process technologies in which the connections are charged with both vacuum as well as overpressure, DIN flanges continue to be used. DIN 2501 (ND 6) and DIN 2502 (ND 10) specify the flange pattern of these flanges. One flange with o-ring groove and one flange with a smooth mating surface must be paired for each connection. Another disadvantage of these flanges relative to the ISO flanges consists of their significantly higher material and space requirements.

UHV flanges

Flanges with cutting edges and copper gaskets, (also referred to as Conflat® or CF flanges) are used for UHV applications. A copper ring is placed between two flanges. The concentric peripheral cutting edges of the flanges penetrate into the copper to form a metallic seal that is characterized by an extremely low leakage and permeation rate, as well as by high temperature resistance. These flanges are standardized in accordance with ISO TS 3669. A sufficient number of screws ensure the necessary high contact pressure. Once used, copper gaskets cannot be reused.

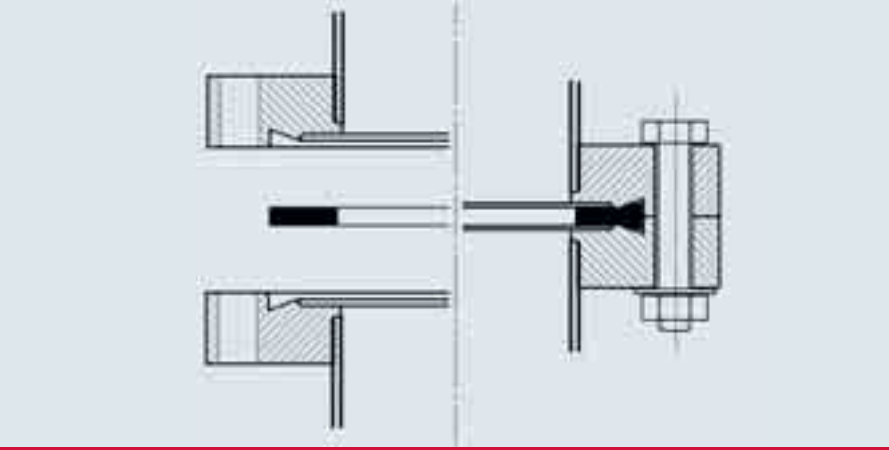


Figure 6.7: Conflat® flange connection

Glass connections
Vacuum systems for glass technology applications employ a glass or ground-in connection, which is used only in connection with small nominal diameters. The connections, consisting of the a tapered male ground joint and the corresponding female ground joint, are held together by the ambient air pressure and are sealed with vacuum grease.

Portfolio
Pfeiffer Vacuum offers all popular standard flanges and other connection elements.

6.4 Non-detachable connections

Non-detachable connections in vacuum technology are achieved by welding, brazing or fusing, or by metalizing or sintering with subsequent brazing. In recent years, vacuum-resistant adhesives have also come into use to join components for applications that do not involve UHV technology. The selected connection technology must be appropriately designed for the major requirements with respect to mechanical strength, temperature and alternating thermal loads, as well as the required gas-tightness. Material pairings such as metal-to-metal, glass-to-glass, glass-to-metal, metal-to-ceramic and glass-to-ceramic are being used more or less frequently in vacuum technology. Metals are most often joined by means of welding and brazing. In glass equipment, the individual glass components are joined through fusion. Non-detachable joints between metal and glass that are produced by fusing or metalizing and fusing are less frequent, and joints between metal and ceramic, which are produced by metalizing or sintering, are also less frequent.

Welded connections
In vacuum equipment, components of plain and stainless steel are usually welded together for vessels and joints. In addition, it is also possible to weld aluminum components together. To ensure that the welds that are produced are vacuum-tight, it is necessary to use proper materials that are free of cracks and voids, and whose surfaces are smooth and free of grease.

In addition, a special geometric design is also required that sometimes differs from the normal welded connections that are employed for non-vacuum applications. Wherever possible in terms of engineering, interior welds must be provided in order to avoid vacuum-side gaps and cracking, so-called latent leaks. If this is not possible, the weld must extend through to the vacuum side. Where necessary, a supplemental atmosphere-side weld can be employed to increase mechanical stability.

In this connection, it is important that this supplemental weld not be continuous in order to allow leak detection, if necessary, and have no air inclusions. In addition to the TIG welding process, microplasma welding also plays a role in vacuum technology, particularly for welding extremely thin-walled components and, to an increasing extent, in electron beam welding, which must be performed under vacuum.

Brazed connections

In addition to welding, the brazing process is also used to join metals. Brazed joints at soldering temperatures of above 600 °C are used almost exclusively in vacuum technology. In order to eliminate the need for highly corrosive flux when soldering, which usually involves high vapor pressure, and in order to obtain oxide-free, high-strength joints, the soldering process is performed under vacuum or in a clean inert gas atmosphere. Soft solder joints are not suitable for vacuum applications. They typically cannot be baked out, have less mechanical strength and in addition to tin frequently contain other alloy components with high vapor pressures.

Fusing

The fusing process is an alternative that is primarily used for joining glass components (in glass equipment) and for glass-to-metal connections. Glass-to-metal fusings are especially important in the production of vacuum-tight current feedthroughs, for bakable sight glasses and in the production of vacuum gauges. To fuse glass-to-metal transitions, the materials must be selected in such a manner that the thermal expansion coefficients of these materials are as similar to one another as possible throughout a broad temperature range. Numerous special alloys have been developed for this purpose that are known under trade names such as Fernico, Kovar, Vacon, Nilo, etc. Fusings with quartz glass are difficult to perform, as this material has an extremely low thermal expansion coefficient; no metal or metal alloy even comes close.

Metalized connections

Ceramic-to-metal connections are used for highly bakable and highly insulating current feedthroughs. They are also employed for manufacturing high-performance transmitting tubes and for configuring ceramic vacuum chambers for particle accelerators at major physics research facilities. In the case of this connection technology, the ceramic, e.g. aluminum oxide (92 % to 98 % $Al_2 0_3$), is pre-metalized at those points to be joined with the metal. In this connection, it is particularly important to ensure that the thin metal layer (molybdenum or titanium) crease an intensive connection with the ceramic substrate that is free of voids and pores. Applied to this is a layer of nickel; this enables a metal cap to be brazed on, for example, to which the current conductors of the current feedthrough are subsequently soldered.

6.5 Valves

Depending upon the application in question, shut-off elements (valves) in vacuum systems can also be subject to special requirements, in addition to the general technical requirements for shut-off elements that are typical of vacuum technology and have to be taken into consideration in engineering the products.

The minimum displaced ultimate pressure and the high flow resistance of components in the molecular flow range must be taken into consideration in configuring and selecting vacuum valves. In addition, minimum leakage rates are required for the valve housing and valve seat.

Vacuum-side lubricants for the moving parts in the valves must be suitable for the required pressure and temperature ranges, or avoided entirely, if possible, in high or ultra high vacuum. Minimum dead volumes and high conductivities are important, particularly in the molecular flow range.

The feedthrough for mechanical actuation elements must be designed in such a manner as to satisfy requirements with respect to tightness, as well as the pressure and temperature ranges. Depending upon the quality required, elastomer-sealed feedthroughs (e.g. shaft seal rings) can be used for lower vacuum requirements in the pressure range of over 10^{-4} mbar, while diaphragm or spring bellows are used for pressure ranges of less than 10^{-4} mbar. In addition, valves sealed with a metal bellows can be baked out if appropriately engineered. Valves with elastomer housing, plate and flange seals are used for pressures of up to 10^{-8} mbar.

All-metal valves, in which all seals are made of metal, are suitable for UHV applications and higher bake-out temperatures, however they usually require higher closing forces to seal. Soft metals (gold on a stainless steel substrate, copper or special alloys) are used as sealing materials. In addition to higher closing forces, shorter seal service life must also be expected.

There are a variety of different types of valves for the various applications in the field of vacuum technology; these valves are named on the basis of their design or function. There are also various ways in which valves can be actuated. Valves can be actuated manually, electromagnetically, pneumatically or electropneumatically, and even by means of electric motors. Depending on the requirement and version in question, visual and / or electrical position indicators (limit switches) are available for most valves.

Angle valves
Angle valves consist of a valve housing having an angled configuration. The valve plate is forced onto the valve seat to close the valve. The valve plate is sealed with either a trapezoid or o-ring elastomer seal.

Figure 6.8 shows the design of an angle valve that is sealed with a metal bellows. Since the mechanical activation elements are located outside the vacuum chamber, they can also be lubricated without any problem. These types of valves are available with either manual actuation or with electromagnetic or pneumatic drives.

Rubber plugs or small plates that seal against blade-shaped valve seats (solenoid valves) are also used for extremely small valves.

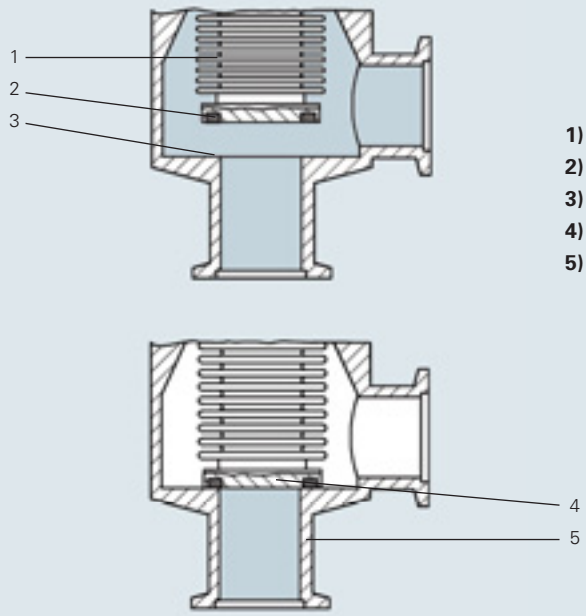


Figure 6.8: High vacuum angle valve

Gate valves

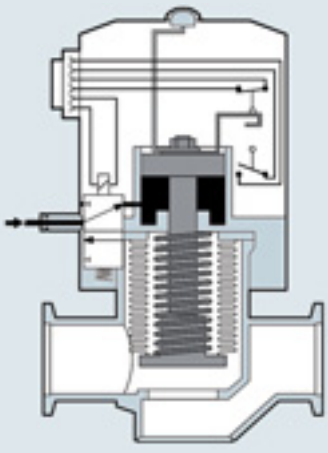


Figure 6.9: Electropneumatically actuated high vacuum inline valve

In principle, inline valves are designed the same as the above-described angle valves, however they differ from them in that the connection flanges are located on one axis. Due to their design, the flow resistance of inline valves is usually higher than that of comparable angle valves.

Gate valves

Gate valves are used for large nominal diameters (> DN 100). They are characterized by their low flow resistance and short physical height. Valve plates, usually of double design, move back and forth to open and close these valves. In the closed position, both elements are forced apart and against the sealing surfaces by means of balls. Depending upon the direction of movement of the valve gate, a distinction is made between rebound valves, shuttle valves and rotary vane valves. While most gate valves can seal against a differential pressure of 1 mbar on the valve plate due to their special design, they can only open in the presence of a low differential pressure on the valve plate.

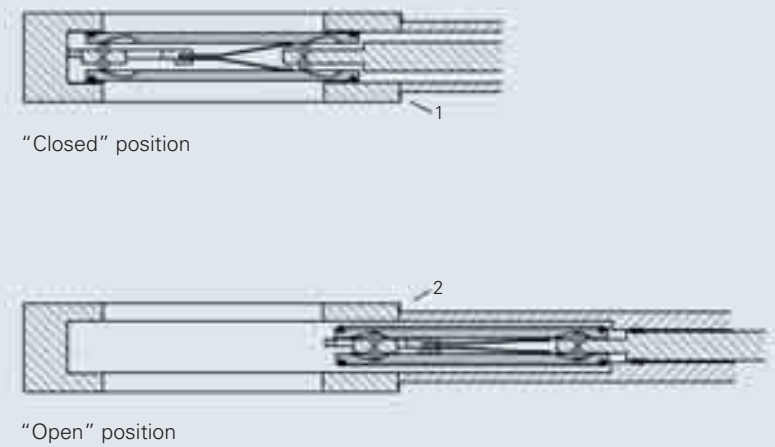


Figure 6.10: Rebound gate valve

Plate and butterfly valves

In valves of this type, the sealing valve plate is swung open by a lever (plate valve) or tilted open by means of a simple rotary motion (butterfly valve), with the valve plate remaining in the valve opening. Plate valves, in particular, are used to close larger nominal diameters.

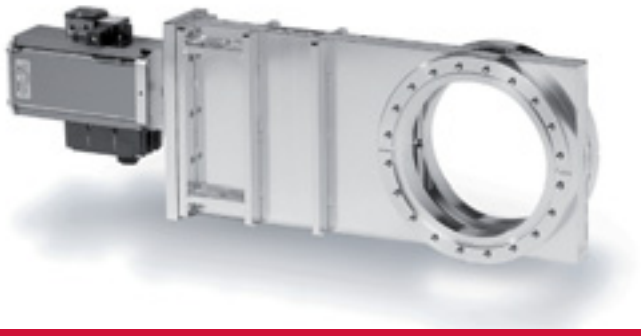


Figure 6.11: Electromagnetically actuated bellows-sealed rebound gate valve

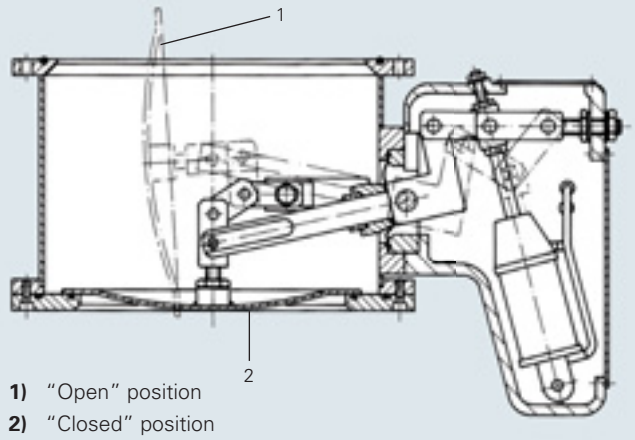


Figure 6.12: Pneumatically actuated plate valve

Source: Pupp / Hartmann, Vakuumtechnik, Grundlagen und Anwendungen, Hanser Verlag

Stopcocks

Stopcocks are shut-off elements in which the sealing and shut-off element has a hole through it, and the flow is shut off or released by rotating this element. Ball valves have a proven track record in the fine and medium vacuum ranges. A ball with a hole through it is rotatably supported and sealed on both sides by means of universal ball joints (usually made of Teflon), which also have holes through them. When the hole is in the direction of flow, the entire cross section is released. Ball valves are actuated either manually by means of a rotary feedthrough or by means of pneumatic swivel actuators for larger nominal diameters. It should be noted that ball valves contain an enclosed volume when closed.

Special valves

In addition to the above-described types of valves, there are also numerous special valves in differing configurations for differing applications:

- Venting valves for slow, dosed venting of a vacuum system
- Gas-dosing valves, some with a control unit, for manual or automatic pressure or flow regulation
- Needle valves for admitting minute volumes of gas that can be very precisely and reproducibly set
- Fast-action valves, e.g. to quickly close a vacuum system in the event of a malfunction
- Pressure relief and differential pressure valves that open and close automatically under certain pressure conditions
- Bakable UHV dosing valves that seal against a metal seat by means of a ceramic plate (Figure 6.13)

Figure 6.13: UHV dosing valve and electromagnetic angle valve

Portfolio
Pfeiffer Vacuum offers all popular types of valves. Please refer to the appropriate sections in the catalog in this connection.

6.6 Feedthroughs

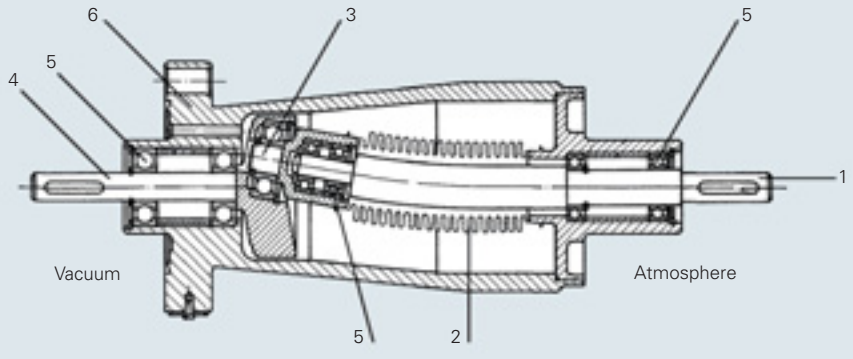
It is often necessary for mechanical movements, electrical current, light or optical signals and liquids to be transferred to the vacuum through vacuum-tight feedthroughs. If they are not integrated in the equipment itself, such as pumps or valves, these feedthroughs are usually installed in vacuum-tight flanges.

Rotary feedthroughs
Although the o-ring is the simplest form of seal, it cannot be used for high speeds and continuous-duty operation due to the high and uncontrolled contact pressures involved.

What are used most frequently are radial shaft seal rings or cap seals, even though they require lubrication. Hydrocarbons in the form of vapors or crack products can penetrate into the vacuum system through the lubricant.

A magnetic coupling consists of a bell-shaped permanent magnet arrangement on the outside that rotates the rotor, which is rotatably mounted in the vacuum and is also equipped with magnets. The two components are separated by a can that forms a hermetic seal. In the case of slow rotation, dry-running ceramic ball bearings can be used in the vacuum. Fast-running shafts in vacuum can be magnetically levitated.

So-called cat's-tail or wobble-tail feedthroughs also afford hermetic separation between vacuum and atmosphere.



1) Drive shaft
2) Spring bellows
3) Crank pin
4) Driven shaft
5) Ball bearings
6) CF flange

Figure 6.14: UHV cat's-tail feedthrough

Figure 6.14 shows the design of such a feedthrough. The angled drive shaft (1), whose end is supported in a crank pin (3), rotates the driven shaft (4) in the vacuum. The hermetic seal consists of a non-rotating bellows seal (2) that performs a wobbling movement. UHV-suitable dry-lubrication ball bearings are used for mounting the drive shaft in the vacuum.

Electric feedthroughs

A major factor in engineering an electric feedthrough is the type of current and voltage for which it will be used and the requirements it will have to satisfy with respect to vacuum-tightness and temperature resistance. The manufacturing processes for feedthroughs are discussed in Section 6.4. Feedthroughs with organic insulating materials can only be used for lower voltages. Simple cast-resin feedthroughs are frequently used for moderate current loads, e.g. for measurement currents. Epoxy resin is very well suited as an insulator and as a vacuum seal for moderate temperatures.

Multi-pole glass-molded feedthroughs to which the leads can be soldered on both sides are installed in small flanges. There are also versions with tubes through which leads can be inserted and soldered in place.

Figure 6.15: UHV multiple metal-to-ceramic electric feedthrough

This is important when using thermocouples, for example, as solder joints could falsify the measuring voltage. The feedthroughs are cooled with water for high amperages.

With respect to their insulating resistance, feedthroughs with glass-to-metal fusings are suitable for high-voltage and weak-current feedthroughs for electronic devices. Feedthroughs with ceramic insulation offer greater mechanical stability and temperature resistance than glass. In addition, ceramic (e.g. aluminum oxide) can also be produced in an insulating form that is suitable for high voltage. This is why ceramic feedthroughs are superior to glass feedthroughs for high voltages and high performance. Only rigid metal-to-ceramic connections should be considered for the most rigorous electrical, thermal and vacuum technology requirements.

The voltage level must be taken into account for electric feedthroughs, because gas discharges and flashover can occur in the vacuum if there are small clearances between conductors with high voltage differentials. In the vulnerable pressure range between 10^{-3} und 10 mbar, appropriate clearances must be provided between high-voltage conductors. Potting with cast resin can also be useful in this regard.

Feedthroughs for liquids and gases

Problems can occur with these feedthroughs if media at extremely high or low temperatures (liquid air) must be advanced into the vacuum vessel. Feedthroughs can be employed in which the thermal conductivity between flange and tube is reduced far enough by a sufficiently long, thin-walled stainless steel tube that the flange remains at room temperature, with normal elastomer seals being used to seal the flange.

Sight glasses

Sight glasses are primarily used to observe the interior of the vacuum chamber, even during the process. Consequently, normal window glass of an appropriate thickness is usually employed and installed in a sight glass flange by means of elastomer seals (ISO-K and ISO-KF sight glasses). The glass is metalized and soldered into the sight flange (CF sight glasses) for UHV applications and high temperatures.

7 Configuration

7.1 General

This section will discuss simple dimensioning questions:

- What size pump should I select in order to attain a specific pressure in a vacuum vessel within a given period of time?
- How large should the backing pump be for a high vacuum pump?
- What do I need to be aware of when pumping high gas loads?
- What is the influence of piping on the volume flow rate of a vacuum pump?

All of these questions can naturally not be discussed exhaustively in this chapter. Simple examples will be used and the anticipated results estimated. The technical data of the pumps and components that are used must be taken into consideration for the concrete application in question. And special literature can also be useful for dimensioning.

Units

Every physical technical parameter consists of a numeric value and a unit. The SI system has been adopted worldwide and standards have been defined for the basic values of length (m), mass (kg), time (s), temperature (T), substance volume (mol), electric current (A) and luminous intensity (cd); these values are used for calibration purposes in the individual countries. All other values are derived from these basic values. With few exceptions, the formulas that are used in this discussion contain only the physical technical values and no conversion factors whatever, such as Pa to mbar. This means that after employing the values in SI units, the results will also be in SI units. Examples of SI units are 1 Pa = 1 N/m^2 = 0.01 mbar for pressure and 1 m^3/s = 3,600 m^3/h. Used largely throughout the following sections are popular non-SI units; however SI units will be used wherever it would appear to be appropriate due to the required conversion.

Exclusive use of SI units would avoid many errors and much conversion effort. Unfortunately, this advantage is only very slowly gaining acceptance throughout the world.

7.2 Calculations

7.2.1 Dimensioning a Roots pumping station

Various preliminary considerations are first required in dimensioning a Roots pumping station.

Compression ratio

The compression ratio K_0 of a Roots pump is typically between 5 and 70. To determine this ratio, we first consider the volume of gas pumped and the backflow by means of conductivity L_R, as well as the return flow of gas from the discharge chamber at volume flow rate S_R:

Formula 7-1
Roots pump gas load

$$p_a \cdot S = p_a \cdot S_0 - L_R (p_v - p_a) - S_R \cdot p_v$$

where p_a = intake pressure and p_v = backing vacuum pressure.

Selecting S as being equal to 0 yields the compression ratio:

Formula 7-2
K_o of a Roots pump

$$\frac{p_v}{p_a} = K_0 = \frac{S_0 + L_R}{L_R + S_R}$$

The following applies in the laminar flow range: $S_0 >> L_R >> S_R$ and thus

Formula 7-3
K_0 laminar

$$K_{0l} = \frac{S_0}{L_R}$$

and the following applies in the molecular flow range due to

Formula 7-4
K_0 molecular

$$S_0 >> S_r >> L_R : K_{0m} = \frac{S_0}{S_R}$$

At laminar flow (high pressure), the compression ratio is limited by backflow through the gap between piston and housing. Since conductivity is proportional to mean pressure, the compression ratio will decline as pressure rises.

In the molecular flow range, the return gas flow $S_R \cdot p_v$ from the discharge side predominates and limits the compression ratio toward low pressure. Because of this effect, the use of Roots pumps is restricted to pressures p_a of less than 10^{-4} mbar.

Volume flow rate (pumping speed)

Roots pumps are equipped with overflow valves that allow maximum pressure differentials Δp_d of between 30 and 60 mbar at the pumps. If a Roots pump is combined with a backing pump, a distinction must be made between pressure ranges with the overflow valve open (S_1) and closed (S_2).

Since gas throughput is the same in both pumps, the following applies:

Formula 7-5
S_1 for $\Delta p_d << pv$

$$S_l = \frac{S_v \cdot p_v}{p_v - \Delta p_d}$$

As long as $\Delta p_d << p_v$ the volume flow rate (pumping speed) of the pumping station will be only slightly higher than that of the backing pump. As backing vacuum pressure nears pressure differential Δp_d, the overflow valve will close and $S = \frac{S_0}{1 - \frac{1}{K_0} + \frac{S_0}{K_0 \cdot S_v}}$ will apply (Formula 2-5).

Let us now consider the special case of a Roots pump working against constant pressure (e. g. condenser operation). Formula 7-3 will apply in the range of high pressures. Using value L_R in Formula 7-1 and disregarding S_R against L_R yields:

Formula 7-6
S against high pressure

$$S = S_0 \cdot \left(1 - \frac{1}{K_0}\left(\frac{p_v}{p_a} - 1\right)\right)$$

At low pressures, S_R from Formula 7-4 is used and yields:

Formula 7-7
S against low pressure

$$S = S_0 \left(1 - \frac{p_v}{K_0 \cdot p_a} \right)$$

From Formula 2-5, it can be seen that S tends toward S_0 if $K_0 >> \frac{S_0}{S_v}$.

Using z. B. $K_0 = 40$ und $\frac{S_0}{S_v} = 10$, for example, yields $S = 0.816\ S_0$.

Consequently, the following should apply for rating a pumping station: $\frac{S_0}{S_v} \leq 10$.

Because the overflow valves are set to pressure differentials of around 50 mbar, virtually only the volume flow rate of the backing pump is effective for pressures of over 50 mbar. If large vessels are to be evacuated to 100 mbar within a given period of time, for example, an appropriately large backing pump must be selected.

Let us consider the example of a pumping station that should evacuate a vessel of V = 2 m³ to $5 \cdot 10^{-3}$ mbar in 10 minutes. To do this, we would select a backing pump that can evacuate the vessel to 50 mbar in t_1 = 5 minutes. The following applies at a constant volume flow rate:

Formula 7-8
Pump-down time

$$t_1 = \frac{V}{S} \ ln \frac{p_0}{p_1}$$

Formula 7-8 yields the volume flow rate $S_v = \frac{2{,}000\ l}{300\ s} \ ln \frac{1{,}000}{50} = 20 \frac{l}{s}$.

We select a Hepta 100 with a pumping speed (volume flow rate) S_v of 100 m³/h as the backing pump. Using the same formula, we estimate that the pumping speed of the Roots pump will be 61 l/s = 220 m³/h, and select an Okta 500 with a pumping speed S_0 of 490 m³/h and an overflow valve pressure differential Δp_d of 53 mbar for the medium vacuum range.

From Table 7.1 below, we select the backing vacuum pressures on the basis of gap p_v, use the corresponding pumping speeds S_v for the Hepta 100 from Figure 2.10 and calculate the throughput: $Q = S_v \cdot p_v$.

The compression ratio $K_\Delta = \frac{p_v + \Delta p_d}{p_v}$ s calculated for an open overflow valve to a backing vacuum pressure of 56 mbar. K_0 can be found in Figure 2.14 for backing vacuum pressures of 153 mbar or less. There are two ways to calculate the pumping speed of the Roots pump:

S_1 can be obtained from Formula 7-5: $S_1 = S_v \cdot K_\Delta$ or an open overflow valve, or S_2 on the basis of Formula 2-5 for a closed overflow valve $S_2 = \frac{S_0}{1 - \frac{1}{K_0} + \frac{S_0}{K_0 \cdot S_v}}$

As the backing vacuum pressure nears pressure differential Δp_d, S_1 will be greater than S_2. The lesser of the two pumping speeds will always be the correct one, which we will designate as S.

The inlet pressure is obtained on the basis of: $p_a = \frac{Q}{S}$ Figure 7.1 shows the pumping speed curve of this pumping station.

Table 7.1: Volume flow rate (pumping speed) of a Roots pumping station

p_a / mbar	p_v / mbar	S_v /(m³ / h)	Q / (mbar · m³/h)	K_Δ	K_0	S_1 /(m³/h)	S_2 /(m³/h)	t / h	t / s
1,000.0000	1,053.00	90.00	94,770.00	1.05		94.77		0.00490	17.66
800.0000	853.00	92.00	78,476.00	1.07		98.10		0.00612	22.04
600.0000	653.00	96.00	62,688.00	1.09		104.48		0.00827	29.79
400.0000	453.00	100.00	45,300.00	1.13		113.25		0.01359	48.93
200.0000	253.00	104.00	26,312.00	1.27		131.56		0.00652	23.45
100.0000	153.00	105.00	16,065.00	1.53	7.00	160.65	321.56	0.00394	14.18
50.0000	103.00	105.00	10,815.00	2.06	13.00	216.30	382.20	0.00608	21.87
14.9841	56.00	110.00	6,160.00	18.70	18.00	2,053.33	411.10	0.00822	29.58
2.5595	10.00	115.00	1,150.00		36.00		449.30	0.01064	38.30
0.2300	1.00	105.00	105.00		50.00		456.52	0.00670	24.13
0.0514	0.30	75.00	22.50		46.00		437.39	0.00813	29.27
0.0099	0.10	37.00	3.70		40.00		375.17	0.00673	24.23
0.0033	0.06	15.00	0.90		39.00		270.42	0.00597	21.51
0.0018	0.05	5.00	0.25		37.00		135.29		
								Pump-down time:	344.94 s

Pump-down times

The pump-down time for the vessel is calculated in individual steps. In ranges with a strong change in volume flow rate, the backing vacuum pressure intervals must be configured close together. Formula 7-8 is employed to determine the pump-down time during an interval, with *S* being used as the mean value of the two volume flow rates for the calculated pressure interval. The total pump-down time will be the sum of all times in the last column of Table 7-1.

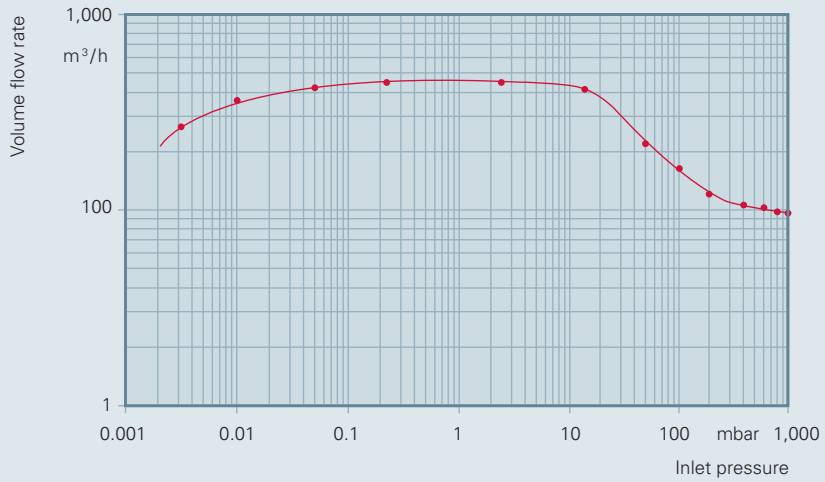


Figure 7.1: Volume flow rate (pumping speed) of a pumping station with Hepta 100 and Okta 500

The pump-down time will additionally be influenced by the leakage rate of the vacuum system, the conductivities of the piping and of vaporizing liquids that are present in the recipient, as well as by degassing of porous materials and contaminated walls. Some of these factors will be discussed in Sections 7.2.3.1 and 7.3. If any of the above-mentioned influences are unknown, it will be necessary to provide appropriate reserves in the pumping station.

7.2.2 Condenser mode

In many vacuum processes (drying, distillation), large volumes of vapor are released that have to be pumped down. Moreover, significant volumes of leakage air will penetrate into large vessels, and those substances that are being vaporized or dried will release additional air that is contained in pores or dissolved in liquids.

In drying processes, the vapor can always be displaced against atmospheric pressure by a vacuum pump having sufficient water vapor capacity and can then be condensed there. However, this process has the following disadvantages:

- The pump must be very large
- A large volume of gas ballast air will be entrained which, together with the vapor, will carry a great deal of oil mist out of the pump
- It will be necessary to dispose of the resulting condensate from the water vapor and oil mist, which is a costly process

Distillation processes operate with condensers, and the object is to lose as little of the condensing distillate as possible through the connected vacuum pump.

Let us consider a vacuum chamber containing material to be dried, to which enough energy will supplied by heat that 10 kg of water will evaporate per hour. In addition, 0.5 kg of air will be released per hour. The pressure in the chamber should be less than 10 mbar. A pumping station in accordance with Figure 7.2 is used for drying, enabling the steam to be condensed cost-effectively through the employment of a condenser.

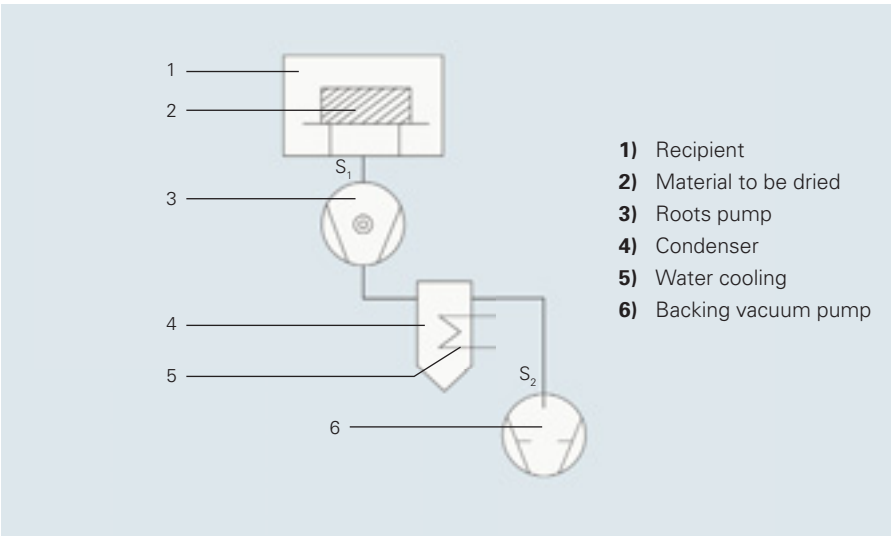


Figure 7.2: Drying system (schematic)

The material to be dried (2) is heated in the vacuum chamber (1). The Roots pump (3) pumps the vapor/air mixture into the condenser (4), where a major portion of the vapor condenses. The condenser is cooled with water. The condensing water at a temperature of 25 °C is in equilibrium with the water vapor pressure of 30 mbar. An additional vacuum pump (6) pumps the percentage of air, along with a small volume of water vapor, and expels the mixture against atmospheric pressure. The first step is to calculate gas throughput

$Q = P_{1a} \cdot S_1$ using Formula 1-11: $Q = S_1 \cdot p_{1a} = \frac{R \cdot T}{t} = \left(\frac{m_{wat}}{M_{wat}} + \frac{m_{air}}{M_{air}} \right)$

where:
T = 300 K suction gas temperature
R = 8,314 J/(kmol · K)
t = 3,600 s time
p_a = 10 mbar = 1,000 Pa inlet pressure
m_{wat} = 10 kg volume of water vapor
M_{wat} = 18 kg/kmol molar mass of water
m_{air} = 0.5 kg volume of air
M_{air} = 28.8 kg/kmol molar mass of air,
to find the gas throughput: Q = 397 Pa · m³/s and after being divided by inlet pressure p_a = 1,000 Pa to obtain the volume flow rate of the Roots pump: S_1 = 0.397 m³/s = 1,428 m³/h.
Gas throughput Q is comprised of 385 Pa · m³/s of water vapor and 12 Pa · m³/s of air.

When evacuating the condenser, the partial air pressure should not exceed 30%, i.e. a maximum of 12.85 mbar. It follows from this that:

$$S_2 = \frac{Q_{air}}{0{,}3 \cdot p_{air}} \cdot S_2 = 0.031 \text{ m}^3/\text{s} = 112 \text{ m}^3/\text{h} .$$

We therefore select a Hepta 100 screw pump as the backing vacuum pump. Because its pumping speed is somewhat lower than the calculated volume flow rate, this pump will achieve a slightly higher partial air pressure. And we select an Okta 2000 with the following values as the Roots pump:
S_0 = 2,065 m³/h
Δp_d = 35 mbar differential pressure at the overflow valve
K_0 = 28 at p_v = 43 mbar.
We estimate the inlet pressure p_a to be 1,000 Pa and calculate S_1 in accordance with Formula 7-6:

$$S_1 = S_0 \cdot \left(1 - \frac{1}{K_0} \left(\frac{p_v}{p_a} - 1 \right) \right) 1{,}822 \text{ m}^3/\text{h} = 0.506 \text{ m}^3/\text{s}.$$

Using $p_a = \frac{Q}{S_1}$, p_a = 785 Pa yields the inlet pressure in the drying chamber which, when again used in Formula 7-6, provides a more precise volume flow rate S_1 of 1,736 m³/h at an inlet pressure p_a of 823 Pa.

We calculate the condenser for a 10 kg/h volume of vapor to be condensed. The following applies for the condensation surface area:

Formula 7-9
Calculation of the condensation surface area

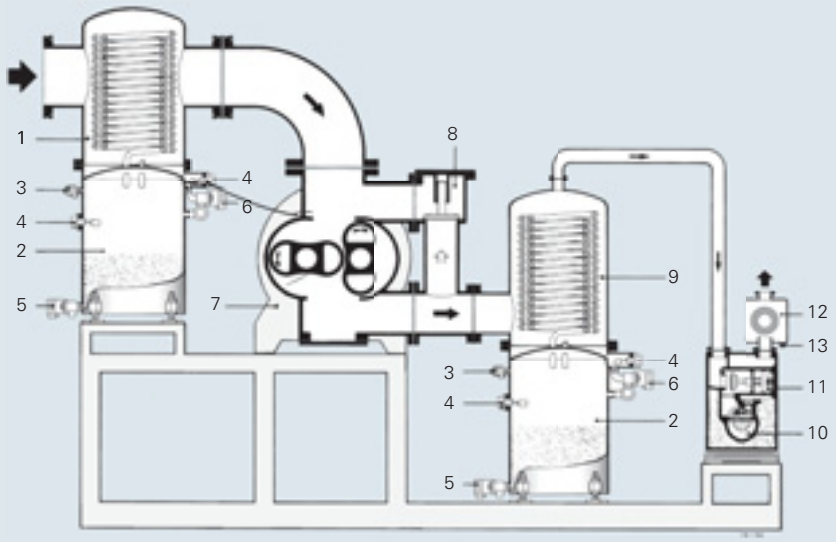
$$A_k = \frac{Q_{wat} \cdot m_{wat}}{t \cdot \Delta T_m \cdot k}$$

where:
Q_{wat} = 2.257 106 WC/kg specific enthalpy of evaporation
m_{wat} = 10 kg volume of water vapor

ΔT_m = 60 K temperature differential between vapor and condensation surface area
t = 3,600 s
k = 400 W/(m² · K) thermal transmission coefficient,
which yields A_k = 0.261 m² as the condensation surface area.

The vapor is heated by more than 100 K through the virtually adiabatic compression, however it re-cools on the way to the condenser. So the assumption that ΔT_m = 60 K is quite conservative. The thermal transmission coefficient k [17] declines significantly as the concentration of inert gas increases, which results in a larger condensation surface area. Inversely, with a lower concentration of inert gas, it is possible to work with a larger backing pump and a smaller condensation surface area. Particular attention should be paid to small leakage rates, as they, too, increase the concentration of inert gas.

Further technical details can be seen from the literature [18].



1) Condenser
2) Condensate collecting vessel
3) Venting valve
4) Float switch
5) Drain valve
6) Shut-off valve
7) Roots pump
8) Overflow valve
9) Intermediate condenser
10) Rotary vane pump
11) High vacuum safety valve
12) Oil mist filter
13) Drain plug

Figure 7.3: Roots pumping station for vapor condensation

In the interest of completeness, let us again consider the entire sequence of the drying process: A pressure equilibrium initially occurs in the drying chamber, which results from the water volume that is being vaporized, which is caused by heat-up of the material to be dried and the volume flow rate of the Roots pump.

The Roots pump advances the water vapor into the condenser, where it condenses. Because laminar flow prevails there, the vapor flow advances the inert gas being released by the material to be dried into the condenser.

Were the backing pump to be shut down, the entire condensation process would quickly come to a stop, as the vapor could only reach the condensation surface area through diffusion. As the drying process progresses, the volume of vapor declines and less condenses in the condenser; however the concentration of vapor being extracted by the backing pump will tend to be larger if the concentration of inert gas decreases. If the vapor pressure in the condenser declines below the condensation threshold, the condensate will begin to re-evaporate. This can be prevented if the condensate drains into a condensate storage vessel via a valve and this valve closes when the vapor pressure declines below the condensation pressure.

In the case of large distillation systems, the pumping speed of the backing pump should be regulated on the basis of the condensation rate. This can be accomplished, for example, with the aid of a dosing pump that uniformly discharges the volume of pumped condensate from the storage vessel. When the concentrate level in the storage vessel declines below a given level, the backing pump's inlet valve opens and the inert gas that has collected in the condenser is pumped down. The condensation rate now increases again, the condensate level increases and the backing pump's inlet valve closes again. This arrangement means that the system pumps only when the condensation rate is too low, and only little condensate is lost.

Summary

When pumping down vapors (drying, distillation), the major pumping effect can be provided by a condenser. Depending upon pressure and temperature conditions, either one or two condensers can be employed (Figure 7.3). The condenser between Roots pump and backing pump is more effective, as the vapor flows into the condenser at a higher temperature and higher pressure, and a small backing pump evacuates only a portion of the vapor. In distillation, condensate loss can be minimized by regulating the pumping speed of the backing pump.

7.2.3 Turbopumping stations

7.2.3.1 Evacuating a vessel to 10^{-8} mbar by means of a turbopumping station

A vessel made of bright stainless steel is to be evacuated to a pressure p_b of 10^{-8} mbar in 12 hours. As can be seen from Section 1.3, there are other effects to consider in addition to the pure pump-down time for air. Both desorption of water vapor and adsorbed gases as well as outgassing from seals will lengthen the pump-down time. The pump-down times required to attain the desired pressure of 10^{-8} mbar are comprised of the following:

- t_1 = pump-down time of the backing pump to 0.1 mbar
- t_2 = pump-down time of the turbopump to 10^{-4} mbar
- t_3 = pumping time for desorption of the stainless steel surface
- t_4 = pumping time for outgassing the FPM seals

The desired base pressure p_b is comprised of the equilibrium pressure caused by gas flowing into the vessel through leaks and permeation Q_l, as well as by gas released from the metal surface Q_{desM} and the seals Q_{desK}:

$$p_b = \frac{Q_l}{S} + \frac{Q_{desM}(t_3)}{S} + \frac{Q_{desK}(t_4)}{S}$$

The vessel has the following data:

V = 0.2 m³ volume

A = 1.88 m² surface area

q_{desM} = 2.7 x 10^{-6} mbar · m³/(s · m²) desorption rate of stainless steel

q_{desK} = 1.2 x 10^{-5} mbar · m³/(s · m²) desorption rate of FPM

A_d = 0.0204 m² surface area of the FPM seal

Q_l < 10^{-8} mbar · l/sec leakage rate

The backing pump should evacuate the vessel to 0.1 mbar in t_1=180 s, and should also be able to achieve this pressure with the gas ballast valve open. The volume flow rate can be obtained in accordance with Formula 7-8:

$$S_v = S_v = \frac{V}{t_1} \; ln \frac{p_0}{p_1} \; 10.2 \text{ l/s} = 36.8 \text{ m}^3/\text{s}.$$

We select a Penta 35 with a pumping speed S_v = 35 m³/h.

The turbomolecular pump should have approximately 10 to 100 times the pumping speed of the backing pump in order to pump down the adsorbed vapors and gases from the metal surface. We select a HiPace 700 with a pumping speed S of 685 l/s. Using Formula 7-8 yields

$$t_2 = \frac{V}{S} \; ln \frac{p_1}{p_2} \; = \; 2.01 \; s$$

Desorption from the surface of the vessel

Gas molecules (primarily water) adsorb on the interior surfaces of the recipient and gradually vaporize again under vacuum. The desorption rates of metal surfaces decline at a rate of 1/t. Time constant t_0 is approximately 1 h.

Using $Q_{des} = q_{des} \cdot A \cdot \frac{t_0}{t_3}$ (Formula 1-24), we calculate the time needed to attain the working pressure p_{b3}=10^{-8} mbar: $t_3 = \frac{q_{desM} \cdot A \cdot t_0}{S \cdot p_{B3}}$; $t_3 = 2.67 \cdot 10^6$ s = 741 h.

This takes too much time! The process must be shortened by baking out the vessel. Increasing the temperature of the vessel from 293 to 370 K, a temperature that the FPM seals can easily withstand, will theoretically increase the desorption speed by more than a factor of 1,000 [6], and the bake-out time will in effect be shortened to several hours.

High desorption rates can also be lowered by approximately a factor of 100 by annealing the vessel under vacuum or by means of certain surface treatments (polishing, pickling). Bake-out, however, is the most effective method.

Since many pre-treatment influences play a role, precise prediction of the pressure curve over time is not possible. However in the case of bake out temperatures of around 150 °C, it will suffice to turn off the heater after attaining a pressure that is a factor of 100 higher than the desired base pressure. The desired pressure p_{b3} will then be attained after the recipient has cooled down.

Seal desorption

The outgassing rates of plastic are important at operation below 10^{-6} mbar. Although the surface areas of the seals are relatively small, desorption decreases only at $\frac{t_0}{\sqrt{t_4}}$ (Formula 1-25).

The reason for this is that the escaping gases are not only bound on the surface, but must also diffuse out of the interior of the seal. With extended pumping times, desorption from plastics can therefore dominate desorption from the metal surfaces. The outgassing rate of plastics is calculated in accordance with:

$Q_{desK} = q_{desK} \cdot A_d \sqrt{\frac{t_0}{t}}$ (Formula 1-25).

We use $Q_{desK} = S \cdot p_{desK}$ and obtain the following for $p_{b4} = 10^{-8}$ mbar: $t_4 = 459\ 10^6$ s = 1,277 h. In this connection, t_0 = 3,600 s and the associated value q_{desK} is read from the diagram for FPM [19]. It can be seen that the contribution to pump-down time made by desorption of the cold-state seal is on a similar order of magnitude as that of the metal surface.

Since the diffusion of the gases released in the interior of the seal will determine the behavior of the desorption gas flow over time, the dependence of diffusion coefficient D upon temperature will have a crucial influence on pumping time:

Formula 7-10
Diffusion coefficient (T)

$$D = D_0 \exp\left(-\frac{E_{dif}}{R \cdot T}\right)$$

As temperature rises, the diffusion coefficient increases, as well; however it will not rise as much as the desorption rate of the metal surface. We thus see that elastomer seals can have a pronouncedly limiting effect on base pressure due to their desorption rates, which is why they are not suitable for generating ultra high vacuum.

Leakage rate and permeation rate

The gas flow that flows into the vacuum system through leaks is constant and results in pressure $p_l = \frac{Q_l}{S}$. A system is considered to be sufficiently tight when this pressure is less than 10 % of working pressure. Leakage rates of 10^{-8} mbar · l/s are usually easy to attain and are also required for this system. This results in a pressure proportion of the leakage rate of $p_l = 1.46 \cdot 10^{-11}$ mbar. This value is not disturbing and can be left out of consideration.

Permeation rates through metal walls do not influence the ultimate pressure that is required in this example; however diffusion through elastomer seals can also have a limiting effect on base pressure in the selected example.

Summary

Pressures of up to 10^{-7} mbar can be attained in approximately one day in clean vessels without the need for any additional measures.

If pressures of up to 10^{-4} mbar are to be attained, the pump-down times of the backing pump and the turbopump must be added together. In the above-mentioned case, this is approximately 200 s. At pressures of less than 10^{-6} mbar, a high turbomolecular pump pumping speed will be required, in particular in order to pump down the water adsorbed on the metal walls.

This will only be possible by additionally baking out the vacuum vessel (90 to 400 °C) if the required base pressure p_b of 10^{-8} mbar is to be attained within a few hours. The heater is turned off after 100 times the value of the desired pressure has been attained. The base pressure will then be reached after cool-down of the vacuum vessel.

At pressures of less than 10^{-8} mbar, only metal seals should be used in order to avoid the high desorption rates of FPM seals.

Leakage and permeation rates can easily be kept sufficiently low in metal vessels at pressures of up to 10^{-10} mbar.

7.2.3.2 Pumping high gas loads by means of turbomolecular pumps

Turbopumps are subject to high stresses under high gas loads. Gas friction heats up the rotors. The maximum gas loads are limited by the permissible rotor temperature of 120 °C. Because the friction loss is proportional to the square of the peripheral speed, it is necessary to reduce the RPM of pumps that operate under high gas loads. This means that higher gas loads are attained at the expense of pumping speed, and in particular, at the expense of the compression ratio; this is not a major disadvantage for these kinds of pumps, as they are not used for generating high vacuum. Pumping heavy noble gases is particularly critical. Due to their high atomic weights, heavy noble gases generate large quantities of heat when they strike the rotor. As a result of their low specific thermal capacity, however, they can transfer only little heat to the stator or to the housing, which results in high rotor temperatures. The maximum gas loads for these gases are therefore relatively low.

When operating with process gases, the turbopump performs two important functions:

- Fast evacuation of the process chamber to a low pressure (clean initial conditions)
- Maintaining the desired pressure at a constant level during the vacuum process (coating, etching, etc.)

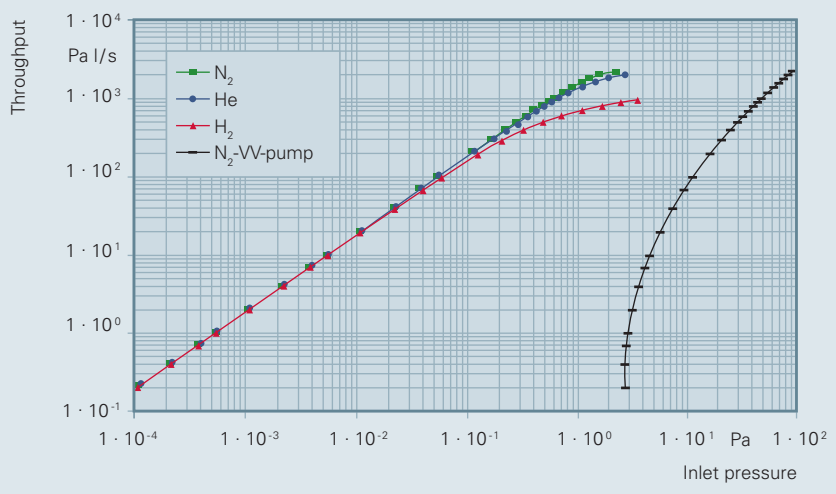


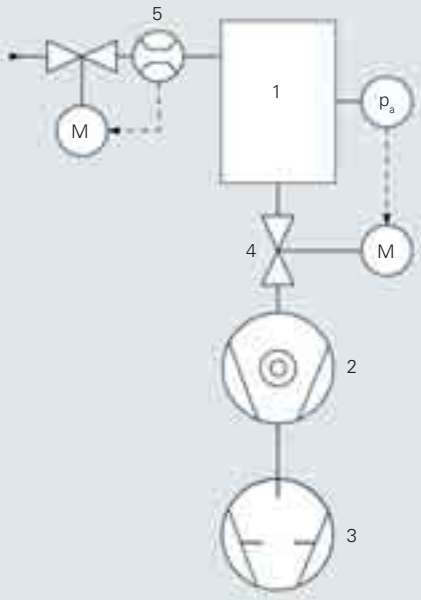
Figure 7.4: Throughput of TPH 2000 PC and Duo 120 C

Gas throughput Q and working pressure p_a during a process are typically specified, and thus the volume flow rate at the process chamber, as well. $S = \frac{Q}{p_a}$

The turbopump will be selected on the basis of the required gas throughput. The maximum permissible gas throughputs for various gases are specified for the respective pumps in the catalog, with the throughput curves of turbopumps and backing pumps being used in this connection (Figure 7.4). The throughput must be the same for both pumps, because the same gas flow will pass through both pumps successively: $S_v = \frac{Q}{p_v}$.

The following rule of thumb applies for the backing pump: If the maximum gas throughput of the turbopump is attained, the pumping speed of the backing pump must be selected high enough so that only one half of the critical backing pressure will be utilized.

The volume flow rate at the process chamber is throttled to the required level by means of either RPM or a regulating valve. It is frequently not possible to employ regulation as a function of RPM, as it takes too long to set the desired pressure via RPM.



1) Process chamber
2) Turbomolecular pump
3) Rotary vane pump
4) Butterfly valves (pressure-regulated)
5) Gas flow regulator

Figure 7.5: Vacuum system with pressure and throughput regulation

Example:
Let us consider a system in accordance with Figure 7.5.
Q = 20 mbar · l/s gas throughput
p_a = 0.05 mbar process pressure

This results in a volume flow rate S of 400 l/s. We select a HiPace 2300 as the turbopump (2) and a Uno 120 as the backing pump (3). With this backing pump, we can attain a backing vacuum pressure of 0.8 mbar at a gas throughput of 20 mbar · l/s, i.e. a little less than one half of the critical backing pressure of 1.8 bar.

The process gas is admitted to the chamber (1) via a gas flow regulator (5). The butterfly valve (4) that is controlled by pressure p_a throttles the pumping speed of the turbopump (2). After the conclusion of the process step, the gas supply is shut off and the control valve opens completely to cleanly evacuate the chamber again. As this is happening, a new work piece is loaded into the process chamber. Further information relating to pumping high gas loads as well as corrosive and abrasive substances is provided in Section 2.7.3.

7.3 Piping conductivities

In calculating the pump-down times of vessels, we have left piping resistance out of consideration for both Roots pumping stations as well as for turbopumping stations. However the piping between a vessel and a pump will also reduce the volume flow rate.

7.3.1 Laminar conductivity

Let us consider the pumping station for the drying system in Section 7.2.2 (Figure 7.2) and calculate the drop in pressure between condenser and backing pump. In this case, a gas throughput of $Q = 4{,}285 \cdot 2.9722\ 10^{-2} = 127$ Pa · m³/s is specified as a result of the pressure of 4,285 Pa and the volume flow rate S_v of the backing pump of 107 m³/h = $2.9722 \cdot 10^{-2}$ m³/s. The DN 63 piping has an inside diameter of 0.07 m and a length of 2 m. Two 90° pipe bends having an equivalent length of 0.2 m each are also taken into consideration.

From $p_2 = 4{,}285$ mbar and $\bar{l} \cdot p_2 = 6.65 \cdot 10^{-3}$ Pa · m as well as the pipe diameter $d = 0.07$ m we use the Knudsen number $Kn = \frac{\bar{l}}{d}$ (Formula 1-9) to determine the flow range and obtain $Kn = 2.22 \cdot 10^{-5}$. Since Kn is less than 0.01, this results in viscous flow. This can be either laminar or turbulent, although we prefer laminar flow as the conductivities here are significantly higher than for turbulent flow, which means that significantly lower volume flow losses will occur. The Reynolds number Re must be less than 2,300 for laminar flow.

To calculate the Reynolds number, we first determine the flow velocity v in the piping:

$$v = \frac{4 \cdot S_v}{d^2 \cdot \pi} = 8.66 \frac{m}{s}$$

and the density ρ of the air at 42.85 mbar from the air density $\rho_0 = 1.293$ kg/m³ at atmospheric pressure.

$$\rho = \frac{1.293 \cdot 42.85}{1013} = 0.0547 \frac{kg}{m^3}$$ and in accordance with Formula 1-10:

$$Re = \frac{\rho}{\eta} \cdot v \cdot d = 1.822,$$ i.e. laminar flow.

We use Formula 1-21 to calculate pressure p_1:

$$L_{Ri} = \frac{\pi \cdot d^4}{256 \cdot \eta \cdot l} \cdot (p_1 + p_2) = \frac{\pi \cdot d^4}{128 \cdot \eta \cdot l} \cdot \bar{p}$$

and multiply by $\Delta p = p_1 - p_2$ to obtain the gas throughput:

$$Q = L_{Ri} \cdot \Delta p = \frac{\pi \cdot d^4}{256 \cdot \eta \cdot l} \cdot (p_1^2 - p_2^2).$$

Since p_2 = 4,285 Pa and Q = 127 Pa · m³/s it is possible to directly determine p_1 from these values:

$$Q_{diff} = q_{diff} \cdot A_d \sqrt{p_2^2 + \frac{Q \cdot 256\ \eta \cdot l}{\pi \cdot d^4}} = 4{,}287.2 \text{ Pa}$$

We have a pressure loss Δp of merely 2.2 Pa, a very low value.
The conductivity of the piping is obtained from Formula 1-14:

$$L_{Ri} = \frac{Q}{\Delta p} = 57.73 \frac{m^3}{s}$$

The effective volume flow rate

$$S_{eff} = \frac{S_v \cdot L_{Ri}}{S_v + L_{Ri}} = 0.029707 \frac{m^3}{s}$$

is only slightly lower than the volume flow rate without the piping: S_v = 0.029722 m³/s.

7.3.2 Molecular conductivity

Now let us also consider the conductivity of the same piping in the molecular flow range. The piping has a diameter of 0.07 m and a length of 2 m. The elongated length of 0.235 each of the two 90° pipe bends, i.e. a total length of 2.47 m is taken into consideration [20]. In accordance with Formula 1-22, the piping resistance is

$$L_{Rm} = \frac{\bar{c} \cdot \pi \cdot d^3}{12 \cdot l} = 0.017123 \cdot \frac{m^3}{s}$$

where $\bar{c}$ = 471 m/s for air at T = 293 K. The orifice conductivity of the pipe inlet has already been taken into account.

The effective volume flow rate is obtained in accordance with the following formula:

$$S_{eff} = \frac{S_v \cdot L_{Rm}}{S_v + L_{Rm}} = 1.0864 \cdot 10^{-2} \frac{m^3}{s} \text{ where } S_v = 2.9722 \cdot 10^{-2} \text{ m}^3/\text{s}.$$

In the molecular flow range, the pumping speed of the backing pump would be reduced to nearly one third! In this range, it is absolutely necessary to pay strict attention to short runs and large piping cross sections between pump and recipient. This applies in particular with respect to turbopumps that are ideally flanged directly to the recipient.

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Pfeiffer Vacuum GmbH

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Rotary

vane pumps

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Selection aid

● Recommended

	Analysis						Semiconductors & electronics										
	Electron microscopy	Leak detection	Mass spectrometry	Surface analysis	Plasma monitoring	Residual gas analysis	Lithography	PVD (Physical Vapor Deposition)	CVD (Chemical Vapor Deposition)	Plasma etching	Implantation – Source	Implantation – Beamline	Inspection	Bonding	MBE (Molecular Beam Epitaxy)	Load locks, transfer chambers, handling systems	Hard drive coating
Model																	
HenaLine™																	
Hena 25																	●
Hena 60																	●
Hena 100																	●
Hena 200																	●
Hena 300																	●
Hena 400																	●
Hena 630																	
Hena 1000																	
PentaLine™																	
Penta 10	●	●	●	●	●	●											●
Penta 20	●	●	●	●	●	●											●
Penta 35		●	●														●
DuoLine™																	
Duo 2.5	●	●	●	●	●	●											●
Duo 5 M	●	●	●	●	●												●
Duo 10 M	●	●	●	●	●	●											●
Duo 20 M	●	●	●	●	●	●											●
Duo 35								●								●	●
Duo 65								●								●	●
Duo 120								●									●
Duo 255								●									●
UnoLine™ Plus																	
BA 251																	
BA 501																	

	Coating						Industry								Research & development								
	Solar cell production (PECVD, CIS, CIGS, etc.)	Glass coating (PVD)	CD/DVD/Blu-ray production (PVD)	Optical coatings (PVD)	Wear protection (PVD, CVD)	Film coating (PVD)	Medical technology	Industrial leak detection	Electron beam welding	Isolation vacuums	Incandescent and fluorescent lamp production	Heat treatment	Vacuum drying	Vacuum furnaces	Nuclear research	Fusion technology	Plasma research	Particle accelerators	Space simulation	Cryogenic research	Elementary particle physics	Nanotechnology	Biotechnology
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									●			●	●	●		●								●

The HenaLine™ innovation

A complete line of single-stage rotary vane pumps for low and medium vacuum applications.
Safe. Reliable. Powerful.

What is HenaLine?
HenaLine is a complete line of oil-sealed rotary vane pumps that are suitable for both industrial applications as well as research & development environments. These pumps offer pumping speeds of between 25 and 1,000 m^3/h.

Moreover, the principle of operation of the HenaLine pumps assures low operating temperatures. This increases the service life of the oil while eliminating the need for additional water cooling for the pump in most applications.

With its HenaLine pumps, Pfeiffer Vacuum has brought to market further first-class products whose dependable, robust engineering, in particular, is convincing. They are ideal for use as standalone pumps, backing pumps or in combination with Pfeiffer Vacuum CombiLine Roots pumping stations.

Advantages at a glance

- A complete line of pumps with pumping speeds of between 25 and 1,000 m^3/h
- Integrated oil mist separator for clean exhaust air
- Low ultimate pressure (up to 0.1 mbar)
- Compact, reliable and powerful
- Simple to service
- Operating and process reliability
- Connection flanges in DN ISO-KF/K,easily adaptable
- Quiet, low-vibration operation

Applications

Industrial

- Electron beam welding
- Lamp manufacturing
- Surface coating
- Vacuum drying and degassing
- Leak detection
- Metallurgy
- Gas recovery
- Load locks/transfer chambers
- General process technology

Research & development

- Simulation chambers
  (Air conditioning, aerospace)

General process technology

Cleanroom transfer chambers

Fluorescent tube manufacturing

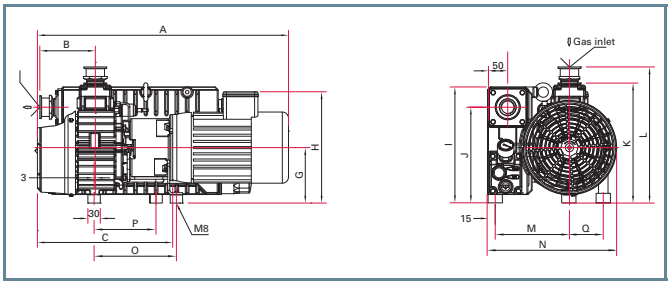
Hena 25

Single-stage, oil-sealed rotary vane pump with a pumping speed of 25 m³/h.

Hena 25

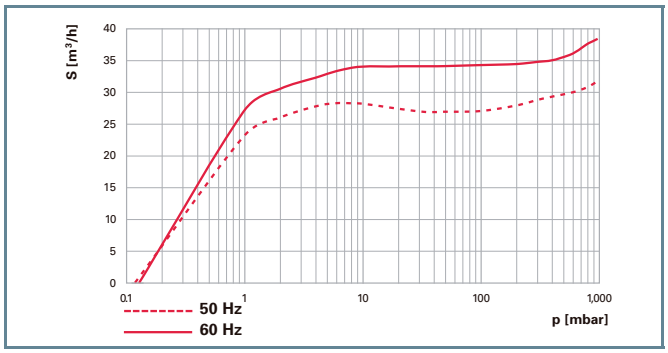
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 25, 3-ph Motor, 3TF, 200/400 V, 50 Hz 210/430 V, 60 Hz	Hena 25, 1-ph Motor, 230 V, 50 Hz	Hena 25, 1-ph Motor, 110 V, 60 Hz	Hena 25, 1-ph Motor, 230 V, 60 Hz
A	599 mm	564 mm	604 mm	604 mm
B	129 mm	129 mm	129 mm	129 mm
C	318 mm	318 mm	318 mm	318 mm
G	123 mm	123 mm	123 mm	123 mm
H	251 mm	240 mm	265 mm	265 mm
I	260 mm	260 mm	260 mm	260 mm
J	210 mm	210 mm	210 mm	210 mm
K	263 mm	263 mm	263 mm	263 mm
L	302 mm	302 mm	302 mm	302 mm
M	171 mm	171 mm	171 mm	171 mm
N	284 mm	284 mm	284 mm	284 mm
O	159 mm	159 mm	159 mm	159 mm
P	120 mm	120 mm	120 mm	120 mm
Q	67 mm	67 mm	67 mm	67 mm

Pumping speed (without gas ballast)



Technical data	Hena 25, 3-ph Motor, 3TF, 200/400 V, 50 Hz 210/430 V, 60 Hz	Hena 25, 1-ph Motor, 230 V, 50 Hz	Hena 25, 1-ph Motor, 110 V, 60 Hz	Hena 25, 1-ph Motor, 230 V, 60 Hz
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Operating fluid	D1	D1	D1	D1
Pump fluid filling	1 l	1 l	1 l	1 l
Emission sound pressure level without gas ballast at 50 Hz	60 dB (A)	60 dB (A)	-	-
Emission sound pressure level without gas ballast at 60 Hz	63 dB (A)	-	63 dB (A)	63 dB (A)
Ultimate pressure with gas ballast	1.5 mbar	1.5 mbar	1.5 mbar	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar	0.2 mbar	0.2 mbar	0.2 mbar
Weight	35 kg	42 kg	44 kg	42 kg
Nominal rotation speed at 50 Hz	1500 1/min	1500 1/min	-	-
Nominal rotation speed at 60 Hz	1800 1/min	-	1800 1/min	1800 1/min
Rated power 50 Hz	0.9 kW	1.10 kW		
Rated power 60 Hz	1.1 kW		2.0 kW	2.0 kW
Mains requirement: voltage	200/400 V, 50 Hz 210/430 V, 60 Hz	230 V, 50 Hz	110 V, 60 Hz	230 V, 60 Hz
Mains requirement: voltage (range)	190-210 V, 380-420 V (+/- 5%) 50 Hz; 190-240 V, 380-480 V (+/- 5%) 60 Hz	220-240 V (+/- 5%) 50 Hz	100-120 V (+/- 5%) 60 Hz	220-240 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	25 m^3/h	25 m^3/h	-	-
Pumping speed at 60 Hz	30 m^3/h	-	30 m^3/h	30 m^3/h
Switch	No	No	No	No
Water vapor capacity 50 Hz	900 g/h	900 g/h	-	-
Water vapor capacity 60 Hz	900 g/h	-	900 g/h	900 g/h
Water vapor tolerance at 50 Hz	40 mbar	40 mbar	-	-
Water vapor tolerance at 60 Hz	40 mbar	-	40 mbar	40 mbar

Order number				
Hena 25	**PK D02 200**	**PK D02 212**	**PK D02 207**	**PK D02 222**

Accessories				
SAS 40, DN 40 ISO-KF, polyester filter	**PK Z60 510**	**PK Z60 510**	**PK Z60 510**	**PK Z60 510**
Barretter actuation unit 3 TF	**P4 768 051 FQ**	**P4 768 051 FQ**	**P4 768 051 FQ**	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**	**PK 005 875-T**	**PK 005 875-T**	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**	**PK 005 876-T**	**PK 005 876-T**	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**	**PK 005 877-T**	**PK 005 877-T**	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**	**PK 005 878-T**	**PK 005 878-T**	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**	**PK 005 879-T**	**PK 005 879-T**	**PK 005 879-T**

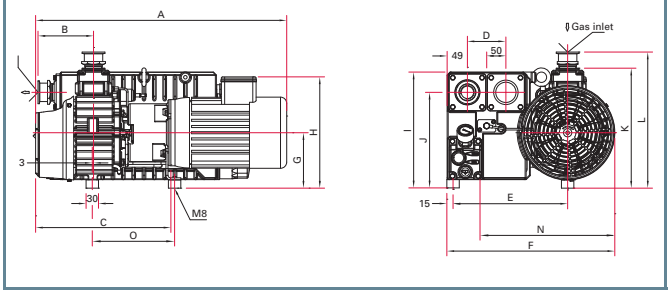
Hena 60

Single-stage, oil-sealed rotary vane pump with a pumping speed of 63 m³/h.

Hena 60

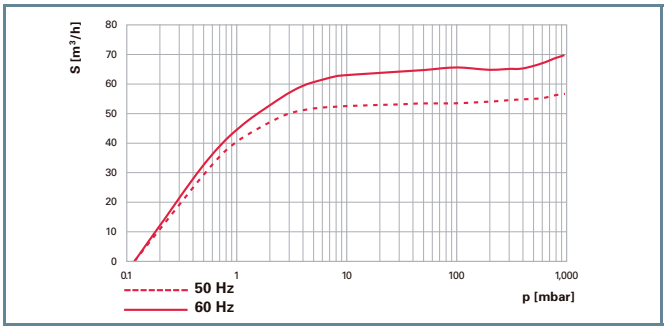
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 60, 3-ph Motor, 3TF, 200/400 V, 50 Hz 210/430 V, 60 Hz
A	640 mm
B	134 mm
C	327 mm
D	93 mm
E	277 mm
F	406 mm
G	134 mm
H	294 mm
I	280 mm
J	231 mm
K	290 mm
L	329 mm
O	199 mm

Pumping speed (without gas ballast)



Technical data	Hena 60
Flange (in)	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF
Operating fluid	D1
Pump fluid filling	2 l
Emission sound pressure level without gas ballast at 50 Hz	64 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	66 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	62 kg
Nominal rotation speed at 50 Hz	1500 1/min
Nominal rotation speed at 60 Hz	1800 1/min
Rated power 50 Hz	1.8 kW
Rated power 60 Hz	2.2 kW
Mains requirement: voltage	200/400 V, 50 Hz 210/430 V, 60 Hz
Mains requirement: voltage (range)	190-210 V, 380-420 V (+/- 5%) 50 Hz; 190-240 V, 380-480 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	63 m^3/h
Pumping speed at 60 Hz	76 m^3/h
Switch	No
Water vapor capacity 50 Hz	1800 g/h
Water vapor capacity 60 Hz	1800 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 60	**PK D02 300**

Accessories	
SAS 40, DN 40 ISO-KF, polyester filter	**PK Z60 510**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

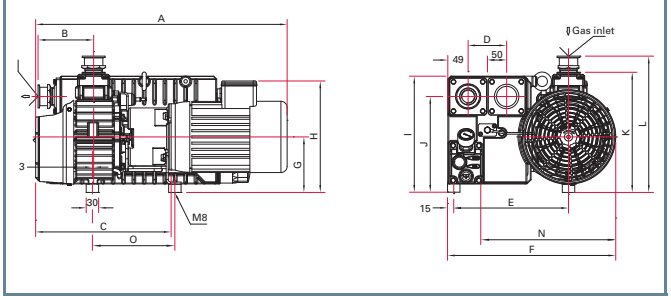
Hena 100

Single-stage, oil-sealed rotary vane pump with a pumping speed of 100 m³/h

Hena 100

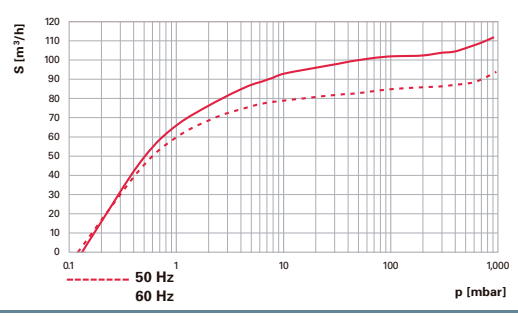
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 100, 3-ph Motor, 3TF, 200/400 V, 50 Hz 210/430 V, 60 Hz
A	699 mm
B	131 mm
C	387 mm
D	93 mm
E	277 mm
F	406 mm
G	134 mm
H	294 mm
I	280 mm
J	231 mm
K	290 mm
L	329 mm
O	226 mm

Pumping speed (without gas ballast)



Technical data	Hena 100
Flange (in)	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF
Operating fluid	D1
Pump fluid filling	2 l
Emission sound pressure level without gas ballast at 50 Hz	65 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	68 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	74 kg
Nominal rotation speed at 50 Hz	1500 1/min
Nominal rotation speed at 60 Hz	1800 1/min
Rated power 50 Hz	2.5 kW
Rated power 60 Hz	3 kW
Mains requirement: voltage	200/400 V, 50 Hz 210/430 V, 60 Hz
Mains requirement: voltage (range)	190-210 V, 380-420 V (+/- 5%) 50 Hz; 190-240 V, 380-480 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	100 m^3/h
Pumping speed at 60 Hz	120 m^3/h
Switch	No
Water vapor capacity 50 Hz	2800 g/h
Water vapor capacity 60 Hz	2800 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 100	**PK D02 350**

Accessories	
SAS 40, DN 40 ISO-KF, polyester filter	**PK Z60 510**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

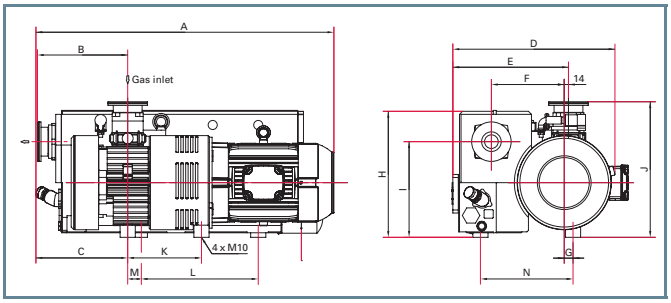
Hena 200

Single-stage, oil-sealed rotary vane pump with a pumping speed of 200 m³/h

Hena 200

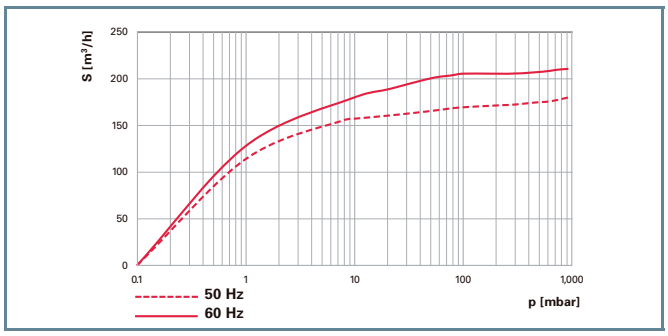
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 200, 3-ph Motor, 3TF, 400/690 V, 50 Hz 430/745 V, 60 Hz
A	981 mm
B	298 mm
C	302 mm
D	534 mm
E	381 mm
F	240 mm
G	29 mm
H	415 mm
I	315 mm
J	446 mm
K	243 mm
L	390 mm
M	40 mm
N	305 mm

Pumping speed (without gas ballast)



Technical data	Hena 200
Flange (in)	DN 100 ISO-K
Flange (out)	DN 100 ISO-K
Operating fluid	D1
Pump fluid filling	6.5 l
Emission sound pressure level without gas ballast at 50 Hz	72 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	74 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	170 kg
Nominal rotation speed at 50 Hz	1500 1/min
Nominal rotation speed at 60 Hz	1800 1/min
Rated power 50 Hz	5.5 kW
Rated power 60 Hz	5.5 kW
Mains requirement: voltage	400/690 V, 50 Hz 430/745 V, 60 Hz
Mains requirement: voltage (range)	380-420 V, 660-720 V (+/- 5%) 50 Hz; 380-480 V, 660-830 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	200 m^3/h
Pumping speed at 60 Hz	240 m^3/h
Switch	No
Water vapor capacity 50 Hz	4000 g/h
Water vapor capacity 60 Hz	4600 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 200	**PK D02 400**

Accessories	
SAS 100, DN 100 ISO-K, polyester filter	**PK Z60 512**
Operating fluid level monitoring	**PK 100 116**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

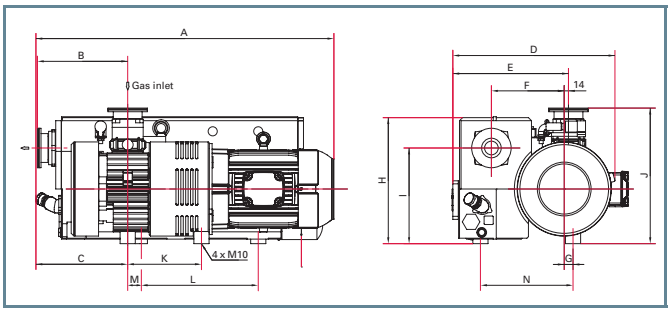
Hena 300

Single-stage, oil-sealed rotary vane pump with a pumping speed of 300 m³/h

Hena 300

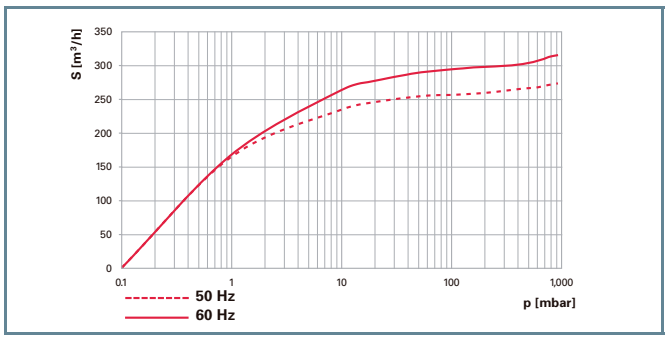
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 300, 3-ph Motor, 3TF, 400/690 V, 50 Hz 430/745 V, 60 Hz
A	1081 mm
B	337 mm
C	342 mm
D	536 mm
E	383 mm
F	240 mm
G	29 mm
H	408 mm
I	305 mm
J	437 mm
K	243 mm
L	390 mm
M	-
N	350 mm

Pumping speed (without gas ballast)



Technical data	Hena 300
Flange (in)	DN 100 ISO-K
Flange (out)	DN 100 ISO-K
Operating fluid	D1
Pump fluid filling	6.5 l
Emission sound pressure level without gas ballast at 50 Hz	74 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	76 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	215 kg
Nominal rotation speed at 50 Hz	1500 1/min
Nominal rotation speed at 60 Hz	1800 1/min
Rated power 50 Hz	7.5 kW
Rated power 60 Hz	7.5 kW
Mains requirement: voltage	400/690 V, 50 Hz 430/745 V, 60 Hz
Mains requirement: voltage (range)	380-420 V, 660-720 V (+/- 5%) 50 Hz; 380-480 V, 660-830 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	300 m^3/h
Pumping speed at 60 Hz	360 m^3/h
Switch	No
Water vapor capacity 50 Hz	5000 g/h
Water vapor capacity 60 Hz	5800 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 300	**PK D02 450**

Accessories	
SAS 100, DN 100 ISO-K, polyester filter	**PK Z60 512**
Operating fluid level monitoring	**PK 100 116**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

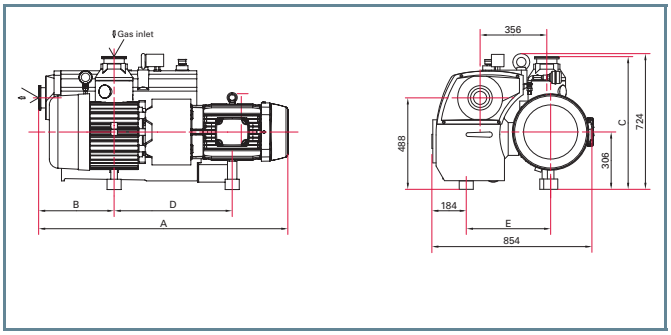
Hena 400

Single-stage, oil-sealed rotary vane pump with a pumping speed of 400 m³/h

Hena 400

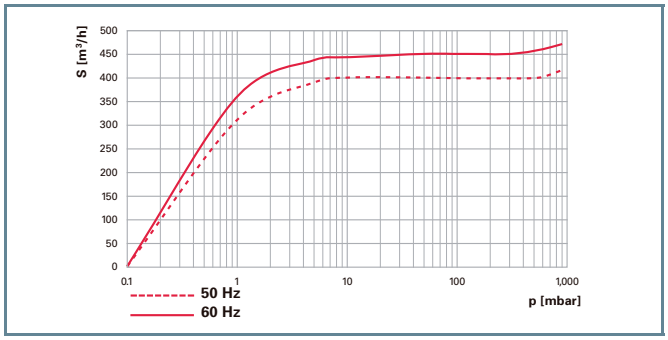
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 400, 3-ph Motor, 3TF, 400/690 V, 50 Hz 430/745 V, 60 Hz
A	1392 mm
B	402 mm
C	708 mm
D	657 mm
E	451 mm

Pumping speed (without gas ballast)



Technical data	Hena 400
Flange (in)	DN 100 ISO-K
Flange (out)	DN 100 ISO-K
Operating fluid	D1
Pump fluid filling	12 l
Emission sound pressure level without gas ballast at 50 Hz	77 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	79 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	465 kg
Nominal rotation speed at 50 Hz	1000 1/min
Nominal rotation speed at 60 Hz	1200 1/min
Rated power 50 Hz	11 kW
Rated power 60 Hz	15 kW
Mains requirement: voltage	400/690 V, 50 Hz 430/745 V, 60 Hz
Mains requirement: voltage (range)	380-420 V, 660-720 V (+/- 5%) 50 Hz; 380-480 V, 660-830 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	400 m^3/h
Pumping speed at 60 Hz	480 m^3/h
Switch	No
Water vapor capacity 50 Hz	9000 g/h
Water vapor capacity 60 Hz	11000 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 400	**PK D02 500**

Accessories	
SAS 100, DN 100 ISO-K, polyester filter	**PK Z60 512**
Operating fluid level monitoring	**PK 100 116**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

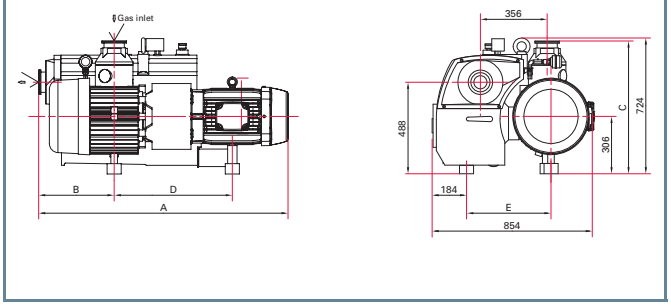
Hena 630

Single-stage, oil-sealed rotary vane pump with a pumping speed of 630 m³/h

Hena 630

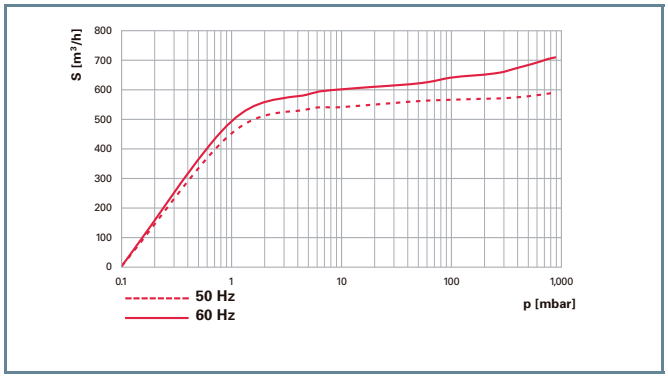
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 630, 3-ph Motor, 3TF, 400/690 V, 50 Hz 430/745 V, 60 Hz
A	1774 mm
B	556 mm
C	711 mm
D	846 mm
E	451 mm

Pumping speed (without gas ballast)



Technical data	Hena 630
Flange (in)	DN 100 ISO-K
Flange (out)	DN 100 ISO-K
Operating fluid	D1
Pump fluid filling	15 l
Emission sound pressure level without gas ballast at 50 Hz	77 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	79 dB (A)
Ultimate pressure with gas ballast	1.5 mbar
Ultimate pressure without gas ballast	0.2 mbar
Weight	620 kg
Nominal rotation speed at 50 Hz	1000 1/min
Nominal rotation speed at 60 Hz	1200 1/min
Rated power 50 Hz	15 kW
Rated power 60 Hz	18.5 kW
Mains requirement: voltage	400/690 V, 50 Hz 430/745 V, 60 Hz
Mains requirement: voltage (range)	380-420 V, 660-720 V (+/- 5%) 50 Hz; 380-480 V, 660-830 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	630 m^3/h
Pumping speed at 60 Hz	760 m^3/h
Switch	No
Water vapor capacity 50 Hz	18000 g/h
Water vapor capacity 60 Hz	22000 g/h
Water vapor tolerance at 50 Hz	40 mbar
Water vapor tolerance at 60 Hz	40 mbar

Order number	
Hena 630	**PK D02 600**

Accessories	
SAS 100, DN 100 ISO-K, polyester filter	**PK Z60 512**
Operating fluid level monitoring	**PK 100 116**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

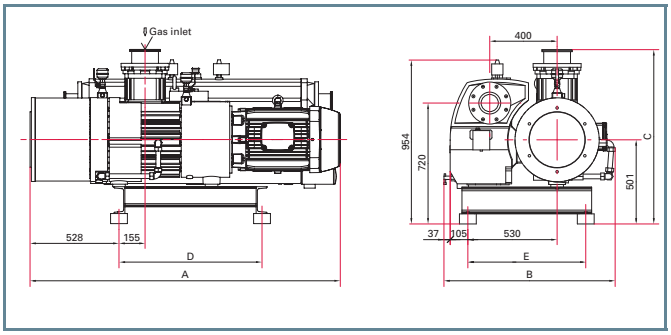
Hena 1000

Single-stage, oil-sealed rotary vane pump with a pumping speed of 1000 m³/h

Hena 1000

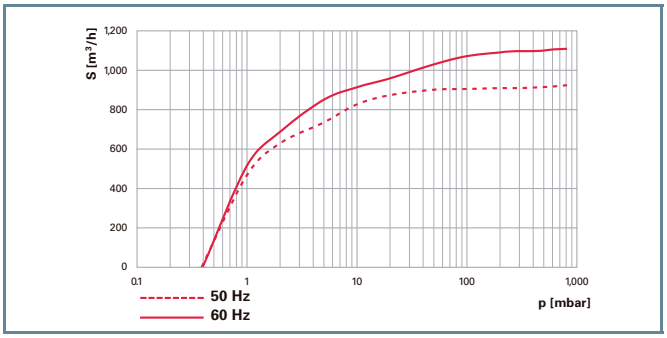
- For industrial applications - very powerful
- Various motor voltages afford worldwide employment
- Integrated oil mist separator provides the highest degree of separation
- Special vane material for long service life

Dimensions



	Hena 1000, 3-ph Motor, 3TF, 400/690 V, 50 Hz 430/745 V, 60 Hz
A	1891 mm
B	1017 mm
C	1038 mm
D	850 mm
E	700 mm

Pumping speed (without gas ballast)



Technical data	Hena 1000
Flange (in)	DN 160 ISO-K
Flange (out)	DN 100 ISO-K
Operating fluid	D1
Pump fluid filling	30 l
Emission sound pressure level without gas ballast at 50 Hz	82 dB (A)
Emission sound pressure level without gas ballast at 60 Hz	82 dB (A)
Ultimate pressure with gas ballast	3 mbar
Ultimate pressure without gas ballast	0.4 mbar
Weight	1080 kg
Nominal rotation speed at 50 Hz	1000 1/min
Nominal rotation speed at 60 Hz	1200 1/min
Rated power 50 Hz	22 kW
Rated power 60 Hz	30 kW
Mains requirement: voltage	400/690 V, 50 Hz 430/745 V, 60 Hz
Mains requirement: voltage (range)	380-420 V, 660-720 V (+/- 5%) 50 Hz; 380-480 V, 660-830 V (+/- 5%) 60 Hz
Pumping speed at 50 Hz	1000 m^3/h
Pumping speed at 60 Hz	1200 m^3/h
Switch	No
Water vapor capacity 50 Hz	19000 g/h
Water vapor capacity 60 Hz	19000 g/h
Water vapor tolerance at 50 Hz	30 mbar
Water vapor tolerance at 60 Hz	30 mbar

Order number	
Hena 1000	**PK D02 700**

Accessories	
SAS 160, DN 160 ISO-K, polyester filter	**PK Z60 514**
Barretter actuation unit 3 TF	**P4 768 051 FQ**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

UnoLine™ Plus

A rugged rotary vane pump.
For harshest industrial use.

What is UnoLine Plus?
The UnoLine Plus is an optimum solution for industrial applications. This rotary vane pump has a proven track record for highest reliability as both a stand-alone pump and as a backing pump for Pfeiffer Vacuum Roots pumps.

This is a water-cooled pump that is extremely resistant to dust and dirt. It is equipped with an oil regeneration system.

This enables condensate, dirt and dust particles to be removed from the operating fluid, collected in the vapor separator and then drained. The adjustable cooling water regulating valve keeps the UnoLine Plus at the required operating temperature. The pumps are equipped with a gas ballast system for pumping off vapors.

UnoLine Plus – The workhorse that offers extremely high vapor capacity!

Advantages at a glance

Rugged and long-lasting

- Low cost of ownership

Resistant to dust and dirt

- Maximum process compatibility

Bearings not in contact with process vapors / gases

- Highest reliability

Extremely low speed

- Maximum service life time

Very high water vapor capacity

- Best suitable for drying processes

Cooling water controller for ideal temperature control

- Optimum process adaption

Applications

- Transformer drying
- Cable drying
- Oil recovery
- Metallurgy
- Coating
- Chemistry and process technology

Metallurgy

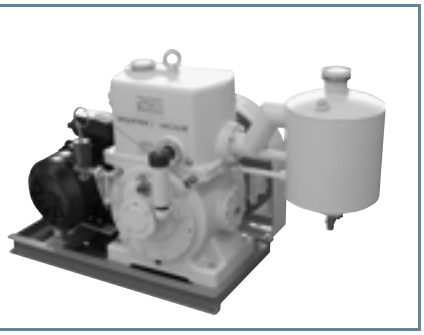
Vacuum furnaces

Transformer drying

UnoLine™ Plus

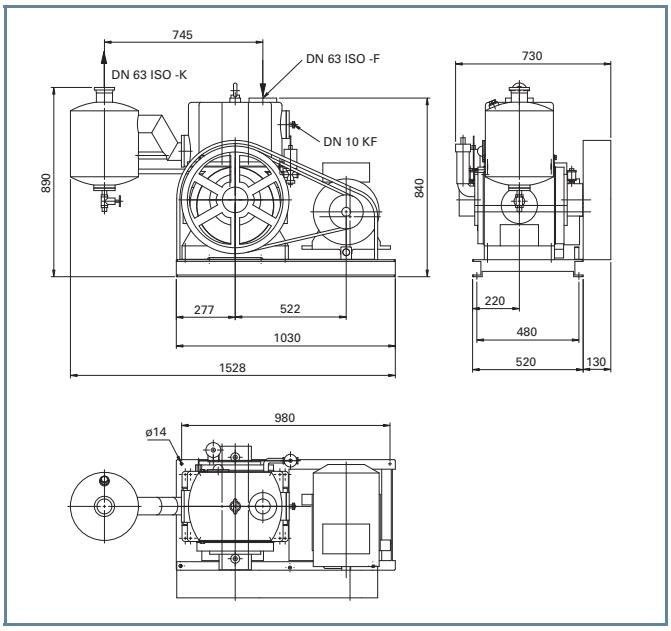
Single-stage, high-performance rotary vane pump with a pumping speed of 251 m³/h

UnoLine™ Plus



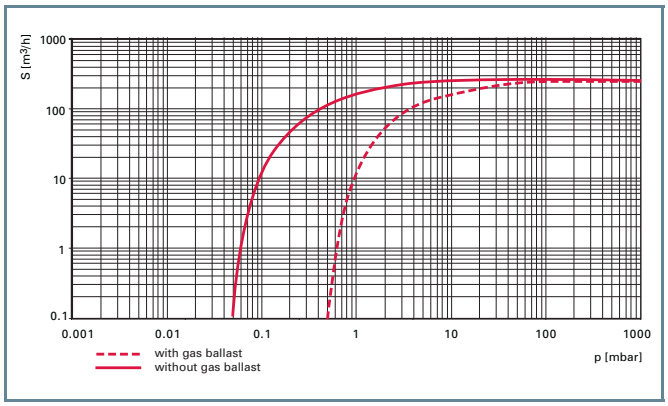
- ▶ Rugged and powerful
- ▶ Integrated gas ballast valve
- ▶ For all low and medium vacuum applications

Dimensions



BA 251

Pumping speed



BA 251

Technical data	BA 251, 3-ph Motor, 220-240/ 380-420 V	BA 251, 3-phase Motor, 440-480 V
Flange (in)	DN 63 ISO-F	DN 63 ISO-F
Flange (out)	DN 63 ISO-K	DN 63 ISO-K
Operating fluid	P 3	P 3
Pump fluid filling	17 l	17 l
Emission sound pressure level without gas ballast	≤ 63 dB (A)	≤ 63 dB (A)
Ultimate pressure with gas ballast	≤ $6 \cdot 10^{-1}$ mbar	≤ $6 \cdot 10^{-1}$ mbar
Ultimate pressure without gas ballast	≤ $6 \cdot 10^{-2}$ mbar	≤ $6 \cdot 10^{-2}$ mbar
Weight: with motor	570 kg	570 kg
Cooling water consumption	50 l/h	50 l/h
Nominal rotation speed at 50 Hz	490 rpm	-
Nominal rotation speed at 60 Hz	-	490 rpm
Rated power 50 Hz	11 kW	-
Rated power 60 Hz	-	12.5 kW
Mains requirement: frequency (range)	220-240 / 380-420 V (+/- 5 %), 50 Hz	440-480 V (+/- 5 %) 60 Hz
Mains cable	no	no
Pumping speed at 50 Hz	250 m^3/h	-
Pumping speed at 60 Hz	-	250 m^3/h
Switch	no	no
Water vapor capacity 50 Hz	7000 g/h	-
Water vapor capacity 60 Hz	-	7000 g/h
Water vapor tolerance at 50 Hz	30 mbar	-
Water vapor tolerance at 60 Hz	-	30 mbar
Water cooling	yes	yes

Order number		
UnoLine™ Plus	**PK C42 602**	**PK C42 637**

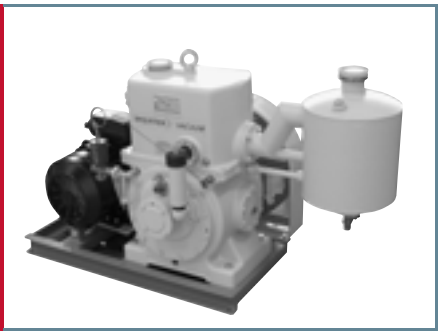
Accessories		
Barretter actuation unit 3TF	**P4 768 051 FQ**	**P4 768 051 FQ**
Pressure monitor for cooling water circulation system BA 251/501	**P47 47 161 MF**	**P47 47 161 MF**
Condensate separators	**PK Z10 010**	**PK Z10 010**
Dust separators	**PK Z60 210**	**PK Z60 210**
Adsorption filter	**PK Z30 010**	**PK Z30 010**
Cooling water connection unit for BA 251 / 501	**PK 133 100-T**	**PK 133 100-T**
Operating fluid level monitoring, 24 V DC for BA 251 / 501	**PK 133 115-T**	**PK 133 115-T**

Consumable material		
P3, mineral oil, 1 l	**PK 001 106-T**	**PK 001 106-T**
P3, mineral oil, 5 l	**PK 001 107-T**	**PK 001 107-T**
P3, mineral oil, 20 l	**PK 001 108-T**	**PK 001 108-T**

UnoLine™ Plus

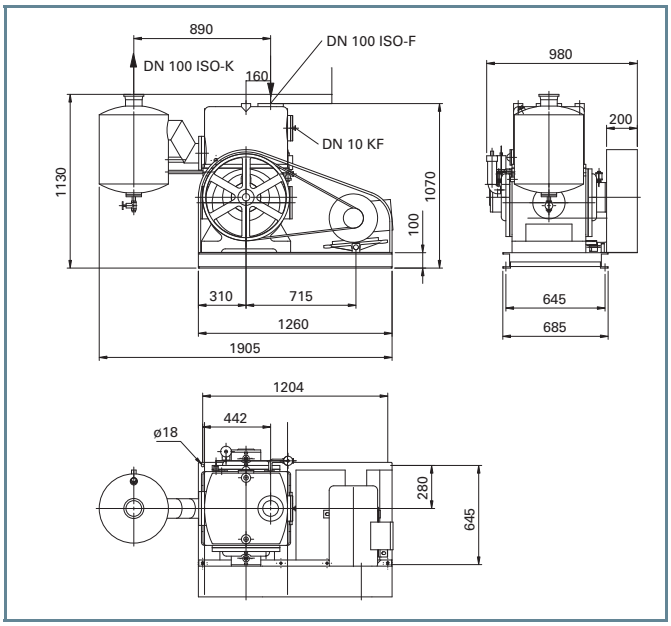
Single-stage, high-performance rotary vane pump with a pumping speed of 501 m³/h

UnoLine™ Plus



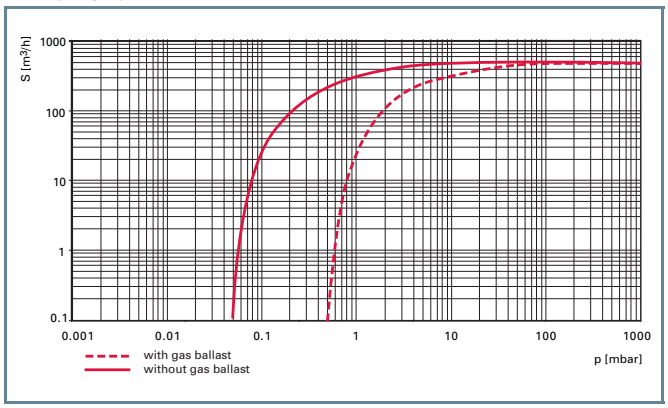
- ▶ Rugged and powerful
- ▶ Integrated gas ballast valve
- ▶ For all low and medium vacuum applications

Dimensions



BA 501

Pumping speed



BA 501

Technical data	BA 501, 3-phase Motor, 220-240/ 380-420 V	BA 501, 3-phase Motor, 440-480 V
Flange (in)	DN 100 ISO-F	DN 100 ISO-F
Flange (out)	DN 100 ISO-K	DN 100 ISO-K
Operating fluid	P 3	P 3
Pump fluid filling	45 l	45 l
Emission sound pressure level without gas ballast	≤ 65 dB (A)	≤ 65 dB (A)
Ultimate pressure with gas ballast	≤ $6 \cdot 10^{-1}$ mbar	≤ $6 \cdot 10^{-1}$ mbar
Ultimate pressure without gas ballast	≤ $6 \cdot 10^{-2}$ mbar	≤ $6 \cdot 10^{-2}$ mbar
Weight: with motor	1100 kg	1100 kg
Cooling water consumption	90 l/h	90 l/h
Nominal rotation speed at 50 Hz	345 rpm	-
Nominal rotation speed at 60 Hz	-	345 rpm
Rated power 50 Hz	15 kW	-
Rated power 60 Hz	-	17 kW
Mains requirement: frequency (range)	220-240 V / 380-420 V (+/- 5 %), 50 Hz	440-480 V (+/- 5 %), 60 Hz
Mains cable	no	no
Pumping speed at 50 Hz	500 m^3/h	-
Pumping speed at 60 Hz	-	500 m^3/h
Switch	no	no
Water vapor capacity 50 Hz	14000 g/h	-
Water vapor capacity 60 Hz	-	14000 g/h
Water vapor tolerance at 50 Hz	30 mbar	-
Water vapor tolerance at 60 Hz	-	30 mbar
Water cooling	yes	yes

Order number		
UnoLine™ Plus	**PK C43 602**	**PK C43 637**

Accessories		
Barretter actuation unit 3TF	**P4 768 051 FQ**	**P4 768 051 FQ**
Pressure monitor for cooling water circulation system BA 251/501	**P47 47 161 MF**	**P47 47 161 MF**
Condensate separators	**PK Z10 012**	**PK Z10 012**
Dust separators	**PK Z60 212**	**PK Z60 212**
Adsorption filter	**PK Z30 012**	**PK Z30 012**
Cooling water connection unit for BA 251 / 501	**PK 133 100-T**	**PK 133 100-T**
Operating fluid level monitoring, 24 V DC for BA 251 / 501	**PK 133 115-T**	**PK 133 115-T**

Consumable material		
P3, mineral oil, 1 l	**PK 001 106-T**	**PK 001 106-T**
P3, mineral oil, 5 l	**PK 001 107-T**	**PK 001 107-T**
P3, mineral oil, 20 l	**PK 001 108-T**	**PK 001 108-T**
P3, mineral oil, 50 l	**PK 001 109-T**	**PK 001 109-T**

The PentaLine™ innovation

A new generation of two-stage rotary vane pumps!

What is PentaLine?

Two-stage rotary vane pumps with pumping speeds up to 35 m^3/h that live up to their promise of reliability and dependability under even the most punishing conditions. PentaLine pumps are able to capably handle both industrial tasks like drying and metallurgical processes, analytical environments, coating or research & development applications.

Advantages at a glance

- Standby mode –
  Longer service life, intelligent process control

- Power-saving –
  Lower operating costs (-50 %), environmentally friendly
- Worldwide power supply –
  Simple logistics, connects to all standard power supply systems
- Lowest switch-on current –
  Easy system integration, cost reduction
- Hermetically sealed –
  No oil leakage, significantly improved leak rate versus conventional rotary vane pumps
- Runs cooler –
  Gives off less heat in standard operation
- Quiet –
  Low vibration, peaceful work environment
- High water vapor tolerance –
  Process reliability thanks to temperature control
- Simple service concept –
  Minimum maintenance costs

Applications

Industry

- Freeze drying
- Metallurgy
- Vacuum degassing

Analytics

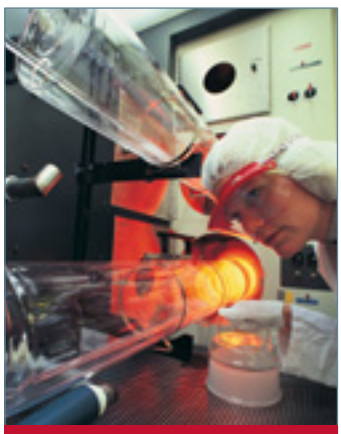
- Mass spectrometry
- Electron microscopy
- Leak detection
- Gas analysis

Research & development

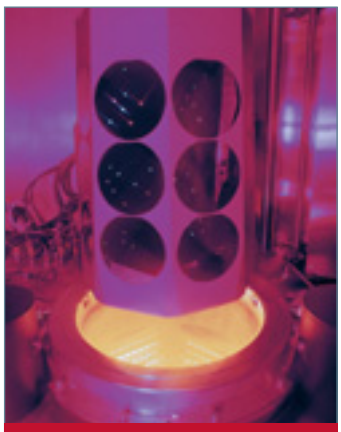
Coating

- Used as backing pumps for turbopumps in wear protection, solar technology and ophthalmics

Analytics



Research & development



Industry

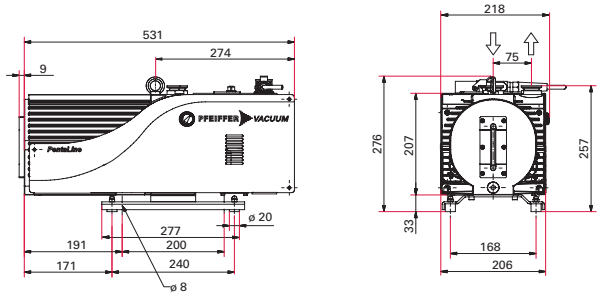
Penta 10

Innovative rotary vane pumps with a pumping speed of 11 m³/h, power-saving worldwide motor and standby function

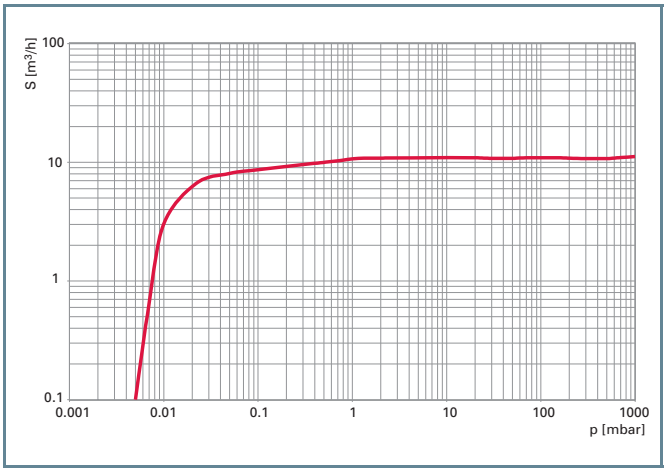
Penta 10

- ▶ Extremely quiet, low-vibration rotary vane pump
- ▶ Stand-by function for intelligent process control and energy savings
- ▶ Hermetical sealing without dynamic seal sustainably prevents leaks
- ▶ Integrated motor with worldwide power supply simplifies integration and offers the same performance data regardless of power supply frequency
- ▶ Low power consumption and reduced heat
- ▶ Compact design ideal for systems integration
- ▶ Integrated high vacuum safety valve offers maximum reliability

Dimensions



Pumping speed



Technical data	Penta 10
Flange (in)	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF
Operating fluid	P3
Pump fluid filling	2.2 l
Rotation speed at stand-by	900 1/min
Rotation speed max.	1800 1/min
Emission sound pressure level without gas ballast	56 dB (A)
Ultimate pressure with gas ballast	≤ $1 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar
Weight	42 kg
Max. power consumption: pump	0.555 kW
Power consumption at 1 mbar	0.39 kW
Power consumption in stand-by mode	0.21 kW
Mains requirement: voltage	110/220 V, 50/60 Hz
Mains requirement: voltage (range)	100-120 V, +/- 10 %, 50/60 Hz 200-240 V, +/- 10 %, 50/60 Hz
Pumping speed, max.	11 m^3/h
Switch	No
Current, max. at 230 V, 50/60 Hz	2.7 A
Temperature: Operating	12 ... 40 °C
Temperature: Storage	- 25 ... 70 °C
Temperature: Transport	- 25 ... 55 °C
Water vapor capacity, max.	250 g/h
Water vapor tolerance, max.	30 mbar

Order number	
Penta 10	**PK D73 010**

Accessories	
STP 025, dust separator, single-stage for minor contamination	**PK Z60 206**
KAS 25, Condensate separator for pumping speeds of up to 10 m^3/h	**PK Z10 032**
ONF 25, oil mist separator for pumping speeds of up to 10 m^3/h	**PK Z40 157**
Oil return system from oil mist separator	**PK198545-T**
ZFO 025, zeolite trap	**PK Z70 006**
URB 025, catalytic trap, 230 V	**PT U10 760**
URB 025, catalytic trap, 115 V	**PT U10 761**
Oil pressure switch	**PK 196 449**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
Customizable power supply plug	**PM 061 200-T**
Customizable release connector	**PK 198 548**

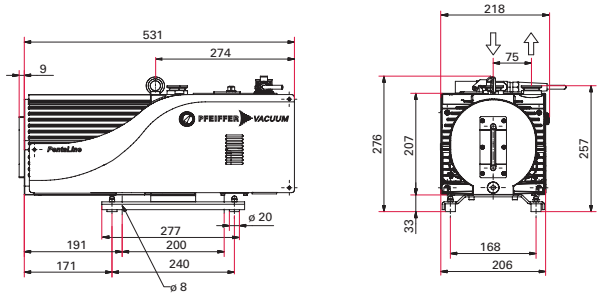
Penta 20

Innovative rotary vane pumps with a pumping speed of 22 m³/h, power-saving worldwide motor and standby function

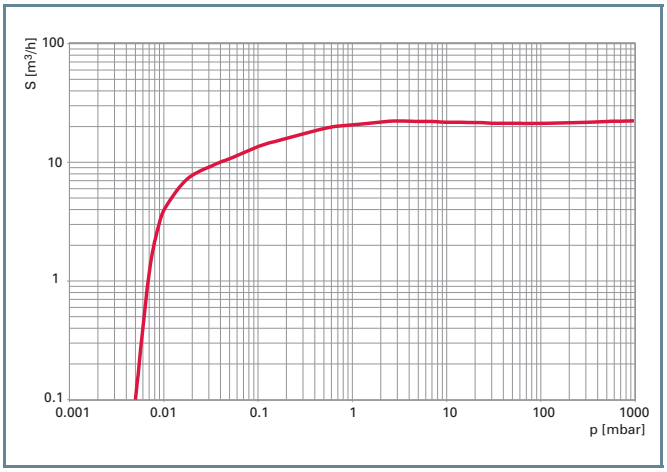
Penta 20

- ▶ Extremely quiet, low-vibration rotary vane pump
- ▶ Stand-by function for intelligent process control and energy savings
- ▶ Hermetical sealing without dynamic seal sustainably prevents leaks
- ▶ Integrated motor with worldwide power supply simplifies integration and offers the same performance data regardless of power supply frequency
- ▶ Low power consumption and reduced heat
- ▶ Compact design ideal for systems integration
- ▶ Integrated high vacuum safety valve offers maximum reliability

Dimensions



Pumping speed



Technical data	Penta 20
Flange (in)	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF
Operating fluid	P3
Pump fluid filling	1.8 l
Rotation speed at stand-by	900 1/min
Rotation speed max.	1800 1/min
Emission sound pressure level without gas ballast	58 dB (A)
Ultimate pressure with gas ballast	≤ $1 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar
Weight	43 kg
Max. power consumption: pump	0.99 kW
Power consumption at 1 mbar	0.41 kW
Power consumption in stand-by mode	0.225 kW
Mains requirement: voltage	110/220 V, 50/60 Hz
Mains requirement: voltage (range)	100-120 V, +/- 10 %, 50/60 Hz 200-240 V, +/- 10 %, 50/60 Hz
Pumping speed, max.	22 m^3/h
Switch	No
Current, max. at 230 V, 50/60 Hz	4.8 A
Temperature: Operating	12 ... 40 °C
Temperature: Storage	- 25 ... 70 °C
Temperature: Transport	- 25 ... 55 °C
Water vapor capacity, max.	300 g/h
Water vapor tolerance, max.	18 mbar

Order number	
Penta 20	**PK D74 010**

Accessories	
STP 025, dust separator, single-stage for minor contamination	**PK Z60 206**
KAS 25 L, Condensate separator for pumping speeds of up to 20 m^3/h	**PK Z10 033**
ONF 25 L, oil mist separator for pumping speeds of up to 20 m^3/h	**PK Z40 158**
Oil return system from oil mist separator	**PK198545-T**
ZFO 025, zeolite trap	**PK Z70 006**
URB 025, catalytic trap, 230 V	**PT U10 760**
URB 025, catalytic trap, 115 V	**PT U10 761**
Oil pressure switch	**PK 196 449**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
Customizable power supply plug	**PM 061 200-T**
Customizable release connector	**PK 198 548**

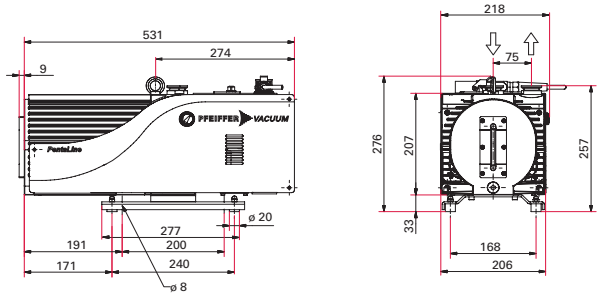
Penta 35

Innovative rotary vane pumps with a pumping speed of 34 m³/h, power-saving worldwide motor and standby function

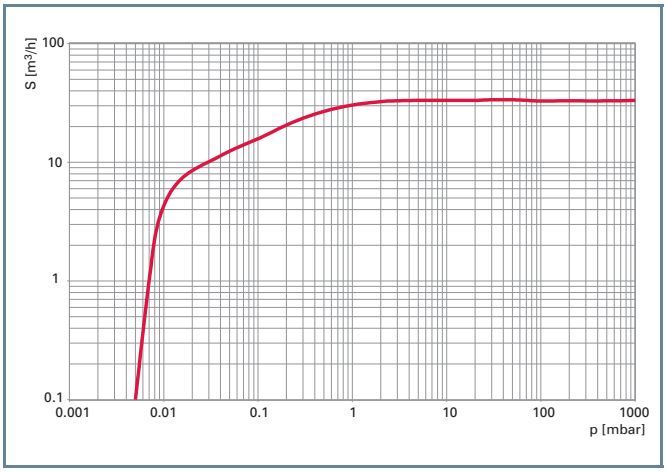
Penta 35

- ▶ Extremely quiet, low-vibration rotary vane pump
- ▶ Stand-by function for intelligent process control and energy savings
- ▶ Hermetical sealing without dynamic seal sustainably prevents leaks
- ▶ Integrated motor with worldwide power supply simplifies integration and offers the same performance data regardless of power supply frequency
- ▶ Low power consumption and reduced heat
- ▶ Compact design ideal for systems integration
- ▶ Integrated high vacuum safety valve offers maximum reliability

Dimensions



Pumping speed



Technical data	Penta 35
Flange (in)	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF
Operating fluid	P3
Pump fluid filling	1.5 l
Rotation speed at stand-by	900 1/min
Rotation speed max.	1800 1/min
Emission sound pressure level without gas ballast	58 dB (A)
Ultimate pressure with gas ballast	≤ $1 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar
Weight	45
Max. power consumption: pump	1,475 kW
Power consumption at 1 mbar	0.41 kW
Power consumption in stand-by mode	0.225 kW
Mains requirement: voltage	110/220 V, 50/60 Hz
Mains requirement: voltage (range)	100-120 V, +/- 10 %, 50/60 Hz 200-240 V, +/- 10 %, 50/60 Hz
Pumping speed, max.	34 m^3/h
Switch	No
Current, max. at 230 V, 50/60 Hz	7 A
Temperature: Operating	12 ... 40 °C
Temperature: Storage	- 25 ... 70 °C
Temperature: Transport	- 25 ... 55 °C
Water vapor capacity, max.	370 g/h
Water vapor tolerance, max.	17 mbar

Order number	
Penta 35	**PK D75 010**

Accessories	
STP 025, dust separator, single-stage for minor contamination	**PK Z60 206**
KAS 25 L, Condensate separator for pumping speeds of up to 20 m^3/h	**PK Z10 033**
ONF 25 XL, oil mist separator for pumping speeds of up to 34 m^3/h	**PK Z40 160**
Oil return system from oil mist separator	**PK198545-T**
ZFO 025, zeolite trap	**PK Z70 006**
URB 025, catalytic trap, 230 V	**PT U10 760**
URB 025, catalytic trap, 115 V	**PT U10 761**
Oil pressure switch	**PK 196 449**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
Customizable power supply plug	**PM 061 200-T**
Customizable release connector	**PK 198 548**

DuoLine™

Two-stage rotary vane pumps with magnetically coupled drive. Cleaner and more dependable for your process and the environment.

What is DuoLine?

DuoLine rotary vane pumps cover allapplications in the low and medium vacuum range of up to 10^{-3} mbar. These pumps offer reliable operation even for such critical industrial applications as drying processes, metallurgical processes or resin potting and casting systems – either as a standalone pump or as a backing pump in our CombiLine or turbo pumping stations.

Thanks to their innovative drive concept, these pumps are hermetically sealed, making them clean and environmentally compatible. Because our magnetically coupled rotary vane pumps do not have radial shaft seals, there is no oil leak.

The use of a magnetic coupling minimizes maintenance requirements and leads to considerable cost savings per pump and maintenance interval.

Advantages at a glance

- Environmentally friendly
- No oil leaks through defective shaft seals
- No exchange between process gas and the environment
- Corrosion-proof because they contain no non-ferrous metals
- Extensive accessories for monitoring and systems integration
- Process integrity thanks to an integral, hydraulically controlled high-speed high vacuum safety valve
- Low operating costs –
  No radial shaft seal ring maintenance required
- High availability –
  No unexpected process interruptions caused by oil leaks
- Very quiet operation –
  No additional silencing necessary

Applications

- Chemistry and process technology
- Thin layer technology
- Semiconductor process technology
- Research & development
- Mechanical engineering
- Metallurgy
- Packaging/freeze-drying
- Mass spectrometry
- Backing pump for turbopumps
- Laboratory use

Vacuum chamber for the production of LCD-Displays with Duo 10 M

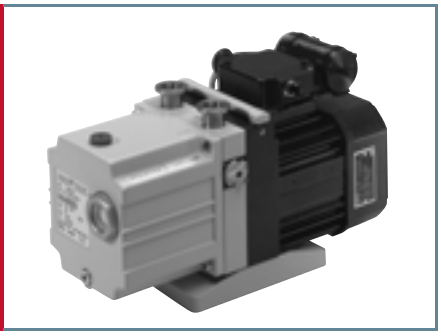
Ophthalmic coaters with THP 2101 and DUO 35 rotary vane pump

Leak detection system with DuoLine rotary vane pumps for refrigeration components

DUO 2.5

Dual-stage rotary vane pumps with a pumping speed of 2.5 m³/h:

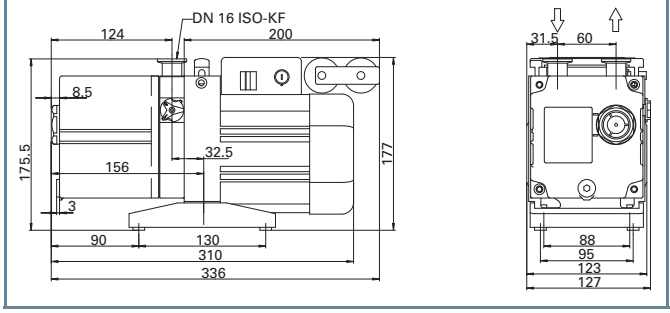
DUO 2.5



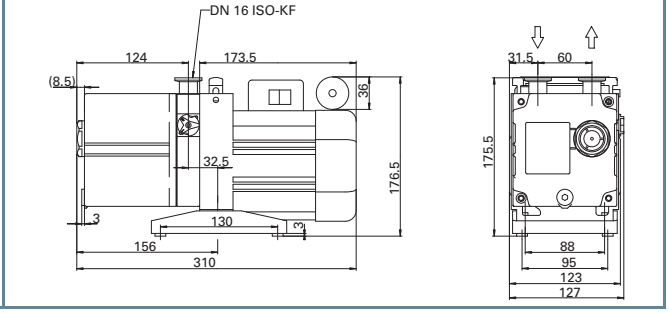
- ▶ Compact design - Excellent performance data
- ▶ Integrated safety and gas ballast valve
- ▶ Contain no non-ferrous metals
- ▶ Various motor voltages afford worldwide employment
- ▶ The most compact pumps in this pumping speed class

C = Corrosive gas version

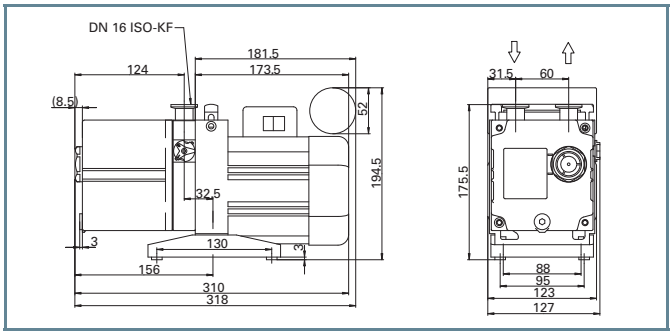
Dimensions



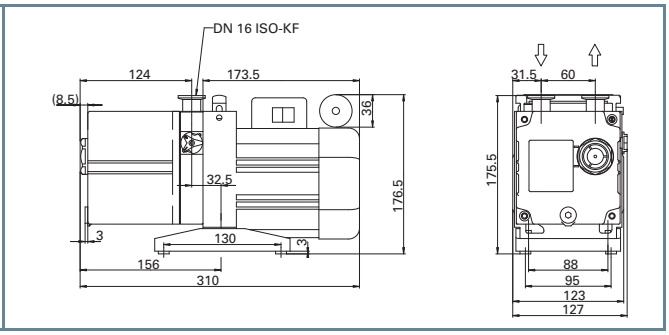
DUO 2.5, 1-phase, 115/230 V (+/- 10%) 50/60 Hz



DUO 2.5, 1-phase, 220-240 V (+/- 5 %) 50 Hz/60 Hz
DUO 2.5, 1-phase, 190-210 V (+/- 5 %) 50 Hz;
200-220 V (+/- 5 %) 60 Hz

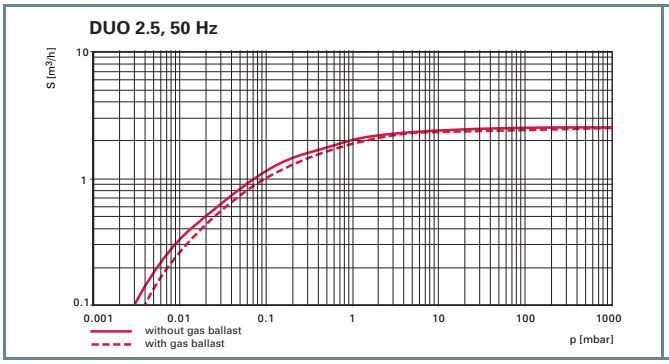


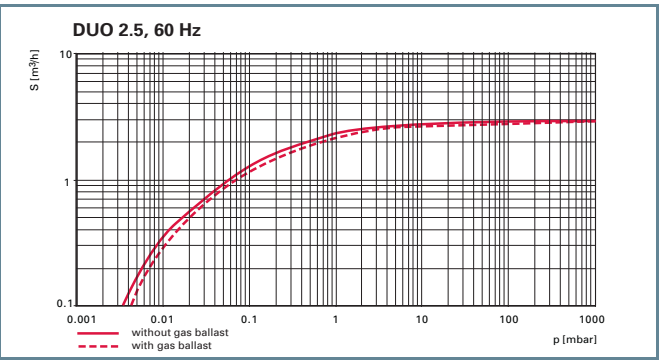
DUO 2.5, 1-phase, 100-105 V (+/- 5 %) 50 Hz;
110-130 V (+/- 5 %) 60 Hz



DUO 2.5, 1-phase, 190-210 V (+/- 5 %) 50 Hz;
200-220 V (+/- 5 %) 60 Hz

Pumping speed





Technical data	DUO 2.5	DUO 2.5 C
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 16 ISO-KF
Operating fluid	P 3	F 4
Pump fluid filling	0.4 l	0.4 l
Rotation speed at 50 Hz	3000 1/rpm	3000 1/rpm
Rotation speed at 60 Hz	3600 1/rpm	3600 1/rpm
Emission sound pressure level without gas ballast	≤ 53 dB (A)	≤ 53 dB (A)
Ultimate pressure with gas ballast	≤ $6 \cdot 10^{-3}$ mbar	≤ $6 \cdot 10^{-3}$ mbar
Ultimate pressure without gas ballast	≤ $6 \cdot 10^{-3}$ mbar	≤ $6 \cdot 10^{-3}$ mbar
Weight	10.5 kg	10.5 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	0.15 kW	0.15 kW
Rated power 60 Hz	0.18 kW	0.18 kW
Pumping speed at 50 Hz	2.5 m^3/h	2.5 m^3/h
Pumping speed at 60 Hz	2.9 m^3/h	2.9 m^3/h
Water vapor capacity 50 Hz	30 g/h	30 g/h
Water vapor capacity 60 Hz	34 g/h	34 g/h
Water vapor tolerance at 50 Hz	15 mbar	15 mbar
Water vapor tolerance at 60 Hz	15 mbar	15 mbar

Order number		
115/230 V (+/- 10%) 50/60 Hz	**PK D41 050**	
95-105 V (+/- 5%) 50 Hz; 100-115 V (+/- 5%) 60 Hz	**PK D41 708**	
220-240 V (+/- 5 %) 50 Hz/60 Hz	**PK D41 712**	**PK D41 014**
190-210 V (+/- 5 %) 50 Hz; 200-220 V (+/- 5 %) 60 Hz	**PK D41 709**	
100-105 V (+/- 5 %) 50 Hz; 110-130 V (+/- 5 %) 60 Hz	**PK D41 707**	**PK D41 019**

Accessories		
KAS 16, Condensate separator for pumping speeds of up to 2.5-5 m^3/h	**PK Z10 003**	
ONF 16, oil mist separator for pumping speeds of up to 2.5-5 m^3/h	**PK Z40 003**	
Oil return unit from ONF 16 to DUO 2.5	**PK 194 315-T**	
STP 016, dust separator, single-stage for minor contamination	**PK Z60 203**	
ZFO 016, zeolite trap	**PK Z70 003**	

Pump fluid		
P3, mineral oil, 0.5 l	**PK 001 136-T**	
F4, Perfluorpolyether, 0.5 l		**PK 005 886-T**

DUO 5 M

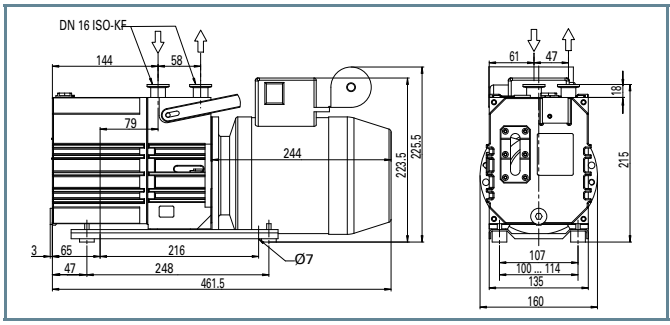
Dual-stage, rotary vane pumps with a pumping speed of 5 m³/h:

DUO 5 M

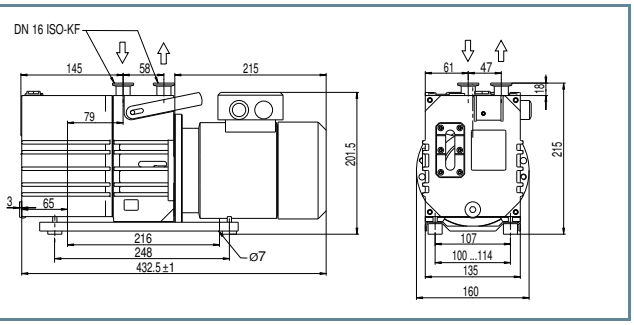
- ▶ Reliable, clean, low maintenance
- ▶ Compact design - Excellent performance data
- ▶ Integrated safety and gas ballast valve
- ▶ Contain no non-ferrous metals
- ▶ Various motor voltages afford worldwide employment

M = Magnetically coupled
MC = Corrosive gas version, magnetically coupled
TF = Temperature sensor

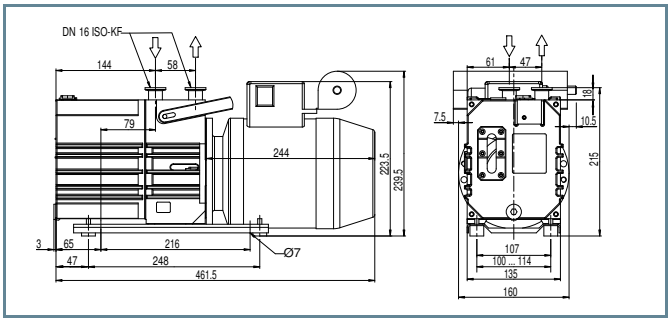
Dimensions



DUO 5 M, 1-phase, 200-240 V (+/- 5 %) 50 Hz;
208-240 V (+/- 5 %) 60 Hz



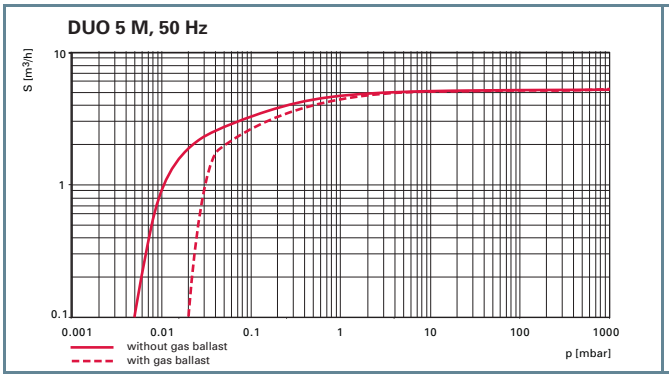
DUO 5 M, 3-phase, 3 TF, 218-242/380-420 V (+/- 5 %) 50 Hz;
254-277/440-480 V (+/- 5 %) 60 Hz

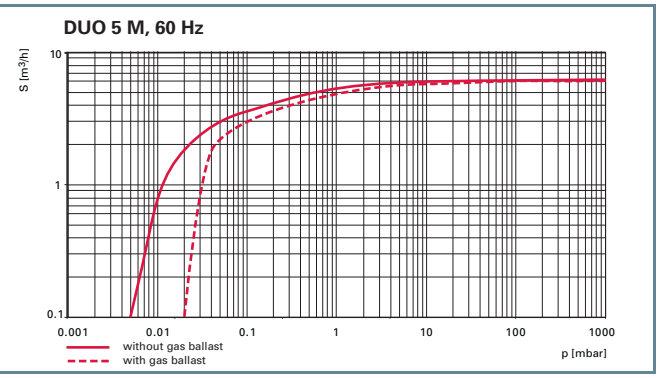


DUO 5 M, 1-phase, 95-120 V (+/- 5 %) 50 Hz;
105-120 V (+/- 5 %) 60 Hz

DUO 5 M, 3-phase, 380-420 V (+/- 5 %) 50 Hz
DUO 5 M, 3-phase, 190-210/330-365 V (+/- 5 %) 50 Hz;
208-230/360-400 V (+/- 5 %) 60 Hz

Pumping speed





Technical data	DUO 5 M	DUO 5 MC
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 16 ISO-KF
Operating fluid	P 3	F 4
Pump fluid filling	0.75 l	0.75 l
Rotation speed at 50 Hz	1500 1/rpm	1500 1/rpm
Rotation speed at 60 Hz	1800 1/rpm	1800 1/rpm
Emission sound pressure level without gas ballast	≤ 55 dB (A)	≤ 57 dB (A)
Ultimate pressure with gas ballast	≤ $2 \cdot 10^{-2}$ mbar	≤ $2 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar
Weight	19 kg	22 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	0.25 kW	0.37 kW
Rated power 60 Hz	0.25 kW	0.37 kW
Pumping speed at 50 Hz	5 m^3/h	5 m^3/h
Pumping speed at 60 Hz	6 m^3/h	6 m^3/h
Water vapor capacity 50 Hz	90 g/h	90 g/h
Water vapor capacity 60 Hz	120 g/h	120 g/h
Water vapor tolerance at 50 Hz	25 mbar	25 mbar
Water vapor tolerance at 60 Hz	28 mbar	28 mbar

Order number		
218-242/380-420 V (+/- 5 %) 50 Hz; 254-277/440-480 V (+/- 5 %) 60 Hz	**PK D61 105**	
380-420 V (+/- 5 %) 50 Hz	**PK D61 305**	
190-210/330-365 V (+/- 5 %) 50 Hz; 208-230/360-400 V (+/- 5 %) 60 Hz	**PK D61 115**	**PK D61 125**
200-240 V (+/- 5 %) 50 Hz; 208-240 V (+/- 5 %) 60 Hz	**PK D61 712**	**PK D61 732**
95-120 V (+/- 5 %) 50 Hz; 105-120 V (+/- 5 %) 60 Hz	**PK D61 707**	**PK D61 727**

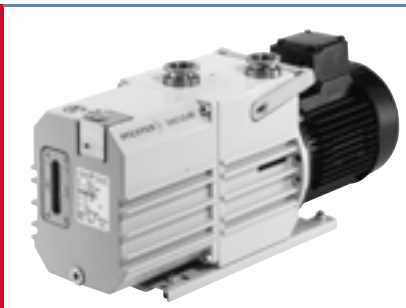
Accessories		
KAS 16, Condensate separator for pumping speeds of up to 2.5-5 m^3/h	**PK Z10 003**	
ONF 16, oil mist separator for pumping speeds of up to 2.5-5 m^3/h	**PK Z40 003**	
STP 016, dust separator, single-stage for minor contamination	**PK Z60 203**	
Oil return unit from ONF 16 to DUO 5 M, oil return unit from ONF 25 to DUO 10 M, oil return unit from ONF 25 L to DUO 20 M, standard version	**PK 196 172-T**	
Oil pressure switch	**PK 196 449**	**PK 196 449**
Operational monitoring unit for DUO 5 M, 10 M, 20 M und DUO 5 MC, 10 MC, 20 MC	**PK 196 141-T**	**PK 196 141-T**
Operating fluid level monitoring, 24 V DC for DUO 5 M, 10 M, 20 M and DUO 5 MC, 10 MC, 20 MC	**PK 196 157-T**	**PK 196 157-T**
Classification Barretter actuation unit	**P4 768 051 FQ**	**P4 768 051 FQ**

Pump fluid		
P3, mineral oil, 1 l	**PK 001 106-T**	
F4, Perfluorpolyether, 1 l		**PK 005 887-T**

DUO 10 M

Dual-stage rotary vane pumps with a pumping speed of 10 m³/h:

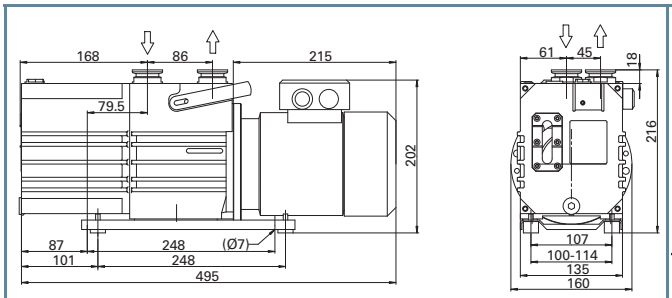
DUO 10 M



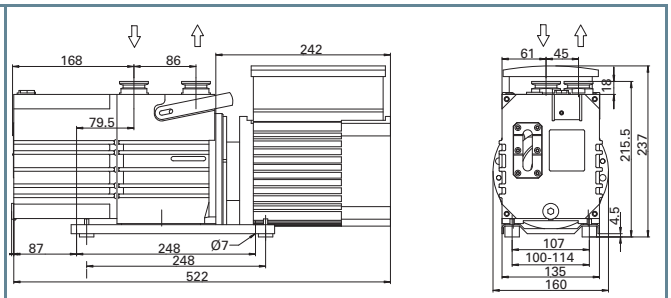
- ▶ Reliable, clean, low maintenance
- ▶ Compact design - Excellent performance data
- ▶ Contain no non-ferrous metals
- ▶ Integrated safety and gas ballast valve
- ▶ Various motor voltages afford worldwide employment

M = Magnetically coupled
MC = Corrosive gas version, magnetically coupled
TF = Temperature sensor

Dimensions

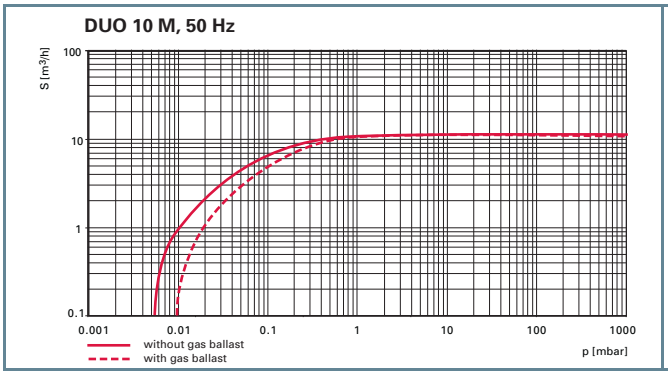


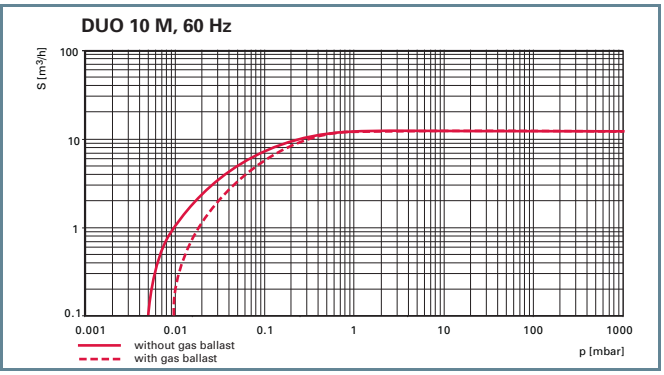
DUO 10 M, 3-phase, 380-420 V (+/- 5 %) 50 Hz
DUO 10 M, 3-phase, 3 TF, 220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz
DUO 10 M, 3-phase, 3 TF, 190-210 / 330-365 V (+/- 5 %) 50 Hz; 208-230/360-400 V (+/- 5 %) 60 Hz



DUO 10 M, 1-phase, 100-110 V (+/- 5 %) 50 Hz; 100-120 V (+/- 5 %) 60 Hz
DUO 10 M, 1-phase, 200-230 V (+/- 5 %) 50 Hz; 200-240 V (+/- 5 %) 60 Hz

Pumping speed





Technical data	DUO 10 M	DUO 10 MC
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF	DN 25 ISO-KF
Operating fluid	P 3	F 4
Pump fluid filling	1 l	1 l
Rotation speed at 50 Hz	1500 1/rpm	1500 1/rpm
Rotation speed at 60 Hz	1800 1/rpm	1800 1/rpm
Emission sound pressure level without gas ballast	≤ 55 dB (A)	≤ 57 dB (A)
Ultimate pressure with gas ballast	≤ $1 \cdot 10^{-2}$ mbar	≤ $1 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar
Weight	24 kg	27 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	0.37 kW	0,45 kW
Rated power 60 Hz	0.44 kW	0,55 kW
Pumping speed at 50 Hz	10 m^3/h	10 m^3/h
Pumping speed at 60 Hz	12 m^3/h	12 m^3/h
Water vapor capacity 50 Hz	210 g/h	210 g/h
Water vapor capacity 60 Hz	300 g/h	300 g/h
Water vapor tolerance at 50 Hz	30 mbar	30 mbar
Water vapor tolerance at 60 Hz	36 mbar	36 mbar

Order number		
380-420 V, +/- 5 %, 50 Hz	**PK D62 305**	**PK D62 325**
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz	**PK D62 105**	
190-210/330-365 V (+/- 5 %) 50 Hz; 208-230/360-400 V (+/- 5 %) 60 Hz	**PK D62 115**	
100-110 V (+/- 5 %) 50 Hz; 100-120 V (+/- 5 %) 60 Hz	**PK D62 707**	**PK D62 727**
200-230 V (+/- 5 %) 50 Hz; 200-240 V (+/- 5 %) 60 Hz	**PK D62 712**	**PK D62 732**

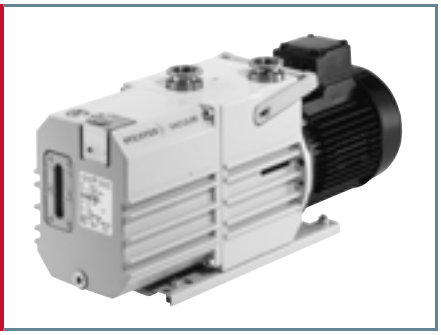
Accessories		
KAS 25, Condensate separator for pumping speeds of up to 10 m^3/h	**PK Z10 032**	
FAK 025, activated carbon filter	**PK Z30 006**	
FBL 025, bleaching earth filter	**PK Z30 106**	
STZ 025, dust separator, dual-stage for severe contamination	**PK Z60 006**	
STR 025, dust separator, dual-stage for medium contamination	**PK Z60 106**	
STP 025, dust separator, single-stage for minor contamination	**PK Z60 206**	
KLF 025, cold trap	**PK Z80 006**	
ONF 25, oil mist separator for pumping speeds of up to 10 m^3/h	**PK Z40 157**	**PK Z40 406**
Zeolite trap ZFO 025	**PK Z70 006**	
Oil return unit from ONF 16 to DUO 5 M, oil return unit from ONF 25 to DUO 10 M, oil return unit from ONF 25 L to DUO 20 M, standard version	**PK 196 172-T**	**PK 196 177-T**
Oil pressure switch	**PK 196 449**	**PK 196 449**
Operational monitoring unit for DUO 5 M, 10 M, 20 M und DUO 5 MC, 10 MC, 20 MC	**PK 196 141-T**	**PK 196 141-T**
Operating fluid level monitoring, 24 V DC for DUO 5 M, 10 M, 20 M and DUO 5 MC, 10 MC, 20 MC	**PK 196 157-T**	**PK 196 157-T**
URB 025, catalytic trap, 230 V	**PT U10 760**	
URB 025, catalytic trap, 115 V	**PT U10 761**	
Classification Barretter actuation unit	**P4 768 051 FQ**	**P4 768 051 FQ**

Pump fluid		
P3, mineral oil, 1 l	**PK 001 106-T**	
F4, Perfluorpolyether, 1 l		**PK 005 887-T**

DUO 20 M

Dual-stage rotary vane pumps with a pumping speed of 20 m³/h :

DUO 20 M



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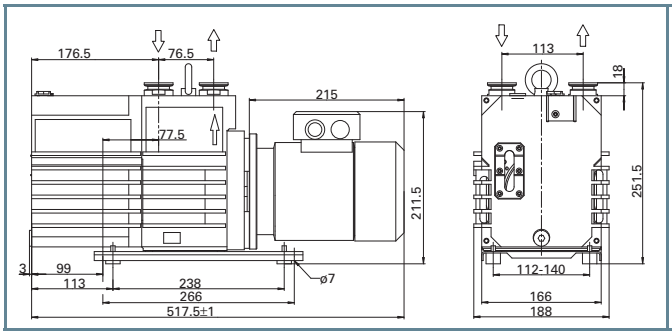
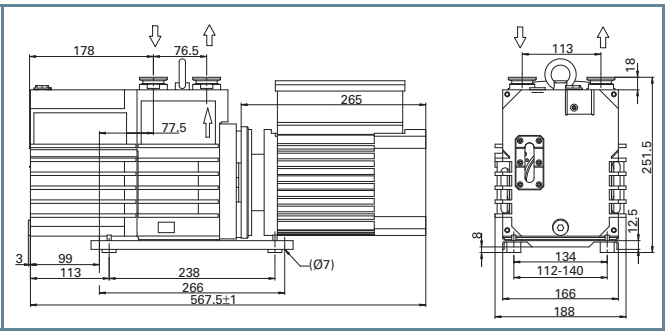
- ▶ Integrated safety and gas ballast valve
- ▶ Various motor voltages afford worldwide employment
- ▶ Contain no non-ferrous metals

M = Magnetically coupled
MC = Corrosive gas version, magnetically coupled
TF = Temperature sensor

Dimensions

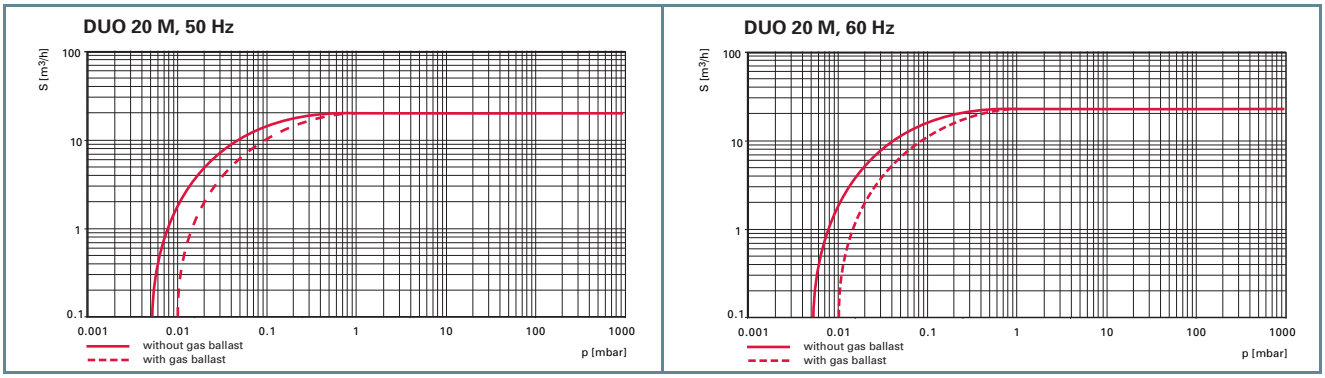


DUO 20 M, 3-phase, 3 TF, 220-240/380-420 V (+/- 5 %) 50 Hz;
250-277/440-480 V (+/- 5 %) 60 Hz
DUO 20 M, 3-phase, 3 TF, 190-210/330-365 V (+/- 5 %) 50 Hz;
208-230/360-400 V (+/- 5 %) 60 Hz
DUO 20 M, 3-phase, 380-420 V (+/- 5 %) 50 Hz



DUO 20 M, 1-phase, 100-110 V (+/- 5 %) 50 Hz;
100-120 V (+/- 5 %) 60 Hz
DUO 20 M, 1-phase, 200-230 V (+/- 5 %) 50 Hz;
200-240 V (+/- 5 %) 60 Hz

Pumping speed



Technical data	DUO 20 M	DUO 20 MC
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF	DN 25 ISO-KF
Operating fluid	P 3	F 4
Pump fluid filling	1 l	1 l
Rotation speed at 50 Hz	1500 1/rpm	1500 1/rpm
Rotation speed at 60 Hz	1800 1/rpm	1500 1/rpm
Emission sound pressure level without gas ballast	≤ 55 dB (A)	≤ 55 dB (A)
Ultimate pressure with gas ballast	≤ $1 \cdot 10^{-2}$ mbar	≤ $1 \cdot 10^{-2}$ mbar
Ultimate pressure without gas ballast	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar
Weight	33 kg	33 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	0.55 kW	0.55 kW
Rated power 60 Hz	0.66 kW	0.66 kW
Pumping speed at 50 Hz	20 m³/h	20 m³/h
Pumping speed at 60 Hz	24 m³/h	24 m³/h
Water vapor capacity 50 Hz	400 g/h	400 g/h
Water vapor capacity 60 Hz	550 g/h	550 g/h
Water vapor tolerance at 50 Hz	30 mbar	30 mbar
Water vapor tolerance at 60 Hz	36 mbar	36 mbar

Order number		
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz	**PK D63 105**	**PK D63 125**
190-210/330-365 V (+/- 5 %) 50 Hz; 208-230/360-400 V (+/- 5 %) 60 Hz	**PK D63 115**	**PK D63 135**
100-110 V (+/- 5 %) 50 Hz; 100-120 V (+/- 5 %) 60 Hz	**PK D63 707**	**PK D63 727**
200-230 V (+/- 5 %) 50 Hz; 200-240 V (+/- 5 %) 60 Hz	**PK D63 712**	**PK D63 732**
380-420 V, +/- 5 %, 50 Hz	**PK D63 305**	

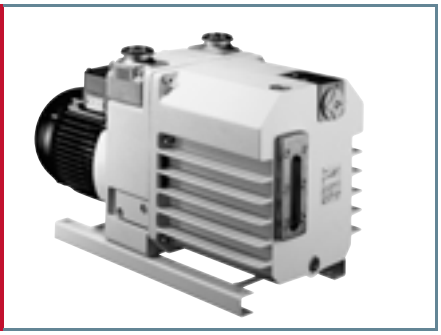
Accessories		
KAS 25 L, Condensate separator for pumping speeds of up to 20 m³/h	**PK Z10 033**	
FAK 025, activated carbon filter	**PK Z30 006**	
FBL 025, bleaching earth filter	**PK Z30 106**	
STZ 025, dust separator, dual-stage for severe contamination	**PK Z60 006**	
STR 025, dust separator, dual-stage for medium contamination	**PK Z60 106**	
STP 025, dust separator, single-stage for minor contamination	**PK Z60 206**	
KLF 025, cold trap	**PK Z80 006**	
ONF 25 L, oil mist separator for pumping speeds of up to 20 m³/h	**PK Z40 158**	**PK Z40 406**
Zeolite trap ZFO 025	**PK Z70 006**	
Oil return unit from ONF 16 to DUO 5 M, oil return unit from ONF 25 to DUO 10 M, oil return unit from ONF 25 L to DUO 20 M, standard version	**PK 196 172-T**	**PK 196 177-T**
Oil pressure switch	**PK 196 449**	**PK 196 449**
URB 025, catalytic trap, 230 V	**PT U10 760**	
URB 025, catalytic trap, 115 V	**PT U10 761**	
Classification Barretter actuation unit	**P4 768 051 FQ**	**P4 768 051 FQ**
Operational monitoring unit for DUO 5 M, 10 M, 20 M und DUO 5 MC, 10 MC, 20 MC	**PK 196 141-T**	**PK 196 141-T**
Operating fluid level monitoring, 24 V DC for DUO 5 M, 10 M, 20 M and DUO 5 MC, 10 MC, 20 MC	**PK 196 157-T**	**PK 196 157-T**

Pump fluid		
P3, mineral oil, 1 l	**PK 001 106-T**	
P3, mineral oil, 5 l	**PK 001 107-T**	
F4, Perfluorpolyether, 0.5 l		**PK 005 886-T**
F4, Perfluorpolyether, 1 l		**PK 005 887-T**

DUO 35

Dual-stage rotary vane pumps with a pumping speed of 35 m³/h:

DUO 35



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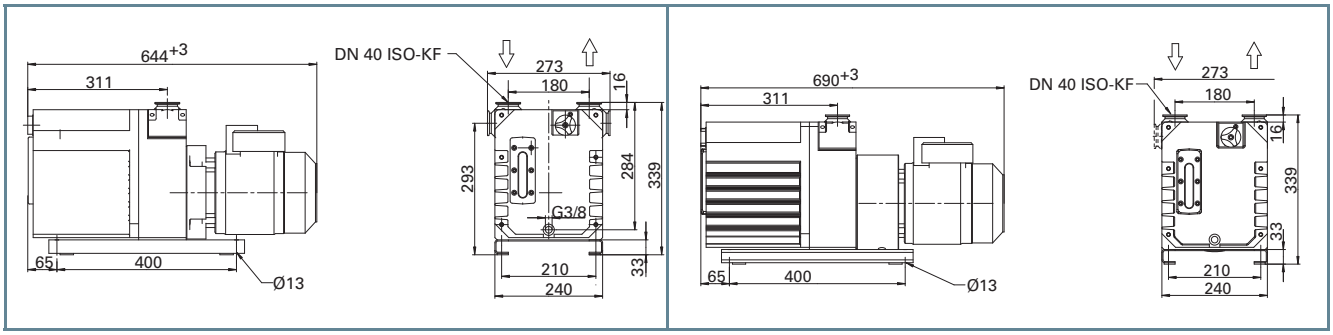
- ▶ Various motor voltages afford worldwide employment
- ▶ Contain no non-ferrous metals

M = Magnetically coupled
C = Corrosive gas version
TF = Temperature sensor

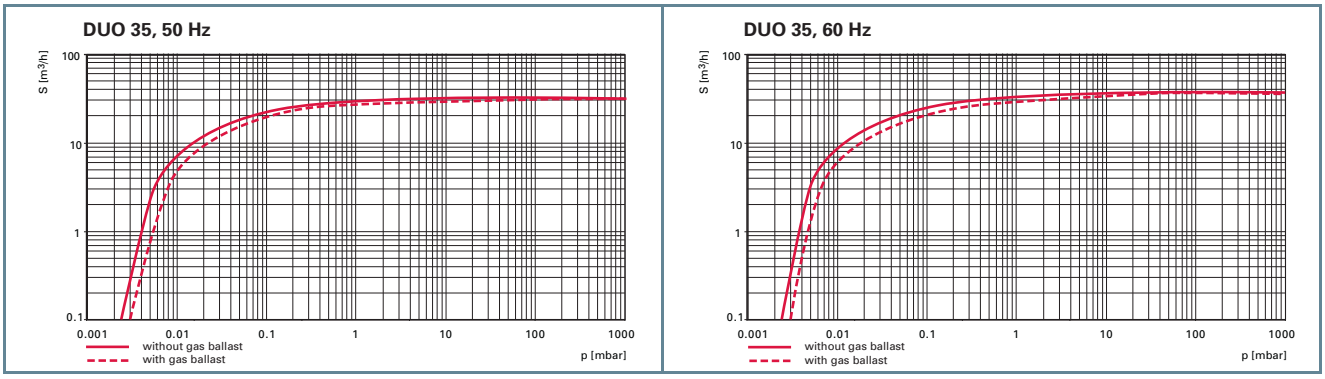
Dimensions



DUO 35
DUO 35 C

DUO 35 M

Pumping speed



Technical data	DUO 35	DUO 35 M	DUO 35 C
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Operating fluid	P 3	P 3	F 5
Pump fluid filling	3.2 l	3.2 l	3.2 l
Rotation speed at 50 Hz	1500 1/rpm	1500 1/rpm	1500 1/rpm
Rotation speed at 60 Hz	1800 1/rpm	1800 1/rpm	1800 1/rpm
Emission sound pressure level without gas ballast	≤ 61 dB (A)	≤ 61 dB (A)	≤ 61 dB (A)
Ultimate pressure with gas ballast	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar
Ultimate pressure without gas ballast	≤ $3 \cdot 10^{-3}$ mbar	≤ $3 \cdot 10^{-3}$ mbar	≤ $3 \cdot 10^{-3}$ mbar
Weight	56 kg	56 kg	56 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤$1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	1.1 kW	1.8 kW	1.1 kW
Rated power 60 Hz	1.3 kW	1.8 kW	1.3 kW
Pumping speed at 50 Hz	32 m³/h	32 m³/h	32 m³/h
Pumping speed at 60 Hz	36 m³/h	36 m³/h	36 m³/h
Water vapor capacity 50 Hz	500 g/h	500 g/h	500 g/h
Water vapor capacity 60 Hz	560 g/h	560 g/h	560 g/h
Water vapor tolerance at 50 Hz	20 mbar	20 mbar	20 mbar
Water vapor tolerance at 60 Hz	20 mbar	20 mbar	20 mbar

Order number			
380-420 V, 50Hz, (+/- 5%) 50Hz	**PK D45 305**		
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz	**PK D45 602**		**PK D45 202**
190-210/330-365 V (+/- 5 %) 50 Hz; 208-230/360-400 V (+/- 5 %) 60 Hz	**PK D45 642**		**PK D45 242**
220-240/380-420 V (+/- 5 %) 50 Hz; 220-277/380-480 V (+/- 5%) 60 Hz		**PK D45 013**	

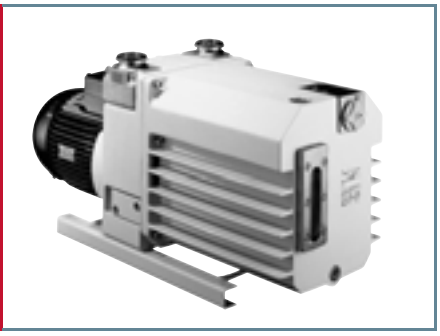
Accessories			
KAS 40, Condensate separator for pumping speeds of up to 35-65 m³/h	**PK Z10 008**	**PK Z10 008**	**PK Z10 408**
FAK 040, activated carbon filter	**PK Z30 008**	**PK Z30 008**	
FBL 040, bleaching earth filter	**PK Z30 108**	**PK Z30 108**	
STZ 040, dust separator, dual-stage for severe contamination	**PK Z60 008**	**PK Z60 008**	
STR 040, dust separator, dual-stage for medium contamination	**PK Z60 108**	**PK Z60 108**	
STP 040, dust separator, single-stage for minor contamination	**PK Z60 208**	**PK Z60 208**	
KLF 040, cold trap	**PK Z80 008**	**PK Z80 008**	**PK Z80 008**
ONF 35/65, oil mist separator for pumping speeds of 35-65 m³/h	**PK Z40 150**	**PK Z40 150**	**PK Z40 152**
ONFR 35/65, oil mist separator with oil return to pump	**PK Z40 151**	**PK Z40 151**	**PK Z40 153**
ZFO 040, zeolite trap	**PK Z70 008**	**PK Z70 008**	
Oil return unit from ONF 35/65 to DUO 35 and DUO 65	**PK 005 710-T**	**PK 005 710-T**	**PK 005 710-T**
OFC 35/65, Chemical oil filter	**PK Z90 320**	**PK Z90 320**	
OFM 35/65, Mechanical oil filter	**PK Z90 321**	**PK Z90 321**	
Operational monitoring - oil pressure switch for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 720-U**	**PK 223 720-U**	**PK 223 720-U**
Operational monitoring - oil pressure switch for DUO 35, 65 with OFC 35/65 or OFM 35/65	**PK 223 741-U**	**PK 223 741-U**	**PK 223 741-U**
Operating fluid level monitoring, 24 V DC for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 718-U**	**PK 223 718-U**	**PK 223 718-U**
Operational monitoring unit for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 739-U**	**PK 223 739-U**	**PK 223 739-U**
URB 040, catalytic trap, 230 V	**PT U10 260**	**PT U10 260**	
URB 040, catalytic trap, 115 V	**PT U10 261**	**PT U10 261**	
Classification Barretter actuation unit	**P4 768 051 FQ**	**P4 768 051 FQ**	**P4 768 051 FQ**

Pump fluid			
P3, mineral oil, 1 l	**PK 001 106-T**	**PK 001 106-T**	
P3, mineral oil, 5 l	**PK 001 107-T**	**PK 001 107-T**	
P3, mineral oil, 20 l	**PK 001 108-T**	**PK 001 108-T**	
F5, Perfluorpolyether, 1 l			**PK 001 852-T**
F5, Perfluorpolyether, 5 l			**PK 001 853-T**
F5, Perfluorpolyether, 20 l			**PK 001 854-T**

DUO 65

Dual-stage rotary vane pumps with a pumping speed of 65 m³/h:

DUO 65



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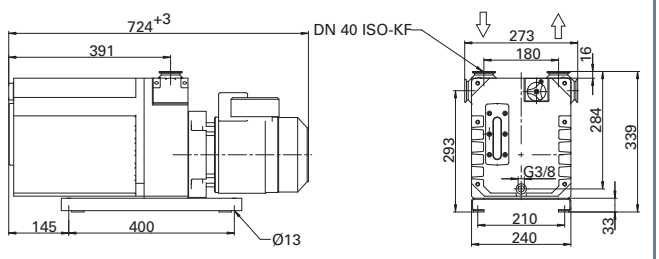
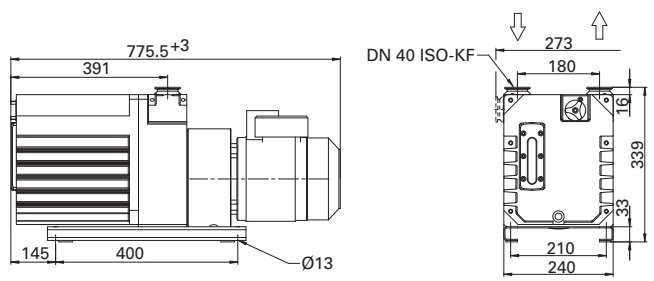
M = Magnetically coupled
C = Corrosive gas version
TF = Temperature sensor

Dimensions

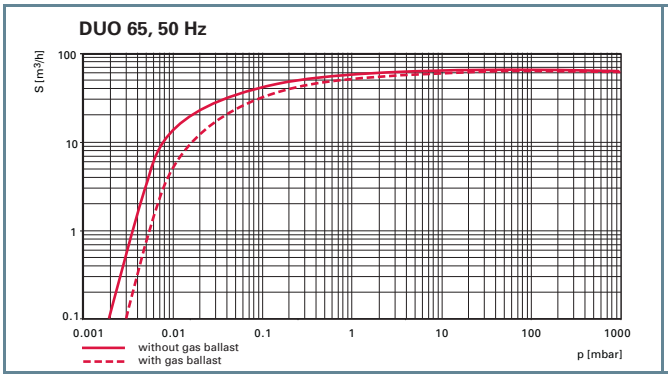


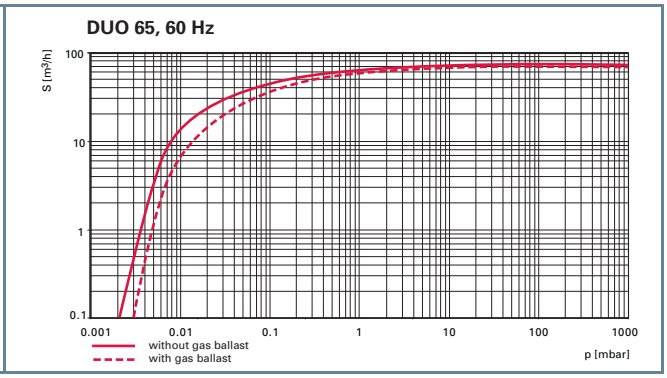
DUO 65
DUO 65 C



DUO 65 M

Pumping speed





Technical data	DUO 65	DUO 65 M	DUO 65 C
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Operating fluid	P 3	P 3	F 5
Pump fluid filling	4.2 l	4.2 l	4.2 l
Rotation speed at 50 Hz	1500 1/rpm	1500 1/rpm	1500 1/rpm
Rotation speed at 60 Hz	1800 1/rpm	1800 1/rpm	1800 1/rpm
Emission sound pressure level without gas ballast	≤ 61 dB (A)	≤ 61 dB (A)	≤ 61 dB (A)
Ultimate pressure with gas ballast	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar	≤ $5 \cdot 10^{-3}$ mbar
Ultimate pressure without gas ballast	≤ $3 \cdot 10^{-3}$ mbar	≤ $3 \cdot 10^{-3}$ mbar	≤ $3 \cdot 10^{-3}$ mbar
Weight	65 kg	65 kg	65 kg
Leakage rate safety valve	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s	≤ $1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	1.5 kW	2.2 kW	1.5 kW
Rated power 60 Hz	1.8 kW	2.2 kW	1.8 kW
Pumping speed at 50 Hz	62 m³/h	62 m³/h	62 m³/h
Pumping speed at 60 Hz	70 m³/h	70 m³/h	70 m³/h
Water vapor capacity 50 Hz	1000 g/h	1000 g/h	1000 g/h
Water vapor capacity 60 Hz	1120 g/h	1120 g/h	1120 g/h
Water vapor tolerance at 50 Hz	20 mbar	20 mbar	20 mbar
Water vapor tolerance at 60 Hz	20 mbar	20 mbar	20 mbar

Order number			
380 - 420 V (+/- 5 %) 50 Hz	**PK D46 305**		
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz	**PK D46 602**		**PK D46 202**
190-210/330-365 V (+/- 5 %) 50 Hz; 200-230/360-400 V (+/- 5 %) 60 Hz	**PK D46 642**		**PK D46 242**
220-240/380-420 V (+/- 5 %) 50 Hz; 220-277/380-480 V (+/- 5%) 60 Hz		**PK D46 013**	

Accessories			
KAS 40, Condensate separator for pumping speeds of up to 35-65 m³/h	**PK Z10 008**	**PK Z10 008**	**PK Z10 408**
FAK 040, activated carbon filter	**PK Z30 008**	**PK Z30 008**	
FBL 040, bleaching earth filter	**PK Z30 108**	**PK Z30 108**	
STZ 040, dust separator, dual-stage for severe contamination	**PK Z60 008**	**PK Z60 008**	
STR 040, dust separator, dual-stage for medium contamination	**PK Z60 108**	**PK Z60 108**	
STP 040, dust separator, single-stage for minor contamination	**PK Z60 208**	**PK Z60 208**	
KLF 040, cold trap	**PK Z80 008**	**PK Z80 008**	**PK Z80 008**
ONF 35/65, oil mist separator for pumping speeds of 35-65 m³/h	**PK Z40 150**	**PK Z40 150**	**PK Z40 152**
ONFR 35/65, oil mist separator with oil return to pump	**PK Z40 151**	**PK Z40 151**	**PK Z40 153**
ZFO 040, zeolite trap	**PK Z70 008**	**PK Z70 008**	
Oil return unit from ONF 35/65 to DUO 35 and DUO 65	**PK 005 710-T**	**PK 005 710-T**	**PK 005 710-T**
OFC 35/65, Chemical oil filter	**PK Z90 320**	**PK Z90 320**	
OFM 35/65, Mechanical oil filter	**PK Z90 321**	**PK Z90 321**	
Operational monitoring - oil pressure switch for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 720-U**	**PK 223 720-U**	**PK 223 720-U**
Operational monitoring - oil pressure switch for DUO 35, 65 with OFC 35/65 or OFM 35/65	**PK 223 741-U**	**PK 223 741-U**	**PK 223 741-U**
Operating fluid level monitoring, 24 V DC for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 718-U**	**PK 223 718-U**	**PK 223 718-U**
Operational monitoring unit for DUO 35, 65 / DUO 35 C, 65 C / DUO 35 M, 65 M	**PK 223 739-U**	**PK 223 739-U**	**PK 223 739-U**
URB 040, catalytic trap, 230 V	**PT U10 260**	**PT U10 260**	
URB 040, catalytic trap, 115 V	**PT U10 261**	**PT U10 261**	
Classification Barretter actuation unit	**P4 768 051 FQ**	**P4 768 051 FQ**	**P4 768 051 FQ**

Pump fluid			
P3, mineral oil, 1 l	**PK 001 106-T**	**PK 001 106-T**	
P3, mineral oil, 5 l	**PK 001 107-T**	**PK 001 107-T**	
P3, mineral oil, 20 l	**PK 001 108-T**	**PK 001 108-T**	
F5, Perfluorpolyether, 1 l			**PK 001 852-T**
F5, Perfluorpolyether, 5 l			**PK 001 853-T**
F5, Perfluorpolyether, 20 l			**PK 001 854-T**

DUO 120

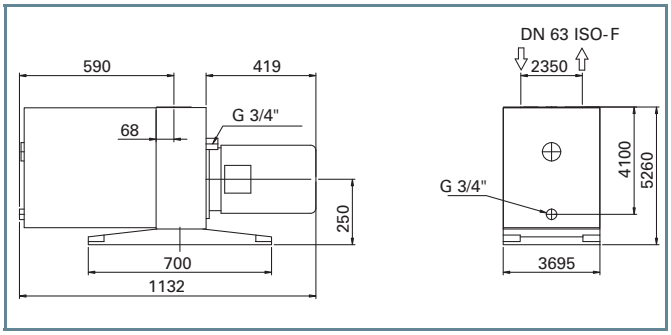
Dual-stage rotary vane pumps with a pumping speed of 120 m³/h:

DUO 120

- ▶ For industrial applications - Very powerful
- ▶ Integrated safety and gas ballast valve
- ▶ Various motor voltages afford worldwide employment

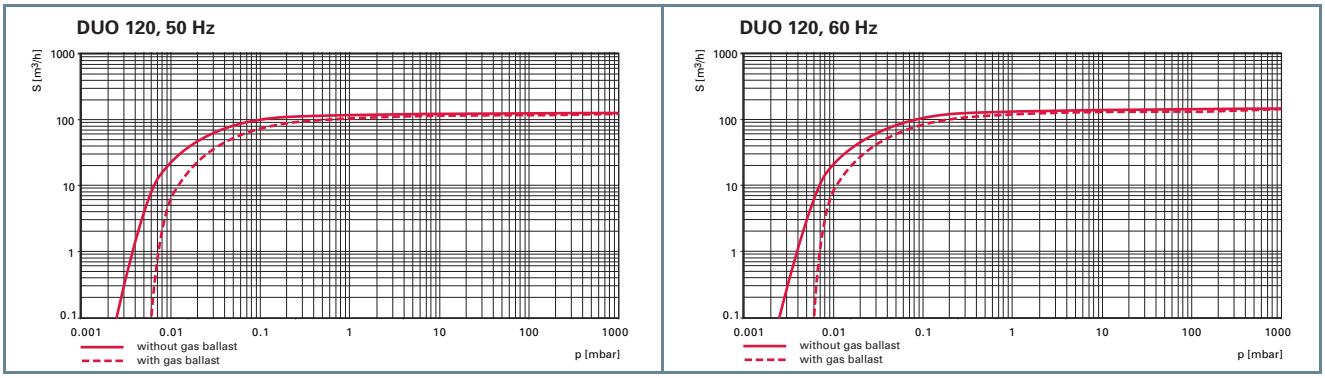
TF = Temperature sensor

Dimensions



DUO 120

Pumping speed



Technical data	DUO 120
Flange (in)	DN 63 ISO-F
Flange (out)	DN 63 ISO-F
Operating fluid	P 3
Pump fluid filling	13 l
Rotation speed at 50 Hz	1000 1/rpm
Rotation speed at 60 Hz	1200 1/rpm
Emission sound pressure level without gas ballast	75 dB (A)
Ultimate pressure with gas ballast	$6 \cdot 10^{-3}$ mbar
Ultimate pressure without gas ballast	$3 \cdot 10^{-3}$ mbar
Weight	215 kg
Leakage rate safety valve	$< 1 \cdot 10^{-4}$ mbar l/s
Nominal rotation speed at 50 Hz	960 rpm
Nominal rotation speed at 60 Hz	1150 rpm
Rated power 50 Hz	4 kW
Rated power 60 Hz	4.8 kW
Pumping speed at 50 Hz	120 m^3/h
Pumping speed at 60 Hz	144 m^3/h
Water vapor capacity 50 Hz	1800 g/h
Water vapor capacity 60 Hz	2150 g/h
Water vapor tolerance at 50 Hz	20 mbar
Water vapor tolerance at 60 Hz	20 mbar

Order number	
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277/440-480 V (+/- 5 %) 60 Hz	**PK D26 602**
190-210/330-365 V (+/- 5 %) 50 Hz; 200-230/360-400 V (+/- 5 %) 60 Hz	**PK D26 652**

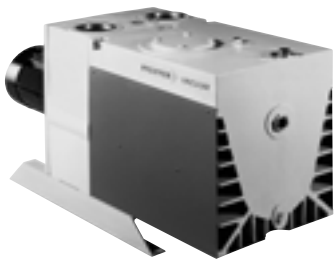
Accessories	
KAS 63, Condensate separator for pumping speeds of up to 120 m^3/h	**PK Z10 010**
ONF 63, oil mist separator for pumping speeds of up to 120 m^3/h	**PK Z40 010**
STZ 063, dust separator, dual-stage for severe contamination	**PK Z60 009**
STR 063, dust separator, dual-stage for medium contamination	**PK Z60 110**
STP 063, dust separator, single-stage for minor contamination	**PK Z60 210**
FAK 063, activated carbon filter	**PK Z30 010**
FBL 063, bleaching earth filter	**PK Z30 110**
KLF 063, cold trap	**PK Z80 010**
ZFO 063, zeolite trap	**PK Z70 010**
Oil return feature, ORF 004, standard version	**PK Z90 041A**
Operating fluid level monitoring for DUO 120 / 250, 24 V DC	**PK 005 639-U**
Operating fluid level monitoring, 20-250 V AC for DUO 120 / 250	**PK 004 930-U**
Classification Barretter actuation unit	**P4 768 051 FQ**

Pump fluid	
P3, mineral oil, 1 l	**PK 001 106-T**
P3, mineral oil, 5 l	**PK 001 107-T**
P3, mineral oil, 20 l	**PK 001 108-T**

DUO 255

Dual-stage rotary vane pumps with a pumping speed of 255 m³/h:

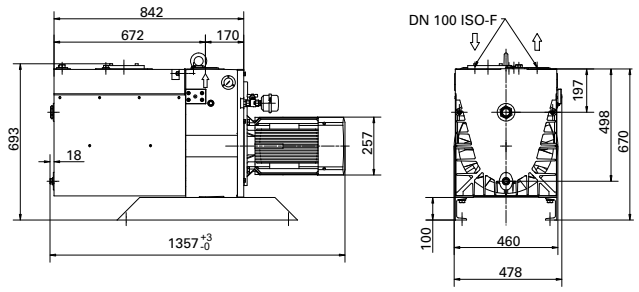
DUO 255



- ▶ For industrial applications - Very powerful
- ▶ Integrated safety and gas ballast valve
- ▶ Various motor voltages afford worldwide employment
- ▶ Contain no non-ferrous metals

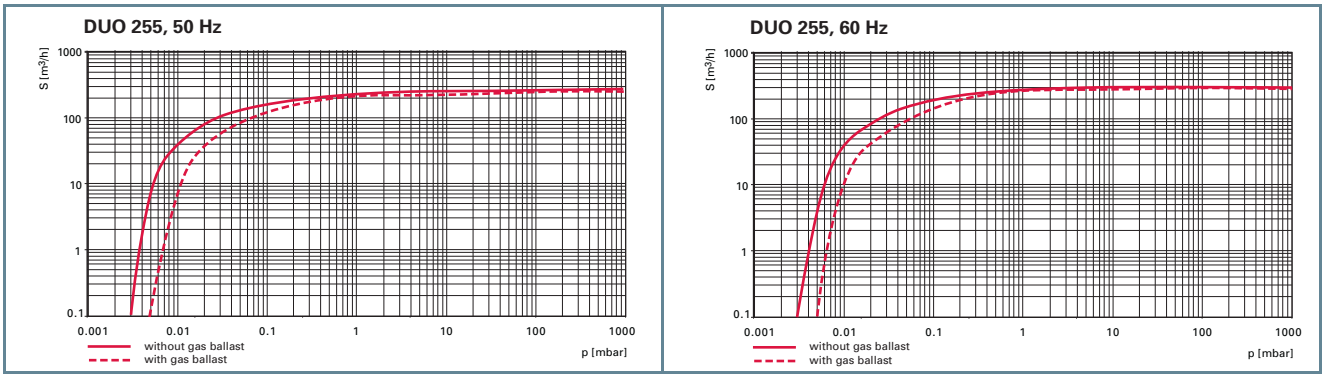
TF = Temperature sensor

Dimensions



DUO 255

Pumping speed



Technical data	DUO 255
Flange (in)	DN 100 ISO-F
Flange (out)	DN 100 ISO-F
Operating fluid	P 3
Pump fluid filling	25 l
Rotation speed at 50 Hz	1000 1/rpm
Rotation speed at 60 Hz	1200 1/rpm
Emission sound pressure level without gas ballast	75 dB (A)
Ultimate pressure with gas ballast	$6 \cdot 10^{-3}$ mbar
Ultimate pressure without gas ballast	$3 \cdot 10^{-3}$ mbar
Weight	360 kg
Leakage rate safety valve	$< 1 \cdot 10^{-4}$ mbar l/s
Rated power 50 Hz	7.5 kW
Rated power 60 Hz	9 kW
Pumping speed at 50 Hz	250 m^3/h
Pumping speed at 60 Hz	300 m^3/h
Water vapor capacity 50 Hz	4350 g/h
Water vapor capacity 60 Hz	5200 g/h
Water vapor tolerance at 50 Hz	25 mbar
Water vapor tolerance at 60 Hz	25 mbar

Order number	
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277 V/440-480 V (+/- 5 %) 60 Hz	**PK D48 602**
210-230/360-400 V (+/- 5 %) 50 Hz; 208-230 V/360-400 V (+/- 5 %) 60 Hz	**PK D48 604**
190-210/330-365 V (+/- 5 %) 50 Hz; 200-230 V/360-400 V (+/- 5 %) 60 Hz	**PK D48 652**
220-240/380-420 V (+/- 5 %) 50 Hz; 250-277 V/440-480 V (+/- 5 %) 60 Hz	**PK D48 950**

Accessories	
STP 100, dust separator, single-stage for minor contamination	**PK Z60 212**
STR 100, dust separator, dual-stage for medium contamination	**PK Z60 112**
KAS 100, Condensate separator for pumping speeds of up to 250 m^3/h	**PK Z10 012**
ONF 100, oil mist separator for pumping speeds of up to 250 m^3/h	**PK Z40 012**
Oil return feature, ORF 004, standard version	**PK Z90 041A**
FAK 100, activated carbon filter	**PK Z30 012**
Classification Barretter actuation unit	**P4 768 051 FQ**
Operating fluid level monitoring for DUO 120 / 250, 24 V DC	**PK 005 639-U**
Operating fluid level monitoring, 20-250 V AC for DUO 120 / 250	**PK 004 930-U**
OMF 255, Mechanical oil filter	**PK Z90 341**

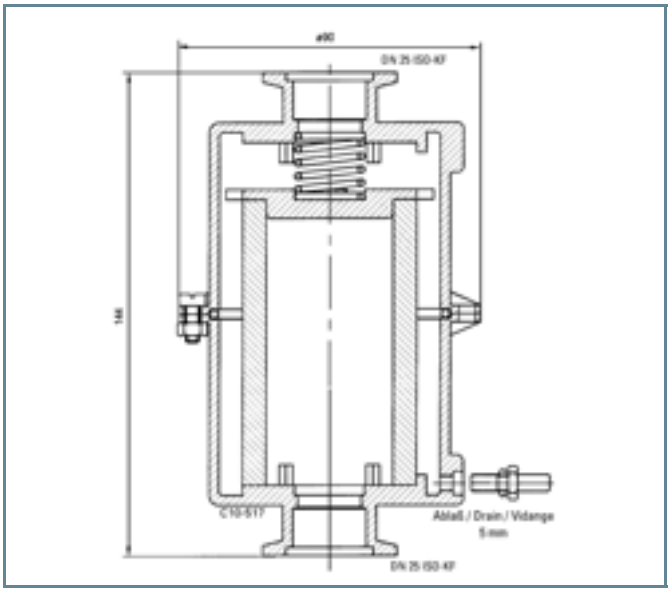
Oil mist separators

ONF 4-20, oil mist separator for pumping speeds of up to 20 m^3/h

Oil mist separators

- ▶ Sits on the pump s exhaust port and sustainably prevents contamination of the air by oil mist
- ▶ Max. pressure, 1 mbar

Dimensions



Technical data	ONF 4-20
Degree of separation	99.98 %
Flange (out)	DN 25 ISO-KF
Flange (in)	DN 25 ISO-KF
Capacity	0.04 l
For pumping speed	20 m³/h
Weight	0.2 kg

Order number	
Oil mist separators	**PK Z40 145**

Accessories	
Oil return unit from ONF 4-20 to DUO 5 M, oil return unit from ONF 4-20 to DUO 10 M, oil return unit from ONF 4-20 to DUO 20 M	**PK 196 173-T**

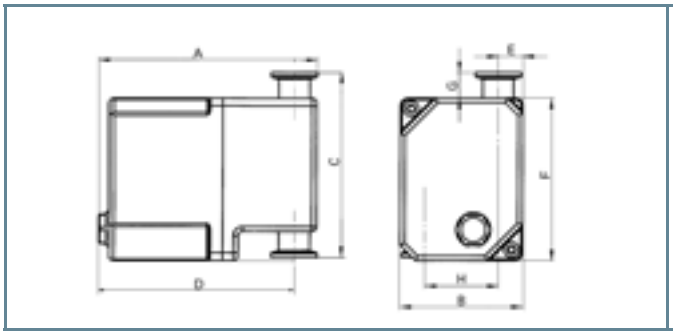
Oil mist separators

For pumping speeds of up to 20 m³/h

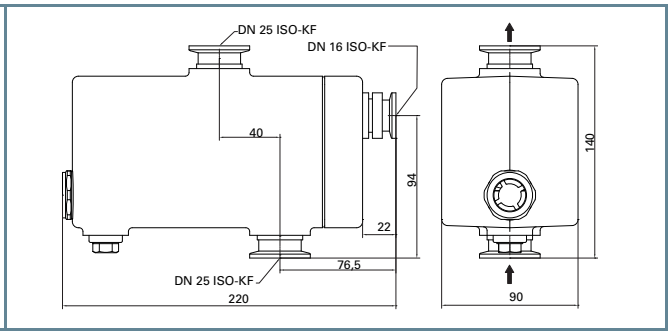
Oil mist separators

▶ Mounted on the pump's exhaust port, they prevent contamination of the air by oil mist. Satisfies the limits established by the German Clean Air Ordinance if a clean filter is employed (separation rate > 99.98 %).

Dimensions



ONF 16
ONF 25
ONF 25 L



ONF 25 C

	ONF 16	ONF 25	ONF 25 L
A	142 mm	147 mm	218 mm
B	80 mm	80 mm	80 mm
C	120 mm	132 mm	134 mm
D	127 mm	127 mm	182 mm
E	16 mm	16 mm	25 mm
F	105 mm	105 mm	105 mm
G	17 mm	23 mm	27 mm
H	48 mm	48 mm	-

Technical data	ONF 16	ONF 25	ONF 25 L	ONF 25 C
Degree of separation	99.98 %	99.98 %	99.98 %	99.98 %
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-K
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-K
Capacity	0.15 l	0.15 l	0.25 l	2.3 l
For pumping speed	2.5-5 m^3/h	10 m^3/h	30 m^3/h	10-20 m^3/h
Weight	1.35 kg	1.4 kg	1.6 kg	1.8 kg

Order number				
Oil mist separators	**PK Z40 003**	**PK Z40 157**	**PK Z40 158**	**PK Z40 406**

Accessories				
Oil return unit from ONF 16 to DUO 5 M, oil return unit from ONF 25 to DUO 10 M, oil return unit from ONF 25 L to DUO 20 M, standard version	**PK 196 172-T**	**PK 196 172-T**	**PK 196 172-T**	
Oil return unit from ONF 16 to DUO 2.5	**PK 194 315-T**			
Oil return unit from ONF 25 C to DUO 5 MC, oil return unit from ONF 25 C to DUO 10 MC, oil return unit from ONF 25 C to DUO 20 MC, corrosive gas version				**PK 196 177-T**

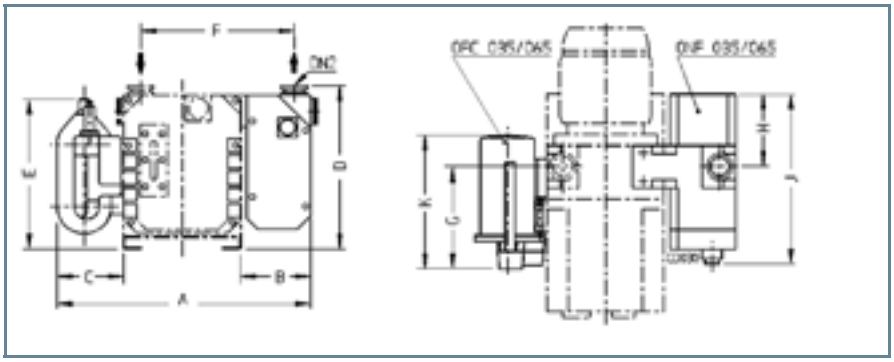
Oil mist separators

For pumping speed 35-65 m³/h

Oil mist separators

- ▶ Oil mist separator with oil return to pump
- ▶ Mounted on the pump's exhaust port and prevents contamination of the air by oil mist

Dimensions



ONF 35/65
ONFR 35/65
ONF 35/65 C
ONFR 35/65 C

	ONF 35/65 ONFR 35/65 ONF 35/65 C ONFR 35/65 C
A	517 mm
B	142 mm
C	135 mm
D	340 mm
E	308 mm
F	322 mm
G	207 mm
H	160 mm
J	350 mm
K	277 mm

Technical data	ONF 35/65	ONF 35/65 C	ONFR 35/65	ONFR 35/65 C
Degree of separation	99.98 %	99.98 %	99.98 %	99.98 %
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Capacity	0.7 l	0.7 l	0.7 l	0.7 l
For pumping speed	35-65 m^3/h	35-65 m^3/h	35-65 m^3/h	35-65 m^3/h
Weight	11 kg	11 kg	11 kg	11 kg

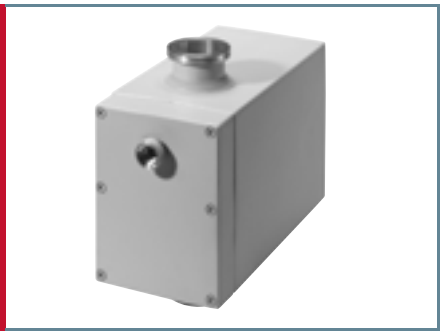
Order number				
Oil mist separators	**PK Z40 150**	**PK Z40 152**	**PK Z40 151**	**PK Z40 153**

Accessories				
Oil return unit from ONF 35/65 to DUO 35 and DUO 65	**PK 005 710-T**	**PK 005 710-T**		

Oil mist separators

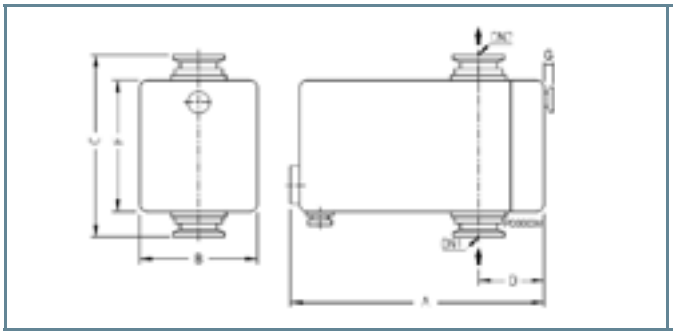
For pumping speed 250 m³/h

Oil mist separators

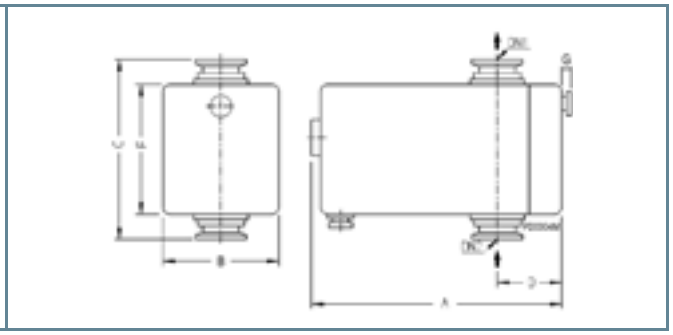


- ▶ Oil mist separator with oil return to pump
- ▶ Mounted on the pump's exhaust port and prevents contamination of the air by oil mist

Dimensions



ONF 63



ONF 100

	ONF 63	ONF 100
A	440 mm	457 mm
B	196 mm	260 mm
C	366 mm	494 mm
D	147 mm	150 mm
F	260 mm	400 mm
G	22 mm	22 mm

Technical data	ONF 63	ONF 100
Degree of separation	99.98 %	99.98 %
Flange (out)	DN 63 ISO-K	DN 100 ISO-K
Flange (in)	DN 63 ISO-K	DN 100 ISO-K
Capacity	1.7 l	2.3 l
For pumping speed	120 m^3/h	250 m^3/h
Weight	13.5 kg	27 kg

Order number		
Oil mist separators	**PK Z40 010**	**PK Z40 012**

Accessories		
Oil return feature, ORF 004, standard version	**PK Z90 041A**	**PK Z90 041A**

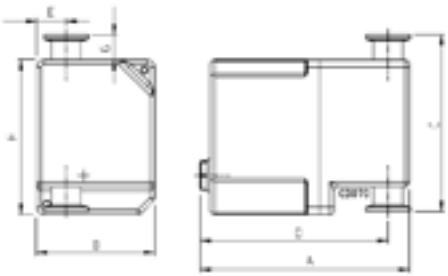
Conden-sate separators

For pumping speeds of up to 34 m³/h

Condensate separators

- For inlet and outlet ports
- Protects the rotary vane pump against condensable vapors and condensate return

Dimensions



	KAS 16	KAS 25	KAS 25 L
A	142 mm	147 mm	202 mm
B	80 mm	80 mm	80 mm
C	120 mm	132 mm	132 mm
D	127 mm	127 mm	182 mm
E	20 mm	20 mm	20 mm
F	105 mm	105 mm	105 mm
G	17 mm	23 mm	23 mm

Technical data	KAS 16	KAS 25	KAS 25 L
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
For pumping speed	2.5-5 m^3/h	10 m^3/h	20 m^3/h
Capacity	0.2 l	0.2 l	0.3 l
Weight	1.1 kg	1.2 kg	1.6 kg

Order number			
Condensate separators	**PK Z10 003**	**PK Z10 032**	**PK Z10 033**

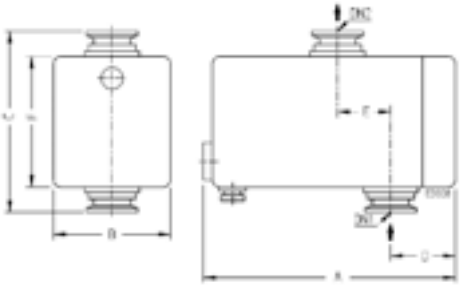
Conden-sate separators

For pumping speed 35-65 m³/h

Condensate separators

- For inlet and outlet ports
- Protects the rotary vane pump against condensable vapors and condensate return

Dimensions



	KAS 40	KAS 40 C
A	338 mm	338 mm
B	160 mm	160 mm
C	230 mm	230 mm
D	100 mm	100 mm
E	60 mm	60 mm
F	166 mm	166 mm

Technical data	KAS 40	KAS 40 C
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF
For pumping speed	35-65 m^3/h	35-65 m^3/h
Capacity	3 l	3 l
Weight	6.1 kg	6.1 kg

Order number		
Condensate separators	**PK Z10 008**	**PK Z10 408**

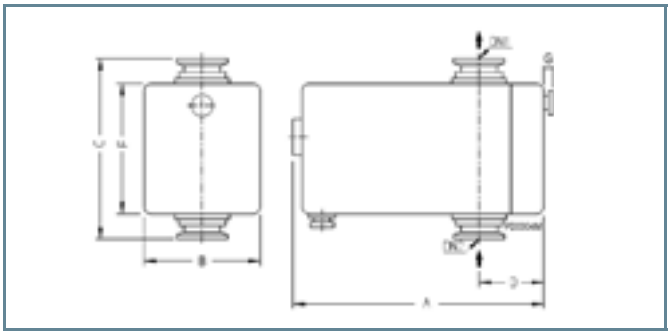
Conden-sate separators

For pumping speed 250 m³/h

Condensate separators

- For inlet and outlet ports
- Protects the rotary vane pump against condensable vapors and condensate return

Dimensions



	KAS 63	KAS 100	KAS 63 C	KAS 100 C
A	440 mm	460 mm	440 mm	460 mm
B	196 mm	260 mm	196 mm	260 mm
C	366 mm	494 mm	366 mm	494 mm
D	146 mm	150 mm	146 mm	150 mm
F	260 mm	400 mm	260 mm	400 mm
G	8 mm	8 mm	8 mm	8 mm

Technical data	KAS 63	KAS 63 C	KAS 100	KAS 100 C
Flange (in)	DN 63 ISO-K	DN 63 ISO-K	DN 100 ISO-K	DN 100 ISO-K
Flange (out)	DN 63 ISO-K	DN 63 ISO-K	DN 100 ISO-K	DN 100 ISO-K
For pumping speed	120 m^3/h	120 m^3/h	250 m^3/h	250 m^3/h
Capacity	12 l	12 l	19 l	19 l
Weight	13.2 kg	13.2 kg	25 kg	25 kg

Order number				
Condensate separators	**PK Z10 010**	**PK Z10 410**	**PK Z10 012**	**PK Z10 412**

Adsorption filter

Filters for employment in conjunction with nitrous gases, acids and bases in the pump.

Adsorption filter

Technical data	FAK 025	FAK 040	FAK 063	FAK 100
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K	DN 100 ISO-K
Flange (out)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K	DN 100 ISO-K
Mounting orientation	Vertical	Vertical	Vertical	Vertical
Filling quantity	1 l	2 l	7.5 l	20 l
For pumping speed up to	30 m^3/h	65 m^3/h	120 m^3/h	500 m^3/h
Weight with contents	4 kg	5.5 kg	16 kg	40 kg
Conductance	$1 \cdot 10^{-2}$ mbar: 2 l/s 1 mbar: 10 l/s 100 mbar: 500 l/s	$1 \cdot 10^{-2}$ mbar: 16 l/s 1 mbar: 150 l/s 100 mbar: 1000 l/s	$1 \cdot 10^{-2}$ mbar: 5 l/s 1 mbar: 9 l/s 100 mbar: 400 l/s	$1 \cdot 10^{-2}$: 5 l/s 1 mbar: 6 l/s 100 mbar: 100 l/s
Order number				
Adsorption filter	**PK Z30 006**	**PK Z30 008**	**PK Z30 010**	**PK Z30 012**

Technical data	ZFO 016	ZFO 025	ZFO 040	ZFO 063
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Mounting orientation	Horizontal	Vertical	Vertical	Vertical
Filling quantity	0.5 l	2 l	2.3 l	4.3 l
For pumping speed up to	5 m^3/h	30 m^3/h	65 m^3/h	120 m^3/h
Weight with contents	1.5 kg	7 kg	13 kg	17 kg
Heating rod	no	Voltage: 230 V power input: 200 W weight: 1,7kg	Voltage: 230 V power input: 300 W Weight: 2,7 kg	Voltage: 230 V Power input: 400 W Weight: 3,4 kg
Conductance	$1 \cdot 10^{-2}$ mbar: 0.3 l/s 1 mbar: 0.7 l/s 100 mbar: 31 l/s	$1 \cdot 10^{-2}$ mbar: 4 l/s 1 mbar: 40 l/s 100 mbar: 900 l/s	$1 \cdot 10^{-2}$ mbar: 7 l/s 1 mbar: 80 l/s 100 mbar: 1300 l/s	$1 \cdot 10^{-2}$ mbar: 22 l/s 1 mbar: 600 l/s 100 mbar: 4000 l/s
Order number				
Adsorption filter	**PK Z70 003**	**PK Z70 006**	**PK Z70 008**	**PK Z70 010**

Technical data		Heating rod for ZFO 025	Heating rod for ZFO 040	Heating rod for ZFO 063
Power consumption		200 W	300 W	400 W
Mains requirement		220 V, 50/60 Hz	220 V, 50/60 Hz	220 V, 50/60 Hz
Accessories				
Zeolite trap heating		**PK Z90 012A**	**PK Z90 020A**	**PK Z90 020A**

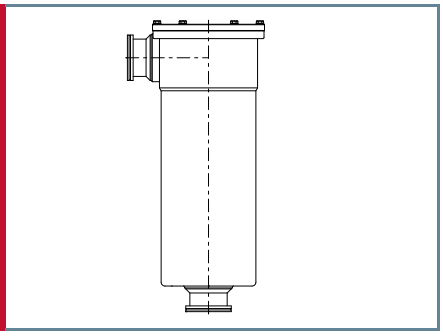
Technical data	KLF 025	KLF 040	KLF 063
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Flange (out)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Mounting orientation	Vertical	Vertical	Vertical
Filling quantity	0.7 l	1.5 l	3.8 l
For pumping speed up to	30 m^3/h	65 m^3/h	120 m^3/h
Weight	3.5 kg	6.5 kg	11.5 kg
Conductance	$1 \cdot 10^{-2}$ mbar: 10 mbar l/s 1 mbar: 60 mbar l/s 100 mbar: 800 mbar l/s	$1 \cdot 10^{-2}$ mbar: 16 mbar l/s 1 mbar: 150 mbar l/s 100 mbar: 1000 mbar l/s	$1 \cdot 10^{-2}$ mbar: 30 mbar l/s 1 mbar: 800 mbar l/s 100 mbar: 3000 mbar l/s
Order number			
Adsorption filter	**PK Z80 006**	**PK Z80 008**	**PK Z80 010**

Technical data	URB 025	URB 025	URB 040	URB 040
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Mounting orientation	Any	Any	Normal operation: any/with water cooling: vertical	Normal operation: any/with water cooling: vertical
Filling quantity	180 g	180 g	480 g	480 g
Weight with contents	1.8 kg	1.8 kg	3.6 kg	3,6 kg
Cooling			Water	Water
Power consumption	25 W	25 W	50 W	50 W
Conductance	$1 \cdot 10^{-2}$ mbar: 3 l/s 1 mbar: 9 l/s	$1 \cdot 10^{-2}$ mbar: 3 l/s 1 mbar: 9 l/s	$1 \cdot 10^{-2}$ mbar: 9 l/s 1 mbar: 45 l/s	$1 \cdot 10^{-2}$ mbar: 9 l/s 1 mbar: 45 l/s
Voltage	230 V	115 V	230 V	115 V
Order number				
Adsorption filter	**PT U10 760**	**PT U10 761**	**PT U10 260**	**PT U10 261**

Dust separators

Prevents dust from reaching the pump through the intake tract.

Dust separators



- ▶ Protects against the ingress of dust when installed on intake side
- ▶ Increases service life of operating fluid and protects pump against contamination and wear
- ▶ Not suitable for pumping down vapors

Technical data	STZ 025	STZ 040	STZ 063
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Flange (out)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K
Mounting orientation	Vertical	Vertical	Vertical
For pumping speed up to	30 m^3/h	65 m^3/h	120 m^3/h
Weight	3.5 kg	5.7 kg	15.8 kg
Grain size limit (separable)	1 µm	1 µm	1 µm
Conductance	$1 \cdot 10^{-2}$ mbar: 11 l/s 1 mbar: 25 l/s 100 mbar: 900 l/s	$1 \cdot 10^{-2}$ mbar: 20 l/s 1 mbar: 50 l/s 100 mbar: 1300 l/s	$1 \cdot 10^{-2}$ mbar: 45 l/s 1 mbar: 750 l/s 100 mbar: 2500 l/s
Contamination quantity max.	1000 mg/m^3	1000 mg/m^3	1000 mg/m^3

Order number			
Dust separators	**PK Z60 006**	**PK Z60 008**	**PK Z60 009**

Technical data	STR 025	STR 040	STR 063	STR 100
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K	DN 100 ISO-K
Flange (out)	DN 25 ISO-KF	DN 40 ISO-KF	DN 63 ISO-K	DN 100 ISO-K
Mounting orientation	Vertical	Vertical	Vertical	Vertical
For pumping speed up to	30 m^3/h	65 m^3/h	120 m^3/h	250 m^3/h
Weight	3.7 kg	6.2 kg	20.3 kg	32 kg
Grain size limit (separable)	2.5 µm	2.5 µm	2.5 µm	2.5 µm
Conductance	$1 \cdot 10^{-2}$ mbar: 11 l/s 1 mbar: 25 l/s 100 mbar: 900 l/s	$1 \cdot 10^{-2}$ mbar: 20 l/s 1 mbar: 50 l/s 100 mbar: 1300 l/s	$1 \cdot 10^{-2}$ mbar: 25 l/s 1 mbar: 250 l/s 100 mbar: 4000 l/s	$1 \cdot 10^{-2}$ mbar: 60 l/s 1 mbar: 400 l/s 100 mbar: 1000 l/s
Contamination quantity max.	100 mg/m^3	100 mg/m^3	100 mg/m^3	100 mg/m^3
Order number				
Dust separators	**PK Z60 106**	**PK Z60 108**	**PK Z60 110**	**PK Z60 112**

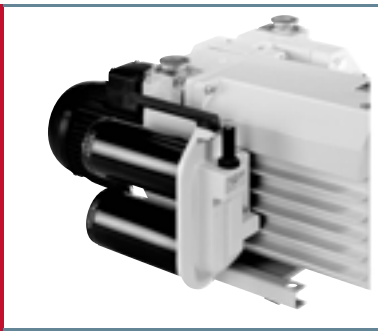
Technical data	STP 016	STP 025	STP 040
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Mounting orientation	Optional	Optional	Optional
For pumping speed up to	5 m^3/h	30 m^3/h	65 m^3/h
Weight	0.7 kg	1.7 kg	2.8 kg
Grain size limit (separable)	5 µm	5 µm	5 µm
Conductance	$1 \cdot 10^{-2}$ mbar: 1.5 l/s 1 mbar: 7 l/s 100 mbar: 70 l/s	$1 \cdot 10^{-2}$ mbar: 15 l/s 1 mbar: 80 l/s 100 mbar: 1000 l/s	$1 \cdot 10^{-2}$ mbar: 25 l/s 1 mbar: 140 l/s 100 mbar: 1500 l/s
Contamination quantity max.	50 mg/m^3	50 mg/m^3	50 mg/m^3
Order number			
Dust separators	**PK Z60 203**	**PK Z60 206**	**PK Z60 208**

Technical data	STP 063	STP 100
Flange (in)	DN 63 ISO-K	DN 100 ISO-K
Flange (out)	DN 63 ISO-K	DN 100 ISO-K
Mounting orientation	Optional	Optional
For pumping speed up to	120 m^3/h	250 m^3/h
Weight	15 kg	25 kg
Grain size limit (separable)	5 µm	5 µm
Conductance	$1 \cdot 10^{-2}$ mbar: 30 l/s 1 mbar: 700 l/s 100 mbar: 4200 l/s	$1 \cdot 10^{-2}$ mbar: 60 l/s 1 mbar: 3000 l/s 100 mbar: 10000 l/s
Contamination quantity max.	50 mg/m^3	50 mg/m^3
Order number		
Dust separators	**PK Z60 210**	**PK Z60 212**

Oil filter

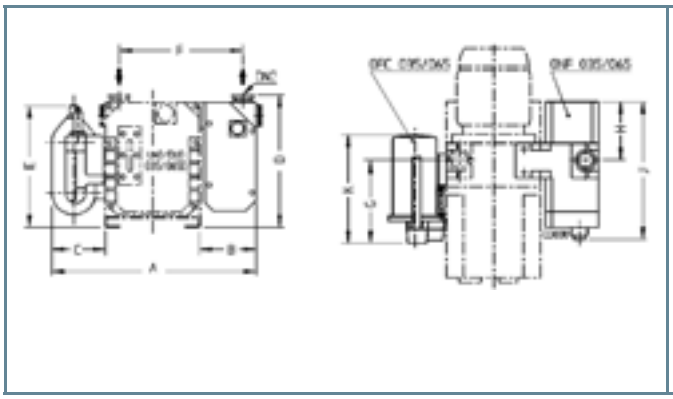
OFC 35/65, Chemical oil filter
OFM 35/65, Mechanical oil filter

Oil filter

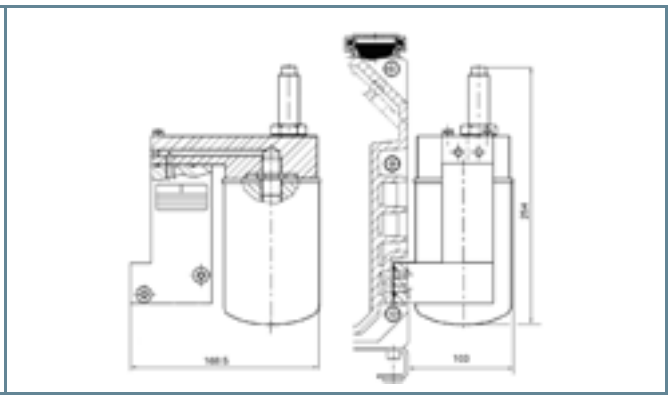


- The chemical oil filter is designed for partial-flow installation in the oil circulation system of rotary vane pumps
- The mechanical oil filter is designed for partial-flow installation in the oil circulation system of rotary vane pumps
- The oil filter filters out dust and particulate matter from the production filter in the operating fluid
- Moreover, corrosive substances are also adsorbed from the operating fluid. This reduces pump wear

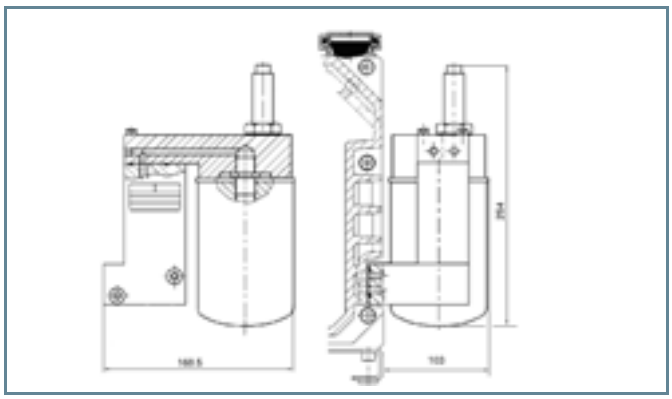
Dimensions



OFC 35/65



OFM 35/65



OMF 255

	OFC 35/65
A	517 mm
B	142 mm
C	135 mm
D	340 mm
E	308 mm
F	322 mm
G	207 mm
H	160 mm
J	350 mm
K	277 mm

Technical data	OFC 35/65	OFM 35/65	OMF 255
For pumping speed	35-65 m^3/h	35-65 m^3/h	255 m^3/h
Capacity	-	0.8 l	4.0 l
Capacity chem. filter	0.8 l	-	-
Capacity mech. filter	1.2 l	-	-
Filter poresize	-	12 µm	10 µm
Weight	8 kg	3.2 kg	2.5 kg

Order number			
Oil filter	**PK Z90 320**	**PK Z90 321**	**PK Z90 341**

Operating fluid

Operating fluids for rotary vane pumps.

P3

For standard applications: To pump air, inert gases and noble gases.

Operating fluid	Achievable ultimate pressure	Order number
P3, mineral oil, 0.5 l	< $1 \cdot 10^{-3}$	**PK 001 136-T**
P3, mineral oil, 1 l	< $1 \cdot 10^{-3}$	**PK 001 106-T**
P3, mineral oil, 5 l	< $1 \cdot 10^{-3}$	**PK 001 107-T**
P3, mineral oil, 20 l	< $1 \cdot 10^{-3}$	**PK 001 108-T**
P3, mineral oil, 50 l	< $1 \cdot 10^{-3}$	**PK 001 109-T**
P3, mineral oil, 200 l	< $1 \cdot 10^{-3}$	**PK 001 110-T**

F5

To pump oxygen, ozone, halogens, uranium compounds, organic and inorganic solvents, HCL, BF_3, HF, PO_3 and fluorine.

Operating fluid	Achievable ultimate pressure	Order number
F5, Perfluorpolyether, 0.5 l	< $1 \cdot 10^{-3}$	**PK 001 851-T**
F5, Perfluorpolyether, 1 l	< $1 \cdot 10^{-3}$	**PK 001 852-T**
F5, Perfluorpolyether, 5 l	< $1 \cdot 10^{-3}$	**PK 001 853-T**
F5, Perfluorpolyether, 20 l	< $1 \cdot 10^{-3}$	**PK 001 854-T**
F5, Perfluorpolyether, 50 l	< $1 \cdot 10^{-3}$	**PK 001 855-T**

D1

Used for high operating temperatures > 100 °C.

Operating fluid	Achievable ultimate pressure	Order number
D1 oil, 0.25 l	< $5 \cdot 10^{-2}$	**PK 005 870-T**
D1 oil, 0.5 l	< $5 \cdot 10^{-2}$	**PK 005 881-T**
D1 oil, 1 l	< $5 \cdot 10^{-2}$	**PK 005 875-T**
D1 oil, 5 l	< $5 \cdot 10^{-2}$	**PK 005 876-T**
D1 oil, 20 l	< $5 \cdot 10^{-2}$	**PK 005 877-T**
D1 oil, 50 l	< $5 \cdot 10^{-2}$	**PK 005 878-T**
D1 oil, 200 l	< $5 \cdot 10^{-2}$	**PK 005 879-T**

F4

For pumping down oxygen, ozone, halogens, uranium compounds, organic and inorganic solvents, HCL, BF_3, HF, PO_3 and fluorine

Operating fluid	Achievable ultimate pressure	Order number
F4, Perfluorpolyether, 0.25 l	< $1 \cdot 10^{-3}$	**PK 005 885-T**
F4, Perfluorpolyether, 0.5 l	< $1 \cdot 10^{-3}$	**PK 005 886-T**
F4, Perfluorpolyether, 1 l	< $1 \cdot 10^{-3}$	**PK 005 887-T**
F4, Perfluorpolyether, 5 l	< $1 \cdot 10^{-3}$	**PK 005 888-T**
F4, Perfluorpolyether, 20 l	< $1 \cdot 10^{-3}$	**PK 005 889-T**
F4, Perfluorpolyether, 50 l	< $1 \cdot 10^{-3}$	**PK 005 890-T**

Further on available

Single-stage rotary vane pumps		Order number
UNO 2.5		
	100-105 V, 50 Hz; 110-130 V, 60 Hz	**PK D31 707**
	95-105 V, 50 Hz; 100-115 V, 60 Hz	**PK D31 708**
	190-210 V, 50 Hz; 200-220 V, 60 Hz	**PK D31 709**
	220-240 V, 50 Hz; 220-240 V, 60 Hz	**PK D31 712**
UNO 5		
	100-105 V, 50 Hz; 110-130 V, 60 Hz	**PK D31 807**
	95-105 V, 50 Hz; 100-115 V, 60 Hz	**PK D31 808**
	190-210 V, 50 Hz; 200-220 V, 60 Hz	**PK D31 809**
	220-240 V, 50 Hz; 220-240 V, 60 Hz	**PK D31 812**
UNO 30 M		
	200-230/380-415 V, 50 Hz; 208-240/380-460 V, 60 Hz	**PK D54 156**
	100-110 V, 50 Hz; 100-120 V, 60 Hz	**PK D54 707**
	200-230 V, 50 Hz; 200-240 V, 60 Hz	**PK D54 712**
	100-110 V, 50 Hz; 100-120 V, 60 Hz	**PK D54 757**
	200-230 V, 50 Hz; 200-240 V, 60 Hz	**PK D54 762**
UNO 35		
	218-242/380-420 V, 50 Hz; 250-277/440-480 V, 60 Hz	**PK D35 602**
	200/346 V, 50 Hz; 200-230/346-400 V, 60 Hz	**PK D35 642**
	400 V, 50 Hz	**PK D35 305**
UNO 65		
	218-242/380-420 V, 50 Hz; 250-277/440-480 V, 60 Hz	**PK D36 602**
	200/346 V, 50 Hz; 200-230/346-400 V, 60 Hz	**PK D36 642**
	400 V, 50 Hz	**PK D36 305**

Notes

Notes

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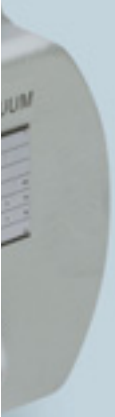
Roots pumps



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Selection aid

● Recommended

Model	A, AD series (with radial shaft sealring)	AM series (hermetically light)	ADx, ADEx series (complies with ATEX)	Analysis						Semiconductors & electronics										
				Electron microscopy	Leak detection	Mass spectrometry	Surface analysis	Plasma monitoring	Residual gas analysis	Lithography	PVD (Physical Vapor Deposition)	CVD (Chemical Vapor Deposition)	Plasma etching	Implantation – Source	Implantation – Beamline	Inspection	Bonding	MBE (Molecular Beam Epitaxy)	Load locks, transfer chambers, handling systems	Hard drive coating
OktaLine™																				
Okta 250	✓	✓								●	●	●	●					●	●	●
Okta 500	✓	✓	✓							●	●	●	●					●	●	●
Okta 1000	✓	✓	✓							●	●	●	●							●
Okta 2000	✓	✓	✓							●	●	●	●							●
Okta 4000	✓	✓	✓							●	●	●	●							
Okta 6000	✓	✓																		
Okta 8000	✓																			
Okta 18000	✓																			

	Coating						Industry								Research & development									
	Solar cell production (PECVD, CIS, CIGS, etc.)	Glass coating (PVD)	CD/DVD/Blu-ray production (PVD)	Optical coatings (PVD)	Wear protection (PVD, CVD)	Film coating (PVD)	Medical technology	Industrial leak detection	Electron beam welding	Isolation vacuums	Incandescent and fluorescent lamp production	Heat treatment	Vacuum drying	Vacuum furnaces	Nuclear research	Fusion technology	Plasma research	Particle accelerators	Space simulation	Cryogenic research	Elementary particle physics	Nanotechnology	Biotechnology
			●	●	●	●		●	●			●			●		●		●		●	●	
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Roots Pumps – OktaLine™

Roots pumps for every low and medium vacuum application.

What is OktaLine?
Pfeiffer Vacuum Roots pumps are displacement pumps that operate in accordance with the Roots principle and have been specially designed for vacuum technology. Their pumping effect is produced by the synchronized counter-rotation of the two figure eight-shaped rotors.

The gear and bearing areas of Pfeiffer Vacuum Roots pumps are separated from the gas displacement area by means of a labyrinth seal. The contactless operating principle of the Roots pistons assures virtually dry, hydrocarbon-free operation.

A program with power

A complete line of powerful pumps

Our Roots pumps offer pumping speeds ranging from 250 to 25,000 m^3/h. They can be safely employed for low and medium vacuum applications in the coating or semiconductor industry, in research & development, metallurgy or in chemistry and process technology.

Advantages at a glance

- Complete line of Roots pumps offers optimum flexibility and maximium process suitability
- Broad range of pumping speeds: 250 to 25,000 m^3/h
- Rugged, compact design
- Fast evacuation thanks to high compression ratio and overflow valve
- Maintenance free, maximum reliability and highest uptime thanks to magnetic coupling
- Low operating costs thanks to air cooling and magnetic coupling
- No thermal overload thanks to integral overflow valve
- Long service intervals and simple on-site maintenance
- On-site service worldwide
- Over 50 years of experience and competence

Applications

- Metallurgy
- Simulation chambers
- Packaging industry
- Freeze/vacuum-drying
- Thin-film technology
- Electron beam welding
- Load-locks/transfer chambers
- Chemistry and process technology
- Industrial leak detection systems

Packaging industry

Electron beam welding

Metallurgy

Series

Depending on the type of application, four series may be considered. The Roots pumps in the **A series** are the proven standard for all low and medium vacuum applications.

For processes which are more demanding in regards to leak tightness and longer service intervals, the **AM series** are the best choice. These series offer a full static seal on the outside, therefore, no shaft feedthrough is implemented by way of a magnetic coupling. Therefore all IEC standard motors can be used.

The directive 94/9 EC (ATEX) requirements are fulfilled by the pumps in the ADEx series. This series is certified for applications of equipment class II, equipment group 2G for materials belonging to explosion group IIB in the temperature class T3.

A series, 250 – 25,000 m^3/h
Roots pump, standard (1 bar)
With shaft sealing ring
Gray cast iron GG
Flange in accordance with ISO-F

AM series, 250 – 6,000 m^3/h
Roots pump, standard (1 bar)
Hermetically sealed
Gray cast iron GG
Flange in accordance with ISO-F

ADEx series, 500 – 4,000 m^3/h
Roots pump pressure surge resistant (16 bar test pressure)
PTFE sealed
Explosion hazard protected
Directive 94/9/EC Ex II 2 G II B T3 x

ADx series, 500 - 4,000 m^3/h
Roots pump pressure surge resistant (16 bar)
PTFE sealed
Explosion hazard protected
Directive 94/9/EC Ex II - i/3G II B T3 x

Features of the A series

Common to all series is the integrated bypass line, which permits switching on the pump beginning at atmospheric pressure (note the cut-in criteria for the ADEx variants). Thus, the pump is automatically protected against thermal overload. The additional gain in pumping speed allows for short cycle times in the case of load lock applications and time critical processes. Monitoring by means of failure prone pressure switches is a thing of the past. The precision manufacturing technology allows for highest compression values allowing for a maximum pumping speed at lowest gas discharge temperatures. For service, pairing up of the rotors is not necessary.

Pfeiffer Vacuum Roots pumps offer the lowest cost of ownership since exclusively electrical energy and – providing the process requires this – a gaseous sealing medium (air, for example) is required. Therefore, costly water cooling arrangements are not required.

Vertical pumping action
Unaffected by dust and liquids
Measurement connections on the intake and delivery sides
The connection of pressure and temperature measuring instruments is possible
Helical gear
Quiet operation

Sealing gas bores at the bearing brackets
If required, simple retrofitting of sealing gas is possible
Material
High-quality cast iron materials, FPM O-ring seal (chambered)

Designed for 50 Hz and 60 Hz operation
- Frequency converter operation for matching to the process is available on request

100 % final testing with $K_{0max.}$
- Value measurement (leak test, load test)

Additional features of the AM series

- No dynamic seal, only statically sealed against the atmosphere – no wear
- Integral leak rate of the pump $< 1 \cdot 10^{-5}$ mbar l/s
- Corrosion-resistant split can version

Safe operation
- Environmentally friendly
- No oil leaks
- No exchange between process gas and the environment

Low operating costs
- Shaft seal maintenance not necessary

Increased uptime
- No unexpected interruptions to process due to oil leaks

Simple integration
- Full compatibility with the Pfeiffer Vacuum Roots pump line and accessories
- All IEC motors can be used

Additional features of the ADEx series

For safe operation of the pumps, compliance with additional components like starting up and shutting down regulations, backing pumps, flame arresters and pressure sensors is mandatory. This list, by no means, claims to be complete. The prementioned components and additional equipment will depend on the specific vacuum design, the way in which the process is run as well as the pressure resistance of the vacuum and exhaust air system. Before ordering please discuss your particular application with Pfeiffer Vacuum.

External area:
The pumps are suited for applications within equipment class II, equipment category 2G for gases and vapors of explosion group IIB in the temperature classes T1 to T3 corresponding to the stipulations of the directive 94/9/EC.

Internal area:
I) Application within equipment class II, equipment category 2G application (Zone 1).
The pumps are suited for pumping of explosive mixtures belonging to explosion group IIB from Zone 1 (equipment category 2G) in the temperature classes from T1 to T3 corresponding to the directive 94/9/EC.

For such application, a backing pump is required which basically needs to provide at least 10 % of the pumping speed of the Roots pump. The selected backing pump must, for pumping of explosive atmospheres of Zone 1, have a Declaration of Conformity for group II, category 2 in accordance with directive 94/9/EC for the intended utilization (explosion group, temperature class).

The start-up pressure of the Roots pump depends on the pressure rating of the entire vacuum system and additional equipment with flame arresters.

II) Application within equipment class II,
equipment category 1G application (Zone 0)

For such application, a backing pump is required which basically needs to provide at least 10 % of the pumping speed of the Roots pump. The selected backing pump must, for pumping of explosive atmospheres of Zone 0, have an EC type approval certificate for the equipment group II, equipment category 1G in accordance with directive 94/9/EC for the intended utilization (explosion group, temperature class).

The switch-on pressure for the Roots pump must be < 800 mbar absolute. However, this is dependent on the pressure rating of the entire vacuum system and the additional equipment with flame arresters.

General information:

Before defining the suitable start-up pressures for the Roots pumps, it is urgently recommended to discuss the application with Pfeiffer Vacuum.

Additional features of the ADx series

Exterior:

These pumps are suitable for employment in Equipment Class II, Equipment Category 3(G) for Explosion Group IIB gases and vapors in Temperature Classes T1 to T3, in accordance with the requirements of directive 94/9/EC.

Interior:

These Roots pumps are not suitable for pumping explosive gas mixtures.

Scope of delivery

Delivery includes the connection kits and seals for the connection flanges. If the pumps are delivered without a motor, the motor lantern and the coupling as well as the connection kit for mounting the motor are included. For pumps which are operated with P3 pump fluid, the initial filling is included with delivery. For shipping reasons, the pump fluid is shipped separately. For pumps in which a special pump fluid is required (F5, D1), the pump fluid must be ordered separately. If necessary, the pumps are assembled and tested using the special pump fluid.

Overview of OktaLine™ series

Miscellaneous available products

- Gas-cooled Roots pumps
- Pumping speed of 250 m^3/h up to 12,000 m^3/h
- Dry (oilfree) compressing
- From 130 mbar up to atmospheric pressure

	WGK 500	WGK 1500	WGK 4000	WGK 8000
Nominal pumping speed 50 Hz (m^3/h)	520	1,500	4,600	8,000
Rotational speed (RPM)	3,000	1,500	1,500	1,500
Pump fluid filling (l)	3	5	21	21
Weight, pump without motor (kg)	116	520	1,100	1,500

Hint: The motor and the eventually necessary gas cooler should be chosen individually, to ensure an optimum adaption to the process.

Accessories

Pump fluid / lubricant for Roots pumps
The pump fluid for the Roots pumps with a dry suction chamber serves only to lubricate the gears, the shaft sealing rings and bearings. Through the labyrinth seal between the suction chamber and oil chambers, it may come into direct contact with pumped gases and vapors. This means that the oil requirements are similar to those of the rotary vane pump and therefore the same oil can be used in both pumps.

Sealing gas supply kit
For protecting the pump fluid and the components in the oil chambers. This kit consists of:
- Connection components
- Seals
- Four orifices at the inlet openings of the bearing plates

In addition the following is required:
- One flow meter with needle valve for adjusting the flowing volume
- Shutoff valve (ball valve)
- Pressure reducer (reduction to max. 1.5 bar absolute)

Gear chamber suction kit
For shorter evacuating time less than one minute

This kit consists of:
- Connection material made of PVC hose DN 15/small flange components
- Oil mist separator DN 10 KF

Flushing kit
Used where deposits tend to form in the suction chambers. The implementation of this kit should be determined based on the specific application. Flushing quantities are defined in the respective pump manuals.

With standard pumps, flushing always requires the use of a sealing gas in order to prevent transfer of liquid into the oil chambers.

Sealing material PTFE
Resistant against aggressive media. PTFE coated FPM O-rings are used as static seals. The radial shaft sealing ring at the motor is made of PTFE.

Coating of the suction chamber of the pump (suction chamber / corrosion protection)
The inside of standard pumps are wetted with the vacuum oil (P3 or the special pump fluid), providing a suitable surface protection can be attained. Pumps where the suction chamber must not be wetted with the pump fluid may, upon request, be phosphated, sealed off with flanges and vented with nitrogen.

The pumps can be provided with an optional coating in order to achieve corrosion resistance and/or good anti-adhesion properties.

Important information relating to the technical data

The effective pumping speed of the Roots pump depends directly on the characteristics of the backing pump used. The values of the effective pumping speed and final pressure provide useful information only when stating the type of backing pump used in this case. The effective pumping speed of a Roots pump with backing pump usually calculates, within the operating pressure range, to a multiple of the backing pump's pumping speed.

The final pressure attained with a Roots pump is lower than the final pressure of the backing pump by a factor of the compression ratio.

Depending on the manufacturer of the motor, the overall length of the pump may deviate by up to 50 mm.

Glass coating

Oil recovery

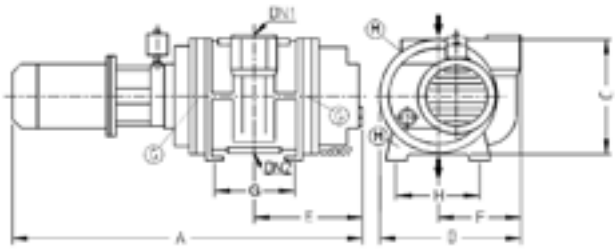
Okta 250

Roots pumps with a pumping speed of up to 330 m³/h :

Okta 250

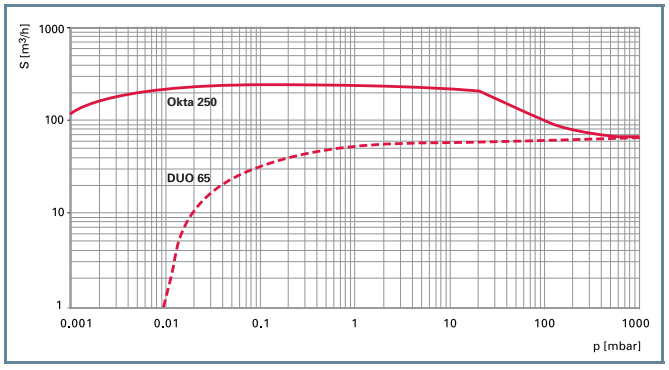
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 250 A	Okta 250 AM
A	770 mm	800 mm
B	324 mm	324 mm
C	280 mm	280 mm
E	220 mm	220 mm
F	184 mm	184 mm
G	170 mm	170 mm
H	220 mm	220 mm
Connection		
DN 1	DN 63 ISO-F	DN 63 ISO-F
DN 2	DN 63 ISO-F	DN 63 ISO-F

Pumping speed



Technical data	Okta 250 A, 230/400 V, 50 Hz	Okta 250 A, 230/400 V, 60 Hz	Okta 250 A, without motor
Nominal pumping speed	270 m^3/h	324 m^3/h	-
Differential pressure at the overflow valve	75 mbar	75 mbar	75 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	70 dB (A)	70 dB (A)	70 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	75 dB (A)	75 dB (A)	75 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	1.5 l	1.5 l	1.5 l
Motor rating	0.75 kW	1.1 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	230/400 V, 50 Hz	230/400 V, 60 Hz	-
Weight	95 kg	95 kg	85 kg

Order number			
Okta 250 A	**PP W21 000**	**PP W21 002**	**PP W21 001**
Okta 250 AM	**PP W22 000**	**PP W22 002**	

A Series = Standard pumps (1 bar), shaft sealing rings, gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F

Accessories	
Splinter shield for Okta 250 A-Series	**PK 300 010-X**

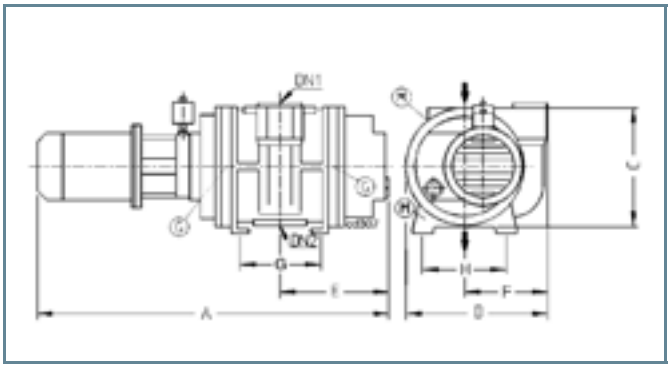
Okta 500

Roots pumps with a pumping speed of up to 590 m³/h :

Okta 500

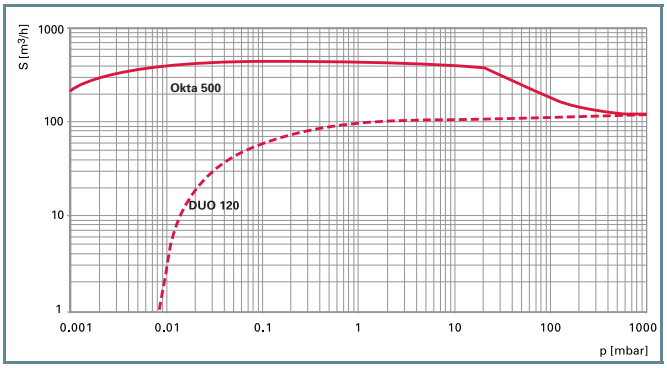
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 500 A	Okta 500 AM	Okta 500 ADEx	Okta 500 ADx
A	920 mm	950 mm	920 mm	920 mm
B	324 mm	324 mm	346 mm	346 mm
C	280 mm	280 mm	280 mm	280 mm
E	275 mm	275 mm	275 mm	275 mm
F	184 mm	184 mm	206 mm	206 mm
G	170 mm	170 mm	170 mm	170 mm
H	220 mm	220 mm	220 mm	220 mm
Connection				
DN 1	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16
DN 2	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16

Pumping speed



Technical data	Okta 500 A, 230/400 V, 50 Hz	Okta 500 A, 230/400 V, 60 Hz	Okta 500 A, without motor
Nominal pumping speed	490 m^3/h	588 m^3/h	-
Differential pressure at the overflow valve	75 mbar	75 mbar	75 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	70 dB (A)	70 dB (A)	70 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	75 dB (A)	75 dB (A)	75 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	1.5 l	1.5 l	1.5 l
Motor rating	1.5 kW	2.2 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	230/400 V, 50 Hz	230/400 V, 60 Hz	-
Weight	125 kg	125 kg	100 kg

Order number			
Okta 500 A	**PP W31 000**	**PP W31 002**	**PP W31 001**
Okta 500 AM	**PP W32 000**	**PP W32 002**	
Okta 500 ADEx			**PP W31 840**
Okta 500 ADx			**PP W33 201**

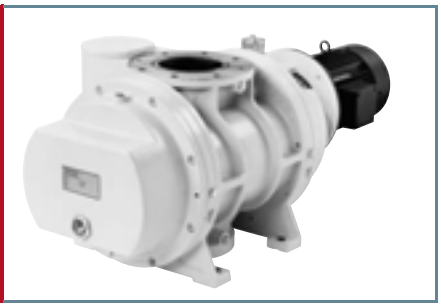
A Series = Standard pumps (1 bar), shaft sealing rings, gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F
ADEx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II 2G IIB T3 (i) (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, integrated Atex-certified temperature sensor, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16
ADx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II - (i) / 3G IIB T3 (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16

Accessories	
Splinter shield for Okta 500 A-Series	**PP 030 149 AX**
Splinter shield for Okta 500 AD-Series	**PP 042 350-X**

Okta 1000

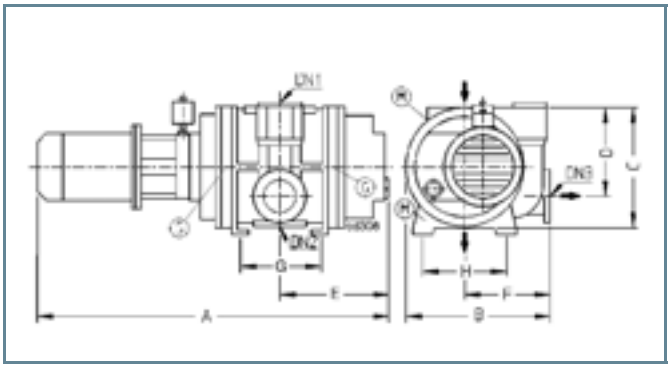
Roots pumps with a pumping speed of up to 1300 m³/h:

Okta 1000



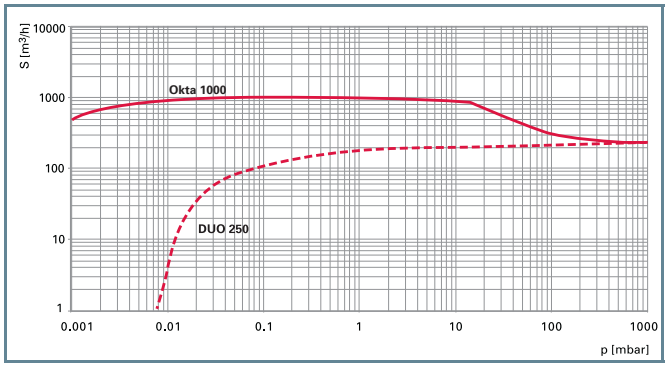
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 1000 A	Okta 1000 AM	Okta 1000 ADEx	Okta 1000 ADx
A	1125 mm	1140 mm	1125 mm	1125 mm
B	446 mm	446 mm	446 mm	446 mm
C	360 mm	360 mm	360 mm	360 mm
D	270 mm	270 mm	270 mm	270 mm
E	337 mm	337 mm	337 mm	337 mm
F	266 mm	266 mm	266 mm	266 mm
G	230 mm	230 mm	230 mm	230 mm
H	280 mm	280 mm	280 mm	280 mm
Connection				
DN 1	DN 160 ISO-F	DN 160 ISO-F	DN 150 PN 16	DN 150 PN 16
DN 2	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16
DN 3	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16

Pumping speed



Technical data	Okta 1000 A, 230/400 V, 50 Hz	Okta 1000 A, 230/400 V, 60 Hz	Okta 1000 A, without motor
Nominal pumping speed	1070 m^3/h	1284 m^3/h	-
Differential pressure at the overflow valve	45 mbar	45 mbar	45 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	72 dB (A)	72 dB (A)	72 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	75 dB (A)	75 dB (A)	75 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	2.9 l	2.9 l	2.9 l
Motor rating	3 kW	4 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	230/400 V, 50 Hz	230/400 V, 60 Hz	-
Weight	250 kg	250 kg	220 kg

Order number			
Okta 1000 A	**PP W41 000**	**PP W41 002**	**PP W41 001**
Okta 1000 AM	**PP W42 000**	**PP W42 002**	
Okta 1000 ADEx			**PP W41 950**
Okta 1000 ADx			**PP W43 201**

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F
ADEx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II 2G IIB T3 (i) (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, integrated Atex-certified temperature sensor, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16
ADx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II - (i) / 3G IIB T3 (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16

Accessories	
Splinter shield for Okta 1000/2000 A-Series	**PP 031 114-X**
Splinter shield for Okta 1000/2000 AD-Series	**PP 031 115-X**

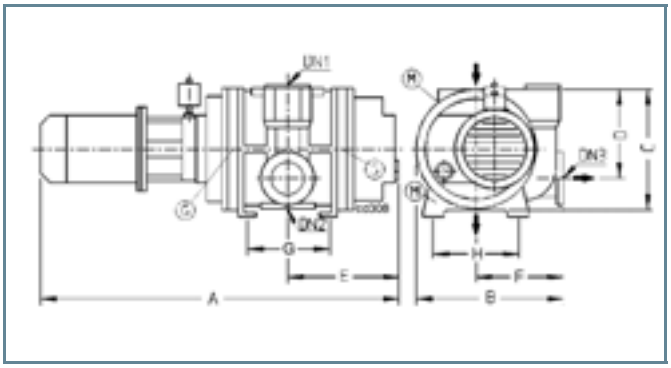
Okta 2000

Roots pumps with a pumping speed of up to 2500 m³/h:

Okta 2000

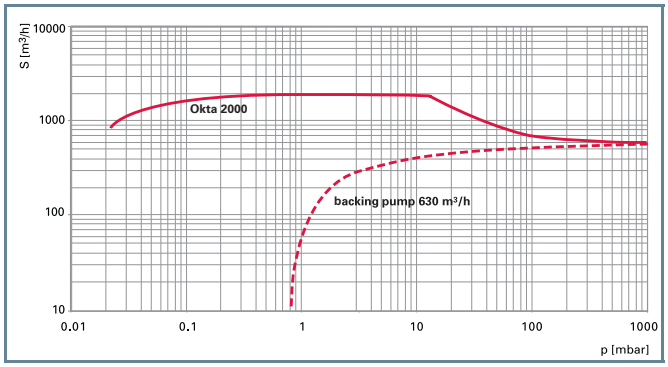
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 2000 A	Okta 2000 AM	Okta 2000 ADEx	Okta 2000 ADx
A	1310 mm	1330 mm	1310 mm	1310 mm
B	502 mm	502 mm	502 mm	502 mm
C	420 mm	420 mm	420 mm	420 mm
D	325 mm	325 mm	325 mm	325 mm
E	373 mm	373 mm	373 mm	373 mm
F	292 mm	292 mm	292 mm	292 mm
G	250 mm	250 mm	250 mm	250 mm
H	360 mm	360 mm	360 mm	360 mm
Connection				
DN 1	DN 160 ISO-F	DN 160 ISO-F	DN 150 PN 16	DN 150 PN 16
DN 2	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16
DN 3	DN 100 ISO-F	DN 100 ISO-F	DN 100 PN 16	DN 100 PN 16

Pumping speed



Technical data	Okta 2000 A, 230/400 V, 50 Hz	Okta 2000 A, 230/400 V, 60 Hz	Okta 2000 A, without motor
Nominal pumping speed	2065 m^3/h	2478 m^3/h	-
Differential pressure at the overflow valve	35 mbar	35 mbar	35 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	72 dB (A)	72 dB (A)	72 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	75 dB (A)	75 dB (A)	75 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	5 l	5 l	5 l
Motor rating	5.5 kW	7.5 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	230/400 V, 50 Hz	230/400 V, 60 Hz	-
Weight	370 kg	370 kg	310 kg

Order number			
Okta 2000 A	**PP W61 000**	**PP W61 002**	**PP W61 001**
Okta 2000 AM	**PP W62 000**	**PP W62 002**	
Okta 2000 ADEx			**PP W61 800**
Okta 2000 ADx			**PP W63 201**

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F
ADEx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II 2G IIB T3 (i) (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, integrated Atex-certified temperature sensor, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16
ADx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II - (i) / 3G IIB T3 (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16

Accessories	
Splinter shield for Okta 1000/2000 A-Series	**PP 031 114-X**
Splinter shield for Okta 1000/2000 AD-Series	**PP 031 115-X**

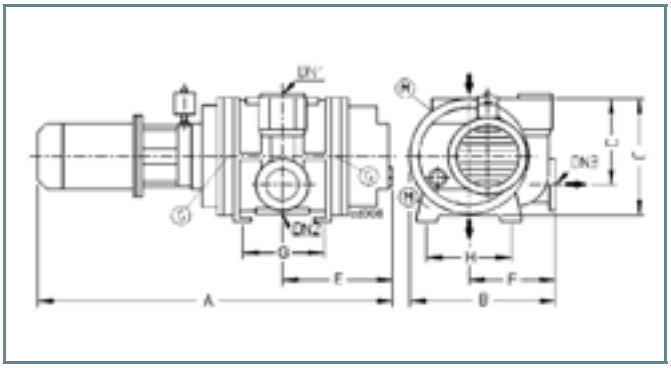
Okta 4000

Roots pumps with a pumping speed of up to 4900 m³/h:

Okta 4000

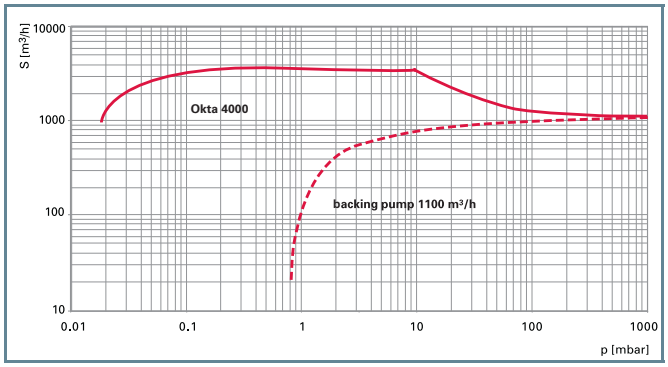
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 4000 A	Okta 4000 AM	Okta 4000 ADEx	Okta 4000 ADx
A	1570 mm	1630 mm	1570 mm	1570 mm
B	655 mm	655 mm	655 mm	655 mm
C	510 mm	510 mm	510 mm	510 mm
D	390 mm	390 mm	390 mm	390 mm
E	453 mm	453 mm	453 mm	453 mm
F	400 mm	400 mm	400 mm	400 mm
G	400 mm	400 mm	400 mm	400 mm
H	450 mm	450 mm	450 mm	450 mm
Connection				
DN 1	DN 250 ISO-F	DN 250 ISO-F	DN 250 PN 16	DN 250 PN 16
DN 2	DN 160 ISO-F	DN 160 ISO-F	DN 150 PN 16	DN 150 PN 16
DN 3	DN 160 ISO-F	DN 160 ISO-F	DN 150 PN 16	DN 150 PN 16

Pumping speed



Technical data	Okta 4000 A, 400 V, 50 Hz	Okta 4000 A, 400 V, 60 Hz	Okta 4000 A, without motor
Nominal pumping speed	4050 m³/h	4860 m³/h	-
Differential pressure at the overflow valve	25 mbar	25 mbar	25 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	74 dB (A)	74 dB (A)	74 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	79 dB (A)	79 dB (A)	79 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	6.8 l	6.8 l	6.8 l
Motor rating	11 kW	15 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	400 V, 50 Hz	400 V, 60 Hz	-
Weight	600 kg	600 kg	520 kg

Order number			
Okta 4000 A	**PP W71 000**	**PP W71 004**	**PP W71 001**
Okta 4000 AM	**PP W72 000**	**PP W72 002**	
Okta 4000 ADEx			**PP W71 990**
Okta 4000 ADx			**PP W73 201**

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F
ADEx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II 2G IIB T3 (i) (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, integrated Atex-certified temperature sensor, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16
ADx Series = Satisfies the explosion requirements under European Union Directive 94/9/EC (II - (i) / 3G IIB T3 (o) X +5°C ≤ T_a ≤ +40°C), with and without Atex-certified motor, PTFE-sealed, nodular graphite cast iron (GGG 40.3), Atex-certified coupling, flange connection in accordance with DIN 2501-1 respectively DIN/EN 1092 PN 16

Accessories	
Splinter shield for Okta 4000/6000 A-Series	**PP 031 136-X**
Splinter shield for Okta 4000 AD-Series	**PP 031 137-X**

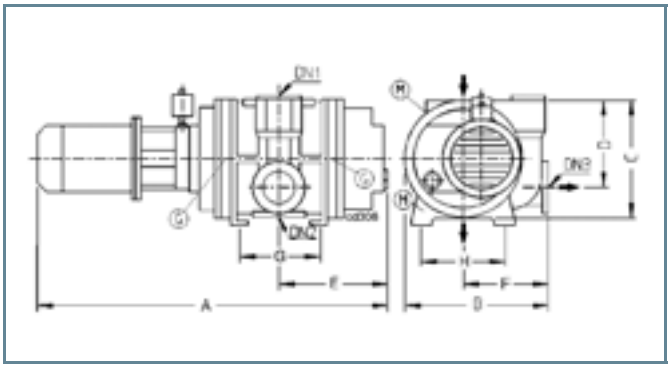
Okta 6000

Roots pumps with a pumping speed of up to 7300 m³/h:

Okta 6000

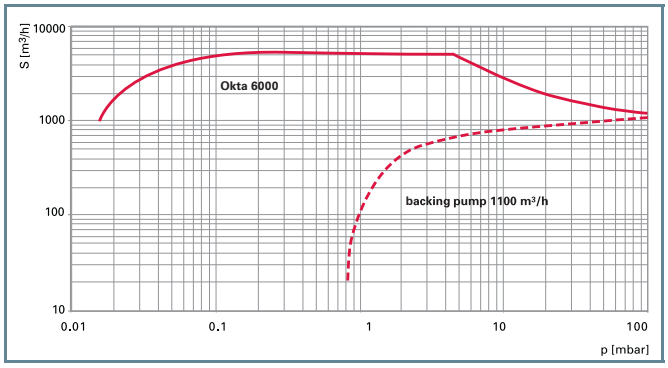
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption

Dimensions



	Okta 6000 A	Okta 6000 AM
A	1860 mm	1920 mm
B	655 mm	655 mm
C	510 mm	510 mm
D	390 mm	390 mm
E	578 mm	578 mm
F	400 mm	400 mm
G	400 mm	400 mm
H	450 mm	450 mm
Connection		
DN 1	DN 250 ISO-F	DN 250 ISO-F
DN 2	DN 160 ISO-F	DN 160 ISO-F
DN 3	DN 160 ISO-F	DN 160 ISO-F

Pumping speed



Technical data	Okta 6000 A, 400 V, 50 Hz	Okta 6000 A, 400 V, 60 Hz	Okta 6000 A, without motor
Nominal pumping speed	6075 m^3/h	7290 m^3/h	-
Differential pressure at the overflow valve	20 mbar	20 mbar	20 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	74 dB (A)	74 dB (A)	74 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	79 dB (A)	79 dB (A)	79 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Leak rate: Magnetic coupled pumps	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s	$1 \cdot 10^{-5}$ mbar l/s
Pump fluid filling	6.8 l	6.8 l	6.8 l
Motor rating	15 kW	18.5 kW	-
Rotation speed	3000 rpm	3600 rpm	-
Mains requirement: voltage (selectable)	400 V, 50 Hz	400 V, 60 Hz	-
Weight	850 kg	850 kg	750 kg

Order number			
Okta 6000 A	**PP W76 000**	**PP W76 004**	**PP W76 001**
Okta 6000 AM	**PP W77 000**	**PP W77 002**	

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), flange connection in accordance with ISO-F
AM Series = Standard pumps (1 bar), hermetically sealed thanks to magnetic coupling, gray cast iron (GG), flange connection in accordance with ISO-F

Accessories	
Splinter shield for Okta 4000/6000 A-Series	**PP 031 136-X**

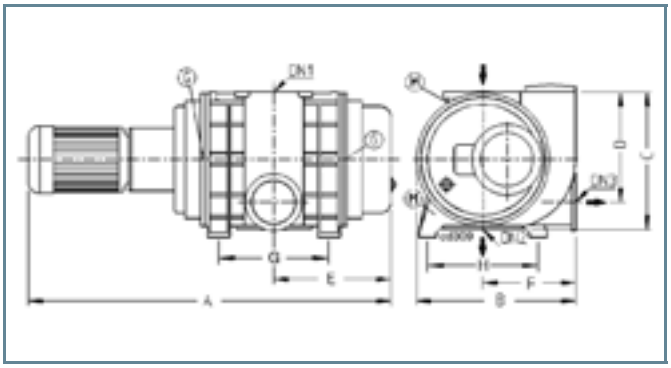
Okta 8000

Roots pumps with a pumping speed of up to 9600 m³/h:

Okta 8000

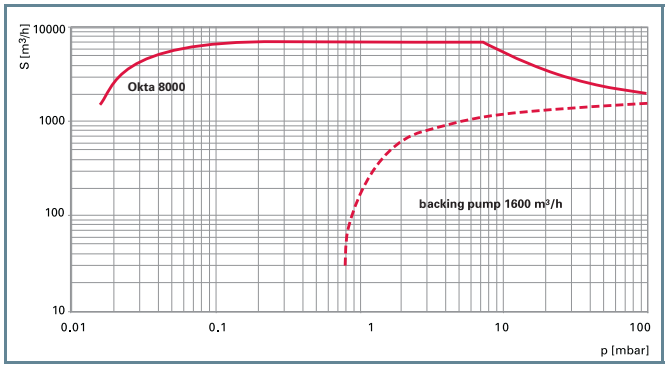
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption
- ▶ Operation by converter up to 12000 m³/h

Dimensions



	Okta 8000
A	2160 mm
B	895 mm
C	765 mm
D	610 mm
E	665 mm
F	510 mm
G	600 mm
H	600 mm
Connection	
DN 1	DN 320 ISO-F
DN 2	DN 320 ISO-F
DN 3	DN 250 ISO-F

Pumping speed



Technical data	Okta 8000, 400 V, 50 Hz	Okta 8000, 400 V, 60 Hz	Okta 8000, without motor
Nominal pumping speed	8000 m^3/h	9600 m^3/h	-
Differential pressure at the overflow valve	27 mbar	27 mbar	27 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	74 dB (A)	74 dB (A)	74 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	78 dB (A)	78 dB (A)	78 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Pump fluid filling	21 l	21 l	21 l
Motor rating	22 kW	30 kW	-
Rotation speed	1500 rpm	1800 rpm	-
Mains requirement: voltage	400 V, 50 Hz	400 V, 60 Hz	-
Weight	1550 kg	1600 kg	1400 kg

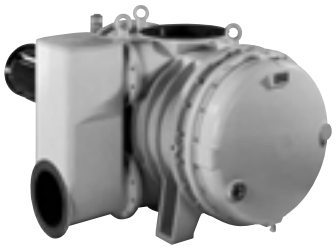
Order number			
Okta 8000	**PP W80 000**	**PP W80 060**	**PP W80 001**

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), flange connection in accordance with ISO-F

Accessories	
Splinter shield for Okta 8000/12000	**PP 030 152-X**

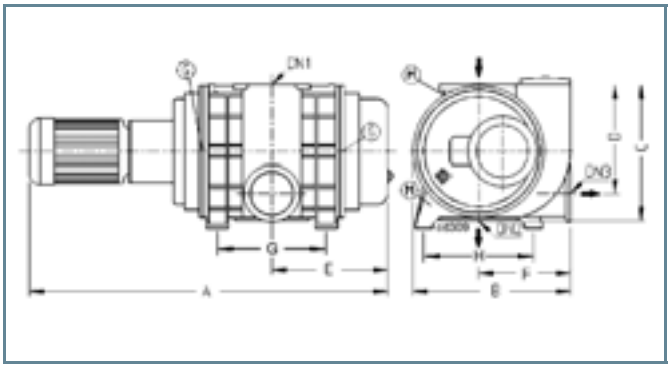
Okta 18000 Roots pumps with a pumping speed of up to 21500 m³/h:

Okta 18000



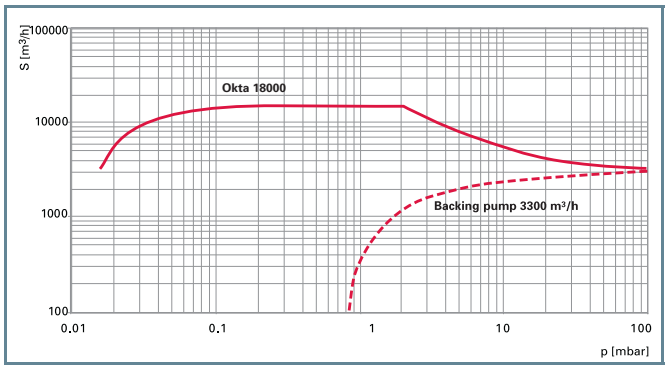
- ▶ Highest compression value of all vendors
- ▶ Integrated overflow valve
- ▶ No cooling water consumption
- ▶ Operation by converter up to 25000 m³/h

Dimensions



	Okta 18000
A	2630 mm
B	1460 mm
C	1000 mm
D	820 mm
E	860 mm
F	960 mm
G	840 mm
H	840 mm
Connection	
DN 1	DN 400 PN 10
DN 2	DN 400 PN 10
DN 3	DN 320 ISO-F

Pumping speed



Technical data	Okta 18000, 400 V, 50 Hz	Okta 18000, 400 V, 60 Hz	Okta 18000, without motor
Nominal pumping speed	17850 m^3/h	21420 m^3/h	-
Differential pressure at the overflow valve	10 mbar	10 mbar	10 mbar
Emission sound pressure level (EN ISO 2151) at intake pressure 1 mbar	75 dB (A)	75 dB (A)	75 dB (A)
Emission sound pressure level (EN ISO 2151) at intake pressure 10 mbar	79 dB (A)	79 dB (A)	79 dB (A)
Leak rate: Pumps with shaft sealings	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Pump fluid filling	68 l	68 l	68 l
Motor rating	45 kW	45 kW	-
Rotation speed	1500 rpm	1800 rpm	-
Mains requirement: voltage	400 V, 50 Hz	400 V, 60 Hz	-
Weight	3300 kg	3300 kg	2800 kg

Order number			
Okta 18000	**PP W90 000**	**PP W90 060**	**PP W90 001**

A Series = Standard pumps (1bar), shaft sealing rings, Gray cast iron (GG), outlet flange and flange bearing: DN 400 PN 10, lateral flange: DN 320 ISO-F

Accessories	
Splinter shield for Okta 18000/25000	**PP 030 336-T**

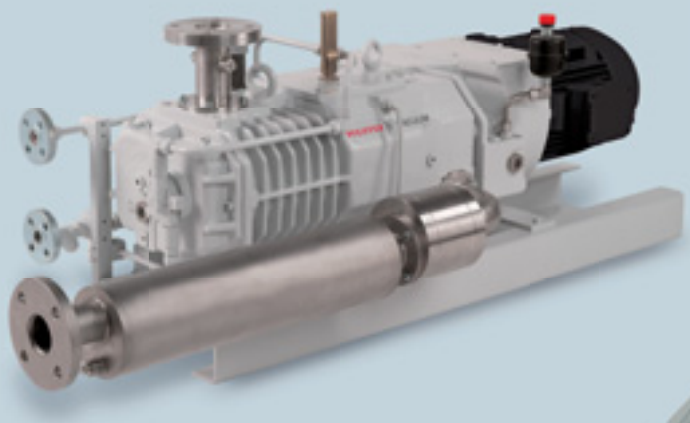
Accessories OktaLine™

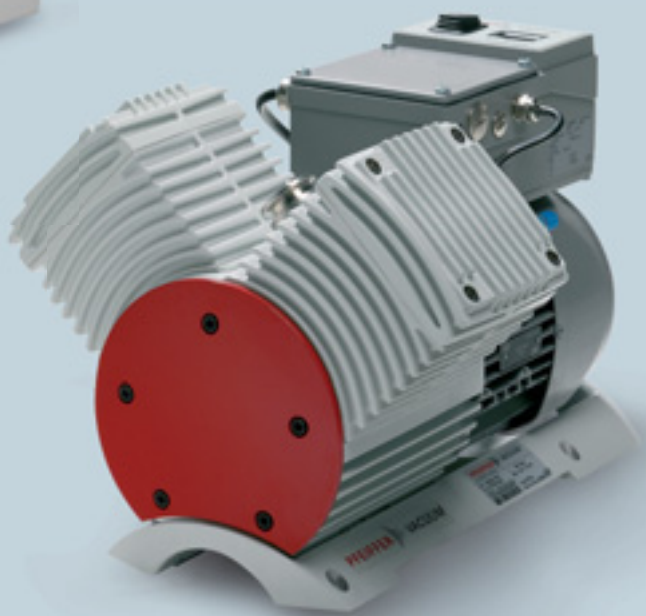
Accessories

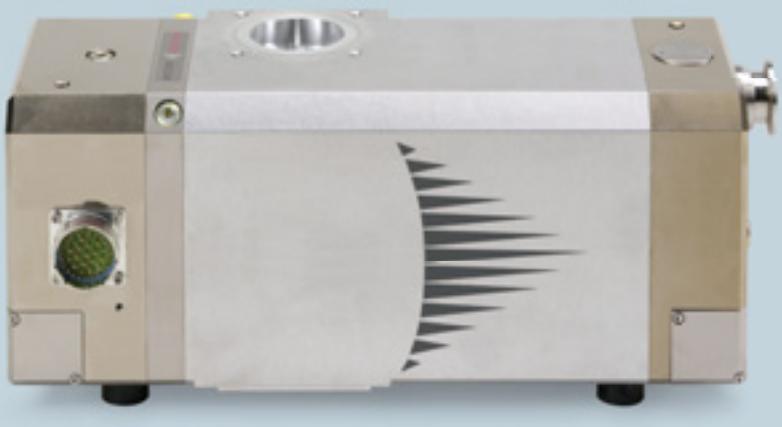
Accessories	
Splinter shield for Okta 250 A-Series	**PK 300 010-X**
Splinter shield for Okta 500 A-Series	**PP 030 149 AX**
Splinter shield for Okta 500 AD-Series	**PP 042 350-X**
Splinter shield for Okta 1000/2000 A-Series	**PP 031 114-X**
Splinter shield for Okta 1000/2000 AD-Series	**PP 031 115-X**
Splinter shield for Okta 4000/6000 A-Series	**PP 031 136-X**
Splinter shield for Okta 4000 AD-Series	**PP 031 137-X**
Splinter shield for Okta 8000/12000	**PP 030 152-X**
Splinter shield for Okta 18000/25000	**PP 030 336-T**

Operating fluid	
P3, mineral oil, 0.5 l	**PK 001 136-T**
P3, mineral oil, 1 l	**PK 001 106-T**
P3, mineral oil, 5 l	**PK 001 107-T**
P3, mineral oil, 20 l	**PK 001 108-T**
P3, mineral oil, 50 l	**PK 001 109-T**
P3, mineral oil, 200 l	**PK 001 110-T**
F5, Perfluorpolyether, 0.5 l	**PK 001 851-T**
F5, Perfluorpolyether, 1 l	**PK 001 852-T**
F5, Perfluorpolyether, 5 l	**PK 001 853-T**
F5, Perfluorpolyether, 20 l	**PK 001 854-T**
F5, Perfluorpolyether, 50 l	**PK 001 855-T**
D1 oil, 0.25 l	**PK 005 870-T**
D1 oil, 0.5 l	**PK 005 881-T**
D1 oil, 1 l	**PK 005 875-T**
D1 oil, 5 l	**PK 005 876-T**
D1 oil, 20 l	**PK 005 877-T**
D1 oil, 50 l	**PK 005 878-T**
D1 oil, 200 l	**PK 005 879-T**

Notes







Dry pumps

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Dry pumps	
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Hepta 300	322
Hepta 400	324
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OnTool™ Booster	**328**
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Selection aid

● Recommended

Model	Analysis						Semiconductors & electronics										
	Electron microscopy	Leak detection	Mass spectrometry	Surface analysis	Plasma monitoring	Residual gas analysis	Lithography	PVD (Physical Vapor Deposition)	CVD (Chemical Vapor Deposition)	Plasma etching	Implantation – Source	Implantation – Beamline	Inspection	Bonding	MBE (Molecular Beam Epitaxy)	Load locks, transfer chambers, handling systems	Hard drive coating
Diaphragm pumps																	
MVP 006			●	●		●											
MVP 015	●	●	●	●		●								●			
MVP 020	●	●	●	●		●								●			
MVP 040	●	●	●	●		●								●			
MVP 040C			●		●									●			
MVP 070	●	●	●	●		●											
MVP 160																	
MVP 160C																	
Piston pump																	
XtraDry™ 150	●	●	●	●	●	●											
XtraDry™ 250																	
Side channel pump																	
OnTool™ Booster							●	●				●	●			●	
Screw pump HeptaDry™																	
Hepta 100							●	●								●	●
Hepta 200																	●
Hepta 300																	●
Hepta 400																	●
Hepta 600																	

	Coating						Industry								Research & development								
	Solar cell production (PECVD, CIS, CIGS, etc.)	Glass coating (PVD)	CD/DVD/Blu-ray production (PVD)	Optical coatings (PVD)	Wear protection (PVD, CVD)	Film coating (PVD)	Medical technology	Industrial leak detection	Electron beam welding	Isolation vacuums	Incandescent and fluorescent lamp production	Heat treatment	Vacuum drying	Vacuum furnaces	Nuclear research	Fusion technology	Plasma research	Particle accelerators	Space simulation	Cryogenic research	Elementary particle physics	Nanotechnology	Biotechnology
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Diaphragm pumps

Dry and oil-free! The ideal backing pump for Pfeiffer Vacuum turbopumps.

What are diaphragm pumps?
Diaphragm pumps are dry, oil-free pumps that offer pumping speeds of 6 to 160 l/min. They are ideally suited for employment as backing pumps for Pfeiffer Vacuum turbopumps and for integration into compact systems.

Advantages at a glance

- Absolutely oil free vacuum
- Long service life
- Long diaphragm service life
- Low noise and vibration levels
- Highly reliable
- Highly gas tight
- Maintenance friendly through easy diaphragm and valve replacement
- Can be used anywhere in the world thanks to multi-voltage motors

Applications

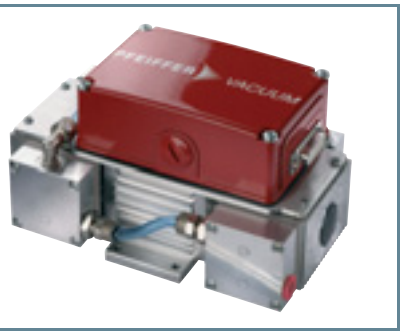
- Suited as a backing pump for Pfeiffer Vacuum turbopumps
- Plants and pumping stations
- Laboratories
- Research & development
- Analytical industry
- Chemical industry (corrosive gas version)
- Leak detection
- All areas where an oil-free, dry vacuum and a contaminated pumping of gases is required

Laboratories

MVP 006

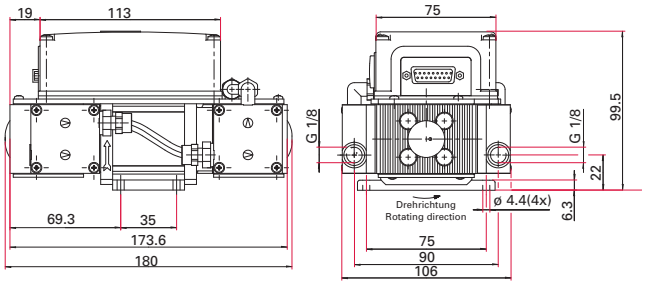
Dry and oil-free diaphragm pumps with a pumping speed of up to 6 l/min:

MVP 006

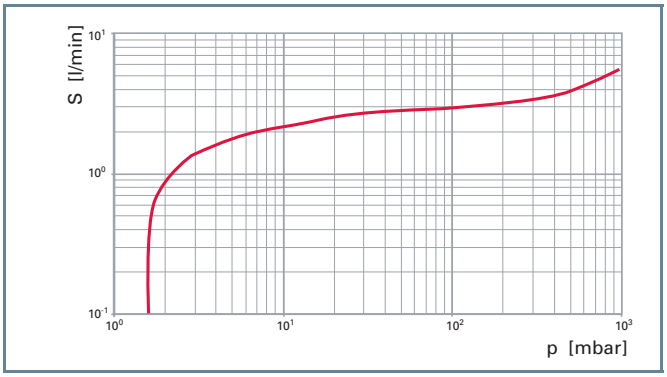


- ▶ Absolutely oil-free
- ▶ Pumping of dry an noncorrosive gases
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbopumps and stand-alone version applicable

Dimensions



Pumping speed



Technical data	MVP 006-4
Flange (in)	G 1/8"
Flange (out)	G 1/8" + Silencer
Ultimate pressure without gas ballast	≤ 2 mbar
Exhaust pressure max.	1300 mbar
Weight	1.8 kg
Leak rate	$6 \cdot 10^{-2}$ mbar l/s
Rated current absorption	0.9 A
Mains requirement: voltage	24 V DC
Pumping speed	0.288 m^3/h
Sound pressure level	≤ 50 dB (A)
Ambient temperature	12-40 °C

4 = 4-stage diaphragm pump for easy applications

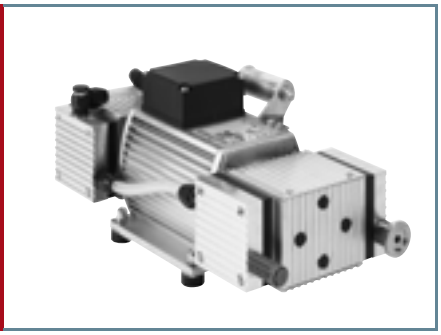
Order number	
MVP 006	**PK T05 070**

Accessories	
Screw-in flange DN 16 ISO-KF / G 1/8" incl. seal	**PK 050 108-T**
TPS 110, mains pack for wall/standard rail fitting	**PM 061 340-T**
TPS 180, mains pack for wall/standard rail fitting	**PM 061 341-T**
230 V AC mains cable with Euro-style safety plug, IEC power socket (straight), 3 m	**P 4564 309 ZA**
115 V AC mains cable with UL plug, IEC power socket (straight), 3 m	**P 4564 309 ZE**
Mains cable 115 / 230 V without plug, IEC 320/C13 socket, 3 m	**P4 564 309 ZH**
Connection cable MVP 006-4 + TPS 110/180 (3 m)	**PM 061 543-T**
Connection cable MVP 006-4 + TC 110 to TPS 180 (0.5 m)	**PM 061 399-T**
Hose connection for MVP 006-4 and HiPace + sealings	**P 0920 739 E**
Hose connection MVP 006-4 and HiPace 10 + sealings	**PM 016 525 -T**
HPU 001, handheld programming unit	**PM 051 510-T**
DCU 002, Display control unit	**PM 061 348-T**

MVP 015

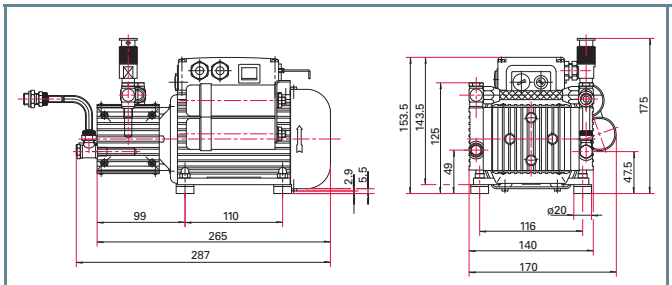
Dry and oil-free diaphragm pumps with a pumping speed of up to 15 l/min:

MVP 015

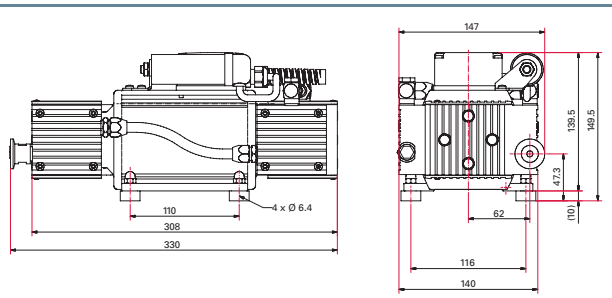


- ▶ Absolutely oil-free
- ▶ Pumping of dry an noncorrosive gases
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbopumps and stand-alone version applicable
- ▶ Integrated gas ballast valve extends the field of applications

Dimensions

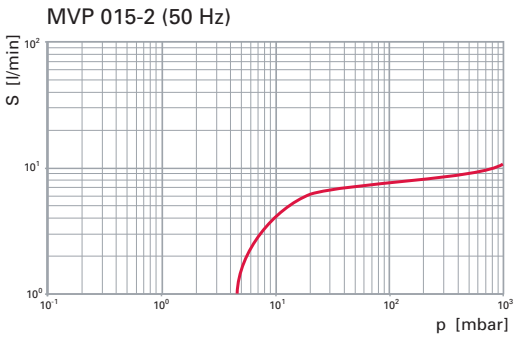


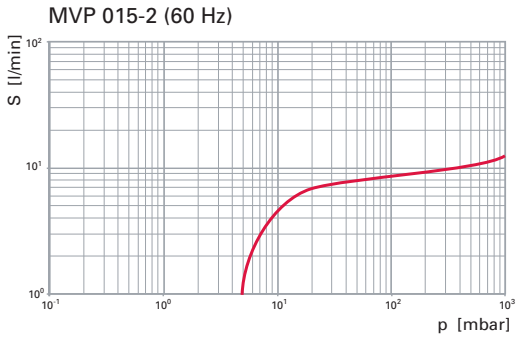
MVP 015-2

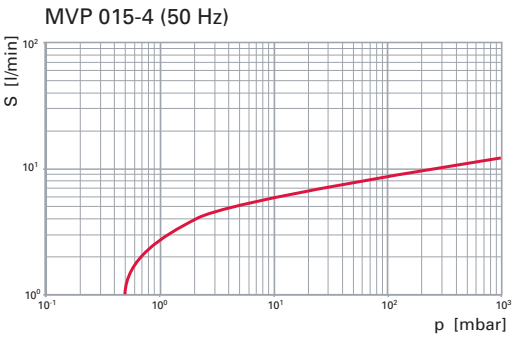


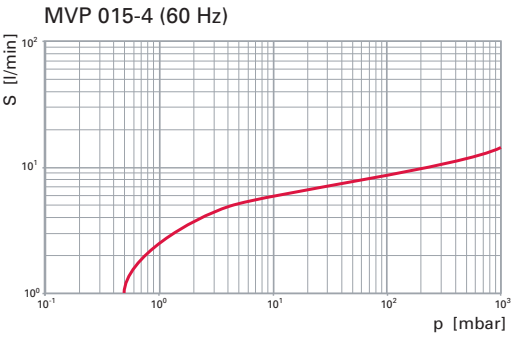
MVP 015-4

Pumping speed









Technical data	MVP 015-2, 90-127 / 187-265 V, 50/60 Hz	MVP 015-4, 120 V, +5 % / -10 %, 60 Hz	MVP 015-4, 230 V, +5 % / -10 %, 50 Hz
Flange (in)	G 1/8" elbow union + enclosed hose DN 6 x 1000 mm with a straight union in G 1/4" at the end	DN 16 ISO-KF / G 1/8"	DN 16 ISO-KF / G 1/8"
Flange (out)	G 1/8" + silencer	G 1/8" + silencer	G 1/8" + silencer
Rotation speed at 50 Hz	1500 rpm	-	1500 rpm
Rotation speed at 60 Hz	1800 rpm	1800 rpm	-
Ultimate pressure with gas ballast	≤ 4.5 mbar	-	-
Ultimate pressure without gas ballast	≤ 3.5 mbar	≤ $5 \cdot 10^{-1}$ mbar	≤ $5 \cdot 10^{-1}$ mbar
Exhaust pressure max.	1050 mbar	1050 mbar	1050 mbar
Weight	6.5 kg	7.5 kg	7.5 kg
Leak rate	$5 \cdot 10^{-3}$ mbar l/s	$5 \cdot 10^{-3}$ mbar l/s	$5 \cdot 10^{-3}$ mbar l/s
Motor rating	120 W	80 W	80 W
Nominal pumping speed at 50 Hz	0.9 m³/h	-	0.9 m³/h
Nominal pumping speed at 60 Hz	1.1 m³/h	1.1 m³/h	-
Rated current absorption	1.1 A	0.4 A	0.3 A
Mains requirement: voltage (range)	-	120 V, +5 %/-10 %, 60 Hz	230 V, +5 %/-10 %, 50 Hz
Mains requirement: voltage (selectable)	90-127/187-265 V, 50/60 Hz	-	-
Sound pressure level	52 dB (A)	52 dB (A)	52 dB (A)
Switch	Yes	No	No
Ambient temperature	12-40 °C	12-40 °C	12-40 °C

2 = 2-stage diaphragm pump for best ultimate pressure
4 = 4-stage diaphragm pump for easy applications

Order number			
MVP 015	**PK T05 100**	**PK T05 064**	**PK T05 065**

Accessories			
Mains cable 230 V with safety plug CEE 7, IEC 320/C13 socket, 3 m	**P 4564 309 ZA**		
Mains cable 115 / 230 V without plug, IEC 320/C13 socket, 3 m	**P4 564 309 ZH**		
Mains cable 115 V with UL-plug, IEC 320/C13 socket, 3 m	**P 4564 309 ZE**		
Relay box for backing pump, 1-phase 5 A		**PM 041 937-T**	**PM 041 937-T**
Screw-in flange DN 16 ISO-KF / G 1/8" incl. seal		**PK 050 108-T**	**PK 050 108-T**

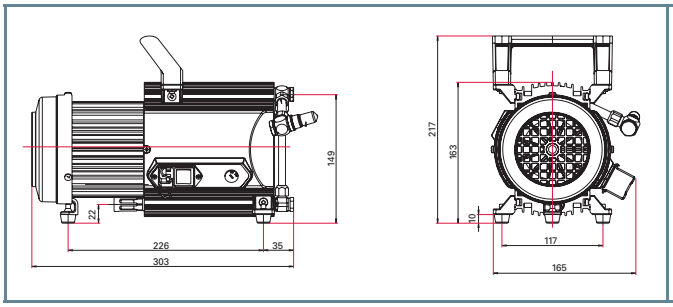
MVP 020

Dry and oil-free diaphragm pumps with a pumping speed of up to 20 l/min:

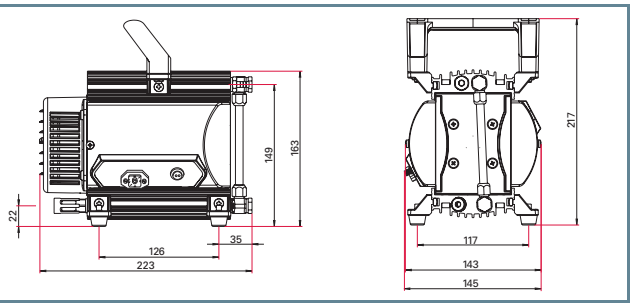
MVP 020

- ▶ Absolutely oil-free
- ▶ Pumping of dry an noncorrosive gases
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbopumps and stand-alone version applicable

Dimensions

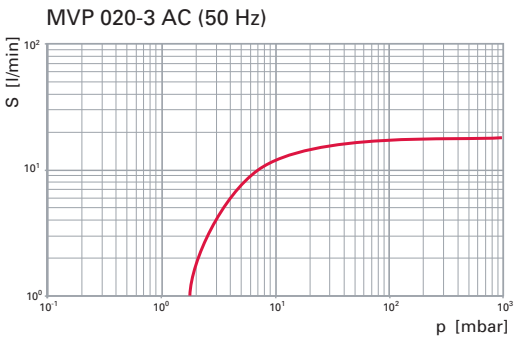


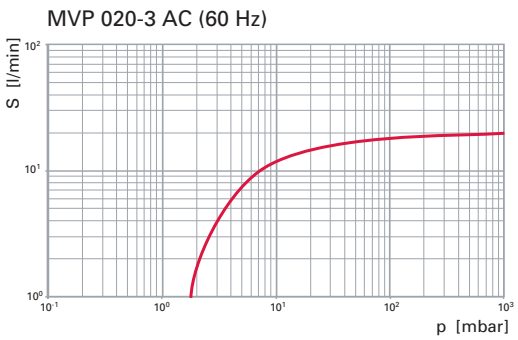
MVP 020-3 AC

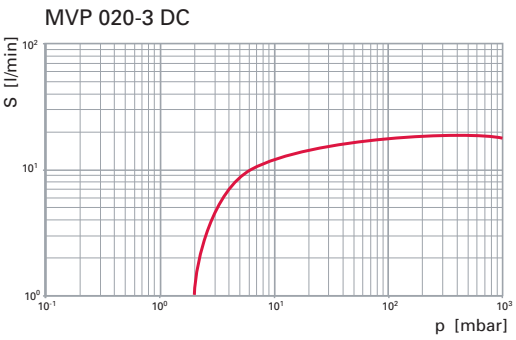


MVP 020-3 DC

Pumping speed







Technical data	MVP 020-3 AC, 90-126 / 180-254 V, 50/60 Hz	MVP 020-3 DC, 24 V, +/- 10 %
Flange (in)	G 1/8" elbow union + enclosed hose DN 8 x 1000 mm with a elbow union in G 1/4" at the end	G 1/8" + hose wave DN 6
Flange (out)	G 1/8" + silencer	G 1/8" + silencer
Rotation speed max.	-	1500 rpm
Rotation speed at 50 Hz	1500 rpm	-
Rotation speed at 60 Hz	1800 rpm	-
Ultimate pressure with flushing gas nozzle	≤ 3 mbar	≤ 3 mbar
Ultimate pressure without gas ballast	≤ 2 mbar	≤ 2 mbar
Exhaust pressure max.	1100 mbar	1100 mbar
Weight	6.5 kg	4.1 kg
Leak rate	$1 \cdot 10^{-1}$ mbar l/s	$1 \cdot 10^{-1}$ mbar l/s
Motor rating	80 W	64 W
Nominal pumping speed at 50 Hz	1.2 m³/h	-
Nominal pumping speed at 60 Hz	1.4 m³/h	-
Rated current absorption	1.7 A	3.5 A
Mains requirement: voltage (range)	-	24 V +/- 10 %
Mains requirement: voltage (selectable)	90-126/180-254 V, 50/60 Hz	-
Pumping speed at 1500 min^{-1}	-	1.2 m³/h
Sound pressure level	48 dB (A)	48 dB (A)
Switch	Yes	No
Ambient temperature	12-40 °C	12-40 °C

AC = AC voltage motor
DC = Direct voltage motor
3 = 3- stage diaphragm pump with optimized pumping speed and ultimate pressure

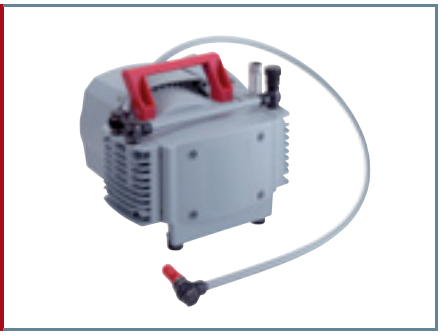
Order number		
MVP 020	**PK T01 100**	**PK T01 150**

Accessories		
Mains cable 115 / 230 V without plug, right angle IEC 320/C13 socket, 3 m	**PK 050 111**	
Mains cable 115 V with UL-plug, right angle IEC 320/C13 socket, 2 m	**PK 050 110**	
Mains cable 230 V with safety plug CEE 7, right angle IEC 320/C13 socket, 2 m	**PK 050 109**	
TPS 150, mains pack for wall/standard rail fitting		**PM 051 461-T**
Connecting cable, length 3 m		**PM 051 103-T**
Connection cable TC-MVP		**PM 041 959-X**
Mains cable 115 V with UL-plug, IEC 320/C13 socket, 3 m		**P 4564 309 ZE**
Mains cable 230 V with safety plug CEE 7, IEC 320/C13 socket, 3 m		**P 4564 309 ZA**
Screw-in flange DN 16 ISO-KF / G 1/8" incl. seal	**PK 050 108-T**	**PK 050 108-T**
Connecting cable, length 5 m		**PM 051 104-T**
Flushing gas nozzle for MVP 020-3 AC/DC	**PK 050 122**	**PK 050 122**

MVP 040

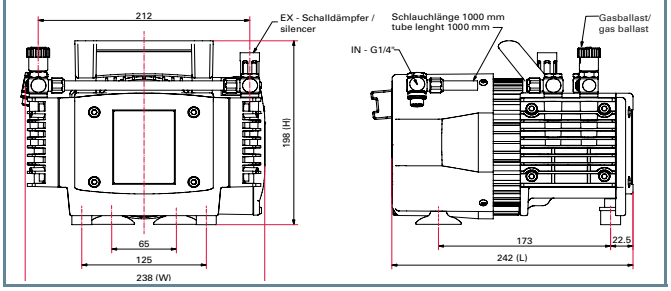
Dry and oil-free diaphragm pumps with a pumping speed of up to 40 l/min:

MVP 040

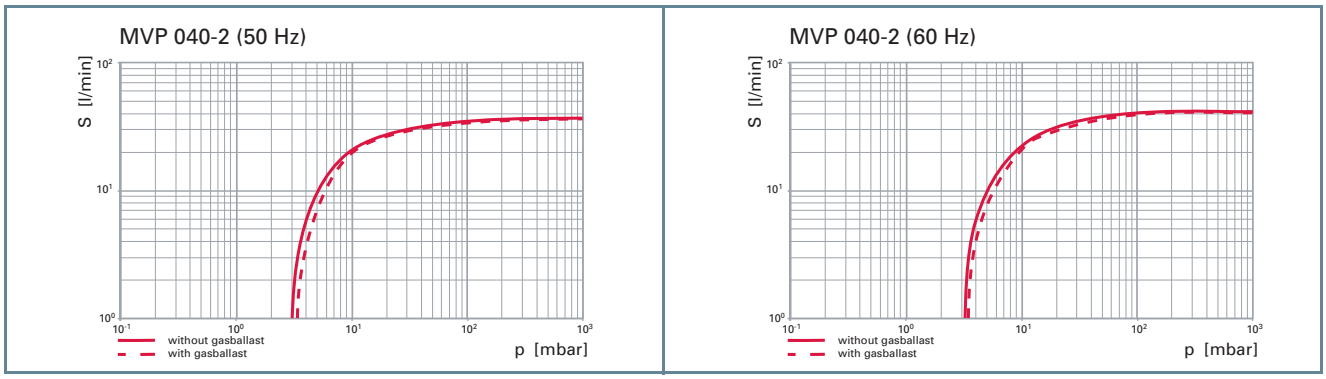


- ▶ Absolutely oil-free
- ▶ Pumping of dry an noncorrosive gases
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbopumps and stand-alone version applicable
- ▶ Integrated gas ballast valve extends the field of applications

Dimensions



Pumping speed



Technical data	MVP 040-2, 100-115 V 50/60 Hz, 120 V 60 Hz, 200-230 V 50/60 Hz
Flange (in)	G 1/4" elbow union + enclosed hose 10/8, 1000 mm with a elbow union in G 1/4" at the end
Flange (out)	G 1/4" + silencer
Rotation speed at 50 Hz	1500 1/min
Rotation speed at 60 Hz	1800 1/min
Ultimate pressure with gas ballast	≤ 5 mbar
Ultimate pressure without gas ballast	≤ 4 mbar
Exhaust pressure max.	1100 mbar
Weight	11.4 kg
Leak rate	$1 \cdot 10^{-2}$ mbar l/s
Motor rating	180 W
Nominal pumping speed at 50 Hz	2.3 m³/h
Nominal pumping speed at 60 Hz	2.5 m³/h
Rated current absorption	100-115 V 50/60 Hz, 3.4 A; 120 V 60 Hz, 3.4 A; 200-230 V 50/60 Hz, 1.8 A
Mains requirement: voltage (selectable)	100-115 V +/- 10% 50/60 Hz, 120 V +/- 10% 60 Hz, 200-230 V +/- 10% 50/60 Hz
Sound pressure level	51 (50Hz) 53 (60Hz) dB (A)
Switch	Yes
Ambient temperature	12-40 °C

2 = 2-stage diaphragm pump for best ultimate pressure

Order number	
MVP 040	**PK T01 210**

Accessories	
Mains cable 115 / 230 V without plug, right angle IEC 320/C13 socket, 3 m	**PK 050 111**
Mains cable 230 V with safety plug CEE 7, right angle I EC 320/C13 socket, 2 m	**PK 050 109**
Mains cable 115 V with UL-plug, right angle IEC 320/C13 socket, 2 m	**PK 050 110**
Screw-in flange DN 16 ISO-KF / G1/4" incl. seal (for MVP 040-2, MVP 070-3 inlet/outlet)	**PK 050 114-T**
Relay box for backing pump, 1-phase 5 A	**PM 041 937-T**

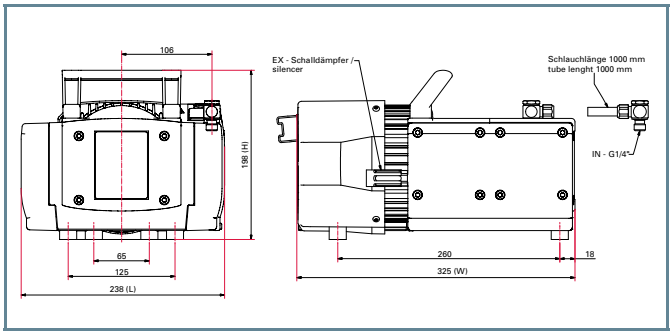
MVP 070

Dry and oil-free diaphragm pumps with a pumping speed of up to 65 l/min:

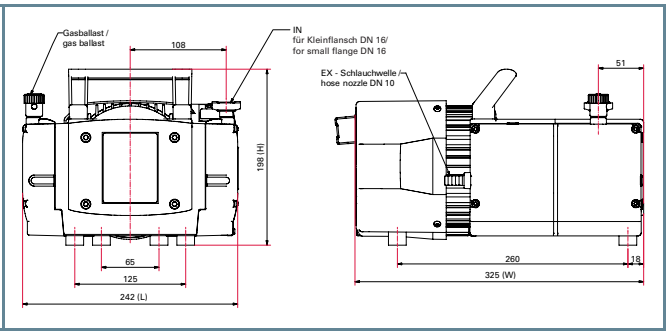
MVP 070

- ▶ Absolutely oil-free
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbo pumps and stand-alone version applicable
- ▶ Robust and powerful
- ▶ Corrosive gas version available

Dimensions

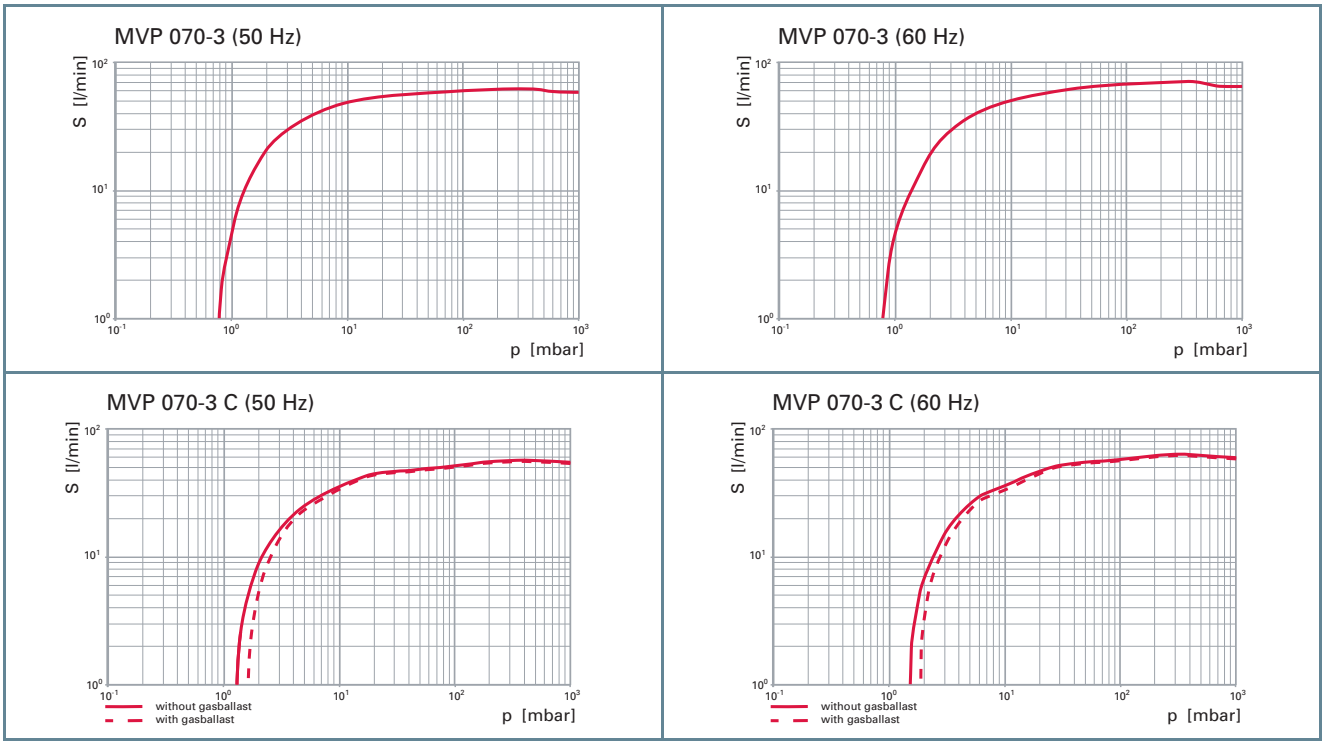


MVP 070-3



MVP 070-3 C

Pumping speed



Technical data	MVP 070-3, 100-115 V 50/60 Hz, 120 V 60 Hz, 200-230 V 50/60 Hz	MVP 070-3 C, 100-115 V 50/60 Hz, 120 V 60 Hz, 200-230 V 50/60 Hz
Flange (in)	G 1/4" elbow union + enclosed hose 10/8, 1000 mm with a elbow union in G 1/4" at the end	For DN 16 ISO-KF
Flange (out)	G 1/4" + silencer	Hose wave 10 mm
Rotation speed at 50 Hz	1500 1/min	1500 1/min
Rotation speed at 60 Hz	1800 1/min	1800 1/min
Ultimate pressure with gas ballast	-	≤ 3 mbar
Ultimate pressure without gas ballast	≤ 1 mbar	≤ 1.5 mbar
Exhaust pressure max.	1100 mbar	1100 mbar
Weight	16.4 kg	14.3 kg
Leak rate	$1 \cdot 10^{-2}$ mbar l/s	$1 \cdot 10^{-2}$ mbar l/s
Motor rating	250 W	250 W
Nominal pumping speed at 50 Hz	3.8 m³/h	3.4 m³/h
Nominal pumping speed at 60 Hz	4.3 m³/h	3.8 m³/h
Rated current absorption	100-115 V 50/60 Hz, 5.7 A; 120 V 60 Hz, 5.7 A; 200-230 V 50/60 Hz, 3.0 A	100-115 V 50/60 Hz, 5.7 A; 120 V 60 Hz, 5.7 A; 200-230 V 50/60 Hz, 3.0 A
Mains requirement: voltage (selectable)	100-115 V +/- 10 %, 50/60 Hz; 120 V +/- 10 %, 60 Hz; 200-230 V +/- 10 %, 50/60 Hz	100-115 V +/- 10 %, 50/60 Hz; 120 V +/- 10 %, 60 Hz; 200-230 V +/- 10 %, 50/60 Hz
Sound pressure level	52 (50 Hz) 55 (60 Hz) dB (A)	45 (50 Hz) 50 (60 Hz) dB (A)
Switch	Yes	Yes
Ambient temperature	12-40 °C	12-40 °C

C = Corrosive gas version
3 = 3- stage diaphragm pump with optimized pumping speed and ultimate pressure

Order number		
MVP 070	**PK T01 310**	**PK T01 360**

Accessories		
Mains cable 230 V with safety plug CEE 7, right angle IEC 320/C13 socket, 2 m	**PK 050 109**	**PK 050 109**
Mains cable 115 V with UL-plug, right angle IEC 320/C13 socket, 2 m	**PK 050 110**	**PK 050 110**
Mains cable 115 / 230 V without plug, right angle IEC 320/C13 socket, 3 m	**PK 050 111**	**PK 050 111**
Relay box for backing pump, 1-phase 5 A	**PM 041 937-T**	**PM 041 937-T**
Screw-in flange DN 16 ISO-KF / G1/4" incl. seal (for MVP 040-2, MVP 070-3 inlet/outlet)	**PK 050 114-T**	

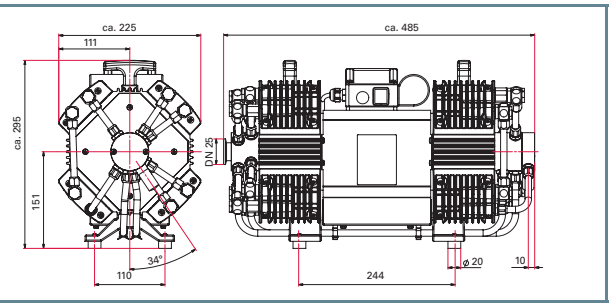
MVP 160

Dry and oil-free diaphragm pumps with a pumping speed of up to 200 l/min:

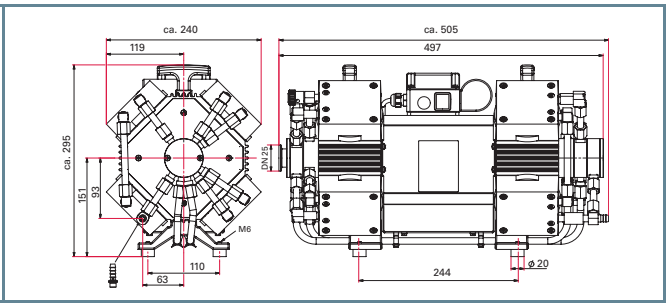
MVP 160

- ▶ Absolutely oil-free
- ▶ Long service life of diaphragms and valves
- ▶ Very quiet
- ▶ As a backing pump for turbopumps and stand-alone version applicable
- ▶ Corrosive gas version available
- ▶ Extended functions with integrated gas ballast valve (C versions)

Dimensions

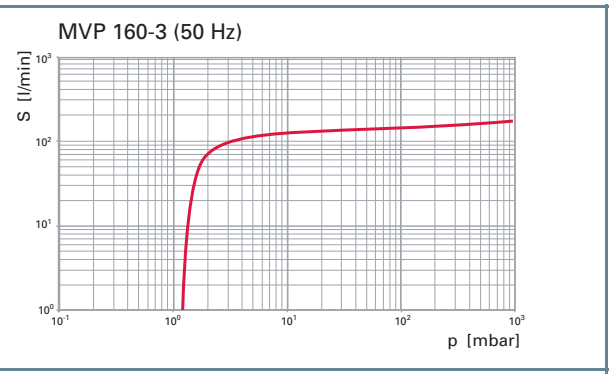


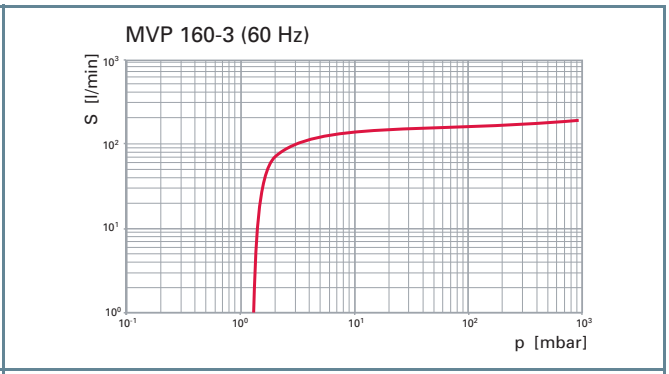
MVP 160-3

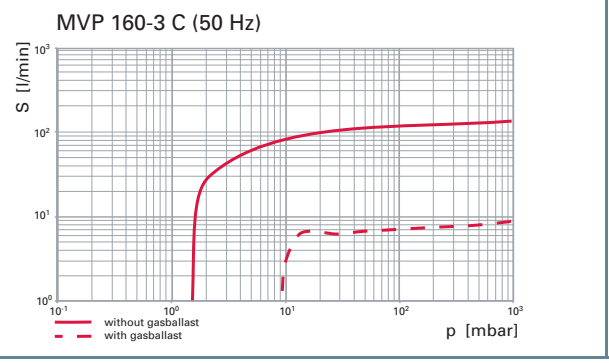


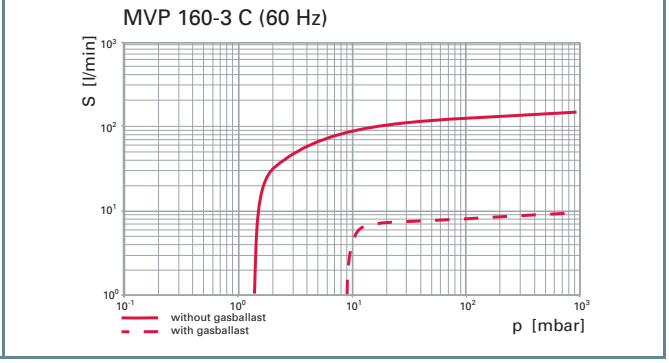
MVP 160-3 C

Pumping speed









Technical data	MVP 160-3, 230 V, +/- 10 %, 50/60 Hz	MVP 160-3, 120 V, +5 % /- 10 %, 60 Hz	MVP 160-3 C, 230 V, +/- 10 %, 50/60 Hz	MVP 160-3 C, 120 V, + 5 % /- 10 %, 60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Flange (out)	G 1/4" + silencer	G 1/4" + silencer	DN 8 Hose wave / 1/8" NPT	DN 8 hose wave / 1/8" NPT
Rotation speed at 50 Hz	1500 rpm	-	1500 rpm	-
Rotation speed at 60 Hz	1800 rpm	1800 rpm	1800 rpm	1800 rpm
Ultimate pressure with gas ballast	-	-	≤ 9 mbar	≤ 9 mbar
Ultimate pressure without gas ballast	≤ 2 mbar	≤ 2 mbar	≤ 2 mbar	≤ 2 mbar
Exhaust pressure max.	1100 mbar	1100 mbar	1100 mbar	1100 mbar
Weight	24 kg	24 kg	25 kg	25 kg
Leak rate	$1 \cdot 10^{-1}$ mbar l/s	$1 \cdot 10^{-1}$ mbar l/s	1 mbar l/s	1 mbar l/s
Motor rating	390 W	390 W	390 W	390 W
Nominal pumping speed at 50 Hz	9.6 m^3/h	-	8.3 m^3/h	-
Nominal pumping speed at 60 Hz	10.4 m^3/h	10.4 m^3/h	8.9 m^3/h	8.9 m^3/h
Rated current absorption	3.1 A	5.2 A	3.1 A	5.2 A
Mains requirement: voltage (range)	230 V, +/- 10 %, 50/60 Hz	120 V, +5 %/- 10 %, 60 Hz	230 V, +/- 10 %, 50/60 Hz	120 V, +5 % / -10 %, 60 Hz
Sound pressure level	53 dB (A)	53 dB (A)	53 dB (A)	53 dB (A)
Switch	Yes	Yes	Yes	Yes
Ambient temperature	12-40 °C	12-40 °C	12-40 °C	12-40 °C
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF

C = Corrosive gas version
3 = 3-stage diaphragm pump with optimized pumping speed and ultimate

Order number				
MVP 160	**PK T01 400**	**PK T01 401**	**PK T01 450**	**PK T01 451**

Accessories				
Mains cable 115 / 230 V without plug, right angle IEC 320/C13 socket, 3 m	**PK 050 111**	**PK 050 111**	**PK 050 111**	**PK 050 111**
Mains cable 115 V with UL-plug, right angle IEC 320/C13 socket, 2 m		**PK 050 110**		**PK 050 110**
Mains cable 230 V with safety plug CEE 7, right angle IEC 320/C13 socket, 2 m	**PK 050 109**		**PK 050 109**	
Face wrench with torgue needle 6 Nm	**P 0998 187**	**P 0998 187**	**P 0998 187**	**P 0998 187**
Relay box backing pump, 1-phase 20 A	**PM 041 938-T**	**PM 041 938-T**	**PM 041 938-T**	**PM 041 938-T**
Flushing gas connection for MVP 160-3 C			**PK 050 123**	**PK 050 123**

Piston pump XtraDry™

The pump for clean and reliable vacuum.
Hook up. Switch on. Start working!

What is XtraDry?
Innovative Technik ohne Partikel-Emission.
As a dry vacuum pump, the XtraDry is ideally suited for your medium-vacuum applications of down to 10^{-1} mbar that involve the need to pump dry, inert and non-reactive gases. It is ideally suited for use in analytical systems and in industrial applications.

Advantages at a glance

- Gas independent pumping characteristics –
  No gas backstreaming in the pumping system
- Particle-free –
  No process contamination
- Hydrocarbon-free –
  Oil-free pumping system
- Vent-safe –
  No sudden air inrush in the event of a power failure
- Automatic standby mode –
  Saves energy without any impact on ultimate pressure
- Hour counter –
  Predictable maintenance intervals
- Service –
  Do-it-yourself kit; maximum time required 30 minutes
- Frequency converter –
  Same performance independent from 50 Hz and 60 Hz mains supply

Applications

Ideal as a stand-alone pump for all medium-vacuum applications …

Analytical systems

- Mass spectrometers
- Leak detectors
- Electron microscopes

Further applications

- Robotics (handling systems)
- Differential sealing systems
- Vacuum packaging

… and as a backing pump for high-vacuum pumps, such as turbopumps from Pfeiffer Vacuum

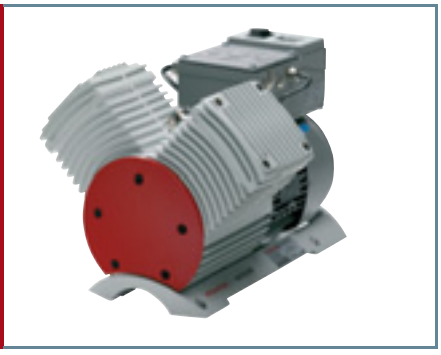
Modular high-vacuum pumping station for custom applications

Calibration system for DigiLine™ pressure gauges with XtraDry™ and turbopump

XtraDry™

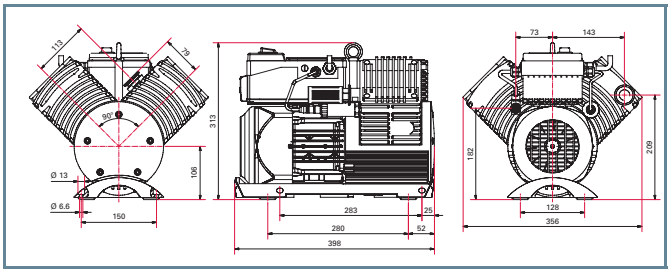
Oil-free vacuum pump with pumping speeds of 7.5 to 13 m^3/h. The XtraDry, as a dry vacuum pump, is ideally suited for applications of down 10^{-1} mbar that involve the need to pump dry, inert and non-reactive gases.

XtraDry™

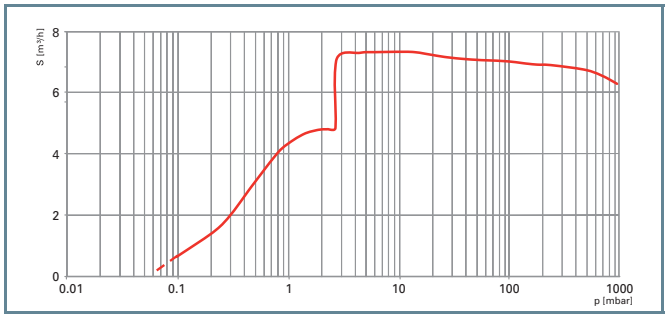


- ▶ No contamination of the process
- ▶ Soft-start mode eliminates turbulences
- ▶ No hydrocarbons on the intake side
- ▶ Pumping speed independent of the type of gas
- ▶ Standby mode extends service life

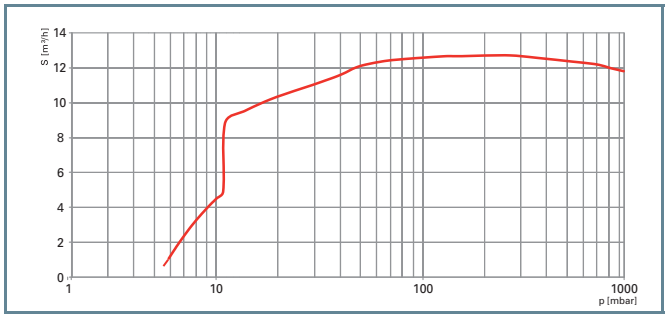
Dimensions



Pumping speed



XtraDry™ 150-2



XtraDry™ 250-1

Technical data	XtraDry™ 150-2	XtraDry™ 250-1
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Flange (out)	DN 25 ISO-KF / 1/2"	DN 25 ISO-KF / 1/2"
Ultimate pressure	0.1 mbar	<7 mbar
Nominal pumping speed	7.5 m^3/h	13 m^3/h
Max. exhaust pressure	1100 mbar	1100 mbar
Leak rate	< 0,01 mbar l/s	< 0.01 mbar l/s
Nominal motor rating	550 W	550 W
Sound pressure level	≤ 65 dB (A)	≤ 65 dB (A)
Ambient temperature	12-40 °C	12-40 °C
Weight	30 kg	30 kg

2 = 2-stage piston pump with maximum compression
1 = 1-stage piston pump with optimized pumping speed

Order number		
230 V, +/- 10 %, 50/60 Hz	**PO P01 150**	**PO P01 160**
115 V, +/- 10 %, 50/60 Hz	**PO P01 151**	**PO P01 161**
100 V, +/- 10 %, 50/60 Hz	**PO P01 152**	**PO P01 162**

The HeptaDry™ innovation

Dry screw pumps.
Optimum ultimate pressure. Absolutely oil-free.
Cool-running.

What is HeptaDry?
HeptaDry is a complete line of dry screw pumps. The line is designed for both industrial and coating applications. HeptaDry is the ideal solution for all areas in which oil-free vacuum is required. The pumping speeds that are offered by this series of products range from 100 to 600 m^3/h.

Advantages at a glance

- Complete series of pumps with pumping speeds from 100 to 600 m^3/h
- Optimum ultimate pressure and broadest range of applications
- Absolutely dry and oil-free
- Water cooling with thermostatic valve
- Lower energy costs due to efficient internal compression
- High-quality axial face seals
- Direct gas flow minimizes deposits
- Low energy consumption, low noise level
- First-class advice and process know-how
- Low maintenance and operating costs
- Worldwide on-site service

Applications

- Metallurgy
- Coating
- Freeze-drying
- Load-locks
- Electron beam welding
- Component drying
- Gas separation
- Vacuum filling

Can be used ideally either as stand-alone pumps or in combination with our OktaLine Roots pumps

Coating

Electron beam welding

Hepta 100

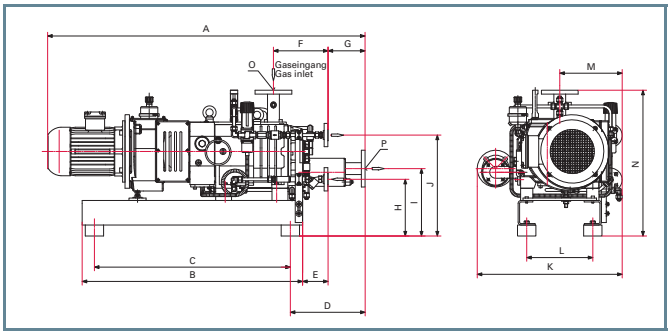
Dry screw pumps with a pumping speed of 110 m³/h at 50 Hz and 130 m³/h at 60 Hz:

Hepta 100

- ▶ Dry screw pump with intake strainer
- ▶ Non-return valve, outlet side
- ▶ Water cooling with thermostatic valve and thermometer
- ▶ Temperature switch in housing
- ▶ Oil-lubricated axial face seals
- ▶ Silencer
- ▶ Oil charge, D1

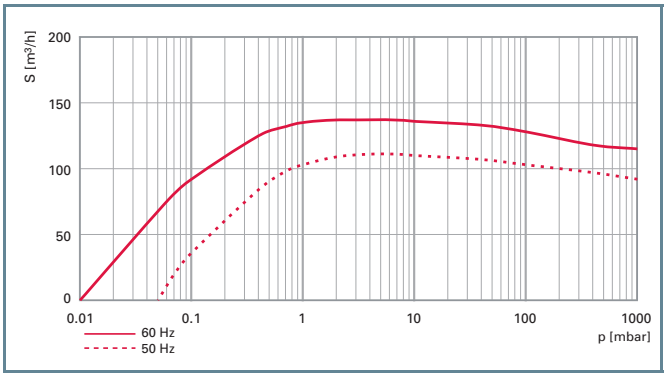
Process-adapted designs and differing voltages upon request

Dimensions



	Hepta 100		Hepta 100
A	1376 mm	I	262 mm
B	900 mm	J	412 mm
C	800 mm	K	592 mm
D	385 mm	L	270 mm
E	104 mm	M	255 mm
F	223 mm	N	421 mm
G	231 mm	O	DN 63 ISO-K
H	232 mm	P	DN 40 PN 16

Pumping speed



Technical data	Hepta 100, 210-250/ 360-440 V, 50 Hz	Hepta 100, 210-250/ 360-440 V, 50 Hz
Flange (in)	DN 63 ISO-K	DN 63 ISO-K
Flange (out)	DN 40 PN 16	DN 40 PN 16
Ultimate pressure	< 0.05 mbar	< 0.05 mbar
Motor rating	3 kW	3 kW
Nominal rotation speed at 50 Hz	3000 1/min	
Nominal rotation speed at 60 Hz		3600 1/min
Nominal pumping speed	110 m^3/h	110 m^3/h
Sound pressure level	70 dB(A)	74 dB(A)
Pump fluid filling	1.6 l	1.6 l
Weight	250 kg	250 kg
Ambient temperature	0-50 °C	0-50 °C

Order number		
Hepta 100	**PU V10 120**	**PU V10 120**

Accessories		
Dust filter, for Hepta 100	**PU Z00 001**	**PU Z00 001**

Hepta 200

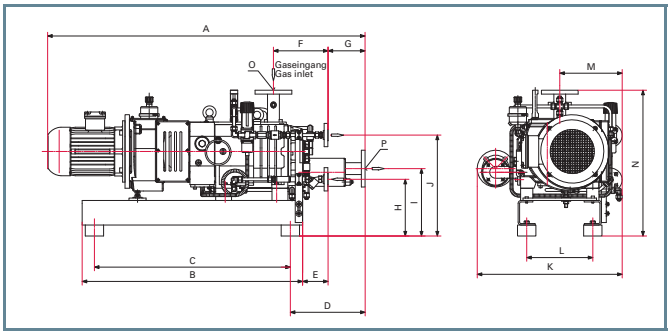
Dry screw pumps with a pumping speed of 220 m³/h at 50 Hz and 265 m³/h at 60 Hz:

Hepta 200

- ▶ Dry screw pump with intake strainer
- ▶ Non-return valve, outlet side
- ▶ Water cooling with thermostatic valve and thermometer
- ▶ Temperature switch in housing
- ▶ Oil-lubricated axial face seals
- ▶ Silencer
- ▶ Oil charge, D1

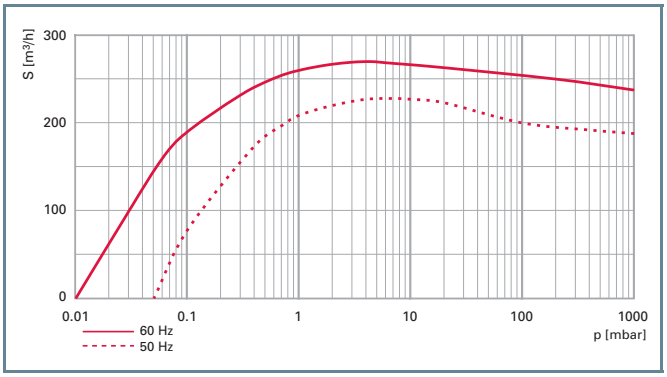
Process-adapted designs and differing voltages upon request

Dimensions



	Hepta 200		Hepta 200
A	1628 mm	I	264 mm
B	1160	J	412 mm
C	1060	K	619 mm
D	520 mm	L	270 mm
E	104 mm	M	255 mm
F	237 mm	N	495 mm
G	366 mm	O	DN 63 ISO-K
H	232 mm	P	DN 50 PN 16

Pumping speed



Technical data	Hepta 200, 360-440/ 630-750 V, 50 Hz	Hepta 200, 220-260/ 380-460 V, 60 Hz
Flange (in)	DN 63 ISO-K	DN 63 ISO-K
Flange (out)	DN 50 PN 16	DN 50 PN 16
Ultimate pressure	< 0.05 mbar	< 0.01 mbar
Motor rating	5.5 kW	7.5 kW
Nominal rotation speed at 50 Hz	3000 1/min	
Nominal rotation speed at 60 Hz		3600 1/min
Nominal pumping speed	220 m^3/h	265 m^3/h
Sound pressure level	71 dB (A)	76 dB (A)
Pump fluid filling	1.6 l	1.6 l
Weight	305 kg	305 kg
Ambient temperature	0-50 °C	0-50 °C

Order number		
Hepta 200	**PU V20 120**	**PU V20 122**

Accessories		
Dust filter, for Hepta 200	**PU Z00 002**	**PU Z00 002**

Hepta 300

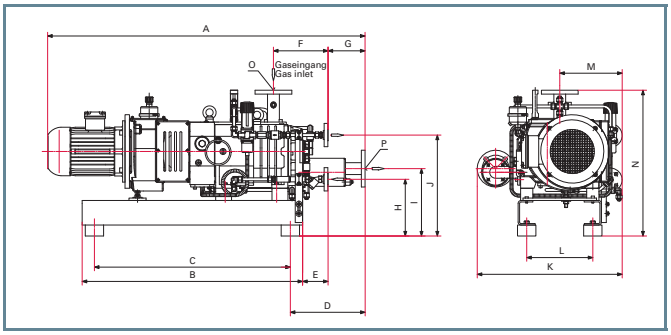
Dry screw pumps with a pumping speed of 320 m³/h at 50 Hz and 410 m³/h at 60 Hz:

Hepta 300

- ▶ Dry screw pump with intake strainer
- ▶ Non-return valve, outlet side
- ▶ Water cooling with thermostatic valve and thermometer
- ▶ Temperature switch in housing
- ▶ Oil-lubricated axial face seals
- ▶ Silencer
- ▶ Oil charge, D1

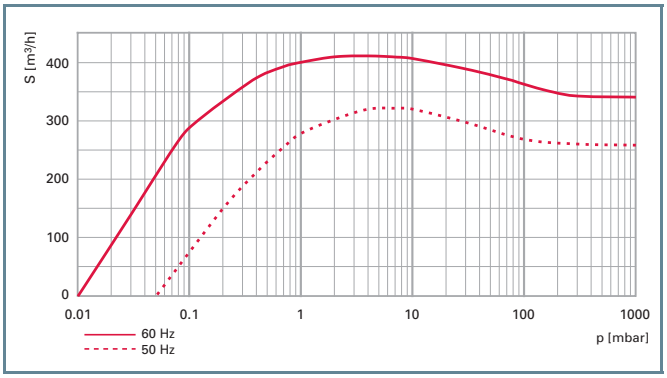
Process-adapted designs and differing voltages upon request

Dimensions



	Hepta 300		Hepta 300
A	1628 mm	I	280 mm
B	1230 mm	J	412 mm
C	1130 mm	K	619 mm
D	522 mm	L	270 mm
E	104 mm	M	255 mm
F	235 mm	N	495 mm
G	368 mm	O	DN 63 ISO-K
H	232 mm	P	DN 50 PN 16

Pumping speed



Technical data	Hepta 300, 360-440/ 630-750 V, 50 Hz	Hepta 300, 420-500 V, 60 Hz
Flange (in)	DN 63 ISO-K	DN 63 ISO-K
Flange (out)	DN 50 PN 16	DN 50 PN 16
Ultimate pressure	< 0.05 mbar	< 0.01 mbar
Motor rating	7.5 kW	9.2 kW
Nominal rotation speed at 50 Hz	3000 1/min	
Nominal rotation speed at 60 Hz		3600 1/min
Nominal pumping speed	320 m^3/h	410 m^3/h
Sound pressure level	72 dB (A)	77 dB (A)
Pump fluid filling	1.6 l	1.6 l
Weight	330 kg	330 kg
Ambient temperature	0-50 °C	0-50 °C

Order number		
Hepta 300	**PU V30 120**	**PU V30 122**

Accessories		
Dust filter, for Hepta 300	**PU Z00 003**	**PU Z00 003**

Hepta 400

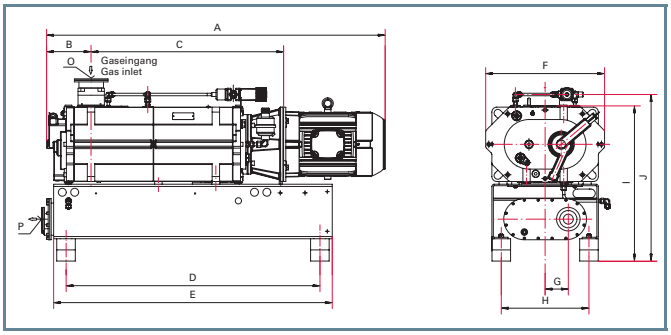
Dry screw pumps with a pumping speed of 350 m³/h at 50 Hz and 420 m³/h at 60 Hz:

Hepta 400

- ▶ Dry screw pump with intake strainer
- ▶ Non-return valve, outlet side
- ▶ Water cooling with thermostatic valve and thermometer
- ▶ Temperature switch in housing
- ▶ Oil-lubricated axial face seals
- ▶ Silencer
- ▶ Oil charge, D1

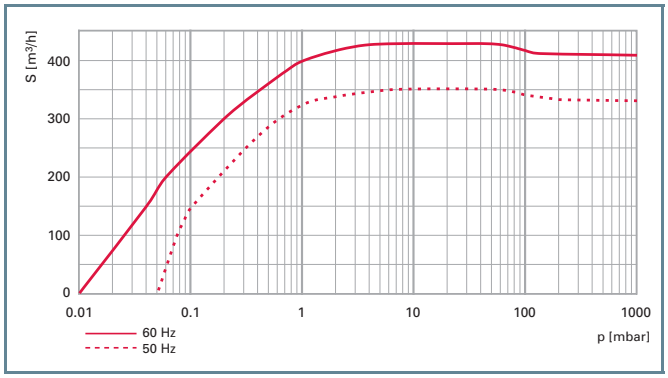
Process-adapted designs and differing voltages upon request

Dimensions



	Hepta 400		Hepta 400
A	1393 mm	I	630 mm
B	180 mm	J	700 mm
C	574 mm	K	-
D	1025 mm	L	-
E	1125 mm	M	-
F	480 mm	N	-
G	94 mm	O	DN 63 ISO-K
H	354 mm	P	DN 80 PN 16

Pumping speed



Technical data	Hepta 400, 360-440/ 630-750 V, 50 Hz	Hepta 400, 420-500 V, 60 Hz
Flange (in)	DN 63 ISO-K	DN 63 ISO-K
Flange (out)	DN 80 PN 16	DN 80 PN 16
Ultimate pressure	< 0.05 mbar	< 0.01 mbar
Motor rating	7.5 kW	9.2 kW
Nominal rotation speed at 50 Hz	3000 1/min	
Nominal rotation speed at 60 Hz		3600 1/min
Nominal pumping speed	350 m^3/h	420 m^3/h
Sound pressure level	66 dB (A)	69 dB (A)
Pump fluid filling	1.6 l	1.6 l
Weight	490 kg	490 kg
Ambient temperature	0-50 °C	0-50 °C

Order number		
Hepta 400	**PU V40 120**	**PU V40 122**

Accessories		
Dust filter, for Hepta 400	**PU Z00 004**	**PU Z00 004**

Hepta 600

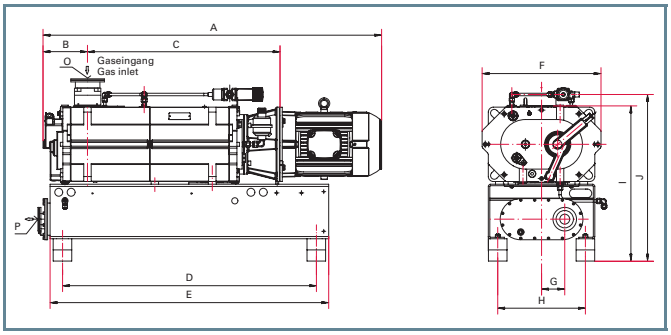
Dry screw pumps with a pumping speed of 525 m³/h at 50 Hz and 630 m³/h at 60 Hz:

Hepta 600

- ▶ Dry screw pump with intake strainer
- ▶ Non-return valve, outlet side
- ▶ Water cooling with thermostatic valve and thermometer
- ▶ Temperature switch in housing
- ▶ Oil-lubricated axial face seals
- ▶ Silencer
- ▶ Oil charge, D1

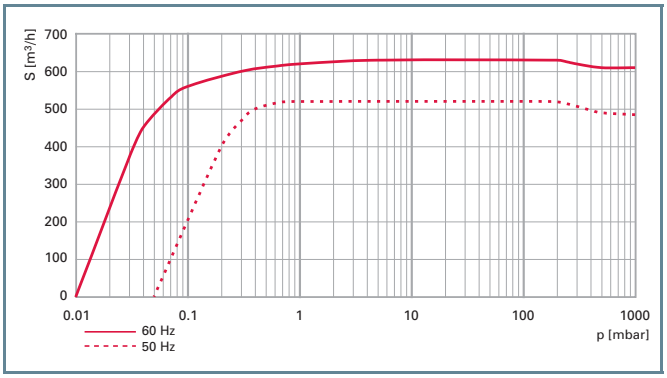
Process-adapted designs and differing voltages upon request

Dimensions



	Hepta 600		Hepta 600
A	1537 mm	I	620 mm
B	326 mm	J	685 mm
C	685 mm	K	-
D	800 mm	L	-
E	1000 mm	M	-
F	558 mm	N	-
G	94 mm	O	DN 100 ISO-K
H	400 mm	P	DN 80 PN 16

Pumping speed



Technical data	Hepta 600, 360-440/ 630-750 V, 50 Hz	Hepta 600, 420-500 V, 60 Hz
Flange (in)	DN 100 ISO-K	DN 100 ISO-K
Flange (out)	DN 80 PN 16	DN 80 PN 16
Ultimate pressure	< 0.05 mbar	< 0.01 mbar
Motor rating	15 kW	17 kW
Nominal rotation speed at 50 Hz	3000 1/min	
Nominal rotation speed at 60 Hz		3600 1/min
Nominal pumping speed	525 m^3/h	630 m^3/h
Sound pressure level	70 dB (A)	75 dB (A)
Pump fluid filling	1.3 l	1.3 l
Weight	690 kg	660 kg
Ambient temperature	0-50 °C	0-50 °C

Order number		
Hepta 600	**PU V60 120**	**PU V60 122**

Accessories		
Dust filter, for Hepta 600	**PU Z00 005**	**PU Z00 005**

OnTool™ Booster

The new high-vacuum pump that works against atmosphere!
Innovative. Compact. Powerful.

What is OnTool Booster?
With its performance and compact design, the new OnTool Booster is setting new standards in vacuum technology for all applications. It is characterized by an extremely high pumping speed of 130 m^3/h and an ultimate pressure of $< 1 \cdot 10^{-5}$.

Solar cell coating

DVD coating

Advantages at a glance

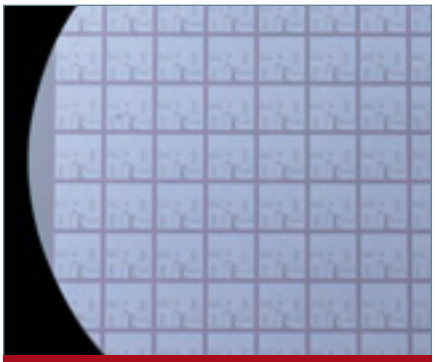
- Innovative – High-vacuum directly against atmosphere
- Compact – Modern, convenient design
- Powerful – Extremely high pumping speed of 130 m^3/h compared to overall size
- Cost-effective – Does not require a backing pump
- Particle-free – For all clean applications
- Flexible – Can be used as either a stand-alone or backing pump

Applications

The new OnTool Booster for all clean applications, such as:

- Transfer chambers
- Load-lock chambers
- EUV lithography
- Solar cell coating
- Optical coating
- Surface finishing
- Simulation chambers
- Light bulb manufacturing

Light bulb manufacturing

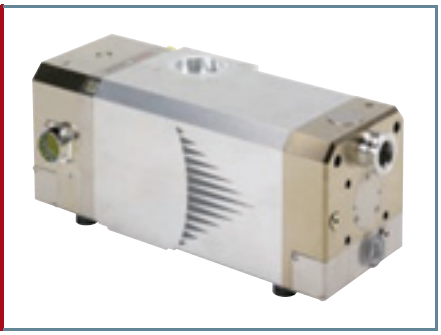


Wafer fabrication

OnTool™ Booster 150

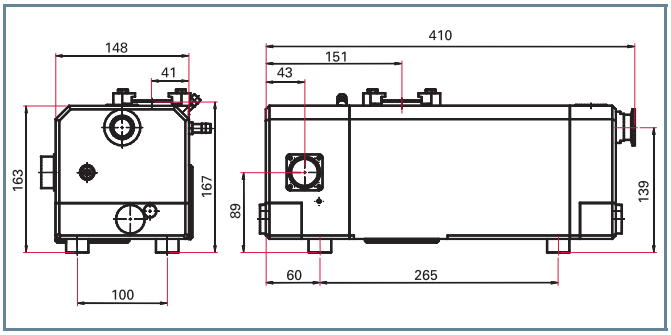
Compact, powerful high-vacuum pump against atmosphere with a pumping speed of 130 m^3/h and an ultimate pressure of < $1 \cdot 10^{-5}$ mbar:

OnTool™ Booster 150

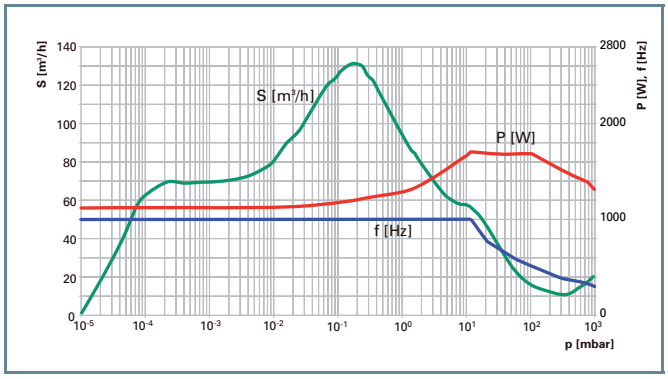


- Compact, powerful high-vacuum pump that works against atmosphere (no backing pump required) with a maximum pumping speed of 130 m^3/h
- The pump reaches an ultimate pressure of < $1 \cdot 10^{-5}$ mbar and is water-cooled as standard
- Can be used as either a stand-alone or backing pump

Dimensions



Pumping speed



Technical data	OnTool™ Booster 150
Flange (in)	DN 50 ISO-KF
Flange (out)	DN 25 ISO-KF
Ultimate pressure	< $1 \cdot 10^{-5}$ mbar
Inlet pressure max.	1013 mbar
Nominal pumping speed	130 m^3/h
Pumping speed at 1000 mbar	18 m^3/h
Gas throughput for Ar	17 mbar l/s
Gas ballast	340 mbar l/s
Quantity of sealing gas	250-290 mbar l/s
Rotation speed	60000 1/min
Run-up time	25 sec.
Noise level with connected exhaust line	< 64 dB (A)
Max. power consumption: pump	2 kW
Power consumption at zero throughput	1.1 kW
Ambient temperature	12-40 °C
Cooling water temperature	15-30 °C
Cooling water required (inlet temperature 18°C)	170 l/h
Lubricant	F3
Lubricant filling	0.05 l
Weight	35

Order number	
OnTool™ Booster 150	**PR P00 009**

Accessories	
TZK 2000, Water cooling unit, 230 V, 50 Hz	**PM Z01 240**
Spacer, stainless steel, DN 50 ISO-KF	**PF 123 250-X**
Bellows, stainless steel, DN 50 ISO-KF	**PF 130 250-X**
Non-return valve DN 25 ISO-KF	**PK 004 521 -U**
Sintering filter for sealing gas inlet G 1/8	**PR 003 505 -T**
TCP 3000, Turbo Controller	**PM C01 731**
TCP 3000 PB, Turbo Controller with integrated profibus interface	**PM C01 732**
TCP 3000 DN, Turbo Controller with integrated DeviceNet interface	**PM C01 733**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
TIC 001, Serial Interface Converter RS-232/RS-485	**PM 051 054-T**
USB Converter to RS-485 interface	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**
Connection cable set TCP 3000 - OnTool Booster, TCP 3000-cooling water monitor	**PR 003 473 -T**
208 V AC mains cable with UL plug, NEMA-HAN 3A, 3 m	**P4 564 309 HB**
Venting flange DN 10 KF-G1/8"	**PM 033 737 -T**
Connection cable, plug M12, RJ 45, length 20 m	**PM 051 729 -T**

R&D
100
Award Winner
PFEIFFER
PFEIFFER VACUUM

Turbopumps

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Selection aid

● Recommended

		Analysis						Semiconductors & electronics											
Model	**Holweck stage**	Electron microscopy	Leak detection	Mass spectrometry	Surface analysis	Plasma monitoring	Residual gas analysis	Lithography	PVD (Physical Vapor Deposition)	CVD (Chemical Vapor Deposition)	Plasma etching	Implantation – Source	Implantation – Beamline	Inspection	Bonding	MBE (Molecular Beam Epitaxy)	Load locks, transfer chambers, handling systems	Hard drive coating	
HiPace 10		●	●	●	●	●	●												
HiPace 80	✓	●	●	●	●	●	●										●		
HiPace 300	✓	●	●	●	●	●	●		●				●	●	●		●	●	
HiPace 300 C		●		●	●	●	●		●	●	●		●	●	●	●		●	
HiPace 400	✓			●	●	●	●		●				●	●	●		●	●	
HiPace 400 C				●	●	●	●		●	●	●	●	●	●	●	●		●	
HiPace 700	✓			●	●	●	●		●				●				●	●	
HiPace 700 C				●	●	●	●		●	●	●	●	●			●		●	
HiPace 1200									●				●					●	
HiPace 1200 C									●	●	●	●	●			●			
HiPace 1500									●				●						
HiPace 1500 C									●	●	●	●	●			●			
HiPace 1800									●				●						
HiPace 1800 C									●	●	●	●	●			●			
HiPace 2300									●				●						
HiPace 2300 C									●	●	●	●	●			●			
HiPace 2400 MC								●	●	●	●	●	●			●			
HiPace 3400 MC								●	●	●	●	●	●			●			

	Coating						Industry								Research & development								
	Solar cell production (PECVD, CIS, CIGS, etc.)	Glass coating (PVD)	CD/DVD/Blu-ray production (PVD)	Optical coatings (PVD)	Wear protection (PVD, CVD)	Film coating (PVD)	Medical technology	Industrial leak detection	Electron beam welding	Isolation vacuums	Incandescent and fluorescent lamp production	Heat treatment	Vacuum drying	Vacuum furnaces	Nuclear research	Fusion technology	Plasma research	Particle accelerators	Space simulation	Cryogenic research	Elementary particle physics	Nanotechnology	Biotechnology
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Turbopumps

Pfeiffer Vacuum, the inventor of the turbopump, is again demonstrating its technology edge with the new HiPace innovation. It enables the entire spectrum of widely varying applications to be handled reliably, safely and cost-effectively.

Features
The new HiPace family covers the 10 - 3,400 liters/second pumping speed classes.

The outstanding features of the Pfeiffer Vacuum HiPace series are its unique rotor design with proven hybrid bearings. This represents a new class of industrial suitability, while simultaneously reducing operating costs. All Pfeiffer Vacuum turbopumps naturally incorporate integrated drive electronics. In fact, even the power supply is integrated in the HiPace 1200 to 2300.

Its advanced design, which is rigorously geared to reliability and ruggedness, assures safe, dependable operation through integrated security concepts and patented venting mechanisms, even in difficult applications.

All turbopumps in the HiPace series conform to the Semi S2 standard. This assures outstanding accessibility to all connections in a range of 120°.

Versions
The turbopumps in the 80 - 700 l/s range are also offered with an integrated Holweck stage. The advantages of this design include:
- Better critical backing pressure
- Lower power consumption
- Higher compression

From the 300 l/s pumping speed class onward, the HiPace is also available in a corrosive-gas version. These pumps have a highly developed rotor coating and come with an integrated sealing gas supply system with electrical shutoff valve as standard equipment. Corrosive-gas versions do not incorporate a Holweck stage.

The HiPace MC series is characterized by a 5-axis, fully magnetic and thus maintenance-free bearing system. Thanks to its comprehensive diagnostic capabilities, users are always informed about the condition of their magnetically levitated turbomolecular pumps.

In addition to the standard design with RS-485 interface, Pfeiffer Vacuum also offers optional versions with DeviceNet or Profibus in response to modern control concepts.

Service
The unique selling point of Pfeiffer Vacuum turbopumps is on-site maintenance by the Pfeiffer Vacuum field service organization. As a result of the unique bearing concept, maintenance intervals of up to 4 years are possible. This means that the maintenance costs amount to only a fraction of those for competition products.

Important information relating to the technical data

Pumping speed
The pumping speed of a turbopump depends on its size and design. It is stated in liters per second and is a function of the intake pressure. The pumping speed characteristics are assigned to the products.

Compression ratio
The compression ratio of a turbopump is the ratio between forevacuum pressure measured at the forevacuum flange of the pump and the high vacuum pressure at the intake flange. Compression is stated for different types of gas and is determined without gas load. With the aid of this value it is possible to determine for a given backing pump the theoretical final pressure of the entire pumping station configuration.

Final pressures
The data stated for the final pressure apply for the conditions laid down in DIN 28428. These values are attained under clean conditions, using metal seals in the high vacuum area and after baking out or degassing the pump for 48 hours. Pumps with an aluminum housing are unsuitable for baking out and for this reason the final pressure is stated which is attained without baking the pump out and with clean FPM seals. The final pressures stated in the technical data are always practice related values which may be easily improved upon in the case of a corresponding pretreatment (venting with dry inert gas, degassing). The theoretically attainable minimum values depend on the gas-type specific compression ratios K_{oi} and the partial pressures P_{vi} on the forevacuum side as well as the system-specific gas flows Q_{total} like, for example, desorption from the surface being pumped down by a turbopump having an effective pumping speed of S_{eff}.

$$P_{end\ min} = \frac{Q_{total}}{S_{eff}} + \frac{P_{vv1}}{K_{01}} + \ldots + \frac{P_{vvn}}{K_{0n}}$$

As a rule, these theoretical final pressures can be attained only approximately since the system-specific conditions will generally have a significant influence on the final pressures.

Final pressures for turbopumps depending on housing material, flange type, backing pump used and rotor coating:

Ultimate pressure conforms to DIN 28 428, attained in a measuring dome 48 hours after bake-out.

	Rotary vane pump or dry backing pump with p < 0.05 mbar	Diaphragm vacuum pump with p < 0.05 mbar	Corrosive gas version with rotary vane pump or dry backing pump with p < 0.05 mbar
Stainless-Steel housing with CF-F[1)]	< $5 \cdot 10^{-10}$ mbar	< $1 \cdot 10^{-8}$ mbar	< $1 \cdot 10^{-8}$ mbar
Stainless-Steel housing with ISO-K[2)]	< $5 \cdot 10^{-10}$ mbar	< $1 \cdot 10^{-8}$ mbar	< $1 \cdot 10^{-8}$ mbar
Aluminum housing with ISO-K[3)]	< $1 \cdot 10^{-7}$ mbar	< $1 \cdot 10^{-7}$ mbar	< $1 \cdot 10^{-7}$ mbar

[1)] Bakeable with copper seal, [2)] Bakeable with aluminum seal, [3)] Not bakeable, with elastomer seal

Gas throughput

The term gas throughput, is used to describe the ability of the turbopump to pump quantities of gas for a certain pressure level through the pump. Here there are dependencies which are also dependent on the specific application.

All gas throughput data stated in the technical data apply under the following conditions:

- Operation with a backing pump which at least offers the performance data of the backing pump specified in connection with the gas load data
- Operation with water cooling at the specified water flow and a water supply temperature of 25° C, a maximum ambient temperature of 25° C and the employment of sealing gas (in connection with heavy gases)

A turbopump cannot be operated simultaneously at its maximum gas load and at its maximum forevacuum pressure

Maximum permissible forevacuum pressure

The maximum permissible forevacuum pressure of the turbopump is the pressure at which the turbopump still produces a compression of 100. It depends on the gas load pumped through the turbopump and the pumping speed of the backing pump used. For gas load operation, the forevacuum pressure should not exceeded more than approximately 50 % of the maximum permissible forevacuum pressure.

Safety is important

Notes relating to the mounting materials for turbopumps

Our turbopumps excel by a high degree of safety. This is based on our own theoretical and practical analyses regarding the crash behavior and the high safety margins in the design of the pumps. And we must claim the same also for the interface between the pumps and the customer's system. For this reason, we are offering a full line of installation components which ensure safe interface connections and which are presented together with the pump accessories.

The HiPace™ innovation

Picking up the pace in vacuum technology!
Faster. Higher. Stronger.

What is HiPace?
HiPace stands for a complete line of compact yet powerful turbopumps featuring pumping speeds that range from 10 – 2,000 liters per second. It offers a cost-effective yet flexible installation. This series offers convincing cost-effectiveness and flexibility, which also includes the ability to install the HiPace 1200 to 2300 in an upside-down orientation. The proven bearing system offers you unparalleled reliability. Thanks to its sophisticated rotor design, very high values are achieved with respect to both pumping speed, critical backing pressure and gas throughout as well as compression for light gases.

Photovoltaic

Glass coating

Drive concepts

- Integrated – no cumbersome and costly cabling
- Small physical size – optimal integration options
- Expanded remote functions – greater flexibility
- Shorter run-up time – ready to service faster
- Modern pump management – operating parameter monitoring
- Suitable for industrial applications – Protection Class IP 54
- Extremely low power consumption – top-efficiency performance
- Innovative electronics – maximum reliability

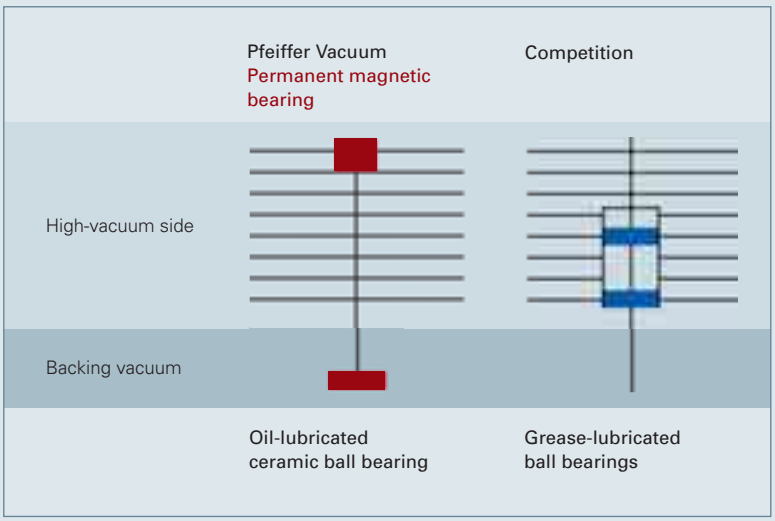
Series 10 – 700 l / s

Advantages at a glance

- Robust engineering and proven bearing system offer maximum reliability
- Compact design makes for minimum footprint
- High gas throughputs and high pumping speeds
- Integrated, powerful cooling system
- Installation possible in any orientation
- Suitable for industrial environments thanks to Protection Class IP 54
- Corrosive-gas version available
- Semi S2 and UL certification
- Complete line of accessories expands the range of potential applications
- Extended maintenance intervals
- On-site bearing change

Drive	**TC 110**		**TC 110 / TC 400**	**TC 400**	
Pump model	**HiPace™ 10**	**HiPace™ 80**	**HiPace™ 300***	**HiPace™ 400**	**HiPace™ 700**
Nominal connection diameter	DN 25	DN 63 ISO-K	DN 100 ISO-K	DN 100 ISO-K	DN 160 ISO-K
		DN 63 CF-F	DN 100 CF-F	DN 100 CF-F	DN 160 CF-F
		DN 40 ISO-KF	DN 100 ISO-F	DN 100 ISO-F	DN 160 ISO-F

* HiPace 300 C only availlable with TC 400



Reliability

Highly reliable

- Robust bearing system
- Extremely low vibration
- Minimum wear
- Mean time to failure > 200,000 hours
- Extended service intervals

Dry high-vacuum pumping station with HiPace™ and XtraDry™

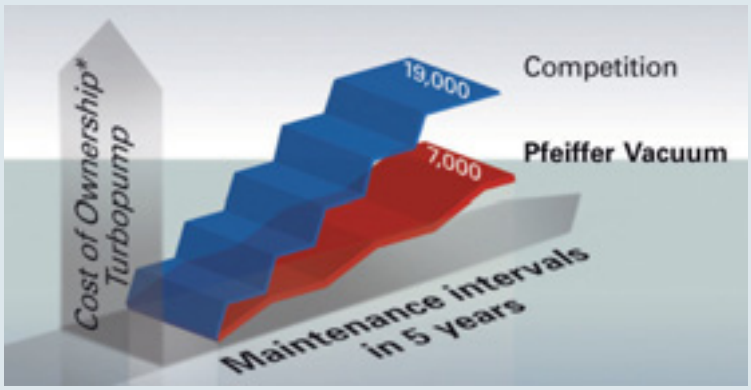
Calibrating pumping station with HiPace™ and OnTool DryPump™

Residual gas analysis with HiPace™ and PrismaPlus™

Series 1,000 – 2,000 l / s

Advantages at a glance

- Four sizes offering pumping speeds of from 1,000 to 2,000 l/s
- High pumping speeds for light gases (H_2, He) and heavy gases (Ar, CF_4)
- High gas throughputs, even for heavy gases (Ar, CF_4)
- Installation orientation available from 0° to 90° and from 90° to 180°
- Corrosive gas versions (C-models) available
- Integrated sealing gas system with throttle and valve
- Integrated, powerful cooling
- Integrated TC 1200 drive unit for direct mains connection
- Standard interfaces: RS-485 and Remote, Profibus or DeviceNet optional
- Compatible with Semi S2
- Certified under UL, CSA and TÜV
- Suitable for industrial environments thanks to Protection Class IP 54
- The utmost in process suitability, resistant to particles
- Robust rotor bearing system
- Simple installation



*approx. development of costs in Euro with use on an implanter

Cost of ownership

Factors for minimum operating costs of Pfeiffer Vacuum turbopumps:

- Simple maintenance offers
- Highest uptime
- Flexible service concepts
- Long service intervals
- On-site bearing change capability

Typical installation on a PVD system

Typical installation on a PVD system

Drive	TC 1200			
Type of pump	**HiPace™ 1200**	**HiPace™ 1500**	**HiPace™ 1800**	**HiPace™ 2300**
Nominal connection diameter	DN 200 ISO-K	DN 250 ISO-K	DN 200 ISO-K	DN 250 ISO-K
	DN 200 ISO-F	DN 250 ISO-F	DN 200 ISO-F	DN 250 ISO-F
	DN 200 CF-F	DN 250 CF-F		DN 250 CF-F
Orientation of flange	up 0° – 90°	up 0° – 90°	up 0° – 90°	up 0° – 90°
	upside down 90° – 180°	upside down 90° – 180°	upside down 90° – 180°	upside down 90° – 180°

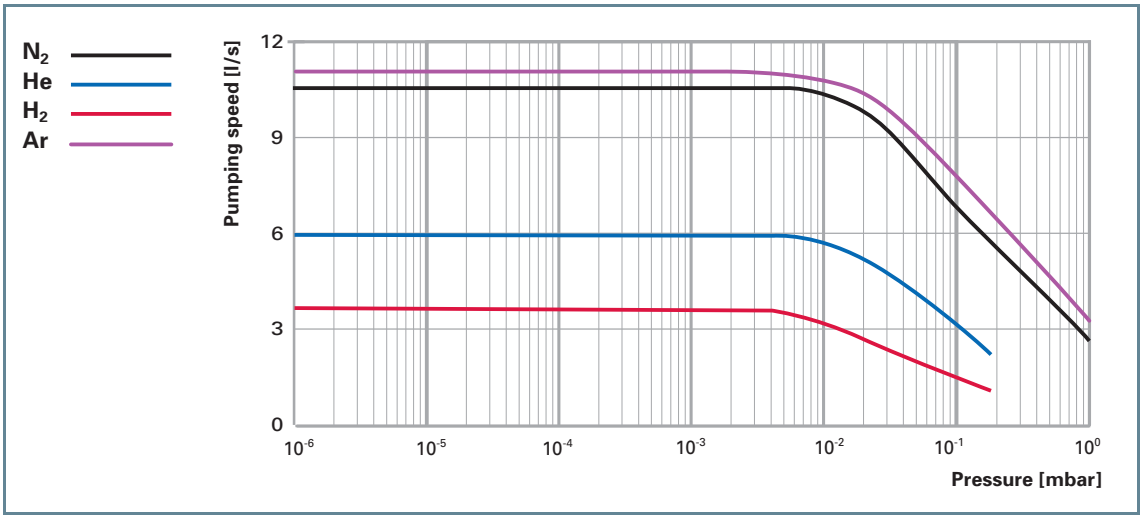
HiPace™ 10

Small and robust turbopump with a pumping speed of 10 l/s for N_2

HiPace™ 10

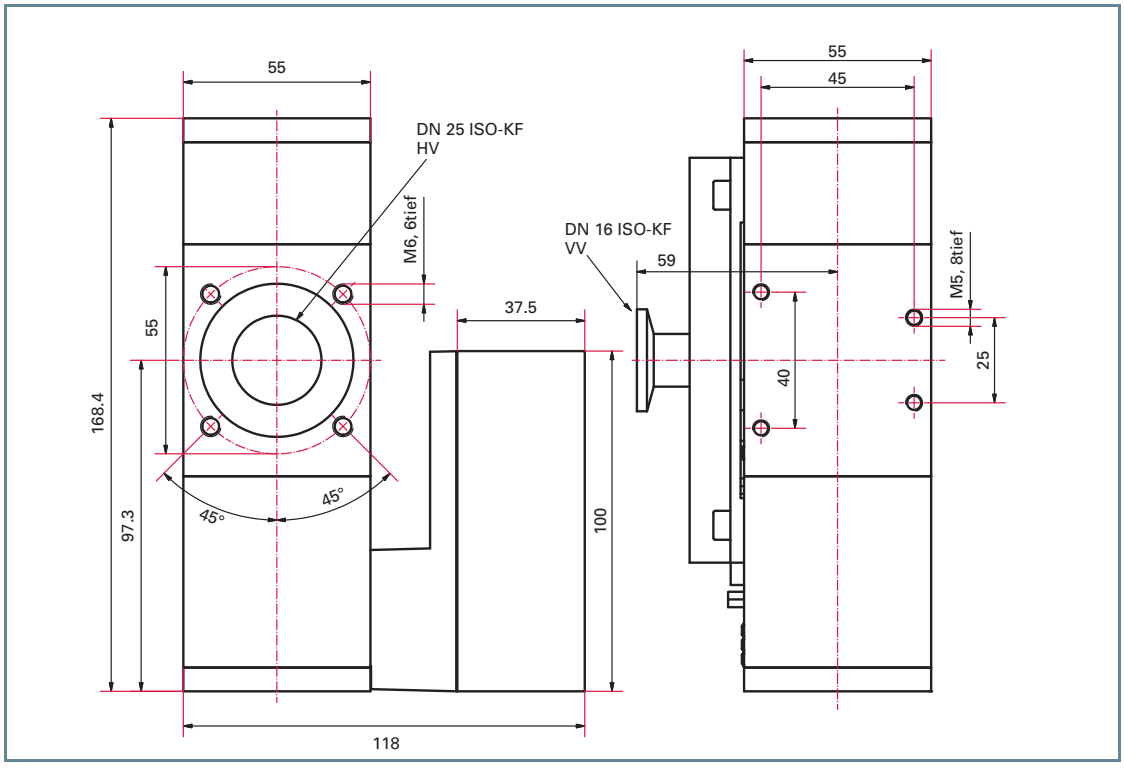
- The small design makes for minimum footprint
- Integrated drive electronics, suitable for industrial environments - Protection class IP 54
- Semi S2- and UL/CSA certification
- Maximum reliability through monitoring of operating data

Pumping speed



HiPace™ 10

Dimensions



HiPace™ 10, with TC 110, DN 25

Technical data	HiPace™ 10, with TC 110, DN 25
Connection nominal diameter	
Flange (in)	DN 25
Flange (out)	DN 16 ISO-KF
Pumping speed	
Pumping speed for H_2	3.7 l/s
Pumping speed for He	6 l/s
Pumping speed for N_2	10 l/s
Pumping speed for Ar	11.5 l/s
Compression	
Compression ratio for H_2	$3 \cdot 10^2$
Compression ratio for He	$3 \cdot 10^3$
Compression ratio for N_2	$3 \cdot 10^6$
Compression ratio for Ar	$3 \cdot 10^7$
Fore Vacuum max. for N_2	25 mbar
Gas througput	
Gas throughput at full rotational speed for H_2	0.15 mbar l/s
Gas throughput at full rotational speed for He	0.15 mbar l/s
Gas throughput at full rotational speed for N_2	0.15 mbar l/s
Gas throughput at full rotational speed for Ar	0.15 mbar l/s
Ultimate pressure	$< 5 \cdot 10^{-5}$ mbar
Rotation speed ±2%	90000 rpm
Run-up time	0.9 min
Cooling method, standard	Convection cooling
Permissible magnetic field max.	3 mT
Sound pressure level	< 45 dB (A)
Protection category	IP 54
Interfaces	RS-485, Remote
Weight	1.8 kg
Order number pump	**PM P03 960**

Accessories	HiPace™ 10, with TC 110, DN 25
Order number pump	**PM P03 960**
Power supplies/power	
DCU - power supply with display control unit	**PM C01 820**
TPS - mains pack for wall/standard rail fitting	**PM 061 340-T**
TPS - mains pack 19" rack module 3 RU	**PM 061 344-T**
Control units	
DCU - Display Control Unit	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m	
230 V AC mains cable with Euro-style safety plug	**P 4564 309 ZA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P 4564 309 ZF**
Connection cable, length 3 m between	
TC 110 / TPS/DCU 110/111/180/181 with accessory ports und RS-485,	**PM 061 351-T**
Connection cable for HiPace with TC 110 to power supply TPS/DCU 110/111/180/181 with bridges and RS-485	**PM 061 350-T**
Backing pump control	
Backing pump relay box, single phase 5 A	**PM 061 372-T**
Backing pump relay box, single phase 20 A	**PM 061 373-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**
General accessories	
Connecting adapter DN 25 ISO-KF	**PM 093 315-T**
Centering ring	**PF 110 125-T**
Centering ring, with integrated mesh screen	**PF 113 225-T**
USB converter	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**
Mounting materials	
Centering ring with 4 prackets, screws and U-washers	**PM 016 627-T**

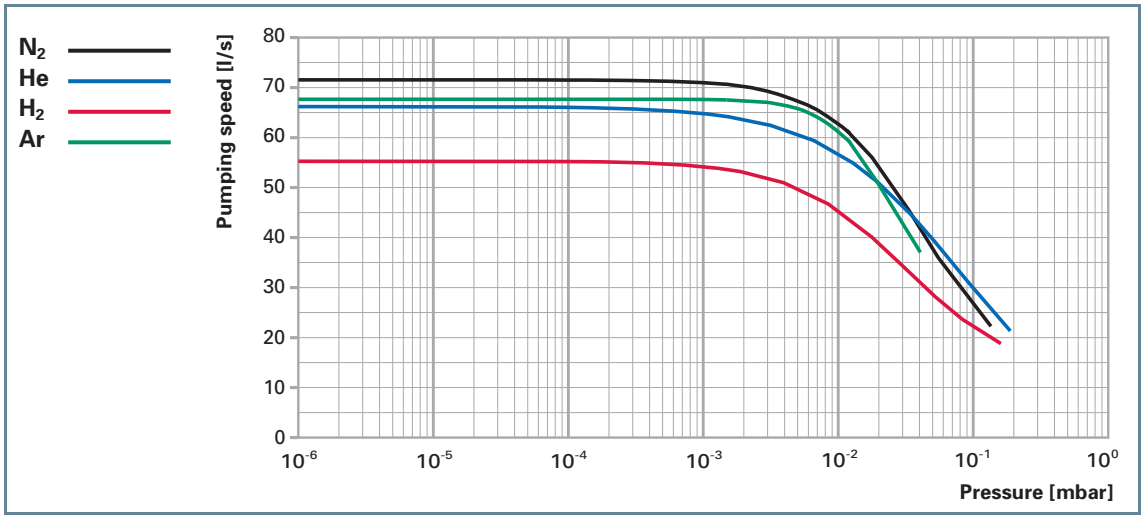
HiPace™ 80

Compact yet powerful turbopumps with pumping speeds of up to 71 l/s for N_2

HiPace™ 80

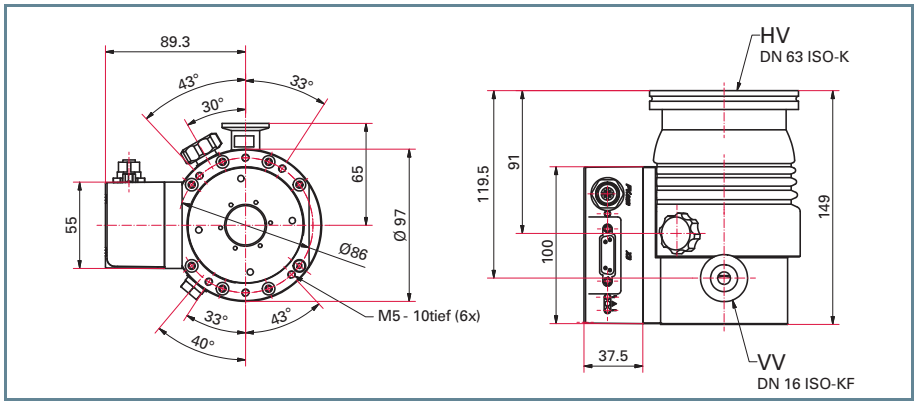
- Compact design makes for minimum footprint
- High pumping speed and maximum compression for all gases
- Integrated drive electronics, suitable for industrial environments - Protection class IP 54
- Semi S2 and UL/CSA certification
- Maximum reliability through monitoring of operating data

Pumping speed

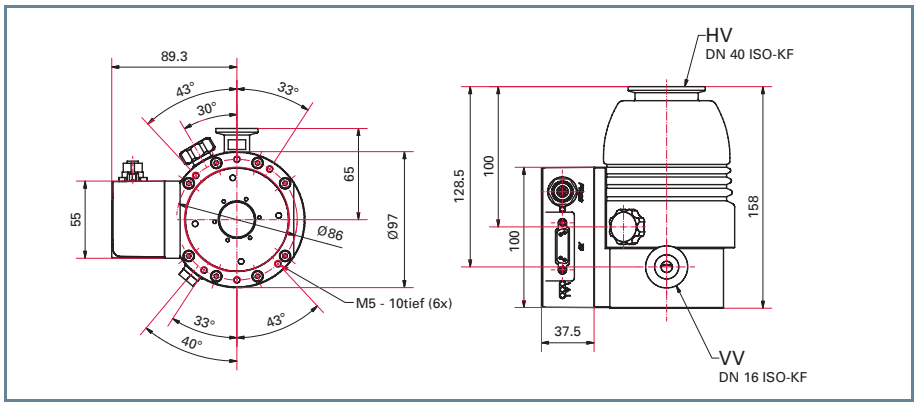


HiPace™ 80

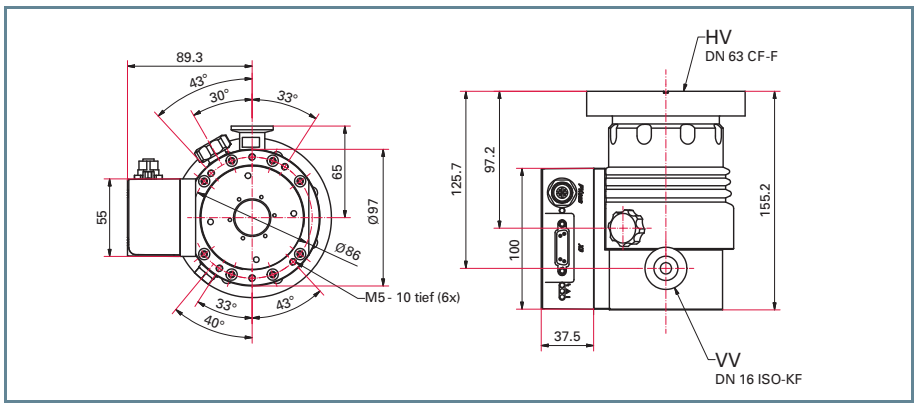
Dimensions



HiPace™ 80 with TC 110, DN 63 ISO-K



HiPace™ 80 with TC 110, DN 40 ISO-KF



HiPace™ 80 with TC 110, DN 63 CF-F

Technical data	HiPace™ 80 with TC 110, DN 63 ISO-K	HiPace™ 80 with TC 110, DN 63 CF-F	HiPace™ 80 with TC 110, DN 40 ISO-KF
Connection nominal diameter			
Flange (in)	DN 63 ISO-K	DN 63 CF-F	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"
Pumping speed			
Pumping speed for H_2	48 l/s	48 l/s	38 l/s
Pumping speed for He	58 l/s	58 l/s	41 l/s
Pumping speed for N_2	67 l/s	67 l/s	35 l/s
Pumping speed for Ar	66 l/s	66 l/s	30 l/s
Compression			
Compression ratio for H_2	$1.4 \cdot 10^5$	$1.4 \cdot 10^5$	$1.4 \cdot 10^5$
Compression ratio for He	$1.3 \cdot 10^7$	$1.3 \cdot 10^7$	$1.3 \cdot 10^7$
Compression ratio for N_2	$> 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Compression ratio for Ar	$> 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Fore Vacuum max. for N_2	22 mbar	22 mbar	22 mbar
Gas througput			
Gas throughput at full rotational speed for H_2	15.3 mbar l/s	15.3 mbar l/s	15.3 mbar l/s
Gas throughput at full rotational speed for He	2.7 mbar l/s	2.7 mbar l/s	2.7 mbar l/s
Gas throughput at full rotational speed for N_2	1.3 mbar l/s	1.3 mbar l/s	1.3 mbar l/s
Gas throughput at full rotational speed for Ar	0.54 mbar l/s	0.54 mbar l/s	0.54 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	90000 rpm	90000 rpm	90000 rpm
Run-up time	1.7 min	1.7 min	1.7 min
Cooling method, standard	Water	Water	Water
Cooling method, optional	Air	Air	Air
Cooling water consumption	75 l/h	75 l/h	75 l/h
Cooling water temperature	5-25 °C	5-25 °C	5-25 °C
Permissible magnetic field max.	3.3 mT	3.3 mT	3.3 mT
Sound pressure level	< 48 dB (A)	< 48 dB (A)	< 48 dB (A)
Protection category	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	2.4 kg	3.8 kg	2.4 kg
Order number pump	**PM P03 940**	**PM P03 941**	**PM P03 942**

	HiPace™ 80 for TCP 350, DN 63 ISO-K	HiPace™ 80 for TCP 350, DN 63 CF-F	HiPace™ 80 for TCP 350, DN 40 ISO-KF
	DN 63 ISO-K	DN 63 CF-F	DN 40 ISO-KF
	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
	G 1/8"	G 1/8"	G 1/8"
	48 l/s	48 l/s	38 l/s
	58 l/s	58 l/s	41 l/s
	67 l/s	67 l/s	35 l/s
	66 l/s	66 l/s	30 l/s
	$1.4 \cdot 10^{5}$	$1.4 \cdot 10^{5}$	$1.4 \cdot 10^{5}$
	$1.3 \cdot 10^{7}$	$1.3 \cdot 10^{7}$	$1.3 \cdot 10^{7}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	22 mbar	22 mbar	22 mbar
	15.3 mbar l/s	15.3 mbar l/s	15.3 mbar l/s
	2.7 mbar l/s	2.7 mbar l/s	2.7 mbar l/s
	1.3 mbar l/s	1.3 mbar l/s	1.3 mbar l/s
	0.54 mbar l/s	0.54 mbar l/s	0.54 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	90000 rpm	90000 rpm	90000 rpm
	1.7 min	1.7 min	1.7 min
	Water	Water	Water
	Air	Air	Air
	75 l/h	75 l/h	75 l/h
	5-25 °C	5-25 °C	5-25 °C
	3.3 mT	3.3 mT	3.3 mT
	< 48 dB (A)	< 48 dB (A)	< 48 dB (A)
	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote
	2.1 kg	3.5 kg	2.1 kg
	PM P03 943	**PM P03 944**	**PM P03 945**

Accessories	HiPace™ 80 with TC 110, DN 63 ISO-K	HiPace™ 80 with TC 110, DN 63 CF-F	HiPace™ 80 with TC 110, DN 40 ISO-KF
Order number pump	**PM P03 940**	**PM P03 941**	**PM P03 942**
Power supplies/power			
DCU - power supply with display control unit	**PM C01 820**	**PM C01 820**	**PM C01 820**
TPS - mains pack for wall/standard rail fitting	**PM 061 340-T**	**PM 061 340-T**	**PM 061 340-T**
TPS - mains pack 19" rack module 3 RU	**PM 061 344-T**	**PM 061 344-T**	**PM 061 344-T**
Control units			
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m			
230 V AC mains cable with Euro-style safety plug	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**
Connection cable, length 3 m between			
TC 110 / TPS/DCU 110/111/180/181 with accessory ports und RS-485,	**PM 061 351-T**	**PM 061 351-T**	**PM 061 351-T**
Connection cable for HiPace with TC 110 to power supply TPS/DCU 110/111/180/181 with bridges and RS-485	**PM 061 350-T**	**PM 061 350-T**	**PM 061 350-T**
TCP 350 - HiPace (for TC 400)			
External drive units			
TCP 350			
TCP 350 PB - Profibus			
TCP 350 DN - DeviceNet			
Venting accessories			
Venting valve	**PM Z01 290**	**PM Z01 290**	**PM Z01 290**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Cooling accessories			
Air cooling	**PM Z01 300**	**PM Z01 300**	**PM Z01 300**
Water cooling	**PM 016 623-T**	**PM 016 623-T**	**PM 016 623-T**
Heating accessories			
Heating jacket 230 V AC, Euro-style safety plug		**PM 061 360-T**	
Heating jacket 208 V AC, UL plug		**PM 061 361-T**	
Heating jacket 115 V AC, UL plug		**PM 061 362-T**	
Backing pump control			
Backing pump relay box, single phase 5 A	**PM 061 372-T**	**PM 061 372-T**	**PM 061 372-T**
Backing pump relay box, single phase 20 A	**PM 061 373-T**	**PM 061 373-T**	**PM 061 373-T**
Connection cable relaisbox - TCP 350			
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 80 for TCP 350, DN 63 ISO-K	HiPace™ 80 for TCP 350, DN 63 CF-F	HiPace™ 80 for TCP 350, DN 40 ISO-KF
	PM P03 943	PM P03 944	PM P03 945
	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF
	PM 061 353-T	PM 061 353-T	PM 061 353-T
	PM C01 740	PM C01 740	PM C01 740
	PM C01 741	PM C01 741	PM C01 741
	PM C01 742	PM C01 742	PM C01 742
	PM Z01 290	PM Z01 290	PM Z01 290
	PM Z00 121	PM Z00 121	PM Z00 121
	PM Z01 300	PM Z01 300	PM Z01 300
	PM 016 623-T	PM 016 623-T	PM 016 623-T
		PM 061 360-T	
		PM 061 361-T	
		PM 061 362-T	
	PM 061 372-T	PM 061 372-T	PM 061 372-T
	PM 061 373-T	PM 061 373-T	PM 061 373-T
	PM 061 376-T	PM 061 376-T	PM 061 376-T
	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 80 with TC 110, DN 63 ISO-K	HiPace™ 80 with TC 110, DN 63 CF-F	HiPace™ 80 with TC 110, DN 40 ISO-KF	
Order number pump	**PM P03 940**	**PM P03 941**	**PM P03 942**	
General accessories				
Sealing gas	**PM Z01 310**	**PM Z01 310**	**PM Z01 310**	
Sealing gas throttle	**PM Z01 316**	**PM Z01 316**	**PM Z01 316**	
Centering ring			**PF 110 140-T**	
Centering ring, with integrated mesh screen			**PF 113 240-T**	
Coated centering ring	**PM 016 206-U**			
Coated centering ring with protection screen	**PM 016 208-U**			
Coated centering ring with integrated splinter shield	**PM 016 207-U**		**PM 006 375-X**	
Protection screen		**PM 016 333**		
Splinter shield		**PM 016 312**		
Vibration dampers	**PM 006 800-X**	**PM 006 801-X**	**PM 006 799-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	
Connection cable, RJ 45 on M12				
Mounting materials				
Mounting kit including coated centering ring, bracket screws	**PM 016 360-T**			
Coated centering ring, with protection screen, clamping screws	**PM 016 362-T**			
Coated centering ring with splinter shield, bracket screws	**PM 016 361-T**			
Set of hexagon bolts		**PM 016 683-T**		
Set of stud screws		**PM 016 684-T**		
Clamping ring with centering ring			**PM 016 625-T**	
Clamping ring with centnering ring with splinter shield			**PM 016 626-T**	
Coated centering ring DN 63 ISO-K, 4 claws M8	**PM 016 510-T**			
Coated centering ring DN 63 ISO-K, 4 claws M8, protection screen	**PM 016 512-T**			
Coated centering ring DN 63 ISO-K, 4 claws M8, splinter shield	**PM 016 511-T**			

	HiPace™ 80 for TCP 350, DN 63 ISO-K	HiPace™ 80 for TCP 350, DN 63 CF-F	HiPace™ 80 for TCP 350, DN 40 ISO-KF
	PM P03 943	PM P03 944	PM P03 945
	PM Z01 310	PM Z01 310	PM Z01 310
	PM Z01 316	PM Z01 316	PM Z01 316
			PF 110 140-T
			PF 113 240-T
	PM 016 206-U		
	PM 016 208-U		
	PM 016 207-U		PM 006 375-X
		PM 016 333	
		PM 016 312	
	PM 006 800-X	PM 006 801-X	PM 006 799-X
	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 051 726-T	PM 051 726-T	PM 051 726-T
	PM 016 360-T PM 016 362-T		
	PM 016 361-T		
		PM 016 683-T	
		PM 016 684-T	
			PM 016 625-T
			PM 016 626-T
	PM 016 510-T		
	PM 016 512-T		
	PM 016 511-T		

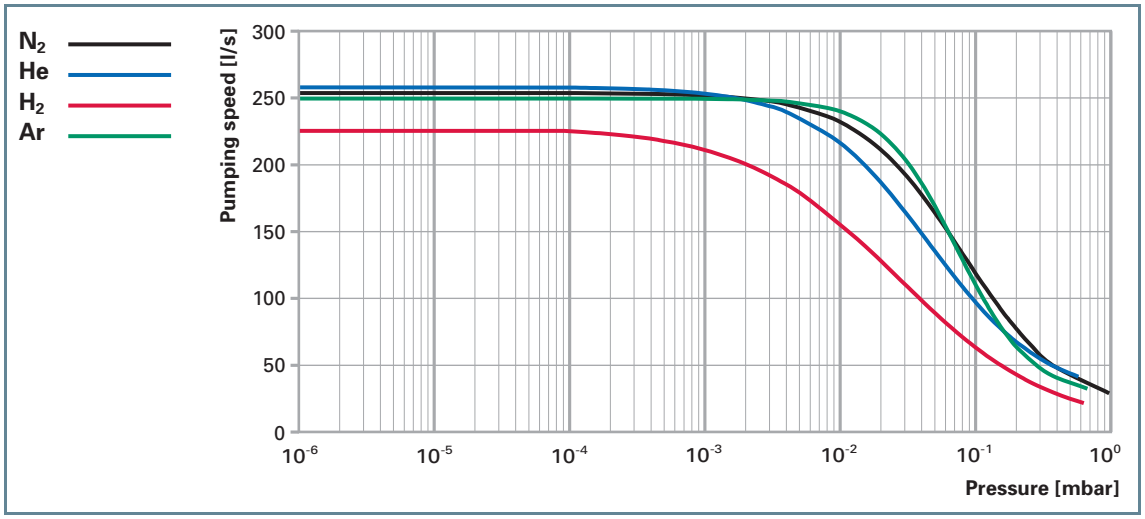
HiPace™ 300

Compact yet powerful turbopumps with pumping speeds of up to 260 l/s for N_2

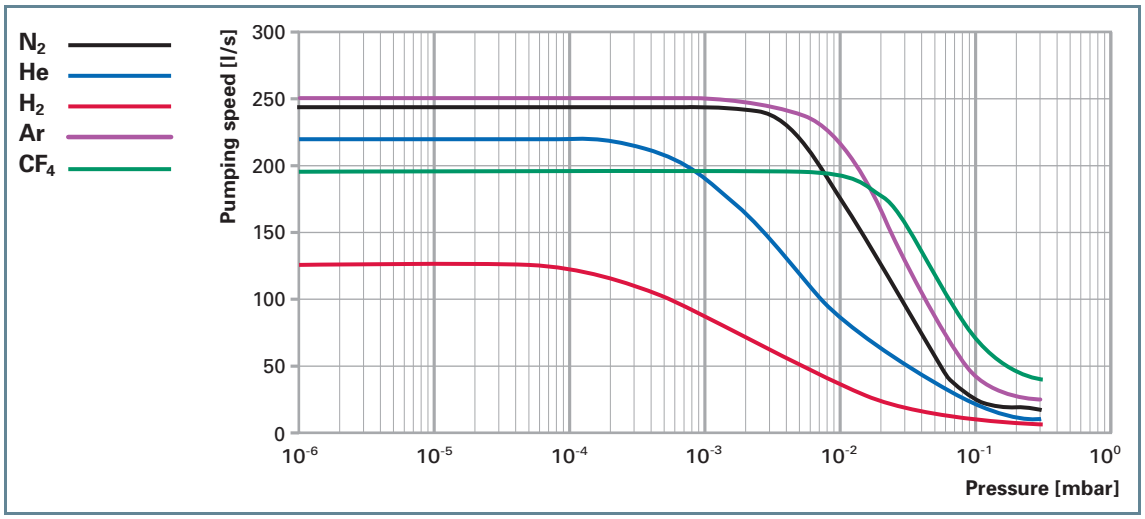
HiPace™ 300

- ▶ Maximum reliability in a compact design
- ▶ High pumping speed and maximum compression for all gases
- ▶ Semi S2 and UL/CSA certification
- ▶ Ideal for industry and research
- ▶ Integrated drive electronics, suitable for industrial environments - Protection class IP 54
- ▶ Continuous monitoring of operating data

Pumping speed

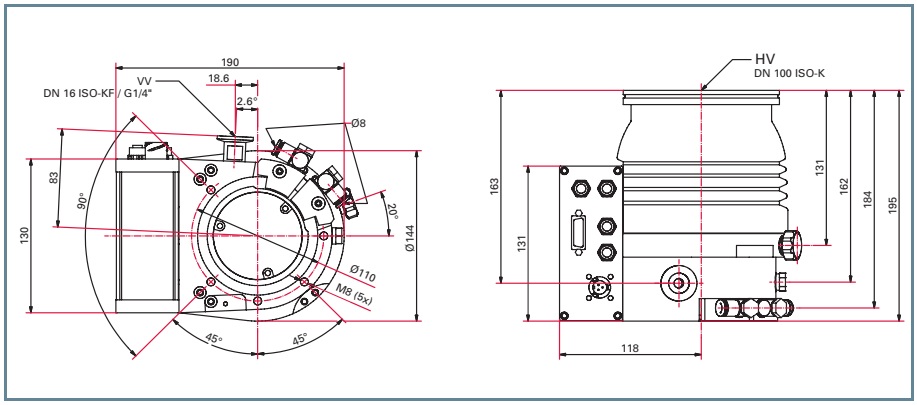


HiPace™ 300, with TC 400

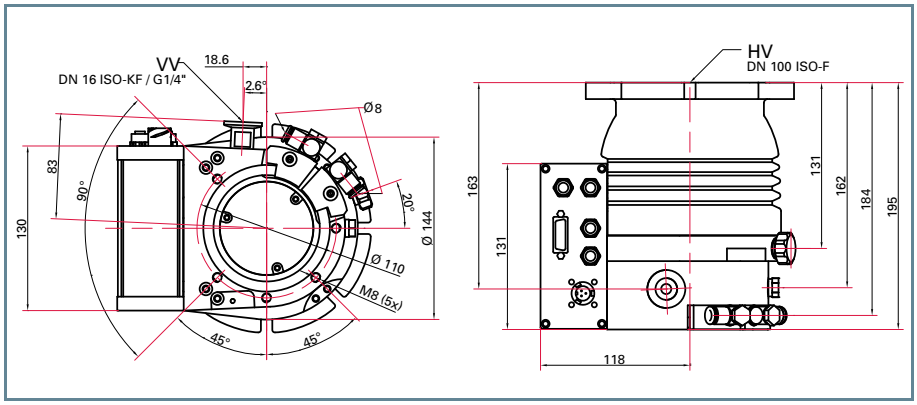


HiPace™ 300 C, with TC 400

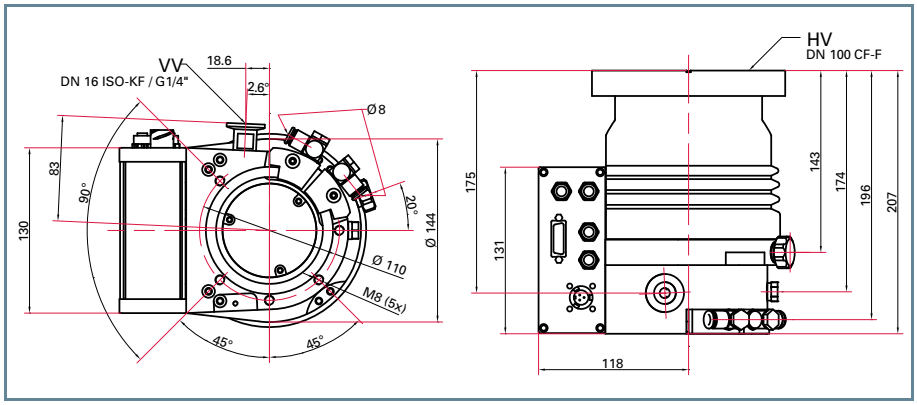
Dimensions



HiPace™ 300, with TC 400, DN 100 ISO-K



HiPace™ 300, with TC 400, DN 100 ISO-F



HiPace™ 300, with TC 400, DN 100 CF-F

Technical data	HiPace™ 300, with TC 110, DN 100 ISO-K	HiPace™ 300, with TC 110, DN 100 CF-F	HiPace™ 300, with TC 110, DN 100 ISO-F	HiPace™ 300, with TC 400, DN 100 ISO-K	HiPace™ 300, with TC 400, DN 100 CF-F
Connection nominal diameter					
Flange (in)	DN 100 ISO-K	DN 100 CF-F	DN 100 ISO-F	DN 100 ISO-K	DN 100 CF-F
Flange (out)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
Pumping speed					
Pumping speed for H_2	220 l/s	220 l/s	220 l/s	220 l/s	220 l/s
Pumping speed for He	255 l/s	255 l/s	255 l/s	255 l/s	255 l/s
Pumping speed for N_2	260 l/s	260 l/s	260 l/s	260 l/s	260 l/s
Pumping speed for Ar	255 l/s	255 l/s	255 l/s	255 l/s	255 l/s
Pumping speed for CF_4	200 l/s	200 l/s	200 l/s	200 l/s	200 l/s
Compression					
Compression ratio for H_2	$9 \cdot 10^5$	$9 \cdot 10^5$	$9 \cdot 10^5$	$9 \cdot 10^5$	$9 \cdot 10^5$
Compression ratio for He	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for N_2	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Compression ratio for Ar	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Compression ratio for CF_4	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Fore Vacuum max. for N_2	15 mbar	15 mbar	15 mbar	20 mbar	20 mbar
Gas througput					
Gas throughput at full rotational speed for H_2	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s
Gas throughput at full rotational speed for He	8 mbar l/s	8 mbar l/s	8 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for N_2	5 mbar l/s	5 mbar l/s	5 mbar l/s	14 mbar l/s	14 mbar l/s
Gas throughput at full rotational speed for Ar	2 mbar l/s	2 mbar l/s	2 mbar l/s	7 mbar l/s	7 mbar l/s
Gas throughput at full rotational speed for CF_4	2 mbar l/s	2 mbar l/s	2 mbar l/s	8 mbar l/s	8 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar
Rotation speed ±2%	60000 rpm	60000 rpm	60000 rpm	60000 rpm	60000 rpm
Run-up time	3.5 min	3.5 min	3.5 min	1.8 min	1.8 min
Cooling method, standard	Air	Air	Air	Water	Water
Cooling method, optional	Water	Water	Water	Air	Air
Cooling water consumption	50 l/h	50 l/h	50 l/h	50 l/h	50 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	5.5 mT	5.5 mT	5.5 mT	5.5 mT	5.5 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	6.2 kg	8.2 kg	6.5 kg	6.7 kg	8.7 kg
Order number pump	**PM P03 990**	**PM P03 991**	**PM P03 992**	**PM P03 900**	**PM P03 901**

	HiPace™ 300, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 ISO-K	HiPace™ 300 C, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K	HiPace™ 300 for TCP 350, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K
	DN 100 ISO-F	DN 100 ISO-K	DN 100 ISO-F	DN 100 CF-F	DN 100 ISO-K	DN 100 CF-F	DN 100 ISO-K
	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
	G 1/8"	G 1/8"	G 1/8" l/s	G 1/8"	G 1/8"	G 1/8"	G 1/8"
	220 l/s	125 l/s	125 l/s	125 l/s	220 l/s	220 l/s	220 l/s
	255 l/s	220 l/s	220 l/s	220 l/s	255 l/s	255 l/s	255 l/s
	260 l/s	245 l/s	245 l/s	245 l/s	260 l/s	260 l/s	260 l/s
	255 l/s	250 l/s	250 l/s	250 l/s	255 l/s	255 l/s	255 l/s
	200 l/s	195 l/s	195 l/s	195 l/s	200 l/s	200 l/s	200 l/s
	$9 \cdot 10^5$	$3 \cdot 10^2$	$3 \cdot 10^2$	$3 \cdot 10^2$	$9 \cdot 10^5$	$9 \cdot 10^5$	$9 \cdot 10^5$
	$> 1 \cdot 10^8$	$2.2 \cdot 10^3$	$2.2 \cdot 10^3$	$2.2 \cdot 10^3$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^6$	$> 1 \cdot 10^6$	$> 1 \cdot 10^6$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^7$	$> 1 \cdot 10^7$	$> 1 \cdot 10^7$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^7$	$> 1 \cdot 10^7$	$> 1 \cdot 10^7$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	20 mbar	1 mbar	1 mbar	1 mbar	17 mbar	17 mbar	17 mbar
	> 14 mbar l/s	> 50 mbar l/s, with backing pump 20 m^3/h	> 50 mbar l/s, with backing pump 20 m^3/h	> 50 mbar l/s, with backing pump 20 m^3/h	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s
	20 mbar l/s	> 20 mbar l/s, with backing pump 20 m^3/h	> 20 mbar l/s, with backing pump 20 m^3/h	> 20 mbar l/s, with backing pump 20 m^3/h	11 mbar l/s	11 mbar l/s	11 mbar l/s
	14 mbar l/s	17 mbar l/s, with backing pump 20 m^3/h	17 mbar l/s, with backing pump 20 m^3/h	17 mbar l/s, with backing pump 20 m^3/h	7 mbar l/s	7 mbar l/s	7 mbar l/s
	7 mbar l/s	4.4 mbar l/s, with backing pump 20 m^3/h	4.4 mbar l/s, with backing pump 20 m^3/h	4.4 mbar l/s, with backing pump 20 m^3/h	4 mbar l/s	4 mbar l/s	4 mbar l/s
	8 mbar l/s	5.4 mbar l/s, with backing pump 20 m^3/h	5.4 mbar l/s, with backing pump 20 m^3/h	5.4 mbar l/s, with backing pump 20 m^3/h	4 mbar l/s	4 mbar l/s	4 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-8}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	60000 rpm	60000 rpm	60000 rpm	60000 rpm	60000 rpm	60000 rpm	60000 rpm
	1.8 min	1.2 min	1.2 min	1.2 min	2.5 min	2.5 min	2.5 min
	Water	Water	Water	Water	Water	Water	Water
	Air	Air	Air	Air	Air	Air	Air
	50 l/h	50 l/h	50 l/h	50 l/h	50 l/h	50 l/h	50 l/h
	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
	5.5 mT	5.5 mT	5.5 mT	5.5 mT	5.5 mT	5.5 mT	5.5 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
	7 kg	6.4 kg	6.7 kg	8.4 kg	5.8 kg	7.8 kg	6.1 kg
	PM P03 902	**PM P03 906**	**PM P03 907**	**PM P03 996**	**PM P03 993**	**PM P03 994**	**PM P03 995**

Accessories	HiPace™ 300, with TC 110, DN 100 ISO-K	HiPace™ 300, with TC 110, DN 100 CF-F	HiPace™ 300, with TC 110, DN 100 ISO-F	HiPace™ 300, with TC 400, DN 100 ISO-K	HiPace™ 300, with TC 400, DN 100 CF-F
Order number pump	**PM P03 990**	**PM P03 991**	**PM P03 992**	**PM P03 900**	**PM P03 901**
Power supplies/power					
DCU - power supply with display control unit	**PM C01 821**	**PM C01 821**	**PM C01 821**	**PM C01 822**	**PM C01 822**
TPS - mains pack for wall/standard rail fitting	**PM 061 341-T**	**PM 061 341-T**	**PM 061 341-T**	**PM 061 342-T**	**PM 061 342-T**
TPS - mains pack 19" rack module 3 RU	**PM 061 345-T**	**PM 061 345-T**	**PM 061 345-T**	**PM 061 346-T**	**PM 061 346-T**
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**
Connection cable, length 3 m between					
TC 110 / TPS/DCU 110/111/180/181 with accessory ports und RS-485,	**PM 061 351-T**	**PM 061 351-T**	**PM 061 351-T**		
Connection cable for HiPace with TC 110 to power supply TPS/DCU 110/111/180/181 with bridges and RS-485	**PM 061 350-T**	**PM 061 350-T**	**PM 061 350-T**		
TC 400 / TPS/DCU 310/311/400/401				**PM 061 352-T**	**PM 061 352-T**
TCP 350 - HiPace (for TC 400)					
External drive units					
TCP 350					
TCP 350 PB - Profibus					
TCP 350 DN - DeviceNet					
Venting accessories					
Venting valve	**PM Z01 290**	**PM Z01 290**	**PM Z01 290**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Cooling accessories					
Air cooling	**PM Z01 301**	**PM Z01 301**	**PM Z01 301**	**PM Z01 302**	**PM Z01 302**
Water cooling	**PM 016 624-T**	**PM 016 624-T**	**PM 016 624-T**		
Heating accessories					
Heating jacket 230 V AC, Euro-style safety plug		**PM 061 363-T**			**PM 061 366-T**
Heating jacket 208 V AC, UL plug		**PM 061 364-T**			**PM 061 367-T**
Heating jacket 115 V AC, UL plug		**PM 061 365-T**			**PM 061 368-T**
Backing pump control					
Backing pump relay box, single phase 5 A	**PM 061 372-T**	**PM 061 372-T**	**PM 061 372-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 373-T**	**PM 061 373-T**	**PM 061 373-T**	**PM 061 375-T**	**PM 061 375-T**
Connection cable relaisbox - TCP 350					
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 300, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 ISO-K	HiPace™ 300 C, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K	HiPace™ 300 for TCP 350, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K
	PM P03 902	PM P03 906	PM P03 907	PM P03 996	PM P03 993	PM P03 994	PM P03 995
	PM C01 822	PM C01 822	PM C01 822	PM C01 822			
	PM 061 342-T	PM 061 342-T	PM 061 342-T	PM 061 342-T			
	PM 061 346-T	PM 061 346-T	PM 061 346-T	PM 061 346-T			
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF
	PM 061 352-T	PM 061 352-T	PM 061 352-T	PM 061 352-T			
					PM 061 356-T	PM 061 356-T	PM 061 356-T
					PM C01 740	PM C01 740	PM C01 740
					PM C01 741	PM C01 741	PM C01 741
					PM C01 742	PM C01 742	PM C01 742
	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM Z01 302	PM Z01 302	PM Z01 302	PM Z01 302	PM Z01 302	PM Z01 302	PM Z01 302
				PM 061 366-T		PM 061 366-T	
				PM 061 367-T		PM 061 367-T	
				PM 061 368-T		PM 061 368-T	
	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
					PM 061 377-T	PM 061 377-T	PM 061 377-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 300, with TC 110, DN 100 ISO-K	HiPace™ 300, with TC 110, DN 100 CF-F	HiPace™ 300, with TC 110, DN 100 ISO-F	HiPace™ 300, with TC 400, DN 100 ISO-K	HiPace™ 300, with TC 400, DN 100 CF-F
Order number pump	**PM P03 990**	**PM P03 991**	**PM P03 992**	**PM P03 900**	**PM P03 901**
General accessories					
Sealing gas	**PM Z01 311**	**PM Z01 311**	**PM Z01 311**	**PM Z01 312**	**PM Z01 312**
Sealing gas throttle	**PM Z01 317**	**PM Z01 317**	**PM Z01 317**	**PM Z01 317**	**PM Z01 317**
Coated centering ring	**PM 016 210-U**		**PM 016 210-U**	**PM 016 210-U**	
Coated centering ring with protection screen	**PM 016 212-U**		**PM 016 212-U**	**PM 016 212-U**	
Coated centering ring with integrated splinter shield	**PM 016 211-U**		**PM 016 211-U**	**PM 016 211-U**	
Protection screen		**PM 016 336**			**PM 016 336**
Splinter shield		**PM 016 315**			**PM 016 315**
Vibration dampers	**PM 006 459-X**	**PM 006 488-X**		**PM 006 459-X**	**PM 006 488-X**
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**
Y-connector, M12 for accessories				**P 4723 012**	**P 4723 012**
Connection cable, RJ 45 on M12					
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 365-T**			**PM 016 365-T**	
Coated centering ring, with protection screen, clamping screws	**PM 016 367-T**			**PM 016 367-T**	
Coated centering ring with splinter shield, bracket screws	**PM 016 366-T**			**PM 016 366-T**	
Coated centering ring, hexagon bolts			**PM 016 450-T**		
Coated centering ring with protection screen, hexagon bolts			**PM 016 452-T**		
Coated centering ring with splinter shield, hexagon bolts			**PM 016 451-T**		
Coated centering ring, stud screws			**PM 016 455-T**		
Coated centering ring with protection screen, stud screws			**PM 016 457-T**		
Coated centering ring with splinter shield, stud screws			**PM 016 456-T**		
Set of hexagon bolts		**PM 016 690-T**			**PM 016 690-T**
Set of stud screws		**PM 016 692 -T**			**PM 016 692 -T**

	HiPace™ 300, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 ISO-K	HiPace™ 300 C, with TC 400, DN 100 ISO-F	HiPace™ 300 C, with TC 400, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K	HiPace™ 300 for TCP 350, DN 100 CF-F	HiPace™ 300 for TCP 350, DN 100 ISO-K
	PM P03 902	PM P03 906	PM P03 907	PM P03 996	PM P03 993	PM P03 994	PM P03 995
	PM Z01 312	PM Z01 312	PM Z01 312	PM Z01 312	PM Z01 312	PM Z01 312	PM Z01 312
	PM Z01 317	PM Z01 317	PM Z01 317	PM Z01 317	PM Z01 317	PM Z01 317	PM Z01 317
	PM 016 210-U	PM 016 210-U	PM 016 210-U		PM 016 210-U		PM 016 210-U
	PM 016 212-U	PM 016 212-U	PM 016 212-U		PM 016 212-U		PM 016 212-U
	PM 016 211-U	PM 016 211-U	PM 016 211-U		PM 016 211-U		PM 016 211-U
				PM 016 336		PM 016 336	
				PM 016 315		PM 016 315	
		PM 006 459-X		PM 006 488-X	PM 006 459-X	PM 006 488-X	
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	P 4723 010	P 4723 010	P 4723 010	P 4723 010			
	P 4723 012	P 4723 012	P 4723 012	P 4723 012			
					PM 051 726-T	PM 051 726-T	PM 051 726-T
		PM 016 365-T			PM 016 365-T		
		PM 016 367-T			PM 016 367-T		
		PM 016 366-T			PM 016 366-T		
	PM 016 450-T		PM 016 450-T				PM 016 450-T
	PM 016 452-T		PM 016 452-T				PM 016 452-T
	PM 016 451-T		PM 016 451-T				PM 016 451-T
	PM 016 455-T		PM 016 455-T				PM 016 455-T
	PM 016 457-T		PM 016 457-T				PM 016 457-T
	PM 016 456-T		PM 016 456-T				PM 016 456-T
				PM 016 690-T		PM 016 690-T	
				PM 016 692 -T		PM 016 692 -T	

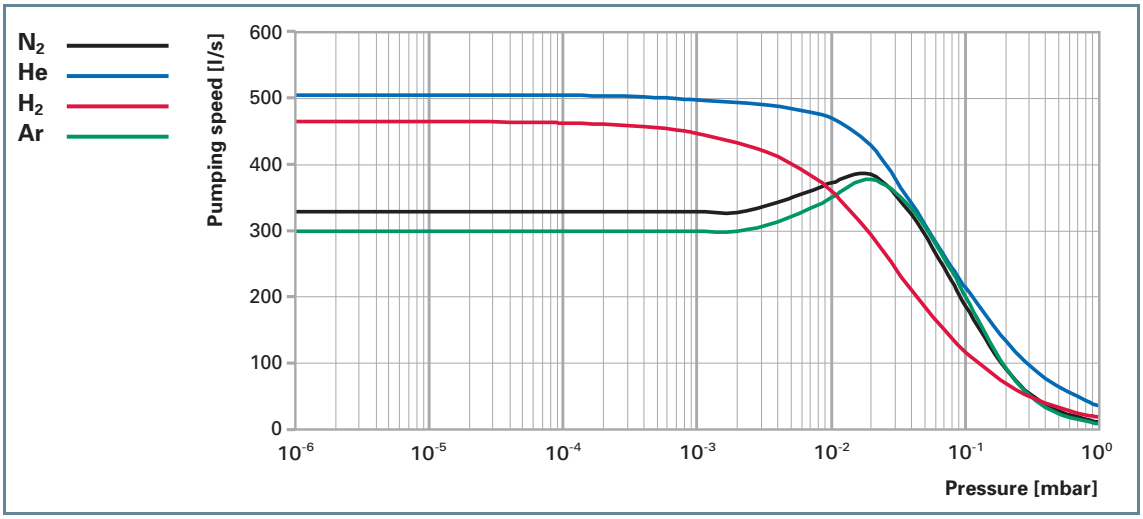
HiPace™ 400

Compact yet powerful turbopumps with pumping speeds of up to 350 l/s for N_2, with a small DN 100 flange connection:

HiPace™ 400

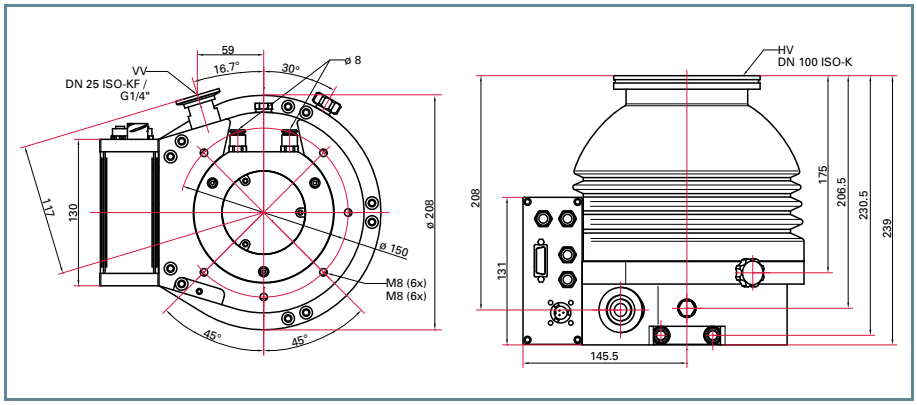
- ▶ Maximum reliability in a compact design
- ▶ Maximum pumping speed and high gas throughput
- ▶ Suitable for industrial environments - Protection class IP 54
- ▶ Semi S2 and UL/CSA certification
- ▶ Monitoring of operating data

Pumping speed

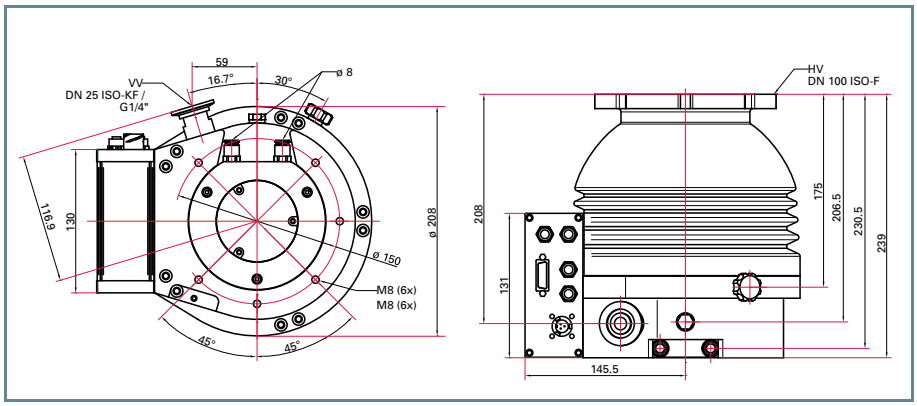


HiPace™ 400

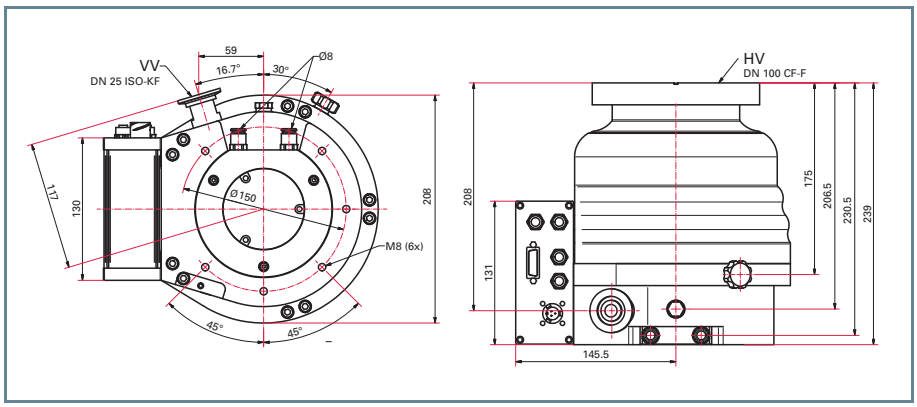
Dimensions



HiPace™ 400, with TC 400, DN 100 ISO-K



HiPace™ 400, with TC 400, DN 100 ISO-F



HiPace™ 400, with TC 400, DN 100 CF-F

Technical data	HiPace™ 400, with TC 400, DN 100 ISO-K	HiPace™ 400, with TC 400, DN 100 CF-F	HiPace™ 400, with TC 400, DN 100 ISO-F
Connection nominal diameter			
Flange (in)	DN 100 ISO-K	DN 100 CF-F	DN 100 ISO-F
Flange (out)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"
Pumping speed			
Pumping speed for H_2	445 l/s	445 l/s	445 l/s
Pumping speed for He	470 l/s	470 l/s	470 l/s
Pumping speed for N_2	355 l/s	355 l/s	355 l/s
Pumping speed for Ar	320 l/s	320 l/s	320 l/s
Compression			
Compression ratio for H_2	$4 \cdot 10^5$	$4 \cdot 10^5$	$4 \cdot 10^5$
Compression ratio for He	$> 3 \cdot 10^7$	$3 \cdot 10^7$	$3 \cdot 10^7$
Compression ratio for N_2	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Compression ratio for Ar	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Fore Vacuum max. for N_2	11 mbar	11 mbar	11 mbar
Gas througput			
Gas throughput at full rotational speed for H_2	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s
Gas throughput at full rotational speed for He	10 mbar l/s	10 mbar l/s	10 mbar l/s
Gas throughput at full rotational speed for N_2	6.5 mbar l/s	6.5 mbar l/s	6.5 mbar l/s
Gas throughput at full rotational speed for Ar	3.5 mbar l/s	3.5 mbar l/s	3.5 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	49200 rpm	49200 rpm	49200 rpm
Run-up time	2 min	2 min	2 min
Cooling method, standard	Water	Water	Water
Cooling method, optional	Air	Air	Air
Cooling water consumption	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	6 mT	6 mT	6 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	11.6 kg	17.5 kg	12 kg
Order number pump	**PM P04 023**	**PM P04 024**	**PM P04 025**

	HiPace™ 400, with TC 400, DN 100 ISO-K	HiPace™ 400, with TC 400, DN 100 CF-F	HiPace™ 400, with TC 400, DN 100 ISO-F
	DN 100 ISO-K	DN 100 CF-F	DN 100 ISO-F
	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
	G 1/8"	G 1/8"	G 1/8"
	445 l/s	445 l/s	445 l/s
	470 l/s	470 l/s	470 l/s
	355 l/s	355 l/s	355 l/s
	320 l/s	320 l/s	320 l/s
	$4 \cdot 10^{5}$	$4 \cdot 10^{5}$	$4 \cdot 10^{5}$
	$3 \cdot 10^{7}$	$3 \cdot 10^{7}$	$3 \cdot 10^{7}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	10 mbar	10 mbar	10 mbar
	> 8 mbar l/s	> 8 mbar l/s	> 8 mbar l/s
	5 mbar l/s	5 mbar l/s	5 mbar l/s
	3 mbar l/s	3 mbar l/s	3 mbar l/s
	1.5 mbar l/s	1.5 mbar l/s	1.5 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	49200 rpm	49200 rpm	49200 rpm
	5.5 min	5.5 min	5.5 min
	Water	Water	Water
	Air	Air	Air
	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C
	6 mT	6 mT	6 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote
	10.9 kg	16.6 kg	11.1 kg
	PM P04 026	**PM P04 027**	**PM P04 028**

Accessories	HiPace™ 400, with TC 400, DN 100 ISO-K	HiPace™ 400, with TC 400, DN 100 CF-F	HiPace™ 400, with TC 400, DN 100 ISO-F
Order number pump	**PM P04 023**	**PM P04 024**	**PM P04 025**
Power supplies/power			
DCU - power supply with display control unit	**PM C01 823**	**PM C01 823**	**PM C01 823**
TPS - mains pack for wall/standard rail fitting	**PM 061 343-T**	**PM 061 343-T**	**PM 061 343-T**
TPS - mains pack 19" rack module 3 RU	**PM 061 347-T**	**PM 061 347-T**	**PM 061 347-T**
Control units			
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m			
230 V AC mains cable with Euro-style safety plug	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**
Connection cable, length 3 m between			
TC 400 / TPS/DCU 310/311/400/401	**PM 061 352-T**	**PM 061 352-T**	**PM 061 352-T**
TCP 350 - HiPace (for TC 400)			
External drive units			
TCP 350			
TCP 350 PB - Profibus			
TCP 350 DN - DeviceNet			
Venting accessories			
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Cooling accessories			
Air cooling	**PM Z01 303**	**PM Z01 303**	**PM Z01 303**
Heating accessories			
Heating jacket 230 V AC, Euro-style safety plug		**PM 061 369-T**	
Heating jacket 208 V AC, UL plug		**PM 061 370-T**	
Heating jacket 115 V AC, UL plug		**PM 061 371-T**	
Backing pump control			
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
Connection cable relaisbox - TCP 350			
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 400 for TCP 350 DN 100 ISO-K	HiPace™ 400 for TCP 350, DN 100 CF-F	HiPace™ 400 for TCP 350, DN 100 ISO-F
	PM P04 026	PM P04 027	PM P04 028
	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF
	PM 061 356-T	PM 061 356-T	PM 061 356-T
	PM C01 740	PM C01 740	PM C01 740
	PM C01 741	PM C01 741	PM C01 741
	PM C01 742	PM C01 742	PM C01 742
	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121
	PM Z01 303	PM Z01 303	PM Z01 303
		PM 061 369-T	
		PM 061 370-T	
		PM 061 371-T	
	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM 061 377-T	PM 061 377-T	PM 061 377-T
	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 400, with TC 400, DN 100 ISO-K	HiPace™ 400, with TC 400, DN 100 CF-F	HiPace™ 400, with TC 400, DN 100 ISO-F	
Order number pump	**PM P04 023**	**PM P04 024**	**PM P04 025**	
General accessories				
Sealing gas	**PM Z01 312**	**PM Z01 312**	**PM Z01 312**	
Sealing gas throttle	**PM Z01 317**	**PM Z01 317**	**PM Z01 317**	
Coated centering ring	**PM 016 210-U**		**PM 016 210-U**	
Coated centering ring with protection screen	**PM 016 212-U**		**PM 016 212-U**	
Coated centering ring with integrated splinter shield	**PM 016 211-U**		**PM 016 211-U**	
Protection screen		**PM 016 336**		
Splinter shield		**PM 016 315**		
Vibration dampers	**PM 006 459-X**	**PM 006 488-X**		
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**	
Connection cable, RJ 45 on M12				
Mounting materials				
Mounting kit including coated centering ring, bracket screws	**PM 016 380-T**			
Coated centering ring, with protection screen, clamping screws	**PM 016 382-T**			
Coated centering ring with splinter shield, bracket screws	**PM 016 381-T**			
Coated centering ring, hexagon bolts			**PM 016 450-T**	
Coated centering ring with protection screen, hexagon bolts			**PM 016 452-T**	
Coated centering ring with splinter shield, hexagon bolts			**PM 016 451-T**	
Coated centering ring, stud screws			**PM 016 455-T**	
Coated centering ring with protection screen, stud screws			**PM 016 457-T**	
Coated centering ring with splinter shield, stud screws			**PM 016 456-T**	
Set of hexagon bolts		**PM 016 690-T**		
Set of stud screws		**PM 016 692 -T**		

	HiPace™ 400 for TCP 350 DN 100 ISO-K	HiPace™ 400 for TCP 350, DN 100 CF-F	HiPace™ 400 for TCP 350, DN 100 ISO-F
	PM P04 026	PM P04 027	PM P04 028
	PM Z01 312	PM Z01 312	PM Z01 312
	PM Z01 317	PM Z01 317	PM Z01 317
	PM 016 210-U		PM 016 210-U
	PM 016 212-U		PM 016 212-U
	PM 016 211-U		PM 016 211-U
		PM 016 336	
		PM 016 315	
	PM 006 459-X	PM 006 488-X	
	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 051 726-T	PM 051 726-T	PM 051 726-T
	PM 016 380-T		
	PM 016 382-T		
	PM 016 381-T		
			PM 016 450-T
			PM 016 452-T
			PM 016 451-T
			PM 016 455-T
			PM 016 457-T
			PM 016 456-T
		PM 016 690-T	
		PM 016 692 -T	

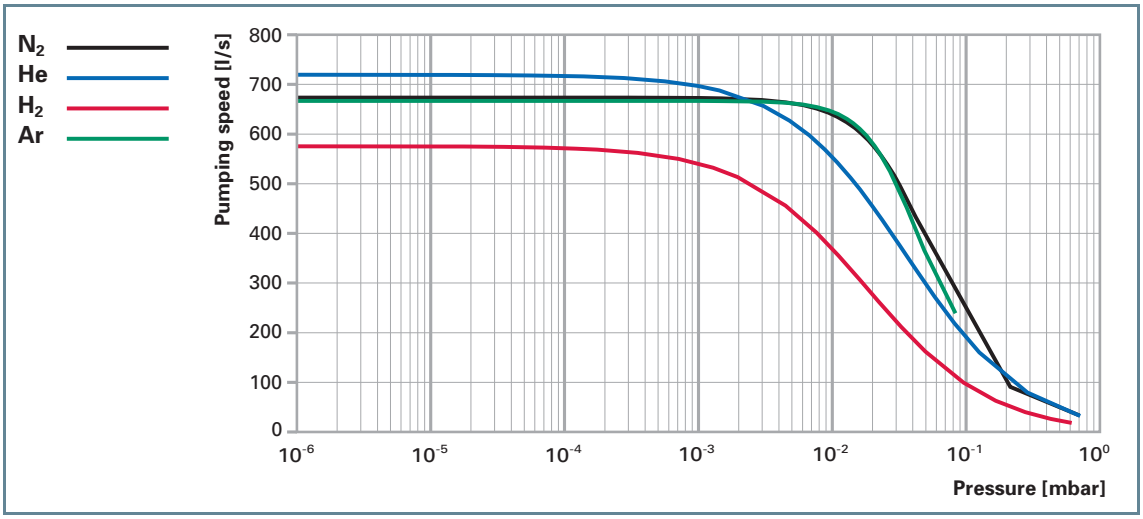
HiPace™ 700

Maximum vacuum performance in a compact design with a pumping speed of 685 l/s for N_2:

HiPace™ 700

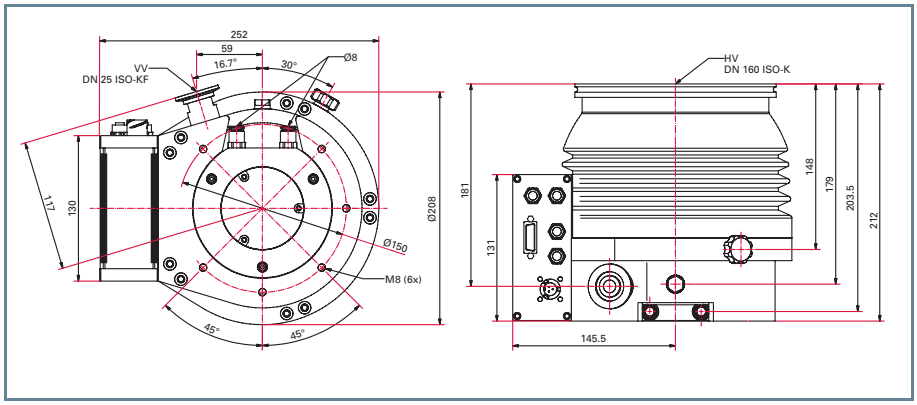
- ▶ Minimum footprint and maximum reliability
- ▶ High gas throughput and high pumping speed
- ▶ Suitable for industrial environments - Protection class IP 54
- ▶ Semi S2 and UL/CSA certification
- ▶ Monitoring of operating data

Pumping speed

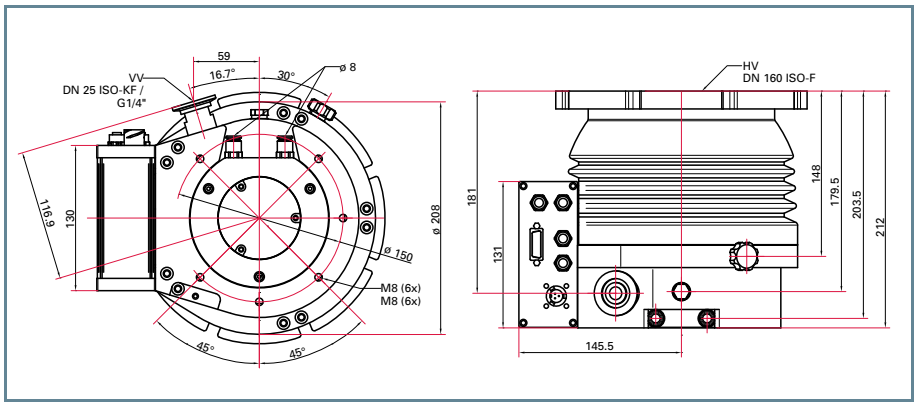


HiPace™ 700

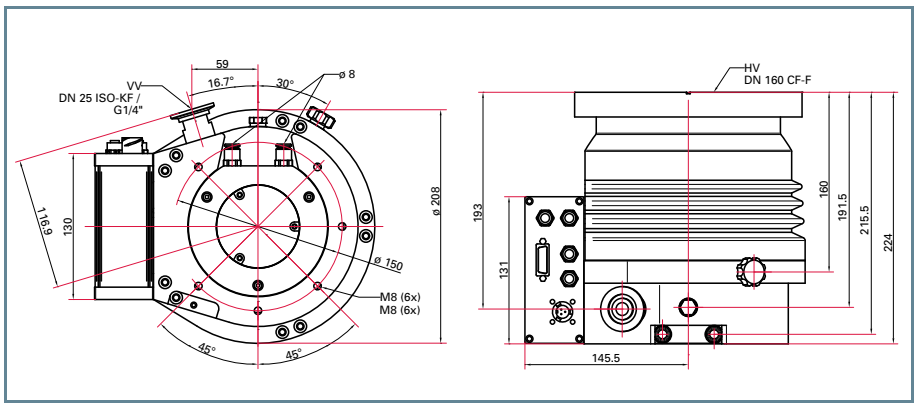
Dimensions



HiPace™ 700, with TC 400, DN 160 ISO-K



HiPace™ 700, with TC 400, DN 160 ISO-F



HiPace™ 700, with TC 400, DN 160 CF-F

Technical data	HiPace™ 700, with TC 400, DN 160 ISO-K	HiPace™ 700, with TC 400, DN 160 CF-F	HiPace™ 700, with TC 400, DN 160 ISO-F
Connection nominal diameter			
Flange (in)	DN 160 ISO-K	DN 160 CF-F	DN 160 ISO-F
Flange (out)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"
Pumping speed			
Pumping speed for H_2	555 l/s	555 l/s	555 l/s
Pumping speed for He	655 l/s	655 l/s	655 l/s
Pumping speed for N_2	685 l/s	685 l/s	685 l/s
Pumping speed for Ar	665 l/s	665 l/s	665 l/s
Compression			
Compression ratio for H_2	$4 \cdot 10^5$	$4 \cdot 10^5$	$4 \cdot 10^5$
Compression ratio for He	$3 \cdot 10^7$	$3 \cdot 10^7$	$3 \cdot 10^7$
Compression ratio for N_2	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Compression ratio for Ar	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
Fore Vacuum max. for N_2	11 mbar	11 mbar	11 mbar
Gas througput			
Gas throughput at full rotational speed for H_2	> 14 mbar l/s	> 14 mbar l/s	> 14 mbar l/s
Gas throughput at full rotational speed for He	10 mbar l/s	10 mbar l/s	10 mbar l/s
Gas throughput at full rotational speed for N_2	6.5 mbar l/s	6.5 mbar l/s	6.5 mbar l/s
Gas throughput at full rotational speed for Ar	3.5 mbar l/s	3.5 mbar l/s	3.5 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	49200 rpm	49200 rpm	49200 rpm
Run-up time	2 min	2 min	2 min
Cooling method, standard	Water	Water	Water
Cooling method, optional	Air	Air	Air
Cooling water consumption	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	6 mT	6 mT	6 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	11.5 kg	17.4 kg	12.1 kg
Order number pump	**PM P03 933**	**PM P03 934**	**PM P03 935**

	HiPace™ 700 for TCP 350, DN 160 ISO-K	HiPace™ 700 for TCP 350, DN 160 CF-F	HiPace™ 700 for TCP 350, DN 160 ISO-F
	DN 160 ISO-K	DN 160 CF-F	DN 160 ISO-F
	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
	G 1/8"	G 1/8"	G 1/8"
	555 l/s	555 l/s	555 l/s
	655 l/s	655 l/s	655 l/s
	685 l/s	685 l/s	685 l/s
	665 l/s	665 l/s	665 l/s
	$4 \cdot 10^5$	$4 \cdot 10^5$	$4 \cdot 10^5$
	$3 \cdot 10^7$	$3 \cdot 10^7$	$3 \cdot 10^7$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$	$> 1 \cdot 10^{11}$
	10 mbar	10 mbar	10 mbar
	> 8 mbar l/s	> 8 mbar l/s	> 8 mbar l/s
	5 mbar l/s	5 mbar l/s	5 mbar l/s
	3 mbar l/s	3 mbar l/s	3 mbar l/s
	1.5 mbar l/s	1.5 mbar l/s	1.5 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 5 \cdot 10^{-10}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	49200 rpm	49200 rpm	49200 rpm
	5.5 min	5.5 min	5.5 min
	Water	Water	Water
	Air	Air	Air
	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C
	6 mT	6 mT	6 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote
	10.6 kg	16.5 kg	11.2 kg
	PM P04 080	**PM P04 081**	**PM P04 082**

Accessories	HiPace™ 700, with TC 400, DN 160 ISO-K	HiPace™ 700, with TC 400, DN 160 CF-F	HiPace™ 700, with TC 400, DN 160 ISO-F
Order number pump	**PM P03 933**	**PM P03 934**	**PM P03 935**
Power supplies/power			
DCU - power supply with display control unit	**PM C01 823**	**PM C01 823**	**PM C01 823**
TPS - mains pack for wall/standard rail fitting	**PM 061 343-T**	**PM 061 343-T**	**PM 061 343-T**
TPS - mains pack 19" rack module 3 RU	**PM 061 347-T**	**PM 061 347-T**	**PM 061 347-T**
Control units			
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m			
230 V AC mains cable with Euro-style safety plug	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**
Connection cable, length 3 m between			
TC 400 / TPS/DCU 310/311/400/401	**PM 061 352-T**	**PM 061 352-T**	**PM 061 352-T**
TCP 350 - HiPace (for TC 400)			
External drive units			
TCP 350			
TCP 350 PB - Profibus			
TCP 350 DN - DeviceNet			
Venting accessories			
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Cooling accessories			
Air cooling	**PM Z01 303**	**PM Z01 303**	**PM Z01 303**
Heating accessories			
Heating jacket 230 V AC, Euro-style safety plug		**PM 061 369-T**	
Heating jacket 208 V AC, UL plug		**PM 061 370-T**	
Heating jacket 115 V AC, UL plug		**PM 061 371-T**	
Backing pump control			
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
Connection cable relaisbox - TCP 350			
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 700 for TCP 350, DN 160 ISO-K	HiPace™ 700 for TCP 350, DN 160 CF-F	HiPace™ 700 for TCP 350, DN 160 ISO-F
	PM P04 080	PM P04 081	PM P04 082
	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P 4564 309 ZA	P 4564 309 ZA	P 4564 309 ZA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P 4564 309 ZF	P 4564 309 ZF	P 4564 309 ZF
	PM 061 356-T	PM 061 356-T	PM 061 356-T
	PM C01 740	PM C01 740	PM C01 740
	PM C01 741	PM C01 741	PM C01 741
	PM C01 742	PM C01 742	PM C01 742
	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121
	PM Z01 303	PM Z01 303	PM Z01 303
		PM 061 369-T	
		PM 061 370-T	
		PM 061 371-T	
	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM 061 377-T	PM 061 377-T	PM 061 377-T
	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 700, with TC 400, DN 160 ISO-K	HiPace™ 700, with TC 400, DN 160 CF-F	HiPace™ 700, with TC 400, DN 160 ISO-F
Order number pump	**PM P03 933**	**PM P03 934**	**PM P03 935**
General accessories			
Sealing gas	**PM Z01 312**	**PM Z01 312**	**PM Z01 312**
Sealing gas throttle	**PM Z01 317**	**PM Z01 317**	**PM Z01 317**
Coated centering ring	**PM 016 216-U**		**PM 016 216-U**
Coated centering ring with protection screen	**PM 016 218-U**		**PM 016 218-U**
Coated centering ring with integrated splinter shield	**PM 016 217-U**		**PM 016 217-U**
Protection screen		**PM 016 339**	
Splinter shield		**PM 016 318**	
Vibration dampers	**PM 006 492-X**	**PM 006 493-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**
Connection cable, RJ 45 on M12			
Mounting materials			
Mounting kit including coated centering ring, bracket screws	**PM 016 375-T**		
Coated centering ring, with protection screen, clamping screws	**PM 016 377-T**		
Coated centering ring with splinter shield, bracket screws	**PM 016 376-T**		
Coated centering ring, hexagon bolts			**PM 016 460-T**
Coated centering ring with protection screen, hexagon bolts			**PM 016 462-T**
Coated centering ring with splinter shield, hexagon bolts			**PM 016 461-T**
Coated centering ring, stud screws			**PM 016 465-T**
Coated centering ring with protection screen, stud screws			**PM 016 467-T**
Coated centering ring with splinter shield, stud screws			**PM 016 466-T**
Set of hexagon bolts		**PM 016 691-T**	
Set of stud screws		**PM 016 693-T**	

	HiPace™ 700 for TCP 350, DN 160 ISO-K	HiPace™ 700 for TCP 350, DN 160 CF-F	HiPace™ 700 for TCP 350, DN 160 ISO-F
	PM P04 080	PM P04 081	PM P04 082
	PM Z01 312	PM Z01 312	PM Z01 312
	PM Z01 317	PM Z01 317	PM Z01 317
	PM 016 210-U		PM 016 210-U
	PM 016 212-U		PM 016 212-U
	PM 016 211-U		PM 016 211-U
		PM 016 339	
		PM 016 318	
	PM 006 492-X	PM 006 493-X	
	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 051 726-T	PM 051 726-T	PM 051 726-T
	PM 016 375-T		
	PM 016 377-T		
	PM 016 376-T		
			PM 016 460-T
			PM 016 462-T
			PM 016 461-T
			PM 016 465-T
			PM 016 467-T
			PM 016 466-T
		PM 016 690-T	
		PM 016 692 -T	

HiPace™ 1200

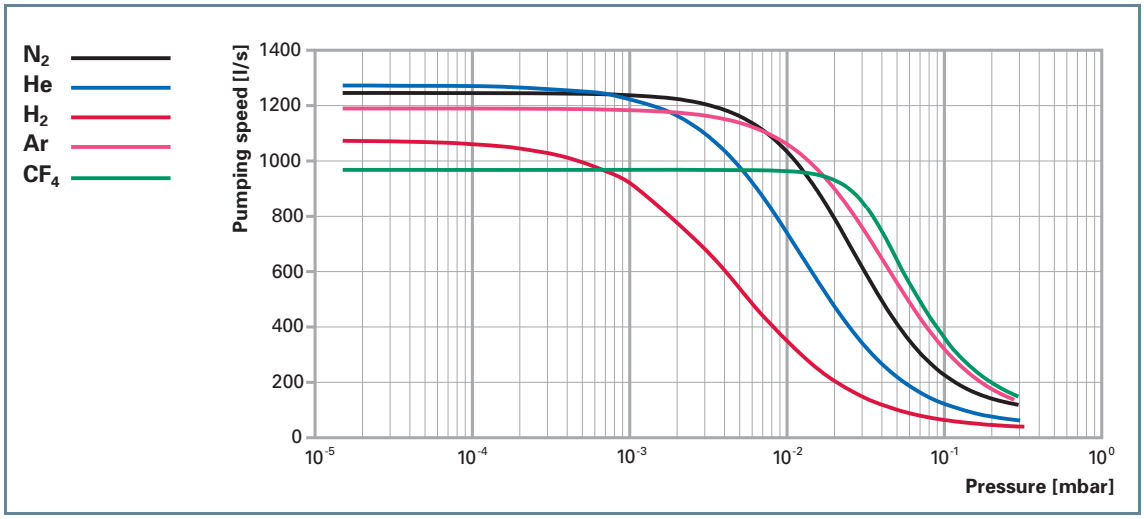
Powerful turbopumps with pumping speeds of up to 1300 l/s.

HiPace™ 1200

- ▶ High pumping speeds for both light and heavy gases
- ▶ High process integrity, resistant to particulate matter
- ▶ High gas throughputs, even for heavy gases

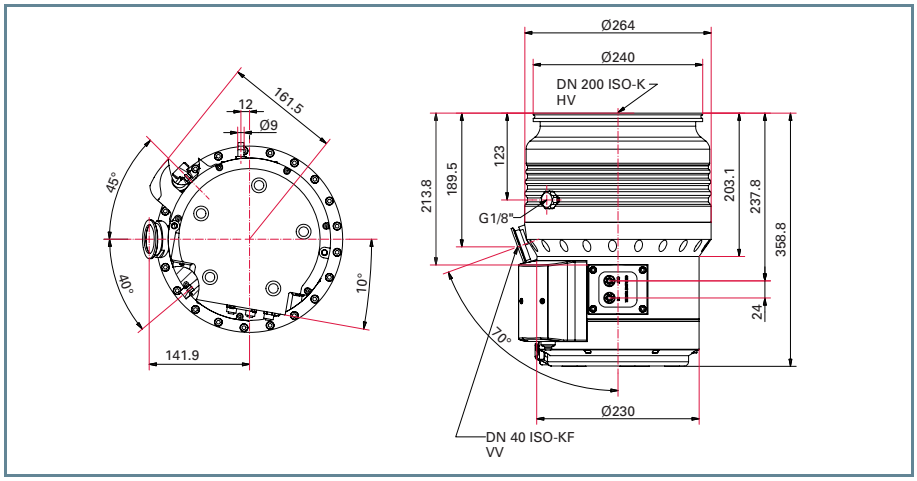
C = Corrosive gas version
U = Upside-down installation orientation

Pumping speed

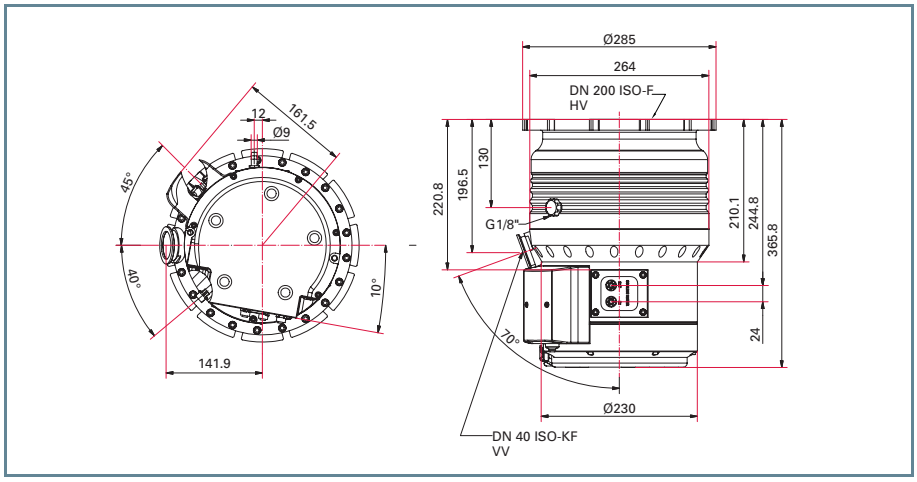


HiPace™ 1200

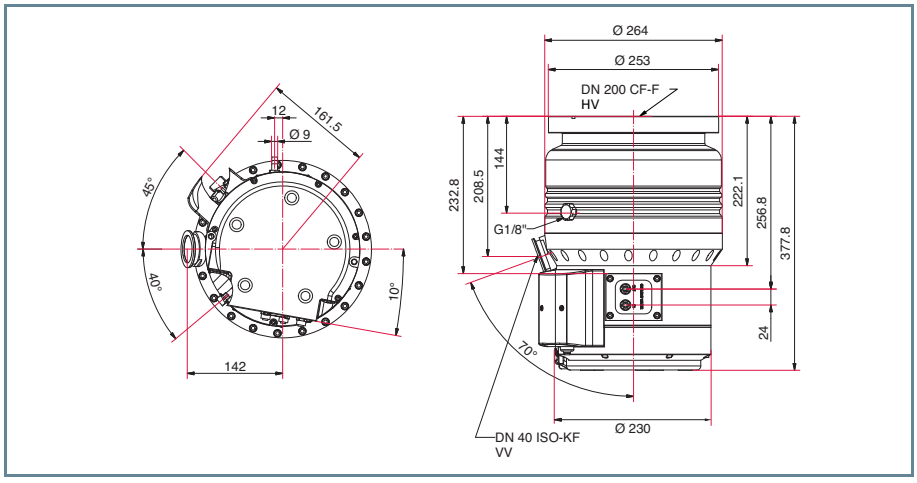
Dimensions



HiPace™ 1200 with TC 1200, DN 200 ISO-K



HiPace™ 1200 with TC 1200, DN 200 ISO-F



HiPace™ 1200, with TC 1200, DN 200 CF-F

Technical data	HiPace™ 1200 with TC 1200, DN 200 ISO-K	HiPace™ 1200 with TC 1200, DN 200 ISO-F	HiPace™ 1200, with TC 1200, DN 200 CF-F	HiPace™ 1200 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1200 U, with TC 1200, DN 200 ISO-F, upside down version
Connection nominal diameter					
Flange (in)	DN 200 ISO-K	DN 200 ISO-F	DN 200 CF-F	DN 200 ISO-K	DN 200 ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
Pumping speed					
Pumping speed for H_2	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s
Pumping speed for He	1300 l/s	1300 l/s	1300 l/s	1300 l/s	1300 l/s
Pumping speed for N_2	1250 l/s	1250 l/s	1250 l/s	1250 l/s	1250 l/s
Pumping speed for Ar	1200 l/s	1200 l/s	1200 l/s	1200 l/s	1200 l/s
Pumping speed for CF_4	950 l/s	950 l/s	950 l/s	950 l/s	950 l/s
Compression					
Compression ratio for H_2	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$
Compression ratio for He	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for Ar	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for CF_4	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Fore Vacuum max. for N_2	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar
Gas througput					
Gas throughput at full rotational speed for H_2	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for He	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for N_2	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for Ar	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s
Gas throughput at full rotational speed for CF_4	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm
Run-up time	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min
Cooling method, standard	Water	Water	Water	Water	Water
Cooling water consumption	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	6 mT	6 mT	6 mT	6 mT	6 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	27 kg	28 kg	40 kg	27 kg	28 kg
Order number pump	**PM P03 910**	**PM P03 911**	**PM P03 912**	**PM P03 913**	**PM P03 914**

	HiPace™ 1200 U, with TC 1200, DN 200 CF-F, upside down version	HiPace™ 1200 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 CF-F, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 CF-F, upside down version, corrosive
	DN 200 CF-F	DN 200 ISO-K	DN 200 ISO-F	DN 200 CF-F	DN 200 ISO-K	DN 200 ISO-F	DN 200 CF-F
	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s
	1300 l/s	1300 l/s	1300 l/s	1300 l/s	1300 l/s	1300 l/s	1300 l/s
	1250 l/s	1250 l/s	1250 l/s	1250 l/s	1250 l/s	1250 l/s	1250 l/s
	1200 l/s	1200 l/s	1200 l/s	1200 l/s	1200 l/s	1200 l/s	1200 l/s
	950 l/s	950 l/s	950 l/s	950 l/s	950 l/s	950 l/s	950 l/s
	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$
	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s
	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm
	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min
	Water	Water	Water	Water	Water	Water	Water
	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
	6 mT	6 mT	6 mT	6 mT	6 mT	6 mT	6 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
	40 kg	27 kg	28 kg	40 kg	27 kg	28 kg	40 kg
	PM P03 915	**PM P03 916**	**PM P03 917**	**PM P04 190**	**PM P03 918**	**PM P03 919**	**PM P04 191**

Accessories	HiPace™ 1200 with TC 1200, DN 200 ISO-K	HiPace™ 1200 with TC 1200, DN 200 ISO-F	HiPace™ 1200, with TC 1200, DN 200 CF-F	HiPace™ 1200 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1200 U, with TC 1200, DN 200 ISO-F, upside down version
Order number pump	**PM P03 910**	**PM P03 911**	**PM P03 912**	**PM P03 913**	**PM P03 914**
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**
Venting accessories					
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Heating accessories					
Heating jacket 230 V AC, Euro-style safety plug			**PM 061 560-T**		
Heating jacket 208 V AC, UL plug			**PM 061 561-T**		
Heating jacket 115 V AC, UL plug			**PM 061 562-T**		
Backing pump control					
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 1200 U, with TC 1200, DN 200 CF-F, upside down version	HiPace™ 1200 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 CF-F, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 CF-F, upside down version, corrosive
	PM P03 915	PM P03 916	PM P03 917	PM P04 190	PM P03 918	PM P03 919	PM P04 191
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB
	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM 061 560-T			PM 061 560-T			PM 061 560-T
	PM 061 561-T			PM 061 561-T			PM 061 561-T
	PM 061 562-T			PM 061 562-T			PM 061 562-T
	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 1200 with TC 1200, DN 200 ISO-K	HiPace™ 1200 with TC 1200, DN 200 ISO-F	HiPace™ 1200, with TC 1200, DN 200 CF-F	HiPace™ 1200 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1200 U, with TC 1200, DN 200 ISO-F, upside down version
Order number pump	**PM P03 910**	**PM P03 911**	**PM P03 912**	**PM P03 913**	**PM P03 914**
General accessories					
Sealing gas	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**
Sealing gas throttle	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**
Coated centering ring	**PM 016 220-U**	**PM 016 220-U**		**PM 016 220-U**	**PM 016 220-U**
Coated centering ring with protection screen	**PM 016 222-U**	**PM 016 222-U**		**PM 016 222-U**	**PM 016 222-U**
Coated centering ring with integrated splinter shield	**PM 016 221-U**	**PM 016 221-U**		**PM 016 221-U**	**PM 016 221-U**
Protection screen			**PM 016 342**		
Splinter shield			**PM 016 321**		
Vibration dampers	**PM 006 668-X**		**PM 006 669-X**	**PM 006 668-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 390-T**			**PM 016 390-T**	
Coated centering ring, with protection screen, clamping screws	**PM 016 392-T**			**PM 016 392-T**	
Coated centering ring with splinter shield, bracket screws	**PM 016 391-T**			**PM 016 391-T**	
Coated centering ring, hexagon bolts		**PM 016 470-T**			**PM 016 470-T**
Coated centering ring with protection screen, hexagon bolts		**PM 016 472-T**			**PM 016 472-T**
Coated centering ring with splinter shield, hexagon bolts		**PM 016 471-T**			**PM 016 471-T**
Coated centering ring, stud screws		**PM 016 475-T**			**PM 016 475-T**
Coated centering ring with protection screen, stud screws		**PM 016 477-T**			**PM 016 477-T**
Coated centering ring with splinter shield, stud screws		**PM 016 476-T**			**PM 016 476-T**
Set of hexagon bolts			**PM 016 687-T**		
Set of stud screws			**PM 016 688-T**		

	HiPace™ 1200 U, with TC 1200, DN 200 CF-F, upside down version	HiPace™ 1200 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1200 C, with TC 1200, DN 200 CF-F, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive	HiPace™ 1200 UC, with TC 1200, DN 200 CF-F, upside down version, corrosive
	PM P03 915	PM P03 916	PM P03 917	PM P04 190	PM P03 918	PM P03 919	PM P04 191
	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313
	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318
		PM 016 220-U	PM 016 220-U		PM 016 220-U	PM 016 220-U	
		PM 016 222-U	PM 016 222-U		PM 016 222-U	PM 016 222-U	
		PM 016 221-U	PM 016 221-U		PM 016 221-U	PM 016 221-U	
	PM 016 342			PM 016 342			PM 016 342
	PM 016 321			PM 016 321			PM 016 321
	PM 006 669-X	PM 006 668-X		PM 006 669-X	PM 006 668-X		PM 006 669-X
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010
	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012
		PM 016 390-T			PM 016 390-T		
		PM 016 392-T			PM 016 392-T		
		PM 016 391-T			PM 016 391-T		
			PM 016 470-T			PM 016 470-T	
			PM 016 472-T			PM 016 472-T	
			PM 016 471-T			PM 016 471-T	
			PM 016 475-T			PM 016 475-T	
			PM 016 477-T			PM 016 477-T	
			PM 016 476-T			PM 016 476-T	
	PM 016 687-T			PM 016 687-T			PM 016 687-T
	PM 016 688-T			PM 016 688-T			PM 016 688-T

HiPace™ 1500

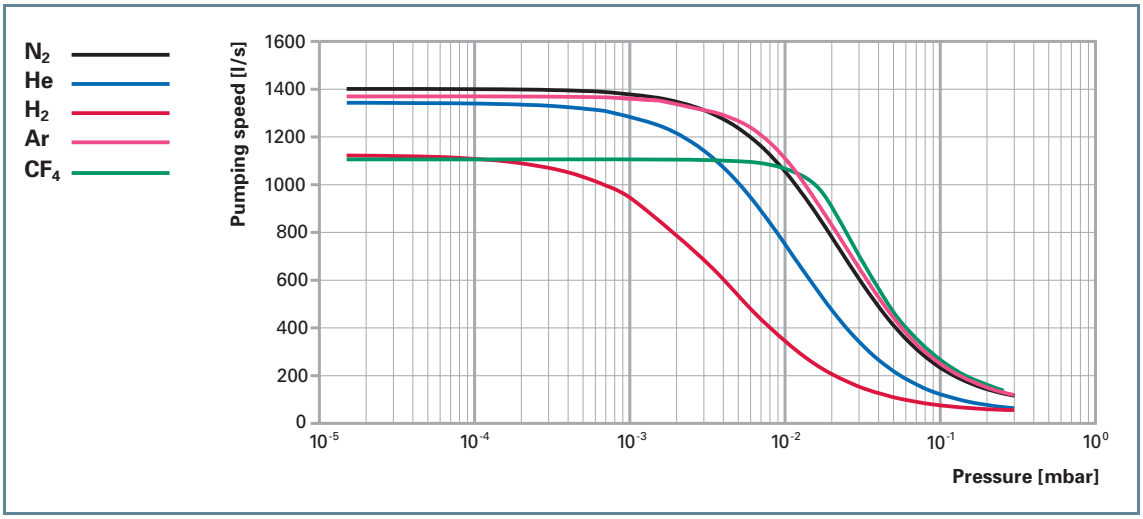
Powerful turbopumps with pumping speeds of up to 1450 l/s.

HiPace™ 1500

- ▶ High pumping speeds for both light and heavy gases
- ▶ High process integrity, resistant to particulate matter
- ▶ High gas throughputs, even for heavy gases

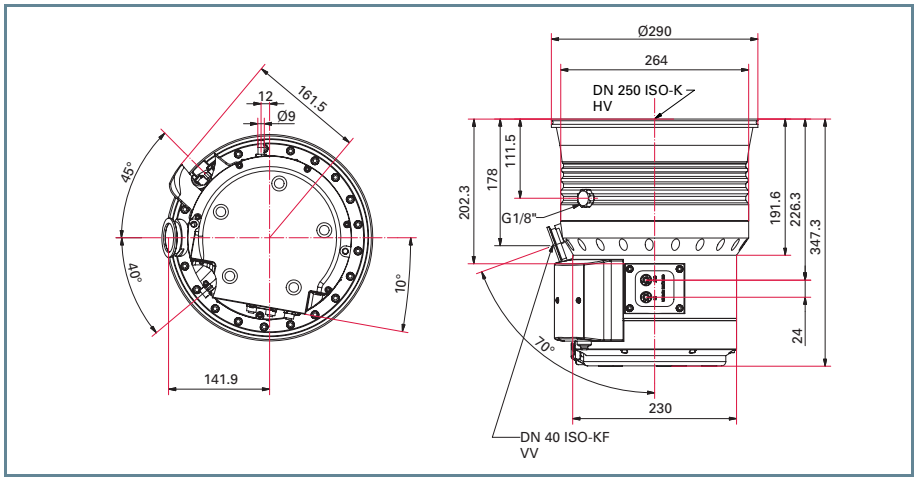
C = Corrosive gas version
U = Upside-down installation orientation

Pumping speed

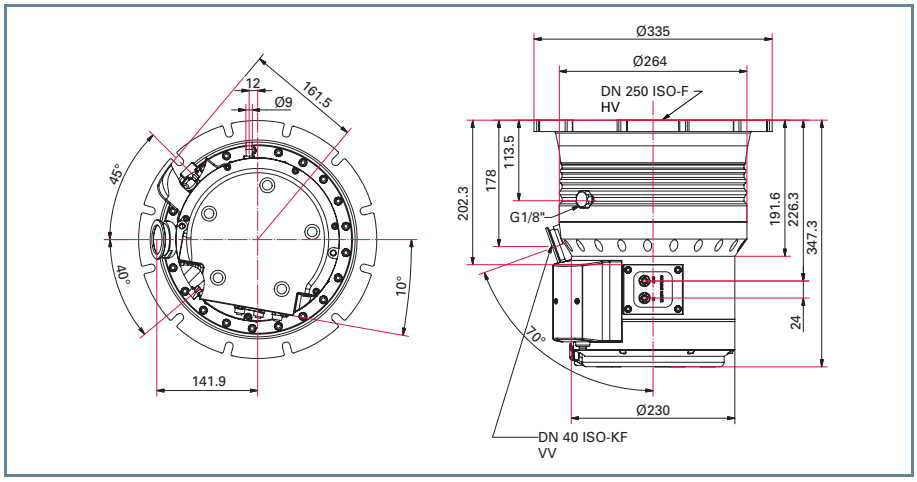


HiPace™ 1500

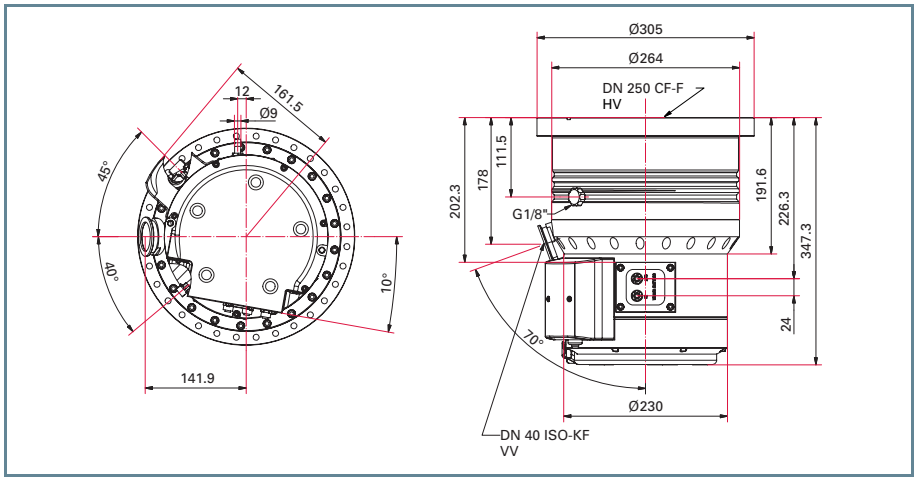
Dimensions



HiPace™ 1500 with TC 1200, DN 250 ISO-K



HiPace™ 1500 with TC 1200, DN 250 ISO-F



HiPace™ 1500 with TC 1200, DN 250 CF-F

Technical data	HiPace™ 1500 with TC 1200, DN 250 ISO-K	HiPace™ 1500 with TC 1200, DN 250 ISO-F	HiPace™ 1500 with TC 1200, DN 250 CF-F	HiPace™ 1500 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 1500 U with TC 1200, DN 250 ISO-F, upside down version
Connection nominal diameter					
Flange (in)	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250-ISO-K	DN 250-ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
Pumping speed					
Pumping speed for H_2	1150 l/s	1150 l/s	1150 l/s	1150 l/s	1150 l/s
Pumping speed for He	1350 l/s	1350 l/s	1350 l/s	1350 l/s	1350 l/s
Pumping speed for N_2	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s
Pumping speed for Ar	1400 l/s	1400 l/s	1400 l/s	1400 l/s	1400 l/s
Pumping speed for CF_4	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s
Compression					
Compression ratio for H_2	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$
Compression ratio for He	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for Ar	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for CF_4	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Fore Vacuum max. for N_2	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar
Gas througput					
Gas throughput at full rotational speed for H_2	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for He	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for N_2	2 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for Ar	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s
Gas throughput at full rotational speed for CF_4	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$> 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm
Run-up time	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min
Cooling method, standard	Water	Water	Water	Water	Water
Cooling water consumption	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	6 mT	6 mT	6 mT	6 mT	6 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	29 kg	30 kg	41 kg	29 kg	30 kg
Order number pump	**PM P04 060**	**PM P04 061**	**PM P04 062**	**PM P04 063**	**PM P04 064**

	HiPace™ 1500 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 1500 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F
	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G /18"	G 1/8"
	1150 l/s	1150 l/s	1150 l/s	1150 l/s	1150 l/s	1150 l/s	1150 l/s
	1350 l/s	1350 l/s	1350 l/s	1350 l/s	1350 l/s	1350 l/s	1350 l/s
	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s
	1400 l/s	1400 l/s	1400 l/s	1400 l/s	1400 l/s	1400 l/s	1400 l/s
	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s	1100 l/s
	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$/	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$	$6 \cdot 10^3$
	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar	2 mbar
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s	11 mbar l/s
	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s	12 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm	37800 rpm
	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min	2.5 min
	Water	Water	Water	Water	Water	Water	Water
	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
	6 mT	6 mT	6 mT	6 mT	6 mT	6	6 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
	41 kg	29 kg	30 kg	41 kg	29 kg	30 kg	41 kg
	PM P04 065	**PM P04 066**	**PM P04 067**	**PM P04 192**	**PM P04 068**	**PM P04 069**	**PM P04 193**

Accessories	HiPace™ 1500 with TC 1200, DN 250 ISO-K	HiPace™ 1500 with TC 1200, DN 250 ISO-F	HiPace™ 1500 with TC 1200, DN 250 CF-F	HiPace™ 1500 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 1500 U with TC 1200, DN 250 ISO-F, upside down version
Order number pump	**PM P04 060**	**PM P04 061**	**PM P04 062**	**PM P04 063**	**PM P04 064**
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**
Venting accessories					
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Heating accessories					
Heating jacket 230 V AC, Euro-style safety plug			**PM 061 560-T**		
Heating jacket 208 V AC, UL plug			**PM 061 561-T**		
Heating jacket 115 V AC, UL plug			**PM 061 562-T**		
Backing pump control					
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 1500 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 1500 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	PM P04 065	PM P04 066	PM P04 067	PM P04 192	PM P04 068	PM P04 069	PM P04 193
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB
	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM 061 560-T			PM 061 560-T			PM 061 560-T
	PM 061 561-T			PM 061 561-T			PM 061 561-T
	PM 061 562-T			PM 061 562-T			PM 061 562-T
	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 1500 with TC 1200, DN 250 ISO-K	HiPace™ 1500 with TC 1200, DN 250 ISO-F	HiPace™ 1500 with TC 1200, DN 250 CF-F	HiPace™ 1500 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 1500 U with TC 1200, DN 250 ISO-F, upside down version
Order number pump	**PM P04 060**	**PM P04 061**	**PM P04 062**	**PM P04 063**	**PM P04 064**
General accessories					
Sealing gas	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**
Sealing gas throttle	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**
Coated centering ring	**PM 016 225-U**	**PM 016 225-U**		**PM 016 225-U**	**PM 016 225-U**
Coated centering ring with protection screen	**PM 016 227-U**	**PM 016 227-U**		**PM 016 227-U**	**PM 016 227-U**
Coated centering ring with integrated splinter shield	**PM 016 226-U**	**PM 016 226-U**		**PM 016 226-U**	**PM 016 226-U**
Protection screen			**PM 016 345**		
Splinter shield			**PM 016 324**		
Vibration dampers	**PM 006 670-X**		**PM 006 671-X**	**PM 006 670-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 395-T**			**PM 016 395-T**	
Coated centering ring, with protection screen, clamping screws	**PM 016 397-T**			**PM 016 397-T**	
Coated centering ring with splinter shield, bracket screws	**PM 016 396-T**			**PM 016 396-T**	
Coated centering ring, hexagon bolts		**PM 016 480-T**			**PM 016 480-T**
Coated centering ring with protection screen, hexagon bolts		**PM 016 482-T**			**PM 016 482-T**
Coated centering ring with splinter shield, hexagon bolts		**PM 016 481-T**			**PM 016 481-T**
Coated centering ring, stud screws		**PM 016 485-T**			**PM 016 485-T**
Coated centering ring with protection screen, stud screws		**PM 016 487-T**			**PM 016 487-T**
Coated centering ring with splinter shield, stud screws		**PM 016 486-T**			**PM 016 486-T**
Set of hexagon bolts			**PM 016 694-T**		
Set of stud screws			**PM 016 695-T**		

	HiPace™ 1500 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 1500 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 1500 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 1500 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	PM P04 065	PM P04 066	PM P04 067	PM P04 192	PM P04 068	PM P04 069	PM P04 193
	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313
	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318
		PM 016 225-U	PM 016 225-U		PM 016 225-U	PM 016 225-U	
		PM 016 227-U	PM 016 227-U		PM 016 227-U	PM 016 227-U	
		PM 016 226-U	PM 016 226-U		PM 016 226-U	PM 016 226-U	
	PM 016 345			PM 016 345			PM 016 345
	PM 016 324			PM 016 324			PM 016 324
	PM 006 671-X	PM 006 670-X		PM 006 671-X	PM 006 670-X		PM 006 671-X
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010
	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012
		PM 016 395-T			PM 016 395-T		
		PM 016 397-T			PM 016 397-T		
		PM 016 396-T			PM 016 396-T		
			PM 016 480-T			PM 016 480-T	
			PM 016 482-T			PM 016 482-T	
			PM 016 481-T			PM 016 481-T	
			PM 016 485-T			PM 016 485-T	
			PM 016 487-T			PM 016 487-T	
			PM 016 486-T			PM 016 486-T	
	PM 016 694-T			PM 016 694-T			PM 016 694-T
	PM 016 695-T			PM 016 695-T			PM 016 695-T

HiPace™ 1800

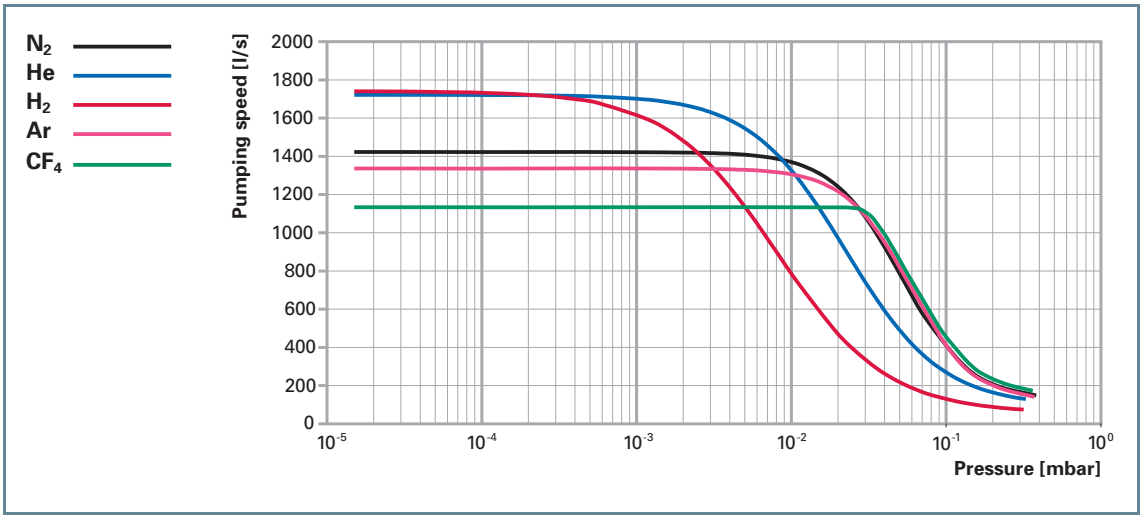
Powerful turbopumps with pumping speeds of up to 1700 l/s.

HiPace™ 1800

- ▶ High pumping speeds for both light and heavy gases
- ▶ High process integrity, resistant to particulate matter
- ▶ High gas throughputs, even for heavy gases

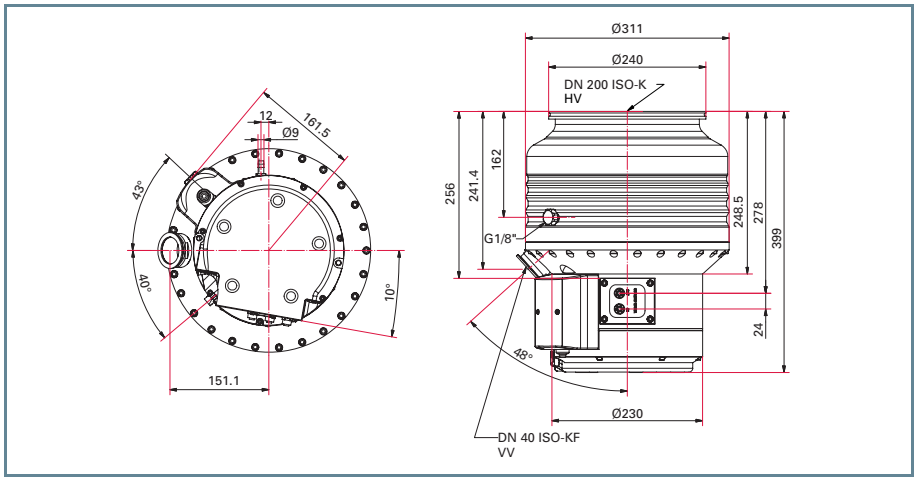
C = Corrosive gas version
U = Upside-down installation orientation

Pumping speed

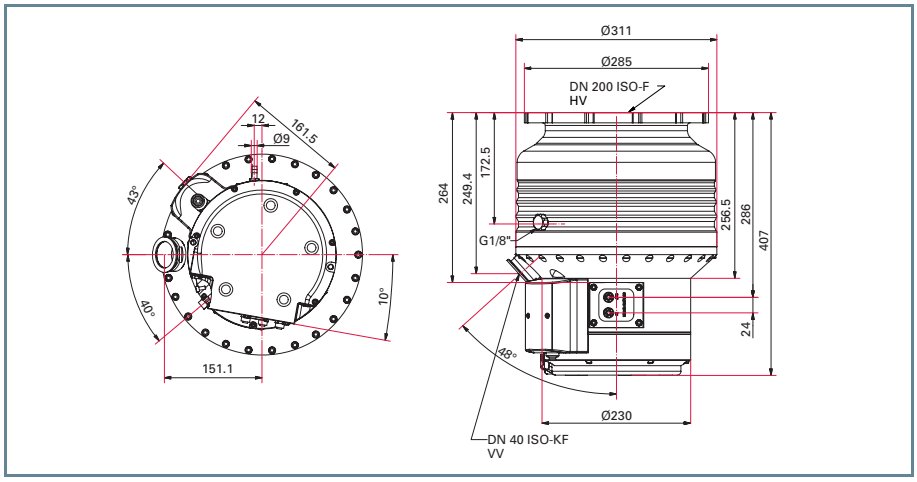


HiPace™ 1800

Dimensions



HiPace™ 1800, with TC 1200, DN 200 ISO-K



HiPace™ 1800 with TC 1200, DN 200 ISO-F

Technical data	HiPace™ 1800, with TC 1200, DN 200 ISO-K	HiPace™ 1800 with TC 1200, DN 200 ISO-F	HiPace™ 1800 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1800 U, with TC 1200, DN 200 ISO-F, upside down version
Connection nominal diameter				
Flange (in)	DN 200 ISO-K	DN 200 ISO-F	DN 200 ISO-K	DN 200 ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"	G 1/8"
Pumping speed				
Pumping speed for H_2	1700 l/s	1700 l/s	1700 l/s	1700 l/s
Pumping speed for He	1650 l/s	1650 l/s	1650 l/s	1650 l/s
Pumping speed for N_2	1450 l/s	1450 l/s	1450 l/s	1450 l/s
Pumping speed for Ar	1370 l/s	1370 l/s	1370 l/s	1370 l/s
Pumping speed for CF_4	1050 l/s	1050 l/s	1050 l/s	1050 l/s
Compression				
Compression ratio for H_2	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$
Compression ratio for He	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for Ar	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for CF_4	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Fore Vacuum max. for N_2	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar
Gas througput				
Gas throughput at full rotational speed for H_2	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for He	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for N_2	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for Ar	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s
Gas throughput at full rotational speed for CF_4	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	31500 rpm	31500 rpm	31500 rpm	31500 rpm
Run-up time	4 min	4 min	4 min	4 min
Cooling method, standard	Water	Water	Water	Water
Cooling water consumption	100 l/h	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	7 mT	7 mT	7 mT	7 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
Protection category	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	33 kg	34 kg	33 kg	34 kg
Order number pump	**PM P04 070**	**PM P04 071**	**PM P04 073**	**PM P04 070**

	HiPace™ 1800 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1800 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive
	DN 200 ISO-K	DN 200 ISO-F	DN 200 ISO-K	DN 200 ISO-F
	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
	G 1/8"	G 1/8"	G 1/8"	G 1/8"
	1700 l/s	1700 l/s	1700 l/s	1700 l/s
	1650 l/s	1650 l/s	1650 l/s	1650 l/s
	1450 l/s	1450 l/s	1450 l/s	1450 l/s
	1370 l/s	1370 l/s	1370 l/s	1370 l/s
	1050 l/s	1050 l/s	1050 l/s	1050 l/s
	$2 \cdot 10^{4}$	$2 \cdot 10^{4}$	$2 \cdot 10^{4}$	$2 \cdot 10^{4}$
	$3 \cdot 10^{5}$	$3 \cdot 10^{5}$	$3 \cdot 10^{5}$	$3 \cdot 10^{5}$
	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$
	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$
	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$	$> 1 \cdot 10^{8}$
	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s
	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	31500 rpm	31500 rpm	31500 rpm	31500 rpm
	4 min	4 min	4 min	4 min
	Water	Water	Water	Water
	100 l/h	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C	15-35 °C
	7 mT	7 mT	7 mT	7 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
	33 kg	34 kg	33 kg	34 kg
	PM P04 076	**PM P04 077**	**PM P04 078**	**PM P04 079**

Accessories	HiPace™ 1800, with TC 1200, DN 200 ISO-K	HiPace™ 1800 with TC 1200, DN 200 ISO-F	HiPace™ 1800 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1800 U, with TC 1200, DN 200 ISO-F, upside down version	
Order number pump	**PM P04 070**	**PM P04 071**	**PM P04 073**	**PM P04 070**	
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	
Venting accessories					
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	
Backing pump control					
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	

	HiPace™ 1800 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1800 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive
	PM P04 076	PM P04 077	PM P04 078	PM P04 079
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB
	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 1800, with TC 1200, DN 200 ISO-K	HiPace™ 1800 with TC 1200, DN 200 ISO-F	HiPace™ 1800 U, with TC 1200, DN 200 ISO-K, upside down version	HiPace™ 1800 U, with TC 1200, DN 200 ISO-F, upside down version	
Order number pump	**PM P04 070**	**PM P04 071**	**PM P04 073**	**PM P04 070**	
General accessories					
Sealing gas	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	
Sealing gas throttle	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	
Coated centering ring	**PM 016 220-U**	**PM 016 220-U**	**PM 016 220-U**	**PM 016 220-U**	
Coated centering ring with protection screen	**PM 016 222-U**	**PM 016 222-U**	**PM 016 222-U**	**PM 016 222-U**	
Coated centering ring with integrated splinter shield	**PM 016 221-U**	**PM 016 221-U**	**PM 016 221-U**	**PM 016 221-U**	
Vibration dampers	**PM 006 668-X**		**PM 006 668-X**		
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**	
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**	
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 410-T**		**PM 016 410-T**		
Coated centering ring, with protection screen, clamping screws	**PM 016 412-T**		**PM 016 412-T**		
Coated centering ring with splinter shield, bracket screws	**PM 016 411-T**		**PM 016 411-T**		
Coated centering ring, hexagon bolts		**PM 016 470-T**		**PM 016 470-T**	
Coated centering ring with protection screen, hexagon bolts		**PM 016 472-T**		**PM 016 472-T**	
Coated centering ring with splinter shield, hexagon bolts		**PM 016 471-T**		**PM 016 471-T**	
Coated centering ring, stud screws		**PM 016 475-T**		**PM 016 475-T**	
Coated centering ring with protection screen, stud screws		**PM 016 477-T**		**PM 016 477-T**	
Coated centering ring with splinter shield, stud screws		**PM 016 476-T**		**PM 016 476-T**	

	HiPace™ 1800 C, with TC 1200, DN 200 ISO-K, corrosive	HiPace™ 1800 C, with TC 1200, DN 200 ISO-F, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-K, upside down version, corrosive	HiPace™ 1800 UC, with TC 1200, DN 200 ISO-F, upside down version, corrosive
	PM P04 076	PM P04 077	PM P04 078	PM P04 079
	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313
	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318
	PM 016 220-U	PM 016 220-U	PM 016 220-U	PM 016 220-U
	PM 016 222-U	PM 016 222-U	PM 016 222-U	PM 016 222-U
	PM 016 221-U	PM 016 221-U	PM 016 221-U	PM 016 221-U
	PM 006 668-X		PM 006 668-X	
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	P 4723 010	P 4723 010	P 4723 010	P 4723 010
	P 4723 012	P 4723 012	P 4723 012	P 4723 012
	PM 016 410-T PM 016 412-T		PM 016 410-T PM 016 412-T	
	PM 016 411-T		PM 016 411-T	
		PM 016 470-T		PM 016 470-T
		PM 016 472-T PM 016 471-T		PM 016 472-T PM 016 471-T
		PM 016 475-T		PM 016 475-T
		PM 016 477-T		PM 016 477-T
		PM 016 476-T		PM 016 476-T

HiPace™ 2300

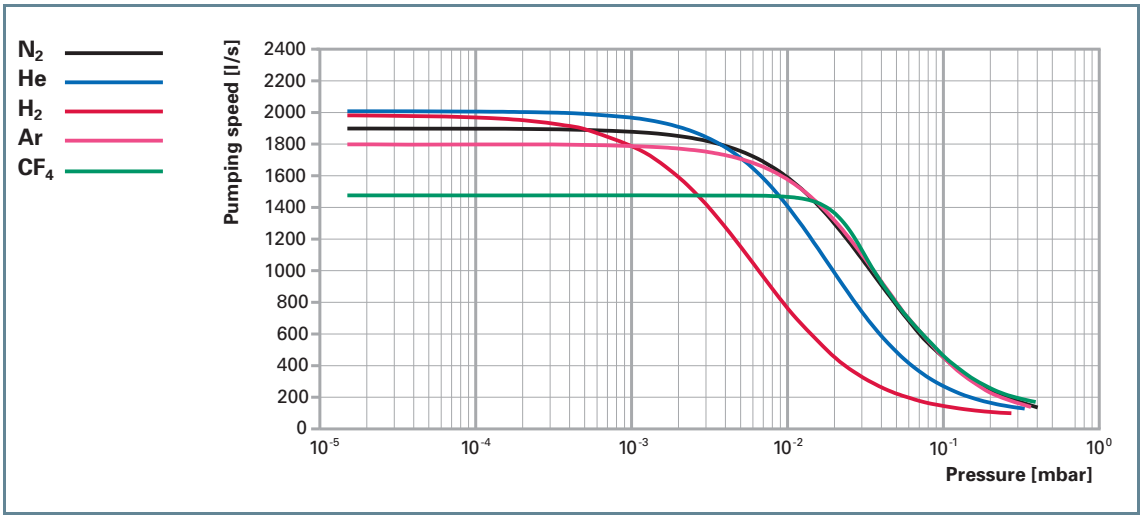
Powerful turbopumps with pumping speeds of up to 2050 l/s.

HiPace™ 2300

- ▶ High pumping speeds for both light and heavy gases
- ▶ High process integrity, resistant to particulate matter
- ▶ High gas throughputs, even for heavy gases

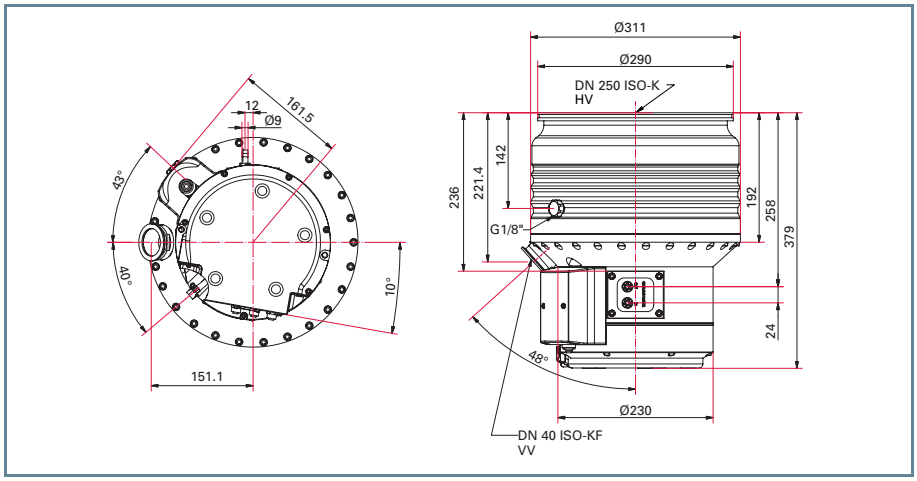
C=Corrosive gas version
U=Upside-down installation orientation

Pumping speed

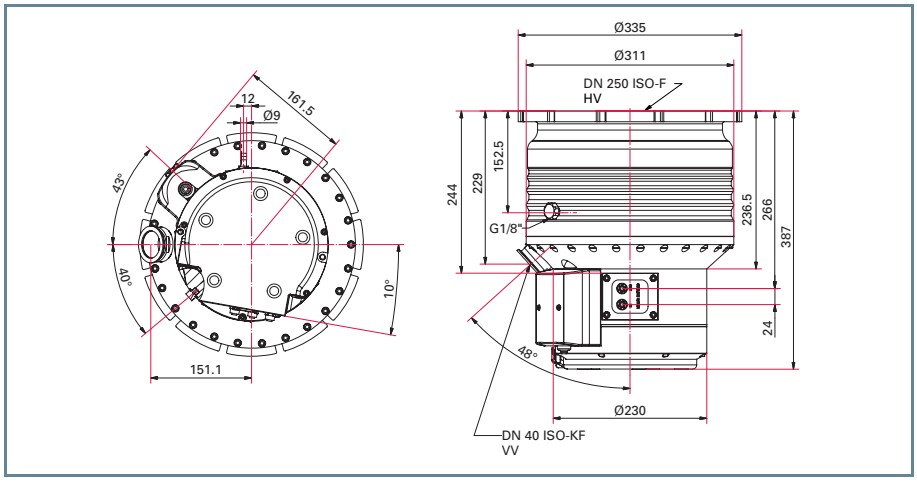


HiPace™ 2300

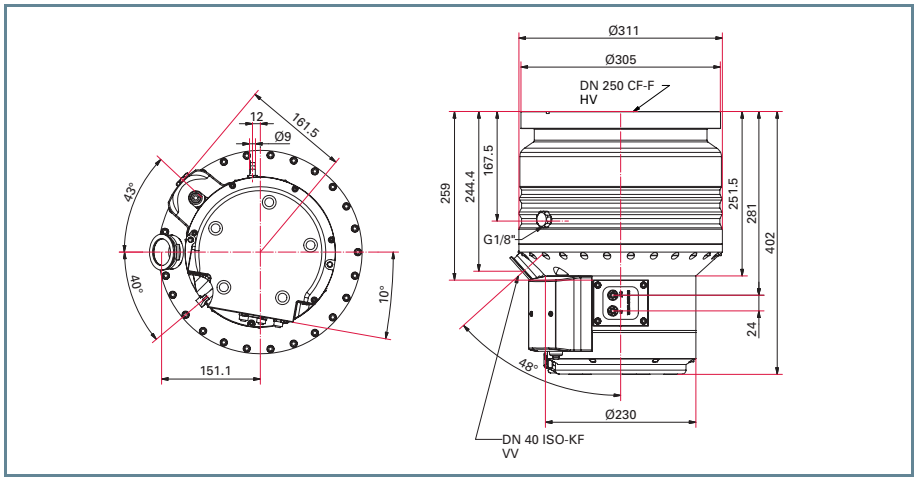
Dimensions



HiPace™ 2300 with TC 1200, DN 250 ISO-K



HiPace™ 2300 with TC 1200, DN 250 ISO-F



HiPace™ 2300 with TC 1200, DN 250 CF-F

Technical data	HiPace™ 2300 with TC 1200, DN 250 ISO-K	HiPace™ 2300 with TC 1200, DN 250 ISO-F	HiPace™ 2300 with TC 1200, DN 250 CF-F	HiPace™ 2300 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 2300 U, with TC 1200, DN 250 ISO-F, upside down version
Connection nominal diameter					
Flange (in)	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
Pumping speed					
Pumping speed for H_2	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s
Pumping speed for He	2050 l/s	2050 l/s	2050 l/s	2050 l/s	2050 l/s
Pumping speed for N_2	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s
Pumping speed for Ar	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s
Pumping speed for CF_4	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s
Compression					
Compression ratio for H_2	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$
Compression ratio for He	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for Ar	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Compression ratio for CF_4	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
Fore Vacuum max. for N_2	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar
Gas througput					
Gas throughput at full rotational speed for H_2	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
Gas throughput at full rotational speed for He	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for N_2	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
Gas throughput at full rotational speed for Ar	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s
Gas throughput at full rotational speed for CF_4	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
Rotation speed ±2%	31500 rpm	31500 rpm	31500 rpm	31500 rpm	31500 rpm
Run-up time	4 min	4 min	4 min	4 min	4 min
Cooling method, standard	Water	Water	Water	Water	Water
Cooling water consumption	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	7 mT	7 mT	7 mT	7 mT	7 mT
Sound pressure level	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50
Protection category	IP 54	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
Weight	34 kg	35 kg	47 kg	34 kg	35 kg
Order number pump	**PM P03 920**	**PM P03 921**	**PM P03 922**	**PM P03 923**	**PM P03 924**

	HiPace™ 2300 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 2300 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F
	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"	G 1/8"
	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s
	2050 l/s	2050 l/s	2050 l/s	2050 l/s	2050 l/s	2050 l/s	2050 l/s
	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s
	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s	1850 l/s
	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s	1450 l/s
	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$	$2 \cdot 10^4$
	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$	$3 \cdot 10^5$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$	$> 1 \cdot 10^8$
	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar	1.8 mbar
	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s	> 30 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s	20 mbar l/s
	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s	16 mbar l/s
	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s	14 mbar l/s
	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar	$< 1 \cdot 10^{-7}$ mbar
	31500 rpm	31500 rpm	31500 rpm	31500 rpm	31500 rpm	31500 rpm	31500 rpm
	4 min	4 min	4 min	4 min	4 min	4 min	4 min
	Water	Water	Water	Water	Water	Water	Water
	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
	7 mT	7 mT	7 mT	7 mT	7 mT	7 mT	7 mT
	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)	≤ 50 dB (A)
	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54	IP 54
	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote
	47 kg	34 kg	35 kg	47 kg	34 kg	35 kg	47 kg
	PM P03 925	**PM P03 926**	**PM P03 927**	**PM P04 194**	**PM P03 928**	**PM P03 929**	**PM P04 195**

Accessories	HiPace™ 2300 with TC 1200, DN 250 ISO-K	HiPace™ 2300 with TC 1200, DN 250 ISO-F	HiPace™ 2300 with TC 1200, DN 250 CF-F	HiPace™ 2300 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 2300 U, with TC 1200, DN 250 ISO-F, upside down version
Order number pump	**PM P03 920**	**PM P03 921**	**PM P03 922**	**PM P03 923**	**PM P03 924**
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**
115 V AC mains cable with UL plug	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**
Venting accessories					
Venting valve	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**	**PM Z01 291**
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Heating accessories					
Heating jacket 230 V AC, Euro-style safety plug			**PM 061 563-T**		
Heating jacket 208 V AC, UL plug			**PM 061 564-T**		
Heating jacket 115 V AC, UL plug			**PM 061 565-T**		
Backing pump control					
Backing pump relay box, single phase 5 A	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**	**PM 061 374-T**
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 2300 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 2300 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	PM P03 925	PM P03 926	PM P03 927	PM P04 194	PM P03 928	PM P03 929	PM P04 195
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA
	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE	P 4564 309 ZE
	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB
	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291	PM Z01 291
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM 061 563-T			PM 061 563-T			PM 061 563-T
	PM 061 564-T			PM 061 564-T			PM 061 564-T
	PM 061 565-T			PM 061 565-T			PM 061 565-T
	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T	PM 061 374-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 2300 with TC 1200, DN 250 ISO-K	HiPace™ 2300 with TC 1200, DN 250 ISO-F	HiPace™ 2300 with TC 1200, DN 250 CF-F	HiPace™ 2300 U, with TC 1200, DN 250 ISO-K, upside down version	HiPace™ 2300 U, with TC 1200, DN 250 ISO-F, upside down version
Order number pump	**PM P03 920**	**PM P03 921**	**PM P03 922**	**PM P03 923**	**PM P03 924**
General accessories					
Sealing gas	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**	**PM Z01 313**
Sealing gas throttle	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**	**PM Z01 318**
Coated centering ring	**PM 016 225-U**	**PM 016 225-U**		**PM 016 225-U**	**PM 016 225-U**
Coated centering ring with protection screen	**PM 016 227-U**	**PM 016 227-U**		**PM 016 227-U**	**PM 016 227-U**
Coated centering ring with integrated splinter shield	**PM 016 226-U**	**PM 016 226-U**		**PM 016 226-U**	**PM 016 226-U**
Protection screen			**PM 016 345**		
Splinter shield			**PM 016 324**		
Vibration dampers	**PM 006 670-X**		**PM 006 671-X**	**PM 006 670-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**	**P 4723 010**
Y-connector, M12 for accessories	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**	**P 4723 012**
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 415-T**			**PM 016 415-T**	
Coated centering ring, with protection screen, clamping screws	**PM 016 417-T**			**PM 016 417-T**	
Coated centering ring with splinter shield, bracket screws	**PM 016 416-T**			**PM 016 416-T**	
Coated centering ring, hexagon bolts		**PM 016 480-T**			**PM 016 480-T**
Coated centering ring with protection screen, hexagon bolts		**PM 016 482-T**			**PM 016 482-T**
Coated centering ring with splinter shield, hexagon bolts		**PM 016 481-T**			**PM 016 481-T**
Coated centering ring, stud screws		**PM 016 485-T**			**PM 016 485-T**
Coated centering ring with protection screen, stud screws		**PM 016 487-T**			**PM 016 487-T**
Coated centering ring with splinter shield, stud screws		**PM 016 486-T**			**PM 016 486-T**
Set of hexagon bolts			**PM 016 694-T**		
Set of stud screws			**PM 016 695-T**		

	HiPace™ 2300 U, with TC 1200, DN 250 CF-F, upside down version	HiPace™ 2300 C, with TC 1200, DN 250 ISO-K, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 ISO-F, corrosive	HiPace™ 2300 C, with TC 1200, DN 250 CF-F, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-K, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 ISO-F, upside down version, corrosive	HiPace™ 2300 UC, with TC 1200, DN 250 CF-F, upside down version, corrosive
	PM P03 925	PM P03 926	PM P03 927	PM P04 194	PM P03 928	PM P03 929	PM P04 195
	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313	PM Z01 313
	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318	PM Z01 318
		PM 016 225-U	PM 016 225-U		PM 016 225-U	PM 016 225-U	
		PM 016 227-U	PM 016 227-U		PM 016 227-U	PM 016 227-U	
		PM 016 226-U	PM 016 226-U		PM 016 226-U	PM 016 226-U	
	PM 016 345			PM 016 345			PM 016 345
	PM 016 324			PM 016 324			PM 016 324
	PM 006 671-X	PM 006 670-X		PM 006 671-X	PM 006 670-X		PM 006 671-X
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010	P 4723 010
	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012	P 4723 012
		PM 016 415-T			PM 016 415-T		
		PM 016 417-T			PM 016 417-T		
		PM 016 416-T			PM 016 416-T		
			PM 016 480-T			PM 016 480-T	
			PM 016 482-T			PM 016 482-T	
			PM 016 481-T			PM 016 481-T	
			PM 016 485-T			PM 016 485-T	
			PM 016 487-T			PM 016 487-T	
			PM 016 486-T			PM 016 486-T	
	PM 016 694-T			PM 016 694-T			PM 016 694-T
	PM 016 695-T			PM 016 695-T			PM 016 695-T

The HiPace™ MC innovation

Magnetically levitated turbopumps with integrated drive electronics.

What is HiPace MC?

HiPace MC is a line of magnetically levitated turbopumps with integrated drive electronics that set a milestone. This not only applies with respect to their especially high pumping speeds, high compression and high gas throughput. Their magnetically levitated bearings, which assure extremely low vibration and maintenance-free operation, are the embodiment of top class technology.

Advantages at a glance

- Integrated drive electronics eliminate the need for cumbersome and costly cabling
- Suitable for most applications thanks to high pumping speed and high gas throughput
- Extremely low vibration and noise for sensitive applications

- Highly reliable thanks to permanent rotor monitoring
- Suitable for industrial applications thanks to Protection Class IP 54
- Robust, long-life safety bearing concept
- Water cooling affords long service life of electronic components
- Reliable operation with cooling water compatibility of up to 35 °C
- Patented centering ring with anti-slip coating to enhance system reliability
- 5-axis active magnetic bearing
- Any desired installation orientation
- Profibus or DeviceNet interfaces (optional)
- Semi S2, F47 and E74 certification

Applications

Semiconductor industry

- EUV lithography
- Chemical vapor deposition (CVD)
- Physical vapor deposition (PVD)
- Ion beam etching
- Ion implantation

Coating

- Glass coating
- Thin films
- Ophthalmics
- Solar cell coating

Industrial

- Metallurgy
- Electron beam welding

Research & development

- Physical equipment
- Space simulation

Semiconductor industry

Wafer production

HiPace™ 2400 MC

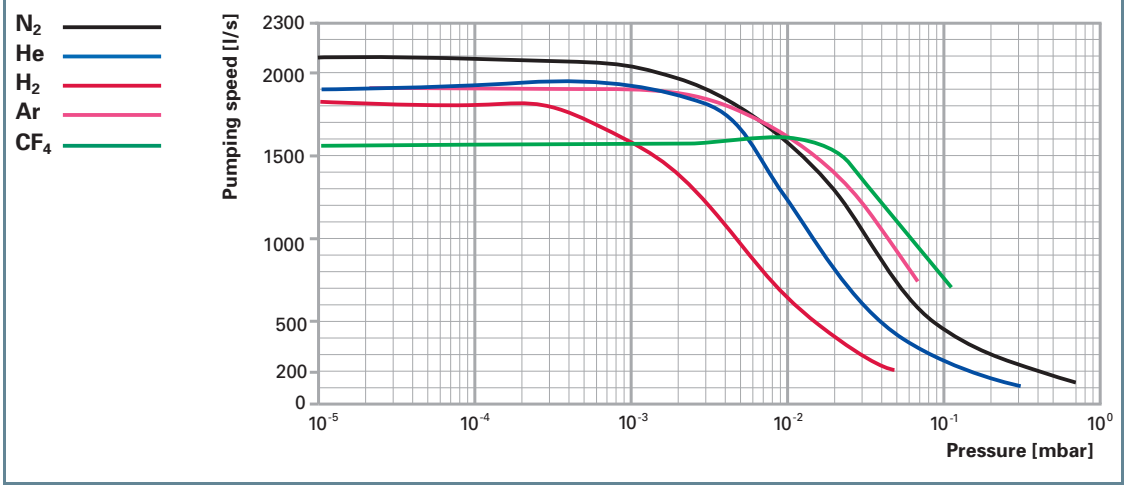
Magnetically levitated turbopumps with pumping speeds of 2100 l/s.

HiPace™ 2400 MC

- ▶ Active 5-axis magnetic levitation system
- ▶ Maintenance-free, hydrocarbon-free
- ▶ Very low vibration and noise levels
- ▶ High pumping speed and gas throughput for both light and heavy gases

M = Magnetically levitated
C = Suitable for corrosive gases
Systems with DeviceNet fieldbus interface instead of Profibus available upon request.

Pumping speed

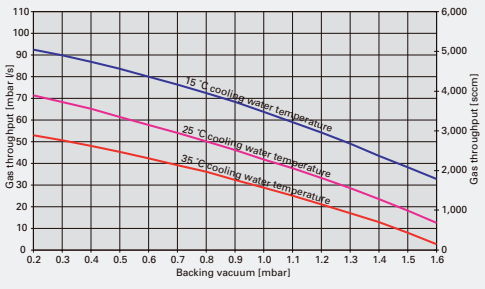


HiPace™ 2400 MC

Gas througput

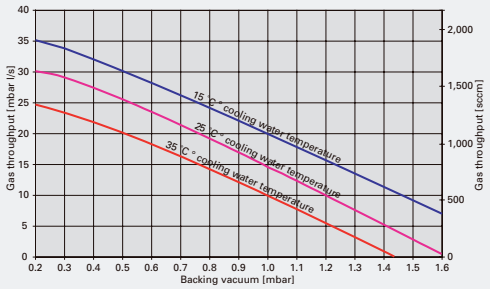
Gases with molecular mass of < 40

at nominal speed, cooling water throughput 100 l/h



Gases with molecular mass of ≥ 40

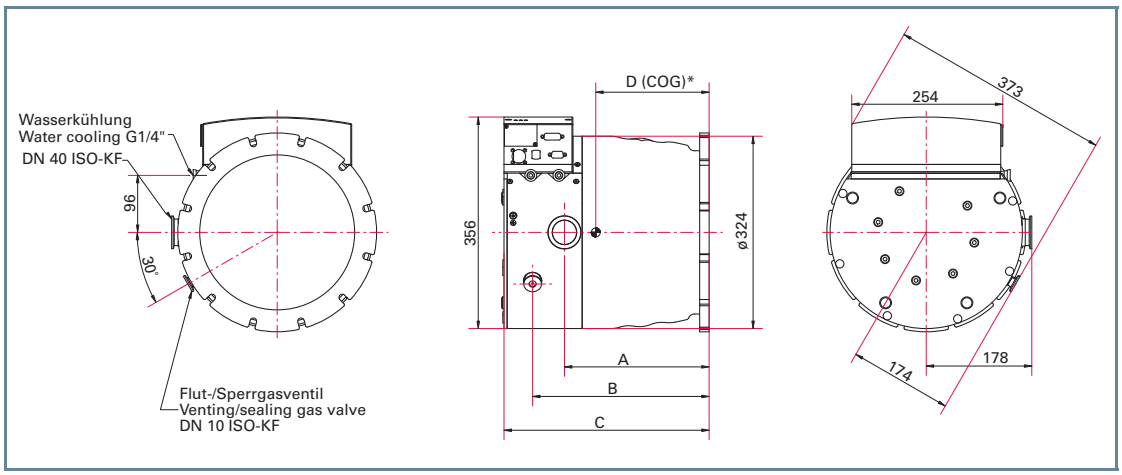
at nominal speed, sealing gas 20 sccm, cooling water throughput 100 l/h



HiPace™ 2400 MC[1)]

[1)] Gas throughput relative to backing vacuum and kind of gas

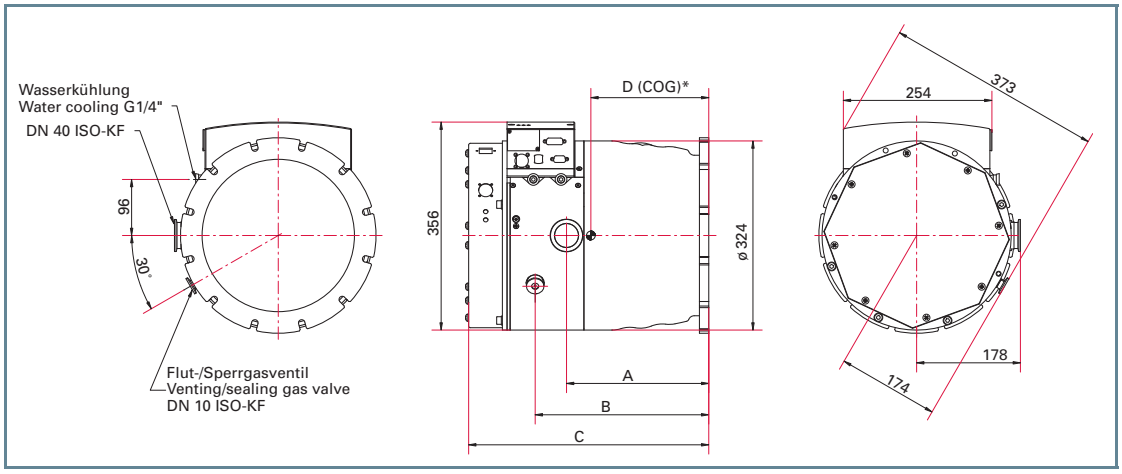
Dimensions



HiPace™ 2400 MC, with TM 3000

	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F
A	244 mm	244 mm	268 mm
B	297 mm	297 mm	322 mm
C	346 mm	346 mm	370 mm
D	199 mm	191 mm	194 mm

Dimensions



HiPace™ 2400 MC, with TM 3000 and integrated power supply

	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F
A	244 mm	244 mm	268 mm
B	297 mm	297 mm	322 mm
C	411 mm	411 mm	436 mm
D	210 mm	202 mm	205 mm

Technical data	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F, Profibus
Connection nominal diameter					
Flange (in)	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF
Pumping speed					
Pumping speed for H_2	1800 l/s	1800 l/s	1800 l/s	1800 l/s	1800 l/s
Pumping speed for He	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s
Pumping speed for N_2	2100 l/s	2100 l/s	2100 l/s	2100 l/s	2100 l/s
Pumping speed for Ar	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s
Pumping speed for CF_4	1600 l/s	1600 l/s	1600 l/s	1600 l/s	1600 l/s
Compression					
Compression ratio for H_2	$1 \cdot 10^4$	$1 \cdot 10^4$	$> 1 \cdot 10^4$	$> 1 \cdot 10^4$	$1 \cdot 10^4$
Compression ratio for He	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$	$2 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Compression ratio for Ar	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Compression ratio for CF_4	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Fore Vacuum max. for N_2	3 mbar	3 mbar	3 mbar	3 mbar	3 mbar
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mabr	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar
Rotation speed ±2%	29400 rpm	29400 rpm	29400 rpm	29400 rpm	29400 rpm
Run-up time	6 min	6 min	6 min	6 min	6 min
Cooling method, standard	Water	Water	Water	Water	Water
Cooling water consumption	100 l/h	100 l/h	100 l/h	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C	15-35 °C	15-35 °C	15-35 °C
Permissible magnetic field max.	10 mT	10 mT	10 mT	10 mT	10 mT
Sound pressure level	45 dB (A)	45 dB (A)	45 dB (A)	45 dB (A)	45 dB (A)
Protection category	IP 54	IP 54	IP 54	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote	RS-485, Remote	RS-485, Remote, Profibus	RS-485, Remote, Profibus
Weight	71 kg	75 kg	75 kg	71 kg	75 kg
Order number pump	**PM P03 490**	**PM P03 491**	**PM P03 492**	**PM P03 493**	**PM P03 494**

	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply, Profibus
	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F	DN 250 ISO-K	DN 250 ISO-F	DN 250 CF-F
	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF	DN 10 ISO-KF
	1800 l/s	1800 l/s	1800 l/s	1800 l/s	1800 l/s	1800 l/s	1800 l/s
	1900 l/s	1900 l/s	1900 l/s	1600 l/s	1900 l/s	1900 l/s	1900 l/s
	2100 l/s	2100 l/s	2100 l/s	2100 l/s	2100 l/s	2100 l/s	2100 l/s
	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s	1900 l/s
	1600 l/s	1600 l/s	1600 l/s	1900 l/s	1600 l/s	1600 l/s	1600 l/s
	$1 \cdot 10^4$	$> 1 \cdot 10^4$	$1 \cdot 10^4$	$1 \cdot 10^4$	$2 \cdot 10^5$	$> 1 \cdot 10^4$	$1 \cdot 10^4$
	$> 1 \cdot 10^9$	$2 \cdot 10^5$	$2 \cdot 10^5$	$> 1 \cdot 10^9$	$1 \cdot 10^4$	$2 \cdot 10^5$	$> 1 \cdot 10^9$
	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
	$2 \cdot 10^5$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$2 \cdot 10^5$	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$	$2 \cdot 10^5$
	3 mbar	1.5 mbar	1.5 mbar	1.5 mbar	1.5 mbar	1.5 mbar	1.5 mbar
	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar
	29400 rpm	29400 rpm	29400 rpm	29400 rpm	29400 rpm	29400 rpm	29400 rpm
	6 min Water	7 min Water	7 min Water	7 min Water	7 min Water	7 min Water	7 min Water
	100 l/h 15-35 °C	100 l/h 15-35 °C	100 l/h 15-35 °C	100 l/h 15-35 °C	100 l/h 15-35 °C	100 l/h 15-35 °C	100 l/h 15-35 °C
	10 mT 45 dB (A)	10 mT 45 dB (A)	10 mT 45 dB (A)	10 mT 45 dB (A)	10 mT 45 db (A)	10 mT 45 dB (A)	10 mT 45 dB (A)
	IP 54 RS-485, Remote, Profibus	IP 54 RS-485, Remote	IP 54 RS-485, Remote	IP 54 RS-485, Remote	IP 54 RS-485, Profibus	IP 54 RS-485, Profibus	IP 54 RS-485, Profibus
	75 kg	77 kg	81 kg	81 kg	77 kg	81 kg	81 kg
	PM P03 495	**PM P03 710**	**PM P03 711**	**PM P03 712**	**PM P03 713**	**PM P03 714**	**PM P03 715**

Accessories	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F, Profibus
Order number pump	**PM P03 490**	**PM P03 491**	**PM P03 492**	**PM P03 493**	**PM P03 494**
Power supplies/power					
TPS - mains pack for wall/standard rail fitting	**PM C01 760**	**PM C01 760**	**PM C01 760**	**PM C01 760**	**PM C01 760**
TPS - mains pack 19" rack module 3 RU	**PM C01 761**	**PM C01 761**	**PM C01 761**	**PM C01 761**	**PM C01 761**
Control units					
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m					
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**	**P4 564 309 HA**
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**	**P4 564 309 HB**
Connection cable, length 3 m between					
TPS 1400 - TM 3000	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**
Connection cable TM 3000 - backing pump relay box, Length 2 m	**PM 061 630-X**	**PM 061 630-X**	**PM 061 630-X**	**PM 061 630-X**	**PM 061 630-X**
Venting accessories					
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**	**PM Z00 121**
Heating accessories					
Heating jacket 230 V AC, Euro-style safety plug			**PM 061 154-T**		
Heating jacket 208 V AC, UL plug			**PM 061 155-T**		
Backing pump control					
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**	**PM 061 375-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**	**PM Z01 206**

	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply, Profibus
	PM P03 495	PM P03 710	PM P03 711	PM P03 712	PM P03 713	PM P03 714	PM P03 715
	PM C01 760						
	PM C01 761						
	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T	PM 061 348-T
	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T	PM 051 510-T
	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T	PM 061 005-T
	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA	P4 564 309 HA
	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB	P4 564 309 HB
	PM 051 983-T						
	PM 061 630-X	PM 061 630-X	PM 061 630-X	PM 061 630-X	PM 061 630-X	PM 061 630-X	PM 061 630-X
	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121	PM Z00 121
	PM 061 154-T			PM 061 154-T			PM 061 154-T
	PM 061 155-T			PM 061 155-T			PM 061 155-T
	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T	PM 061 375-T
	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205	PM Z01 205
	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206	PM Z01 206

Accessories	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F, Profibus
Order number pump	**PM P03 490**	**PM P03 491**	**PM P03 492**	**PM P03 493**	**PM P03 494**
General accessories					
Coated centering ring	**PM 016 225-U**	**PM 016 225-U**		**PM 016 225-U**	**PM 016 225-U**
Coated centering ring with protection screen	**PM 016 227-U**	**PM 016 227-U**		**PM 016 227-U**	**PM 016 227-U**
Coated centering ring with integrated splinter shield	**PM 016 226-U**	**PM 016 226-U**		**PM 016 226-U**	**PM 016 226-U**
Protection screen			**PM 016 345**		
Splinter shield			**PM 016 324**		
Vibration dampers	**PM 006 670-X**		**PM 006 671-X**	**PM 006 670-X**	
USB converter	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**	**PM 061 283-T**
Connection cable for HiPace MC with TM 3000, 3 m	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**	**PM 051 983-T**
TIC 001, Serial Interface Converter RS-232/RS-485	**PM 051 054-T**	**PM 051 054-T**	**PM 051 054-T**	**PM 051 054-T**	**PM 051 054-T**
Connection cable, RJ 45 on M12	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**
Mounting materials					
Mounting kit including coated centering ring, bracket screws	**PM 016 420-T**			**PM 016 420-T**	
Coated centering ring, with protection screen, clamping screws	**PM 016 422-T**			**PM 016 422-T**	
Coated centering ring with splinter shield, bracket screws	**PM 016 421-T**			**PM 016 421-T**	
Coated centering ring, hexagon bolts		**PM 016 480-T**			**PM 016 480-T**
Coated centering ring with protection screen, hexagon bolts		**PM 016 482-T**			**PM 016 482-T**
Coated centering ring with splinter shield, hexagon bolts		**PM 016 481-T**			**PM 016 481-T**
Coated centering ring, stud screws		**PM 016 485-T**			**PM 016 485-T**
Coated centering ring with protection screen, stud screws		**PM 016 487-T**			**PM 016 487-T**
Coated centering ring with splinter shield, stud screws		**PM 016 486-T**			**PM 016 486-T**
Set of hexagon bolts			**PM 016 694-T**		
Set of stud screws			**PM 016 695-T**		

	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-K and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 ISO-F and integrated power supply, Profibus	HiPace™ 2400 MC, with TM 3000, DN 250 CF-F and integrated power supply, Profibus
	PM P03 495	PM P03 710	PM P03 711	PM P03 712	PM P03 713	PM P03 714	PM P03 715
		PM 016 225-U	PM 016 225-U		PM 016 225-U	PM 016 225-U	
		PM 016 227-U	PM 016 227-U		PM 016 227-U	PM 016 227-U	
		PM 016 226-U	PM 016 226-U		PM 016 226-U	PM 016 226-U	
	PM 016 345			PM 016 345			PM 016 345
	PM 016 324			PM 016 324			PM 016 324
	PM 006 671-X	PM 006 670-X		PM 006 671-X	PM 006 670-X		PM 006 671-X
	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T	PM 061 207-T
	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T	PM 061 283-T
	PM 051 983-T						
	PM 051 054-T	PM 051 054-T	PM 051 054-T	PM 051 054-T	PM 051 054-T	PM 051 054-T	PM 051 054-T
	PM 051 726-T	PM 051 726-T	PM 051 726-T	PM 051 726-T	PM 051 726-T	PM 051 726-T	PM 051 726-T
		PM 016 420-T			PM 016 420-T		
		PM 016 422-T			PM 016 422-T		
		PM 016 421-T			PM 016 421-T		
			PM 016 480-T			PM 016 480-T	
			PM 016 482-T			PM 016 482-T	
			PM 016 481-T			PM 016 481-T	
			PM 016 485-T			PM 016 485-T	
			PM 016 487-T			PM 016 487-T	
			PM 016 486-T			PM 016 486-T	
	PM 016 694-T			PM 016 694-T			PM 016 694-T
	PM 016 695-T			PM 016 695-T			PM 016 695-T

HiPace™ 3400 MC

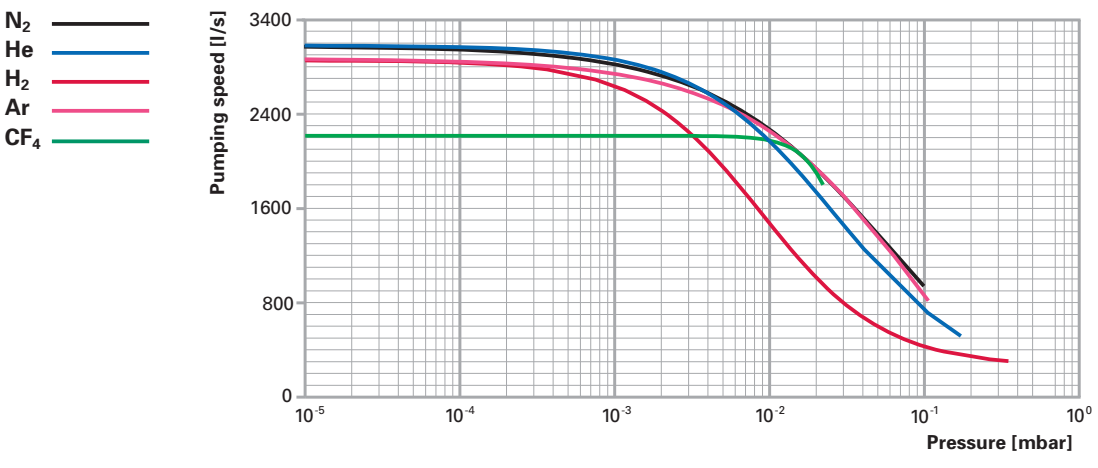
Powerful magnetically levitated turbo-pumps with pumping speeds of 3000 l/s.

HiPace™ 3400 MC

- ▶ Active 5-axis magnetic levitation system
- ▶ Maintenance-free, hydrocarbon-free
- ▶ Very low vibration and noise levels
- ▶ High pumping speed and gas throughput for both light and heavy gases

M = Magnetically levitated
C = Suitable for corrosive gases
Systems with DeviceNet fieldbus interface instead of Profibus available upon request.

Pumping speed

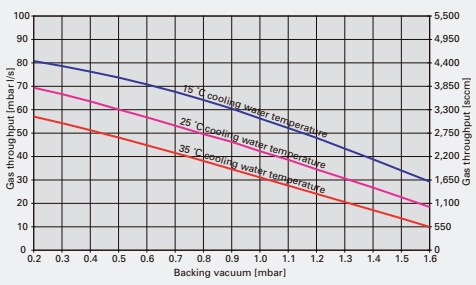


HiPace™ 3400 MC

Gas througput

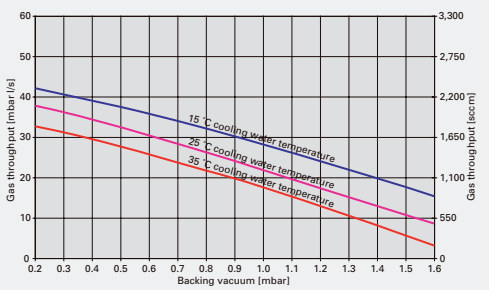
Gases with molecular mass of < 40

at nominal speed, cooling water throughput 100 l/h



Gases with molecular mass of ≥ 40

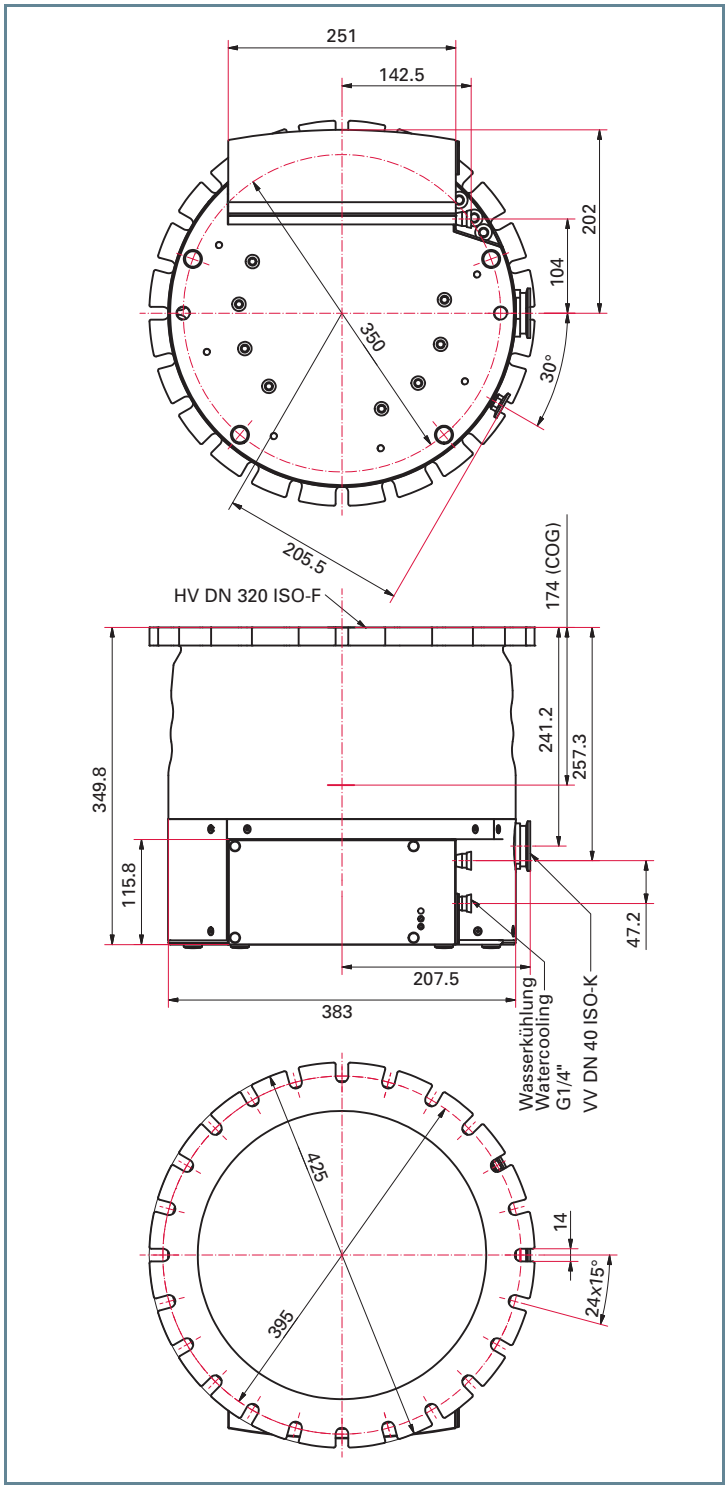
at nominal speed, sealing gas 20 sccm, cooling water throughput 100 l/h



HiPace™ 3400 MC, DN 320 ISO-F[1)]

[1)] Gas throughput relative to backing vacuum and kind of gas

Dimensions


251
142.5
202
104
350
30°
205.5
174 (COG)
HV DN 320 ISO-F
241.2
257.3
349.8
115.8
47.2
207.5
383
Wasserkühlung
Watercooling
G1/4"
VV DN 40 ISO-K
425
14
24x15°
395

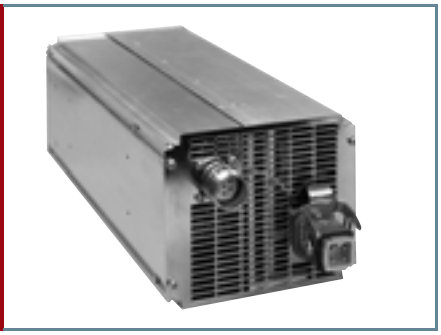
Technical data	HiPace™ 3400, with TM 3000, DN 320 ISO-F	HiPace™ 3400 MC, with TM 3000, DN 320 ISO-F
Connection nominal diameter		
Flange (in)	DN 320 ISO-F	DN 320 ISO-F
Flange (out)	DN 40 ISO-KF	DN 40 ISO-KF
Venting connection	DN 10 ISO-KF	DN 10 ISO-KF
Pumping speed		
Pumping speed for H_2	2850 l/s	2850 l/s
Pumping speed for He	2950 l/s	2850 l/s
Pumping speed for N_2	2950 l/s	2950 l/s
Pumping speed for Ar	2850 l/s	2850 l/s
Pumping speed for CF_4	2200 l/s	2200 l/s
Compression		
Compression ratio for H_2	$4 \cdot 10^4$	$4 \cdot 10^4$
Compression ratio for He	$4 \cdot 10^5$	$4 \cdot 10^5$
Compression ratio for N_2	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Compression ratio for Ar	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Compression ratio for CF_4	$> 1 \cdot 10^9$	$> 1 \cdot 10^9$
Fore Vacuum max. for N_2	2 mbar	2 mbar
Ultimate pressure with OnTool™ DryPump	$< 1 \cdot 10^{-9}$ mbar	$< 1 \cdot 10^{-9}$ mbar
Rotation speed ±2%	24000 rpm	24000 rpm
Run-up time	11 min	11 min
Cooling method, standard	Water	Water
Cooling water consumption	100 l/h	100 l/h
Cooling water temperature	15-35 °C	15-35 °C
Permissible magnetic field max.	10 mT	10 mT
Sound pressure level	45 dB (A)	45 dB (A)
Protection category	IP 54	IP 54
Interfaces	RS-485, Remote	RS-485, Remote, Profibus
Weight	94 kg	94 kg
Order number pump	**PM P03 501**	**PM P03 504**

Accessories	HiPace™ 3400, with TM 3000, DN 320 ISO-F	HiPace™ 3400 MC, with TM 3000, DN 320 ISO-F
Order number pump	**PM P03 501**	**PM P03 504**
Power supplies/power		
TPS - mains pack for wall/standard rail fitting	**PM C01 760**	**PM C01 760**
TPS - mains pack 19" rack module 3 RU	**PM C01 761**	**PM C01 761**
Control units		
DCU - Display Control Unit	**PM 061 348-T**	**PM 061 348-T**
HPU - Handheld Programming Unit	**PM 051 510-T**	**PM 051 510-T**
Accessories for HPU	**PM 061 005-T**	**PM 061 005-T**
Mains cable DCU/TPS/TCP, 3 m		
230 V AC mains cable with Euro-style safety plug	**P4 564 309 HA**	**P4 564 309 HA**
208 V AC mains cable with UL plug	**P4 564 309 HB**	**P4 564 309 HB**
Connection cable, length 3 m between		
TPS 1400 - TM 3000	**PM 051 983-T**	**PM 051 983-T**
Connection cable TM 3000 - backing pump relay box, Length 2 m	**PM 061 630-X**	**PM 061 630-X**
Venting accessories		
Air drier TTV 001	**PM Z00 121**	**PM Z00 121**
Backing pump control		
Backing pump relay box, single phase 20 A	**PM 061 375-T**	**PM 061 375-T**
TVV 001 backing vacuum safety valve, 230 V AC	**PM Z01 205**	**PM Z01 205**
TVV 001 backing vacuum safety valve, 115 V AC	**PM Z01 206**	**PM Z01 206**
General accessories		
Coated centering ring	**PM 016 232 AU**	**PM 016 232 AU**
Coated centering ring with protection screen	**PM 016 234-U**	**PM 016 234-U**
Coated centering ring with integrated splinter shield	**PM 016 233-U**	**PM 016 233-U**
Interface cable, 3 m, M 12	**PM 061 283-T**	**PM 061 283-T**
Connection cable for HiPace MC with TM 3000, 3 m	**PM 051 983-T**	**PM 051 983-T**
TIC 001, Serial Interface Converter RS-232/RS-485	**PM 051 054-T**	**PM 051 054-T**
Connection cable, RJ 45 on M12	**PM 051 726-T**	**PM 051 726-T**
Mounting materials		
Coated centering ring, hexagon bolts	**PM 016 490-T**	**PM 016 490-T**
Coated centering ring with protection screen, hexagon bolts	**PM 016 492-T**	**PM 016 492-T**
Coated centering ring with splinter shield, hexagon bolts	**PM 016 491 -T**	**PM 016 491 -T**
Coated centering ring, stud screws	**PM 016 495-T**	**PM 016 495-T**
Coated centering ring with protection screen, stud screws	**PM 016 497-T**	**PM 016 497-T**

TPS wall rail fitting

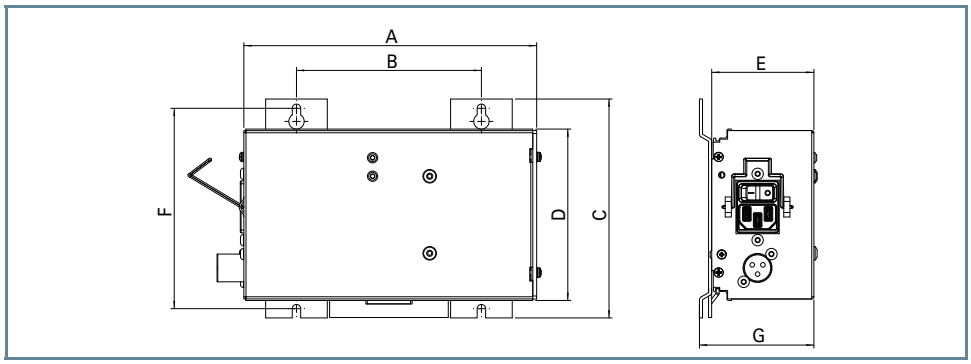
Power supplies for wall and standard-rail mounting. Simple integration and Plug and Play-ready. Performance ideally matched to the respective pump model. Satisfies international standards.

TPS wall rail fitting



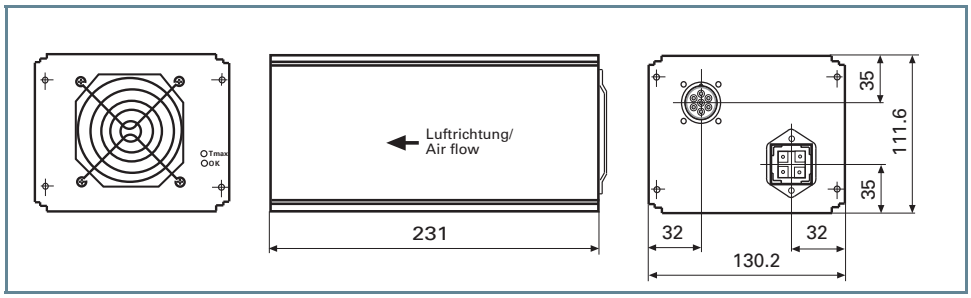
▶ Power supply for wall or standard-rail mounting

Dimensions



TPS 110
TPS 180
TPS 310
TPS 400

	TPS 110	TPS 180	TPS 310	TPS 400
A	169 mm	190 mm	190 mm	190 mm
B	120 mm	120 mm	120 mm	120 mm
C	142 mm	142 mm	142 mm	142 mm
D	111.2 mm	111.2 mm	111.2 mm	111.2 mm
E	48.7 mm	58.4 mm	67.3 mm	104.6 mm
F	130 mm	130 mm	130 mm	130 mm
G	56.6 mm	66.5 mm	75.5 mm	112.5 mm



TPS 1400

Technical data	TPS 110	TPS 180	TPS 310	TPS 400
Output voltage	24 +/-2% V DC	24 +/-2% V DC	24 +/-2% V DC	48 +/-2% V DC
Output current	4.6 A	7.5 A	12.5 A	8.4 A
Weight	0.7 kg	1.0 kg	1.1 kg	1.75 kg
Mains requirement: frequency (range)	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Mains requirement: power consumption	130 VA	210 VA	340 VA	450 VA
Mains requirement: voltage (range)	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC
Protection category	IP 20	IP 20	IP 20	IP 20
Ambient temperature	5-50 °C	5-50 °C	5-50 °C	5-50 °C

Order number	TPS 110	TPS 180	TPS 310	TPS 400
TPS wall rail fitting	**PM 061 340-T**	**PM 061 341-T**	**PM 061 342-T**	**PM 061 343-T**

Accessories				
230 V AC mains cable with Euro-style safety plug, IEC power socket (straight), 3 m	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZE**
115 V AC mains cable with UL plug, IEC power socket (straight), 3 m	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZF**
208 V AC mains cable with UL plug, 3 m	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZA**

Technical data	TPS 1400
Output voltage	140 V DC
Output current	10 A
Weight	3.4 kg
Mains requirement: power consumption	1700 VA
Mains requirement: voltage (range)	187 - 265 V AC, 50/60 Hz
Protection category	IP 20
Ambient temperature	5-40 °C

Order number	TPS 1400
TPS wall rail fitting	**PM C01 760**

Accessories	
Connection cable for linking HiPace MC with TM 3000 to TPS 1400/1401	**PM 051 983-T**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
208 V AC mains cable with UL plug, NEMA-HAN 3A, 3 m	**P4 564 309 HB**

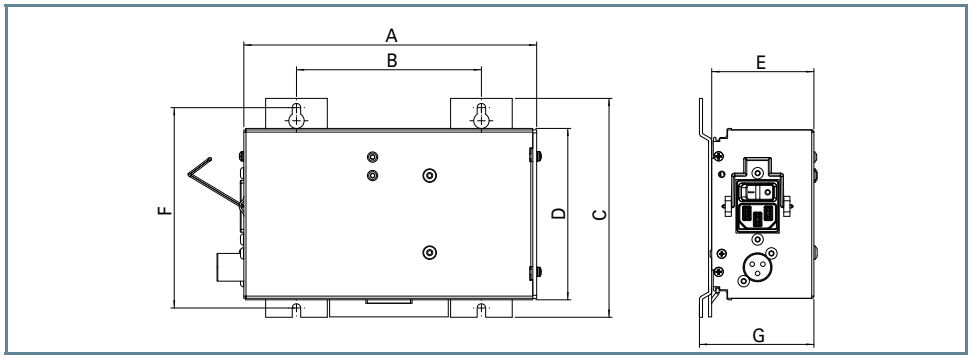
TPS-19" rack module

Power supply in the form of a 3 RU 19" rack module with front panel; for installation directly in 19" rack systems. Performance ideally matched to the respective HiPace pump model. Plug and Play-ready. Satisfies international standards.

TPS-19" rack module

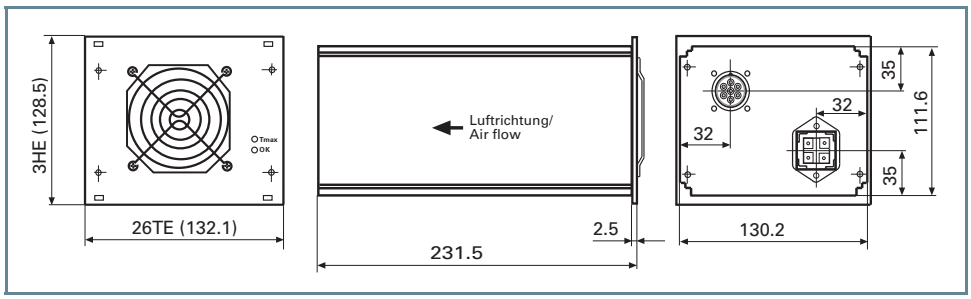
▶ Power supply in the form of a 3 RU 19" rack module with front panel

Dimensions



TPS 111
TPS 181
TPS 311
TPS 401

	TPS 111	TPS 181	TPS 311	TPS 401
A	161.5 mm	187.5 mm	187.5 mm	187.5 mm
B	164 mm	190 mm	190 mm	190 mm
C	128.4 mm	128.4 mm	128.4 mm	128.4 mm
D	111.2 mm	111.2 mm	111.2 mm	111.2 mm
E	48.7 mm	58.4 mm	67.3 mm	104.6 mm
F	50.5 mm	60.7 mm	70.8 mm	106.4 mm



TPS 1400

Technical data	TPS 111	TPS 181	TPS 311	TPS 401
Output voltage	24 +/-2% V DC	24 +/-2% V DC	24 +/-2% V DC	48 +/-2% V DC
Output current	4.6 A	7.5 A	12.5 A	8.4 A
Weight	0.7 kg	1.0 kg	1.1 kg	1.75 kg
Mains requirement: frequency (range)	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Mains requirement: power consumption	130 VA	210 VA	340 VA	450 VA
Mains requirement: voltage (range)	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC
Protection category	IP 20	IP 20	IP 20	IP 20
Ambient temperature	5-50 °C	5-50 °C	5-50 °C	5-50 °C

Order number	TPS 111	TPS 181	TPS 311	TPS 401
TPS-19" rack module	**PM 061 344-T**	**PM 061 345-T**	**PM 061 346-T**	**PM 061 347-T**

Accessories				
230 V AC mains cable with Euro-style safety plug, IEC power socket (straight), 3 m	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug, IEC power socket (straight), 3 m	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug, 3 m	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**

Technical data	TPS 1401
Output voltage	140 V DC
Output current	10 A
Weight	3.4 kg
Mains requirement: power consumption	1700 VA
Mains requirement: voltage (range)	187 - 265 V AC, 50/60 Hz
Protection category	IP 20
Ambient temperature	5-40 °C

Order number	TPS 1401
TPS-19" rack module	**PM C01 761**

Accessories	
Connection cable for linking HiPace MC with TM 3000 to TPS 1400/1401	**PM 051 983-T**
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	**P4 564 309 HA**
208 V AC mains cable with UL plug, NEMA-HAN 3A, 3 m	**P4 564 309 HB**

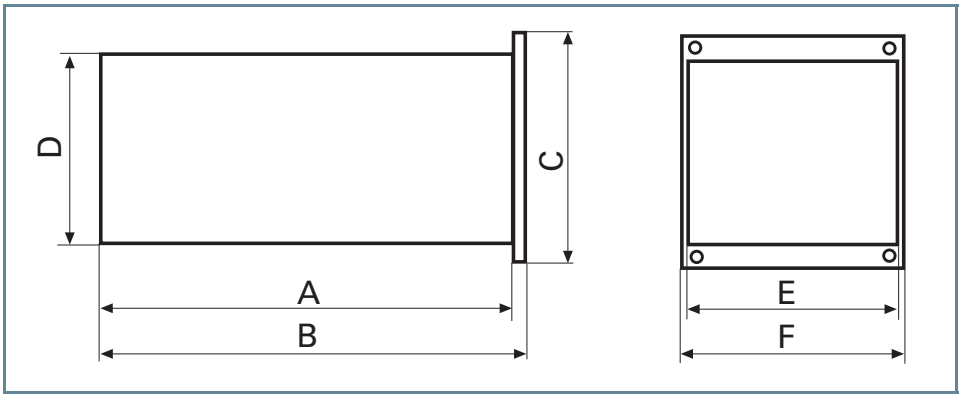
DCU with integrated power supply

Display Control Unit (DCU) with integrated power supply for electrical supply to the HiPace series of pumps. 3 RU 19" rack module with easy-to-read, backlit display. The DCU affords operation and monitoring of all parameters of the HiPace turbopumps.

DCU with integrated power supply

- To control and monitor all parameters of the drive electronics
- With integrated power supply
- The operating voltage is securely isolated from the power supply in accordance with EN60742.
- Pressure measurement with Pfeiffer Vacuum gauge heads is possible.

Dimensions



DCU with integrated power supply

	DCU 110	DCU 180	DCU 310	DCU 400
A	197.5 mm	227.5 mm	227.5 mm	227.5 mm
B	200 mm	230 mm	230 mm	230 mm
C	128.5 mm	128.5 mm	128.5 mm	128.5 mm
D	111.2 mm	111.2 mm	111.2 mm	111.2 mm
E	106 mm	106 mm	106 mm	106 mm
F	106.4 mm	106.4 mm	106.4 mm	106.4 mm

Technical data	DCU 110	DCU 180	DCU 310	DCU 400
Output voltage	24 +/-2% V DC	24 +/-2% V DC	24 +/-2% V DC	48 +/-2% V DC
Output current	4.6 A	7.5 A	12.5 A	8.4 A
Weight	1.2 kg	1.7 kg	1.85 kg	2.3 kg
Mains requirement: frequency (range)	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Mains requirement: power consumption	130 VA	210 VA	340 VA	450 VA
Mains requirement: voltage (range)	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC	115-230 -20/+15% V AC
Protection category	IP 20	IP 20	IP 20	IP 20
Ambient temperature	5-50 °C	5-50 °C	5-50 °C	5-50 °C

Order number	DCU 110	DCU 180	DCU 310	DCU 400
DCU with integrated power supply	**PM C01 820**	**PM C01 821**	**PM C01 822**	**PM C01 823**

Accessories				
230 V AC mains cable with Euro-style safety plug, IEC power socket (straight), 3 m	**P 4564 309 ZA**	**P 4564 309 ZE**	**P 4564 309 ZA**	**P 4564 309 ZA**
115 V AC mains cable with UL plug, IEC power socket (straight), 3 m	**P 4564 309 ZE**	**P 4564 309 ZF**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug, 3 m	**P 4564 309 ZF**	**P 4564 309 ZA**	**P 4564 309 ZF**	**P 4564 309 ZF**

Control and display units

Control and display units for setting and monitoring the operating parameters of the turbopumps.

HPU 001

HPU 001, handheld programming unit

- The ideal assistant for controlling and monitoring the pump parameters
- Administration of complete pump configurations / parameter records
- Connects to the pump's drive electronics via RS-485 interface
- Connection cable (3 m) for drive electronics included in scope of delivery
- Multilingual menus
- For loading and copying parameter records
- Graphical display

Technical data	HPU 001
Dimensions (l x w x h)	150 x 80 x 30 mm
Connection	9 - 24 V DC
Weight	0.25 kg
Power consumption	2 W
Protection category	IP 20
Ambient temperature	5-40 °C

Order number	HPU 001
Control and display units	**PM 051 510-T**

Accessories	
Connection cable, plug M12, RJ 45	**PM 051 726-T**
Accessories package for HPU - Power supply, software and PC cable	**PM 061 005-T**

Accessories package for HPU

- Scope of delivery: CD (with HPU Communicator software), HPU-PC connection cable, power supply for HPU, 3 power cord plug adapters (America, UK, Southern Europe)
- The HPU Communicator software enables the pump parameter records to be displayed and administered on the PC and/or sent via e-mail
- The HPU-PC connection cable is used to exchange data between PC and HPU

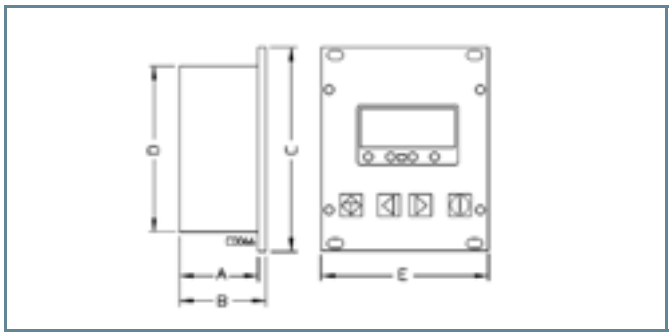
Order number	
Accessories package for HPU - Power supply, software and PC cable	**PM 061 005-T**

DCU 002

DCU 002, Display control unit

- ▶For operating and monitoring all parameters of the drive electronics
- ▶Power supplied exclusively from the drive electronics
- ▶Suitable for all HiPace turbopumps
- ▶19" rack module, 3 RU
- ▶Connects to the pump´s drive electronics via RS-485 interface
- ▶Connection cable (3 m) for drive electronics included in scope of delivery
- ▶Various Pfeiffer Vacuum gauges can be connected and read

Dimensions



DCU 002, Display control unit

	DCU 002
A	50 mm
B	52.5 mm
C	128.5 mm
D	106 mm
E	106.3 mm

Technical data	DCU 002
Connection	12-30 V DC
Weight	0.4 kg
Power consumption	5 VA
Protection category	IP 20
Ambient temperature	5-40 °C

Order number	DCU 002
Control and display units	**PM 061 348-T**

Accessories	
Connection cable, plug M12, RJ 45	**PM 051 726-T**

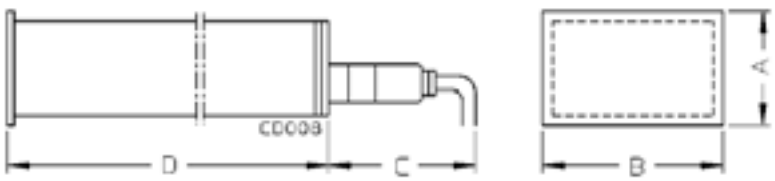
External drive units

External drives for HiPace pumps via connection cables.

External drive units

- The TCP 350 drive electronics unit is employed for driving and monitoring the HiPace 80, 300, 400 and 700
- Complete electronics in a single unit
- Mating plug for "Remote" connector included in scope of delivery

Dimensions



	TCP 350 drive electronics	TCP 350 PB, drive electronics	TCP 350 DN, drive electronics
A	128.5 mm	128.5 mm	128.5 mm
B	141.9 mm	141.9 mm	141.9 mm
C	120 mm	120 mm	120 mm
D	232 mm	232 mm	232 mm

Technical data	TCP 350 drive electronics	TCP 350 PB, drive electronics - Profibus	TCP 350 DN, drive electronics - DeviceNet
Frequency	50-60 Hz	50-60 Hz	50-60 Hz
Weight	2.8 kg	2.8 kg	2.8 kg
Cable length Turbo-TCP-max.	100 m	100 m	100 m
Mains requirement: power consumption	400 VA	400 VA	400 VA
Mains requirement: voltage (range)	95-265 V AC	95-265 V AC	95-265 V AC
Interface	RS-485 / RS-232 / Remote (SPS-compatible)	RS-485 / RS-232 / Remote (SPS-compatible) Profibus	RS-485 / RS-232 / Remote and DeviceNet
Protection category	IP 20	IP 20	IP 20
Ambient temperature	5-40 °C	5-40 °C	5-40 °C

Order number	TCP 350 drive electronics	TCP 350 PB, drive electronics - Profibus	TCP 350 DN, drive electronics - DeviceNet
External drive units	**PM C01 740**	**PM C01 741**	**PM C01 742**

Accessories			
115 V AC mains cable with UL plug, IEC power socket (straight), 3 m	**P 4564 309 ZE**	**P 4564 309 ZE**	**P 4564 309 ZE**
208 V AC mains cable with UL plug, 3 m	**P 4564 309 ZF**	**P 4564 309 ZF**	**P 4564 309 ZF**
230 V AC mains cable with Euro-style safety plug, IEC power socket (straight), 3 m	**P 4564 309 ZA**	**P 4564 309 ZA**	**P 4564 309 ZA**

Venting accessories

Accessories for safe and secure venting of the HiPace turbopumps. For secure processes and maximum reliability.

Venting accessories

24 V DC venting valve, G 1/8", for connection to TC 110

- ▶ Cable with M8 plug for connection to TC 110 included in scope of delivery
- ▶ Venting mode, venting time and venting duration set by means of drive electronics and DCU/HPU
- ▶ G 1/8" connection
- ▶ Normally closed valve
- ▶ Connects directly to connection cable PM061351-T

24 V DC venting valve, G 1/8", for connection to TC 400

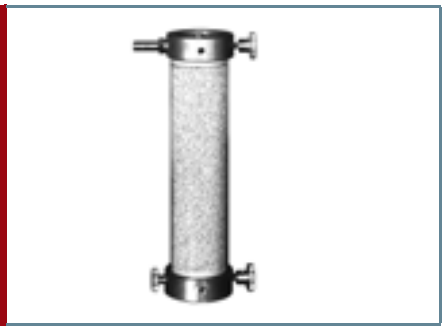
- ▶ Cable with M12 plug for connection to TC 400 included in scope of delivery
- ▶ Venting mode, venting time and venting duration set by means of drive electronics and DCU/HPU
- ▶ G 1/8" connection
- ▶ Normally closed valve

Technical data	24 V DC venting valve, G 1/8", for connection to TC 110	24 V DC venting valve, G 1/8", for connection to TC 400
Flange (in)	G 1/8"	G 1/8"
Flange (out)	G 1/8"	G 1/8"
Venting gas excess pressure, max.	1.5 bar (absolute)	1.5 bar (absolute)
Gas flow at atmospheric pressure	130 mbar l/s	130 mbar l/s
Weight	100 g	100 g
Leak rate	$<1 \cdot 10^{-8}$ mbar l/s	$<1 \cdot 10^{-8}$ mbar l/s
Control voltage	24 V DC	24 V DC

Order number	24 V DC venting valve, G 1/8", for connection to TC 110	24 V DC venting valve, G 1/8", for connection to TC 400
Venting accessories	**PM Z01 290**	**PM Z01 291**

Accessories		
TTV 001, air drier for venting turbopumps	**PM Z00 121**	**PM Z00 121**

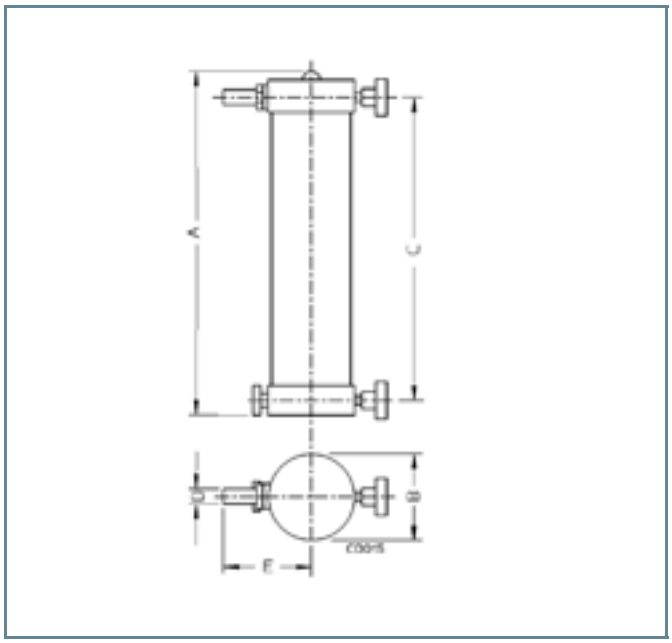
TTV 001



TTV 001, air drier for venting turbopumps

- ▶Dries air securely when venting the turbopumps
- ▶Shortens pump-down time
- ▶Color indicator shows saturation of drying agent
- ▶Simple connection to venting valves

Dimensions



TTV 001

	TTV 001
A	235 mm
B	59 mm
C	206 mm
D	9 mm
E	57 mm

Order number	TTV 001, air drier for venting turbopumps
Venting accessories	PM Z00 121

Accessories	
Filling for air drier, TTV 001, approx. 260 cm³	PM 006 786-T

Cooling accessories

Accessories for cooling. For maximum reliability and process flexibility.

Cooling accessories

Air cooling

Ideal for systems integration, does not require additional water supply.

Air cooling	Control voltage	Order number
Air cooling for HiPace 80 with TC 110	24 V DC	**PM Z01 300**
Air cooling for HiPace 300 with TC 110	24 V DC	**PM Z01 301**
Air cooling for HiPace 300 with TC 400	24 V DC	**PM Z01 302**
Air cooling for HiPace 400 and HiPace 700 with TC 400	24 V DC	**PM Z01 303**

Water cooling

For maximum performance and additional process flexibility.
Required for maximum performance and fast cycling.
Indispensable for UHV applications when pump is heated.

Water cooling	Order number
Water cooling for HiPace 80, TC 110	**PM 016 623-T**
Water cooling for HiPace 300, TC 110	**PM 016 624-T**

Heating accessories

In many cases, it is necessary to condition the turbopump for cleaning in UHV operation or for process adaptation. Matching heating elements are available. Automatic control by means of integrated TC 110 and TC 400 drive electronics.

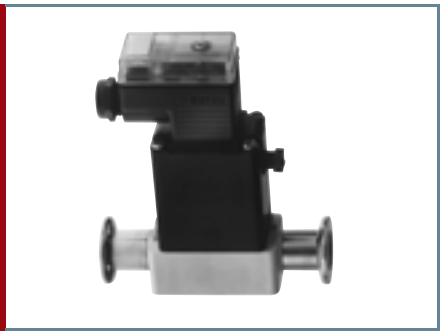
Heating accessories

Heating accessories	Order number
Heating jacket for HiPace 80 with TC 110/TCP 350, 230 V AC, Euro-style safety plug	**PM 061 360-T**
Heating jacket for HiPace 80 with TC 110/TCP 350, 208 V AC, UL plug	**PM 061 361-T**
Heating jacket for HiPace 80 with TC 110/TCP 350, 115 V AC, UL plug	**PM 061 362-T**
Heating jacket for HiPace 300 with TC 110/TCP 350, 230 V AC, Euro-style safety plug	**PM 061 363-T**
Heating jacket for HiPace 300 with TC 110/TCP 350, 208 V AC, UL plug	**PM 061 364-T**
Heating jacket for HiPace 300 with TC 110/TCP 350,115 V AC, UL plug	**PM 061 365-T**
Heating jacket for HiPace 300 with TC 400/TCP 350, 230 V AC, Euro-style safety plug	**PM 061 366-T**
Heating jacket for HiPace 300 with TC 400/TCP 350, 208 V AC, UL plug	**PM 061 367-T**
Heating jacket for HiPace 300 with TC 400/TCP 350,115 V AC, UL plug	**PM 061 368-T**
Heating jacket for HiPace 400/700 with TC 400/TCP 350, 230 V AC, Euro-style safety plug	**PM 061 369-T**
Heating jacket for HiPace 400/700 with TC 400/TCP 350, 208 V AC, UL plug	**PM 061 370-T**
Heating jacket for HiPace 400/700 with TC 400/TCP 350, 115 V AC, UL plug	**PM 061 371-T**
Heating jacket for HiPace 1200/1500 with TC 1200, 230 V AC, Euro-style safety plug	**PM 061 560-T**
Heating jacket for HiPace 1200/1500 with TC 1200, 208 V AC, UL plug	**PM 061 561-T**
Heating jacket for HiPace 1200/1500 with TC 1200, 115 V AC, UL plug	**PM 061 562-T**
Heating jacket for HiPace 1800/2300 with TC 1200, 230 V AC, Euro-style safety plug	**PM 061 563-T**
Heating jacket for HiPace 1800/2300 with TC 1200, 208 V AC, UL plug	**PM 061 564-T**
Heating jacket for HiPace 1800/2300 with TC 1200, 115 V AC, UL plug	**PM 061 565-T**
Heating jacket for HiPace 2400 MC with TM 3000, 230 V AC, Euro-style safety plug	**PM 061 154-T**
Heating jacket for HiPace 2400 MC with TM 3000, 208 V AC, UL plug	**PM 061 155-T**

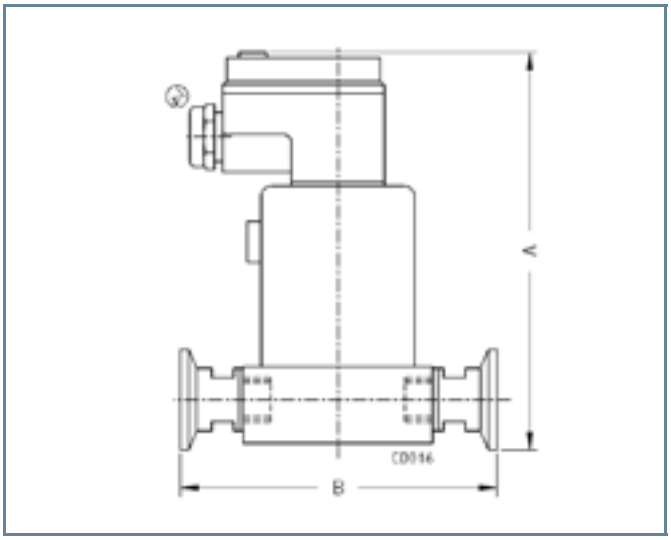
Backing pump control

HiPace turbopumps afford meaningful control of backing pumps. Pumping station control is effected via TC 110 and TC 400 and TC 1200. Parameter setting with DCU. Process adaptation performed in interval mode.

Backing pump control



Dimensions



TVV 001

	TVV 001 backing vacuum safety valve, 230 V AC	TVV 001 backing vacuum safety valve, 115 V AC
A	117 mm	117 mm
B	83 mm	83 mm

Technical data	TVV 001 backing vacuum safety valve, 230 V AC	TVV 001 backing vacuum safety valve, 115 V AC
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 16 ISO-KF
Permanent current	064 A	0.6 A
Weight	0.4 kg	0.4 kg
Leak rate	$1 \cdot 10^{-4}$ mbar l/s	$1 \cdot 10^{-4}$ mbar l/s
Mains requirement: voltage	230 V AC, 50/60 Hz	115 V AC, 50/60 Hz
Protection category	IP 65	IP 65
Ambient temperature	0-55 °C	0-55 °C
Time delay	0.5-35 s	0.5 - 35 s

Order number	TVV 001 backing vacuum safety valve, 230 V AC	TVV 001 backing vacuum safety valve, 115 V AC
Backing pump control	**PM Z01 205**	**PM Z01 206**

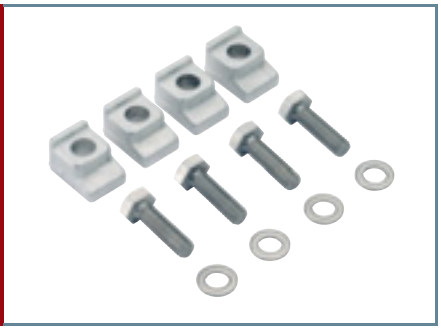
Technical data	Backing pump relay box, single phase 5 A, for TC 110/TCP 350	Backing pump relay box, single phase 20 A, for TC 110/TCP 350	Backing pump relay box, single phase 5 A, for TC 400/TCP 350	Backing pump relay box, single phase 20 A, for TC 400/TCP 350 and TM 3000
Contact rating	5.0 A	20 A	5.0 A	20 A
Mains requirement: voltage (range)	100-240 V AC, ±10%, 50/60 Hz	100-240 V AC, ±10%, 50/60 Hz	100-240 V AC, ±10%, 50/60 Hz	100-240 V AC, ±10%, 50/60 Hz
Control voltage	24 V DC	24 V DC	24 V DC	24 V DC

Order number	Backing pump relay box, single phase 5 A, for TC 110/TCP 350	Backing pump relay box, single phase 20 A, for TC 110/TCP 350	Backing pump relay box, single phase 5 A, for TC 400/TCP 350	Backing pump relay box, single phase 20 A, for TC 400/TCP 350 and TM 3000
Backing pump control	**PM 061 372-T**	**PM 061 373-T**	**PM 061 374-T**	**PM 061 375-T**

Accessories				
Connection cable from M8 socket on relay box to TCP 350	**PM 061 376-T**	**PM 061 376-T**		
Connection cable from M12 socket on relay box to TCP 350			**PM 061 377-T**	
Connection cable from M12 socket on relay box to TM 3000				**PM 061 630-X**

Mounting materials

Mounting materials



Mounting kits

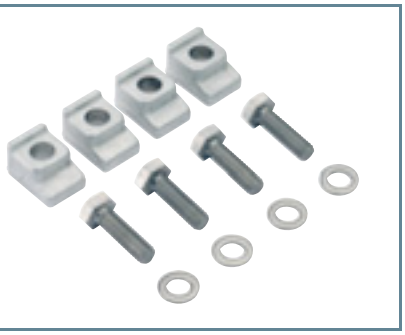
Installation materials for the safest possible mounting of turbopumps.

Mounting kits	Order number
Mounting kit for HiPace 10, DN 25 ISO-KF, including centering ring with 4 claws, screws and U-washers	**PM 016 627-T**
Mounting kit for HiPace 80, DN 40 ISO-KF, including centering ring and clamping ring	**PM 016 625-T**
Mounting kit for HiPace 80, DN 63 ISO-K, including coated centering ring, bracket screws	**PM 016 360-T**
Mounting kit for HiPace 300, DN 100 ISO-K, including coated centering ring, bracket screws	**PM 016 365-T**
Mounting kit for HiPace 400, DN 100 ISO-K, including coated centering ring	**PM 016 380-T**
Mounting kit for HiPace 700, DN 160 ISO-K, including coated centering ring, bracket screws	**PM 016 375-T**
Mounting kit for HiPace 1200, DN 200 ISO-K, including coated centering ring, bracket screws	**PM 016 390-T**
Mounting kit for HiPace 1500, DN 250 ISO-K, including coated centering ring, bracket screws	**PM 016 395-T**
Mounting kit for HiPace 1800, DN 200 ISO-K, including coated centering ring, bracket screws	**PM 016 410-T**
Mounting kit for HiPace 2300, DN 250 ISO-K, including coated centering ring, bracket screws	**PM 016 415-T**
Mounting kit for HiPace 2400 MC, DN 250 ISO-K, including coated centering ring, bracket screws	**PM 016 420-T**
Mounting kit for HiPace 80, DN 63 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 362-T**
Mounting kit for HiPace 300, DN 100 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 367-T**
Mounting kit for HiPace 400, DN 100 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 382-T**
Mounting kit for HiPace 700, DN 160 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 377-T**
Mounting kit for HiPace 1200, DN 200 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 392-T**
Mounting kit for HiPace 1500, DN 250 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 397-T**
Mounting kit for HiPace 1800, DN 200 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 412-T**
Mounting kit for HiPace 2300, DN 250 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 417-T**
Mounting kit for HiPace 2400 MC, DN 250 ISO-K, including coated centering ring, protection screen, clamping screws	**PM 016 422-T**
Mounting kit for HiPace 80, DN 40 ISO-KF, splinter shield, clamping ring	**PM 016 626-T**
Mounting kit for HiPace 80, DN 63 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 361-T**
Mounting kit for HiPace 300, DN 100 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 366-T**
Mounting kit for HiPace 400, DN 100 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 381-T**
Mounting kit for HiPace 700, DN 160 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 376-T**
Mounting kit for HiPace 1200, DN 200 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 391-T**
Mounting kit for HiPace 1500, DN 250 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 396-T**
Mounting kit for HiPace 1800, DN 200 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 411-T**
Mounting kit for HiPace 2300, DN 250 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 416-T**
Mounting kit for HiPace 2400 MC, DN 250 ISO-K, including coated centering ring, splinter shield, bracket screws	**PM 016 421-T**

Mounting kits	Order number
Mounting kit for HiPace 80, DN 63 ISO-K to DN 63 ISO-F, including coated centering ring, claws	**PM 016 510-T**
Mounting kit for HiPace 300 and HiPace 400, DN 100 ISO-F, including coated centering ring, hexagon screws	**PM 016 450-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, hexagon screws	**PM 016 460-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, hexagon screws	**PM 016 470-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400 MC, DN 250 ISO-F, including coated centering ring, hexagon screws	**PM 016 480-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, hexagon screws	**PM 016 490-T**
Mounting kit for HiPace 80, DN 63 ISO-K to DN 63 ISO-F, including coating centering ring, protection screen, claws	**PM 016 512-T**
Mounting kit for HiPace 300 und HiPace 400, DN 100 ISO-F, including coated centering ring, protection screen, hexagon screws	**PM 016 452-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, protection screen, hexagon screws	**PM 016 462-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, protection screen, hexagon screws	**PM 016 472-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400MC, DN 250 ISO-F, including coated centering ring, protection screen, hexagon screws	**PM 016 482-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, protection screen, hexagon screws	**PM 016 492-T**
Mounting kit for HiPace 80, from DN 63 ISO-K to DN 63 ISO-F, including coated centering ring, splinter and claws	**PM 016 511-T**
Mounting kit for HiPace 300 and HiPace 400, DN 100 ISO-F, including coated centering ring, splinter shield, hexagon screws	**PM 016 451-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, splinter shield, hexagon screws	**PM 016 461-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, splinter shield, hexagon screws	**PM 016 471-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400 MC, DN 250 ISO-F, including coated centering ring, splinter shield, hexagon screws	**PM 016 481-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, splinter shield, hexagon screws	**PM 016 491 -T**
Mounting kit for HiPace 300 and HiPace 400, DN 100 ISO-F, including coated centering ring, stud screws	**PM 016 455-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, stud screws	**PM 016 465-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, stud screws	**PM 016 475-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400 MC, DN 250 ISO-F, including coated centering ring, stud screws	**PM 016 485-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, stud screws	**PM 016 495-T**
Mounting kit for HiPace 300 and HiPace 400, DN 100 ISO-F, including coated centering ring, protection screen, stud screws	**PM 016 457-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, protection screen, stud screws	**PM 016 467-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, protection screen, stud screws	**PM 016 477-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400 MC, DN 250 ISO-F, including coated centering ring, protection screen, stud screws	**PM 016 487-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, protection screen, stud screws	**PM 016 497-T**
Mounting kit for HiPace 300 and HiPace 400, DN 100 ISO-F, including coated centering ring, splinter shield, stud screws	**PM 016 456-T**
Mounting kit for HiPace 700, DN 160 ISO-F, including coated centering ring, splinter shield, stud screws	**PM 016 466-T**
Mounting kit for HiPace 1200 and HiPace 1800, DN 200 ISO-F, including coated centering ring, splinter shield, stud screws	**PM 016 476-T**
Mounting kit for HiPace 1500, HiPace 2300 and HiPace 2400 MC, DN 250 ISO-F, including coated centering ring, splinter shield, stud screws	**PM 016 486-T**
Mounting kit for HiPace 3400 MC, DN 320 ISO-F, including coated centering ring, splinter shield, stud screws	**PM 016 496-T**

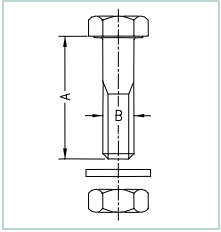
Mounting materials

Mounting materials



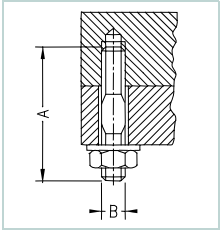
Set of hexagon screws

Required torque 22 Nm

Dimensions	Material	Nominal diameter	A	B	C	Order number
	Stainless steel	DN 63 CF	45	M8	8	**PM 016 683-T**
	Stainless steel	DN 100 CF	50	M8	16	**PM 016 690-T**
	Stainless steel	DN 160 CF	55	M8	20	**PM 016 691-T**
	Stainless steel	DN 200 CF	60	M8	24	**PM 016 687-T**
	Stainless steel	DN 250 CF	60	M8	32	**PM 016 694-T**
	C = quantity delivered					

Set of stud screws

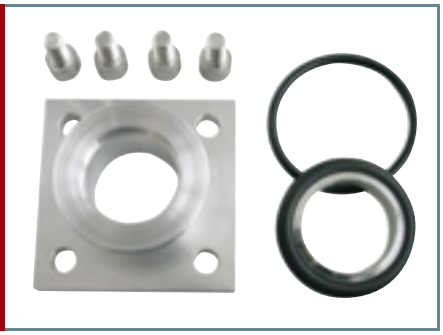
Required torque 22 Nm

Dimensions	Material	Nominal diameter	A	B	C	Order number
	Stainless steel	DN 63 CF	39	M8	8	**PM 016 684-T**
	Stainless steel	DN 100 CF	39	M8	16	**PM 016 692-T**
	Stainless steel	DN 160 CF	44	M8	20	**PM 016 693-T**
	Stainless steel	DN 200 CF	47	M8	24	**PM 016 688-T**
	Stainless steel	DN 250 CF	47	M8	32	**PM 016 695-T**
	C = quantity delivered					

General accessories

These accessories broaden the range of potential applications and offer maximum reliability.

General accessories



A maximum of 4 controllable accessories can be connected to HiPace turbopumps with TC 400 and TC 1200 drive electronics.
A maximum of 2 controllable accessories can be connected to HiPace turbopumps with TC 110 drive electronics.
Connection cable PM061351-T is required for connecting accessories.

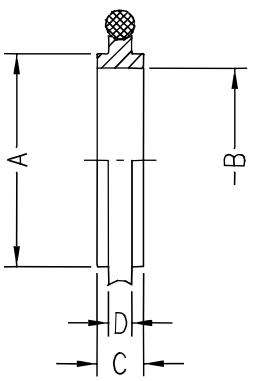
General accessories	Order number
Sealing gas valve for HiPace 80	**PM Z01 310**
Sealing gas valve for HiPace 300 with TC 110	**PM Z01 311**
Sealing gas valve for HiPace 300, 400 and 700 with TC 400	**PM Z01 312**
Sealing gas valve for HiPace 1200,1500,1800,2300	**PM Z01 313**
Sealing gas throttle for HiPace 80	**PM Z01 316**
Sealing gas throttle for HiPace 300,400 and 700	**PM Z01 317**
Sealing gas throttle for HiPace 1200,1500,1800,2300	**PM Z01 318**
Connecting adapter TPD 011 - DN 25 ISO-KF	**PM 093 315-T**
USB Converter to RS-485 interface	**PM 061 207-T**
TIC 001, Serial Interface Converter RS-232/RS-485	**PM 051 054-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**
Interface cable, 3 m, M 12	**PM 061 283-T**
Y-connector, M12, for RS-485	**P 4723 010**
Y-connector, M12 for accessories	**P 4723 012**

Centering rings, protection screens, splinter shields

These elements offer maximum protection against foreign objects with the lowest conductivity losses. Optimally matched to the respective pump size, engineered in accordance with the latest containment analysis findings.

Centering rings, protection screens, splinter shields

Dimensions



Centering ring

Centering ring

Centering ring	Material	Nominal diameter	A	B	C	D	Order number
Centering ring, DN 25 ISO-KF pumps	FPM/ aluminium	DN 25 ISO-KF	26	25	8	3.9	**PF 110 125-T**
Centering ring, DN 40 ISO-KF pumps	Neoprene/ aluminium	DN 40 ISO-KF	41	40	8	3.9	**PF 110 140-T**

Centering ring, with integrated mesh screen

Centering ring, with integrated mesh screen	Material	Nominal diameter	A	B	C	D	Order number
Centering ring, with integrated mesh screen, DN 25 ISO-KF	FPM/stainless steel	DN 25 ISO-KF	26	19.5	8	3.9	**PF 113 225-T**
Centering ring, with integrated mesh screen, DN 40 ISO-KF	FPM/stainless steel	DN 40 ISO-KF	41	32	8	3.9	**PF 113 240-T**

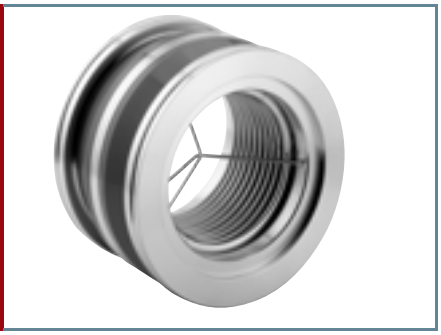
Centering rings, protection screens, splinter shields

Centering rings, protection screens, splinter shields	Screen conductance l/s for N_2	Order number
Centering ring, with multifunction coating, DN 63 ISO-K/-F pumps		**PM 016 206-U**
Centering ring, with multifunction coating, DN 100 ISO-K/-F pumps		**PM 016 210-U**
Centering ring, with multifunction coating, DN 160 ISO-K/-F pumps		**PM 016 216-U**
Centering ring, with multifunction coating, DN 200 ISO-K/-F pumps		**PM 016 220-U**
Centering ring, with multifunction coating, DN 250 ISO-K/-F pumps		**PM 016 225-U**
Centering ring, with multifunction coating, DN 250 ISO-K/-F pumps		**PM 016 232-U**
Centering ring, with multifunction coating and integrated protection screen, DN 63 ISO-K/-F	303	**PM 016 208-U**
Centering ring, with multifunction coating and integrated protection screen, DN 100 ISO-K/-F	763	**PM 016 212-U**
Centering ring, with multifunction coating and integrated protection screen, DN 160 ISO-K/-F	1952	**PM 016 218-U**
Centering ring, with multifunction coating and integrated protection screen, DN 200 ISO-K/-F	3051	**PM 016 222-U**
Centering ring, with multifunction coating and integrated protection screen, DN 250 ISO-K/-F	4767	**PM 016 227-U**
Zentrierring, mit Multifunktionsbeschichtung und integriertem Schutzgitter, DN 320 ISO-K/-F	1250	**PM 016 234-U**
Centering ring, with integrated splinter shield, DN 40 ISO-KF	41	**PM 006 375-X**
Centering ring, with multifunction coating and integrated splinter shield, DN 63 ISO-K/-F	194	**PM 016 207-U**
Centering ring, with multifunction coating and integrated splinter shield, DN 100 ISO-K/-F	488	**PM 016 211-U**
Centering ring, with multifunction coating and integrated splinter shield, DN 160 ISO-K/-F	1250	**PM 016 217-U**
Centering ring, with multifunction coating and integrated splinter shield, DN 200 ISO-K/-F	1952	**PM 016 221-U**
Centering ring, with multifunction coating and integrated splinter shield, DN 250 ISO-K/-F	3051	**PM 016 226-U**
Centering ring, with multifunction coating and integrated splinter shield, DN 320 ISO-K/-F	3051	**PM 016 333-U**
Protection screen, DN 63 CF-F	303	**PM 016 333**
Protection screen, DN 100 CF-F	763	**PM 016 336**
Protection screen, DN 160 CF-F	1952	**PM 016 339**
Protection screen, DN 200 CF-F	3051	**PM 016 342**
Protection screen, DN 250 CF-F	4767	**PM 016 345**
Splinter screen, DN 63 CF-F	194	**PM 016 312**
Splinter screen, DN 100 CF-F	488	**PM 016 315**
Splinter screen, DN 160 CF-F	1250	**PM 016 318**
Splinter screen, DN 200 CF-F	1952	**PM 016 321**
Splinter screen, DN 250 CF-F	3051	**PM 016 324**

Vibration dampers

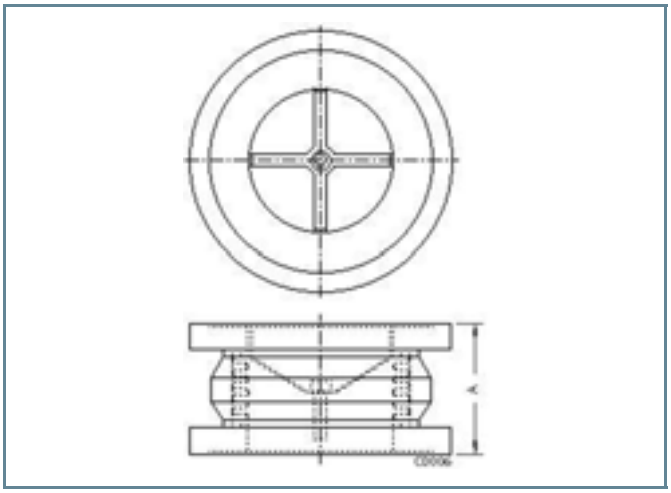
For employment of turbopumps on systems and plants that are extremely sensitive to vibration. Reliable damping in vertical attitude. Integral securing means eliminate the need for support.

Vibration dampers



- For the employment of turbopumps on systems and plants that are extremely sensitive to vibration
- The reduced conductivity must be taken into consideration in dimensioning the pump system

Dimensions



Vibration dampers

Vibration dampers	A	Order number
Vibration damper for HiPace 80, DN 63 ISO-K	87 mm	**PM 006 800-X**
Vibration damper for HiPace 80, DN 63 CF-F	98 mm	**PM 006 801-X**
Vibration damper for HiPace 80, DN 40 ISO-KF	85 mm	**PM 006 799-X**
Vibration damper for HiPace 300 and HiPace 400, DN 100 ISO-K	84 mm	**PM 006 459-X**
Vibration damper for HiPace 300 and HiPace 400, DN 100 CF-F	99 mm	**PM 006 488-X**
Vibration damper for HiPace 700, DN 160 ISO-K	84 mm	**PM 006 492-X**
Vibration damper for HiPace 700, DN 160 CF-F	104 mm	**PM 006 493-X**
Vibration damper for HiPace 1200 and HiPace 1800, DN 200 ISO-K	83 mm	**PM 006 668-X**
Vibration damper for HiPace 1200, DN 200 CF-F	108 mm	**PM 006 669-X**
Vibration damper for HiPace 1500 and HiPace 2300, DN 250 ISO-K	84 mm	**PM 006 670-X**
Vibration damper for HiPace 1500 and HiPace 2300, DN 250 CF-F	112 mm	**PM 006 671-X**

Notes

Vacuum measurement and control units

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Vacuum measurement and control units

Selection aid

● Recommended
▲ Possible

		Measurement range		Application					
		max. (mbar)	min. (mbar)	Vacuum furnaces	Sputterring	Evaporation Chambers	Reactive Processes	Loadlock	Acceleratorr
Transmitter / Gauges									
DigiLine™									
Digital Piezo Transmitter	CPT 100	2,000	1	▲	▲	▲	▲	▲	
Digital Pirani Transmitter	PPT 100	1,000	$1 \cdot 10^{-4}$	●	▲	●	▲	●	
Digital Piezo/Pirani Transmitter	RPT 100	1,200	$1 \cdot 10^{-4}$	●	▲	●	▲	●	
Digital Pirani/Kaltkathode Transmitter	MPT 100	1,000	$5 \cdot 10^{-9}$	●	●	●	●	▲	▲
Digital Pirani/Bayard-Alpert Transmitter	HPT 100	1,000	$1 \cdot 10^{-9}$	▲	●				
ActiveLine									
Active Piezo Transmitter	APR 250	1,100	$1 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 260	1,100	$1 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 262	2,200	$2 \cdot 10^{-1}$	▲	▲	▲	▲	▲	
	APR 265	5,500	0,5	▲	▲	▲	▲	▲	
	APR 266	11,000	1	▲	▲	▲	▲	▲	
	APR 267	55,000	5	▲	▲	▲	▲	▲	
Active Capacitance Transmitter	CMR 361	1.100	$1 \cdot 10^{-1}$	▲	●	●	●		
Temperature compensated	CMR 362	110	$1 \cdot 10^{-2}$	▲	●	●	●		
	CMR 363	11	$1 \cdot 10^{-3}$	▲	●	●	●		
	CMR 364	1.1	$1 \cdot 10^{-4}$	▲	●	●	●		
	CMR 365	0.11	$1 \cdot 10^{-5}$	▲	●	●	●		
Temperature regulated	CMR 271	1,100	$1 \cdot 10^{-1}$	▲	●	●	●		
	CMR 272	110	$1 \cdot 10^{-2}$	▲	●	●	●		
	CMR 273	11	$1 \cdot 10^{-3}$	▲	●	●	●		
	CMR 274	1.1	$1 \cdot 10^{-4}$	▲	●	●	●		
	CMR 275	0.11	$1 \cdot 10^{-5}$	▲	●	●	●		
Active Pirani Transmitter	TPR 280	1,000	$5 \cdot 10^{-4}$	●	▲	▲		▲	
	TPR 281	1,000	$5 \cdot 10^{-4}$	●	▲	▲	▲	▲	
Active Pirani / Capacitance Transmitter	PCR 260	1,500	$5 \cdot 10^{-4}$	●	▲	▲		●	
Active Cold Cathode Transmitter	IKR 251	0.01	$2 \cdot 10^{-9}$	▲	▲	●	▲		
	IKR 261	0.01	$2 \cdot 10^{-9}$	▲	▲	●	▲		
	IKR 270	0.01	$5 \cdot 10^{-11}$	▲	▲	●	▲		
Active Cold Cathode Transmitter	PKR 251	1,000	$5 \cdot 10^{-9}$	▲	▲	▲	▲		
	PKR 261	1,000	$5 \cdot 10^{-9}$	▲	▲	▲	▲		
Active Hot Cathode Transmitter	IMR 265	1,000	$2 \cdot 10^{-6}$	▲	●	▲			
Active Pirani Bayard-Alpert Transmitter	PBR 260	1,000	$5 \cdot 10^{-10}$	▲	▲	▲	▲		
ModulLine									
Pirani pressure gauge	TPR 010	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	▲	▲	▲
	TPR 017	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	▲	▲	●
	TPR 018	1,000	$8 \cdot 10^{-4}$	▲	▲	▲	●	▲	●
Cold Cathode pressure gauge	IKR 050	$5 \cdot 10^{-3}$	$2 \cdot 10^{-9}$	▲	▲	●	▲		●
	IKR 060	$5 \cdot 10^{-3}$	$1 \cdot 10^{-10}$	▲	▲	●	▲		●
	IKR 070	$5 \cdot 10^{-3}$	$1 \cdot 10^{-11}$	▲	▲	●	▲		●

Measurement and analysis equipment

Many vacuum applications operate only in a given pressure range. Analog and digital vacuum and total pressure measurement equipment is used to determine and regulate the total pressure in a vacuum system. Pfeiffer Vacuum offers three different series of equipment for total pressure measurement.

The criteria used in selecting the sensor will depend upon the differing conditions:

- Pressure range to be detected
- Gas composition (inert or corrosive)
- Required accuracy and repeatability
- Ambient conditions, radioactivity

Each series, in its own right, covers the entire pressure range. This means that Pfeiffer Vacuum supplies you with the best solution for your total pressure measurement task, matched to the pump technology in question.

Series at a glance

- **DigiLine**

Total pressure measurement with digital signal output

- **ActiveLine**

Total pressure measurement with analog signal output

- **ModulLine**

Total pressure measurement in radioactive environments

Total pressure measurement with an HPT 100 on a coating system

Employment of an HPT 100 on a calibration pumping station

Integration of an HPT 100 into a plant control system via Profibus

DigiLine™

Innovative Vacuum Measurement!
Digital Transmitters.

What is DigiLine?
The sensors in the DigiLine series are supplied with a 24 V direct current. The measured values are output via a digital RS-232 or RS-485 interface. The DPG 101 power supply can be used to operate individual transmitters (combinations of sensor and electronics) and display their measured values. The DPG 109 can supply up to nine transmitters. Transmitter signals can also be presented and processed directly on a PC or PLC with the aid of DokuStar Plus software.

Converters can be used to convert the RS-485 signal to a fieldbus signal (Profibus-DP or DeviceNet), enabling it to be utilized in plant control systems with fieldbus control, which affords simple and cost-effective cabling.

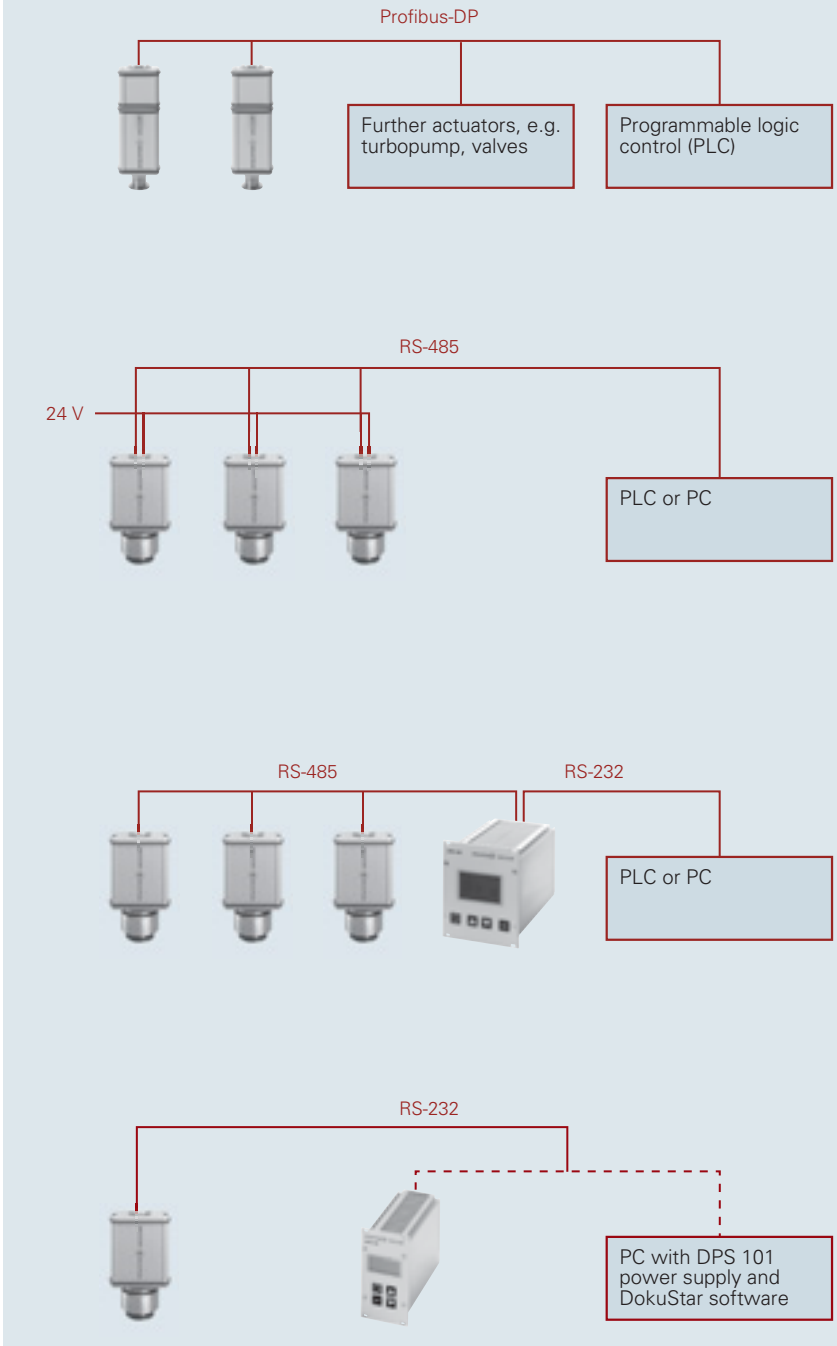
- **Fieldbus solution**
  Bus system for a uniform system control concept. Transmitter with attached Profibus converter. For up to 126 units.

- **Customer-specific solution**
  Data is input directly into a PLC or a PC (software DokuStar Plus). Up to 32 units (up to 15 transmitters can be addressed).

- **Combination solution**
  Operation of up to 9 transmitters with display unit DPG 109. Very simple calibration through the DPG 109. Data can be input directly to the PLC or a PC.

  Alternative: Power supply without a display through the power supply DPS 109.

- **Single solution**
  Operation of one transmitter with the display unit DPG 101. Very simple calibration through the DPG 101. Alternatively, the data can be input directly to a PC using the power supply DPS 101.



DigiLine™ application concepts

Vacuum measurement and control units

Advantages at a glance

Perfect for the industry

- Reliable data transfer through digital signals
- Serial interface RS-232/485 selectable
- Components freely combinable
- Data can be directly input to a PC
- With Profibus converter for integration in system controllers
- Suited for heavy duty industrial applications
- Directly transferable values, i. e., no complex characteristics are necessary
- Very easy to calibrate
- Connecting up all components without problems
- Low wiring complexity

Applications

- Coating systems
- Vacuum furnaces
- Accelerators
- Mass spectrometers
- Semiconductor production
- Leak detection systems

HPT 100 (Pirani/Bayard-Alpert) and CPT 100 (Piezo) on a vacuum furnace for producing sintered metals

RPT 100 (Piezo/Pirani) replaces in a helium leak detection unit two conventionalgauge heads. Data transfer through Profibus module

Notes

DigiLine™

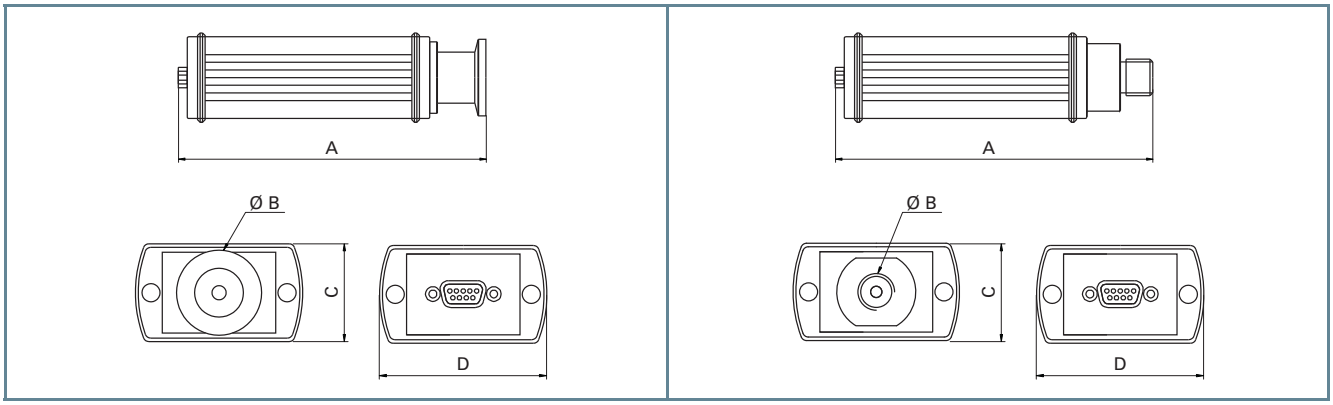
Digital Piezo transmitter CPT 100
Piezo (1-2000 mbar)

DigiLine™

- ▶ Accurate
- ▶ Rugged
- ▶ For industrial applications

G = Cylindrical pipe thread

Dimensions



DN 16 ISO-KF

G 1/4"

	DN 16 ISO-KF	G 1/4"
A	120 mm	120 mm
B	30 mm	G 1/4"
C	35 mm	35 mm
D	60 mm	60 mm

Technical data	Digital Piezo transmitter CPT 100, DN 16 ISO-KF	Digital Piezo transmitter CPT 100, G1/4"
Flange (in)	DN 16 ISO-KF	G 1/4"
Seal	FPM	FPM
Pressure max.	4 bar	4 bar
Feedthrough	Glass	Glass
Flange	DN 16 ISO-KF	G 1/4"
Accuracy: % of measurement	1-1200 mbar: +/- 0.5 % F.S. >1200 mbar: +/-2 % F.S.	1-1200 mbar: +/- 0.5 % F.S. >1200 mbar: +/-2 % F.S.
Weight	0.2 kg	0.2 kg
Materials in contact with media	Ceramic, Stainless steel, FPM	Ceramic, Stainless steel, FPM
Measurement range max.	2000 mbar	2000 mbar
Measurement range min.	1 mbar	1 mbar
Sensor cable length max.	1000 m	1000 m
Method of measurement	Piezo	Piezo
Measuring cycle	40 ms	40 ms
Interface: Connection	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket
Protection category	IP 40 / IP 54	IP 40 / IP 54
Temperature: Bakeout	70 °C	70 °C
Temperature: Operating	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-40 - +60 °C	-40 - +60 °C
Supply: Voltage	24 V DC	24 V DC
Supply: Power consumption max.	0.5 W	0.5 W

Order number		
Digital Piezo transmitter CPT 100	**PT R31 130**	**PT R31 230**

Accessories		
TIC 251, Profibus converter for CPT 100, PPT 100, RPT 100	**PT 348 110**	**PT 348 110**
TIC 002, converter for DigiLine™ Transmitter	**PM 051 519-T**	**PM 051 519-T**
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	
Fine filter for TPR 265, pore size 0.0004 mm	**PT 120 132-T**	
Centering ring, with fine filter, DN 16 ISO-KF	**PT 120 132-T**	

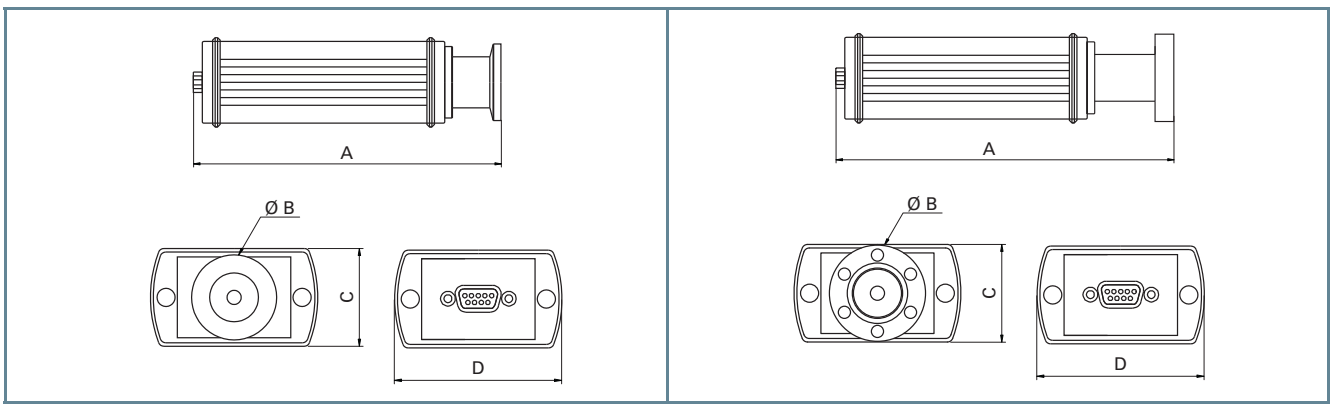
DigiLine™

Digital Piezo/Pirani transmitter RPT 100
Piezo/Pirani combination
(1·10^{-4} - 1200 mbar)

DigiLine™

- Measurement range from 1·10^{-4} mbar to 1200 mbar
- For industrial applications with Profibus interface
- Highly accurate throughout the entire measurement range

Dimensions



DN 16 ISO-KF

DN 16 CF

	DN 16 ISO-KF	DN 16 CF
A	120 mm	132 mm
B	30 mm	34 mm
C	35 mm	35 mm
D	60 mm	60 mm

Technical data	Digital Piezo/ Pirani transmitter RPT 100, DN 16 ISO-KF	Digital Piezo/ Pirani transmitter RPT 100, DN 16 CF
Flange (in)	DN 16 ISO-KF	DN 16 CF
Seal	Metal	Metal
Pressure max.	4 bar	4 bar
Feedthrough	Glass	Glass
Flange	DN 16 ISO-KF	DN 16 CF
Accuracy: % of measurement	5-1200 mbar: +/- 0.5 % F.S. $1 \cdot 10^{-3}$ - 1 mbar: +/-5 %	5-1200 mbar: +/- 0.5 % F.S. $1 \cdot 10^{-3}$ - 1 mbar: +/-5 %
Weight	0.2 kg	0.2 kg
Materials in contact with media	Tungsten, Gold, Silicon	Tungsten, Gold, Silicon
Measurement range max.	1200 mbar	1200 mbar
Measurement range min.	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Sensor cable length max.	1000 m	1000 m
Method of measurement	Piezo / Pirani	Piezo / Pirani
Measuring cycle	40 ms	40 ms
Interface: Connection	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket
Protection category	IP 40 / IP 54	IP 40 / IP 54
Temperature: Bakeout	70 °C	70 °C
Temperature: Operating	+5 - + 50 °C	+5 - + 50 °C
Temperature: Storage	-40 - +60 °C	-40 - +60 °C
Supply: Voltage	24 V DC	24 V DC
Supply: Power consumption max.	2 W	2 W
Repeatability: % of measurement	5-1200 mbar: +/- 0.5 % F.S. $1 \cdot 10^{-3}$ - 1 mbar: +/- 1 %	5-1200 mbar: +/- 0.5 % F.S. $1 \cdot 10^{-3}$ - 1 mbar: +/- 1 %

Order number		
Digital Piezo/Pirani transmitter RPT 100	**PT R32 130**	**PT R32 330**

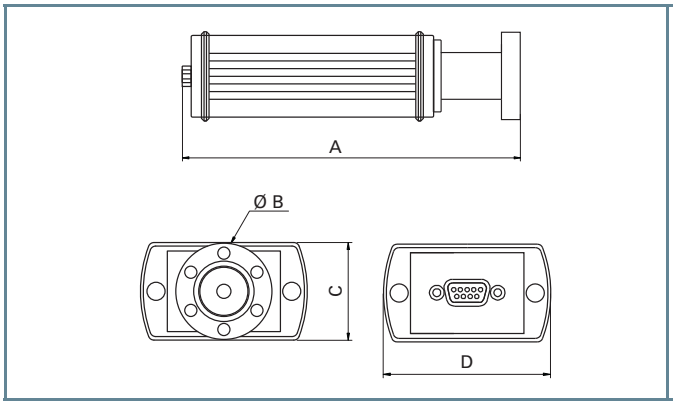
Accessories		
TIC 251, Profibus converter for CPT 100, PPT 100, RPT 100	**PT 348 110**	**PT 348 110**
TIC 002, converter for DigiLine™ Transmitter	**PM 051 519-T**	**PM 051 519-T**
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	
Centering ring, with fine filter, DN 16 ISO-KF	**PT 120 132-T**	

DigiLine™ Digital Pirani transmitter PPT 100 Pirani ($1 \cdot 10^{-4}$ - 1000 mbar)

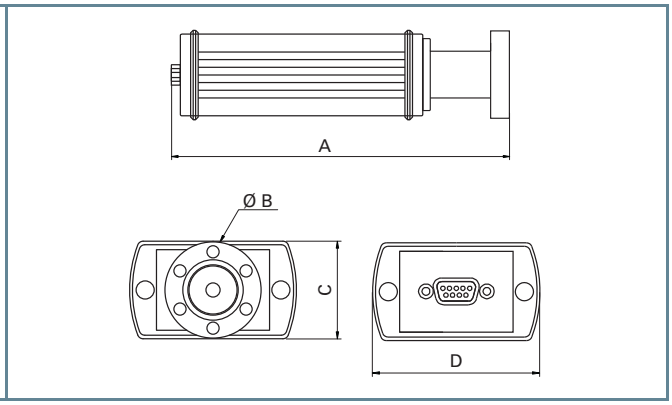
DigiLine™

- Measurement range from $1 \cdot 10^{-4}$ mbar to 1000 mbar
- Extremely accurate
- For industrial applications with Profibus interface

Dimensions



DN 16 ISO-KF



DN 16 CF

	DN 16 ISO-KF	DN 16 CF
A	120 mm	132 mm
B	30 mm	34 mm
C	35 mm	35 mm
D	60 mm	60 mm

Technical data	Digital Pirani transmitter PPT 100, DN 16 ISO-KF	Digital Pirani transmitter PPT 100, DN 16 CF
Flange (in)	DN 16 ISO-KF	DN 16 CF
Seal	Metal	Metal
Pressure max.	4 bar	4 bar
Feedthrough	Glass	Glass
Flange	DN 16 ISO-KF	DN 16 CF
Accuracy: % of measurement	$1 \cdot 10^{-3}$ - 1mbar: +/-5 %	$1 \cdot 10^{-3}$ - 1mbar: +/-5 %
Weight	0.2 kg	0.2 kg
Materials in contact with media	Tungsten, stainless steel	Tungsten, stainless steel
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Sensor cable length max.	1000 m	1000 m
Method of measurement	Pirani	Pirani
Measuring cycle	40 ms	40 ms
Interface: Connection	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket
Protection category	IP 40 / IP 54	IP 40 / IP 54
Temperature: Bakeout	70 °C	70 °C
Temperature: Operating	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-40 - +60 °C	-40 - +60 °C
Supply: Voltage	24 V DC	24 V DC
Supply: Power consumption max.	2 W	2 W
Repeatability: % of measurement	$1 \cdot 10^{-3}$ - 1mbar: +/-1 %	$1 \cdot 10^{-3}$ - 1mbar: +/-1 %

Order number		
Digital Pirani transmitter PPT 100	**PT R33 130**	**PT R33 330**

Accessories		
TIC 251, Profibus converter for CPT 100, PPT 100, RPT 100	**PT 348 110**	**PT 348 110**
TIC 002, converter for DigiLine™ Transmitter	**PM 051 519-T**	**PM 051 519-T**
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	
Centering ring, with fine filter, DN 16 ISO-KF	**PT 120 132-T**	

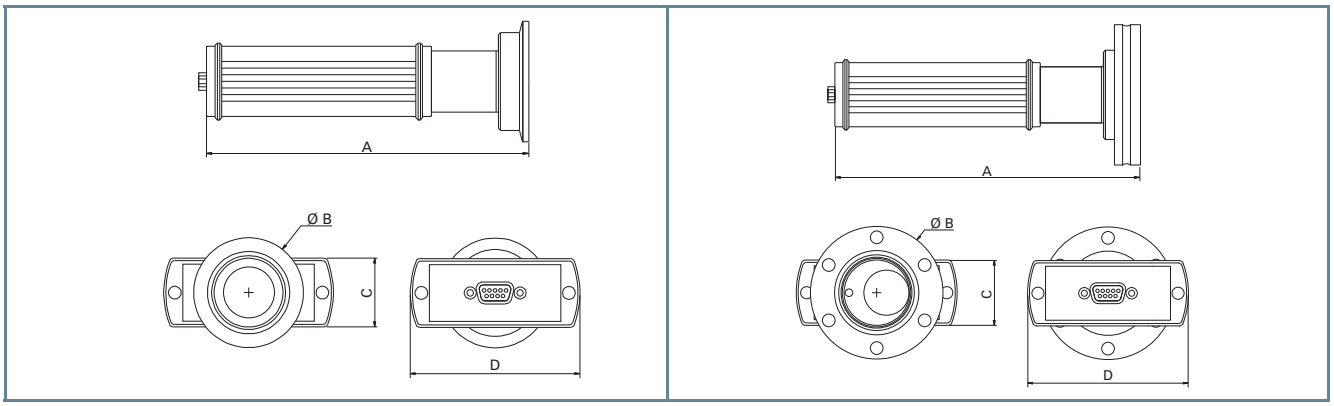
DigiLine™

Digital Pirani/Bayard-Alpert transmitter HPT 100 Pirani/Bayard-Alpert combination ($1 \cdot 10^{-9}$ - 1000 mbar)

DigiLine™

- Measurement range from $1 \cdot 10^{-9}$ mbar to 1000 mbar
- Extremely accurate
- For industrial applications with Profibus interface
- Highly reliable with 2 filaments

Dimensions



DN 40 ISO-KF DN 40 CF

	DN 40 ISO-KF	DN 40 CF
A	147 mm	156 mm
B	55 mm	70 mm
C	35 mm	35 mm
D	85 mm	85 mm

Technical data	Digital Pirani/ Bayard-Alpert transmitter HPT 100, DN 40 ISO-KF	Digital Pirani/ Bayard-Alpert transmitter HPT 100, DN 40 CF
Flange (in)	DN 40 ISO-KF	DN 40 CF
Number of filaments	2	2
Seal	Metal	Metal
Pressure max.	4 bar	4 bar
Feedthrough	Glass, Ceramic	Glass, Ceramic
Filament	iridium yttriated, twice	Iridium yttriated, twice
Flange	DN 40 ISO-KF	DN 40 CF
Accuracy: % of measurement	$1 \cdot 10^{-7}$ - 1 mbar: +/- 10 %	$1 \cdot 10^{-7}$ - 1 mbar: +/- 10 %
Weight	0.4 kg	0.4 kg
Materials in contact with media	Tungsten, stainless steel, nickel	Tungsten, stainless steel, nickel
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar
Sensor cable length max.	1000 m	1000 m
Method of measurement	Pirani/Bayard-Alpert	Pirani/Bayard-Alpert
Measuring cycle	40 ms	40 ms
Interface: Connection	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket
Protection category	IP 40 / IP 54	IP 40 / IP 54
Temperature: Bakeout (electronics removed)	180 °C	180 °C
Temperature: Operating	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-40 - +60 °C	-40 - +60 °C
Supply: Voltage	24 V DC	24 V DC
Supply: Power consumption max.	7.5 W	7.5 W
Repeatability: % of measurement	$1 \cdot 10^{-7}$ - 1 mbar: +/- 5 %	$1 \cdot 10^{-7}$ - 1 mbar: +/- 5 %

Order number		
Digital Pirani/Bayard-Alpert transmitter HPT 100	**PT R34 130**	**PT R34 330**

Accessories		
TIC 252, Profibus converter for HPT 100, MPT 100	**PT 348 111**	**PT 348 111**
TIC 002, converter for DigiLine™ Transmitter	**PM 051 519-T**	**PM 051 519-T**

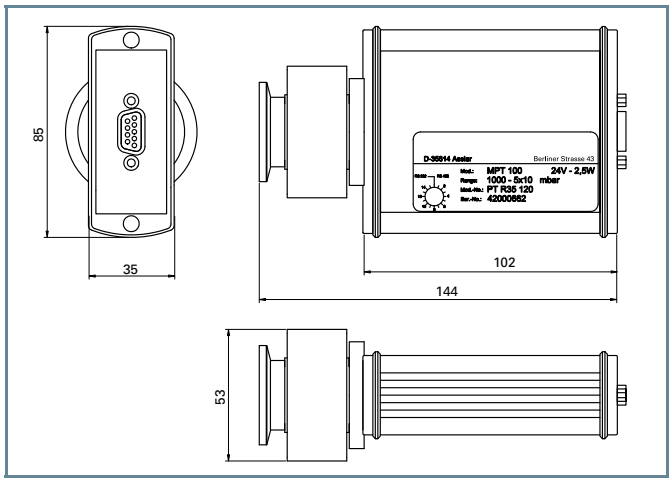
DigiLine™

Digital Pirani/cold cathode transmitter MPT 100
Pirani/cold cathode combination ($5 \cdot 10^{-9}$ - 1000 mbar)

DigiLine™

- ▶ Broad measurement range from $5 \cdot 10^{-9}$ to 1000 mbar
- ▶ Combination of a Pirani and cold cathode sensor
- ▶ Insensitive to gas ingress
- ▶ More rugged than hot cathodes
- ▶ Highly accurate
- ▶ Compatible with DigiLine controllers and accessories

Dimensions



Digital Pirani/cold cathode transmitter MPT 100

Technical data	Digital Pirani/ cold cathode transmitter MPT 100, DN 25 ISO-KF	Digital Pirani/ cold cathode transmitter MPT 100, DN 40 ISO-KF	Digital Pirani/ cold cathode transmitter MPT 100, DN 40 CF-R
Anode	Mo	Mo	Mo
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 40 CF-R
Seal	Metal	Metal	Metal
Pressure max.	4 bar	4 bar	4 bar
Feedthrough	Glass, ceramic	Glass, ceramic	Glass, ceramic
Accuracy: % of measurement	$1 \cdot 10^{-7}$ - $1 \cdot 10^{-2}$ mbar: +/- 25 %, $1 \cdot 10^{-2}$ - 100 mbar: +/-15 %	$1 \cdot 10^{-7}$ - $1 \cdot 10^{-2}$ mbar: +/- 25 %, $1 \cdot 10^{-2}$ - 100 mbar: +/-15 %	$1 \cdot 10^{-7}$ - $1 \cdot 10^{-2}$ mbar: +/- 25 %, $1 \cdot 10^{-2}$ - 100 mbar: +/-15 %
Weight	0,580 kg	0,580 kg	0,580 kg
Materials in contact with media	Tungsten, stainless steel, nickel	Tungsten, stainless steel, nickel	Tungsten, stainless steel, nickel
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Sensor cable length max.	1000 m	1000 m	1000 m
Method of measurement	Pirani / Cold Cathode	Pirani / Cold Cathode	Pirani / Cold Cathode
Measuring cycle	40 ms	40 ms	40 ms
Interface: Connection	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket	Digital RS-232 / RS-485, 9-pin, Sub-D-socket
Protection category	IP 40	IP 40	IP 40
Temperature: Bakeout (electronics removed)	180 °C	180 °C	180 °C
Temperature: Operating	+5 - +50 °C	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-40 - +60 °C	-40 - +60 °C	-40 - +60 °C
Supply: Voltage	24 V DC	24 V DC	24 V DC
Supply: Power consumption max.	2.5 W	2.5 W	2.5 W
Volume	9.5 cm^3	9.5 cm^3	9.5 cm^3
Repeatability: % of measurement	$1 \cdot 10^{-7}$ - 100 mbar: +/-5 %	$1 \cdot 10^{-7}$ - 100 mbar: +/-5 %	$1 \cdot 10^{-7}$ - 100 mbar: +/-5 %
Ignition aid	Stainless steel	Stainless steel	Stainless steel

Order number			
Digital Pirani/cold cathode transmitter MPT 100	**PT R35 120**	**PT R35 130**	**PT R35 330**

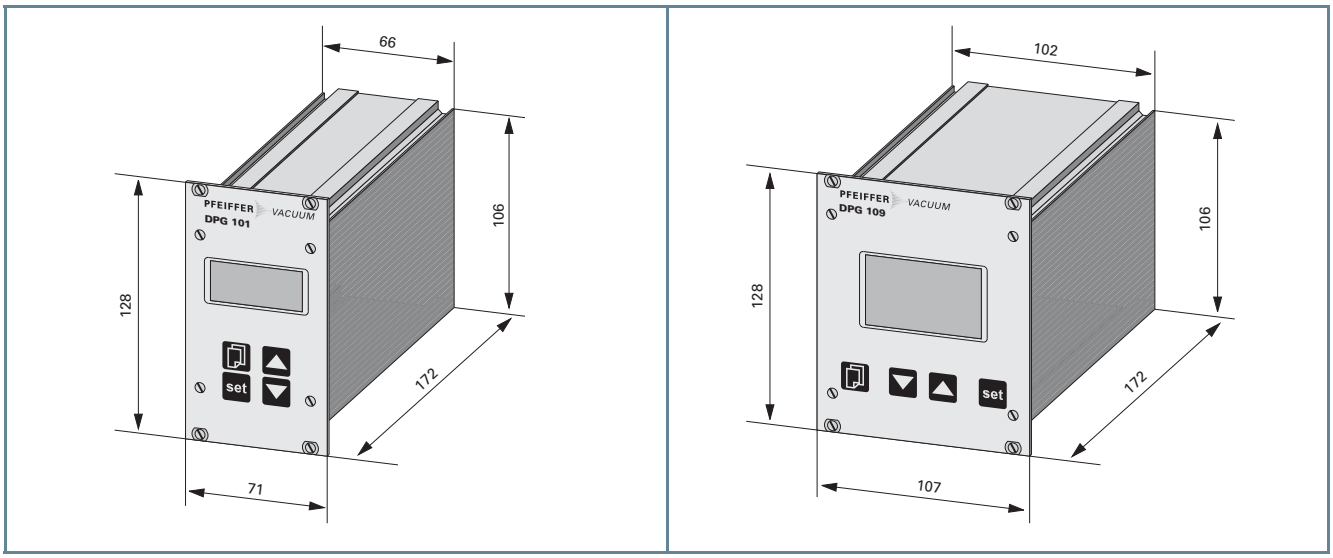
Accessories			
TIC 252, Profibus converter for HPT 100, MPT 100	**PT 348 111**	**PT 348 111**	**PT 348 111**

DigiLine™ Controllers
DPG 101, controller for 1 transmitter
DPG 109, controller for 9 transmitters

DigiLine™

▶ Controllers with 1 and 9 channels are suitable for operating the transmitters. Their intuitive operation affords simple transmitter calibration.

Dimensions



DPG 101, controller

DPG 109, controller

Technical data	DPG 101, controller for 1 transmitter	DPG 109, controller for 9 transmitters
Connections for transmitter	1	9 (max. 4 HPT 100)
Display	LCD-Display, backlit, four digit	LCD-Display, backlit, four digit
Weight	0.7 kg	1 kg
Measurement range max.	2000 mbar	2000 mbar
Measurement range min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Measurement rate	30 1/s	30 1/s
Mains requirement: frequency (range)	50/60 Hz	50/60 Hz
Mains requirement: power consumption	15 VA	48 VA
Mains requirement: voltage (range)	90 - 260 V AC	90 - 260 V AC
Set point: Voltage max.	260 V AC, 2 A; 50 V DC, 2 A	50 V AC, 3 A; 30 V DC, 3 A
Set point: Changeover contact, potential-free	2 pieces	8 pieces
Signal output: Measuring value, analog	0 - 10 V	-
Interface	-	RS-232-C
Temperature: Operating	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-20 - +60 °C	-20 - +50 °C

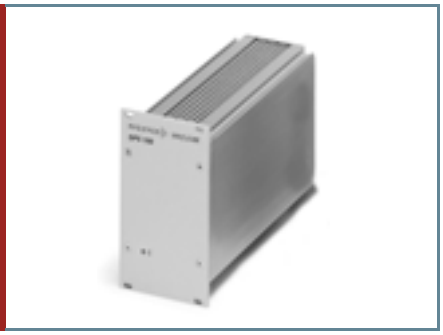
Order number		
Controllers	**PT G10 010**	**PT G15 010**

Accessories		
Transmitter connection cable, 10 m	**PT 348 210-T**	**PT 348 410-T**
Transmitter connection cable, 6 m	**PT 348 206-T**	**PT 348 406-T**
Transmitter connection cable, 3 m	**PT 348 203-T**	**PT 348 403-T**
Power cord, US plug, 2.5 m	**P4 564 309 YX**	**P4 564 309 YX**
Euro-style safety plug, 2.5 m	**P4 564 309 YU**	**P4 564 309 YU**
Power cord, Swiss plug, 2.5 m	**P4 564 309 YR**	**P4 564 309 YR**
Power cord, U.K. plug, 2.5 m	**P4 564 309 Y1**	**P4 564 309 Y1**
DokuStar Plus software		**PT 882 501**
PC data cable, 3 m		**PT 348 130-T**

DigiLine™

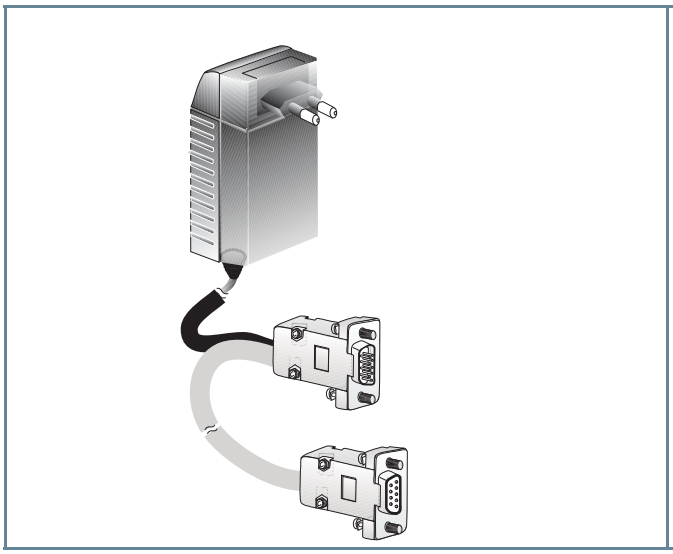
Power supply units without display
DPS 101, for 1 transmitter
DPS 109, for 9 transmitters

DigiLine™

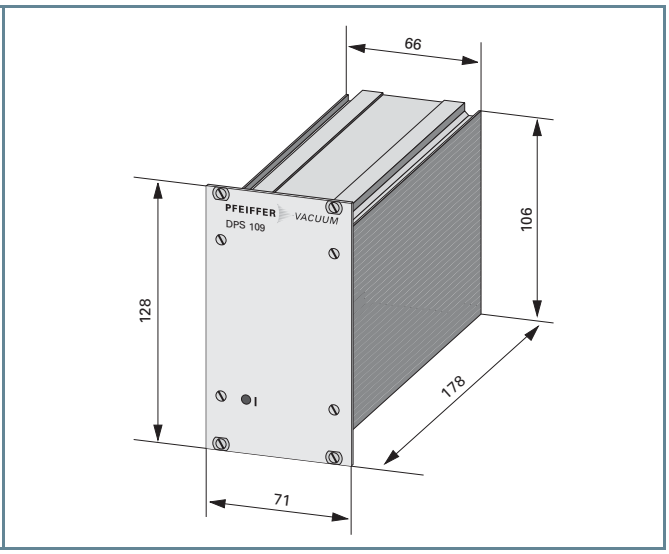


▶ Power supply units with either 1 or 9 channels are provided for operating the transmitters without an additional display. They can be connected with a PC or SPC via an RS-232 interface.

Dimensions



DPS 101, for 1 transmitter, EU plug



DPS 109, for 9 transmitters

Technical data	DPS 101, for 1 transmitter, EU plug	DPS 101, for 1 transmitter, US plug	DPS 101, for 1 transmitter, UK plug	DPS 109, for 9 transmitters
Weight	0.3 kg	0.3 kg	0.3 kg	0.7 kg
Measurement range max.	2000 mbar	2000 mbar	2000 mbar	2000 mbar
Measurement range min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Mains requirement: frequency (range)	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Mains requirement: power consumption	18 VA	18 VA	18 VA	48 VA
Mains requirement: voltage (range)	100 - 240 V	100 - 240 V	100 - 240 V	90 - 260 V
Interface	RS-232-C	RS-232-C	RS-232-C	RS-232
Software DokuStar	Included	Included	Included	-
Temperature: Operating	+5 - +50 °C	+5 - +50 °C	+5 - +50 °C	+5 - +50 °C
Temperature: Storage	-30 - +50 °C	-30 +50 °C	-30 - +50 °C	-20 - +60 °C

Order number				
Controllers	**PT G20 010**	**PT G20 011**	**PT G20 012**	**PT G25 010**

Accessories				
DokuStar Plus software				**PT 882 501**
Transmitter connection cable, 10 m				**PT 348 410-T**
Transmitter connection cable, 6 m				**PT 348 406-T**
Transmitter connection cable, 3 m				**PT 348 403-T**
Power cord, US plug, 2.5 m				**P4 564 309 YX**
Euro-style safety plug, 2.5 m				**P4 564 309 YU**
Power cord, Swiss plug, 2.5 m				**P4 564 309 YR**
Power cord, U.K. plug, 2.5 m				**P4 564 309 Y1**

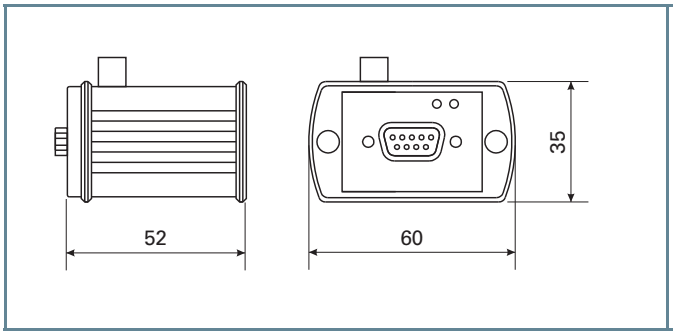
DigiLine™ accessories

TIC 251, Profibus converter
TIC 252, Profibus converter

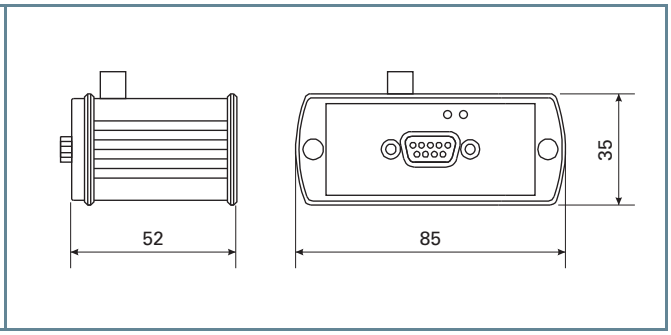
DigiLine™ accessories

- TIC 251, Profibus converter for CPT 100, PPT 100, RPT 100
- TIC 252, Profibus converter for HPT 100, MPT 100

Dimensions



TIC 251



TIC 252

Technical data	TIC 251, Profibus converter for CPT 100, PPT 100, RPT 100	TIC 252, Profibus converter for HPT 100, MPT 100
Weight	0.1 kg	0.12 kg
Power	3.5 W (without transmitter)	3.5 W (without transmitter)
Interface: Type	Profibus - DP	Profibus - DP
Voltage	Connection 21- 30 V DC	Connection 21- 30 V DC
Temperature: Operating	+5 - +40 °C	+5 - +40 °C

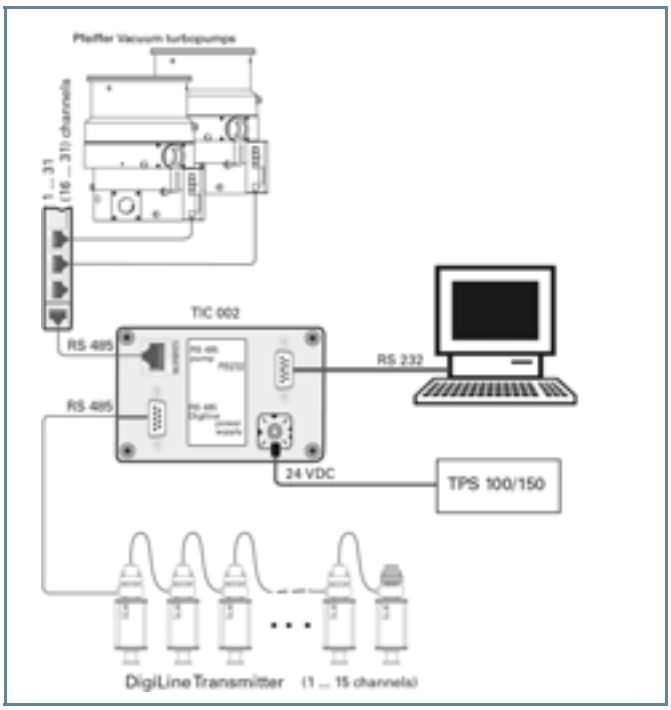
Order number		
Profibus converter	**PT 348 110**	**PT 348 111**

DigiLine™ accessories

TIC 002, Konverter für DigiLine™ Transmitter

DigiLine™ accessories

- For operating Pfeiffer Vacuum products via an RS - 485 Bus connection from pumps and DigiLine transmitters for up to 32 devices
- For supplying the operating voltage for DigiLine transmitters
- RS - 485 / RS - 232 interface converter for connection with a PC or SPC



TIC 002

Technical data	TIC 002, converter for DigiLine™ Transmitter
Power consumption	ca. 1 W
Voltage	24 V DC

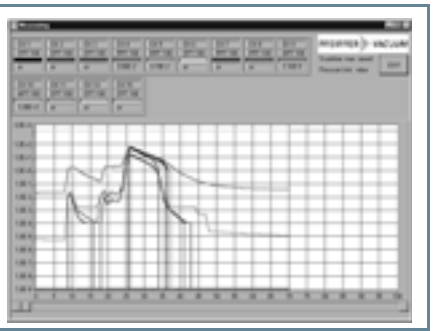
Order number	
TIC 002	**PM 051 519-T**

Accessories	
TPS 100, mains pack for wall/standard rail fitting	**PM 041 827-T**
Mating plug for voltage supply	**P0 920 635 E**
Plug - in bus termination, for RS-485	**PT 348 100-T**

DigiLine™ accessories

DokuStar Plus software

DigiLine™ accessories



- System requirements:
  PC min. Pentium 160 MHz - 64 MB RAM - 15 MB of free HD memory
- Interface: RS - 232
- For DPG / DPS 109
- Visualization and storage of readings from up to 15 transmitters

Technical data	DokuStar Plus software
PC min.	Pentium 160 MHz
RAM	64 MB
Interface	RS - 232
Memory	15 MB free HD memory

Order number	
DokuStar Plus software	**PT 882 501**

Notes

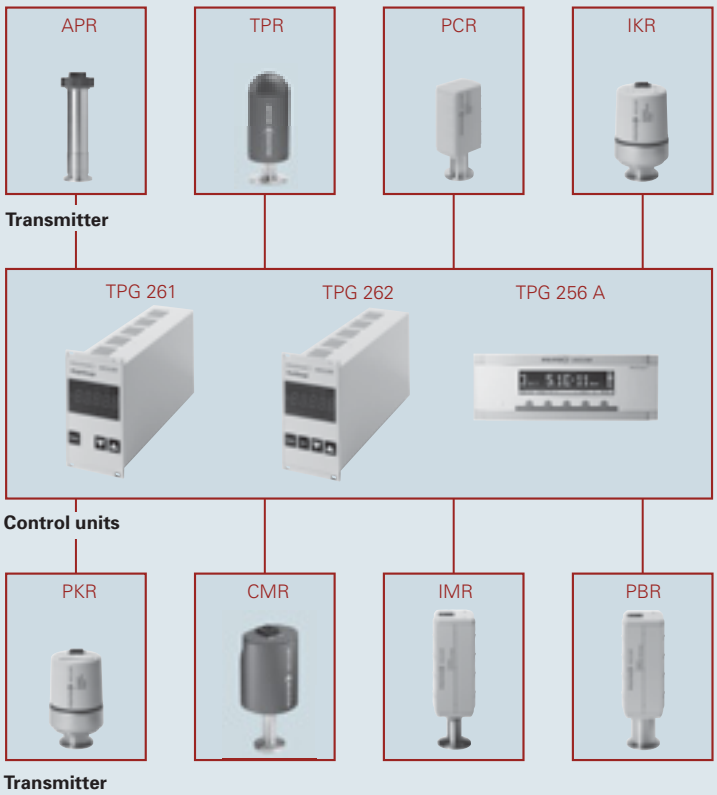
ActiveLine

Innovative Vacuum Measurement!
Capazitive Transmitters.

What is ActiveLine?
The ActiveLine family includes three control units and eight transmitters. The six APR piezo transmitter models cover five measurement ranges from 55 bar to 0.1 mbar.

The CMR capacitative diaphragm transmitters are available both as temperature-compensated and temperature-regulated versions in four and five measurement ranges, respectively, from 1,100 to 10^{-5} mbar.

- The ActiveLine comprises three controllers and eight transmitters
- Control units for connecting of one, two and six transmitters
- Each transmitter can be operated with every controller
- No cable mix-up – identical cables for connecting the transmitters to the controllers



ActiveLine application concepts

Advantages at a glance

- Large variety of transmitters to cover the entire pressure range (10^{-11} to 55,000 mbar)
- Compact design
- Easy integration
- Cost effective
- Integrated measurement connections
- Compact independent transmitter
- Output signal 0 – 10 V with integrated error signal
- Any pressure unit possible

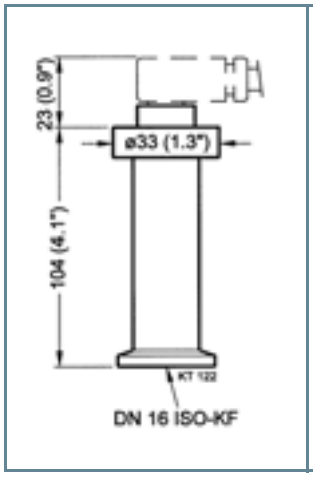
ActiveLine

Active Piezo transmitters
APR 250/260 ($1 \cdot 10^{-1}$ - 1100 mbar)

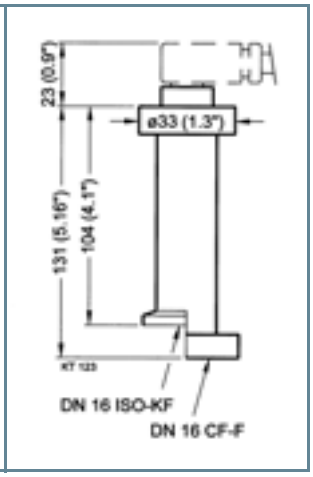
ActiveLine

- ▶ Measurement range from 0.1 mbar to 1100 mbar
- ▶ Pressure measurement independent of type of gas
- ▶ Corrosion-resistant

Dimensions



Active Piezo transmitter
APR 250, DN 16 ISO-KF



Active Piezo transmitter
APR 260, DN 16 ISO-KF
Active Piezo transmitter
APR 260, DN 16 CF-F

Technical data	Active Piezo transmitter APR 250, DN 16 ISO-KF	Active Piezo transmitter APR 260, DN 16 ISO-KF	Active Piezo transmitter APR 260, DN 16 CF-F
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 CF-F
Output signal: Sensor error below	0.4 V	0.4 V	0.4 V
Output signal: Pressure range	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature	80 °C	80 °C	80 °C
Pressure max.	3 bar	3 bar	3 bar
Stability of sensitivity	0.5 %/year	0.2 %/year	0.2 %/year
Accuracy	2 % F.S.	1 % F.S.	1 % F.S.
Weight	120 g	120 g	150 g
Linearity and hysteresis	0.5 % F.S.	0.2 % F.S.	0.2 % F.S.
Measurement range max.	1100 mbar	1100 mbar	1100 mbar
Measurement range min.	$1 \cdot 10^{-1}$ mbar	$1 \cdot 10^{-1}$ mbar	$1 \cdot 10^{-1}$ mbar
Sensor cable length	50 m	50 m	50 m
Zero stability	0.5 % F.S./year	0.3 % F.S./year	0.3 % F.S./year
Temperature: Operating	+10 - +60 °C	+10 - +60 °C	+10 - +60 °C
Temperature: Storage	-40 °C - +70 °C	-40 - +70° C	-40 - +70 °C
Thermal sensitivity drift	0.5 %	0.5 %	0.5 %
Thermal zero drift	0.5 % F.S.	0.2 % F.S.	0.2 % F.S.
Supply: Voltage	13-30 V DC	13-30 V DC	13-30 V DC
Supply: Power consumption max.	0.2 W	0.2 W	0.2 W
Volume	2 cm^3	2 cm^3	6 cm^3
Material	Stainless steel	Stainless steel	Stainless steel

Order number			
ActiveLine transmitters	**P 5215 102 TF**	**P 5215 112 TF**	**P 5215 114 TF**

Accessories			
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

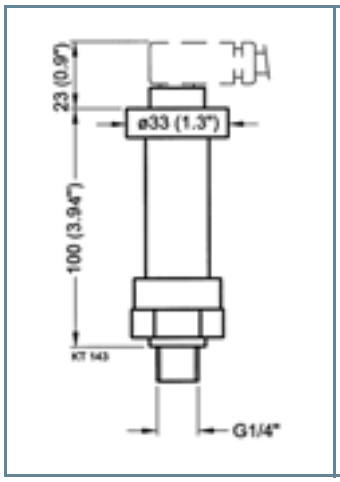
ActiveLine

Active Piezo transmitters
APR 262/265/266/267 ($2 \cdot 10^{-1}$ - 55000 mbar)

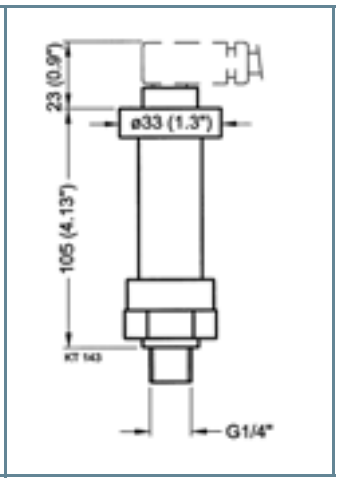
ActiveLine

- ▶ Measurement range from 0.2 mbar to 2200 mbar
- ▶ Pressure measurement independent of type of gas
- ▶ Corrosion-resistant

Dimensions



Active Piezo transmitter APR 262
Active Piezo transmitter APR 265
Active Piezo transmitter APR 266



Active Piezo transmitter APR 267

Technical data	Active Piezo transmitter APR 262, G1/4 "	Active Piezo transmitter APR 265, G 1/4"	Active Piezo transmitter APR 266, G 1/4"	Active Piezo transmitter APR 267, G 1/4"
Flange (in)	G 1/4"	G 1/4"	G 1/4"	G 1/4"
Output signal: Sensor error below	0.4 V	0.4 V	0.4 V	0.4 V
Output signal: Pressure range	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature	80 °C	80 °C	80 °C	80 °C
Pressure max.	6 bar	15 bar	30 bar	150 bar
Stability of sensitivity	0.2 %/year	0.2 %/year	0.2 %/year	0.2 %/year
Accuracy	2 % F.S.	2 % F.S.	2 % F.S.	2 % F.S.
Weight	120 g	120 g	120 g	120 g
Linearity and hysteresis	0.5 % F.S.	0.5 % F.S.	0.5 % F.S.	0.5 % F.S.
Measurement range max.	2200 mbar	5500 mbar	11000 mbar	55000 mbar
Measurement range min.	$2 \cdot 10^{-1}$ mbar	0.5 mbar	1 mbar	5 mbar
Sensor cable length	50 m	50 m	50 m	50 m
Zero stability	0.5 % F.S./year	0.5 % F.S./year	0.5 % F.S./year	0.5 % F.S./year
Temperature: Operating	+10 - +60 °C	+10 - +60 °C	+10 - +60 °C	+10 - +60 °C
Temperature: Storage	-40 - +70 °C	-40 - +70 °C	-40 - +70 °C	-40 - +70 °C
Thermal sensitivity drift	0.5 %	0.5 %	0.5 %	0.5 %
Thermal zero drift	0.5 % F.S.	0.5 % F.S.	0.5 % F.S.	0.5 % F.S.
Supply: Voltage	13-30 V DC	13-30 V DC	13-30 V DC	13-30 V DC
Supply: Power consumption max.	0.2 W	0.2 W	0.2 W	0.2 W
Volume	0.5 cm^3	0.5 cm^3	0.5 cm^3	0.5 cm^3
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel

Order number				
ActiveLine transmitters	**P 5215 120 TF**	**P 5215 126 TF**	**P 5215 132 TF**	**P5 215 138 TF**

Accessories				
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

ActiveLine

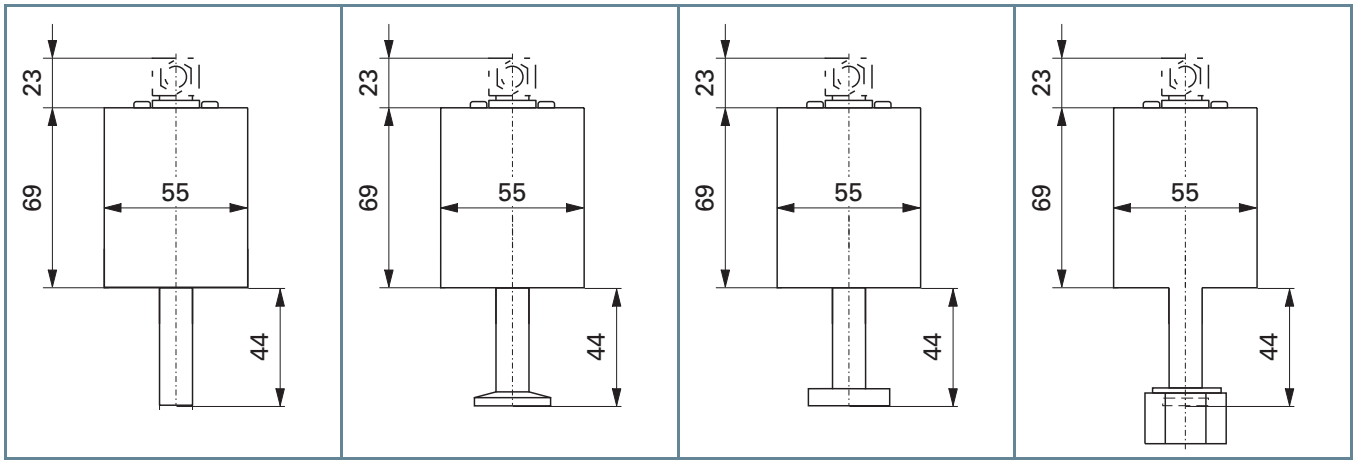
Active capacitive transmitters ($1 \cdot 10^{-5}$ - 1100 mbar)

Active capacitive transmitter CMR 361
Active capacitive transmitter CMR 362
Active capacitive transmitter CMR 363
Active capacitive transmitter CMR 364
Active capacitive transmitter CMR 365

ActiveLine

- Measurement range from $1 \cdot 10^{-1}$ mbar to 1100 mbar
- Capacitive diaphragm transmitter for ActiveLine
- Sensor in ceramic technology
- No memory effects
- Materials employed have identical temperature coefficients
- Excellent temperature compensation
- Resistant to corrosive gases
- Excellent zero stability

Dimensions



Tube OD 1/2" | DN 16 ISO-KF | DN 16 CF-R | DN 8 VCR

Technical data	Active capacitive transmitter CMR 361	Active capacitive transmitter CMR 362	Active capacitive transmitter CMR 363	Active capacitive transmitter CMR 364	Active capacitive transmitter CMR 365
Resolution	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.
Output signal: Sensor error above	9.8 V	9.8 V	9.8 V	9.8 V	9.8 V
Output signal: Sensor error below	0.4 V	0.4 V	0.4 V	0.4 V	0.4 V
Output signal: Pressure range	1...9.8 V	1...9.8 V	1...9.8 V	1...9.8 V	1...9.8 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature max. at the flange	110 °C	110 °C	110 °C	110 °C	110 °C
Pressure max.	3 bar	2 bar	2 bar	2 bar	1.3 bar
Accuracy	0.2 % of reading	0.2 % of reading	0.2 % of reading	0.2 % of reading	0.5 % of reading
Weight	< 300 g	< 300 g	< 300 g	< 300 g	< 300 g
Membrane and measuring chamber	Ceramics (Al_2O_3>99,5%)	Ceramics (Al_2O_3>99,5%)	Ceramics (Al_2O_3 >99,5%)	Ceramics (Al_2O_3>99,5%)	Ceramics (Al_2O_3>99,5%)
Measurement range max.	1100 mbar	110 mbar	11 mbar	1.1 mbar	0.11 mbar
Measurement range min.	$1 \cdot 10^{-1}$ mbar	$1 \cdot 10^{-2}$ mbar	$1 \cdot 10^{-3}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-5}$ mbar
Sensor cable length	120 m	120 m	120 m	120 m	120 m
Pipe and flange	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Temperature: Operating	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C
Temperature: Storage	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C
Temperature effect: on span	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.03 % of reading/°C
Temperature effect: on zero	0.005 % F.S./°C	0.005 % F.S./°C	0.005 % F.S./°C	0.015 % F.S./°C	0.02 % F.S./°C
Supply: Voltage	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC
Supply: Power consumption max.	1 W	1 W	1 W	1 W	1 W
Volume	6 cm^3	6 cm^3	6 cm^3	6 cm^3	6 cm^3

	Active capacitive transmitter CMR 361	Active capacitive transmitter CMR 362	Active capacitive transmitter CMR 363	Active capacitive transmitter CMR 364	Active capacitive transmitter CMR 365
Flange (in)	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"
Order number	**PT R24 600**	**PT R24 610**	**PT R24 620**	**PT R24 630**	**PT R24 640**
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Order number	**PT R24 601**	**PT R24 611**	**PT R24 621**	**PT R24 631**	**PT R24 641**
Flange (in)	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R
Order number	**PT R24 602**	**PT R24 612**	**PT R24 622**	**PT R24 632**	**PT R24 642**
Flange (in)	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR
Order number	**PT R24 603**	**PT R24 613**	**PT R24 623**	**PT R24 633**	**PT R24 643**

Accessories					
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

ActiveLine

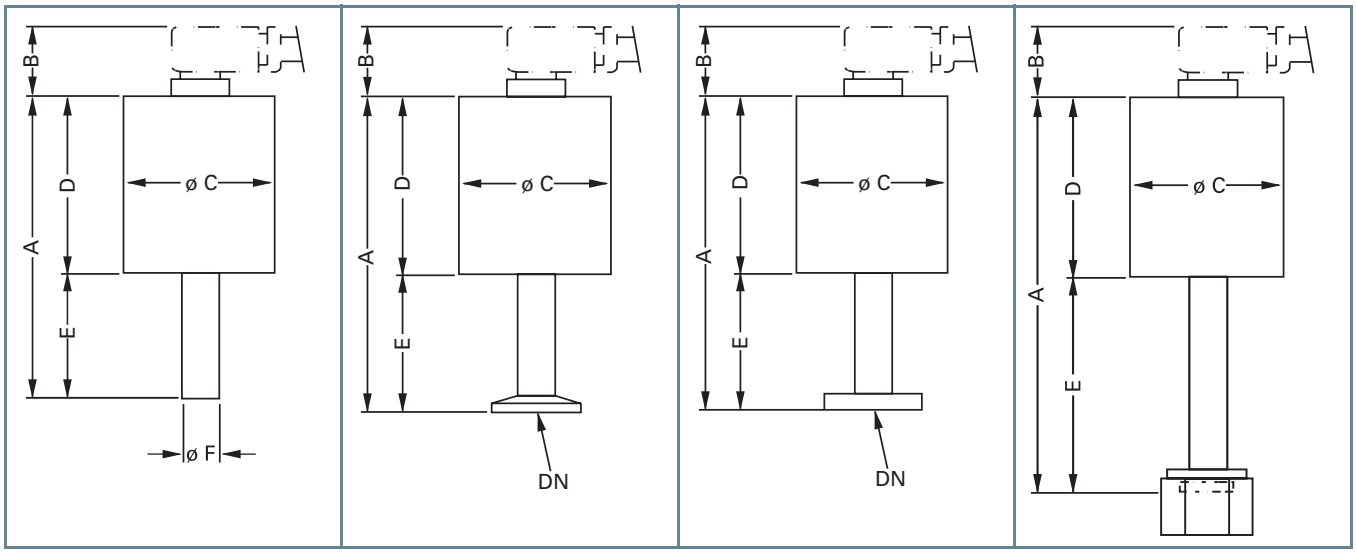
Active capacitive transmitters ($1 \cdot 10^{-5}$ - 1100 mbar)

Active capacitive transmitter CMR 271
Active capacitive transmitter CMR 272
Active capacitive transmitter CMR 273
Active capacitive transmitter CMR 274
Active capacitive transmitter CMR 275

ActiveLine

- Measurement range from 0.2 mbar to 2200 mbar
- Pressure measurement independent of type of gas
- Corrosion-resistant

Dimensions



Tube OD 1/2" | DN 16 ISO-KF | DN 16 CF-R | DN 8 VCR

	Tube OD 1/2"	DN 16 ISO-KF	DN 16 CF-R	Cajon 8 VCR
A	126 mm	128 mm	128 mm	154.5 mm
B	23 mm	23 mm	23 mm	23 mm
C	78 mm	78 mm	78 mm	78 mm
D	80 mm	80 mm	80 mm	80 mm
E	46 mm	48 mm	48 mm	74.5 mm
F	12.7 mm	-	-	-

Technical data	Active capacitive transmitter CMR 271	Active capacitive transmitter CMR 272	Active capacitive transmitter CMR 273	Active capacitive transmitter CMR 274	Active capacitive transmitter CMR 275
Resolution	0.0015 % F.S.	0.0015 % F.S.	0.0015 % F.S.	0.0025 % F.S.	0.0025 % F.S.
Output signal: Sensor error below	0.4 V	0.4 V	0.4 V	0.4 V	0.4 V
Output signal: Pressure range	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V	1.0-9.8 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature max. at the flange	90 °C	90 °C	90 °C	90 °C	90 °C
Pressure max.	3 bar	2 bar	2 bar	2 bar	2 bar
Accuracy	0.15 % of reading	0.15 % of reading	0.15 % of reading	0.15 % of reading	0.15 % of reading
Membrane and measuring chamber	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70
Measurement range max.	1100 mbar	110 mbar	11 mbar	1.1 mbar	0.11 mbar
Measurement range min.	$1 \cdot 10^{-1}$ mbar	$1 \cdot 10^{-2}$ mbar	$1 \cdot 10^{-3}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-5}$ mbar
Sensor cable length	65 m	65 m	65 m	65 m	65 m
Pipe and flange	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Temperature: Operating	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C
Temperature: Storage	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C
Temperature effect: on span	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C
Temperature effect: on zero	0.0025 % F.S./°C	0.0025 % F.S./°C	0.0025 % F.S./°C	0.0025 % F.S./°C	0.0065 % F.S./°C
Temperature stabilization	45 °C	45 °C	45 °C	45 °C	45 °C
Supply: Voltage	18-30 V DC	18-30 V DC	18-30 V DC	18-30 V DC	18-30 V DC
Supply: Power consumption max.	7.5 W	7.5 W	7.5 W	7.5 W	7.5 W

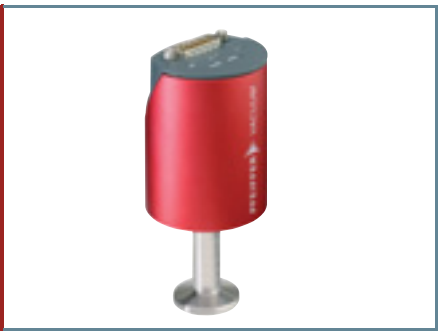
	Active capacitive transmitter CMR 271	Active capacitive transmitter CMR 272	Active capacitive transmitter CMR 273	Active capacitive transmitter CMR 274	Active capacitive transmitter CMR 275
Flange (in)	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"
Weight	485 g	485 g	485 g	485 g	485 g
Volume	7 cm^3	7 cm^3	7 cm^3	7 cm^3	7 cm^3
Order number	**PT R25 000**	**PT R25 010**	**PT R25 020**	**PT R25 030**	**PT R25 040**
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Weight	495 g	495 g	495 g	495 g	495 g
Volume	7,25 cm^3	7,25 cm^3	7,25 cm^3	7,25 cm^3	7,25 cm^3
Order number	**PT R25 001**	**PT R25 011**	**PT R25 021**	**PT R25 031**	**PT R25 041**
Flange (in)	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R
Weight	505 g	505 g	505 g	505 g	505 g
Volume	7,25 cm^3	7,25 cm^3	7,25 cm^3	7,25 cm^3	7,25 cm^3
Order number	**PT R25 002**	**PT R25 012**	**PT R25 022**	**PT R25 032**	**PT R25 042**
Flange (in)	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR
Weight	515 g	515 g	515 g	515 g	515 g
Volume	9,25 cm^3	9,25 cm^3	9,25 cm^3	9,25 cm^3	9,25 cm^3
Order number	**PT R25 003**	**PT R25 013**	**PT R25 023**	**PT R25 033**	**PT R25 043**

Accessories					
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

ActiveLine

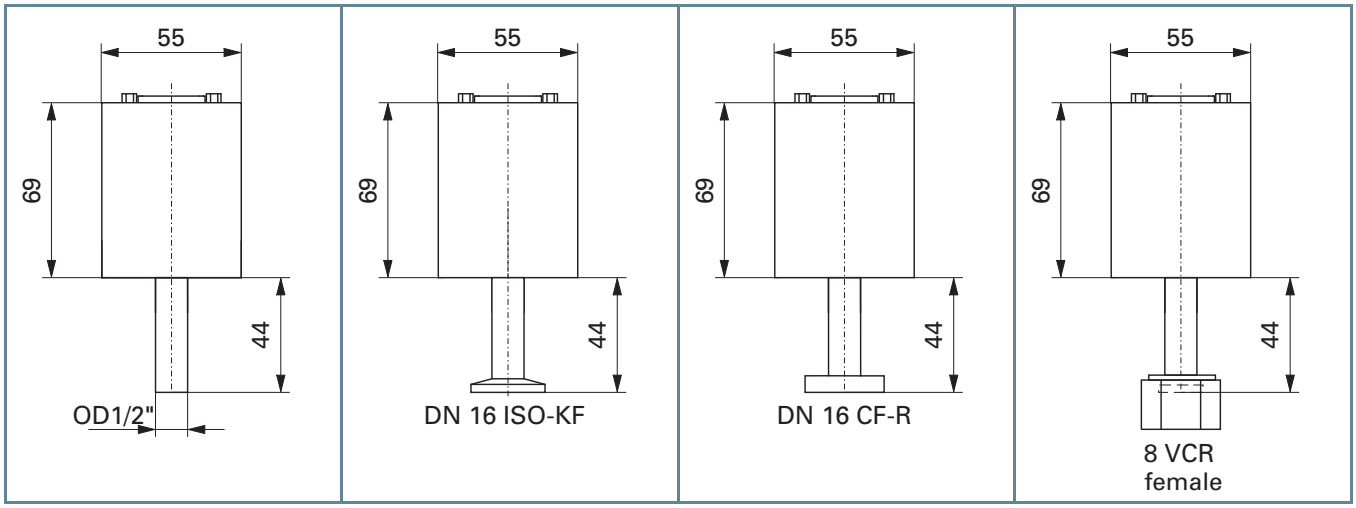
Active capacitive transmitters
CCR (1·10^{-5} - 1000 torr)
Active capacitive transmitter CCR 361
Active capacitive transmitter CCR 361
Active capacitive transmitter CCR 363
Active capacitive transmitter CCR 364
Active capacitive transmitter CCR 365

ActiveLine



- Measurement range from 1·10^{-1} to 1000 torr
- Capacitative diaphragm transmitter for measurement of pressure independently of type of gas
- Sensor in ceramic technology
- No memory effects
- Materials employed have identical temperature coefficients
- Excellent temperature compensation
- Resistant to corrosive gases
- Excellent zero stability
- Transmitter cannot be connected to controllers TPG 261, TPG 262 and TPG 256 A
- MKS-compatible

Dimensions



Tube OD 1/2" | DN 16 ISO-KF | DN 16 CF-R | Cajon 8 VCR

Technical data	Active capacitive transmitter CCR 361	Active capacitive transmitter CCR 362	Active capacitive transmitter CCR 363	Active capacitive transmitter CCR 364	Active capacitive transmitter CCR 365
Resolution	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.	0.003 % F.S.
Output signal: Pressure range	0...10 V	0...10 V	0...10 V	0...10 V	0...10 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature max. at the flange	110 °C	110 °C	110 °C	110 °C	110 °C
Pressure max.	3 bar	2 bar	2 bar	2 bar	1,3 bar
Accuracy	0.2 % of reading	0.2 % of reading	0.2 % of reading	0.2 % of reading	0.5 % of reading
Weight	< 300 g	< 300 g	< 300 g	< 300 g	< 300 g
Membrane and measuring chamber	Ceramics (Al_2O_3 >99,5%)	Ceramics (Al_2O_3 >99,5%)	Ceramics (Al_2O_3 >99,5%)	Ceramics (Al_2O_3 >99,5%)	Ceramics (Al_2O_3 >99,5%)
Measurement range max.	1000 Torr	100 Torr	10 Torr	1 Torr	$1 \cdot 10^{-1}$ Torr
Measurement range min.	$1 \cdot 10^{-1}$ Torr	$1 \cdot 10^{-2}$ Torr	$1 \cdot 10^{-3}$ Torr	$1 \cdot 10^{-4}$ Torr	$1 \cdot 10^{-5}$ Torr
Sensor cable length	100 m (0,14 mm² conductor)	100 m (0,14 mm² conductor)	100 m (0,14 mm² conductor)	100 m (0,14 mm² conductor)	100 m (0,14 mm² conductor)
Pipe and flange	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Temperature: Operating	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C	+5 ... +50 °C
Temperature: Storage	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C	-40 ... +65 °C
Temperature effect: on span	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.03 % of reading/°C
Temperature effect: on zero	0.005 % F.S./°C	0.005 % F.S./°C	0.005 % F.S./°C	0.015 % F.S./°C	0.02 % F.S./°C
Supply: Voltage	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC	14 ... 30 VDC
Supply: Power consumption max.	1 W	1 W	1 W	1 W	1 W
Volume	6 cm³	6 cm³	6 cm³	6 cm³	6 cm³

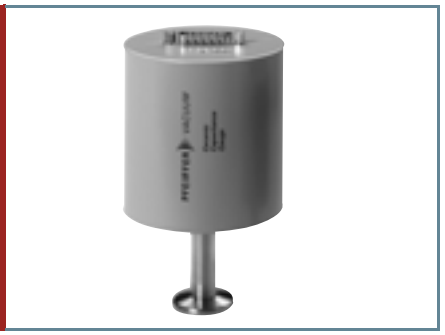
	Active capacitive transmitter CCR 361	Active capacitive transmitter CCR 362	Active capacitive transmitter CCR 363	Active capacitive transmitter CCR 364	Active capacitive transmitter CCR 365
Flange (in)	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"
Order number	**PT R27 600**	**PT R27 610**	**PT R27 620**	**PT R27 630**	**PT R27 640**
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Order number	**PT R27 601**	**PT R27 611**	**PT R27 621**	**PT R27 631**	**PT R27 641**
Flange (in)	-	-	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R
Order number	-	-	**PT R27 622**	**PT R27 632**	**PT R27 642**
Flange (in)	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR
Order number	**PT R27 603**	**PT R27 613**	**PT R27 623**	**PT R27 633**	**PT R27 643**

ActiveLine

Active capacitive transmitters CCR ($1 \cdot 10^{-5}$ - 1000 torr)

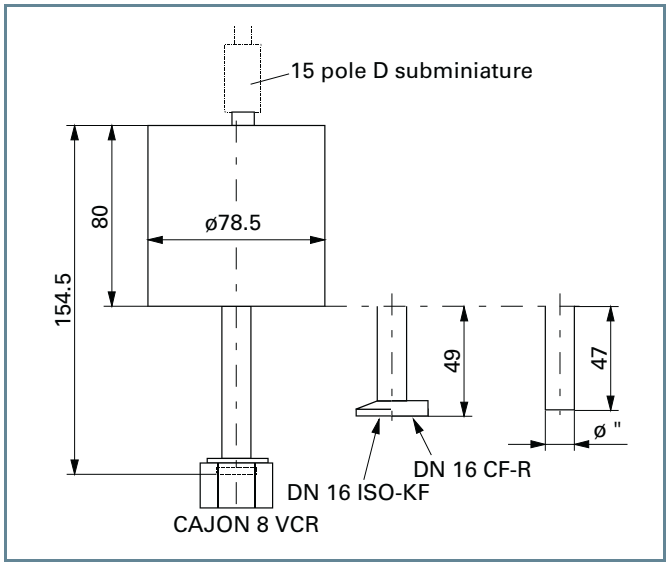
Active capacitive transmitter CCR 271
Active capacitive transmitter CCR 272
Active capacitive transmitter CCR 273
Active capacitive transmitter CCR 274
Active capacitive transmitter CCR 275

ActiveLine



- Measurement range from $1 \cdot 10^{-1}$ to 1000 torr
- Pressure measurement independent of type of gas
- Outstanding long-term and temperature stability
- Only marginal zero drift
- Corrosion-resistant ceramic technology
- Transmitter cannot be connected to controllers TPG 261, TPG 262 and TPG 256 A
- MKS-compatible

Dimensions



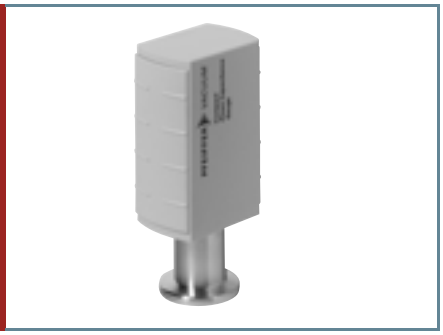
Technical data	Active capacitive transmitter CCR 271	Active capacitive transmitter CCR 272	Active capacitive transmitter CCR 273	Active capacitive transmitter CCR 274	Active capacitive transmitter CCR 275
Resolution	0.0015 % F.S.	0.0015 % F.S.	0.0015 % F.S.	0.0025 % F.S.	0.0025 % F.S.
Output signal: Pressure range	0 - 10 V	0 - 10 V	0 - 10 V	0 - 10 V	0 - 10 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature	65 °C	65 °C	65 °C	65 °C	65 °C
Pressure max.	$3 \cdot 10^3$ Torr	$2 \cdot 10^3$ Torr	$2 \cdot 10^3$ Torr	$2 \cdot 10^3$ Torr	$1 \cdot 10^3$ Torr
Accuracy	0.15 % of reading	0.15 % of reading	0.15 % of reading	0.15 % of reading	0.15 % of reading
Membrane and measuring chamber	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70	Al_2O_3, Vacon 70
Measurement range max.	$1 \cdot 10^3$ Torr	$1 \cdot 10^2$ Torr	$1 \cdot 10^1$ Torr	$1 \cdot 10^0$ Torr	$1 \cdot 10^{-1}$ Torr
Measurement range min.	$1 \cdot 10^{-1}$ Torr	$1 \cdot 10^{-2}$ Torr	$1 \cdot 10^{-3}$ Torr	$1 \cdot 10^{-4}$ Torr	$1 \cdot 10^{-5}$ Torr
Sensor cable length	50 m	50 m	50 m	50 m	50 m
Pipe and flange	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Temperature: Operating	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C	+15 - +40 °C
Temperature: Storage	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C
Temperature effect: on span	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C	0.01 % of reading/°C
Temperature effect: on zero	0.0025 % F.S./°C	0.0025 % F.S./°C	0.0025 % F.S./°C	0.0025 % F.S./°C	0.005 % F.S./°C
Temperature stabilization	45°C	45 °C	45 °C	45 °C	45 °C
Supply: Voltage	18 - 26,4 V DC or 15 V DC +-5 %	18 - 26,4 V DC or 15 V DC +-5 %	18 - 26,4 V DC or 15 V DC +-5 %	18 - 26,4 V DC or 15 V DC +-5 %	18 - 26,4 V DC or 15 V DC +-5 %
Supply: Power consumption max.	19 W	19 W	19 W	19 W	19 W
Volume	7 cm^3	7 cm^3	7 cm^3	7 cm^3	7 cm^3

	Active capacitive transmitter CCR 271	Active capacitive transmitter CCR 272	Active capacitive transmitter CCR 273	Active capacitive transmitter CCR 274	Active capacitive transmitter CCR 275
Flange (in)	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"	Tube OD 1/2"
Weight	485 g	485 g	485 g	485 g	485 g
Order number	**PT R28 000**	**PT R28 010**	**PT R28 020**	**PT R28 030**	**PT R28 040**
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Weight	495 g	495 g	495 g	495 g	495 g
Order number	**PT R28 001**	**PT R28 011**	**PT R28 021**	**PT R28 031**	**PT R28 041**
Flange (in)	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R	DN 16 CF-R
Weight	505 g	505 g	505 g	505 g	505 g
Order number	**PT R28 002**	**PT R28 012**	**PT R28 022**	**PT R28 032**	**PT R28 042**
Flange (in)	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR	Cajon 8 VCR
Weight	515 g	515 g	515 g	515 g	515 g
Order number	**PT R28 003**	**PT R28 013**	**PT R28 023**	**PT R28 033**	**PT R28 043**

ActiveLine

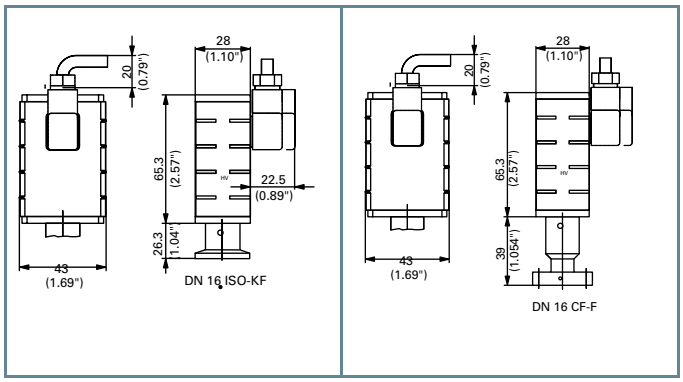
Active Pirani/capacitive transmitters PCR 260 ($5 \cdot 10^{-4}$ - 1500 mbar)

ActiveLine



- Measurement range from $5 \cdot 10^{-4}$ mbar to 1500 mbar
- Highly accurate
- Especially suitable for load-lock applications
- Maximum pressure refers to inert gases

Dimensions



DN 16 ISO-KF DN 16 CF-F

Technical data	Active Pirani/ capacitive transmitter PCR 260
Output signal: Pressure range	2.2-8.68 V
Output signal: Minimum load	10 kOhm
Bakeout temperature	80 °C
Seal	Metal
Pressure max.	5 bar
Feedthrough	Glass
Feature	Stainless steel, metal sealed
Flange	Stainless steel
Accuracy	10^{-3} - 50 mbar: +/- 15 % 50 - 950 mbar: +/- 5 % 950 - 1050 mbar: +/- 2,5 %
Filament	Tungsten
Measurement range max.	1500 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar
Sensor cable length	200 m
Temperature: Operating	+10 - +50 °C
Temperature: Storage	-20 - +65 °C
Supply: Voltage	15-30 V DC
Supply: Power consumption max.	2.5 W
Repeatability: 10^{-3} - 1100 mbar	+/- 2 %

	Active Pirani/ capacitive transmitter PCR 260
Flange (in)	DN 16 ISO-KF
Weight	90 g
Volume	6 cm^3
Order number	**PT R26 850**
Flange (in)	DN 16 CF-F
Weight	120 g
Volume	8 cm^3
Order number	**PT R26 851**

Accessories	
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**
Sensor cable, 3 m	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**

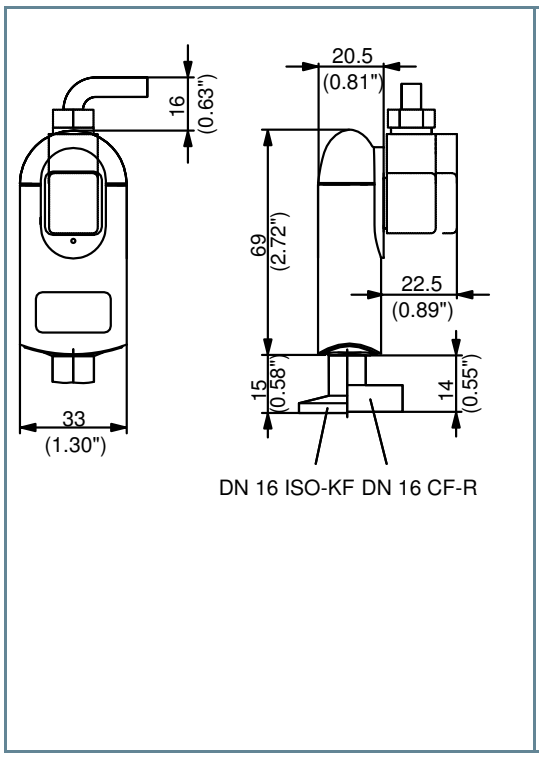
ActiveLine

Active Pirani transmitters
TPR 280, ($5 \cdot 10^{-4}$ - 1000 mbar)

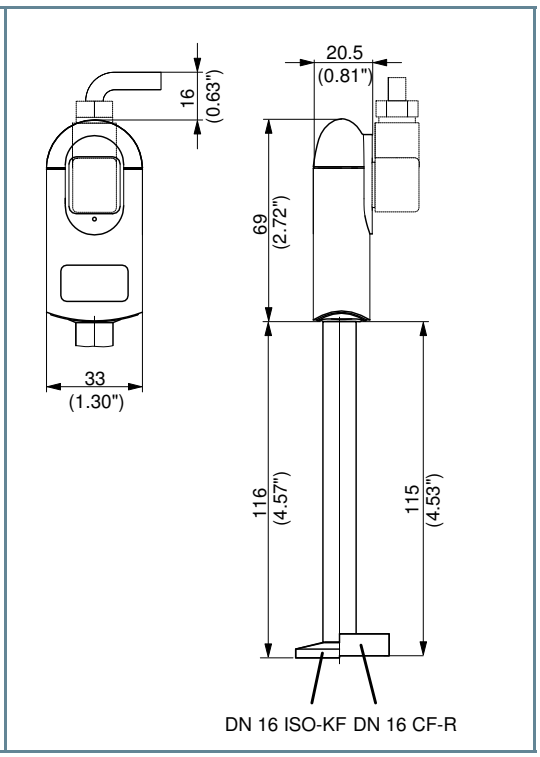
ActiveLine

- Measurement range from $5 \cdot 10^{-4}$ to 1000 mbar
- Compact and rugged
- Fast, stable measurement
- For general vacuum applications
- Maximum pressure refers to inert gases

Dimensions



Active Pirani Transmitter TPR 280, 80 °C



Active Pirani transmitter TPR 280, 250 °C

Technical data	Active Pirani Transmitter TPR 280, 80 °C	Active Pirani transmitter TPR 280, 250 °C
Output signal: Sensor error below	0.5 V	0.5 V
Output signal: Pressure range	2.2-8.5 V	2.2-8.5 V
Output signal: Minimum load	10 kOhm	10 kOhm
Bakeout temperature	80 °C	250 °C
Seal	Metal	Metal
Pressure max.	10 bar	10 bar
Feedthrough	Glass	Glass
Feature	Stainless steel, metal sealed	Stainless steel, metal sealed
Flange	Stainless steel	Stainless steel
Accuracy: 10^{-3} - 10^{2} mbar	+/- 15 %	+/- 15 %
Filament	Tungsten	Tungsten
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar	$5 \cdot 10^{-4}$ mbar
Sensor cable length max.	200 m	200 m
Temperature: Operating	+5 - +60 °C	+5 - +60 °C
Temperature: Storage	-20 - +65 °C	-20 - +65 °C
Supply: Voltage	14-30 V DC	14- 30 V DC
Supply: Power consumption max.	1 W	1 W
Repeatability: 10^{-3} - 10^{2} mbar	+/- 2 %	+/- 2 %

	Active Pirani Transmitter TPR 280, 80 °C	Active Pirani transmitter TPR 280, 250 °C
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Weight	80 g	130 g
Volume	1.5 cm^3	10 cm^3
Order number	**PT R26 950**	**PT R26 960**
Flange (in)	DN 16 CF-R	DN 16 CF-R
Weight	100 g	140 g
Volume	1.5 cm^3	10 cm^3
Order number	**PT R26 951**	**PT R26 961**
Flange (in)	1/8" NPT	
Weight	70 g	
Volume	2 cm^3	
Order number	**PT R26 952**	
Flange (in)	8 VCR	
Weight	130 g	
Volume	2 cm^3	
Order number	**PT R26 953**	

Accessories		
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	
Fine filter for TPR 265, pore size 0.0004 mm	**PT 120 132-T**	
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**

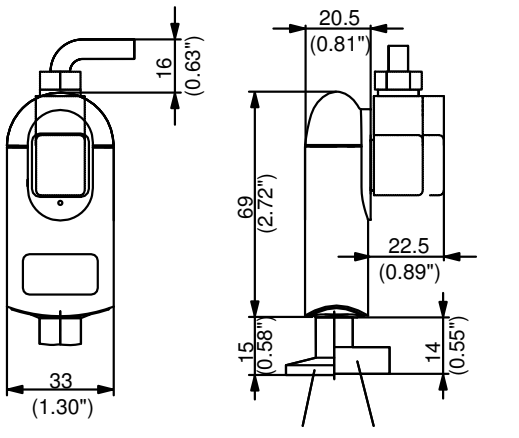
ActiveLine

Active Pirani transmitters TPR 281, ($5 \cdot 10^{-4}$ - 1000 mbar), for corrosive media

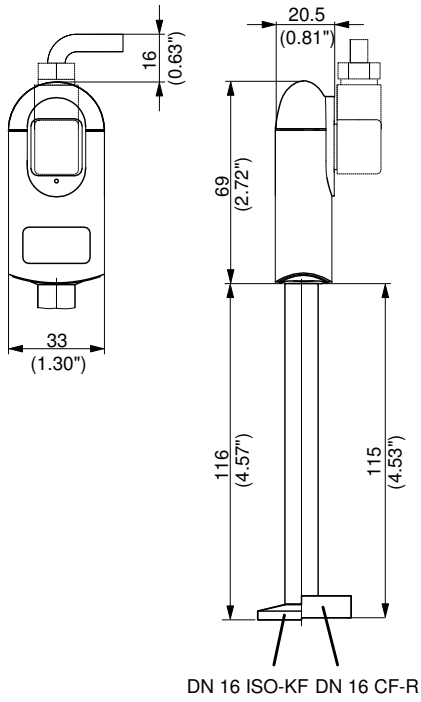
ActiveLine

- Measurement range from $5 \cdot 10^{-4}$ to 1000 bar
- Compact and rugged
- Fast, stable measurement
- For corrosive media
- Maximum pressure refers to inert gases

Dimensions



Active Pirani transmitter TPR 281, 65 °C



Active Pirani Transmitter TPR 281, 250 °C

Technical data	Active Pirani transmitter TPR 281, 65 °C	Active Pirani Transmitter TPR 281, 250 °C
Output signal: Sensor error below	0.5 V	0.5 V
Output signal: Pressure range	2.2-8.5 V	2.2-8.5 V
Output signal: Minimum load	10 kOhm	10 kOhm
Bakeout temperature	80 °C	250 °C
Seal	Metal	Metal
Pressure max.	10 bar	10 bar
Feedthrough	Glass	Glass
Feature	for corrosive media	for corrosive media
Flange	Stainless steel	Stainless steel
Accuracy: 10^{-3} - 10^{2} mbar	+/- 15 %	+/- 15 %
Filament	Nickel	Nickel
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar	$5 \cdot 10^{-4}$ mbar
Sensor cable length max.	200 m	200 m
Temperature: Operating	+5 - +60 °C	+5 - +60 °C
Temperature: Storage	-20 - +65 °C	-20 - +65 °C
Supply: Voltage	14-30 V DC	14-30 V DC
Supply: Power consumption max.	1 W	1 W
Repeatability: 10^{-3} - 10^{2} mbar	+/- 2 %	+/- 2 %

	Active Pirani transmitter TPR 281, 65 °C	Active Pirani Transmitter TPR 281, 250 °C
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Weight	80 g	130 g
Volume	1.3 cm^3	10 cm^3
Order number	**PT R21 950**	**PT R21 960**
Flange (in)	DN 16 CF-R	DN 16 CF-R
Weight	100 g	140 g
Volume	1.5 cm^3	10 cm^3
Order number	**PT R21 951**	**PT R21 961**

Accessories		
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	
Fine filter for TPR 265, pore size 0.0004 mm	**PT 120 132-T**	
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**

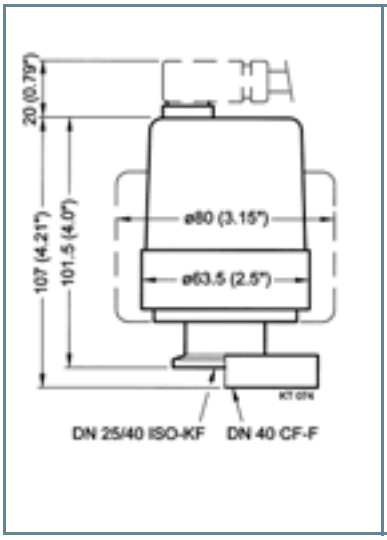
ActiveLine

Active cold cathode transmitters IKR 251/261 ($2 \cdot 10^{-9}$ - 0.01 mbar)

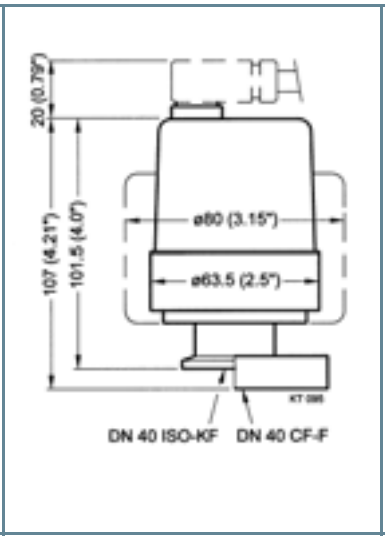
ActiveLine

- ▶ Flange size: DN 25 ISO-KF
- ▶ Measurement range from $2 \cdot 10^{-9}$ to 0.01 mbar
- ▶ Cold cathode (inverted magnetron)
- ▶ Rugged and dependable
- ▶ Insensitive to air ingress
- ▶ Corrosion-resistant

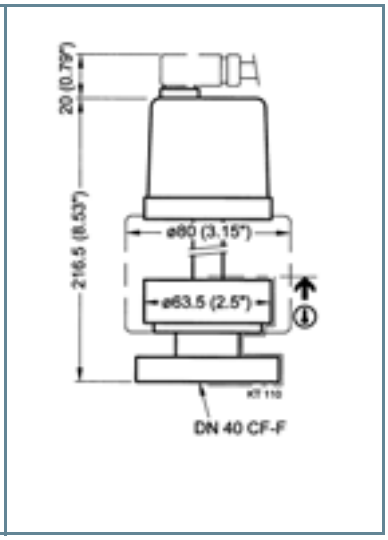
Dimensions



Active cold cathode transmitter
IKR 251



Active cold cathode transmitter
IKR 261



Active cold cathode transmitter
IKR 261, DN 40 CF-F, extra-long case

Technical data	Active cold cathode transmitter IKR 251	Active cold cathode transmitter IKR 261	Active cold cathode transmitter IKR 261, DN 40 CF-F, extra-long case
Output signal: Sensor error below	0.5 V	0.5 V	0.5 V
Output signal: Pressure range	1.8-8.5 V	1.8-8.5 V	1.8-8.5 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature	150 °C, electronic removed	250 °C, electronic removed	250 °C
Seal	FPM	Ag	Ag
Pressure max.	10 bar	10 bar	10 bar
Feedthrough	Al_2O_3	Al_2O_3	Al_2O_3
Feature	interior FPM sealed	metal sealed	metal sealed
Flange	Stainless steel	Stainless steel	Stainless steel
Accuracy: 10^{-8} - 10^{-3} mbar	+/- 30 %	+/- 30 %	+/- 30 %
Filament	Molybdenum	Molybdenum	Molybdenum
Measurement range max.	0.01 mbar	0.01 mbar	0.01 mbar
Measurement range min.	$2 \cdot 10^{-9}$ mbar	$2 \cdot 10^{-9}$ mbar	$2 \cdot 10^{-9}$ mbar
Sensor cable length	500 m	500 m	500 m
Temperature: Operating	+5 - +55 °C	+5 - +55 °C	+5 - +55 °C
Temperature: Storage	-40 - +65 °C	-40 - +65 °C	-40 - +65 °C
Supply: Voltage	15-30 V	15-30 V	15-30 V
Supply: Power consumption max.	2 W	2 W	2 W
Volume	20 cm^3	20 cm^3	20 cm^3
Repeatability: 10^{-8} - 10^{-3} mbar	+/- 5 %	+/- 5 %	+/- 5 %

	Active cold cathode transmitter IKR 251	Active cold cathode transmitter IKR 261	Active cold cathode transmitter IKR 261, DN 40 CF-F, extra-long case
Flange (in)	DN 25 ISO-KF		
Weight	700 g		
Order number	**PT R25 500**		
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	
Weight	700 g	700 g	
Order number	**PT R25 501**	**PT R25 750**	
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Weight	950 g	950 g	1200 g
Order number	**PT R25 502**	**PT R25 751**	**PT R25 761**

Accessories			
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

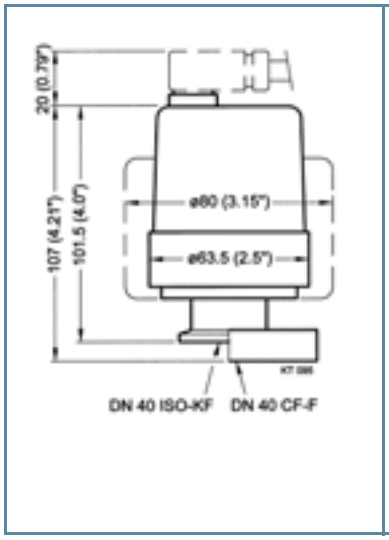
ActiveLine

Active cold cathode transmitters IKR 270 ($5 \cdot 10^{-11}$ - 0,01 mbar)

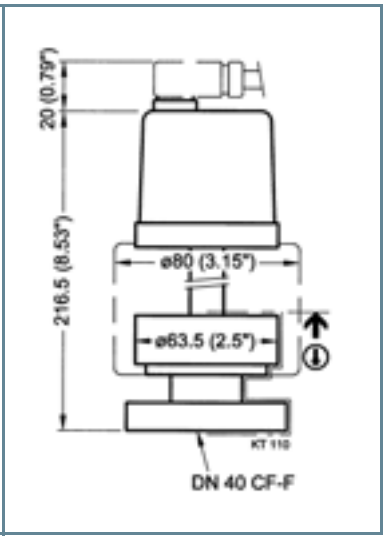
ActiveLine

- Measurement range from $5 \cdot 10^{-11}$ to 0.01 mbar
- Cold cathode (inverted magnetron)
- Rugged and dependable
- Insensitive to air ingress
- Corrosion-resistant

Dimensions



Active cold cathode transmitter
IKR 270



Active cold cathode transmitter
IKR 270, DN 40 CF-F, extra-long case

Technical data	Active cold cathode transmitter IKR 270, DN 40 CF-F	Active cold cathode transmitter IKR 270, DN 40 CF-F, extra-long case
Flange (in)	DN 40 CF-F	DN 40 CF-F
Output signal: Sensor error below	0.5 V	0.5 V
Output signal: Pressure range	1.8-8.5 V	1.8-8.5 V
Output signal: Minimum load	10 kOhm	10 kOhm
Bakeout temperature	250 °C electronic removed	250 °C
Seal	Ag	Ag
Pressure max.	10 bar	10 bar
Feedthrough	Al_2O_3	Al_2O_3
Feature	metal sealed	metal sealed
Flange	Stainless steel	Stainless steel
Accuracy: 10^{-9} - 10^{-3} mbar	+/- 30 %	+/- 30 %
Weight	950 g	1200 g
Cable length	500 m	500 m
Filament	Molybdenum	Molybdenum
Measurement range max.	0.01 mbar	0.01 mbar
Measurement range min.	$5 \cdot 10^{-11}$ mbar	$5 \cdot 10^{-11}$ mbar
Temperature: Operating	+5 - +55 °C	+5 - +55 °C, in the bakeout range
Temperature: Storage	-40 - +65 °C	-40 - +65 °C
Supply: Voltage	15-30 V	15-30 V
Supply: Power consumption max.	2 W	2 W
Volume	20 cm^3	20 cm^3
Repeatability: 10^{-9} - 10^{-3} mbar	+/- 5 %	+/- 5 %

Order number		
ActiveLine transmitters	**PT R21 251**	**PT R21 261**

Accessories		
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**

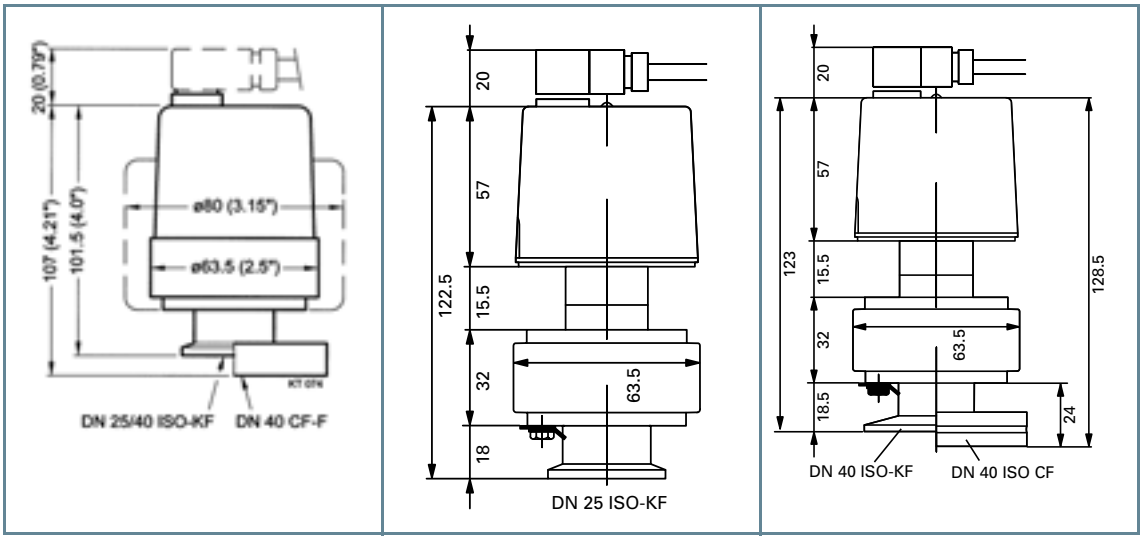
ActiveLine

Active Pirani/cold cathode transmitter PKR 251/261 ($5 \cdot 10^{-9}$ - 1000 mbar)

ActiveLine

- Measurement range from $5 \cdot 10^{-9}$ to 1000 mbar
- Two gauge heads (Pirani and cold cathode) in a single case (inverted magnetron)
- A single flange from atmospheric pressure to UHV
- Corrosion-resistant

Dimensions



Active Pirani/cold cathode transmitter PKR 251

Active Pirani/cold cathode transmitter PKR 261, DN 25 ISO-KF

Active Pirani/cold cathode transmitter PKR 261, DN 40 ISO-KF
Active Pirani/cold cathode transmitter PKR 261, DN 40 CF-F

Technical data	Active Pirani/ cold cathode transmitter PKR 251	Active Pirani/ cold cathode transmitter PKR 261
Output signal: Sensor error above	9.5 V	9.5 V
Output signal: Sensor error below	0.5 V	0.5 V
Output signal: Pressure range	1.8-8.6 V	1.8-8.6 V
Output signal: Minimum load	10 kOhm	10 kOhm
Bakeout temperature	150 °C, electronic removed	150 °C, electronic removed
Seal	FPM	Ag, Cu
Pressure max.	10 bar	10 bar
Feedthrough	Al_2O_3, Glass	Al_2O_3, Glas
Feature	interior FPM sealed	metal sealed
Flange	Stainless steel	Stainless steel
Accuracy: 10^{-8} - 10^{2} mbar	+/- 30 %	+/- 30 %
Filament	Tungsten	Tungsten
Filament	Molybdenum	Molybdenum
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Sensor cable length	300 m	300 m
Temperature: Operating	+5 - +55 °C	+5 - +55 °C, up to 150 °C on flange (horizontal installation)
Temperature: Storage	-40 - +65 °C	-40 - +65 °C
Supply: Voltage	15-30 V DC	15-30 V DC
Supply: Power consumption max.	2 W	2 W
Volume	20 cm^3	20 cm^3
Repeatability: 10^{-8} - 10^{2} mbar	+/- 5 %	+/- 5 %

	Active Pirani/ cold cathode transmitter PKR 251	Active Pirani/ cold cathode transmitter PKR 261
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Weight	700 g	700 g
Order number	**PT R26 000**	**PT R26 250**
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF
Weight	700 g	750 g
Order number	**PT R26 001**	**PT R26 251**
Flange (in)	DN 40 CF-F	DN 40 CF-F
Weight	950 g	995 g
Order number	**PT R26 002**	**PT R26 252**

Accessories		
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**

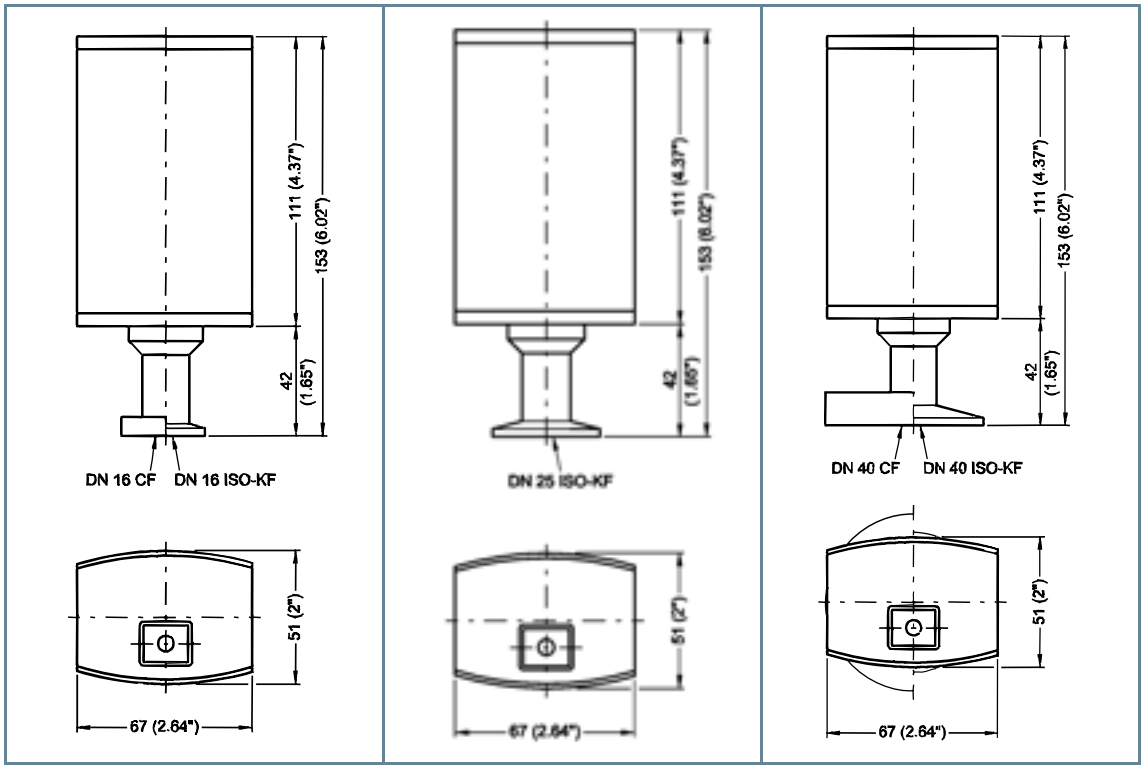
ActiveLine

Active hot cathode transmitters IMR 265, (2·10^{-6} - 1000 mbar)

ActiveLine

- Measurement range from 2·10^{-6} to 1000 mbar
- Two gauge heads (Pirani and hot cathode) in a single case
- Highly accurate
- Excellent reproducibility
- Automatic cathode protection
- A single flange from atmosphere to UHV
- Corrosion-resistant

Dimensions



Active hot cathode transmitter IMR 265, DN 16 ISO-KF
Active hot cathode transmitter IMR 265, DN 16 CF-F

Active hot cathode transmitter IMR 265, DN 25 ISO-KF

Active hot cathode transmitter IMR 265, DN 40 ISO-KF
Active hot cathode transmitter IMR 265, DN 40 CF-F

Technical data	Active hot cathode transmitter IMR 265
Output signal: Sensor error	0.5 V
Output signal: Pressure range Ioni	1,5-7,5 V
Output signal: Pressure range Pirani	8,5-9,75 V
Output signal: Minimum load	10 kOhm
Bakeout temperature	150 °C, electronic removed
Pressure max.	5 bar
Electron collector	Stainless steel
Flange	Stainless steel
Filament holder	Molybdenum, Platinum
Ion collector	Stainless steel
Isolator	Glass
Filament	iridium yttriated
Measurement range max.	1000 mbar
Measurement range min.	$2 \cdot 10^{-6}$ mbar
Sensor cable length	100 m
Pirani measurement element	Copper, Tungsten
Temperature: Operating	0 - +50 °C
Temperature: Storage	-20 - +70 °C
Supply: Voltage	20-30 V DC
Supply: Power consumption max.	16 W
Volume	20 cm^3
Repeatability: 10^{-1} - 10^{2} mbar	30 % reading
Repeatability: 10^{-5} - 10^{-1} mbar	2 % reading

	Active hot cathode transmitter IMR 265
Flange (in)	DN 16 ISO-KF
Weight	270 g
Order number	**PT R26 504**
Flange (in)	DN 25 ISO-KF
Weight	285 g
Order number	**PT R26 500**
Flange (in)	DN 40 ISO-KF
Weight	315 g
Order number	**PT R26 501**
Flange (in)	DN 16 CF-F
Weight	400 g
Order number	**PT R26 502**
Flange (in)	DN 40 CF-F
Weight	550 g
Order number	**PT R26 503**

Accessories	
Sensor cable, 3 m	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**

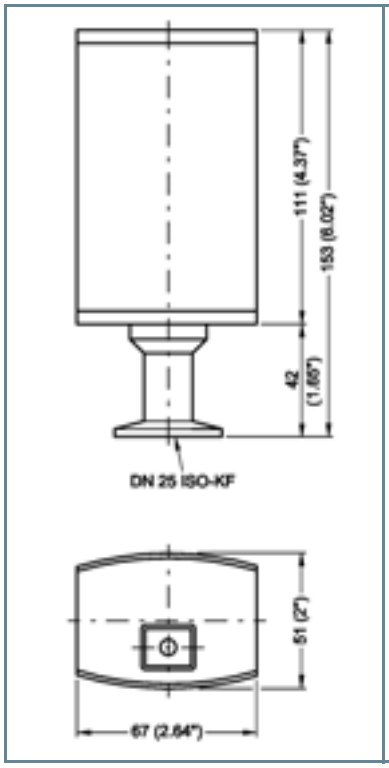
ActiveLine

Active Pirani/Bayard-Alpert transmitter PBR 260, ($5 \cdot 10^{-10}$ - 1000 mbar)

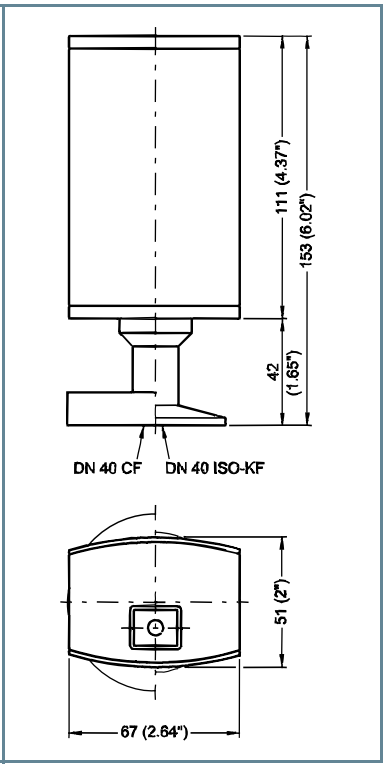
ActiveLine

- Measurement range from $5 \cdot 10^{-10}$ to 1000 mbar
- Two gauge heads (Pirani and BA hot cathode) in a single case
- Bayard-Alpert sensor ON/OFF automatically controlled by Pirani sensor
- Highly accurate
- A single flange from atmosphere to UHV
- Corrosion-resistant

Dimensions



Active Pirani/Bayard-Alpert transmitter PBR 260, DN 25 ISO-KF



Active Pirani/Bayard-Alpert transmitter PBR 260, DN 40 ISO-KF
Active Pirani/Bayard-Alpert transmitter PBR 260, DN 40 CF-R

Technical data	Active Pirani/ Bayard-Alpert transmitter PBR 260, DN 25 ISO-KF	Active Pirani/ Bayard-Alpert transmitter PBR 260, DN 40 ISO-KF	Active Pirani/ Bayard-Alpert transmitter PBR 260, DN 40 CF-R
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 40 CF-R
Output signal: Sensor error below	0.5 V	0.5 V	0.5 V
Output signal: Pressure range	0.774 - 10 V	0,774 - 10 V	0,774 - 10 V
Output signal: Minimum load	10 kOhm	10 kOhm	10 kOhm
Bakeout temperature	150 °C, electronic removed	150 °C, electronic removed	150 °C, electronic removed
Pressure max.	2 bar	2 bar	2 bar
Flange	Stainless steel	Stainless steel	Stainless steel
Accuracy: 10^{-8} - 10^{-2} mbar	15 % reading	15 % reading	15 % reading
Weight	285 g	315 g	550 g
Filament	Tungsten	Tungsten	Tungsten
Filament	iridium yttriated	iridium yttriated	iridium yttriated
Materials in contact with media	Cu, W, glass, NiFe, Mo, Stainless Steel, NiCr	Cu, W, glass, NiFe, Mo, Stainless steel, NiCr	Cu, W, glass, NiFe, Mo, Stainless steel, NiCr
Measurement range max.	1,000 mbar	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-10}$ mbar	$5 \cdot 10^{-10}$ mbar	$5 \cdot 10^{-10}$ mbar
Sensor cable length	100 m	100 m	100 m
Temperature: Operating	0 - +50 °C	0 - +50 °C	0 - +50 °C
Temperature: Storage	-20 - +70 °C	-20 - +70 °C	-20 - +70 °C
Supply: Voltage	20-28 V DC	20-28 V DC	20-28 V DC
Supply: Power consumption max.	16 W	16 W	16 W
Volume	24 cm^3	24 cm^3	25 cm^3
Repeatability: 10^{-8} - 10^{-2} mbar	5 % reading	5 % reading	5 % reading

Order number			
ActiveLine transmitters	**PT R27 000**	**PT R27 001**	**PT R27 002**

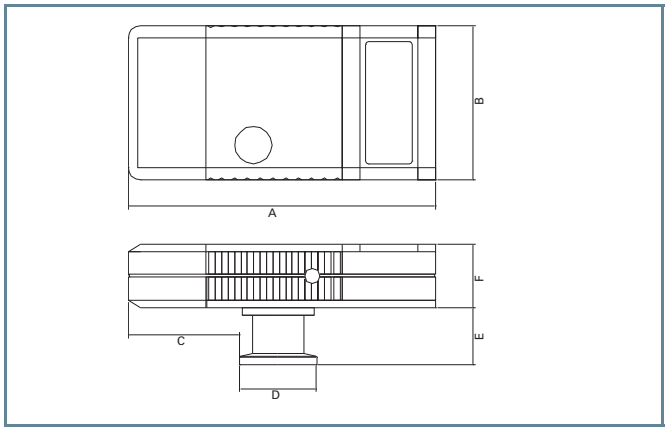
Accessories			
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**	**PT 448 250-T**
Mating connector for compact gauge	**B 4707 283 MA**	**B 4707 283 MA**	**B 4707 283 MA**

ActiveLine

TPG 201, Pirani manual measurement unit

- ▶ Battery-operated manual measurement unit
- ▶ Measurement range from $5 \cdot 10^{-4}$ to 1000 mbar
- ▶ Sensor and display in a single case
- ▶ Scope of delivery: Battery not included

Dimensions



TPG 201

	TPG 201
A	120 mm
B	60 mm
C	43.5 mm
D	30 mm
E	22 mm
F	25 mm

Technical data	TPG 201, Pirani manual measurement unit
Dimensions w x h x d	120 x 60 x 42 mm
Connection: Vacuum side	DN 16 KF
Battery type	9 V Alkaline E bloc/6 LR61/6 AM 6 Litium E bloc
Seal	Metal
Accuracy 10 - 100 mbar: % of measurement	ca. 30
Accuracy 10^{-2} - 10 mbar: % of measurement	ca. 10
Weight	0.195 kg
Materials in contact with media	Nickel, stainless steel, tungsten, glass-feedthroughs
Measurement range max.	1000 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar
Method of measurement	Pirani
Protection category	IP 20
Temperature: Operating	+5 - +40°C

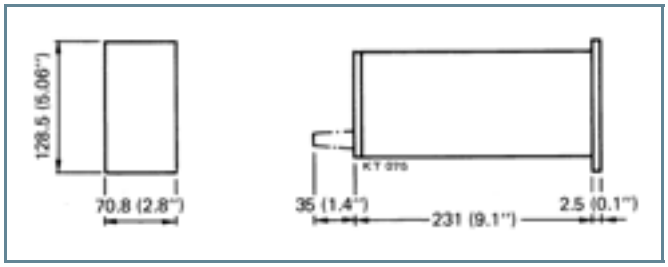
Order number	
TPG 201, Pirani manual measurement unit	**PT G28 201**

ActiveLine

TPG 261, controller for 1 transmitter

- For one transmitter
- Easy to operate
- Involatile parameter memory
- Auto-diagnostics
- For operation of all transmitters

Dimensions



TPG 261, controller for 1 transmitter

Technical data	TPG 261, controller for 1 transmitter
Connections for transmitter	1
Display rate	10 1/s
Error signal: Working contact, potential-free	1 piece
Error singal: Switching voltage max.	60 V DC
Filter time constant	1.2 / 0.4 / 0.02 s
Weight	1.1 kg
Measurement range max.	55000 mbar
Measurement range min.	$5 \cdot 10^{-11}$ mbar
Measurement rate	50 1/s
Mains requirement: frequency (range)	50/60 Hz
Mains requirement: power consumption	45 VA
Mains requirement: voltage (range)	90 - 250 V
Set point: Voltage max.	60 V DC
Set point: Current max.	1 A
Set point: Changeover contact, potential-free	2 pieces
Interface	RS-232-C
Protection category	IP 30
Safety	EN61010-1 / EN 50081-1 / EN50082-2 / IEC1010
Signal output: Measuring value, analog	0-10 V
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-20 - +65 °C

Order number	
TPG 261, controller for 1 transmitter	**PT G28 030**

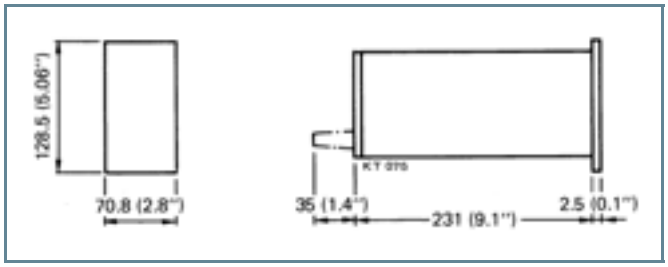
Accessories	
Sensor cable, 3 m	**PT 448 250-T**
Sensor cable, 5 m	**PT 448 251-T**
Sensor cable, 10 m	**PT 448 252-T**
Sensor cable, 15 m	**PT 448 253-T**
Sensor cable, 20 m	**PT 448 254-T**
Sensor cable, 25 m	**PT 448 255-T**
Sensor cable, 30 m	**PT 448 256-T**
Sensor cable, 35 m	**PT 448 257-T**
Sensor cable, 40 m	**PT 448 258-T**
Sensor cable, 45 m	**PT 448 259-T**
Sensor cable, 50 m	**PT 448 260-T**

ActiveLine

TPG 262, controller for 2 transmitters

- For two transmitters
- Easy to operate
- Involatile parameter memory
- Auto-diagnostics
- For operation of all transmitters

Dimensions



TPG 262, controller for 2 transmitters

Technical data	TPG 262 DualGauge™ controller
Connections for transmitter	2
Display rate	10 1/s
Automatic changeover: Pirani-cold cathode	$6 \cdot 10^{-3}$ mbar
Error signal: Working contact, potential-free	1 piece
Filter time constant	1,2 / 0,4 / 0,02 s
Weight	1.1 kg
Measurement range max.	55000 mbar
Measurement range min.	$5 \cdot 10^{-11}$ mbar
Measurement rate	50 1/s
Mains requirement: frequency (range)	50/60 Hz
Mains requirement: power consumption	45 VA
Mains requirement: voltage (range)	90-250 V
Set point: Voltage max.	60 V DC
Set point: Current max.	1 A
Set point: Changeover contact, potential-free	4 pieces
Interface	RS-232-C
Protection category	IP 30
Safety	EN61010-1 / EN 50081-1 / EN50082-2 / IEC1010
Signal output: Measuring value, analog	0-10 V
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-20 - +65 °C

Order number	
TPG 262, controller for 2 transmitters	**PT G28 280**

Accessories	
Sensor cable, 3 m	**PT 448 250-T**
Sensor cable, 5 m	**PT 448 251-T**
Sensor cable, 10 m	**PT 448 252-T**
Sensor cable, 15 m	**PT 448 253-T**
Sensor cable, 20 m	**PT 448 254-T**
Sensor cable, 25 m	**PT 448 255-T**
Sensor cable, 30 m	**PT 448 256-T**
Sensor cable, 35 m	**PT 448 257-T**
Sensor cable, 40 m	**PT 448 258-T**
Sensor cable, 45 m	**PT 448 259-T**
Sensor cable, 50 m	**PT 448 260-T**

ActiveLine

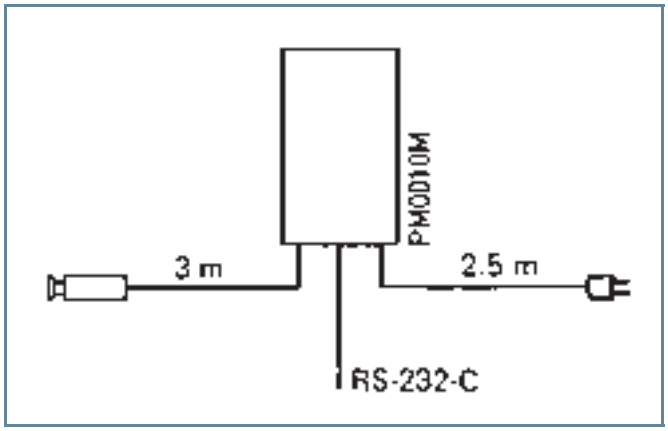
SingleGauge™ measurement equipment

ActiveLine

- SingleGauge measurement unit TPG 261
- Active Pirani transmitter TPR 280
- Flange size: DN 16 ISO-KF

- SingleGauge measurement unit TPG 261
- Active cold cathode transmitter IKR 251
- Flange size: DN 25 ISO-KF

Dimensions



SingleGauge™ measurement equipment

- SingleGauge measurement unit TPG 261
- Active Pirani/cold cathode transmitter PKR 251
- Flange size: DN 25 ISO-KF

- SingleGauge measurement unit TPG 261
- Active Pirani/Bayard-Alpert transmitter PBR 260
- Flange size: DN 25 ISO-KF

Technical data	SingleGauge™ measurement equipment TPG 261, 1 TPR 280, 3 m cable	SingleGauge™ measurement equipment TPG 261, 1 IKR 251, 3 m cable	SingleGauge™ measurement equipment TPG 261, 1 PKR 251, 3 m cable	SingleGauge™ measurement equipment TPG 261, 1 PBR 260, 3 m cable
Connections for transmitter	1	1	1	1
Measurement range max.	1,000 mbar	0.01 mbar	1000 mbar	1,000 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar	$2 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-10}$ mbar
Gauge head	1 TPR 265	1 IKR 251	1 PKR 251	1 PBR 260
Mains requirement: voltage (range)	90-250 V, 50/60 Hz	90-250 V, 50/60 Hz	90-250 V, 50/60 Hz	90-250 V, 50/60 Hz
Interface	RS-232-C	RS-232-C	RS-232-C	RS-232-C

Order number				
SingleGauge™ measurement equipment	**PT 441 930-T**	**PT 441 933-T**	**PT 441 935-T**	**PT 441 938-T**

Accessories				
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	-	-	-

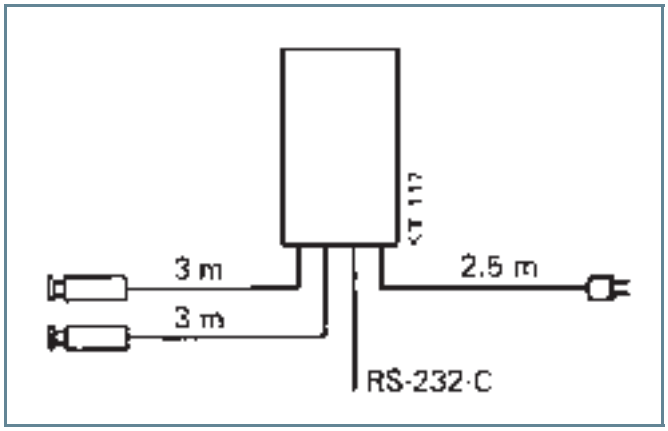
ActiveLine DualGauge™ measurement equipment

ActiveLine

- DualGauge measurement unit TPG 262
- Active Pirani transmitter TPR 280
- Flange size: DN 16 ISO-KF

- DualGauge measurement unit TPG 262
- Active Pirani transmitter TPR 280
- Flange size: DN 16 ISO-KF
- Active cold cathode transmitter IKR 251
- Flange size: DN 25 ISO-KF

Dimensions



DualGauge™ measurement equipment

- DualGauge measurement unit TPG 262
- Active Pirani/cold cathode transmitter PKR 251
- Flange size: DN 25 ISO-KF

- DualGauge measurement unit TPG 262
- Active Pirani transmitter TPR 280
- Flange size: DN 16 ISO-KF
- Active Pirani/cold cathode transmitter PKR 251
- Flange size: DN 25 ISO-KF

Technical data	DualGauge™ measurement equipment TPG 262, 2 TPR 280, 3 m cable	DualGauge™ measurement equipment TPG 262, 1 TPR 280, 1 IKR 251, 3 m cable	DualGauge™ measurement equipment TPG 262, 2 PKR 251, 3 m cable	DualGauge™ measurement equipment TPG 262, 1 TPR 280, 1 PKR 251, 3 m cable
Connections for transmitter	2	2	2	2
Measurement range max.	1,000 mbar	1,000 mbar	1,000 mbar	1,000 mbar
Measurement range min.	$5 \cdot 10^{-4}$ mbar	$2 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Gauge head	2 TPR 265	1 TPR 280, 1 IKR 251	2 PKR 251	1 TPR 280, 1 PKR 251
Mains requirement: voltage (range)	90-250 V, 50/60 Hz	90-250 V, 50/60 Hz	90-250 V, 50/60 Hz	90 - 250 V, 50/60 Hz
Interface	RS-232-C	RS-232-C	RS-232-C	RS-232-C

Order number				
DualGauge™ measurement equipment	**PT 441 940-T**	**PT 441 943-T**	**PT 441 945-T**	**PT 441 948-T**

Accessories				
Centering ring with poral filter, FPM/stainless steel, DN 16 ISO-KF	**PF 117 216-T**	**PF 117 216-T**	-	**PF 117 216-T**

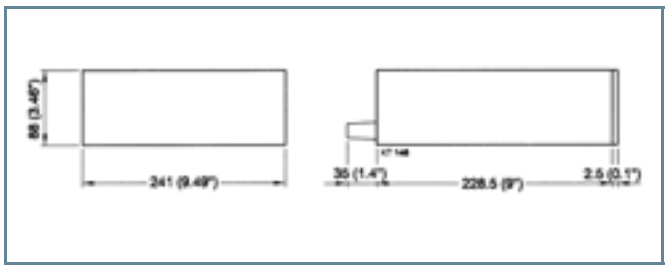
ActiveLine

Maxi Gauge™ TPG 256 A, controller for 6 transmitters

ActiveLine

- For operating 6 ActiveLine transmitters
- With RS-232-C and RS-422 interfaces, uninsulated

Dimensions



Maxi Gauge™ TPG 256 A, controller for 6 transmitters

Technical data	TPG 256 A MaxiGauge™ measurement unit	TPG 256 A MaxiGauge™ measurement unit
Connections for transmitter	6 (max. 3 IMR 265 / PBR 260 / CMR 27x)	6 (max. 3 IMR 265 / PBR 260 / CMR 27x)
Display rate	4 1/s	4,0 1/s
Error signal: Working contact, potential-free	1 piece	1 piece
Error singal: Switching voltage max.	60 V DC	60 V DC
Error signal: Switching current max.	3 A	3 A
Filter time constant	2.1/0.32/0.1 s	2.1/0.32/0.1 s
Weight	2.1 kg	2.1 kg
Measurement range max.	55000 mbar	5,5E+04 mbar
Measurement range min.	$5 \cdot 10^{-11}$ mbar	5,0E-11 mbar
Measurement rate	100 1/s	100 1/s
Mains requirement: frequency (range)	50-60 Hz	50-60 Hz
Mains requirement: power consumption	60 VA	6,0E+01 VA
Mains requirement: voltage (range)	90-250 V	90-250 V
Set point: Voltage max.	60 V DC	60 V DC
Set point: Current max.	3 A	3 A
Set point: Changeover contact, potential-free	6 pieces	6,0 pieces
Switching voltage	240 V with RI 256	240 V with RI 256
Interface	RS-232-C, RS-422	RS-232-C, RS-422, RS-422 isolated, RS-485 isolated
Protection category	IP30	IP30
Safety	EN61010-1 / IEC 1010, EN60950, EN 50081-1 / EN50082-1	EN61010-1 / IEC 1010, EN60950, EN 50081-1&2
Signal output: Output resistance	660 Ohm	660 Ohm
Signal output: Measuring value, analog	0-10 V DC	0-10 V DC
Temperature: Operating	+5 - +40 °C	+5 - +40 °C
Temperature: Storage	-20 - +60 °C	-20 - +60 °C

Order number		
Maxi Gauge™ TPG 256 A, controller for 6 transmitters	**PT G28 760**	**PT G28 761**

Accessories		
Sensor cable, 3 m	**PT 448 250-T**	**PT 448 250-T**
Sensor cable, 5 m	**PT 448 251-T**	**PT 448 251-T**
Sensor cable, 10 m	**PT 448 252-T**	**PT 448 252-T**
Sensor cable, 15 m	**PT 448 253-T**	**PT 448 253-T**
Sensor cable, 20 m	**PT 448 254-T**	**PT 448 254-T**
Sensor cable, 25 m	**PT 448 255-T**	**PT 448 255-T**
Sensor cable, 30 m	**PT 448 256-T**	**PT 448 256-T**
Sensor cable, 35 m	**PT 448 257-T**	**PT 448 257-T**
Sensor cable, 40 m	**PT 448 258-T**	**PT 448 258-T**
Sensor cable, 45 m	**PT 448 259-T**	**PT 448 259-T**
Sensor cable, 50 m	**PT 448 260-T**	**PT 448 260-T**

ModulLine

For applications in research & development!

What is ModulLine?

The ModulLine series includes three TPR Pirani gauge heads with a measurement range from 1,000 to 8 ·10^{-4} mbar and three IKR cold cathode gauge heads with a measurement range of 5 · 10^{-3} to 10^{-11} mbar. Since the gauge heads do not contain any electronics, they are suitable for employment in high-radiation locations.

Advantages at a glance

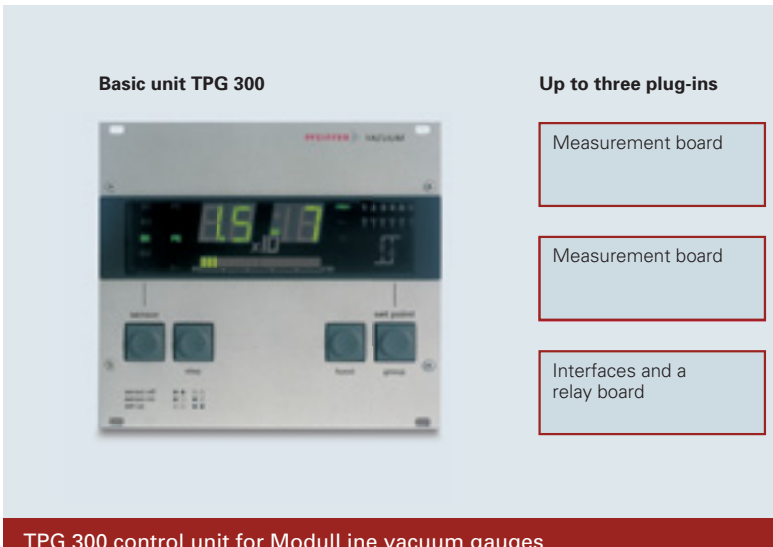
- Rugged and well proven design
- Basically uneffected by radioactivity and electromagnetic fields
- Is being used on all large accelerators

- Four different interface options (Profibus)
- Metal-sealed versions of the sensors are available
- Automatic switchover from Pirani to cold cathode sensor

Applications

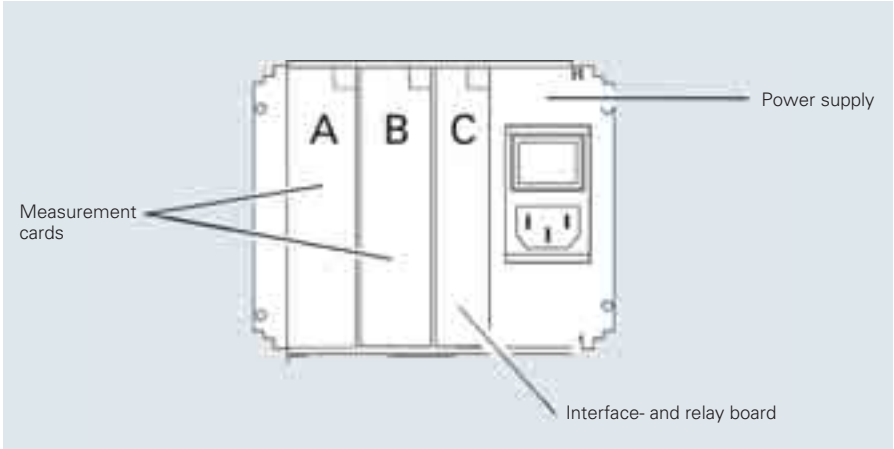
- For use in critical areas like high radiation, for example
- For UHV

- Two measurement boards are possible
- Up to 4 gauge heads max. can be connected
- Cable matching the respective gauge heads
- One interface and relay board
- Profibus is possible



TPG 300 control unit for ModulLine vacuum gauges

Complete measurement units



Scheme measurement unit

Vacuum measurement and control units

Complete measurement units containing basic unit and the follwing measurement and relay cards

1 = one card
2 = two cards

	Pirani	Pirani/Cold cathode combinded		RS-232-C-Inter-face and relay	RS-232-C-Inter-face and relay
	PI 300 D	**CP 300 C9**	**CP 300 C10**	**IF 300 A**	**IF 300 B**
PT G25 250	1				
PT G25 306	1			1	
PT G25 251	1				1
PT G25 290		1			
PT G25 307		1		1	
PT G25 291		1			1
PT G25 256			1		
PT G25 312			1	1	
PT G25 257			1		1
PT G25 252	2				
PT G25 310	2			1	
PT G25 253	2				1
PT G25 294		2			
PT G25 311		2		1	
PT G25 295		2			1
PT G25 292	1	1			
PT G25 302	1	1		1	
PT G25 293	1	1			1
PT G25 262	1		1		
PT G25 313	1		1	1	
PT G25 263	1		1		1

Notes

ModulLine Pirani gauge heads

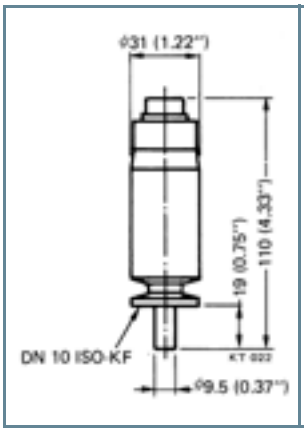
ModulLine

TPR 010
▶ For general applications

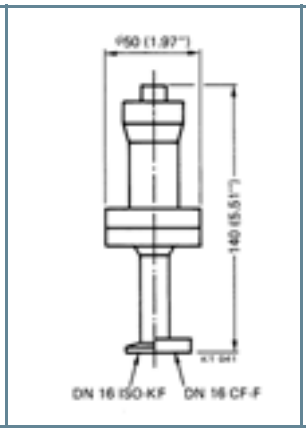
TPR 017
▶ For corrosive media

TPR 018
▶ For UHV

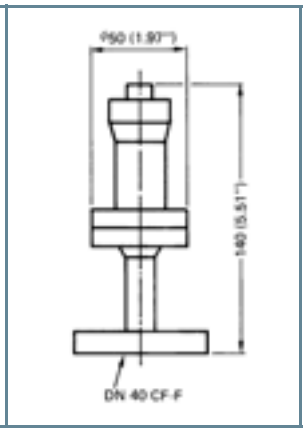
Dimensions



TPR 010



TPR 017
TPR 018



TPR 018, UHV

Technical data	TPR 010	TPR 017	TPR 018
Bakeout temperature	100 °C	250 °C	250 °C
Operating temperature, high temperature sensor cable	-	0-120 °C	0-120 °C
Operating temperature, standard sensor cable	0-70 °C	0-80 °C	0-80 °C
Weight	0.14 kg	0.6 kg	0.6 kg
Isolator	FPM	Al_2O_3	Al_2O_3
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar
Filament/holder	T/Ni	Ni/Ni	T/Ni
Chamber wall, inside	AlSiMg	Stainless steel	Stainless steel
Protective filter	Sintered bronze	-	-
Radiation resistance	-	$1 \cdot 10^4$ Gy	$1 \cdot 10^4$ Gy

	TPR 010	TPR 017	TPR 018
Flange (in)	DN 10 ISO-KF		
Order number	**PT R02 270**		
Flange (in)		DN 16 ISO-KF	DN 16 ISO-KF
Order number		**PT R13 270**	**PT R15 010**
Flange (in)		DN 16 CF-F	DN 16 CF-F
Order number		**PT R13 271**	**PT R15 011**
Flange (in)			DN 40 CF-F
Order number			**PT R15 014**

Accessories			
Sensor cable, TPR 010, 3 m, 80 °C	**PT 548 402-T**		
Sensor cable, TPR 010, 6 m, 80 °C	**PT 548 403-T**		
Sensor cable, TPR 017/018, 3 m, 80 °C		**PT 548 308-T**	**PT 548 308-T**
Sensor cable, TPR 017/018, 6 m, 80 °C		**PT 548 309-T**	**PT 548 309-T**

ModulLine Cold cathode gauge heads

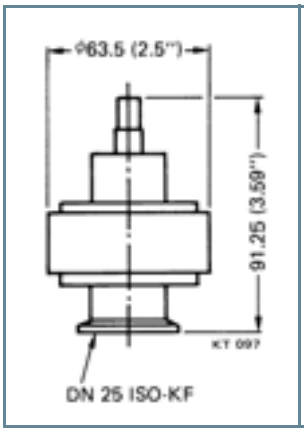
ModulLine

IKR 050 coaxial
▶ For general applications

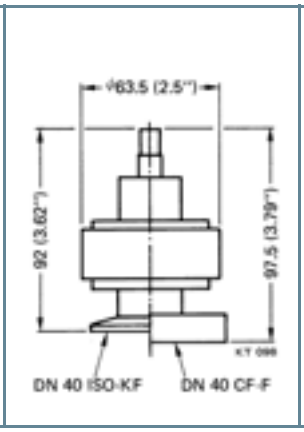
IKR 060 coaxial
▶ For UHV
▶ Radiation-resistant

IKR 070 coaxial
▶ For UHV
▶ Radiation-resistant

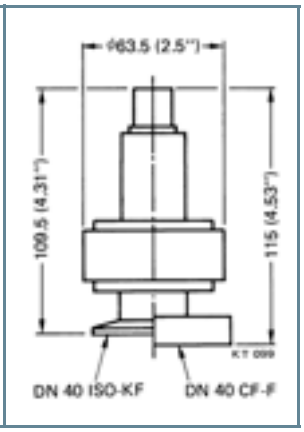
Dimensions



IKR 050 coaxial



IKR 050 coaxial
IKR 060 coaxial



IKR 070 coaxial

Technical data	IKR 050 coaxial	IKR 060 coaxial	IKR 070 coaxial
Bakeout temperature	150 °C	250 °C	250 °C
Operating temperature, high temperature sensor cable	5-150 °C	5-250 °C	-
Operating temperature, standard sensor cable	5-80 °C	5-80 °C	5-80 °C
Internal seal	FPM	Silver	Silver
Flange	Stainless steel	Stainless steel	Stainless steel
Weight	0.6 kg	0.85 kg	0.85 kg
Isolator	Al_2O_3	Al_2O_3	Al_2O_3
Measurement range max.	$5 \cdot 10^{-3}$ mbar	$5 \cdot 10^{-3}$ mbar	$5 \cdot 10^{-3}$ mbar
Measurement range min.	$2 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-11}$ mbar
Radiation resistance	-	$1 \cdot 10^{7}$ Gy	$1 \cdot 10^{7}$ Gy

	IKR 050 coaxial	IKR 060 coaxial	IKR 070 coaxial
Flange (in)	DN 25 ISO-KF		
Weight	0.6 kg		
Order number	**PT R18 500**		
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Weight	0.6 kg	0.6 kg	0.6 kg
Order number	**PT R18 501**	**PT R18 753**	**PT R20 501**
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Weight	0.85 kg	0.85 kg	0.85 kg
Order number	**PT R18 502**	**PT R18 751**	**PT R20 502**

Accessories			
Sensor cable, IKR 050/060, 3 m, 80 °C	**PT 548 406-T**	**PT 548 406-T**	
Sensor cable, IKR 050/060, 6 m, 80 °C	**PT 548 407-T**	**PT 548 407-T**	
Sensor cable, IKR 070, 3 m, 80 °C			**PT 548 306-T**
Sensor cable, IKR 070, 6 m, 80 °C			**PT 548 317-T**

ModulLine Accessories

ModulLine

- ▶ Sensor cables
- ▶ Extension for sensor cables
- ▶ High-temperature sensor cables

Sensor cables	Order number
Sensor cable, TPR 017/018, 3 m, 80 °C	**PT 548 308-T**
Sensor cable, TPR 017/018, 6 m, 80 °C	**PT 548 309-T**
Sensor cable, TPR 017/018, 10 m, 80 °C	**PT 548 456-T**
Sensor cable, TPR 017/018, 15 m, 80 °C	**PT 548 457-T**
Sensor cable, TPR 017/018, 20 m, 80 °C	**PT 548 458-T**
Sensor cable, TPR 017/018, 25 m, 80 °C	**PT 548 459-T**
Sensor cable, TPR 017/018, 30 m, 80 °C	**PT 548 460-T**
Sensor cable, TPR 017/018, 35 m, 80 °C	**PT 548 461-T**
Sensor cable, TPR 017/018, 40 m, 80 °C	**PT 548 462-T**
Sensor cable, TPR 017/018, 45 m, 80 °C	**PT 548 463-T**
Sensor cable, TPR 017/018, 50 m, 80 °	**PT 548 464-T**
Sensor cable, TPR 010, 2 m, 80 °C	**PT 548 401-T**
Sensor cable, TPR 010, 3 m, 80 °C	**PT 548 402-T**
Sensor cable, TPR 010, 6 m, 80 °C	**PT 548 403-T**
Sensor cable, TPR 010, 30 m, 80 °C	**PT 548 415-T**
Sensor cable, TPR 010, 40 m, 80 °C	**PT 548 416-T**
Sensor cable, TPR 010, 50 m, 80 °C	**PT 548 417-T**
Sensor cable, TPR 010, 10 m, 80 °C	**PT 548 450-T**
Sensor cable, TPR 010, 15 m, 80 °C	**PT 548 451-T**
Sensor cable, TPR 010, 20 m, 80 °C	**PT 548 452-T**
Sensor cable, TPR 010, 25 m, 80 °C	**PT 548 453-T**
Sensor cable, TPR 010, 35 m, 80 °C	**PT 548 454-T**
Sensor cable, TPR 010, 45 m, 80 °C	**PT 548 455-T**
Sensor cable, IKR 050/060, 3 m, 80 °C	**PT 548 406-T**
Sensor cable, IKR 050/060, 6 m, 80 °C	**PT 548 407-T**
Sensor cable, IKR 050/060, 10 m, 80 °C	**PT 548 419-T**
Sensor cable, IKR 050/060, 30 m, 80 °C	**PT 548 422-T**
Sensor cable, IKR 050/060, 15 m, 80 °C	**PT 548 483-T**
Sensor cable, IKR 050/060, 20 m, 80 °C	**PT 548 484-T**
Sensor cable, IKR 050/060, 25 m, 80 °C	**PT 548 485-T**
Sensor cable, IKR 050/060, 35 m, 80 °C	**PT 548 486-T**
Sensor cable, IKR 050/060, 40 m, 80 °C	**PT 548 487-T**
Sensor cable, IKR 050/060, 45 m, 80 °C	**PT 548 488-T**
Sensor cable, IKR 050/060, 50 m, 80 °C	**PT 548 489-T**
Sensor cable, IKR 070, 3 m, 80 °C	**PT 548 306-T**
Sensor cable, IKR 070, 6 m, 80 °C	**PT 548 317-T**
Sensor cable, IKR 070, 10 m, 80 °C	**PT 548 490-T**
Sensor cable, IKR 070, 15 m, 80 °C	**PT 548 491-T**
Sensor cable, IKR 070, 20 m, 80 °C	**PT 548 492-T**
Sensor cable, IKR 070, 30 m, 80 °C	**PT 548 493-T**
Sensor cable, IKR 070, 40 m, 80 °C	**PT 548 494-T**
Sensor cable, IKR 070, 45 m, 80 °C	**PT 548 495-T**
Sensor cable, IKR 070, 50 m, 80 °C	**BP 229 748-T**

Extension for sensor cables	Order number
Extension for sensor cable, TPR 010/017/018, 10 m, 80 °C	**PT 548 466-T**
Extension for sensor cable, TPR 010/017/018, 20 m, 80 °C	**PT 548 468-T**
Extension for sensor cable, TPR 010/017/018, 30 m, 80 °C	**PT 548 470-T**
Extension for sensor cable, TPR 010/017/018, 40 m, 80 °C	**PT 548 472-T**
Extension for sensor cable, TPR 010/17/018, 50 m, 80 °C	**PT 548 474-T**

High-temperature sensor cables	Order number
High-temperature sensor cable, TPR 017/018, 3 m, 250 °C	**PT 548 414-T**
High-temperature sensor cable, TPR 017/018, 6 m, 250 °C	**PT 548 465-T**
High-temperature sensor cable, TPR 017/018, 10 m, 250 °C	**PT 448 047-T**
High-temperature sensor cable, TPR 017/018, 15 m, 250 °C	**PT 448 043-T**
High-temperature sensor cable, TPR 017/018, 20 m, 250 °C	**PT 448 044-T**
High-temperature sensor cable, IKR 050/060, 3 m, 250 °C	**PT 548 542-T**
High-temperature sensor cable, IKR 050/060, 6 m, 250 °C	**PT 548 543-T**
High-temperature sensor cable, IKR 050/060, 10 m, 250 °C	**PT 448 045-T**
High-temperature sensor cable, IKR 050/060, 15 m, 250 °C	**PT 548 989-T**
High-temperature sensor cable, IKR 050/060, 20 m, 250 °C	**PT 448 046-T**

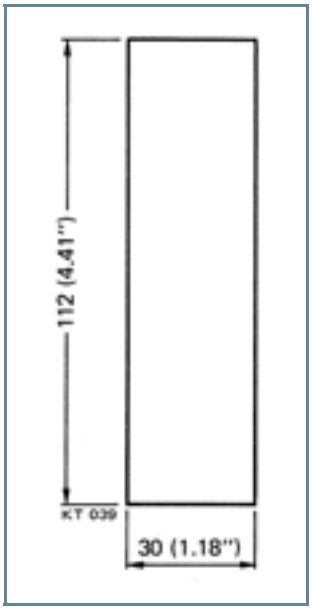
ModulLine Pirani Measurement board

ModulLine

Pirani measurement board PI 300 D
- ▶ For 2 TPR 010/018
- ▶ Measurement range from 1000 to $8 \cdot 10^{-4}$ mbar

Pirani measurement board PI 300 DN
- ▶ For 2 TPR 017
- ▶ Measurement range from 1000 to $8 \cdot 10^{-4}$ mbar

Dimensions



Pirani Measurement board

Technical data	Pirani measurement board PI 300 D, for 2 TPR 010/018s	Pirani measurement board PI 300 DN, for 2 TPR 017s
Number of measuring circuits	2	2
For gauge	TPR 010, TPR 018	TPR 017
Weight	0.14 kg	0.14 kg
Measurement range max.	1000 mbar	1000 mbar
Measurement range min.	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar
Sensor cable length	100 m	100 m
Measurement board	Pirani measurement board	Pirani Measurement board
Reaction time of the output signal: Decay	600 ms	600 ms
Reaction time of the output signal: Rise	50 ms	50 ms

Order number		
Pirani Measurement board	**PT 546 920-T**	**PT 549 214-T**

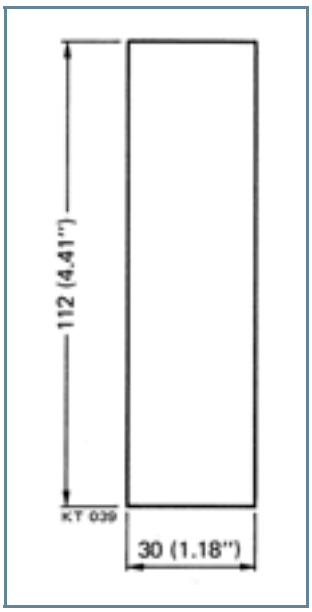
ModulLine Cold cathode measurement board

ModulLine

Cold cathode measurement board PE 300 DC9

- ▶ Measurement range from $1 \cdot 10^{-9}$ to $5 \cdot 10^{-3}$ mbar
- ▶ For 2 IKR 050

Dimensions



Cold cathode measurement board

Technical data	Cold cathode measurement board PE 300 DC9, for 2 IKR 050s
Number of measuring circuits	2
For gauge	IKR 050
Weight	0.26 kg
Measurement range max.	$5 \cdot 10^{-3}$ mbar
Measurement range min.	$1 \cdot 10^{-9}$ mbar
Sensor cable length	100 m
Measurement board	Cold cathode measurement board
Reaction time of the output signal: Rise	16 ms

Order number	
Cold cathode measurement board	**PT 441 375-T**

ModulLine

Pirani/cold cathode measurement board

ModulLine

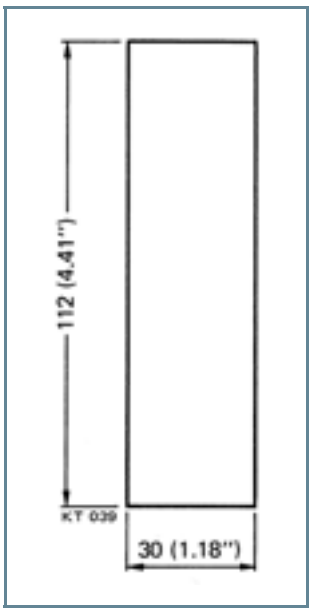
CP 300 T11L
- ▶ For 1 TPR 010/018 and 1 IKR 070
- ▶ Max. sensor cable length: 500 m
- ▶ Measurement range from $1 \cdot 10^{-11}$ to 1000 mbar

CP 300 C9
- ▶ For 1 TPR 010/018 and 1 IKR 050
- ▶ Measurement range from 1000 to $5 \cdot 10^{-9}$ mbar

CP 300 T11
- ▶ For 1 TPR 010/018 and 1 IKR 070
- ▶ Measurement range from 1000 to $1 \cdot 10^{-11}$ mbar

CP 300 C10
- ▶ For 1 TPR 010/018 and 1 IKR 060
- ▶ Measurement range from 1000 to $1 \cdot 10^{-10}$ mbar

Dimensions



Pirani/cold cathode measurement board

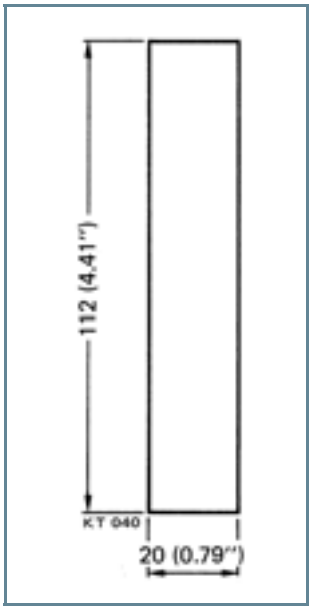
Technical data	Pirani/cold cathode measurement board CP 300 T11L, for 1 TPR 010/018, 1 IKR 070	Pirani/cold cathode measurement board CP 300 C9, for 1 TPR 010/018, 1 IKR 050	Pirani/cold cathode measurement board CP 300 T11, for 1 TPR 010/018, 1 IKR 070	Pirani/cold cathode measurement board CP 300 C10, for 1 TPR 010/018, 1 IKR 060
Number of measuring circuits	2	1 each	1 each	1 each
For gauge	TPR 010, TPR 018, IKR 070	TPR 010, TPR 018, IKR 050	TPR 010, TPR 018, IKR 070	TPR 010, TPR 018, IKR 060
Weight	0.21 kg	0.21 kg	0.25 kg	0.23 kg
Measurement range max.	1000 mbar	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$1 \cdot 10^{-11}$ mbar	$5 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-11}$ mbar	$1 \cdot 10^{-10}$ mbar
Sensor cable length	500 m	100 m	100 m	100 m
Measurement board	-	Pirani/cold cathode measurement board	Pirani/cold cathode measurement board	Pirani/Cold cathode measurement board
Reaction time of the output signal: Rise	10 ms	10 ms	50 ms	50 ms

Order number				
Pirani/cold cathode measurement board	**PT 441 122-T**	**PT 441 000-T**	**PT 441 080-T**	**PT 441 114-T**

ModulLine Interface and relay board

ModulLine

Dimensions



Interface and relay board

Technical data	Interface and relay board IF 300 A, RS-232-C, 45 W, 75 VA	Interface and relay board IF 300 B, RS-232-C, 120 W, 1,000 VA	Interface and relay board IF 300 C, RS-422, 50 V AC / DC	Interface and relay board IF 300 P, Profibus-DP, 45 W, 75 VA
Weight	0.14 kg	0.15 kg	0.14 kg	0.16 kg
Relay: Connector 15 pole (pins)	D-Sub	GdsA-H, DIN 41612	D-Sub	D-Sub
Relay: Number	5 pieces	5 pieces	5 pieces	5 pieces
Relay: Switching capacity	45 W, 75 VA	120 W, 1000 VA	45 W, 75 VA	45 W, 75 VA
Relay: Switching voltage	30 V DC / 50 V AC	30 V DC / 250 V AC	50 V AC / DC	50 V AC / DC
Relay: Switching current	1.5 A	4 A	1.5 A	1.5 A
Relay: Changeover contacts, potential-free, per relay	1 piece	1 piece	1 piece	1 piece
Relay: Resistance (with connector)	125 mOhm	70 mOhm	125 mOhm	125 mOhm
Interface	RS-232-C	RS-232-C	RS-422	Profibus-DP
Interface: Connection	D-sub connector, 9-pole, pins	Cable with D-sub connector, 9-pole, pins	D-sub connector, 9-pole, sockets	D-sub connector, 9-pole, pins
Interface: Baud rates	300, 1200, 2400, 4800, 9600	300, 1200, 2400, 4800, 9600	300, 1200, 2400, 4800, 9600	12 Mbaud
Interface: Data format	ASCII, 1 start bit, 8 data bits, 1 stop bit, no parity bit	ASCII, 1 start bit, 8 data bits, 1 stop bit, no parity bit	ASCII, 1 start bit, 8 data bits, 1 stop bit, no parity bit	-
Interface: Cable length max.	30 m	30 m	1200 m	1200 m
Interface: Type	RS-232-C asynchronus	RS-232-C asynchronus	RS-422 asynchronus	Profibus-DP

Order number				
Interface and relay board	**PT 441 130-T**	**PT 441 250-T**	**PT 441 390-T**	**PT 441 395-T**

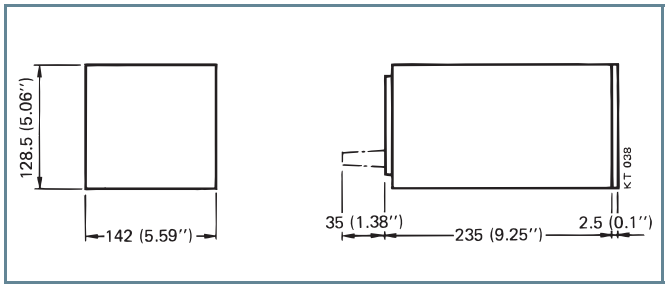
Accessories				
D-Sub mating connector, female, 15-pin, for IF 300 A/C, relay output	**PT 441 129-T**		**PT 441 129-T**	
D-Sub mating connector, female, for IF 300 A, RS-232-C	**PT 441 128-T**			
Interface cable, for IF 300 B, RS-232-C, 0.4 m		**PT 548 932-T**		
Relay connector, complete, for IF 300 B		**PT 546 999-T**		

ModulLine TPG 300, basic unit

ModulLine

- Basic unit with power supply and 3 free slots for measurement, interface and relay boards

Dimensions



TPG 300, basic unit

Technical data	TPG 300, Basic unit
Display rate	5 1/s
Error display	1 LED, red
Filter time constant	16 ms, 160 ms (standard), 1.6 s
Weight: without boards	1.4 kg
Limit frequency	10 Hz, 1 Hz (standard), 0.1 Hz
Unit of measure	mbar, Torr, Pa
Measurement range max.	1000 mbar
Measurement range min.	$1 \cdot 10^{-11}$ mbar
Measurement rate	100 1/s
Measured value display	15 mm high numbers
Mains requirement: frequency (range)	50-60 Hz
Mains requirement: power consumption	55 VA
Mains requirement: voltage (range)	90-264 V AC
Safety	IEC 384, class 1, VDE 0411, part 2.80
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-40 - +65 °C

Order number	
TPG 300, basic unit	**PT 546 900-T**

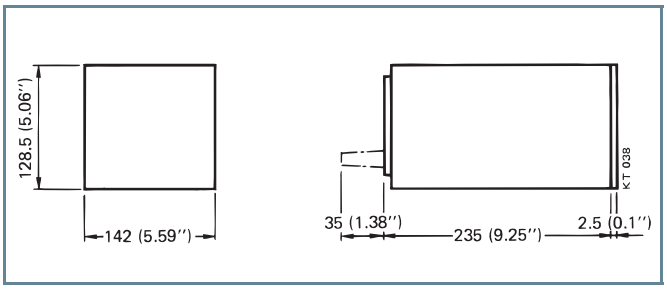
Accessories	
Blank panel for measurement board	**PT 441 259**
Blank panel, for IF 300	**PT 441 017**

ModulLine

TPG 300, complete units with measurement boards and power cords

ModulLine

Dimensions



TPG 300, basic unit

Technical data	TPG 300, complete units with measurement boards and power cords
Display rate	5 1/s
Error display	1 LED, red
Filter time constant	16 ms, 160 ms (standard), 1.6 s
Weight: without boards	1.4 kg
Limit frequency	10 Hz, 1 Hz (standard), 0.1 Hz
Unit of measure	mbar, Torr, Pa
Measurement rate	100 1/s
Measured value display	15 mm high numbers
Mains requirement: frequency (range)	50-60 Hz
Mains requirement: power consumption	55 VA
Mains requirement: voltage (range)	90-264 V AC
Safety	IEC 384, class 1, VDE 0411, part 2.80
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-40 - +65 °C

Technical data	TPG 300, complete measurement unit, incl. PI 300 D	TPG 300, complete measurement unit incl. PI 300 D, IF 300 A	TPG 300, complete measurement unit, incl. PI 300 D, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar
Measurement board	PI 300 D for 2 Pirani Gauge TPR 010/018	PI 300 D for 2 Pirani Gauge TPR 010/018	PI 300 D for 2 Pirani Gauge TPR 010/018
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 250**	**PT G25 306**	**PT G25 251**

Technical data	TPG 300, complete measurement unit, incl. 2 PI 300 D	TPG 300, complete measurement unit incl. 2 PI 300 D, IF 300 A	TPG 300, complete measurement unit, incl. 2 PI 300 D, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar	$8 \cdot 10^{-4}$ mbar
Measurement board	2 PI 300 D for 4 Pirani Gauge TPR 010/018	2 PI 300 D for 4 Pirani Gauge TPR 010/018	2 PI 300 D for 4 Pirani Gauge TPR 010/018
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 252**	**PT G25 310**	**PT G25 253**

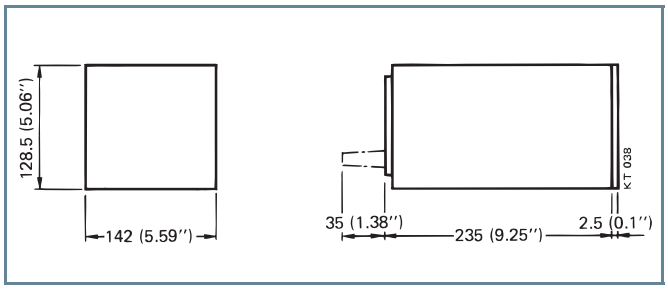
Technical data	TPG 300, complete measurement unit, incl. CP 300 C10	TPG 300, complete measurement unit incl. CP 300 C10, IF 300 A	TPG 300, complete measurement unit, incl. CP 300 C10, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Measurement board	CP 300 C10 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060	CP 300 C10 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060	CP 300 C10 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 256**	**PT G25 312**	**PT G25 257**

ModulLine

TPG 300, complete units with measurement boards and power cords

ModulLine

Dimensions



TPG 300, basic unit

Technical data	TPG 300, complete units with measurement boards and power cords
Display rate	5 1/s
Error display	1 LED, red
Filter time constant	16 ms, 160 ms (standard), 1.6 s
Weight: without boards	1.4 kg
Limit frequency	10 Hz, 1 Hz (standard), 0.1 Hz
Unit of measure	mbar, Torr, Pa
Measurement rate	100 1/s
Measured value display	15 mm high numbers
Mains requirement: frequency (range)	50-60 Hz
Mains requirement: power consumption	55 VA
Mains requirement: voltage (range)	90-264 V AC
Safety	IEC 384, class 1, VDE 0411, part 2.80
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-40 - +65 °C

Technical data	TPG 300, complete measurement unit, incl. PI 300 D, CP 300 C10	TPG 300, complete measurement unit, incl. PI 300 D, CP 300 C10, IF 300 A	TPG 300, complete measurement unit, incl. PI 300 D, CP 300 C10, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Measurement board	PI 300 D, CP 300 C10 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060	PI 300 D, CP 300 C10 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060	PI 300 D, CP 300 C10 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 060
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 262**	**PT G25 313**	**PT G25 263**

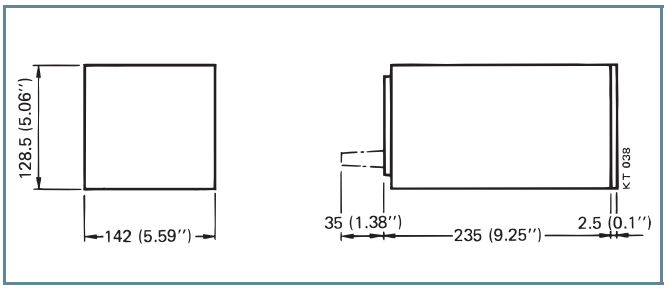
Technical data	TPG 300, complete measurement unit incl. CP 300 C9	TPG 300, complete measurement unit incl. CP 300 C9, IF 300 A	TPG 300, complete measurement unit, incl. CP 300 C9, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Measurement board	CP 300 C9 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 050	CP 300 C9 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 050	CP 300 C9 for 1 Pirani- and 1 Cold Cathode Gauge TPR 010/ 018, IKR 050
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 290**	**PT G25 307**	**PT G25 291**

ModulLine

TPG 300, complete units with measurement boards and power cords

ModulLine

Dimensions



TPG 300, basic unit

Technical data	TPG 300, complete units with measurement boards and power cords
Display rate	5 1/s
Error display	1 LED, red
Filter time constant	16 ms, 160 ms (standard), 1.6 s
Weight: without boards	1.4 kg
Limit frequency	10 Hz, 1 Hz (standard), 0.1 Hz
Unit of measure	mbar, Torr, Pa
Measurement rate	100 1/s
Measured value display	15 mm high numbers
Mains requirement: frequency (range)	50-60 Hz
Mains requirement: power consumption	55 VA
Mains requirement: voltage (range)	90-264 V AC
Safety	IEC 384, class 1, VDE 0411, part 2.80
Temperature: Operating	+5 - +50 °C
Temperature: Storage	-40 - +65 °C

Technical data	TPG 300, complete measurement unit, incl. PI 300 D, CP 300 C9	TPG 300, complete measurement unit incl. PI 300 D, CP 300 C9, IF 300 A	TPG 300, complete measurement unit, incl. PI 300 D, CP 300 C9, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Measurement board	PI 300 D, CP 300 C9 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/018, IKR 050	PI 300 D, CP 300 C9 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/018, IKR 050	PI 300 D, CP 300 C9 for 3 Pirani- and 1 Cold Cathode Gauge TPR 010/018, IKR 050
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 292**	**PT G25 302**	**PT G25 293**

Technical data	TPG 300, complete measurement unit incl. 2 CP 300 C9	TPG 300, complete measurement unit incl. 2 CP 300 C9, IF 300 A	TPG 300, complete measurement unit, incl. 2 CP 300 C9, IF 300 B
Measurement range max.	1000 mbar	1000 mbar	1000 mbar
Measurement range min.	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar	$5 \cdot 10^{-9}$ mbar
Measurement board	2 CP 300 C9 for 2 Pirani- and 2 Cold Cathode Gauge TPR 010/ 018, IKR 050	2 CP 300 C9 for 2 Pirani- and 2 Cold Cathode Gauge TPR 010/ 018, IKR 050	2 CP 300 C9 for 2 Pirani- and 2 Cold Cathode Gauge TPR 010/ 018, IKR 050
Relay: Switching voltage	-	30 V DC / 50 V AC	30 V DC / 250 V AC
Interfaces	-	RS-232-C, IF 300 A	RS-232-C, IF 300 B
Order number			
TPG 300, complete units with measurement boards and power cords	**PT G25 294**	**PT G25 311**	**PT G25 295**

Mass S

Spectrometers

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Mass spectrometers	
New mass spectrometers	**548**
Overview of technologies	**548**
Quadera® – mass spectrometer software	**549**
PrismaPlus™	**552**
HiQuad™	**560**

New mass spectrometers

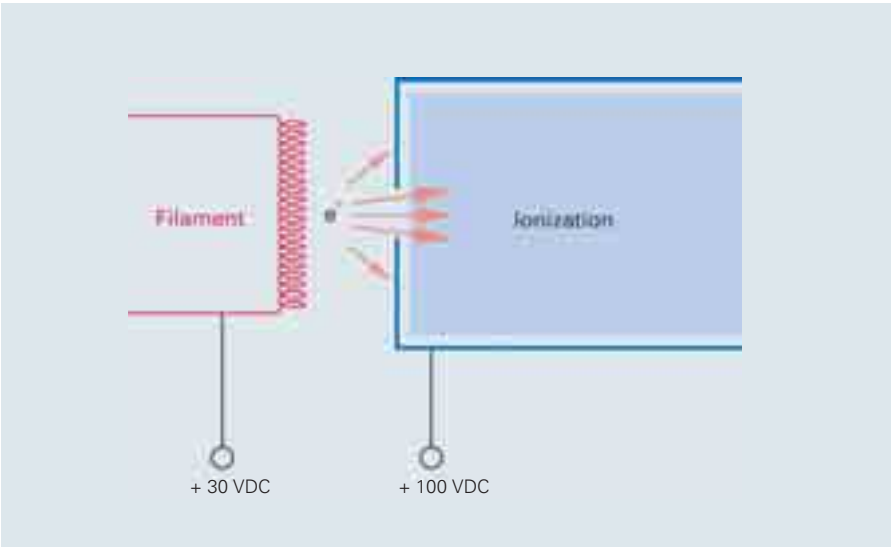
Pfeiffer Vacuum supplies a broad portfolio of mass spectrometers, ranging all the way to high-performance mass spectrometers for plasma analysis.

The gas composition in a production system can be determined with the aid of a mass spectrometer. Because in the manufacturing process, it is not only important to know "how much" is in it, but also "what it is."

Pfeiffer Vacuum offers two basic mass spectrometer models:
- The PrismaPlus compact mass spectrometer
- The HiQuad high-resolution mass spectrometer

Overview of technologies

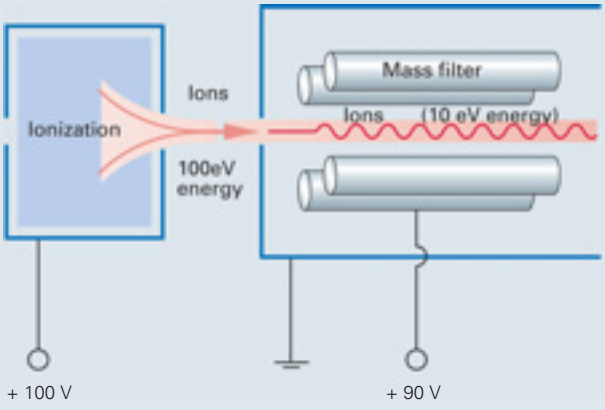
Biased ionization chamber
Biasing the ionization chamber results in an extremely low background signal. The electron-emitting filament is positively biased relative to ground. This design prevents desorption of gas particles from the chamber walls, and thus the generation of an undesired background signal by electron stimulated desorption.



Biased ionization chamber

Field-axis technology

One of the most important factors in the performance of a mass spectrometer is the transmission of the ions from the ion source into the mass filter. With the aid of field-axis technology, the ions are able to cross the peripheral fields of the separating system without any noteworthy interaction. This enables a high level of sensitivity (A/mbar) to be achieved without the need for pre and post filters.



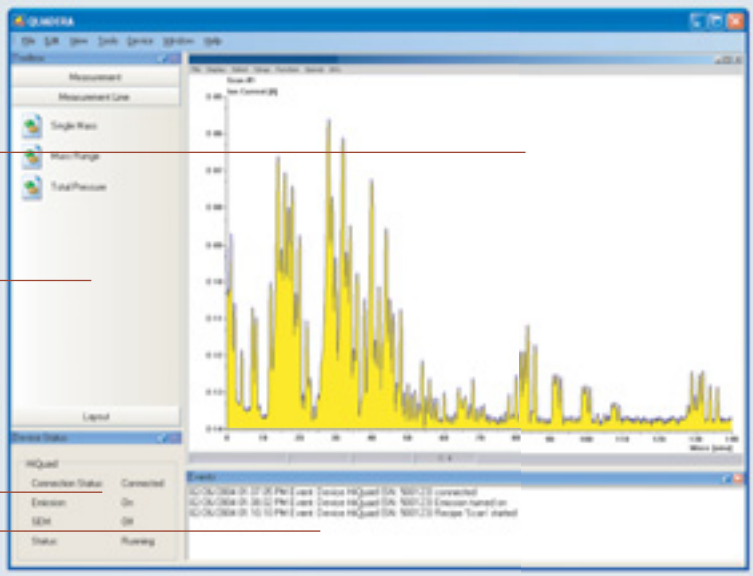
Field-axis technology

Quadera® mass spectrometer software

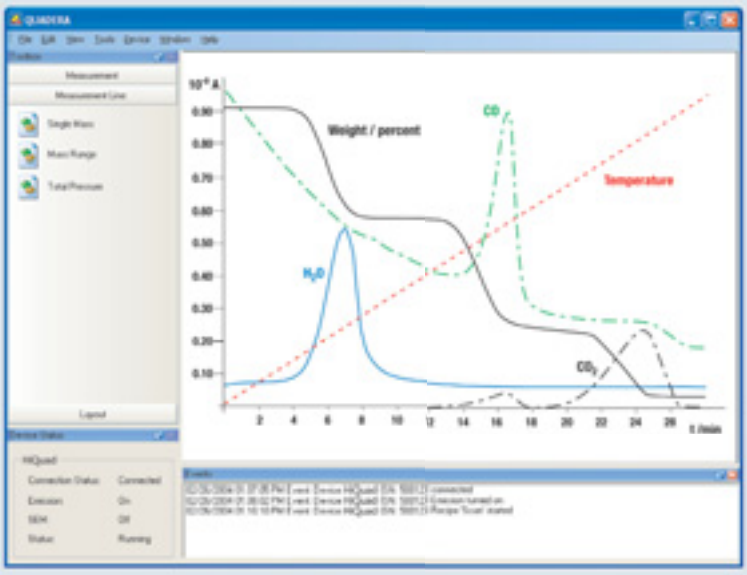
With its modular design, Quadera® software offers an easy-to-understand and operate platform for recording and presenting both measurement data as well as parameter records. Complete measurement procedures can be programmed.This is why operation, data analysis, presentation and data storage are handled by means of a PC and Quadera® software.

Pfeiffer Vacuum Quadera® mass spectrometer software is a modular system. Quadera® can be employed with the PrismaPlus and HiQuad devices and their newly developed electronics. The PC can be connected with the PrismaPlus or HiQuad via an Ethernet. Quadera® serves as the interface between the mass spectrometer and the user. It offers impressively simple, easy to understand operation. Repetitive measurement tasks can be automated by creating recipes and using program sequences.

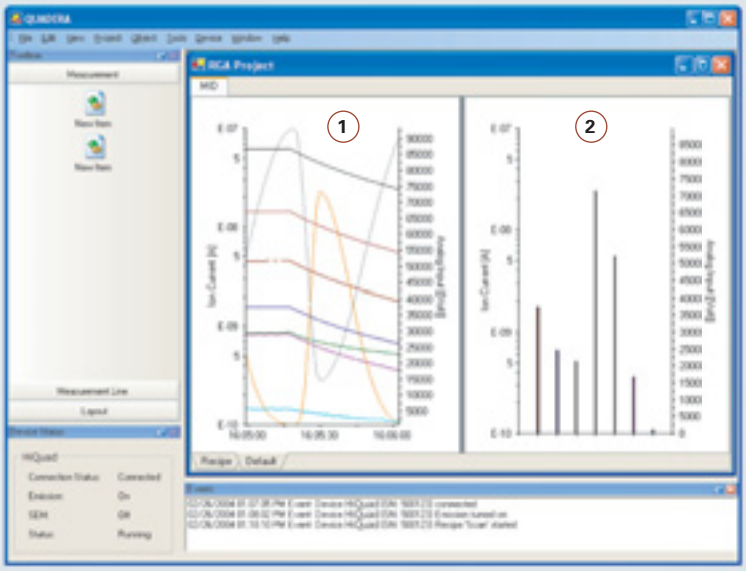
- Predefined recipes available, e.g. spectrum, trend, bar graph
- Easy-to-understand presentation of mass spectrometer system functions
- Automated measurement sequences programmable by means of integrated Visual Basic script editor
- Can be adapted for special applications through exchange with other programs



The measurement data are presented in the center of the screen. Tools and links, as well as the status of the device, are shown at the bottom left. Important messages are displayed as plain text.



It is easy to display the data from the mass spectrometer together with such external data as temperature, workpiece weight, etc. The illustration shows an example of the mass spectrometer coupled with a thermobalance.



① Presentation over time
② Momentary intensity of the various masses

Differing user-defined views of a measurement can be displayed simultaneously.

Such typical measurement tasks as residual gas analysis or leak detection are preprogrammed and can be launched with a mouse click.

The mass spectrometer must be calibrated beforehand if quantitative analysis is to be performed. Repetitive procedures, e.g. calibration followed by quantitative analysis, can be programmed by means of VSTA (Visual Studio for Applications). No programming skills are required, as prefabricated modules are used for this purpose.

To solve complicated measurement tasks, Quadera® has a library available containing fractal distributions for various frequently encountered gases and compounds.

PrismaPlus™

The New Mass Spectrometer with the Added Plus!
Modular Design. Powerful Software.
Wide Range of Applications.

What is PrismaPlus?

This is a compact, powerful device that unites the following features:

- 100, 200 and 300 amu mass ranges
- A Faraday cup and a C-SEM are available as detectors
- Equipped with various ion sources and filaments
- The analyzer can be baked out at up to 150 °C

The optimum combination of high sensitivity, maximum stability and intelligent operation is the added plus in our new mass spectrometer – a true innovation!

Its modular design offers you a variety of application options in industrial and analytical environments, in research & development, in leak detection and semiconductor production, as well as in coating technology. The PrismaPlus is the ideal solution for applications ranging from quality assurance and residual gas analysis right through to complex, quantitative tasks.

Our product and service professionals around the world stand ready to provide you with application assistance on the implementation of the PrismaPlus. Long years of customer and applicationspecific experience make Pfeiffer Vacuum your ideal partner.
The added plus for gas analysis!

Advantages at a glance

- Modular design offers optimum adaptability
- Compact size yet high performance
- A variety of interfaces make for simple systems integration
- Networkable through Ethernet
- High measurement speed, stability and resolution
- Interchangeability of analyzers and electronics
- Two filaments mean maximum up-time
- Lowest detectable partial pressure $1 \cdot 10^{-14}$ mbar
- Connectable Pfeiffer Vacuum total pressure gauge
- Intuitive operation of the Quadera® software
- World-class support and worldwide on-site service

High pressure analyzer

PrismaPlus™ on a coating system

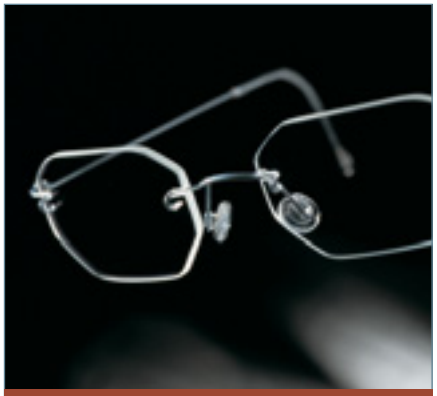
Accelerator

Research & Development

Applications

The PrismaPlus can be optimally employed for leak detection, residual gas analysis or complex, quantitative analyses:

- Metallurgy
- Vacuum furnaces
- Accelerators
- Sputter process analysis
- Semiconductor production
- Glass coating
- Research & development
- Vacuum process systems



Coating

Metallurgy

Notes

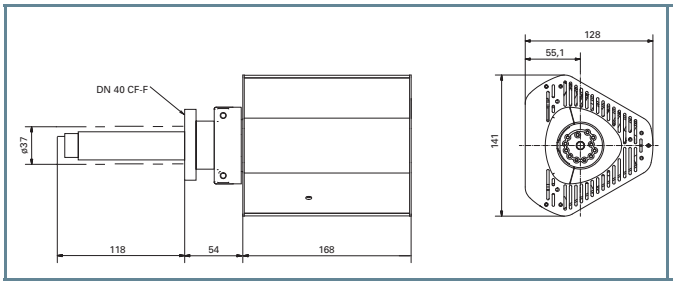
Prisma Plus™

Residual gas analysis in high vacuum

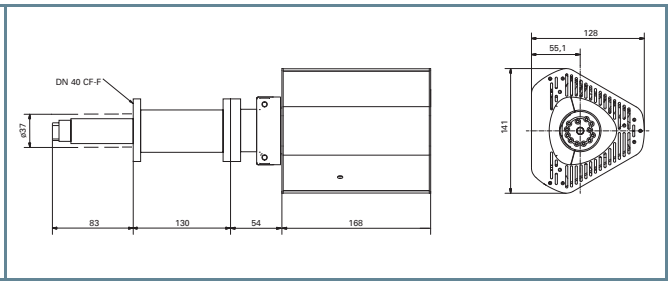
PrismaPlus™

- ▶ Robust, cost-effective residual gas analysis and vacuum process monitoring in the high vacuum range
- ▶ Interchangeability of analyzers and electronics
- ▶ Optimum availability thanks to two filaments

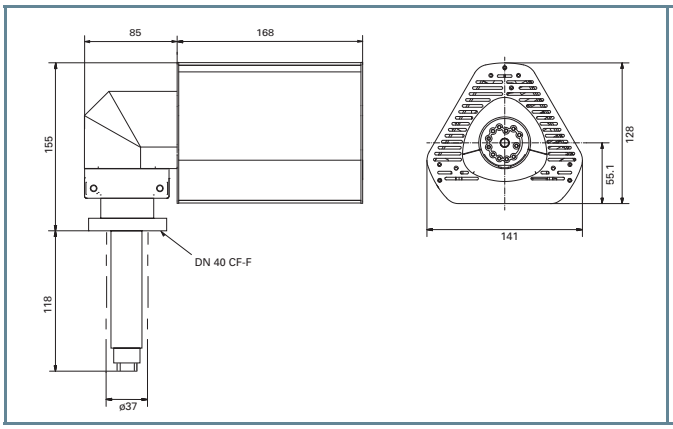
Dimensions



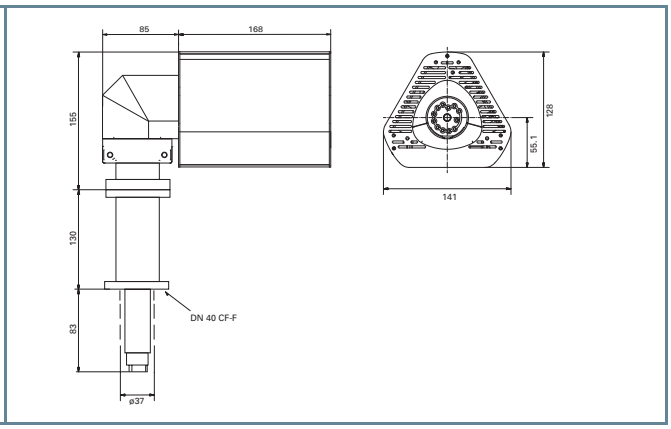
QMG 220 F1, PrismaPlus™
0°



QMG 220 M1, PrismaPlus™
0°



QMG 220 F1, PrismaPlus™
90°



QMG 220 M1, PrismaPlus™
90°

Scope of delivery

Analyzer
QMA 200
Faraday,
C-SEM/Faraday

Electronics unit
QME 220
0° or 90° connection

I/O module 220
(optional)

SP 220 power supply
inclusive mains cable

Software

Technical data	QMG 220 F1, PrismaPlus™	QMG 220 F2, PrismaPlus™	QMG 220 F3 PrismaPlus™
Detector	Faraday	Faraday	Faraday
Mass range	1-100 amu	1-200 amu	1-300 amu
Rod system: Diameter	6 mm	6 mm	6 mm
Rod system: Length	100 mm	100 mm	100 mm
Detection limit	$1 \cdot 10^{-12}$ mbar	$2 \cdot 10^{-12}$ mbar	$4 \cdot 10^{-12}$ mbar
Sensitivity for Ar	$1 \cdot 10^{-3}$ A/mbar	$6 \cdot 10^{-4}$ A/mbar	$3 \cdot 10^{-4}$ A/mbar
Operating pressure max.	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Contribution to neighboring mass: 40 to 41	<10 ppm	<20 ppm	<50 ppm
Operating temperature: analyzer	150 °C	150 °C	150 °C
Operating temperature: electronics	0-40 °C	0-40 °C	0-40 °C
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution, adjustable at 10 % peak height	0.5-2.5 amu	0.5-2.5 amu	0.5-2.5 amu
Scan speed: scan analog	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: scan bargraph	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: MID	2 ms - 60 s/amu	2 ms - 60 s/amu	2 ms - 60 s/amu
Measuring channels	128 pieces	128 pieces	128 pieces
Peak ratio reproducibility	± 0.5 %	± 0.5 %	± 0.5 %
Interfaces	Ethernet	Ethernet	Ethernet
Input: Digital	Ext_Protection, 24 V	Ext_Protection, 24 V	Ext_Protection, 24 V
Supply: Voltage	90 ... 260 V AC	90 ... 260 V AC	90 ... 260 V AC

Technical data	QMG 220 M1, PrismaPlus™	QMG 220 M2, PrismaPlus™	QMG 220 M3, PrismaPlus™
Detector	C-SEM/Faraday	C-SEM/Faraday	C-SEM/Faraday
Mass range	1-100 amu	1 - 200 amu	1-300 amu
Rod system: Diameter	6 mm	6 mm	6 mm
Rod system: Length	100 mm	100 mm	100 mm
Detection limit min.: Faraday	$5 \cdot 10^{-12}$ mbar	$1 \cdot 10^{-11}$ mbar	$2 \cdot 10^{-11}$ mbar
Detection limit min.: C-SEM	$<1 \cdot 10^{-14}$ mbar	$< 2 \cdot 10^{-14}$ mbar	$< 4 \cdot 10^{-14}$ mbar
Sensitivity for Ar: Faraday	$5 \cdot 10^{-4}$ A/mbar	$3 \cdot 10^{-4}$ A/mbar	$1{,}5 \cdot 10^{-4}$ A/mbar
Sensitivity for Ar: C-SEM	200 A/mbar	200 A/mbar	100 A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: C-SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Contribution to neighboring mass: 40 to 41	<10 ppm	<20 ppm	<50 ppm
Operating temperature: analyzer	150 °C	150 °C	150 °C
Operating temperature: electronics	0-40 °C	0 - 40 °C	0-40 °C
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution, adjustable at 10 % peak height	0.5-2.5 amu	0.5-2.5 amu	0.5-2.5 amu
Scan speed: scan analog	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: scan bargraph	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: MID	2 ms - 60 s/amu	2 ms - 60 s/amu	2 ms - 60 s/amu
Measuring channels	128 pieces	128 pieces	128 pieces
Peak ratio reproducibility	± 0.5 %	± 0.5 %	± 0.5 %
Interfaces	Ethernet	Ethernet	Ethernet
Input: Digital	Ext_Protection, 24 V	Ext_Protection, 24 V	Ext_Protection, 24 V
Supply: Voltage	90 ... 260 V AC	90 ... 260 V AC	90 ... 260 V AC

Selection aid – Order number structure

PT M0a bcd efg

a – Detector version[1]
5 – Faraday only
for leak detection and high-vacuum residual gas analysis
6 – C-SEM/Faraday
C-SEM = Continuous Secondary Electron Multiplier for fast, sensitive UHV residual gas analysis, analytical applications and leak detection

b – Mass range
1 – 1–100 amu
2 – 1–200 amu
3 – 1–300 amu
The smallest suitable mass range for the application should be selected.

c – Ion source[2]
1 – open ion source
for high-vacuum residual gas analysis; high sensitivity and good linearity
2 – gas-tight ion source
for use in combination with gas inlet systems; low gas consumption, high signal-to-noise ratio
3 – Crossbeam ion source
For direct gas beam inlet, without interaction with the walls of the ion source
4 – Grid ion source
for UHV residual gas analysis; minimum outgassing and desorption rate

g – I/O module and VBA software extension
0 – without option
1 – with I/O module
for control and signal interchange via analog and digital inputs/outputs
2 – with VBA software extension
for programming program sequences and for exchanging commands and data with other programs
3 – with I/O module and VBA software extension

f – Connection
Electronics and analyzer
1 – 0° (on one axis)
2 – 90° off axis

e – Bakeout temperature[3]
1 – up to 200 °C
2 – up to 300 °C

d – Filament
1 – Tungsten
2 – yttriated iridium

[1] Faraday version with open ion source only
[2] Grid ion sources with tungsten filament only
[3] Electronics removed

I/O module – Connection options

	Analog outputs	Analog inputs	Digital outputs	Digital inputs
Number	4	5	16	5
Specification	0–10 V	-10 – +10 V	V_{out} = 24 V	V_{in} = 24 V
Resolution	12 bit	14 bit	–	–
Application examples	• Measured values, e.g. ion currents • Ratios (concentrations) • Data transfer to higher-level systems	Reading in external values, e.g. pressure, temperature, gas flow	• Free assignment of switchpoints • Valve actuation	Starting or stopping measurement tasks by means of external signal

Total pressure measurement with ActiveLine

Total pressure measurement with DigiLine™

Ethernet

SP 220 power supply

L x B x H:
145 x 75 x 40 mm

Cable length: 3 m

Weight: 0.7 kg

24 VDC

Voltage: 90–260 VAC
Frequency: 50–60 Hz

HiQuad™

High-End Mass Spectrometer!
Fast, Flexible and Easy to Operate.

What is HiQuad?

With the new HiQuad mass spectrometer, Pfeiffer Vacuum combines high performance, flexibility and ease of operation. As a stand-alone unit, the HiQuad can be optimally integrated into your application. Depending upon the application in question, it is possible to select:

- Mass ranges
- Rod diameters
- Ion sources
- Detectors
- Interfaces

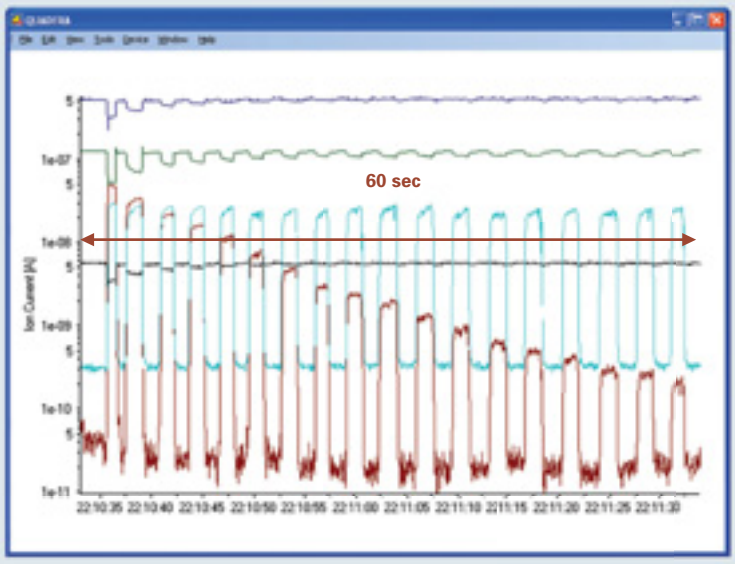
This mass spectrometer achieves extremely high measurement speeds of up to 125 µs/amu. It is characterized by the highest sensitivity and a wide dynamic range. This mass spectrometer is easy to operate with the aid of the Quadera software.
These characteristics make the HiQuad suitable for both research & development applications as well as for integration into analytical systems.
We compile the right solution for your individual application!

Advantages at a glance

- Modular, flexible design
- Simple operation with Quadera® software
- Extremely high measurement speed
- Maximum sensitivity and wide dynamic range
- Outstanding long-term stability
- Ethernet interface
- Integral Internet browser and OPC server for communicating with PC-based programs

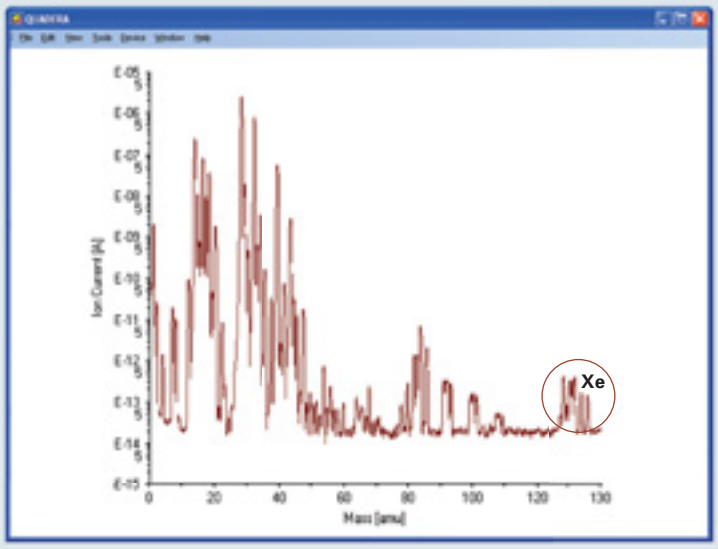
Applications

- High measurement speed – up to 125 µs/amu



Very fast measurements can be performed with the HiQuad™ mass spectrometer. This example shows the mass specresponse during respiration analysis. N_2, O_2 and CO_2 were detected with a very fast cycle time.

- Wide dynamic range

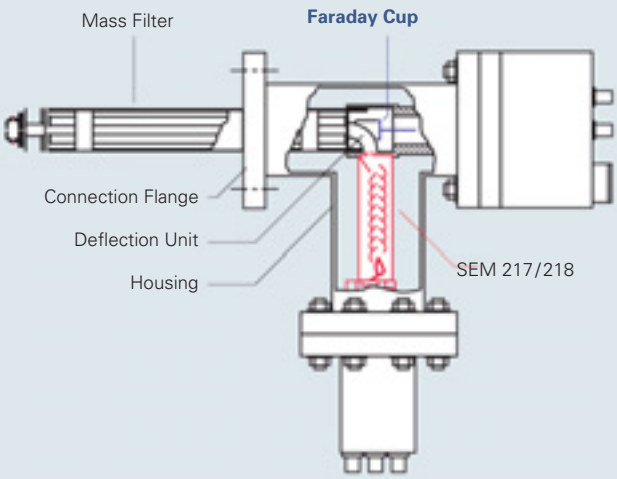


Xe in air

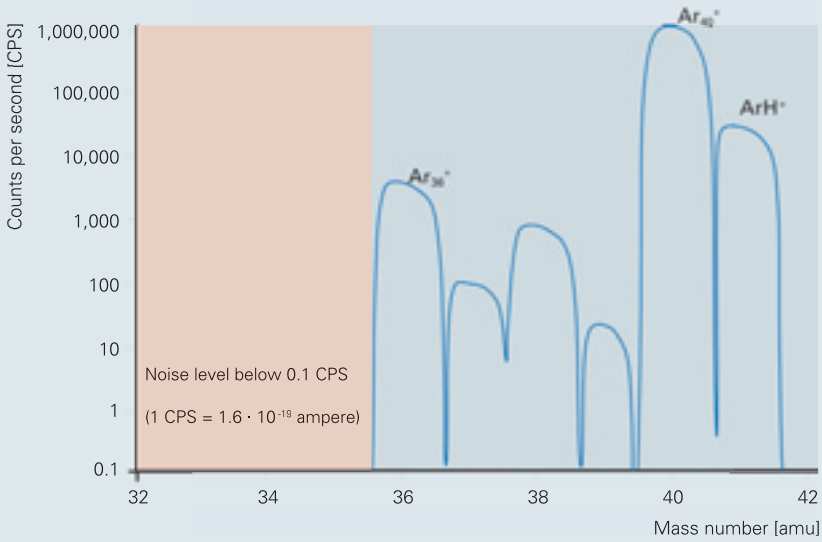
This scan shows a spectrum for air. In addition to the primary components, consisting of N_2, O_2, Ar and CO_2 even minute concentrations of Xe are detected. The ion current at mass 136 is equivalent to a concentration of 7.8 ppb of Xe in air. And it is decades above the background noise level, enabling a widedynamic range of 10 decades to be achieved.

90° off-axis secondary electron multiplier (SEM)
The task of the secondary electron multiplier is to increase the sensitivity of the mass spectrometer. In the HiQuad, the multiplier is attached in the vacuum at a right angle to the rod system. This prevents any radiation from the ion source reaching the detector and thus generating background noise.

In combination with an ion-counting arrangement, it is also possible to achieve a wide dynamic range in addition to a low background noise level. The example illustrated below shows a very low background count ratewhile measuring ArH^+ ions generated in a plasma.



Design of the detectors in a QMA 400 HiQuad™ analyzer with Faraday cup and SEM

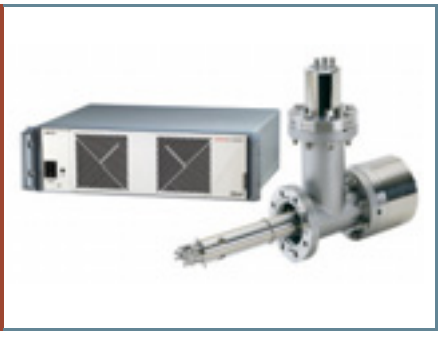


Ions from a DC-Argon plasma

HiQuad™

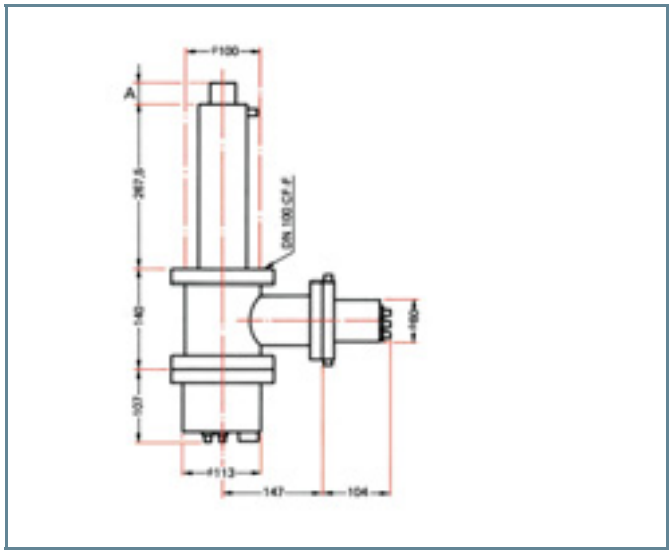
QMG 700, HiQuad™

HiQuad™

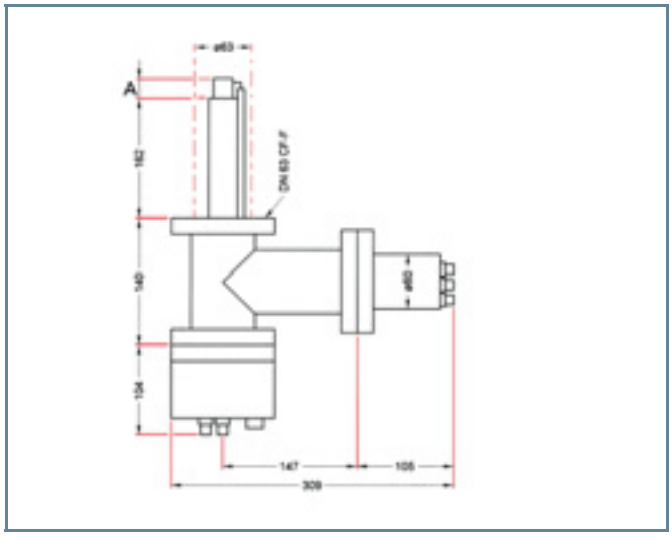


- HiQuad mass spectrometer system with user-friendly Quadera software. Comes with HiQuad control unit, HF generator and QMA 410 analyzer with 16 mm molybdenum rod system and 90° off-axis secondary electron multiplier (SEM). Available for 1-128 amu and 1-340 amu mass ranges. The system with the lowest suitable mass range for the application in question should be chosen.
- Maximum sensitivity and broad dynamic range
- Outstanding long-term stability
- Extremely high measuring speed
- Optimum resolution, mass separation and transmission

Dimensions



QMA 410



QMA 400
QMA 430

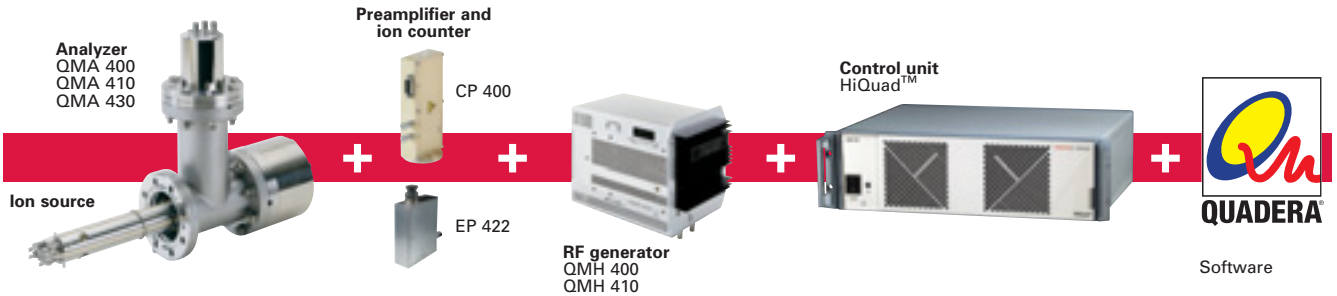
A	Axial ion source = 26 mm; Grid ion source = 27 mm; Cross-beam ion source = 35.5 mm (23.5 mm to the center of the sensitive volume); Gas-tight cross-beam ion source = 48 mm (axial gas connection); Three-lens ion optics = 129 mm; Cross-beam ion source with axial ion optics = 43.5 mm; Cross-beam ion source with three-lens ion optics = 171 mm

Technical data	1-128	1-340	1-300
Detection limit	$5 \cdot 10^{-16}$ mbar	$1 \cdot 10^{-15}$ mbar	$2 \cdot 10^{-15}$ mbar
Sensitivity for Ar: Faraday	$1 \cdot 10^{-3}$ A/mbar	$5 \cdot 10^{-4}$ A/mbar	$2 \cdot 10^{-4}$ A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Partial pressure ratio with SEM	< 0.3 ppb	< 0.5 ppb	< 1 ppb
Analyzer	QMA 410	QMA 410	QMA 430
Rod system: Diameter	16 mm	16 mm	8 mm
Rod system: Length	300 mm	300 mm	200 mm
Rod system: Material	Molybdenum	Molybdenum	Stainless steel
RF generator	QMH 400-1	QMH 410-3	QMH 400-5
Pre-amplifier	EP 422	EP 422	EP 422
Operating temperature: analyzer	150 °C	150 °C	150 °C
Bakeout temperature: analyzer	400 °C	400 °C	400 °C
Flange (in)	DN 100 CF-F	DN 100 CF-F	DN 63 CF-F

Technical data	1-512	1-1024	1-2048
Detection limit	$1 \cdot 10^{-15}$ mbar	-	-
Sensitivity for Ar: Faraday	$5 \cdot 10^{-4}$ A/mbar	$2 \cdot 10^{-4}$ A/mbar	$1 \cdot 10^{-4}$ A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Partial pressure ratio with SEM	< 0.5 ppb	< 5 ppb	< 20 ppb
Analyzer	QMA 400	QMA 400	QMA 400
Rod system: Diameter	8 mm	8 mm	8 mm
Rod system: Length	200 mm	200 mm	200 mm
Rod system: Material	molybdenum	Molybdenum	Molybdenum
RF generator	QMH 400-5	QMH 410-1	QMH 410-2
Pre-amplifier	EP 422	EP 422	EP 422
Operating temperature: analyzer	150 °C	150 °C	150 °C
Bakeout temperature: analyzer	400 °C	400 °C	400 °C
Flange (in)	DN 63 CF-F	DN 63 CF-F	DN 63 CF-F

Bakeout temperature for analyzer for ion source and magnet: 300 °C

Scope of delivery



Selection aid – Typical applications and solutions

PTQ1	a	bc
Applications	**Analyzer/mass range**	**Ion source/ion optics**
General gas analysis	3, 5	01
Particle-beam and general gas analysis	2, 3, 4, 5, 6, 7[1]	02, 03
Analysis of gases or gas mixtures; for trace analysis; less residual gas influence than with open ion sources	2, 3, 5	04, 05
Plasma technology, SIMS, photoionization	5	11
UHV residual gas analysis, desorption measurements	4, 5, 6[1]	06[2]
Thermally desorbed ions, electron-induced desorption, SIMS, photoionization, plasma ions	3, 5, 6	10, 11

[1] For mass range of 1 to 2048 amu, Analyzer QMA 400 with SEM 218 and HV 702 and EP 422
[2] With tungsten filament only

Ordering example:

PT Q 1 5 02 1 1 1 1

5	–	QMA 400 / 1 – 512 amu
02	–	Cross-beam ion source
1	–	Tungsten
1	–	SEM 217 + HV 701
1	–	EP 422
1	–	IO 700

a – Analyzer/mass range
The combination of analyzer and RF generator defines the mass range.
The smallest suitable mass range for the application should be selected. The larger-diameter, precision-manufactured rod system affords improved transmission and higher sensitivity.
– QMA 410:
Molybdenum,
16 mm dia. rod system
– QMA 430:
Stainless steel, 8 mm dia. rod system for mass range of up to 300 amu
– QMA 400:
Molybdenum, 8 mm dia. rod system

bc – Ion source/ion optics
Selection of the correct ion source is a crucial factor in the measurements.
– Axial ion source:
High sensitivity and good linearity
– Cross-beam ion source:
For direct gas beam inlet, without wall interaction
– Cross-beam with magnet:
High sensitivity
– Gas-tight cross-beam:
Low gas consumption, high signal-to-noise ratio
– Grid ion source:
Low outgassing and desorption rate
– Three-lens ion optics with beam stop:
For detecting positive and negative ions
– Ion optics with cross-beam ion source:
For detecting neutrals and ions

d	e	f	g
Filament	Detector and high-voltage power supply	Preamplifier and ion counter	Interface options
1, 2, 3	1	1, 4	1, 2
1, 2	1, 3	1, 4	1, 2
1, 2	1, 2	1, 4	1, 2
1, 2	1, 2	1, 2, 3, 4	1, 2
1, 2	1	1, 2	1, 2
0	2	2	1, 2

d – Filament
- Tungsten: For UHV applications
- Yttriated iridium: Low temperatures, high resistance to air inrushes
- Rhenium: For residual gas analysis

e – Detector and high-voltage power supply
- SEM 217 + HV 701: Secondary electron multiplier in combination with a high-voltage power supply for detecting positive ions
- SEM 217 + HV 702: For measuring positive and negative ions
- SEM 218 + HV 702 Secondary electron multiplier with conversion dynode for detecting high masses

f – Preamplifier/ion counter
- EP 422: Fast, sensitive preamplifier
- CP 400: Ion counting down to 1 count per 10 seconds, wide dynamic range

g – Interface options
- IO 700 board with 8 analog inputs and 8 analog outputs; 0 to 10 V, 12-bit resolution, 32 digital inputs and 32 digital outputs
- CAN Open fieldbus

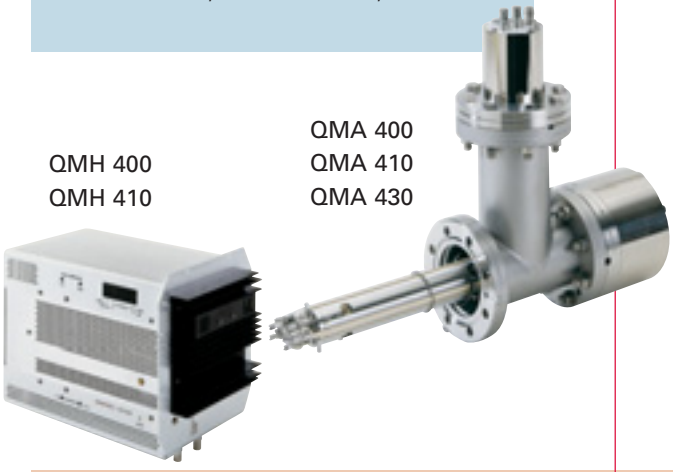
Order number structure

PT Q 1 a bc d e f g

a - Analyzer/mass range
2 - QMA 410 / 1 – 128 amu / QMH 400-1
3 - QMA 410 / 1 – 340 amu / QMH 410-3
4 - QMA 430 / 1 – 300 amu / QMH 400-5
5 - QMA 400 / 1 – 512 amu / QMH 400-5
6 - QMA 400 / 1 – 1024 amu / QMH 410-1
7 - QMA 400 / 1 – 2048 amu / QMH 410-2

QMH 400
QMH 410

QMA 400
QMA 410
QMA 430



bc - Ion source
01 - Axial ion source
02 - Cross-beam ion source
03 - Cross-beam ion source with magnet
04 - Gas-tight cross-beam ion source
05 - Gas-tight cross-beam ion source with magnet
06 - Grid ion source

Ion optics
10 - Two-lens ion optics
11 - Three-lens ion optics
12 - Two-lens ion optics with cross-beam ion source
13 - Three-lens ion optics with cross-beam ion source

Axial ion source

Cross-beam ion source

Grid ion source

Three-lens ion optics

g - Interface options
0 - None
1 - IO 700
2 - CAN Open

f - Preamplifier and ion counter
0 - None
1 - EP 422
2 - CP 400
3 - EP 422 + CP 400
4 - 2 x EP 422

EP 422

CP 400

e - Detector and high-voltage power supply
1 - SEM 217 + HV 701
2 - SEM 217 + HV 702
3 - SEM 218 + HV 702

d - Filament
0 - None
1 - Tungsten
2 - Yttriated iridium
3 - Rhenium

Notes

reddot design award
winner 2005
SmartTest
SmartTest
PFEIFFER VACUUM

eak Detectors

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Selection aid

- ● Suitable
- ▲ With test chamber
- ■ External backing pump, S > 10 m³/h
- ✖ External backing pump, S < 10 m³/h

	Applications										
	Semiconductor production	Vacuum furnaces	Lamp production	Vacuum coating systems	Vehicle manufacture	Refrigerating, air conditioning	Particle accelerators	Pharmaceutical	Manufacture of fuel cells	UHV engineering	Packaging
Leak Detectors											
SmartTest HLT 550	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
SmartTest HLT 560		●	●	●	●	●	▲	▲	●	●	●
SmartTest HLT 565		●	●	●	●	▲			▲	●	▲
SmartTest HLT 570	●	▲	▲	▲	▲	▲	▲	▲			●
SmartTest HLT 572	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
SmartTest HLT 575	●	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

	Workpiece Application		Workpiece Volume		Detectable Leakage Rate, in mbar l / s		Remarks
	Vacuum	Overpressure	> 20 l	< 20 l	< $1 \cdot 10^{-7}$	> $1 \cdot 10^{-7}$	
Mode							
Vacuum	●	▲	■	✕	●	●	External backing pump required
Sniffing		●	●	●		●	
Vacuum	●	▲		●	●	●	Rotary vane pump, S = 5 m^3/h
Sniffing		●	●	●		●	
Vacuum	●	▲	●	●	●	●	Rotary vane pump, S = 30 m^3/h
Sniffing		●	●	●		●	
Vacuum	●	▲		●	●	●	Dry backing vacuum pump, S = 2 m^3/h
Sniffing		●	●	●		●	
Vacuum	●	▲		●	●	●	Dry backing vacuum pump, S = 7,5 m^3/h
Sniffing		●	●	●		●	
Vacuum	●	▲	●	●	●	●	Dry backing vacuum pump, S = 26 m^3/h
Sniffing		●	●	●		●	

Leak Detectors – SmartTest

Modular Concept.
Simple Operation. Top Performance.

What is SmartTest?
SmartTest is the name of a family of helium leak detectors that can be optimally adapted for every leak detection application through the employment of various backing vacuum pumps.

SmartTest is suitable for both vacuum and sniffer leak detection.

The Ingenious Solution to your Quality Assurance

Helium leak detection the easy way
With its modular design, ease of operation and modern optics, the SmartTest is setting new standards in vacuum leak detection.

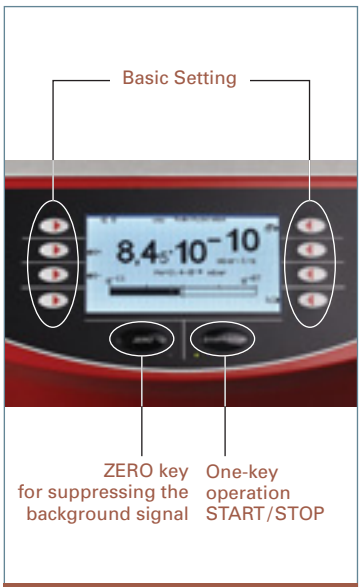
Modular concept
A variety of configurations offers the optimum solution for your application:

- with a rotary vane pump, for general leak detection
- with a dry pump, for absolutely oil-free leak detection
- without a backing pump, for use in leak detection systems

The bypass option affords fast leak detection in connection with large workpieces or workpieces with high gas discharge. This concept is additionally complemented by a remote control option, a trolley and sniffer probes of varying length.

Cart

Remote control and sniffer probe

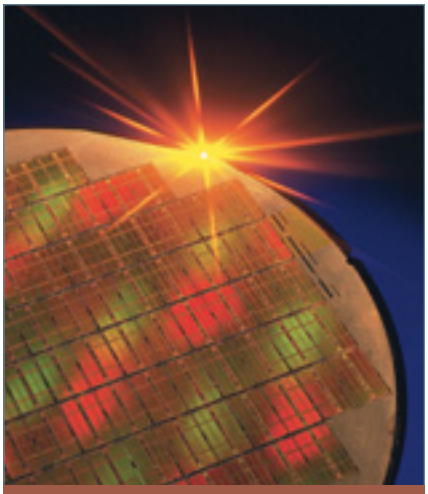


Simple operation

Simple operation
For the first time, you can optimally adapt your SmartTest for your specific application by means of eight basic setting keys. The ZERO function enables you to identify the smallest leaks, even in the presence of a higher He background signal.

The START/STOP function offers a simple and secure way to start and stop the measurement.

Leak Detectors



Semiconductor production

Refrigeration, air conditioning

Leak testing is required for:

- Assuring the quality of the product
- Increasing the yield of production processes
- Enabling sophisticated experiments to be performed
- Optimizing energy consumption
- Minimizing harmful environmental influences

Helium leak detection offers the following advantages over other testing methods:

- Maximum sensitivity for detecting even minute leaks
- Quantifiability of leaks
- Maximum measurement repeatability
- The helium test gas is non-toxic and non-flammable

Advantages at a glance

- One-button operation – Ultra-simple handling
- Robust engineering – Reliable and long-lived
- Modular design – Application-specific solutions possible
- Pfeiffer Vacuum turbopump – Maximum inlet pressure 25 mbar, extremely short recovery times
- Interfaces (DI/DO, AO, RS-232 C, RS-485) – Easy integration into control systems
- Proven, reliable analyzer – Minimum service cost and effort

Can be used for either sniffer or vacuum leak detectors

Notes

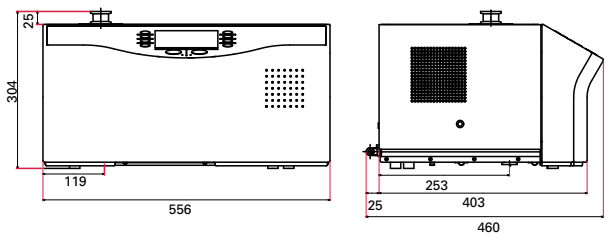
HLT 550

Leak detector without backing pump

HLT 550

- Rugged, dependable helium leak detector with integrated test leak
- For a mains voltage of 100-230 V, 50/60 Hz
- Without internal backing pump, external backing pump required
- Very easy operation to achieve precise measuring results
- Optimum adaptation to every application, simple maintenance
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection

Dimensions



General technical data	
Smallest detectable leak rate for ^{4}He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^{4}He, ^{3}He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0.5 s
Pumping speed for He	2.5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	150 VA
Weight	34 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Cero, Calibration, Bypass detection
Interface	RS-232-C, RS-485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 V AC
Relay: Switching current	3 A

Technical data	HLT 550 100-230 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection
Supply	100-230 V, 50/60 Hz
Roughing pump	Without

Order number	
HLT 550	**PT L02 020**

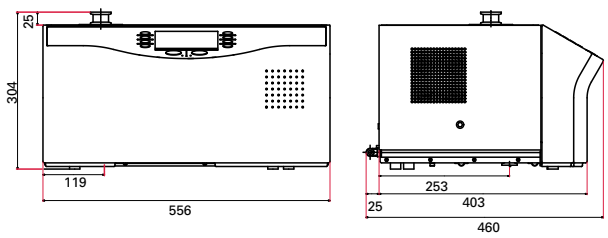
Accessories	
Remote control unit for SmartTest	
Remote control unit for SmartTest	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**
Calibrated test leak	
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**
Bypass option	
Bypass option, with mains cable and German plug	**PT 445 410-T**
Bypass option, with US plug	**PT 445 412-T**
Cart for SmartTest	
Cart with power connection, 230 VAC	**PT 445 415**
Cart with power connection, 100-120 VAC	**PT 445 416**
Sniffer probe	
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**
Sniffer test leak	
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**
Software for SmartTest	
Software for SmartTest helium leak detector	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**
Other accessories	
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**
Helium pistol	**BG 512 125-T**
Transport case for SmartTest	**PT 445 403**

HLT 560

Leak detector with rotary vane pump, pumping speed 5 m³/h

- Rugged, dependable helium leak detector
- Very easy operation to achieve precise measuring results
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection
- Simple maintenance - low cost of ownership

Dimensions



General technical data	
Smallest detectable leak rate for ^{4}He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^{4}He, ^{3}He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0,5 s
Pumping time to ready: 0.5 l test volume	1 s
Pumping time to ready: 10 l test volume	45 s
Pumping time to ready: 100 l test volume	590 s
Pumping speed for He	2,5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	400 VA
Weight	44 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Cero, Calibration, Bypass detection
Interface	RS-232-C, RS-485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 V AC
Relay: Switching current	3 A

Technical data	HLT 560 230 V, 50 Hz	HLT 560 120 V, 60 Hz	HLT 560 100 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection
Supply	230 V, 50 Hz	120 V, 60 Hz	100 V, 50/60 Hz
Roughing pump	Rotary vane pump 5 m^3/h	Rotary vane pump 5 m^3/h	Rotary vane pump 5 m^3/h

Order number			
HLT 560	**PT L02 000**	**PT L02 001**	**PT L02 002**

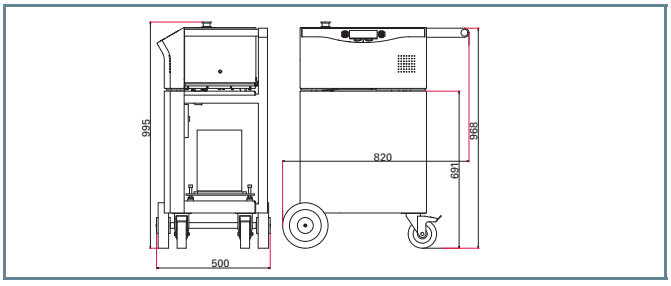
Accessories			
Remote control unit for SmartTest			
Remote control unit for SmartTest	**PT 445 400**	**PT 445 400**	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**	**PT 445 401**	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**	**PT 445 402**	**PT 445 402**
Calibrated test leak			
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**	**B8 116 557**	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**	**B8 115 580**	**B8 115 580**
Bypass option			
Bypass option, with mains cable and German plug	**PT 445 410-T**		
Bypass option, with US plug		**PT 445 412-T**	**PT 445 412-T**
Cart for SmartTest			
Cart with power connection, 230 VAC	**PT 445 415**		
Cart with power connection, 100-120 VAC		**PT 445 416**	**PT 445 416**
Sniffer probe			
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**	**BG 449 207-T**	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**	**BG 449 208-T**	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**	**BG 449 209-T**	**BG 449 209-T**
Sniffer test leak			
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**	**BG 447 704-T**	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**	**BG 447 705-T**	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**	**BG 447 706-T**	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**	**BG 449 025A**	**BG 449 025A**
Software for SmartTest			
Software for SmartTest helium leak detector	**PT 882 610-T**	**PT 882 610-T**	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**
Other accessories			
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**	**PF 117 225-T**	**PF 117 225-T**
Screw-in flange, DN 25 ISO-KF, for connection of an external additional backing pump	**PT 445 417-T**	**PT 445 417-T**	**PT 445 417-T**
Helium pistol	**BG 512 125-T**	**BG 512 125-T**	**BG 512 125-T**
Transport case for SmartTest	**PT 445 403**	**PT 445 403**	**PT 445 403**

HLT 565

Leak detector with rotary vane pump and cart, pumping speed 30 m^3/h

- Rugged, dependable helium leak detector
- With cart and 30 m^3/h rotary vane pump
- Very easy operation to achieve precise measuring results
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection
- Simple maintenance - low cost of ownership

Dimensions



General technical data	
Smallest detectable leak rate for ^4He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^4He, ^3He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0,5 s
Pumping time to ready: 0.5 l test volume	1 s
Pumping time to ready: 10 l test volume	16 s
Pumping time to ready: 100 l test volume	160 s
Pumping speed for He	2,5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	900 VA/50 Hz, 1050 VA/60 Hz
Weight	133 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Cero, Calibration, Bypass detection
Interface	RS 232-C, RS 485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 VAC
Relay: Switching current	3 A

Technical data	HLT 565 230 V, 50 Hz	HLT 565 100-120 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection
Supply	230 V, 50 Hz	100-120 V, 50/60 Hz
Roughing pump	Rotary vane pump, 30 m^3/h	Rotary vane pump, 30 m^3/h

Order number		
HLT 565	**PT L02 050**	**PT L02 051**

Accessories		
Remote control unit for SmartTest		
Remote control unit for SmartTest	**PT 445 400**	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**	**PT 445 402**
Calibrated test leak		
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**	**B8 115 580**
Bypass option		
Bypass option, with mains cable and German plug	**PT 445 410-T**	
Bypass option, with US plug		**PT 445 412-T**
Sniffer probe		
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**	**BG 449 209-T**
Sniffer test leak		
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**	**BG 449 025A**
Software for SmartTest		
Software for SmartTest helium leak detector	**PT 882 610-T**	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**	**PM 051 726-T**
Other accessories		
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**	**PF 117 225-T**
Helium pistol	**BG 512 125-T**	**BG 512 125-T**

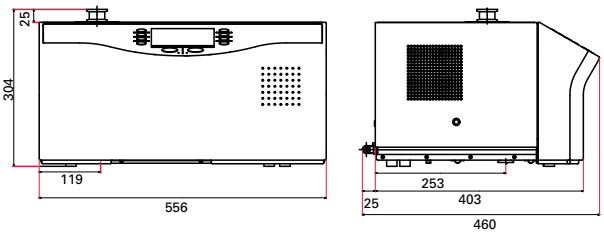
HLT 570

Leak detector with dry pump, pumping speed 2 m³/h

HLT 570

- Rugged, dependable helium leak detector, absolutely oil-free
- Very easy operation to achieve precise measuring results
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection
- Simple maintenance - low cost of ownership

Dimensions



General technical data	
Smallest detectable leak rate for ^{4}He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^{4}He, ^{3}He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0,5 s
Pumping time to ready: 0.5 l test volume	1 s
Pumping time to ready: 10 l test volume	125 s
Pumping time to ready: 100 l test volume	1300 s
Pumping speed for He	2,5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	300 VA
Weight	44 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Cero, Calibration, Bypass detection
Interface	RS 232-C, RS 485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 VAC
Relay: Switching current	3 A

Technical data	HLT 570 230 V, 50 Hz	HLT 570 120 V, 60 Hz	HLT 570 100 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection
Supply	230 V, 50 Hz	120 V, 60 Hz	100 V, 50/60 Hz
Roughing pump	Diaphragm pump 2 m^3/h	Diaphragm pump 2 m^3/h	Diaphragm pump 2 m^3/h
Order number			
HLT 570	**PT L02 010**	**PT L02 011**	**PT L02 012**
Accessories			
Remote control unit for SmartTest			
Remote control unit for SmartTest	**PT 445 400**	**PT 445 400**	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**	**PT 445 401**	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**	**PT 445 402**	**PT 445 402**
Calibrated test leak			
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**	**B8 116 557**	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**	**B8 115 580**	**B8 115 580**
Bypass option			
Bypass option, with mains cable and German plug	**PT 445 410-T**		
Bypass option, with US plug		**PT 445 412-T**	**PT 445 412-T**
Cart for SmartTest			
Cart with power connection, 230 VAC	**PT 445 415**		
Cart with power connection, 100-120 VAC		**PT 445 416**	**PT 445 416**
Sniffer probe			
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**	**BG 449 207-T**	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**	**BG 449 208-T**	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**	**BG 449 209-T**	**BG 449 209-T**
Sniffer test leak			
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**	**BG 447 704-T**	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**	**BG 447 705-T**	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**	**BG 447 706-T**	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**	**BG 449 025A**	**BG 449 025A**
Software for SmartTest			
Software for SmartTest helium leak detector	**PT 882 610-T**	**PT 882 610-T**	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**
Other accessories			
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**	**PF 117 225-T**	**PF 117 225-T**
Screw-in flange, DN 25 ISO-KF, for connection of an external additional backing pump	**PT 445 417-T**	**PT 445 417-T**	**PT 445 417-T**
Helium pistol	**BG 512 125-T**	**BG 512 125-T**	**BG 512 125-T**
Transport case for SmartTest		**PT 445 403**	**PT 445 403**

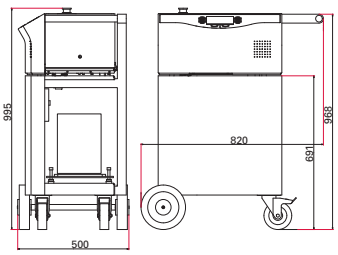
HLT 572

Leak detector with dry pump and cart, pumping speed 7.5 m^3/h

HLT 572

- Rugged, dependable helium leak detector, absolutely oil-free
- With cart and 7.5 m^3/h XtraDry dry pump
- Very easy operation to achieve precise measuring results
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection
- Simple maintenance - low cost of ownership

Dimensions



General technical data	
Smallest detectable leak rate for ^4He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^4He, ^3He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0.5 s
Pumping time to ready: 0.5 l test volume	1 s
Pumping time to ready: 10 l test volume	35 s
Pumping time to ready: 100 l test volume	410 s
Pumping speed for He	2.5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	700 VA
Weight	119 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Cero, Calibration, Bypass detection
Interface	RS 232-C, RS 485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 VAC
Relay: Switching current	3 A

Technical data	HLT 572 230 V, 50 Hz	HLT 572 120 V, 50/60 Hz	HLT 572 100 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection
Supply	230 V, 50 Hz	120 V, 50/60 Hz	100 V, 50/60 Hz
Roughing pump	XtraDry, 7.5 m^3/h	XtraDry, 7.5 m^3/h	XtraDry, 7.5 m^3/h

Order number			
HLT 572	**PT L02 060**	**PT L02 061**	**PT L02 062**

Accessories			
Remote control unit for SmartTest			
Remote control unit for SmartTest	**PT 445 400**	**PT 445 400**	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**	**PT 445 401**	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**	**PT 445 402**	**PT 445 402**
Calibrated test leak			
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**	**B8 116 557**	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**	**B8 115 580**	**B8 115 580**
Bypass option			
Bypass option, with mains cable and German plug	**PT 445 410-T**		
Bypass option, with US plug		**PT 445 412-T**	**PT 445 412-T**
Sniffer probe			
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**	**BG 449 207-T**	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**	**BG 449 208-T**	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**	**BG 449 209-T**	**BG 449 209-T**
Sniffer test leak			
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**	**BG 447 704-T**	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**	**BG 447 705-T**	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**	**BG 447 706-T**	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**	**BG 449 025A**	**BG 449 025A**
Software for SmartTest			
Software for SmartTest helium leak detector	**PT 882 610-T**	**PT 882 610-T**	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**	**PM 061 207-T**	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**	**PM 051 726-T**	**PM 051 726-T**
Other accessories			
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**	**PF 117 225-T**	**PF 117 225-T**
Helium pistol	**BG 512 125-T**	**BG 512 125-T**	**BG 512 125-T**

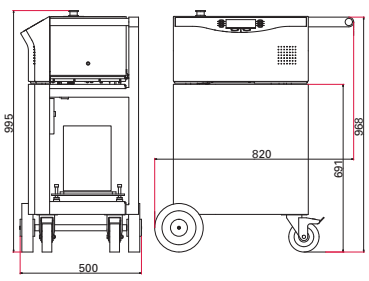
HLT 575

Leak detector with dry pump and cart, pumping speed 28 m^3/h

HLT 575

- Rugged, dependable helium leak detector, absolutely oil-free
- With cart and 28 m^3/h dry pump
- Very easy operation to achieve precise measuring results
- Analog and digital inputs and outputs for industrial use
- Durable and industry-tested mass spectrometer
- Integrated test leak
- Bypass option for large test items
- For sniffer and vacuum leak detection
- Simple maintenance - low cost of ownership

Dimensions



General technical data	
Smallest detectable leak rate for ^4He (according AVS 2.1)	< $5 \cdot 10^{-12}$ mbar l/s
Sniffer probe, detectable leak rate	< $5 \cdot 10^{-8}$ mbar l/s
Detectable gases	^4He, ^3He, H_2
Leak rate display	10^{-12} - 1 mbar l/s
Cold start to ready	3 min
Response time	0,5 s
Pumping time to ready: 0.5 l test volume	1 s
Pumping time to ready: 10 l test volume	16 s
Pumping time to ready: 100 l test volume	160 s
Pumping speed for He	2,5 l/s
Inlet pressure max.	25 mbar
Ambient temperature	+10 to +35 °C
Power consumption	900 VA
Weight	140 kg
Input: Analog	ActiveLine vacuum transmitter
Input: Digital	Start/Stop, Vent, Zero, Calibration, Bypass detection
Interface	RS 232-C, RS 485
Output: Analog	Leakage rate signal 2x 0-10 V, lin/log
Output: Digital	Ready to start, Ready to measure, Leak, Error, Bypass valve, Calibration acknowledge
Relay: Switching capacity	2x 230 VAC
Relay: Switching current	3 A

Technical data	HLT 575 230 V, 50 Hz	HLT 575 100-120 V, 50/60 Hz
Flange (in)	DN 25 ISO-KF	DN 25 ISO-KF
Test method	Vacuum and sniffing leak detection	Vacuum and sniffing leak detection
Supply	230 V, 50 Hz	100-120 V, 50/60 Hz
Roughing pump	Scrollpump 28 m^3/h	Scrollpump 28 m^3/h

Order number		
HLT 575	**PT L02 065**	**PT L02 066**

Accessories		
Remote control unit for SmartTest		
Remote control unit for SmartTest	**PT 445 400**	**PT 445 400**
Connection cable for remote control unit, 4 m	**PT 445 401**	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**	**PT 445 402**
Calibrated test leak		
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**	**B8 116 557**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	**B8 115 580**	**B8 115 580**
Bypass option		
Bypass option, with mains cable and German plug	**PT 445 410-T**	
Bypass option, with US plug		**PT 445 412-T**
Sniffer probe		
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**	**BG 449 209-T**
Sniffer test leak		
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**	**BG 449 025A**
Software for SmartTest		
Software for SmartTest helium leak detector	**PT 882 610-T**	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**	**PM 051 726-T**
Other accessories		
Centering ring with poral filter, FPM/stainless steel, DN 25 ISO-KF	**PF 117 225-T**	**PF 117 225-T**
Helium pistol	**BG 512 125-T**	**BG 512 125-T**

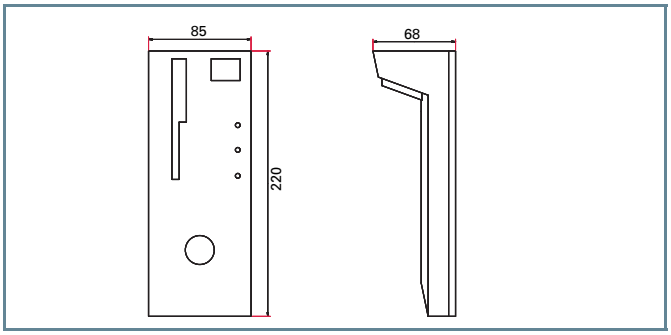
Remote control unit

Remote control unit for SmartTest

Remote control unit

- ▶ Rugged and reliable
- ▶ Easy operation
- ▶ Clear and unambiguous display
- ▶ Integrated magnetic holder
- ▶ Cable length, up to 28 m
- ▶ Note: For connection to the SmartTest, the connection cable PT445401 is required

Dimensions



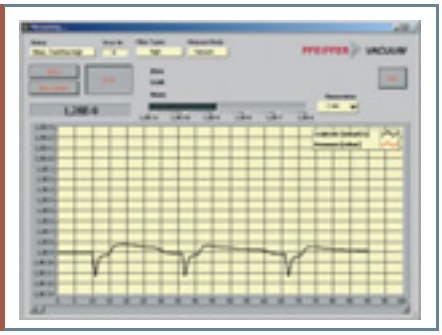
Order number	
Remote control unit for SmartTest	**PT 445 400**

Accessories	
Connection cable for remote control unit, 4 m	**PT 445 401**
Extension cable for remote control unit, 8 m	**PT 445 402**

Software

Software for SmartTest helium leak detector

Software



- For display and storage of leak test data
- Leak detector operation via PC
- System requirements:
- Hardware: Pentium PC (166 MHz or higher recommended); 32 MB RAM (128 MB recommended), 20 MB free hard disk memory, Super VGA monitor (with 1024 x 768 display resolution, small type size), 24-bit True Color, free COM port; local printer, mouse
- Operating system: Windows 98, Windows NT 4.0 operating system with Service Pack 4 installed, Windows 2000, Windows XP (administrative privileges required)

Ordering No.	
Software for SmartTest helium leak detector	**PT 882 610-T**
USB Converter to RS-485 interface	**PM 061 207-T**
Connection cable, plug M12, RJ 45	**PM 051 726-T**

Sniffer probe

Sniffer probe for sniffer leak detection. Easy connection to the SmartTest by an extra coupling. Enables both vacuum and sniffer leak detection without requiring much alteration work

Sniffer probe

- Sniffer probe with standard tip
- GO/NO-GO indication by LEDs
- Button for background suppression
- Sniffer tip rigid, 120 mm long
- Capillary filter
- Easy connection to the SmartTest with an extra interface

Ordering No.	
LP 503, sniffer probe with standard tip, 3 m	**BG 449 207-T**
LP 505, sniffer probe with standard tip, 5 m	**BG 449 208-T**
LP 510, sniffer probe with standard tip, 10 m	**BG 449 209-T**

Accessories	
Capillary filter, metal version, for sniffer tip	**BG 449 140-T**
TP 312, Sniffer tip stiff, 120 mm	**BG 449 215-T**
TP 385, Sniffer tip stiff, 385 mm	**BG 449 216-T**
TF 312, Sniffer tip flexible, 120 mm	**BG 449 217-T**
TF 385, Sniffer tip flexible, 385 mm	**BG 449 218-T**

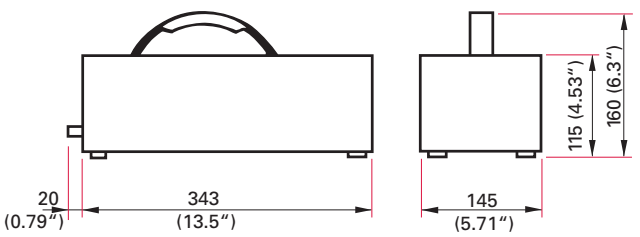
Sniffer test leak

For calibrating sniffer leak detection

Sniffer test leak

- ▶ Helium test leak, calibrated acc. to DIN 28417
- ▶ High accuracy, rugged design
- ▶ Long life
- ▶ With integrated pressure gauge and gas storage tanks

Dimensions

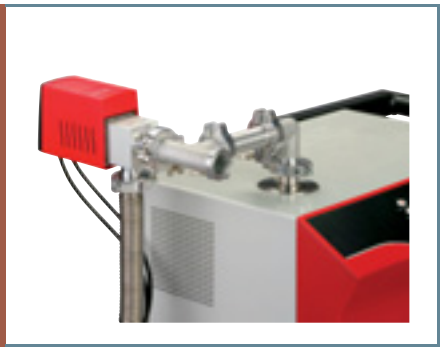


Ordering No.	
CL 004, Sniffer test leak, He leak rate approx. 10^{-4} mbar l/s, He	**BG 447 704-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	**BG 447 705-T**
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	**BG 447 706-T**
CL 002 A Sniffer test leak, gas mixture He : H_2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	**BG 449 025A**

Bypass option

For vacuum leak detection on large vessels and for protection of the leak detector against dirt

Bypass option



- Optional extra for the SmartTest to reduce the pump-down time of large test items or items with a high exhaust gas rate
- For protection of the leak detector against dirt
- Including mains cable with German plug
- For a mains voltage of 85-248 V, 50/60 Hz
- Fully configured, easy to install

Ordering No.	
Bypass option, with mains cable and German plug	**PT 445 410-T**
Bypass option, with US plug	**PT 445 412-T**

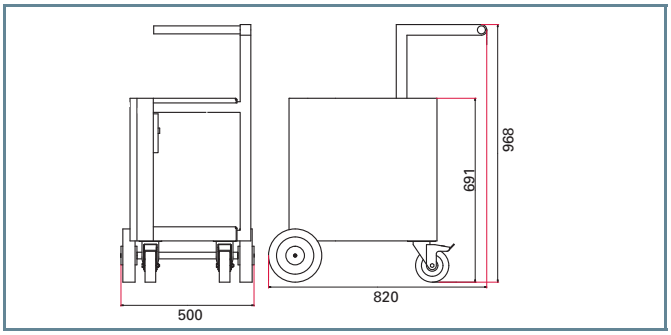
Cart for SmartTest

The ideal add-on unit for the SmartTest leak detector. Electrically and mechanically prepared to receive the SmartTest

Cart for SmartTest

- ▶ Prepared for rotary vane pump and XtraDry dry pump
- ▶ Easy installation thanks to plug-and-socket connections
- ▶ Provision for a helium gas cylinder holder
- ▶ Safe against overturning

Dimensions



Ordering No.	
Cart with power connection, 100-120 VAC	**PT 445 416**
Cart with power connection, 230 VAC	**PT 445 415**

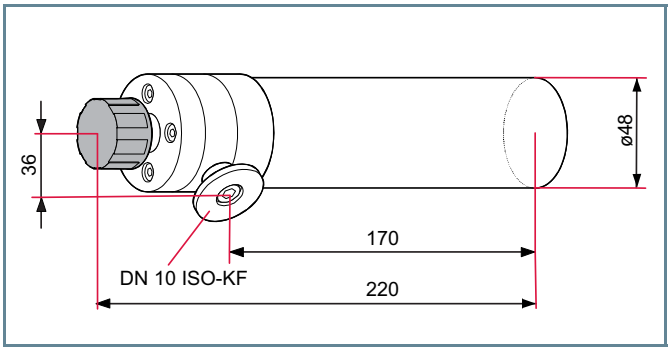
Calibrated test leak

Calibrated test leak for vacuum applications, with manually operated valve, including gas storage tank

Calibrated test leak

- ▶ Connection flange DN 10 ISO-KF
- ▶ With manually operated valve
- ▶ With integrated gas storage tank

Dimensions



Ordering No.	
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10 $^{-4}$ mbar l/s, DN 10 ISO-KF	**B8 115 580**
CT 408, He test leak, leak rate approx. 10^{-8} mbar l/s, DN 10 ISO-KF	**B8 116 557**

Helium pistol

For local leak detection in plants and systems

Helium pistol

- Locating of leaks in plants and systems
- Connection to helium cylinder with pressure reducer via a plastic hose
- Robust
- Easy metering
- Spiral hose connection R 1/4"
- Helium-tight, no unintentional enrichment of the environment

Ordering No.	
Helium pistol	**BG 512 125-T**

Signal tower

Optical indication of exceeded threshold values

Signal tower

- Indication of exceeded threshold values by red-green lights
- Easy installation by means of a plug-and socket connection
- Magnetic holder
- Connection to digital interface of the leak detector

Ordering No.	
Signal tower	**B4681891KC**

Transport case for SmartTest

For transportation of the SmartTest helium leak detector and accessories

Transport case for SmartTest

- For transportation of the leak detector and accessories
- Dimensions: 730 mm x 570 mm x 500 mm
- Weight: 18 kg
- For SmartTest models HLT 550, 560, 570

Ordering No.	
Transport case	**PT 445 403**

Components and feedthrou

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Selection aid

● available

	Nominal diameter																Material			Seal				
	10	16	25	40	50	63	100	160	200	250	320	400	500	630	800	1,000	Aluminum	Steel	Stainless steel	Neoprene	FPM	Aluminum	Copper	Copper, silver plated
Components																								
ISO-KF																								
Connection components	●	●	●	●	●																			
Seal	●	●	●	●	●															●	●	●		
Flange	●	●	●	●	●												●	●	●					
Pipe components	●	●	●	●	●												●		●					
Bellows		●	●	●	●														●					
Adapter	●	●	●	●	●												●		●					
Rotary feedthrough		●	●	●																				
Rotary/linear feedthrough		●	●	●																				
Liquid feedthrough				●																				
Sight glass			●	●	●																			
Electric feedthrough		●		●																				
Coaxial feedthrough		●																						
ISO-K																								
Connection components						●	●	●	●	●	●	●	●	●										
Seal						●	●	●	●	●	●	●	●	●	●	●				●	●			
Flange						●	●	●	●	●	●	●	●	●			●	●	●					
Pipe components						●	●	●	●	●									●					
Bellows						●	●	●	●	●									●					
Adapter				●	●	●	●	●	●	●							●		●					
Rotary feedthrough						●																		
Sight glass						●	●	●	●															
CF-F/R																								
Connection components		●		●		●	●	●	●	●														
Seal		●		●		●	●	●	●	●											●		●	●
Flange		●		●		●	●	●	●	●									●					
Pipe components		●		●		●	●	●											●					
Bellows		●		●		●	●	●											●					
Adapter		●	●	●		●	●	●	●										●					
Rotary feedthrough		●		●																				
Linear feedthrough		●		●																				
Liquid feedthrough				●																				
Sight glass		●		●		●	●	●																
Electric feedthrough		●		●																				
Coaxial feedthrough		●																						

Components and feedthroughs

Flange components and feedthroughs for all vacuum applications

Versions

The Pfeiffer Vacuum product portfolio is rounded out by a broad range of components and feedthroughs! Numerous versions of flanges, piping components, bellows, reducers, adapters and feedthroughs for a wide range of configurations.

- **ISO-KF** – Small flange components made of aluminum or steel
- **ISO-K / F** – Clamping flange components
- **CF** – UHV-components

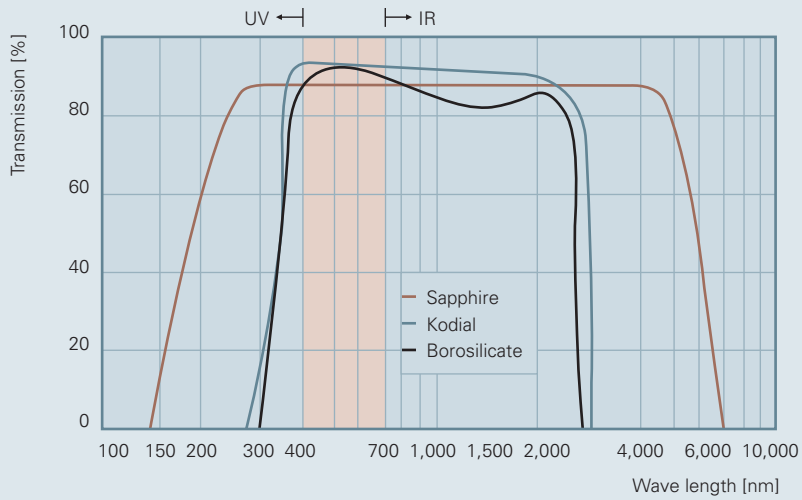
General information

Table: Sealing material

		Temperature range	Reusable
Elastomers	CR (Neoprene)	-40 to 100 °C	yes
	FPM	-15 to 150 °C	yes
Metals	Aluminum	-196 to 200 °C	no
	Copper	-196 to 200 °C	no
	Copper, silver plated	-270 to 450 °C	no

Table: Pressure ranges of the flange connections

		Pressure mbar	bar	Leak tightness mbar l/s	Centering	Connection element
ISO-KF	Aluminum	10^{-7}	2,5	10^{-8}	inside	Clamping/quick clamping ring
	Stainless Steel	10^{-8}	2,5	10^{-9}	inside	Clamping/quick clamping ring
		10^{-8}	5	10^{-9}	outside	Clamping/quick clamping ring
		10^{-8}	10	10^{-9}	outside	Tensioning chain
ISO-K	Stainless Steel	10^{-8}	2,5	10^{-9}	inside	Clamps/claws
CF	Stainless Steel	10^{-12}	1	$< 10^{-10}$		Screws



Transmission Curve for the sight glasses

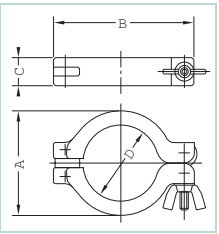
Notes

ISO-KF

Clamping rings/claw grips

Clamping rings for elastomer seals

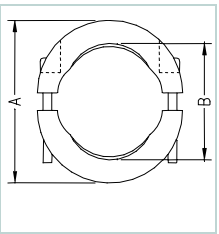
Clamping rings with wing nuts for standard small flange connections.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium/steel, zinc plated	DN 10-16 ISO-KF	43	62	16	22	**PF 100 316-T**
	Aluminium/steel, zinc plated	DN 20-25 ISO-KF	55	72	16	32	**PF 100 325-T**
	Aluminium/steel, zinc plated	DN 32-40 ISO-KF	70	90	17	47	**PF 100 340-T**
	Alumnium/steel, zinc plated	DN 50 ISO-KF	93	123	24	62	**PF 100 350-T**

Clamping rings for elastomer and metallic seals

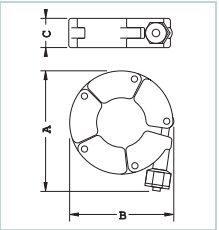
Clamping rings with hexagon socket screw.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 10-16 ISO-KF	55	22			**PF 105 016-T**
	Stainless steel	DN 20-25 ISO-KF	67	32			**PF 105 025-T**
	Stainless steel	DN 32-40 ISO-KF	83	47			**PF 105 040-T**
	Stainless steel	DN 50 ISO-KF	114	62			**PF 105 050-T**

Bulkhead clamps for elastomer and metallic seals

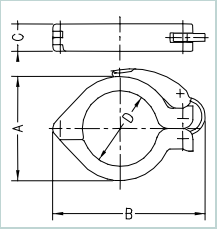
Bulkhead clamps in conjunction with external centering ring and stainless steel components, for pressures of up to 10 bar.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium/ stainless steel	DN 16-10 ISO-KF	71	52.5	18		**PF 106 016-T**
	Aluminium/ stainless steel	DN 20-25 ISO-KF	82	65	18		**PF 106 025-T**
	Aluminium/ stainless steel	DN 32-40 ISO-KF	98	79	18		**PF 106 040-T**
	Aluminium/ stainless steel	DN 50 ISO-KF	117	97.5	20		**PF 106 050-T**

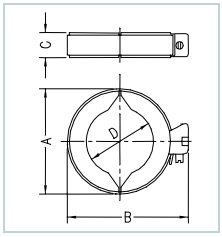
Rapid-action fastening clamps for elastomer seals

Rapid-action fastening clamps with lever-actuated rapid-action closure.



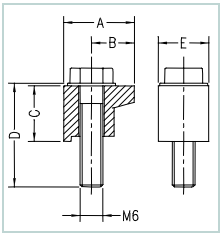
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium/plastic	DN 10-16 ISO-KF	45	66	16	24	**PF 101 016-T**
	Aluminium/plastic	DN 20-25 ISO-KF	55	78	16	33	**PF 101 025-T**
	Aluminium/plastic	DN 32-40 ISO-KF	70	98	18	48.5	**PF 101 040-T**

Hose clip clamping rings for elastomer seals

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium/steel	DN 10-16 ISO-KF	42	52.5	16	22	**PF 103 016-T**
	Aluminium/steel	DN 20-25 ISO-KF	51	62.5	16	31	**PF 103 025-T**
	Aluminium/steel	DN 32-40 ISO-KF	67	78	16	47	**PF 103 040-T**

Claw grips

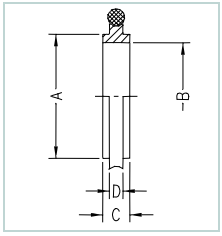
Claw grips for mounting a small flange directly to a housing wall.

Dimensions	Material	Nominal diameter	A	B	C	D	E	Order number
	Aluminium/ stainless steel	DN 10-50 ISO-KF	20	11.5	12.5	20	14	**PF 104 000-T**

Seals

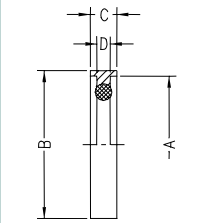
Centering rings

Centering rings of aluminum or stainless steel with o-ring of CR (Neoprene) or FPM. Temperature range for CR (Neoprene): -40 °C to 100 °C. Temperature range for FPM: -15 °C to 150 °C.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene/ aluminium	DN 10 ISO-KF	12	10	8	3.9	**PF 110 010-T**
	Neoprene/ aluminium	DN 16 ISO-KF	17	16	8	3.9	**PF 110 016-T**
	Neoprene/ aluminium	DN 25 ISO-KF	26	25	8	3.9	**PF 110 025-T**
	Neoprene/ aluminium	DN 40 ISO-KF	41	40	8	3.9	**PF 110 040-T**
	Neoprene/ aluminium	DN 50 ISO-KF	52	50	8	3.9	**PF 110 050-T**
	FPM/ aluminum	DN 10 ISO-KF	12	10	8	3.9	**PF 110 110-T**
	FPM/aluminium	DN 16 ISO-KF	17	16	8	3.9	**PF 110 116-T**
	FPM/aluminium	DN 25 ISO-KF	26	25	8	3.9	**PF 110 125-T**
	FPM/aluminium	DN 40 ISO-KF	41	40	8	3.9	**PF 110 140-T**
	FPM/aluminium	DN 50 ISO-KF	52	50	8	3.9	**PF 110 150-T**
	FPM/stainless steel	DN 10 ISO-KF	12	10	8	3.9	**PF 110 210-T**
	FPM/stainless steel	DN 16 ISO-KF	17	16	8	3.9	**PF 110 216-T**
	FPM/stainless steel	DN 25 ISO-KF	26	25	8	3.9	**PF 110 225-T**
	FPM/stainless steel	DN 40 ISO-KF	41	40	8	3.9	**PF 110 240-T**
	FPM/stainless steel	DN 50 ISO-KF	52	50	8	3.9	**PF 110 250-T**

External centering rings

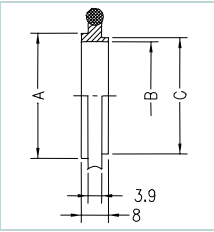
External centering rings for pressures of up to 5 bar absolute or up to 10 bar absolute when a bulkhead clamp is employed.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM/aluminium	DN 10-16 ISO-KF	30	32.5	7	3.9	**PF 111 116-T**
	FPM/aluminium	DN 20-25 ISO-KF	40	42.5	7	3.9	**PF 111 125-T**
	FPM/aluminium	DN 32-40 ISO-KF	55.5	57	7	3.9	**PF 111 140-T**
	FPM/aluminium	DN 50 ISO-KF	75	77.5	7	3.9	**PF 111 150-T**

Reducing centering rings

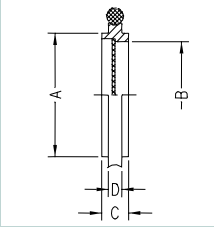
Reducing centering rings of aluminum or stainless steel with o-ring of CR (Neoprene) or FPM. Temperature range for CR (Neoprene): -40 °C to 100 °C. Temperature range for FPM: -15 °C to 150 °C.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene/ aluminium	DN 16-10 ISO-KF	17	10	12		**PF 112 016-T**
	Neoprene/ aluminium	DN 25-20 ISO-KF	26	21	22		**PF 112 025-T**
	Neoprene/ aluminium	DN 40-32 ISO-KF	41	32	34		**PF 112 040-T**
	FPM/aluminium	DN 16-10 ISO-KF	17	10	12		**PF 112 116-T**
	FPM/aluminium	DN 25-20 ISO-KF	26	21	22		**PF 112 125-T**
	FPM/aluminium	DN 40-32 ISO-KF	41	32	34		**PF 112 140-T**
	FPM/ stainless steel	DN 16-10 ISO-KF	17	10	12		**PF 112 216-T**
	FPM/ stainless steel	DN 25-20 ISO-KF	26	21	22		**PF 112 225-T**
	FPM/ stainless steel	DN 40-32 ISO-KF	41	32	34		**PF 112 240-T**

Centering rings with mesh screen, 72 mesh

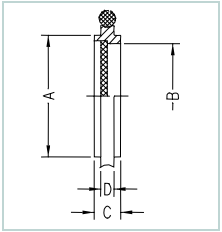
Centering rings of stainless steel with FPM o-ring.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM/ stainless steel	DN 10 ISO-KF	12	8	8	3.9	**PF 113 210-T**
	FPM/ stainless steel	DN 16 ISO-KF	17	9.5	8	3.9	**PF 113 216-T**
	FPM/ stainless steel	DN 25 ISO-KF	26	19.5	8	3.9	**PF 113 225-T**
	FPM/ stainless steel	DN 40 ISO-KF	41	32	8	3.9	**PF 113 240-T**
	FPM/ stainless steel	DN 50 ISO-KF	52	43	8	3.9	**PF 113 250-T**

Centering rings with poral filter, pore size 0.02 mm

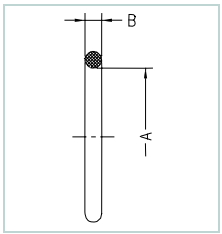
Centering rings of stainless steel with FPM o-ring.



Material	Nominal diameter	A	B	C	D	Through-put	Order number
FPM/ stainless steel	DN 10 ISO-KF	12	9	8	3.9	0.5 m³/h	**PF 117 210-T**
FPM / stainless steel	DN 16 ISO-KF	17	13	8	3.9	1.2 m³/h	**PF 117 216-T**
FPM/ stainless steel	DN 25 ISO-KF	26	22	8	3.9	4.2 m³/h	**PF 117 225-T**
FPM/ stainless steel	DN 40 ISO-KF	41	35.5	8	3.9	11.3 m³/h	**PF 117 240-T**
FPM/ stainless steel	DN 50 ISO-KF	52	45.7	8	3.9	18.1 m³/h	**PF 117 250-T**

O-rings of CR (Neoprene)

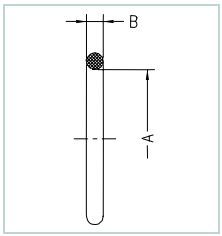
Temperature range -40 °C to 100 °C.



Material	Nominal diameter	A	B	C	D	Order number
Neoprene	DN 10 ISO-KF	15	5			**P 4070 262 PN**
Neoprene	DN 16 ISO-KF	18	5			**P 4070 321 PN**
Neoprene	DN 25 ISO-KF	28	5			**P 4070 488 PN**
Neoprene	DN 40 ISO-KF	42	5			**P 4070 676 PN**
Neoprene	DN 50 ISO-KF	55	5			**P 4070 837 PN**

O-rings of FPM

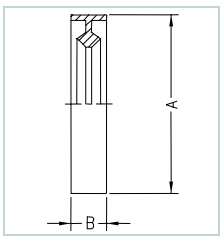
Temperature range -15 °C to 150 °C.



Material	Nominal diameter	A	B	C	D	Order number
FPM	DN 10 ISO-KF	15	5			**P 4070 262 PV**
FPM	DN 16 ISO-KF	18	5			**P 4070 321 PV**
FPM	DN 25 ISO-KF	28	5			**P 4070 488 PV**
FPM	DN 40 ISO-KF	42	5			**P 4070 676 PV**
FPM	DN 50 ISO-KF	55	5			**P 4070 837 PV**

Aluminium seals

Metallic seals for a temperature range of -196 °C to 200 °C.

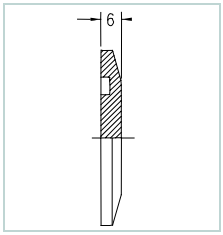


Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 10-16 ISO-KF	32	7			**PF 115 016**
Aluminium	DN 20-25 ISO-KF	42	7			**PF 115 025**
Aluminium	DN 32-40 ISO-KF	57	7			**PF 115 040**
Aluminium	DN 50 ISO-KF	77	7			**PF 115 050**

Flanges

Blank flanges

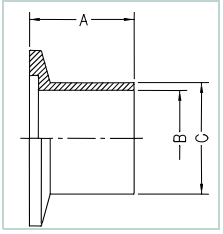
Blank flanges of aluminum and stainless steel.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 10 ISO-KF					**PF 120 010**
	Aluminium	DN 16 ISO-KF					**PF 120 016**
	Aluminium	DN 25 ISO-KF					**PF 120 025**
	Aluminium	DN 40 ISO-KF					**PF 120 040**
	Aluminium	DN 50 ISO-KF					**PF 120 050**
	Stainless steel	DN 10 ISO-KF					**PF 120 210**
	Stainless steel	DN 16 ISO-KF					**PF 120 216**
	Stainless steel	DN 25 ISO-KF					**PF 120 225**
	Stainless steel	DN 40 ISO-KF					**PF 120 240**
	Stainless steel	DN 50 ISO-KF					**PF 120 250**

Flanges with short pipe socket

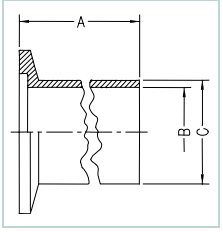
Flanges with a length of 30 mm.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel	DN 10 ISO-KF	30	10	14		**PF 121 110**
	Steel	DN 16 ISO-KF	30	16	20		**PF 121 116**
	Steel	DN 25 ISO-KF	30	24	28		**PF 121 125**
	Steel	DN 40 ISO-KF	30	40.5	44.5		**PF 121 140**
	Steel	DN 50 ISO-KF	30	51	57		**PF 121 150**
	Stainless steel 316 L	DN 10 ISO-KF	30	10	14		**PF 121 210**
	Stainless steel 316 L	DN 16 ISO-KF	30	16	20		**PF 121 216**
	Stainless steel 316 L	DN 25 ISO-KF	30	24	28		**PF 121 225**
	Stainless steel 316 L	DN 40 ISO-KF	30	40.5	44.5		**PF 121 240**
	Stainless steel 316 L	DN 50 ISO-KF	30	51	57		**PF 121 250**

Flanges with long pipe socket

Flange with a length of 70 mm.

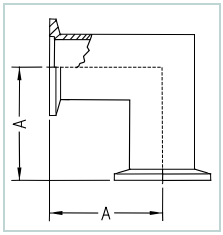


Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel	DN 10 ISO-KF	70	10	14		**PF 122 110-X**
	Steel	DN 16 ISO-KF	70	16	20		**PF 122 116-X**
	Steel	DN 25 ISO-KF	70	24	28		**PF 122 125-X**
	Steel	DN 40 ISO-KF	70	40.5	44.5		**PF 122 140-X**
	Steel	DN 50 ISO-KF	70	51	57		**PF 122 150-X**
	Stainless steel 316 L	DN 10 ISO-KF	70	10	14		**PF 122 210-X**
	Stainless steel 316 L	DN 16 ISO-KF	70	16	20		**PF 122 216-X**
	Stainless steel 316 L	DN 25 ISO-KF	70	24	28		**PF 122 225-X**
	Stainless steel 316 L	DN 40 ISO-KF	70	40.5	44.5		**PF 122 240-X**
	Stainless steel 316 L	DN 50 ISO-KF	70	51	57		**PF 122 250-X**

Piping components

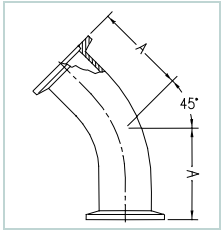
90° elbows

Aluminum elbows designed as angle pieces, stainless steel elbows as pipe bends.



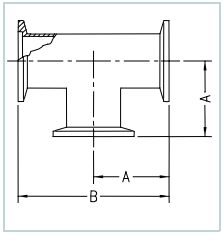
Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 10 ISO-KF	30				**PF 124 010**
Aluminium	DN 16 ISO-KF	40				**PF 124 016**
Aluminium	DN 25 ISO-KF	50				**PF 124 025**
Aluminium	DN 40 ISO-KF	65				**PF 124 040**
Stainless steel	DN 10 ISO-KF	30				**PF 124 210-X**
Stainless steel	DN 16 ISO-KF	40				**PF 124 216-X**
Stainless steel	DN 25 ISO-KF	50				**PF 124 225-X**
Stainless steel	DN 40 ISO-KF	65				**PF 124 240-X**
Stainless steel	DN 50 ISO-KF	70				**PF 124 250-X**

45° elbows



Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 10 ISO-KF	30				**PF 125 210-X**
Stainless steel	DN 16 ISO-KF	26				**PF 125 216-X**
Stainless steel	DN 25 ISO-KF	32				**PF 125 225-X**
Stainless steel	DN 40 ISO-KF	40				**PF 125 240-X**

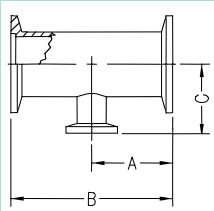
T-pieces



Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 10 ISO-KF	30	60			**PF 126 010**
Aluminium	DN 16 ISO-KF	40	80			**PF 126 016**
Aluminium	DN 25 ISO-KF	50	100			**PF 126 025**
Aluminium	DN 40 ISO-KF	65	130			**PF 126 040**
Stainless steel	DN 10 ISO-KF	30	60			**PF 126 210-X**
Stainless steel	DN 16 ISO-KF	40	80			**PF 126 216-X**
Stainless steel	DN 25 ISO-KF	50	100			**PF 126 225-X**
Stainless steel	DN 40 ISO-KF	65	130			**PF 126 240-X**
Stainless steel	DN 50 ISO-KF	70	140			**PF 126 250-X**

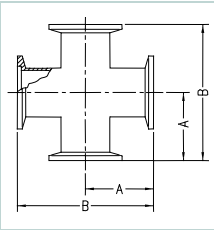
Reducing T-pieces

Opposite flanges have the same nominal diameter; lateral branch has reduced nominal diameter.



Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 25-16 ISO-KF	50	100	40		**PF 127 232-X**
Stainless steel	DN 40-16 ISO-KF	65	130	40		**PF 127 242-X**
Stainless steel	DN 40-25 ISO-KF	65	130	50		**PF 127 243-X**
Stainless steel	DN 50-16 ISO-KF	70	140	50		**PF 127 252-X**
Stainless steel	DN 50-25 ISO-KF	70	140	65		**PF 127 253-X**
Stainless steel	DN 50-40 ISO-KF	70	140	65		**PF 127 254-X**

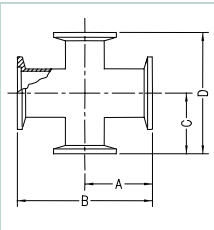
Crosspieces



Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 10 ISO-KF	30	60			**PF 128 010**
Aluminium	DN 16 ISO-KF	40	80			**PF 128 016**
Aluminium	DN 25 ISO-KF	50	100			**PF 128 025**
Aluminium	DN 40 ISO-KF	65	130			**PF 128 040**
Stainless steel	DN 10 ISO-KF	30	60			**PF 128 210-X**
Stainless steel	DN 16 ISO-KF	40	80			**PF 128 216-X**
Stainless steel	DN 25 ISO-KF	50	100			**PF 128 225-X**
Stainless steel	DN 40 ISO-KF	65	130			**PF 128 240-X**
Stainless steel	DN 50 ISO-KF	70	140			**PF 128 250-X**

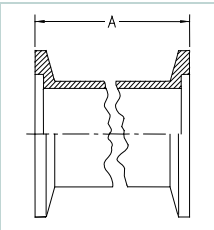
Reducing crosspieces

Each pair of opposite flanges has the same nominal diameter.



Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 25-16 ISO-KF	50	100	40	80	**PF 129 232-X**
Stainless steel	DN 40-16 ISO-KF	65	130	40	80	**PF 129 242-X**
Stainless steel	DN 40-25 ISO-KF	65	130	50	100	**PF 129 243-X**
Stainless steel	DN 50-16 ISO-KF	70	140	40	80	**PF 129 252-X**
Stainless steel	DN 50-25 ISO-KF	70	140	50	100	**PF 129 253-X**

Spacers

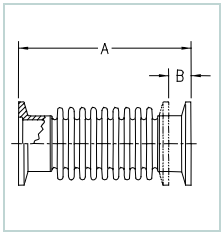


Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 10 ISO-KF	60				**PF 123 010**
Aluminium	DN 16 ISO-KF	80				**PF 123 016**
Aluminium	DN 25 ISO-KF	100				**PF 123 025**
Aluminium	DN 40 ISO-KF	130				**PF 123 040**
Stainless steel	DN 16 ISO-KF	80				**PF 123 216-X**
Stainless steel	DN 25 ISO-KF	100				**PF 123 225-X**
Stainless steel	DN 40 ISO-KF	130				**PF 123 240-X**
Stainless steel	DN 50 ISO-KF	140				**PF 123 250-X**

Metallic hoses and bellows

Bellows, stainless steel

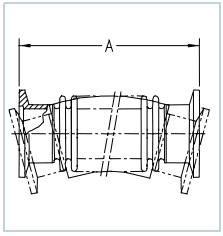
To compensate for axial movement and to dampen vibrations.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 ISO-KF	123	21			**PF 130 216-X**
	Stainless steel	DN 25 ISO-KF	123	21			**PF 130 225-X**
	Stainless steel	DN 40 ISO-KF	123	21			**PF 130 240-X**
	Stainless steel	DN 50 ISO-KF	123	21			**PF 130 250-X**

Metallic hoses, standard

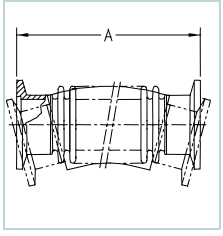
Metallic hoses for flexible connections.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 ISO-KF	250				**PF 131 225-X**
	Stainless steel	DN 16 ISO-KF	500				**PF 131 250-X**
	Stainless steel	DN 16 ISO-KF	750				**PF 131 275-X**
	Stainless steel	DN 16 ISO-KF	1000				**PF 131 210-X**
	Stainless steel	DN 25 ISO-KF	250				**PF 131 325-X**
	Stainless steel	DN 25 ISO-KF	500				**PF 131 350-X**
	Stainless steel	DN 25 ISO-KF	750				**PF 131 375-X**
	Stainless steel	DN 25 ISO-KF	1000				**PF 131 310-X**
	Stainless steel	DN 40 ISO-KF	250				**PF 131 425-X**
	Stainless steel	DN 40 ISO-KF	500				**PF 131 450-X**
	Stainless steel	DN 40 ISO-KF	750				**PF 131 475-X**
	Stainless steel	DN 40 ISO-KF	1000				**PF 131 410-X**
	Stainless steel	DN 50 ISO-KF	250				**PF 131 525-X**
	Stainless steel	DN 50 ISO-KF	500				**PF 131 550-X**
	Stainless steel	DN 50 ISO-KF	750				**PF 131 575-X**
	Stainless steel	DN 50 ISO-KF	1000				**PF 131 510-X**

Metallic hoses, highly flexible

Metallic hoses of stainless steel for flexible connections.

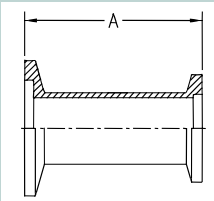


Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 ISO-KF	250				**PF 139 225-X**
	Stainless steel	DN 16 ISO-KF	500				**PF 139 250-X**
	Stainless steel	DN 16 ISO-KF	750				**PF 139 275-X**
	Stainless steel	DN 16 ISO-KF	1000				**PF 139 210-X**
	Stainless steel	DN 25 ISO-KF	250				**PF 139 325-X**
	Stainless steel	DN 25 ISO-KF	500				**PF 139 350-X**
	Stainless steel	DN 25 ISO-KF	750				**PF 139 375-X**
	Stainless steel	DN 25 ISO-KF	1000				**PF 139 310-X**
	Stainless steel	DN 40 ISO-KF	250				**PF 139 425-X**
	Stainless steel	DN 40 ISO-KF	500				**PF 139 450-X**
	Stainless steel	DN 40 ISO-KF	750				**PF 139 475-X**
	Stainless steel	DN 40 ISO-KF	1000				**PF 139 410-X**

Reducers and adapters

Reducing pieces, ISO-KF/ISO-KF

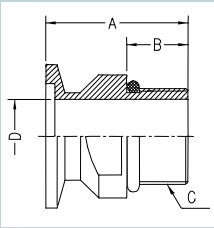
Short style, length 40 mm.



Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 25-10 ISO-KF	40				**PF 140 031**
Aluminium	DN 25-16 ISO-KF	40				**PF 140 032**
Aluminium	DN 40-10 ISO-KF	40				**PF 140 041**
Aluminium	DN 40-16 ISO-KF	40				**PF 140 042**
Aluminium	DN 40-25 ISO-KF	40				**PF 140 043**
Aluminium	DN 50-40 ISO-KF	40				**PF 140 054**
Stainless steel	DN 25-16 ISO-KF	40				**PF 140 232-X**
Stainless steel	DN 40-16 ISO-KF	40				**PF 140 242-X**
Stainless steel	DN 40-25 ISO-KF	40				**PF 140 243-X**
Stainless steel	DN 50-16 ISO-KF	40				**PF 140 252-X**
Stainless steel	DN 50-25 ISO-KF	40				**PF 140 253-X**
Stainless steel	DN 50-40 ISO-KF	40				**PF 140 254-X**

Screw-in flanges

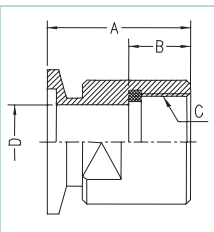
Flanges designed to be screwed into a pipe or the chamber wall.



Material	Nominal diameter	A	B	C	D	Order number
FPM/ stainless steel	DN 10 ISO-KF-G 3/8"	35	15	G 3/8"	10	**PF 141 214-T**
FPM/ stainless steel	DN 16 ISO-KF-G 1/2"	35	16	G 1/2"	15	**PF 141 225-T**
FPM/ stainless steel	DN 25 ISO-KF-G 1"	45	24	G 1"	24	**PF 141 237-T**
FPM/ stainless steel	DN 40 ISO-KF-G 1 1/2"	50	28	G 1 1/2"	40	**PF 141 248-T**

Screw-on flanges

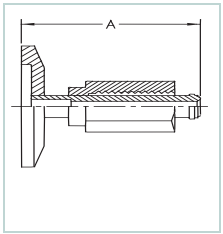
Connection flanges designed to be screwed onto a pipe with male thread.



Material	Nominal diameter	A	B	C	D	Order number
FPM/ stainless steel	DN 10 ISO-KF-G 3/8"	35	15.5	G 3/8"	10	**PF 142 214-T**
FPM/ stainless steel	DN 16 ISO-KF-G 1/2"	35	16	G 1/2"	15	**PF 142 225-T**
FPM/ stainless steel	DN 25 ISO-KF-G 1"	45	22	G 1"	24	**PF 142 237-T**
FPM/ stainless steel	DN 40 ISO-KF-G 1 1/2"	50	26	G 1 1/2"	40	**PF 142 248-T**

Adapters, ISO-KF/VCR®, female

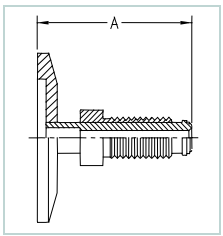
Adapters, ISO-KF to VCR screw coupling, of stainless steel.



Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 16 ISO-KF/VCR 1/4"	36				**PF 142 422-X**
Stainless steel	DN 25 ISO-KF/VCR 1/2"	41				**PF 142 433-X**
Stainless steel	DN 40 ISO-KF/VCR 3/4"	54				**PF 142 444-X**

Adapters, ISO-KF/VCR®, male

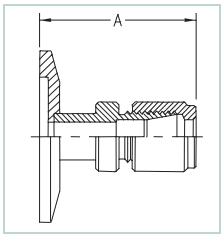
Adapters, ISO-KF to VCR screw coupling, of stainless steel.



Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 16 ISO-KF/VCR 1/4"	36				**PF 141 422-X**
Stainless steel	DN 25 ISO-KF/VCR 1/2"	41				**PF 141 433-X**
Stainless steel	DN 40 ISO-KF/VCR 3/4"	54				**PF 141 444-X**

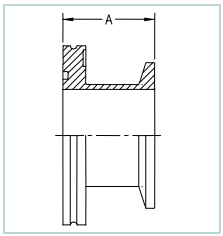
Adapters, ISO-KF/Swagelok®

Adapters, ISO-KF to Swagelok screw coupling, of stainless steel.



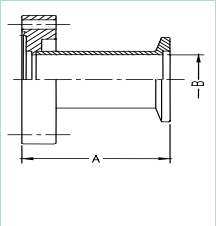
Material	Nominal diameter	A	B	C	D	Order number
Stainless steel	DN 16 ISO-KF/6 mm	37				**PF 141 522-X**
Stainless steel	DN 25 ISO-KF/10 mm	45				**PF 141 534-X**
Stainless steel	DN 40 ISO-KF/16 mm	53				**PF 141 546-X**

Adapters, ISO-KF/ISO-K



Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 63 ISO-K/40 KF	40				**PF 322 004**
Aluminium	DN 63 ISO-K/50 KF	45				**PF 322 005**
Stainless steel	DN 63 ISO-K/40 KF	40				**PF 322 204-X**
Stainless steel	DN 63 ISO-K/50 KF	40				**PF 322 205-X**
Stainless steel	DN 100 ISO-K/40 KF	38.5				**PF 322 214-X**

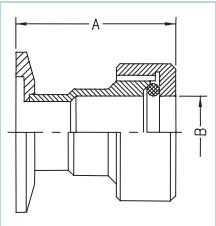
Adapters, ISO-KF/CF-F



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-F/ DN 16 ISO-KF	36	16			**PF 545 202-X**
	Stainless steel	DN 16 CF-F/ DN 25 ISO-KF	36	16			**PF 545 203-X**
	Stainless steel	DN 16 ISO-KF/ DN 40 CF-F	36	16			**PF 545 212-X**
	Stainless steel	DN 40 CF-F/ DN 25 ISO-KF	36	24			**PF 545 213-X**
	Stainless steel	DN 40 CF-F/ DN 40 ISO-KF	50	37			**PF 545 214-X**
	Stainless steel	DN 63 CF-F/ DN 40 ISO-KF	50	41			**PF 545 224-X**
	Stainless steel	DN 100 CF-F/ DN 40 ISO-KF	50	41			**PF 545 234-X**

Compression-fit piping adapters

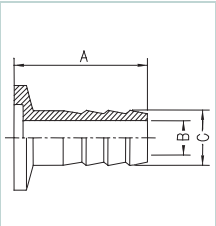
Compression-fit piping adapters for transitioning to metallic and glass tubing.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM/ stainless steel	DN 10 ISO-KF-10 mm	50	10			**PF 143 210-T**
	FPM/ stainless steel	DN 40 ISO-KF-20 mm	64	20			**PF 143 244-T**
	FPM/ stainless steel	DN 40 ISO-KF-26 mm	71	26			**PF 143 246-T**

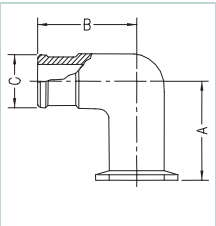
Hose connections

Hose connections for nominal diameter of 12.



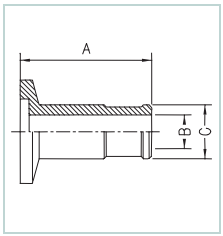
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 16 ISO-KF-12	40	8	12		**PF 144 021**
	Aluminium	DN 25 ISO-KF-12	40	8	12		**PF 144 031**
	Aluminium	DN 40 ISO-KF-12	40	8	12		**PF 144 041**

90° elbows-hos adapters for PVC hose and sleeve



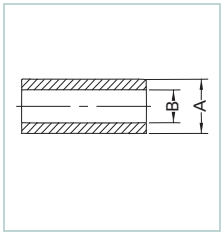
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 16 ISO-KF-16	40	40	17		**PF 145 023**
	Aluminium	DN 25 ISO-KF-25	50	50	26		**PF 145 037**
	Aluminium	DN 40 ISO-KF-40	65	65	41		**PF 145 048**

Hose nipples for PVC hose and sleeve

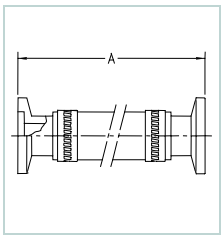
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 10 ISO-KF-14	40	9	14		**PF 146 012**
	Aluminium	DN 16 ISO-KF-16	40	13	17		**PF 146 023**
	Aluminium	DN 16 ISO-KF-20	40	15	20		**PF 146 024**
	Aluminium	DN 25 ISO-KF-20	40	16	20		**PF 146 034**
	Aluminium	DN 25 ISO-KF-28	40	22	26		**PF 146 037**
	Aluminium	DN 40 ISO-KF-25	40	22	26		**PF 146 047**
	Aluminium	DN 40 ISO-KF-40	40	37	41		**PF 146 048**
	Aluminium	DN 40 ISO-KF-45	40	38	45		**PF 146 049**

PVC hoses/sleeves/protective covers

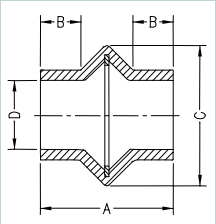
PVC hoses with embedded support spiral

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	PVC, polyester spiral	12	21	10			**P 2358 262 SS**
	PVC, polyester spiral	14	19	13			**P 2359 314 NV**
	PVC, polyester spiral	16	23	16			**P 2359 345 NV**
	PVC, polyester spiral	20	26	19			**P 2359 455 NV**
	PVC, polyester spiral	25	34	25			**P 2359 647 NV**
	PVC, polyester spiral	40	49	38			**P 2359 810 NV**
	PVC, steel spiral	45	55	45			**P 2359 837 BR**

PVC hoses, complete with KF flanges

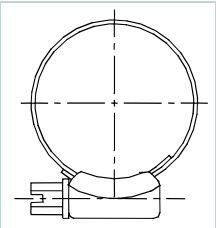
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	PVC/aluminium	DN 16 ISO-KF	500				**PF 151 250-T**
	PVC/aluminium	DN 16 ISO-KF	1000				**PF 151 210-T**
	PVC/aluminium	DN 25 ISO-KF	500				**PF 151 350-T**
	PVC/aluminium	DN 25 ISO-KF	1000				**PF 151 310-T**
	PVC/aluminium	DN 40 ISO-KF	500				**PF 151 450-T**
	PVC/aluminium	DN 40 ISO-KF	1000				**PF 151 410-T**

Sleeves, CR (Neoprene)

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene	20	44	12	44	17	**PF 147 004**
	Neoprene	25	50	15	50	25	**PF 147 007**
	Neoprene	45	56	18	68	44	**PF 147 009**

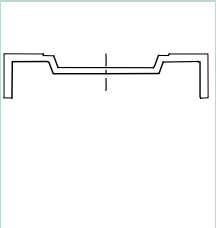
Hose clips, galvanized steel

Hose clips for attaching PVC hoses and sleeves.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, zinc plated	20					**P 4163 107 B**
	Steel, zinc plated	25					**P 4163 109 B**
	Steel, zinc plated	45					**P 4163 114 B**

Protective covers, plastic

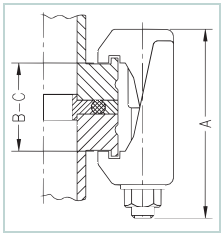
Protective covers to protect flange sealing surfaces.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Plastic	DN 10-16 ISO-KF					**PF 149 316**
	Plastic	DN 20-25 ISO-KF					**PF 149 325**
	Plastic	DN 32-40 ISO-KF					**PF 149 340**
	Plastic	DN 50 ISO-KF					**PF 149 350**

Connection elements/claw clamps/claw grips

Claw clamps

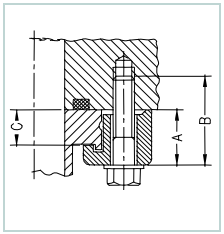
Claw clamps for the connection between clamping flange and clamping flange.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, coated	DN 63-250 ISO	60	27	17		**PF 300 110-T**
	Steel, zinc plated	DN 320-500 ISO	75	39	27.5		**PF 300 101-T**
	Steel, zinc plated	DN 630 ISO	85	46	30		**PF 300 102-T**
	Stainless steel	DN 63-250 ISO	60	27	17		**PF 300 200-T**

Claw grips for the connection between clamping flange and base plate, with sealing groove

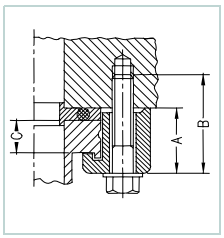
Note: Special mounting kits must be used to install turbopumps (see accessories for the respective turbopump).



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, zinc plated	DN 63-100 ISO	18.6	30	10		**PF 301 110-T**
	Steel, zinc plated	DN 160-250 ISO	19.1	35	10		**PF 301 111-T**
	Steel, zinc plated	DN 320-500 ISO	30.9	45	15		**PF 301 112-T**
	Steel, zinc plated	DN 630 ISO	36.5	50	20		**PF 301 113-T**

Claw grips for the connection between clamping flange and base plate

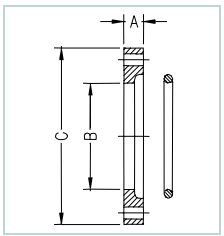
Note: Special mounting kits must be used to install turbopumps (see accessories for the respective turbopump).



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, zinc plated	DN 63-100 ISO	22.5	35	10		**PF 301 100-T**
	Steel, zinc plated	DN 160-250 ISO	23	35	10		**PF 301 101-T**
	Steel, zinc plated	DN 320-500 ISO	36.5	50	15		**PF 301 102-T**
	Steel, zinc plated	DN 630 ISO	41.5	55	20		**PF 301 103-T**

Collar flanges with retainer ring

Collar flanges for the connection between ISO-K clamping flange and ISO-F fixed flange. Note: Special mounting kits must be used to install turbopumps (see accessories for the respective turbopump).

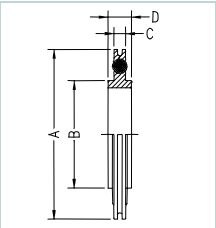


Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, nickel plated	DN 63 ISO-F	12	95.5	130		**PF 307 106-T**
	Steel, nickel plated	DN 100 ISO-F	12	130.5	165		**PF 307 110-T**
	Steel, nickel plated	DN 160 ISO-F	16	180.7	225		**PF 307 116-T**
	Steel, nickel plated	DN 200 ISO-F	16	240.7	285		**PF 307 120-T**
	Steel, nickel plated	DN 250 ISO-F	16	290.7	335		**PF 307 125-T**
	Steel, nickel plated	DN 320 ISO-F	20	370.8	425		**PF 307 132-T**
	Steel, nickel plated	DN 400 ISO-F	20	451	510		**PF 307 140-T**

Seals

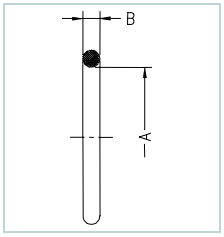
Centering rings

Centering rings of aluminum or stainless steel with o-ring of CR (Neoprene) or FPM. Temperature range for CR (Neoprene): -40 °C to 100 °C. Temperature range for FPM: -15 °C to 150 °C

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene/ aluminium	DN 63 ISO	95	70	3.9	8	**PF 303 006-T**
	Neoprene/ aluminium	DN 100 ISO	127	102	3.9	8	**PF 303 010-T**
	Neoprene/ aluminium	DN 160 ISO	178	153	3.9	8	**PF 303 016-T**
	Neoprene/ aluminium	DN 200 ISO	238	213	3.9	8	**PF 303 020-T**
	Neoprene/ aluminium	DN 250 ISO	286	261	3.9	8	**PF 303 025-T**
	Neoprene/ aluminium	DN 320 ISO	356	318	5.6	14	**PF 303 032-T**
	Neoprene/ aluminium	DN 400 ISO	438	400	5.6	14	**PF 303 040-T**
	Neoprene/ aluminium	DN 500 ISO	539	501	5.6	14	**PF 303 050-T**
	Neoprene/ aluminium	DN 630 ISO	689	651	5.6	14	**PF 303 063-T**
	FPM/aluminium	DN 63 ISO	95	70	3.9	8	**PF 303 106-T**
	FPM/aluminium	DN 100 ISO	127	102	3.9	8	**PF 303 110-T**
	FPM/aluminium	DN 160 ISO	178	153	3.9	8	**PF 303 116-T**
	FPM/aluminium	DN 200 ISO	238	213	3.9	8	**PF 303 120-T**
	FPM/aluminium	DN 250 ISO	286	261	3.9	8	**PF 303 125-T**
	FPM/aluminium	DN 320 ISO	356	318	5.6	14	**PF 303 132-T**
	FPM/aluminium	DN 400 ISO	438	400	5.6	14	**PF 303 140-T**
	FPM/aluminium	DN 500 ISO	539	501	5.6	14	**PF 303 150-T**
	FPM/aluminium	DN 630 ISO	689	651	5.6	14	**PF 303 163-T**
	FPM/aluminium	DN 800 ISO	840	800	5.6	14	**PF 303 180-T**
	FPM/aluminium	DN 1000 ISO	1040	1000	5.6	14	**PF 303 199-T**
	FPM/ stainless steel	DN 63 ISO	95	70	3.9	8	**PF 303 206-T**
	FPM/ stainless steel	DN 100 ISO	127	102	3.9	8	**PF 303 210-T**
	FPM/ stainless steel	DN 160 ISO	178	153	3.9	8	**PF 303 216-T**
	FPM/ stainless steel	DN 200 ISO	238	213	3.9	8	**PF 303 220-T**
	FPM/ stainless steel	DN 250 ISO	286	261	3.9	8	**PF 303 225-T**

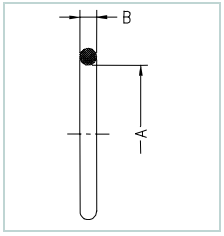
O-rings of CR (Neopren)

Temperature range: -40 °C to 100 °C.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene	DN 63 ISO	75.6	5.3			**P 4071 054 PN**
	Neoprene	DN 100 ISO	107.3	5.3			**P 4071 274 PN**
	Neoprene	DN 160 ISO	158.1	5.3			**P 4071 524 PN**
	Neoprene	DN 200 ISO	208.9	5.3			**P 4071 659 PN**
	Neoprene	DN 250 ISO	253.4	5.3			**P 4071 774 PN**
	Neoprene	DN 320 ISO	330	7			**P 4071 886 PN**
	Neoprene	DN 400 ISO	405	7			**P 4074 005 PN**
	Neoprene	DN 400 ISO	507	7			**P 4074 106 PN**
	Neoprene	DN 630 ISO	659	7			**P 4074 245 PN**

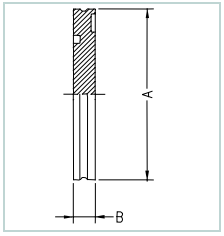
O-rings of FPM

Temperature range: -15 °C to 150 °C.

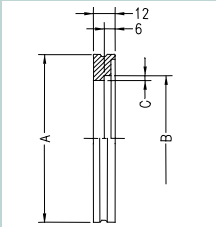
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM	DN 63 ISO	75.6	5.3			**P 4071 054 PV**
	FPM	DN 63 ISO	107.3	5.3			**P 4071 274 PV**
	FPM	DN 160 ISO	158.1	5.3			**P 4071 524 PV**
	FPM	DN 200 ISO	208.9	5.3			**P 4071 659 PV**
	FPM	DN 250 ISO	253.4	5.3			**P 4071 774 PV**
	FPM	DN 320 ISO	330	7			**P 4071 886 PV**
	FPM	DN 400 ISO	405	7			**P 4074 005 PV**
	FPM	DN 500 ISO	507	7			**P 4074 106 PV**
	FPM	DN 630 ISO	659	7			**P 4074 245 PV**
	FPM	DN 800 ISO	808	7			**P 4074 363 PV**
	FPM	DN 1000 ISO	1006	7			**P 4074 523 PV**

Flanges

Blank flanges

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, nickel plated	DN 63 ISO-K	95	12			**PF 305 106**
	Steel, nickel plated	DN 100 ISO-K	130	12			**PF 305 110**
	Steel, nickel plated	DN 160 ISO-K	180	12			**PF 305 116**
	Stainless steel	DN 63 ISO-K	95	12			**PF 305 206**
	Stainless steel	DN 100 ISO-K	130	12			**PF 305 210**
	Stainless steel	DN 160 ISO-K	180	12			**PF 305 216**
	Stainless steel	DN 200 ISO-K	240	12			**PF 305 220**
	Stainless steel	DN 250 ISO-K	290	12			**PF 305 225**
	Stainless steel	DN 320 ISO-K	370	17			**PF 305 232**
	Stainless steel	DN 400 ISO-K	450	17			**PF 305 240**
	Stainless steel	DN 500 ISO-K	550	17			**PF 305 250**
	Stainless steel	DN 630 ISO-K	690	22			**PF 305 263**

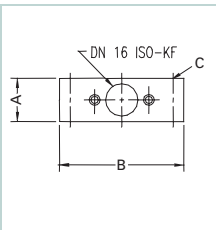
Welding flanges



Material	Nominal diameter	A	B	C	D	Order number
Steel	DN 63 ISO-K	95	76.5	3		**PF 306 106**
Steel	DN 100 ISO-K	130	108.5	4		**PF 306 110**
Steel	DN 160 ISO-K	180	159.5	4.5		**PF 306 116**
Steel	DN 250 ISO-K	290	267.5	3		**PF 306 125**
Stainless steel 304	DN 63 ISO-K	95	76.5	2.9		**PF 306 306**
Stainless steel 304	DN 100 ISO-K	130	108.5	2.9		**PF 306 310**
Stainless steel 304	DN 160 ISO-K	180	159.5	3		**PF 306 316**
Stainless steel 304	DN 200 ISO-K	240	219.5	3		**PF 306 320**
Stainless steel 304	DN 250 ISO-K	290	267.5	3		**PF 306 325**
Stainless steel 304	DN 250 ISO-K	290	273.5	3		**PF 306 327**

Measurement flanges

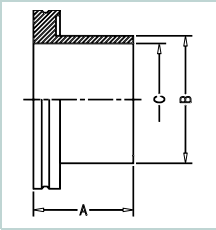
Measurement flanges with lateral DN 16 ISO-KF measurement flange for gauge head.



Material	Nominal diameter	A	B	C	D	Order number
Aluminium	DN 63 ISO-F	35	130	4 x M8		**PF 308 006-T**
Aluminium	DN 100 ISO-F	35	165	8 x M8		**PF 308 010-T**
Aluminium	DN 160 ISO-F	35	225	8 x M10		**PF 308 016-T**

Flanges with pipe socket

Flanges of plain and stainless steel for welding into chamber walls.

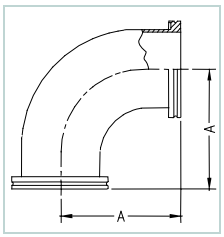


Material	Nominal diameter	A	B	C	D	Order number
Steel	DN 63 ISO-K	100	76	70		**PF 310 106-X**
Steel	DN 100 ISO-K	100	108	100		**PF 310 110-X**
Steel	DN 160 ISO-K	100	159	150		**PF 310 116-X**
Steel	DN 250 ISO-K	100	267	261		**PF 310 125-X**
Stainless steel 304	DN 63 ISO-K	100	76.1	71.5		**PF 310 306-X**
Stainless steel 304	DN 100 ISO-K	100	108	104		**PF 310 310-X**
Stainless steel 304	DN 160 ISO-K	100	159	155		**PF 310 316-X**
Stainless steel 304	DN 200 ISO-K	100	219	213		**PF 310 320-X**
Stainless steel 304	DN 250 ISO-K	100	267	261		**PF 310 325-X**
Stainless steel 304	DN 250 ISO-K	100	273	267		**PF 310 327-X**
Stainless steel 304	DN 320 ISO-K	100	324	318		**PF 310 332-X**
Stainless steel 304	DN 400 ISO-K	100	406	400		**PF 310 240-X**
Stainless steel 304	DN 500 ISO-K	100	508	500		**PF 310 350-X**
Stainless steel 304	DN 630 ISO-K	100	660	650		**PF 310 363-X**

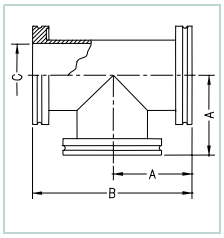
Piping components

90° elbows

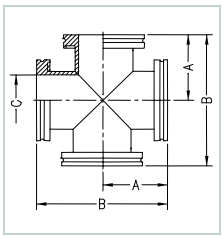
DN 63 and 100 with pipe bend. DN 160, 200 and 250 designed as angle piece.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	88				**PF 311 206-X**
	Stainless steel	DN 100 ISO-K	108				**PF 311 210-X**
	Stainless steel	DN 160 ISO-K	138				**PF 311 216-X**
	Stainless steel	DN 200 ISO-K	178				**PF 311 220-X**
	Stainless steel	DN 250 ISO-K	208				**PF 311 225-X**

T-pieces

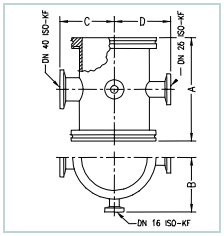
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	88	176	70		**PF 312 206-X**
	Stainless steel	DN 100 ISO-K	108	216	102		**PF 312 210-X**
	Stainless steel	DN 160 ISO-K	138	276	153		**PF 312 216-X**
	Stainless steel	DN 200 ISO-K	178	356	213		**PF 312 220-X**
	Stainless steel	DN 250 ISO-K	208	416	261		**PF 312 225-X**

Crosspieces

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	88	176	70		**PF 314 206-X**
	Stainless steel	DN 100 ISO-K	108	216	102		**PF 314 210-X**
	Stainless steel	DN 160 ISO-K	138	276	153		**PF 314 216-X**
	Stainless steel	DN 200 ISO-K	178	356	213		**PF 314 220-X**
	Stainless steel	DN 250 ISO-K	208	416	261		**PF 314 225-X**

Measurement crosspieces

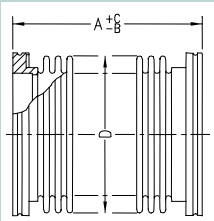
Measurement crosspieces with lateral DN 40, 25 and 16 ISO-KF connection flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	88	66	59	64	**PF 317 206-X**
	Stainless steel	DN 100 ISO-K	100	82	77	80	**PF 317 210-X**
	Stainless steel	DN 160 ISO-K	100	107	105	107	**PF 317 216-X**

Metallic hoses/bellows

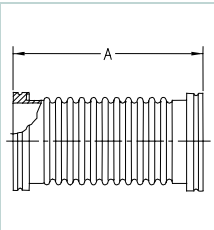
Bellows

Bellows to compensate for axial movement and to dampen vibrations.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	127	25	5	90	**PF 318 206-X**
	Stainless steel	DN 100 ISO-K	127	20	5	127	**PF 318 210-X**
	Stainless steel	DN 160 ISO-K	220	28	1	190	**PF 318 216-X**
	Stainless steel	DN 200 ISO-K	220	29	0	228	**PF 318 220-X**
	Stainless steel	DN 250 ISO-K	220	25	25	285	**PF 318 225-X**

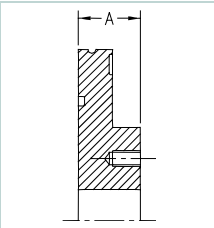
Metallic hoses

Metallic hoses for flexible connections.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 ISO-K	250				**PF 319 025-X**
	Stainless steel	DN 63 ISO-K	500				**PF 319 050-X**
	Stainless steel	DN 63 ISO-K	750				**PF 319 075-X**
	Stainless steel	DN 63 ISO-K	1000				**PF 319 010-X**
	Stainless steel	DN 100 ISO-K	250				**PF 319 125-X**
	Stainless steel	DN 100 ISO-K	500				**PF 319 150-X**
	Stainless steel	DN 100 ISO-K	750				**PF 319 175-X**
	Stainless steel	DN 100 ISO-K	1000				**PF 319 110-X**

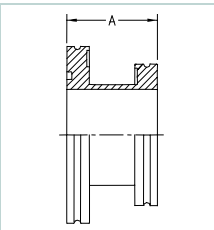
Reducing pieces and adapters

Reducing flanges, ISO-K/ISO-F

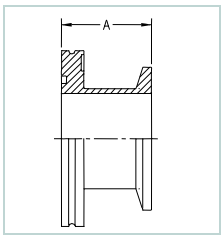
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 160/63 ISO-K/F	22				**PF 320 220**
	Stainless steel	DN 160/100 ISO-K/F	20				**PF 320 221**
	Stainless steel	DN 200/100 ISO-K/F	20				**PF 320 231**
	Stainless steel	DN 200/160 ISO-K/F	25				**PF 320 232**
	Stainless steel	DN 250/160 ISO-K/F	30				**PF 320 242**

Reducing pieces, ISO-K/ISO-K

Short style, length 50 mm.

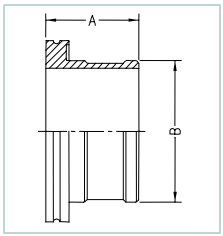
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 100/63 ISO-K	50				**PF 321 210-X**
	Stainless steel	DN 160/100 ISO-K	50				**PF 321 221-X**
	Stainless steel	DN 200/160 ISO-K	50				**PF 321 232-X**
	Stainless steel	DN 250/200 ISO-K	50				**PF 321 243-X**

Adapters, ISO-K/ISO-KF

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 63 ISO-K/40 KF	40				**PF 322 004**
	Aluminium	DN 63 ISO-K/50 KF	45				**PF 322 005**
	Stainless steel	DN 63 ISO-K/40 KF	40				**PF 322 204-X**
	Stainless steel	DN 63 ISO-K/50 KF	40				**PF 322 205-X**
	Stainless steel	DN 100 ISO-K/40 KF	38.5				**PF 322 214-X**

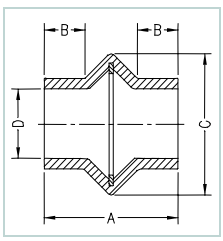
Sleeves/protective covers

Sleeve connections

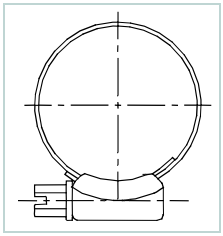
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Aluminium	DN 63 ISO-K	51	76			**PF 323 006**
	Aluminium	DN 100 ISO-K	56	108			**PF 323 010**
	Aluminium	DN 160 ISO-K	56	159			**PF 323 016**

Sleeves

Sleeves of CR (Neoprene).

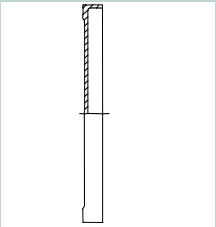
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Neoprene	76	65	20	115	78	**PF 324 006**
	Neoprene	108	75	16	160	105	**PF 324 010**
	Neoprene	159	75	16	218	156	**PF 324 016**

Hose clips

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Steel, zinc plated	76					**P 4163 117 B**
	Steel, zinc plated	108					**P 4163 121 B**
	Steel, zinc plated	159					**P 4163 125 B**

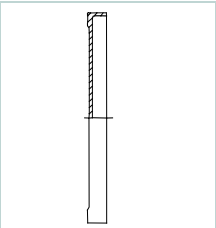
Protective covers

Protective covers of plastic ISO-K

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Plastic	DN 63 ISO-K					**PM 143 460**
	Plastic	DN 100 ISO-K					**PM 143 461**
	Plastic	DN 160 ISO-K					**PM 143 462**
	Plastic	DN 200 ISO-K					**PM 143 250**
	Plastic	DN 250 ISO-K					**PM 143 252**

Protective covers

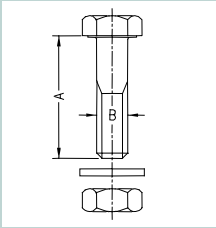
Protective covers of plastic ISO-F

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Plastic	DN 100 ISO-F					**PM 143 463**
	Plastic	DN 160 ISO-F					**PM 143 464**
	Plastic	DN 200 ISO-F					**PM 143 254**
	Plastic	DN 250 ISO-F					**PM 143 255**

Connection elements/sets of screws and bolts

Set of hexagonal bolts

Stainless steel bolts with washers and nuts.

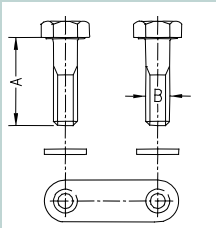


Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	20	M4	6		**PM 016 696-T**
	Stainless steel	DN 40 CF	35	M6	6		**PM 016 697-T**
	Stainless steel	DN 63 CF	45	M8	8		**PM 016 683-T**
	Stainless steel	DN 100 CF	50	M8	16		**PM 016 690-T**
	Stainless steel	DN 200 CF	60	M8	24		**PM 016 687-T**
	Stainless steel	DN 250 CF	60	M8	32		**PM 016 694-T**
	Stainless steel	DN 160 CF	55	M8	20		**PM 016 691-T**

C = quantity delivered

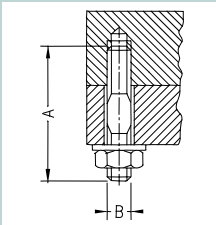
Set of hexagon bolts with duo nuts

Set of 6 stainless steel bolts and 3 duo nuts.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	20	M4			**PF 506 000-T**
	Stainless steel	DN 40 CF	35	M6			**PF 506 001-T**

Set of stud screws



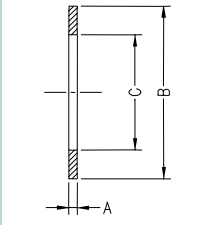
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	25	M4	6		**PM 016 698-T**
	Stainless steel	DN 40 CF	35	M6	6		**PM 016 699-T**
	Stainless steel	DN 63 CF	39	M8	8		**PM 016 684-T**
	Stainless steel	DN 100 CF	39	M8	16		**PM 016 692-T**
	Stainless steel	DN 160 CF	44	M8	20		**PM 016 693-T**
	Stainless steel	DN 200 CF	47	M8	24		**PM 016 688-T**
	Stainless steel	DN 250 CF	47	M8	32		**PM 016 695-T**

C = quantity delivered

Seals

Copper seal, 10 count (DN 250, 5 count)

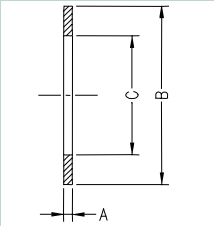
Copper seals of OFHC copper, temperature range -196 °C to 200 °C.



Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	OFHC copper	DN 16 CF	2	21.3	16		**PF 501 401-T**
	OFHC copper	DN 40 CF	2	48.2	37		**PF 501 404-T**
	OFHC copper	DN 63 CF	2	82.4	63.4		**PF 501 406-T**
	OFHC copper	DN 100 CF	2	120.5	101.5		**PF 501 410-T**
	OFHC copper	DN 160 CF	2	171.2	152.6		**PF 501 416-T**
	OFHC copper	DN 200 CF	2	222.1	203		**PF 501 420-T**
	OFHC copper	DN 250 CF	2	272.8	254		**PF 501 425-T**

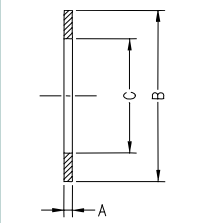
Copper seal silver-plated, 10 count (DN 250, 5 count)

Temperature range: -270 °C to 450 °C.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	OFHC copper, silver plated	DN 16 CF	2	21.3	16		**PF 501 501-T**
	OFHC copper, silver plated	DN 40 CF	2	48.2	37		**PF 501 504-T**
	OFHC copper, silver plated	DN 63 CF	2	82.4	63.4		**PF 501 506-T**
	OFHC copper, silver plated	DN 100 CF	2	120.5	101.5		**PF 501 510-T**
	OFHC copper, silver plated	DN 160 CF	2	171.2	152.6		**PF 501 516-T**
	OFHC copper, silver plated	DN 200 CF	2	222.1	203		**PF 501 520-T**
	OFHC copper, silver plated	DN 250 CF	2	272.8	254		**PF 501 525-T**

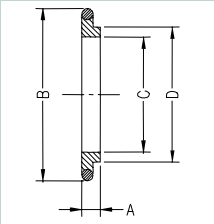
FPM seals, 5 count

Reusable CF seals, temperature range: -15 °C to 150 °C.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM	DN 16 CF	2	21.3	16.1		**PF 501 301-T**
	FPM	DN 40 CF	3.2	48.1	41.6		**PF 501 304-T**

FPM seals with support ring, 1 count

FPM o-ring with aluminum support ring, temperature range: -15 °C to 150 °C.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	FPM/aluminium	DN 63 CF	5	74	58	63.3	**PF 501 306-T**
	FPM/aluminium	DN 100 CF	5	113	95	100.3	**PF 501 310-T**
	FPM/aluminium	DN 160 CF	5	163	145	150.5	**PF 501 316-T**
	FPM/aluminium	DN 200 CF	5	213	195	200.3	**PF 501 320-T**
	FPM/aluminium	DN 250 CF	5	266	248.3	256.2	**PF 501 325-T**

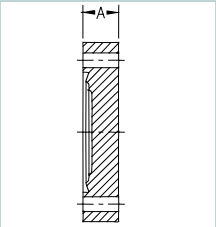
Release tool

Release tool for disassembling frozen copper seals.

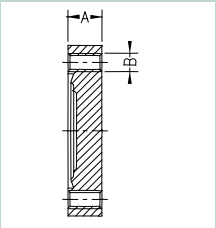
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
		DN 16-250 CF					**PF 420 187**

Flanges

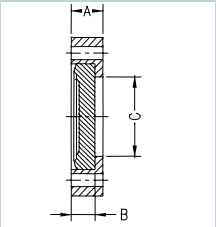
Blank flanges

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-F	7.8				**PF 510 201**
	Stainless steel	DN 40 CF-F	13				**PF 510 204**
	Stainless steel	DN 63 CF-F	17.5				**PF 510 206**
	Stainless steel	DN 100 CF-F	20				**PF 510 210**
	Stainless steel	DN 160 CF-F	22				**PF 510 216**
	Stainless steel	DN 200 CF-F	24.5				**PF 510 220**
	Stainless steel	DN 250 CF-F	26				**PF 510 225**

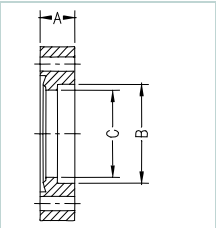
Blank flanges with tapped holes

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 40 CF-F	13	6 x M6			**PF 511 204**
	Stainless steel	DN 63 CF-F	17.5	8 x M8			**PF 511 206**

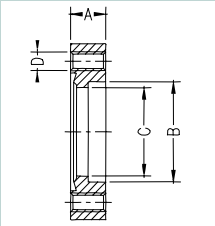
Blank flanges, rotatable

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-R	7.8	5.8	18.6		**PF 512 201-U**
	Stainless steel	DN 40 CF-R	13	7.6	39		**PF 512 204-U**
	Stainless steel	DN 63 CF-R	19	12.6	71		**PF 512 206-U**
	Stainless steel	DN 100 CF-R	21.5	14.3	109		**PF 512 210-U**
	Stainless steel	DN 160 CF-R	22	15.8	160		**PF 512 216-U**
	Stainless steel	DN 200 CF-R	24.5	17.1	206.5		**PF 512 220-U**
	Stainless steel	DN 250 CF-R	26	18	257		**PF 512 225-U**

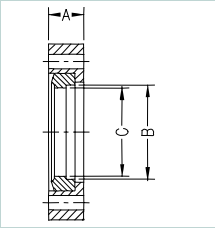
Welding flanges

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-F	7.8	18.2	17		**PF 513 201**
	Stainless steel 304 L	DN 40 CF-F	13	38.2	35		**PF 513 203**
	Stainless steel 304 L	DN 40 CF-F	13	40.2	37		**PF 513 204**
	Stainless steel 304 L	DN 63 CF-F	17.5	70.3	66		**PF 513 206**
	Stainless steel 304 L	DN 100 CF-F	20	108.4	104		**PF 513 210**
	Stainless steel 304 L	DN 160 CF-F	22	159.3	155		**PF 513 216**
	Stainless steel 304 L	DN 200 CF-F	24.5	205.3	201		**PF 513 220**
	Stainless steel 304 L	DN 250 CF-F	26	256.3	250		**PF 513 225**

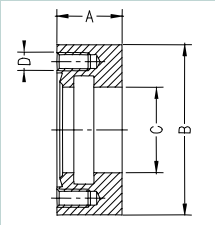
Welding flanges with tapped holes

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-F	7.8	18.2	17	6 x M4	**PF 514 201**
	Stainless steel 304 L	DN 40 CF-F	13	38.2	35	6 x M6	**PF 514 203**
	Stainless steel 304 L	DN 40 CF-F	13	40.2	37	6 x M6	**PF 514 204**
	Stainless steel 304 L	DN 63 CF-F	17.5	70.3	66	8 x M8	**PF 514 206**
	Stainless steel 304 L	DN 100 CF-F	20	108.4	104	16 x M8	**PF 514 210**
	Stainless steel 304 L	DN 160 CF-F	22	159.3	155	20 x M8	**PF 514 216**
	Stainless steel 304 L	DN 200 CF-F	24.5	205.3	201	24 x M8	**PF 514 220**
	Stainless steel 304 L	DN 250 CF-F	26	256.3	250	32 x M8	**PF 514 225**

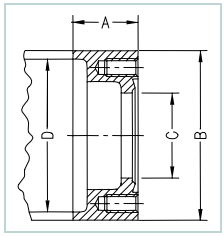
Welding flanges, rotatable

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-R	7.8	18.2	17		**PF 515 201-U**
	Stainless steel 304 L	DN 40 CF-R	13	38.2	35		**PF 515 203-U**
	Stainless steel 304 L	DN 40 CF-R	13	40.2	37		**PF 515 204-U**
	Stainless steel 304 L	DN 63 CF-R	17.5	70.3	66		**PF 515 206-U**
	Stainless steel 304 L	DN 100 CF-R	20	108.4	104		**PF 515 210-U**
	Stainless steel 304 L	DN 160 CF-R	22	159.3	155		**PF 515 216-U**
	Stainless steel 304 L	DN 200 CF-R	24.5	205.3	201		**PF 515 220-U**
	Stainless steel 304 L	DN 250 CF-R	26	256.3	250		**PF 515 225-U**

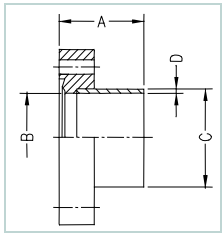
Welding flanges, outside

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-F	16	34	16	6 x M4	**PF 516 201**
	Stainless steel 304 L	DN 40 CF-F	24	69.5	37	6 x M6	**PF 516 204**
	Stainless steel 304 L	DN 63 CF-F	24	113.5	63	8 x M8	**PF 516 206**
	Stainless steel 304 L	DN 100 CF-F	24	152	100	16 x M8	**PF 516 210**

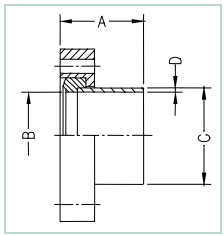
Welding flange for gauge head

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 40 CF-F	24	69.5	38	66	**PF 516 203**

Flanges with pipe socket

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-F	12	16	18.2	1.1	**PF 517 201-X**
	Stainless steel 304 L	DN 16 CF-F	38	16	18	1	**PF 517 202-X**
	Stainless steel 304 L	DN 40 CF-F	38	37	40	1.5	**PF 517 211-X**
	Stainless steel 304 L	DN 40 CF-F	63	37	40	1.5	**PF 517 212-X**
	Stainless steel 304 L	DN 63 CF-F	105	63	70	2	**PF 517 221-X**
	Stainless steel 304 L	DN 100 CF-F	135	100	108	2	**PF 517 231-X**
	Stainless steel 304 L	DN 160 CF-F	167	150	159	2	**PF 517 241-X**

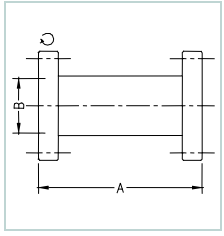
Flanges with pipe socket, rotatable

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel 304 L	DN 16 CF-R	12	16	18.2	1.1	**PF 518 201-U**
	Stainless steel 304 L	DN 16 CF-R	38	16	18	1	**PF 518 202-U**
	Stainless steel 304 L	DN 40 CF-R	38	37	40	1.5	**PF 518 211-U**
	Stainless steel 304 L	DN 63 CF-R	105	63	70	2	**PF 518 221-U**

Piping components

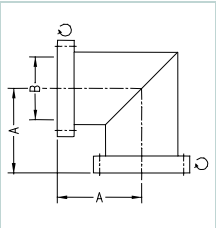
Intermediate pieces

DN 16 and 40 CF: One flange rotatable. DN 63, 100 und 160 CF: Fixed flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	76	16			**PF 520 201-X**
	Stainless steel	DN 40 CF	126	37			**PF 520 204-X**
	Stainless steel	DN 63 CF-F	210	66			**PF 520 206-X**
	Stainless steel	DN 100 CF-F	270	102			**PF 520 210-X**
	Stainless steel	DN 160 CF-F	334	148.5			**PF 520 216-X**

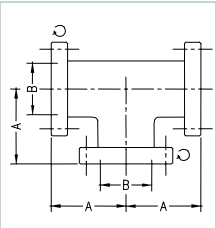
90° elbows

DN 16 and 40 CF: Two flanges rotatable. DN 63, 100 and 160 CF: Fixed flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-R	38	16.6			**PF 521 201-X**
	Stainless steel	DN 40 CF-R	63	35			**PF 521 204-X**
	Stainless steel	DN 63 CF-F	105	63			**PF 521 206-X**
	Stainless steel	DN 100 CF-F	135	100			**PF 521 210-X**
	Stainless steel	DN 160 CF-F	167	148.5			**PF 521 216-X**

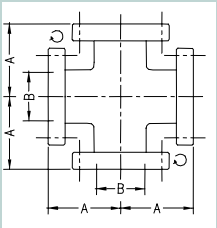
T-pieces

DN 16 and 40 CF: Two flanges, rotatable. DN 63, 100 and 160 CF: Fixed flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	38	16.6			**PF 522 201-X**
	Stainless steel	DN 40 CF	63	38			**PF 522 204-X**
	Stainless steel	DN 63 CF-F	105	66			**PF 522 206-X**
	Stainless steel	DN 100 CF-F	135	102			**PF 522 210-X**
	Stainless steel	DN 160 CF-F	167	148.5			**PF 522 216-X**

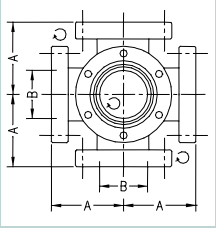
Crosspieces

DN 16 and 40 CF: Two flanges, rotatable. DN 63, 100 and 160 CF: Fixed flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	38	16.6			**PF 524 201-X**
	Stainless steel	DN 40 CF	63	38			**PF 524 204-X**
	Stainless steel	DN 63 CF-F	105	66			**PF 524 206-X**
	Stainless steel	DN 100 CF-F	135	102			**PF 524 210-X**
	Stainless steel	DN 160 CF-F	167	148.5			**PF 524 216-X**

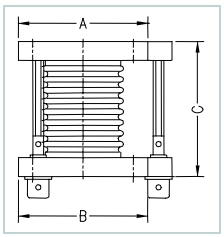
Double crosspieces

DN 16 and 40 CF: Three flanges, rotatable. DN 63, 100 and 160 CF: Fixed flanges.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF	38	16.6			**PF 526 201-X**
	Stainless steel	DN 40 CF	63	38			**PF 526 204-X**
	Stainless steel	DN 63 CF-F	105	66			**PF 526 206-X**
	Stainless steel	DN 100 CF-F	135	102			**PF 526 210-X**
	Stainless steel	DN 160 CF-F	167	148.5			**PF 526 216-X**

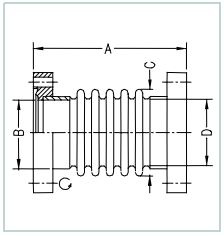
Bellows and adjusting pieces

Adjusting pieces

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 40 CF-F	70	70	80		**PF 528 204-X**
	Stainless steel	DN 63 CF-F	114	114	80		**PF 528 206-X**

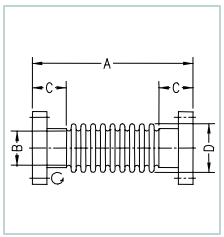
Bellows with flanges

Bellows to compensate for axial movement and to dampen vibrations.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-R	110	15	24	16	**PF 541 200-X**
	Stainless steel	DN 40 CF-R	160	41	58	39	**PF 541 210-X**
	Stainless steel	DN 63 CF-R	250	70	90	70	**PF 541 220-X**
	Stainless steel	DN 100 CF-R	250	102	127	102	**PF 541 230-X**
	Stainless steel	DN 160 CF-R	270	153	190	158	**PF 541 240-X**

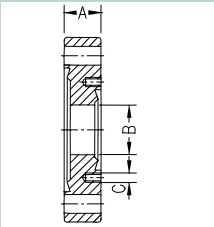
Metallic hoses

Metallic hoses for flexible connections.

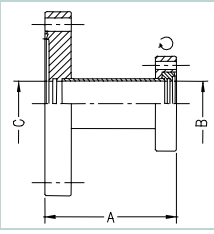
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-R	250	12	20	19.5	**PF 530 025-X**
	Stainless steel	DN 16 CF-R	500	12	20	19.5	**PF 530 050-X**
	Stainless steel	DN 16 CF-R	750	12	20	19.5	**PF 530 075-X**
	Stainless steel	DN 16 CF-R	1000	12	20	19.5	**PF 530 010-X**
	Stainless steel	DN 40 CF-R	250	37	50	52.5	**PF 530 125-X**
	Stainless steel	DN 40 CF-R	500	37	50	52.5	**PF 530 150-X**
	Stainless steel	DN 40 CF-R	750	37	50	52.5	**PF 530 175-X**
	Stainless steel	DN 40 CF-R	1000	37	50	52.5	**PF 530 110-X**

Reducing pieces and adapters

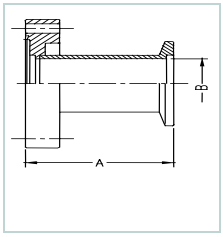
Reducing flanges CF-F/CF-F

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 40 CF-F/ DN 16 CF-F	13	16	6 x M4		**PF 543 210**
	Stainless steel	DN 63 CF-F/ DN 40 CF-F	24	37	6 x M6		**PF 543 221**
	Stainless steel	DN 100 CF-F/ DN 40 CF-F	24	37	6 x M6		**PF 543 231**
	Stainless steel	DN 100 CF-F/ DN 63 CF-F	24	63	8 x M8		**PF 543 232**
	Stainless steel	DN 160 CF-F/ DN 40 CF-F	24	37	6 x M6		**PF 543 241**
	Stainless steel	DN 160 CF-F/ DN 40 CF-F	24	63	8 x M8		**PF 543 242**
	Stainless steel	DN 160 CF-F/ DN 100 CF-F	24	100	16 x M8		**PF 543 243**
	Stainless steel	DN 200 CF-F/ DN 40 CF-F	24	37	6 x M6		**PF 543 251**
	Stainless steel	DN 200 CF-F/ DN 63 CF-F	24	63	8 x M8		**PF 543 252**
	Stainless steel	DN 200 CF-F/ DN 100 CF-F	24	100	16 x M8		**PF 543 253**
	Stainless steel	DN 200 CF-F/ DN 160 CF-F	24	150	20 x M8		**PF 543 254**

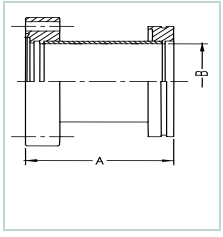
Reducing pieces CF-F/CF-R

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 40 CF-F/ DN 16 CF-R	45	16	16		**PF 544 210-X**
	Stainless steel	DN 63 CF-F/ DN 40 CF-R	75	37	37		**PF 544 221-X**
	Stainless steel	DN 100 CF-F/ DN 63 CF-R	95	63	66		**PF 544 232-X**
	Stainless steel	DN 160 CF-F/ DN 100 CF-R	105	100	104		**PF 544 243-X**

Adapters CF-F/ISO-KF

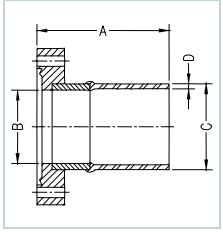
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF-F/ DN 16 ISO-KF	36	16			**PF 545 202-X**
	Stainless steel	DN 16 CF-F/ DN 25 ISO-KF	36	16			**PF 545 203-X**
	Stainless steel	DN 16 ISO-KF/ DN 40 CF-F	36	16			**PF 545 212-X**
	Stainless steel	DN 40 CF-F/ DN 25 ISO-KF	36	24			**PF 545 213-X**
	Stainless steel	DN 40 CF-F/ DN 40 ISO-KF	50	37			**PF 545 214-X**
	Stainless steel	DN 63 CF-F/ DN 40 ISO-KF	50	41			**PF 545 224-X**
	Stainless steel	DN 100 CF-F/ DN 40 ISO-KF	50	41			**PF 545 234-X**

Adapters, CF-F/ISO-K

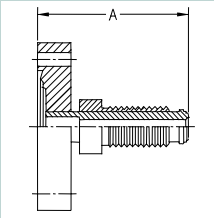
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 63 CF-F/ DN 63 ISO-K	90	63			**PF 546 220-X**
	Stainless steel	DN 100 CF-F/ DN 100 ISO-K	90	100			**PF 546 231-X**
	Stainless steel	DN 160 CF-F/ DN 160 ISO-K	90	150			**PF 546 242-X**

Glass/metal connection with flange

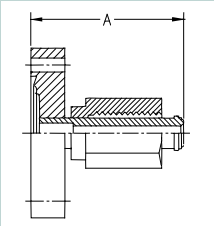
Glass tube of Pyrex.

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Flange: Stainless steel; glas tube: Pyrex	DN 16 CF-F	91	8	12	1.75	**PF 547 201-X**
	Flange: Stainless steel; glass tube: Pyrex	DN 16 CF-F	94	16	20	2	**PF 547 202-X**

Adapters CF/VCR®, male

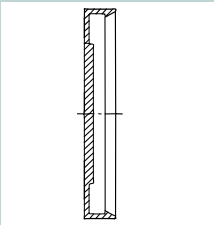
Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF/VCR 1/4"	36				**PF 548 402-X**
	Stainless steel	DN 40 CF/VCR 3/4"	53				**PF 548 414-X**

Adapters, CF/VCR®, female

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Stainless steel	DN 16 CF/VCR 1/4"	36				**PF 550 402-X**
	Stainless steel	DN 40 CF/VCR 3/4"	53				**PF 550 414-X**

Protective covers

Protective covers

Dimensions	Material	Nominal diameter	A	B	C	D	Order number
	Plastic	DN 16 CF					**PF 549 301**
	Plastic	DN 40 CF					**PF 549 304**
	Plastic	DN 63 CF					**PM 143 465**
	Plastic	DN 100 CF					**PM 143 466**
	Plastic	DN 160 CF					**PM 143 467**
	Plastic	DN 200 CF					**PM 143 256**
	Plastic	DN 250 CF					**PM 143 257**

Notes

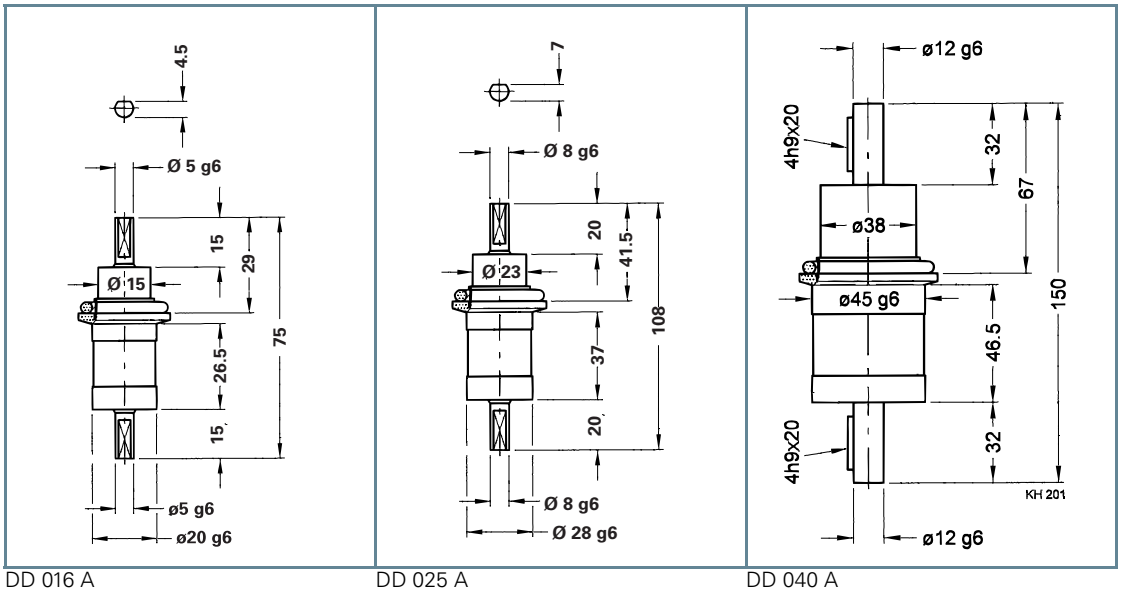
Rotary feed-throughs

ISO-KF

Rotary feedthroughs

- For transmitting high torques
- With FPM shaft seal and ball bearing
- Rotary speed can be increased by up to a factor of two if reduced service life is acceptable

Dimensions



DD 016 A | DD 025 A | DD 040 A

Technical data	DD 016 A	DD 025 A	DD 040 A
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature	110 °C	110 °C	110 °C
Operating temperature	50 °C	50 °C	50 °C
Tightness (static)	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Rotation speed	1500 rpm	1000 rpm	750 rpm
Pressure max.	1 bar	1 bar	1 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	FPM	FPM	FPM
Weight	0.1 kg	0.2 kg	0.6 kg
Service life (revolutions)	20000000	20 000 000	20 000 000
Transferable torque	1.5 Nm	6 Nm	25 Nm
Shaft connection	ø 5 x 14 mm	ø 8 x 20 mm	ø 12 x 30 mm
Shaft load, axial	30 N	50 N	60 N
Shaft load, radial	60 N	150 N	250 N
Material	Stainless steel , aluminium, FPM	Stainless steel , aluminium, FPM	Stainless steel , aluminium, FPM

Order number			
Rotary feedthroughs	**PF 222 010-T**	**PF 223 010-T**	**PF 224 010-T**

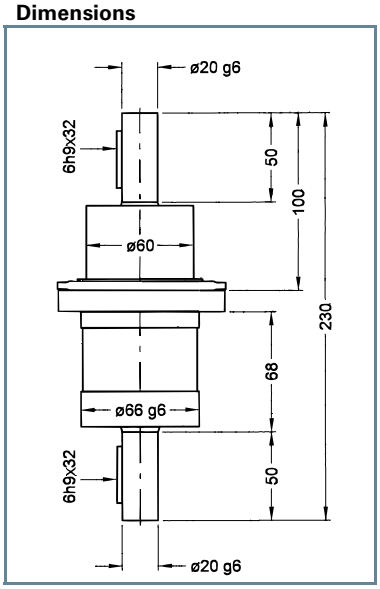
Rotary feed-throughs

ISO-K

Rotary feedthroughs

- For transmitting high torques
- With FPM shaft seal and ball bearing
- Rotary speed can be increased by up to a factor of two if reduced service life is acceptable
- DN 63 ISO-K

Dimensions



DD 063 A

Technical data	DD 063 A
Flange (in)	DN 63 ISO-K
Bakeout temperature	110 °C
Operating temperature	50 °C
Tightness (static)	$1 \cdot 10^{-9}$ mbar l/s
Rotation speed	500 rpm
Pressure max.	1 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Feedthrough	FPM
Weight	2 kg
Service life (revolutions)	10000000
Transferable torque	100 Nm
Shaft connection	ø 20 x 50 mm
Shaft load, axial	100 N
Shaft load, radial	500 N
Material	Stainless steel , aluminium, FPM

Order number	
Rotary feedthroughs	**PF 420 010-T**

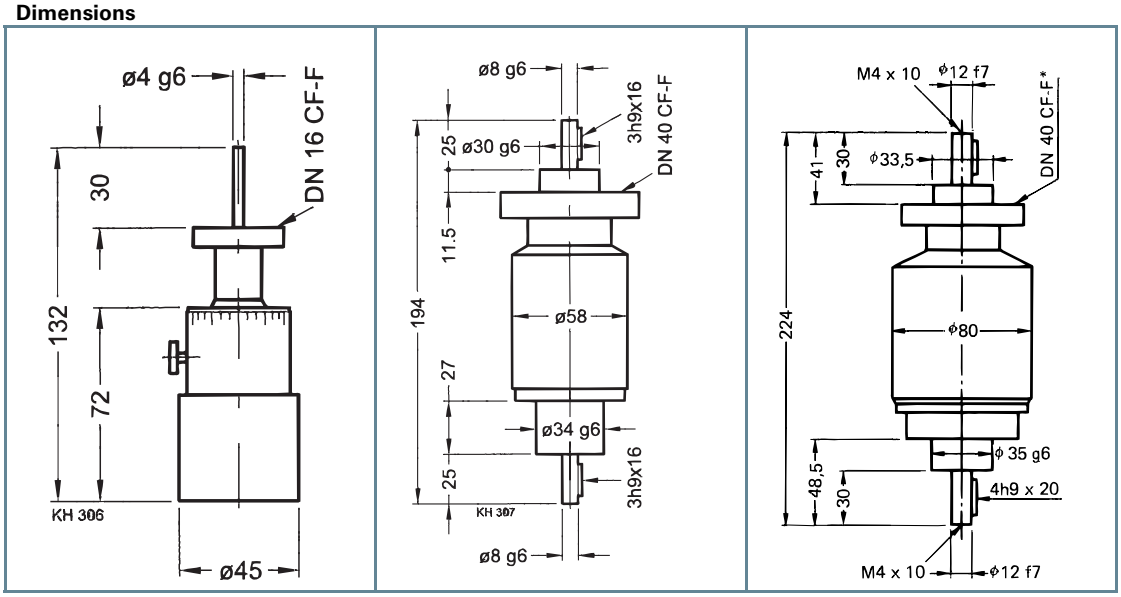
Rotary feed-throughs

CF

Rotary feedthroughs

- ▶ Bellows-sealed, all-metal design
- ▶ For the highest vacuum requirements
- ▶ Rotary knob enables arresting in any position
- ▶ Dynamic torque of only up to 0.2 Nm at operating temperature of 300 °C

Dimensions



UD 016 | UD 140 | UDD 235

Technical data	UD 016	UD 140	UDD 235
Flange (in)	DN 16 CF-F	DN 40 CF-F	DN 40 CF-F
Bakeout temperature	300 °C	300 °C	300 °C
Operating temperature	300 °C	300 °C	300 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Rotation speed	200 rpm	1000 rpm	500 rpm
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar
Feedthrough	Bellows	Bellows	Bellows
Weight	0.3 kg	1.5 kg	3 kg
Materials in contact with media	Stainless steel	Stainless steel	Stainless steel
Scale division: rotary knob	10 °	-	-
Service life (revolutions)	1000000	2 000 000	1 000 000
Transferable torque dynamic	0.4 Nm	4 Nm	10 Nm
Transferable torque static	0.2 Nm	3 Nm	5 Nm
Shaft connection	ø 4 mm	ø 8 mm	ø 12 mm
Shaft load, axial	5 N	20 N	30 N
Shaft load, radial	10 N	60 N	100 N

Order number			
Rotary feedthroughs	**PF 620 010-T**	**PF 621 010-T**	**PF 621 012-T**

Linear feed-throughs

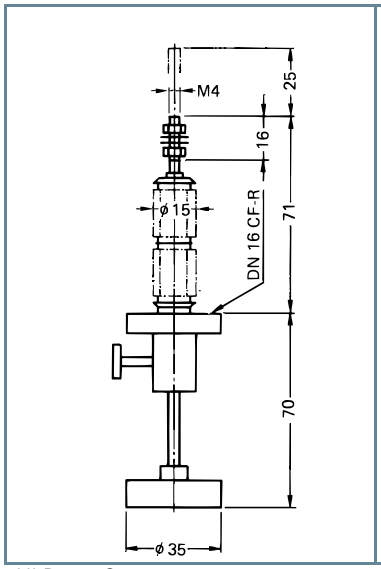
CF

Linear feedthroughs

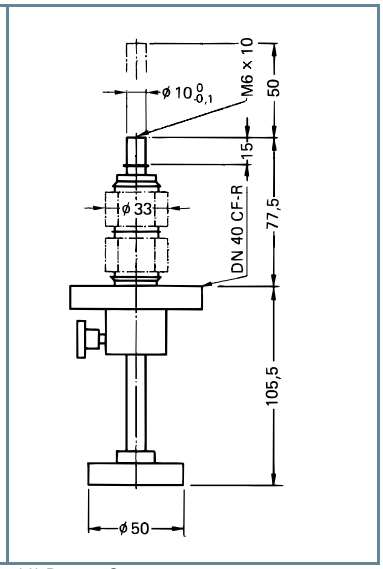
- With bellows for the highest vacuum requirements
- Direct manual push/pull actuation
- With setscrew

DP = With micrometer screw for high setting accuracy
S = Direct push/pull actuation

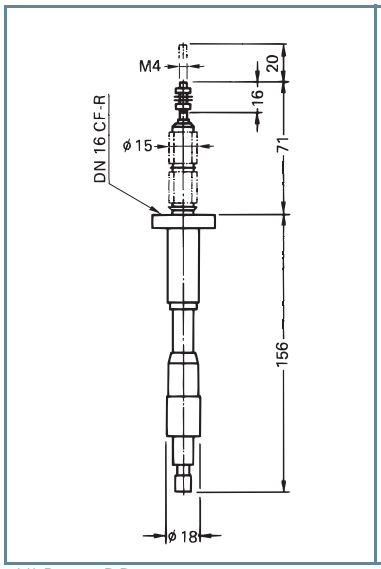
Dimensions



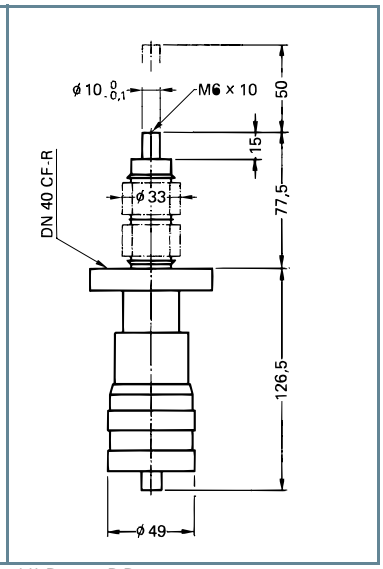
ULD 016 S



ULD 135 S



ULD 016 DP



ULD 135 DP

Technical data	ULD 016 S	ULD 135 S
Flange (in)	DN 16 CF-R	DN 40 CF-R
Actuator	Manually	Manually
Bakeout temperature	300 °C	300 °C
Load capacity radial: at max. displacement	20 N	100 N
Load capacity: torsion	0.2 Nm	0.5 Nm
Operating temperature	300 °C	300 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar
Feedthrough	Bellows	Bellows
Weight	0.2 kg	0.8 kg
Stroke	25 mm	50 mm
Scale division	5 mm	10 mm
Shaft connection	M4 x 16 mm	M6 x 10 mm / ø 10 x 15 mm
Shaft load, axial: to atmosphere	100 N	200 N
Shaft load, axial: to vacuum	85 N	140 N
Material	Stainless steel	Stainless steel

Order number		
Linear feedthroughs	**PF 630 010-T**	**PF 631 010-T**

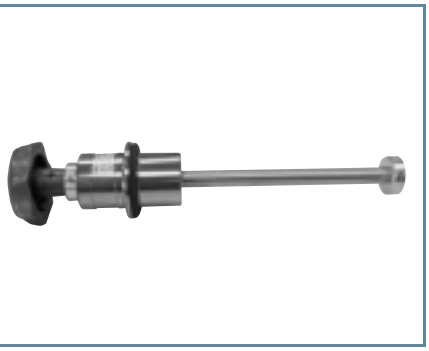
Technical data	ULD 016 DP	ULD 135 DP
Flange (in)	DN 16 CF-R	DN 40 CF-R
Actuator	Micrometer	Micrometer
Bakeout temperature: feedthrough	300 °C	300 °C
Bakeout temperature: micrometer screw/piston	100 °C	100 °C
Axial load capacity: to the inside/to the outside	185/200 N	
Load capacity radial: at max. displacement	20 N	100 N
Load capacity: torsion	0.2 Nm	0.5 Nm
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar
Feedthrough	Bellows	Bellows
Weight	0.25 kg	1 kg
Stroke	20 mm	50 mm
Stroke per revolution	0.5 mm	1 mm
Scale division	0.01 mm	0.005 mm
Shaft connection	M4 x 16mm	M6 x 10 mm / ø 10 x 15 mm
Shaft load, axial: to atmosphere	200 N	500 N
Shaft load, axial: to vacuum	185 N	440 N
Material	Stainless steel	Stainless steel

Order number		
Linear feedthroughs	**PF 630 012-T**	**PF 631 012-T**

Rotary/ linear motion feed- throughs

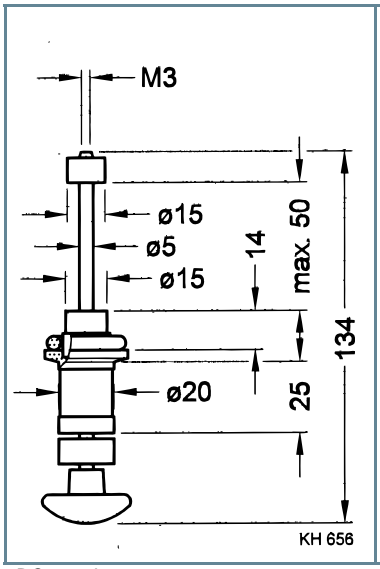
ISO-KF

Rotary/ linear motion feedthroughs

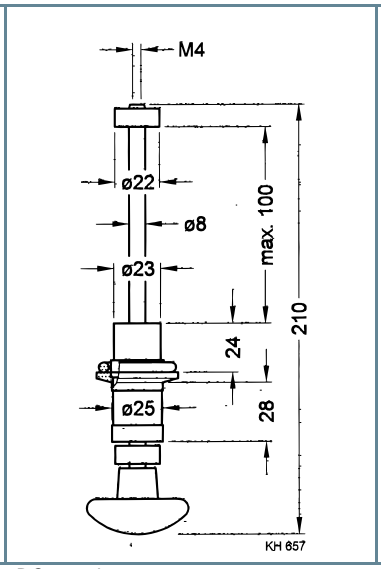


- ▶ Two FPM shaft seals
- ▶ Direct push/pull and rotary actuation
- ▶ With locking ring and optional locking piston

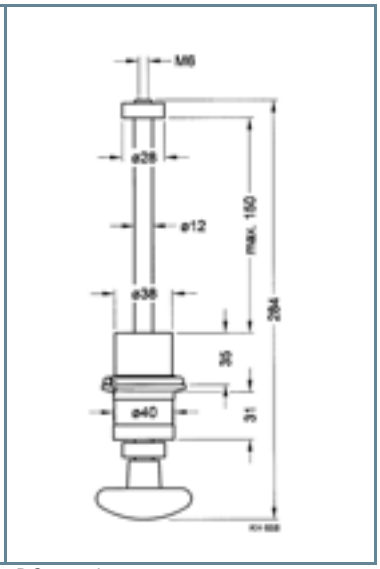
Dimensions



DS 016 A



DS 025 A



DS 040 A

Technical data	DS 016 A	DS 025 A	DS 040 A
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Actuator	Rotary knob	Rotary knob	Rotary knob
Bakeout temperature	110 °C	110 °C	110 °C
Load capacity radial: at max. displacement	10 N	15 N	30 N
Load capacity: torsion	2 Nm	8 Nm	20 Nm
Operating temperature	50 °C	50 °C	50 °C
Tightness (static)	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Pressure max.	1 bar	1 bar	1 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	FPM shaft seals	FPM shaft seals	FPM shaft seals
Weight	0.1 kg	0.2 kg	0.3 kg
Stroke	50 mm	100 mm	150 mm
Shaft connection	M3 x 6 / ø 5 mm	M4 x 8 / ø 8 mm	M6 x 10 / ø 12 mm
Material	Stainless steel, aluminium, FPM	Stainless steel, aluminium, FPM	Stainless steel, aluminium, FPM

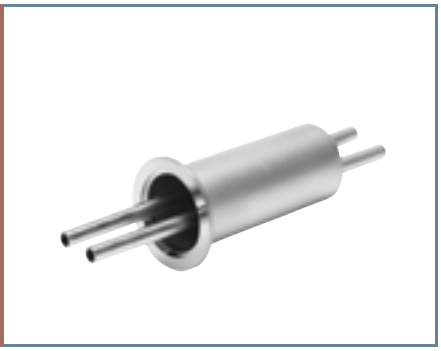
Order number			
Rotary/linear motion feedthroughs	**PF 242 010-T**	**PF 243 010-T**	**PF 244 011-T**

Accessories			
Locking piston	**PT 226 978-T**	**PT 226 979-T**	**PT 226 980-T**

Liquid feed-throughs

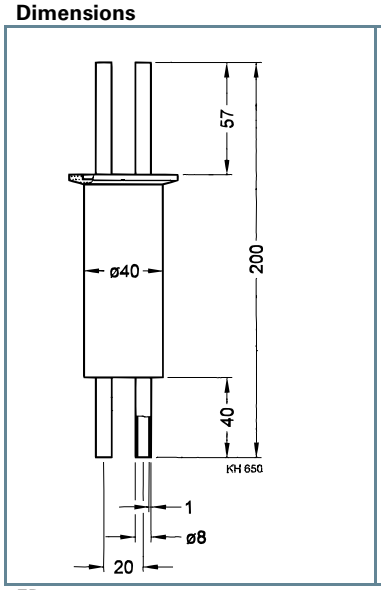
ISO-KF
CF

Liquid feedthroughs

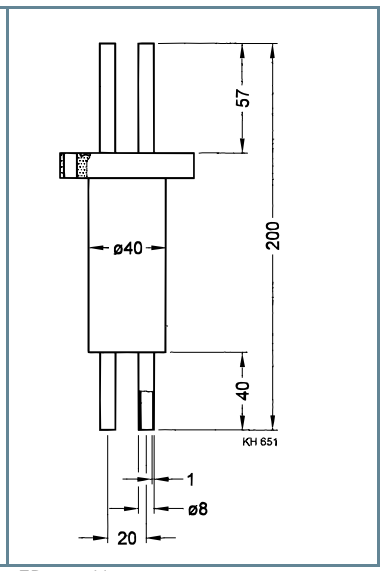


- Thermally insulated
- Also suitable for very hot and very cold media

Dimensions



FD 040



FD 040 U

Technical data	FD 040	FD 040 U
Connection	ø 8 x 1 mm	ø 8 x 1 mm
Flange (in)	DN 40 ISO-KF	DN 40 CF-F
Number of pipes	2 Stk	2 Stk
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2.5 bar	10 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-9}$ mbar
Feedthrough	Welded	Welded
Weight	0.3 kg	0.4 kg
Temperature range	-200 - +150 °C	-200 - +400 °C
Material	Stainless steel	Stainless steel

Order number		
Liquid feedthroughs	**PF 284 011-X**	**PF 681 011-X**

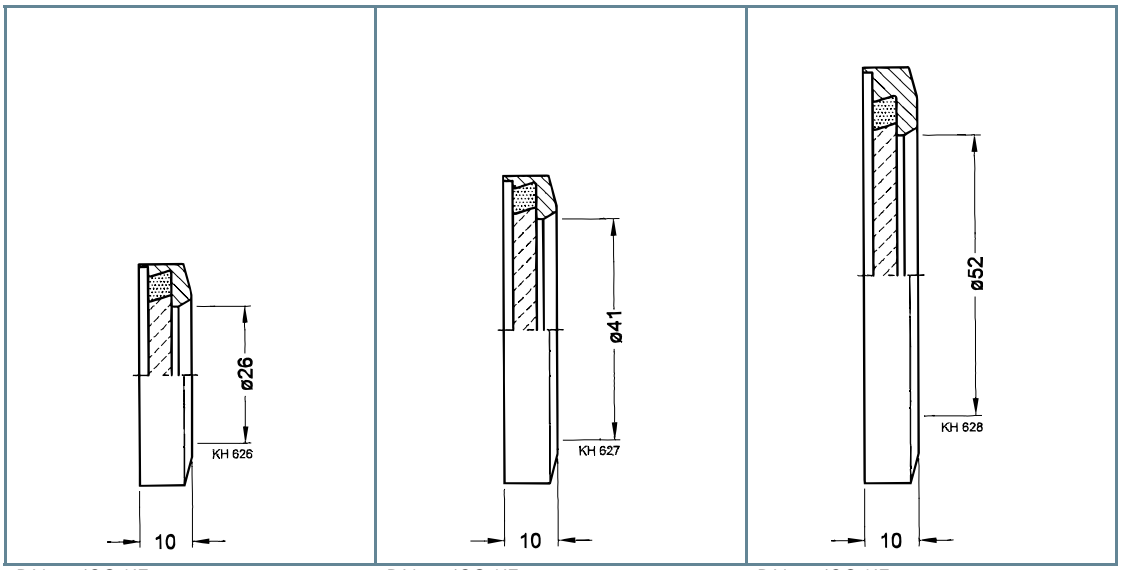
Sight glasses

ISO-KF

Sight glasses

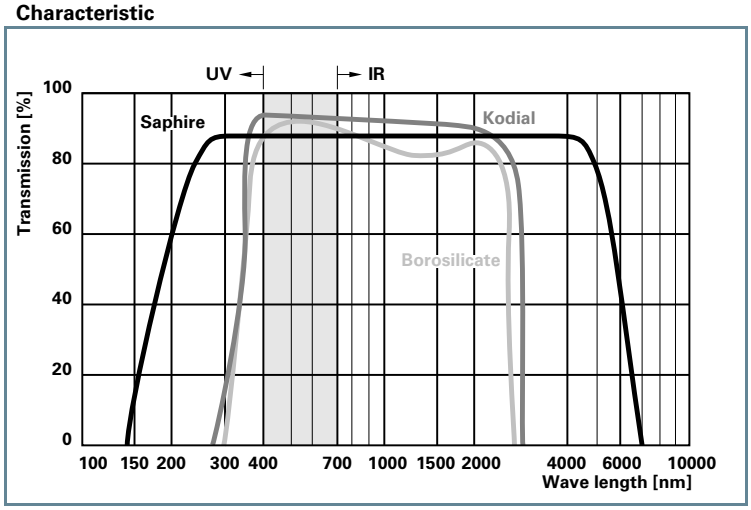
- For visually monitoring a process in a vacuum chamber
- Wide viewing angle
- Max. pressure: Only 3 bar at 150 °C

Dimensions



DN 25 ISO-KF | DN 40 ISO-KF | DN 50 ISO-KF

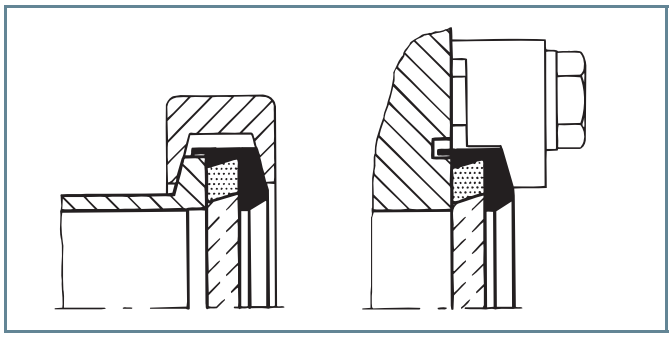
Characteristic



Technical data	DN 25 ISO-KF	DN 40 ISO-KF	DN 50 ISO-KF
Flange (in)	DN 25 ISO-KF	DN 40 ISO-KF	DN 50 ISO-KF
Bakeout temperature	150 °C	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	4 bar	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Flange	Aluminium	Aluminium	Aluminium
Weight	20 g	30 g	40 g
Glass thickness	3.8 mm	3.8 mm	3.8 mm
Sight glass	Borosilicate	Borosilicate	Borosilicate

Order number			
Sight glasses	**PF 213 011-T**	**PF 214 011-T**	**PF 215 011-T**

Mounting



Mounting onto a plane requires a groove:
Width 2,5 mm; depth 2,5 mm, ID 40 mm

Mounting onto a plane requires a groove:
Width 2,5 mm; depth 2,5 mm, ID 55 mm

Mounting onto a plane requires a groove:
Width 2,5 mm; depth 2,5 mm, ID 75 mm

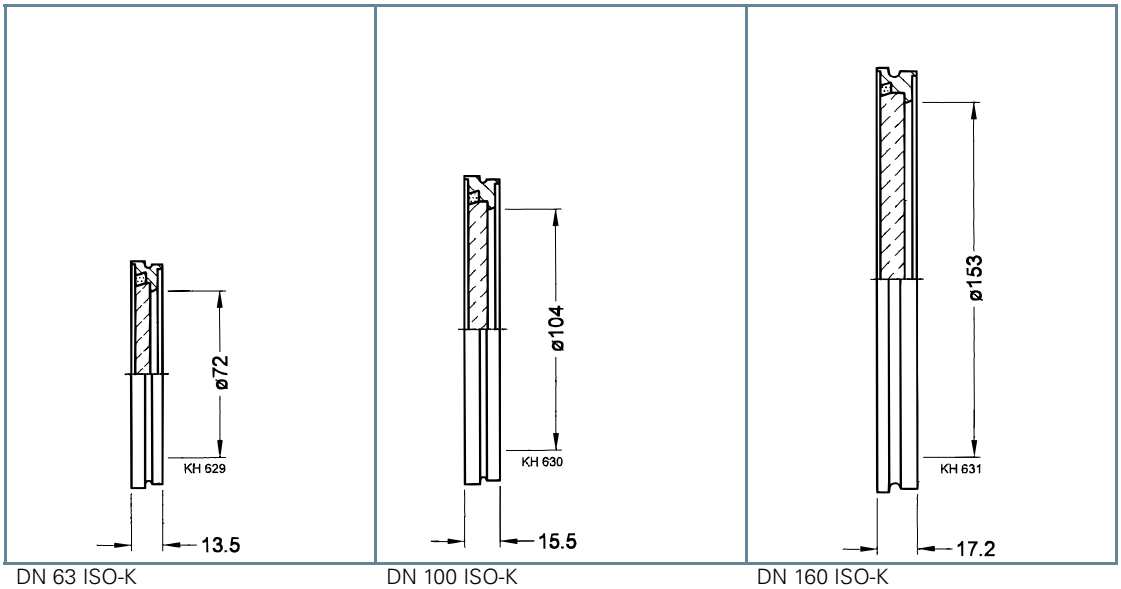
Sight glasses

ISO-K

Sight glasses

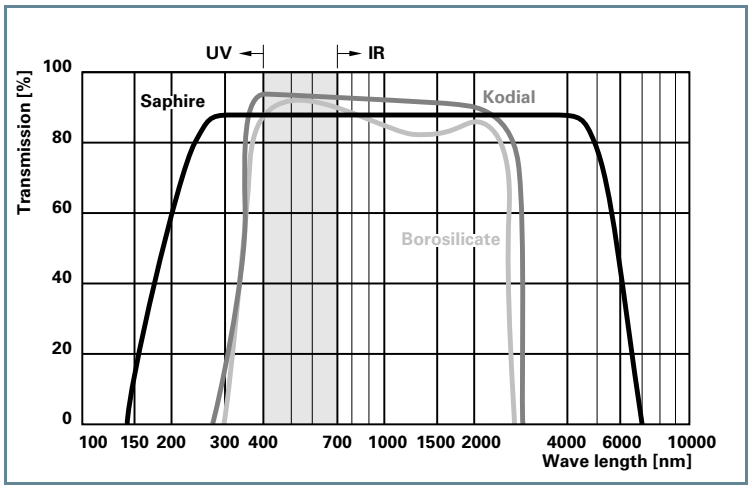
- For visually monitoring a process in a vacuum chamber
- Wide viewing angle
- Max. pressure: Only 1 bar at 150 °C

Dimensions



DN 63 ISO-K | DN 100 ISO-K | DN 160 ISO-K

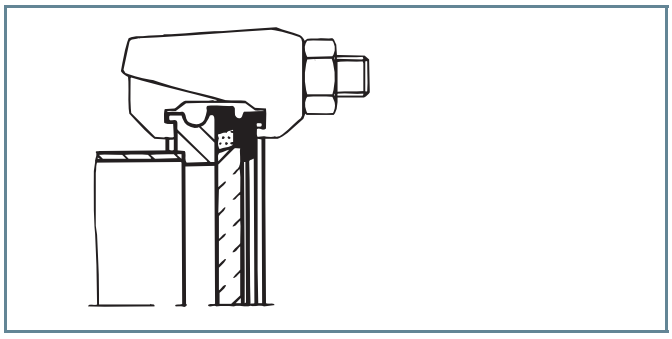
Characteristic



Technical data	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Flange (in)	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Bakeout temperature	150 °C	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Flange	Aluminium	Aluminium	Aluminium
Weight	0.2 kg	0.3 kg	0.4 kg
Glass thickness	6 mm	8 mm	10 mm
Sight glass	Borosilicate	Borosilicate	Borosilicate

Order number			
Sight glasses	**PF 410 011-T**	**PF 411 011-T**	**PF 412 011-T**

Mounting



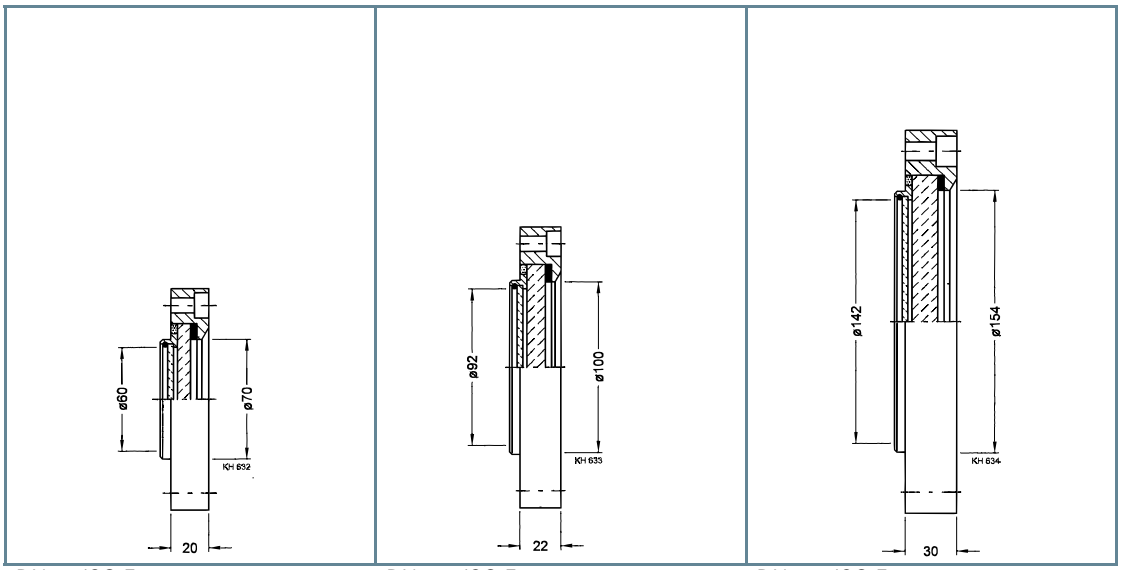
Sight glasses

ISO-F

Sight glasses

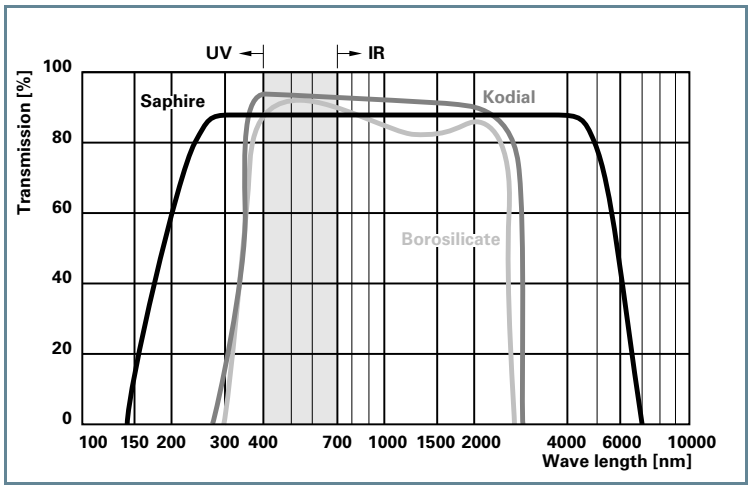
- For visually monitoring a process in a vacuum chamber
- Wide viewing angle
- Replaceable safety glass
- Max. pressure: Only 1 bar at 150 °C
- Including claws, bolts, washers and nuts for installation

Dimensions



DN 63 ISO-F | DN 100 ISO-F | DN 160 ISO-F

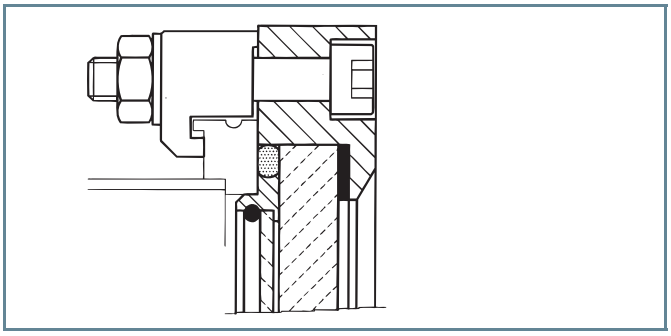
Characteristic



Technical data	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F
Flange (in)	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F
Bakeout temperature	150 °C	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Flange	Anodized aluminium, black	Anodized aluminium, black	Anodized aluminium, black
Weight	0.8 kg	1.4 kg	3 kg
Sight glass	Borosilicate	Borosilicate	Borosilicate
Window thickness	7.5 mm	11 mm	15 mm
Safety glass thickness	2.5 mm	2.5 mm	2.5 mm

Order number			
Sight glasses	**PF 410 013-T**	**PF 411 013-T**	**PF 412 013-T**

Mounting



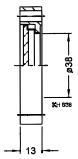
Sight glasses

CF

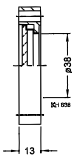
Sight glasses

- For visually monitoring a process in a vacuum chamber
- Wide viewing angle
- Max. pressure: Only 1 bar at 400 °C

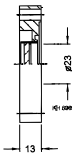
Dimensions



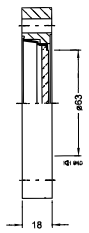
DN 16 CF-F



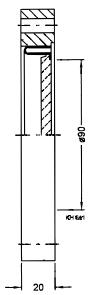
DN 40 CF-F



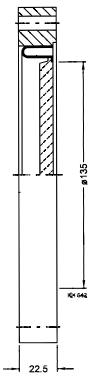
DN 40 CF-F



DN 63 CF-F

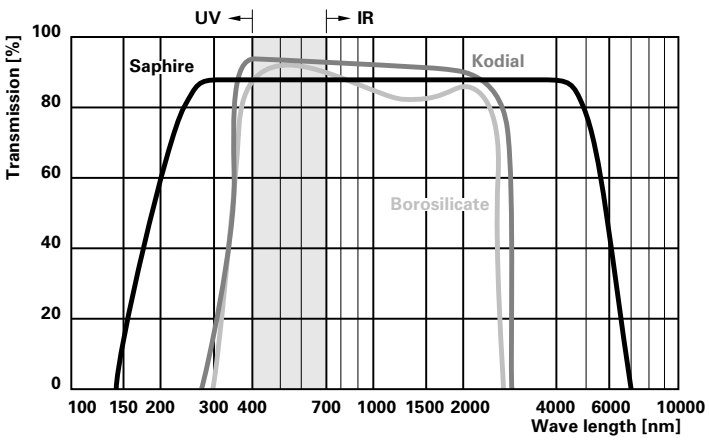


DN 100 CF-F



DN 160 CF-F

Characteristic



Technical data	DN 16 CF-F	DN 40 CF-F	DN 40 CF-F
Flange (in)	DN 16 CF-F	DN 40 CF-F	DN 40 CF-F
Bakeout temperature	400 °C	400 °C	400 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Seal	Metal	Metal	Metal
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Flange	Stainless steel	Stainless steel	Stainless steel
Weight	40 g	0.24 kg	0.35 kg
Sight glass	Kodial	Kodial	Sapphire
Window thickness	1.5 mm	3 mm	3 mm

Order number			
Sight glasses	**PF 610 010-X**	**PF 611 010-X**	**PF 611 012-X**

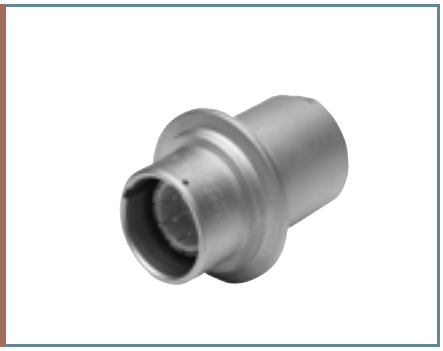
Technical data	DN 63 CF-F	DN 100 CF-F	DN 160 CF-F
Flange (in)	DN 63 CF-F	DN 100 CF-F	DN 160 CF-F
Bakeout temperature	400 °C	400 °C	400 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Seal	Metal	Metal	Metal
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Flange	Stainless steel	Stainless steel	Stainless steel
Weight	0.85 kg	1.4 kg	2.8 kg
Sight glass	Kodial	Kodial	Kodial
Window thickness	4 mm	6 mm	8 mm

Order number			
Sight glasses	**PF 612 010-X**	**PF 613 010-X**	**PF 614 010-X**

Electric feed-throughs

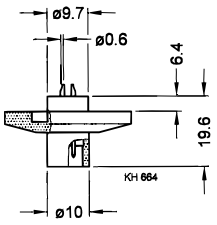
DN 16 ISO-KF

Electric feedthroughs

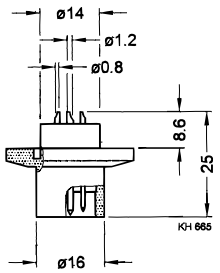


- ▶ Vacuum-side soldered connection
- ▶ DN 16 ISO-KF
- ▶ Max. pressure 10 bar with external centering ring

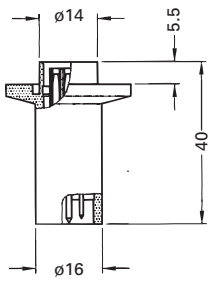
Dimensions



Feedthrough, 4-pole

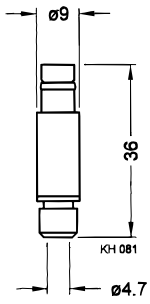


Feedthrough, 9-pole

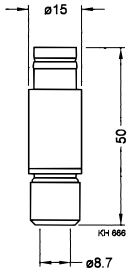


Feedthrough, 9-pole

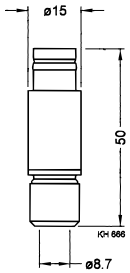
Outside connector



PF 297 010

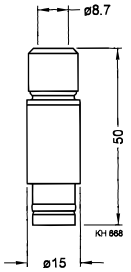


PF 297 013-T



PF 297 013-T

Inside connector



PF 297 015-T

Technical data	Feedthrough, 4-pole	Feedthrough, 9-pole	Feedthrough, 9-pole
Connection: Atmospheric side	Connector	Connector	Connector
Connection: Vacuum side	Solder connection	Solder connection	Connector
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF	DN 16 ISO-KF
Number of feedthroughs	4	9	9
Bakeout temperature	130 °C	130 °C	130 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2.5 bar	2.5 bar	2.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Connection wire diameter	0.6 mm	1.2 mm	1.2 mm
Housing	Nickel-plated steel	Nickel-plated steel	Nickel-plated steel
Isolator	PTFE/Araldit	PTFE/Araldit	PTFE/Araldit
Cable diameter for plug connectors	4.7 mm	8.7 mm	8.7 mm
Contact	Gold-plated bronze	Gold-plated bronze	Gold-plated bronze
Test voltage	500 V / 50 Hz	500 V / 50 Hz	500 V / 50 Hz
Voltage, per pole	50 V	50 V	50 V
Current, per pole	1 A	2 A	2 A

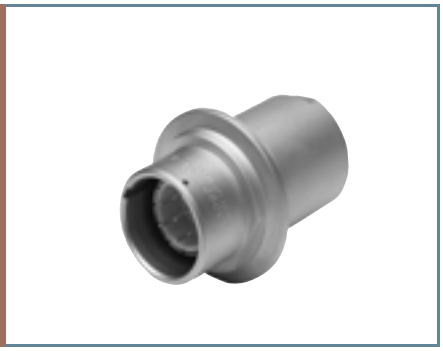
Order number			
Electric feedthroughs	**PF 272 011-X**	**PF 272 013-X**	**PF 272 015-X**

Accessories			
Outside connector	**PF 297 010**	**PF 297 013-T**	**PF 297 013-T**
Inside connector			**PF 297 015-T**

Electric feed-throughs

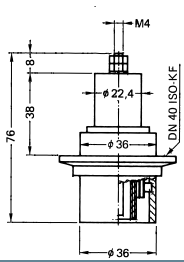
DN 40 ISO-KF

Electric feedthroughs

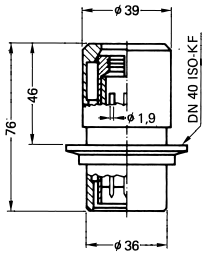


- Vacuum-side screw connection
- DN 40 ISO-KF
- Max. pressure 10 bar with external centering ring

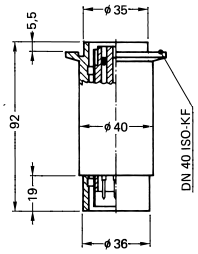
Dimensions



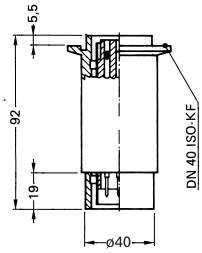
Feedthrough, 1-pole



Feedthrough, 7-pole

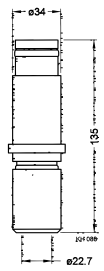


Feedthrough, 7-pole

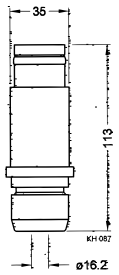


Feedthrough, 4-pole

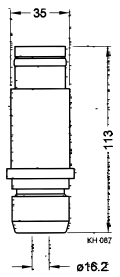
Outside connector



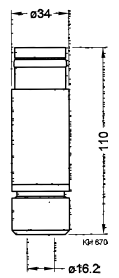
PF 295 010



PF 296 010

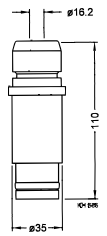


PF 296 010

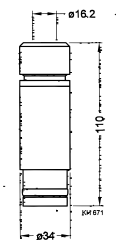


PF 296 022-T

Inside connector



PF 296 012



PF 296 024-T

Technical data	Feedthrough, 1-pole	Feedthrough, 7-pole	Feedthrough, 7-pole	Feedthrough, 4-pole
Connection: Atmospheric side	Connector	Connector	Connector	Connector
Connection: Vacuum side	Screw connection	Solder connection	Connector	Connector
Flange (in)	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF	DN 40 ISO-KF
Number of feedthroughs	1	7	7	4
Bakeout temperature	130 °C	130 °C	130 °C	130 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM	FPM
Pressure max.	2.5 bar	2.5 bar	2.5 bar	2.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Connection wire diameter	5 mm	1.8 mm	1.8 mm	2.5 mm
Housing	Chrome-plated steel	Chrome-plated steel	Chrome-plated steel	Chrome-plated steel
Isolator	PTFE/Araldit	PTFE/Araldit	PTFE/Araldit	PTFE/Araldit
Cable diameter for plug connectors	22.7 mm	16.2 mm	16.2 mm	16.2 mm
Contact	Nickel-plated brass	Gold-plated bronze	Gold-plated bronze	Gold-plated bronze
Test voltage	15 kV / 50 Hz	-	-	-
Voltage, per pole	6000 V	380 V	380 V	800 V
Current, per pole	25 A	16 A	16 A	16 A

Order number				
Electric feedthroughs	**PF 254 010**	**PF 264 010**	**PF 264 012**	**PF 264 016-X**

Accessories				
Outside connector	**PF 295 010**	**PF 296 010**	**PF 296 010**	**PF 296 022-T**
Inside connector			**PF 296 012**	**PF 296 024-T**

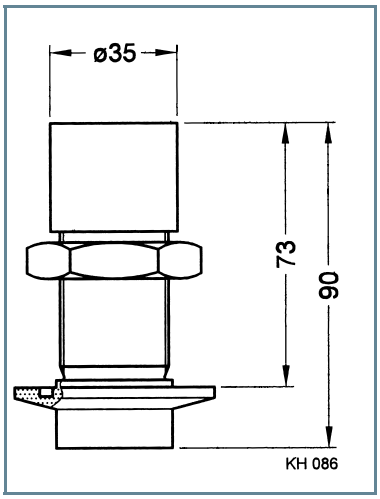
Electric feed-throughs

High-current feedthrough DN 40 ISO-KF

Electric feedthroughs

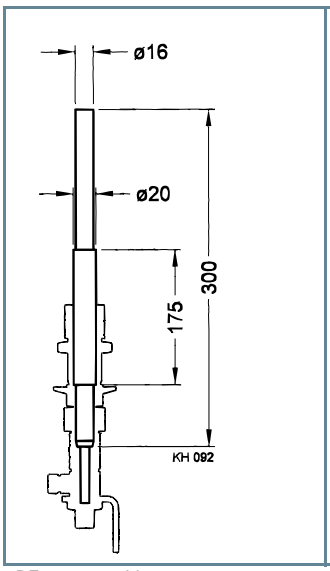
- Feedthrough core, DN 40 KF
- Additionally required: One electrode and the power connection, please see accessories
- Power connection must be water cooled for currents of 250 A or higher

Dimensions



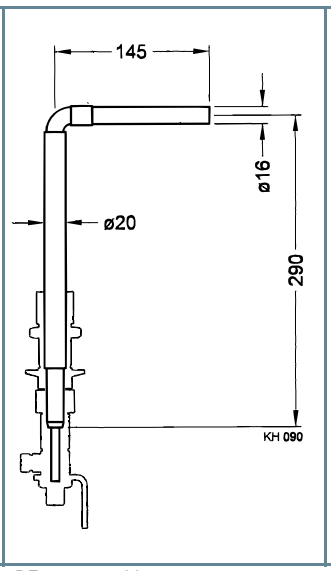
High-current feedthrough

Straight electrode



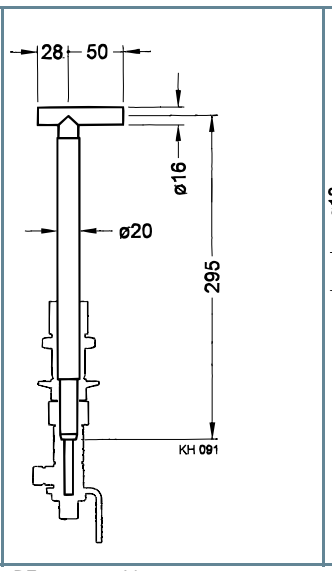
PF 296 014-X

Angle electrode



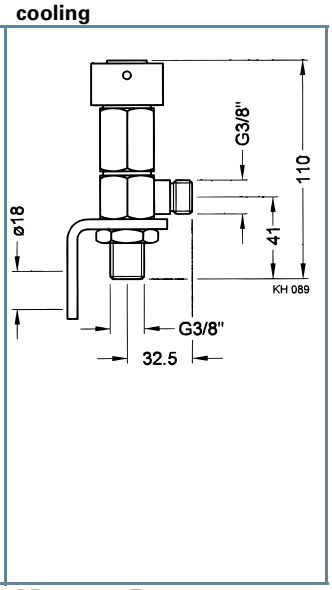
PF 296 016-X

T-electrode



PF 296 018-X

Power connection with water cooling



PF 296 026-T

Technical data	High-current feedthrough
Flange (in)	DN 40 ISO-KF
Number of feedthroughs	1
Bakeout temperature	110 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Pressure max.	2.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Housing	Aluminium
Isolator	Duroplast
Voltage, per pole	50 V
Current, per pole	1500 A

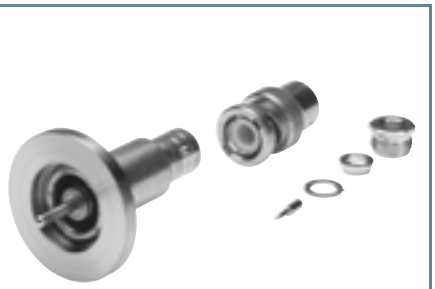
Order number	
Electric feedthroughs	**PF 264 018-T**

Accessories	
Straight electrode	**PF 296 014-X**
Angle electrode	**PF 296 016-X**
T-electrode	**PF 296 018-X**
Power connection with water cooling	**PF 296 026-T**

Electric feed-throughs

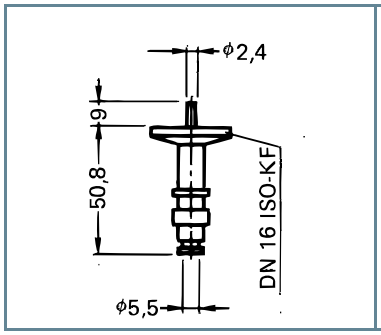
Coaxial feedthrough, BNC DN 16 ISO-KF

Electric feedthroughs

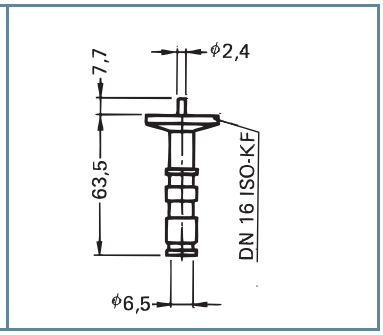


- ▶ Including outer connector
- ▶ Max. pressure 10 bar with external centering ring and plug connector
- ▶ Bakeout temperature (without outer connector): 200 °C with aluminum seal, 150 °C with FPM seal
- ▶ DN 16 ISO-KF

Dimensions



Coaxial feedthrough, BNC



Coaxial feedthrough, MHV

Technical data	Coaxial feedthrough, BNC	Coaxial feedthrough, MHV
Flange (in)	DN 16 ISO-KF	DN 16 ISO-KF
Standard connection: Outside connector	UG 88/U	UG 932/U
Standard connection: Cable	RG 58/U	RG 59/U
Number of feedthroughs	1	1
Bakeout temperature (with metal seal): without connector	200 °C	200 °C
Bakeout temperature: with connector	50 °C	50 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Pressure max.	2.5 bar	2.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	Al_2O_3	Al_2O_3
Frequency	150 MHz	-
Housing, flange, conductors	Stainless steel	Stainless steel
Weight	0.1 kg	0.1 kg
Impedance	50-60 Ohm	-
Insulation resistance at 20°C	$1 \cdot 10^{10}$ Ohm	$1 \cdot 10^{10}$ Ohm
Voltage AC/50Hz	0.35 kV	3.5 kV
Voltage DC	0.5 kV	5 kV
Current	3 A	3 A

Order number		
Electric feedthroughs	**PF 272 016-X**	**PF 272 018-X**

Electric feed-throughs

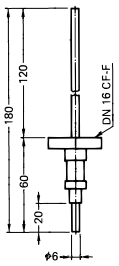
CF

Electric feedthroughs

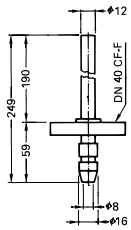
- ▶ Electrical feedthrough for currents up to 1000 A and oltages up to 12 kV
- ▶ Ceramic isolator

UKD = For high currents and voltages

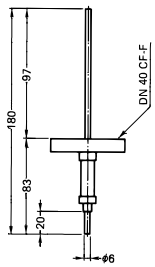
Dimensions



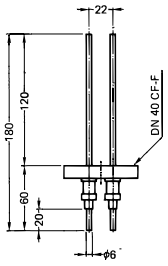
UKD 016



UKD 035

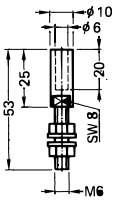


UKD 136

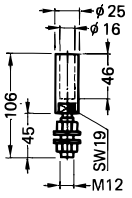


UKD 236

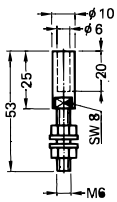
Outer connector



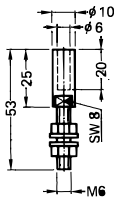
PF 696 011-T



PF 696 014-T

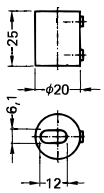


PF 696 011-T

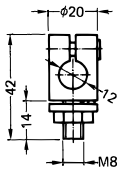


PF 696 011-T

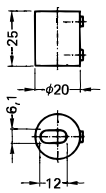
Inner connection piece



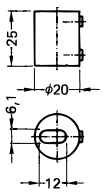
PF 696 013-T



PF 696 018-T

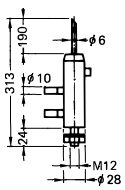


PF 696 013-T



PF 696 013-T

Outer connector, water cooled



PF 696 016-T

Technical data	UKD 016	UKD 035	UKD 136	UKD 236
Flange (in)	DN 16 CF-F	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Number of feedthroughs	1	1	1	2
Bakeout temperature	400 °C	400 °C	400 °C	400 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2 bar	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Flange	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Weight	0.15 kg	0.5 kg	0.45 kg	0.45 kg
Isolator	UMK 006, Ceramic	UMK 012, Ceramic	UMK 106, Ceramic	UMK 006, Ceramic
Conductor	Copper	Copper	Stainless steel	Copper
Voltage, per pole	4 kV	1 kV	12 kV	4 kV
Current without water cooling, per pole	-	250 A	-	-
Current, per pole	150 A	1000 A , max. current with water cooling	25 A	150 A
Temperature rise at max. current	50 °C	40 °C	30 °C	50 °C

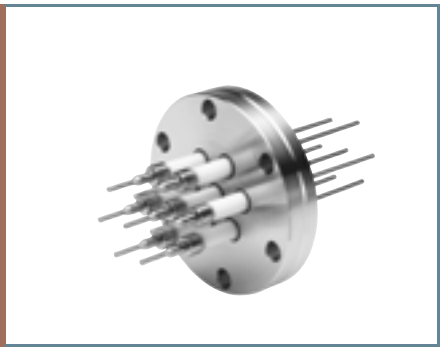
Order number				
Electric feedthroughs	**PF 660 010-X**	**PF 651 012-X**	**PF 651 010-X**	**PF 661 010-X**

Accessories	2-count package	1-count package	2-count package	2-count package
Outer connector	**PF 696 011-T**	**PF 696 014-T**	**PF 696 011-T**	**PF 696 011-T**
Inner connection piece	**PF 696 013-T**	**PF 696 018-T**	**PF 696 013-T**	**PF 696 013-T**
Outer connector, water cooled		**PF 696 016-T**		

Electric feed-throughs

CF

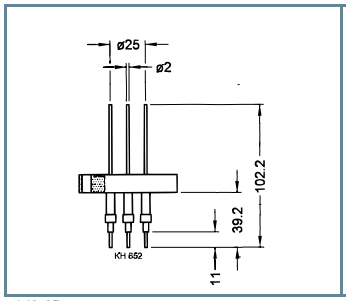
Electric feedthroughs



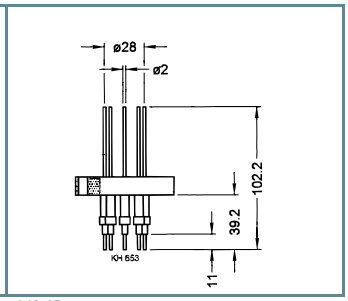
- ▶ Measuring current feedthrough DN 40 CF-F for ultra-high vacuum applications
- ▶ Ceramic isolator

UMD = Measurement-current feedthrough

Dimensions

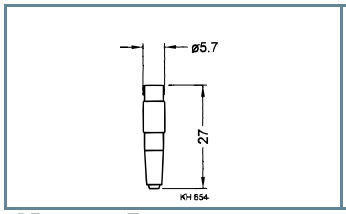


UMD 440

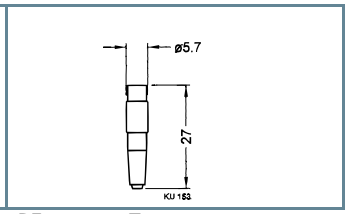


UMD 940

Outer connector

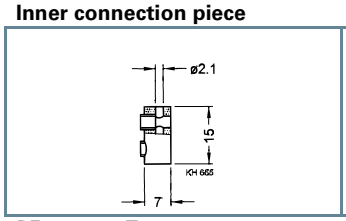


PF 697 016-T

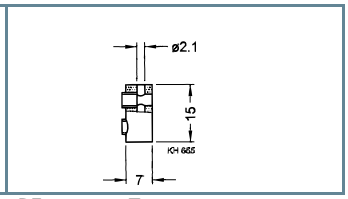


PF 697 018-T

Inner connection piece



PF 697 017-T



PF 697 019-T

Technical data	UMD 440	UMD 940
Flange (in)	DN 40 CF-F	DN 40 CF-F
Number of feedthroughs	4	9
Bakeout temperature	400 °C	400 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Flange	Stainless steel	Stainless steel
Weight	0.3 kg	0.4 kg
Isolator	UMK 002, Ceramic	UMK 002, Ceramic
Conductor	Stainless steel	Stainless steel
Voltage, per pole	1 kV	1 kV
Current, per pole	8 A	8 A
Temperature rise at max. current	40 °C	40 °C

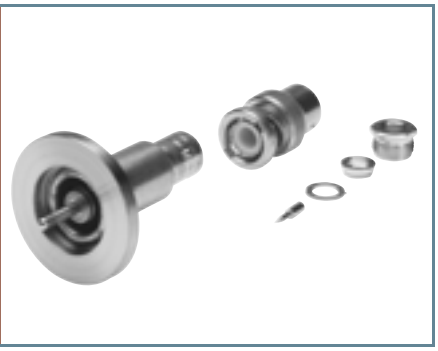
Order number		
Electric feedthroughs	**PF 671 011-X**	**PF 671 013-X**

Accessories	5-count package	10-count package
Outer connector	**PF 697 016-T**	**PF 697 018-T**
Inner connection piece	**PF 697 017-T**	**PF 697 019-T**

Electric feed-throughs

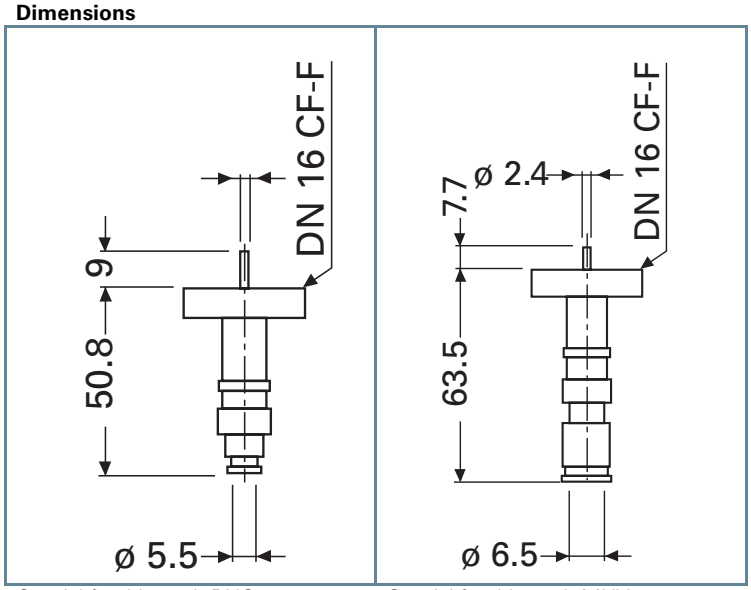
Coaxial feedthrough, BNC DN 16 CF-F

Electric feedthroughs



- ▶ Including outer connector
- ▶ Max. bakeout pressure 2 bar
- ▶ DN 16 CF-F

Dimensions



Coaxial feedthrough BNC

Coaxial feedthrough MHV

Technical data	Coaxial feedthrough BNC	Coaxial feedthrough MHV
Flange (in)	DN 16 CF-F	DN 16 CF-F
Standard connection: Outside connector	UG 88/U	UG 932/U
Standard connection: Cable	RG 58/U	RG 59/U
Number of feedthroughs	1	1
Bakeout temperature (with metal seal): without connector	400 °C	-
Bakeout temperature: with connector	50 °C	50 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Pressure max.	2.5 bar	2.5 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Feedthrough	Al_2O_3	Al_2O_3
Frequency	150 MHz	-
Housing, flange, conductors	Stainless steel	Stainless steel
Weight	0.14 kg	0.14 kg
Impedance	50-60 Ohm	-
Insulation resistance at 20°C	$1 \cdot 10^{10}$ Ohm	$1 \cdot 10^{10}$ Ohm
Voltage AC/50Hz	0.35 kV	3.5 kV
Voltage DC	0.5 kV	5 kV
Current	3 A	3 A

Order number		
Electric feedthroughs	**PF 670 012-X**	**PF 670 014-X**

Lubricants

Thread lubricant

▶ For lubricating CF screw connections
▶ Prevents seizing of screw connections
on the atmosphere side, even at high temperatures

Technical data	C 100
In packages of	28 g
Temperature stability	1000 °C

Order number	
Thread lubricant	**B 2751 050 CA**

Sealants

▶ For sealing small leaks.

Technical data	Sprayseal	Rhodorsil 340
Version	Spray	Paste
Solvent	Axarel 6100/9100	Axarel 6100/9100
In packages of	170 g	100 g
Temperature stability	350 °C	-40-200 °C

Order number		
Sealants	**B 2751 049-E**	**B 2753 420-K**

Vacuum greases/ -oils

Vacuum greases/-oils

▶ For sliding elastomer seals under vacuum.

Technical data	Apiezon "M"	DC	OL 090
Resistance to chemicals	-	Good	Very good
Resistance to oxidation	-	Very good	Very good
Resistance to thermal decomposition	-	Very good	Good
Vapor pressure at 100 °C	-	$5 \cdot 10^{-6}$ mbar	$1 \cdot 10^{-6}$ mbar
Vapor pressure at 20 °C	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-12}$ mbar
In packages of	25 g	50 g	10 ml
Lubricity	Good	Good	Good
Temperature stability	10-30 °C	-40-200 °C	-60-300 °C
Material	Mineral grease	Silicone grease	Fluorinated Fomblin oil
Order number			
Vacuum greases/-oils	**B 8010 070 28**	**B 2751 020 DK**	**B N845 804-T**

Technical data	FU 90	FM 090
Resistance to chemicals	Very good	Very good
Resistance to oxidation	Very good	Very good
Resistance to thermal decomposition	Good	Good
Vapor pressure at 100 °C	$1 \cdot 10^{-6}$ mbar	$1 \cdot 10^{-7}$ mbar
Vapor pressure at 20 °C	$1 \cdot 10^{-12}$ mbar	$1 \cdot 10^{-12}$ mbar
In packages of	10 g	30 g
Lubricity	Good	Good/very good
Temperature stability	-20-200 °C	-60-300 °C
Material	Fluorinated Fomblin grease	Fluorinated Fomblin grease
Order number		
Vacuum greases/-oils	**B 2751 055 UB**	**B N845 805-T**

Valves

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Selection aid

● Available

Designation	Nominal diameter ISO-KF					Nominal diameter ISO-K					Nominal diameter ISO-F					Nominal diameter CF						
	DN5 - Mini	DN 10	DN 16	DN 25	DN 40	DN 63	DN 100	DN 160	DN 200	DN 250	DN 63	DN 100	DN 160	DN 200	DN 250	DN 16	DN 40	DN 63	DN 100	DN 160	DN 200	DN 250
Type of actuation, Type																						
Manual																						
Angle, with bellows feedthrough	EVI 005 S	●																				
	AVC...SA/SX			●	●	●																
	EVB...SA/SX						●	●														
Angle, all metal	UVH 016 - UVH 063 VI/CU															●	●	●				
Inline, with bellows feedthrough	DVC...SX			●	●	●																
Gate valve	SVV...HA			●	●	●																
	SVV...HA										●	●	●									
Bellows-sealed gate valve	SVV...HM/HF																●	●	●	●	●	
Electropneumatic																						
Angle, with bellows feedthrough	EVI 005/105 P	●																				
	AVC...PA			●	●	●																
	AVC...PX			●	●	●																
	EVB...PA						●	●	●													
	EVB...PX						●	●														
Inline, with bellows feedthrough	DVC...PX			●	●	●																
Gate valve	SVV...PA			●	●	●																
	SVV...PA										●	●	●	●	●							
Bellows-sealed gate valve	SVV...PM/PF																●	●	●	●	●	●
Electromagnetic																						
Angle, without vacuum feedthrough	EVI 005 M	●																				
	EVC 110 M		●																			
Angle, with bellows feedthrough	AVC...MA/MX			●	●	●																
Inline, without vacuum feedthrough	DVI 005/205 M		●																			
Special valves																						
Venting valve, manually operated	FVB 010 HA/HX		●																			
Pressure relief valve	AVA 016 X			●																		
Rough gas and dosing valve	EVD 010 H		●																			
Gas dosing/shut-off valve	EVN 116			●																		
All metal regulating valve	UDV 040/046/146																●					
Gas dosing system regulating valve	EVR 116 + RME 005 A	●																				

Innovative Valves

Electromagnetically, electropneumatically and manually actuated!

Series at a glance

The Pfeiffer Vacuum product portfolio includes various types of valves in a wide variety of versions, e.g. manually, electropneumatically or electromagnetically actuated, for shut-off, venting and dosing applications.

Valves

The following series are available:

- Angle valves
- Inline valves
- Gate valves
- Mini-valves
- Special valves

Advantages at a glance for angle and inline valves

- All in one: Pilot valve and position indicator in one and the same housing, without any additional attachments
- Drives: Electromagnetically, electropneumatically and manually actuated
- 1 for 1 replacement for existing Pfeiffer Vacuum valves
- Robust, insensitive to contamination and suitable for industrial applications
- Simple maintenance: Only 4 screws need to be removed for cleaning and seal replacement
- Compressed air connection with standardized components
- Improved conductivities, differential pressure resistance and cycle times

Model designations

AVC = Angle valve
DVC = Inline valve

016–040 = Connection flange 016–040, DN ISO-KF

S = Manually actuated
P = Electropneumatically actuated
M = Electromagnetically actuated

A = Aluminum housing
X = Stainless steel housing

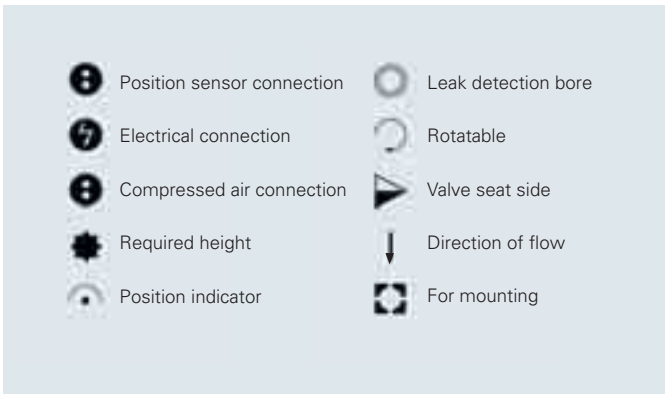
Coating

Leak detection systems

Gas dosing valves

	Type	Gas flow at an inlet pressure of 1 bar (mbar l / s)	
		10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3}	
Manually	EVD 010 H		40 - 1,700
	EVN 116		$5 \cdot 10^{-6}$ - 1,000
	UDV 040/046		10^{-10} - 600
Automatic	EVR 116 + RVC 300		$5 \cdot 10^{-6}$ - 1,250
	RME 005 A + RVC 300		10^{-3} - 85
	UDV 146 + RVG 050 C		10^{-10} - 600

Special Icons in the Dimensions



Angle valves

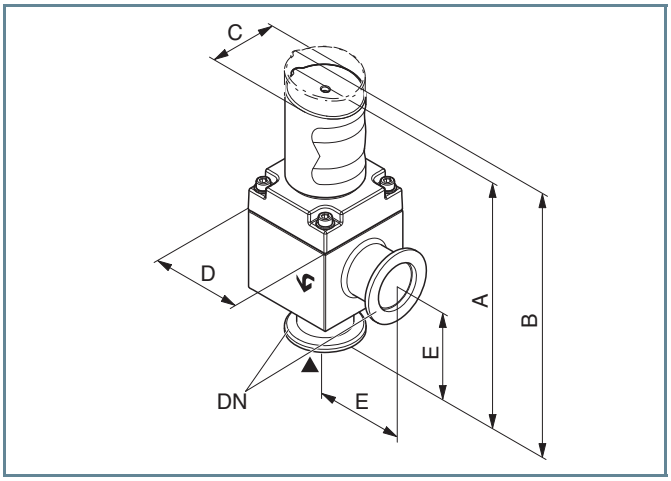
Manually actuated
Flange sizes from
DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- ▶ Manually actuated angle valve
- ▶ With visual indication of open and closed positions
- ▶ Housing material: Aluminum
- ▶ Service life: 10000 operating cycles

AVC = Angle valve with bellows feedthrough
SA = Manually actuated, aluminum housing
SX = Manually actuated, stainless steel housing

Dimensions



	AVC 016 SA	AVC 025 SA	AVC 040 SA
A	141.3 mm	145.3 mm	186.2 mm
B	149.5 mm	155.7 mm	201.4 mm
C	39.6 mm	39.6 mm	50 mm
D	45 mm	54 mm	69 mm
E	40 mm	50 mm	65 mm

	AVC 016 SX	AVC 025 SX	AVC 040 SX
A	143.9 mm	148.7 mm	189.2 mm
B	152.1 mm	159.1 mm	204.4 mm
C	39.6 mm	39.6 mm	50 mm
D	45 mm	54 mm	69 mm
E	40 mm	50 mm	65 mm

Technical data	AVC 016 SA AVC 016 SX	AVC 025 SA AVC 025 SX	AVC 040 SA AVC 040 SX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Actuator	Rotary knob	Rotary knob	Rotary knob
Bakeout temperature: actuator	50 °C	50 °C	50 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	1.5 bar
Differential pressure in closing direction	4 bar	4 bar	2 bar
Pressure max.	2 bar	2 bar	1.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Service life	10000 cycles	10000 cycles	10000 cycles

	AVC 016 SA	AVC 025 SA	AVC 040 SA
Bakeout temperature: housing	80 °C	80 °C	80 °C
Housing	Aluminum	Aluminum	Aluminum
Weight	0.31 kg	0.42 kg	0.85 kg
Order number	**PF A31 003**	**PF A41 003**	**PF A51 003**

	AVC 016 SX	AVC 025 SX	AVC 040 SX
Bakeout temperature: housing	150 °C	150 °C	150 °C
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.34 kg	0.49 kg	0.96 kg
Order number	**PF A31 033**	**PF A41 033**	**PF A51 033**

Angle valves

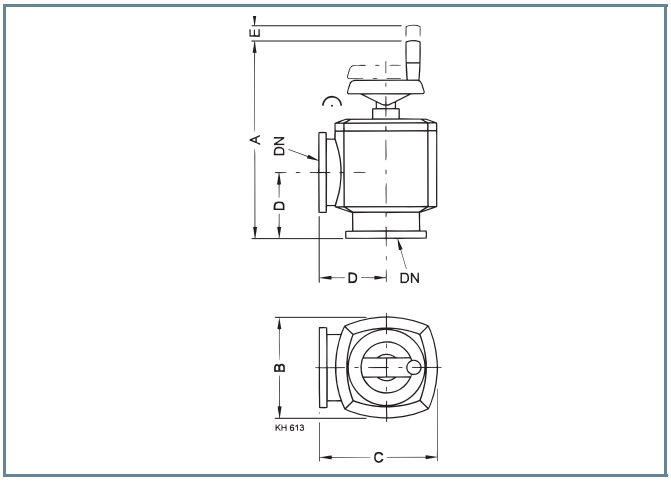
Manually actuated
Flange sizes from
DN 63 ISO-K to DN 100 ISO-K

Angle valves

- ▶ Spindle drive with handwheel
- ▶ Continuous opening
- ▶ Housing material: Aluminum
- ▶ Service life: 10000 operating cycles

EVB = Angle valve with bellows feedthrough
SA = Manually actuated, aluminum housing
SX = Manually actuated, stainless steel housing

Dimensions



	EVB 063 SA	EVB 100 SA
A	266 mm	320 mm
B	124 mm	164 mm
C	150 mm	190 mm
D	88 mm	108 mm
E	20 mm	25 mm

	EVB 063 SX	EVB 100 SX
A	266 mm	320 mm
B	124 mm	164 mm
C	150 mm	190 mm
D	88 mm	108 mm
E	20 mm	25 mm

Technical data	EVB 063 SA EVB 063 SX	EVB 100 SA EVB 100 SX
Flange (in)	DN 63 ISO-K	DN 100 ISO-K
Flange (out)	DN 63 ISO-K	DN 100 ISO-K
Actuator	Spindle	Spindle
Bakeout temperature: actuator	60 °C	60 °C
Bakeout temperature: housing	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM
Differential pressure in opening direction	1.5 bar	1.5 bar
Differential pressure in closing direction	1.5 bar	1.5 bar
Pressure max.	1.5 bar	1.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel
Conductance for molecular flow	140 l/s	330 l/s
Can be opened to a pressure difference of	1.5 bar	1.5 bar
Service life	10000 cycles	10000 cycles

	EVB 063 SA	EVB 100 SA
Housing	Aluminum	Aluminum
Weight	3.6 kg	6.1 kg
Order number	**PF B12 001**	**PF B22 001**

	EVB 063 SX	EVB 100 SX
Housing	Stainless steel	Stainless steel
Weight	6.5 kg	11.1 kg
Order number	**PF B12 031**	**PF B22 031**

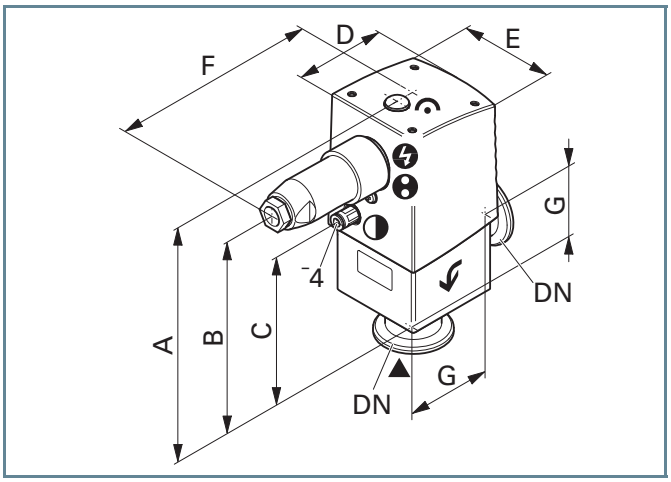
Angle valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- One-box design - All in one: Pilot valve (PV) and position indicator (PI) in one and the same housing
- Drive: Electropneumatically actuated
- Pilot valves from 24 V to 230 V
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



AVC = Angle valve with bellows feedthrough
PA = Electropneumatically actuated, aluminum housing
PX = Electropneumatically actuated, stainless steel housing
AC = Alternating current

	AVC 016 PA	AVC 025 PA	AVC 040 PA
A	142 mm	146.9 mm	188.8 mm
B	112.9 mm	117.8 mm	159.7 mm
C	75.1 mm	79 mm	114.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60.1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

Technical data	AVC 016 PA	AVC 025 PA	AVC 040 PA
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Bakeout temperature: housing	80 °C	80 °C	80 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Aluminum	Aluminum	Aluminum
Weight	0.49 kg	0.68 kg	1.21 kg
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Power pilot valve	4.8/3.6 VA	4.8/3.6 VA	4.8/3.6 VA
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	included	included	included

	AVC 016 PA	AVC 025 PA	AVC 040 PA
Supply	24 VAC	24 VAC	24 VAC
Order number	**PF A38 103**	**PF A48 103**	**PF A58 103**
Supply	24 VDC	24 VDC	24 VDC
Order number	**PF A38 204**	**PF A48 204**	**PF A58 204**
Supply	100...115 VAC	100...115 VAC	100...115 VAC
Order number	**PF A38 403**	**PF A48 403**	**PF A58 403**
Supply	200...230 VAC	200...230 VAC	200...230 VAC
Order number	**PF A38 503**	**PF A48 503**	**PF A58 503**

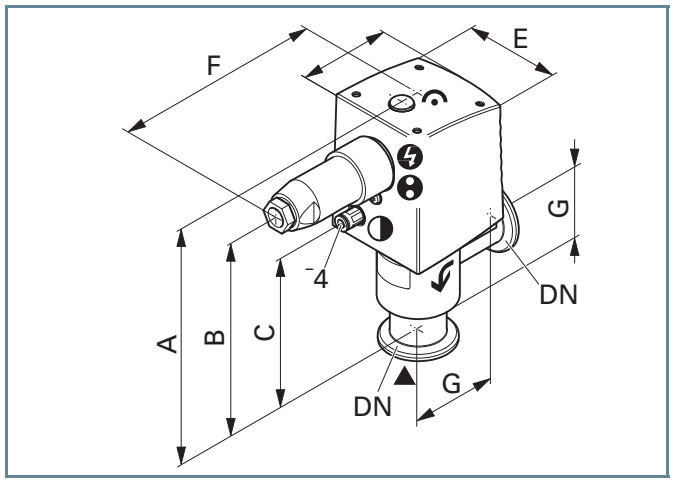
Angle valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- One-box design - All in one: Pilot valve (PV) and position indicator (PI) in one and the same housing
- Drive: Electropneumatically actuated
- Pilot valves from 24 V to 230 V
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



AVC = Angle valve with bellows feedthrough
PA = Electropneumatically actuated, aluminum housing
PX = Electropneumatically actuated, stainless steel housing
AC = Alternating current

	AVC 016 PX	AVC 025 PX	AVC 040 PX
A	144.5 mm	150.3 mm	191.8 mm
B	115.4 mm	121.2 mm	162.7 mm
C	77.6 mm	82.5 mm	117.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60.1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

Technical data	AVC 016 PX	AVC 025 PX	AVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.52 kg	0.75 kg	1.33 kg
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Power pilot valve	4.8/3.6 VA	4.8/3.6 VA	4.8/3.6 VA
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	included	included	included

	AVC 016 PX	AVC 025 PX	AVC 040 PX
Supply	24 VAC	24 VAC	24 VAC
Order number	**PF A38 133**	**PF A48 133**	**PF A58 133**
Supply	24 VDC	24 VDC	24 VDC
Order number	**PF A38 234**	**PF A48 234**	**PF A58 234**
Supply	100...115 VAC	100...115 VAC	100...115 VAC
Order number	**PF A38 433**	**PF A48 433**	**PF A58 533**
Supply	200...230 VAC	200...230 VAC	200...230 VAC
Order number	**PF A38 533**	**PF A48 533**	**PF A58 533**

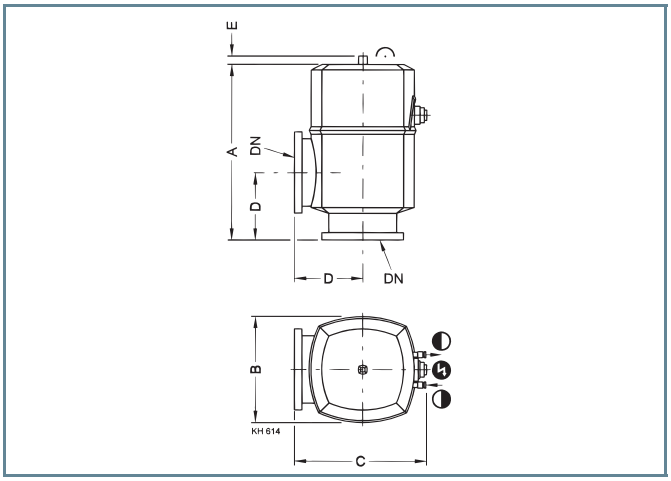
Angle valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV) Flange sizes from DN 63 to DN 160 ISO-K

Angle valves

- One-box design - All in one: Pilot valve (PV) and position indicator (PI) in one and the same housing
- Drive: Electropneumatically actuated
- Pilot valves from 24 V to 240 V
- With integral position indicator
- Robust, suitable for industrial use and insensitive to contamination

Dimensions



EVB = Angle valve with bellows feedthrough
PA = Electropneumatically actuated, aluminum housing
PX = Electropneumatically actuated, stainless steel housing
AC = Alternating current

	EVB 063 PA	EVB 100 PA	EVB 160 PA
A	250 mm	281.5 mm	366 mm
B	124 mm	164 mm	215 mm
C	168 mm	198 mm	264 mm
D	88 mm	108 mm	138 mm
E	14 mm	14 mm	14 mm

	EVB 063 PX	EVB 100 PX
A	250 mm	282 mm
B	124 mm	164 mm
C	168 mm	208 mm
D	88 mm	108 mm
E	14 mm	14 mm

General technical data	EVB 063 PA EVB 063 PX	EVB 100 PA EVB 100 PX	EVB 160 PA
Flange (in)	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Flange (out)	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Bakeout temperature: actuator, pilot valve	60 °C	60 °C	60 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	1.5 bar	1.5 bar	1.5 bar
Differential pressure in closing direction	1.5 bar	1.5 bar	1.5 bar
Pressure max.	4 bar	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	75 cm^3	195 cm^3	570 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Aluminum	Aluminum	Aluminum
Position feedback: Load capacity	250 V AC / 0.125 A; 50 V DC / 0.25 A	250 V AC / 0.125 A; 50 V DC / 0.25 A	250 V AC / 0.125 A; 50 V DC / 0.25 A
Conductance for molecular flow	140 l/s	330 l/s	800 l/s
Power pilot valve	3.1/2.2 VA	3.1/2.2 VA	3.1/2.2 VA
Can be opened to a pressure difference of	1.5 bar	1.5 bar	1.5 bar
Opening time	300 ms	400 ms	600 ms
Closing time	300 ms	400 ms	650 ms
Service life	1500000 cycles	1500000 cycles	1500000 cycles
Electrical position indicator	included	included	included
Control valve	included	included	included

Technical data	EVB 063 PA	EVB 100 PA	EVB 160 PA
Bakeout temperature: housing	80 °C	80 °C	80 °C
Weight	4 kg	6.7 kg	11.4 kg

	EVB 063 PA	EVB 100 PA	EVB 160 PA
Supply	24 V AC	24 V AC	24 V AC
Order number	**PF B18 101**	**PF B28 101**	**PF B38 101**
Supply	24 V DC	24 V DC	24 V DC
Order number	**PF B18 201**	**PF B28 201**	**PF B38 201**
Supply	100-115 V AC	100-115 V AC	100-115 V AC
Order number	**PF B18 401**	**PF B28 401**	**PF B38 401**
Supply	200-240 V AC	200-240 V AC	200-240 V AC
Order number	**PF B18 501**	**PF B28 501**	**PF B38 501**

Technical data	EVB 063 PX	EVB 100 PX
Bakeout temperature: housing	150 °C	150 °C
Weight	6.8 kg	11.7 kg

	EVB 063 PX	EVB 100 PX
Supply	24 V AC	24 V AC
Order number	**PF B18 131**	**PF B28 131**
Supply	24 V DC	24 V DC
Order number	**PF B18 231**	**PF B28 231**
Supply	100-115 V AC	100-115 V AC
Order number	**PF B18 431**	**PF B28 431**
Supply	200-240 V AC	200-240 V AC
Order number	**PF B18 531**	**PF B28 531**

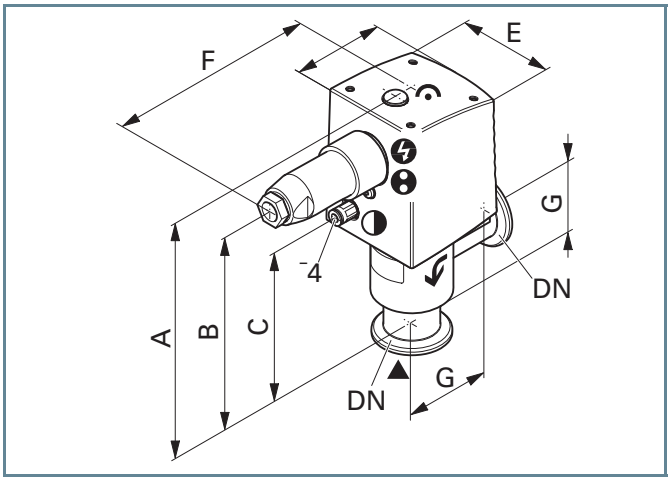
Angle valves

Pneumatically actuated, with position indicator (PI), without pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- One-box design - All in one: With position indicator in one and the same housing
- Drive: Pneumatically actuated
- Without pilot valve
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



AVC = Angle valve with bellows feedthrough
PA = Pneumatically actuated, aluminum housing
PX= Pneumatically actuated, stainless steel housing

	AVC 016 PA	AVC 025 PA	AVC 040 PA
A	142 mm	146.9 mm	188.8 mm
B	112.9 mm	117.8 mm	159.7 mm
C	75.1 mm	79 mm	114.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60,1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

	AVC 016 PX	AVC 025 PX	AVC 040 PX
A	144.5 mm	150.3 mm	191.8 mm
B	115.4 mm	121.2 mm	162.2 mm
C	77.6 mm	82.5 mm	117.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60,1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

Technical data	AVC 016 PA AVC 016 PX	AVC 025 PA AVC 025 PX	AVC 040 PA AVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	without	without	without

	AVC 016 PA	AVC 025 PA	AVC 040 PA
Bakeout temperature: housing	80 °C	80 °C	80 °C
Housing	Aluminum	Aluminum	Aluminum
Weight	0.49 kg	0.68 kg	1.21 kg
Order number	**PF A36 003**	**PF A46 003**	**PF A56 003**

	AVC 016 PX	AVC 025 PX	AVC 040 PX
Bakeout temperature: housing	150 °C	150 °C	150 °C
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.52 kg	0.75 kg	1.33 kg
Order number	**PF A36 033**	**PF A46 033**	**PF A56 033**

Angle valves

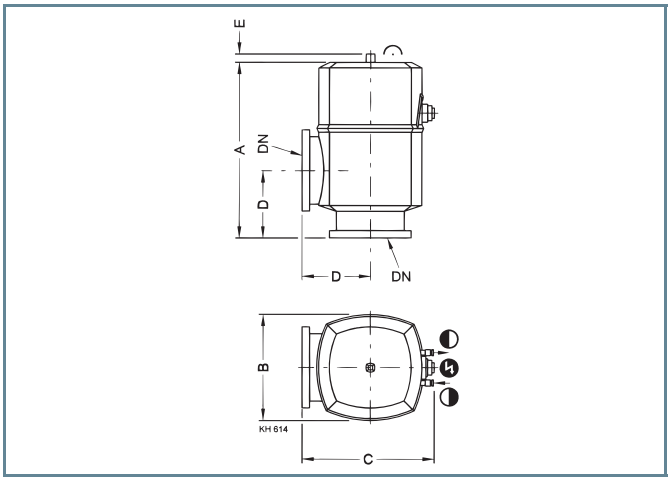
Pneumatically actuated, with position indicator (PI), without pilot valve (PV) Flange sizes from DN 63 ISO-K to DN 160 ISO-K

Angle valves

- ▶ One-box design - All in one: With position indicator in one and the same housing
- ▶ Drive: Pneumatically actuated
- ▶ With integral position indicator
- ▶ Robust, suitable for industrial use and insensitive to contamination

EVB = Angle valve with bellows feedthrough
PA = Pneumatically actuated, aluminum housing
PX = Pneumatically actuated, stainless steel housing

Dimensions



	EVB 063 PA	EVB 100 PA	EVB 160 PA
A	250 mm	282 mm	366 mm
B	124 mm	164 mm	215 mm
C	168 mm	208 mm	264 mm
D	88 mm	108 mm	138 mm
E	14 mm	14 mm	14 mm

	EVB 063 PX	EVB 100 PX
A	250 mm	282 mm
B	124 mm	164 mm
C	168 mm	208 mm
D	88 mm	108 mm
E	14 mm	14 mm

Technical data	EVB 063 PA EVB 063 PX	EVB 100 PA EVB 100 PX	EVB 160 PA
Flange (in)	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Flange (out)	DN 63 ISO-K	DN 100 ISO-K	DN 160 ISO-K
Bakeout temperature: actuator, pilot valve	60 °C	60 °C	60 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM seal	FPM
Differential pressure in opening direction	1.5 bar	1.5 bar	1.5 bar
Differential pressure in closing direction	1.5 bar	1.5 bar	1.5 bar
Pressure max.	4 bar	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	75 cm^3	195 cm^3	570 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Position feedback: Load capacity	250 V AC / 0.125 A; 50 V DC / 0.25 A	250 V AC / 0.125 A; 50 V DC / 0.25 A	250 V AC / 0.125 A; 50 V DC / 0.25 A
Conductance for molecular flow	140 l/s	330 l/s	800 l/s
Can be opened to a pressure difference of	1.5 bar	1.5 bar	1.5 bar
Opening time	300 ms	400 ms	600 ms
Closing time	300 ms	400 ms	650 ms
Service life	1500000 cycles	1500000 cycles	1500000 cycles
Electrical position indicator	included	included	included
Control valve	-	-	-
Supply	-	-	-

	EVB 063 PA	EVB 100 PA	EVB 160 PA
Bakeout temperature: housing	80 °C	80 °C	150 °C
Housing	Aluminum	Aluminum	Aluminum
Weight	4 kg	6.7 kg	11.4 kg
Order number	**PF B16 002**	**PF B26 002**	**PF B36 002**

	EVB 063 PX	EVB 100 PX
Bakeout temperature: housing	150 °C	150 °C
Housing	Stainless steel	Stainless steel
Weight	6.8 kg	11.7 kg
Order number	**PF B16 032**	**PF B26 032**

Angle valves

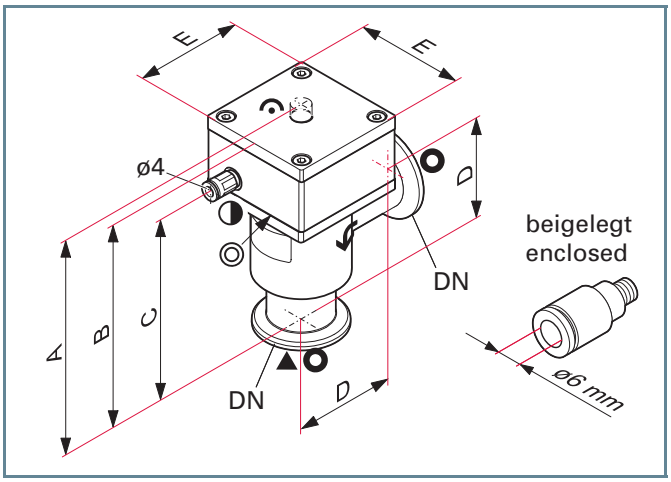
Pneumatically actuated, without position indicator (PI), without pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- ▶ Drive: pneumatically actuated
- ▶ Service life: 10 million operating cycles
- ▶ Without position indicator (PI)
- ▶ Without pilot valve (PV)
- ▶ Robust, suitable for industrial use and insensitive to contamination
- ▶ Simple maintenance

AVC = Angle valve with bellows feedthrough
PA = Pneumatically actuated, aluminum housing
PX = Pneumatically actuated, stainless steel housing

Dimensions



	AVC 016 PA	AVC 025 PA	AVC 040 PA
A	100.5 mm	108.5 mm	150.5 mm
B	95.7 mm	102.6 mm	144.7 mm
C	75.6 mm	80.6 mm	116.6 mm
D	40 mm	50 mm	65 mm
E	45 mm	54 mm	69 mm

	AVC 016 PX	AVC 025 PX	AVC 040 PX
A	103 mm	112 mm	153.5 mm
B	98.2 mm	106 mm	147.7 mm
C	78.1 mm	84 mm	119.6 mm
D	40 mm	50 mm	65 mm
E	45 mm	54 mm	69 mm

Technical data	AVC 016 PA AVC 016 PX	AVC 025 PA AVC 025 PX	AVC 040 PA AVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	120 °C	120 °C	120 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	-	-	-
Control valve	-	-	-

	AVC 016 PA	AVC 025 PA	AVC 040 PA
Bakeout temperature: housing	80 °C	80 °C	80 °C
Housing	Aluminum	Aluminum	Aluminum
Weight	0.38 kg	0.57 kg	1.17 kg
Order number	**PF A35 004**	**PF A45 004**	**PF A55 004**

	AVC 016 PX	AVC 025 PX	AVC 040 PX
Bakeout temperature: housing	150 °C	150 °C	150 °C
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.42 kg	0.66 kg	1.28 kg
Order number	**PF A35 034**	**PF A45 034**	**PF A55 034**

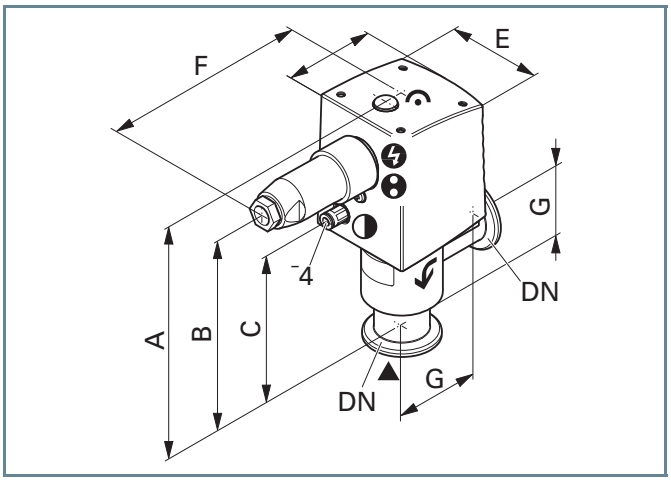
Angle valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV), normally open
Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- ▶ Drive: electropneumatically actuated
- ▶ Service life: 10 million operating cycles
- ▶ With position indicator (PI)
- ▶ With pilot valve (PV)
- ▶ Normally open (N/O)
- ▶ Robust, suitable for industrial use and insensitive to contamination
- ▶ Simple maintenance

Dimensions



AVC = Angle valve with bellows feedthrough
PA = Electropneumatically actuated, aluminum housing
PX = Electropneumatically actuated, stainless steel housing
DC = Direct current

	AVC 016 PA	AVC 025 PA	AVC 040 PA
A	142 mm	146.9 mm	188.8 mm
B	112.9 mm	117.8 mm	159.7 mm
C	75.1 mm	79 mm	114.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60.1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

	AVC 016 PX	AVC 025 PX	AVC 040 PX
A	144.5 mm	150.3 mm	191.8 mm
B	115.4 mm	121.2 mm	162.7 mm
C	77.6 mm	82.5 mm	117.9 mm
D	55 mm	64.3 mm	81.3 mm
E	51.4 mm	60.1 mm	75.7 mm
F	93.2 mm	97.8 mm	105.3 mm
G	40 mm	50 mm	65 mm

Technical data	AVC 016 PA AVC 016 PX	AVC 025 PA AVC 025 PX	AVC 040 PA AVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Power pilot valve	2.5 W	2.5 W	2.5 W
Conductance for molecular flow	5 l/s	14 l/s	45 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	included	included	included
Supply	24 VDC	24 VDC	24 VDC

	AVC 016 PA	AVC 025 PA	AVC 040 PA
Bakeout temperature: housing	80 °C	80 °C	80 °C
Housing	Aluminum	Aluminum	Aluminum
Weight	0.49 kg	0.68 kg	1.21 kg
Order number	**PF A38 205**	**PF A48 205**	**PF A58 205**

	AVC 016 PX	AVC 025 PX	AVC 040 PX
Bakeout temperature: housing	150 °C	150 °C	150 °C
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.52 kg	0.75 kg	1.33 kg
Order number	**PF A38 235**	**PF A48 235**	**PF A58 235**

Angle valves

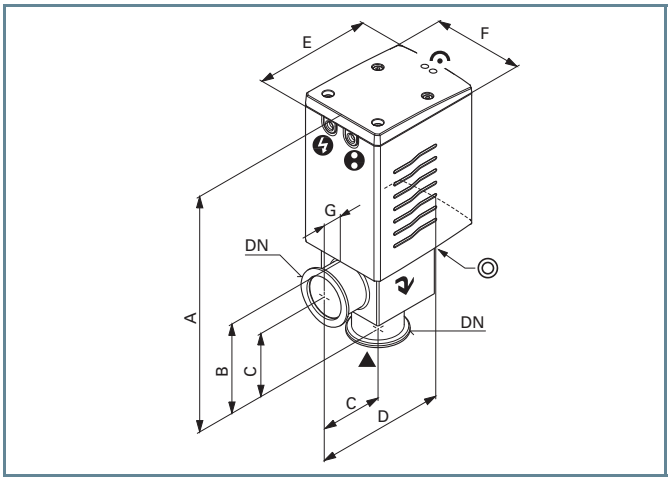
Solenoid actuated
Flange sizes from
DN 16 ISO-KF to DN 40 ISO-KF

Angle valves

- ▶ Drive: Solenoid actuated
- ▶ Service life: > 1.5 million operating cycles
- ▶ Robust, suitable for industrial use and insensitive to contaminatio

AVC = Angle valve with bellows feedthrough
MA = Solenoid actuated, aluminum housing
MX = Solenoid actuated, stainless steel housing

Dimensions



	AVC 016 MA	AVC 025 MA	AVC 040 MA
A	170.9 mm	193 mm	246 mm
B	51.4 mm	64.9 mm	92.9 mm
C	40 mm	50 mm	65 mm
D	96 mm	112,7 mm	139 mm
E	86 mm	97.3 mm	119,5 mm
F	59 mm	70 mm	90 mm
G	10 mm	15.4 mm	19.5 mm

	AVC 016 MX	AVC 025 MX	AVC 040 MX
A	172.9 mm	196,4 mm	249 mm
B	53.4 mm	68.3 mm	95.9 mm
C	40 mm	50 mm	65 mm
D	96 mm	112,7 mm	139 mm
E	86 mm	97.3 mm	119,5 mm
F	59 mm	70 mm	90 mm
G	10 mm	15.4 mm	19.5 mm

Technical data	AVC 016 MA AVC 016 MX	AVC 025 MA AVC 025 MX	AVC 040 MA AVC 040 MX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Pickup/holding power	405 / 8.1 W	416 / 8.3 W	367 / 7,5 W
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	1.3 bar	1.3 bar	1.3 bar
Differential pressure in closing direction	1.3 bar	1.3 bar	1.3 bar
Pressure max.	1.3 bar	1.3 bar	1.3 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Mounting orientation	any	any	any
Position feedback: Load capacity	30 VDC / 0.1 A	30 VDC / 0.1 A	30 VDC / 0.1 A
Conductance for molecular flow	4 l/s	13 l/s	35 l/s
Can be opened to a pressure difference of	1.3 bar	1.3 bar	1.3 bar
Opening time	100 ms	120 ms	230 ms
Switching frequency at 40°C	30 1/min	30 1/min	30 1/min
Switching frequency at 50°C	20 1/min	20 1/min	20 1/min
Closing time	220 ms	230 ms	650 ms
Service life	2000000 cycles	2000000 cycles	2000000 cycles
Electrical position indicator	included	included	included
Control voltage	15 - 30 VDC	15 - 30 VDC	15 - 30 VDC
Control current	3 - 5 mA	3 - 5 mA	3 - 5 mA
Ambient temperature	0...50 °C	0...50 °C	0...50 °C
Supply	90...264 V, 47...63 Hz	90...264 V, 47...63 Hz	90...264 V, 47...63 Hz

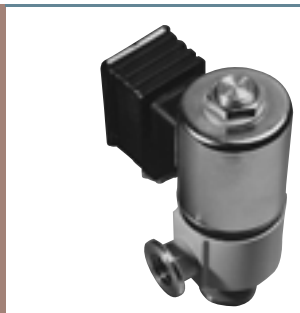
	AVC 016 MA	AVC 025 MA	AVC 040 MA
Housing	Aluminum	Aluminum	Aluminum
Weight	1.1 kg	1.9 kg	4.3 kg
Order number	**PF A34 506**	**PF A44 506**	**PF A54 506**

	AVC 016 MX	AVC 025 MX	AVC 040 MX
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	1.2 kg	2 kg	4.4 kg
Order number	**PF A34 536**	**PF A44 536**	**PF A54 536**

Angle valves

Solenoid actuated
Flanschgröße DN 10 ISO-KF

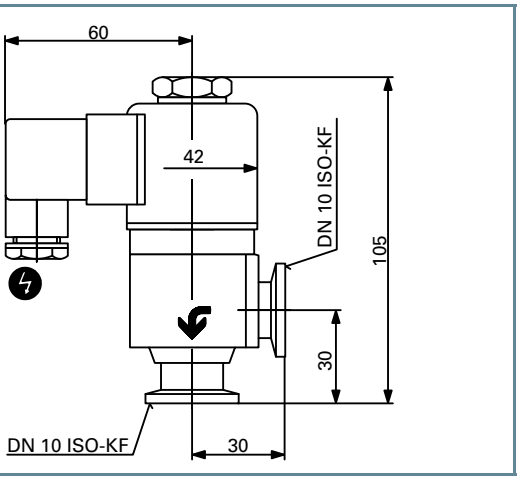
Angle valves



- ▶ Drive: Solenoid actuated
- ▶ Service life: > 1.5 million operating cycles
- ▶ Robust, suitable for industrial use and insensitive to contaminatio

EVC = Angle valve without vacuum feedthrough

Dimensions



Technical data	EVC 110 M
Flange (in)	DN 10 ISO-KF
Flange (out)	DN 10 ISO-KF
Pickup/holding power	35/15 VA
Bakeout temperature: actuator	80 °C
Bakeout temperature: housing	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Differential pressure in opening direction	1 bar
Differential pressure in closing direction	10 bar
Pressure max.	10 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Feedthrough	-
Housing	Aluminum
Weight	0.46 kg
Conductance for molecular flow	1 l/s
Can be opened to a pressure difference of	2 bar
Opening time	45 ms
Switching frequency	50 rpm
Closing time	60 ms
Service life	1500000 cycles
Electrical position indicator	-

Supply	24 V, 50/60 Hz
Order number	**PF A23 101**
Supply	24 V DC
Order number	**PF A23 201**
Supply	115 V, 50/60 Hz
Order number	**PF A23 401**
Supply	230 V, 50/60 Hz
Order number	**PF A23 501**

Accessories	
Centering ring, FPM/ aluminum, DN 10 ISO-KF	**PF 110 110-T**

Inline valves

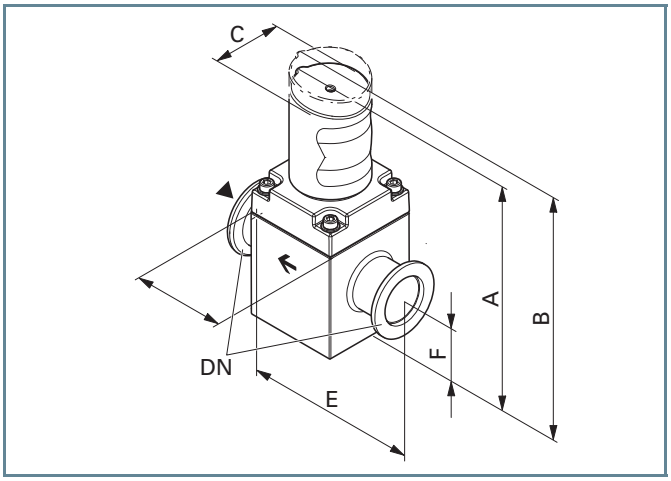
Manually actuated
Flange sizes from
DN 16 ISO-KF to DN 40 ISO-KF

Inline valves

- ▶ Manually actuated inline valves
- ▶ With visual indication of open and closed positions
- ▶ Housing material: Stainless steel
- ▶ Service life: 10000 operating cycles

DVC = Inline valve with bellows feedthrough
SX = Manually actuated,
stainless steel housing

Dimensions



	DVC 016 SX	DVC 025 SX	DVC 040 SX
A	125.4 mm	132 mm	166.5 mm
B	133.6 mm	142.4 mm	181.7 mm
C	39.6 mm	39.6 mm	50 mm
D	45 mm	54 mm	69 mm
E	80 mm	100 mm	139 mm
F	20 mm	31.8 mm	40.8 mm

Technical data	DVC 016 SX	DVC 025 SX	DVC 040 SX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Actuator	Rotary knob	Rotary knob	Rotary knob
Bakeout temperature: actuator	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	1.5 bar
Differential pressure in closing direction	4 bar	4 bar	2 bar
Pressure max.	2 bar	2 bar	1.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.71 kg	1.09 kg	1.83 kg
Conductance for molecular flow	2.5 l/s	7 l/s	20 l/s
Service life	10000 cycles	10000 cycles	10000 cycles

Order number			
Inline valves	**PF D31 033**	**PF D41 033**	**PF D51 033**

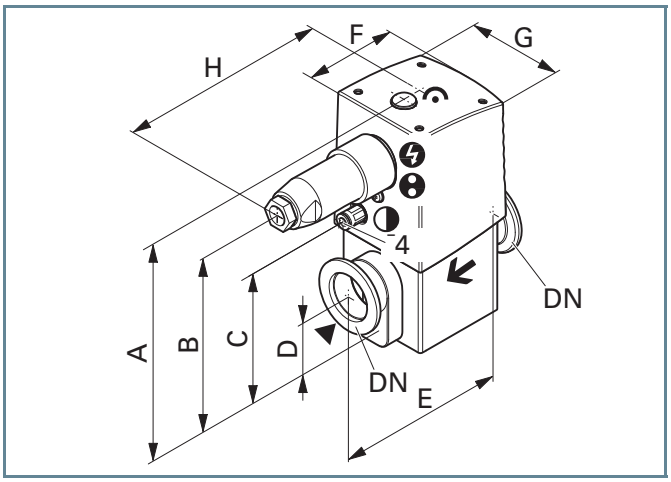
Inline valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Inline valves

- One-box design - All in one: Pilot valve (PV) and position indicator (PI) in one and the same housing
- Drive: Electropneumatically actuated
- Pilot valves from 24 V to 230 V
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



DVC = Inline valve with bellows feedthrough
PX = Electropneumatically actuated, stainless steel housing
AC = Alternating current
DC = Direct current

	DVC 016 PX	DVC 025 PX	DVC 040 PX
A	126.1 mm	133.6 mm	169.1 mm
B	97 mm	104.5 mm	140 mm
C	59.2 mm	65.7 mm	95.2 mm
D	20 mm	31.8 mm	40.8 mm
E	80 mm	100 mm	130 mm
F	55 mm	64.3 mm	81.3 mm
G	51.4 mm	60.1 mm	75.7 mm
H	93.2 mm	97.8 mm	105.3 mm

Technical data	DVC 016 PX	DVC 025 PX	DVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.89 kg	1.35 kg	2.2 kg
Conductance for molecular flow	2.5 l/s	7 l/s	20 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	included	included	included

	DVC 016 PX	DVC 025 PX	DVC 040 PX
Supply	24 VAC	24 VAC	24 VAC
Power pilot valve	4,8/3,6 VA	4,8/3,6 VA	4,8/3,6 VA
Order number	**PF D38 133**	**PF D48 133**	**PF D58 133**
Supply	24 VAC	24 VDC	24 VDC
Power pilot valve	2.5 W	2.5 W	2.5 W
Order number	**PF D38 234**	**PF D48 234**	**PF D58 234**
Supply	100...115 VAC	100...115 VAC	100...115 VAC
Power pilot valve	4,8/3,6 VA	4,8/3,6 VA	4,8/3,6 VA
Order number	**PF D38 433**	**PF D48 433**	**PF D58 433**
Supply	200...230 VAC	200...230 VAC	200...230 VAC
Power pilot valve	4,8/3,6 VA	4,8/3,6 VA	4,8/3,6 VA
Order number	**PF D38 533**	**PF D48 533**	**PF D58 533**

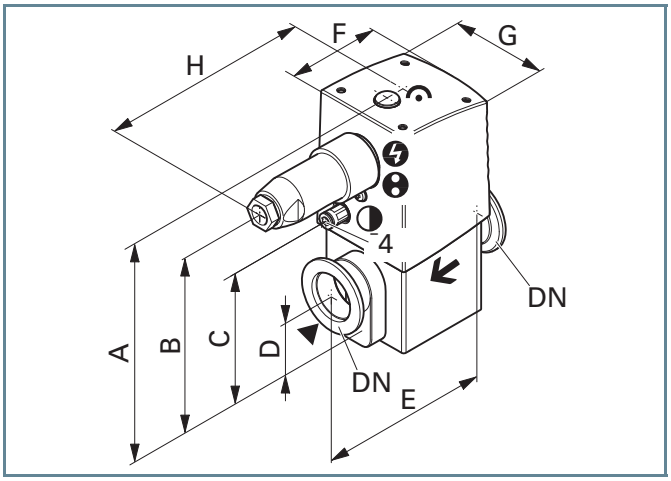
Inline valves

Pneumatically actuated, with position indicator (PI), without pilot valve (PV) Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Inline valves

- One-box design - All in one: With position indicator in one and the same housing
- Drive: Pneumatically actuated
- 24 V DC pilot valve included
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



DVC = Inline valve with bellows feedthrough
PX = Pneumatically actuated, stainless steel housing

	DVC 016 PX	DVC 025 PX	DVC 040 PX
A	126.1 mm	133.6 mm	169.1 mm
B	97 mm	104.5 mm	140 mm
C	59.2 mm	65.7 mm	95.2 mm
D	20 mm	31.8 mm	40.8 mm
E	80 mm	100 mm	130 mm
F	55 mm	64.3 mm	81.3 mm
G	51.4 mm	60.1 mm	75.7 mm
H	93.2 mm	97.8 mm	105.3 mm

Technical data	DVC 016 PX	DVC 025 PX	DVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.89 kg	1.35 kg	2.2 kg
Conductance for molecular flow	2.5 l/s	7 l/s	20 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	-	-	-

Order number			
Inline valves	**PF D36 033**	**PF D46 033**	**PF D56 033**

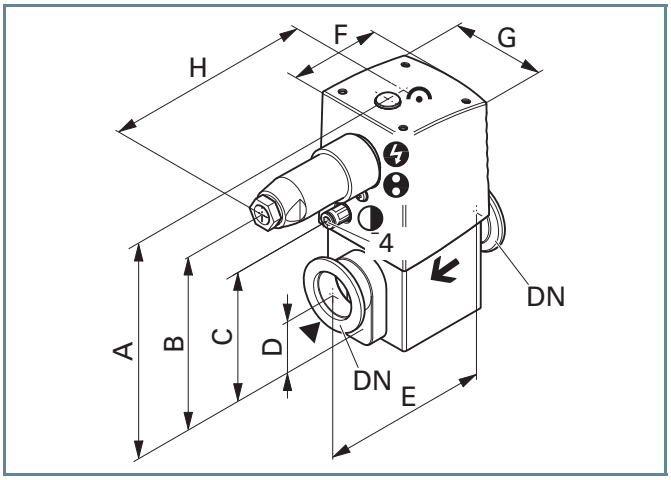
Inline valves

Electropneumatically actuated, with position indicator (PI), with pilot valve (PV), normally open
Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

Inline valves

- One-box design - All in one: With position indicator in one and the same housing
- Drive: Pneumatically actuated
- 24 V DC pilot valve included
- With integral position indicator
- Service life: 10 million operating cycles
- Robust, suitable for industrial use and insensitive to contamination
- Simple maintenance

Dimensions



DVC = Inline valve with bellows feedthrough
PX = Pneumatically actuated, stainless steel housing

	DVC 016 PX	DVC 025 PX	DVC 040 PX
A	126.1 mm	133.6 mm	169.1 mm
B	97 mm	104.5 mm	140 mm
C	59.2 mm	65.7 mm	95.2 mm
D	20 mm	31.8 mm	40.8 mm
E	80 mm	100 mm	130 mm
F	55 mm	64.3 mm	81.3 mm
G	51.4 mm	60.1 mm	75.7 mm
H	93.2 mm	97.8 mm	105.3 mm

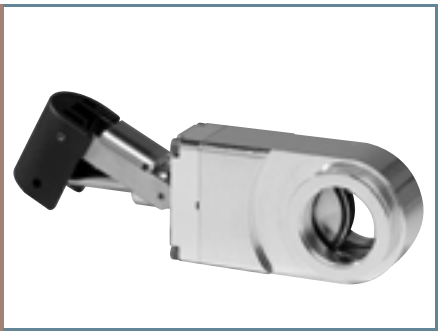
Technical data	DVC 016 PX	DVC 025 PX	DVC 040 PX
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Bakeout temperature: actuator, pilot valve	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Operating pressure max.	2 bar	2 bar	2 bar
Operating pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Differential pressure in opening direction	2 bar	2 bar	2 bar
Differential pressure in closing direction	5 bar	5 bar	5 bar
Compressed air (overpressure) max.	8 bar	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	4 cm^3	11 cm^3	35 cm^3
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.89 kg	1.35 kg	2.2 kg
Power pilot valve	2.5 W	2.5 W	2.5 W
Conductance for molecular flow	2.5 l/s	7 l/s	20 l/s
Opening time	100 ms	120 ms	260 ms
Closing time	100 ms	160 ms	540 ms
Service life	10000000 cycles	10000000 cycles	10000000 cycles
Electrical position indicator	included	included	included
Electrical position indicator: Rating	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A	250 V AC /25 VA/ 0.1 A; 50 V DC/ 12.5 W/ 0.25 A
Control valve	included	included	included
Supply	24 VAC	24 VDC	24 VDC

Order number			
Inline valves	**PF D38 235**	**PF D48 235**	**PF D58 235**

Gate valves

Manually actuated
Flange sizes from
DN 16 ISO-KF to DN 40 ISO-KF

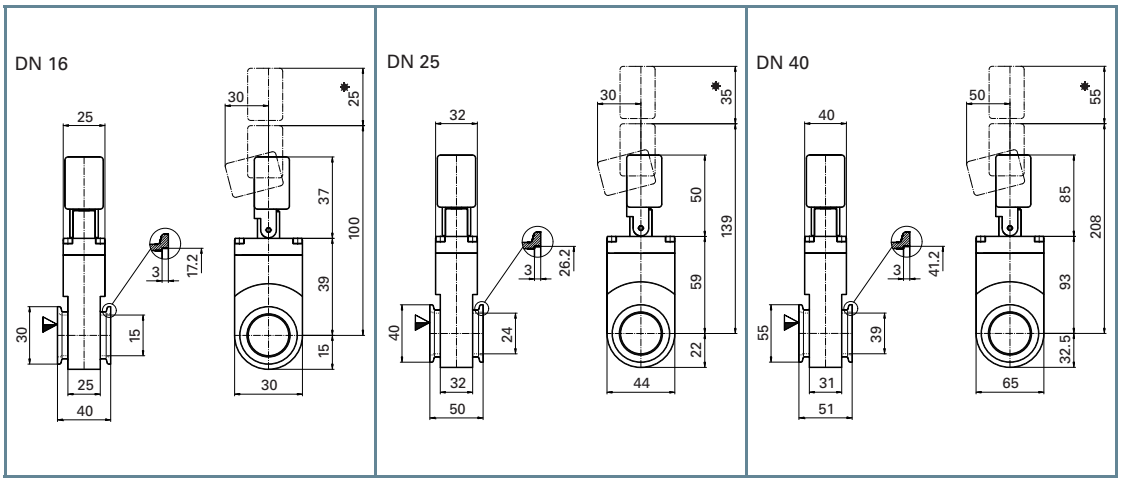
Gate valves



- ▶ Compact installation dimensions
- ▶ A very maintenance-friendly gate valve for industrial applications
- ▶ Seal: Linear feedthrough

SVV = Gate valve
HA = Manually actuated, aluminum housing

Dimensions



SVV 016 HA | SVV 025 HA | SVV 040 HA

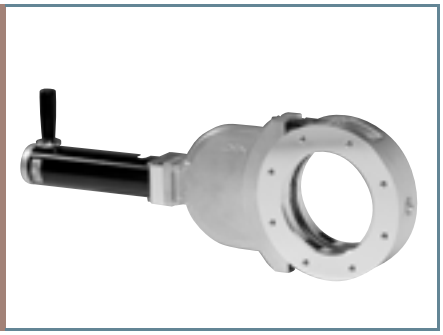
Technical data	SVV 016 HA	SVV 025 HA	SVV 040 HA
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Actuator	Toggle lever	Toggle lever	Toggle lever
Bakeout temperature: actuator	80 °C	80 °C	80 °C
Bakeout temperature: housing	100 °C	100 °C	100 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar
Feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough
Housing	Aluminum	Aluminum	Aluminum
Weight	0.4 kg	0.4 kg	0.7 kg
Conductance for molecular flow	10 l/s	34 l/s	140 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Service life	50000 cycles	50000 cycles	50000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel

Order number			
Gate valves	**PF D31 000**	**PF D41 000**	**PF D51 000**

Gate valves

Manually actuated
Flange sizes from
DN 63 ISO-F to DN 160 ISO-F

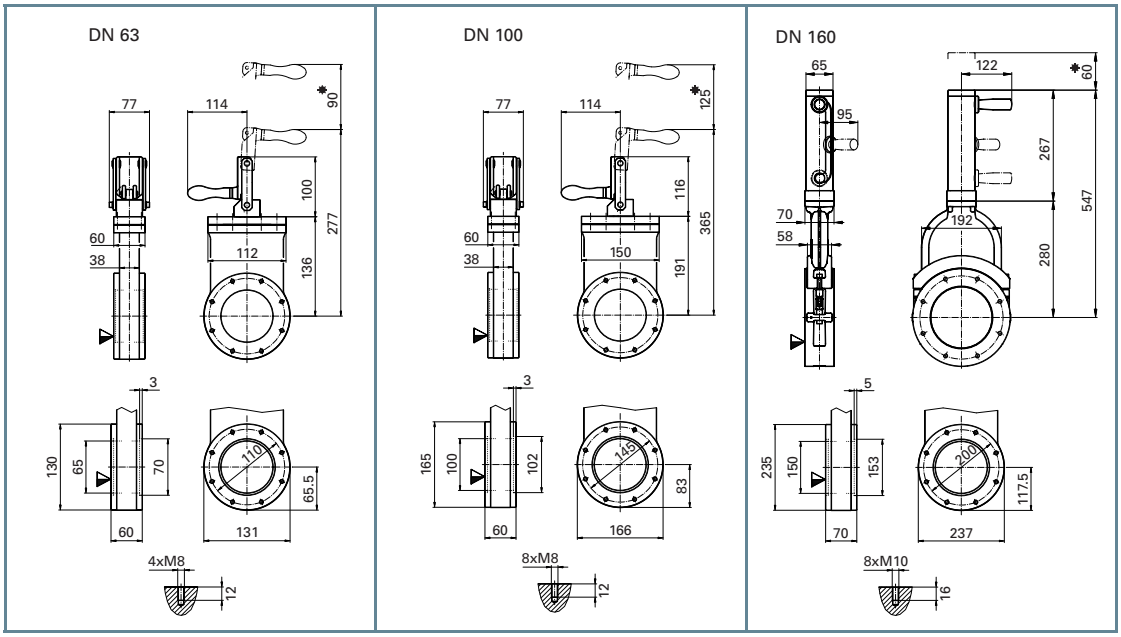
Gate valves



- ▶ Compact installation dimensions
- ▶ A very maintenance-friendly gate valve for industrial applications
- ▶ Seal: Linear feedthrough

SVV = Gate valve
HA = Manually actuated, aluminum housing

Dimensions



SVV 063 HA | SVV 100 HA | SVV 160 HA

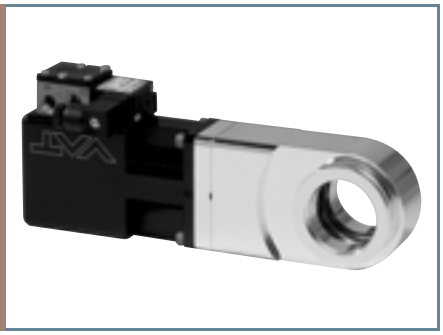
Technical data	SVV 063 HA	SVV 100 HA	SVV 160 HA
Flange (in)	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F
Flange (out)	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F
Actuator	Toggle lever	Toggle lever	Connecting rod
Bakeout temperature: actuator	80 °C	80 °C	80 °C
Bakeout temperature: housing	120 °C	120 °C	120 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	1.6 bar	1.6 bar	1.6 bar
Pressure min.	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar
Feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough
Housing	Aluminum	Aluminum	Aluminum
Weight	3 kg	4.5 kg	9 kg
Conductance for molecular flow	550 l/s	2000 l/s	6000 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Service life	200000 cycles	200000 cycles	100000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel

Order number			
Gate valves	**PF E11 001**	**PF E21 001**	**PF E31 001**

Gate valves

Electropneumatically actuated Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF

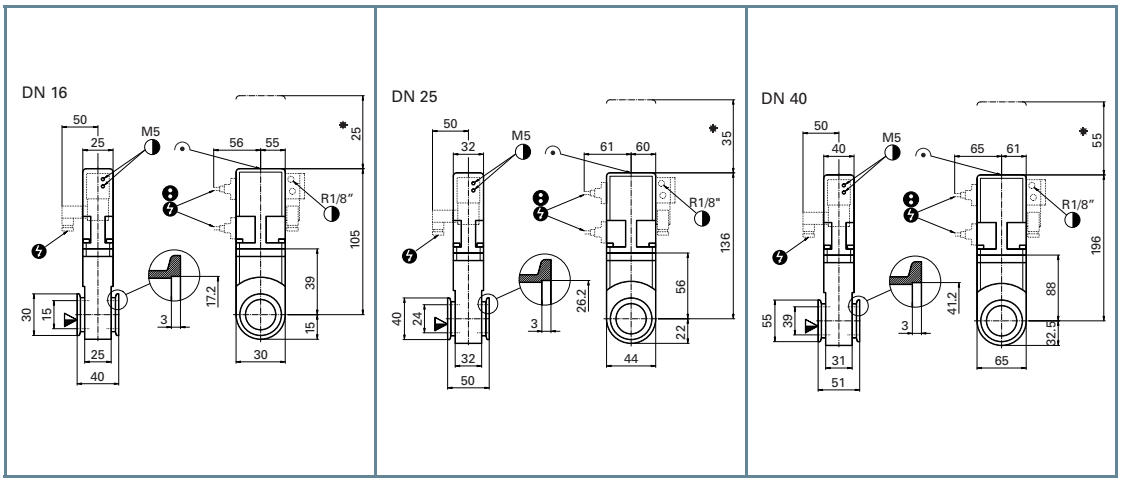
Gate valves



- ▶ Compact installation dimensions
- ▶ A very maintenance-friendly gate valve for industrial applications
- ▶ Seal: Linear feedthrough

SVV = Gate valve
PA =Electropneumatically actuated, aluminum housing
DC = Direct current

Dimensions



SVV 016 PA | SVV 025 PA | SVV 040 PA

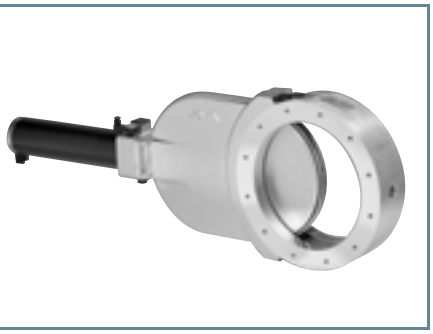
Technical data	SVV 016 PA	SVV 025 PA	SVV 040 PA
Flange (in)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Flange (out)	DN 16 ISO-KF	DN 25 ISO-KF	DN 40 ISO-KF
Actuator	Electropneumatically actuated	Electropneumatically actuated	Electropneumatically actuated
Bakeout temperature: actuator	50 °C	50 °C	50 °C
Bakeout temperature: housing	100 °C	100 °C	100 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2 bar	2 bar	2 bar
Pressure min.	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar
Compressed air (overpressure) max.	7 bar	7 bar	7 bar
Compressed air (overpressure) min.	4.5 bar	4.5 bar	4.5 bar
Compressed air volume	10 cm^3	30 cm^3	70 cm^3
Feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough
Housing	Aluminum	Aluminum	Aluminum
Weight	0.8 kg	0.8 kg	1.2 kg
Position feedback: Load capacity	50 V/0.5 A	50 V/0.5 A	50 V/0.5 A
Power consumption	6 VA	6 VA	6 VA
Conductance for molecular flow	10 l/s	34 l/s	140 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Closing / opening time	0.5 s	0.8 s	1.1 s
Service life	50000 cycles	50000 cycles	50000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel

	SVV 016 PA	SVV 025 PA	SVV 040 PA
Supply	24 V DC	24 V DC	24 V DC
Order number	**PF D38 200**	**PF D48 200**	**PF D58 200**
Supply	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz
Order number	**PF D38 100**	**PF D48 100**	**PF D58 100**
Supply	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Order number	**PF D38 500**	**PF D48 500**	**PF D58 500**

Gate valves

Electropneumatically actuated
Flange sizes from
DN 63 ISO-F to DN 250 ISO-F
Gate valve with linear feedthrough

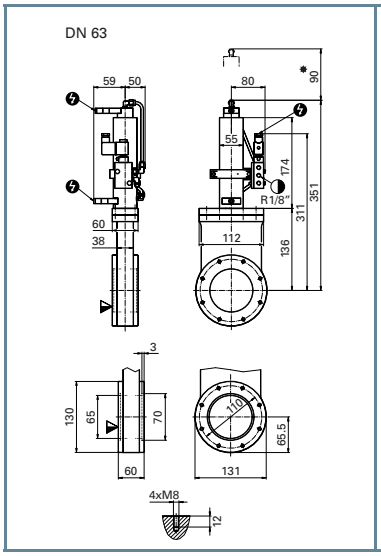
Gate valves



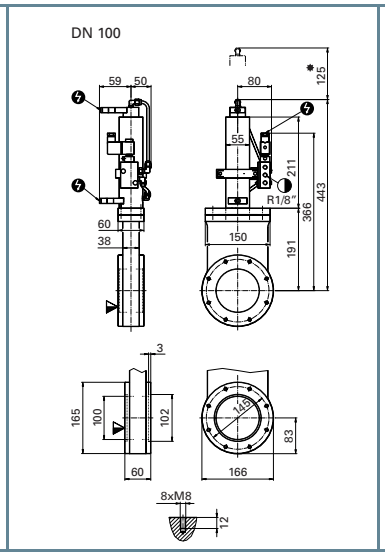
- ▶ Compact installation dimensions
- ▶ A very maintenance-friendly gate valve for industrial applications
- ▶ Seal: Linear feedthrough

SVV = Gate valve
PA =Electropneumatically actuated, aluminum housing
DC = Direct current

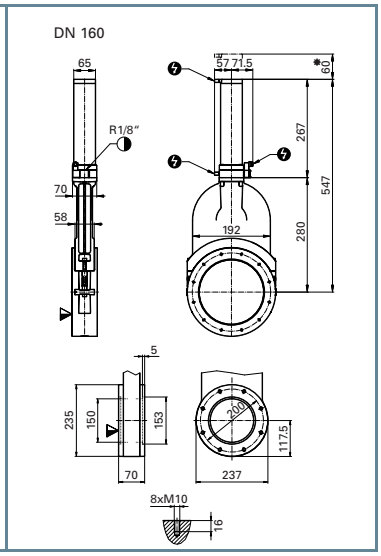
Dimensions



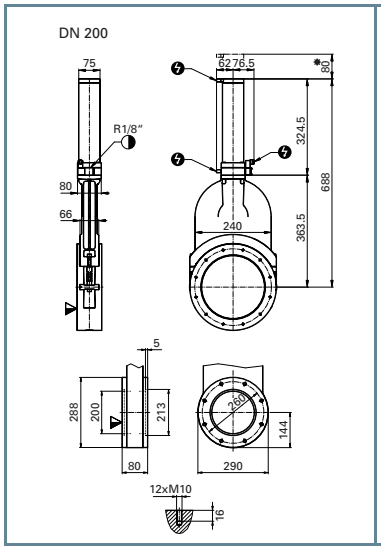
SVV 063 PA



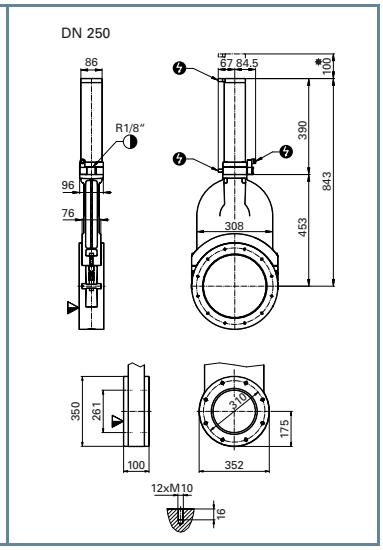
SVV 100 PA



SVV 160 PA



SVV 200 PA



SVV 250 PA

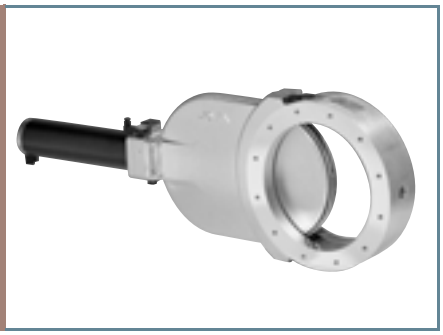
Technical data	SVV 063 PA	SVV 100 PA	SVV 160 PA	SVV 200 PA	SVV 250 PA
Flange (in)	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F	DN 200 ISO-F	DN 250 ISO-F
Flange (out)	DN 63 ISO-F	DN 100 ISO-F	DN 160 ISO-F	DN 200 ISO-F	DN 250 ISO-F
Actuator	Electropneumatically actuated	Electropneumatically actuated	Electropneumatically actuated	Electropneumatically actuated	Electropneumatically actuated
Bakeout temperature: actuator	80 °C	80 °C	50 °C	50 °C	50 °C
Bakeout temperature: housing	120 °C	120 °C	120 °C	120 °C	120 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM	FPM	FPM
Pressure max.	1.6 bar	1.6 bar	1.6 bar	1.6 bar	1.2 bar
Pressure min.	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar	$1 \cdot 10^{-7}$ mbar
Compressed air (overpressure) max.	7 bar	7 bar	7 bar	7 bar	7 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar	4 bar	4 bar
Compressed air volume	160 cm^3	220 cm^3	500 cm^3	900 cm^3	1500 cm^3
Feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough	Shaft feedthrough
Housing	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum
Weight	3 kg	4.5 kg	9 kg	18 kg	25 kg
Position feedback: Load capacity	250 V/2 A	250 V/2 A	250 V/5 A	250 V/5 A	250 V/5 A
Power consumption	5.4 VA	5.4 VA	6 VA	6 VA	6 VA
Conductance for molecular flow	550 l/s	2,000 l/s	6000 l/s	12000 l/s	22000 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Closing / opening time	1.5 s	2 s	2 s	3 s	5 s
Service life	200000 cycles	200000 cycles	100000 cycles	100000 cycles	100000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel

	SVV 063 PA	SVV 100 PA	SVV 160 PA	SVV 200 PA	SVV 250 PA
Supply	24 V DC	24 V DC	24 V DC	24 V DC	24 V DC
Order number	**PF E18 201**	**PF E28 201**	**PF E38 201**	**PF E48 201**	**PF E58 201**
Supply	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz
Order number	**PF E18 101**	**PF E28 101**	**PF E38 101**	**PF E48 101**	**PF E58 101**
Supply	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Order number	**PF E18 501**	**PF E28 501**	**PF E38 501**	**PF E48 501**	**PF E58 501**

Gate valves

Electropneumatically actuated
Flange sizes from
DN 200 ISO-F to DN 250 ISO-F
Gate valve with rotary feedthrough

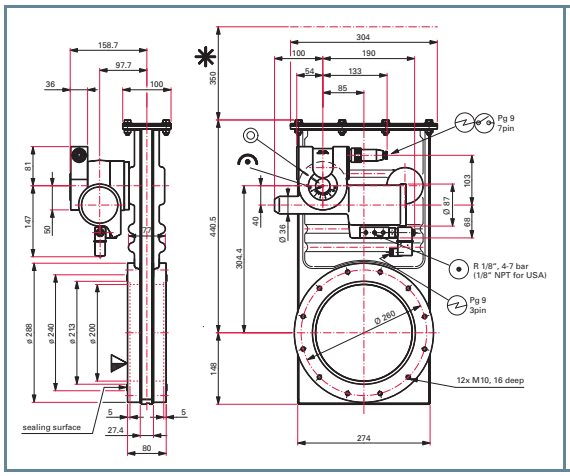
Gate valves



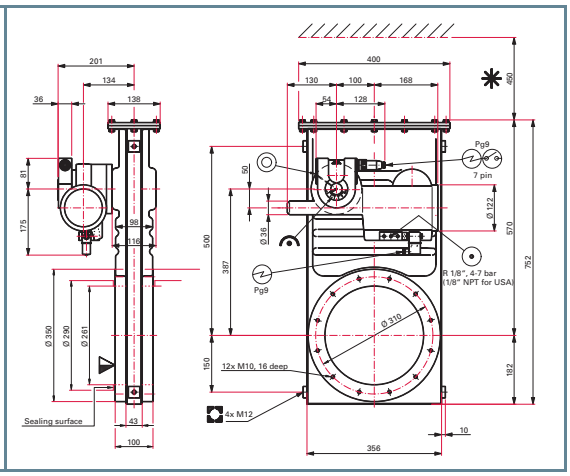
- ▶ Compact gate valve for process systems, offering long service life
- ▶ Seal: Rotary feedthrough for long service life and low particulate matter generation

SVV = Gate valve
PA = Electropneumatically actuated, aluminium housing
AC = Alternating current
DC = Direct current

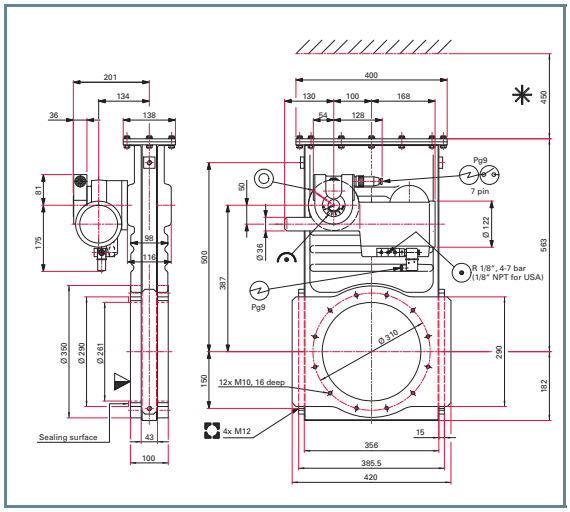
Dimensions



SVV 201 PA



SVV 251 PA



SVV 252 PA

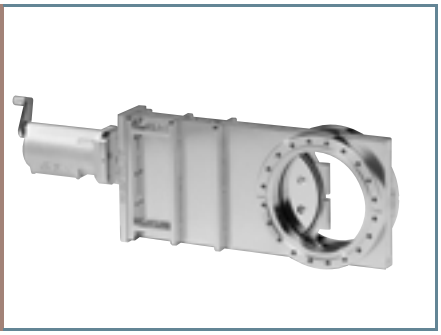
Technical data	SVV 201 PA	SVV 251 PA	SVV 252 PA
Flange (in)	DN 200 ISO-F	DN 250 ISO-F	DN 250 ISO-F
Flange (out)	DN 200 ISO-F	DN 250 ISO-F	DN 250 ISO-F
Bakeout temperature: actuator	50 °C	50 °C	50 °C
Bakeout temperature: housing	150 °C	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM	FPM
Pressure max.	2 bar	1.2 bar	1.2 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Compressed air (overpressure) max.	7 bar	7 bar	7 bar
Compressed air (overpressure) min.	4 bar	4 bar	4 bar
Compressed air volume	280 cm^3	750 cm^3	750 cm^3
Feedthrough	rotary feedthrough	rotary feedthrough	rotary feedthrough
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	30 kg	60 kg	60 kg
Position feedback: Load capacity	250 V/5 A	250 V/5 A	250 V/5 A
Power consumption	3 VA	3 VA	3 VA
Conductance for molecular flow	12000 l/s	22000 l/s	22000 l/s
Can be opened to a pressure difference of	30 mbar	30 mbar	30 mbar
Closing / opening time	2.5 s	4 s	4 s
Service life	200000 cycles	200000 cycles	200000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel

	SVV 201 PA	SVV 251 PA	SVV 252 PA
Supply	24 V DC	24 V DC	24 V DC
Order number	**PF E48 240**	**PF E58 240**	**PF E58 250**
Supply	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz
Order number	**PF E48 140**	**PF E58 140**	**PF E58 150**
Supply	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Order number	**PF E48 540**	**PF E58 540**	**PF E58 550**

Bellows-sealed gate valves

Manually actuated - CF-F
Flange sizes from
DN 40 CF-F to DN 200 CF-F

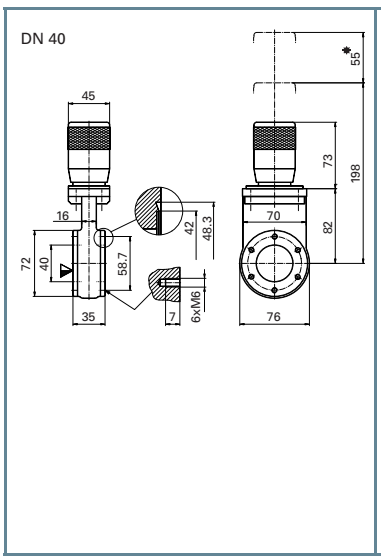
Bellows-sealed gate valves



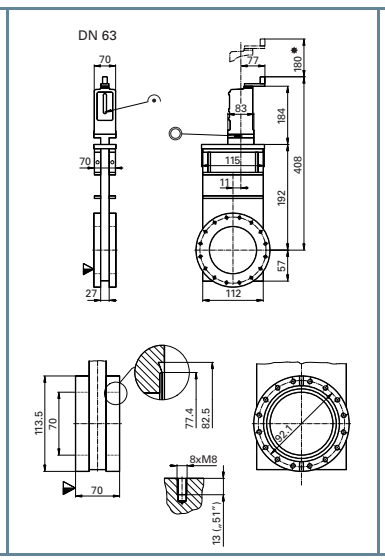
- ▶ For UHV applications in industry and research
- ▶ Seal: Stainless steel bellows feedthrough

SVV = Gate valve
HF/HM = Manually actuated

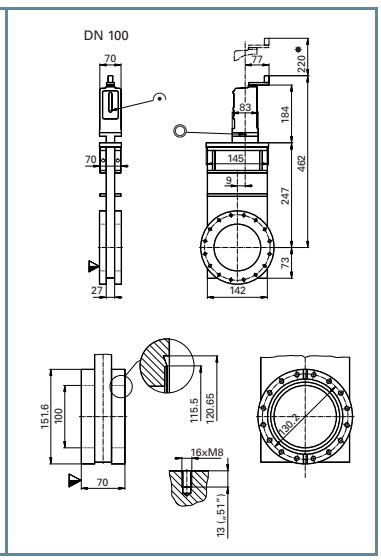
Dimensions



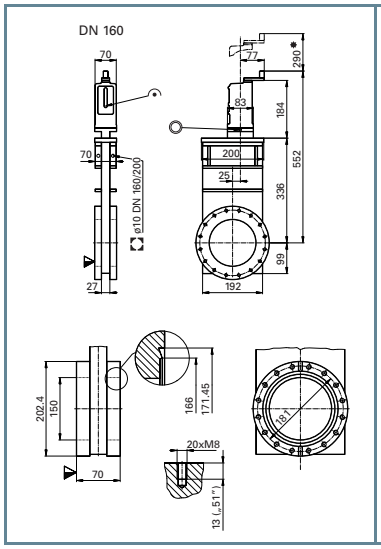
SVV 040 HM



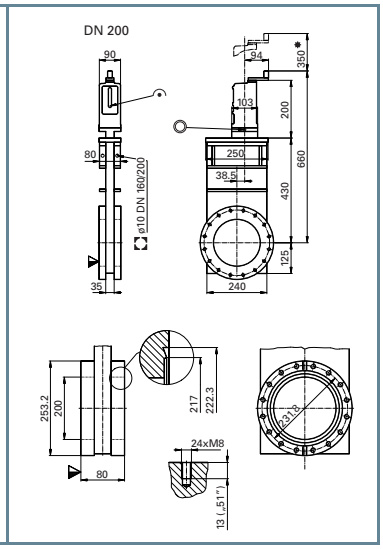
SVV 063 HF



SVV 100 HF



SVV 160 HF



SVV 200 HF

Technical data	SVV 040 HM	SVV 063 HF	SVV 100 HF
Flange (in)	DN 40 CF-F	DN 63 CF-F	DN 100 CF-F
Flange (out)	DN 40 CF-F	DN 63 CF-F	DN 100 CF-F
Actuator	Hand wheel	Hand wheel	Hand wheel
Bakeout temperature: Valve open, under vacuum	250 °C	250 °C	250 °C
Bakeout temperature: Valve closed	200 °C	200 °C	200 °C
Tightness: Housing	$5 \cdot 10^{-10}$ mbar l/s	$5 \cdot 10^{-10}$ mbar l/s	$5 \cdot 10^{-10}$ mbar l/s
Tightness: Valve seat	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal: Housing	Metal	Metal	Metal
Seal: Valve seat	FPM	FPM	FPM
Pressure max.	2 bar	1.6 bar	1.6 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Feedthrough	Bellows	Bellows	Bellows
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	1.5 kg	9 kg	12 kg
Conductance for molecular flow	220 l/s	600 l/s	1700 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Service life	50000 cycles	50000 cycles	50000 cycles
Valve plate	Stainless steel	Stainless steel	Stainless steel

Order number			
Bellows-sealed gate valves	**PF F51 031**	**PF F61 031**	**PF F71 031**

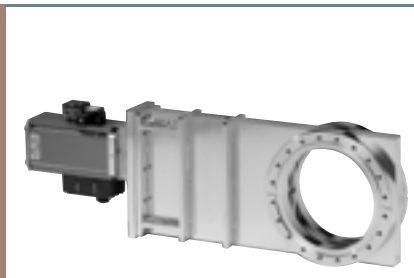
Technical data	SVV 160 HF	SVV 200 HF
Flange (in)	DN 160 CF-F	DN 200 CF-F
Flange (out)	DN 160 CF-F	DN 200 CF-F
Actuator	Hand wheel	Hand wheel
Bakeout temperature: Valve open, under vacuum	250 °C	250 °C
Bakeout temperature: Valve closed	200 °C	200 °C
Tightness: Housing	$5 \cdot 10^{-10}$ mbar l/s	$5 \cdot 10^{-10}$ mbar l/s
Tightness: Valve seat	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal: Housing	Metal	Metal
Seal: Valve seat	FPM	FPM
Pressure max.	1.6 bar	1.6 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar	$1 \cdot 10^{-10}$ mbar
Feedthrough	Bellows	Bellows
Housing	Stainless steel	Stainless steel
Weight	18 kg	28 kg
Conductance for molecular flow	6000 l/s	12000 l/s
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar	$3 \cdot 10^{1}$ mbar
Service life	50000 cycles	50000 cycles
Valve plate	Stainless steel	Stainless steel

Order number		
Bellows-sealed gate valves	**PF F81 031**	**PF F91 031**

Bellows-sealed gate valves

Electropneumatically actuated
Flange sizes from
DN 40 CF-F to DN 250 CF-F

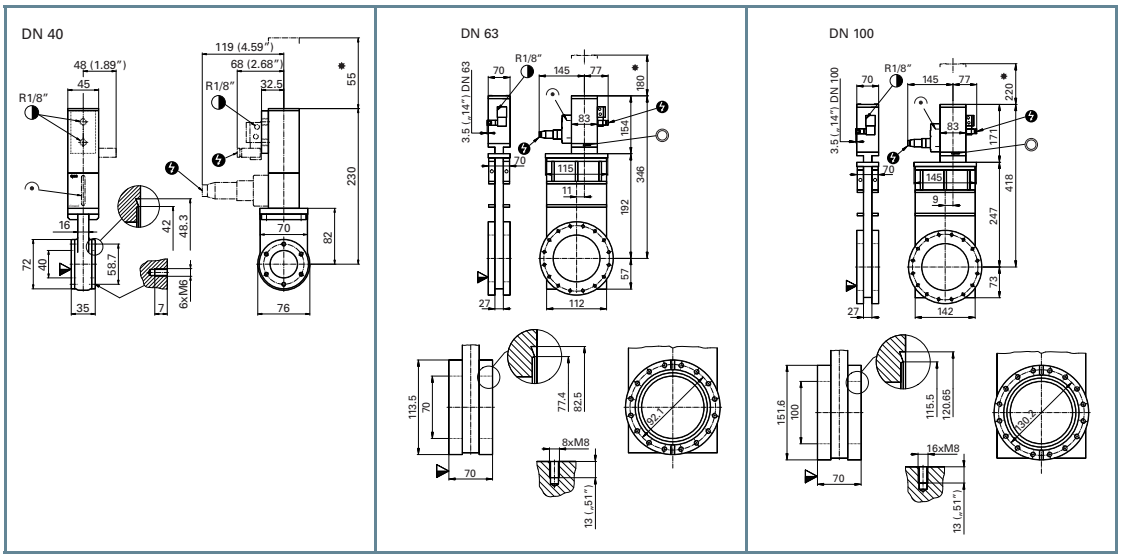
Bellows-sealed gate valves



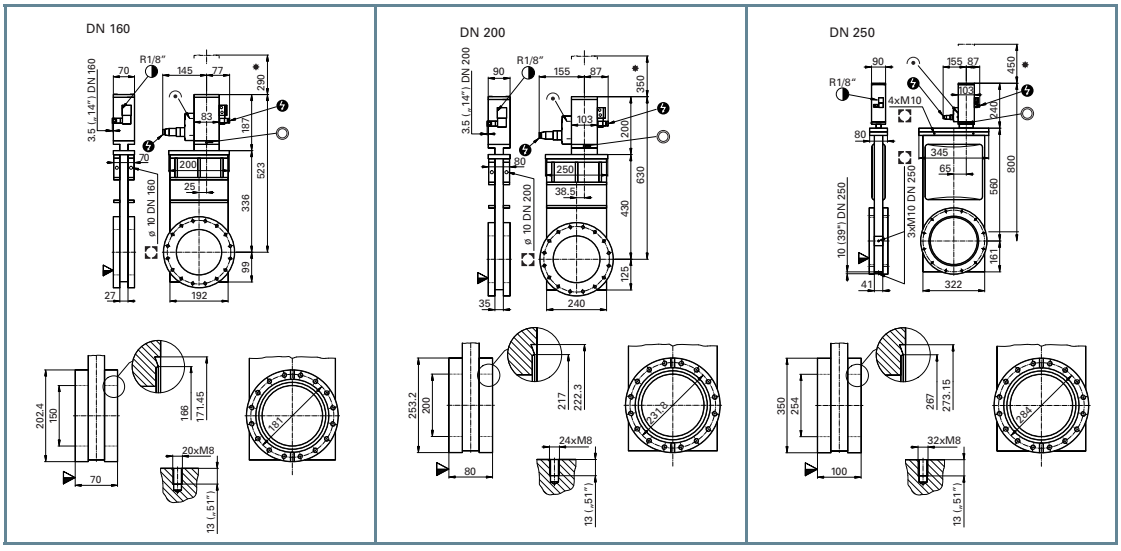
- ▶ For UHV applications in industry and research
- ▶ Seal: Stainless steel bellows feedthrough

SVV = Gate valve
PM/PF = Electropneumatically actuated
DC = Direct current

Dimensions



SVV 040 PM | SVV 063 PF | SVV 100 PF



SVV 160 PF | SVV 200 PF | SVV 250 PF

General technical data	
Actuator	Electropneumatic ally actuated
Bakeout temperature: actuator	200 °C
Bakeout temperature: Valve open, under vacuum	250 °C
Bakeout temperature: Valve closed	200 °C
Tightness: Housing	$5 \cdot 10^{-10}$ mbar l/s
Tightness: Valve seat	$1 \cdot 10^{-9}$ mbar l/s
Seal: Housing	Metal
Seal: Valve seat	FPM
Pressure min.	$1 \cdot 10^{-10}$ mbar
Compressed air (overpressure) max.	7 bar
Feedthrough	Bellows
Housing	Stainless steel
Position feedback: Load capacity	250 V/5 A
Power consumption	6 VA
Can be opened to a pressure difference of	$3 \cdot 10^{1}$ mbar
Service life	50000 cycles
Valve plate	Stainless steel

Technical data	SVV 040 PM	SVV 063 PF	SVV 100 PF
Flange (in)	DN 40 CF-F	DN 63 CF-F	DN 100 CF-F
Flange (out)	DN 40 CF-F	DN 63 CF-F	DN 100 CF-F
Pressure max.	2 bar	1.6 bar	1.6 bar
Compressed air (overpressure) min.	4.5 bar	4 bar	4 bar
Compressed air volume	60 cm^3	80 cm^3	110 cm^3
Weight	1.8 kg	9 kg	12 kg
Conductance for molecular flow	220 l/s	600 l/s	1700 l/s
Closing / opening time	0.7 s	1 s	1.2 s

	SVV 040 PM	SVV 063 PF	SVV 100 PF
Supply	24 V DC	24 V DC	24 V DC
Order number	**PF F58 231**	**PF F68 231**	**PF F78 231**
Supply	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz
Order number	**PF F58 131**	**PF F68 131**	**PF F78 131**
Supply	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Order number	**PF F58 531**	**PF F68 531**	**PF F78 531**

Technical data	SVV 160 PF	SVV 200 PF	SVV 250 PF
Flange (in)	DN 160 CF-F	DN 200 CF-F	DN 250 CF-F
Flange (out)	DN 160 CF-F	DN 200 CF-F	DN 250 CF-F
Pressure max.	1.6 bar	1.6 bar	1.2 bar
Compressed air (overpressure) min.	4 bar	4 bar	5 bar
Compressed air volume	140 cm^3	250 cm^3	350 cm^3
Weight	18 kg	28 kg	42 kg
Conductance for molecular flow	6000 l/s	12000 l/s	26000 l/s
Closing / opening time	1.5 s	2 s	4 s

	SVV 160 PF	SVV 200 PF	SVV 250 PF
Supply	24 V DC	24 V DC	24 V DC
Order number	**PF F88 231**	**PF F98 231**	**PF F98 241**
Supply	24 V, 50 Hz	24 V, 50 Hz	24 V, 50 Hz
Order number	**PF F88 131**	**PF F98 131**	**PF F98 141**
Supply	230 V, 50 Hz	230 V, 50 Hz	230 V, 50 Hz
Order number	**PF F88 531**	**PF F98 531**	**PF F98 541**

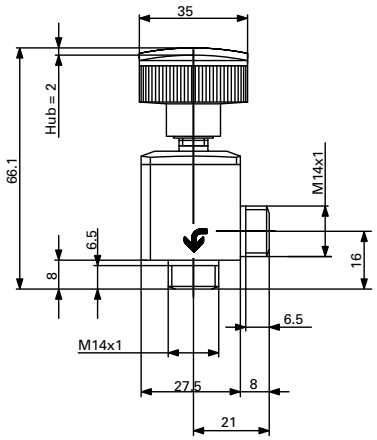
Mini angle valves

Manually actuated

Mini angle valves

- For industrial applications
- Seal: Bellows
- Compact design

Dimensions

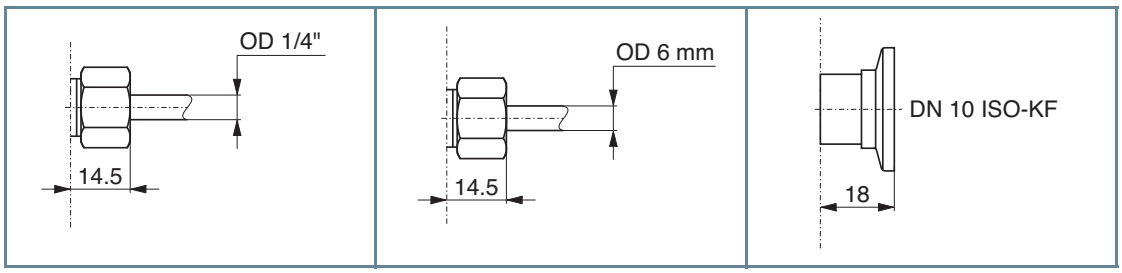


Technical data	EVI 005 S
Flange (in)	DN 5 mm M14x1
Flange (out)	DN 5 mm M14x1
Bakeout temperature: actuator	70 °C
Bakeout temperature: housing	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Differential pressure in opening direction	4 bar
Differential pressure in closing direction	4 bar
Pressure max.	5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Feedthrough	Bellows, stainless steel
Housing	Stainless steel
Weight	150 g
Conductance for laminar flow	4 l/s
Conductance for molecular flow	0.4 l/s
Can be opened to a pressure difference of	4 bar
Service life	1500000 cycles
Ambient temperature	5 - 70 °C
Valve plate	Stainless steel

Order number	
Mini angle valves	**PF H12 031**

Accessories	
Connection, for ¼" tube O.D.	**PT 420 913-T**
Connection, for 6 mm tube O.D.	**PT 420 914-T**
Connection, DN 10 ISO-KF	**PT 420 912-T**

Dimensions



Tube O.D. 1/4" | Tube O.D. 6 mm | DN 10 ISO-KF

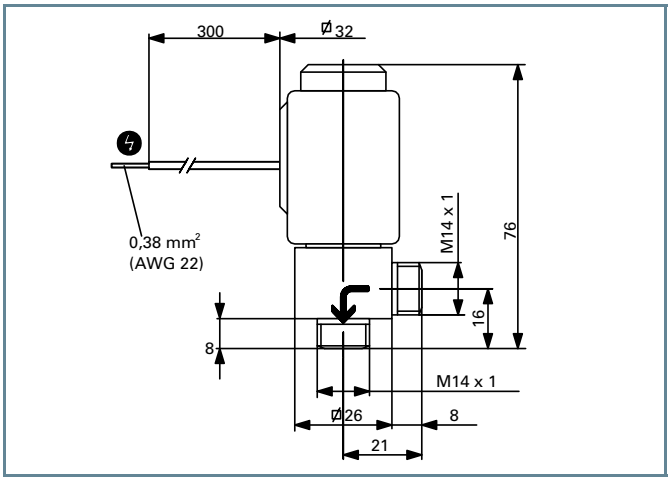
Mini angle valves

Solenoid actuated

Mini angle valves

- ▶ Very long service life, 2 million cycles
- ▶ Short opening time
- ▶ Compact design
- ▶ For industrial applications

Dimensions

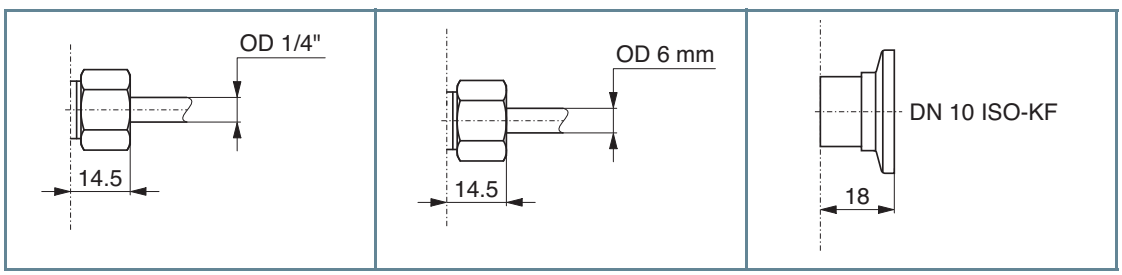


Technical data	EVI 005 M
Flange (in)	DN 5 mm M14x1
Flange (out)	DN 5 mm M14x1
Actuator	Stainless steel
Version	normally closed
Bakeout temperature: actuator	120 °C
Bakeout temperature: housing	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Differential pressure in opening direction	1.5 bar
Differential pressure in closing direction	5 bar
Pressure max.	10 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Feedthrough	-
Housing	Stainless steel
Weight	300 g
Conductance for laminar flow	3 l/s
Conductance for molecular flow	0.3 l/s
Can be opened to a pressure difference of	1 bar
Switching frequency	5 1/s
Closing / opening time	7/30 ms
Protection acc. to DIN 40050	IP 65
Service life	2000000 cycles
Electrical position indicator	-
Ambient temperature	5 - 40 °C
Supply	24 V DC
Supply: Power consumption max.	10 W

Order number	
Mini angle valves	**PF H13 231**

Accessories	
Connection, for ¼" tube O.D.	**PT 420 913-T**
Connection, for 6 mm tube O.D.	**PT 420 914-T**
Connection, DN 10 ISO-KF	**PT 420 912-T**

Dimensions



Tube O.D. 1/4" | Tube O.D. 6 mm | DN 10 ISO-KF

Mini angle valves

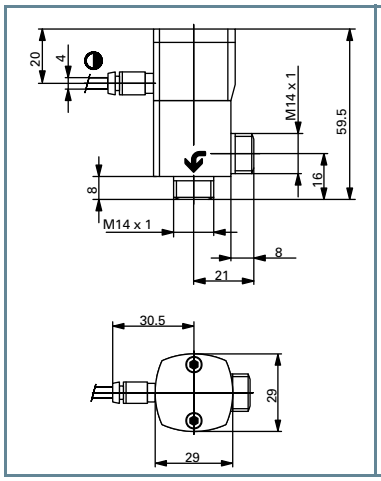
Electropneumatically actuated

Mini angle valves

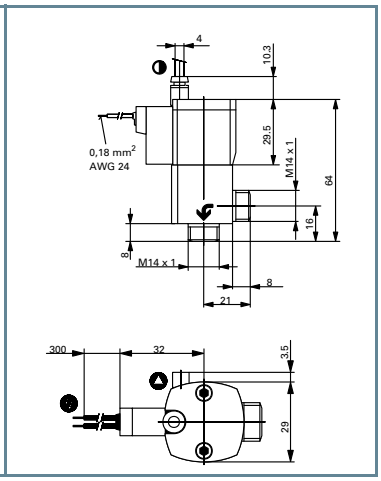
- ▶ Very long service life, 2 million cycles
- ▶ Short opening time
- ▶ Compact design
- ▶ For industrial applications

EVI = Mini angle valve with bellows feedthrough
P = Electropneumatically actuated

Dimensions



EVI 005 P



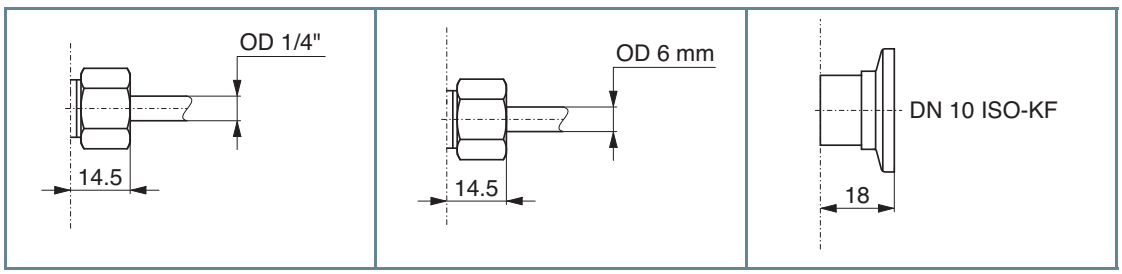
EVI 105 P

Technical data	EVI 005 P	EVI 105 P
Flange (in)	DN 5 mm M14x1	DN 5 mm M14x1
Flange (out)	DN 5 mm M14x1	DN 5 mm M14x1
Bakeout temperature: actuator	80 °C	80 °C
Bakeout temperature: housing	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM
Differential pressure in opening direction	3 bar	3 bar
Differential pressure in closing direction	3 bar	3 bar
Pressure max.	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Compressed air (overpressure) max.	8 bar	8 bar
Compressed air (overpressure) min.	4 bar	4 bar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel
Weight	200 g	200 g
Conductance for laminar flow	4 l/s	4 l/s
Conductance for molecular flow	0.4 l/s	0.4 l/s
Can be opened to a pressure difference of	3 bar	3 bar
Switching frequency	150 rpm	150 rpm
Closing / opening time	35/35 ms	35/35 ms
Protection acc. to DIN 40050	IP 65	IP 65
Service life	5000000 cycles	5000000 cycles
Electrical position indicator	-	-
Control valve	-	included
Ambient temperature	5 - 80 °C	5 - 40 °C
Supply	-	24 V DC
Supply: Power consumption max.	-	1 W

Order number		
Mini angle valves	**PF H15 031**	**PF H17 231**

Accessories		
Connection, for ¼" tube O.D.	**PT 420 913-T**	**PT 420 913-T**
Connection, for 6 mm tube O.D.	**PT 420 914-T**	**PT 420 914-T**
Connection, DN 10 ISO-KF	**PT 420 912-T**	**PT 420 912-T**

Dimensions



Tube O.D. 1/4" | Tube O.D. 6 mm | DN 10 ISO-KF

Mini inline valves

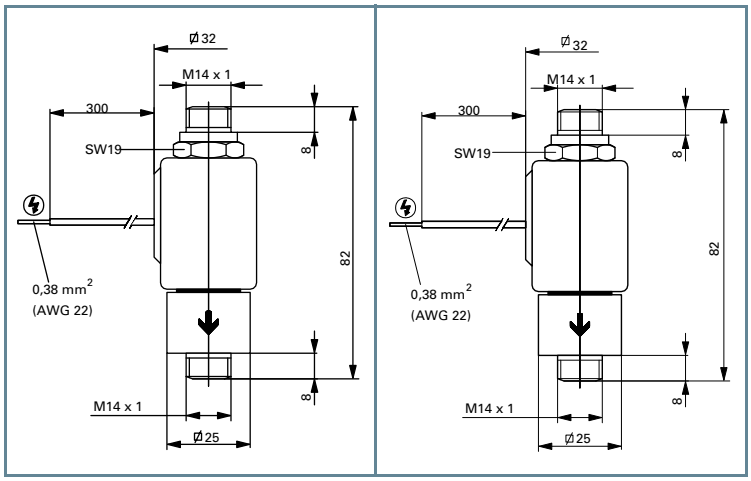
Solenoid actuated

Mini inline valves

- ▶ Very long service life, 2 million cycles
- ▶ Short opening time
- ▶ Compact design
- ▶ For industrial applications

DVI = Mini inline valve with bellows feedthrough
M = Solenoid actuated

Dimensions



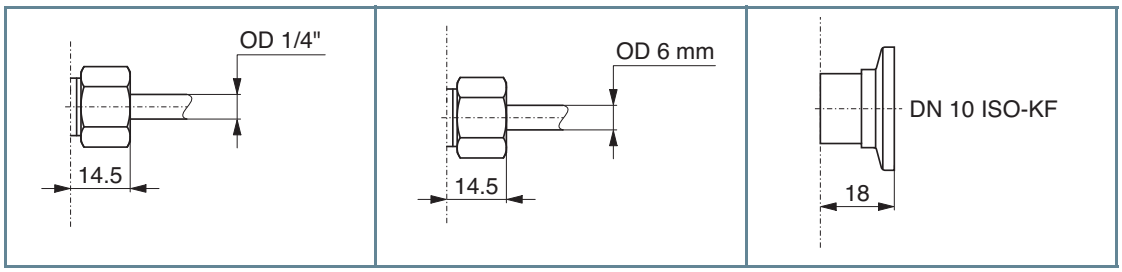
DVI 005 M DVI 205 M

Technical data	DVI 005 M	DVI 205 M
Flange (in)	DN 5 mm M14x1	DN 5 mm M14x1
Flange (out)	DN 5 mm M14x1	DN 5 mm M14x1
Actuator	Stainless steel	Stainless steel
Version	normally closed	normally open
Bakeout temperature: actuator	120 °C	120 °C
Bakeout temperature: housing	150 °C	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM
Differential pressure in opening direction	1.5 bar	2 bar
Differential pressure in closing direction	5 bar	4 bar
Pressure max.	10 bar	10 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Feedthrough	-	-
Housing	Stainless steel	Stainless steel
Weight	300 g	300 g
Conductance for laminar flow	2 l/s	2 l/s
Conductance for molecular flow	0.2 l/s	0.2 l/s
Can be opened to a pressure difference of	1 bar	4 bar
Switching frequency	5 1/s	5 1/s
Closing / opening time	7/30 ms	30/10 ms
Protection acc. to DIN 40050	IP 65	IP 65
Service life	2000000 cycles	2000000 cycles
Electrical position indicator	-	-
Ambient temperature	5 - 40 °C	5 - 40 °C
Supply	24 V DC	24 V DC
Supply: Power consumption max.	10 W	10 W

Order number		
Mini inline valves	**PF H13 232**	**PF H13 233**

Accessories		
Connection, for ¼" tube O.D.	**PT 420 913-T**	**PT 420 913-T**
Connection, for 6 mm tube O.D.	**PT 420 914-T**	**PT 420 914-T**
Connection, DN 10 ISO-KF	**PT 420 912-T**	**PT 420 912-T**

Dimensions



Tube O.D. 1/4" | Tube O.D. 6 mm | DN 10 ISO-KF

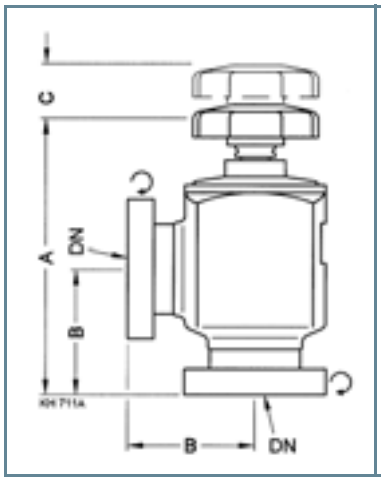
All-metal angle valves

All-metal angle valves

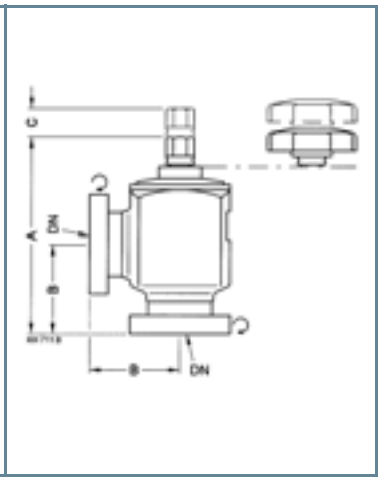
- ▶ For HV and UHV applications
- ▶ Anti-magnetic materials

UVH = All-metal angle valve
CU = Copper seal plate
VI = FPM valve plate seal

Dimensions



UVH 016 - VI



UVH 016 - CU

	UVH 016 - VI	UVH 040 - VI	UVH 063 - VI
A	104.2 mm	150.9 mm	231.2 mm
B	38 mm	63 mm	105 mm
C	15 mm	27 mm	36 mm

	UVH 016 - CU	UVH 040 - CU	UVH 063 - CU
A	88 mm	140 mm	210 mm
B	38 mm	63 mm	105 mm
C	15 mm	27 mm	36 mm

Technical data	UVH 016 - VI	UVH 040 - VI	UVH 063 - VI
Flange (in)	DN 16 CF-R	DN 40 CF-R	DN 63 CF-R
Flange (out)	DN 16 CF-R	DN 40 CF-R	DN 63 CF-R
Actuator	Hand wheel	Hand wheel	Hand wheel
Bakeout temperature: with adjustment knob	80 °C	80 °C	80 °C
Bakeout temperature: without adjustment knob	180 °C	180 °C	180 °C
Tightness	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Seal: Valve plate	FPM	FPM	FPM
Pressure max.	4 bar	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar	$1 \cdot 10^{-9}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.35 kg	1.8 kg	4.8 kg
Conductance for molecular flow	3 l/s	38 l/s	100 l/s
Service life	50000 cycles	50000 cycles	50000 cycles

Order number			
All-metal angle valves	**PF C32 032**	**PF C52 032**	**PF C62 032**

Technical data	UVH 016 - CU	UVH 040 - CU	UVH 063 - CU
Flange (in)	DN 16 CF-R	DN 40 CF-R	DN 63 CF-R
Flange (out)	DN 16 CF-R	DN 40 CF-R	DN 63 CF-R
Actuator	Hand wheel / Outer hexagon	Hand wheel / Outer hexagon	Hand wheel / Outer hexagon
Heat up and cool down speed	4 °C/min	4 °C/min	2 °C/min
Bakeout temperature: with adjustment knob	80 °C	80 °C	80 °C
Bakeout temperature: without adjustment knob	350 °C	350 °C	350 °C
Tightness	$1 \cdot 10^{-12}$ mbar l/s	$1 \cdot 10^{-12}$ mbar l/s	$1 \cdot 10^{-12}$ mbar l/s
Seal plate	Copper	Copper	Copper
Pressure max.	4 bar	4 bar	4 bar
Pressure min.	$1 \cdot 10^{-11}$ mbar	$1 \cdot 10^{-11}$ mbar	$1 \cdot 10^{-11}$ mbar
Feedthrough	Bellows, stainless steel	Bellows, stainless steel	Bellows, stainless steel
Housing	Stainless steel	Stainless steel	Stainless steel
Weight	0.4 kg	2 kg	5 kg
Conductance for molecular flow	3 l/s	38 l/s	100 l/s
Service life	1000 cycles	1000 cycles	1000 cycles

Order number			
All-metal angle valves	**PF K32 032**	**PF K52 032**	**PF K62 032**

Venting valves

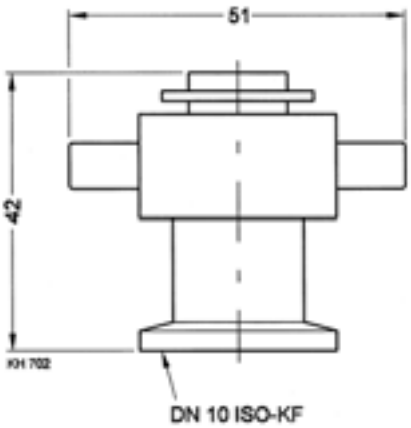
Manually actuated

Venting valves

- For manually venting small vacuum chambers
- Valve opens and closes easily by loosening/ tightening the screw cap

FVB = Venting valve
HA = Manually actuated, aluminum housing
HX = Manually actuated, stainless steel housing

Dimensions



Technical data	FVB 010 HA	FVB 010 HX
Flange (in)	DN 10 ISO-KF	DN 10 ISO-KF
Bakeout temperature	80 °C	120 °C
Venting time for 50 l volume	14 s	14 s
Tightness	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM	FPM
Pressure max.	1 bar	1 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar	$1 \cdot 10^{-8}$ mbar
Housing	Aluminum	Stainless steel
Weight	0.1 kg	0.15 kg
Screw cap	Brass	Brass
Valve plate	Aluminum	Stainless steel

Order number		
Venting valves	**PF I22 003**	**PF I22 031**

Pressure relief valves

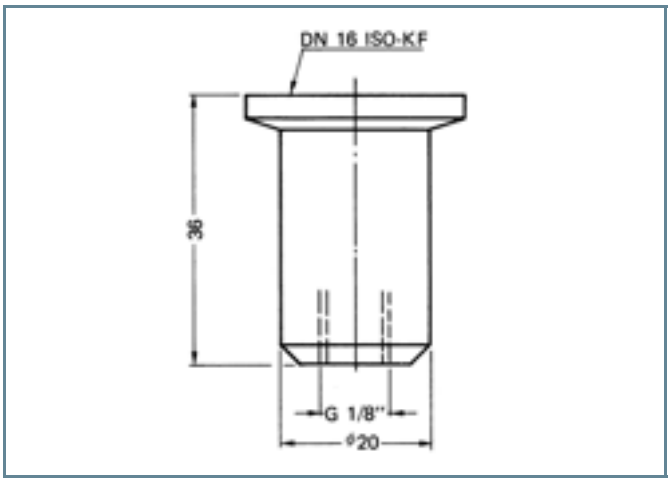
Pressure relief valve

Pressure relief valves

- ▶ Pressure relief valve
- ▶ Housing material: Stainless steel
- ▶ Response pressure: 1.2 to 1.5 bar

AVA = Pressure relief valve
X = Stainless steel housing

Dimensions



Technical data	AVA 016 X
Flange (in)	DN 16 ISO-KF
Flange (out)	G 1/8"
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Differential pressure max.	0.5 bar
Differential pressure min.	0.2 bar
Flow rate max.	6 l/min
Material	Housing, stainless steel

Order number	
Pressure relief valve	**PF I30 032**

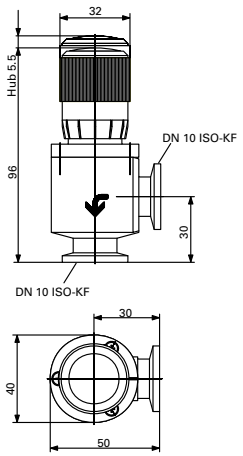
Gas dosing valves

Coarse gas dosing valve

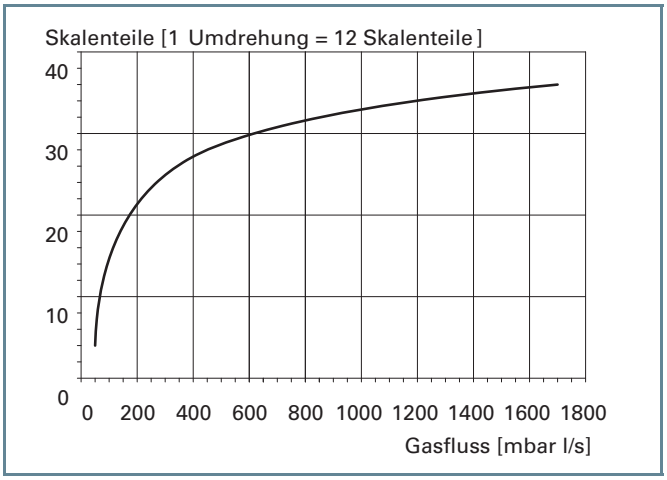
Gas dosing valves

▶ For slow, manual venting

Dimensions



Characteristic



Technical data	EVD 010 H
Flange (in)	DN 10 ISO-KF
Flange (out)	DN 10 ISO-KF
Bakeout temperature	100 °C
Tightness	$1 \cdot 10^{-8}$ mbar l/s
Seal	FPM
Pressure max.	4 bar
Gas flow max. controllable	$1.7 \cdot 10^{3}$ mbar l/s
Gas flow min. controllable	40 mbar l/s
Housing	Aluminum
Weight	0.2 kg

Order number	
Gas dosing valves	**PF I22 001**

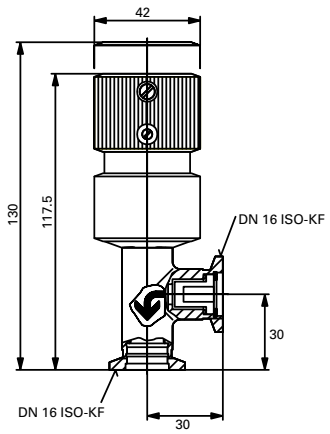
Gas dosing valves

Gas dosing/shut-off valve

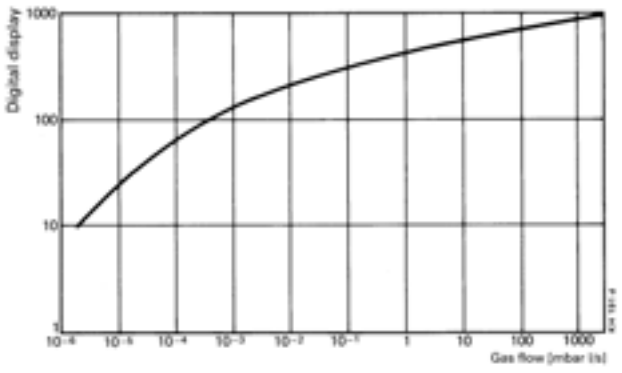
Gas dosing valves

- ▶ Very broad regulating range
- ▶ Optimum characteristic
- ▶ Digital position display
- ▶ Excellent reproducibility
- ▶ Extremely small dead volume
- ▶ Integrated shut-off valve

Dimensions



Characteristic

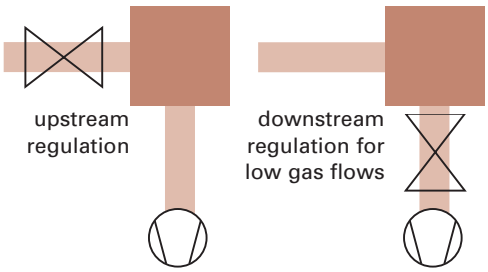


Technical data	EVN 116
Flange (in)	DN 16 ISO-KF
Flange (out)	DN 16 ISO-KF
Bakeout temperature: flanges	150 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Differential pressure	2.5 bar
Dosing sleeve	Fluorplastomer
Gas flow max. controllable	$1 \cdot 10^{3}$ mbar l/s
Gas flow min. controllable	$5 \cdot 10^{-6}$ mbar l/s
Housing/needle/filter	Stainless steel
Weight	0.4 kg
Temperature: Operating	80 °C
Dead volume	0.032 cm^3

Order number	
Gas dosing valves	**PF I32 031**

Notes

Overview gas dosing systems



Regulation valve

Control

RME 005 A

RVC 300

or

EVR 116

RVC 300

or

IF 200

PC
PLC

Example:
ActiveLine Gauges

process chamber

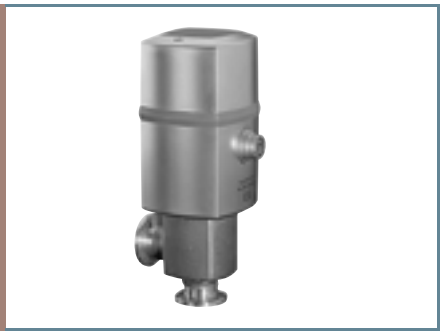
CMR 362 PKR 251 TPR 280

Valves

Gas dosing valves

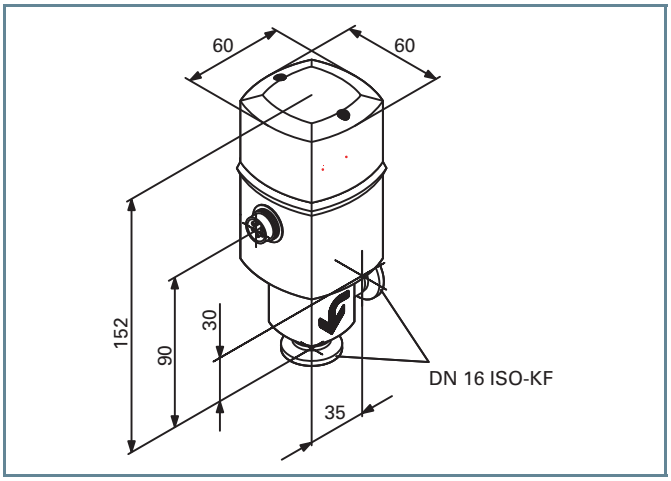
Regulating valve EVR 116

Gas dosing valves



- ▶ High gas throughput
- ▶ Very broad regulating range
- ▶ Resistant to corrosive gases - materials: Stainless steel / FPM
- ▶ With integrated motor control electronics

Dimensions



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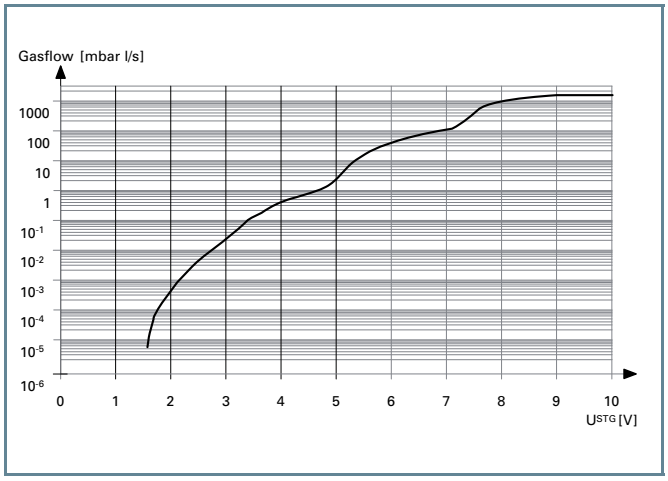


Technical data	EVR 116
Flange (in)	DN 16 ISO-KF
Flange (out)	DN 16 ISO-KF
Control	RVC 300 or IF 200
Bakeout temperature: actuator	60 °C
Bakeout temperature: housing	80 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Dosing sleeve	Fluorplastomer
Pressure max.	2.5 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Gas flow max. controllable	$1.25 \cdot 10^{3}$ mbar l/s
Gas flow min. controllable	$5 \cdot 10^{-6}$ mbar l/s
Housing/needle/filter	Stainless steel
Weight	0.5 kg
Control voltage	0 - 10 V DC
Closing / opening time	< 3 / 4 s
Ambient temperature	5 - 40 °C
Supply: Voltage	24 V DC
Supply: Power consumption max.	12 VA

Order number	
Gas dosing valves	**PF I39 931**

Accessories	
RVC-EVR, connection cable, 3 m	**PT 583 115-T**
RVC-EVR, connection cable, 5 m	**PT 583 116-T**
RVC-EVR, connection cable, 10 m	**PT 583 117-T**
RVC-EVR, connection cable, 15 m	**PT 583 118-T**
RVC-EVR, connection cable, 20 m	**PT 583 119-T**

Gas dosing valves

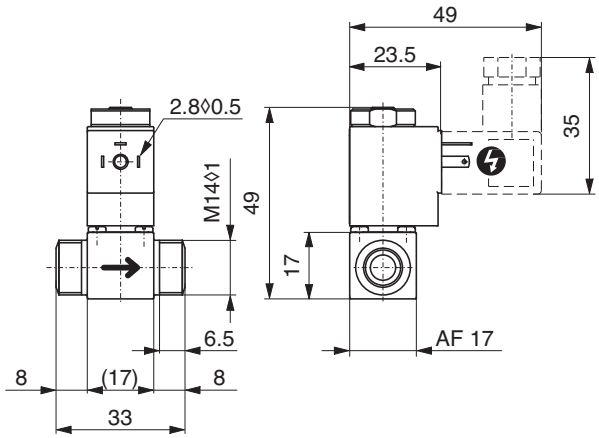
Regulating valve RME 005 A

Gas dosing valves

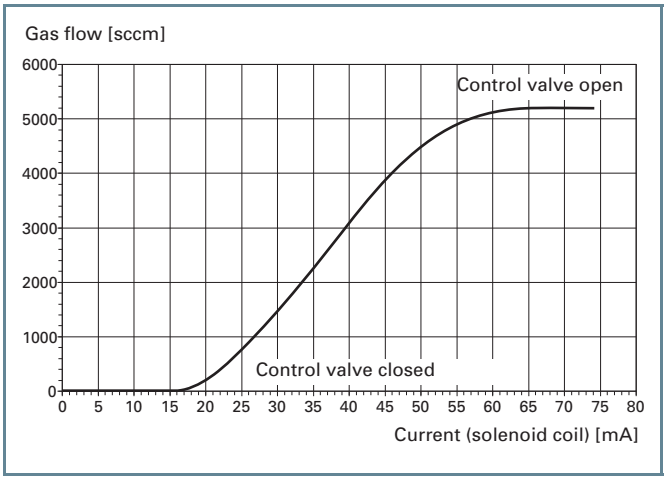
- ▶ Regulating range from 0.0017 to 85 mbar l /s
- ▶ Including connector
- ▶ Drive: Solenoid

RME = Gas dosing system regulating valve

Dimensions



Characteristic



Technical data	RME 005 A
Flange (in)	DN 5 mm M14x1
Flange (out)	DN 5 mm M14x1
Response time	< 30 ms
Control	RVC 300
Bakeout temperature: actuator, powerless	80 °C
Tightness	$1 \cdot 10^{-9}$ mbar l/s
Seal	FPM
Pressure max.	2 bar
Pressure min.	$1 \cdot 10^{-8}$ mbar
Mounting orientation	any, preferably perpendicular
Duty cycle (ED)	100 %
Housing	Stainless steel
Weight	96 g
Control voltage	0 - 24 V DC
Ambient temperature	5 - 50 °C
Supply: Power consumption max.	2.5 W

	RME 005 A
Gas flow max. controllable	85 mbar l/s
Gas flow min. controllable	0.85 mbar l/s
Order number	**PF I13 931**
Gas flow max. controllable	17 mbar l/s
Gas flow min. controllable	0.17 mbar l/s
Order number	**PF I13 932**
Gas flow max. controllable	8.5 mbar l/s
Gas flow min. controllable	0.085 mbar l/s
Order number	**PF I13 933**
Gas flow max. controllable	1.7 mbar l/s
Gas flow min. controllable	0.017 mbar l/s
Order number	**PF I13 934**
Gas flow max. controllable	0,8 mbar l/s
Gas flow min. controllable	0.008 mbar l/s
Order number	**PF I13 935**
Gas flow max. controllable	0.17 mbar l/s
Gas flow min. controllable	0.0017 mbar l/s
Order number	**PF I13 936**

Accessories	
Connection, for ¼" tube O.D.	**PT 420 913-T**
Connection, for 6 mm tube O.D.	**PT 420 914-T**
RVC 300 - RME 005, connection cable, 3 m	**PT 250 003-T**
RVC 300 - RME 005, connection cable, 5 m	**PT 250 005-T**
RVC 300 - RME 005, connection cable, 10 m	**PT 250 010-T**
RVC 300 - RME 005, connection cable, 15 m	**PT 250 015-T**
RVC 300 - RME 005, connection cable, 20 m	**PT 250 020-T**
RVC 300 - RME 005, connection cable, 25 m	**PT 250 025-T**
Connection, DN 10 ISO-KF	**PT 420 912-T**

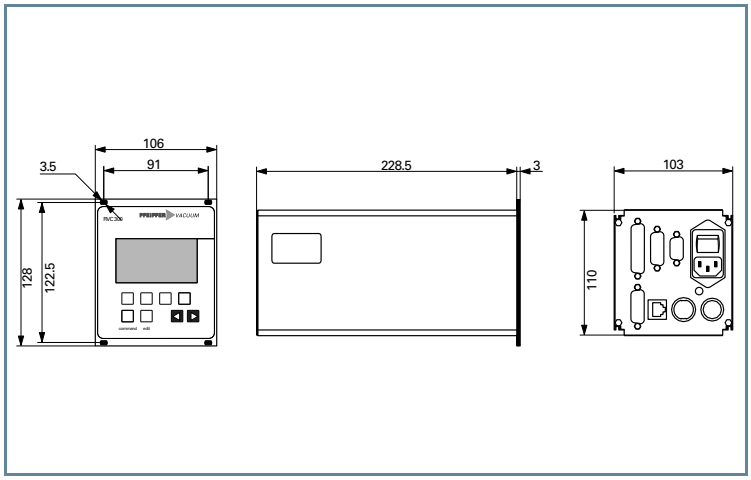
Gas dosing valves

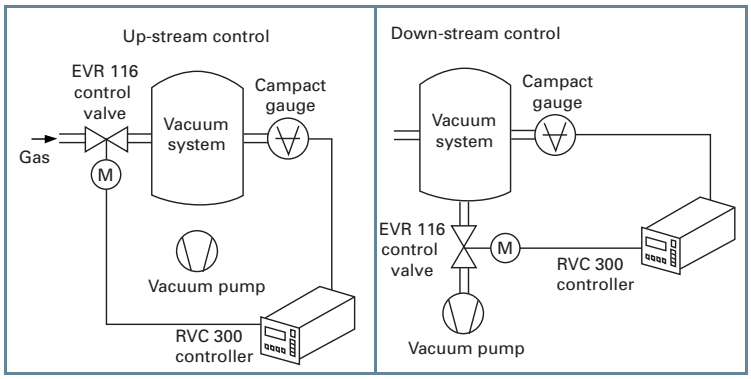
RVC 300, gas dosing system control unit

Gas dosing valves

- ▶ RVC 300 as a complete solution, with EVR 116 or RME 005 A regulating valves
- ▶ Simple operation
- ▶ Self-explanatory LCD display and function keys
- ▶ Analog/digital inputs/outputs and interfaces
- ▶ Settable PID regulating algorithm
- ▶ For system manufacturers, as a supplement to their own control unit

Dimensions





Technical data	RVC 300
Output: Analog	4 channels: Pressure sensor signal/ valve signal (0 - 10 VDC)/ valve position EVR 116/ + 10 VDC reference voltage (10 mA)
Output: Digital	8 channels: Valve closed/ valve open/ valve in position/ valve error/ sensor error/ ready/ emission ON/ sensor status
Input: Analog	2 channels: Pressure setpoint (nominal value)/ flow setpoint (nominal value)
Input: Digital	8 channels: Flow decrease/ flow increase/ external CLOSE/ external OPEN/ flow mode/ pressure mode/ emission ON/ Degas ON
Weight	1.65 kg
Mains requirement: frequency (range)	50/60 Hz
Mains requirement: power consumption	50 VA
Mains requirement: voltage (range)	90...250 V
Control range	APR 250/260: 1 - 1100 mbar
Control range	CMR 361/271: 1 - 1100 mbar
Control range	TPR 280: $5 \cdot 10^{-4}$ - 1000 mbar
Control range	TPR 281: $5 \cdot 10^{-4}$ - 1000 mbar
Control range	CMR 362/272: 0.1 - 110 mbar
Control range	CMR 363/273: $1 \cdot 10^{-2}$ - 11 mbar
Control range	CMR 364/274: $1 \cdot 10^{-3}$ - 1.1 mbar
Control range	CMR 275: $1 \cdot 10^{-4}$ - 0.11 mbar
Control range	IKR 251/261: $2 \cdot 10^{-9}$ - $1 \cdot 10^{-2}$ mbar
Control range	IMR 265: $1 \cdot 10^{-6}$ - 1000 mbar
Control range	PBR 260: $5 \cdot 10^{-10}$ - 1000 mbar
Control range	PKR 251/261: $5 \cdot 10^{-9}$ - 1000 mbar
Interface: Baud rates	9600 Baud
Interface: Type	RS-232, RS-485
Temperature: Operating	5...50 °C
Temperature: Storage	-40...60 °C

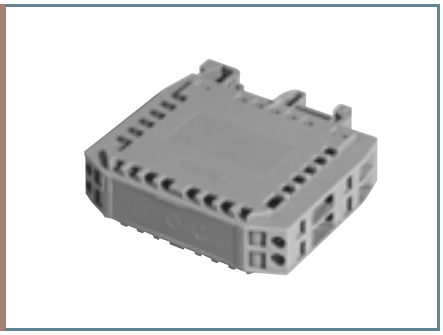
Order number	
Gas dosing valves	**PF I00 792**

Accessories	
RVC 300 - RME 005, connection cable, 3 m	**PT 250 003-T**
RVC 300 - RME 005, connection cable, 5 m	**PT 250 005-T**
RVC 300 - RME 005, connection cable, 10 m	**PT 250 010-T**
RVC 300 - RME 005, connection cable, 15 m	**PT 250 015-T**
RVC 300 - RME 005, connection cable, 20 m	**PT 250 020-T**
RVC-EVR, connection cable, 3 m	**PT 583 115-T**
RVC-EVR, connection cable, 5 m	**PT 583 116-T**
RVC-EVR, connection cable, 10 m	**PT 583 117-T**
RVC-EVR, connection cable, 15 m	**PT 583 118-T**
RVC-EVR, connection cable, 20 m	**PT 583 119-T**
RME 005 A, regulating range from 0.0017 to 0.17 mbar l/s	**PF I13 936**
RME 005 A, regulating range from 0.008 to 0.8 mbar l/s	**PF I13 935**
RME 005 A, regulating range from 0.017 to 1.7 mbar l/s	**PF I13 934**
RME 005 A, regulating range from 0.085 to 8.5 mbar l/s	**PF I13 933**
RME 005 A, regulating range from 0.17 to 17mbar l/s	**PF I13 932**
RME 005 A, regulating range from 0.85 to 85 mbar l/s	**PF I13 931**
EVR 116, regulating valve	**PF I39 931**

Gas dosing valves

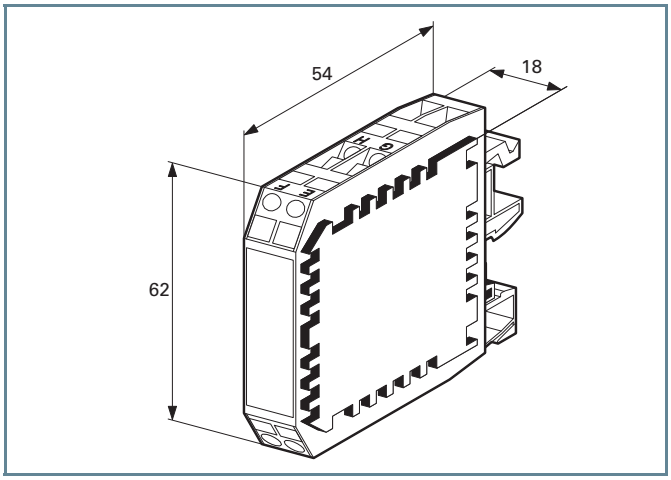
IF 200, gas dosing system interface

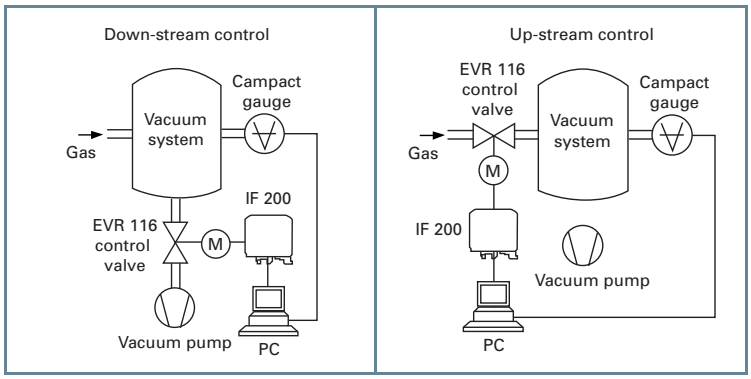
Gas dosing valves



- Simple, cost-effective integration into systems
- Pressure measurement signal must be prepared by the customer´s system control unit
- For system manufacturers who use their own control unit

Dimensions





Technical data	IF 200
Connection	Terminals
Fixation	Mounting rail
Weight	40 g
Interface	RS-232-C
Supply	0.5 A
Supply: Voltage	24 V DC

Order number	
Gas dosing valves	**PF I00 091**

Accessories	
EVR 116, regulating valve	**PF I39 931**

All-metal gas dosing valves/ -systems

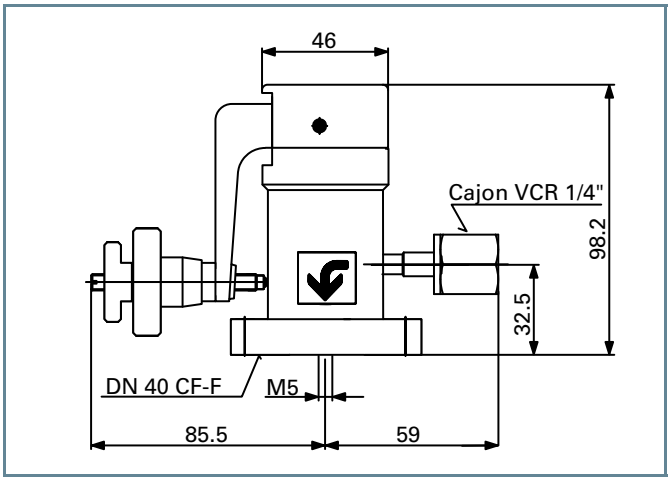
All-metal gas dosing valve

All-metal gas dosing valves/ -systems

- Minimum dead volume
- Operating temperature up to 200 °C
- For mass spectrometer applications
- Specific routing of gas stream when a capillary (accessory) is used

UDV = All-metal regulating valve

Dimensions



Technical data	UDV 040	UDV 046
Flange (in)	VCR 1/4"	DN 16 CF-R
Flange (out)	DN 40 CF-F	DN 40 CF-F
Actuator	manual	manual
Tightness	$1 \cdot 10^{-11}$ mbar l/s	$1 \cdot 10^{-11}$ mbar l/s
Pressure max.	30 bar	30 bar
Pressure min.	$1 \cdot 10^{-11}$ mbar	$1 \cdot 10^{-11}$ mbar
Gas flow max.	$6 \cdot 10^{2}$ mbar l/s	$6 \cdot 10^{2}$ mbar l/s
Flow rate min. for: air	$1 \cdot 10^{-9}$ mbar l/s	$1 \cdot 10^{-9}$ mbar l/s
Flow rate min. for: pure gases	$1 \cdot 10^{-10}$ mbar l/s	$1 \cdot 10^{-10}$ mbar l/s
Housing	Stainless steel	Stainless steel
Weight	1.4 kg	1.4 kg
Conductance for laminar flow	0.7 l/s	0.7 l/s
Temperature: Bakeout	450 °C	350 °C
Temperature: Operating	200 °C	200 °C
Valve seat	Copper	Copper
Valve plate	Sapphire	Sapphire

Order number		
All-metal gas dosing valve	**PF I52 031**	**PF I52 035**

Accessories		
Complete capillary, vacuum side, length 1 m	**PT 418 976-T**	**PT 418 976-T**
Complete capillary, inlet side, length 2 m	**PT 420 537-T**	**PT 420 537-T**
Heater, 200° C	**PT 420 376-T**	**PT 420 376-T**

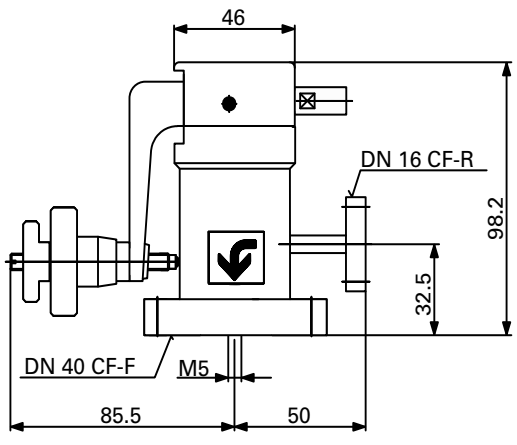
All-metal gas dosing valves/ -systems

All-metal regulating valve

All-metal gas dosing valves/ -systems

- Minimum dead volume
- Operating temperature up to 200 °C
- For mass spectrometer applications
- Specific routing of gas stream when a capillary (accessory) is used

Dimensions



Technical data	UDV 146
Flange (in)	DN 16 CF-R
Flange (out)	DN 40 CF-F
Actuator	manual/ thermomechanic
Tightness	$1 \cdot 10^{-11}$ mbar l/s
Pressure max.	30 bar
Pressure min.	$1 \cdot 10^{-10}$ mbar
Gas flow max.	$6 \cdot 10^{2}$ mbar l/s
Flow rate min. for: air	$1 \cdot 10^{-9}$ mbar l/s
Flow rate min. for: pure gases	$1 \cdot 10^{-10}$ mbar l/s
Housing	Stainless steel
Weight	1.4 kg
Conductance for molecular flow	0.7 l/s
Temperature: Bakeout	350 °C
Temperature: Operating	200 °C
Valve seat	Copper
Valve plate	Sapphire

Order number	
All-metal gas dosing valve	**PF I52 034**

Accessories	
Complete capillary, vacuum side, length 1 m	**PT 418 976-T**
Complete capillary, inlet side, length 2 m	**PT 420 537-T**
Heater, 200° C	**PT 420 376-T**
RVG 050 C, control unit all-metal gas dosing system, 115/230 V	**PF I00 795**

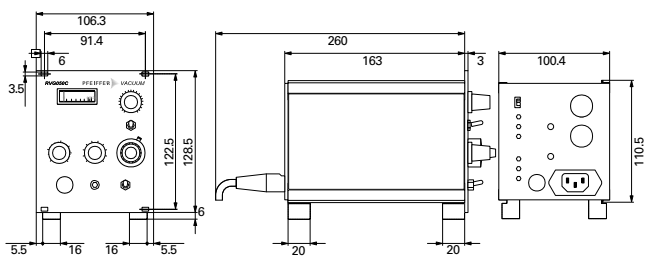
All-metal gas dosing valves/ -systems

Control unit RVG 050 C for UDV 146

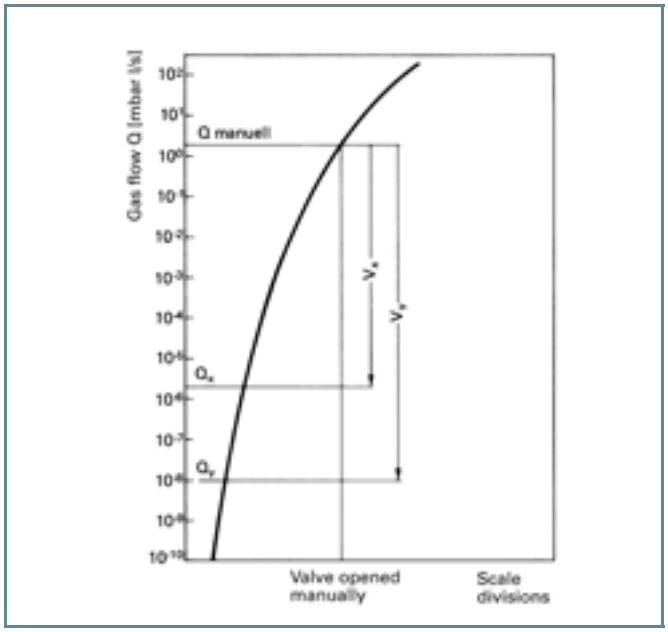
All-metal gas dosing valves/ -systems

▶ For creating a control section in conjunction with UHV gas dosing valve UDV 146

Dimensions



Characteristic

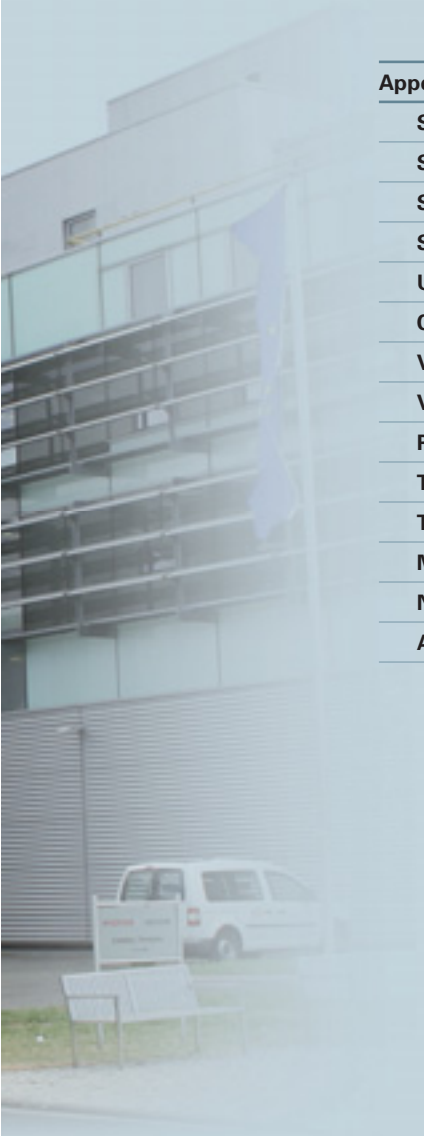


Technical data	RVG 050 C
Output for valve heater: Voltage	20 V DC
Output for valve heater: Current	0.5 A
Weight	2.3 kg
Actual value input: Analog voltage	10 V DC
Actual value input: Impedance	100 kOhm
Power consumption	20 VA
Mains requirement: voltage (selectable)	115/230 V AC
Control range for 1 bar N_2, inlet side	$1 \cdot 10^{-9}$ - 100 mbar l/s
Control characteristic (proportional-integral)	PI
Set point input: External	10 V DC
Set point input: Impedance	100 kOhm
Set point input: Internal (scale division)	0 - 1000
Ambient temperature	5-50 °C
Time contant, adjustable	2 - 30 s

Order number	
All-metal gas dosing valve	**PF I00 795**

Accessories	
UDV 146, all-metal regulating valve, DN 16 CF-F	**PF I52 034**
RVG-UDV, extension cable, 2 m, 200 °C	**PT 519 953-T**
RVG-UDV, connection cable, 3 m, 80 °C	**PT 519 178-T**
RVG-UDV, connection cable, 12 m, 80°C	**PT 519 343-T**

Appendix



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System solutions – CombiLine™ pumping stations

Proven solutions for Roots pumping stations.
More advice. More competence. More than vacuum.

What is a pumping station?

Pumping stations of combinations of individual pumps. They can contain the following major components: Roots, rotary vane and turbopumps, dry pumps, liquid ring, cryo and diffusion pumps, measurement equipment, analysis equipment, pumping station control systems (PLC-based as well) and bus interfaces.

Pfeiffer Vacuum – Your ideal partner!

- 40 years of experience in building pumping stations
- Highly competent
- Innovative, absolutely dependable products
- High technology level
- Pressure range from atmosphere to high vacuum
- Standard pumping stations and custom solutions
- Support in designing your vacuum system
- Magnetically coupled pumping stations also available – hermetically sealed and maintenance-free

We provide you with individual support, train you and offer you on-site service worldwide. True added value for you!

Assembly

Final inspection

Standard CombiLine™ pumping stations

Roots pumping stations with single-stage HenaLine / UnoLine Plus rotary vane pump – WU:

- Ultimate pressure < 3 · 10^{-2} mbar
- Cost-effective solution
- Metallurgy, load locks, helium leak detection, electron beam welding

Roots pumping stations with two-stage DuoLine rotary vane pump – WD:

- Ultimate pressure < 5 · 10^{-4} mbar
- Backing vacuum pumping station for high vacuum pumps
- Metallurgy, coating, research & development, electron beam welding

Roots pumping stations with HeptaDry dry pump – WH:

- Ultimate pressure < 1 · 10^{-2} mbar
- Dry, oil-free suction chamber
- Metallurgy, coating, research & development, electron beam welding

Roots pumping station with single-stage rotary vane pump

Roots pumping station with two-stage rotary vane pump

Roots pumping station with dry pump

Custom solutions

For applications requiring extremely high pumping speeds and/or ultimate pressures of 10^{-3} mbar or less.

What you get are multi-stage pumping stations as well as versions that incorporate Pfeiffer Vacuum turbopumps for high vacuum applications. What we do is to develop and manufacture custom solutions for you that are matched to your specific application.

Our real-life examples show applications in all fields, such as evacuating space simulation or electron beam welding chambers. Highly successful applications include employment in glass coating and solar technology. We are garnering successes with our new Vacu² multi-stage vacuum process for die casting.

Applications

- Solar technology
- Die casting
- Space simulation
- Coating

Competence

- Complete vacuum system design
- Precise dimensioning of the components, based upon calculation programs developed at Pfeiffer Vacuum
- If provided with the design data, we supply you with the calculations for:
  - Pumping speeds
  - Evacuation times
  - Conductivities
  - Interstage pressures
  - Gas outlet temperatures
  - Cool-down effects

Pump selection

- Depending upon the application in question, we offer you:
  - Rotary vane pumps with circulatory-oil lubrication, single- or two-stage (including magnetically coupled versions)
  - Liquid ring pumps
  - Dry-compressing vacuum pumps (including magnetically coupled versions)
  - Roots pumps (including magnetically coupled versions)
  - Turbopumps (including magnetically coupled versions)
  - Oil diffusion pumps
  - Cryopumps

Accessories

- The following accessories can be integrated:
  - Electrical control systems
  - Measurement equipment/mass spectrometers
  - Pressure regulating facilities
  - Heat exchangers and condensers
  - Soundproofing encapsulations for indoor and outdoor use
  - Silencers
  - Liquid separators
  - Dust separators
  - Flushing devices
  - Vibration isolation

We would be pleased to provide you with the right solution for your application!

- Brochure: PW 0030 PD, German
  PW 0030 PE, English

System solutions – Vacu² multi-stage vacuum process

The revolution in die casting!

Vacu²

From raw material ...

... to finished product

Vacu² lowers the costs of your die casting process!

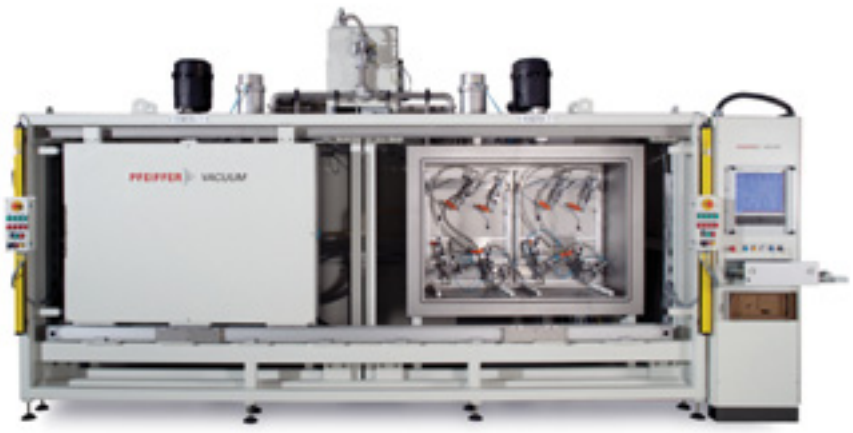
Advantages at a glance

- Better vacuum produces optimum workpiece quality
- Reliable process monitoring reduces the reject rate
- Faster process optimization and savings in mold-building and vent valves lower your costs

- Brochure: PA 0060 PD, German
  PA 0060 PE, English

System solutions –
Helium leak detection systems

**The best technology for your quality assurance.
Custom-designed. Cost-effective. Efficient.**



Testing air conditioning lines

Advantages at a glance

- Maximum sensitivity in detecting even minute leaks
- Dry testing in contrast to the bubble test
- Automated measurement process
- Minimizes testing times and operating costs
- Satisfies quality and environmental requirements
- Fully automated test cycle

Applications

- Automotive industry
  (e.g. airbags, aluminum rims, fuel system components, components for air conditioning systems and air suspension systems)
- Refrigeration/air conditioning technology
  (e.g. evaporators, compressors)
- Vacuum and overpressure technology
  (e.g. valves and fittings)
- Packaging technology
  (e.g. for pharmaceutical products, food)

Testing expansion valves

Testing compressors

Testing fuel tanks

▶ Brochure: PA 0055 PD, German
PA 0055 PE, English

System solutions –
HiCube turbopump pumping stations

The ideal solution for high vacuum applications.
The modular pumping station for clean vacuum.

HiCube Eco

HiCube Classic

HiCube Pro

Advantages at a glance

- Generating high and ultra high vacuum
- Simple operation
- Robust design and construction
- Well engineered details
- Compact, functionable units
- Proven components
- Versions for nearly all applications
- Direct connection for Pfeiffer Vacuum ActiveLine vacuum measurement devices
- Simple maintenance
- UL-compatible
- Remote turbo option (the turbo can be attached directly to the recipient by means of a long backing vacuum line)

▶ Brochure: PT 0130 PD, German
PT 0130 PE, English

Units and symbols

Decimal multiples and divisions

Power of ten	Combining form	Combining symbol
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	Kilo	k
10^{-2}	Centi	c
10^{-3}	Milli	m
10^{-6}	Micro	µ
10^{-9}	Nano	n
10^{-12}	Pico	p

Lengths, surface areas, volumes

[1] liter (l) as a special designation for 1 dm^3 [2] At 0 °C and 1013.25 mbar

Quantity	Symbol	SI units	Recommended units
Length	l	m	m, mm, µm, nm
Width	b	m	m, mm, µm
Height	h	m	m, mm, µm
Thickness	d	m	m, mm, µm, nm
Radius	r	m	m, mm, µm
Diameter	d	m	m, mm, µm
Path	s	m	m, mm, µm, nm
Wavelength	λ	m	nm
Surface area	A	m^2	m^2, mm^2, $µm^2$
Volume [1]	V	m^3	m^3, dm^3, cm^3, mm^3
Standard volume [1] [2]	V_n	m^3	m^3, dm^3, cm^3, mm^3

Electrical and magnetic quantities

Quantity	Symbol	SI units	Recommended units
Electric current	I	A	A, mA, µA, nA
Electric voltage	U	V	kV, V, mV, µV
Electric resistance	R	Ω	MΩ, kΩ, Ω, mΩ
Electric conductance	G	S	S
Electric conductivity	K	S/m	
Permeability	µ	V s/A m	

Mass

Quantity	Symbol	SI units	Recommended units
Mass	m	kg	kg, g, mg
Mass per unit area	m“	kg/m^2	g/cm^2, mg/cm^2
Density	δ	kg/m^3	kg/m^3, g/cm^3
Mass momentum of inertia	J	kg m^2	kg m^2

Temperature and heat

Quantity	Symbol	SI units	Recommended units
Thermodynamic temperature	t	K	K
Celsius temperature	t		°C
Temperature difference	ΔT, $\Delta \vartheta$	K	K
Quantity of heat	Q	J	KJ, J
Heat capacity	C	J/K	KJ/K, J/K
Specific heat capacity	c	J/kg K	kJ/kg K, J/g K

Force, energy, power

Quantity	Symbol	SI units	Recommended units
Force	F	N	kN, N, mN
Weight	G	N	kN, N, mN
Mass (weight)	m	kg	mg, g, kg, t
Impulse	b	N s	N s
Moment of momentum	L	N s m	N s m
Pressure	p	N/m^2, Pa	bar, mbar
Torque	M	N m	N m
Energy	E	J	kJ, kW h, W s, eV
Work	W	J	kJ, kW h, W s
Power	P	W	MW, kW, W
Efficiency	η	1	1

Vacuum engineering quantities

Quantity	Symbol	SI units	Recommended units
Pressure, absolute	p	N/m^2, Pa	bar, mbar
Total pressure	p_t		mbar
Partial pressure of the gas constituent "i"	p_i		mbar (z. B. P_{H2}, P_{N2})
Saturation vapor pressure	p_s		mbar
Vapor pressure	p_d		mbar
Residual total pressure	p_r		mbar
Residual gas pressure	p_{rg}		mbar
Residual vapor pressure	p_{rd}		mbar
Final pressure	p_{end}		mbar
Mean free path	T, l	m	m, cm
Collision rate	z	1/s	s^{-1}
Collision rate per unit area	z"	1/s m^2	$s^{-1}\,m^{-2}$, $s^{-1}cm^{-2}$,
Particle number density	n	$1/m^3$	m^{-3}, cm^{-3}
Throughput	q_{pv}	N m/s	mbar l/s
Leak rate	q_L	N m/s	mbar l/s
Pumping speed	S	m^3/s	l/s, m^3/h
Flow conductance	C	m^3/s	m^3/s, l/s
Flow resistance	R	s/m^3	s/m^3, s/l

Time

Quantity	Symbol	SI units	Recommended units
Time span, duration	t	s	h, min, s, ms, µs
Period	T	s	s
Frequency	f	Hz	Hz, kHz, MHz
Rotational speed	n	1/s	1/s, 1/min
Velocity	v	m/s	m/s, mm/s
Acceleration	a	m/s^2	m/s^2
Angular velocity	ω	1/s; rad/s	
Angular acceleration	α	$1/s^2$; rad/s^2	

Conversion tables

Length

	m	ft	in
1 m	1	3.28	39.37
1 ft (foot)	0.305	1	12.2
1 in (inch)	0.025	0.08	1

Mass

	kg	lb	oz
1 kg	1	2.20	35.27
1 lb (pound)	0.45	1	16
1 oz (ounce)	0.03	0.06	1

Temperature

	K	°C	°F
Kelvin	1	°C + 273.15	5/9 (°F + 459.67)
°Celsius	K - 273.15	1	5/9 (°F - 32)
°Fahrenheit	9/5 K - 459.67	9/5 °C + 32	1

Pumping speed, conductance

	m^3/s	l/s	m^3/h	cbft/min
1 m^3/s	1	1,000	3,600	2,118.88
1 l/s	10^{-3}	1	3.6	2.119
1 m^3/h	$2.78 \cdot 10^{-4}$	0.278	1	0.59
1 cbft/min	$4.72 \cdot 10^{-4}$	0.47	1.69	1

pV flow, leak rate at 25 °C

	W	mbar l / s	Torr l / s	sccm
1 Pa m^3/s = 1 W	1	10	7.5	586
1 mbar l/s	0.1	1	0.75	58.6
1 Torr l/s	0.133	1.33	1	78.0
1 sccm[1)]	$1.82 \cdot 10^{-3}$	0.018	0.013	1

Work, energy

	J	kpm	lbft	kWh	kcal	BTU
1 J	1	0.102	0.737	$2.78 \cdot 10^{-7}$	$2.39 \cdot 10^{-4}$	$9.48 \cdot 10^{-4}$
1 kpm	9.81	1	7.23	$2.72 \cdot 10^{-6}$	$2.34 \cdot 10^{-3}$	$9.29 \cdot 10^{-3}$
1 lbft	1.36	0.14	1	$3.77 \cdot 10^{-7}$	$3.24 \cdot 10^{-4}$	$1.29 \cdot 10^{-3}$
1 kWh	3.6 · 106	3.67 · 106	2.65 · 106	1	860	3,412
1 kcal	4,186.8	426.9	3,088	$1.16 \cdot 10^{-3}$	1	3.97
1 BTU	1,055.06	107.6	778	$2.93 \cdot 10^{-4}$	0.25	1

Pressure

[1)] standard cubic centimeter per minute [2)] physical atmosphere [3)] technical atmosphere

	Pa	mbar	bar	Torr	atm	at = kp / cm^2	mWS	psf	psi
1 N/m^2 = 1 Pascal	1	0.01	10^{-5}	$7.5 \cdot 10^{-3}$					
1 mbar	100	1	10^{-3}	0.75			0.0102	2.09	0.014
1 bar	10^5	1,000	1	750.06	0.98	1.02	10.19	2,089	14.50
1 Torr = 1 mm Hg	133.32	1.33		1				2.78	0.019
1 atm [2)]	101,325	1,013	1.013	760	1	1.033	10.33	216.2	14.69
1 at = 1 kp/cm^2 [3)]	98,066.5	981	0.981	735.6	0.97	1	10	2,048.2	14.22
1 m head of water	9,806.65	98.1	0.098	73.56	0.097	0.1	1	204.82	1.42
1 lb/sqft = 1 psf	47.88	0.48		0.36				1	
1 lb/sqin = 1 psi	6,894.8	68.95		51.71	0.068			144	1

The particle number densities apply at a temperature of 20 °C. d = pipe diameter

Vacuum ranges	mbar	Particle number density	Mean free path (l)
Rough vacuum (GV)	1,000 – 1	$2.5 \cdot 10^{25}$ - $2.5 \cdot 10^{22}$ m^{-3}	$l \ll d$
Medium vacuum (FV)	1 – 10^{-3}	$2.5 \cdot 10^{22}$ - $2.5 \cdot 10^{19}$ m^{-3}	$l \approx d$
High vacuum (HV)	10^{-3} – 10^{-7}	$2.5 \cdot 10^{19}$ - $2.5 \cdot 10^{15}$ m^{-3}	$l > d$
Ultrahigh vacuum (UHV)	< 10^{-7}	< $2.5 \cdot 10^{15}$ m^{-3}	$l \gg d$

Vacuum engineering terms

A

Absorption
Absorption is a sorption in which the gas (absorbate) enters inside a solid object or liquid (absorbent).

Adsorption
Adsorption is a sorption in which the gas (adsorbate) is bound to the surface of a solid object or a liquid (adsorbent).

B

Backing pump
A backing pump is a vacuum pump which within a vacuum pump combination together with another vacuum pump allows for its operation by providing on the outlet side of the other pump the necessary lower pressure.

C

Cold trap
A cold trap is a trap, the effect of which is based on the condensation of gases on cooled surfaces.

Compression chamber
A compression chamber is that chamber within a stator of some positive displacement vacuum pumps, the volume of which is reduced and in which the gas is compressed before being ejected.

Compression ratio
The compression ratio is the ratio between the exhaust pressure and the inlet pressure of a pump for a certain gas.

D

Degassing
Degassing is a desorption which is accelerated by means of physical processes.

Desorption
Desorption is the process where sorbed gases are released from a sorbent. This release may be spontaneous or accelerated through physical processes.

Diffusion
Gas diffusion is the movement of a gas due to its concentration gradient in an other medium. This medium may be gaseous, liquid or solid.

F

Final pressure
The final pressure is that value which is asymptotically approximated by the pressure in the case of a blanked off vacuum pump during normal operation and without admitting gas.

Flow
Viscous flow
Viscous flow is the passage of a gas through a duct under conditions such that the mean free path is very small in comparison with the smallest internal dimension of a cross section of the duct. The flow is therefore dependent on the viscosity of the gas and may be laminar or turbulent. In the case of viscous flow the resistance is a function of the pressure.

Turbulent flow
Turbulent flow (eddy flow) is a viscous flow with mixing motion above a critical Reynolds number (for circular cylindrical pipes Re = 2300).

Laminar flow
Laminar flow (parallel flow) is a viscous flow without mixing motion at small Reynolds numbers.

Molecular flow
Molecular flow is the passage of a gas through a duct under conditions such that the mean free path is very large in comparison with the largest internal dimensions of a cross section of the duct.

In the case of molecular flow, the resistance is independent of the pressure.

Flow resistance
In most applications the vacuum pump is connected via a pipe to the vacuum chamber. This pipe exhibits a flow resistance which is defined by the ratio between the pressure difference Δp and at the gas flow q. In the high vacuum and ultrahigh vacuum range, the flow resistance is independent of the pressure. The unit of flow resistance is:
$s \cdot m^{-3}$, $s \cdot l^{-1}$.

G

Gas
Gas in a narrower sense is matter in the gaseous state which at the prevailing temperature cannot be brought by compression into the liquid or solid state.

Gas ballast
Admission of a controlled quantity of a gas, usually into the compression chamber of a positive displacement pump for the purpose of avoiding the formation of condensate within the pump.

Gas load
The gas load is defined as the pV flow conveyed towards a vacuum pump. The unit is mbar l/s or sccm (standard cubic centimeters per minute). Standard conditions are 1,013.25 mbar and 273.15 K.
At 20 °C 1 mbar l/s = 55.18 sccm

Gettering
Gettering is bonding of gas, preferably by means of a chemical reaction. Often getters (getter materials) have large surfaces.

K

Knudsen number
The flow ranges are characterized by the ratio between the mean free path and the pipe diameter. This ratio is expressed through the Knudsen number $Kn = \bar{l}/d$.

L

Laminar flow
The laminar flow is a viscous flow without mixture movement at small Reynolds numbers.

Leak
Leaks in a vacuum apparatus are leakages in the wall or at joints, caused by faulty material or processing or incorrect handling of the sealing elements.

Leak rate
The leak rate is defined as the pV flow of a gas through a leak. The leak rate is dependent on type of gas, pressure difference and temperature. The unit of the leak rate is $1\ Pa \cdot m^3 \cdot s^{-1} = 10\ mbar \cdot l \cdot s^{-1}$

M

Mass flow
The mass flow is defined through the ratio between the mass of a gas flowing during a certain time span through a line cross-section and the time span. It can also be stated in sccm.

Mean free path
The mean free path is the average distance that a particle travels between two successive collisions with other particles.

Multistage vacuum pump
A multistage vacuum pump consists of several pumping systems in a common enclosure.

O

Occlusion
Occlusion is the incorporation of quantities of gas in solids or liquids.

Oil separator on vacuum pumps
An oil separator on vacuum pumps is a separator on the delivery side of positive displacement vacuum pumps for the purpose of collecting and, if required, returning vacuum pump oil back to the vacuum pump. If the oil accumulates by way of droplets, the facility is also called oil mist separator or oil mist filter.

Outgassing
Outgassing is a spontaneous desorption.

P

Partial pressure
The partial pressure is the pressure arising from a certain type of gas or vapor within a mixture of gases and/or vapors.

Particle number density
The particle number density is the ratio between the number of particles contained in a volume unit and the volume of that volume unit.

Permeation
Permeation is the transfer of a gas through a solid material or a liquid of finite thickness.

Pressure
The pressure of a gas on a limiting wall is defined as the ratio between the normal component of the force which is exerted by the gas on a surface unit of the wall and the area of that surface unit.

Pressure units
The legal pressure units are "Pascal" as SI unit, unit Pa; "Bar", unit bar, as a special unit designation for 105 Pa.

$1\ Pa = 1\ Nm^{-2}$
$1\ bar = 1{,}000\ mbar =$
$10^5\ Nm^{-2} = 10^5\ Pa$

The unit commonly used in the area of vacuum engineering is millibar (mbar).

Pumping speed
The pumping speed S is the mean volume flow through the crosssection of the intake opening of a pump. Units of pumping speed are: $m^3 \cdot s^{-1}$, $l \cdot s^{-1}$, $m^3 \cdot h^{-1}$.

pV flow
The pV flow is the ratio between the pV value of a gas which flows during a time span at a specific prevailing temperature through a line crosssection and the time span.

pV value
The pV value is the product of pressure and volume of a certain quantity of gas at a specific prevailing temperature. If the pV value is to be taken as a measure for the quantity of substance or the mass of a gas, it needs to be an ideal gas, the temperature of which must be stated.

R

Reynolds number
Dimension less number

$$Re = \frac{\rho}{\eta} \cdot v \cdot d$$

ρ = Density of the liquid
v = Mean velocity of the flow
l = Characteristic length (pipe diameter, for example)
η = Dynamic viscosity
$Re < 2{,}300$: laminar flow
$Re > 4{,}000$: turbulent flow

S

Saturation vapor pressure
The saturation vapor pressure is that pressure which is exerted by a vapor which, at the prevailing temperature, is at a thermodynamic equilibrium with its condensing phases.

Separator on vacuum pumps
Separators on vacuum pumps are devices at the intake or delivery side of vacuum pumps designed for collecting condensates which may form in the vacuum lines or in parts of the vacuum pump or which also collect solid substances accumulating in vacuum lines and vacuum pumps while pumping vapors.

Sorption
Sorption is binding of gas (sorbate) by a solid or a liquid (sorbent). Sorbents are also called sorption agents.

Standard pressure
P_n = 101,325 Pa = 1,013.25 mbar

Standard reference conditions
The standard reference conditions is the state of solid, liquid or gaseous matter defined by standard temperature and a standard pressure.

Standard temperature
T_n = 273.15 K δ_n = 0 °C

T

Throughput
The throughput of a vacuum pump is the pV flow of the gas being pumped.The units of throughput are: $Pa \cdot l \cdot s^{-1}$, $mbar \cdot l \cdot s^{-1}$.

Total pressure
The total pressure is the total of the partial pressures of the gases or vapors present. This term is used when the shorter designation „pressure" in the given context does not allow for differentiating between the individual partial pressures and their total.

Trap
A trap is a device in which the partial pressures of unwanted constituents of a gas mixture are reduced by physical or chemical means.

Turbulent flow
The turbulent flow is a viscous flow with mixing movement above a critical Reynolds number Re (for cylindrical pipes Re = 2300).

V

Vacuum pump oil
Vacuum pump oil is a liquid which is used for sealing, cooling and lubrication within oil-sealed vacuum pumps.

Vane
A vane is a sliding component, which divides the space (compression chamber) between rotor and stator in some positive displacement vacuum pumps into different chambers.

Vapor
Vapor is matter in the gaseous state which is either in a thermodynamic equilibrium with its liquid or solid state (saturated vapor) or which at the prevailing temperature can be brought to a thermal equilibrium (condensed) by means of compression (unsaturated vapor).

Remark:
In the area of vacuum engineering, the word "gas" is used in an extended sense both for a noncondensable gas as well as for all vapors in those cases where it is not necessary to differentiate.

Vapor pressure
Vapor pressure is the partial pressure of a vapor.

Volume flow
The volume flow is the ratio between the volume of a gas which during a time span at a specific prevailing pressure and temperature, flows through a line crosssection and the time span itself.

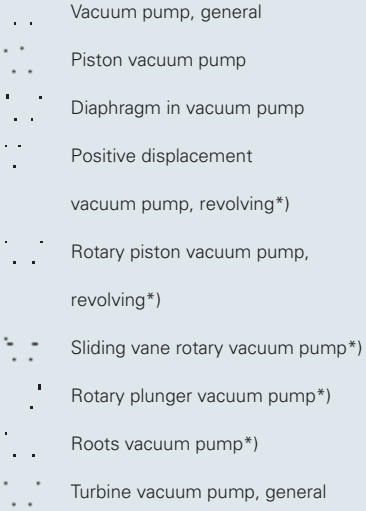
W

Water vapor capacity C_{Wo}
The water vapor capacity is the greatest quantity of water which a vacuum pump is capable of continuously taking in and pumping per unit of time under the ambient conditions of 20 °C and 1,013 mbar by way of water vapor.

Water vapor tolerance p_{Wo}
The water vapor tolerance states the highest intake pressure for pure water vapor the pump is continuously capable of pumping. The water vapor tolerance is stated in units of mbar.

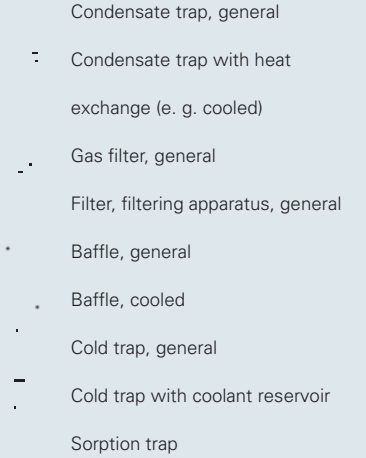
Vacuum symbols

Vacuum pumps



Vacuum pump, general
Piston vacuum pump
Diaphragm in vacuum pump
Positive displacement vacuum pump, revolving*)
Rotary piston vacuum pump, revolving*)
Sliding vane rotary vacuum pump*)
Rotary plunger vacuum pump*)
Roots vacuum pump*)
Turbine vacuum pump, general
Turbomolecular pump
Ejector vacuum pump*)
Diffusion pump*)
Adsorption pump*)
Getter pump
Sputter-ion pump
Cryopump
Scroll pump*)

Vacuum accessories

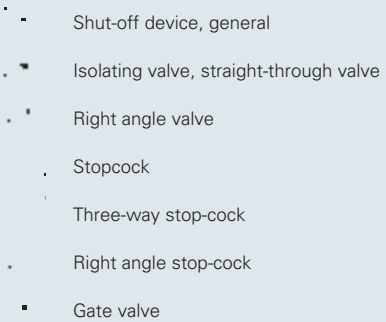


Condensate trap, general
Condensate trap with heat exchange (e. g. cooled)
Gas filter, general
Filter, filtering apparatus, general
Baffle, general
Baffle, cooled
Cold trap, general
Cold trap with coolant reservoir
Sorption trap

Chambers

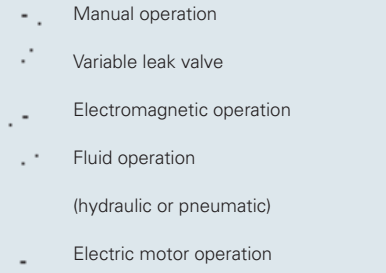
Chamber with curved bottom, vacuum chamber in general
Vacuum bell jar

Isolating devices



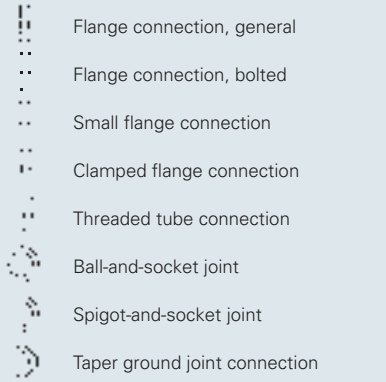
Shut-off device, general
Isolating valve, straight-through valve
Right angle valve
Stopcock
Three-way stop-cock
Right angle stop-cock
Gate valve
Butterfly valve
Safety shut-off valve

Valve actuation

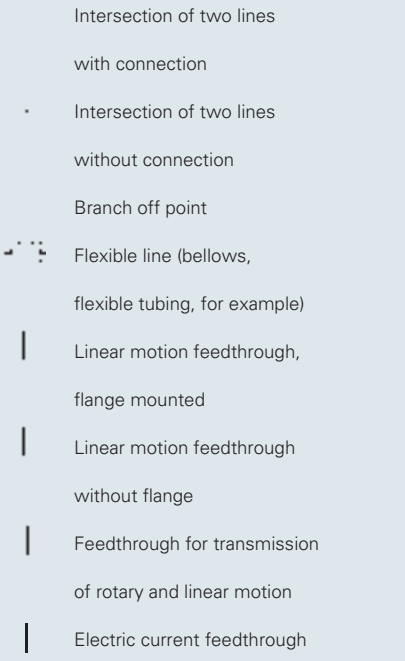


Manual operation
Variable leak valve
Electromagnetic operation
Fluid operation (hydraulic or pneumatic)
Electric motor operation

Connections and tubes

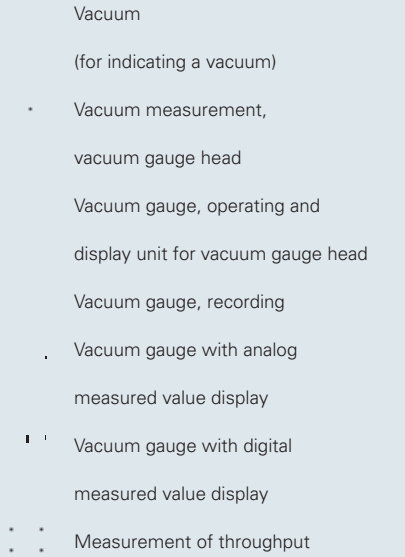


Flange connection, general
Flange connection, bolted
Small flange connection
Clamped flange connection
Threaded tube connection
Ball-and-socket joint
Spigot-and-socket joint
Taper ground joint connection



Intersection of two lines with connection
Intersection of two lines without connection
Branch off point
Flexible line (bellows, flexible tubing, for example)
Linear motion feedthrough, flange mounted
Linear motion feedthrough without flange
Feedthrough for transmission of rotary and linear motion
Electric current feedthrough

Measurement and gauges



Vacuum (for indicating a vacuum)
Vacuum measurement, vacuum gauge head
Vacuum gauge, operating and display unit for vacuum gauge head
Vacuum gauge, recording
Vacuum gauge with analog measured value display
Vacuum gauge with digital measured value display
Measurement of throughput

All vacuum symbols, with the exception of those marked by *) can be used in any orientation.

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Bellows, stainless steel, DN 50 ISO-KF	PF 130 250-X	
- Metallic hoses, standard		**613**
Metallic hose, 250 mm, DN 16 ISO-KF	PF 131 225-X	
Metallic hose, 500 mm, DN 16 ISO-KF	PF 131 250-X	
Metallic hose, 750 mm, DN 16 ISO-KF	PF 131 275-X	
Metallic hose, 1000 mm, DN 16 ISO-KF	PF 131 210-X	
Metallic hose, 250 mm, DN 25 ISO-KF	PF 131 325-X	
Metallic hose, 500 mm, DN 25 ISO-KF	PF 131 350-X	
Metallic hose, 750 mm, DN 25 ISO-KF	PF 131 375-X	
Metallic hose, 1000 mm, DN 25 ISO-KF	PF 131 310-X	
Metallic hose, 250 mm, DN 40 ISO-KF	PF 131 425-X	
Metallic hose, 500 mm, DN 40 ISO-KF	PF 131 450-X	
Metallic hose, 750 mm, DN 40 ISO-KF	PF 131 475-X	
Metallic hose, 1000 mm, DN 40 ISO-KF	PF 131 410-X	
Metallic hose, 250 mm, DN 50 ISO-KF	PF 131 525-X	
Metallic hose, 500 mm, DN 50 ISO-KF	PF 131 550-X	
Metallic hose, 750 mm, DN 50 ISO-KF	PF 131 575-X	
Metallic hose, 1000 mm, DN 50 ISO-KF	PF 131 510-X	
- Metallic hoses, highly flexible		**613**
Metallic hose, highly flexible, 250 mm, DN 16 ISO-KF	PF 139 225-X	
Metallic hose, highly flexible, 500 mm, DN 16 ISO-KF	PF 139 250-X	
Metallic hose, highly flexible, 750 mm, DN 16 ISO-KF	PF 139 275-X	
Metallic hose, highly flexible, 1000 mm, DN 16 ISO-KF	PF 139 210-X	
Metallic hose, highly flexible, 250 mm, DN 25 ISO-KF	PF 139 325-X	
Metallic hose, highly flexible, 500 mm, DN 25 ISO-KF	PF 139 350-X	
Metallic hose, highly flexible, 750 mm, DN 25 ISO-KF	PF 139 375-X	
Metallic hose, highly flexible, 1000 mm, DN 25 ISO-KF	PF 139 310-X	
Metallic hose, highly flexible, 250 mm, DN 40 ISO-KF	PF 139 425-X	
Metallic hose, highly flexible, 500 mm, DN 40 ISO-KF	PF 139 450-X	
Metallic hose, highly flexible, 750 mm, DN 40 ISO-KF	PF 139 475-X	
Metallic hose, highly flexible, 1000 mm, DN 40 ISO-KF	PF 139 410-X	
Reducers and adapters		**614**
- Reducing pieces, ISO-KF / ISO-KF		**614**
Reducing piece, aluminum, DN 25 - 10 ISO-KF	PF 140 031	
Reducing piece, aluminum, DN 25 - 16 ISO-KF	PF 140 032	
Reducing piece, aluminum, DN 40 - 10 ISO-KF	PF 140 041	
Reducing piece, aluminum, DN 40 - 16 ISO-KF	PF 140 042	
Reducing piece, aluminum, DN 40 - 25 ISO-KF	PF 140 043	
Reducing piece, aluminum, DN 50 - 40 ISO-KF	PF 140 054	
Reducing piece, stainless steel, DN 25-16 ISO-KF	PF 140 232-X	
Reducing piece, stainless steel, DN 40-16 ISO-KF	PF 140 242-X	
Reducing piece, stainless steel, DN 40-25 ISO-KF	PF 140 243-X	
Reducing piece, stainless steel, DN 50-16 ISO-KF	PF 140 252-X	
Reducing piece, stainless steel, DN 50-25 ISO-KF	PF 140 253-X	
Reducing piece, stainless steel, DN 50-40 ISO-KF	PF 140 254-X	

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- Screw-in flanges		**614**
Screw-in flange, FPM/stainless steel, DN 10 ISO-KF, G 3/8"	PF 141 214-T	
Screw-in flange, FPM/stainless steel, DN 16 ISO-KF, G 1/2"	PF 141 225-T	
Screw-in flange, FPM/stainless steel, DN 25 ISO-KF, G 1"	PF 141 237-T	
Screw-in flange, FPM/stainless steel, DN 40 ISO-KF, G 1 1/2"	PF 141 248-T	
- Screw-on flanges		**614**
Screw-on flange, FPM/stainless steel, DN 10 ISO-KF, G 3/8"	PF 142 214-T	
Screw-on flange, FPM/stainless steel, DN 16 ISO-KF, G 1/2"	PF 142 225-T	
Screw-on flange, FPM/stainless steel, DN 25 ISO-KF, G 1"	PF 142 237-T	
Screw-on flange, FPM/stainless steel, DN 40 ISO-KF, G 1 1/2"	PF 142 248-T	
- Adapters ISO-KF / VCR®, female		**615**
Adapter, DN 16 ISO-KF/VCR 1/4", female	PF 142 422-X	
Adapter, DN 25 ISO-KF/VCR 1/2", female	PF 142 433-X	
Adapter, DN 40 ISO-KF/VCR 3/4", female	PF 142 444-X	
- Adapters ISO-KF / VCR®, male		**615**
Adapter, DN 16 ISO-KF/VCR 1/4", male	PF 141 422-X	
Adapter, DN 25 ISO-KF/VCR 1/2", male	PF 141 433-X	
Adapter, DN 40 ISO-KF/VCR 3/4", male	PF 141 444-X	
- Adapters ISO-KF / Swagelok®		**615**
Adapter, DN 16 ISO-KF/6 mm, Swagelok®	PF 141 522-X	
Adapter, DN 25 ISO-KF/10 mm, Swagelok®	PF 141 534-X	
Adapter, DN 40 ISO-KF/16 mm, Swagelok®	PF 141 546-X	
- Adapters ISO-KF / ISO-K		**615**
Adapter, aluminum, DN 63 ISO-K/40 KF	PF 322 004	
Adapter, aluminum, DN 63 ISO-K/50 KF	PF 322 005	
Adapter, stainless steel, DN 63 ISO-K/40 KF	PF 322 204-X	
Adapter, stainless steel, DN 63 ISO-K/50 KF	PF 322 205-X	
Adapter, stainless steel, DN 100 ISO-K/40 KF	PF 322 214-X	
- Adapters ISO-KF/CF-F		**616**
Adapter, DN 16 CF-F/DN 16 ISO-KF	PF 545 202-X	
Adapter, DN 16 CF-F/DN 25 ISO-KF	PF 545 203-X	
Adapter, DN 16 ISO-KF/DN 40 CF-F	PF 545 212-X	
Adapter, DN 40 CF-F/DN 25 ISO-KF	PF 545 213-X	
Adapter, DN 40 CF-F/DN 40 ISO-KF	PF 545 214-X	
Adapter, DN 63 CF-F/DN 40 ISO-KF	PF 545 224-X	
Adapter, DN 100 CF-F/DN 40 ISO-KF	PF 545 234-X	
- Compression-fit piping adapters		**616**
Compression-fit piping adapter, DN 10 ISO-KF, ø 10 mm	PF 143 210-T	
Compression-fit piping adapter, DN 40 ISO-KF, ø 20 mm	PF 143 244-T	
Compression-fit piping adapter, DN 40 ISO-KF, ø 26 mm	PF 143 246-T	
- Hose connections		**616**
Hose connection, aluminum, DN 16 ISO-KF-12	PF 144 021	
Hose connection, aluminum, DN 25 ISO-KF-12	PF 144 031	
Hose connection, aluminum, DN 40 ISO-KF-12	PF 144 041	
- 90° elbows-hos adapters for PVC hose and sleeve		**616**
90° elbow S, for PVC hose and sleeve, nominal diameter 16, DN 16 ISO-KF	PF 145 023	
90° elbow S, for PVC hose and sleeve, nominal diameter 25, DN 25 ISO-KF	PF 145 037	
90° elbow S, for PVC hose and sleeve, nominal diameter 40, DN 40 ISO-KF	PF 145 048	
- Hose nipples for PVC hose and sleeve		**617**
Hose nipple, for PVC hose and sleeve, DN 10 ISO-KF-14	PF 146 012	
Hose nipple, for PVC hose and sleeve, DN 16 ISO-KF-16	PF 146 023	
Hose nipple, for PVC hose and sleeve, DN 16 ISO-KF-20	PF 146 024	
Hose nipple, for PVC hose and sleeve, DN 25 ISO-KF-20	PF 146 034	
Hose nipple, for PVC hose and sleeve, DN 25 ISO-KF-28	PF 146 037	
Hose nipple, for PVC hose and sleeve, DN 40 ISO-KF-25	PF 146 047	
Hose nipple, for PVC hose and sleeve, DN 40 ISO-KF-40	PF 146 048	
Hose nipple, for PVC hose and sleeve, DN 40 ISO-KF-45	PF 146 049	

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PVC hoses, sleeves, protective covers		**617**
- PVC hoses with embedded support spiral		**617**
PVC hose, nominal diameter 12, with embedded polyester spiral	P 2358 262 SS	
PVC hose, nominal diameter 14, with embedded polyester spiral	P 2359 314 NV	
PVC hose, nominal diameter 16, with embedded polyester spiral	P 2359 345 NV	
PVC hose, nominal diameter 20, with embedded polyester spiral	P 2359 455 NV	
PVC hose, nominal diameter 25, with embeded polyester spiral	P 2359 647 NV	
PVC hose, nominal diameter 40, with embeded polyester spiral	P 2359 810 NV	
PVC hose, nominal diameter 45, with casted-in steel spiral	P 2359 837 BR	
- PVC hoses, complete with KF flanges		**617**
PVC hose complete, 500 mm, DN 16 ISO-KF	PF 151 250-T	
PVC hose complete, 1000 mm, DN 16 ISO-KF	PF 151 210-T	
PVC hose complete, 500 mm, DN 25 ISO-KF	PF 151 350-T	
PVC hose complete, 1000 mm, DN 25 ISO-KF	PF 151 310-T	
PVC hose complete, 500 mm, DN 40 ISO-KF	PF 151 450-T	
PVC hose complete, 1000 mm, DN 40 ISO-KF	PF 151 410-T	
- Sleeves, CR (Neoprene)		**618**
Sleeve, nominal diameter 20	PF 147 004	
Sleeve, nominal diameter 25	PF 147 007	
Sleeve, nominal diameter 45	PF 147 009	
- Hose clips, galvanized steel		**618**
Hose clip, nominal diameter 20	P 4163 107 B	
Hose clip, nominal diameter 25	P 4163 109 B	
Hose clip, nominal diameter 45	P 4163 114 B	
- Protective covers, plastic		**618**
Protective cover, DN 10-16 ISO-KF	PF 149 316	
Protective cover, DN 20-25 ISO-KF	PF 149 325	
Protective cover, DN 32-40 ISO-KF	PF 149 340	
Protective cover, DN 50 ISO-KF	PF 149 350	
ISO-K / F		**619**
Connection elements / claw clamps / claw grips		**619**
- Claw clamps		
Claw clamp, coated steel, DN 63-250 ISO	PF 300 110-T	
Claw clamp, galvanized steel, DN 320-500 ISO	PF 300 101-T	
Claw clamp, galvanized steel, DN 630 ISO	PF 300 102-T	
Claw clamp, stainless steel, DN 63-250 ISO	PF 300 200-T	
- Claw grips for the connection between clamping flange and base plate, with sealing groove		**619**
Claw grip, galvanized steel, for the connection between clamping flange and base plate, with sealing groove, DN 63-100 ISO	PF 301 110-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, with sealing groove, DN 160-250 ISO	PF 301 111-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, with sealing groove, DN 320-500 ISO	PF 301 112-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, with sealing groove, DN 630 ISO	PF 301 113-T	
- Claw grips for the connection between clamping flange and base plate		**619**
Claw grip, galvanized steel, for the connection between clamping flange and base plate, DN 63-100 ISO	PF 301 100-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, DN 160-250 ISO	PF 301 101-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, DN 320-500 ISO	PF 301 102-T	
Claw grip, galvanized steel, for the connection between clamping flange and base plate, DN 630 ISO	PF 301 103-T	

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- Collar flanges with retainer ring		**619**
Collar flange with retaining ring, steel, nickel plated, DN 63 ISO-F	PF 307 106-T	
Collar flange with retaining ring, steel, nickel plated, DN 100 ISO-F	PF 307 110-T	
Collar flange with retaining ring, steel, nickel plated, DN 160 ISO-F	PF 307 116-T	
Collar flange with retaining ring, steel, nickel plated, DN 200 ISO-F	PF 307 120-T	
Collar flange with retaining ring, steel, nickel plated, DN 250 ISO-F	PF 307 125-T	
Collar flange with retaining ring, steel, nickel plated, DN 320 ISO-F	PF 307 132-T	
Collar flange with retaining ring, steel, nickel plated, DN 400 ISO-F	PF 307 140-T	
Seals		**620**
- Centering rings		**620**
Centering ring, CR (Neoprene/aluminum), DN 63 ISO	PF 303 006-T	
Centering ring, CR (Neoprene/aluminum), DN 100 ISO	PF 303 010-T	
Centering ring, CR (Neoprene/aluminum), DN 160 ISO	PF 303 016-T	
Centering ring, CR (Neoprene/aluminum), DN 200 ISO	PF 303 020-T	
Centering ring, CR (Neoprene/aluminum), DN 250 ISO	PF 303 025-T	
Centering ring, CR (Neoprene/aluminum), DN 320 ISO	PF 303 032-T	
Centering ring, CR (Neoprene/aluminum), DN 400 ISO	PF 303 040-T	
Centering ring, CR (Neoprene/aluminum), DN 500 ISO	PF 303 050-T	
Centering ring, CR (Neoprene/aluminum), DN 630 ISO	PF 303 063-T	
Centering ring, FPM/aluminum, DN 63 ISO	PF 303 106-T	
Centering ring, FPM/aluminum, DN 100 ISO	PF 303 110-T	
Centering ring, FPM/aluminum, DN 160 ISO	PF 303 116-T	
Centering ring, FPM/aluminum, DN 200 ISO	PF 303 120-T	
Centering ring, FPM/aluminum, DN 250 ISO	PF 303 125-T	
Centering ring, FPM/aluminum, DN 320 ISO	PF 303 132-T	
Centering ring, FPM/aluminum, DN 400 ISO	PF 303 140-T	
Centering ring, FPM/aluminum, DN 500 ISO	PF 303 150-T	
Centering ring, FPM/aluminum, DN 630 ISO	PF 303 163-T	
Centering ring, FPM/aluminum, DN 800 ISO	PF 303 180-T	
Centering ring, FPM/aluminum, DN 1000 ISO	PF 303 199-T	
Centering ring, FPM/stainless steel, DN 63 ISO	PF 303 206-T	
Centering ring, FPM/stainless steel, DN 100 ISO	PF 303 210-T	
Centering ring, FPM/stainless steel, DN 160 ISO	PF 303 216-T	
Centering ring, FPM/stainless steel, DN 200 ISO	PF 303 220-T	
Centering ring, FPM/stainless steel, DN 250 ISO	PF 303 225-T	
- O-rings of CR (Neopren)		**621**
O-ring, CR (Neoprene), DN 63 ISO	P 4071 054 PN	
O-ring, CR (Neoprene), DN 100 ISO	P 4071 274 PN	
O-ring, CR (Neoprene), DN 160 ISO	P 4071 524 PN	
O-ring, CR (Neoprene), DN 200 ISO	P 4071 659 PN	
O-ring, CR (Neoprene), DN 250 ISO	P 4071 774 PN	
O-ring, CR (Neoprene), DN 320 ISO	P 4071 886 PN	
O-ring, CR (Neoprene), DN 400 ISO	P 4074 005 PN	
O-ring, CR (Neoprene), DN 500 ISO	P 4074 106 PN	
O-ring, CR (Neoprene), DN 630 ISO	P 4074 245 PN	
- O-rings of FPM		**621**
O-ring, FPM, DN 63 ISO	P 4071 054 PV	
O-ring, FPM, DN 100 ISO	P 4071 274 PV	
O-ring, FPM, DN 160 ISO	P 4071 524 PV	
O-ring, FPM, DN 200 ISO	P 4071 659 PV	
O-ring, FPM, DN 250 ISO	P 4071 774 PV	
O-ring, FPM, DN 320 ISO	P 4071 886 PV	
O-ring, FPM, DN 400 ISO	P 4074 005 PV	
O-ring, FPM, DN 500 ISO	P 4074 106 PV	
O-ring, FPM, DN 630 ISO	P 4074 245 PV	
O-ring, FPM, DN 800 ISO	P 4074 363 PV	
O-ring, FPM, DN 1000 ISO	P 4074 523 PV	
Flanges		**621**
- Blank flanges		**621**
Blank flange, steel, nickel plated, DN 63 ISO-K	PF 305 106	
Blank flange, steel, nickel-plated, DN 100 ISO-K	PF 305 110	
Blank flange, steel, nickel plated, DN 160 ISO-K	PF 305 116	
Blank flange, stainless steel 316L, DN 63 ISO-K	PF 305 206	
Blank flange, stainless steel 316L, DN 100 ISO-K	PF 305 210	
Blank flange, stainless steel 316L, DN 160 ISO-K	PF 305 216	
Blank flange, stainless steel 316L, DN 200 ISO-K	PF 305 220	
Blank flange, stainless steel 316L, DN 250 ISO-K	PF 305 225	
Blank flange, stainless steel 316L, DN 320 ISO-K	PF 305 232	
Blank flange, stainless steel 316L, DN 400 ISO-K	PF 305 240	
Blank flange, stainless steel 316L, DN 500 ISO-K	PF 305 250	
Blank flange, stainless steel 316L, DN 630 ISO-K	PF 305 263	
- Welding flanges		**622**
Welding flange, steel, DN 63 ISO-K	PF 306 106	
Welding flange, steel, DN 100 ISO-K	PF 306 110	
Welding flange, steel, DN 160 ISO-K	PF 306 116	
Welding flange, steel, DN 250 ISO-K	PF 306 125	
Welding flange, stainless steel 304, DN 63 ISO-K	PF 306 306	
Welding flange, stainless steel 304, DN 100 ISO-K	PF 306 310	
Welding flange, stainless steel 304, DN 160 ISO-K	PF 306 316	
Welding flange, stainless steel 304, DN 200 ISO-K	PF 306 320	
Welding flange, stainless steel 304, DN 250 ISO-K	PF 306 325	
Welding flange, stainless steel 304, DN 250 ISO-K	PF 306 327	
- Measurement flanges		**622**
Measurement flange, aluminum, DN 63 ISO-F	PF 308 006-T	
Measurement flange, aluminum, DN 100 ISO-F	PF 308 010-T	
Measurement flange, aluminum, DN 160 ISO-F	PF 308 016-T	
- **Flanges with pipe socket**		**622**
Flange with pipe socket, steel, DN 63 ISO-K	PF 310 106-X	
Flange with pipe socket, steel, DN 100 ISO-K	PF 310 110-X	
Flange with pipe socket, steel, DN 160 ISO-K	PF 310 116-X	
Flange with pipe socket, steel, DN 250 ISO-K	PF 310 125-X	
Flange with pipe socket, stainless steel 304, DN 63 ISO-K	PF 310 306-X	
Flange with pipe socket, stainless steel 304, DN 100 ISO-K	PF 310 310-X	
Flange with pipe socket, stainless steel 304, DN 160 ISO-K	PF 310 316-X	
Flange with pipe socket, stainless steel 304, DN 200 ISO-K	PF 310 320-X	
Flange with pipe socket, stainless steel 304, DN 250 ISO-K	PF 310 325-X	
Flange with pipe socket, stainless steel 304, DN 250 ISO-K	PF 310 327-X	
Flange with pipe socket, stainless steel 304, DN 320 ISO-K	PF 310 332-X	
Flange with pipe socket, stainless steel 304, DN 400 ISO-K	PF 310 340-X	
Flange with pipe socket, stainless steel 304, DN 500 ISO-K	PF 310 350-X	
Flange with pipe socket, stainless steel 304, DN 630 ISO-K	PF 310 363-X	
Piping components		**623**
- 90° elbows		**623**
90° elbow, stainless steel 316L, DN 63 ISO-K	PF 311 206-X	
90° elbow, stainless steel 316L, DN 100 ISO-K	PF 311 210-X	
90° elbow, stainless steel 316L, DN 160 ISO-K	PF 311 216-X	
90° elbow, stainless steel 316L, DN 200 ISO-K	PF 311 220-X	
90° elbow, stainless steel 316L, DN 250 ISO-K	PF 311 225-X	
- T-pieces		**623**
T-piece, stainless steel 316L, DN 63 ISO-K	PF 312 206-X	
T-piece, stainless steel 316L, DN 100 ISO-K	PF 312 210-X	
T-piece, stainless steel 316L, DN 160 ISO-K	PF 312 216-X	
T-piece, stainless steel 316L, DN 200 ISO-K	PF 312 220-X	
T-piece, stainless steel 316L, DN 250 ISO-K	PF 312 225-X	
- Crosspieces		**623**
Crosspiece, stainless steel 316L, DN 63 ISO-K	PF 314 206-X	
Crosspiece, stainless steel 316L, DN 100 ISO-K	PF 314 210-X	
Crosspiece, stainless steel 316L, DN 160 ISO-K	PF 314 216-X	
Crosspiece, stainless steel 316L, DN 200 ISO-K	PF 314 220-X	
Crosspiece, stainless steel 316L, DN 250 ISO-K	PF 314 225-X	
- Measurement crosspieces		**623**
Measurement piece, stainless steel, DN 63 ISO-K	PF 317 206-X	
Measurement piece, stainless steel, DN 100 ISO-K	PF 317 210-X	
Measurement piece, stainless steel, DN 160 ISO-K	PF 317 216-X	

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Metallic hoses / bellows		**624**
- Bellows		**624**
Bellows, stainless steel, DN 63 ISO-K	PF 318 206-X	
Bellows, stainless steel, DN 100 ISO-K	PF 318 210-X	
Bellows, stainless steel, DN 160 ISO-K	PF 318 216-X	
Bellows, stainless steel, DN 200 ISO-K	PF 318 220-X	
Bellows, stainless steel, DN 250 ISO-K	PF 318 225-X	
- Metallic hoses		**624**
Metallic hose, stainless steel, 250 mm, DN 63 ISO-K	PF 319 025-X	
Metallic hose, stainless steel, 500 mm, DN 63 ISO-K	PF 319 050-X	
Metallic hose, stainless steel, 750 mm, DN 63 ISO-K	PF 319 075-X	
Metallic hose, stainless steel, 1000 mm, DN 63 ISO-K	PF 319 010-X	
Metallic hose, stainless steel, 250 mm, DN 100 ISO-K	PF 319 125-X	
Metallic hose, stainless steel, 500 mm, DN 100 ISO-K	PF 319 150-X	
Metallic hose, stainless steel, 750 mm, DN 100 ISO-K	PF 319 175-X	
Metallic hose, stainless steel, 1000 mm, DN 100 ISO-K	PF 319 110-X	
Reducing pieces and adapters		**624**
- Reducing flanges, ISO-K / ISO-F		**624**
Reducing flange, stainless steel, DN 160/63 ISO-K/F	PF 320 220	
Reducing flange, stainless steel, DN 160/100 ISO-K/F	PF 320 221	
Reducing flange, stainless steel, DN 200/100 ISO-K/F	PF 320 231	
Reducing flange, stainless steel, DN 200/160 ISO-K/F	PF 320 232	
Reducing flange, stainless steel, DN 250/160 ISO-K/F	PF 320 242	
- Reducing pieces, ISO-K / ISO-K		**624**
Reducing piece, stainless steel, DN 100/63 ISO-K	PF 321 210-X	
Reducing piece, stainless steel, DN 160/100 ISO-K	PF 321 221-X	
Reducing piece, stainless steel, DN 200/160 ISO-K	PF 321 232-X	
Reducing piece, stainless steel, DN 250/200 ISO-K	PF 321 243-X	
Adapters, ISO-K / ISO-KF		**625**
Adapter, aluminum, DN 63 ISO-K/40 KF	PF 322 004	
Adapter, aluminum, DN 63 ISO-K/50 KF	PF 322 005	
Adapter, stainless steel, DN 63 ISO-K/40 KF	PF 322 204-X	
Adapter, stainless steel, DN 63 ISO-K/50 KF	PF 322 205-X	
Adapter, stainless steel, DN 100 ISO-K/40 KF	PF 322 214-X	
Sleeves / protective covers		
- Sleeve connections		
Sleeve connection, aluminum, DN 63 ISO-K, ND 76	PF 323 006	**625**
Sleeve connection, aluminum, DN 100 ISO-K, ND 108	PF 323 010	**625**
Sleeve connection, aluminum, DN 160 ISO-K, ND 159	PF 323 016	
- Sleeves		**625**
Sleeve, Neoprene, nominal diameter 76	PF 324 006	
Sleeve, Neoprene, nominal diameter 108	PF 324 010	
Sleeve, Neoprene, nominal diameter 159	PF 324 016	
- Hose clips		**625**
Hose clip, for nominal diameter 76	P 4163 117 B	
Hose clip, for nominal diameter 108	P 4163 121 B	
Hose clip, for nominal diameter 159	P 4163 125 B	
Protective covers		**626**
- Protective covers of plastic ISO-K		**626**
Protective cover, DN 63 ISO-K	PM 143 460	
Protective cover, DN 100 ISO-K	PM 143 461	
Protective cover, DN 160 ISO-K	PM 143 462	
Protective cover, DN 200 ISO-K	PM 143 250	
Protective cover, DN 250 ISO-K	PM 143 252	
Protective covers		**626**
- Protective covers, plastic ISO-F		**626**
Protective cover, DN 100 ISO-F	PM 143 463	
Protective cover, DN 160 ISO-F	PM 143 464	
Protective cover, DN 200 ISO-F	PM 143 254	
Protective cover, DN 250 ISO-F	PM 143 255	
CF		**627**
Connection elements / sets of screws and bolts		**627**
- Set of hexagonal bolts		
Set of hexagonal bolts, 6 count, M4, DN 16 CF	PM 016 696-T	
Set of hexagonal bolts, 6 count, M6, DN 40 CF	PM 016 697-T	
Set of hexagonal bolts, 8 count, M8, DN 63 CF	PM 016 683-T	
Set of hexagonal bolts, 16 count, M8, DN 100 CF	PM 016 690-T	
Set of hexagonal bolts, 20 count, M8, DN 160 CF	PM 016 691-T	

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Set of hexagonal screws, 24 count, M8, DN 200 CF	PM 016 687 -T	
Set of hexagonal screws, 32 count, M8, DN 250 CF	PM 016 694 -T	
- Set of hexagon bolts with duo nuts		**627**
Set of hexagonal bolts, 6 count, with 3 M4 duo nuts, DN 16 CF	PF 506 000-T	
Set of hexagonal bolts, 6 count, with 3 M6 duo nuts, DN 40 CF	PF 506 001-T	
- Set of stud screws		**627**
Set of stud screws, 6 count, M4, DN 16 CF	PM 016 698-T	
Set of stud screws, 6 count, M6, DN 40 CF	PM 016 699-T	
Set of stud screws, 8 count, M8, DN 63 CF	PM 016 684-T	
Set of stud screws, 16 count, M8, DN 100 CF	PM 016 692-T	
Set of stud screws, 20 count, M8, DN 160 CF	PM 016 693-T	
Set of stud screws, 24 count, M8, DN 200 CF	PM 016 688-T	
Set of stud screws, 32 count, M8, DN 250 CF	PM 016 695-T	
Seals		**627**
- Copper seal, 10 count (DN 250, 5 count)		**627**
Copper seal, 10 count, DN 16 CF	PF 501 401-T	
Copper seal, 10 count, DN 40 CF	PF 501 404-T	
Copper seal, 10 count, DN 63 CF	PF 501 406-T	
Copper seal, 10 count, DN 100 CF	PF 501 410-T	
Copper seal, 10 count, DN 160 CF	PF 501 416-T	
Copper seal, 10 count, DN 200 CF	PF 501 420-T	
Copper seal, 5 count, DN 250 CF	PF 501 425-T	
- Copper seal silver-plated, 10 count (DN 250, 5 count)		**628**
Copper seal, silver plated, 10 count, DN 16 CF	PF 501 501-T	
Copper seal, silver plated, 10 count, DN 40 CF	PF 501 504-T	
Copper seal, silver plated, 10 count, DN 63 CF	PF 501 506-T	
Copper seal, silver plated, 10 count, DN 100 CF	PF 501 510-T	
Copper seal, silver plated, 10 count, DN 160 CF	PF 501 516-T	
Copper seal, silver plated, 10 count, DN 200 CF	PF 501 520-T	
Copper seal, silver plated, 5 count, DN 250 CF	PF 501 525-T	
- FPM seals, 5 count		**628**
FPM seal, 5 count, DN 16 CF	PF 501 301-T	
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Software for SmartTest helium leak detector	PT 882 610-T	
USB Converter to RS-485 interface	PM 061 207-T	
Connection cable, plug M12, RJ 45, length 3 m	PM 051 726-T	
- Sniffer probe		**592**
LP 503, sniffer probe with standard tip, 3 m	BG 449 207-T	
LP 505, sniffer probe with standard tip, 5 m	BG 449 208-T	
LP 510, sniffer probe with standard tip, 10 m	BG 449 209-T	
Capillary filter, metal version, for sniffer tip	BG 449 140-T	
TP 312, Sniffer tip stiff, 120 mm	BG 449 215-T	
TP 385, Sniffer tip stiff, 385 mm	BG 449 216-T	
TF 312, Sniffer tip flexible, 120 mm	BG 449 217-T	
TF 385, Sniffer tip flexible, 385 mm	BG 449 218-T	
- Sniffer test leak		**593**
CL 004, Sniffer test leak, He leak rate approx 10^{-4} mbar l/s, He	BG 447 704-T	
CL 004, Sniffer test leak, He leak rate approx 10^{-5} mbar l/s, He	BG 447 705-T	
CL 004, Sniffer test leak, He leak rate approx 10^{-6} mbar l/s, He	BG 447 706-T	
CL 002 A Sniffer test leak, gas mixture He : H2 = 95 % : 5 % leak rate approx. 10^{-6} mbar l/s	BG 449 025A	
- Bypass option		**594**
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Bypass option, with US plug	PT 445 412-T	
- Cart for SmartTest		**595**
Cart with power connection, 100-120 VAC	PT 445 416	
Cart with power connection, 230 VAC	PT 445 415	
- Calibrated test leak		**596**
CT 446, He test leak, leak rate adjustable from 10^{-6} - 10^{-4} mbar l/s, DN 10 ISO-KF	B8 115 580	
CT 408, He test leak, leak rate approx. 10-8 mbar l/s, DN 10 ISO-KF	B8 116 557	
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Helium pistol	BG 512 125-T	
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Signal tower	B4681891KC	
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Transport case for SmartTest	PT 445 403	

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Measurement and control units

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DigiLine **454**

Transmitter **458**

- Piezo (1 - 2,000 mbar)

Digital Piezo transmitter CPT 100, DN 16 ISO-KF	PT R31 130	
Digital Piezo transmitter CPT 100, G1/4"	PT R31 230	
- Piezo / Pirani Kombination (1 · 10^{-4} - 1,200 mbar)		**460**
Digital Piezo/Pirani transmitter RPT 100, DN 16 ISO-KF	PT R32 130	
Digital Piezo/Pirani transmitter RPT 100, DN 16 CF	PT R32 330	
- Pirani (1 · 10^{-4} - 1,000 mbar)		**462**
Digital Pirani transmitter PPT 100, DN 16 ISO-KF	PT R33 130	
Digital Pirani transmitter PPT 100, DN 16 CF	PT R33 330	
- Pirani / Bayard-Alpert combination (1 · 10^{-9} - 1,000 mbar)		**464**
Digital Pirani/Bayard-Alpert transmitter HPT 100, DN 40 ISO-KF	PT R34 130	
Digital Pirani/Bayard-Alpert transmitter HPT 100, DN 40 CF	PT R34 330	
- Pirani / cold cathode combination (5 · 10^{-9} - 1,000 mbar)		**466**
Digital Pirani/cold cathode transmitter MPT 100, DN 25 ISO-KF	PT R35 120	
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DPS 101, for 1 transmitter, US plug	PT G20 011	
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TIC 002, converter for DigiLine Transmitter	PM 051 519-T	
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- Software		**476**
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Transmitter connecting cable for DPG 101, length 6 m	PT 348 206-T	
Transmitter connecting cable for DPG 101, length 10 m	PT 348 210-T	
Transmitter connecting cable for DPG/DPS 109, length 3 m	PT 348 403-T	
Transmitter connecting cable for DPG/DPS 109, length 6 m	PT 348 406-T	
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Power cord, US plug, 2.5 m	P4 564 309 YX	
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PC data cable, 3 m	PT 348 130-T	
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ActiveLine transmitter		**480**
Active Piezo transmitter (1 · 10^{-1} - 55,000 mbar)		
- Active Piezo transmitter APR 250 / 260 (1·10^{-1} - 1.100 mbar)		
Active Piezo transmitter APR 250, DN 16 ISO-KF	P 5215 102 TF	
Active Piezo transmitter APR 260, DN 16 ISO-KF	P 5215 112 TF	
Active Piezo transmitter APR 260, DN 16 CF-F	P 5215 114 TF	
- Active Piezo transmitter APR 262 / 265 / 266 / 267 (2 · 10^{-1} - 55,000 mbar)		**482**
Active Piezo transmitter APR 262, G1/4"	P 5215 120 TF	
Active Piezo transmitter APR 265, G 1/4"	P 5215 126 TF	
Active Piezo transmitter APR 266, G 1/4"	P 5215 132 TF	
Active Piezo transmitter APR 267, G 1/4"	P 5215 138 TF	
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- Active capacitive transmitter CMR 361 (1 · 10^{-1} - 1,100 mbar), temperature-compensated		
Active capacitive transmitter CMR 361, tube OD 1/2"	PT R24 600	
Active capacitive transmitter CMR 361, DN 16 ISO-KF	PT R24 601	
Active capacitive transmitter CMR 361, DN 16 CF-R	PT R24 602	
Active capacitive transmitter CMR 361, 8 VCR	PT R24 603	
- Active capacitive transmitter CMR 362 (1·10^{-2} - 110 mbar), temperature-compensated		**484**
Active capacitive transmitter CMR 362, tube OD 1/2"	PT R24 610	
Active capacitive transmitter CMR 362, DN 16 ISO-KF	PT R24 611	
Active capacitive transmitter CMR 362, DN 16 CF-R	PT R24 612	
Active capacitive transmitter CMR 362, 8 VCR	PT R24 613	

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Active capacitive transmitter CMR 363, DN 16 ISO-KF	PT R24 621	
Active capacitive transmitter CMR 363, DN 16 CF-R	PT R24 622	
Active capacitive transmitter CMR 363, 8 VCR	PT R24 623	
- Active capacitive transmitter CMR 364 (1 · 10⁻⁴ - 1.1 mbar), temperature-compensated		**484**
Active capacitive transmitter CMR 364, tube OD 1/2"	PT R24 630	
Active capacitive transmitter CMR 364, DN 16 ISO-KF	PT R24 631	
Active capacitive transmitter CMR 364, DN 16 CF-R	PT R24 632	
Active capacitive transmitter CMR 364, 8 VCR	PT R24 633	
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Active capacitive transmitter CMR 365, tube OD 1/2"	PT R24 640	
Active capacitive transmitter CMR 365, DN 16 ISO-KF	PT R24 641	
Active capacitive transmitter CMR 365, DN 16 CF-R	PT R24 642	
Active capacitive transmitter CMR 365, 8 VCR	PT R24 643	
- Active capacitive transmitter CMR 271, (1 · 10⁻¹ - 1,100 mbar), temperature-controlled (45 °C)		**486**
Active capacitive transmitter CMR 271, tube OD 1/2"	PT R25 000	
Active capacitive transmitter CMR 271, DN 16 ISO-KF	PT R25 001	
Active capacitive transmitter CMR 271, DN 16 CF-R	PT R25 002	
Active capacitive transmitter CMR 271, 8 VCR	PT R25 003	
- Active capacitive transmitter CMR 272, (1 · 10⁻² - 110 mbar), temperature-controlled (45 °C)		**486**
Active capacitive transmitter CMR 272, tube OD 1/2"	PT R25 010	
Active capacitive transmitter CMR 272, DN 16 ISO-KF	PT R25 011	
Active capacitive transmitter CMR 272, DN 16 CF-R	PT R25 012	
Active capacitive transmitter CMR 272, 8 VCR	PT R25 013	
- Active capacitive transmitter CMR 273, (1 · 10⁻³ - 11 mbar), temperature-controlled (45 °C)		**486**
Active capacitive transmitter CMR 273, tube OD 1/2"	PT R25 020	
Active capacitive transmitter CMR 273, DN 16 ISO-KF	PT R25 021	
Active capacitive transmitter CMR 273, DN 16 CF-R	PT R25 022	
Active capacitive transmitter CMR 273, DN 8 VCR	PT R25 023	
- Active capacitive transmitter CMR 274 (1 · 10⁻⁴ - 1.1 mbar), temperature-controlled (45 °C)		**486**
Active capacitive transmitter CMR 274, tube OD 1/2"	PT R25 030	
Active capacitive transmitter CMR 274, DN 16 ISO-KF	PT R25 031	
Active capacitive transmitter CMR 274, DN 16 CF-R	PT R25 032	
Active capacitive transmitter CMR 274, 8 VCR	PT R25 033	
- Active capacitive transmitter CMR 275 (1 · 10⁻⁵ - 0.11 mbar), temperature-controlled (45 °C)		**486**
Active capacitive transmitter CMR 275, tube OD 1/2"	PT R25 040	
Active capacitive transmitter CMR 275, DN 16 ISO-KF	PT R25 041	
Active capacitive transmitter CMR 275, DN 16 CF-R	PT R25 042	
Active capacitive transmitter CMR 275, 8 VCR	PT R25 043	
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- Active capacitive transmitter CCR 361, temperature-compensated		
Active capacitive transmitter CCR 361, tube OD 1/2"	PT R27 600	
Active capacitive transmitter CCR 361, DN 16 ISO-KF	PT R27 601	
Active capacitive transmitter CCR 361, 8 VCR	PT R27 603	
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Active capacitive transmitter CCR 362, DN 16 ISO-KF	PT R27 611	
Active capacitive transmitter CCR 362, 8 VCR	PT R27 613	
- Active capacitive transmitter CCR 363, (1 · 10⁻³ - 10 Torr), temperature-compensated		**488**
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Active capacitive transmitter CCR 364, DN 16 CF-R	PT R27 632	
Active capacitive transmitter CCR 364, 8 VCR	PT R27 633	
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Active capacitive transmitter CCR 365, DN 16 ISO-KF	PT R27 641	
Active capacitive transmitter CCR 365, DN 16 CF-R	PT R27 642	
Active capacitive transmitter CCR 365, 8 VCR	PT R27 643	
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Active capacitive transmitter CCR 272, DN 16 ISO-KF	PT R28 011	
Active capacitive transmitter CCR 272, DN 16 CF-R	PT R28 012	
Active capacitive transmitter CCR 272, 8 VCR	PT R28 013	
- Active capacitive transmitter CCR 273, (1 · 10⁻³ - 10 Torr), temperature-controlled		**490**
Active capacitive transmitter CCR 273, tube OD 1/2"	PT R28 020	
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Active capacitive transmitter CCR 273, DN 16 CF-R	PT R28 022	
Active capacitive transmitter CCR 273, 8 VCR	PT R28 023	
- Active capacitive transmitter CCR 274, (1 · 10⁻⁴ - 1 Torr), temperature-controlled		**490**
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Active capacitive transmitter CCR 274, DN 16 ISO-KF	PT R28 031	
Active capacitive transmitter CCR 274, DN 16 CF-R	PT R28 032	
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Active Pirani / capacitive transmitter PCR 260, 80 °C, DN 16 ISO-KF	PT R26 850	
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Active Pirani transmitter TPR 280, 80 °C, DN 16 ISO-KF	PT R26 950	
Active Pirani transmitter TPR 280, 80 °C, DN 16 CF-R	PT R26 951	
Active Pirani transmitter TPR 280, 80 °C, 1/8" NPT	PT R26 952	
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Active Pirani transmitter TPR 281, 65°C, DN 16 CF-R	PT R21 951	
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Active cold cathode transmitter IKR 261, DN 40 CF-F	PT R25 751	
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Active cold cathode transmitter IKR 270, DN 40 CF-F	PT R21 251	
Active cold cathode transmitter IKR 270, DN 40 CF-F, extra-long case	PT R21 261	
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Active Pirani / cold cathode transmitter PKR 251, DN 40 ISO-KF	PT R26 001	
Active Pirani / cold cathode transmitter PKR 251, DN 40 CF-F	PT R26 002	
Active Pirani / cold cathode transmitter PKR 261, DN 25 ISO-KF	PT R26 250	
Active Pirani / cold cathode transmitter PKR 261, DN 40 ISO-KF	PT R26 251	
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Active hot cathode transmitter IMR 265, DN 40 ISO-KF	PT R26 501	
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Active Pirani/Bayard-Alpert transmitter PBR 260, DN 25 ISO-KF	PT R27 000	
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Okta 250 AM, 230/400 V, 60 Hz	PP W22 002	
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Okta 1000 AM, 230/400 V, 50 Hz	PP W42 002	
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Okta 2000 A, 230/400 V, 60 Hz	PP W61 002	
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Okta 2000 ADEx, without motor	PP W61 800	
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P3, mineral oil, 1 l	PK 001 106-T	
P3, mineral oil, 5 l	PK 001 107-T	
P3, mineral oil, 20 l	PK 001 108-T	
P3, mineral oil, 50 l	PK 001 109-T	
P3, mineral oil, 200 l	PK 001 110-T	
F5, Perfluorpolyether, 0.5 l	PK 001 851-T	
F5, Perfluorpolyether, 1 l	PK 001 852-T	
F5, Perfluorpolyether, 5 l	PK 001 853-T	
F5, Perfluorpolyether, 20 l	PK 001 854-T	
F5, Perfluorpolyether, 50 l	PK 001 855-T	
D1 oil, 0.25 l	PK 005 880-T	
D1 oil, 0.5 l	PK 005 881-T	
D1 oil, 1 l	PK 005 875-T	
D1 oil, 5 l	PK 005 876-T	
D1 oil, 20 l	PK 005 877-T	
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Hena 25, 1-ph Motor, 230 V, 50 Hz	PK D02 212	
Hena 25, 1-ph Motor, 110 V, 60 Hz	PK D02 207	
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SAS 100, DN 100 ISO-K, polyester filter	PK Z60 512	**207**
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Barretter actuation unit 3TF	P4 768 051 FQ	
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BA 251, 3-ph Motor, 440-480 V, 60 Hz, without HV safety valve	PK C42 637	
BA 501, 3-ph Motor, 220-240/380-420 V, 50 Hz, without HV safety valve	PK C43 602	
BA 501, 3-ph Motor, 440-480 V, 60 Hz, without HV safety valve	PK C43 637	
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DUO 2.5, 1 phase, 95-105 V, 50 Hz; 100-115 V, 60 Hz	PK D41 708	
DUO 2.5, 1 phase, 220-240 V, 50 Hz/60 Hz	PK D41 712	
DUO 2.5 C, 1 phase, 220-240 V, 50 Hz/60 Hz	PK D41 014	
DUO 2.5, 1 phase 190-210 V, 50 Hz; 200-220 V, 60 Hz	PK D41 709	
DUO 2.5, 1 phase, 100-105 V, 50 Hz; 110-130 V, 60 Hz	PK D41 707	
DUO 2.5 C, 1 phase, 100-105 V, 50 Hz ; 110-130 V, 60 Hz	PK D41 019	
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DUO 5 M, 3 phase 200/346 V, 50 Hz 220/380 V, 60 Hz	PK D61 115	
DUO 5 MC, 3 phase, 200/346 V, 50 Hz 265/460 V, 60 Hz	PK D61 125	
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DUO 20 M, 3 phase, 3 TF, 200/346 V, 50 Hz 220/380 V, 60 Hz	PK D63 115	
DUO 20 MC, 3 phase, 3 TF, 200/346 V, 50 Hz 220/380 V, 60 Hz	PK D63 135	
DUO 20 M, 1 phase, 105 V, 50 Hz 110 V, 60 Hz	PK D63 707	
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DUO 35 C, 3 phase, 3 TF, 200/346 V, 50 Hz 220/380 V, 60 Hz	PK D45 242	
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KAS 40, Condensate separator for pumping speed bis 35-65 m^3/h	PK Z10 008	
KAS 40 C, Condensate separator, corrosive version, DUO 35 C, 65 C	PK Z10 408	
KAS 63, Condensate separator	PK Z10 010	
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FAK 040, activated carbon filter	PK Z30 008	
FAK 063, activated carbon filter	PK Z30 010	
FAK 100, activated carbon filter	PK Z30 012	
ZFO 016, zeolite trap	PK Z70 003	
ZFO 25, zeolite trap	PK Z70 006	
ZFO 040, zeolite trap	PK Z70 008	
ZFO 063, zeolite trap	PK Z70 010	
Heating rod for ZFO 025, 220 V, 50/60 Hz	PK Z90 012A	
Heating rod for ZFO 040, 220 V, 50/60 Hz	PK Z90 020A	
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KLF 063, cold trap	PK Z80 010	
URB 025, catalytic trap, 230 V	PT U10 760	
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Operational monitoring unit for DUO 35,65/DUO 35C,65C / DUO 35M,65M	PK 223 739-U	
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P3, mineral oil, 1 l	PK 001 106-T	
P3, mineral oil, 5 l	PK 001 107-T	
P3, mineral oil, 20 l	PK 001 108-T	
P3, mineral oil, 50 l	PK 001 109-T	
P3, mineral oil, 200 l	PK 001 110-T	
F5, Perfluorpolyether, 0.5 l	PK 001 851-T	
F5, Perfluorpolyether, 1 l	PK 001 852-T	
F5, Perfluorpolyether, 5 l	PK 001 853-T	
F5, Perfluorpolyether, 20 l	PK 001 854-T	
F5, Perfluorpolyether, 50 l	PK 001 855-T	
D1 oil, 0.25 l	PK 005 880-T	
D1 oil, 0.5 l	PK 005 881-T	
D1 oil, 1 l	PK 005 875-T	
D1 oil, 5 l	PK 005 876-T	
D1 oil, 20 l	PK 005 877-T	
D1 oil, 50 l	PK 005 878-T	
D1 oil, 200 l	PK 005 879-T	
F4, Perfluorpolyether, 0.25 l	PK 005 885-T	
F4, Perfluorpolyether, 0.5 l	PK 005 886-T	
F4, Perfluorpolyether, 1 l	PK 005 887-T	
F4, Perfluorpolyether, 5 l	PK 005 888-T	
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UNO 2.5, 1 phase motor, 95-105 V, 50 Hz; 100-115 V, 60 Hz	PK D31 708	
UNO 2.5, 1 phase motor, 200 V, 50 Hz; 210 V, 60 Hz	PK D31 709	
UNO 2.5, 1 phase motor, 220-240 V, 50/60 Hz	PK D31 712	
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UNO 5, 1 phase motor, 95-105 V, 50 Hz; 100-115 V, 60 Hz	PK D31 806	
UNO 5, 1 phase motor, 200 V, 50 Hz; 210 V, 60 Hz	PK D31 809	
UNO 5, 1 phase motor, 220-240 V, 50/60 Hz	PK D31 812	
UNO 30 M, with ONFR, 200-230/380-415 V, 50 Hz; 208-240/380-460 V, 60 Hz	PK D54 156	
UNO 30 M, without ONFR, 100-110 V, 50 Hz; 110-120 V, 60 Hz	PK D54 707	
UNO 30 M, without ONFR, 200-230 V, 50 Hz; 200-240 V, 60 Hz	PK D54 712	
UNO 30 M, with ONFR, 100-110 V, 50 Hz; 100-120 V, 60 Hz	PK D54 757	
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UNO 65, 3-phase, 220-240/380-420 V, 50 Hz; 250-277/440-480 V, 60 Hz	PK D36 602	
UNO 65, 3-phase, 3 TF, 190-210/330-365 V, 50 Hz; 200-230/360-400 V, 60 Hz	PK D36 642	
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Centering ring, with multifunction coating and integrated splinter shield, DN 160 ISO-K/-F	PM 016 217-U	
Centering ring, with multifunction coating and integrated splinter shield, DN 200 ISO-K/-F	PM 016 221-U	
Centering ring, with multifunction coating and integrated splinter shield, DN 250 ISO-K/-F	PM 016 226-U	
Centering ring, with multifunction coating and integrated splinter shield, DN 320 ISO-K/-F	PM 016 333-U	
Protection screen, DN 63 CF-F	PM 016 333	
Protection screen, DN 100 CF-F	PM 016 336	
Protection screen, DN 160 CF-F	PM 016 339	
Protection screen, DN 200 CF-F	PM 016 342	
Protection screen, DN 250 CF-F	PM 016 345	
Splinter screen, DN 63 CF-F	PM 016 312	
Splinter screen, DN 100 CF-F	PM 016 315	
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Vibration damper, DN 63 ISO-K	PM 006 800-X	
Vibration damper, DN 63 CF-F	PM 006 801-X	
Vibration damper, DN 40 ISO-KF	PM 006 799-X	
Vibration damper, DN 100 ISO-K	PM 006 459-X	
Vibration damper, DN 100 CF-F	PM 006 488-X	
Vibration damper, DN 160 ISO-K	PM 006 492-X	
Vibration damper, DN 160 CF-F	PM 006 493-X	
Vibration damper, DN 200 ISO-K	PM 006 668-X	
Vibration damper, DN 200 CF-F	PM 006 669-X	
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115 V AC mains cable with UL plug, 3 m	P 4564 309 ZE	**325**
208 V AC mains cable with UL plug, 3 m	P 4564 309 ZF	
230 V AC mains cable with Euro-style safety plug, VII-HAN 3A, 3 m	P4 564 309 HA	
208 V AC mains cable with UL plug, NEMA-HAN 3A, 3 m	P4 564 309 HB	
Connection cable for linking HiPace with TC 110 to power supply TPS/DCU 110/111/180/181	PM 061 350-T	
Connection cable for linking HiPace with TC 110 to power supply TPS/DCU 110/111/180/181	PM 061 351-T	
Connection cable for linking HiPace with TC 110 to power supply TPS/DCU 310/311/400/401	PM 061 352-T	
Connection cable for linking HiPace 80 to TCP 350	PM 061 353-T	
Connection cable for linking HiPace 300,400 and 700 to TCP 350	PM 061 356-T	
Connection cable for linking HiPace MC with TM 3000 to TPS 1400/1401	PM 051 983-T	
Connection cable TM 3000/TCP 350 - backing pump relay box, Length 2 m	PM 061 630-X	
Connection cable, plug M12, RJ 45, length 3 m	PM 051 726-T	
V Vacuum analysis		**546**
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- PrismaPlus QMG 220 F1, 1-100 amu		
QMG 220 F1, PrismaPlus, 1-100 amu, open ion source, W, 200 °C, 0°	PT M05 111 110	
QMG 220 F1, PrismaPlus, 1-100 amu, open ion source, W, 200 °C, 0°, IO 220 module	PT M05 111 111	
QMG 220 F1, PrismaPlus, 1 - 100 amu, open ion source, W, 200 °C, 90°	PT M05 111 120	
QMG 220 F1, PrismaPlus, 1 - 100 amu, open ion source, W, 200 °C, 90°, IO 220 module	PT M05 111 121	
QMG 220 F1, PrismaPlus, 1 - 100 amu, open ion source, Y, 200 °C, 0°, IO 220 module	PT M05 112 111	
QMG 220 F1, PrismaPlus, 1 - 100 amu, open ion source, Y, 200 °C, 0°	PT M05 112 110	
- PrismaPlus QMG 220 F2, 1- 200 amu		**556**
QMG 220 F2, PrismaPlus, 1 -200 amu, open ion source, W, 200 °C, 0°, IO 220 module	PT M05 211 111	
QMG 220 F2, PrismaPlus, 1 -200 amu, open ion source, Y, 200 °C, 0°, IO 220 module	PT M05 212 111	
QMG 220 F2, PrismaPlus, 1 - 200 amu, open ion source, W, 200 °C, 0°	PT M05 211 110	
- PrismaPlus QMG 220 F3, 1-300 amu		**558**
QMG 220 F3, PrismaPlus™, 1 -300 amu, open ion source, W , 200 °C, 0°, IO 220 module	PT M05 311 111	
QMG 220 F3, PrismaPlus™, 1 -300 amu, open ion source, Y, 200 °C, 0°, IO 220 module	PT M05 312 111	
Residual gas analysis in ultra high vacuum		**558**
PrismaPlus QMG 220 M with C-SEM-detector		**558**
- PrismaPlus QMG 220 M1, 1-100 amu		
PrismaPlus QMG 220 M1 with open ion source		
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QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, open ion source, W, 300 °C, 0°, IO 220 module	PT M06 111 211	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, open ion source, W, 200 °C, 90°, IO 220 module	PT M06 111 121	
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- PrismaPlus QMG 220 M1 with gas-tight ion source		558
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, gas tight ion source,, W, 200 °C, 0°	PT M06 121 110	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, gas tight ion source, W, 200 °C, 0°	PT M06 121 120	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, gas tight ion source,, W, 200 °C, 0°, IO 220 module	PT M06 121 111	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, gas tight ion source,, W, 200 °C, 90°, IO 220 module	PT M06 121 121	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, gas tight ion source,, Y, 200 °C, 0°, IO 220 module	PT M06 122 111	
- PrismaPlus QMG 220 M1 with grid ion source		558
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 0°	PT M06 141 110	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 90°	PT M06 141 120	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 0°, IO 220-Modul	PT M06 141 111	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 90°, IO 220-Modul	PT M06 141 121	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 300 °C, 0°	PT M06 141 210	
- PrismaPlus QMG 220 M1 wiht crossbeam ion source		558
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QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 90°	PT M06 131 120	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 0°, IO 220-Modul	PT M06 131 111	
QMG 220 M1, PrismaPlus, C-SEM, 1 - 100 amu, grid ion source, W, 200 °C, 90°, IO 220-Modul	PT M06 131 121	
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- PrismaPlus QMG 220 M2 with open ion source,		558
QMG 220 ^{M2}, PrismaPlus, C-SEM, 1 - 200 amu, open ion source, W, 200 °C, 0°, IO 200 module	PT M06 211 111	
QMG 220 M2, PrismaPlus, C-SEM, 1 - 200 amu, open ion source, Y, 200 °C, IO 220-Modul	PT M06 212 111	
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, open ion source, Y, 300°C, 90°, IO 220 module	PT M06 212 221	
- PrismaPlus QMG 220 M2 with gas-tight ion source		558
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, gas tight ion source, Y, 200°C, 0°, IO 220 module	PT M06 222 111	
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, gas tight ion source, W, 200°C, 0°, IO 220 module	PT M06 221 111	
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, gas tight ion source, W, 200°C, 90°, IO 220 module	PT M06 221 121	
- PrismaPlus QMG 220 M2 with grid ion source		558
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, W, 200°C, 0°, IO 220 module	PT M06 241 111	
- PrismaPlus QMG 220 M2 with crossbeam ion source		558
QMG 220 M2, PrismaPlus, C-SEM, 1-200 amu, crossbeam ion source, W, 200°C, 0°, IO 220 module	PT M06 231 111	
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PrismaPlus QMG 220 M3, 1-300 amu		558
- PrismaPlus™ QMG 220 M3 with open ion source		558
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- PrismaPlus QMG 220 M3 with gas-tight ion source		558
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QMG 220 M1, PrismaPlus, C-SEM, 1-100 amu, gas tight ion source, Y, 200°C, 0°, IO 220 module	PT M06 322 111	
- PrismaPlus QMG 220 M3 with grid ion source		558
QMG 220 M3, PrismaPlus, C-SEM, 1-300 amu, grid ion source, W, 200°C, 0°, IO 220 module	PT M06 341 111	
- PrismaPlus QMG 220 M3 with crossbeam ion source		558
QMG 220 M3, PrismaPlus, C-SEM, 1-300 amu, crossbeam ion source, W, 200°C, 0°, IO 220 module	PT M06 331 111	
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- HiQuad, QMG 700, with QMA 430, 8 mm stainless steel rod system - HiQuad with QMA 430, 1-300 amu, with crossbeam ion source	PT Q14 021 110	564
HiQuad, QMG 700, with QMA 400, 8 mm molybdenum rod system		
- HiQuad with QMA 400, 1-512 amu, with crossbeam ion source and magnet	PT Q15 031 110	564
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Individual components for PrismaPlus Analyzers QMA 200 F / M		
- Prisma Quadrupol-Analyzer, with Faraday		
QMA 200 F, Prisma Quadrupol-Analyzer, with iridium yttriated filament	PT M25 250	
QQMA 200 F, Prisma Quadrupol-Analyzer, with tungsten filament	PT M25 251	
- Prisma Quadrupol-Analyzer, with C-SEM		
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- Prisma Quadrupol electronics with C-SEM		
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SP 220, power supply for PrismaPlus™	PT 160 200	
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Accessories for PrismaPlus		
- Filaments for open ion source		
Cathode unit, 2 filaments, yttr. Iridium, for QMA 200 with open ion source	BN 846 138-T	
Cathode unit, 2 filaments, Tungsten, for QMA 200 with open ion source	BN 846 139-T	
- Filaments for gas tight ion source and GSD		
Cathode unit, 2 filaments, tungsten, for QMA 200 with gas tight ion source	BN 846 281-T	
Cathode unit, 2 filaments, yttr. Iridium, for QMA 200 with gas tight ion source	BN 846 395-T	
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Cathode unit, 2 filaments, tungsten, for QMA 200 with Cross-Beam ion source	PT 160 000 -T	

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Accessories for QMG 422, HiQuad and ion beam analysis		
- Filaments for axial ion source, QMA 400 / 410/ 430		
Rhenium filaments, 5 pieces, for QMA 400/410/430 with axial ion source	BN 845 022-T	
Tungsten filaments, 5 pieces, for QMA 400/410/430 with axial ion source	BN 845 024-T	
Iridium yttriated filament, 1 piece, for QMA 400/410/430 with axial ion source	BN 845 057-T	
- Filaments for grid ion source, QMA 400 / 410 / 430		
Tungsten filament, 1 piece, to QMA 400/410/430 with grid ion source	BN 845 095-T	
- Filaments for Cross-Beam ion source, QMA 400 / 410 / 430	BN 845 052-T	
Rhenium filaments, 2 pieces, for QMA 125/400/410/430 with Cross-Beam ion source (also gas tight)	BN 845 088-T	
Tungsten filaments, 2 pieces, for QMA 125/400/410/430 with Cross-Beam ion source (also gas tight)	BN 845 282-T	
Iridium yttriated filaments, 2 pieces, for QMA 125/400/ 410/430 with Cross-Beam ion source (also gas tight)		
Analog and digital input/output boards IO 700, I/O-module for HiQuad	PT 450 006	
Accessory for PrismaPlus QMG 220 IO 220, I/O module for PrismaPlus QMG 220	PTM 286 99	
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Angle valves		**680**
Manually actuated		**680**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
AVC 016 SA, angle vale, manually actuated	PF A31 003	
AVC 016 SX, angle vale, manually actuated	PF A31 033	
AVC 025 SA, angle vale, manually actuated	PF A41 003	
AVC 025 SX, angle vale, manually actuated	PF A41 033	
AVC 040 SA, angle vale, manually actuated	PF A51 003	
AVC 040 SX, angle vale, manually actuated	PF A51 033	
- Flange sizes from DN 63 ISO-K to DN 100 ISO-K		**682**
EVB 063 SA, Eckventil, handbetätigt	PF B12 001	
EVB 063 SX, Eckventil, handbetätigt	PF B12 031	
EVB 100 SA, Eckventil, handbetätigt	PF B22 001	
EVB 100 SX, Eckventil, handbetätigt	PF B22 031	
Electropneumatically actuated, with position indicator (PI), with pilot valve (PV)		**684**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		**684**
AVC 016 PA, angle valve electropneumatically actuated, 24 VDC	PF A38 103	to **687**
AVC 016 PA, angle valve electropneumatically actuated, PV 24 VDC	PF A38 204	
AVC 016 PA, angle valve electropneumatically actuated, PV 100-115 VAC	PF A38 403	
AVC 016 PA, angle valve electropneumatically actuated, PV 200-230 VAC	PF A38 503	
AVC 025 PA, angle valve electropneumatically actuated, PV 24 VAC	PF A48 103	
AVC 025 PA, angle valve electropneumatically actuated, PV 24 VDC	PF A48 204	
AVC 025 PA, angle valve electropneumatically actuated, PV 100-115 VAC	PF A48 403	
AVC 025 PA, angle valve electropneumatically actuated, PV 200-230 VAC	PF A48 503	
AVC 040 PA, angle valve electropneumatically actuated, PV 24 VAC	PF A58 103	
AVC 040 PA, angle valve electropneumatically actuated, PV 24 VDC	PF A58 204	
AVC 040 PA, angle valve electropneumatically actuated, PV 100-115 VAC	PF A58 403	
AVC 040 PA, angle valve electropneumatically actuated, PV 200-230 VAC	PF A58 503	
AVC 016 PX, angle valve electropneumatically actuated, 24 VDC	PF A38 133	
AVC 016 PX, angle valve electropneumatically actuated, PV 24 VDC	PF A38 234	
AVC 016 PX, angle valve electropneumatically actuated, PV 100-115 VAC	PF A38 433	
AVC 016 PX, angle valve electropneumatically actuated, PV 200-230 VAC	PF A38 533	
AVC 025 PX, angle valve electropneumatically actuated, PV 24 VDC	PF A48 133	
AVC 025 PX, angle valve electropneumatically actuated, PV 24 VDC	PF A48 234	
AVC 025 PX, angle valve electropneumatically actuated, PV 110-115 VAC	PF A48 433	
AVC 025 PX, angle valve electropneumatically actuated, PV 200-230 VAC	PF A48 533	
AVC 040 PX, angle valve electropneumatically actuated, PV 24 VDC	PF A58 133	
AVC 040 PX, angle valve electropneumatically actuated, PV 24 VDC	PF A58 234	
AVC 040 PX, angle valve electropneumatically actuated, PV 200-230 VAC	PF A58 433	
	PF A58 533	
- Flange sizes from DN 63 to DN 160 ISO-K		**688**
EVB 063 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V AC	PF B18 101	
EVB 063 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V DC	PF B18 201	
EVB 063 PA, angle valve with position indicator (PI), with pilot valve (PV), 100 - 115 V AC	PF B18 401	
EVB 063 PA, angle valve with position indicator (PI), with pilot valve (PV), 200 - 240 V AC	PF B18 501	
EVB 063 PX, angle valve with position indicator (PI), with pilot valve (PV), 24 V AC	PF B18 131	
EVB 063 PX, angle valve with position indicator (PI), with pilot valve (PV), 24 V DC	PF B18 231	
EVB 063 PX, angle valve with position indicator (PI), with pilot valve (PV), 100 - 115 V AC	PF B18 431	
EVB 063 PX, angle valve with position indicator (PI), with pilot valve (PV), 200 - 240 V AC	PF B18 531	
EVB 100 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V AC	PF B28 101	
EVB 100 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V DC	PF B28 201	
EVB 100 PA, angle valve with position indicator (PI), with pilot valve (PV), 100 - 115 V AC	PF B28 401	
EVB 100 PA, angle valve with position indicator (PI), with pilot valve (PV), 200 - 240 V AC	PF B28 501	
EVB 100 PX, angle valve with position indicator (PI), with pilot valve (PV), 24 V AC	PF B28 131	
EVB 100 PX, angle valve with position indicator (PI), with pilot valve (PV), 24 V DC	PF B28 231	
EVB 100 PX, angle valve with position indicator (PI), with pilot valve (PV), 100 - 115 V AC	PF B28 431	
EVB 100 PX, angle valve with position indicator (PI), with pilot valve (PV), 200 - 240 V AC	PF B28 531	
EVB 160 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V AC	PF B38 101	
EVB 160 PA, angle valve with position indicator (PI), with pilot valve (PV), 24 V DC	PF B38 201	
EVB 160 PA, angle valve with position indicator (PI), with pilot valve (PV), 100 - 115 V AC	PF B38 401	
EVB 160 PA, angle valve with position indicator (PI), with pilot valve (PV), 200 - 240 V AC	PF B38 501	
Pneumatically actuated, with position indicator (PI), without pilot valve (PV)		**690**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		**690**
AVC 016 PA, angle valve pneumatically actuated	PF A36 003	
AVC 016 PX, angle valve pneumatically actuated	PF A36 033	
AVC 025 PA, angle valve pneumatically actuated	PF A46 003	

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AVC 025 PX, angle valve pneumatically actuated	PF A46 033	
AVC 040 PA, angle valve pneumatically actuated	PF A56 003	
AVC 040 PX, angle valve pneumatically actuated	PF A56 033	
- Flange sizes from DN 63 ISO-K to DN 160 ISO-K		**692**
EVB 063 PA, angle valve with position indicator (PI), without pilot valve (PV)	PF B16 002	
EVB 063 PX, angle valve with position indicator (PI), without pilot valve (PV)	PF B16 032	
EVB 100 PA, angle valve with position indicator (PI), without pilot valve (PV)	PF B26 002	
EVB 100 PX, angle valve with position indicator (PI), without pilot valve (PV)	PF B26 032	
EVB 160 PA, angle valve with position indicator (PI), without pilot valve (PV)	PF B36 002	
Pneumatically actuated, without position indicator (PI), without pilot valve (PV)		**694** **694**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
AVC 016 PA, angle valve pneumatically actuated	PF A35 004	
AVC 016 PX, angle valve pneumatically actuated	PF A35 034	
AVC 025 PA, angle valve pneumatically actuated	PF A45 004	
AVC 025 PX, angle valve pneumatically actuated	PF A45 034	
AVC 040 PA, angle valve pneumatically actuated	PF A55 004	
AVC 040 PX, angle valve pneumatically actuated	PF A55 034	
Electropneumatically actuated, with position indicator (PI), with pilot valve (PV), normally open		**696** **696**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
AVC 016 PA, angle valve electropneumatically actuated, 24 VDC	PF A38 103	
AVC 016 PX, angle valve electropneumatically actuated, 24 VDC	PF A38 133	
AVC 025 PA, angle valve electropneumatically actuated, 24 VDC	PF A48 205	
AVC 025 PX, angle valve electropneumatically actuated, 24 VDC	PF A48 235	
AVC 040 PA, angle valve electropneumatically actuated, 24 VDC	PF A58 205	
AVC 040 PX, angle valve electropneumatically actuated, 24 VDC	PF A58 235	
Solenoid actuated		**698**
- Flange sizes from DN 10 ISO-KF to DN 40 ISO-KF		**698**
AVC 016 MA, angle valve, solenoid actuated	PF A34 506	
AVC 016 MX, angle valve, solenoid actuated	PF A34 536	
AVC 025 MA, angle valve, solenoid actuated	PF A44 506	
AVC 025 MX, angle valve, solenoid actuated	PF A44 536	
AVC 040 MA, angle valve, solenoid actuated	PF A54 506	
AVC 040 MX, angle valve, solenoid actuated	PF A54 536	
EVC 110 M, angle valve, 24 V, 50/60 Hz	PF A23 101	
EVC 110 M, angle valve, 24 V DC	PF A23 201	
EVC 110 M, angle valve, 115 V, 50/60 Hz	PF A23 401	
EVC 110 M, angle valve, 230 V, 50/60 Hz	PF A23 501	
Angle valve accessories		**701**
Centering ring, FPM/aluminum, DN 10 ISO-KF	PF 110 110-T	
Inline valves		**702**
Manually actuated		**702**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
DVC 016 SX, Inline-valve, manually actuated	PF D31 033	
DVC 025 SX, Inline-valve, manually actuated	PF D41 033	
DVC 040 SX, Inline-valve, manually actuated	PF D51 033	
Electropneumatically actuated, with position indicator (PI), with pilot valve (PV)		**704** **704**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
DVC 016 PX, inline valve electropneumatically actuated, 24 VAC	PF D38 133	
DVC 016 PX, inline valve electropneumatically actuated, 24 VDC	PF D38 234	
DVC 016 PX, inline valve electropneumatically actuated, 100-115 VAC	PF D38 433	
DVC 016 PX, inline valve electropneumatically actuated, 200-230 VAC	PF D38 533	
DVC 025 PX, inline valve electropneumatically actuated, 24 VAC	PF D48 133	
DVC 025 PX, inline valve electropneumatically actuated, 24 VDC	PF D48 234	
DVC 025 PX, inline valve electropneumatically actuated, 100-115 VAC	PF D48 433	
DVC 025 PX, inline valve electropneumatically actuated, 200-230 VAC	PF D48 533	
DVC 040 PX, inline valve electropneumatically actuated, 24 VAC	PF D58 133	
DVC 040 PX, inline valve electropneumatically actuated, 24 VDC	PF D58 234	
DVC 040 PX, inline valve electropneumatically actuated, 100-115 VAC	PF D58 433	
DVC 040 PX, inline valve electropneumatically actuated, 200-230 VAC	PF D58 533	
Pneumatically actuated, with position indicator (PI), without pilot valve (PV)		**706** **706**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
DVC 016 PX, inline valve pneumatically actuated	PF D36 033	
DVC 025 PX, inline valve pneumatically actuated	PF D46 033	
DVC 040 PX, inline valve pneumatically actuated	PF D56 033	
Electropneumatically actuated, with position indicator (PI), with pilot valve (PV), normally open		**708** **708**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
DVC 016 PX, inline valve electropneumatically actuated, 24 VDC	PF D38 235	
DVC 025 PX, inline valve electropneumatically actuated, 24 VDC	PF D48 235	
DVC 040 PX, inline valve electropneumatically actuated, 24 VDC	PF D58 235	
Gate valves		**710**
Manually actuated		**710**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		
SVV 016 HA, gate valve, manually actuated	PF D31 000	
SVV 025 HA, gate valve, manually actuated	PF D41 000	
SVV 040 HA, gate valve, manually actuated	PF D51 000	
- Flange sizes from DN 63 ISO-F to DN 160 ISO-F		**712**
SVV 063 HA, gate valve, manually actuated	PF E11 001	
SVV 100 HA, gate valve, manually actuated	PF E21 001	
SVV 160 HA, gate valve, manually actuated	PF E31 001	
Electropneumatically actuated		**714**
- Flange sizes from DN 16 ISO-KF to DN 40 ISO-KF		**714**
SVV 016 PA, gate valve, 24 V DC	PF D38 200	
SVV 016 PA, gate valve, 24 V, 50 Hz	PF D38 100	
SVV 016 PA, gate valve 230 V, 50 Hz	PF D38 500	
SVV 025 PA, gate valve, 24 V DC	PF D48 200	
SVV 025 PA, gate valve, 24 V, 50 Hz	PF D48 100	
SVV 025 PA, gate valve, 230 V, 50 Hz	PF D48 500	
SVV 040 PA, gate valve, 24 V DC	PF D58 200	
SVV 040 PA, gate valve, 24 V / 50 Hz	PF D58 100	
SVV 040 PA, gate valve, 230 V, 50 Hz	PF D58 500	
- Flange sizes from DN 63 ISO-F to DN 250 ISO-F		**716**
- Gate valve with linear feedthrough		**716**
SVV 063 PA, gate valve, 24 VDC	PF E18 201	
SVV 063 PA, gate valve, 24 V, 50 Hz	PF E18 101	
SVV 063 PA, gate valve, 230 V, 50 Hz	PF E18 501	
SVV 100 PA, gate valve, 24 VDC	PF E28 201	
SVV 100 PA, gate valve, 24 V, 50 Hz	PF E28 101	
SVV 100 PA, gate valve, 230 V, 50 Hz	PF E28 501	
SVV 160 PA, gate valve, 24 VDC	PF E38 201	
SVV 160 PA, gate valve, 24 V, 50 Hz	PF E38 101	
SVV 160 PA, gate valve, 230 V, 50 Hz	PF E38 501	
SVV 200 PA, gate valve, 24 VDC	PF E48 201	
SVV 200 PA, gate valve, 24 V, 50 Hz	PF E48 101	
SVV 200 PA, gate valve, 230 V, 50 Hz	PF E48 501	
SVV 250 PA, gate valve, 24 VDC	PF E58 201	
SVV 250 PA, gate valve, 24 V, 50 Hz	PF E58 101	
SVV 250 PA, gate valve, 230 V, 50 Hz	PF E58 501	
- Gate valve with rotary feedthrough		**718**
SVV 201 PA, gate valve,	PF E48 240	

Product	Order number	Page
electropneumatically actuated, 24 VDC		
SVV 201 PA, gate valve, electropneumatically actuated, 24 VAC	PF E48 140	
SVV 201 PA, gate valve, electropneumatically actuated, 230 VAC	PF E48 540	
SVV 251 PA, gate valve, electropneumatically actuated, 24 VDC	PF E58 240	
SVV 251 PA, gate valve, electropneumatically actuated, 24 VAC	PF E58 140	
SVV 251 PA, gate valve, electropneumatically actuated, 230 VAC	PF E58 540	
SVV 252 PA, gate valve, electropneumatically actuated, 24 VDC	PF E58 250	
SVV 252 PA, gate valve, electropneumatically actuated, 24 VAC	PF E58 150	
SVV 252 PA, gate valve, electropneumatically actuated, 230 VAC	PF E58 550	
Bellows-sealed gate valves		**720**
Manually actuated - CF-F		**720**
- Flange sizes from DN 40 CF-F to DN 200 CF-F		
SVV 040 HM, bellows-sealed gate valve, manually actuated	PF F51 031	
SVV 063 HF, bellows-sealed gate valve, manually actuated	PF F61 031	
SVV 100 HF, bellows-sealed gate valve, manually actuated	PF F71 031	
SVV 160 HF, bellows-sealed gate valve, manually actuated	PF F81 031	
SVV 200 HF, bellows-sealed gate valve, manually actuated	PF F91 031	
Electropneumatically actuated		**722**
- Flange sizes from DN 40 CF-F to DN 250 CF-F		**722**
SVV 040 PM, bellows-sealed gate valve, 24 VDC	PF F58 231	
SVV 040 PM, bellows-sealed gate valve, 24 V, 50 Hz	PF F58 131	
SVV 040 PM, bellows-sealed gate valve, 230 V, 50 Hz	PF F58 531	
SVV 063 PF, bellows-sealed gate valve, 24 VDC	PF F68 231	
SVV 063 PF, bellows-sealed gate valve, 24 V, 50 Hz	PF F68 131	
SVV 063 PF, Bellows sealed gate valve, 230 V, 50 Hz	PF F68 531	
SVV 100 PF, bellows-sealed gate valve, 24 VDC	PF F78 231	
SVV 100 PF, bellows-sealed gate valve, 24 V, 50 Hz	PF F78 131	
SVV 100 PF, bellows-sealed gate valve, 230 V, 50 Hz	PF F78 531	
SVV 160 PF, bellows-sealed gate valve, 24 VDC	PF F88 231	
SVV 160 PF, bellows-sealed gate valve, 24 V, 50 Hz	PF F88 131	
SVV 160 PF, Bellows sealed gate valve, 230 V, 50 Hz	PF F88 531	
SVV 200 PF, bellows-sealed gate valve, 24 VDC	PF F98 231	
SVV 200 PF, Bellows sealed gate valve, 24 V, 50 Hz	PF F98 131	
SVV 200 PF, bellows-sealed gate valve, 230 V, 50 Hz	PF F98 531	
SVV 250 PF, bellows-sealed gate valve, 24 VDC	PF F98 241	
SVV 250 PF, bellows-sealed gate valve, 24 V, 50 Hz	PF F98 141	
SVV 250 PF, bellows-sealed gate valve, 230 V, 50 Hz	PF F98 541	
Mini angle valves		**724**
Manually actuated		**724**
EVI 005 S, complete valve, manually actuated	PF H12 031	
Solenoid actuated		**726**
EVI 005 M, complete valve, solenoid actuated	PF H13 231	
Electropneumatically actuated		**728**
EVI 005 P, complete valve, without control valve	PF H15 031	
EVI 105 P, complete valve, with control valve	PF H17 231	
Mini angle valve accessories		**725**
Connection		to
Connection, for ¼" tube O.D.	PT 420 913-T	**731**
Connection, for 6 mm tube O.D.	PT 420 914-T	
Connection, DN 10 ISO-KF	PT 420 912-T	
Mini inline valves		**730**
Solenoid actuated		**730**
DVI 005 M, complete valve, solenoid actuated	PF H13 232	
DVI 205 M, Complete valve, solenoid actuated	PF H13 233	
Mini inline valve accessories		**731**
Connection, for ¼" tube O.D.	PT 420 913-T	
Connection, for 6 mm tube O.D.	PT 420 914-T	
Connection, DN 10 ISO-KF	PT 420 912-T	

Product	Order number	Page
All-metal angle valves		**732**
UVH 016 - VI, all-metal angle valve	PF C32 032	
UVH 040 - VI, all-metal angle valve	PF C52 032	
UVH 063 - VI, all-metal angle valve	PF C62 032	
UVH 016 - CU, all-metal angle valve	PF K32 032	
UVH 040 - CU, all-metal angle valve	PF K52 032	
UVH 063 - CU, all-metal angle valve	PF K62 032	
Venting valves		**734**
Manually actuated		
FVB 010 HA, venting valve, manually actuated	PF I22 003	
FVB 010 HX, venting valve, manually actuated	PF I22 031	
Pressure relief valves		**736**
AVA 016 X, pressure relief valve, stainless steel	PF I30 032	
Gas dosing valves		**738**
Coarse gas dosing valve		**738**
EVD 010 H, coarse gas dosing valve	PF I22 001	
Gas dosing / shut-off valve		**740**
EVN 116, gas dosing and shut-off valve	PF I32 031	
Regulating valve EVR 116		**744**
EVR 116, regulating valve	PF I39 931	
Regulating valve RME 005 A		**746**
RME 005 A, regulating range from 0.85 to 85 mbar l/s	PF I13 931	
RME 005 A, regulating range from 0.17 to 17mbar l/s	PF I13 932	
RME 005 A, regulating range from 0.085 to 8.5 mbar l/s	PF I13 933	
RME 005 A, regulating range from 0.017 to 1.7 mbar l/s	PF I13 934	
RME 005 A, regulating range from 0.008 to 0.8 mbar l/s	PF I13 935	
RME 005 A, regulating range from 0.0017 to 0.17 mbar l/s	PF I13 936	
Gas dosing system control units		**748**
RVC 300, gas dosing system control unit	PF I00 792	
IF 200, gas dosing system interface	PF I00 091	
Gas dosing system accessories		**745**
- Connection cable RVC-EVR / RME		to
RVC 300 - RME 005, connection cable, 3 m	PT 250 003-T	**749**
RVC 300 - RME 005, connection cable, 5 m	PT 250 005-T	
RVC 300 - RME 005, connection cable, 10 m	PT 250 010-T	
RVC 300 - RME 005, connection cable, 15 m	PT 250 015-T	
RVC 300 - RME 005, connection cable, 20 m	PT 250 020-T	
RVC 300 - RME 005, connection cable, 25 m	PT 250 025-T	
RVC-EVR, connection cable, 3 m	PT 583 115-T	
RVC-EVR, connection cable, 5 m	PT 583 116-T	
RVC-EVR, connection cable, 10 m	PT 583 117-T	
RVC-EVR, connection cable, 15 m	PT 583 118-T	
RVC-EVR, connection cable, 20 m	PT 583 119-T	
Connection DN 10 ISO-KF	PT 420 912-T	
Connection for tube OD 1/4"	PT 420 913-T	
Connection for tube OD 6 mm	PT 420 914-T	
All-metal gas dosing valves / -systems		**752**
- All-metal gas dosing valve		**752**
UDV 040, all-metal gas dosing valve	PF I52 031	
UDV 046, all-metal gas dosing valve	PF I52 035	
- All-metal regulating valve		**754**
UDV 146, all-metal regulating valve, DN 16 CF-F	PF I52 034	
- Control unit RVG 050 C for UDV 146		**756**
RVG 050 C, control unit all-metal gas dosing system, 115/230 V	PF I00 795	
All-metal gas dosing valve / system accessories		**755**
- Accessories for UDV 040 / 046 / 146		**to**
Complete capillary, vacuum side, length 1 m	PT 418 976-T	**757**
Complete capillary, inlet side, length 2 m	PT 420 537-T	
Heater, 200° C	PT 420 376-T	
RVG 050 C, control unit all-metal gas dosing system, 115/230 V	PF I00 795	
UDV 146, all-metal regulating valve, DN 16 CF-F	PF I52 034	
RVG-UDV, extension cable, 2 m, 200° C	PT 519 953-T	
RVG-UDV, connection cable, 3 m, 80° C	PT 519 178-T	
RVG-UDV, connection cable, 12 m, 80° C	PT 519 343-T	

General Terms and Conditions of Sale and Supply

I. Proposal

In the absence of any separate contractual agreements, Pfeiffer Vacuum, as the supplier, shall effect deliveries and provide services exclusively under the terms and conditions set forth herein. Under no circumstances shall any contradictory terms and conditions of purchase of Purchaser become a part of the contract – and neither by acceptance of an order –, even if not expressly refuted. These General Terms and Conditions of Sale and Supply shall apply to both the present transaction as well as to any and all future business transactions.

II. Proposal and Contract

The information contained in price lists, catalogs and advertising media relating to Pfeiffer Vacuum's performances shall not represent any proposals. Such documents as illustrations, drawings, weights and measurements pertaining to a proposal shall be subject to change without notice and shall be only approximately definitive, unless they have been expressly stipulated as being binding. Verbal advice, collateral agreements and assurances of whatever nature shall be void unless they have been confirmed in writing by Pfeiffer Vacuum as being agreed. Minor variances from product specifications shall be deemed to have been approved. In the absence of any special agreement, a contract shall only be deemed to have been entered into upon Pfeiffer Vacuum's written confirmation of order or upon delivery of the goods. Pfeiffer Vacuum reserves all ownership rights and copyrights to its samples, cost estimates, plans, drawings and similar information of either a tangible or intangible nature – including information in electronic form –, as well as to any and all other documents; said items shall only be made available to third parties with the written consent of Pfeiffer Vacuum.

III. Scope of Supply

Pfeiffer Vacuum's written confirmation of order shall be definitive with respect to the scope of and all further details relating to the supply; in the case of a time-limited proposal from Pfeiffer Vacuum and its acceptance by Purchaser within the stipulated term, said proposal shall be deemed to be definitive in the absence of timely confirmation of order by Pfeiffer Vacuum. Any collateral agreements or modifications shall require written confirmation by Pfeiffer Vacuum.

IV. Prices and Payment

1. Prices shall be either ex works or ex consignment warehouse, including loading at the factory or consignment warehouse, however exclusive of packing materials and statutory value added tax. Pfeiffer Vacuum shall be entitled to invoice packing materials at cost and reserves the right to require return of its transport packing materials free of charge, provided said packing materials have been delivered free of charge by Pfeiffer Vacuum. No credit shall be given for returned packing materials.
2. In the absence of any special agreement, payment shall be made in cash at Pfeiffer Vacuum's payment office, with no deductions. The following payment terms shall be applicable with respect to systems and plants: 30 % advance payment upon receipt of the confirmation of order 40 % as soon as Purchaser has been notified that the major components are ready for shipment 20 % upon delivery and the remainder within a period of one month subsequent to passage of the risk.
3. Purchaser shall only be entitled to withhold payments or set them off against any counterclaims if said counterclaims are undisputed or have become legally final.
4. The minimum order value shall be to EURO 100.00.
5. Should the goods be returned, Pfeiffer Vacuum shall invoice the required functional testing and refurbishment at a rate of 10% of the net value of the goods, however not less than EURO 100.00.
6. In the event of cancellation of an order, Pfeiffer Vacuum shall fundamentally charge a cancellation fee in the amount of 15% of the total value of said order. Cancellation shall be made in writing and shall only be possible with 14 days subsequent to our confirmation of order.

V. Delivery Term / Delayed Delivery

1. The delivery term shall be based upon the agreements reached between the contracting parties. Compliance with the delivery term by Pfeiffer Vacuum shall necessitate that all commercial and technical questions between the contracting parties have been clarified and that Purchaser has satisfied all of its obligations, e.g. submittal of the documents, approvals or releases to be procured by Purchaser, or that an agreed advance payment has been made. Should this not be the case, the delivery term shall be appropriately extended. This shall not apply to the extent that Pfeiffer Vacuum is responsible for said delay.
2. Compliance with the delivery term shall be subject to correct and timely delivery of raw materials and supplies toPfeiffer Vacuum.
3. The delivery term shall be deemed to have been observed if the supplied items have left Pfeiffer Vacuum's factoryor notification of readiness for shipment has been made prior to the expiration of the delivery term. Should acceptance testing be required, the date of the acceptance testing – with the exception of justified refusal to perform said acceptance testing – shall be definitive, or alternatively notification of readiness for acceptance testing.
4. Should shipment or acceptance testing of the supplied item be delayed due to reasons for which Purchaser is responsible, Purchaser shall be charged for the costs incurred as a result of said delay, beginning one month subsequent to notification of readiness for shipment or acceptance testing.
5. Should failure to observe the delivery term be caused by force majeure, strikes, lock-outs or other events beyond the control of Pfeiffer Vacuum, the delivery term shall be appropriately extended. This shall also apply if a subcontractor is subjected to such circumstances. Nor shall the above-described circumstances be the responsibility of Pfeiffer Vacuum if they arise during the course of an existing delay. In important cases, Pfeiffer Vacuum shall inform Purchaser as soon as possible of the beginning and end of such hindrances.
6. Purchaser shall be entitled to withdraw from the contract without notice it has finally become impossible for Pfeiffer Vacuum to provide the entire performance prior to passage of the risk. Furthermore, Purchaser shall also be entitled to withdraw from the contract if the execution of a part of an order has become impossible or if Purchaser has a legitimate interest in refusing partial delivery. Should this not be the case, Purchaser shall pay the contractual price relating to the partial delivery. The same shall also apply in the event of Pfeiffer Vacuum's inability to perform. Apart from this, Point IX. 2 shall apply. Should the impossibility or inability to perform occur during the course of delay in acceptance testing or should Purchaser solely or predominantly be responsible for said circumstances, Purchasershall be obligated to provide compensation therefor.
7. Should Pfeiffer Vacuum be delayed in making delivery and should Purchaser incur damages therefrom, Purchaser shall be entitled to demand liquidated damages for delayed performance, to the exclusion of any and all further claims. Said liquidated damages shall amount to 0.5% of the invoice amount per full week of delay, however not more than 5% of the value of that portion of the entire delivery that cannot be utilized in a timely fashion or according to the contact as a result of said delay. Any and all further claims arising from the delay in delivery shall be governed exclusively by Point IX. 2. Should Purchaser grant the supplier in delay an adequate term for performance – with due regard to statutory exceptions – Purchaser shall be entitled to withdraw from the contract within the framework of statutory provisions if said adequate term is not observed. At the demand of Pfeiffer Vacuum, Purchaser shall agree to state within an adequate term whether it intends to exercise its right to withdraw from the contract.
8. Should shipment be delayed at the request of Purchaser, Purchaser shall be charged the storage costs incurred therefor, beginning one month subsequent to notification of readiness for shipment; in the case of storage at the Pfeiffer Vacuum factory or consignment warehouse, however, at least 0.5% of the invoice amount for each month. Following stipulation and expiration of an adequate term, Pfeiffer Vacuum shall additionally be entitled to otherwise dispose of the item to be supplied and to effect delivery to Purchaser subject to a reasonable extended term.

VI. Passage of Risk and Acceptance Testing

1. The risk shall pass to Purchaser at the latest upon shipment of the items to be supplied, even if partial deliveries are made or if Pfeiffer Vacuum has assumed other performances, e.g. shipping costs for delivery and installation. Upon request by Purchaser, Pfeiffer Vacuum shall insure the consignment at Purchaser's expense against theft, breakage, shipping, fire or water damage, as well as any and other insurable perils. Should acceptance testing be performed, the time of said acceptance testing shall be definitive for passage of the risk. Said acceptance testing shall be performed without delay on the date set for the acceptance testing, or alternatively subsequent to notification by Pfeiffer Vacuum of readiness for acceptance testing. The presence of an immaterial defect or deficiency shall not entitle Purchaser to refuse to perform acceptance testing.
2. Should shipment or acceptance testing be delayed or not be performed due to circumstances for which Pfeiffer Vacuum is not responsible, the risk shall pass to Purchaser upon the day that notification of readiness for shipment or acceptance testing is made. Pfeiffer Vacuum shall undertake to obtain the insurance coverages requested by Purchaser at Purchaser's expense.
3. Purchaser shall not be entitled to either pledge or use as collateral the supplied item. Purchaser shall be required to inform Pfeiffer Vacuum immediately in the event of confiscation or other third-party dispositions.
4. Should Purchaser be in breach of the contract, in particular in the case of payment default, Pfeiffer Vacuum shall be entitled to retrieve the supplied item following issuance of a warning notice, and Purchaser shall be required to surrender said supplied item.

Pfeiffer Vacuum's right to assert its right to retention of title or to attachment of the item shall not constitute a withdrawal from the contract on the part of Pfeiffer Vacuum.

5 Petition for the initiation of insolvency proceedings shall entitle Pfeiffer Vacuum to withdraw from the contract and to demand the immediate return of the supplied item.

VIII. Warranty

Subject to the exclusion of any further claims – and as governed by Point IX – Pfeiffer Vacuum shall warrant against material defects and deficiencies in title as follows:

Material defects

1. All components that prove to be deficient due to circumstances existing prior to the time of passage of the risk shall be remedied or re-supplied free of charge by Pfeiffer Vacuum at its option. Pfeiffer Vacuum shall be notified of such defects and deficiencies in writing without delay. § 377 of the German Commercial Code ("HGB") shall apply accordingly. Replaced components shall become the property of Pfeiffer Vacuum. In the case of major products from third-party suppliers, Pfeiffer Vacuum's liability shall be limited to assignment of its claims against said third-party suppliers, provided that said claims are not subject to the statute of limitations and are not significantly lower than those claims being asserted by Pfeiffer Vacuum.
2. Following written notification, Purchaser shall provide Pfeiffer Vacuum with the required time and opportunity to remedy any and all defects or effect any and all replacement supplies that Pfeiffer Vacuum shall deem necessary; otherwise, Pfeiffer Vacuum shall not be liable for the consequences thereof. Only in urgent cases endangering operational safety or to prevent unreasonable high damages, whereby Pfeiffer Vacuum shall be notified immediately, shall Purchaser have the right to remedy the defects itself or to have them remedied by third parties, and to demand restitution for the necessary expenses incurred.
3. Of the costs resulting from repair or replacement, Pfeiffer Vacuum – should the complaint prove to be legitimate – shall bear the costs of the replacement item, including shipping (however excluding express deliveries and deliveries to other countries), as well as the reasonable costs associated with removal and reinstallation, as well as the costs of any required provision of Pfeiffer Vacuum's fitters and helpers which may equitably be necessitated on the basis of the individual case in question.
4. Within the framework of statutory provisions, Purchaser shall have the right to withdraw from the contract should Pfeiffer Vacuum – with due consideration being given to statutory exceptions – allow an appropriate term to repair or replace, of which it has been notified in writing, to lapse. In the case of only immaterial defects or deficiencies, Purchaser shall only be entitled to claim a reduction of the contractual price. There shall otherwise be no right to a reduction of the contractual price.
5. No warranty shall be assumed in the following cases, in particular:
   Use of non-genuine Pfeiffer Vacuum parts, unsuitable or improper use, faulty or defective assembly and/or start-up by Purchaser or by third parties, natural wear and tear, faulty or neglectful treatment, improper maintenance, unsuitable operating fluids, deficient construction work, unsuitable building substrates, chemical, electrochemical or electrical influences that are not the responsibility of Pfeiffer Vacuum.
6. Should Purchaser or a third party improperly remedy any defect, Pfeiffer Vacuum shall not be liable for the consequences resulting therefrom. The same shall also apply with respect to any alterations of the supplied item by Purchaser or third parties without the prior consent of Pfeiffer Vacuum.

Deficiencies in title

7. Should the use of the supplied item lead to infringement of intellectual property rights or copyrights in Germany, Pfeiffer Vacuum shall at its own expense assure that Purchaser shall fundamentally be given the right of further use or that the supplied item be modified in such a way that can reasonably be expected to be acceptable to Purchaser as to ensure that the infringement of intellectual property rights or copyrights no longer exists. Should this not be possible at economically reasonable terms or conditions or within a reasonable term, Purchaser shall be entitled to withdraw from the contract. Under the above-indicated prerequisites, Pfeiffer Vacuum shall also be entitled to withdraw from the contract. Furthermore, Pfeiffer Vacuum shall save and hold harmless Purchaser against undisputed or legally final claims asserted by the respective owners of intellectual property rights or copyrights.
8. Pfeiffer Vacuum's obligations set forth in Point VIII. 7, as subject to Point IX. 2, shall be definitive in the event of a breach of intellectual property rights or copyrights.
   They shall only be applicable if and when
   - Purchaser notifies Pfeiffer Vacuum immediately of any asserted claims with respect to the infringement of any intellectual property rights or copyrights
   - Purchaser supports Pfeiffer Vacuum to an appropriate extent in connection with defending against the asserted claims or to an extent that will enable Pfeiffer Vacuum to perform the modification measures pursuant to Point VIII.7
   - Pfeiffer Vacuum reserves the right to engage in all defensive measures, including out-of-court settlements
   - The deficiency in title is not based upon an instruction on the part of Purchaser, and
   - The legal infringement was not caused by the fact that Purchaser has independently modified the supplied item or has used it in a non-contractual manner

IX. Liability

1. If through the fault of Pfeiffer Vacuum the supplied item cannot be used by Purchaser in accordance with the contract due to neglected or faulty execution in connection with proposals and consultations prior to or subsequent to the execution of the contract or through infringement of other collateral contractual obligations – in particular with regard to instructions for the operation and maintenance of the supplied item – the provisions set forth in Points VIII. and IX. 2 shall apply accordingly, to the exclusion of any and all further claims by Purchaser.
2. In the case of damages that are not incurred on the supplied item, itself, Pfeiffer Vacuum shall – for whatever legal reasons – be liable only
   a) In the event of willful intent
   b) In the event of gross negligence on the part of its owner/corporate bodies or executives
   c) In the event of culpable injury to life, limb or health
   d) In the event of defects or deficiencies that Pfeiffer Vacuum has maliciously concealed
   e) Within the framework of an assured warranty
   f) In the event of defects or deficiencies in the supplied item to the extent liability exists under the German Product Liability Act for personal injury or property damage in connection with privately utilized items. In the event of a culpable infringement of major contractual obligations, Pfeiffer Vacuum shall also be liable in the case of gross negligence on the part of non-executive employees and in the case of minor negligence, however in the latter case limited to typical damage under the contract that could reasonably be foreseen. No further entitlements shall exist.

X. Statue of Limitations

Any and all claims on the part of Purchaser – regardless of the legal grounds therefor – shall be subject to a statute of limitations of 12 months. This term shall not recommence for spare or replacement parts supplied within this period; the original warranty term for the supplied item shall instead continue to be definitive. Claims for indemnification pursuant to Points IX. 2.a) - d) and f), as well as claims under the German Product Liability Act, shall be subject to the statutory terms.

XI. Use of Software

Should software be included in the scope of supply, Purchaser shall be granted a non-exclusive right to use said supplied software, including the documentation pertaining thereto. Said software shall be provided for utilization on the supplied item for which it is intended. Utilization of the software on more than one system shall be prohibited. Purchaser shall only be entitled to copy, modify, translate or convert the software from object code to source code within the legally permissible scope (§§ 69 a ff. of the German Copyright Law ["UrhG"]). Purchaser agrees to refrain from removing manufacturer's information or Pfeiffer Vacuum's information – in particular copyright notices – or from modifying them without express prior approval from Pfeiffer Vacuum. Any and all other rights to the software and the documentation, including copies thereof, shall remain with Pfeiffer Vacuum and/or the software supplier. The issuance of sub-licenses shall not permissible.

XII. Applicable Law / Venue (does not apply to consumers)

1. Any and all legal relationships between Pfeiffer Vacuum and Purchaser shall be subject exclusively to the pertinent laws of the Federal Republic of Germany. This shall also apply with respect to foreign business transactions. The application of the U.N. Convention on Contracts for the International Sale of Goods (CISG) shall be excluded.
2. The venue shall be the court having jurisdiction for Pfeiffer Vacuum's domicile. However Pfeiffer Vacuum shall also be entitled to bring action at Purchaser's primary domicile.

Trademarks used in this catalog

Pfeiffer Vacuum GmbH trademarks:

CombiLine™
DigiLine™
DuoLine™
HeptaDry™
HiPace™
HiQuad™
OktaLine™
OnTool™ Booster
OnTool DryPump™
PrismaPlus™
SplitFlow™ Turbo
UnoLine™
UnoLine™ Plus
XtraDry™

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Cajon®
Swagelok®
VCR®

Inficon trademarks:

Compact FullRange™ Gauge
DualGauge™
MaxiGauge™
Quadera®
SingleGauge™

Masthead

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Note

The Vacuum Technology Book, effective September 1, 2008

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Pfeiffer Vacuum GmbH, September 2008

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