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0 Safety Information

0.1 Symbols used
The first two symbols identify other information in this manual that is essential or useful in achieving optimal performance from the transmitter. The last symbol below is used throughout this manual to further define the safety concerns associated with the product.

**Critical**
Failure to read message could result in damage to the equipment.

**Attention**
Calls attention to important procedures, practices or conditions.

**Caution**
Refer to manual. Failure to read message could result in personal injury or serious damage to the equipment or both.

0.2 Personnel Qualifications

**Skilled personnel**
All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.

0.3 General safety information

The safety instructions should always be followed during installation and operation of the transmitter. Pass safety information to all users.

- Adhere to the applicable regulations and take the necessary precautions for the process media used.
  Consider possible reactions between the materials and the process media.
  Consider possible reactions (e.g. explosion) of the process media due to the heat generated by the product.
- Adhere to the applicable regulations and take the necessary precautions for all work you are going to do and consider the safety instructions in this document.
- Before beginning to work, find out whether any vacuum components are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

Safety Precautions:

**Critical**
**Explosive Environments.** Do not use the transmitter in presence of flammable gases or other explosive environments.

**Caution**
**Corrosive Environments.** The transmitter is not intended for use in corrosive environments. Refer to Transmitter installation chapter 3 of this manual.
**Critical**

**Service and Repair.** Do not substitute parts or modify instrument other than described in chapter 2.3. Do not install substituted parts or perform any unauthorized modification to the instrument. Return the instrument to an Leybold Calibration and Service Center for service and repair to ensure all of the safety features are maintained.

---

**Critical**

**DANGER: contaminated parts**
Contaminated parts can be detrimental to health and environment. Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts. If you need further support please contact LEYBOLD.

---

**Attention**

**Caution: vacuum component**
Dirt and damages impair the function of the vacuum component. When handling vacuum components, take appropriate measures to ensure cleanliness and prevent damages.

---

**Attention**

**CE marking** The transmitter complies with European standards for CE marking. Refer to Declaration of Conformity chapter 10 of this manual.

---

**Caution**

**Fuse.** The transmitter power supply input has an internal thermal fuse. The fuse is self-recoverable and should not be changed.

---

**Caution**

**Electrical connections.** The transmitter must be properly electrically connected in order to perform according to the specifications. Output pins are not protected against wrong electrical connections. Wrong electrical connections can cause permanent damage to the transmitter or interference to measuring performance. Refer to electrical connections description in chapter 4 of this manual.

---

**Caution**

**Caution: dirt sensitive area**
Touching the product or parts thereof with one's bare hands increases the desorption rate. Always wear clean, lint-free gloves and use clean tools when working in this area.
0.4 Liability and Warranty

Leybold assumes no liability and the warranty becomes null and void if the end-user or third parties

- disregard the information in this document
- use the product in a non-conforming manner
- make any kind of interventions (modifications, alterations etc.) on the product
- use the product with accessories not listed in the product documentation

The end-user assumes the responsibility in conjunction with the process media used. Transmitter failures due to contamination are not covered by the warranty.
1 Unpacking

Before unpacking your transmitter, check all surfaces of the packing material for shipping damage. Inspect for visible damage. If found, notify the carrier immediately.

Please be sure that your transmitter package contains these items:

- 1 pcs. TTR 200 N THERMOVAC Transmitter
- 1 pcs. English short form manual (P/N: 300544670_002)
- 1 pcs. German short form manual (P/N: 300544670_001)
- 1 pcs. Product Inspection and Test Report
- 1 pcs. Pin for adjusting settings via button

If any items are missing, please contact Leybold.
2 Description

The TTR 200 N THERMOVAC series vacuum transmitters offer a wide measuring range from $5 \times 10^{-5}$ mbar to 1500 mbar and are based on the measurement of thermal conductivity in a small cavity on a MEMS Pirani silicon chip sensor and mechanical deflection of a silicon membrane in a Piezo sensor.

The transmitters have a RS232 digital communication interface and can set up transmitter parameters and provide real time pressure measurement. Please see the Communication Protocol 300544663 (RS232) for further details.

Each transmitter is individually tested throughout the measuring range before leaving the factory. A test report is included in the package. In addition, each transmitter pressure reading is individually temperature-compensated within the specified operating temperature range.

The transmitters have three mechanical relays which can be used for process control, for example interlocking valves or pumps. The analog voltage output can be interfaced to external analog equipment for pressure readout or controlling.

Sensor technology

The transmitters contain two separate sensor elements. The MEMS Pirani (MEMS = Micro-Electro-Mechanical-System) sensor element is based on measurement of thermal conductivity. The MEMS Pirani sensor consists of a silicon chip with a heated resistive element forming one surface of a cavity. A cover on top of the chip forms the other surface of the cavity. Due to the geometry of the sensor, convection cannot take place within the cavity and consequently the sensor is insensitive to mounting position. Gas molecules are passed by diffusion only to the heated element where the heat loss of the gas is measured.

The Piezo sensor is based on measurement of mechanical deflection of a silicon membrane where one side of the membrane is exposed to ambient pressure and the other side is exposed to vacuum. The Piezo measures true differential pressure independent of gas composition and concentration.

Both sensor elements are very robust and can withstand high G-forces and instant air inrush.

Applications

The differential Piezo sensor will always measure accurately relative to the ambient pressure regardless of changes in ambient conditions. This makes it an ideal candidate for high precision control of:

- Load-locks (Ensure accurate and fast venting and prevent air contamination of loadlock)
- Chamber over and under pressure control relative to ambient.

![Diagram of pressure changes over time](image-url)
Example:
A customer wants to open his load-lock at an overpressure of 10 mbar relative to the ambient to avoid gas inrush into his load-lock when he opens his load-lock. To do that the customer can make a control algorithm based on the differential piezo reading. When the piezo reading is +10 mbar it means that the pressure in the load-lock is 10 mbar over the ambient pressure outside the load-lock (no matter if the ambient pressure is e.g. 1000 or 1020 mbar). In addition to the differential measurement, the transmitter also offers a wide absolute measurement range that can be accessed either through the analog output.

The transmitters can be used in many different vacuum applications within the industrial application, research and development, semiconductor, analytical and coating industries:
- Loadlock pressure controlling
- General vacuum pressure measurement
- Fore line and roughing pressure measurement
- Gas backfilling measurement and controlling
- Mass spectrometer control
- Activation of UHV gauge
- System process control
- Sense abnormal pressure and take appropriate security measure using set point relays
- Control system pressure

**Disposal**
The TTR 200 N transmitters are manufactured according to the RoHS directive.

![Attention]

For the benefit of the environment, at the end of life of the transmitter, it should not be disposed in the normal unsorted waste stream. It should be deposited at an appropriate collection point or facility to enable recovery or recycling.
2.1 Technical Data

Measurement principle:
- Thermal conductance according to a MEMS Pirani sensor
- Mechanical deflection of a silicone membrane in a Piezo sensor

Measurement range (N₂ and Air):
5×10⁻⁵ to 1500 mbar

Measurement range differential:
-1013 to 1013 mbar (RS232)

Accuracy (1) (N₂):
- MEMS Pirani: 5×10⁻⁴ to 1×10⁻³ mbar: ±10% of reading
- 1×10⁻³ to 100 mbar: ± 5% of reading
- 100 to 1000 mbar: ± 25% of reading
- Diff. Piezo:
  - -10 to 10 mbar: ±10% of reading ± 0.67 mbar
  - -100 to -10 mbar: ± 8% of reading
  - -1013 mbar to -100 mbar: ± 1% of reading
  - 10 to 100 mbar ± 5% of reading

Repeatability (1) (N₂):
- MEMS Pirani: 1×10⁻³ to 100 mbar: ± 2% of reading
- Diff. Piezo: -1013 to 10 mbar: ± 1% of reading

Supply Voltage: 9 – 30 VDC
Power consumption: < 1.2 Watt
Fuse (thermal recoverable): 200 mA
Analog output: 0.61-10.23 VDC, Log. 1.286 VDC/decade
Analog output resolution: 16 bit
Analog output impedance: 100 Ω
Analog output update rate: 16 Hz
Sensor fail, analog output: 0.5 V

Setpoint relay(s):
P/N: 230365V02: 3
Setpoint relay range:
- Absolute: 2×10⁻⁴ to 1300 mbar
- Differential: -1013 mbar to 1333 mbar
Setpoint relay contact rating: 1 A / 30 VDC/AC (resistive load)
Setpoint relay response time: < 100 ms
Setpoint relay contact resistance: 100 mΩ (max)
Setpoint relay contact endurance: 100,000 cycles (min) (30 VDC/1 A load)
Setpoint relay contact endurance: 2,000,000 cycles (min) (30 VDC/0.2 A load)

Materials exposed to vacuum (2):
- 304 stainless steel, sealing material FPM

Internal volume: KF16 flange 2.8 cm³
Housing material: Stainless steel 304
Flange material: Stainless steel 304
Weight: 305 g

Maximum allowed pressure: 2 bar
Operating temperature: 0 to 40 °C (32 to 104 °F)
Bake out temperature (Power off): 85 °C (185 °F)
Filament temperature: 35 °C above ambient temperature
Humidity: 0 – 95% Non-condensing
Ingress Protection Rating: IP40
Leak rate: < 5.10⁻⁹ mbar⁻¹/s

(1) Accuracy and repeatability are typical values measured in Nitrogen atmosphere after zero adjustment at ambient temperature.
(2) For the full list of all materials exposed to process gases please contact LEYBOLD.
## 2.2 Dimensions [mm]

<table>
<thead>
<tr>
<th>P/N: 230365V02</th>
<th>Flanges:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KF 16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>40.75</td>
</tr>
<tr>
<td>Height</td>
<td>36.20</td>
</tr>
<tr>
<td>Width</td>
<td>34.10</td>
</tr>
<tr>
<td>Length</td>
<td>30.11</td>
</tr>
<tr>
<td>Width of Flange</td>
<td>30.00</td>
</tr>
<tr>
<td>Diameter of Flange</td>
<td>12.84</td>
</tr>
</tbody>
</table>
2.3 Accessories and replacement part numbers

<table>
<thead>
<tr>
<th>Part</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
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<td>230365V02</td>
</tr>
<tr>
<td>Spiral tube DN 16 ISO-KF</td>
<td>230082</td>
</tr>
<tr>
<td>Baffle DN 25 ISO-KF with centering</td>
<td>230078</td>
</tr>
<tr>
<td>Centering Rings (Stainless Steel 1.4305) with O-Ring, DN16 KF</td>
<td>88346</td>
</tr>
<tr>
<td>Centering Rings (Stainless Steel) with Sintered Metal Filter, DN16 KF</td>
<td>88351</td>
</tr>
<tr>
<td>Clamping Rings (Aluminum), DN16 KF</td>
<td>18341</td>
</tr>
<tr>
<td>Centering Ring with fine filter DN16 KF</td>
<td>88396</td>
</tr>
</tbody>
</table>
3 Transmitter Installation (Mechanical)

3.1 Conforming utilization
- The transmitter is intended for measuring pressure.
- The transmitters are intended for use in relatively clean environments.
- The transmitter can only be used by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.
- Always ensure that all vacuum sealing items and surfaces are clean, without damage and free of particles.
- Use a cable with strain relief to ensure proper electrical connection and to reduce stress on the connectors.
- To comply with EN61326-1 immunity requirements, use a braided, shielded cable.

3.2 Non-conforming utilization
- The transmitter cannot be used for measurements other than described in this manual.
- The transmitters are not intended for use in dirty and corrosive environments.
- Do not use the transmitter in presence of flammable gases or other explosive environments.
- Do not install substituted parts or perform any unauthorized modification to the instrument.
- The transmitter is not intended for use above maximum allowed pressure.

3.3 Process compatibility
The TTR 200 N THERMOVAC transmitters are intended for use in relatively clean environments. The transmitters cannot be used in corrosive environments like a semiconductor etch process chamber where aggressive gases like fluorine are used.

If the transmitters are located close to a gas source connection like a flow controller or leak valve the transmitter pressure measurement can be higher than the actual chamber pressure. Location close to a pumping system connection can cause a lower pressure measurement than actual chamber pressure.

The transmitters and their sensor design can be mounted in any orientation without compromising accuracy. However it is not recommended to mount the transmitters upside down, as dust and dirt might fall into the sensor.

Caution
Do not use or install the transmitter where the following conditions occur:
- Temperatures lower than 0 °C or higher than 40 °C
- Corrosive or explosive gases
- Direct sunlight or other heat sources

Explosive Environments
The sensor filament is kept at a low temperature of only 35 °C above ambient temperature, however in case of malfunction in the sensor element can exceed normal operating temperature and consequently the transmitter should not be used in explosive environments.
Temperature
The TTR 200 N THERMOVAC transmitters have an active and individual sensor temperature compensation circuit that ensures accurate measurement in a wide temperature range. For best measuring performance avoid large temperature gradients and direct cooling like air-condition air stream or direct heating like a pump exhaust stream.

Bake out
The transmitter electronics can withstand maximum 85 °C (185 °F) when the power is turned off.

Contamination
Locate and orient the transmitter where contamination is least likely. The MEMS Pirani sensor has a low filament temperature of only 35°C above ambient temperature; therefore, the MEMS Pirani is less prone to contamination by cracking products from fore vacuum pump oil.

Vibrations and instant air inrush
The sensor elements are extremely robust to mechanical forces like vibration and G-forces. The sensor element cannot be damaged by fast and repeated pressure cycles or instant inrush of air.

3.4 Vacuum connections
The transmitter is available with different types of vacuum fittings. When mounting the transmitter, always ensure that all vacuum sealing items and surfaces are clean, without damage and free of particles. Do not touch the vacuum flange sealing surface.

Pressure range
The standard 200N transmitters are internally sealed with elastomer FPM sealing and are intended for use in the pressure range 5×10⁻⁶ to 1500 mbar. If used in UHV applications the out gassing rate of FPM can be too high.
4 Transmitter Installation (Electrical)

The TTR 200 N THERMOVAC transmitters are available with different input/output connectors. Use a cable with strain relief to ensure proper electrical connection and to reduce stress on the connectors.

Attention

Ensure a low impedance electrical connection between the transmitter body and the grounded vacuum system to shield the sensor from external electromagnetic sources.
Ensure that the analog output is connected to floating input.

To comply with EN61326-1 immunity requirements, use a braided shielded cable. Connect the braid to the metal hoods at both ends of the cable with the end for power supply connected to earth ground.

Ground loops, differences of potential, or EMC problems may affect the measurement signal. For optimum signal quality, please do observe the following notes:

- Use an overall metal braided shielded cable. The connector must have a metal case.
- Connect the cable shield to ground at one side via the connector case. Make sure the connector case has direct contact to the cable's shield on its whole circumference. Do not connect the other side of the shield.
- Connect the supply common with protective ground directly at the power.
- Use differential measurement input (signal common and supply common conducted separately).
- Potential difference between supply common and housing ≤18 V (overvoltage protection).

The power supply input is 9 to 30 VDC. The power supply input is protected by an internal thermal fuse. The fuse is self-recoverable; do not replace it. Damage may occur to the circuitry if excessive voltage is applied, polarity reversed or if a wrong connection is made.

If using the analog voltage output, connect the positive analog out and negative analog out pins to a differential input voltmeter or an analog-to-digital (A/D) converter. Do not connect the negative side of the analog output to the negative side of the power supply input or to any other ground. Doing so will cause half of the power current to flow through this wire. Measurement errors in the output voltage may be seen due to the voltage drop from this current. The longer the cable, the worse the error will be. Do not connect the set point relay terminals to the analog output.

Correct connection of analog output to floating input

Incorrect connection of analog output to non-floating input
4.1 Input/Output Wiring

To comply with EN61326-1 immunity requirements, use a braided, shielded cable. Connect the braid to the metal hoods at both ends of the cable with the end for power supply connected to earth ground.

Part Numbers: 230365V02:
I/O Connector (15 pin HD Sub D male)

PIN Description
1  RS232 Transmit
2  RS232 Receive
3  Power + (9-30VDC)
4  Power return - (GND)
5  Analog Output +
6  Analog Output -
7  Relay 1, Normally Open
8  Relay 1, Common

9  Relay 1, Normally Closed
10 Relay 2, Normally Closed
11 Relay 2, Common
12 Relay 2, Normally Open
13 Relay 3, Normally Closed
14 Relay 3, Common
15 Relay 3, Normally Open
4.2 Setpoint relays

The TTR 200 N THERMOVAC transmitters come with 3 mechanical relays that can be used for controlling external process equipment. The relay has closing and breaking contacts and the contacts are rated 30 VDC, 1A resistive load. For the setup of the setpoints, refer to chapter 0.

Inductive relay load
Special precautions should be taken when driving inductive loads with the relay contact. When an inductive load like a solenoid is energized, the in-rush current is significant higher than the regular load current. In-rush currents exceeding the relay contact rating can cause reduction of relay contact life time or contact reliability. When a solenoid is de-energized, the collapsing magnetic field can cause significant voltage spikes. These spikes can couple capacitively from cable to cable and interfere with measuring electronics or transmitter signal.

An arc suppression network, as shown schematically to the right, is recommended. The values of the capacitance C and the resistance R can be calculated by the following equations:

\[ C = \frac{I^2}{1 \times 10^7} \]

\[ R = \frac{E}{I a} \]

where:

- C is in Farads. R is in ohms
- I is DC or AC peak load current in amperes. E is DC or AC peak source voltage in volts
- \( a = 1 + \left( \frac{50}{E} \right) \)

Note that \( R_{\text{min}} = 0.5 \ \Omega \) and \( C_{\text{min}} = 1 \times 10^{-9} \ \text{F} \), D is a fast transient suppression diode.

Setpoint functionality
The set point relays can be activated either above or below the set point values. The graphs below show the different relays stages in either below or above configuration. The NC contact will always be closed in case of power failure.

Please see the vacuum transmitter Communication Protocol 300544663 (RS232) for further details.

When using the setpoint relay to control process equipment always take appropriate precautions to prevent system damage in case of transmitter power failure. The NC contact will be closed in case of transmitter power failure.
5 Operations

5.1 Pressure output

The TTR 200 N THERMOVAC transmitters can provide pressure measurement output as an analog voltage or RS232 digital value (P/N: 230365V02). For details about the digital interface, please refer to the Communication Protocol 300544663.

The analog output is per default based on the MEMS Pirani and Piezo combined reading and provides a 16 bit voltage output of 1.286 VDC/decade standard configuration. Refer to Analog output page 23 for details.

Combined reading

The combined readings are based on the MEMS Pirani and a normalized absolute pressure measurement. When the transmitter is powered on for the first time, the combined output will read 1013 mbar (normal sea level pressure) at Zero differential pressure regardless of the actual absolute ambient barometric pressure. The ambient atmospheric pressure varies with weather and elevation of the location where the transmitter is used. When the transmitter is pumped down below 1.6 mbar the transmitter can determine the ambient pressure by reading and normalizing the differential Piezo output with reverse sign. The transmitter will automatically calibrate the Piezo absolute reading when the transmitter is pumped below 1.6 mbar. If the calibration deviates more than +/- 13 mbar from the current calibration value the calibration is stored in the nonvolatile memory. When the transmitter is vented back to ambient pressure the combined output and analog output will read the correct ambient pressure.

The measurement switching is gas dependent with the following pressure values:

<table>
<thead>
<tr>
<th>Combination of Gas</th>
<th>MEMS Pirani Reading</th>
<th>MEMS Pirani/Piezo absolute integration</th>
<th>Piezo absolute Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen, Air, Neon, CO₂, Xenon: (MP)</td>
<td>&lt;53.3 mbar</td>
<td>53.3-80 mbar</td>
<td>&gt;80 mbar</td>
</tr>
<tr>
<td>Hydrogen: (PZabs)</td>
<td>&lt;6.7 mbar</td>
<td>6.7-9.3 mbar</td>
<td>&gt;9.3 mbar</td>
</tr>
<tr>
<td>Argon, Helium, H₂O: (PZabs)</td>
<td>&lt;9.3 mbar</td>
<td>9.3-13.3 mbar</td>
<td>&gt;13.3 mbar</td>
</tr>
</tbody>
</table>

Resolution

The digital pressure output can provide three digit or four digit values. However, the resolution is limited in certain parts of the measuring range.

- 1x10⁻⁵ to 1x10⁻⁴ mbar: one digit resolution 1.000x10⁻⁵
- 1x10⁻⁴ to 1x10⁻³ mbar: two digit resolution 1.200x10⁻⁴
- 1x10⁻³ to 900 mbar: three or four digit resolution 1.234x10⁻³

Measuring noise

External sources can interfere with the sensor signal and cause noise on the signal. The low measuring range is most sensitive to measuring noise due to low signal levels.
5.2 Analog output

The TTR 200 N THERMOVAC transmitter provides a voltage output as function of pressure. The standard output is 1.286 VDC/decade but can also be configured to emulate other analog outputs.

Conversion formulae:

\[ P_{\text{mbar}} = 10^{((V_{\text{out}} - 6.143)/1.286)} \]

\[ V_{\text{out}} = \log_{10}(P_{\text{mbar}}) \times 1.286 + 6.143 \]
Analog output setup

The TTR 200 N THERMOVAC transmitters can emulate analog voltage outputs from other vacuum transmitters. The TTR 200 N THERMOVAC transmitter analog output can be assigned to the MEMS Pirani sensor measurement, Piezo absolute sensor measurement and the combined Piezo/MEMS Pirani reading. The analog output provides 16 bit resolution.

⚠️ Attention
Due to curve form and limits, some of the alternative analog outputs will cause loss of measuring range and accuracy. For best performance use the standard Leybold analog output. Change of analog output setup does not interfere on digital reading.
5.3 Sensor gas dependence

The TTR 200 N THERMOVAC transmitter sensor is based on measurement of thermal conductivity (for the MEMS Pirani-sensor) and consequently its reading depends on gas and gas concentration. The default analog output will provide a combined reading of the gas dependent MEMS Pirani sensor reading and the gas independent Piezo sensor reading as described in chapter 5.1. Thus only a part of the combined measurement range, from $5 \times 10^{-5}$ to 80 mbar, will be gas dependent. The TTR 200 N THERMOVAC transmitter has calibration curves for a number of common gases. For gas setup, please refer to the Communication Protocol 300544663 (RS232). The sensor is per factory default calibrated for Nitrogen gas and shown below is the TTR 200 N THERMOVAC Nitrogen MEMS Pirani reading in different gas types. Be aware that when measuring in environments where other gases than nitrogen (calibration gas) are present, the readings can deviate from the true pressure.

In the range below 1 mbar, the pressure indication is linear. For gases other than air, the pressure can be determined by means of a simple conversion formula:

$$ p_{eff} = C \cdot \text{pressure reading} $$

For which:

<table>
<thead>
<tr>
<th>Gas type</th>
<th>Calibration factor C</th>
<th>Valid range (mbar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>1.4</td>
<td>$3 \times 10^{-3}$ to 0.3 mbar</td>
</tr>
<tr>
<td>Ar</td>
<td>1.57</td>
<td>$10^{-3}$ to 1 mbar</td>
</tr>
<tr>
<td>H₂</td>
<td>0.84</td>
<td>$3 \times 10^{-3}$ to 0.2 mbar</td>
</tr>
<tr>
<td>Air, O₂, CO, N₂</td>
<td>1</td>
<td>$3 \times 10^{-3}$ to 0.3 mbar</td>
</tr>
</tbody>
</table>

These conversion factors are average values.
6 Functions

The user switch, red/green LED-ring/LED status indicator and connector can be found at the top of the transmitter.

6.1 LED-ring/LED status indicator

The LED-ring/LED will indicate the status of the transmitter by showing a certain color-code:

<table>
<thead>
<tr>
<th>LED-ring/LED</th>
<th>Transmitter status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid green</td>
<td>Normal operation</td>
</tr>
<tr>
<td>2 sec. red</td>
<td>Power on sequence</td>
</tr>
<tr>
<td>Green 1 sec. flash cycle</td>
<td>Test mode</td>
</tr>
<tr>
<td>2 sec. red</td>
<td>User switch disabled</td>
</tr>
<tr>
<td>Continuously RED</td>
<td>Transmitter defect</td>
</tr>
<tr>
<td>Off</td>
<td>Power off</td>
</tr>
<tr>
<td>Other</td>
<td>Relates to configuration of Vacuum-zero/Full-scale adjustment see chapter 6.2.</td>
</tr>
</tbody>
</table>
6.2 Vacuum-zero adjustment and setpoint adjustments

Zero adjustment before operation is recommended to obtain best measurement performance in the lowest part of the measuring range. Vacuum-zero adjustment is not required for measurements above $5 \times 10^{-4}$ mbar. However, drift can occur over time and periodic vacuum-zero adjustments are then recommended to optimize measurement performance.

With the RS232 digital communication interface (P/N: 230365V02) it is possible to make setpoint adjustments by using the digital communication interface. Refer to Communication Protocol 300544663 for further details.

**MEMS Pirani-sensor vacuum-zero (Zero) adjustments**

The vacuum-zero adjustment function changes the MEMS Pirani measurement offset at low pressure. Temporary or permanent shift in zero offset can be caused by contamination, corrosion, electrical noise interference and temperature.

The MEMS Pirani full scale adjustment allows the user to adjust the MEMS Pirani full scale reading (only possible by using the serial interface). Vent the transmitter to atmospheric pressure using the gas that corresponds to the gas calibration setup. Full scale adjustment can only be executed with air or Nitrogen.

- **By using User switch**
  
  It is possible to perform vacuum-zero adjustments (Zero) of the MEMS Pirani-sensor by using the user switch. See chapter 6.3.

- **By using Serial interface**
  
  For transmitter versions with RS232 digital communication interface (P/N: 230087V02) it is possible to make vacuum-zero and full-scale (Zero/FS) adjustments using the RS232 digital communication interface. Refer to Communication Protocol 300544663 for further details.

---

<table>
<thead>
<tr>
<th>Attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>To obtain best measuring performance, it is recommended that the transmitter is evacuated to a pressure below $1 \times 10^{-5}$ mbar before executing zero adjustment of the MEMS Pirani sensor. Zero adjustment of the MEMS Pirani sensor can be executed at pressures higher than $1 \times 10^{-5}$ mbar, but this can cause inaccurate readings in the lower part of the measuring range.</td>
</tr>
<tr>
<td>If the pressure measured by the transmitter is higher than approximately $1 \times 10^{-2}$ mbar, then the zero adjustment cannot be executed. If the zero adjustment failed, the LED-ring/LED will flash red three times.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero adjustment only changes the low measuring range and will have no influence on measuring errors in the range from $1 \times 10^{-2}$ mbar and above.</td>
</tr>
<tr>
<td>Full scale adjustment only changes the high measuring range and will have no influence on measuring errors in the range below 10 mbar.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before performing the atmospheric adjustment with the user switch, vent transmitter to Nitrogen or air pressure of 1000 mbar. The transmitter will only accept full-scale adjustment when the pressure readout is within 600 to 1000 mbar. Note that if the adjustment is performed at a true pressure different from 1000 mbar, it can cause measurement deviations in the upper part of the measuring range.</td>
</tr>
</tbody>
</table>
Piezo-sensor zero adjustments

The Piezo-sensor atmospheric zero adjustment allows the user to adjust zero offset error for the differential measurement.

The Piezo-sensor atmospheric output adjustment allows the user to adjust the absolute Piezo reading at zero differential pressure (only possible by using the serial interface). The Piezo absolute output adjustment is automatically adjusted whenever the pressure measured by the MEMS Pirani sensor is lower than 1.6 mbar.

The Piezo full scale adjustment allows the user to adjust the Piezo full scale reading. Vent the transmitter to atmospheric pressure using the gas that corresponds to the gas calibration setup. Full scale adjustment can only be executed with air or Nitrogen (only possible by using the serial interface).

- **By using User switch**
  It is possible to perform zero adjustments (Zero) of the Piezo-sensor by using the user switch. See chapter 6.3.

- **By using Serial interface**
  For transmitter versions with RS232 digital communication interface (P/N: 230088V02) it is possible to make atmospheric zero adjustments, atmospheric output adjustments (at zero differential pressure) and full-scale adjustments using the RS232 digital communication interface. Refer to Communication Protocol 300544663 for further details.
6.3 User switch adjustments

The user switch-button can be pressed (as seen below) by using the adjusting-pin that is added in the transmitter package or by using another pin with similar shape (Ø 1mm).

<table>
<thead>
<tr>
<th>Transmitter status</th>
<th>LED-ring/LED color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operation</td>
<td>Solid green</td>
</tr>
<tr>
<td>Vacuum-zero/Full-scale adjustment</td>
<td>Pulsing between red and green</td>
</tr>
</tbody>
</table>

### Attention

If the user switch is activated by accident and vacuum Zero adjustment is executed the original factory adjustment can be recovered using the FD!VAC or FD!ATM command. Please refer to the Communication Protocol 300544663 (RS232).
To change the transmitter from normal operation to Vacuum-zero/Full-scale adjustment-mode with the user switch, use the following guiding diagram:

![Normal operation to Zero adjustment diagram]

To further adjust in the Vacuum-zero/Full-scale adjustment mode, use the following guiding diagram:

![Zero adjustment diagram]

All steps from Normal operation to Vacuum-zero/Full-scale adjustment mode and related adjusting steps can also be found in the following guide:

<table>
<thead>
<tr>
<th>Adjustment</th>
<th>User switch and LED-ring/LED action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero adjustment</td>
<td>Press button for 1 second until light ring is off</td>
</tr>
<tr>
<td></td>
<td>Release button to enter Zero adjustment mode</td>
</tr>
<tr>
<td></td>
<td>Light ring is pulsing red and green</td>
</tr>
<tr>
<td></td>
<td>Press button &gt;1 second to perform Zero adjustment</td>
</tr>
<tr>
<td></td>
<td>LED-ring/LED is off</td>
</tr>
<tr>
<td></td>
<td>Release button</td>
</tr>
<tr>
<td></td>
<td>LED-ring/LED flashes green 10 times: Zero adjustment succeeded</td>
</tr>
<tr>
<td></td>
<td>LED-ring/LED flashes red 10 times: Zero adjustment failed</td>
</tr>
</tbody>
</table>

*Process*  
*LED-ring behavior*  
*Action*  
*Setpoint properties*
7 FAQ (Frequently Asked Questions)

Applications
Q: Can the transmitter and sensor element continuously withstand vibrations from a mechanical fore-pump?
A: Yes – the MEMS Pirani sensor element can withstand continuous vibrations.

Q: Is the transmitter compatible with fluorine gases?
A: No – The transmitter is not intended for use in aggressive environments, like semiconductor etch applications.

Q: When the transmitter is pumped down and isolated by closing a valve the pressure is raising. Is the transmitter leaking?
A: Not likely - when a confined space is evacuated and the pumping is stopped the pressure will rise because of outgassing, mainly by water vapor. The pressure can easily rise to a few mbar over time.

Q: When the transmitter is leak checked on a helium leak detector, leak reading is building up slowly after approximately 30 seconds. Is the transmitter leaking?
A: No - the internal sealing of the TTR 200 THERMOVAC transmitter uses elastomer FPM sealing and consequently helium molecules can permeate through the FPM material and cause slow increase of helium leak readout. If a leaking transmitter is tested directly on a helium leak detector the leak is almost instantly displayed.

Q: Can the transmitter be mounted in any orientation?
A: Yes - the transmitter can be mounted in any orientation without compromise of performance or calibration. However it is recommended not to mount the transmitter with the flange port facing upwards to avoid contamination like particulates or liquids from entering the device.

Q: Can the transmitter withstand instant ventilation?
A: Yes - the MEMS Pirani and Piezo sensor elements are extremely robust to mechanical forces and can withstand continuous pressure cycles and instant air ventilation.

Q: Can I connect a valve to be controlled by the transmitter relay contact?
A: Driving inductive loads such as valves requires special precautions. Refer to chapter 4.2.

Q: How many pressure cycles can the transmitter withstand?
A: Both the MEMS Pirani and Piezo sensor elements are very robust to pressure changes and the number of pressure cycles will have no effect on the lifetime of the transmitter. The setpoint relay contact endurance is minimum 2,000,000 cycles at 30VDC/0.2A load.

Analog output
Q: What is the update rate of the analog output?
A: 16 times per second.

Q: What is the maximum length of analog output cable?
A: The length of analog cable depends on cable quality and electrical noise environment. Cable lengths up to 100 m do not normally require any special precautions other than the cable must be screened.

Q: The digital reading is correct but the analog output reading has some deviation from actual pressure?
A: Check that the analog out is connected to a floating input and not an input that is connected to ground. If connected analog out return is connected to ground, the supply current will flow in the signal line and cause voltage drop and ground looping.

Q: Can I get an analog output for the differential Piezo signal?
A: Yes – the analog output can be configured to any of the sensor signals. Refer to the analog output set up in the communication protocol.

Digital output
Q: How fast can I request pressure measurements via the digital interface?
A: 10 times per second is the fastest recommended pressure request frequency.

Q: How long is the waiting time from turning power on to valid measuring values?
A: The power on sequence is approximately 2 seconds. The light ring is illuminating red during power up sequence and the digital interface will not reply on commands. Reliable measurements are typically available within 1 minute.
Q: The first character is sometimes lost in the transmitter digital communication reply?
A: This can be caused by too fast transmitter communication reply. See RS delay command description in the Communication Protocol 300544663 (RS232).

Calibration and adjustment
Q: How often does the transmitter require calibration or Zero adjustment?
A: It depends on the application and pressure range but in many applications user adjustment is never required. Factors that temporally or permanently can influence the measuring performance is contamination, corrosion, heat and electronic interference.

Q: Will the transmitter retain user calibration after power is shut off?
A: Yes - all transmitter parameters including calibration data are stored internally in the transmitter nonvolatile memory.

Service and repair
Q: Can the sensor element be changed if contaminated?
A: No

Q: A +24 VDC supply voltage has been connected to analog output+. Is the transmitter damaged?
A: Likely - the analog output is not protected against applying power to the output pin.

Q: Reverse voltage has been connected to power supply input. Is the transmitter damaged?
A: Not likely – the transmitter power supply circuit has reverse voltage and over voltage protection, however, Leybold cannot guarantee that the transmitter will not be damaged.

Q: The status LED is constantly illuminating red?
A: The red status indicates a defect MEMS Pirani sensor element most likely damaged by corrosion or contamination. It can also occur if electronics malfunction.
## 8 Trouble shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause/Remedy</th>
</tr>
</thead>
</table>
| **No digital communication**                  | - Check electrical connections (3 wires from transmitter to communication equipment)  
- Transmitter and communication equipment baud rates have to match  
- Use of incorrect transmitter address. Try address 254  
- Attention characters missing (@)  
- Termination characters missing (;FF) |
| **NAK180 is received when transmitting setpoint commands** | - The transmitter setup is locked. Refer to disable lock procedure in the communication protocol.                                                |
| **Incorrect pressure value**                  | - Other gas present than transmitter gas setting or trace of gas.  
- Contaminated sensor. Transmitter repair required.  
- Corroded sensor. Transmitter repair required.  
- Perform a zero adjustment/FS adjustment. |
| **Incorrect pressure value at low pressure.** | - Contaminated sensor. Transmitter repair required.  
- Corroded sensor. Transmitter repair required.  
- Incorrect zero adjustment has been executed.  
- Transmitter exposed to heat or cooling air stream.  
- Perform a zero adjustment. |
| **Incorrect pressure value at high pressure.** | - Contaminated sensor. Transmitter repair required.  
- Corroded sensor. Transmitter repair required.  
- Incorrect FS adjustment has been executed.  
- Other gas or gas trace present than transmitter gas setting.  
- Perform a FS adjustment. |
| **Set point relay does not trip**             | - Setpoint not enabled.  
- Setpoint value not set to proper value.  
- Setpoint direction is different than the user expects.  
- Check electrical connection.  
- Check part number to see if transmitter has setpoint relays. |
| **No analog output**                          | - Power supply turned off.  
- Check electrical connections. |
| **Status light ring illuminating red**        | - Sensor element defect. |
9 Declaration of Contamination

Safety information on contamination of compressors, vacuum pumps and components.

Scope:

Every employer (user) is held responsible for the health and safety of his employees. This also applies to service personnel performing maintenance work either at the premises of the user or the service company in charge.

By means of the declaration attached the contractor is to be informed about any possible contamination of the compressor, vacuum pump or component sent in for servicing. Based on this information the contractor will be able to take the necessary safety precautions.

Preparation before dispatch

Before shipping any parts, the user must complete the following declaration and add it to the dispatch papers. All dispatch instructions laid down in the manual must be followed e.g.:

- Drain all service fluids
- Remove filter elements
- Seal all openings airtight
- Pack / handle appropriately
- Attach the declaration of contamination outside of the packaging
Declaration of Contamination of Compressors, Vacuum Pumps and Components

The repair and / or servicing of compressors, vacuum pumps and components will be carried out only if a correctly completed declaration has been submitted. Non-completion will result in delay. The manufacturer can refuse to accept any equipment without a declaration. A separate declaration has to be completed for each single component.

This declaration may be completed and signed only by authorized and qualified staff.

Customer/Dep. /Institute:
Address:
Person to contact:
Phone:
Fax:
End user:

<table>
<thead>
<tr>
<th>Reason for return:</th>
<th>applicable please mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair</td>
<td>chargeable warranty</td>
</tr>
<tr>
<td>Exchange</td>
<td>chargeable warranty</td>
</tr>
<tr>
<td></td>
<td>Exchange already arranged / received</td>
</tr>
<tr>
<td>Return only</td>
<td>rent loan for credit</td>
</tr>
<tr>
<td>Calibration</td>
<td>DKD Factory-calibr.</td>
</tr>
<tr>
<td></td>
<td>Quality test certificate DIN 55350-18-4.2.1</td>
</tr>
</tbody>
</table>

A. Description of the Leybold product:
Material description:
Catalog number:
Serial number:
Type of oil (For Vacuum-Pumps):

Failure description:
Additional parts:
Application-Tool:
Application-Process:

B. Condition of the equipment

<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Contamination:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>toxic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>corrosive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>flammable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>explosive 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>radioactive 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>microbial 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>other harmful substances</td>
</tr>
</tbody>
</table>

1) If answered with "No", go to D.

C. Description of processed substances (Please fill in absolutely)

1. What substances have come into contact with the equipment?
   - Trade name and / or chemical term of service fluids and substances processed, properties of the substances
   - According to safety data sheet (e.g. toxic, inflammable, corrosive, radioactive)

<table>
<thead>
<tr>
<th>X</th>
<th>Tradename:</th>
<th>Chemical name:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2) Components contaminated by microbiological, explosive or radioactive products/substances will not be accepted without written evidence of decontamination.

2. Are these substances harmful?
3. Dangerous decomposition products when heated?

D. Legally binding declaration
I / we hereby declare that the information supplied on this form is accurate and sufficient to judge any contamination level.

Name of authorized person (block letters):

Date

signature of authorized person
10 Declaration of Conformity

EU Declaration of Conformity
(Translation of original Declaration of Conformity)

The manufacturer: Leybold GmbH
Bonner Strasse 498
D-50968 Köln
Germany

hereby declares that the products specified and listed below which we have placed on the market, comply with the applicable EU Council Directives. This declaration becomes invalid if modifications are made to the product without agreement of Leybold GmbH.

Product designation: THERMOVAC Transmitter

Type designation: TTR 81 N, TTR 91 N, TTR 95 N, TTR 911 N, TTR 916 N, TTR 101 N, TTR 200 N

Part numbers:
230035V02, 230036V02, 230037V02, 230038V02, 230040V02, 230043V02, 230045V02, 230047V02, 230280S02, 230280V02, 230350V02, 230351V02, 230352V02, 230353V02, 230354V02, 230355V02, 230356V02, 230358V02, 230385V02, 230386V02, 89650V02, 89654V02, 89655V02, 89659V02, 89660V02, 230700V02", 230701V02", 230702V02"

The products complies to the following European Council Directives:

Electromagnetic Compatibility (2014/30/EU)

The following harmonized standards have been applied:

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 1: General requirements

EN 55011:2009/A1:2010 Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement

Group 1. Class B (* Class A)

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