

Vacuum Measurement

Active sensors
ranging from atmosphere
to 10^{-10} mbar



Vacuum Transmitters

Measurement principles and measurement ranges

Vacuum Pressure Measurement and Principles

The vacuum pressure range where pressure measurements can be performed ranges from atmospheric pressure (1000 mbar) to 10^{-12} mbar, i.e. over 15 orders of magnitude.

Due to physical characteristics, no single vacuum sensor exists which is capable to perform quantitative measurements within the entire pressure range. For this reason Oerlikon Leybold Vacuum offers sensors of different designs with own characteristic measurement range, usually spanning several orders of magnitude. A difference is made between so-called direct and indirect pressure measurements.

Direct, gas type independent pressure measurement

The direct (absolute) type of pressure measurement is independent of the gas type to be measured. The measurement is performed mechanically by way of the pressure acting upon the surface of a diaphragm. Vacuum sensors for direct pressure measurements are for example:

- Capacitance gauges from the CERAVAC line, equipped with diaphragms with different sensitivity covering the pressure range from 10^{-5} mbar to 1000 mbar with high precision.
- Capacitive and piezo pressure sensors from the DI/DU series with a pressure range from 10^{-1} mbar to 2000 mbar.

Indirect, gas type dependent pressure measurement

Indirect pressure measurement is determined as a function of a pressure dependent property of the gas (thermal conductivity, ionization probability, for example) and the molar mass, and is therefore dependent on the specific type of gas. The measurement readout is referenced to air or nitrogen as the measurement gas and through correction factors for other gases. Vacuum sensors for the indirect type of pressure measurement are:

- Thermal conductivity vacuum gauges after Pirani (THERMOVAC)
- Cold cathode ionization vacuum gauges after Penning (PENNINGVAC)
- Hot cathode ionization vacuum gauges after Bayard-Alpert (IONIVAC) for pressures ranging from 10^{-2} to 10^{-10} mbar.

The measurement range is the decisive factor for an appropriate vacuum sensor

Measurement principle	Measurement range/display range													[mbar]		
	2000	1000	100	10	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}
Capacitance gauge			CERAVAC CTR 101													
			CERAVAC CTR 100													
			DI/DU 200 ... 2001													
Thermal conductivity vacuum gauge (Pirani)			THERMOVAC TTR 91/91 S, TTR 96													
			THERMOVAC TTR 101/101 S2													
Cold cathode ionization gauge (Penning)					PENNINGVAC PTR 225/225 S, PTR 237											
			PENNINGVAC PTR 90													
Hot cathode ionization gauge			IONIVAC ITR 90, ITR 200 S													

Active Sensors

Application areas and selection criteria

Typical Fields of Application

Application	Sensors:	CERAVAC	Pressure sensors	THERMOVAC	PENNINGVAC	IONIVAC
		CTR	DI/DU	TTR	PTR	ITR
Research and Development		■		■	■	
Chemical/Chemistry processes		■	■	■	■	
Heat Treatment/Metallurgy			■	■	■	■
Automotive Industry			■	■	■	
Space Simulation			■	■	■	■
Analytical			■	■	■	■
Refrigeration and Air conditioning		■	■	■		
Chemistry and Research laboratories		■	■	■	■	■
High vacuum pump systems		■		■	■	■
Mechanical Engineering		■	■	■	■	■
Sputter Systems		■	■	■	■	■
Process Industry		■	■	■	■	■
Solar		■	■	■		

For further application examples, please refer to our full line catalog, chapter pressure gauges.

Further Selection Criteria for Vacuum Sensors

The pressure range and the operating conditions are decisive factors for the selection of a matching vacuum sensor.

DI/DU sensors and CERAVAC capacitance manometers from the CTR line are qualified for universal pressure measurements in the medium and rough vacuum ranges (also in the presence of corrosive process gases), in chemical process engineering and in semiconductor production processes.

The THERMOVAC TTR, PENNINGVAC PTR and IONIVAC ITR gauges are suited for many industrial and research applications.



Compact calibration system with CERAVAC CTR, THERMOVAC TTR and IONIVAC ITR transmitters

Vacuum Transmitters

Proven design, reproducible measurement results.

CERAVAC Transmitters



Linear Pressure Sensors



Oerlikon Leybold Vacuum transmitters for vacuum measurements are specially suited for system integration.

These high precision vacuum sensors are suited for forevacuum pressure measurements in applications where the following criteria apply:

- High reliability
- Simple operation
- Highly reproducible measurement results
- Several measurement locations to be constantly monitored
- Simple, cost and space saving installation
- Increased transmission distances (up to 100 m) between measurement location and processing station
- Direct data transfer to PLC/computer via digital/analog interface
- Increased electromagnetic compatibility (EMC) requirements
- Compliance with international standards and regulations (CE, UL, RoHS, WEEE etc.)

CTR 100 (temperature compensated)
CTR 101 (heated to 45 °C)

The CERAVAC transmitters offer an excellent measurement accuracy and reproducibility based upon their diaphragm made of pure aluminium oxide ceramics. They are suited for universal pressure measurements in the medium and rough vacuum range, even for corrosive process gases.

Principle of measurement

- Ceramic capacitance vacuum gauge

Measurement/display range

- 0.1 Torr / $1 \cdot 10^{-5}$ - 0.1 Torr
- 1 Torr / $1 \cdot 10^{-4}$ - 1 Torr
- 10 Torr / $1 \cdot 10^{-3}$ - 10 Torr
- 20 Torr / $2 \cdot 10^{-3}$ - 20 Torr
- 100 Torr / 0.01 - 100 Torr
- 1000 Torr / 0.1 - 1000 Torr

DI/DU 200, DI/DU 201,
DI/DU 2000, DI/DU 2001,
DI/DU 2001 rel.

Piezo resistive or capacitive pressure sensors based on ceramics technology for pressure measurements in the rough vacuum range, even for corrosive media.

Available either as DI models for two-wire arrangements (output signal 4 - 20 mA) or as DU models for four-wire arrangements (output signal 2 - 10 V).

The DU sensors excel through their excellent overload response (being equipped with an Al_2O_3 ceramics diaphragm) as well as excellent corrosion and vibration resistance. Operation of the DU sensors is independent of the type of gas.

Principle of measurement

- Ceramic capacitive diaphragm sensor
- Piezo resistive diaphragm sensor

Measurement/display range

- Absolute pressure measurement ranges from 0.1 to 200 mbar or 1 to 2000 mbar
- Measurement range for relative pressures spanning -1000 mbar to + 1000 mbar

High Precision Vacuum Measurements

from 1000 to 10^{-10} mbar

THERMOVAC Transmitters



TTR 91 **TTR 91 S (with switching relay)** **TTR 96 S (with switching relay)**

Operation of the THERMOVAC transmitters is based on the thermal conductivity principle after Pirani. The measurement cells are equipped either with a tungsten (TTR 91/TTR 91 S) or a nickel (TTR 96 S) filament. The THERMOVAC TTR 91 S and TTR 96 S are equipped with two integrated switching relays.

Principle of measurement

- Thermal conductivity after Pirani

Measurement/display range

- $5 \cdot 10^{-4}$ to 1000 mbar

TTR 101/101 S2

The THERMOVAC TTR 101 transmitters combine the principle of thermal conductivity after Pirani with that of capacitance vacuum gauges.

For this reason the TTR 101 gauges offer gas type independent measurements in the range between 10 mbar and 1500 mbar.

The THERMOVAC TTR 101 line provides optionally an integrated display, Profibus interface and/or two integrated switching relays.

Principle of measurement

- Thermal conductivity after Pirani combined with capacitive pressure measurements

Measurement/display range

- $5 \cdot 10^{-5}$ to 1500 mbar

PENNINGVAC Transmitters



PTR 90

The PENNINGVAC transmitters are equipped with a rugged cold cathode measurement cell for integration within programmable systems. They offer a high level of reproducibility combined with a low tendency to collect contamination even in argon operation.

The PENNINGVAC PTR 90 gauge head combines the cold cathode ionization principle with the Pirani measurement system and may be operated with modern display and operation instruments.

Principle of measurement

- Cold cathode ionization based on the principle of the inverted magnetron combined with thermal conductivity after Pirani

Measurement/display range

- $5 \cdot 10^{-9}$ to 1000 mbar

PTR 225

PTR 225 S (with switching relay) **PTR 225 PB (with ProfiBus)** **PTR 237**

The PENNINGVAC PTR 225 line is equipped with a DN 25 KF flange connection and optionally with an integrated switching relay (PTR 225 S). The PTR 237 is equipped with a DN 40 CF flange connection.

Principle of measurement

- Cold cathode ionization after Penning

Measurement/display range

- $1 \cdot 10^{-9}$ to $1 \cdot 10^{-2}$ mbar

IONIVAC Transmitters



ITR 90

ITR 90 PB (with ProfiBus) **ITR 200 S (with switching relay)** **ITR 200 SP (with two switching relays and ProfiBus)**

The IONIVAC ITR units permit, by way of combined hot cathode ionization meters with a Pirani sensor, vacuum pressure measurements on non-combustible gases and gas mixtures within a wide range of pressures.

The IONIVAC ITR 90 units are optionally available with an integrated display and Profibus interface with flange sizes of DN 25 KF, DN 25 CF or DN 40 CF. The CF flanges are rotatable and bakeable (up to 150 °C).

The IONIVAC ITR 200 S models are equipped with a dual cathode measurement system, switching functions, KF or CF connections and are optionally available with Profibus interface as well as an integrated display.

The IONIVAC ITR 200 SP provides two integrated switching functions and a Profibus interface.

Principle of measurement

- Hot cathode ionization vacuum gauges after Bayard-Alpert combined with thermal conductivity after Pirani

Measurement/display range

- $5 \cdot 10^{-10}$ to 1000 mbar

Technical Data

Vacuum transmitters

Vacuum transmitters	CERAVAC		Linear pressure sensors		
	CTR 100	CTR 101	DI / DU 200 / 201	DI / DU 2000/2001	DU 2001 rel.

Principle of measurement		ceramics capacitance vacuum gauge, temperature compensated	ceramics capacitance vacuum gauge, 45 °C heated	capacitive	piezo-resistive	
Measurement / display range	mbar	0.1 Torr / $1 \cdot 10^{-5}$ - 0.1 Torr 1 Torr / $1 \cdot 10^{-4}$ - 1 Torr 10 Torr / $1 \cdot 10^{-3}$ - 10 Torr 20 Torr / $2 \cdot 10^{-3}$ - 20 Torr 100 Torr / 0.01 - 100 Torr 1000 Torr / 0.1 - 100 Torr	0.1 Torr / $1 \cdot 10^{-5}$ - 0.1 Torr 1 Torr / $1 \cdot 10^{-4}$ - 1 Torr 10 Torr / $1 \cdot 10^{-3}$ - 10 Torr 100 Torr / 0.01 - 100 Torr 1000 Torr / 0.1 - 1000 Torr	0.1 to 200	1 to 2000	-1000 to +1000 relative pressure
Measurement uncertainty	% mbar	0.2% of the measured value +/- temperature influences		0.25 FS linearity, reproducibility and hysteresis		
Vacuum connection	DN	16 KF, 16 CF, 8-VCR, 1/2-in. tube		16 KF with G 1/4" internal thread		
Max. bakeout temperature (at the flange)	°C	≤ 110°C				
Overpressure resistance, abs.	bar	3 max., dependent on the measurement range		6	5	
Protection class	IP	30		54		
Switching thresholds			2 x			
Max. cable length Electrical connection	m	50 (type C) sub-D, 15-way female		25 DI: 7 pole diode plug, 5 m / DU: FCC 68, 5 m		
Interfaces Standard Optional		RS 232 C -	RS 232 C -	DI: 4 - 10 mA / DU: 2 - 10 V		
Remarks				DI/DU 200/2000: FPM (FKM) seals DI/DU 201/2001/2001 rel.: EPDM seals		
Display and operating units		CENTER series		DI: N.A. DU: DISPLAY and CENTER series		

THERMOVAC				PENNINGVAC			IONIVAC	
TTR 91 TTR 91 S	TTR 96	TTR 101	TTR 101 S2	PTR 90	PTR 225	PTR 237	ITR 90 ITR 90 PB	ITR 200 S ITR 200 SP

thermal conductivity after Pirani		thermal conductivity after Pirani combined with capacitive pressure measurement		inverted magnetron and Pirani	cold cathode after Penning		Bayard-Alpert and Pirani	
5 · 10 ⁻⁴ - 1000		5 · 10 ⁻⁵ - 1500		5 · 10 ⁻⁹ - 1000	1 · 10 ⁻⁹ - 1 · 10 ⁻²		5 · 10 ⁻¹⁰ ...1000	5 · 10 ⁻¹⁰ ...1000
15% at 1 · 10 ⁻³ - 100 mbar 50% at 5 · 10 ⁻⁴ - 1 · 10 ⁻³ mbar 50% at 100 - 1000 mbar		15% at 1 · 10 ⁻³ - 50 mbar 50% at 5 · 10 ⁻⁴ - 1 · 10 ⁻³ mbar 5% in the range of 50 - 950 mbar 2.5% at atm (in the range of 950 - 1050 mbar)		30% in the range 1 · 10 ⁻⁸ - 100 mbar	+/- 30% of the measured value in the range 1 · 10 ⁻⁸ - 1 · 10 ⁻⁴ mbar		15% of the measured value in the range 1 · 10 ⁻⁸ ...1 · 10 ⁻² mbar > 15% of the measured value in the range 10 ⁻¹ - 1000 mbar	
16 KF, 1/8" NPT, 16 CF		16 KF, 1/8" NPT		25 KF 40 KF, 40 CF	25 KF	40 CF	25 KF 40 CF	25 KF 40 CF
80 250 (bakeable version)		80		up to 150	up to 250	up to 350	150 with bake-out extension	80
10, limited to inert gases		5		10, limited to inert gases	≤ 10	≤ 10	2	2
40				40			30	
0 at TTR 91 2 at TTR 91 S (LED display)		0 at TTR 100 2 at TTR 100 S2 (LED display)		-	1 at PTR 225 S (changeover relay)	-	2 at ITR 90 P	1 - 2
100 (type A) FCC 68, 8 way				100 (type A) FCC 68, 8 way			50 (type C) sub-D, 15-way female	
-		-		-	-	-	RS 232 C Profibus	RS 232 C Profibus
Tungsten filament	Nickel filament						1 filament	dual filament
DISPLAY and CENTER series				DISPLAY and CENTER series	DISPLAY TWO/THREE and CENTER series		CENTER series	

Display and Operating Instruments for vacuum transmitters

DISPLAY Series

CENTER Series

A number of different display and operating instruments is available for the active sensors from Oerlikon Leybold Vacuum.

These single or multichannel instruments serve the purpose of locally displaying the measured values and supply the transmitters with the necessary operating voltage.

They may be operated either as a benchtop unit or can be installed with the aid of an adapter in 19-in. racks for system control purposes.

For active sensors, Oerlikon Leybold Vacuum offers the following display and operating instruments:

- DISPLAY series
Single and multichannel instruments
- CENTER series
Single and multichannel instruments



DISPLAY ONE, DISPLAY THREE, CENTER ONE, CENTER THREE (operator sides)

Display and Operating Instruments

for active sensors	CTR	DU	ITR	TTR	PTR 90	PTR 225/237
Single/multichannel instruments						
DISPLAY ONE	-	✓	-	✓	✓	-
DISPLAY TWO	-	✓	-	✓	✓	✓
DISPLAY THREE	-	✓	-	✓	✓	✓
CENTER ONE	✓	✓	✓	✓	✓	✓
CENTER TWO	✓	✓	✓	✓	✓	✓
CENTER THREE	✓	✓	✓	✓	✓	✓

Typification of the Connection Lines

Display and operating instrument

	DISPLAY ONE	DISPLAY TWO DISPLAY THREE	CENTER ONE CENTER TWO CENTER THREE
THERMOVAC transmitter TTR 91 / TTR 101	Type A	Type A	Type A
PENNINGVAC transmitter PTR 90	Type A	Type A	Type A
PENNINGVAC transmitter PTR 225 / 237	—	Type A	Type A
CERAVAC transmitter CTR 100 / CTR 101	—	—	Type C
IONIVAC transmitter ITR 90 / ITR 200	—	—	Type C

Type A: at both ends FCC 68 (RJ 45), eight-way shielded

Type B: sub-D, 15-way female to FCC 68 (RJ 45), eight-way shielded

Type C: sub-D, 15-way female to sub-D 15-way male, shielded

For more detailed information, please refer to the Oerlikon Leybold Vacuum full line catalog, chapter pressure gauges.

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