Leak Detection

Vacuum Measurement and Components

In Situ Analysis

LEYBOLD

LEYBOLD INFICON

BG 804 174 BE

SKY™ *Smart Sensor*

TR090
TR090S

Pirani Gauge

Cat.-Nr.

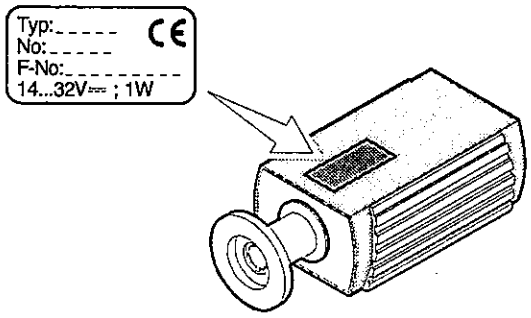
128 10
128 11
128 12
128 13

128 20
128 21
128 22
128 23

Operating manual

Product identification

In all communications with Leybold Inficon, please specify the information given on the product nameplate. Copy that information into the nameplate replica.



Validity

This document applies to products with part number

TR090 (without switching function)

128 10	(DN 16 ISO-KF short)
128 11	(¼" NPT short)
128 12	(DN 16 CF-R long)
128 13	(Pipe ½" short)

TR090S (with switching function)

128 20	(DN 16 ISO-KF short)
128 21	(¼" NPT short)
128 22	(DN 16 CF-R long)
128 23	(Pipe ½" short)

The part number can be taken from the nameplate.

As a result of Leybold Inficon's continuing product improvement and quality assurance programs, product design and specifications are subject to change without notice or obligation.

Intended use

The Pirani gauges TR090 and TR090S have been designed for vacuum measurement of gases in the pressure range of 5×10^{-4} ... 1000 mbar.

The gauges are part of the SKY™ Smart Sensors family and can be operated in connection with the COMBIVAC® IT23 or with another evaluation unit.

Functional principle

Over the whole measurement range, the measuring signal is output as a logarithm of the pressure.

Trade marks

COMBIVAC®	Leybold
SKY™	Leybold Inficon

Table of contents

For cross-references within this document, the symbol (→ 🖹 XY) is used, for cross-references to other documents, the symbol (→ 🕮 [Z]).

1 Safety

1.1 Symbols used

DANGER

Information on preventing any kind of physical injury.

WARNING

Information on preventing extensive equipment and environmental damage.

Note

Information on correct handling or use. Disregard can lead to malfunctions or minor equipment damage.

1.2 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.

1.3 General safety instructions

- Adhere to the applicable regulations and take the necessary precautions for the process media used.

  Consider possible reactions between the materials (→ 🕮 6) and the process media.

  Consider possible reactions of the process media due to heat generated by the product.
- All work may only be carried out in adherance to the applicable regulations and with the necessary precautions. Consider the safety remarks within this document.
- Before you begin to work, find out whether any vacuum components are contaminated. Adhere to the revelant regulations and take the necessary precautions when handling contaminated parts.

Communicate the safety instructions to other users.

1.4 Liability and warranty

Leybold Inficon 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 changes (modifications, alterations etc.) to the product
- use the product with accessories not listed in the corresponding product documentation.

The end-user assumes the responsibility in conjunction with the process media used.

2 Technical Data

Measuring	Measurement principle	thermal conductance Pirani
	Measurement range (air, N_2, O_2, CO)	5×10^{-4} ... 1000 mbar
	Accuracy	≈ 10 % of reading in the range of 1×10^{-3} ... 100 mbar (outside of this range up to factor 2)
	Repeatability	≈ 2 % reading in the range of 1×10^{-3} ... 100 mbar
	Gas type dependency	→ Appendix B
Output signal	Voltage range	≈ 0 V ... ≈ +10.3 V
	Measurement range	1.9 V ... 10.0 V
	Relationship voltage-pressure	logarithmic, increase 1.286 V / decade (→ Appendix A)
	Error signal	< 0.5 V (filament rupture)
	Output impedance	2×10 Ω
	Minimum load	10 kΩ, short circuit-proof
	Rise time	≈ 10 ms
	Gauge identification	27 kΩ resistance referenced to supply common
Adjustment	Trimming potentiometer <HV>	Adjustment at 5×10^{-4} mbar
	Trimming potentiometer <ATM>	Adjustment at atmospheric pressure
Threshold (TR090S)	Setting range with trimming potentiometer	≈ 2×10^{-3} ... 500 mbar (≈ 2 rotations per pressure decade)
	Hysteresis	≈ 30 % of the pressure reading
	Relay contact closed open	60 V, 0.5 ADC, potential free at low pressure (lamp glows) at high pressure, Error, no supply

Supply

STOP DANGER

The gauge may only be connected to supply and evaluation units that conform to the requirements of a grounded protective extra-low voltage (SELV-E according to EN 61010). The connection to the gauge has to be fused.

	Voltage at gauge	14.0 ... 32.0 V= (max. ripple 1 V_{pp})
	Power consumption	≤ 1 W
	Fuse	≤ 1 AT
	Electrical connection	FCC-68 socket, 8 poles, with screening
	Cable	8 poles plus screening
	Cable length max.	100 m (0.14 mm^2 conductor)

Grounding concept	→ Figure 1
Vacuum flange – measuring common	connected by 10 kΩ (max. voltage differential ±50 V)
Supply common – signal common	conducted separately; for great cable lengths (≥10 m) differential measuring is recommended

Vacuum

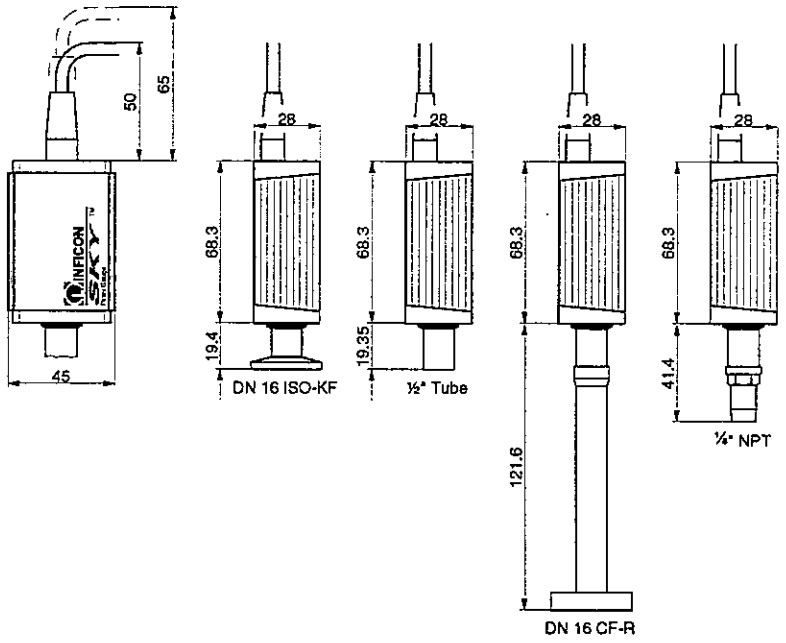
Materials on the vacuum side	
Flange	stainless steel
Filament	tungsten
Feedthrough	glas
Bafflephragm (only DN 16 ISO-KF)	stainless steel
Other materials	Ni, copper, NiFe
Internal volume	
short version	≈ 2cm³
long version	≈ 10cm³
Pressure max.	≤ 10 bar (absolute) limited to inert gases

Environment

Admissible temperatures		
Storage		–20°C ... +65°C
Operation		+ 5°C ... +60°C
Flange temperature	short version	up to 80 °C
	long version	up to 250 °C
Relative humidity		max. 80% for temperatures up to +31 °C decreasing to 50 % at +40 °C
Application		only for indoor use altitudes up to 2000 m NN
Type of protection		IP 40

Dimensions

Measurements [mm]



Weight	≈ 100 g (DN 16 ISO-KF short) ≈ 100 g (Pipe ½" short) ≈ 160 g (DN 16 CF-R long) ≈ 120 g (⅛" NPT short)

SD 804 174 BE (0902) TR200 em

3 Installation

3.1 Vacuum connection

Note

Caution: vacuum component

Dirt and damages impair the function of the vacuum component.

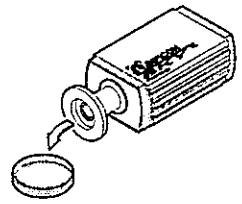
When handling vacuum components, take appropriate measures to ensure cleanliness and prevent damages.

The gauge may be mounted in any orientation. A horizontal to upright orientation is to be preferred, to keep condensates and particles from getting into the meas - uring chamber.

Procedure

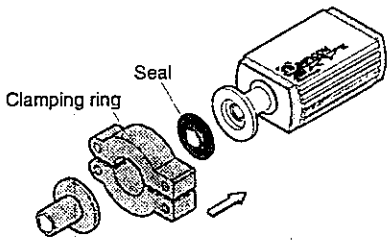
1. Remove the protective cap.

   The protective cap will be needed for maintenance.



Protective cap

2. Make the flange connection.



If adjustment must be possible after the gauge has been installed, be sure to install it so that trimming potentiometers <HV> and <ATM> can be ac - cessed with a screwdriver.

For the TR090S also ensure access to the threshold setting.

The space necessary can be gathered from the diagram (→ 🕮 6).

DANGER

Caution: overpressure in the vacuum system > 4 bar

KF flange connections with elastomer sealing rings (e.g. O-rings) cannot withstand such pressures. Process media can thus leak and possibly damage your health.

Use sealing rings provided with an outer centering ring.

DANGER

Caution: overpressure in the vacuum system > 1 bar

If clamps are opened incorrectly or inadvertently, injury can be caused by catapulted parts and your health can be damaged by leaking pro - cess gases.

Use the type of clamps which can only be opened and closed by means of a tool (e.g. hose clip clamping ring).

STOP DANGER

The gauge must be electrically connected to the grounded vacuum chamber. This connection must conform to the requirements of a protective connection according to EN 61010:

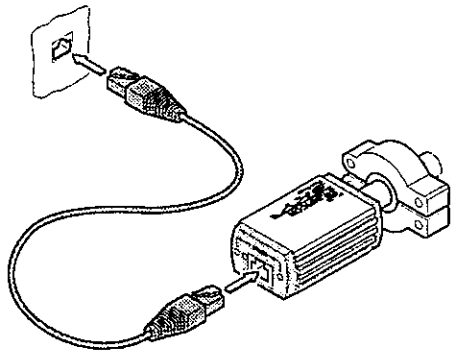
- CF and NPT flanges fulfill this requirement
- For gauges with a KF flange, use a conductive metallic clamping ring
- For the ½" pipe take the appropriate measures to fulfill this requirement.

3.2 Electrical connection

3.2.1 Use with COMBIVAC® IT23

If the gauge is used with a COMBIVAC® IT23, a corresponding sensor cable is required (→ 🖹 16).

- Put the plug into the gauge and the COMBIVAC® IT23 until it clicks.



3.2.2 Use with other evaluation units

The gauge can also be operated with other evaluation units. In this case, an individual sensor cable must be made.

For cable lengths up to 10 m (with 0.14 mm^2 conductor cross section), the measurement signal can be read directly between positive signal (pin 3) and supply common (pin 2) without a loss in accuracy. For longer sensor cable lengths, we recommend a differential measurement between signal and signal common (Pin 5) (as a result of the voltage drop along the supply cable grounding lead, the common mode signal is approx. 0.5 V at the max. permissible cable length).

Procedure

❶ Connect a FCC-68 plug for the gauge side to the sensor cable according to the diagram.

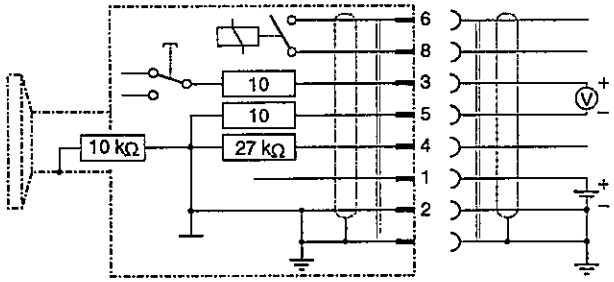
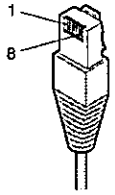


Figure 1 Electrical connection :

Pin 1	supply (14 ... 32 V)
Pin 2	supply common
Pin 3	signal output (measuring signal)
Pin 4	identification
Pin 5	signal common
Pin 6,8	switching contacts

Screening: connector shell



8 poles, FCC-68 plug

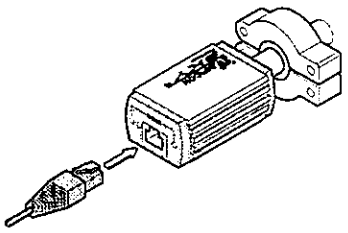
WARNING

Supply common (pin 5) and screen (pin 6) must be grounded to the supply unit.

Incorrect connection, incorrect polarity or inadmissible supply voltages can damage the gauge.

❷ Equip the other end of the sensor cable with the appropriate connection for the evaluation unit.

❸ Put the plug in to the click.



4 Operation

When voltage is being supplied to the gauge, the measuring signal is available between pins 3 and 5 (relationship between measuring signal and pressure → Appendix A).

Allow for a stabilization period of approx. 2 min. It is advisable to operate the gauge continuously.

The gauge is factory-calibrated. Adjustment may become necessary because of contamination, aging, or extreme temperatures (→ 🗎 12).

Measurement accuracy is reduced in the pressure range above 100 mbar and below 1×10^{-3} mbar.

4.1 Measurement principle

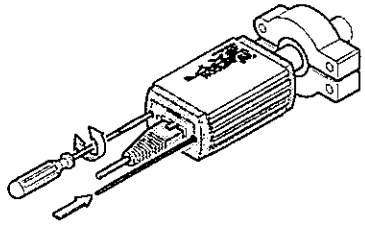
This gauge uses the thermal conductivity of gases for vacuum measurements (Pirani). For this, two thin tungsten wires are heated up to two different, constant temperatures (ca. 65 °C and 120 °C). The difference between the required thermal inputs for this is a measure for the pressure (independent of the ambient tem - perature). After logarithmization the output signal is generated from this value (→ Appendix A).

Gas type dependency

The measuring signal depends on the type of gas being measured. The relation - ship between measuring signal and pressure (→ Appendix A) is accurate for N_2, O_2, dry air and CO. They can be mathematically converted for other gases (→ Appendix B).

4.2 Switching function (TR090S only)

By pressing the button <SETPOINT> (e.g. with an Allen key Ø2.5 mm) the lower switching threshold becomes available at the signal output.



With the trimming potentiometer <SETPOINT> the built-in (lower) threshold can be set in the range of approx. 2×10^{-3} ... 500 mbar while the button is pressed.
2 clockwise rotations raise the threshold by one press ure decade. The upper threshold is about 30 % higher (Hysteresis).

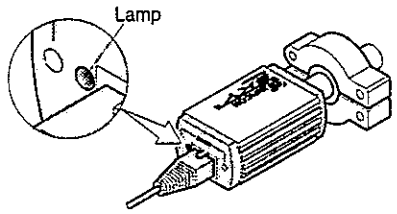
STOP DANGER

Caution: malfunction

If processes are being controlled with the signal output, it should be considered, that the pressing of the button <SETPOINT> interrupts the measuring signal and instead outputs the lower threshold. This may lead to malfunctions.

Only press the button <SETPOINT> after having ensured that no damages can arise from a malfunction.

The switching function is available as a potential free relay contact (normally open) at pin 6 and pin 8. Below the set threshold, the contact is closed and the lamp glows green.



5 Maintenance

STOP DANGER

Caution: contaminated parts

Contaminated parts can be detrimental to your health.

Before you begin to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

5.1 Adjusting the gauge

The gauge is factory calibrated. Through contamination, ageing or extreme temperatures a shifting of the characteristic curve can occur and readjustment can become necessary. Otherwise the gauge requires no maintenance.

During adjustment, the effect on the pressure range between approx. 10^{-2} mbar and 10^{2} mbar is negligable.

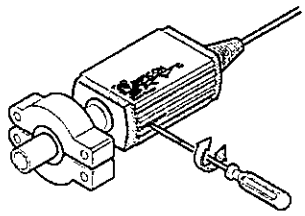
Note

Malfunctions of the gauge, that are caused by contamination are not covered by warranty.

Tools required

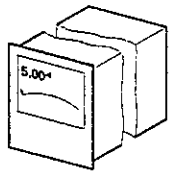
- Screw driver (included)

Procedure

1. Activate the gauge (possibly in the same position it is going to be used in).
2. Evacuate to $p << 10^{-4}$ mbar, and wait ≥2 min.
3. 

   Adjust the potentiometer <HV> to ...

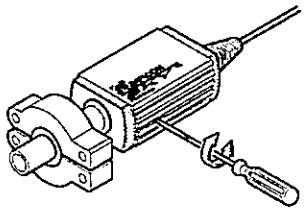
   ... 5×10^{-4} mbar or ... 1.90 V

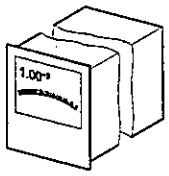
   ...and then turn it approx. 45° counter-clockwise.
4. Vent with air at atmospheric pressure, and wait ≥2 min.

❺



Adjust the potentiometer <ATM> to ...

... 1×10^3 mbar or ... 10.00 V



5.2 Cleaning the sensor

STOP DANGER

Caution: cleaning agents

Cleaning agents can be detrimental to health and environment.

Adhere to the relevant regulations and take the necessary precautions when handling and disposing of cleaning agents. Consider possible reactions with the product materials (→ 🖹 6).

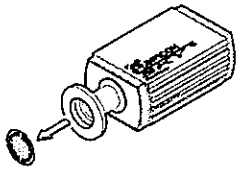
Tools / materials required

- Screw driver Nr. 1
- Industrial alcohol

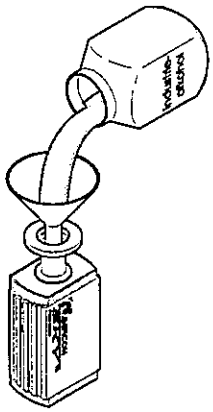
Procedure

❶ Remove the gauge from the system (→ 🖹 15).

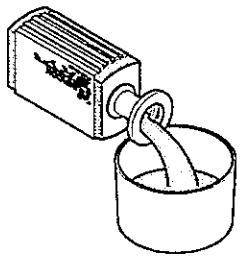
❷ Remove the baffle carefully with the screw driver (only for versions with flange DN 16 ISO-KF).



❸
- Fill with industrial alcohol.
- Allow it to soak for 5 min.

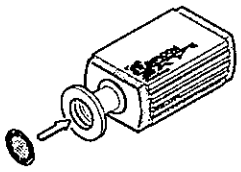


4. Pour out the industrial alcohol and dispose of it.



5. Allow the measurement chamber to dry for at least 10 min.

6. Insert the cleaned or a new baffle (only versions with flange DN 16 ISO-KF).



7.
- Install the gauge (→ 7).
- Pump down
- Make the electrical connection
- Adjust the gauge (→ 12).

5.3 What to do in case of problems

Problem	Possible cause	Correction
Measuring signal continually < 0.5 V. Evaluation unit: "no SIG" (COMBIVAC® IT23)	No supply voltage	Turn on the supply voltage.
	Sensor defective (filament rupture)	Replace the gauge.
	Gauge maladjusted	Adjust the gauge (→ 12).
Readout is too high at low pressures.	Sensor contaminated	Adjust the gauge (→ 12). Clean the sensor (→ 13). Replace the gauge.

6 Removal

DANGER

Caution: contaminated parts

Contaminated parts can be detrimental to your health.

Before you begin to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

Note

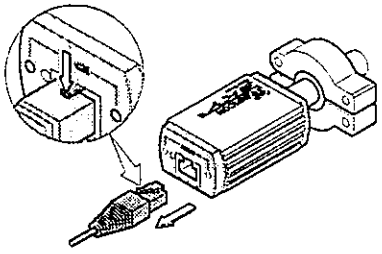
Caution: vacuum component

Dirt and damages impair the function of the vacuum component.

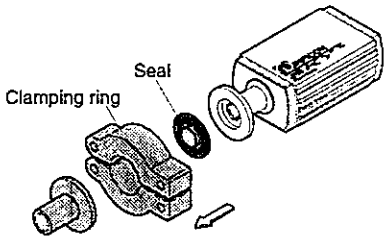
When handling vacuum components, take appropriate measures to ensure cleanliness and prevent damages.

Procedure

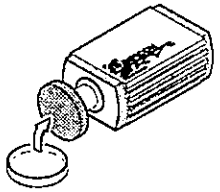
1. Vent the vacuum system.
2. Take the gauge out of operation.
3. Unplug the sensor cable.



4. Remove the gauge from the vacuum system.



5. Put protective cap on.



Protective cap

7 Accessories

	Ordering number
Sensor cable 10 m, with FCC-68-plug on both ends, 8 poles (screened)	157 33

8 Returning the product

⚠ WARNING

Caution: forwarding contaminated products

Products returned to Leybold Inficon for service or repair should preferably be free of harmful substances (e.g. radioactive, toxic, caustic or microbiological).

Adhere to the forwarding regulations of all involved countries and forwarding companies and enclose a completed declaration of contamination.

Products not accompanied by a completed declaration of contamination are returned to the sender.

When returning a product for service, put it in a tight and impact resistant package.

9 Disposal

⚠ WARNING

Caution: substances detrimental to the environment

Products, operating materials etc. may require disposal in accordance with special regulations.

Dispose of environmentally detrimental substances according to local regulations.

Separating the parts

After disassembly of the product separate the parts into the following categories for disposal:

Components exposed to process gases

Components which have been exposed to radioactive, toxic, caustic, or micro-biological process gases must be disposed of in accordance with the relevant national regulations.

Components which have been exposed to other process gases must be separated according to their materials and recycled.

Components without exposure to process gases

Such components must be separated according to their materials and recycled.

Appendix

A: Relationship between measuring signal and pressure

Conversion formula

$$p = 10^{0.778(U-c)} \quad \Leftrightarrow \quad U = c + 1.286 \log_{10} p$$

U	p	c
[V]	[mbar]	6.143
[V]	[µbar]	2.287

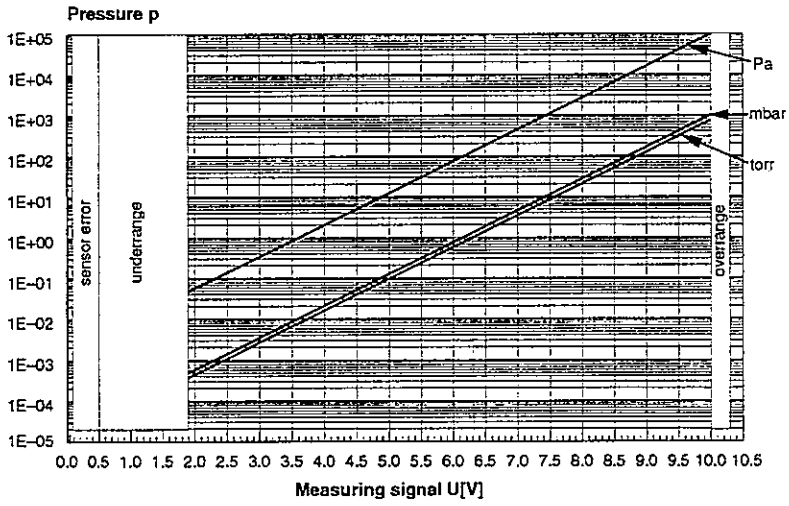
U	p	c
[V]	[Torr]	6.304
[V]	[mTorr]	2.448
[V]	[micron]	2.448

U	p	c
[V]	[Pa]	3.572
[V]	[kPa]	7.429

where p pressure
U measuring signal
c constant (pressure unit dependent)

valid in the range 5×10^{-4} mbar < p < 1000 mbar
3.75×10^{-4} Torr < p < 750 Torr
5×10^{-2} Pa < p < 1×10^{5} Pa

Conversion curves

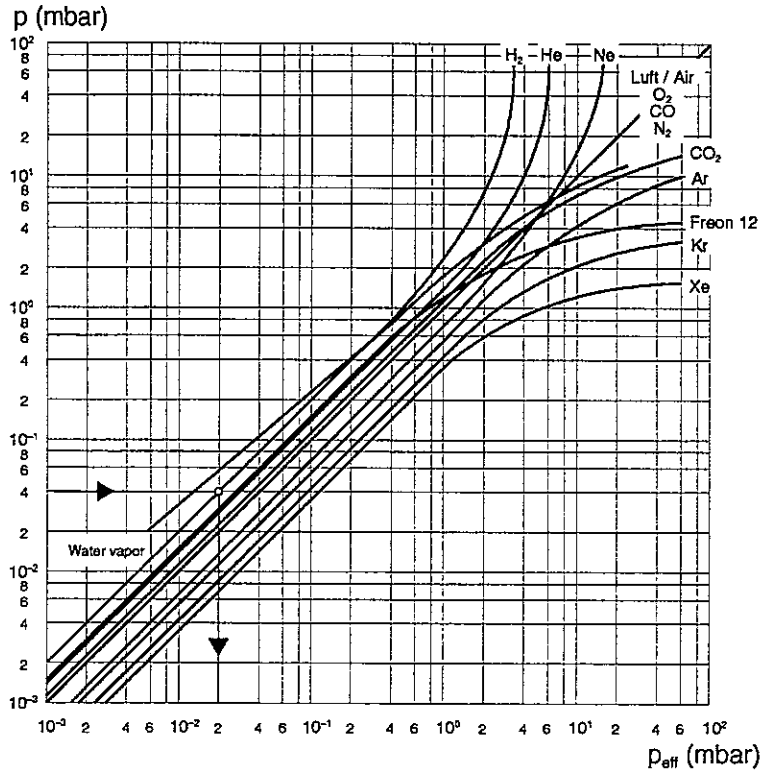


Conversion table

Measuring signal U [V]	Pressure p [mbar]	[Torr]	[Pa]
< 0.5		Sensor error	
0.5...1.9		Underrange	
1.9	5.0×10^{-4}	3.8×10^{-4}	5.0×10^{-2}
2.29	1.0×10^{-3}	7.5×10^{-4}	0.1
3.57	1.0×10^{-2}	7.5×10^{-3}	1.0
4.86	0.1	7.5×10^{-2}	10
6.14	1.0	0.75	100
7.43	10	7.5	1000
8.72	100	75	1.0×10^{4}
10.00	1000	750	1.0×10^{5}
10.0 ... 10.3		Overrange	

B: Gas type dependency

Indicated pressure
(Gauge calibrated for air)



Note

A mixture of gases is often involved. In this case, accurate determination is only possible with a partial pressure measurement instrument, e.g. a quadrupole mass spectrometer.

Adjustment factors for the pressure range below 1 mbar

Gas type	Adjustment factor K	Gas type	Adjustment factor K
He	0.8	H_2	0.5
Ne	1.4	N_2, O_2, CO, air	1.0
Ar	1.7	CO_2	0.9
Kr	2.4	water vapor	0.5
Xe	3.0	Freon 12	0.7

p_{eff} = K × Indicated pressure

Declaration of contamination

The repair and/or service of vacuum equipment and components will only be carried out if a correctly completed declaration has been submitted. Non-completion will result in delay.
This declaration can only be completed and signed by authorised and qualified staff.

❶ Description of product

Type _____
Article No. _____
Serial No. _____

❷ Reason for return

_____
_____
_____

❸ Operating fluid(s) used

_____
_____

❹ Process related comtamination of product:

toxic	no ☐	yes ☐
corrosive	no ☐	yes ☐
biological hazard	no ☐	yes ☐ *)
explosive	no ☐	yes ☐ *)
radioactive	no ☐	yes ☐ *)
other harmful substances	no ☐	yes ☐

*) Products thus contaminated will not be accepted without written evidence of decontamination!

❺ Harmful substances, gases and/or by-products

Please list all substances, gases and by-products which may have come into contact with the product:

Trade/Product name Manufacturer	Chemical name (or symbol)	Dangerous material class	Measures if spillage	First aid in case of human contact

❻ Legally binding declaration:

I hereby declare that the information supplied on this form is complete and accurate. The dispatch of the contaminated product will be in accordance with the appropriate regulations covering packaging, transportation and labelling of dangerous substances.

Name of organisation or company _____

Address _____ Post code _____

Phone _____ Telex _____

E-Mail _____

Name _____

Date and legally binding signature _____

Company stamp

Copies: Original to manufacturer or representative - 1 copy attach to consignment packaging - 1 copy for file of sender

Original: German BG 804 174 BD (9903)

Leybold Inficon
Postfach 1000
FL–9496 Balzers
Liechtenstein
Tel +41 (0) 75 388 45 25
Fax +41 (0) 75 388 54 31
reachkt@bi.balzers.net

http://www.inficon.com