Series 9FL

Piezoresistive OEM pressure transducers with very high stability and a flanged design

Features

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

Technology

- Insulated piezoresistive pressure sensor encapsulated in an oil-filled metal housing
- Housing with flange for direct welding or axial seal using an O-ring
- Typical range of output signal of 160 mV/mA

Typical Applications

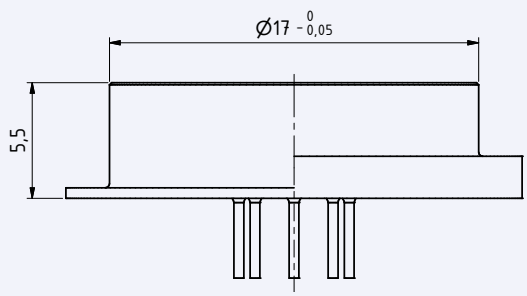
- OEM
- Heating pumps
- Autoclaves
- Meteorology

Accuracy
± 0,25 %FS

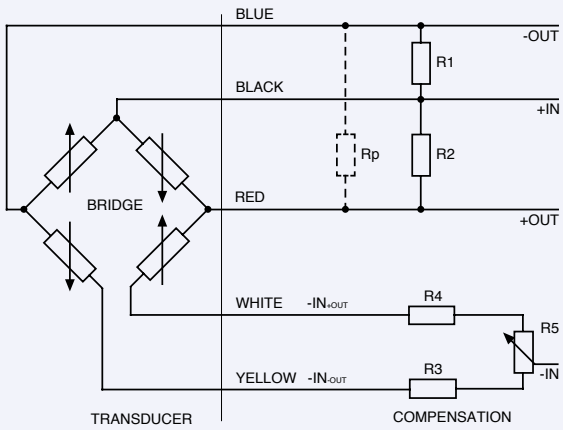
Long-term Stability
± 0,20 %FS/year

Pressure Ranges
0…0,2 bar to 0…200 bar

Series 9FL



Electrical Diagram of a 9FL with compensation resistors



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Series 9FL – Specifications

Standard Pressure Ranges

Relative pressure PR		Absolute pressure PAA	Absolute pressure PA	Proof pressure	Sensitivity		
					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)		
Zero at atmospheric pressure		Zero at 0 bar abs. (vacuum)	Zero at 1 bar abs.	With reference to zero			

Performance

Accuracy @ RT (20…25 °C)	± 0,25 %FS typ.	Non-linearity (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
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 zero 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	

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Series 9FL – Specifications

Temperature Ranges

Compensated temperature range	-10…80 °C	Optional: Temperature ranges within -55…150 °C possible
Media temperature range	-40…125 °C	
Ambient temperature range	-40…125 °C	
Storage temperature range	-40…125 °C	

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 AWG22, 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
Seal ring	None	

Other materials

Pressure transducer oil filling	Silicone oil	Optional: Other oil fillings on request

Further details

Diameter × height	ø 17 / 21 mm × 5,5 mm	See Dimensions and Options
Reference tube connection	ø 1,2 mm × 3 mm	Optional: Silicone reference tube for reference offset
Weight	approx. 7 g	

Dynamics

Vibration resistance	20 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	0…100 %FS
Dead volume change @ RT (20…25 °C)	< 2 mm^3	

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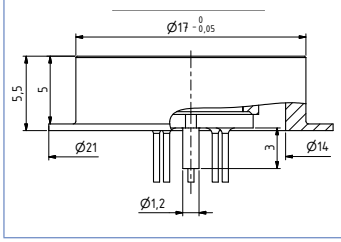
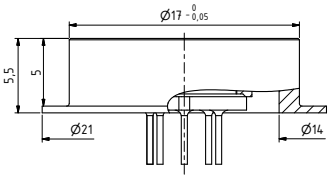
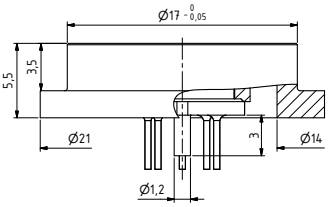
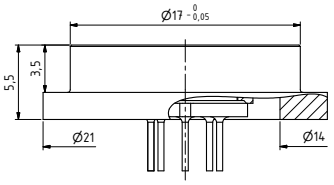
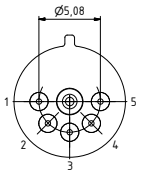
Series 9FL – Dimensions and Options

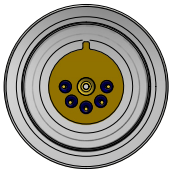
Overview of Versions

Thin flange		Thick flange	
PR for pressure ranges up to 30 bar	PAA / PA for pressure ranges up to 50 bar	PR for pressure ranges up to 30 bar	PAA / PA for pressure ranges up to 200 bar
			

Electrical Connection

Glass feedthrough connection





Half-open measurement bridge pin assignment

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

Overview of Customer-specific Options

- Custom pressure ranges
- Custom temperature ranges
- Custom mathematical modeling
- Electrical connection with silicone wires
- Housing and diaphragm made of Hastelloy C-276 or titanium
- Other oil filling types for pressure transducers: e.g. special oils for oxygen applications
- Modifications to customer-specific applications

Examples of Related Products

- Series 9FLX: Pressure transducer 9FL with digital compensation electronics
- Series PD-9FLX: Differential pressure version with digital compensation electronics
- Series 7FL: More compact design with flange
- Series 9L: Version without flange

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Series 9FL – Analysis and Characteristic Lines

Standard Analysis

The 9FL 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

```
---------------------------------------------------------------------- 449
PA-10L / 10 bar / 10-1005-118 (1)        Sn I107547 (2)
---------------------------------------------------------------------- 29/01
(3) Temp   (4) Zero    (5) +510    (6) Comp    (7) dZero
   [°C]      [mV]       [mV]        [mV]        [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 (8)        R3      56.0 Ohm (8)
RB         3482 Ohm (9)
ZERO        -0.8 mV (10)        P_atm     964 bar
SENS       16.41 mV/bar (11)

LIN                                (14) Lnorm   (15) Lbfsl
  (12) [bar]      (13) [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 (16)
Lot 72114-2 (17)
Test 500 Volt Ok (18)
Supply 1.000 mA (19)
01.09.17 (20) ---------------------------------- GOL3.A03D1K (20)
```

1. Type (PA-10L) and measuring range (10 bar) of pressure sensor
2. Serial number of pressure sensor
3. Test temperatures
4. Uncompensated zero offset
5. Zero offset values with compensation resistor R1 (+) or R2 (-) connected
6. Zero offset with calculated compensation resistors connected
7. Temperature zero error with compensation resistors connected
8. Calculated compensation resistor values R1 or R2 (TCzero) and R3 or R4 (offset)
9. RB: Bridge resistance at room temperature
10. Calculated offset with compensation resistors R1 or R2 and R3 or R4 connected
11. Sensitivity of pressure sensor at room temperature
12. Pressure test points
13. Signal at pressure test points
14. Non-linearity (best straight line through zero)
15. Non-linearity (best straight line)
16. Results of long-term test
17. Sensor traceability information
18. Insulation test
19. Excitation (constant current)
20. Date of test -------- Test equipment

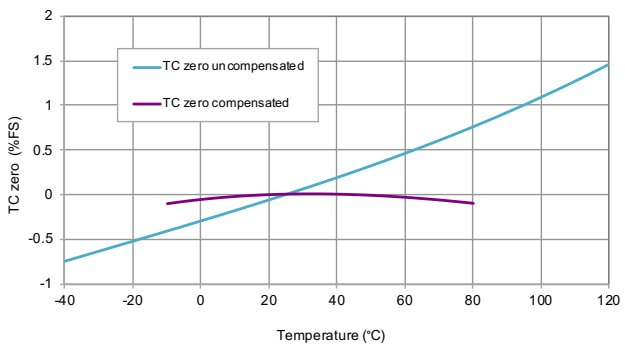
Notes

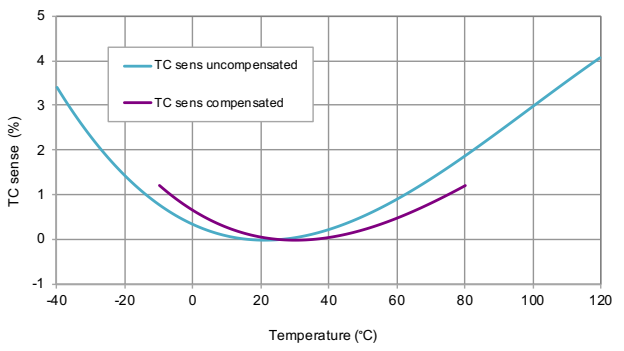
- The indicated specifications apply only for constant current supply of 1 mA. The sensor must not be supplied more than 3 mA. The output voltage is proportional to the current supply (excitation). If excitation other than 1mA used, the output signal will deviate from the calibrated values.
- If exposed to extreme temperatures, the compensation resistors should have a temperature coefficient of < 50 ppm/°C. Sensor and resistors can be exposed to different temperatures.
- Fine adjustment of zero with R5 potentiometer (20 Ω) is possible. In addition, a maximum TC-sensitivity can be guaranteed on request or the value for the compensation resistor (Rp) can be indicated. See Electrical Diagram of a 9FL with Compensationon page 1.

Characteristic Lines

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

Temperature coefficient zero, TCzero	Temperature coefficient sensitivity, TCsens





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Series 9FL – Analysis and Characteristic Lines

Mathematical Compensation Model

The KELLER pressure transducers of series 9FL 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 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.

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