Piezoresistive OEM Pressure Transmitters

Series 4 LD…9 LD

WITH I²C INTERFACE AND EMBEDDED SIGNAL CONDITIONING

With the D-line, Keller introduces a unique combination consisting of an exceedingly robust industrial pressure transducer and the popular I²C microcontroller interface. Pressure transmitters with this interface are commonly available only in consumer market housings made of plastic or ceramic, where merely the parameters for compensation are stored in an integrated memory. The D-line OEM transmitters however have an unprecedented embedded digital signal processing (DSP) core for the compensation and normalization of the output values.

Technology

The Series 4 LD...9 LD is based on KELLER's famous Chip-In-Oil (CIO) technology. The "L" stands for the laser welded stainless steel housing and could equally be representative for low-power (typ. 0,1 µA in idle/sleep mode) and low-voltage (Supply: 1,8...3,6 VDC). The housing is hermetically-sealed, oil-filled and builds a Faraday cage with feed-through capacitors around the entire electronics. The digital interface of the electronics with dual information of pressure and temperature is indicated by the "D".

Interface

The easiest way to couple an OEM pressure transmitter to a microcontroller based system is a digital I/O-compatible interface; no amplification, no analog to digital conversion, no calibration, no temperature coefficients. In short: no problems.
I²C (Inter-Integrated Circuit) is designed for a direct connection between devices on a printed circuit board. It is a BUS-system because it allows the connection of multiple transmitters (slaves) to the same communication lines, but it is not a fieldbus with the classic long distance inter-connectability. So the D-Line combines an industrial pressure interface for harsh environment with an electrical interface for OEM applications.
The values are in 16 Bit unsigned integer format and the scaling is given by constants or by the memory content of the transmitter (two floating point values IEEE 754 for the pressure scaling).

Performance features

- Ultra low power consumption, optimised for battery powered applications
- Hermetically protected sensor electronics – extremely resistant to environmental influences
- Ultra-compact, robust housing made from stainless steel (optional Hastelloy C-276)
- No external electronics for compensation or signal processing
- Extremely accurate, outstanding long-term stability, no hysteresis
- Pressure ranges of 1 bar to 1000 bar
- Easy to integrate into microcontroller based systems
- Internal two-chip solution with pressure sensor and signal processing separation provides a high degree of flexibility

4 LD

7 LD

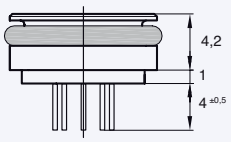
9 LD

9 FLD

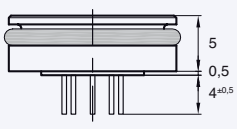
6 LD HP / 7 LD HP (high pressure)

I²C is a trademark of NXP

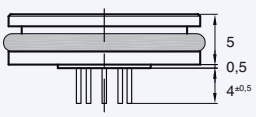
Series 4 LD
Ø 11



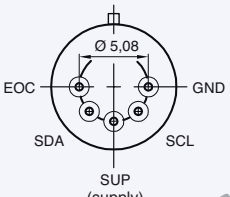
Series 7 LD
Ø 15



Series 9 LD
Ø 19

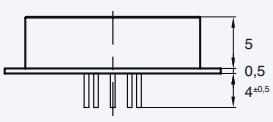


Connection

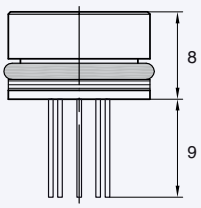


RoHS

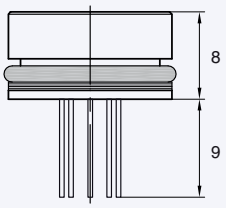
Series 9 FLD
Ø 17 / Ø 21



Series 6 LD HP
Ø 13



Series 7 LD HP
Ø 15



For proper handling please check our installation instructions on our product specific web page.

Label	Description	Wire
SUP	1,8…3,6 V	BK
GND	GND	WH
SCL	I²C Clock	YE
SDA	I²C Data	BU
EOC	End of Conversion	RD

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Version 02/2018
Änderungen vorbehalten
Unternehmen zertifiziert nach ISO 9001
www.keller-druck.com

Specifications

Pressure Ranges rel.											
PR	0…1	-0,5…0,5	-1…3	-1…10	-1…30						bar
Pressure Ranges abs.											
PA			0…3	0…10	0…30	0…100	0…200	0…400	0…600	0…1000	bar
PAA	0…1	0,5…1,5	0…3	0…10							bar

Accuracy (1) max. ± 0,15 %FS (600 bar: ± 0,25 %FS / 1000 bar: ± 0,35 %FS)
Overpressure 4 x pressure range (max. 350 bar resp. 1200 bar for 6 LD HP, 7 LD HP)
Long Term Stability typ. ± 0,1 %FS, max. ± 0,2 %FS (limited to max. ± 3 mbar)

Type/ Version	Dimensions [mm] (5)	Pressure Range	Operating Temperature	Comp. Temp. Range	TEB (2) [%FS]
4 LD	ø 11 x 4,2	3…200 bar abs.(3)	-10…+80 °C	0…50 °C	± 0,7 %FS
7 LD	ø 15 x 5	3…200 bar abs. 3…30 bar rel. (4)	-40…+110 °C	0…50 °C -10…80 °C	± 0,5 %FS ± 0,7 %FS
9 LD	ø 19 x 5	1…200 bar abs. 1…30 bar rel.	-40…+110 °C	0…50 °C -10…80 °C	± 0,5 %FS ± 0,7 %FS
9 FLD	ø 17 x 5,5 Flange ø 21	1…30 bar abs. 1…30 bar rel.			
6 LD HP	ø 13 x 8	400…1000 bar abs.	-40…+110 °C	0…50 °C -10…80 °C	± 0,7 %FS ± 1,0 %FS
7 LD HP	ø 15 x 8				

(1) Linearity best straight line@RT, hysteresis, repeatability
(2) TEB (Total Error Band): Maximum deviation within specified pressure and compensated temperature range
(3) abs: Absolute Pressure Measurement (PAA: Absolute. Zero at vacuum PA: Sealed Gauge. Zero at 1,0 bar abs.)
(4) rel: Referential version (PR: Vented Gauge. Zero at atmospheric pressure)
(5) Dimensions without glass feed through

Interface	digital I²C (serial synchronus)
Signal Output	P [bar], T [°C]: normalised to 16 Bit unsigned integer
Pressure Range Reserve	typ. ± 10 %FS, min. ± 5 %FS
Supply	1,8…3,6 V
Power Consumption	typ. 1,5 mA during conversion typ. 100 nA in idle mode
Bit Rate	≤ 400 kHz
Start-up Time (Supply ON)	< 1 ms
Conversion Time	typ. 6 ms, max. 8 ms (for P and T)
Logic Levels	LOW: max. 15 %V_{SUP}, HIGH: min. 85 %V_{SUP}
Noise Floor	max. ± 0,015 %FS (temperature 4 Bit)
Temperature Accuracy	typ. ± 2 °C
Supply Voltage Dependency	none
Isolation	> 100 MΩ @ 500 VDC
ESD – Human Body Model	4 kV (HBM: C = 100 pF / R = 1,5 kΩ)
Material in Contact with Media	- Stainless Steel AISI 316L (DIN 1.4404 / 1.4435) - O-Ring: Viton® Shore A (-20…200 °C, exchangeable)
Oil Filling	Silicone oil, others on request
Pressure Endurance	0…100 %FS @ 25 °C: > 10 million pressure cycles with appropriate installation
Vibration Endurance	20 g, 5…2000 Hz, X/Y/Z-Achse
Shock	75 g sine 11 ms
Electrical Connection	- Glass feed through pins ø 0,45 mm, L = 4 ± 0,5 mm - Plug JST 1 mm, 5-pole. Type: BM05B-SRSS-TB. Only for -20…85 °C and not for 4 LD & 6 LD. As counterpart: Crimp-socket with wires AWG 28. Type: SHR-05V-S-(B), Crimp-contact: SSH-003T-P0.2
Options	- Electrical connection: 7 cm silicone wires 0,09 mm² on the glass feed through pins - Hastelloy housing (dep. on version also Inconel, Titanium) - Extended temperature range within -50…125 °C
Other possible versions	- Series 9 LD: With pressure range 300 mbar rel. - Series 10 LD: Type 10 L (ø 19 x 15), spec. same as 9 LD - Series 20 D: With pressure connection G1/4", G1/8" etc. - Series 21 D: With screened cable (0,5 to 3 m)
Remarks	- Intermediate press. ranges only for high-volume projects - Series 21 D is not available with plug (I²C is not a fieldbus)

Communication Protocol

D-Line OEM-transmitter samples only on request. The idle state is the sleep mode to save power.

Sequence for data acquisition:

1. Request measurement
   2 bytes from master

ADDR	0	0xAC

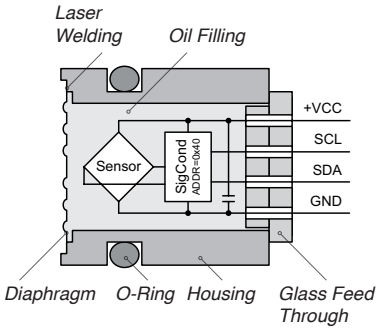
2. Await the end of conversion (three ways)
   - Simple delay of 8 ms
   - Polling of the "Busy?" flag [5] in the status byte (only one byte reading needed)
   - Event triggering by the additional "EOC" handshake pin (goes to VDD)

3. Read out measurement results
   1 byte from master, 3…5 bytes from slave

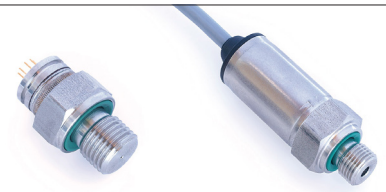
ADDR	1	STATUS	P MSB	P LSB	…
…			T MSB	T LSB	

4. Interpretation of new data
   P [bar] = P min…P max ≙ 16384…49152
   T [°C] = -50…150 °C ≙ 384…64384

The complete communication protocol is available on the KELLER homepage.



Plug JST with Series 7 LD



Series 20 D G1/4"

Series 21 D G1/8" with Cable

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Version 02/2018
Änderungen vorbehalten
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