

Technical Information

USD70

Differential pressure measurement



Silicon differential pressure sensor

Application

The differential pressure sensors USD70 are available for small measuring ranges with extremely high overload resistance. The differential pressure sensors USD70 with piezoresistive sensor and welded metal diaphragm are typically used in process and environmental industries.

Applications are level, volume or mass measurement in liquids, differential pressure monitoring, e. g. of filters and pumps as well as flow measurement (volume or mass flow).

Your benefits

- Measuring ranges from 10 mbar (0.15 psi) and 30 mbar (0.45 psi)
- Bridge output signal (mV/V)
- High accuracy, repeatability and long-term stability
- High overload resistance:
 - Up to 160 bar (2 400 psi) on one side
 - Up to 240 bar (3 600 psi) on both sides
- 316 L (stainless steel) version
- Optional choice of diaphragm materials and filling oils

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About this document

Document function This document contains all the technical data for the device and provides an overview of the device versions that can be ordered.

Symbols used	Safety symbols	
	Symbol	Meaning
	 WARNING	WARNING! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
	 NOTICE	NOTICE! This symbol contains information on procedures and other facts which do not result in personal injury.

Symbols for certain types of information

Symbol	Meaning
	Tip Indicates additional information.
	Reference to documentation
	Reference to page

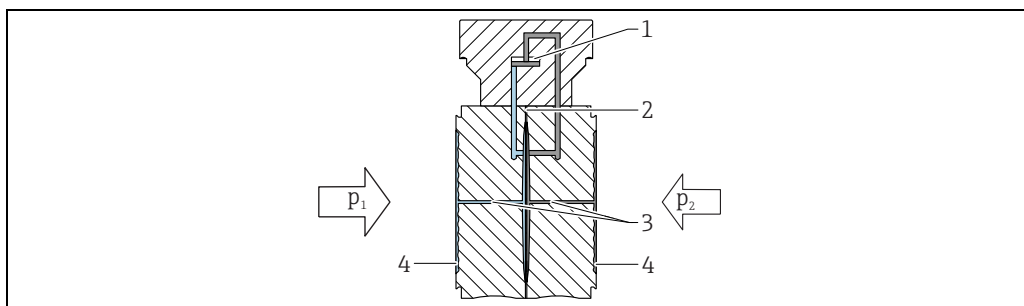
Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
A, B, C, ...	Views

Function and input parameters

Measuring principle

Metallic process diaphragm



A0062558

- 1 Measuring element
 2 Overload diaphragm
 3 Filling liquid
 4 Process diaphragm
 p_1 Pressure 1
 p_2 Pressure 2

The metallic process diaphragms (4) are deflected on both sides by the applied pressures p_1 and p_2 . A filling liquid (3) transfers the pressure to one side of the measuring element, on which a resistance measuring bridge is located (semiconductor technology). The differential pressure-dependent change in the bridge output voltage is measured and put out.

Measured variable

Differential pressure

Measuring range

Sensor	Maximum sensor measuring range		MWP	OPL	
	Lower (LRL)	Upper (URL)		One-sided	Both-sided
	[mbar (psi)]	[mbar (psi)]		[bar (psi)]	[bar (psi)]
10 (0.15)	-10 (-0.15)	+10 (+0.15)	160 (2 400) ¹⁾	160 (2 400)	240 (3 600)
30 (0.45)	-30 (-0.45)	+30 (+0.45)			

1) MWP only both-sided

⚠ WARNING

- ▶ The measuring device must be operated only within the specified limits!
- ▶ The specified values are only achieved in the reference installation (→ 9).
- ▶ The maximum pressure for the sensor depends on the lowest-rated element with regard to pressure.

Output

Output signal

Uncompensated bridge output signal.
Specifications valid at 0.5 mA supply current.

Sensor [mbar (psi)]	Typical span (referred to zero point)
10 (0.15)	9 to 19 $\pm$ mV
30 (0.45)	18 to 34 $\pm$ mV

Bridge resistance

4.5 to 5.6 k Ω (at 25 °C (77 °F))

Dynamic behavior

Warm-up period (according to IEC 62828-4)	Time constant T63
~5 ms	max. 450 ms

Performance characteristics

Reference operating conditions

- According to IEC 62828-2
- Ambient temperature T_A = constant, in the range 22 to 28 °C (72 to 82 °F)
- Humidity j = constant, in the range: 5 to 80 % rH $\pm$ 5 %
- Ambient pressure p_U = constant, in the range: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of measuring cell: horizontal $\pm 1^\circ$
- Measuring span based on zero point

Sensor characteristics

Measuring cell 10 mbar (0.15 psi)				
Characteristic	Min.	Typical	Max.	Unit
Resistance @25 °C (77 °F) (R _b)	4.5	5	5.6	k Ω
Sensitivity@25 °C (77 °F) (sens)	300	500	700	mV/(V·bar)
Fullscale @25 °C (77 °F) (FS)	3	5	7	mV/V
Offset @25 °C (77 °F)	-3	0	3	mV/V
Linearity error @25 °C (77 °F)	1.5	2.5	4.5	%FS
Temperature coefficient of the resistance (TCR)				
@ -40 to 25 °C (-40 to 77 °F)	1.4	1.7	2	%R _b /10 K
@ 25 to 85 °C (77 to 185 °F)	2.3	2.65	3	%R _b /10 K
Temperature coefficient of the sensitivity (TCS)				
@ -40 to 25 °C (-40 to 77 °F)	-2.7	-2.5	-2.3	%FS/10 K
@ 25 to 85 °C (77 to 185 °F)	-2.1	-1.9	-1.7	%FS/10 K
Temperature coefficient of the offset (TCO)				
@ -40 to 25 °C (-40 to 77 °F)	-3	-0.5	2.5	%FS/10 K
@ 25 to 85 °C (77 to 185 °F)	-2	-0.2	2	%FS/10 K

Measuring cell 30 mbar (0.45 psi)				
Characteristic	Min.	Typical	Max.	Unit
Resistance @25 °C (77 °F) (Rb)	4.5	5	5.6	kΩ
Sensitivity@25 °C (77 °F) (sens)	300	400	500	mV/(V·bar)
Fullscale @25 °C (77 °F) (FS)	9	12	15	mV/V
Offset @25 °C (77 °F)	-3	0	3	mV/V
Linearity error @25 °C (77 °F)	1.5	2.5	3.9	%FS
Temperature coefficient of the resistor (TCR)				
@ -40 to 25 °C (-40 to 77 °F)	1.4	1.7	2	%Rb/10 K
@ 25 to 85 °C (77 to 185 °F)	2.3	2.65	3	%Rb/10 K
Temperature coefficient of the sensitivity (TCS)				
@ -40 to 25 °C (-40 to 77 °F)	-2.7	-2.5	-2.3	%FS/10 K
@ 25 to 85 °C (77 to 185 °F)	-2.1	-1.9	-1.7	%FS/10 K
Temperature coefficient of the offset (TCO)				
@ -40 to 25 °C (-40 to 77 °F)	-1.1	-0.2	0.9	%FS/10 K
@ 25 to 85 °C (77 to 185 °F)	-0.8	-0.1	0.7	%FS/10 K

Calculation of thermal effect Offset(T) = offset(25 °C) + TCO·FS·ΔT
 Sens(T) = sens(25 °C) · (1+TCS·ΔT)
 Rb(T) = Rb(25 °C) · (1+TCR·ΔT)

Testing the sensor The differential pressure sensors USD70 are 100 % tested for compensability and compliance with the temperature coefficients as part of the quality control process.

Static pressure influence The "static pressure influence" describes the influence on the output due to changes in the static pressure of the process (difference between the output at any static pressure and the output at atmospheric pressure [IEC 62828-2 / IEC 61298-3] and thus the combination of influence of the working pressure on the zero point and the span).

Measuring cell [mbar (psi)]	Influence on the zero point	Influence on the span
10 (0.15)	±0.23 % of URL per 7 bar (105 psi)	±0.035 % of span per 7 bar (105 psi)
30 (0.45)	±0.70 % of URL per 70 bar (1050 psi)	±0.14 % of span per 70 bar (1050 psi)

* Data on static pressure influence refer to pressurization on both sides

Long-term stability 1 year: ±0.20 % of URL
 5 years: ±0.28 % of URL
 10 years: ±0.31 % of URL
 15 years: ±0.34 % of URL

Process

Process temperature range	-40 to 85 °C (-40 to 185 °F) Devices with inert oil: Minimum process and ambient temperature -20 °C (-4 °F)
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Process pressure range	Pressure data
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WARNING

- ▶ **MWP (Maximum Working Pressure):** This value refers to a reference temperature of 20 °C (68 °F) and may be applied to the sensor for an unlimited time.
Note the pressure-temperature dependence of the MWP. For pressure values permitted at higher temperatures, please refer to EN 1092-1: 2001 Tab. 18, ASME B 16.5a, JIS B 2220 (the current version of the standard applies). Deviating MXP specifications can be found in the relevant chapters of the technical information.
- ▶ **OPL (Over Pressure Limit):** The test pressure corresponds to the overload limit of the sensor and may only be applied for a limited time to prevent permanent damage.
- ▶ The overload limit is the maximum pressure with which a device may be loaded during a test. It is greater than the maximum operating pressure by a certain factor. This value refers to a reference temperature of 20 °C (68 °F).
- ▶ The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the device.
- ▶ The measuring cells were designed for high pressure levels with load changes. With very frequent load changes and at pressures ≥ 63 bar (913.5 psi), check the zero point regularly.

Oxygen applications (gaseous)

Oxygen and other gases can react explosively with oils, fats and plastics. The following precautions must be taken:

- All components of the system, such as devices, must be cleaned in accordance with national requirements.
- Depending on the materials used, a certain maximum temperature and pressure must not be exceeded in oxygen applications.
 - For filling oil: Inert oil
 - $p_{\max}$: 80 bar (1200 psi)
 - $T_{\max}$: 60 °C (140 °F)

Environment

Ambient temperature range	-40 to 85 °C (-40 to 185 °F) Devices with inert oil: Minimum process and ambient temperature -20 °C (-4 °F)
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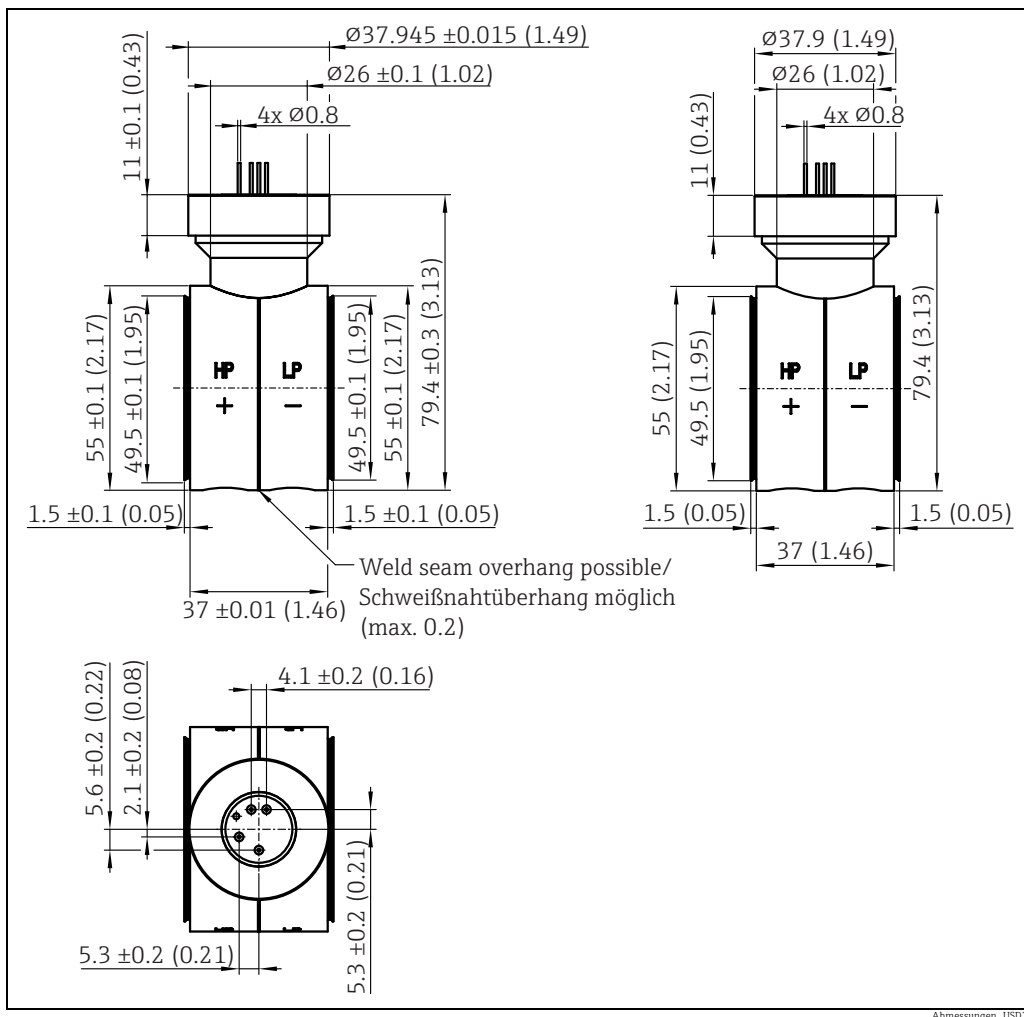
Storage temperature range	-40 to 85 °C (-40 to 185 °F)
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Degree of protection	System	Degree of protection
	Open	IP00

Climate class	System	Climate class	Note
	Open	Class 3K22 (former 3K3)	Air temperature: 5 to 40 °C (41 to 104 °F), Relative humidity: 5 to 85 % satisfied according to 60721-3-3 (condensation not permitted)

Mechanical construction

Dimensions



Materials

Materials in contact with process

Diaphragm material:

- Stainless steel AISI 316L (1.4435)
- Alloy C276 (2.4819)

Base body:

- stainless steel AISI 316L (1.4404)

Materials not in contact with process

Measuring cell body:

- Stainless steel AISI 316L (1.4404)

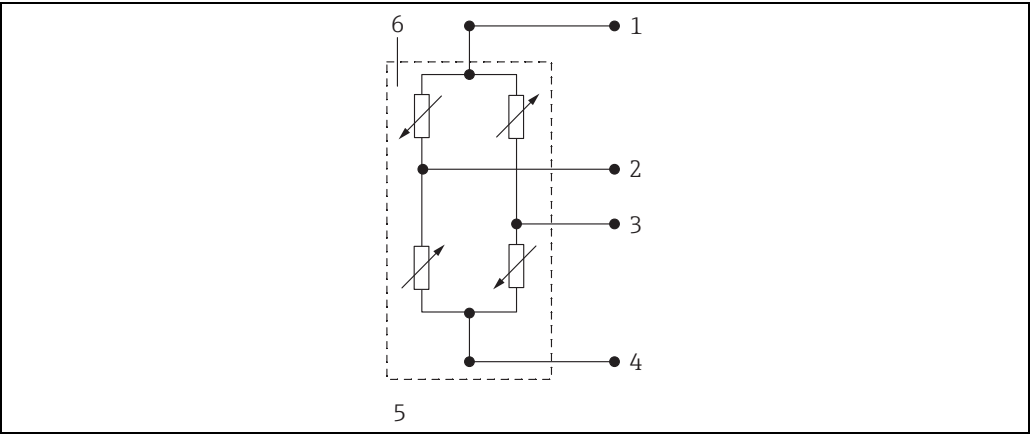
Filling fluid:

- Silicone oil
- Inert oil
 - not suitable for temperatures below $-20\text{ }^{\circ}\text{C}$ ($-4\text{ }^{\circ}\text{F}$)
 - For oxygen applications: see chapter "Process" (→ 7).

Power supply

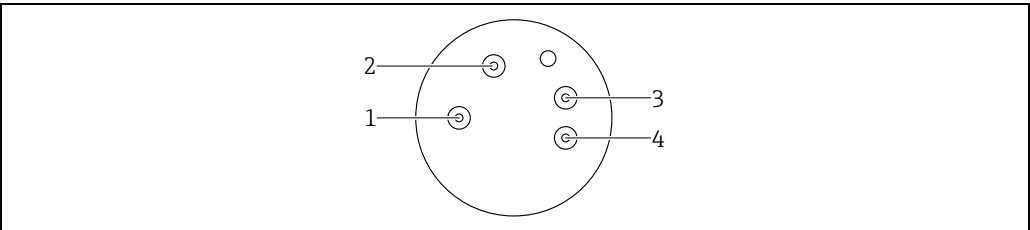
Current supply <1 mA

Electrical connection Wiring diagram



- 1 Positive current supply
- 2 Positive output signal
- 3 Negative output signal
- 4 Negative current supply
- 5 Isolated potential housing
- 6 Bridge

PIN assignment



- 1 Positive current supply
- 2 Positive output signal
- 3 Negative output signal
- 4 Negative current supply

Installation

Reference installation Reference installation according to installation instructions EA014840.

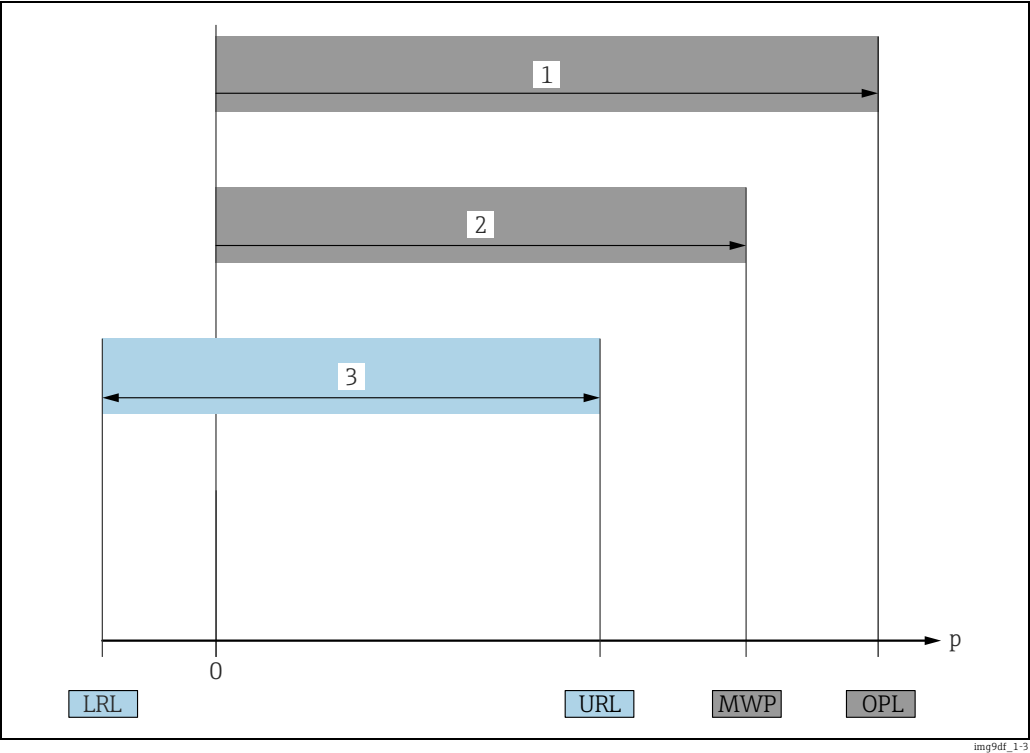
Certificates and approvals

RoHS	The measuring system complies with the substance restrictions of the Restriction on Hazardous Substances Directive 2011/65/EU.
Other standards and guidelines	The applicable European guidelines and standards can be found in the relevant EU Declarations of Conformity. The following were also applied: DIN EN 60770 (IEC 60770): Transmitters for use in industrial process control systems Part 1: Methods for evaluating the performance of transmitters for control and regulation in industrial process control systems. DIN 16086: Procedure for writing specifications in data sheets for electrical pressure measuring instruments, pressure sensors and pressure transmitters.

Explanations and supplementary documentation

Supplementary documentation	 Installation instructions: EAO14840
Disposal	 If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), our products are marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Such products may not be disposed of as unsorted municipal waste and can be returned to Endress+Hauser for disposal at conditions stipulated in our General Terms and Conditions or as individually agreed.
Contact addresses	Internet: www.sensors-components.endress.com E-mail: sensors-components.ehlp@endress.com Address: Endress+Hauser SE+Co. KG Sensors & Components Hauptstraße 1 79689 Maulburg Germany

Terms and abbreviations



Item	Term/abbreviation	Explanation
1	OPL	The OPL (over pressure limit = sensor overload limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. in addition to the measuring cell, the process connection must also be taken into account. Also observe pressure-temperature dependency. The test pressure corresponds to the overload limit of the sensor (OPL = 1.5 x MWP) and may only be applied for a limited time to prevent permanent damage.
2	MWP	The MWP (maximum working pressure) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. in addition to the measuring cell, the process connection must also be taken into account. Also observe pressure-temperature dependency. The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS", this corresponds to the MWP of the measuring device. The MWP refers to a reference temperature of 20 °C (68 °F) and may be applied to the device for an unlimited time.
3	Maximum sensor measuring range	Span between LRL and URL This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
–	p	Pressure
–	LRL	Lower range limit
–	URL	Upper range limit



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