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Technical Information
Ceraphant PTC31B, PTP31B

Process pressure measurement

Pressure switch for safe measurement and monitoring of absolute and gauge pressure

Application

The Ceraphant is a pressure switch for the measurement of absolute and gauge pressure in gases, vapors, liquids and dust. The Ceraphant can be used internationally thanks to a wide range of approvals and process connections.

Your benefits

- High reproducibility and long-term stability
- Reference accuracy: up to 0.3%
- Customized measuring ranges
  - Turn down up to 5:1
  - Sensor for measuring ranges up to 400 bar (6 000 psi)
- Housing and process isolating diaphragm made of 316L
- Optionally available with IO-Link

Operation and electrical connection in accordance with VDMA 24574-1:2008

Endress+Hauser
People for Process Automation

PTB31B IO-Link: 10 to 30 V DC at a DC power unit

IO-Link communication is guaranteed only if the supply voltage is at least 18 V.

Output

Devices with IO-Link:
c/Q output for communication (SIO mode (switch output))

PTC31B:
- 1 x PNP switch output (three-wire) (not with IO-Link)
- 2 x PNP switch output (four-wire), IO-Link
- 1 x PNP switch output + 4 to 20 mA output (four-wire), IO-Link

PTP31B:
- 1 x PNP switch output (three-wire) (not with IO-Link)
- 2 x PNP switch output (four-wire), IO-Link
- 1 x PNP switch output + 4 to 20 mA output (four-wire), IO-Link

Material

PTC31B:
- Housing made from 316L (1.4404)
- Process connections made from 316L
- Process isolating diaphragm made from Al_2O_3 aluminum-oxide ceramic, (Ceraphire®), ultrapure 99.9 %

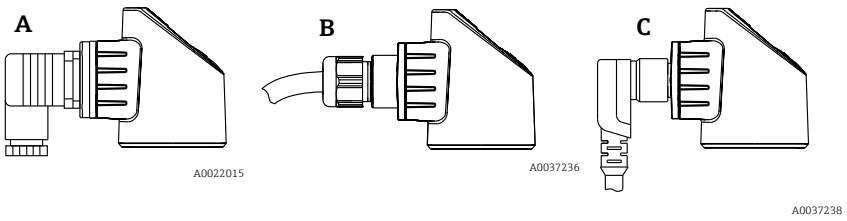
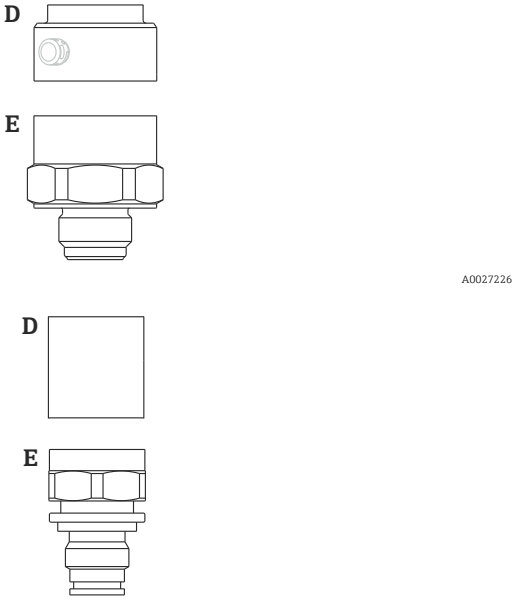
PTP31B:
- Housing made from 316L (1.4404)
- Process connections made from 316L (1.4404)
- Process isolating diaphragm made from 316L (1.4435)

Options

PTC31B:
- Certificate of calibration
- Cleaned from oil+grease
- Min. alarm current setting
- 3.1 Material certificates
- Cleaned for O_2 service
- IO-Link

PTP31B:
- Certificate of calibration
- Cleaned from oil+grease
- Min. alarm current setting
- 3.1 Material certificates
- IO-Link

Product design

Overview	Item	Description
	A	Valve plug
	B	Cable
	C	M12 plug Housing cap made of plastic
	D E	Housing Process connection (sample illustration)

System integration

The device can be given a tag name (max. 32 alphanumeric characters).

Designation	Option [1]
Measuring point (TAG), see additional specifications	Z1

1) Product Configurator order code for "Marking"

For devices with IO-Link, an IO-DD is available in the Downloads area of the Endress+Hauser website → 40.

Input

Measured variable

Measured process variable

Gauge pressure or absolute pressure

Calculated process variable

Pressure

Measuring range

Ceramic process isolating diaphragm

Sensor	Device	Maximum Sensor measuring range		Lowest calibratable span [1]	MWP	OPL	Factory settings [2]	Option [3]
		lower (LRL)	upper (URL)					
		[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]		
Devices for gauge pressure measurement								
100 mbar (1.5 psi) [4]	PTC31B	−0.1 (−1.5)	+0.1 (+1.5)	0.02 (0.3)	2.7 (40.5)	4 (60)	0 to 100 mbar (0 to 1.5 psi)	1C
250 mbar (4 psi) [5]	PTC31B	−0.25 (−4)	+0.25 (+4)	0.05 (1)	3.3 (49.5)	5 (75)	0 to 250 mbar (0 to 4 psi)	1E
400 mbar (6 psi) [6]	PTC31B	−0.4 (−6)	+0.4 (+6)	0.08 (1.2)	5.3 (79.5)	8 (120)	0 to 400 mbar (0 to 6 psi)	1F
1 bar (15 psi) [6]	PTC31B	−1 (−15)	+1 (+15)	0.2 (3)	6.7 (100.5)	10 (150)	0 to 1 bar (0 to 15 psi)	1H
2 bar (30 psi) [6]	PTC31B	−1 (−15)	+2 (+30)	0.4 (6)	12 (180)	18 (270)	0 to 2 bar (0 to 30 psi)	1K
4 bar (60 psi) [6]	PTC31B	−1 (−15)	+4 (+60)	0.8 (12)	16.7 (250.5)	25 (375)	0 to 4 bar (0 to 60 psi)	1M
10 bar (150 psi) [6]	PTC31B	−1 (−15)	+10 (+150)	2 (30)	26.7 (400.5)	40 (600)	0 to 10 bar (0 to 150 psi)	1P
40 bar (600 psi) [6]	PTC31B	−1 (−15)	+40 (+600)	8 (120)	40 (600)	60 (900)	0 to 40 bar (0 to 600 psi)	1S
Devices for absolute pressure measurement								
100 mbar (1.5 psi) [6]	PTC31B	0	+0.1 (+1.5)	0.1 (1.5)	2.7 (40.5)	4 (60)	0 to 100 mbar (0 to 1.5 psi)	2C
250 mbar (4 psi) [6]	PTC31B	0	+0.25 (+4)	0.25 (4)	3.3 (49.5)	5 (75)	0 to 250 mbar (0 to 4 psi)	2E
400 mbar (6 psi) [6]	PTC31B	0	+0.4 (+6)	0.4 (6)	5.3 (79.5)	8 (120)	0 to 400 mbar (0 to 6 psi)	2F
1 bar (15 psi) [6]	PTC31B	0	+1 (+15)	0.4 (6)	6.7 (100.5)	10 (150)	0 to 1 bar (0 to 15 psi)	2H
2 bar (30 psi) [6]	PTC31B	0	+2 (+30)	0.4 (6)	12 (180)	18 (270)	0 to 2 bar (0 to 30 psi)	2K
4 bar (60 psi) [6]	PTC31B	0	+4 (+60)	0.8 (12)	16.7 (250.5)	25 (375)	0 to 4 bar (0 to 60 psi)	2M
10 bar (150 psi) [6]	PTC31B	0	+10 (+150)	2 (30)	26.7 (400.5)	40 (600)	0 to 10 bar (0 to 150 psi)	2P
40 bar (600 psi) [6]	PTC31B	0	+40 (+600)	8 (120)	40 (600)	60 (900)	0 to 40 bar (0 to 600 psi)	2S

1) Highest turn down that can be set at the factory: 5:1. The turn down is preset and cannot be changed.
2) Other measuring ranges (e.g. −1 to +5 bar (−15 to 75 psi)) can be ordered with customer-specific settings (see the Product Configurator, order code for "Calibration; Unit" option "U"). It is possible to invert the output signal (LRV = 20 mA; URV = 4 mA). Prerequisite: URV < LRV
3) Product Configurator, order code for "Sensor range"
4) Vacuum resistance: 0.7 bar (10.5 psi) abs
5) Vacuum resistance: 0.5 bar (7.5 psi) abs
6) Vacuum resistance: 0 bar (0 psi) abs

Maximum turn down which can be ordered for absolute pressure and gauge pressure sensors

Devices for gauge pressure measurement
- 6 bar (90 psi), 16 bar (240 psi), 25 bar (375 psi): TD 1:1 to TD 2.5:1
- All other measuring ranges: TD 1:1 to TD 5:1

Devices for absolute pressure measurement
- 100 mbar (1.5 psi), 250 mbar (4 psi), 400 mbar (6 psi): TD 1:1
- 1 bar (15 psi): TD 1:1 to TD 2.5:1
- All other measuring ranges: TD 1:1 to TD 5:1

Metal process isolating diaphragm

Sensor	Device	Maximum Sensor measuring range		Lowest calibratable span [1]	MWP	OPL	Factory settings [2]	Option [3]
		lower (LRL)	upper (URL)					
		[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]		
Devices for gauge pressure measurement								
400 mbar (6 psi) [4]	PTP31B	−0.4 (−6)	+0.4 (+6)	0.4 (6)	1 (15)	1.6 (24)	0 to 400 mbar (0 to 6 psi)	1F
1 bar (15 psi) [4]	PTP31B	−1 (−15)	+1 (+15)	0.4 (6)	2.7 (40.5)	4 (60)	0 to 1 bar (0 to 15 psi)	1H
2 bar (30 psi) [4]	PTP31B	−1 (−15)	+2 (+30)	0.4 (6)	6.7 (100.5)	10 (150)	0 to 2 bar (0 to 30 psi)	1K
4 bar (60 psi) [4]	PTP31B	−1 (−15)	+4 (+60)	0.8 (12)	10.7 (160.5)	16 (240)	0 to 4 bar (0 to 60 psi)	1M
10 bar (150 psi) [4]	PTP31B	−1 (−15)	+10 (+150)	2 (30)	25 (375)	40 (600)	0 to 10 bar (0 to 150 psi)	1P
40 bar (600 psi) [4]	PTP31B	−1 (−15)	+40 (+600)	8 (120)	100 (1500)	160 (2400)	0 to 40 bar (0 to 600 psi)	1S
100 bar (1 500 psi) [4]	PTP31B	−1 (−15)	+100 (+1500)	20 (300)	100 (1500)	160 (2400)	0 to 100 bar (0 to 1 500 psi)	1U
400 bar (6 000 psi) [4]	PTP31B	−1 (−15)	+400 (+6000)	80 (1200)	400 (6000)	600 (9000)	0 to 400 bar (0 to 6 000 psi)	1W
Devices for absolute pressure measurement								
400 mbar (6 psi) [4]	PTP31B	0 (0)	0.4 (+6)	0.4 (6)	1 (15)	1.6 (24)	0 to 400 mbar (0 to 6 psi)	2F
1 bar (15 psi) [4]	PTP31B	0 (0)	1 (+15)	0.4 (6)	2.7 (40.5)	4 (60)	0 to 1 bar (0 to 15 psi)	2H
2 bar (30 psi) [4]	PTP31B	0 (0)	2 (+30)	0.4 (6)	6.7 (100.5)	10 (150)	0 to 2 bar (0 to 30 psi)	2K
4 bar (60 psi) [4]	PTP31B	0 (0)	4 (+60)	0.8 (12)	10.7 (160.5)	16 (240)	0 to 4 bar (0 to 60 psi)	2M
10 bar (150 psi) [4]	PTP31B	0 (0)	10 (+150)	2 (30)	25 (375)	40 (600)	0 to 10 bar (0 to 150 psi)	2P
40 bar (600 psi) [4]	PTP31B	0 (0)	+40 (+600)	8 (120)	100 (1500)	160 (2400)	0 to 40 bar (0 to 600 psi)	2S
100 bar (1 500 psi) [4]	PTP31B	0 (0)	+100 (+1500)	20 (300)	100 (1500)	160 (2400)	0 to 100 bar (0 to 1 500 psi)	2U
400 bar (6 000 psi) [4]	PTP31B	0 (0)	+400 (+6000)	80 (1200)	400 (6000)	600 (9000)	0 to 400 bar (0 to 6 000 psi)	2W

1) Highest turn down that can be set at the factory: 5:1. The turn down is preset and cannot be changed.
2) Other measuring ranges (e.g. −1 to +5 bar (−15 to 75 psi)) can be ordered with customer-specific settings (see the Product Configurator, order code for "Calibration; Unit" option "U"). It is possible to invert the output signal (LRV = 20 mA; URV = 4 mA). Prerequisite: URV < LRV
3) Product Configurator, order code for "Sensor range"
4) Vacuum resistance: 0.01 bar (0.145 psi) abs

Maximum turn down which can be ordered for absolute pressure and gauge pressure sensors

Ranges 0.5%/0.3%: TD 1:1 to TD 5:1

Output

Output signal

Designation	Option [1]
PNP switch output + 4 to 20 mA output (4-wire), IO-Link	7
PNP switch output (3-wire)	4
2 x PNP switch output (4-wire), IO-Link	8

1) Product Configurator, order code for "Output"

Range of adjustment

- Switch output
  Switch point (SP): 0.5 to 100 % in increments of 0.1% (min. 1 mbar * (0.015 psi)) of the upper range limit (URL) switchback point (RSP): 0 to 99.5% in increments of 0.1% (min. 1 mbar * (0.015 psi)) of the upper range limit (URL)
  Minimum distance between SP and RSP: 0.5 % URL
- Analog output (if available)
  Lower range value (LRV) and upper range value (URV) can be set anywhere within the sensor range (LRL - URL). Turn down for analog output up to 5:1 of upper sensor limit (URL).
- Factory setting (if no customer-specific setting is ordered):
  Switch point SP1: 90 %; switchback point RP1: 10 %;
  Switch point SP2: 95 %; switchback point RP2: 15 %;
  Analog output: LRV 0 %; URV 100 %

* For measuring ranges with a negative gauge pressure up to 4 bar (60 psi), the increment when setting the switch point is min. 10 mbar (0.15 psi)

Switching capacity

- Switch state ON: $I_a \leq 250$ mA; switch state OFF: $I_a \leq 1$ mA
- Devices with IO-Link: Switch state ON [1]: $I_a \leq 200$ mA [2]; switch state OFF: $I_a \leq 100$ µA
- Switch cycles: >10,000,000
- Voltage drop PNP: ≤2 V
- Overload protection: Automatic load testing of switching current;
  - Max. capacitive load: 14 µF at max. supply voltage (without resistive load)
  - Devices with IO-Link: Max. capacitive load: 1 µF at max. supply voltage (without resistive load)
  - Max. cycle duration: 0.5 s; min. t_{on}: 4 ms
  - Max. cycle duration: 0.5 s; min. t_{on}: 40 µs
  - Periodic disconnection from protective circuit in the event of overcurrent (f = 2 Hz) and "F804" displayed

Signal range 4 to 20 mA

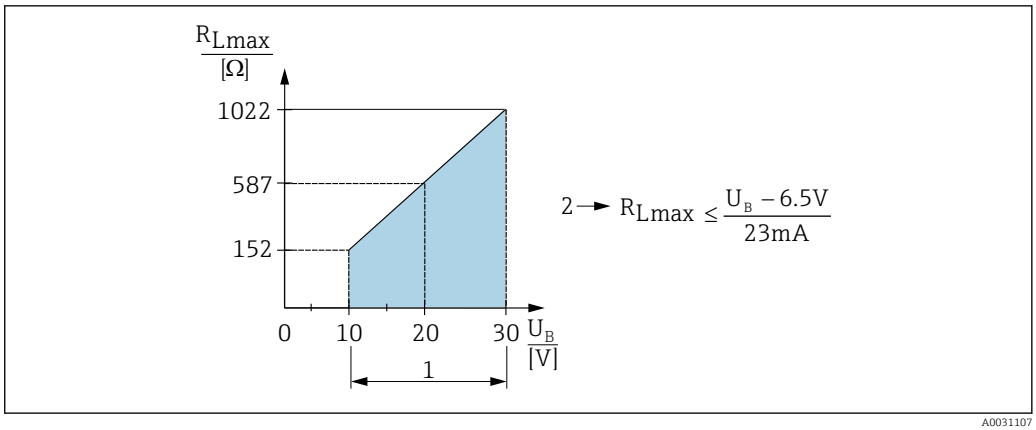
3.8 mA to 20.5 mA

Load (for devices with analog output)

In order to guarantee sufficient terminal voltage, a maximum load resistance R_L (including line resistance) must not be exceeded depending on the supply voltage U_B of the supply unit.

The maximum load resistance depends on the terminal voltage and is calculated according to the following formula:

1) 100 mA can be guaranteed over the entire temperature range for the switch outputs "2 x PNP" and "1 x PNP + 4 to 20 mA output". For lower ambient temperatures, higher currents are possible but cannot be guaranteed. Typical value at 20 °C (68 °F) approx. 200 mA. 200 mA can be guaranteed over the entire temperature range for the "1 x PNP" current output.
2) Larger currents are supported, thus deviating from the IO-Link standard.



1 Power supply 10 to 30 V DC
2 R_{Lmax} maximum load resistance
U_B Supply voltage

If load is too great:
- failure current is output and "S803" displayed (output: MIN alarm current)
- Periodic checking to establish if it is possible to quit fault state
- In order to guarantee sufficient terminal voltage, a maximum load resistance RL (including line resistance) must not be exceeded depending on the supply voltage UB of the supply unit.

Signal on alarm 4 to 20 mA

The response of the output to error is regulated in accordance with NAMUR NE43.

The behavior of the current output in the event of faults is defined in the following parameters:
- Alarm current FCU "MIN": Lower alarm current (≤3.6 mA) (optional, see the following table)
- Alarm current FCU "MAX" (factory setting): Upper alarm current (≥21 mA)
- Alarm current FCU "HLD" (HOLD) (optional, see the following table): Last measured current value is held. When the device starts, the current output is set to "Lower alarm current" (≤3.6 mA).

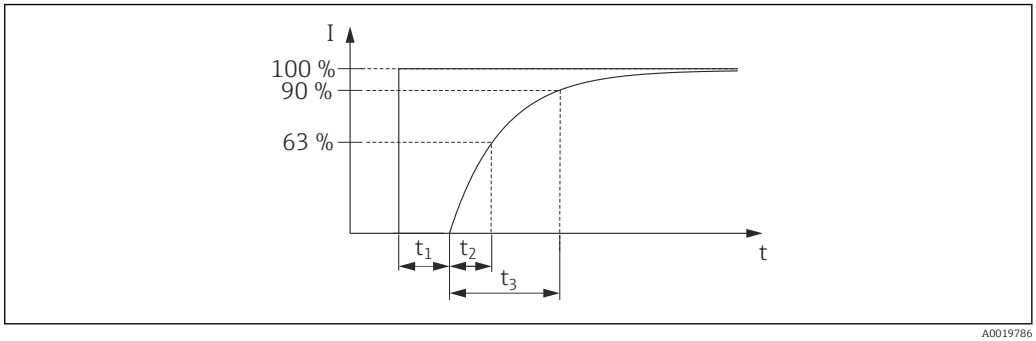
alarm current

Device	Description	Option
PTC31B PTP31B	Adjusted min. alarm current	IA [1]
PTC31B PTP31B	1 low ≤3.6 mA 2 high ≥21 mA 3 last current value	U [2]

1) Product Configurator order code for "Service"
2) Product Configurator order code for "Calibration/unit"

Dead time, time constant

Presentation of the dead time and the time constant:



Dynamic behavior

Analog electronics

Dead time (t_1) [ms]	Time constant (T63), t_2 [ms]	Time constant (T90), t_3 [ms]
7 ms	11 ms	16 ms

Dynamic behavior of switch output

PNP switch output and 2 x PNP switch output: response time ≤20 ms

Damping

Once the supply voltage has been applied, damping for the first measured value is at 0 i.e. the first measured value applied always corresponds to the actual measured value (regardless of damping).

A damping affects all outputs (output signal, display):
- Via local display, infinitely variable 0 to 999.9 s
- Factory setting: 2.0 s

Power supply

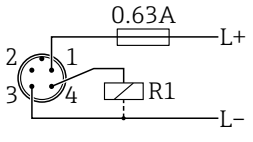
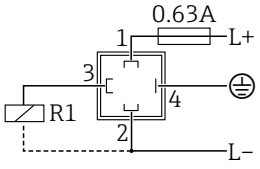
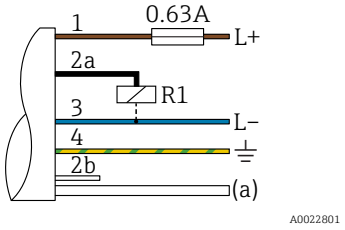
⚠ WARNING

Electrical safety is compromised by an incorrect connection!

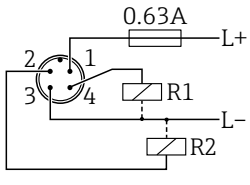
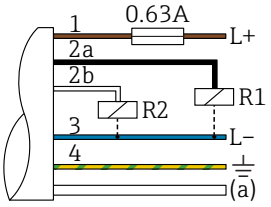
- In accordance with IEC/EN61010 a separate circuit breaker must be provided for the device .
- Protective circuits against reverse polarity, HF influences and overvoltage peaks are integrated.
- The device must be operated with a 630 mA fine-wire fuse (slow-blow).

Terminal assignment

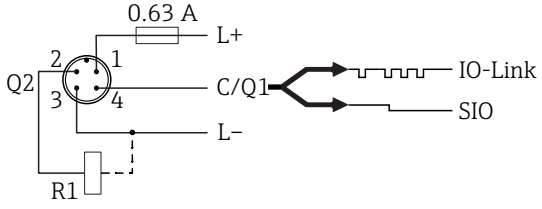
1 x PNP switch output R1 (not with IO-Link functionality)

M12 plug	Valve plug	Cable
		 *1 brown = L+* *2a black = switch output 1* *2b white = not in use* *3 blue = L-* *4 green/yellow = ground* *(a) reference air hose*

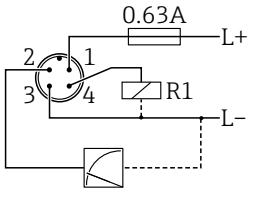
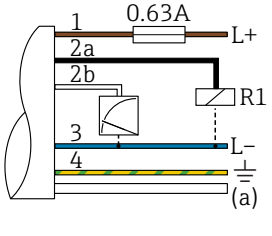
2 x PNP switch output R1 and R2

M12 plug	Valve plug	Cable
	-	 *1 brown = L+* *2a black = switch output 1* *2b white = switch output 2* *3 blue = L-* *4 green/yellow = ground* *(a) reference air hose*

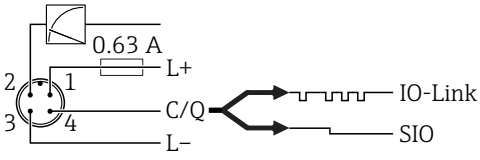
IO-Link: 2 x PNP switch output R1 and R2

M12 plug


1 x PNP switch output R1 with additional analog output 4 to 20 mA (active)

M12 plug	Valve plug	Cable
	-	 *1 brown = L+* *2a black = switch output 1* *2b white = analog output 4 to 20 mA* *3 blue = L-* *4 green/yellow = ground* *(a) reference air hose*

IO-Link: 1 x PNP switch output R1 with additional analog output 4 to 20 mA (active)

M12 plug


Supply voltage

Supply voltage: 10 to 30 V DC at a DC power unit

Supply voltage IO-Link: 10 to 30 V DC at a DC power unit

IO-Link communication is guaranteed only if the supply voltage is at least 18 V.

Current consumption and alarm signal

Intrinsic power consumption	Alarm current (for devices with analog output) [1]
≤ 60 mA	≥21 mA (factory setting)
Devices with IO-Link: Maximum current consumption: ≤ 300 mA	

1) Setting min. alarm current ≤3.6mA can be ordered via the product order structure. Min. alarm current ≤3.6mA can be configured at the device or via IO-Link.

Power supply fault

- Behavior in the event of overvoltage (>30 V):
  The device works continuously up to 34 V DC without damage. If the supply voltage is exceeded, the specified characteristics are no longer guaranteed.
- Behavior in the event of undervoltage:
  If the supply voltage falls below the minimum value, the device switches off in a defined manner.

Electrical connection

Degree of protection

Device	Connection	Degree of protection	Option [1]
PTC31B PTP31B	Cable5 m (16 ft)	IP66/67 NEMA type 4X enclosure	D
PTC31B PTP31B	Cable10 m (33 ft)	IP66/67 NEMA type 4X enclosure	E
PTC31B PTP31B	Cable25 m (82 ft)	IP66/67 NEMA type 4X enclosure	F
PTC31B PTP31B	M12 plug	IP65/67 NEMA type 4X enclosure	M

Device	Connection	Degree of protection	Option [1]
PTC31B PTP31B	Valve plug ISO4400 M16	IP65 NEMA type 4X enclosure	U
PTC31B PTP31B	Valve plug ISO4400 NPT ½	IP65 NEMA type 4X enclosure	V

1) Product Configurator order code for "Electrical connection"

Cable specification

For valve plug: < 1.5 mm^2 (16 AWG) and Ø4.5 to 10 mm (0.18 to 0.39 in)

Residual ripple

The device operates within the reference accuracy up to ±5 % of the residual ripple of the supply voltage, within the permitted voltage range.

Influence of power supply

≤0.005 % of the URL/1 V

Overvoltage protection

The device does not contain any special elements to protect against overvoltage ("wire to ground"). Nevertheless the requirements of the applicable EMC standard EN 61000-4-5 (testing voltage 1kV EMC wire/ground) are met.

Performance characteristics of ceramic process isolating diaphragm

Reference operating conditions

- As per IEC 60770
- Ambient temperature T_A = constant, in the range of:+21 to +33 °C (+70 to +91 °F)
- Humidity φ = constant, in the range of 5 to 80 % rH
- Ambient pressure p_A = constant, in the range of:860 to 1060 mbar (12.47 to 15.37 psi)
- Position of measuring cell = constant, in range: horizontal ±1° (see also "Influence of the installation position" section → 🖹 23)
- Zero based span
- Material of process isolating diaphragm: Al_2O_3 (aluminum-oxide ceramic, Ceraphire®)
- Supply voltage: 24 V DC ±3 V DC
- Load: 320 Ω (at 4 to 20 mA output)

Measuring uncertainty for small absolute pressure measuring ranges

The smallest extended uncertainty of measurement that can delivered by our standards is:

- in range 1 to 30 mbar (0.0145 to 0.435 psi): 0.4 % of reading
- in range < 1 mbar (0.0145 psi): 1 % of reading.

Influence of the installation position

→ 🖹 23

Resolution

Current output: min. 1.6 µA

Display: can be set (factory setting: presentation of the maximum accuracy of the transmitter)

Reference accuracy

The reference accuracy contains the non-linearity [DIN EN 61298-2 3.11] including the pressure hysteresis [DIN EN 61298-23.13] and non-repeatability [DIN EN 61298-2 3.11] in accordance with the limit point method as per [DIN EN 60770].

Device	% of the calibrated span to the maximum turn down		
	Reference accuracy	Non-linearity [1]	Non-repeatability
PTC31B - standard	±0.5	±0.1	±0.1
PTC31B - platinum	±0.3	±0.1	±0.1

1) The non-linearity for the 40 bar (600 psi) sensor can be up to ± 0.15% of the calibrated span up to the maximum turn down.

Overview of the turn down ranges → 🖹 12

Ordering Information

Description	Option [1]
Platinum (on request)	D
Standard	G

1) Product Configurator, order code for "Reference accuracy"

Thermal change of the zero output and the output span

Measuring cell	−20 to +85 °C (−4 to +185 °F)	−40 to −20 °C (−40 to −4 °F) +85 to +100 °C (+185 to +212 °F)
	% of URL for TD 1:1	
<1 bar (15 psi)	<1	<1.2
≥ 1 bar (15 psi)	<0.8	<1

Long-term stability

1 year	5 years	8 years
% of URL		
±0.2	±0.4	In preparation