



## Series 6LHP

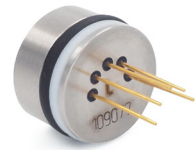
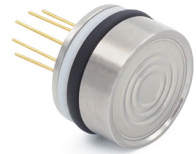
Piezoresistive OEM high-pressure transducers with a wide range of applications

### Features

- High long-term stability
- Robust housing made from stainless steel, Hastelloy or Inconel
- Front-flush diaphragm welded with no gaps
- High operating temperature up to 150 °C
- Optimised thermal behaviour

### Technology

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



### Typical applications

- Oil and gas
- Oceanology
- Geology
- Energy sector
- Hydraulics

#### Accuracy

± 0,25 %FS

#### Long-term stability

± 0,25 %FS / year

#### Pressure ranges

0...100 bar to 0...2000 bar



Series 6LHP

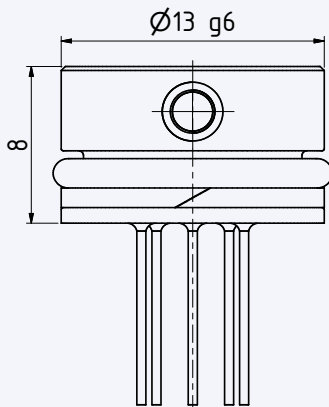
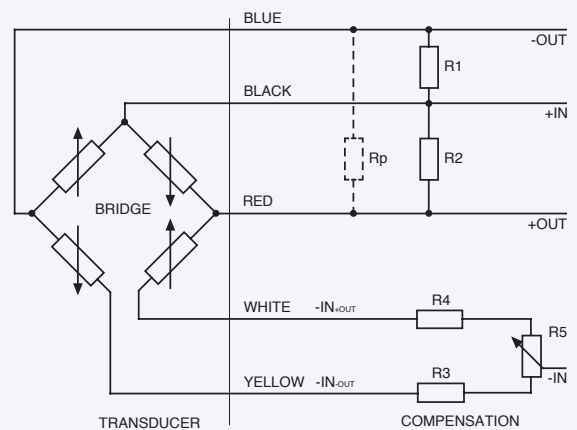


Diagram of a measurement bridge with compensation





## Series 6LHP – specifications

### Standard pressure ranges

| Absolute pressure<br>PAA          | Absolute pressure<br>PA | Overload resistance    | Sensitivity   |       |       |
|-----------------------------------|-------------------------|------------------------|---|-------|-------|
|                                   |                         |                        | min.  | typ.  | max.  |
| 0...100                           | 0...100                 | 250                    | 1,20  | 1,60  | 2,0   |
| 0...160                           | 0...160                 | 400                    | 0,75  | 1,00  | 1,25  |
| 0...250                           | 0...250                 | 625                    | 0,48  | 0,64  | 0,80  |
| 0...400                           | 0...400                 | 1000                   | 0,30  | 0,40  | 0,50  |
| 0...600                           | 0...600                 | 1500                   | 0,20  | 0,267 | 0,333 |
| 0...1000                          | 0...1000                | 2200                   | 0,12  | 0,16  | 0,20  |
| 0...1600                          | 0...1600                | 2200                   | 0,075   | 0,10  | 0,125 |
| 0...2000                          | 0...2000                | 2200                   | 0,075   | 0,10  | 0,125 |
| bar abs.                          | bar abs.                | bar                    | mV/(mA × bar)   |       |       |
| Zero at<br>0 bar abs.<br>(vacuum) | Zero at<br>1 bar abs.   | with reference to zero | The standard pressure ranges are available from the warehouse. Calibrations to any intermediate pressure ranges can also be made. |       |       |

### Performance

|                                  |                   |  |
|----------------------------------|-------------------|--|
| Accuracy @ RT (20...25 °C)       | ± 0,25 %FS typ.   | Nonlinearity (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 -40...150 °C are possible as an option            |
| Long-term stability              | ≤ ± 0,25 %FS      | Per year under reference conditions  |
| Degree of dependency on location | ≤ 2 mbar          | Calibrated in vertical installation position with metal diaphragm facing downwards |
| Temperature coefficient (TC)     | ≤ ± 0,025 %FS/K   | Zero (TCzero) pre-compensated with R1 or R2  |
|                                  | ≤ ± 0,06 %/K      | Sensitivity (TCsens)   |
|                                  | 1800...3000 ppm/K | Total bridge resistance (TCresistance)   |

### Electrical data

#### Half-open measurement bridge

|                                     |  |   |
|-------------------------------------|--|---|
| Constant current supply             | 1 mA nominal<br>3 mA maximum                       |   |
| Bridge resistance @ RT (20...25 °C) | 3,5 kΩ ± 20 %                                      |   |
| Electrical connection               | Gold-plated pins<br>ø 0,45 mm<br>L = 9 mm ± 0,5 mm | Optional: Silicone wires<br>AWG28, L = 70 mm,<br>other lengths on request |
| Insulation                          | > 100 MΩ @ 500 VDC                                 |   |



## Series 6LHP – specifications

### Mechanical data

Materials in contact with media

|                       |                            |  |
|-----------------------|----------------------------|--|
| Housing and diaphragm | Stainless steel AISI 316L  | Series 6LHP  |
|                       | Hastelloy C-276            | Series 6LHPH   |
|                       | Inconel 718                | Series 6LHPI   |
| Seal ring             | FKM (75 Shore)             | Optional: others on request  |
|                       | ø 10,5 mm × 1,5 mm         |  |
|                       | -20...200 °C               |  |
| Support ring          | > 100...600 bar: PTFE      | Installation via O-ring/support ring is not suitable for pressures >1600 bar. We recommend welding the pressure transducer to a housing. |
|                       | > 600...1600 bar: PEEK     |  |
|                       | ø 10,8 mm / ø 13 mm × 1 mm |  |

Other materials

|                    |              |                             |
|--------------------|--------------|-----------------------------|
| Oil filling sensor | Silicone oil | Optional: others on request |
|--------------------|--------------|-----------------------------|

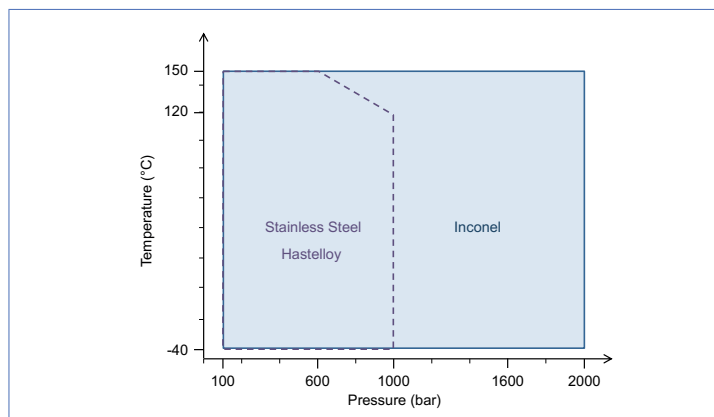
Further details

|                   |                |                            |
|-------------------|----------------|----------------------------|
| Diameter × height | ø 13 mm × 8 mm | See dimensions and options |
| Weight            | approx. 6,3 g  | Series 6LHP                |
|                   | approx. 6,9 g  | Series 6LHPH               |
|                   | approx. 6,4 g  | Series 6LHPI               |

### Ambient conditions

|                                      |                              |                |
|--------------------------------------|------------------------------|----------------|
| Media temperature range              | -40...150 °C                 |                |
| Ambient temperature range            | -40...150 °C                 |                |
| Storage temperature range            | -20...70 °C                  |                |
| Vibration endurance                  | 10 g, 10...2000 Hz, ± 10 mm  | IEC 60068-2-6  |
| Shock endurance                      | < 50 g, 6 ms                 | IEC 60068-2-27 |
| Natural frequency (resonance)        | > 30 kHz                     |                |
| Pressure endurance @ RT (20...25 °C) | > 10 million pressure cycles | 0...100 %FS    |
| Dead volume change @ RT (20...25 °C) | < 2 mm <sup>3</sup>          |                |

### Recommended material selection according to pressure and temperature

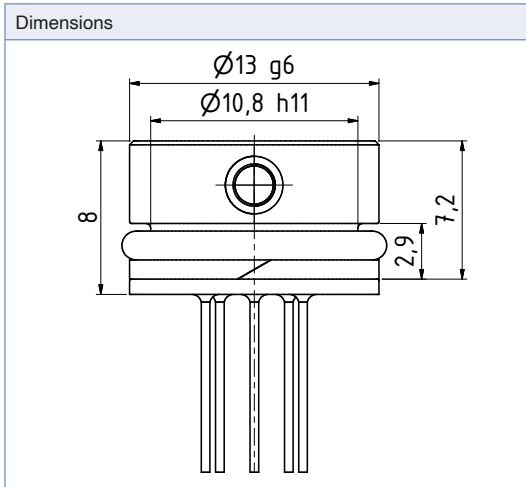


KELLER 6LHP series high-pressure transducers are available with various material options. Stainless steel, Hastelloy C-276, Inconel 718 or titanium can be selected (see "Mechanical data") in line with requirements.

The diagram opposite shows the material options available based on pressure and temperature. All the materials mentioned are compatible with pressure ranges up to 1000 bar. Only Inconel is offered above 1000 bar due to its mechanical strength.



## Series 6LHP – Dimensions and options



### Electrical connection

| Glass feedthrough connection |  | Half-open measurement bridge pin assignment |                    |                                |             |
|------------------------------|--|---|--------------------|--------------------------------|-------------|
|                              |  | PIN   | Label              | Designation                    | Wire colour |
|                              |  | 1   | +OUT               | Pos. output                    | red         |
|                              |  | 2   | +IN                | Pos. supply                    | black       |
|                              |  | 3   | -OUT               | Neg. output                    | blue        |
|                              |  | 4   | -IN <sub>OUT</sub> | Neg. supply (half bridge -OUT) | yellow      |
|                              |  | 5   | -IN <sub>OUT</sub> | Neg. supply (half bridge +OUT) | white       |

### Overview of customer-specific options

- Analysis for other pressure ranges
- Analysis for other temperature ranges between -40...150 °C
- Analysis using a mathematical compensation model
- Electrical connection using silicone wires
- Seal 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 related products

- Series 7LHP: high-pressure transducer with ø 15 mm and temperature range up to 180 °C
- Series 7LHPTi: high-pressure transducer made from titanium
- Series 6LHPX: high-pressure transducer 6LHP with digital compensation electronics
- Series 10LHP: high-pressure transducer with ø 19 mm



## Series 6LHP – Analysis and characteristic lines

### Standard analysis

The pressure transducers are intended for O-ring mounting and are therefore designed for low transmission of forces. This installation enables the values measured in the test equipment to remain unchanged. If the transducers are not de-energised when they are installed, the mechanical forces may change the measured values and the stability of the pressure transducers.

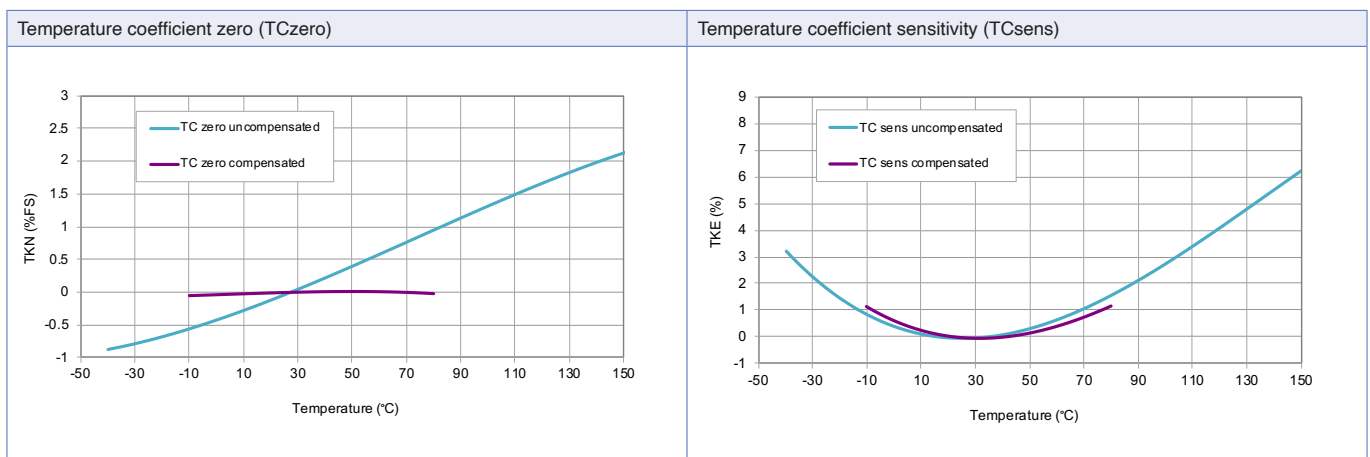
| Calibration sheet: Example type PA-10L                     |                                     |                                  |                          |                           | Key   |
|--|-------------------------------------|----------------------------------|--------------------------|---------------------------|---|
| ----- 449  |                                     |                                  |                          |                           | <ol style="list-style-type: none"> <li>Type (PA-10L) and measuring range (10 bar) of pressure sensor</li> <li>Serial number of pressure sensor</li> <li>Test temperatures</li> <li>Uncompensated zero offset values</li> <li>Zero offset values with compensation resistor R1 (+) or R2 (-) connected</li> <li>Zero offset with calculated compensation resistors</li> <li>Temperature zero error with compensation resistors</li> <li>Compensation resistor values R1 or R2 (TCzero) and R3 or R4 (offset)</li> <li>RB: Bridge resistance at room temperature</li> <li>Offset with compensation resistors R1 or R2 and R3 or R4</li> <li>Sensitivity of pressure sensor at room temperature</li> <li>Pressure test points</li> <li>Signal at pressure test points</li> <li>Nonlinearity (best straight line through zero)</li> <li>Nonlinearity (best straight line)</li> <li>Results of long-term stability</li> <li>Lot number and identification of silicon wafer</li> <li>Insulation test</li> <li>Excitation (constant current)</li> <li>Date of test ----- Test equipment</li> </ol> |
| <b>PA-10L/10 bar/10-1005-118</b> <sup>(1)</sup>            |                                     | <b>Sn I107547</b> <sup>(2)</sup> |                          |                           |   |
| ----- 29/01  |                                     |                                  |                          |                           |   |
| <sup>(3)</sup> Temp [°C]                                   | <sup>(4)</sup> Zero [mV]            | <sup>(5)</sup> +510 [mV]         | <sup>(6)</sup> Comp [mV] | <sup>(7)</sup> 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                      |   |
| ----- L1   |                                     |                                  |                          |                           |   |
| COMP R1  | 510 kOhm <sup>(8)</sup>             | R3                               | 56.0 Ohm <sup>(8)</sup>  |                           |   |
| RB   | 3482 Ohm <sup>(9)</sup>             |                                  |                          |                           |   |
| ZERO   | -0.8 mV <sup>(10)</sup>             |                                  | P_atm                    | 964 bar                   |   |
| <b>SENS</b>  | <b>16.41 mV/bar</b> <sup>(11)</sup> |                                  |                          |                           |   |
| LIN  |                                     |                                  | <sup>(14)</sup> Lnorm    | <sup>(15)</sup> Lbfsl     |   |
| <sup>(12)</sup> [bar]                                      | <sup>(13)</sup> [mV]                | [%Fs]                            |                          | [%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 <sup>(16)</sup>                     |                                     |                                  |                          |                           |   |
| Lot 72114-2 <sup>(17)</sup>                                |                                     |                                  |                          |                           |   |
| Test 500 Volt Ok <sup>(18)</sup>                           |                                     |                                  |                          |                           |   |
| Supply <b>1.000 mA</b> <sup>(19)</sup>                     |                                     |                                  |                          |                           |   |
| 01.09.17 <sup>(20)</sup> ----- GOL3.A03DIK <sup>(20)</sup> |                                     |                                  |                          |                           |   |

#### Notes

- The indicated specifications apply only for a constant current supply of 1 mA. The sensor should not be supplied with more than 3 mA. The output voltage is proportional to the current supply (excitation). If the supply deviates from the calibration, signal shifts may occur.
- The compensation resistors described in this data sheet are not part of the pressure transducer and are not included in the scope of delivery.
- Compensation resistors with a temperature coefficient of < 50 ppm/°C must be used in extreme temperatures. The sensor and the resistors can be exposed to different temperatures.
- Fine adjustment of zero with R5 potentiometer (20 Ω) is possible. In addition, a maximum TCsens can be guaranteed on request or the value for the compensation resistor (Rp) can be indicated. See Diagram "Measurement bridge with compensation" on page 1.

### Characteristic lines

Examples of typical characteristic lines of the temperature coefficients, normalised at 25 °C, uncompensated and compensated





## Series 6LHP – Analysis and characteristic lines

### Mathematical compensation model

As an option, the 6LHP series KELLER pressure transducers can be ordered together with a 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 enables the calculation of the compensation coefficients of the pressure transducer. These compensation coefficients are made available to the customer along with the respective pressure transducer.