Piezoresistive OEM Pressure Transmitters

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 4LD...9LD 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

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Companies approved to ISO 9001
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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 (*) 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 6LHPD, 7LHPD)
Long Term Stability typ. ± 0,1 %FS, max. ± 0,2 %FS (limited to max. ± 3 mbar)

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

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

Interface
digital I²C (serial synchronous)

Signal Output
P [bar], T [°C]: normalised to 16 Bit unsigned integer
Pressure Range Reserve (limited to max. ± 3 mbar)

Pressure Ranges rel.
PR: Vented Gauge. Zero at atmospheric pressure
Abs: Absolute Pressure Measurement (PAA: Absolute. Zero at vacuum)

TEB: Maximum deviation within specified pressure and compensated temperature range
Linearity: best straight line@RT, hysteresis, repeatability

Pressure Ranges abs.
PA: Sealed Gauge. Zero at 1,0 bar abs.

Pressure Accuracy typ. ± 0,1 %FS, max. ± 0,2 %FS (limited to max. ± 3 mbar)
Pressure Ranges abs.

Temperature Accuracy typ. ± 0,5 %FS (temperature 4 Bit)

Supply Voltage Dependency none

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 4LD & 6LD

Options
- Electrical connection: 7 cm silicone wires 0,09 mm² on the glass feed through pins
- Hasseloy housing (dep. on version also Inconel, Titanium)
- Extended temperature range within -50...125 °C

Other possible versions
- Series 9LD: With pressure range 300 mbar rel.
- Series 10LD: Type 10L ø 19 x 15, spec. same as 9LD
- Series 20D: With pressure connection G1/4", G1/8" etc.
- Series 21D: With screened cable (0,5 to 3 m)

Remarks
- Intermediate press. ranges only for high-volume projects
- Series 21D 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: 0x40
   SUP: HIGH: min. 85 %V
   LOW: max. 15 %V

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: 0x40
   SUP: HIGH: min. 85 %V
   LOW: max. 15 %V
   T [°C] = -50...150 °C
   P [bar] = P min...P max
   16384...49152
   384...64384

The complete communication protocol is available on the KELLER homepage.

Subject to alterations
Companies approved to ISO 9001