Highly Precise Pressure Transmitters

for hazardous applications

Series 33 X Ei (LV) / 35 X Ei (LV) / 36 XW Ei (LV) / PD-33 X Ei (LV)

These piezoresistive pressure transmitters are approved for use in high explosive gas and dust atmospheres of groups I (mining industry) and II (industrial applications) where there is a high risk of explosion. Optionally available are Low Voltage Versions (LV) with 3,2…8,5 V.

Signal processing

This series features microcontroller-based electronic evaluation to ensure maximum accuracy. Each transmitter is gauged across the entire pressure and temperature range. This measurement data is used to calculate a mathematical model that enables correction of all reproducible errors. In this way, KELLER can guarantee high accuracy as an error band within the over-all compensated pressure and temperature range. Two compensated temperature ranges are available for the transmitters, according to choice: -10…80 °C and 10…40 °C. The level probes are gauged in the 0…50 °C temperature range only. The calculated pressure value can be read via the interface, and is simultaneously processed as an analog signal.

Interface

The interface is designed as a robust RS485 half-duplex for 9'600 and 115'200 baud. There is an external leadthrough for the interface on all products except the version with the DIN 43650 plug.

Communication protocol: KELLER Bus and MODBUS RTU. The transmitters can be configured and the measured values can be recorded with the CCS30 software:

- Read out current measured pressure and temperature values with maximum resolution Speed: at 115'200 baud, up to 330 measured values per second (depending on the converter)
- Call up information and status (pressure and temperature ranges, serial number, software version, etc.)
- Reprogram analog output (e.g. different units or pressure range)
- Calibration: zero point and amplification can be adjusted
- Special calculations, such as non-linear curve adaptation or root calculation for flow
- Possibility of adjusting the low-pass filter and the communication parameters

Ex-Classification

Ex I M1 Ex ia I Ma
Ex II 1G Ex ia IIC T4...T6 Ga
Ex II 1D Ex ia IIIC T 130 °C Da
KEMA 04 ATEX 1081 X
IECEx DEK 14.0070 X
CE 0081

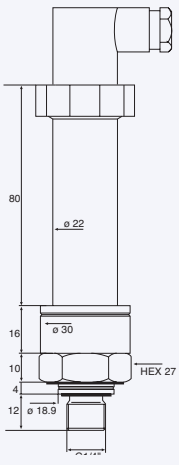
T4 for $T_a \leq 90$ °C, T6 for $T_a \leq 70$ °C

Series 33 X Ei (LV)
Industrial applications

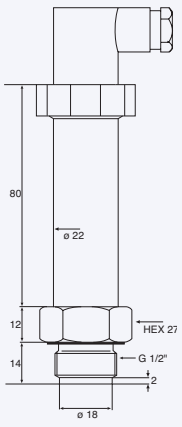
Series 35 X Ei (LV)
Flush diaphragm

Series 36 XW Ei (LV)
Level transmitter

Series PD-33 X Ei (LV)
Differential pressure measurement



Series 33 X Ei (G1/4")



Series 35 X Ei (G1/2")

ELECTRICAL CONNECTIONS

Output	Function	Binder 723	M12 A-coded	DIN 43650	MIL C-26482	Cable
2-Leiter Current	OUT/GND	1	1	1	C	white
	+Vcc	3	3	3	A	black
3-Leiter Voltage	GND	1	1	1	C	white
	OUT	2	2	2	B	red
	+Vcc	3	3	3	A	black
Digital	RS485A	4	4	–	D	blue
	RS485B	5	5	–	F	yellow
Transmitter Housing				⏚		Shield
		use shielded cable				

Drawings of **Series 36 XW Ei**, **PD-33 X Ei** and **mining version M** available on request.

RoHS

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Companies approved to ISO 9001
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KELLER

Specifications

Standard Pressure Ranges (FS) and Overpressure in Bar											
PR-36 XW Ei	0,3 (1)		1		3	10	30				
PAA-36 XW Ei			0,8…2,3		0,8…4	0,8…11	0,8…31				
PR-33 X Ei, PR-35 X Ei	0,3 (1)	±0,3 (1)	1	±1	3	10	30				
PA(A)-33 X Ei, PA(A)-35 X Ei	0,8…1,2		1		3	10	30	100	300	700	1000
(pressure ranges Series PD-33 X Ei on request)											
Überdruck	2	2	2	2	5	20	60	200	400	1000	1100

PAA: Absolute. Zero at vacuum PA: Absolute. Zero at 1 bar abs. PR: Gauge pressure. Zero at atmospheric pressure PD: Differential

All intermediate ranges for the analog output are realizable with no surcharge by spreading the standard ranges. Accessing the extended area 0.1 bar Also negative and further +/- ranges possible. Option: Adjustment directly to intermediate ranges (below 20 pieces against surcharge).

Type	**RS 485**	**4…20 mA** (2-wire)	**0…10 V** (3-wire)	**0…5 V** (3-wire)	**0,1…2,5 V** (3-wire)
Digital Interface	RS485	RS485	RS485	RS485	RS485
Supply (U)	10…30 Vcc	10…30 Vcc	15…30 Vcc	10…30 Vcc	3,5…8,5 V (LV)
Accuracy (2) @ RT (digital) typ.	0,02 %FS	0,04 %FS	0,02 %FS	0,02 %FS	0,02 %FS
Total Error Band (3) (10…40 °C)	0,05 %FS	0,10 %FS (5)	0,10 %FS (6)	0,10 %FS (6)	0,10 %FS
Total Error Band (3) (-10...80 °C) (4)	0,10 %FS	0,15 %FS (5)	0,15 %FS (6)	0,15 %FS (6)	0,15 %FS
Power Consumption (without communication)	< 8 mA	3,2…22,5 mA	< 8 mA	< 8 mA	< 3 mA

(1) Specified “Accuracy” and “Total error band” multiplied by a factor of 2
(2) Linearity (best straight line), hysteresis and repeatability
(3) Accuracy and temperature error within the selected, compensated temperature range
(4) Compensated temperature range for Series 36 XW Ei: TEB 1 % @ 0…50 °C
(5) Disturbance of the 4...20 mA signal occurs during communication through RS485. 3-wire types are suitable for simultaneous operation of analog output and RS485.
(6) Without burden of the voltage output (R_i = 100 Ω). With burden R_a = 100 kΩ the error increases by 0.1 %FS.

Output Rate	400 Hz
Resolution	0,002 %FS
Long Term Stability typ.	Range ≤ 1 bar: 1 mbar Range > 1 bar: 0,1 %FS
Load Resistance	<(U-10 V) / 25 mA (2-wire) > 100 kΩ (3-wire) (6)
Electrical Connection	DIN 43650*, Binder Series 723*, M12, MIL-C 26482, Subconn BH MSS and MCBH MSS or cable * Mating connector included
Start-up Time (Supply On)	< 600 ms
Insulation	10 MΩ / 500 V
Storage Temperature	-40…+120 °C
Operating Temperature**	-40… +90 °C for T4 -40… +70 °C for T6 ** Available for P_i ≤ 640 mW, see operational manual for other options.
Pressure Endurance	10 Million Pressure Cycles 0…100 %FS @ 25 °C
Vibration Endurance, IEC 60068-2-6	20 g (10...2000 Hz)
Shock Endurance, IEC 60068-2-27	50 g (11 ms)
Protection	IP 65 optional: IP 67 or IP 68 (with cable)
CE-Conformity (EMC)	EN 61000-6-1 to 6-4 / EN 61326-1 / EN 61326-2-3
Material in Contact with Media	Stainless Steel 316L (DIN 1.4435) / Viton®
Weight	Series 33 X Ei ≈ 140 g; Series 35 X Ei ≈ 160 g Series PD-33 X Ei ≈ 500 g, Series 36 XW Ei ≈ 200 g
Dead Volume Change	< 0,1 mm³

Options:
- Special calculations with pressure and temperature
- Different housing-material, oil filling, pressure thread
- Different compensated temperature and pressure ranges
- Low Voltage Version labelled with “LV” in Type Designation
- Mining Version labelled with “M” in Type Designation

Further versions:
- Series PD-39 X Ei: for differential pressure measurements with high double-sided overload resistance
- Series 41 X Ei: for low pressure ranges
- Series 46 X Ei: for low pressure ranges, flush diaphragm

(see separate data sheets)

Intrinsically safe in conjunction with certified intrinsically safe power circuits, with the following maximum connected loads:

U_i ≤ 30 V, I_i ≤ 200 mA, P_i ≤ 0,64…1,3 W (depending on the application, see operating instructions)

Low Voltage Version “LV”

U_i ≤ 8,5 V, I_i ≤ 200 mA, P_i ≤ 1,3 W
L_i = 0 mH, C_i = 6,5 µF

Polynomial Compensation

This uses a mathematical model to derive the precise pressure value (P) from the signals measured by the pressure sensor (S) and the temperature sensor (T). The microprocessor in the transmitter calculates P using the following polynomial:

$$P(S,T) = A(T)\cdot S^0 + B(T)\cdot S^1 + C(T)\cdot S^2 + D(T)\cdot S^3$$

With the following coefficients A(T)…D(T) depending on the temperature:

$$A(T) = A_0\cdot T^0 + A_1\cdot T^1 + A_2\cdot T^2 + A_3\cdot T^3$$
$$B(T) = B_0\cdot T^0 + B_1\cdot T^1 + B_2\cdot T^2 + B_3\cdot T^3$$
$$C(T) = C_0\cdot T^0 + C_1\cdot T^1 + C_2\cdot T^2 + C_3\cdot T^3$$
$$D(T) = D_0\cdot T^0 + D_1\cdot T^1 + D_2\cdot T^2 + D_3\cdot T^3$$

The transmitter is factory-tested at various levels of pressure and temperature. The corresponding measured values of S, together with the exact pressure and temperature values, allow the coefficients A_0...D_3 to be calculated. These are written into the EEPROM of the microprocessor.

When the pressure transmitter is in service, the microprocessor measures the signals (S) and (T), calculates the coefficients according to the temperature and produces the exact pressure value by solving the P(S,T) equation.

Calculations and conversions are performed at least 400 times per second.

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