Vacuum Measurement
User-optimized Active Gauges for Various Applications from 2000 mbar to $10^{-10}$ mbar
Measurement principles suited for your application

Vacuum Pressure Measurement and Principles

The vacuum pressure range where pressure measurements can be performed ranges from 2000 mbar to $10^{-12}$ mbar, i.e. over 16 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 Leybold 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.

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.

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 and can be applied to other gases via correction factors.

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

Simple gauge and controller selection:

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<tr>
<th>Measurement Principle</th>
<th>Range [mbar]</th>
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<tr>
<td>Direct, gas type independent pressure measurement</td>
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<tr>
<td>Vacuum sensors:</td>
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<tr>
<td>CERAVAC capacitive gauges equipped with diaphragms with different sensitivity covering the pressure range from $10^{-5}$ mbar to 1333 mbar (1000 Torr) with high precision.</td>
<td></td>
</tr>
<tr>
<td>DI/DU capacitive and piezo pressure sensors with a pressure range from $10^{-1}$ mbar to 2000 mbar in absolute pressure measurements and -1000 mbar to +1000 mbar in relative pressure measurements.</td>
<td></td>
</tr>
</tbody>
</table>

Indirect, gas type dependent pressure measurement

Vacuum sensors:

- THERMOVAC thermal conductivity vacuum gauges according to Pirani
- PENNINGVAC cold cathode ionization vacuum gauges according to Penning
- IONIVAC hot cathode ionization vacuum gauges according to Bayard-Alpert for pressures ranging from $10^{-10}$ mbar to 1000 mbar.

Direct, gas type independent pressure measurement

Vacuum sensors:

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Indirect, gas type dependent pressure measurement

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Simple gauge and controller selection:
The ideal vacuum gauge for your requirements

<table>
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<tr>
<th>Application</th>
<th>Sensors:</th>
<th>CERAVAC CTR</th>
<th>Linear pressure sensors DI/DU</th>
<th>THERMOVAC TTR</th>
<th>PENNINGVAC PTR</th>
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<td>Automotive Industry</td>
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<tr>
<td>Space Simulation</td>
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<td>Analytical</td>
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<td>Refrigeration and Air conditioning</td>
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<td>High vacuum pump systems</td>
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<td>Mechanical Engineering</td>
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<td>Sputter Systems</td>
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<td>Process Industry</td>
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<td>Solar</td>
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</tbody>
</table>

For further application examples, please refer to our full line catalog, chapter “vacuum - measuring, controlling”.

Leybold transmitters are specially suited for system integration

Our high-precision vacuum sensors meet your demands:

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

**Capacitance Diaphragm Gauges (CDG)**

**Thermal Conductivity Gauges (Pirani)**

**CERAVAC Transmitters**

**CTR 100 N / CTR 101 N**

The CERAVAC transmitters are suited for corrosive process gases.

**Benefits**
- New sensing cell: the new all-welded Inconel® sensor is extremely robust
- Microprocessor-based electronics for excellent accuracy and reproducibility
- Long-term stability: no calibration shifts after bursts of pressure

**Principle of measurement**
Capacitive diaphragm stainless steel sensor

**Measurement/display range**
Spanning from $10^{-5}$ to 1000 Torr, depending on the model

**Linear Pressure Sensors**

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

These sensors excel through a high overload response as well as excellent corrosion and vibration resistance.

**Benefits**
- Wide measurement range due to the combined measurement principle
- Very compact: just one sensor needed
- Two-in-one sensor: cost and space saving solution

**Principle of measurement**
Capacitive ceramic diaphragm sensor, piezo resistive diaphragm sensor

**Measurement/display range**
Absolute pressure measurement: 0.1 to 200 mbar or 1 to 2000 mbar
Relative pressure measurement: -1000 mbar to +1000 mbar

**THERMOVAC Transmitters**

**TTR 91 N(S) / TTR 96 N**

Operation of the THERMOVAC transmitters is based on the thermal conductivity principle after Pirani. S-versions offer set point relays for improved process control.

The THERMOVAC series is equipped with a LED-ring (360°) showing the sensor status.

**Benefits**
- New MEMS-Pirani for high resistance
- Fast response and high accuracy: time saving and highly reliable
- Optimized price-to-performance ratio

**Principle of measurement**
Thermal conductivity after Pirani

**Measurement/display range**
5 · $10^{-5}$ to 1000 mbar

**TTR 101 N(S)**

The THERMOVAC TTR 101 N models use a thermal conductivity MEMS Pirani / Piezo solid state sensor combination. They are resilient to vibration and shock venting and provide superior accuracy and gas type independent readings between 10 mbar and 1500 mbar.

**Benefits**
- Two-in-one sensor: cost and space saving measurement solution
- Large measurement range and time-saving measurements

**Principle of measurement**
Thermal conductivity after Pirani combined with Piezo

**Measurement/display range**
5 · $10^{-5}$ to 1500 mbar

**TTR 911 N(C/S) / TTR 916 N**

The TTR 911 and TTR 916 have a touch display and/or digital interfaces. C-versions are equipped with a Parylene HT®-coated sensor for chemical and aggressive applications.

**Principle of measurement**
Thermal conductivity after Pirani

**Measurement/display range**
5 · $10^{-5}$ to 1500 mbar
High endurance - accurate and reproducible results

<table>
<thead>
<tr>
<th>PENNINGVAC Transmitters</th>
<th>Multiple combination Gauges</th>
<th>IONIVAC Transmitters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PTR 90 N</strong></td>
<td><strong>TTR 200 N</strong></td>
<td><strong>ITR 90 / ITR 90 PB</strong></td>
</tr>
<tr>
<td>These PENNINGVAC transmitters are the perfect gauge for a wide range of applications.</td>
<td>The TTR 200 N and PTR 200 N combine different measurement technologies in one housing making them the perfect gauges for load lock applications.</td>
<td>The IONIVAC 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. Optionally, the pressure can be displayed on an integrated display.</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td><strong>Benefits</strong></td>
<td><strong>Benefits</strong></td>
</tr>
<tr>
<td>New MEMS-Pirani / cold cathode combination for cost and time-saving measurements</td>
<td>Combination of absolute and differential measurements offers unprecedented loadlock control</td>
<td>The Pirani / hot cathode ionization (Bayard-Alpert) combination allows continuous pressure measurements</td>
</tr>
<tr>
<td>Complete coverage of the measurement range from 1x 10^-8 mbar to atmosphere by a single transmitter</td>
<td>Differential range (relative to ambient pressure): -1013 to 1013 mbar</td>
<td>Just one gauge required to cover a wide measurement range</td>
</tr>
<tr>
<td>Automatic ignition of the cold cathode by the MEMS-Pirani: ease of use and high process stability</td>
<td>The highly accurate differential sensor is ideal for loadlock control since it is insensitive to changes in ambient pressure conditions</td>
<td>Cost- and space-saving solution</td>
</tr>
<tr>
<td>Modular design for easy servicability</td>
<td>Efficient loadlock control improves throughput and cycle time</td>
<td>The integrated dual Pirani provides a long service life</td>
</tr>
<tr>
<td><strong>Principle of measurement</strong></td>
<td><strong>Principle of measurement</strong></td>
<td><strong>Principle of measurement</strong></td>
</tr>
<tr>
<td>Cold cathode ionization after Penning combined with thermal conductivity (MEMS Pirani)</td>
<td>Cold cathode ionization after Penning</td>
<td>Hot cathode ionization vacuum gauges after Bayard-Alpert combined with thermal conductivity after Pirani</td>
</tr>
<tr>
<td>Measurement/display range 1 · 10^-8 to 1000 mbar</td>
<td>Measurement/display range 5 · 10^-10 to 1000 mbar</td>
<td>Measurement/display range 5 · 10^-10 to 1000 mbar</td>
</tr>
</tbody>
</table>

**PTR 225 N / PTR 237 N**

Easy system integration, providing excellent process control even in rough applications.

**Benefits**
- Robust cold cathode sensing cell: reliable measurements and high process quality
- Modular design provides low TCO by easy and inexpensive servicing

**Principle of measurement**
- Cold cathode ionization after Penning

**Measurement/display range**
- 1 · 10^-8 to 5 · 10^-3 mbar

**IONIVAC Transmitters**

**ITR 200 S / ITR 200 SP**

The IONIVAC 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. Optionally, the pressure can be displayed on an integrated display.

**Benefits**
- The Pirani / hot cathode ionization (Bayard-Alpert) combination allows continuous pressure measurements
- Just one gauge required to cover a wide measurement range
- Cost- and space-saving solution
- The integrated dual Pirani provides a long service life

**Principle of measurement**
- Hot cathode ionization vacuum gauges after Bayard-Alpert combined with thermal conductivity after Pirani

**Measurement/display range**
- 5 · 10^-10 to 1000 mbar
# High Precision Vacuum Measurements

## Technical Data

<table>
<thead>
<tr>
<th>Vacuum Transmitter</th>
<th>CERAVA C</th>
<th>Linear Pressure Sensor s</th>
<th>TTR 91 N/S</th>
<th>TTR 96 N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTR 100 N</td>
<td>CTR 101 N</td>
<td>DI / DU 200 / 201</td>
<td>DI / DU 2000/2001/2001 rel.</td>
<td>TTR 91 N(S)</td>
</tr>
</tbody>
</table>

### Principle of measurement
- Capacitive diaphragm
  - Stainless steel sensor
- Capacitive diaphragm
  - Stainless steel sensor
- Capacitive ceramic diaphragm sensor
- Piezoresistive ceramic diaphragm

### Measurement range / mbar
- Display range
  - 1000 / 1 · 10⁻³ Torr
  - 100 / 1 · 10⁻² Torr
  - 20 / 2 · 10⁻² Torr
  - 10 / 1 · 10⁻¹ Torr
  - 1 / 1 · 10⁰ Torr
  - 0.1 / 1 · 10⁻¹ Torr

### Measurement uncertainty / mbar
- 0.2% of reading ± temperature effect
- 0.5% of reading ± temperature effect (0.1 Torr)
- 0.12% of reading ± temperature effect
- 0.15% of reading ± temperature effect (0.1 Torr)
- 0.25% of full scale linearity, reproducibility and hysteresis is

### Status indicators
- LED
- LED-ring (360°)

### Max. bakeout temperature / °C
- Not bakeable
- 70
- 85, non-operating

### Overpressure limit / bar
- 6
- 5
- 6

### Protection class / IP
- 40
- 54
- 40

### Setpoint / m
- 0
- 0
- 0 at TTR 91 N
- 2 at TTR 91 NS
- 2 at TTR 96 N

### Max. cable length / m
- 30 (type C)
- Sub-D, 15 pin
- 25
- Di: 7 pole diode plug (5 m) / DU: FCC 68 (5 m)
- 100 (type A)
- FCC 68 / RJ45

### Interfaces
- RS 232
- Di: 4 - 20 mA / DU: 2 - 10 V
- –

### Controller type
- GRAPHIX series
- Di: GRAPHIX and DISPLAY series via signal converter
- DU: DISPLAY and GRAPHIX series
- DISPLAY and GRAPHIX series

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* 1 Torr = 1.333 mbar
** Example, please refer to catalog for further details
<table>
<thead>
<tr>
<th>THERM Ovac</th>
<th>Pennin Gvac</th>
<th>Loadloc K Combination s</th>
<th>Ioniva C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TTR 911 N(C/S)</strong> TTR 916 N</td>
<td><strong>TTR 101 N(S)</strong> PTR 90 N</td>
<td><strong>TTR 200 N</strong> PTR 225 N PTR 237 N</td>
<td><strong>TTR 90</strong> ITR 200 S</td>
</tr>
<tr>
<td>TTR 911 N: MEMS-Pirani TTR 911 N/C / TTR 916 N Coated MEMS-Pirani</td>
<td>MEMS-Pirani and Piezo Cold cathode according to Penning and MEMS Pirani</td>
<td>MEMS-Pirani and Diff. Piezo Cold cathode; MEMS-Pirani and Diff. Piezo</td>
<td>Bayard-Alpert and Pirani</td>
</tr>
<tr>
<td><strong>5 · 10⁻² - 1000:</strong></td>
<td><strong>5 · 10⁻² - 1500</strong></td>
<td><strong>1 · 10⁻² - 5 · 10⁻¹</strong></td>
<td><strong>5 · 10⁻² - 1000</strong></td>
</tr>
<tr>
<td>5 · 10⁻⁴ to 1 · 10⁻¹ ±10 % of reading 1 · 10⁻¹ to 100 ±5 % of reading 100 to atm ±25 % of reading</td>
<td>5 · 10⁻⁴ to 1 · 10⁻¹ ±10 % of reading 1 · 10⁻¹ to 100 ±5 % of reading 100 to 1333 ±25 % of reading 1 · 10⁻¹ to 1 · 10⁻² ±30 % of reading</td>
<td>±30 % at 1 · 10⁻² to 1 · 10⁻¹ mbar MEMS-Pirani 1 · 10⁻⁴ to 1 · 10⁻² ±10 % of reading Diff. Piezo -10 to 10 ±10 % of reading ±0.67 mbar **</td>
<td>15% at 1 · 10⁻⁴ - 1 · 10⁻² mbar &gt; 15% at 10⁻¹ - 1000 mbar</td>
</tr>
<tr>
<td>LED-ring (360°)</td>
<td>LED-ring (360°)</td>
<td>LED-ring (360°)</td>
<td>–</td>
</tr>
<tr>
<td>85, non-operating</td>
<td>85, non-operating</td>
<td>85, non-operating</td>
<td>85, non-operating</td>
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<tr>
<td>6</td>
<td>2</td>
<td>2</td>
<td>150 with bake-out extension</td>
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<tr>
<td>40</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>2 (Profibus / EtherCAT / Display)</td>
<td>0 (RS 232)</td>
<td>0 (RS 232)</td>
<td>3</td>
</tr>
<tr>
<td>100 (Type A) FCC 68 / RJ45</td>
<td>0 (RS 232)</td>
<td>2 (EtherCAT)</td>
<td>3</td>
</tr>
</tbody>
</table>

from 2000 mbar to 10⁻¹⁰ mbar
Display and Operating Instruments

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

- **DISPLAY** series
  - Single and multichannel instruments

- **GRAPHIX** series
  - Single and multichannel instruments

- **VACVISION**
  - Universal vacuum controller

All these display and operating units display the measured values and supply the operating voltage. They may be operated either as a bench top unit or within 19" racks.

The new GRAPHIX series comprises vacuum controllers with up to three measurement channels. GRAPHIX monitors and controls the entire vacuum process of active sensors for direct pressure measurements (10⁻¹⁰ mbar to 2000 mbar).

### Typification of the Connection Lines

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<th>Display and operating unit</th>
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<th>DISPLAY THREE</th>
<th>GRAPHIX ONE</th>
<th>GRAPHIX TWO</th>
<th>GRAPHIX THREE</th>
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<tbody>
<tr>
<td>THERMOVAC transmitter TTR series</td>
<td>Type A</td>
<td>Type A</td>
<td>Type A</td>
<td>Type A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PENNINGVAC transmitter PTR series</td>
<td>Type A</td>
<td>Type A</td>
<td>Type A</td>
<td>Type A</td>
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<tr>
<td>CERAVAC transmitter CTR series (digital signal)</td>
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<td>—</td>
<td>Type C</td>
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<td></td>
</tr>
<tr>
<td>Linear pressure sensors DU 200/1 and DU 2000/1/rel</td>
<td>Type A*</td>
<td>Type A*</td>
<td>Type A*</td>
<td>Type A*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear pressure sensors DI 200/1 and DI 2000/1/rel (with signal converter)</td>
<td>Type A**</td>
<td>Type A**</td>
<td>Type A**</td>
<td>Type A**</td>
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<tr>
<td>IONIVAC transmitter ITR series</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Type C</td>
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</tbody>
</table>

| Type A : FCC 68 (RJ 45) at both ends, eight-way shielded / Type A* : Preconnected measuring cable (5 m) with FCC 68 (RJ 45), eight-way shielded / Type A** : Preconnected measuring cable (5 m) with diode plug, 7-pole. / Type C : Sub-D, 15-way female to Sub-D 15-way male, shielded |
| Operation requires the use of a signal converter |

For more detailed information, please refer to the Oerlikon Leybold Vacuum full line catalog, chapter "vacuum - measuring, controlling".

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Representante oficial en México y centro américa

**Equipo, refacciones, accesorios y servicio.**

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