



C16

Total Pressure Gauges

Vacuum Gauges and
Control Instruments
 10^{-12} – 2000 mbar (10^{-12} – 1500 Torr),
Calibration Service

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Applications for Vacuum Gauges

	BOURDONVAC A	BOURDONVAC C	Capsule vacuum gauge	DIAVAC DV 1000	CERAVAC	Linear Pressure Transmitter CTR	THERMOVAC Sensor DI	PENNINGVAC transmitter TTR	IONIVAC transmitter PTR	IONIVAC IM 540	Pressure switch PS 113 A	Pressure switch PS 115	Diaphragm regulator MR 16/50
Mechanical engineering													
Car industry; filling of brake and air conditioning systems						■	■	■					
Vacuum conveying technology	■	■	■	■	■								■
Packaging technology			■	■	■							■	
Isolation vacuum	■		■	■	■	■						■	
Chemical processes													
Absolute pressure measurements in gas mixtures	■	■	■	■	■	■							
Drying and degassing processes		■		■	■								■
Solvent recovery				■		■							■
Vacuum pressure control in existing central vacuum supply systems						■							■
Electrics/electronics/optics													
Evaporation and coating systems				■		■	■	■					
Monitoring and controlling of sputter systems						■	■	■					
Semiconductor technology (CVD, plasma etching etc.)				■		■			■				
Ion implantation				■		■	■						
Lamp production		■		■	■	■							
Analytical instruments and surface physics													
ESCA, SIMS, AES, XPS						■	■	■	■				
Electron microscopy						■	■	■	■				
Crystal growing							■	■	■				
Gas analysis systems, mass spectrometers						■	■	■	■				
Research													
Measurement of ultimate pressure in UHV systems									■				
Application in MBE systems							■	■	■				
Particle accelerators									■				
Beam guidance systems, cyclotron							■		■				
Fusion experiments									■				
Space simulation chamber						■	■	■	■				
System control/pressure control													
Pressure checks on backing pumps and vacuum systems						■						■	
Safety circuits in vacuum systems, protection of vacuum gate valves						■		■		■	■		
Control of ionization vacuum gauges						■							
Pressure measurements on HV pump systems, e.g. diffusion, TMP, cryo pump systems						■	■	■	■				
Venting systems										■	■		
Valve control, pressure dependant systems control					■	■	■	■	■	■	■		
Simple pressure control arrangements				■	■		■				■	■	
Calibration													
Calibration of vacuum gauges and mass spectrometers				■					■				
Reference instruments for the determination of the physical properties of gases				■									
Precision measurements of low pressures also in the presence of corrosive or reactive gases				■									
Miscellaneous													
Vacuum annealing, melting, soldering and hardening furnaces				■		■	■	■					
Cooling and air conditioning technology					■	■							
Electron beam welding				■		■	■	■					
Metallurgy						■	■	■					

Select the Combination of Sensor and Operating Range

mbar		10 ⁻¹¹	10 ⁻¹⁰	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	10 ⁻¹	1	10	100	1000
Part Number																
Capacitance Diaphragm																
CERAVAC Transmitters (x = 2, 3, 4 or 5) ¹⁾																
CTR 90	159 x1											0.13			1330→	
CTR 90	159 x2										0.013				133	
CTR 90	159 x3									0.0013				13		
CTR 90	159 x4								0.00013			1.3				
CTR 91	159 x5											0.13			1330→	
CTR 91	159 x6										0.013				133	
CTR 91	159 x7									0.0013				13		
CTR 91	159 x8								0.00013			1.3				
CTR 91	159 x9							0.000013			0.13					
Linear Diaphragm Sensors ²⁾																
DI 200	158 12											0.1			200	
DI 201	158 14											0.1			200	
DI 2000	158 13												1		2000→	
DI 2001	158 15												1		2000→	
DI 2001 rel.	245 000												-1000		+1000→	
Thermal Conductivity (according to Pirani)																
THERMOVAC Transmitters ¹⁾																
TTR 100	230 026/230 028										0.0005				1500→	
(Pirani combined with capacitance diaphragm)																
TTR 91	230 035 - 230 038									0.0005					1000	
TTR 96 S	230 045 - 230 048									0.0005					1000	
Cold Cathode Ionization (according to Penning)																
PENNINGVAC Transmitters																
PTR 225, DN 25 KF	157 34				1 x 10 ⁻⁹					0.01						
PTR 237, DN 40 CF	157 36				1 x 10 ⁻⁹					0.01						
Hot Cathode Ionization																
IONIVAC Transmitters (Bayard-Alpert combined with Pirani) ¹⁾																
ITR 90	120 90/120 92				5 x 10 ⁻¹⁰										1000	
ITR 90 with Display	120 91/120 94				5 x 10 ⁻¹⁰										1000	
IONIVAC Sensors																
IE 414 (Bayard-Alpert)	158 66			2 x 10 ⁻¹¹						0.01						
IE 514 (Extractor)	158 67	1 x 10 ⁻¹²						0.0001								
mbar		10 ⁻¹¹	10 ⁻¹⁰	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	10 ⁻¹	1	10	100	1000

¹⁾ Different part numbers depend on the vacuum connection

²⁾ Differences of the sensors in the same operating range caused by the materials in contact with the medium

Gauges which is ideal for your Application

	DISPLAY			CENTER			COMBIVAC	IONIVAC
	ONE	TWO	THREE	ONE	TWO	THREE	2T	IM 540
Part No. EU	230 001	230 024	230 025	230 002	230 004	230 003	230 000	230 100
Part No. US	235 001	235 024	235 025	235 002	235 004	235 003	230 000	230 100
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
				1	1, 2	1, 2, 3		3, 4
							2	
							2	
							2	
							2	
		1, 2	1, 2, 3	1	1, 2	1, 2, 3		3, 4
	1	1, 2	1, 2, 3	1	1, 2	1, 2, 3	2	3, 4
	1	1, 2	1, 2, 3	1	1, 2	1, 2, 3	2	3, 4
		1, 2	1, 2, 3	1	1, 2	1, 2, 3	2	
		1, 2	1, 2, 3	1	1, 2	1, 2, 3	2	
				1	1, 2	1, 2, 3	3	
								1, 2
								1, 2

1, 2, 3 indicate the channel to which the sensor may be connected

Basic Terms of Vacuum Metrology

Today, the total range of vacuum pressure accessible to measurement extends from atmospheric pressure (about 1000 mbar (750 Torr)) down to 10^{-12} mbar/Torr, i.e. it extends over 15 powers of ten. The instruments used for measuring the pressure within this wide range are called vacuum gauges. For physical reasons it is not possible to create a single vacuum sensor through which it might be possible to perform quantitative measurements within the entire pressure range. Therefore, a variety of different vacuum gauges are available, each with their own characteristic measurement range which commonly extends over several powers of ten. A difference is made between direct and indirect pressure measurements. In the case of direct (or absolute) pressure measurements, the readings obtained through the vacuum gauge are independent of the type of gas and the pressure which is to be measured. Common are so-called mechanical vacuum gauges where the pressure is determined directly by recording the force acting on the surface of a diaphragm. In the case of so-called indirect pressure measurements the pressure is determined as a function of a pressure dependant property of the gas (thermal conductivity, ionization probability, for example). These properties do not only depend on the pressure, but also on the molar mass of the gases. For this reason, the pressure readings obtained through vacuum gauges which rely on indirect pressure measurements, depend on the type of gas. The readings usually relate to air or nitrogen as the measurement gas. For the measurement of other vapors or gases the corresponding correction factors must be applied.

Vacuum Gauges where the Pressure Readings are Independent of the Type of Gas (Mechanical Vacuum Gauges)

BOURDON Vacuum Gauge

The inside of a tube which is bent into a circular arc (the so-called Bourdon tube) is connected to the vacuum system. Due to the effect of the external atmospheric pressure, the end of the tube bends more or less during the evacuation process. This actuates the pointer arrangement which is attached to this point. The corresponding pressure can be read off on a linear scale. With Bourdon gauges it is possible to roughly determine pressures between 10 mbar (7.5 Torr) and atmospheric pressure.

Capsule Vacuum Gauge

This vacuum gauge contains a hermetically sealed, evacuated, thin-walled diaphragm capsule which is located within the instrument. As the vacuum pressure reduces, the capsule bulges. This movement is transferred via a system of levers to a pointer and can then be read off as the pressure on a linear scale.

Diaphragm Vacuum Gauge

In the case of the diaphragm vacuum gauge which is capable of absolute pressure measurements, a sealed and evacuated vacuum chamber is separated by a diaphragm from the vacuum pressure to be measured. This serves as the reference quantity. With increasing evacuation, the difference between the pressure which is to be measured and the pressure within the reference chamber becomes less, causing the diaphragm flex. This flexure may be transferred by mechanical means like a lever, for example, to a pointer and scale, or electrically by means of a strain gauge or a bending bar for conversion into an electrical measurement signal. The measurement range of such diaphragm vacuum gauges extends from 1 mbar (0.75 Torr) to over 2000 mbar (1500 Torr).

Capacitance Vacuum Gauge

The pressure sensitive diaphragm of these capacitive absolute pressure sensors is made of Al_2O_3 ceramics. The term "capacitive measurement" means that a plate capacitor is created by the diaphragm with a fixed electrode behind the diaphragm. When the distance between the two plates of this capacitor changes, a change in capacitance will result. This change, which is proportional to the pressure, is then converted into a corresponding electrical measurement signal. Here too, an evacuated reference chamber serves as the reference for the pressure measurements. With capacitance gauges it is possible to accurately measure pressures from 10^{-5} mbar/Torr to well above atmospheric pressure, whereby different capacitance gauges having diaphragms of different thickness (and therefore sensitivity) will have to be used.

Vacuum Gauges where the Pressure Readings depend of the Type of Gas

Thermal Conductivity Gauge (Pirani)

This measurement principle utilizes the thermal conductivity of gases for the purpose of pressure measurements in the range from 10^{-4} mbar/Torr to atmospheric pressure. Today, only the principle of the controlled Pirani gauge is used by Leybold in order to attain a quick response. The filament within the gauge head forms one arm of a Wheatstone bridge. The heating voltage which is applied to the bridge is controlled in such a way, that the filament resistance and thus the temperature of the filament remains constant regardless of the quantity of heat given off by the filament. Since the heat transfer from the filament to the gas increases with increasing pressures, the voltage across the bridge is a measure of the pressure.

Improvements with regard to temperature compensation have resulted in stable pressure readings also in the face of large temperature changes, in particular when measuring low pressures.

Cold Cathode Ionization Vacuum Gauge (Penning)

Here the pressure is measured through a gas discharge within a gauge head whereby the gas discharge is ignited by applying a high tension. The resulting ion current is output as a signal which is proportional to the prevailing pressure. The gas discharge is maintained also at low pressures with the aid of a magnet.

New concepts for the design of such sensors permit safe and reliable operation of these so-called Penning sensors in the pressure range from 10^{-2} to 1×10^{-9} mbar/Torr.

Hot Cathode Ionization Vacuum Gauge

These sensors commonly use three electrodes. A hot cathode emits electrons which impinge on an anode. The gas, the pressure of which is to be measured, is thus ionized. The resulting positive ion current is detected through the third electrode - the so-called ion detector - and this current is used as the signal which is proportional to the pressure.

The hot cathode sensors which are mostly used today, are based on the Bayard-Alpert principle. With this electrode arrangement it is possible to make measurements in the pressure range from 10^{-10} to 10^{-2} mbar/Torr.

Other electrode arrangements permit access to a higher range of pressures from 10^{-1} mbar/Torr down to 10^{-10} mbar/Torr. For the measurement of pressures below 10^{-10} mbar/Torr so-called extractor ionization sensors after Redhead are employed. In extractor ionization gauges the created ions are focused onto a very thin and short ion detector. Due to the geometrical arrangement of this system, interfering influences such as X-ray effects and ion desorption can be almost completely eliminated. The extractor ionization gauge permits pressure measurements in the range from 10^{-4} to 10^{-12} mbar/Torr.

Selection of the right Vacuum Gauge

When selecting a suitable instrument for pressure measurements, the pressure range is not the only criteria. The operating conditions for the instrument play an important part. If, for example, there is the risk of excessive contamination, vibrations, or if air inrushes are to be expected etc., the instrument must be rugged enough. Thus for industrial applications diaphragm gauges, controlled thermal conductivity gauges as well as cold cathode ionization gauges after Penning are strongly recommended. Precision instruments are very often quite sensitive to rough operating conditions. These should therefore only be used while observing the corresponding applications information.

Connection Accessories for Small Flanges

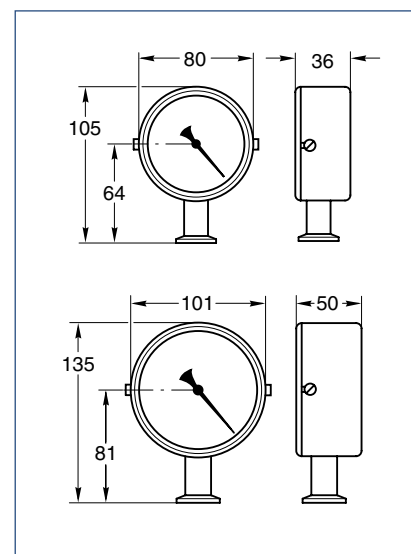
Ordering Information	DN 10 KF	DN 16 KF	DN 25 KF	DN 32 KF
Outer centering ring with O-ring Aluminium / FPM (Viton)	Part No. 183 53	Part No. 183 54	Part No. 183 55	–
Fine filter on centering ring with O-ring Stainless steel / FPM (Viton)	Part No. 883 95	Part No. 883 96	Part No. 883 97	–
Baffle with centering ring (FPM)	–	–	Part No. 230 078	–
Connection accessories for metal seals or degassing room up to 150 °C				
Ultra sealing ring, aluminum (Set of 3)	Part No. 883 73	Part No. 883 75	Part No. 883 75	–
Outer support ring	Part No. 883 74	Part No. 883 76	Part No. 883 76	–
Clamping ring	Part No. 882 75	Part No. 882 77	Part No. 882 77	–

Ordering Information	DN 40 KF	DN 16 CF	DN 40 CF
Outer centering ring with O-ring Aluminium / FPM (Viton)	Part No. 183 55	–	–
Fine filter on centering ring with O-ring Stainless steel / FPM (Viton)	Part No. 883 98	–	–
Baffle with centering ring (FPM)	Part No. 230 079	–	–
Connection accessories for metal seals or degassing room up to 150 °C			
Ultra sealing ring, aluminum (Set of 3)	Part No. 883 77	–	–
Outer support ring	Part No. 883 78	–	–
Clamping ring	Part No. 882 78	–	–
Connection accessories for CF connections			
Copper seals, (set of 10 pieces)	–	Part No. 839 41	Part No. 839 43
Screw (set of 25 pieces)	–	Part No. 839 40	Part No. 839 01

Bourdon Vacuum Gauges



Rugged relative pressure vacuum gauges based on the Bourdon principle covering the pressure range from 1 to 1020 mbar (0.75 to 765 Torr).



Dimensional drawing for the BOURDONVAC A (top) and the BOURDONVAC C (bottom)

Advantages to the User

- Highly reliable, rugged, insensitive to vibrations
- Linear readout, independent of the type of gas
- Excellent media compatibility owing to the stainless steel movement (BOURDONVAC C)
- IP 54 protection (BOURDONVAC C)

Typical Applications

- Vacuum distillation
- Drying processes
- For explosion hazard applications
- Vacuum conveying systems

Technical Data		BOURDONVAC A	BOURDONVAC C
Measurement range	mbar	1 to 1020	1 to 1020
Measurement uncertainty	% FS	1	1
Overload range (abs. briefly)	bar	1.5	1.3
Storage temperature range	°C	-25 to +60	-25 to +60
Nominal temperature range	°C	10 to 60	10 to 100 (max.)
Flange connection	DN	16 KF	16 KF
Length of scale	mm	140	207
Diameter	mm	79	101
Overall weight	mm	105	135
Weight	kg (lbs)	0.25 (0.55)	0.6 (1.33)
Materials in contact with the medium		nickel plated standard steel, bronze, soft solder	stainless steel 1.4571
Ordering Information		BOURDONVAC A	BOURDONVAC C
Bourdon vacuum gauge		Part No. 160 40	Part No. 161 20
(Operating Instructions)		(GA 09.100)	(GA 09.100)

Capsule Vacuum Gauges



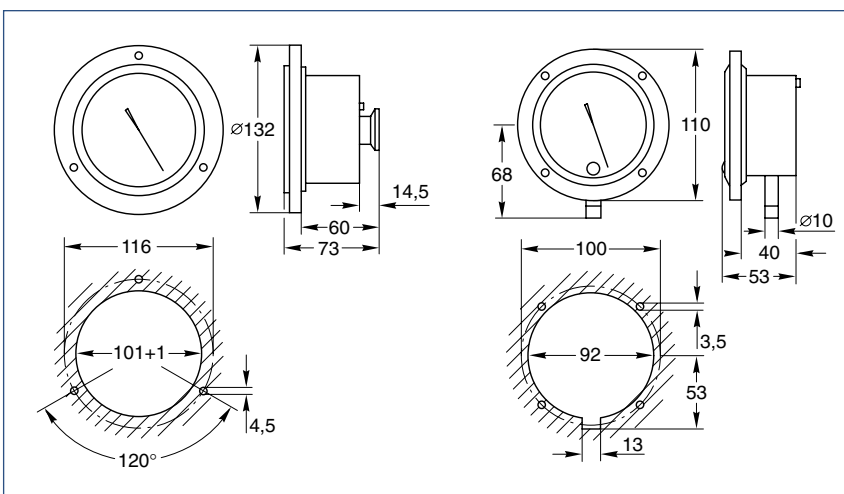
Rugged absolute pressure gauges for the pressure range from 1 to 1000 mbar (0.75 to 750 Torr).

Advantages to the User

- Rugged and insensitive to vibrations
- Models available for two measurement ranges (1 to 100 mbar and 1 to 1000 mbar)
- Readout independent of the type of gas and changes in atmospheric pressure
- Linear pressure readout
- Installation direct via the connection flange or panel mounting
- Model with integrated isolation valve for use on packaging machines (Part No. 160 68)

Typical Applications

- Measurement of absolute pressures (for inert gases only)
- Vacuum conveying systems
- Operation monitoring
- Packaging



Dimensional drawings and panel cut-outs for the capsule vacuum gauges
Part Nos. 160 63/64 (left) and Part No. 160 68 (right)

Technical Data		Capsule Vacuum Gauges		
Measurement range	mbar	1 to 100	1 to 100	1 to 1000
Measurement uncertainty	% FS	1.0	2.5	1.6
Overload range (abs. briefly)	bar	1.5	1.5	1.5
Storage temperature range	°C	-25 to +60	-25 to +60	-25 to +60
Nominal temperature range	°C	10 to 50	10 to 50	10 to 50
Length of scale	mm	205	180	205
Totvolumen, ca.	cm ³	235	167	235
Diameter	mm	132	110	132
Weight	kg (lbs)	0.7 (1.54)	0.6 (1.32)	0.7 (1.54)
Vacuum Connection	DN	16 KF	10 mm dia. hose nozzle with integrated isolation valve	16 KF
Max. inclination when installed		45°	45°	45°
Materials in contact with the medium		brass standard steel nickel plated glass NBR aluminum copper beryllium soft and hard solder resin	brass standard steel nickel plated glass NBR aluminum copper beryllium soft and hard solder resin	brass standard steel nickel plated glass NBR aluminum copper beryllium soft and hard solder resin
Ordering Information		Capsule Vacuum Gauges		
Capsule vacuum gauge		Part No. 160 63	Part No. 160 68	Part No. 160 64
(Operating Instructions)		(GA 09.101)	(GA 09.101)	(GA 09.101)

Diaphragm Vacuum Gauge DIAVAC DV 1000



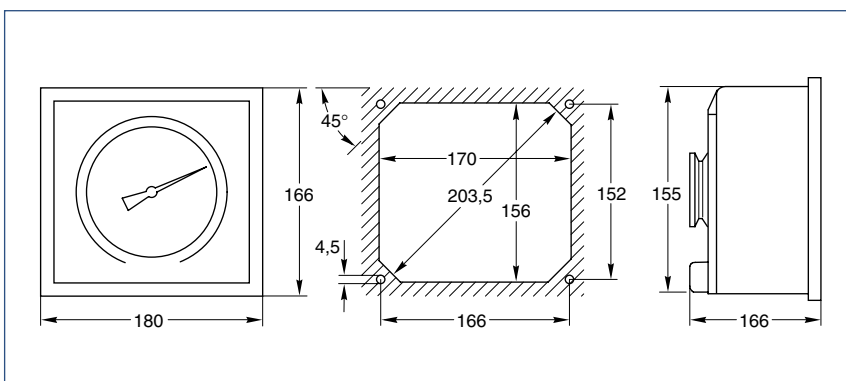
Rugged mechanical diaphragm vacuum gauge of high accuracy for the rough vacuum range from 1 to 1000 mbar (1 to 750 Torr).

Advantages to the User

- Wide measurement range from 1 to 1000 mbar (1 to 750 Torr) with high resolution in the range from 1 to 100 mbar (1 to 75 Torr)
- The scale of each gauge is individually calibrated
- Absolute pressure gauge
- Readout independent of the type of gas and changes in atmospheric pressure
- Stainless steel diaphragm for excellent compatibility with most media
- Laser welding technology for high precision diaphragm mount
- Rugged table-top housing, can be freely mounted above the flange connection; also for panel mounting
- Measurement chamber can be easily cleaned owing to the detachable measurement flange

Typical Applications

- Chemical processes
- Vacuum distillation
- Absolute pressure measurements for gas mixtures
- For use in explosion hazard rated areas
- Drying processes
- Lamp manufacture



Dimensional drawing and panel cut-out for the DIAVAC DV 1000

Technical Data		DIAVAC DV 1000
Measurement range	mbar (Torr)	1 to 1000 (1 to 750)
Measurement uncertainty		
1 - 10 mbar (1 - 7.5 Torr)		± 1 mbar (Torr)
10 - 1000 mbar (7.5 - 750 Torr)		± 10 % of meas. value
Storage temperature range	°C	-25 to +60
Nominal temperature range	°C	0 bis 60
Permissible overload (abs.)	bar	3
Length of scale / dead volume	mm	270 / 130
Vacuum Connection	DN	40 KF
Dimension (W x H x D)	mm	180 x 166 x 100
Weight	kg (lbs)	2.7 (5.95)
Materials in contact with the medium		stainless steel 1.4301, 1.4310 (diaphragm), FPM
Ordering Information		DIAVAC DV 1000
DIAVAC DV 1000		
mbar readout		Part No. 160 67 ¹⁾
Torr readout		Part No. 896 06 ¹⁾
(Operating Instructions)		(GA 09.102)
DKD-calibration		Part No. 157 12
Replacement sintred filter with DN 40 KF centering ring		Part No. 231 93 515
Replacement housing, complete		Part No. 240 000

¹⁾ Complete with centering ring and sintered filter

CERAVAC Transmitters CTR 90 / CTR 91



The CERAVAC Transmitter with its diaphragm made of pure aluminium oxide ceramics offers excellent accuracy and reproducibility.

Advantages to the User

- Excellent accuracy
- Corrosion resistant
- High resolution
- Very good temperature stability
- Electrically and mechanically compatible with the conventional capacitance manometers with stainless steel diaphragm
- Heated and unheated types are available

Typical Applications

- General pressure measurements in the fine and rough vacuum range, also for corrosive process gases
- Chemical process engineering
- Semiconductor production processes
- Suited as a reference sensor for monitoring test instruments in accordance with DIN/ISO 9000

The Ceramics Diaphragm

The stiffness of aluminium oxide ceramics is greater than that of metal so that the ceramics material offer improved long term stability characteristics when exposed to frequent pressure changes or overpressures. The aluminium oxide ceramics diaphragm of the CERAVAC sensors is capable of returning precisely to its initial position with respect to a certain pressure so that the measurements will be highly reproducible. Since the diaphragm is

not impaired by overpressures or frequent pressure changes, no blocking valves will be required – a significant contribution towards reducing costs.

Moreover, aluminium oxide ceramics diaphragms return faster to their initial position compared to metal diaphragms; the time need between the processes for the measurement to stabilise is reduced. This is particularly important in the case of measurements close to Zero where

metal diaphragms take several minutes to return to their rest position.

Whereas metal diaphragms suffer from residual tensions and unavoidable irregularities due to their production process, diaphragms made of aluminium oxide ceramics are exceptionally homogeneous, and owing to the firing process at 2500 °C entirely free of tensions. This considerably reduces part to part variations in the sensors.

Technical Data		CTR 90 (Temperature Compensated)	
Full Scale (FS)		Measurement Range	Measurement Range
1000 Torr		0.1 - 1000 Torr	0.1 - 1000 Torr
100 Torr		0.01 - 100 Torr	0.01 - 100 Torr
10 Torr		1×10^{-3} - 10 Torr	1×10^{-3} - 10 Torr
1 Torr		1×10^{-4} - 1 Torr	1×10^{-4} - 1 Torr
		Pressure Units: 1 Torr = 1.33 mbar = 133 Pascal	Pressure Units: 1 Torr = 1.33 mbar = 133 Pascal
Materials exposed to gases		ceramic (Al ₂ O ₃), stainless steel 316, Vacon 70	ceramic (Al ₂ O ₃), stainless steel 316, Vacon 70
Max. overrange pressure		1000 Torr for 0.1 Torr sensors, 2000 Torr for 1/10/100 Torr sensors, 3000 Torr for 1000 Torr sensors	1000 Torr for 0.1 Torr sensors, 2000 Torr for 1/10/100 Torr sensors, 3000 Torr for 1000 Torr sensors
Measurement uncertainty		0.2% of reading ± temperature effect	0.2% of reading ± temperature effect
Resolution		0.0025% of FS for 0.1/1 Torr sensors 0.0015% of FS for 10/100/1000 Torr sensors	0.0025% of FS for 0.1/1 Torr sensors 0.0015% of FS for 10/100/1000 Torr sensors
Temperature effects			
Zero coefficient	%/°C	1 Torr sensor 0.015 of Full scale	10/100/1000 Torr sensor 0.005 of Full scale
Span coefficient	%/°C	0.01 of reading	0.01 of reading
Reaction time	ms	≤ 30	≤ 30
Nominal temperature range	°C	5 to 50	5 to 50
Supply voltage	V DC	either ± 15 or + 24	either ± 15 or + 24
Current consumption	mA	23	23
Signal Output	V	0 - 10; linear	0 - 10; linear
Weight approx.	kg (lbs)	0.26 (0,57)	0.26 (0,57)
Dead Volume	cm ³	6	6
Connection cable		see section "Connection Cable for active Sensors"	see section "Connection Cable for active Sensors"
Calibration		see section "Miscellaneous", para. "Leybold Calibration Service"	see section "Miscellaneous", para. "Leybold Calibration Service"

Technical Data		CTR 91 (45 °C heated)	
Full Scale (FS) 1000 Torr 100 Torr 10 Torr 1 Torr 0.1 Torr		Measurement Range 0.1 - 1000 Torr 0.01 - 100 Torr 1×10^{-3} - 10 Torr 1×10^{-4} - 1 Torr – Pressure Units: 1 Torr = 1.33 mbar = 133 Pascal	Measurement Range 0.1 - 1000 Torr 0.01 - 100 Torr 1×10^{-3} - 10 Torr 1×10^{-4} - 1 Torr 1×10^{-5} - 0.1 Torr Pressure Units: 1 Torr = 1.33 mbar = 133 Pascal
	Materials exposed to gases	ceramic (Al ₂ O ₃), stainless steel 316, Vacon 70	ceramic (Al ₂ O ₃), stainless steel 316, Vacon 70
	Max. overrange pressure	1000 Torr for 0.1 Torr sensors, 2000 Torr for 1/10/100 Torr sensors, 3000 Torr for 1000 Torr sensors	1000 Torr for 0.1 Torr sensors, 2000 Torr for 1/10/100 Torr sensors, 3000 Torr for 1000 Torr sensors
	Measurement uncertainty	0.2% of reading ± temperature effect	0.15% of reading ± temperature effect
	Resolution	0.0025% of FS for 0.1/1 Torr sensors 0.0015% of FS for 10/100/1000 Torr sensors	0.0025% of FS for 0.1/1 Torr sensors 0.0015% of FS for 10/100/1000 Torr sensors
	Temperature effects		
Zero coefficient	%/°C	1 Torr sensor 0.005 of Full scale	10/100/1000 Torr sensor 0.0025 of Full scale
Span coefficient	%/°C	0.01 of reading	0.01 of reading
Reaction time	ms	≤ 30	≤ 30
Nominal temperature range	°C	5 to 50	15 to 40
Supply voltage	V DC	either ± 15 or + 24	either ± 15 or + 24
Current consumption	mA	23	300
Signal Output	V	0 - 10; linear	0 - 10; linear
Weight approx.	kg (lbs)	0.26 (0.57)	0.485 (1.07)
Dead Volume	cm³	6	7
Connection cable		see section "Connection Cable for active Sensors"	see section "Connection Cable for active Sensors"
Calibration		see section "Miscellaneous", para. "Leybold Calibration Service"	see section "Miscellaneous", para. "Leybold Calibration Service"

Ordering information

CTR 90 (temperature-compensated)

Vacuum fitting

DN KF 16

DN CF 16

Cajon 8 VCR

1/2" tube

Measurement range

1000 Torr

100 Torr

10 Torr

1 Torr

2

3

4

5

1

2

3

4

Part No. 159 -

(GA 09.040)

Ordering information

CTR 91 (45 °C heated)

Vacuum fitting

DN KF 16

DN CF 16

Cajon 8 VCR

1/2" tube

Measurement range

1000 Torr

100 Torr

10 Torr

1 Torr

0.1 Torr

2

3

4

5

5

6

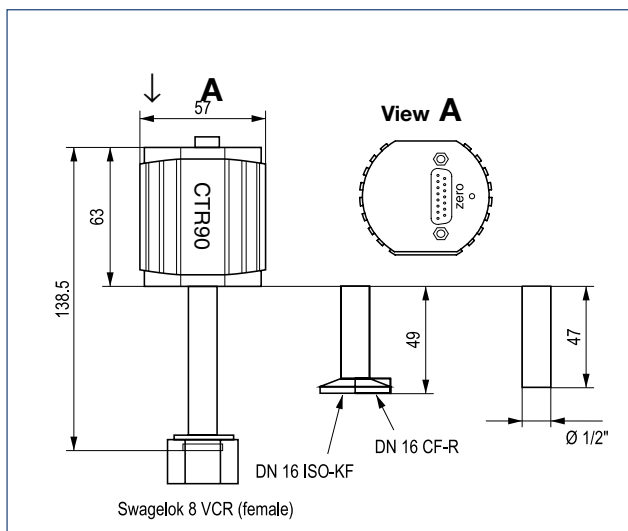
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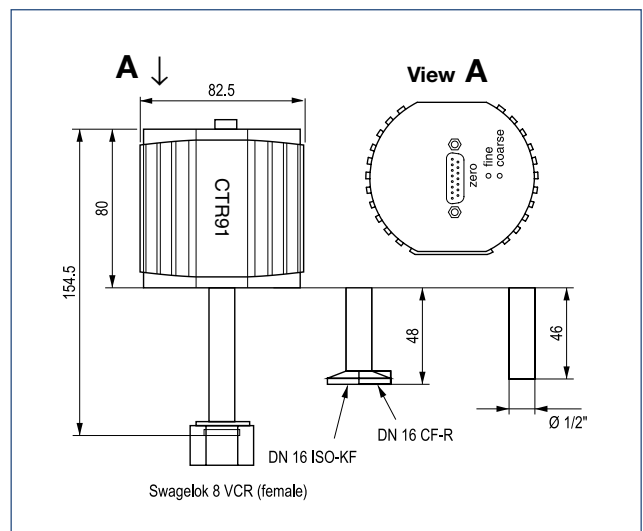
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Part No. 159 -

(GA 09.041)



Dimensional drawing for the CERAVAC Transmitter CTR 90



Dimensional drawing for the CERAVAC Transmitter CTR 91

THERMOVAC Transmitters TTR 91 / TTR 91 S / TTR 96 S



THERMOVAC transmitters are active sensors (pressure to voltage converters) using thermal conductivity according to Pirani. The further developed THERMOVAC transmitters have optimized price-to-performance ratio.

The value of the trigger point can be switched easily on the analog output and be shown on the display of the operating unit.

Advantages to the User

- Rugged sensing cells made of stainless steel
- Compact design
- Stable measurements within a wide temperature range
- Highly resistant to overpressures
- Exchangeable sensing cells
- Fast response
- Available with integrated switching relay (TTR 91 S, TTR 96 S)

Typical Applications

- Analytical engineering
- Safety circuits in vacuum systems
- Controlling ionization gauges
- General pressure measurement and control on systems in the fine and rough vacuum range

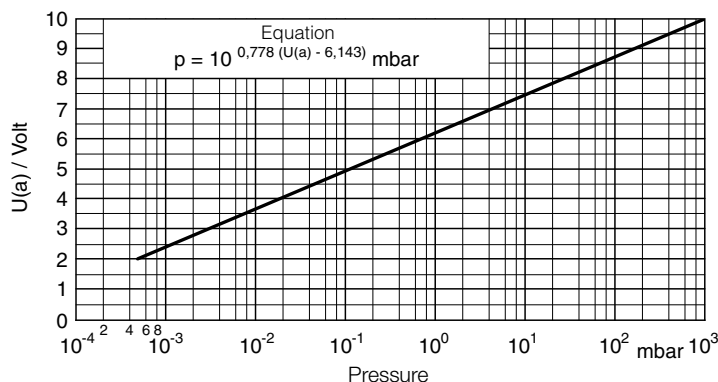
Sensor

The THERMOVAC transmitter has a Pirani sensing cell equipped with a tungsten (TTR 91/TTR 91 S) or nickel (TTR 96 S) filament. If required, the sensing cells can easily be aligned to any precisely known pressure value (atmospheric,

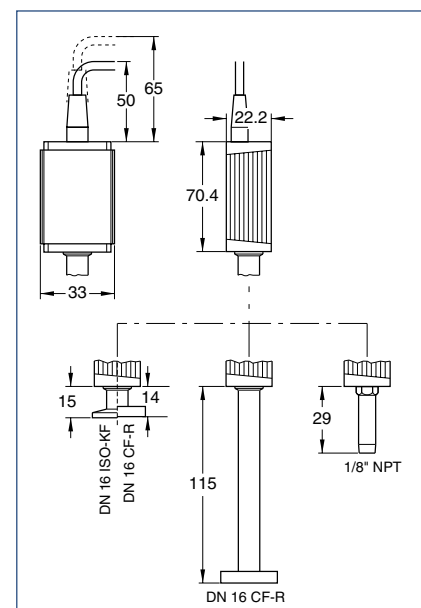
“zero”, reference pressure) by pressing a button.

Integration of the transmitters in programmable control systems is facilitated by the linear characteristic, which can be defined by entering a simple equation into the computer. The transmitters TTR 91 / TTR 91 S / TTR 96 S are compatible to older TTR models like TTR 211, TTR 216 S or TTR 90.

Built-in relays allow switching functions to be performed directly by the transmitter, without the need of a programmable control.



Characteristic of the THERMOVAC Transmitters



Dimensional drawing for the
TTR 91 / TTR 91 S / TTR 96 S

Technical Data		TTR Transmitter TTR 91 / TTR 91 S / TTR 96 S
Measurement range	mbar (Torr)	5×10^{-4} to 1000 (3.75×10^{-4} to 750)
Measurement uncertainty		15 % in the range 1×10^{-3} to 100 mbar (0.75×10^{-3} to 75 Torr)
Principle of measurement		Thermal conductivity according to Pirani
Supply voltage		14 to 30 V DC Hum voltage $\leq 1 V_{pp}$
Power consumption	VA	≤ 1
Storage temperature range	°C	-20 to +65
Nominal temperature range	°C	5 to 60
Max. rel. humidity	% n.c.	≤ 80
Protection class		IP 40
Weight, approx., for DN 16 KF	kg (lbs)	0.08 (0.18)
Sensor		Exchangeable sensing cell
Degassing temperature, max.	°C	80 (250 with long tube)
Dead volume, approx.	cm ³	2 (10 with long tube)
Materials in contact with the medium - filament		Stainless steel, Ni, glass, NiFe Tungsten (TTR 91, TTR 91 S) or nickel (TTR 96 S)
Over-pressure rating, abs.	bar	10
Signal output ($R_a > 10 \text{ k}\Omega$) Measurement signal		0 to 10.3 V DC 1.9 to 10 V DC, corresp. 5×10^{-4} to 1×10^3 mbar 1.286 V/decade, logarithmic
Status signal		Error: $\leq 0.5 \text{ V}$
Trigger (only TTR 91 S / TTR 96 S) Adjustment range	mbar (Torr)	Normally open relay contact 2×10^{-3} to 500 (1.5×10^{-3} to 375)
Hysteresis		10 %
Rating		30 V, 0.5 A DC, floating
Error status		Relay contact open
Status indicators (only TTR 91 S / TTR 96 S)		Trigger (active): Green LED
Electrical connection		FCC-68/RJ45 socket, 8 way with shield
Cable length, max.	m	100

Ordering Information	TTR Transmitter TTR 91 / TTR 91 S / TTR 96 S
Without switching threshold TTR 91, DN 16 KF TTR 91, 1/8" NPT TTR 91, DN 16 CF TTR 91, 1/2" Tube, DN 16 CF	Part No. 230 035 Part No. 230 038 Part No. 230 036 Part No. 230 037
With switching threshold TTR 91 S, DN 16 KF TTR 91 S, 1/8" NPT TTR 91 S, DN 16 CF TTR 91 S, 1/2" Tube, DN 16 CF TTR 96 S, DN 16 KF TTR 96 S, 1/8" NPT TTR 96 S, DN 16 CF TTR 96 S, 1/2" Tube, DN 16 CF	Part No. 230 040 Part No. 230 043 Part No. 230 041 Part No. 230 042 Part No. 230 045 Part No. 230 048 Part No. 230 046 Part No. 230 047
(Operating Instructions)	(GA 09.222)
Replacement sensing cell for TTR 91 / TTR 91 S DN 16 KF 1/8" NPT DN 16 CF 1/2" Tube, DN 16 CF for TTR 96 S DN 16 KF 1/8" NPT DN 16 CF 1/2" Tube, DN 16 CF	Part No. 230 050 Part No. 230 053 Part No. 230 051 Part No. 230 052 Part No. 230 055 Part No. 230 058 Part No. 230 056 Part No. 230 057
Calibration	see section "Miscellaneous", para. "Leybold Calibration Service"
Connection cable, FCC 68 on both ends, 8 way, shielded 5 m 10 m 15 m 20 m 30 m 40 m 50 m 75 m 100 m	Type A Part No. 124 26 Part No. 230 012 Part No. 124 27 Part No. 124 28 Part No. 124 29 Part No. 124 30 Part No. 124 31 Part No. 124 32 Part No. 124 33

Notes

THERMOVAC Transmitters TTR 100 / TTR 100 S2



The Pirani Capacitance Diaphragm Gauge is the first vacuum gauge which combines ceramic capacitance diaphragm and thermal conductivity technologies. Unlike standard heat transfer technology, the Leybold TTR 100 offers superior accuracy and gas-type-independent readings between 100 mbar and 1500 mbar.

Advantages to the User

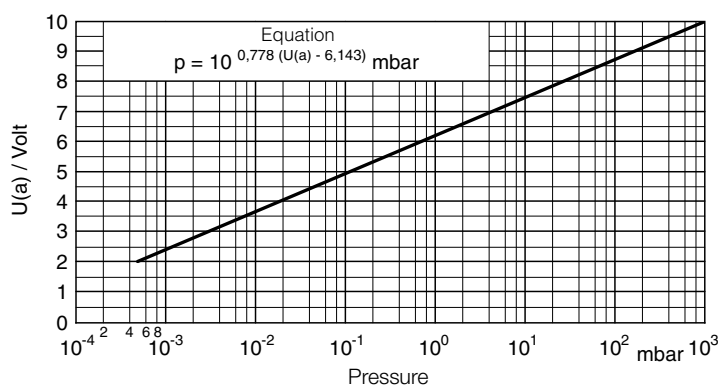
- Wide measurement range from 5×10^{-4} to 1500 mbar
- Gas-type-independent pressure measurement between 100 mbar and 1500 mbar
- Available with up to two integrated relays (TTR 100 S2)
- Mounts in any orientation
- 0 to 10.3 V analog output for easy system integration
- Compact design
- Flow independent
- Rapid cycling
- Follows true pressure in pump and vent

Typical Applications

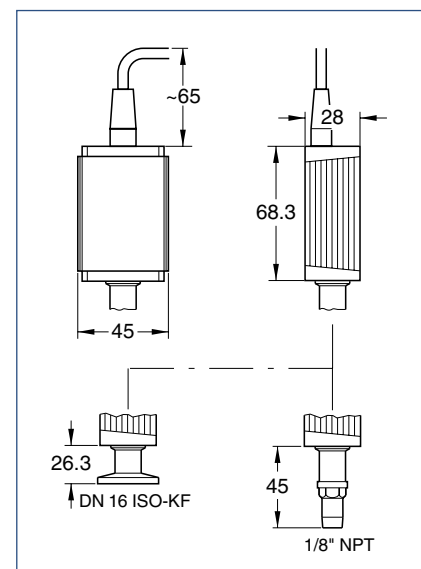
- Loadlock control
- Forevacuum pressure monitoring
- Safety circuits in vacuum systems
- General measurement and control in the medium and rough vacuum range
- Control of high vacuum ionization gauges

Option

Dust and other particles may cause increasing measurement errors and reduced lifetime. Therefore we recommend the installation of a fine filter in critical applications. Fine filters are listed in section "General", para. "Connection Accessories for Small Flanges".



Characteristic of the THERMOVAC Transmitters



Dimensional drawing for the TTR 100

Technical Data	TTR Transmitter TTR 100 / TTR 100 S2
Measurement principle	Thermal conductance according to Pirani combined with capacitance diaphragm
Measurement range (air, O ₂ , CO, N ₂) mbar(Torr)	5 x 10 ⁻⁴ to 1500 (3.8 x 10 ⁻⁴ to 1125)
Accuracy 1 x 10 ⁻³ to 50 mbar 50 to 950 mbar ATM (atmospheric pressure)	±15% of reading ±5% of reading ±2.5% of reading
Repeatability	±2% of reading
Trigger (only TTR 100 S2) Setting range with potentiometer Relay contacts closed open Hysteresis Contact rating Relay status	2 1.5 x 10 ⁻³ to 1400 mbar N.O. / potential free at low pressure (lamp lit) at high pressure or no supply (lamp off) 10% of threshold 30 V DC / 1 A active: LED, green
Output signal analog Measurement range Voltage vs. pressure	0 to 10.3 V +1.9 to +10.23 V 1.286 V / decade, logarithmic
Output impedance	2 x 4.7 Ohm, short circuit-proof
Minimum load impedance	10 kOhm
Response time	10 ms
Power supply Voltage (ripple ≤1 V _{pp}) Consumption, max. Fuse to be connected	+15 to +30 V DC 2.5 W 1 AT (slow)
Electrical connection	FCC-68, 8 way with shield
Cable length, max. m (ft)	100 (330)

Technical Data		TTR Transmitter TTR 100 / TTR 100 S2	
Materials exposed to vacuum (process media)			
Vacuum connection		stainless steel	
Pirani filament		tungsten	
Capacitance sensor cell		Al ₂ O ₃	
Feedthrough		glass	
Other materials		Ni, Cu, NiFe, SnAg, AgPd	
Internal volume			
DN 16 ISO-KF	cm ³ (inch ³)	6 (0.37)	
1/8" NPT	cm ³ (inch ³)	8 (0.49)	
Over-pressure rating, abs.	bar	5	
Temperature			
Operation (ambient)	°C	+10 to +50	
Storage	°C	-20 to +65	
Bakeout at flange, max.	°C	+80	
Filament temperature	°C	< 160	
Relative humidity		< 80 % at temperatures < +31 °C, decreasing to 50% at +40 °C	
Mounting orientation any		any	
Use		Indoors only, altitudes up to 2000 m NN	
Protection class	IP	40	
Weight			
DN 16 ISO-KF	kg (lbs)	0.09 (0.20)	
1/8" NPT	kg (lbs)	0.09 (0.20)	
Ordering Information		TTR Transmitter TTR 100 / TTR 100 S2	
Without switching threshold			
TTR 100, DN 16 KF		Part No. 230 026	
TTR 100, 1/8" NPT		Part No. 230 028	
With switching threshold			
TTR 100 S2, DN 16 KF		Part No. 230 027	
TTR 100 S2, 1/8" NPT		Part No. 230 029	
(Operating Instructions)		(GA 09.221)	
Calibration		see section "Miscellaneous", para. "Leybold Calibration Service"	
Connection cable, FCC 68 on both ends, 8 way, shielded			
5 m		Type A Part No. 124 26	
10 m		Part No. 230 012	
15 m		Part No. 124 27	
20 m		Part No. 124 28	
30 m		Part No. 124 29	
40 m		Part No. 124 30	
50 m		Part No. 124 31	
75 m		Part No. 124 32	
100 m		Part No. 124 33	

Notes

PENNINGVAC Transmitters

PTR 225 / PTR 225 S / PTR 237



The PENNINGVAC transmitters have been developed especially for integration in programmable control systems. As active sensors (pressure to voltage converters) - equipped with a rugged cold cathode sensing cell and with matched operating and processing electronics - these transmitters offer a wide measurement range of 1×10^{-9} to 1×10^{-2} mbar (0.75×10^{-9} to 0.75×10^{-2} Torr). The measurement signal may be transmitted over long distances without problems.

Advantages to the User

- All-metal cold cathode sensors (inverted Penning)
- High reproducibility
- Good ignition characteristics through the optimized design for the electrodes
- Low tendency for contamination (also during argon operation) due to high voltage reduction after ignition of the plasma and due to the titanium cathodes
- Switching threshold adjustable over a wide range (1×10^{-9} to 1×10^{-2} mbar (0.75×10^{-9} to 0.75×10^{-2} Torr)) and with a load-bearing relay contact (PTR 225 S)
- Low stray magnetic field
- High EMI compatibility through screened housing, FCC-68 connector and cables
- LED indicator for operation
- Logarithmic signal output (algorithm supplied)
- Intelligent interface
- CE mark
- High resistance against sputtering due to titanium cathode plates

Typical Applications

- Evaporation and sputtering systems
- Analytical engineering
- Vacuum furnaces
- High vacuum systems
- General pressure measurement and control on systems in the fine and rough vacuum range which have the following requirements:
 - Immediate data transfer to a programmable control/ computer via analog interface
 - Coverage of greater distances between the point of the measurement and processing location
 - Several locations which are to be monitored continuously
 - Low voltage supply
 - Simple, cost and space saving installation
 - Increased reliability, also in argon processes (sputtering)
 - Simple operation
 - Increased requirements concerning electromagnetic compatibility (EMI)

Option

For protection of the sensors PTR 225 against contamination, radiation and other disturbing factors the installation of a baffle is recommended.

Sensor

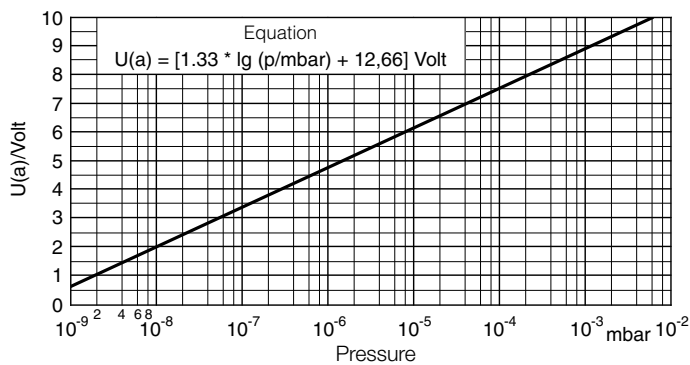
Cold cathode sensors - based on the well-proven principle of the inverted Penning - are built into the PENNINGVAC transmitters PTR 225/225 S/237 which have a DN 25 KF or DN 40 CF flange. The housing of the transmitter, including its electronics, as well as the magnet can easily be removed for degassing of the all-metal sensor with Al_2O_3 current feed-through. The design of the Penning sensors with its closed magnetic field

causes a negligible stray field. Thus the PTR 225/225 S/237 may also be installed close to sensitive parts within a system.

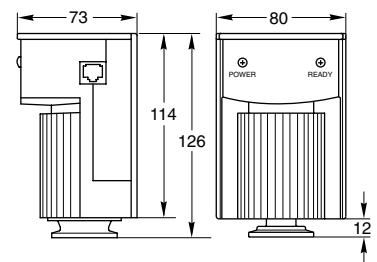
The anode ring and the titanium cathode plates can be exchanged easily for quick maintenance of the sensors in case of contamination. The shape of the cathode plates is such that they also act as a baffle for the sensors.

Integration of the transmitter in programmable control systems is facilitated by the linear characteristic which can be defined by entering a simple equation into the computer.

Built-in relays (PTR 225 S) allow switching functions to be performed directly by the transmitter, without the need of a programmable control.



Characteristic of the PTR 225/225 S/237



Dimensional drawing for the PTR 225/225 S/237

Technical Data		PTR Transmitter
Display range	mbar (Torr)	1×10^{-9} to 1×10^{-2} (0.75×10^{-9} to 0.75×10^{-2})
Measurement uncertainty		30 % in the range 1×10^{-8} to 1×10^{-4} mbar (0.75×10^{-8} to 0.75×10^{-4} Torr)
Principle of measurement		Cold cathode ionization according to Penning
Supply voltage		14.5 to 36 V DC typ. 24 V DC hum voltage < 2 Vpp
Power consumption	VA	< 2
Storage temperature range	°C	-20 to +70
Nominal temperature range	°C	10 to 50
Max. rel. humidity (climatic class F)	% n.c.	95
Protection class		IP 40
Dimensions (H x W x D)	mm	125 x 80 x 73
Weight, approx.	kg (lbs)	0.5 (1.1)
Inflammability		UL 94 - V 2
Sensor		Detachable for cleaning
Vacuum connection	DN	25 KF or 40 CF
Degassing temperature, max.	°C	350 with electronics detached
Dead volume, max.	cm ³	21
Materials in contact with the medium		Stainless steel, CrNi, Al ₂ O ₃ ceramics, NiFe, Mo, Cu, Ni, titanium
Over-pressure rating (abs.)	bar	10
Signal output ($R_a > 10 \text{ k}\Omega$) Measurement signal		0 to 10.6 V 0.66 to 10 V, corresponds to 1×10^{-9} to 1×10^{-2} mbar logarithm. divisions 1.333 V/decade
Trigger (PTR 225 S) Adjustment range Hysteresis Rating Error status	mbar (Torr)	Changeover relay contact 1×10^{-9} to 1×10^{-3} (0.75×10^{-9} to 0.75×10^{-3}) About 30 % of the adjusted pressure 60 V, 0.5 A DC Contact in its rest position when "no ignition" / "HT off"
High voltage control input		ON: At $U < 2.9 \text{ V}$, or $U > 12 \text{ V}$ OFF: At $U > 3 \text{ V}$, or $U < 7 \text{ V}$
Status output Ready to measure Error (no ignition)		Voltage level HIGH (typ. 24 V DC) LOW (0 V)
Status indicators		Operation: Orange LED Ready to measure (ignited): Green LED Trigger (active): Green LED
Monitor output ($R_a > 100 \text{ k}\Omega$)		Jack socket (3.5 mm) at which the trigger setting is available
Electrical connection		FCC-68 socket, 8 way with shield
Cable length, max.	m	100
Interface PTR 225 PB PTR 237 D		Profibus DP DeviceNet

Ordering Information	PTR Transmitter
PTR 225, DN 25 KF	Part No. 157 34
PTR 225 S, DN 25 KF	Part No. 164 34
PTR 225 PB, DN 25 KF Profibus interface	Part No. 896 41
PTR 237, DN 40 CF	Part No. 157 36
PTR 237 D, DN 40 CF DeviceNet interface	Part No. 896 42
(Operating Instructions)	(GA 09.308)
Baffle, DN 25 KF, with centering ring	Part No. 230 078
Replacement cathode plates, titanium (set of 5 pieces)	Part No. 162 91
Replacement anode ring	Part No. 240 002
Calibration	see section "Miscellaneous", para. "Leybold Calibration Service"
Connection cable, FCC 68 on both ends, 8 way, shielded	Type A Part No. 124 26 Part No. 230 012 Part No. 124 27 Part No. 124 28 Part No. 124 29 Part No. 124 30 Part No. 124 31 Part No. 124 32 Part No. 124 33

IONIVAC Transmitter ITR 90



The ITR 90 is a optimized combination transmitter. The combination of a hot cathode ionisation sensor according to Bayard-Alpert and a Pirani sensor permits vacuum pressure measurements of non-ignitable gases and gas mixtures in the pressure range from 5×10^{-10} to 1000 mbar.

If needed, the pressure can be displayed via the integrated display.

Advantages to the User

- Continuous pressure measurements from 10^{-10} mbar to atmospheric pressure
- High degree of reproducibility within the typical range for process pressures of 10^{-2} to 10^{-8} mbar
- Controlled switching on and off sequencing through the integrated double Pirani optimises the service life of the yttrium coated iridium cathodes
- Compact design
- Enclosed, rugged electrode geometry in a rugged metal housing
- Efficient degassing by electron bombardment
- Simple fitting of the sensor
- Extension for higher degassing temperatures during the measurements
- One signal covering 13 decades
- One flange joint for 13 decade
- ITR 90 model with built-in display for stand-alone operation without additional display components
- RS 232 C interface

Typical Applications

- Analytical
- Evaporation and coating
- Vacuum furnaces
- General purpose pressure measurements in the fine and high vacuum ranges

Option

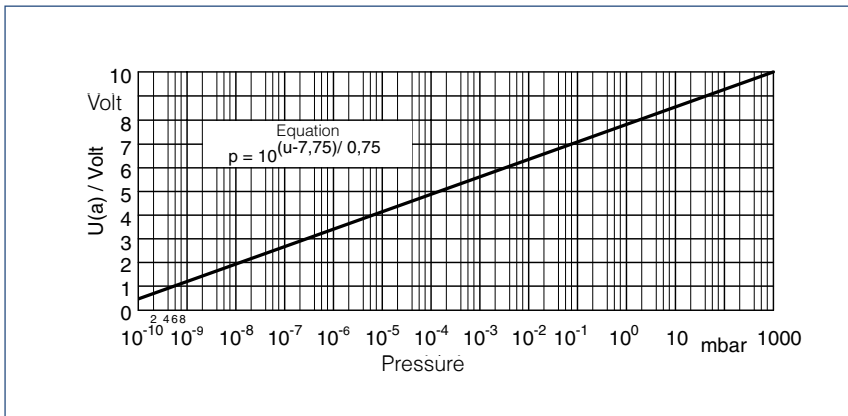
For protection of the sensor ITR 90 against contamination, radiation and other disturbing factors the installation of a baffle is recommended.

Two types of baffles are available: A build-in version for CF connections is mounted in the sensor; the baffle for KF connections is integrated in a centering ring.

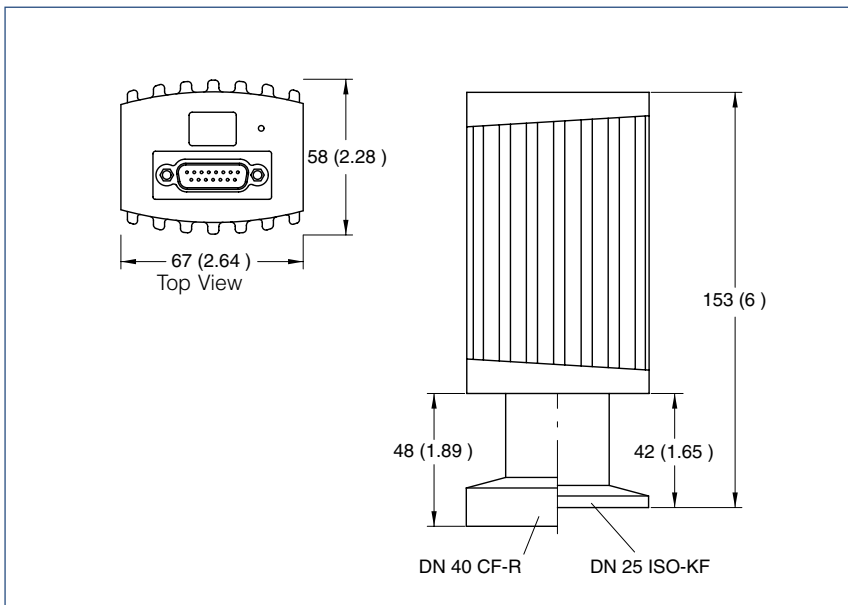
Sensor

The sensor of the ITR 90 contains a dual filament Pirani system as well as a Bayard-Alpert measurement system.

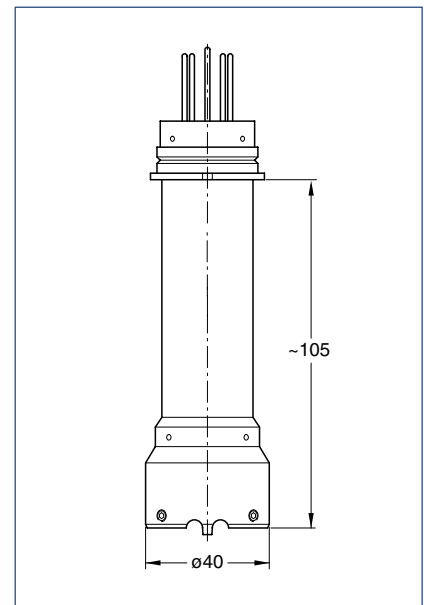
When using the degassing extension, measurements will be possible also at flange temperatures up to 150 °C.



Characteristic of the ITR 90



Dimensional drawing for the ITR 90; dimensions in brackets () are in inch



Dimensional drawing for the degassing extension

Technical Data		ITR Transmitter
Display range	mbar (Torr)	5×10^{-10} to 1000 (3.75×10^{-10} to 750)
Measurement uncertainty, 10^{-8} - 10^{-2} mbar		15 % of the meas. value
Reproducibility, 10^{-8} - 10^{-2} mbar		5 % of the meas. value
Principles of measurement		Hot cathode ionization according to Bayard-Alpert combined with thermal conductivity according to Pirani
Degas		Electron bombardment 3 minutes, max.
Supply voltage		20 to 28 V DC, typ. 24 V DC
Power consumption, max.	W	16
Storage/nominal temperature range	°C	-20 to +70 / 0 to +50
Protection class		IP 30
Weight, approx.		
ITR 90, DN 25 KF	kg (lbs)	0.285 (0.64)
ITR 90, DN 40 CF	kg (lbs)	0.550 (1.24)
Sensor		Fully sealed, exchangeable
Degassing temperature, max.	°C	150 ¹⁾
Dead volume, max.	cm ³	24 at DN 25 KF 34 at DN 40 CF
Materials in contact with the medium		Cu, W, Glas, NiFe, Mo, stainless steel, Aluminum, Iridium, Yttrium, NiCr,
Over-pressure rating (abs.)	bar	2
Signal output ($R_a \geq 10 \text{ k}\Omega$)		
Measurement signal		0 - 10 V, 0.774 - 10 V, 0.75 V pro decade
Error signal		< 0,5 V
Interface (standard / optional)		RS 232 C / ProfiBus
Electrical connection		15 way Sub-D male connector / pin contacts
Cable length, max.	m	100 / 30 at RS 232 C

¹⁾ Flange temperature when using the degassing extension

Ordering Information	ITR Transmitter	
	Without Display	With Display
ITR 90, DN 25 KF	Part No. 120 90	Part No. 120 91
ITR 90, DN 25 KF Profibus interface	Part No. 230 030	–
ITR 90, DN 40 CF-R, rotatable CF flange	Part No. 120 92	Part No. 120 94
ITR 90, DN 40 CF-R, rotatable CF flange Profibus interface	Part No. 230 031	–
(Operating Instructions)	(GA 09.420)	(GA 09.420)
Options Power supply for IONIVAC transmitter 100 V - 240 V AC / 24 V DC incl. 5 m connection cable and 5 m RS 232 C cable Degassing extension (100 mm, approx.) Baffle, DN 25 KF, with centering ring (FPM) Installation baffle for CF variant	Part No. 121 06 Part No. 127 06 Part No. 230 078 Part No. 121 07	Part No. 121 06 Part No. 127 06 Part No. 230 078 Part No. 121 07
Replacement sensor IE 90, DN 25 KF ¹⁾ IE 90, DN 40 CF-R ¹⁾	Part No. 121 02 Part No. 121 03	Part No. 121 02 Part No. 121 03
Calibration	see section "Miscellaneous", para. "Leybold Calibration Service"	see section "Miscellaneous", para. "Leybold Calibration Service"
Connection cable	see section "Connection Cable for active Sensors"	see section "Connection Cable for active Sensors"

¹⁾ including hex. socket screw key

Connection Cables for Active Sensors

Active Sensors	Operating Units for Active Sensors		
	DISPLAY ONE	DISPLAY TWO DISPLAY THREE	CENTER ONE CENTER TWO CENTER THREE
THERMOVAC Transmitter TTR 91, TTR 91 S, TTR 96 S a. o.	Type A	Type A	Type A
PENNINGVAC PTR 225, PTR 225 S, PTR 237	–	Type A	Type A
CERAVAC CTR 90, CTR 91	–	–	Type B
IONIVAC ITR 90	–	–	Type C

Active Sensors	Operating Units for Active Sensors		
	COMBIVAC 2T	IONIVAC IM 540 (Channel 3 and 4)	Bare wire ends
THERMOVAC Transmitter TTR 91, TTR 91 S, TTR 96 S a. o.	Type A	Type A	–
PENNINGVAC PTR 225, PTR 225 S, PTR 237	Type A	–	–
CERAVAC CTR 90, CTR 91	Type B	Type B	–
IONIVAC ITR 90	Type C	–	Type E

Technical Data	Connection Cable	
Cables Type A Type B Type C Type D Type E	FCC 68 (RJ45) on both ends, 8 way, shielded Sub-D 15 way female to FCC 68 (RJ45), 8 way, shielded Sub-D 15 way female to Sub-D 15 way male, shielded Sub-D 15 way female to MAS 70 S, shielded Sub-D 15 way female to bare wire ends, shielded	
Ordering Information	Connection Cable	
Cable length 5 m 10 m 15 m 20 m 30 m 40 m 50 m 75 m 100 m	Type A	Type B
	Part No. 124 26 Part No. 230 012 Part No. 124 27 Part No. 124 28 Part No. 124 29 Part No. 124 30 Part No. 124 31 Part No. 124 32 Part No. 124 33	Part No. 230 013 Part No. 230 014 Part No. 230 015 Part No. 230 016 Part No. 230 017 Part No. 230 018 Part No. 230 019 Part No. 230 020 Part No. 230 021
Ordering Information	Connection Cable	
Cable length 5 m 10 m 15 m 20 m 30 m 40 m 50 m 75 m 100 m	Type C	Type E
	Part No. 124 55 Part No. 230 022 Part No. 124 56 Part No. 124 57 Part No. 124 58 1) 1) 1) 1)	Part No. 124 63 Part No. 230 023 Part No. 124 64 Part No. 124 65 Part No. 124 66 Part No. 124 67 Part No. 124 68 Part No. 124 69 Part No. 124 70

¹⁾ Longer cable runs are not specified because of the RS 232 C connection

DISPLAY ONE



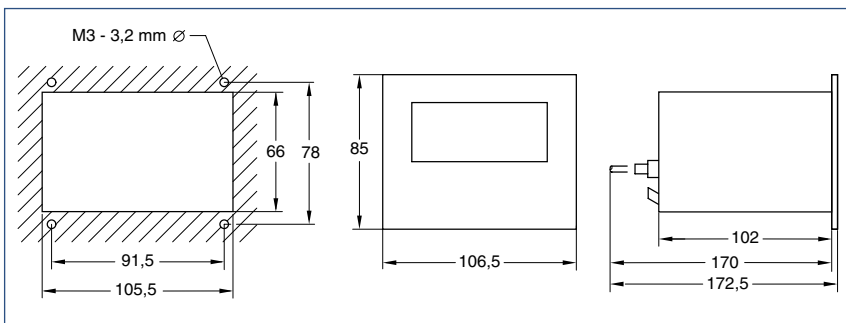
Cost-effective, compact single channel display unit for the transmitters from the THERMOVAC serie.

Advantages to the User

- Power supply voltage for the transmitters
- Two-digit mantissa in the range from 5×10^{-4} to 1×10^3 mbar
- Readout selectable between mbar, Torr or Pascal
- 0 to 10 V chart recorder output via plug-in screw terminals
- The switching threshold of the transmitters has been looped through to plug-in terminals
- Transmitter threshold settings can be displayed by a single key press on the transmitter
- Compact bench top enclosure (1/4 19 in., 2 HU)
- For fitting into 19 in., 3 HU racks

Connectable Sensors

- TTR 211
- TTR 216 S
- TTR 90
- TTR 90 S
- TTR 91
- TTR 91 S
- TTR 96 S



Dimensional drawing and panel cut-out for the DISPLAY ONE

Technical Data	DISPLAY ONE
Number of measurement channels	1
Display for measured values	digital, 7 segment LED
Display range mbar (Torr)	5×10^{-4} to 1×10^3 (3.8×10^{-4} to 7.5×10^2)
Unit of measurement (selectable)	mbar, Torr, Pascal
Switching thresholds	from the transmitter are run to a terminal strip
Chart recorder output ($R_a > 2.5 \text{ k}\Omega$)	0 - 10 Volt, characteristic corresponds to the connected transmitter
Main connection	
EU version	180 V - 250 V / 50-60 Hz
US version	90 V - 130 V / 50-60 Hz
Ordering Information	DISPLAY ONE
EU version, including mains cord	Part No. 230 001
US version, including mains cord	Part No. 235 001
(Operating Instructions)	(GA 09.034)
THERMOVAC Transmitter TTR 91, TTR 91 S, TTR 96 S	see section "Active Sensors/Transmitters"
Connection cable, FCC 68 on both ends, 8 way, shielded	
5 m	Type A Part No. 124 26
10 m	Part No. 230 012
15 m	Part No. 124 27
20 m	Part No. 124 28
30 m	Part No. 124 29
40 m	Part No. 124 30
50 m	Part No. 124 31
75 m	Part No. 124 32
100 m	Part No. 124 33
Adapter panel for installation in a 3 HU, 19 in. rack	Part No. 230 005

DISPLAY TWO / THREE



Cost-effective, operating and display units for the transmitters from the THERMOVAC and PENNINGVAC series.

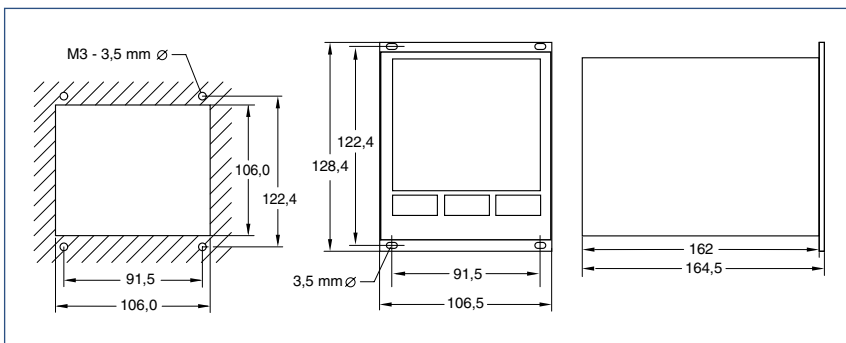
All channels are displayed simultaneously.

Advantages to the User

- Power supply voltage for the transmitters
- Display range from 1×10^{-9} to 1500 mbar
- Readout selectable between mbar, Torr or Pascal
- Adjustable switching thresholds with variable hysteresis, floating changeover contacts and visual indication of the switching status in the display
- Option of entering gas correction factors for PENNINGVACs
- Separate chart recorder outputs 0-10 V for each measurement channel
- Compact bench top enclosure (1/4 19 in., 3 HU)
- For fitting into 19 in., 3 HU racks

Connectable Sensors

- TTR 211
- TTR 216 S
- TTR 90
- TTR 91
- TTR 96 S
- TTR 100
- PTR 225
- PTR 227



Dimensional drawing and panel cut-out for the DISPLAY TWO and THREE

Technical Data	DISPLAY TWO	DISPLAY THREE
Number of measurement channels	2	3
Display for measured values	digital, 7 segment LED, 4 digits	digital, 7 segment LED, 4 digits
Display range mbar(Torr)	1×10^{-10} to 2000 (0.75×10^{-10} to 1500)	1×10^{-10} to 2000 (0.75×10^{-10} to 1500)
Unit of measurement (selectable)	mbar, Torr, Pascal	mbar, Torr, Pascal
Gas type correction (for PTR)	factor adjustable	factor adjustable
Sensor connection	FCC68 (RJ45)	FCC68 (RJ45)
Sensor power supply V DC	24	24
Electrical outputs	screw terminal	screw terminal
Switching threshold Number Adjustment range Hysteresis Relay contact Load rating	2 (1 per channel) sensor dependent adjustable floating changeover contact 60 V, 1 A DC / 30 V, 1 A AC	3 (1 per channel) sensor dependent adjustable floating changeover contact 60 V, 1 A DC / 30 V, 1 A AC
Ready relay Relay contact Load rating	normally open contact 60 V, 1 A DC / 30 V, 1 A AC	normally open contact 60 V, 1 A DC / 30 V, 1 A AC
Chart recorder output ($R_a > 10 \text{ k}\Omega$)	0 - 10 V per measurement channel, output characteristic corresponds to the connected transmitter	0 - 10 V per measurement channel, output characteristic corresponds to the connected transmitter
Control input	PENNINGVAC PTR: high voltage on	PENNINGVAC PTR: high voltage on
Mains connection V AC / Hz	85 - 240 / 50 - 60	85 - 240 / 50 - 60
Power consumption W	< 10	< 15
Nominal temperature range °C	+5 to +50	+5 to +50
Weight kg (lbs)	1.3 (2.87)	1.4 (3.09)
Protection class IP	40	40
Ordering Information	DISPLAY TWO	DISPLAY THREE
EU version, including mains cord US version, including mains cord	Part No. 230 024 Part No. 235 024	Part No. 230 025 Part No. 235 025
(Operating Instructions)	(GA 09.037)	(GA 09.037)
THERMOVAC Transmitter TTR 91, TTR 96 S, TTR 100	see section "Active Sensors/Transmitters"	see section "Active Sensors/Transmitters"
PENNINGVAC Transmitter PTR 225, PTR 227	see section "Active Sensors/Transmitters"	see section "Active Sensors/Transmitters"
Connection cables for THERMOVAC and PENNINGVAC (Type A)	see section "Connection Cables for Active Sensors"	see section "Connection Cables for Active Sensors"
Adapter panel for installation in a 3 HU, 19 in. rack	Part No. 230 005	Part No. 230 005

CENTER ONE



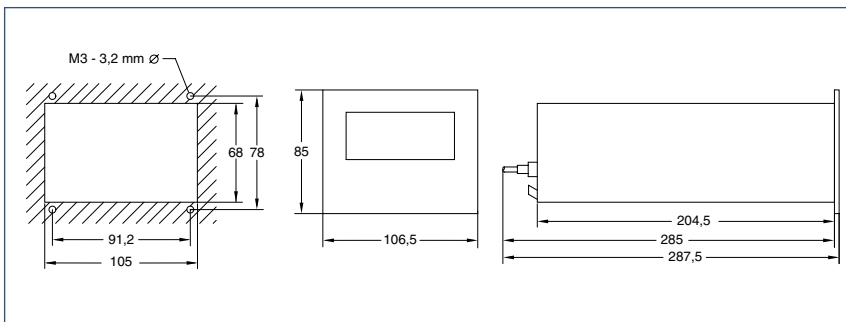
Universal and compact display and operating unit for the active sensors from the CERA-VAC, THERMO-VAC, PENNING-VAC and IONIVAC series.

Advantages to the User

- Power supply voltage for the transmitters
- Display range from 1×10^{-10} to 1500 mbar
- Automatic switchover to exponential readout of the measured data depending on the pressure range
- Readout selectable between mbar, Torr or Pascal
- Adjustable switching threshold with variable hysteresis, floating changeover contact and visual indication of the switching status on the display
- Zero correction for both display and chart recorder output through a key when using CERA-VAC transmitters
- Option of entering gas correction factors for PENNING-VACs
- Chart recorder output 0 - 10 Volt
- RS 232 C interface with adjustable baud rate
- Relay output for error signalling
- Compact bench top enclosure (1/4 19 in., 2 HU)
- For fitting into 19 in., 3 HU racks

Connectable Sensors

- THERMO-VAC TTR 90, TTR 91, TTR 96 S, TTR 100, TTR 211, TTR 216 S
- PENNING-VAC PTR 225 and PTR 237
- CERA-VAC CTR 90 and CTR 91
- IONIVAC ITR 90 and ITR 100



Dimensional drawing and panel cut-out for the CENTER ONE

Technical Data	CENTER ONE
Number of measurement channels	1
Display for measured values	digital, 7 segment LED, 5 digits
Display range mbar (Torr)	1×10^{-10} to 1500 (0.75×10^{-10} to 1125)
Unit of measurement (selectable)	mbar, Torr, Pascal, Micron
Gas type correction	factor adjustable
Sensor connection	15 way Sub-D socket FCC68 (RJ45)
Sensor power supply V DC	24
Electrical inputs and outputs	9 way Sub-D plug
Switching threshold Number Adjustment range Hysteresis Relay contact Load rating	1 sensor dependent adjustable floating changeover contact 60 V, 0.5 A DC / 30 V, 0.5 A AC
Error message Relay contact Load rating	floating normally open contact 60 V, 0.5 A DC / 30 V, 0.5 A AC
Chart recorder output ($R_a > 10 \text{ k}\Omega$)	0 - 10 Volt, characteristic corresponds to the connected transmitter
Control input	PTR: high voltage on ITR 100: emission on
Interface RS 232 C	9 way Sub-D socket
Mains connection V AC / Hz	85 V - 264 / 50-60
Power consumption W	< 30
Weight kg (lbs)	0.85 (1.9)
Protection class IP	30
Ordering Information	CENTER ONE
EU version with 2 m EURO mains cord US-Version with 2 m US mains cord	Part No. 230 002 Part No. 235 002
(Operating Instructions)	(GA 09.033)
THERMOVAC, PENNINGVAC, CERA-VAC and IONIVAC Transmitters	see section "Active Sensors / Transmitters"
Connection cables for THERMOVAC and PENNINGVAC (Type A), CERA-VAC (Type B) and IONIVAC (Type C)	see section "Connection Cables for Active Sensors"
Adapter panel for installation in a 3 HU, 19 in. rack	Part No. 230 005
Screw terminal for the 25 way output socket	Part No. 230 006

CENTER TWO / THREE



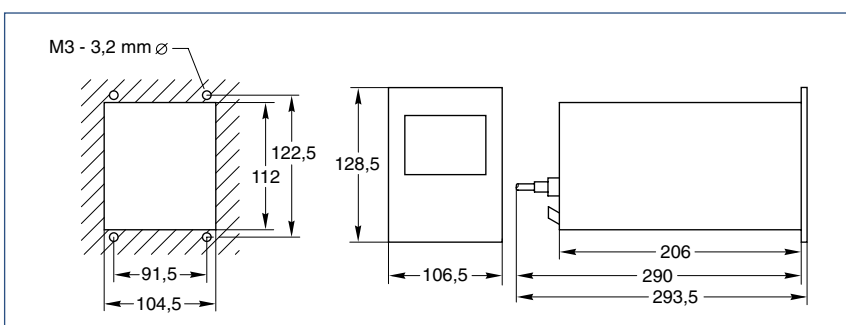
Universal display and operating units for the active sensors from the CERA-VAC, THERMOVAC, PENNINGVAC and IONIVAC series. All channels are displayed simultaneously.

Advantages to the User

- Power supply voltage for the transmitters
- Display range from 1×10^{-10} to 1330 mbar
- Automatic switchover to exponential readout of the measured data depending on the pressure range
- Readout selectable between mbar, Torr, Micron or Pascal
- Adjustable switching thresholds with variable hysteresis, floating changeover contacts and visual indication of the switching status in the display, freely assignable to the individual measurement channels
- Zero correction for both display and chart recorder output through a key when using CERA-VAC transmitters
- Option of entering gas correction factors for PENNINGVACs
- Separate chart recorder outputs 0-10 V for each measurement channel
- Additional chart recorder output 0-10 V programmable to several measurement channels
- RS 232 C interface with adjustable baud rate
- Relay output for error signalling
- Compact bench top enclosure (1/4 19 in., 3 HU)
- For fitting into 19 in., 3 HU racks

Connectable Sensors

- THERMOVAC TTR 90, TTR 91, TTR 96 S, TTR 100, TTR 211, TTR 216 S
- PENNINGVAC PTR 225 and PTR 237
- CERA-VAC CTR 90 und CTR 91
- IONIVAC ITR 90



Dimensional drawing and panel cut-out for the CENTER TWO and THREE

Technical Data	CENTER TWO	CENTER THREE
Number of measurement channels	2	3
Display for measured values	digital, 7 segment LED, 5 digits	digital, 7 segment LED, 5 digits
Display range mbar(Torr)	1×10^{-10} to 1330 (0.75×10^{-10} to 1000)	1×10^{-10} to 1330 (0.75×10^{-10} to 1000)
Unit of measurement (selectable)	mbar, Torr, Pascal, Micron	mbar, Torr, Pascal, Micron
Gas type correction	factor adjustable	factor adjustable
Sensor connection	15 way Sub-D socket FCC68 (RJ45)	15 way Sub-D socket FCC68 (RJ45)
Sensor power supply V DC	24	24
Electrical outputs	25 way Sub-D socket	25 way Sub-D socket
Switching threshold	independently assignable	independently assignable
Number	4	6
Adjustment range	sensor dependent	sensor dependent
Hysteresis	adjustable	adjustable
Relay contact	floating changeover contact	floating changeover contact
Load rating	60 V, 0.5 A DC / 30 V, 0.5 A AC	60 V, 0.5 A DC / 30 V, 0.5 A AC
Error message		
Relay contact	floating normally open contact	floating normally open contact
Load rating	60 V, 0.5 A DC / 30 V, 0.5 A AC	60 V, 0.5 A DC / 30 V, 0.5 A AC
Chart recorder output ($R_a > 10 \text{ k}\Omega$)	0 - 10 V per measurement channel, output characteristic corresponds to the connected sensor; in addition one chart recorder output can be programmed	0 - 10 V per measurement channel, output characteristic corresponds to the connected sensor; in addition one chart recorder output can be programmed
Control input	PENNINGVAC PTR: high voltage on	PENNINGVAC PTR: high voltage on
Interface RS 232 C	9 way Sub-D socket	9 way Sub-D socket
Mains connection V AC / Hz	90 - 250 / 50 - 60	90 - 250 / 50 - 60
Power consumption W	45	65
Nominal temperature range °C	+5 to +50	+5 to +50
Weight kg (lbs)	1.1 (2.43)	1.2 (2.65)
Protection class IP	20	20
Ordering Information	CENTER TWO	CENTER THREE
EU version with 2 m EURO mains cord US-Version with 2 m US mains cord	Part No. 230 004 Part No. 235 004	Part No. 230 003 Part No. 235 003
(Operating Instructions)	(GA 09.035)	(GA 09.035)
THERMOVAC, PENNINGVAC, CERA VAC and IONIVAC Transmitters	see section "Active Sensors / Transmitters"	see section "Active Sensors / Transmitters"
Connection cables for THERMOVAC and PENNINGVAC (Type A), CERA VAC (Type B) and IONIVAC (Type C)	see section "Connection Cables for Active Sensors"	see section "Connection Cables for Active Sensors"
Screwed connection for 9 way Sub-D socket	Part No. 230 006	Part No. 230 006

COMBIVAC 2T



By combining two transmitter types, the COMBIVAC 2T covers the entire range of vacuum pressure measurement from 10^{-10} mbar to 2000 mbar.

Moreover, the unit offers a manually or pressure controlled switching function to START and STOP the high-vacuum pumps from the TW line.

The pump status "normal operation", "run-up", "standby" and "fail" is indicated on the display.

Advantages to the User

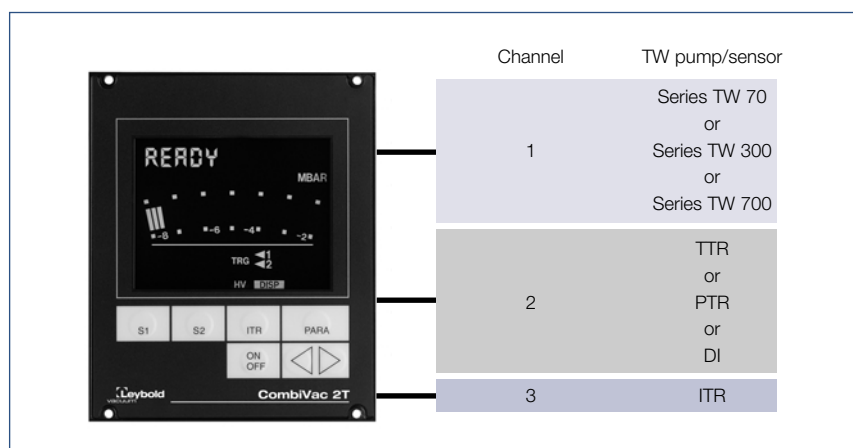
- Wide measurement and display range from 2000 to 1×10^{-10} mbar (1500 to 0.75×10^{-10} Torr) through the combination of two sensors with automatic switchover on the display
- Analog bargraph display runs simultaneously with digital readouts
- Three adjustable thresholds with relay contacts and adjustable hysteresis, assignable to each channel
- Userfriendly adjustment to each application, e. g. by
 - selectable measurement unit
 - automatic emission start of IONIVAC transmitter
- automatic ignition of PENNINGVAC transmitter
- Separate 0 to 10 V chart recorder outputs for each measurement channel
- Additional 0 to 10 V chart recorder output, programmable for coverage of several measurement channels
- Full remote control via RS 232 C interface
- Compact bench-top unit (1/4 19 in., 3 HU) which can also be installed in panel cutouts and 19 in. racks
- CE mark

Connectable Sensors

- THERMOVAC TTR 90, TTR 91, TTR 96 S, TTR 211, TTR 216 S
- PENNINGVAC PTR 225 and PTR 237
- IONIVAC ITR 90 and ITR 100
- DI 200/201 and DI 2000/2001

Typical Applications

- General pressure measurements on high vacuum pump systems
- Vacuum furnaces
- Coating systems
- Analytical instruments



Connectable transmitters COMBIVAC 2T

Technical Data		COMBIVAC 2T
Number of measurement channels		2
Measurement display (backlit)		digital, 7-segments LCD analog LCD-bargraph display can be switched over by hand or automatically to the connected sensors
Display range	mbar (Torr)	2000 to 2×10^{-10} (1500 to 1.5×10^{-10})
Display range by using the connectable transmitters		
DI 200/DI 201	mbar (Torr)	0.1 to 200 (0.075 to 150)
DI 2000/DI 2001	mbar (Torr)	1 to 2000 (0.75 to 1500)
TTR 90/91/96 S	mbar (Torr)	5×10^{-4} to 1000 (3.75×10^{-4} to 750)
PTR 225/237	mbar (Torr)	1×10^{-9} to 1×10^{-2} (0.75×10^{-9} to 0.75×10^{-2})
ITR 90	mbar (Torr)	5×10^{-10} to 1000 (3.75×10^{-10} to 750)
ITR 100	mbar (Torr)	1×10^{-10} to 1×10^{-1} (0.75×10^{-10} to 0.75×10^{-1})
Unit of measurement (selectable)		mbar, Torr, Pascal, Micron
Type of gas (selectable)		Air, Ar, N ₂ (only ITR 100)
Switching thresholds		3, independently assignable
Adjustment range		according to the assigned sensor
Hysteresis		adjustable
Relay contact		potential free changeover contact
Capacity		60 V, 0.5 A DC
Ready indication		1 relay contact 60 V, 0.5 A DC for all channels
Chart recorder output ($R_a > 10 \text{ k}\Omega$)		4, each 0 to 10 V per channel: initial characteristics dependent on connected transmitters one 0 to 10 V analog output per one or several linear or logarithmic channels
Electric outputs		relay contacts and chart recorder outputs over 25 pin Sub-D-socket
Interface		RS 232 C
Main supply		90 - 250 V AC
Power consumption	VA	40
Nominal temperature range	°C	0 to 50
Max. rel. humidity	% n. c.	85
Weight	kg (lbs)	1.5 (3.31)
Dimensions (W x H x D)	mm	106.5 x 128.5 x 240

Ordering Information	COMBIVAC 2T
COMBIVAC 2T, 90 - 250 V AC	Part No. 230 000
(Operating Instructions)	(GA 09.594)
Calibration	see section "Miscellaneous", para. "Leybold Calibration Service"
THERMOVAC, PENNINGVAC and IONIVAC Transmitters	see section "Active Sensors / Transmitters"
Linear pressure sensors DI	see section "Additional Sensors"
Connection cable THERMOVAC and PENNINGVAC 5 m 10 m 15 m 20 m 30 m 40 m 50 m 75 m 100 m	Type A Part No. 124 26 Part No. 230 012 Part No. 124 27 Part No. 124 28 Part No. 124 29 Part No. 124 30 Part No. 124 31 Part No. 124 32 Part No. 124 33
Connection cable IONIVAC 5 m 10 m 15 m 20 m 30 m	Type C Part No. 124 55 Part No. 230 022 Part No. 124 56 Part No. 124 57 Part No. 124 58
Connection cable DI sensor, 5 m	Part No. 163 84
Connection cable TW 70, TW 300 and TW 700 5 m 10 m 15 m 20 m	Part No. 230 007 Part No. 230 008 Part No. 230 009 Part No. 230 010

Notes

Linear Pressure Sensors

DI 200/DI 201/DI 2000/DI 2001/DI 2001 rel



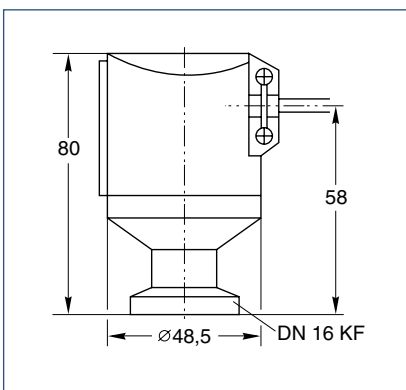
Capacitive pressure sensor based on ceramics technology. Available as absolute or relative pressure sensor

Advantages to the User

- Pressure sensor of the two-wire type
- Absolute pressure ranges from 0.1 to 200 mbar or 1 to 2000 mbar
- Relative pressure range from -1000 mbar to +1000 mbar
- Excellent overload characteristic due to the Al_2O_3 ceramics diaphragm
- Highly corrosion resistant
- Independent of the type of gas
- Vibration resistant
- Supply voltage range of 12 to 30 V DC
- Linear output signal of 4 to 20 mA
- Compact design

Typical Applications

- Pressure measurements in the rough vacuum range, and for corrosive media
- Chemical process engineering
- Vacuum packaging
- Drying processes
- Measurement of operating and filling pressure, during the production of lamps
- Filling systems for brake fluids (DI 201/DI 2001)
- Filling systems for refrigerants
- Measurement of pressure relative to atmospheric pressure (DI 2001 rel)



Dimensional drawing for the sensors
DI 200/DI 201/DI 2000/DI 2001/DI 2001 rel

Technical Data		DI 200	DI 201	DI 2000	DI 2001	DI 2001 rel
Measurement range	mbar (Torr)	0.1 to 200 (0.075 to 150)	0.1 to 200 (0.075 to 150)	1 to 2000 (0.75 to 1500)	1 to 2000 (0.75 to 1500)	-1000 to +1000 (-750 to +750) relative pressure
Overload range, max.	bar	5	5	10	10	10
Nominal temperature range	°C	0 to +60	0 to +60	0 to +60	0 to +60	0 to +60
Measurement uncertainty ¹⁾ (± temperature error)	% FS	0.2	0.2	0.2	0.2	0.2
Resolution	% FS	0.05	0.05	0.05	0.05	0.05
Reproducibility	% FS	0.1	0.1	0.1	0.1	0.1
Linearity	% FS	0.1	0.1	0.1	0.1	0.1
Temperature error						
Zero drift	% FS/10°K	0.1	0.1	0.1	0.1	0.1
Sensitivity drift	% FS/10°K	0.15	0.15	0.15	0.15	0.15
Principle of measurement		Capacitive	Capacitive	Capacitive	Capacitive	Capacitive
Sensing head supply		Two-wire system	Two-wire system	Two-wire system	Two-wire system	Two-wire system
Output signal	mA	4 to 20	4 to 20	4 to 20	4 to 20	4 to 20
Supply voltage	V DC	+24 typ.	+24 typ.	+24 typ.	+24 typ.	+24 typ.
Operating range	V	12 to 30, ripple 1 V _{pp}	12 to 30, ripple 1 V _{pp}	12 to 30, ripple 1 V _{pp}	12 to 30, ripple 1 V _{pp}	12 to 30, ripple 1 V _{pp}
Dead volume	cm ³	3	3	3	3	3
Vacuum connection	DN	16 KF	16 KF	16 KF	16 KF	16 KF
Weight, approx.	kg (lbs)	0.55 (1.2)	0.55 (1.2)	0.55 (1.2)	0.55 (1.2)	0.55 (1.2)
Protection class	IP	44	44	44	44	44
Materials in contact with the medium		Stainless Steel 1.4305 Al ₂ O ₃ (96 %) Ceramics FKM	Stainless Steel 1.4305 Al ₂ O ₃ (96 %) Ceramics EPDM	Stainless Steel 1.4305 Al ₂ O ₃ (96 %) Ceramics FKM	Stainless Steel, 1.4305 Al ₂ O ₃ (96 %) Ceramics, EPDM	Stainless Steel 1.4305 Al ₂ O ₃ (96 %) Ceramics EPDM
Operating units		MEMBRANOVAC DM 11, DM 12 / PIEZOVAC PV 20 / COMBIVAC CM 32, 2T	MEMBRANOVAC DM 11, DM 12 / PIEZOVAC PV 20 / COMBIVAC CM 32, 2T	MEMBRANOVAC DM 11, DM 12 / PIEZOVAC PV 20 / COMBIVAC CM 32, 2T	MEMBRANOVAC DM 11, DM 12 / COMBIVAC CM 32, 2T	MEMBRANOVAC DM 11, DM 12 / COMBIVAC CM 32
Ordering Information		DI 200	DI 201	DI 2000	DI 2001	DI 2001 rel
Linear absolute pressure sensor, complete with 5 m long connection cable and connecting plug		Part No. 158 12	Part No. 158 14	Part No. 158 13	Part No. 158 15	Part No. 245 000
(Operating Instructions)		(GA 09.116)	(GA 09.116)	(GA 09.116)	(GA 09.116)	–

¹⁾ Sum of linearity, hysteresis and reproducibility

THERMOVAC Sensors

TR 211/TR 211 NPT/TR 212/TR 216



These passive sensors use thermal conductivity technology according to Pirani.

Advantages to the User

- Measurement range 5×10^{-4} to 1000 mbar (3.75×10^{-4} to 750 Torr)
- Tungsten or platinum filament
- Cost-effective sensing cell
- Fully aligned and temperature compensated 0 to +40 °C
- Constant filament temperature

TR 211

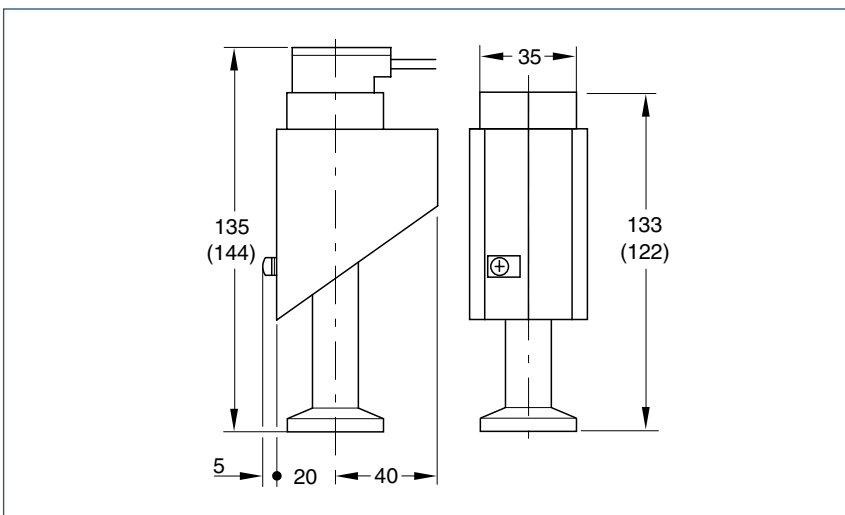
- Aluminum sensing cell with tungsten filament
- Improved temperature compensation

TR 211 NPT/TR 212

- Stainless steel sensing cell with tungsten filament
- Over-pressure resistant

TR 216

- Stainless steel sensing cell with platinum filament and ceramics feed through
- Well suited for corrosive processes and water vapour atmospheres



Dimensional drawing for the TR 211, TR 212 and TR 216; TR 211 NPT in brackets

Technical Data	TR 211	TR 211 NPT	TR 212	TR 216
Measurement range mbar (Torr)	5 x 10 ⁻⁴ to 1000	5 x 10 ⁻⁴ to 1000	5 x 10 ⁻⁴ to 1000	5 x 10 ⁻⁴ to 1000
Operating temperature range (compensated) °C	0 to +40	0 to +40	0 to +40	0 to +40
Storage temperature range, max. °C	80	80	80	80
Filament	tungsten	tungsten	tungsten	platinum
Filament temperature °C	110	110	110	110
Permissible overload (abs.), max. bar	3	3	10	10
Volume of the sensing cell, approx. cm ³	11	11	11	11
Vacuum connection DN	16 KF	1/8" NPT	16 KF/16 CF	16 KF
Materials in contact with the medium	aluminum, Vacon, glass, tungsten CrNi 8020, epoxy cement	stainless steel, Vacon, glass, tungsten CrNi 8020 epoxy cement	stainless steel, Vacon, glass, tungsten CrNi 8020 epoxy cement	stainless steel 1.4301 (SS 304), Al ₂ O ₃ ceramics, CrNi 8020,
Operating units	THERMOVAC TM 21, 22, 23 / COMBIVAC CM 31, 32, 33 / PIEZOVAC PV 20	THERMOVAC TM 21, 22, 23 / COMBIVAC CM 31, 32, 33 / PIEZOVAC PV 20	THERMOVAC TM 21, 22, 23 / COMBIVAC CM 31, 32, 33 / PIEZOVAC PV 20	THERMOVAC TM 21, 22, 23 / COMBIVAC CM 31, 32, 33 / PIEZOVAC PV 20
Ordering Information	TR 211	TR 211 NPT	TR 212	TR 216
THERMOVAC sensors Series 200				
DN 16 KF	Part No. 157 85	–	Part No. 158 52	Part No. 157 87
DN 16 CF	–	–	Part No. 157 86	–
DN 1/8" NPT	–	Part No. 896 33	–	–
(Operating Instructions)	(GA 09.210)	(GA 09.210)	(GA 09.210)	(GA 09.210)
Replacement sensing cell	Part No. 157 75	Part No. 896 34	–	Part No. 157 77

PENNINGVAC Sensors PR 25/PR 26/PR 27/PR 28



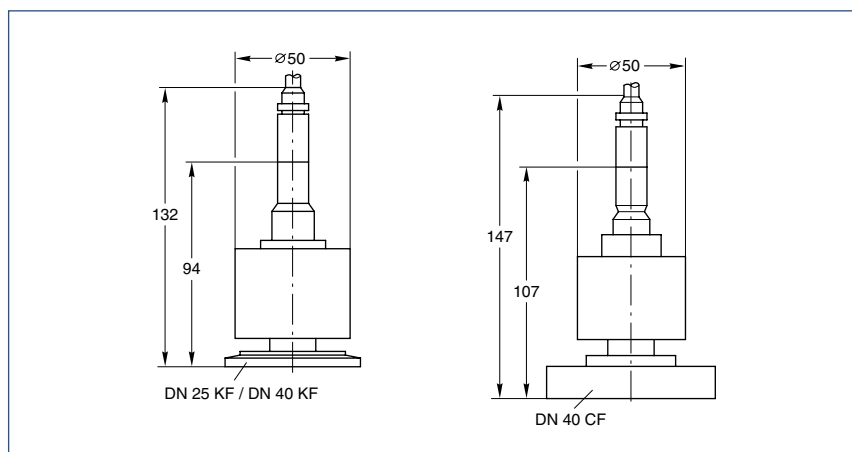
These passive sensors use cold cathode ionization technology according to Penning.

Advantages to the User

- Rugged
- Insensitive to air inrushes and vibrations
- Easy disassembly and cleaning of the measurement system
- Exchangeable cathode plate
- Improved ignition characteristic through titanium cathodes

Option

For protection of the PENNINGVAC sensors against contamination, radiation and other disturbing factors the installation of a baffle is recommended.



Dimensional drawing for the PENNINGVAC PR Sensors

Technical Data		PR 25	PR 26	PR 27	PR 28
Measurement range	mbar (Torr)	1×10^{-9} to 10^{-2} (0.75×10^{-9} to 10^{-2})	1×10^{-9} to 10^{-2} (0.75×10^{-9} to 10^{-2})	1×10^{-9} to 10^{-2} (0.75×10^{-9} to 10^{-2})	1×10^{-9} to 10^{-2} (0.75×10^{-9} to 10^{-2})
High voltage supply (anode potential)	kV	+3.3/+1.6	+3.3/+1.6	+3.3/+1.6	+3.3/+1.6
Storage temperature range	°C	-25 to +80	-25 to +80	-25 to +80	-25 to +80
Nominal temperature range	°C	0 to +80	0 to +80	0 to +80	0 to +200
Degassing temperature (flange)	°C	–	–	–	350
Permissible overload (abs.)	bar	6 ¹⁾	6 ¹⁾	6 ¹⁾	6 ¹⁾
Dead volume	cm ³	21	21	21	21
Materials in contact with the medium		stainless steel, nichrome, ceramics, titanium	stainless steel, nichrome, ceramics, titanium	stainless steel, nichrome, ceramics, titanium	stainless steel, nichrome, ceramics, titanium
Weight, approx.	kg (lbs)	0.75 (1.66)	0.75 (1.66)	0.8 (1.66)	0.8 (1.66)
Vacuum connection	DN	25 KF	40 KF	40 CF	40 CF
Operating units		COMBIVAC CM 31, 32, 33 / PENNINGVAC PM 31	COMBIVAC CM 31, 32, 33 / PENNINGVAC PM 31	COMBIVAC CM 31, 32, 33 / PENNINGVAC PM 31	COMBIVAC CM 31, 32, 33 / PENNINGVAC PM 31
Ordering Information		PR 25	PR 26	PR 27	PR 28
PENNINGVAC sensors		Part No. 157 52	Part No. 136 46	Part No. 136 47	Part No. 136 48
(Operating Instructions)		(GA 09.309)	(GA 09.309)	(GA 09.309)	(GA 09.309)
Replacement cathode plate, titanium (5 pcs., incl. 5 ceramics discs)		Part No. 162 91	Part No. 162 91	Part No. 162 91	Part No. 162 91
Replacement anode ring		Part No. 200 28 711	Part No. 200 28 711	Part No. 200 28 711	Part No. 200 28 711
Baffle, with centering ring		Part No. 230 078	Part No. 230 079	–	–

¹⁾ When using an ultra sealing gasket at the vacuum connection

IONIVAC Sensors IE 414/IE 514



These passive sensors use hot cathode ionization technology.

Advantages to the User

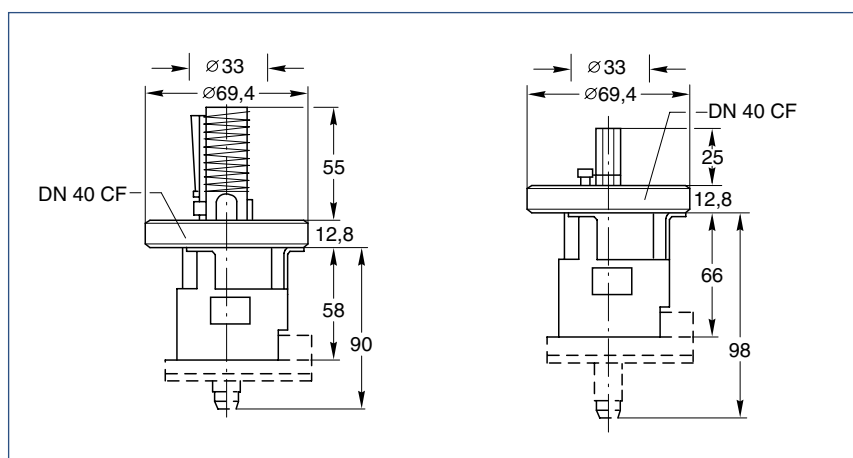
- Exchangeable cathode
- High accuracy of the measurements due to individually calibrated sensing system

IE 414

- Bayard-Alpert sensing system
- Measurement range to 2×10^{-11} mbar (1.5×10^{-11} Torr)
- Protection shield welded in place

IE 514

- Extractor sensing system
- Reliable to 1×10^{-12} mbar (0.75×10^{-12} Torr)
- Significant reduction of X-ray and ion desorption effects



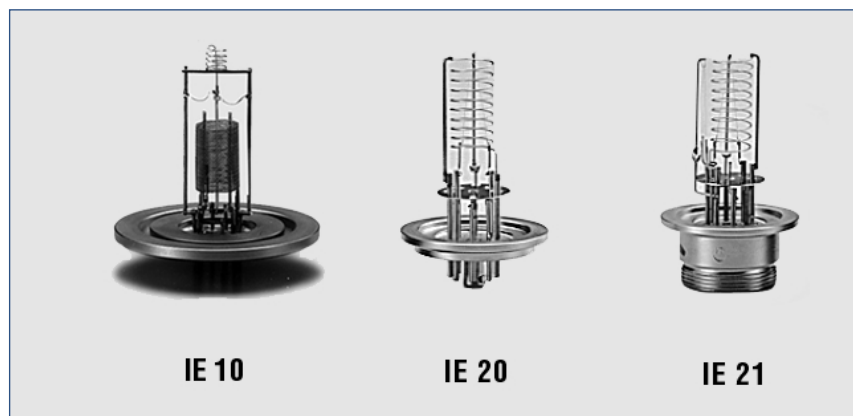
Dimensional drawing for the IE 414 (left) and IE 514 (right)

Technical Data		IE 414	IE 514
Measurement range	mbar (Torr)	2×10^{-11} to 10^{-2} (1.5×10^{-11} to 10^{-2})	10^{-12} to 1×10^{-4} (10^{-12} to 7.5×10^{-5})
X-ray limit	mbar (Torr)	$\leq 10^{-11}$ ($\leq 10^{-11}$)	$\leq 10^{-12}$ ($\leq 10^{-12}$)
Operating temperature range	°C	0 to +80	0 to +80
Degassing temperature at the flange, max.	°C	+250 ¹⁾ / +350 ²⁾	+250 ¹⁾ / +350 ²⁾
Material			
Cathode		Iridium with yttric oxide coating	Iridium with yttric oxide coating
Feedthrough pins		NiFe 42	NiFe 42
Anode		Pt/Ir 90/10/pt wire	Mo and CoNiCr
Vacuum connection	DN	40 CF	40 CF
Adjustment data			
Ion detector potential	V	0	0
Cathode potential	V	80	100
Anode potential	V	220	220
Emission current	mA	0.06 to 0.6	1.6
Heating current for the hot cathode	A	1.4	1.4
Heating voltage for the hot cathode	V	2.7	3.7
Sensitivity for nitrogen	mbar ⁻¹	17	6.6
Degassing operation	V	700	700
Electron bombardment	mA	30	30
Operating units		IM 520, 510, 540	IM 520, 510, 540
Ordering Information		IE 414	IE 514
IONIVAC sensors		Part No. 158 66	Part No. 158 67
Replacement cathode		Part No. 158 63	Part No. 158 61

¹⁾ With bakeable gauge head cable

²⁾ With gauge head cable detached

Spare Sensors for Older Operating Units



Type	Corresponding Sensors/ Operating Units	Ordering Information
IE 10	IM 110, IM 110 D	Part No. 163 43
IE 20	IM 210, IM 210 D, IT 230	Part No. 163 14
IE 21	IM 210, IM 221	Part No. 158 17
Cathode	IE 220	Part No. 158 58 ¹⁾
TR 301	TM 320, CM 350, IM 520, DM 11, DM 12, CM 32	Part No. 157 40 ¹⁾
Sensing Cell	TR 201/901 DN 16 KF	Part No. 162 09 ¹⁾
Sensing Cell	TR 201/901 NPT	Part No. 896 76 ¹⁾
Sensing Cell	TR 301	Part No. 157 43 ¹⁾
VK 201	VISCOVAC VM 212	Part No. 158 82 ¹⁾

¹⁾ to be discontinued

Notes

IONIVAC IM 540



The 3-channel display and operating unit IONIVAC IM 540 offers, by combination of up to 4 different principles of measurement – Pirani, capacitive, Bayard-Alpert and Extractor –, complete coverage and control of the vacuum pressure in the range between 10^{-12} mbar and atmospheric pressure.

Advantages to the User

- Precise UHV pressure measurements with the Bayard-Alpert sensor IE 414 (offering excellent long-term stability) or the Extractor sensor IE 514 (offering an extremely low X-ray limit of $< 1 \times 10^{-12}$ mbar)
- 1 measurement channel for IONIVAC sensor (Bayard-Alpert or Extractor)
- Possibility of simultaneously connecting a second IONIVAC sensor
- Degassing of the anode through electron bombardment with time-limit
- Continuous UHV measurement also during the degassing phase (up to $+250^\circ\text{C}$ with bakeable gauge head cable)
- 2 measurement channels for direct connection of transmitters from the series THERMOVAC TTR and CERA-VAC CTR 90/91
- Selectable pressure units (mbar, Torr, Pascal, Micron)
- Display of a single measurement channel with pressure trend through analogue bargraph or simultaneous display of all measurement channels
- Two adjustable thresholds with adjustable hysteresis and freely assignable to the measurement channels

- Compact benchtop enclosure (1/2 19 in., 3 HU)
- RS 232 C interface provided as standard
- Simple software updates possible through the RS 232 interface
- Profibus interface (optional)
- CE mark

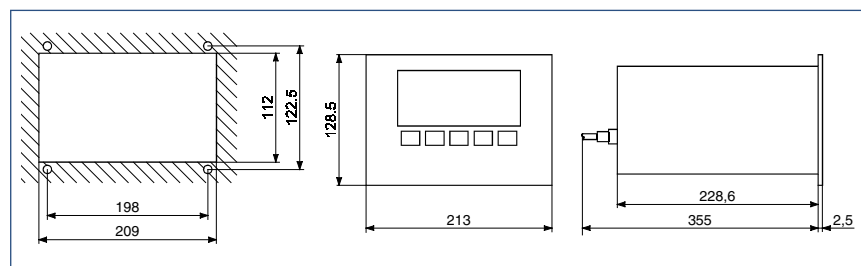
Typical Applications

- Pressure measurement and control in the UHV range
- Measurement of ultimate pressure in UHV systems
- Checking of ultimate pressure in semiconductor production
- Total pressure measurements in the area of cryo technology
- Total pressure measurements in calibration systems

Connectable Sensors

- Bayard-Alpert sensor IE 414
 - Extractor sensor IE 514
- (see Chapter “Additional Sensors”) combined with
- THERMOVAC TTR 90, TTR 211, TTR 91, TTR 96 S, TTR 100
 - CERA-VAC CTR 90 and CTR 91
- (see Chapter “Active Sensors/Transmitters”)

Two passive sensors working with ionization technology (IE 414 and/or IE 514) could be connected simultaneously to the IONIVAC 540 while only one is in operation. A pressure dependent emission control of these sensors is possible if a THERMOVAC TTR or CERA-VAC CTR 90/CTR 91 of suitable range overlap is connected.



Front panel cut out (left) and dimensional drawing (right) for the IONIVAC 540

Technical Data		IONIVAC IM 540
Number of measurement channels		3
Bayard-Alpert / Extractor		Channel 1 or 2
THERMOVAC / CERA VAC		Channel 3 and 4
Display range	mbar	1×10^{-12} to 1100
Display range Extractor	mbar	1×10^{-12} to 1×10^{-4}
Display range Bayard-Alpert	mbar	1×10^{-11} to 1×10^{-2}
Measurement range switching		automatic or decade pre-select
Units of measurement (selectable)		mbar, Torr, Pa, Micron
Measurement uncertainty	%	± 10 of the value displayed
Trend indication		bargraph
Measurement value display rate		1×10^{-10} to 1×10^{-2} mbar, 5 s^{-1} 1×10^{-12} to 1×10^{-10} mbar, 0.5 s^{-1}
Emission current		
Extractor sensor	mA	1.6
Bayard-Alpert sensor	mA	0.1 to 10; automatic control
Emission current shutdown at		$p > 1 \times 10^{-2}$ mbar, broken cathode, short-circuit, interruption of the electric circuit
Bake out power		
Extractor/ Bayard-Alpert	W	20 / 40
Sensor supply, potential for		anode Extractor / Bayard-Alpert: 220 V, cathode Extractor / Bayard-Alpert: 100 V/ 80 V, Reflector Extractor: 205 V
Sensor connections		Bayard-Alpert and Extractor - single operation is possible 2 x Bayard-Alpert or Extractor (redundant operation)
Measurement system detection		automatically
Measurement system switchover		automatically, pressure dependent, error dependent
Chart recorder outputs for Extractor/Bayard-Alpert ($R_a > 2.5 \text{ k}\Omega$)		logarithmic 0 to 10 V (1 V / dec.) or linear 0 to 10 Volt, error indication $U > 10.5 \text{ V}$
Interface (standard / optional)		RS 232 C / Profibus
Switching thresholds (single operation or interval)		2 with floating changeover contact
Mains connection	V / Hz	90 - 264 / 50/60
Storage temperature range	°C	-40 to +60
Nominal temperature range	°C	+5 to +50
Dimensions of the benchtop instrument (WxHxD)		213 x 128,5 x 250
Weight, approx.	kg (lbs)	3 (6.62)

Ordering Information	IONIVAC IM 540
IONIVAC IM 540 with 2 m long mains cord (EU + US)	Part No. 230 100
(Operating Instructions)	(GA 09.419)
Options Profibus DP interface	Part No. 230 101
DKD calibration	see section "Miscellaneous"
IONIVAC sensors IE 414, DN 40 CF Replacement cathode IE 414 IE 514, DN 40 CF Replacement cathode IE 514	see also section "Additional Sensors" Part No. 158 66 Part No. 158 63 Part No. 158 67 Part No. 158 61
Gauge head cables for IE 414/514 5 m 10 m 5 m, bakeable up to 250 °C	Part No. 158 68 Part No. 150 88 Part No. 158 44
Extension cables for IE 414/514 10 m 20 m	Part No. 245 002 Part No. 200 02 937
THERMOVAC Transmitter TTR	see section "Active Sensors/Transmitters"
Connection cable for THERMOVAC (Type A)	see section "Connection Cables for Active Sensors"
CERAVAC Transmitter CTR 90/91	see section "Active Sensors/Transmitters"
Connection cable for CERAVAC (Type B)	see section "Connection cables for active sensors"

Notes

Low Pressure Safety Switch PS 113 A



Switch indicating whether or not the pressure has reached the level of the atmospheric pressure after venting. Preset diaphragm pressure switch set to a trigger of 6 mbar (4 Torr) below atmospheric pressure.

Advantages to the User

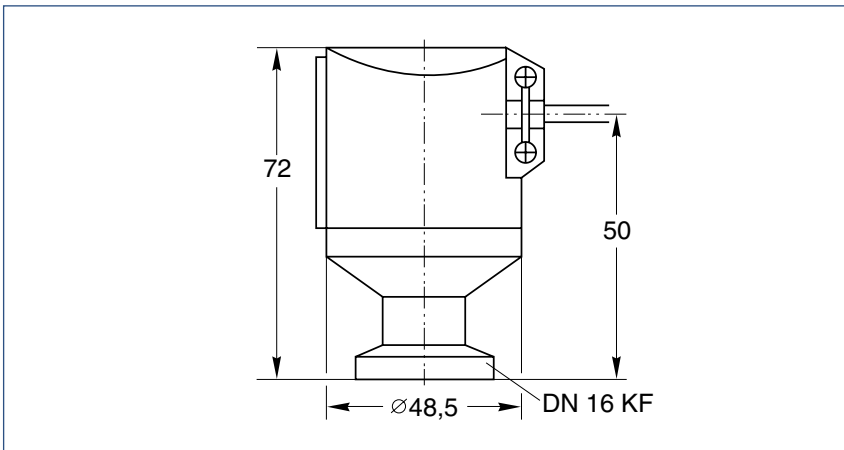
- Rugged design
- High switching capacity
- Corrosion protected
- Easy to use
- IP 44 protection
- Can be connected to a programmable control

Typical Applications

- Venting facilities
- Safety shutdown of vacuum systems
- Load locks

Technical Note

Due to the diaphragm material used (EPDM) the PS 113 A is not suited for applications in which the process gas contains large quantities of helium. Owing to diffusion effects the leak rate of the diaphragm settles at about 1×10^{-6} mbar l/s for helium.



Dimensional drawing for the low pressure safety switch PS 113 A

Technical Data		Low Pressure Safety Switch
Switching pressure	mbar (Torr)	Approx. 6 (4.5) below atmospheric pressure
Return switching pressure	mbar (Torr)	3 (2.3) below atmospheric pressure
Switching inaccuracy	mbar (Torr)	2 (1.5)
Max. permissible operating pressure (abs.)	mbar (Torr)	2000 (1500)
Storage temperature range	°C	-25 to +85
Nominal temperature range	°C	0 to +85
Switching contact		Changeover contacts, gold-plated, for prog. controls
Contact life		> 10 ⁵ switching cycles
Switching capacity		100 mA / 24 V AC 30 mA / 24 V DC
Electrical connection		6.3 mm flat plug
Vacuum connection	DN	16 KF
Materials in contact with the medium		Stainless steel 1.4305, 1.4310, Stainless steel 1.4300 PTFE coated
Protection class	IP	44
Ordering Information		Low Pressure Safety Switch
Low pressure safety switch PS 113 A, DN 16 KF; complete with 3 m long cable		Part No. 230 011
(Operating Instructions)		(GA 09.616)

Pressure Switch PS 115

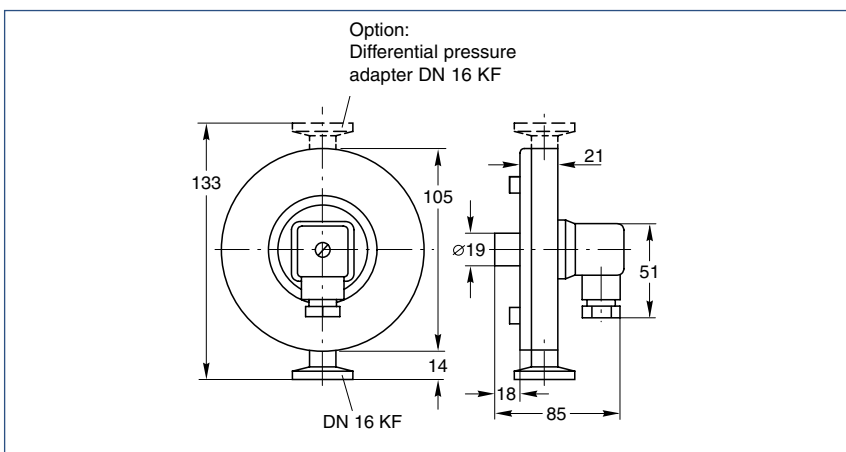


Rugged absolute pressure switch with electrical switching contact and a adjustable switching pressure between 0.5 and 2000 mbar (0.4 and 1500 Torr).

Through the differential pressure adapter (optional) the PS 115 pressure switch may be converted to operate as a differential pressure switch. The adapter consists of a DN 16 KF flange with screw-in thread and a sealing arrangement, and it is screwed into the PS 115 instead of the adjustment valve. The operating range extends to 2000 mbar (1500 Torr). Brief overloading to 3000 mbar (2250 Torr) is permissible without impairing switching accuracy. In this operating range differential values of +5 to -20 mbar (+3.75 to -15 Torr) can be adjusted via the set screw.

Advantages to the User

- High switching accuracy (± 0.1 mbar)
- Stable long term operating characteristics
- Rugged, corrosion protected design
- Increased switching capacity (floating) when using the switching amplifier SV 110
- Switching contact (n.c.) in the reference chamber and thus protected against corrosion
- For operating pressures up to 3 bar
- For high ambient temperatures
- Upon request, the switching threshold may be set in the factory



Dimensional drawing for the pressure switch PS 115

Technical Data		Pressure Switch
Switching range	mbar (Torr)	0.5 to 2000 (0.375 to 1500)
Overload limit	mbar (Torr)	3000 (2250)
Sensitivity	mbar (Torr)	0.1 (0.75)
Switching hysteresis	mbar (Torr)	0.5 (0.375)
Temperature coefficient	%/°K	0.4 of the switching value
Nominal temperature range		
briefly (max. 8 h)	°C	120
continuous	°C	0 to +90
Switching contact		Normally closed, gold-plated, for prog. controls
Switching voltage	V	24
Switching current (max.)	mA	10
Contact resistance, max.	kΩ	1
Electrical connection		Plug (DIN 43 650)
Protection class	IP	65
Vacuum connection	DN	16 KF
Materials in contact with the medium		
Measurement chamber		Stainless steel 1.4301; 1.4401; 1.4310; 1.3541; FPM
Reference chamber		Stainless steel 1.4301; 1.4401; 1.3541; glass; gold
Volume of the measurement chamber	cm ³	4
Volume of the reference chamber	cm ³	20
Weight	kg (lbs)	1.3 (2.87)
Ordering Information		Pressure Switch
Pressure Switch PS 115, DN 16 KF		Part No. 160 04
Pressure switch adjustment		Part No. 160 05
(Operating Instructions)		(GA 09.611)
For floating installations without SV 110, Clamping ring DN 16 KF, plastic Centering ring, DN 16 KF, plastic		Part No. 200 28 306 Part No. 200 28 307
Option Differential pressure adapter, DN 16 KF, for connection to the PS 115		Part No. 160 74
Spare parts kit PS 115		Part No. 160 06
SV 110 switching amplifier		Part No. 160 78

Switching Amplifier SV 110

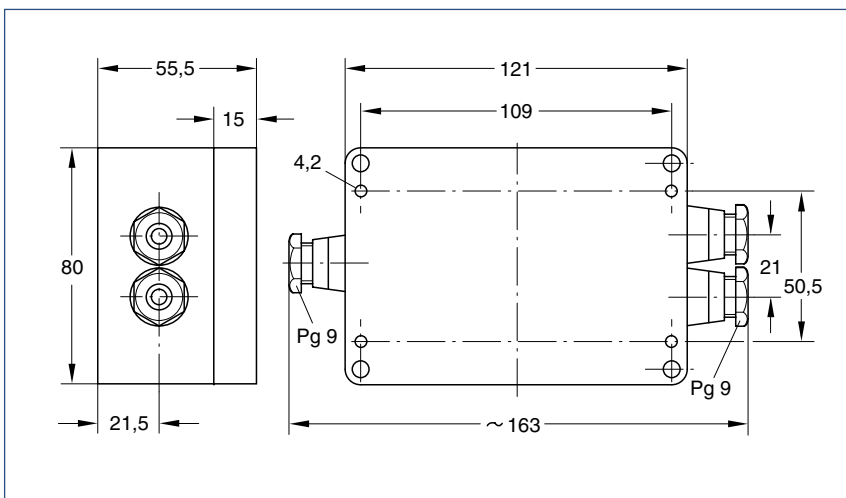
The diaphragm contact of the pressure switches is connected on one side to ground and is rated to 24 V / 10 mA max. When wanting to switch higher voltages or currents, a switching amplifier will be needed. The switching amplifier is equipped with powerful floating changeover

contacts. The output relay is energized as soon as the pressure drops below the switching threshold set up on the pressure switch.

The electrical connections are provided via screw terminals and are run out of the plastic enclosure through PG fittings.

Advantages to the User

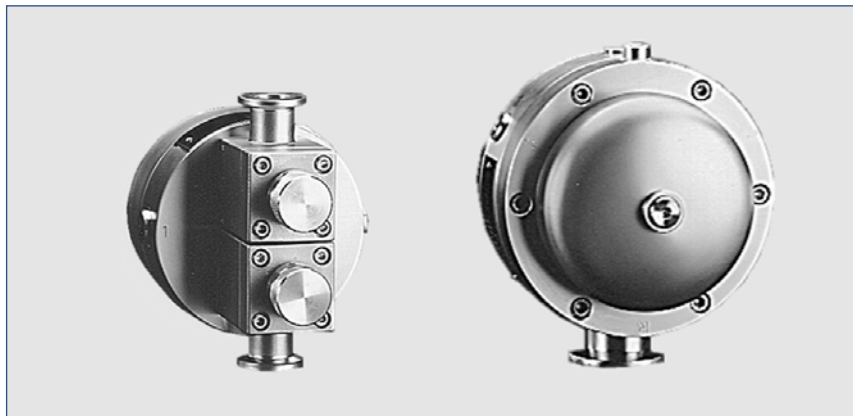
- Increased ratings for the switch
- Changeover contact



Dimensional drawing for the switching amplifier SV 110

Technical Data		Switching Amplifier
Mains supply, 50/60 Hz		110/130/220/240 V, selectable
Power consumption	VA	3
Output relay		
Switching voltage/current	V / A	250 / 5
Switching power, max.	VA	500
Response time	ms	30
Relaise time	ms	7
Control circuit	V / mA	24 / 10
Ambient temperature, max.	°C	50
Weight, approx	kg (lbs)	0.36 (0.79)
Ordering Information		Switching Amplifier
Switching amplifier SV 110		Part No. 160 78
(Operating Instructions)		(GA 09.611)

Diaphragm Pressure Regulators MR 16/MR 50



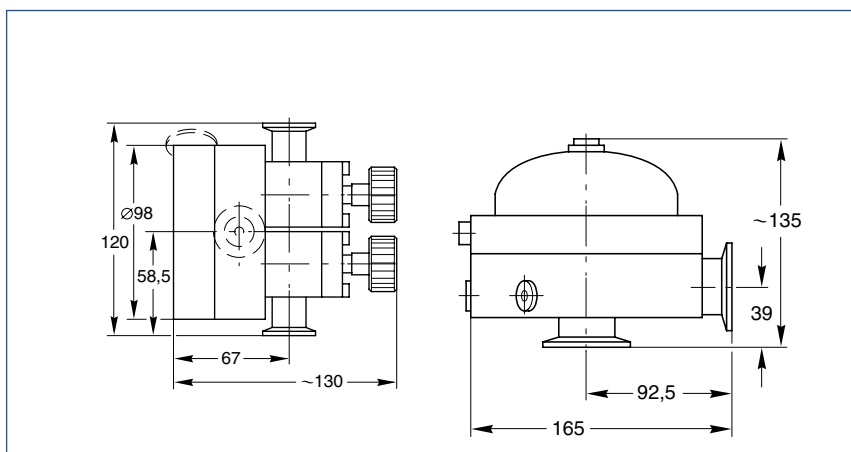
The MR 16/50 diaphragm regulators are absolute pressure regulators which automatically adapt the pumping speed of a vacuum pump depending on the amount of gas, without the need for an external power supply.

Advantages to the User

- Non-incremental, automatic pressure control
- Simple setting of the control pressures
- High control accuracy
- Corrosion protected stainless steel design
- Easy to disassemble for cleaning and maintenance
- Trouble-free operation in ex. areas
- Built-in isolation valves for the process connection and the vacuum pump (MR 16)

Typical Applications

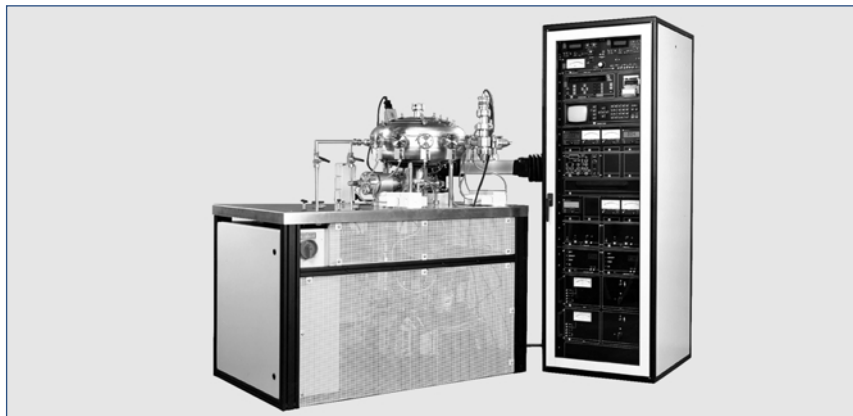
- Distillation processes of all kinds
- Solvent recovery
- Drying processes
- Temperature control on bath cryostats
- Degassing of liquids and plastics



Dimensional drawing for the diaphragm regulator MR 16 (left) and MR 50 (right)

Technical Data		Diaphragm Pressure Regulator	
		MR 16	MR 50
Control range	mbar (Torr)	10 to 1000 (7.5 to 750)	10 to 1000 (7.5 to 750)
Control inaccuracy		± 2 % of the pressure control (10 - 90 % of flow)	± 2 % of the pressure control (10 - 90 % of flow)
Throughput	m ³ /h	16	50
Nominal temperature range	°C	+5 to +100	+5 to +100
Storage temperature range	°C	-25 to +60	-25 to +60
Temperature coefficient	%/K	0.3	0.3
Settling time	ms	5	5
Permissible overload for brief periods	bar	3	3
Diaphragm material		FPM/EPDM	FPM/EPDM
Housing material		stainless steel 1.4571	stainless steel 1.4571
Installation orientation		Any	Any
Dimensions		see dimensional drawing	see dimensional drawing
Vacuum connection	2x DN	16 KF	40 KF
Measurement connection	3x thread R	1/8"	1/8"
Weight, approx.	kg (lbs)	2.7 (6.0)	8.0 (17.6)
Ordering Information		Diaphragm Pressure Regulator	
		MR 16	MR 50
Diaphragm pressure regulator MR 16, DN 16 KF MR 50, DN 40 KF		Part No. 160 25 —	— Part No. 160 27
(Operating Instructions)		(GA 09.605)	(GA 09.606)
Options Stainless steel measurement flange, DN 16 KF, for connection to a reference and/or process chamber or pumping stud KALREZ diaphragm		Part No. 160 26 —	Part No. 160 26 Part No. 200 28 597
Spare parts EPDM diaphragm and seal kit Viton diaphragm and seal kit Seal kit MR 50, incl. EPDM and Viton diaphragms Adjustment screw for the adjustable valve, complete with seal		Part No. 160 29 Part No. 160 31 — —	— — Part No. 160 32 Part No. 240 001

Leybold Calibration Service



Calibration of vacuum gauges in the pressure range from 10^{-9} to 1000 mbar (10^{-9} to 750 Torr) as DKD or factory calibration.

Advantages to the User

- Clear reference to the reference quantities
- Reproducible measurements
- Constantly high quality over time
- Reliable checking of existing gauges
- Unambiguous description of the process

Since 1981 Leybold has been offering to all customers an impartial calibration service for gauges and sensors of any make. A DKD calibration certificate or a factory calibration certificate is issued for every calibration. Instruments with insufficient long-term stability or such instruments where the principle of measurement is not suited for calibration, can not be calibrated.

Typical Applications

Calibrated vacuum gauges are used under the following conditions:

- If the requirements concerning reproducibility and comparability of experiment runs are high

- If an unambiguous reference is required for a large number of pressure gauges
- If an unambiguous description for processes is required
- If for experiments and processes unambiguous traceability of the measured pressures to basic quantities is demanded by the authorities
- If testing to DIN/ISO 9000 is required in the following areas
 - Research
 - Thin-film engineering
 - Manufacture of systems
 - Military
 - Energy
 - Chemistry production
 - Production of pharmaceuticals and herbicides
 - Sputtering systems
 - Aircraft and space industry
 - Manufacture of lamp

DKD / Factory Calibration

It is the task of the German Calibration Service (DKD) to ensure traceability of industrial measurements and testing to national standards.

The German Calibration Service is supported jointly by the Federal Institution for Physics and Technology (PTB), the industry, the Federal Minister for Economics and the Western European Metrology Club (WEMC).

The transfer standards in the DKD calibration facility used by Leybold are checked regularly (recalibrated) by the PTB.

Within the framework of the German Calibration Service, the calibration system at Leybold has been checked and approved by the PTB and the applied transfer standards have been calibrated by the PTB.

Factory calibrations were performed with standards which have not been calibrated directly at the PTB; instead the transfer standards of the in-house DKD calibration service are used. Thus traceability to national standards is ensured in both cases.

Technical Data	DKD Calibration		
Calibration range mbar	to 10 ⁻³	to 10 ⁻⁵	to 10 ⁻⁹
Ordering Information	DKD Calibration		
DKD calibration	Part No. 157 12	Part No. 157 13	Part No. 157 14

Technical Data	Factory Calibration		
Calibration range mbar	to 10 ⁻³	to 10 ⁻⁵	to 10 ⁻⁸
Ordering Information	Factory Calibration		
Factory calibration	Part No. 154 22	Part No. 154 23	Part No. 154 24

Calibration Systems are described in the Product Section C10.

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