

Series 9L

Piezoresistive OEM pressure transducers with very high stability in a compact design

Features

- Very high long-term stability
- Robust, compact stainless-steel housing
- Front-flush, crevice-free welded diaphragm
- Very high proof pressure
- Optimised thermal behaviour

Technology

- Insulated piezoresistive pressure sensor encapsulated in an oil-filled metal housing
- Ideal for mounting with O-ring
- Typical range of output signal of 160 mV/mA

Typical Applications

- OEM
- Industry
- Laboratory
- Gas meters

Accuracy

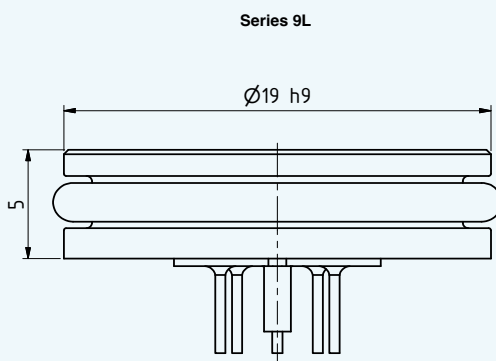
$\pm 0,25\%$ FS

Long-term Stability

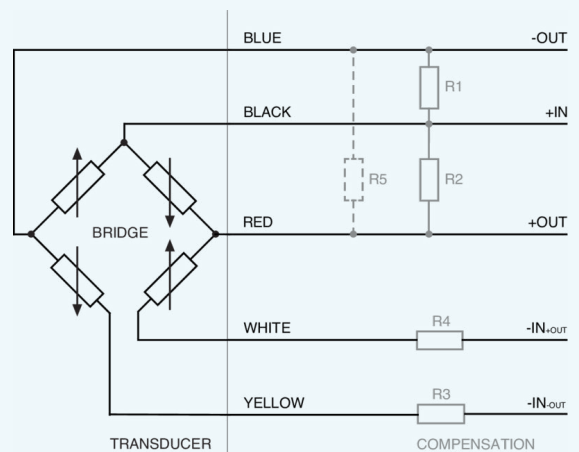
$\pm 0,20\%$ FS/year

Pressure Ranges

0...0,2 bar to 0...200 bar



Electrical Diagram of a 9L with compensation resistors



Series 9L – Specifications

Standard Pressure Ranges

Relative pressure		Absolute pressure	Absolute pressure	Proof pressure	Sensitivity		
PR		PAA	PA		min.	typ.	max.
-0,2...0,2	0...0,2	0...0,2		3	98	130	163
-0,3...0,3	0...0,3	0...0,3					
-0,5...0,5	0...0,5	0...0,5					
-1...0	0...1	0...1	0...1	6	60	80	100
-1...1	0...2	0...2	0...2	9	40	53	66,7
-1...2	0...3	0...3	0...3				
	0...5	0...5	0...5	15	24	32	40
	0...10	0...10	0...10	30	12	16	20
	0...20	0...20	0...20	60	6	8	10
	0...30	0...30	0...30	90	4	5,3	6,7
	0...50	0...50	0...50	150	2,4	3,2	4
		0...100	0...100	300	1,2	1,6	2
		0...160	0...160		0,75	1,0	1,25
		0...200	0...200				
bar rel.		bar abs.	bar	bar	mV/(mA × bar)		
Reference pressure at ambient pressure		Reference pressure at 0 bar abs. (vacuum)	Reference pressure at 1 bar abs.	Based on reference pressure	The standard pressure ranges are available from the warehouse. Additional calibrations to intermediate pressure ranges can also be made.		

Performance

Accuracy @ RT (20...25 °C)	± 0,25 %FS typ.	Non-linearity (minimum value setting BFSL), pressure hysteresis, non-repeatability
	± 0,50 %FS max.	
Offset @ RT (20...25 °C)	< ± 25 mV/mA	Uncompensated, the sensitivity value must be added for PA.
	< ± 2 mV/mA	Compensated with R3 or R4.
Compensated temperature range	-10...80 °C	Other temperature ranges between -55...150 °C are possible as an option.
Long-term stability	≤ ± 0,2 %FS	For pressure ranges > 1 bar, per year under reference conditions.
	≤ ± 2 mbar	For pressure ranges ≤ 1 bar, per year under reference conditions.
Position dependency	≤ 2 mbar	Calibrated in vertical installation position with metal diaphragm facing downwards.
Temperature coefficient TCzero pre-compensated with R1 or R2	≤ ± 0,02 %FS/K	For pressure ranges ≥ 2 bar
	≤ ± 0,4 mbar/K	For pressure ranges < 2 bar
Temperature coefficient sensitivity TCsens	≤ ± 0,06 %/K	For pressure ranges ≥ 3 bar
	≤ ± 0,12 %/K	For pressure ranges < 3 bar
Temperature coefficient total bridge resistance TC-resistance	1800...3000 ppm/K	

Series 9L – Specifications

Electrical Data

Half-bridge configuration

Constant current supply	1 mA nominal 3 mA max.	
Bridge resistance @ RT (20...25 °C)	3,5 kΩ ± 20 %	
Electrical connection	Gold-plated pins ø 0.45 mm L = 4 mm ± 0,5 mm	Optional: Silicone wires AWG28 (0,09 mm ²), L = 70 mm, other lengths on request.
Insulation	> 100 MΩ @ 500 VDC	

Mechanical Data

Materials in contact with media

Housing and diaphragm	Stainless steel AISI 316L	Optional: Hastelloy C-276, titanium
O-ring	ø 15,6 mm × 1,78 mm FKM (75 Shore) -20...200 °C	For medium temperatures < -20 °C FVMQ is used. Other materials on request.

Other materials

Pressure transducer oil filling	Silicone oil	Others on request.
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Further details

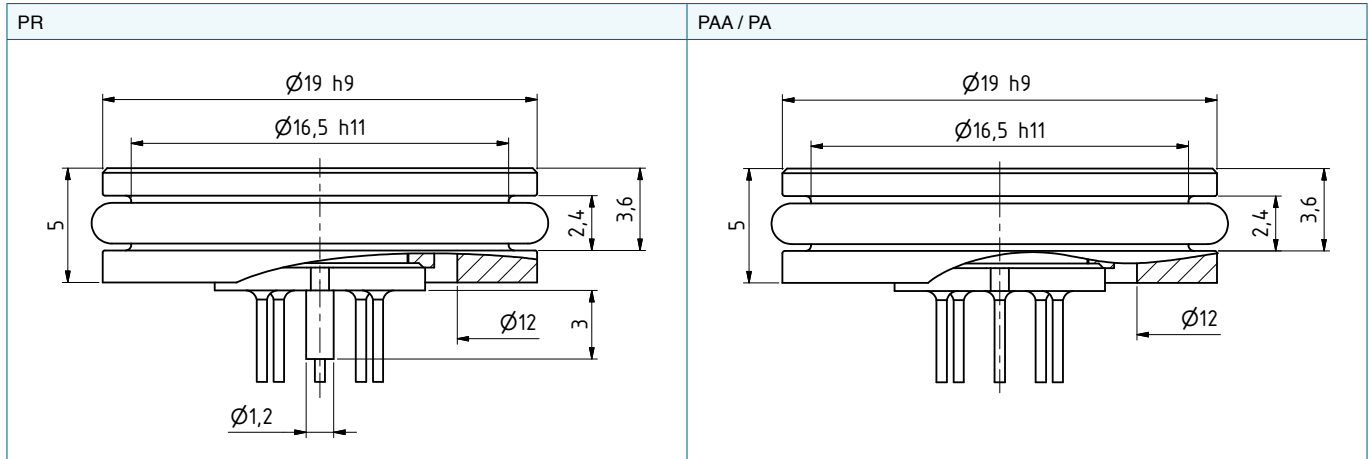
Diameter × height	ø 19 mm × 5 mm	See Dimensions and Options
Connection for capillary for reference pressure compensation	ø 1,2 mm × 3 mm	Optional: Capillary (silicone)
Weight	approx. 8 g	

Environmental conditions

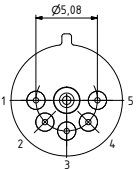
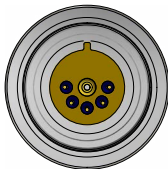
Media temperature range	-40...125 °C	Optional: -55...150 °C	Operating temperature, consider o-ring. Icing not permitted.
Ambient temperature range	-40...125 °C		
Storage temperature range	-40...125 °C		
Vibration resistance	10 g, 10...2000 Hz, ± 10 mm		IEC 60068-2-6
Shock resistance	50 g, 11 ms		IEC 60068-2-27
Natural frequency (resonance)	> 30 kHz		
Endurance @ RT (20...25 °C)	> 10 million pressure cycles		
Dead volume change @ RT (20...25 °C)	< 2 mm ³		0...100 %FS

Series 9L – Dimensions and Options

Overview of Versions



Electrical Connection

Glass feedthrough connection	Half-open measurement bridge pin assignment																											
		<table border="1"> <thead> <tr> <th>PIN</th> <th>Label</th> <th>Designation</th> <th>Wire colour</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>+OUT</td> <td>Positive Output</td> <td>red</td> </tr> <tr> <td>2</td> <td>+IN</td> <td>Positive Supply</td> <td>black</td> </tr> <tr> <td>3</td> <td>-OUT</td> <td>Negative Output</td> <td>blue</td> </tr> <tr> <td>4</td> <td>-IN_{-OUT}</td> <td>Negative Supply (half bridge -OUT)</td> <td>yellow</td> </tr> <tr> <td>5</td> <td>-IN_{+OUT}</td> <td>Negative Supply (half bridge +OUT)</td> <td>white</td> </tr> </tbody> </table>	PIN	Label	Designation	Wire colour	1	+OUT	Positive Output	red	2	+IN	Positive Supply	black	3	-OUT	Negative Output	blue	4	-IN _{-OUT}	Negative Supply (half bridge -OUT)	yellow	5	-IN _{+OUT}	Negative Supply (half bridge +OUT)	white		
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Overview of Customer-specific Options

- Calibration to other pressure ranges
- Calibration to other temperature ranges
- Calibration with mathematical modeling
- Electrical connection via silicone wires execute
- Housing and diaphragm made of Hastelloy C-276 or titanium
- O-Rings made of other materials
- Other oil filling types for pressure transducers – e.g. special oils for oxygen applications
- Modifications to customer-specific applications

Examples of Similar Products

- Series 10L: Low-pressure transducer with maximum long-term stability
- Series 9FL: Version with flange
- Series 9LX: Pressure transducer 9L with digital compensation electronics
- Series 4L...7L: More compact sizes

Series 9L – Analysis and Characteristic Lines

Standard Analysis

The 9L are intended for o-ring mounting and depend on the stress isolation provided by o-rings for performance within stated specifications. This installation enables the values measured during factory testing to remain valid. If the transducers are not installed free from stress, the mechanical forces may change the measured values and the stability of the pressure transducers.

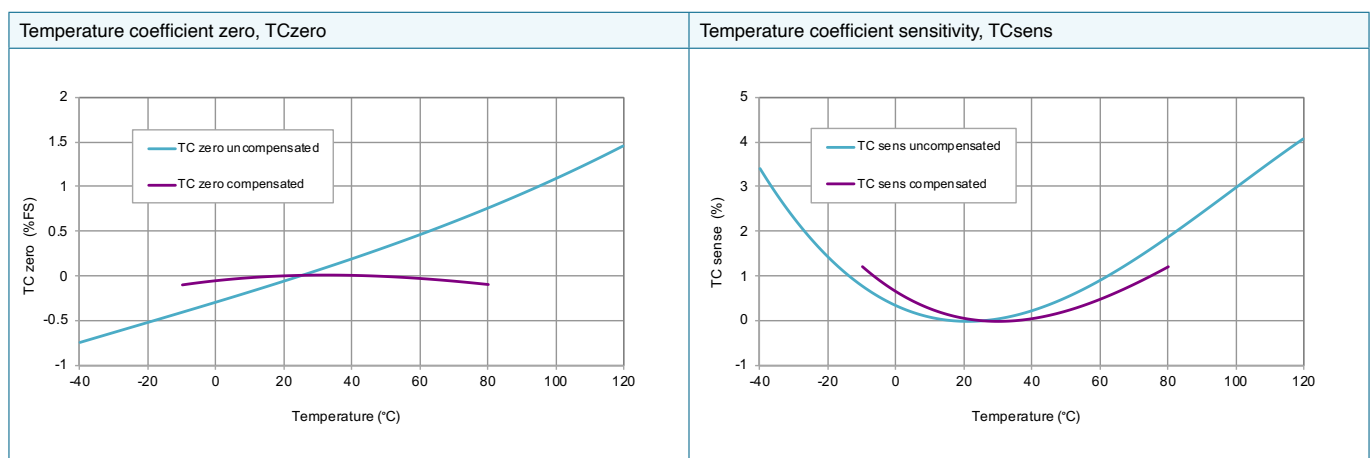
Calibration sheet: Example type PA-10L					Key																																																																																																																																										
<table border="1"> <tr> <td colspan="4">PA-10L / 10 bar / 10-1005-118 ⁽¹⁾</td> <td colspan="1">Sn I107547 ⁽²⁾</td> <td colspan="1">449</td> </tr> <tr> <td colspan="4"></td> <td colspan="1">29/01</td> <td colspan="1"></td> </tr> <tr> <td>⁽³⁾Temp [°C]</td> <td>⁽⁴⁾Zero [mV]</td> <td>⁽⁵⁾+510 [mV]</td> <td>⁽⁶⁾Comp [mV]</td> <td>⁽⁷⁾dZero [mV]</td> <td></td> </tr> <tr> <td>-9.5</td> <td>18.5</td> <td>13.3</td> <td>-0.6</td> <td>0.2</td> <td></td> </tr> <tr> <td>0.1</td> <td>18.7</td> <td>13.3</td> <td>-0.6</td> <td>0.2</td> <td></td> </tr> <tr> <td>25.0</td> <td>19.1</td> <td>13.1</td> <td>-0.8</td> <td>0.0</td> <td></td> </tr> <tr> <td>50.2</td> <td>19.8</td> <td>13.0</td> <td>-0.9</td> <td>-0.1</td> <td></td> </tr> <tr> <td>79.9</td> <td>20.8</td> <td>12.9</td> <td>-1.1</td> <td>-0.2</td> <td></td> </tr> <tr> <td colspan="5">COMP R1 510 kOhm ⁽⁸⁾ R3 56.0 Ohm ⁽⁹⁾</td> <td></td> </tr> <tr> <td colspan="5">RB 3482 Ohm ⁽⁹⁾</td> <td></td> </tr> <tr> <td colspan="5">ZERO -0.8 mV ⁽¹⁰⁾ P_atm 964 bar</td> <td></td> </tr> <tr> <td colspan="5">SENS 16.41 mV/bar ⁽¹¹⁾</td> <td></td> </tr> <tr> <td>LIN ⁽¹²⁾ [bar]</td> <td>⁽¹³⁾ [mV]</td> <td>⁽¹⁴⁾ Lnorm [%Fs]</td> <td>⁽¹⁵⁾ Lbfsl [%Fs]</td> <td></td> <td></td> </tr> <tr> <td>0.000</td> <td>0.0</td> <td>0.00</td> <td>-0.01</td> <td></td> <td></td> </tr> <tr> <td>2.500</td> <td>41.1</td> <td>0.02</td> <td>0.01</td> <td></td> <td></td> </tr> <tr> <td>5.000</td> <td>82.1</td> <td>0.00</td> <td>0.00</td> <td></td> <td></td> </tr> <tr> <td>7.500</td> <td>123.1</td> <td>-0.02</td> <td>-0.01</td> <td></td> <td></td> </tr> <tr> <td>10.000</td> <td>164.1</td> <td>-0.01</td> <td>-0.01</td> <td></td> <td></td> </tr> <tr> <td colspan="5">Long Term Stability Ok ⁽¹⁶⁾</td> <td></td> </tr> <tr> <td colspan="5">Lot 72114-2 ⁽¹⁷⁾</td> <td></td> </tr> <tr> <td colspan="5">Test 500 Volt Ok ⁽¹⁸⁾</td> <td></td> </tr> <tr> <td colspan="5">Supply 1.000 mA ⁽¹⁹⁾</td> <td></td> </tr> <tr> <td colspan="5">01.09.17 ⁽²⁰⁾ ----- GOL3.A03D1K ⁽²⁰⁾</td> <td></td> </tr> </table>					PA-10L / 10 bar / 10-1005-118 ⁽¹⁾				Sn I107547 ⁽²⁾	449					29/01		⁽³⁾ Temp [°C]	⁽⁴⁾ Zero [mV]	⁽⁵⁾ +510 [mV]	⁽⁶⁾ Comp [mV]	⁽⁷⁾ dZero [mV]		-9.5	18.5	13.3	-0.6	0.2		0.1	18.7	13.3	-0.6	0.2		25.0	19.1	13.1	-0.8	0.0		50.2	19.8	13.0	-0.9	-0.1		79.9	20.8	12.9	-1.1	-0.2		COMP R1 510 kOhm ⁽⁸⁾ R3 56.0 Ohm ⁽⁹⁾						RB 3482 Ohm ⁽⁹⁾						ZERO -0.8 mV ⁽¹⁰⁾ P_atm 964 bar						SENS 16.41 mV/bar ⁽¹¹⁾						LIN ⁽¹²⁾ [bar]	⁽¹³⁾ [mV]	⁽¹⁴⁾ Lnorm [%Fs]	⁽¹⁵⁾ Lbfsl [%Fs]			0.000	0.0	0.00	-0.01			2.500	41.1	0.02	0.01			5.000	82.1	0.00	0.00			7.500	123.1	-0.02	-0.01			10.000	164.1	-0.01	-0.01			Long Term Stability Ok ⁽¹⁶⁾						Lot 72114-2 ⁽¹⁷⁾						Test 500 Volt Ok ⁽¹⁸⁾						Supply 1.000 mA ⁽¹⁹⁾						01.09.17 ⁽²⁰⁾ ----- GOL3.A03D1K ⁽²⁰⁾						<ol style="list-style-type: none"> Type (PA-10L) and measuring range (10 bar) of pressure sensor Serial number of pressure sensor Actual test temperatures Uncompensated zero offset Zero offset values with calculated compensation resistor R1 (+) or R2 (-) Zero offset values with calculated compensation resistors R1 or R2 and R3 or R4 Temperature zero error with calculated compensation resistors Calculated compensation resistor R1 or R2 (TCzero) and R3 or R4 (offset) RB: Bridge resistance at room temperature Calculated offset with compensation resistors R1 or R2 and R3 or R4 Sensitivity of pressure sensor at room temperature 25° C Pressure test points Signal change at pressure test points at room temperature 25° C Non-linearity (best straight line through zero) Non-linearity (best straight line) Result of the long-term stability test Sensor traceability information Insulation test Excitation (constant current) Date of test ----- Test equipment
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Notes

- The indicated specifications apply only for constant current supply of 1 mA. The sensor must not be supplied with more than 3 mA. The output voltage is proportional to the supply current. If the supply deviates from the calibration, this will cause signal shifts.
- The compensation resistors described in this data sheet are not part of the pressure transducer and are not included in the scope of delivery.
- It is recommended to use compensation resistors with temperature coefficients of < 50 ppm/°C for large temperature ranges. Sensor and resistors can be exposed to different temperatures.
- In addition, a maximum TC-sensitivity can be guaranteed on request or the value for the compensation resistor (R5) can be indicated. See "Electrical diagram of compensation resistors" on page 1.

Characteristic Lines

Examples of typical characteristic curves of the temperature coefficients, normalised at 25 °C, uncompensated vs. compensated.



Series 9L – Analysis and Characteristic Lines

Mathematical compensation model

KELLER's 9L Series pressure transducers can be ordered with an optional mathematical compensation model.

The compensation model is a mathematical formula that helps to calculate the compensated pressure value of the pressure transducer. Both the pressure signal and the temperature signal of the pressure transducer are incorporated into the calculation. Polynomial functions are used as the basis for this mathematical model.

The pressure transducers are characterised in the factory in order to produce the compensation model. This involves measuring pressure and temperature signals at various pressure and temperature levels. Comparing the measured values with the known pressure and temperature values makes it possible to calculate the compensation coefficients of the pressure transducer. These compensation coefficients are made available to the customer along with the respective pressure transducer.



KELLER myCalibration

Content

myCalibration is a digital data platform provided free of charge to KELLER customers. It provides an easy option for transferring and providing sensor calibration data.

Format

The calibration data is available in the standard JSON file format, which facilitates smooth integration into the customer's software. The file structure is clearly defined in a publicly accessible JSON schema. This means that the customer is able to integrate the data seamlessly into their software.

Access

The platform can be accessed either via a standard web browser (web view) or directly within the customer's linked software using an API. The calibration data remains available in myCalibration for 24 months.

Web app

Customers can access the calibration data for their sensors via a user-friendly interface. The system ensures secure authentication by asking users to enter their personal login details, thereby preventing unauthorised access to the data by third parties.

The user has the option to use various search and filter functions to download calibration data for specific sensors or mass export multiple datasets simultaneously.

API

Customers have the option to use the REST API for automated access and to integrate it into their processes. This means that calibration data for new sensors can be called up automatically and then processed, for example.

Documentation

Comprehensive technical documentation including example software is available at the following link: <https://mycalibration.github.io/>