

The sensitive sensor signals are connected to the signal conditioning IC via ultrashort wire-bonding wires, and are fed outwards as low-resistance processed signals via the glass feedthrough pins. Even EMC and ESD protection are integrated.

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## OEM-TRANSMITTERS : ALL-INCLUSIVE

### Miniaturization in Pressure Measurement Technology

KELLER's OEM transmitters are systems that can be described as „embedded“ in the best sense of the word – and in two different ways. First, the sensor and the signal conditioning electronics are embedded in the same housing and second, the transmitter capsules themselves are ideally suited for embedding in application-specific systems. Depending on requirements, the output signal is standardized and temperature-compensated (ratiometric or digital).

Thanks to the Chip-in-Oil (CiO) technology developed at KELLER, the trend toward sensor miniaturization is now

a reality. This development can offer impressive advantages: an extremely compact structural design, high resistance to electromagnetic noise fields and high vibration resistance thanks to low mass and short conduction paths.

To put it clearly, CiO technology means that a signal processor is fitted directly next to the pressure sensor - in the same housing - to provide users with a whole range of beneficial functions. However, this does not make the pressure measurement capsule any larger: its external dimensions remain the same. This transmitter concept is available in housings 4L ... 10L, starting from a diameter of 11 mm.

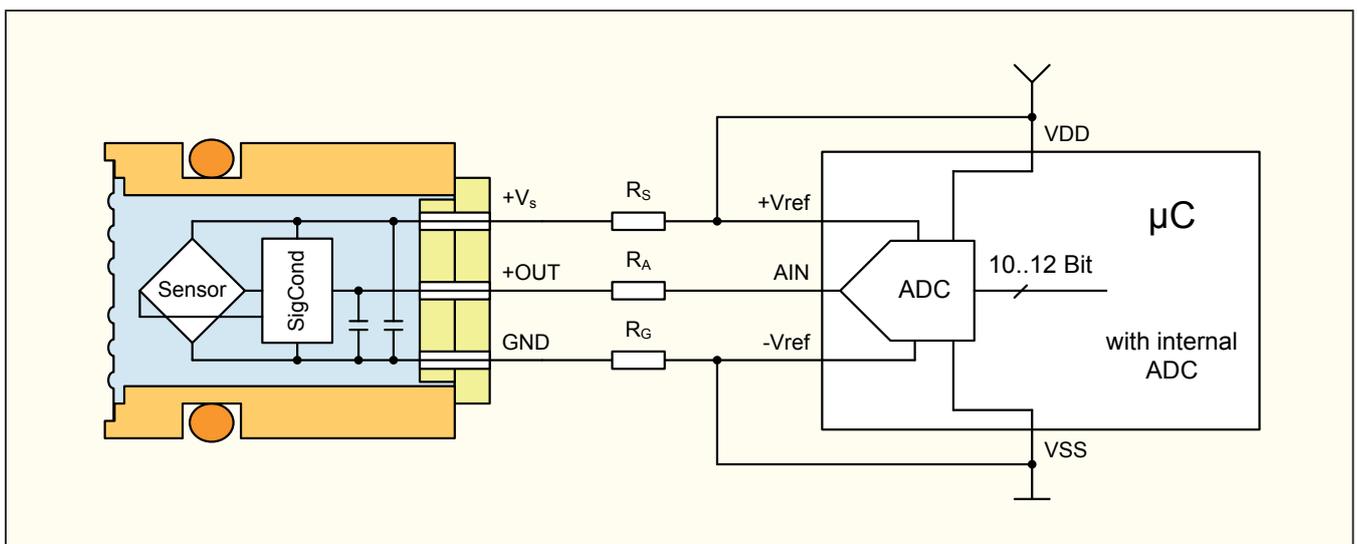
Pressure-resistant glass lead-throughs feed the transmitter signals outwards. The internal wiring uses short, light-weight bonding wires - with the total exclusion of air in oil. First, this approach eliminates the need to connect filigree signal processing boards with multiwire cabling in the rest of the installation process for the pressure transducer. And second, there is no need to protect the downstream electronics against moisture and condensation.

Together with the high-grade steel housing, the glass leadthroughs act as feedthrough capacitors, forming a Faraday cage. This makes the CiO technology extremely resilient to electrical fields. Even field strengths of 250 V/m at frequencies of up to 4 GHz are unable to influence the

measurement signal. The digital interface must be protected by the equipment manufacturer itself.

The ASIC is designed as a microcontroller with the corresponding peripherals, so the sensor signals can be registered with high resolution and dynamism. In addition to the process pressure as such, the temperature of the pressure sensor is measured and is used for mathematical temperature compensation when the signal is processed.

OEM transmitters supply two output signals: a ratiometric analog voltage output and a digital inter-integrated circuit interface (I2C).



Schematic structure of a C-line OEM transmitter, directly connected to a microcontroller with integrated analog/digital converter. If care is taken to keep the line resistances low, no calibration is needed because the ADC and „SigCond“ are referenced to one another.

### Ratiometric output signal

The secret of the ratiometric format of the output signal is that it actually has no format at all, because it depends on the voltage supplied. This is an inestimable advantage for applications in integrated systems. If the analog-to-digital converter downstream of the transmitter is operated with the same supply voltage, the digital measured value will always be correct. This is because the height of the digitization steps depends on the voltage supply, but the number of steps does not – and their number is the critical factor. Using ratiometric signals substantially reduces the

outlay on passing signals from the pressure transmitter to the A/D converter in the signal conditioning electronics, and calibration steps are unnecessary; in the specific case of connection to a microcontroller with an integrated A/D converter, this outlay equals zero. Nevertheless, an interval is specified for the output signal, i.e. 0,5 ... 4,5 V for a supply voltage of exactly 5,0 V. With a stable and precise supply voltage, this interval can also be used directly as the „standard signal“. The sampling rate of 2kHz offers amazingly good dynamic scope for a product based on the AD/DA principle. Moreover, the embedded

electronics in CiO technology provide constant protection against overvoltage and polarity reversal on all lines up to  $\pm 33$  VDC.



Series 4LC / 4LD  
.....the smallest with a diameter of 11 mm

### Embedded Interface I2C

OEM transmitters that are the same size as pressure measurement capsules are never connected directly to field bus systems. Instead, the respective coupling modules have corresponding input interfaces, e.g. for the inter-integrated circuit or I2C interface. For years, this has been the serial standard to cope with short distances in embedded systems. The I2C master needs two lines for the serial data and the pulse (clock) for synchronous sampling. Consequently, no timing requirements are specified for the master - which, in fact, determines the timing. Each OEM transmitter has its own address, which is addressed by the I2C master. In the existing configuration, one master could manage 128 different addresses. The pressure and temperature values are registered by means of a request from the master, and are then available at the transmitters (I2C-slaves) after less than 8 ms, so that they can be clocked out according to a specified protocol. The values are temperature-compensated and –standardized, and they only need to be scaled from the 15-bit integer to a pressure and/or temperature with units.



Series 6LC  
...the high-pressure version

### Mobile Application

Unlike the CiO version with a ratiometric output, CiO versions with a I2C output can also operate with a voltage supply of only 1,8...3,6 VDC, so they are excellently prepared for mobile battery-powered applications. In this case, however, features also include the short conversion time of less than 8 ms (during which a mere 1,5 mA is drawn) and the excellently optimised Sleep mode: unless they are polled, the transmitters remain in this mode, which is typically specified as 0,1  $\mu$ A. If the master allows suitably fast communication, 100 samples per second can therefore be attained.



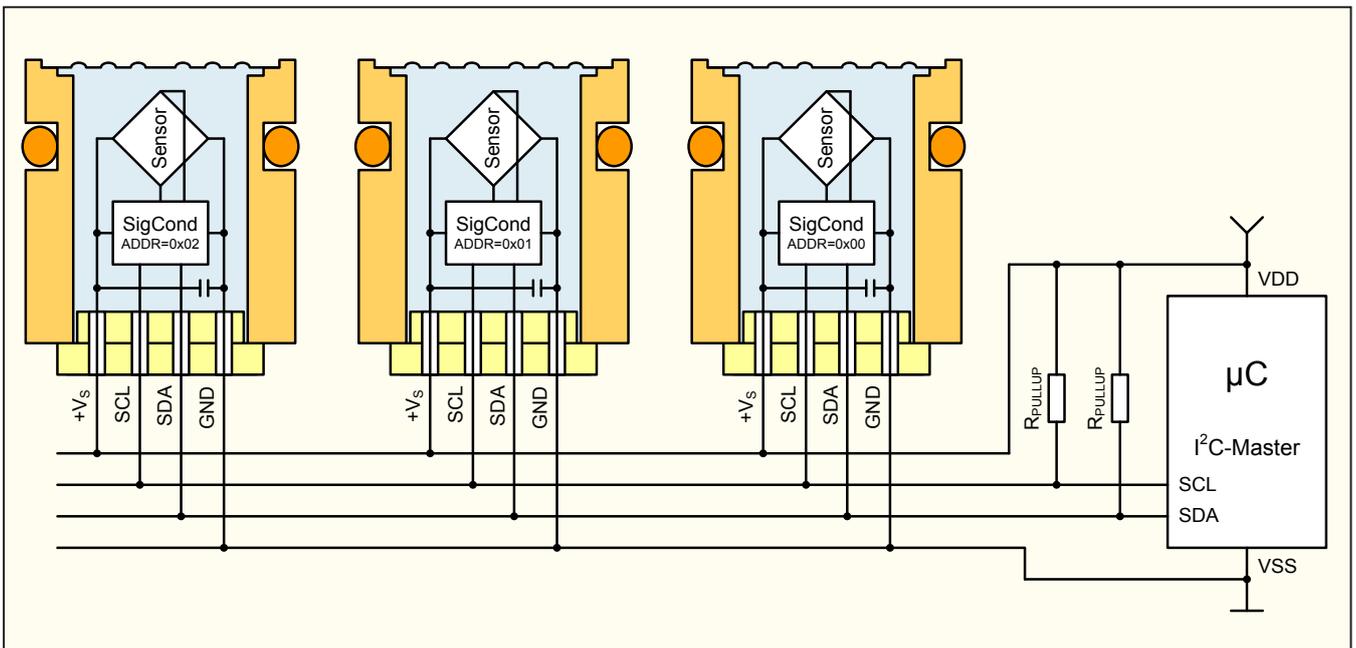
Series 9FLC / 9FLD  
.....with flange for welding or sealing



Series 9LC / 9LD  
...the low-pressure version

### OEM Transmitters for Everyone

Typical key data vary according to the format of the output signal – ratiometric or digital. With an analog output, the transmitter can be used at temperatures of between  $-40$  °C and  $+150$  °C, whereas the I2C output is subject to an upper limit of  $110$  °C. The pressure ranges are from 300 mbar relative to 1000 bar absolute. For a greater dynamic scope with increased power consumption up to a maximum of 8 mA, the analog version should be chosen. For low voltage and low power applications, the digital version (which also supplies the temperature information) is recommended.



Schematic structure of a mini-network of D-line OEM transmitters with the I2C interface. Two free digital tri-state I/O lines are the only requirement for the microcontroller, which freely determines the timing in its capacity as master.

### Summary

KELLER's C-Line OEM transmitters herald a new chapter in the history of high-integration pressure measurement technology. The Chip-in-Oil concept moves signal processing directly into the protective oil-filled pressure measurement capsule housing, made of stainless steel. Linearization, temperature compensation and parameterization are handled here. For integration into higher-level systems or battery-powered devices, versions are available with a ratiometric voltage output or with I2C interface. Various structural designs and materials can be supplied depending on the specific application.

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