Piezoresistive OEM Pressure Transducers

Laser Welded Diaphragm - Compatible with Corrosive Media

Series 3 L…10 L are a new generation of transducers from KELLER which feature smaller capsule dimensions and a crevice-free diaphragms. KELLER’s expertise in laser welding very thin materials enables the production of a line of transducers with a crevice-free media interface while improving on performance and long-term stability.

Each transducer undergoes extensive automated testing and is supplied with calibration data which includes sensitivity, linearity, initial zero offset and thermal effects over the compensated temperature range. This provides the user with the information required to ensure performance within specifications.

The 3 L…10 L transducers feature floating O-ring mounting to avoid errors which can be caused by mechanical stresses imparted to the transducer housing and ensures performance within the specifications. The transducer housing encases the piezoresistive silicon pressure sensor and a small quantity of oil, the latter of which is required to efficiently transfer the pressure exerted on the media-isolation diaphragm to the silicon pressure sensor.

The type of oil is most typically silicone but other oils are available for special applications where silicones are not allowed.

With the laser welded technology, transducers having diameters as low as 9.5 mm can be realised. As can be discerned from the below chart, the lower the pressure ranges are available in only the larger, i.e., Ø 19 mm diameter, due to the inherent increase in diaphragm stiffness as the diameter is reduced.

Also note from the chart the lengths of the "L" vs. “L HP” designs, e.g., Series 6 L and 6 L HP, wherein the 6 L HP is 3.5 mm longer than the 6 L in order to accommodate the thicker glass feedthrough required to contain the higher pressures.

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions (mm)</th>
<th>Ranges (bar)</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 L</td>
<td>Ø 9.5 x 4.2</td>
<td>20...200</td>
<td>abs.</td>
</tr>
<tr>
<td>4 L</td>
<td>Ø 11 x 4.2</td>
<td>10...200</td>
<td>abs.</td>
</tr>
<tr>
<td>5 L</td>
<td>Ø 12 x 4.5</td>
<td>10...200</td>
<td>abs.</td>
</tr>
<tr>
<td>6 L</td>
<td>Ø 13 x 4.5</td>
<td>20...200</td>
<td>abs.</td>
</tr>
<tr>
<td>6 L HP</td>
<td>Ø 13 x 8</td>
<td>200...1000</td>
<td>abs.</td>
</tr>
<tr>
<td>7 L</td>
<td>Ø 15 x 5</td>
<td>10...200</td>
<td>abs. / gauge</td>
</tr>
<tr>
<td>7 L HP</td>
<td>Ø 15 x 8</td>
<td>200...1000</td>
<td>abs.</td>
</tr>
<tr>
<td>8 L</td>
<td>Ø 17 x 7</td>
<td>0.2...200</td>
<td>abs. / gauge</td>
</tr>
<tr>
<td>9 L</td>
<td>Ø 19 x 5</td>
<td>0.2...200</td>
<td>abs. / gauge</td>
</tr>
<tr>
<td>PD-9 L</td>
<td>Ø 19 x 15</td>
<td>0.1...50</td>
<td>diff. / nass-nass</td>
</tr>
<tr>
<td>10 L</td>
<td>Ø 19 x 15</td>
<td>0.1...100</td>
<td>abs. / gauge</td>
</tr>
<tr>
<td>10 L HP</td>
<td>Ø 19 x 15</td>
<td>200...1000</td>
<td>abs. / gauge</td>
</tr>
<tr>
<td>PD-10 L</td>
<td>Ø 19 x 26</td>
<td>0.1...50</td>
<td>diff. / nass-nass</td>
</tr>
</tbody>
</table>
Specifications

**Excitation** I = 1 mA

### Series 3 L…10 L

<table>
<thead>
<tr>
<th>Standard Pressure Ranges (FS) in bar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PR</strong></td>
</tr>
<tr>
<td><strong>PD</strong></td>
</tr>
<tr>
<td><strong>PA</strong></td>
</tr>
</tbody>
</table>

**Compensated Range**

<table>
<thead>
<tr>
<th>-0.5</th>
<th>-0.2</th>
<th>-0.1</th>
<th>0.1</th>
<th>0.2</th>
<th>0.5</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>50</td>
<td>25</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>60</td>
<td>100</td>
<td>140</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

**Overpressure**

<table>
<thead>
<tr>
<th>-1</th>
<th>-1</th>
<th>-1</th>
<th>2.5</th>
<th>2.5</th>
<th>2.5</th>
<th>3</th>
<th>4</th>
<th>7</th>
<th>15</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

**PD-9 L, max. Line Pressure**

<table>
<thead>
<tr>
<th>50</th>
</tr>
</thead>
</table>

**PD-10 L, max. Line Pressure**

| 200 |

- **Bridge Resistance** @ 25 °C: 3.5 kΩ ± 20%
- **Current Supply**: 1 mA nominal, 3 mA max.
- **Insulation** @ 500 VDC: 100 MΩ
- **Compensated Range (1)**
  -0.5 °C (2 L…5 L)
  -10...-80 °C (6 L…10 L)
- **Vibration (20 to 5000 Hz)**: 20 g
- **Endurance @ 25 °C**: > 10 Mio. FS cycles

### Housing and Diaphragm

- **Material**: Stainless steel, type 316 L (3)
- **O-Ring Material**: 3 L: L: Nitrile; 4 L: L…10 L: Viton (1)
- **Oil Filling**: Silicone oil (2)
- **Dead Volume Change @ 25 °C**: < 0.1 mm³/FS
- **Electr. Connection Wires (PD-9 L, PD-10 L, 10 L)**: 0.09 mm² (12 x Ø 0.1 mm), Silicone sheathed Ø 1.2 mm, Length: 7 cm (10 L), 10 cm (PD-9 L, PD-10 L)

### Accuracy (2)

- **0.25 %FS typ.** (1)
- **0.5 %FS max.**

### Offsets at 25 °C

- **< 5 mV** (compensated with R5 of 20 kΩ (3))

### Temperature Coefficient Sensitivity (2)

- **0.02 %/°C typ.** (0...50 °C)
- **0.05 %/°C typ.** (< -10...80 °C)

### Line Pressure Influence

- **< 0.0125 mV/bar** (PD-9 L, PD-10 L)

### Natural Frequency (Resonance)

> 30 kHz

The sensor characteristics may be influenced by installation conditions. Please follow the installation instructions on our product-specific web pages.

### Options

- **Diaphragm and housing**: Hastelloy C-276, Inconel 718 or Titanium; gold-plated diaphragm
- **Oil for low temperatures**: Oxygen-compatible oil, Olive oil
- **Integrated temperature sensor** (version PA, PAA, PR)
- **Special characteristics**: Linearity, overpressure, lower TC-zero resp. TC-sensitivity
- **Extended temperature range** from -55 to 150 °C (7 L…10 L)
- **All pressure ranges between 0.1 and 1000 bar**: Series 10 L: Pressure ranges up to 2000 bar
- **Series PD-10 L**: Line Pressure up to 600 bar
- **Compensation PCB fitted**
- **Mathematical modelling**: See data sheet Series 30 X

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(1) Others on request.
(2) Including linearity, hysteresis and repeatability. Linearity calculated as best straight line through zero.
(3) Note: Generally, accuracy and overload is improved by factor of 2 to 4 if the sensor is used in the range of 0...50 %FS.
(4) External compensation; potentiometer is not supplied.
(5) Temperature Coefficients of Zero
(6) On request, a maximal TC Sensitivity can be guaranteed or the value for the compensation resistor (R) is indicated.
STANDARDISED PREMIUM-LINE

The preceding two pages present a variety of possibilities for the design, pressure ranges, accuracies, materials and manufacturing processes for the Series 3 L …10 L. The benefits of standardised processes are only of limited use when custom-manufacturing this unique, piezoresistive OEM pressure sensor. For this reason, variants have been selected from the existing L-Series and refined by our engineers to create a “Standardised Premium-Line”, starting with Series 10 L.

Creating this standard has brought significant advantages. For instance, processes have been optimised, streamlined and standardised, while stock needs can be anticipated in advance (which results in shorter delivery times). The expertise and advantages represented by the wide variety of pressure sensors have also been bundled together. By channelling their technology into a standard based on selected pressure ranges and designs, our engineers have succeeded in further enhancing the performance of our most stable sensors, improving reproducibility through a specific set of sensor chips with a uniform design and optimised diaphragm stamping and oil volume.

Technical Features
• Optimum long-term stability
• Durable stainless-steel housing
• Flush, crevice-free welded diaphragms
• High overload resistance
• Optimised thermal behaviour
• Pressure ranges from 0,3 bar to 100 bar, available from stock

Specifications Series 10 L (of the „Standardised Premium-Line“)

<table>
<thead>
<tr>
<th>Pressure Ranges (FS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR-10 L</td>
</tr>
<tr>
<td>0,3 1 2 3 5 10 20 30 50 bar</td>
</tr>
<tr>
<td>±0,3 ±1 -1…3 -1…5 -1…10 -1…20 -1…30 -1…50 bar</td>
</tr>
<tr>
<td>PD-10 L</td>
</tr>
<tr>
<td>0,3 1 3 10 30 bar</td>
</tr>
<tr>
<td>±0,3 ±1 bar</td>
</tr>
<tr>
<td>PAA-10 L</td>
</tr>
<tr>
<td>0,3 1 2 3 5 10 20 30 50 100 bar</td>
</tr>
<tr>
<td>PA-10 L</td>
</tr>
<tr>
<td>1 2 3 5 10 20 30 50 100 bar</td>
</tr>
</tbody>
</table>

Sensitivity typ. * @ Supply 1 mA
130 80 53 53 32 16 8 5,3 3,2 1,6 mV/bar

Overpressure max.
PR, PAA, PA
3 6 9 9 15 30 60 90 150 300 bar
PD pos.
3 12 12 40 120 bar
PD neg.
2 6 6 20 60 bar

PAA: Absolute. Zero at vacuum
PA: Sealed Gauge. Zero at atmospheric pressure (at calibration day)
PR: Vented Gauge
PD: Differential
* max. ±25%

Series 10 L
PR, PAA, PA

Series 10 L
PD

Pin Assignment
Half-open bridge

Label Desigination Wires
+IN Pos. Supply ** BK
+OUT Pos. Output RD
-OUT Neg. Output BU
+IN_OUT Neg. Supply WH
-OUT_OUT Neg. Supply YE

** Top of Bridge (TOB)
### Performance

- **Long Term Stability**: 0,25 mV typ.
- **Accuracy**: 0,25 %FS typ. 0,5 %FS max.
- **Influence Line Pressure**: < 0,0125 mV/bar (PD)

### Electrical Characteristics

- **Constant Current Supply**: 1 mA nominal 3 mA max.
- **Bridge Resistance @ 25 °C**: 3,5 kΩ ± 20%
- **Insulation @ 500 VDC**: 100 MΩ

### Material

- **Housing and diaphragm**: Stainless steel, type 316 L
- **Seal Ring**: Ø 15,6 x 1,78 mm FKM (Viton® Type A -20…200 °C)
- **Oil Filling**: Silicone oil AK100

### Temperature Characteristics

- **Compensated Range**: -10…80 °C
- **Storage-/Operating Temperature**: -30…100 °C (PR, PAA, PA) -40…120 °C (PD)

#### Temperature Coefficient

- **Zero (R1/R2 pre-compensated)**: TCzero 0,025 mV/°C max.
- **Sensitivity TCsens**: 0,06 %%/°C typ. 0,03 %%/°C max. (Rp pre-compensated)
- **Total Bridge Resistance**: 2200 ppm/°C typ.

### Dynamics

- **Vibration (20 bis 5000 Hz)**: 20 g
- **Natural Frequency (Resonance)**: > 30 kHz
- **Endurance @ 25 °C**: > 10 Mio. FS cycles
- **Dead Volume Change @ 25 °C**: < 0,1mm³ / FS
- **Weight**: 25 g (PR, PAA, PA) 36 g (PD)

### Options

- Characteristics indicated for partial pressure ranges (3), such as 0,1 / 0,2 / 0,5 / 1 bar etc., or according to DIN 0,1 / 0,16 / 0,25 / 0,4 / 0,6 / 1 bar etc.
- Other temperature ranges, oil fillings, sealings, electrical connections (e.g. 7 cm wires)
- Diaphragm and housing made of Hastelloy C-276
- Diaphragm and housing made of Titanium only for PA(A)/PR-Version
- Integrated temperature or absolute pressure sensor only for PD-Version
- Mathematical modelling: See data sheet Series 30 X
- Modifications to customer specific applications

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The sensor characteristics may be influenced by installation conditions. Please follow the installation instructions on our product-specific web pages.

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(1) Including linearity, hysteresis and repeatability. Linearity calculated as best straight line through zero.

Note: Generally, accuracy and overload is improved by factor of 2 to 4 if the sensor is used in the range of 0...50 %FS.

(2) On request, a maximal TC Sensitivity can be guaranteed or the value for the compensation resistor (Rp) can be indicated.

(3) An analogue or digital zoom with a factor of three and good stability values can be achieved using zero-drift op amps, high-resolution ADCs and digital signal processing.

Piezoresistive technology is ideally suited to downscaling thanks to its high gauge factor and the resultant high output signal.

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**Example of a Characteristic Line of the Temperature Coefficients** (normalised at 25 °C, pre-compensated with R1/R2)

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**Series 3 L to 10 L**