



## 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.

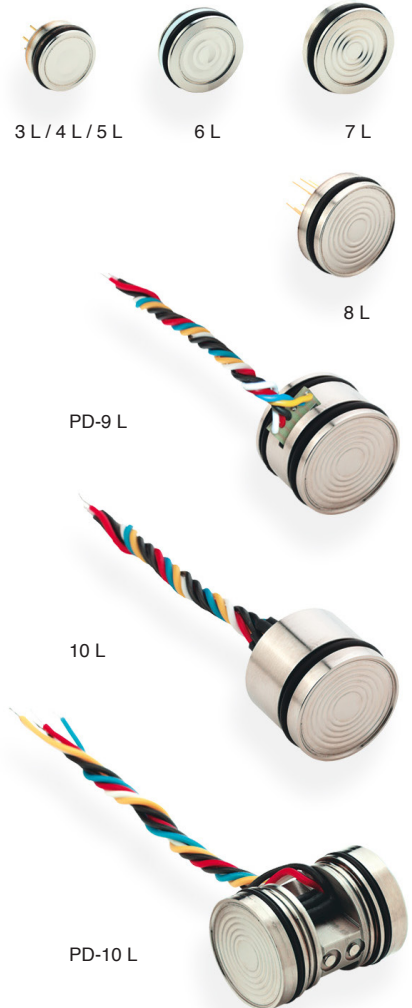
The 3 L...10 L transducers feature floating O-ring mounting to avoid errors which can be caused by mechanical stresses imparted to the transducer housing and ensures performance within the specifications. The transducer housing encases the piezoresistive silicon pressure sensor and a small quantity of 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.

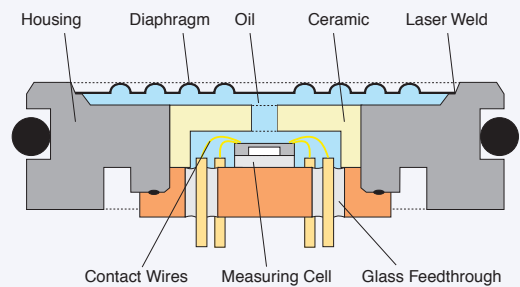
With the laser welded technology, transducers having diameters as low as 9,5 mm can be realised. As can be discerned from the below chart, the lower the pressure ranges are available in only the larger, i.e., Ø 19 mm diameter, due to the inherent increase in diaphragm stiffness as the diameter is reduced.

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.

## SERIES 3 L TO 10 L



Type	Dimensions (mm)	Ranges (bar)	Version
3 L	Ø 9,5 x 4,2	20...200	abs.
4 L	Ø 11 x 4,2	10...200	abs.
5 L	Ø 12 x 4,5	10...200	abs.
6 L	Ø 13 x 4,5	20...200	abs.
6 L HP	Ø 13 x 8	200...1000	abs.
7 L	Ø 15 x 5	10...200	abs. / gauge (< 50 bar)
7 L HP	Ø 15 x 8	200...1000	abs.
8 L	Ø 17 x 7	0,2...200	abs. / gauge (< 50 bar)
9 L	Ø 19 x 5	0,2...200	abs. / gauge (< 50 bar)
PD-9 L	Ø 19 x 15	0,1...50	diff. / nass-nass
10 L	Ø 19 x 15	0,1...100	abs. / gauge
10 L HP	Ø 19 x 15	200...1000	abs. / gauge (< 50 bar)
PD-10 L	Ø 19 x 26	0,1...50	diff. / nass-nass





**Specifications**

Excitation I = 1 mA

Series 3 L...10 L	Standard Pressure Ranges (FS) in bar																			
PR	-1	-0,5	-0,2	-0,1	0,1	0,2	0,5	1	2	5	10	20								
PD					0,1	0,2	0,5	1	2	5	10	20	50							
PAA					0,1	0,2	0,5	1	2	5	10	20								
PA								1	2	5	10	20	50	100	200	400	600	1000		
Signal Output typ.* [mV]	75	50	25	15	15	30	60	100	140	200	200	200	200	200	200	200	200	200	200	200
Overpressure	-1	-1	-1	-1	2,5	2,5	2,5	3	4	7	15	30	100	200	300	600	900	1100		
PD, neg. Overpressure [-]					1	1	1	2	3	5	7	10	10							
PD-9 L, max. Line Pressure													50							
PD-10 L, max. Line Pressure													200 <sup>(1)</sup>							

PR: Vented Gauge. Zero at atmospheric pressure    PAA: Absolute. Zero at vacuum    PA: Sealed Gauge. Zero at atmospheric pressure (at calibration day)    PD: Differential    \* ± 40%

Bridge Resistance @ 25 °C	3,5 kΩ	± 20%
Constant Current Supply	1 mA nominal	3 mA max.
Insulation @ 500 VDC	100 MΩ	
Compensated Range <sup>(1)</sup>	0...50 °C (3 L...5 L)	-10...80 °C (6 L...10 L)
Storage- / Operating Temperature	-10...80 °C (3 L...5 L)	-20...100 °C (6 L...10 L)
Vibration (20 to 5000 Hz)	20 g	
Endurance @ 25 °C	> 10 Mio. FS cycles	
Housing and Diaphragm	Stainless steel, type 316 L <sup>(1)</sup>	
O-Ring Material	3 L, 5 L: Nitrile    4 L, 6 L...10 L: Viton® <sup>(1)</sup>	
Oil Filling	Silicone oil <sup>(1)</sup>	
Dead Volume Change @ 25 °C	< 0,1 mm <sup>3</sup> / FS	
Electr. Connection Wires (PD-9 L, PD-10 L, 10 L)	0,09 mm <sup>2</sup> (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)	

	Compensated Range 0...50 °C		Compensated Range -10...80 °C	
	TC (Zero) max <sup>(4)</sup> [mV/°C]	Stability typ. [mV]	TC (Zero) max. [mV/°C]	Stability typ. [mV]
Series 3 L / 4 L	0,0375	0,75	—	—
Series 5 L	0,025	0,50	—	—
Series 6 L / 7 L / 8 L	0,025	0,50	0,050	0,75
Series 9 L	0,0175	0,50	0,0375	0,75
Series 10 L	0,0125	0,25	0,025	0,50

Accuracy <sup>(2)</sup>	0,25 %FS typ. <sup>(1)</sup>	0,5 %FS max.
Offset at 25 °C	< 5 mV (compensated with R5 of 20 Ω <sup>(3)</sup> )	
Temperature Coefficient Sensitivity <sup>(5)</sup>	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.

- (1) Others on request.
- (2) 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
- (3) External compensation; potentiometer is not supplied.
- (4) Temperature-Coefficients of Zero
- (5) On request, a maximal TC Sensitivity can be guaranteed or the value for the compensation resistor (Rp) can be indicated.

**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

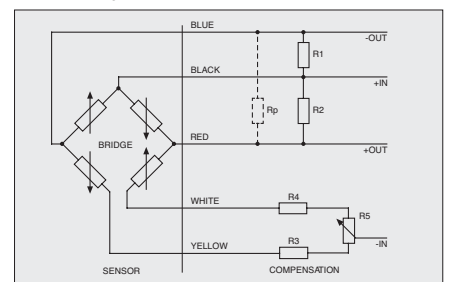
PA-10L/20 BAR/81838.3 <sup>(1)</sup> SN E133755 <sup>(2)</sup> 134				
(3) Temp [°C]	(4) Zero [mV]	(5) +1000 [mV]	(6) Comp [mV]	(7) dZero [mV]
-9.8	0.0	-2.6	0.4	0.2
-0.6	0.1	-2.6	0.4	0.1
21.8	0.2	-2.8	0.2	0.0
49.4	0.5	-2.9	0.0	-0.2
79.6	0.8	-3.2	-0.2	-0.4
-----L1				
COMP R1	1000 kOhm <sup>(8)</sup>	R4	12.0 Ohm <sup>(8)</sup>	
RB	3465 Ohm <sup>(8)</sup>			
ZERO	0.2 mV <sup>(9)</sup>	P_atm	965 mbar <sup>(10)</sup>	
SENS	8.43 mV/bar at 1.000 mA <sup>(11)</sup>			
(12) [bar]	(13) [mV]	(14) Lnrm [%FS]	(15) Lbfs [%FS]	
0.000	0.0	0.00	-0.11	
5.000	42.4	0.14	0.07	
10.000	84.5	0.15	0.11	
15.000	126.5	0.04	0.04	
20.000	168.3	-0.15	-0.11	
-----L1				
Long Term Stability Ok <sup>(16)</sup>				
Lot 70590 <sup>(17)</sup>				
Test 500 Volt ok <sup>(18)</sup>				
Supply 1.000 mA <sup>(19)</sup>				
20.06.15 <sup>(20)</sup> ----- PH02.A03DqK <sup>(20)</sup>				

Each sensor is delivered with a calibration sheet with the following data:

1. Type (PA-10L) and range (20 bar) of pressure sensor
2. Serial number of pressure sensor (not standard)
3. Test temperatures
4. Uncompensated zero offset in mV
5. Zero offset values, in mV, with test resistance (1000 kΩ) (for factory computation only)
6. Zero offset, in mV, with calculated compensation resistors
7. Temp. zero error, in mV, with compensation resistors
8. Compensation resistor values R1 / R2 and R3 / R4, RB: Bridge resistance
9. Offset with compensation resistors R1 / R2 and R3 / R4 fitted (fine adjustment of zero with R5 potentiometer)
10. Ambient pressure, zero reference for absolute sensors < 20 bar
11. Sensitivity of pressure sensor
12. Pressure test points
13. Signal at pressure test points
14. Linearity (best straight line through zero)
15. Linearity (best straight line)
16. Results of long term stability
17. Lot-type (on request, identification of silicon chip)
18. Voltage insulation test
19. Excitation (constant current)
20. Date of test -----Test equipment

**Remarks:**

- The indicated specifications apply only for constant current supply of 1 mA. The sensor must not be supplied more than 3 mA. The output voltage is proportional to the current supply (excitation). By using excitation unlike the calibrated excitation the output signal can deviate from the calibrated values.
- If exposed to extreme temperatures, the compensation resistors should have a temperature coefficient of < 50 ppm/°C. Sensor and resistors can be exposed to different temperatures.
- The sensors may be ordered with integrated compensation resistors (surcharge).





# 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 30 bar, available from stock



Serie PR-10 L



Serie PA(A)-10 L



Serie PD-10 L

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

### Pressure Ranges (FS)

PR-10 L	0,3	1	3	10	30		bar	
	±0,3	±1	-1...3	-1...10	-1...30		bar	
PD-10 L	0,3	1	3	10	30		bar	
	±0,3	±1					bar	
PAA-10 L	0,3	1	3	10	30	100	bar	
PA-10 L		1	3	10	30	100	bar	
Sensitivity typ.* @ Supply 1 mA	135	48	48	16	5,5	1,6	mV/bar	
Overpressure max..	PR, PAA, PA	3	9	9	30	90	300	bar
	PD pos.	3	12	12	35	100		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    grey: in progress    \* max. ±25 %

**Series 10 L**  
PR, PAA, PA

Pins glass feed-through Ø 0,45 mm, L = 4 ± 0,5 mm, 45°-grid on Ø 5,08 mm (0,2")  
Referential tube Ø 1,2 mm

**Series 10 L**  
PD

Wires 0,09 mm² (12 x Ø 0,1 mm), Silicone sheathed Ø 1,2 mm, length 10 cm

**Pin Assignment**  
Half-open bridge

Label	Designation	Wires
+IN	Pos. Supply**	BK
+OUT	Pos. Output	RD
-OUT	Neg. Output	BU
-IN <sub>+OUT</sub>	Neg. Supply	WH
-IN <sub>-OUT</sub>	Neg. Supply	YE

\*\* Top of Bridge (TOB)



## Performance

Long Term Stability	0,25 mV typ.	
Accuracy <sup>(1)</sup>	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)
	Operation below -20 °C (on request)	VMQ (silicone) / FVMQ (fluoro-silicone)
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 <sup>(2)</sup>	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	< 0,1mm <sup>3</sup> / FS	
Weight	25 g (PR, PAA, PA)	36 g (PD)

## Options (against extra charge and not available from stock)

- Characteristics indicated for partial pressure ranges <sup>(3)</sup>, 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

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

<sup>(1)</sup> 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.

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

<sup>(3)</sup> 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.

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

