ALTOSONIC 5

Ultrasonic liquid flowmeter for custody transfer

- Suitable for all flow regimes, no Reynolds limitation
- Integrated full pipe detection
- Significant easier small volume proving

GUIDANT
POWERED BY KROHNE

4004362905 - TD ALTOSONIC 5 en R05

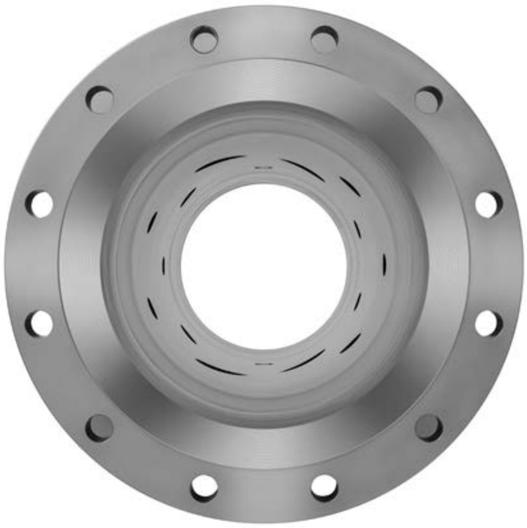
1.1 ALTOSONIC 5 flowmeter for custody transfer

The ALTOSONIC product line for fluids has established itself as the standard in multi-path custody transfer flow metering. The absence of obstructing and moving parts ensures no wear or pressure loss. This in combination with large meter sizes permits simplified configuration of metering systems.

Operation is maintenance free. Due to long-term stability, periodic calibration can be reduced to a minimum which results in drastically cutting costs for on-site equipment and procedures.

In addition, the diagnostics of the flowmeter will ensure a good performance and will prevent malfunctioning of the measurement by providing essential information upon which the operator is able to take preventive action.

This all results in considerable cost savings in both capital (CAPEX) and operational expenditure (OPEX).



Highlights

- All fluids and no Reynolds restriction
  - Widest certified turndown
  - Guaranteed performance in all flow regimes (laminar, transition and turbulent)
  - Multi-product application
  - From light to heavy crudes and LNG
  - Bi-directional flow measurement
- Proven long-term stability
  - No moving parts
  - Longest installed base (1996 - present)
  - No unscheduled downtime due to transducer failure since introduction
- Small footprint
  - Short inlet run
  - Short installation height
- Entrained gas detection (Full Pipe Guarantee)
  - Dedicated diagnostic path
  - Permanent diagnostics
- Compact prover compliance (SVP)

Industries

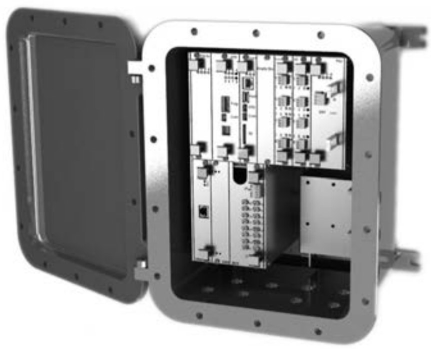
- Oil and gas
- Petrochemical
- Chemical

Applications

- Offshore oil production
- Onshore oil production
- Crude oil pipelines
- Multi-product pipelines
- Loading and off-loading terminals (crudes, refined products and LNG)
- Refineries

1.2 Options and variants

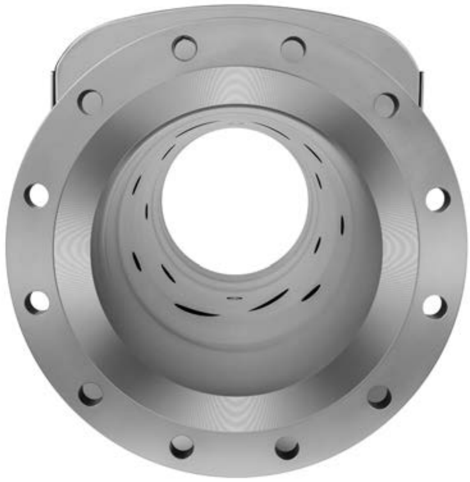
To be able to cover a wide range of applications, process conditions and ambient conditions, the ALTOSONIC 5 flowmeter consists of a flow sensor and a separate remote signal converter.
The flow sensor, installed in the pipeline, contains multiple ultrasonic transducers for flow measurement and diagnostics. In addition, a vertical mounted transducer pair will ensure that there is no gas on top of the liquid. To avoid influence from flow sensor expansion on the measurement a temperature sensor is integrated to compensate for this effect.



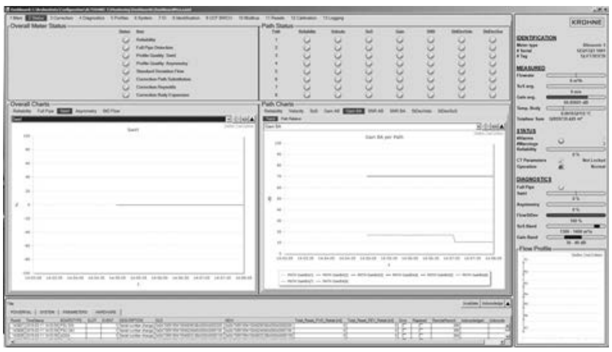
The remote signal converter determines the actual flow based on the information received from the flow sensor. Next to the flow, the signal converter will gather a large amount of diagnostic information such as signal-to-noise ratio, velocity of sound and profile. Based on this diagnostic information, the signal converter is able to determine the health of the measurement. In addition to gathering the information and diagnosing the health of the meter, all this information can be logged internally and is available whenever it is necessary.

Should a local display be required, an optional explosionproof display can be connected to the signal converter. The display can be configured to show any of the process and / or measuring data.

For custody transfer applications the standard flow has to be calculated by correcting for pressure and temperature. The common standard flow calculation API 11.1 is certified for use in the remote signal converter that also accomodates batching functionality. Other calculation standards require a flowcomputer. KROHNE offers the internationally recognized and approved flow computer, SUMMIT 8800, to fulfil this task.



Variants
- Standard, for viscosities up to 150 cSt
- High viscosity, for viscosities higher than 150 cSt
- Low temperature, for cryogenic process conditions such as LNG
- High temperature, up to 250°C (482°F)



Standard diagnostics

With the above instruments it is possible to build an excellent measuring system. But what if there is any doubt about the measuring results? Is this due to the measuring system itself or is it due to changing process conditions, such as air in the pipeline? With the Monitoring, Configuration and Diagnostics tool in the flowmeter it is not only possible to determine the cause, but it will also give the user a preventative warning in case of mal-functioning or changing of process conditions.

Example: During operation a thin layer of air occurs on top of the fluid. Assuming this layer displaces 0.1% of the fluid, the reading of the flowmeter will have an additional uncertainty of 0.1%, because an ultrasonic flowmeter assumes the pipe to be hundred percent full. By integrating a vertical diagnostic path the slightest bit of air will be detected and the user will be informed. Full-pipe detection is essential for every custody transfer transaction to guarantee the absence of gas in the pipeline.

1.3 Measuring principle

The ultrasonic liquid flowmeter operates according to the principle of measuring the transit time of an ultrasonic sound wave. The liquid velocity is derived from the difference in transit time of a sound wave travelling in a direction with the flow direction and the sound wave travelling in the opposite direction. The trajectory of the sound wave is called the acoustic path.

2.1 Technical data table

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

Measuring system

Measuring principle	Ultrasonic transit time
Application range	Flow measurement of liquids in custody transfer applications
Versions	Standard (ST)
	High Viscosity (HV)
	Low Temperature (LT)
	High Temperature (HT)
Measured value	Actual volume flow
Calculated value	Totalised flow, velocity of sound

Design

General	The ALTOSONIC 5 flowmeter consists of a flow sensor and a signal converter.
Flow sensor	
Construction	The flow sensor has an eight-path design with a central path for optimal differentiation between turbulent, transition or laminar flow. It also includes a dedicated vertical diagnostic path for full pipe detection.
Nominal diameter	4"...24" / DN100...600
	Other diameters on request.
Signal converter	
Construction	The remote signal converter is placed in a flameproof box, There are different slide-in PCB's for easy replacement, with removable cable connectors.
Functionality	Calculation of totalised volume
	Diagnosis of flow profiles
	Body temperature correction
	Logging of relevant parameters
	Optional display connection
	Integrated standard volume correction acc, API11.1
	Batching and ticketing
	Smart IO with 4 to 8 free configurable in/out analog/digital
	TCP/IP and USB connecttivity
	3 Modbus slaves, 1 Modbus master
	Integrated data logging and audit log

Measuring accuracy

Measuring range	0...15 m/s (bidirectional)
	Reduced bore:
	Reynolds range: no limits (turbulent, transition and laminar flow regimes)
	Certified for custody transfer: 0.2...15 m/s (bidirectional)
	See table inputs outputs for specific meter certified size max flowrates
	Full bore:
	Reynolds range: > 10000
	Certified for custody transfer: 0.5...15 m/s (bidirectional)
	See table inputs outputs for specific meter certified size max flowrates
Linearity	0.10%, for Reynolds range > 10000 with a turndown of 30:1 (0.5...15 m/s)
	0.15%, for whole Reynolds range with a turndown of 75:1 (0.2...15 m/s)
Uncertainty	< ±0.027% according to API
Repeatability	according to API chapter 5.8 table B1
Zero stability	< 0.2 mm/s

Ambient temperatures

Flow sensor	
ATEX, IECEx, DIV1/ZONE1	Standard: -40...+65°C / -40...+149°F
	Optional: -55...+65°C / -67...+149°F
Storage temperature	-40...+65°C / -40...+149°F
Signal converter	
ATEX	Standard: -40...+65°C (IIB) / +60°C (IIB + H2) / -40...+149°F (IIB) / +140°F (IIB + H2)
	Low Ambient Temperature (LTA): -55...+65°C (IIB) / +60°C (IIB + H2) / -67...+149°F (IIB) / +140°F (IIB + H2)
IECEx	Standard: -40...+65°C (IIB) / +60°C (IIB + H2) / -40...+149°F (IIB) / +140°F (IIB + H2)
	Low Ambient Temperature (LTA): -55...+65°C (IIB) / +60°C (IIB + H2) / -67...+149°F (IIB) / +140°F (IIB + H2)
DIV1 / ZONE1 (C/US)	Standard: -40...+65°C / -40...+149°F
	Low Ambient Temperature (LTA): -55...+65°C / -67...+149°F
Storage temperature	-40...+65°C / -40...+149°F

Process conditions

Process temperature	Standard version: -40...+120°C / -40...+240°F	
	Low temperature version: -200...+120°C / -328...+240°F	
	High temperature version: -40...+250°C / -40...+482°F	
	High viscosity version: -40...+120°C / -40...+240°F	
Viscosity range	All versions: 0.1...230 cSt	
	High viscosity version: 0.1...1500 cSt	
Pressure range	ASME 150...600	
	Pressure rating according to ASME B16.5 (-29...+38°C / -20...+100°F):	
	Class 150 lbs:	Stainless steel: 19.0 bar / 275 psi
		Carbon steel: 19.6 bar / 285 psi
	Class 300 lbs:	Stainless steel: 49.6 bar / 720 psi
		Carbon steel: 51.1 bar / 740 psi
	Class 600 lbs:	Stainless steel: 99.3 bar / 1440 psi
		Carbon steel: 102.1 bar / 1480 psi
	Other pressure ranges on request.	
Minimum pressure requirement	For detailed information, refer to *Backpressure* on page 25.	
Water content	Velocity above 1 m/s: ≤ 6%	
	Velocity above 2 m/s: ≤ 10%	
Solids content	< 5% (volume)	
Air/gas content	< 2% (volume)	

Installation conditions

Installation	For detailed information, refer to *Mechanical installation* on page 19.
Dimensions and weights	For detailed information, refer to *Dimensions and weights* on page 14.
Altitude	< 2000 m
	Higher altitudes are possible, contact supplier.
Overvoltage category	II
Pollution degree	3

Materials

Flanges (RF)	Carbon steel ASTM A105 / A350 Gr.LF2
	Stainless steel AISI 316 / 316 L (1.4404) (dual certified)
	Other materials / flange types on request
Measuring tube	Carbon steel ASTM A105 / A350 Gr.LF2
	Stainless steel AISI 316 / 316 L (1.4404) (dual certified)
	Other materials on request
Converter housing	Standard: Copper free aluminum
	Option: Stainless steel 316 (1.4408) for offshore applications
Coating flow sensor	Standard: KROHNE 1 layer paint system in accordance with ISO 12944-2:2007 Category C3 Medium / C4 Low Color: KROHNE grey (air) CNC 5252 - gloss
	Option: KROHNE 3 layer paint system in accordance with ISO 12944-2:2007 Category C5I High / C5m High Color: KROHNE Grey (air) CNC 5252 - gloss
	Option: Blasted (not coated) (only for stainless steel flow sensor)
	Other coating types on request.

Electrical connections

Power supply	DC: 24 VDC +10%/-15%
	AC: 100...240 VAC, 50/60 Hz
Power consumption	DC: 28 W (with optional heater: 203 W)
	AC: 35 W
Transducer signals	Intrinsically safe flow sensor circuits:
	$Vmax/U_i$ = 18 V, I_{max}/I_i = 210 mA, C_i = 100 nF, L_i = 700 μH, P_i = 1 W
	Intrinsically safe signal converter circuits:
	V_{oc}/U_o = 6.51 V, I_{sc}/I_o = 208 mA, C_a/C_o = 22 μF (IIB) / 6 μF (IIB + H2), L_a/ L_o = 1.5 mH (IIB) / 500 μH (IIB + H2), P_o = 0.34 W
PT100 signal	Intrinsically safe (ia) circuit:
	V_{max}/U_i = 10 V, I_{max}/I_i = 25 mA, P_i = 250 mW, L_i = 10 μH, C_i = 1 nF
Cable entries	Standard: M20 x 1.5
	Option: ½" NPT, PF ½

Inputs and outputs

Available options	1x Ethernet (including Modbus TCP/IP availability)			
	4x RS485 communication ports (1 Master, 3 Slaves)			
	4x (Basic IO) or 8x (optional, extended IO) IO configurable input/output with: - Alarms - Analog values 0/4...20 mA inputs/outputs - Digital dual pulse, phase shifted (see next line for more details) All circuits: galvanically isolated, rated < 16 V r.m.s. / 22.6 V peak / < 35 VDC			
Digital dual pulse, phase shifted	Maximum frequency: 10 kHz (default setting 2 kHz)			
	Size [inch]	max. flow [m3/h]	K-factor (default setting) [pulse/m3]	K-factor (default setting) [liter/pulse]
	4	375	19200.0	0.052083
	6	750	9600.00	0.104167
	8	1750	4114.29	0.243056
	10	2250	3200.00	0.312500
	12	3125	2304.00	0.434028
	14	3750	1920.00	0.520833
	16	4500	1600.00	0.625000
	18	5800	1241.38	0.805556
	20	7000	1028.57	0.972222
	24	10000	720.000	1.388889
MODBUS				
Description	Modbus RTU/ASCII, RS485/TCP-IP, Modicon/NonModicon			
Transmission procedure	Half duplex, asynchronous			
Address range	1...247			
Supported function codes	1, 2, 3, 4, 5, 6, 8, 15, 16			
Supported Baud rate	50, 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 (default), 56000, 64000, 115200, 128000 Baud			

Approvals and certificates

CE			
This device fulfills the statutory requirements of the relevant directives. The manufacturer certifies successful testing of the product by applying the conformity mark on the device.			
	For more information on the directives, standards and the approved certifications, please refer to the declaration of conformity supplied with the device or the website of the manufacturer.		
Measurement Instrument Directive	2014/32/EU		
	Certificate: TC8722		
	Accuracy: class 0,3		
	Environmental classes: M2 / E2		
Hazardous areas approvals			
		Marking	Certificate
ATEX	Flow sensor	II 2G Ex ia IIC T6...T2 Gb	FTZU 14 ATEX 0131X
	Signal converter	II 2G Ex db [ia] IIB T5 Gb or II 2G Ex db [ia] IIB+H2 T5 Gb	FTZU 14 ATEX 0042X
IECEx	Flow sensor	Ex ia IIC T6...T2 Gb	IECEx FTZU 14.0020X
	Signal converter	Ex db [ia] IIB T5 Gb or Ex db [ia] IIB+H2 T5 Gb	IECEx FTZU 14.0029X
DIV 1	Flow sensor	Class I, DIV 1, Groups B, C, D, temp class T6...T2	LR 1338-1
	Signal converter	Class I, DIV1, Groups B, C, D, temp class T5	LR 1338-2
ZONE 1 (Canada)	Flow sensor	Ex ia IIB+H2 T6...T2 Gb	LR 1338-1
	Signal converter	Ex d [ia] IIB+H2 T5 Gb	LR 1338-2
ZONE 1 (USA)	Flow sensor	Class I, Zone 1, AEx ia IIB + H2 T6...T2 Gb	LR 1338-1
	Signal converter	Class I, Zone 1, AEx d [ia] IIB + H2 T5 Gb	LR 1338-2
NEPSI (China)	Flow sensor	Ex ia IIC T2~T6 Gb	GYJ21.1269X
	Signal converter	Ex d [ia] IIB T5 Gb, Ex d [ia] IIB+H2 T5 Gb	GYJ21.1270X
CCoE or PESO (India)	Flow sensor	Ex ia IIC T6...T2 Gb	P508409/2
	Signal converter	Ex db [ia] IIB T5 Gb or Ex db [ia] IIB+H2 T5 Gb	P508409/1
UKCA (United Kingdom)	Flow sensor	II 2G Ex ia IIC T6...T2 Gb	CSAE 21UKEX2734X
	Signal converter	II 2G Ex db [ia] IIB T5 Gb or II 2G Ex db [ia] IIB+H2 T5 Gb	CSAE 22UKEX1445X
DNV (Brazil)	Flow sensor	Ex ia IIC T6...T2 Gb	DNV 20.0078 X
	Signal converter	Ex db [ia Ga] IIB T5 Gb or Ex db [ia Ga] IIB+H2 T5 Gb	DNV 16.0091 X
EAC (Russia)	Flow sensor	1Ex ia IIC T6...T4 Gb X or 1Ex ia IIC T6...T2 Gb X	RU C-NL.AA97.B.00234/19
	Signal converter	1Ex d [ia] IIB T5 Gb X, 1Ex d [ia] IIB+H2 T5 Gb X	RU C-NL.AA97.B.00234/19
	Display UFD 5	1Ex d IIC T6...T5 Gb X	RU C-NL.AA97.B.00234/19

Other approvals	
Ingress protection	IP66 or NEMA Type 4X
Shock resistance	Flow sensor and signal converter: IEC 60721-3-4 Class 4M4 15 g for 6 ms
Vibration resistance	Flow sensor and signal converter: IEC 60721-3-4 Class 4M4 1 g up to 200 Hz
	Flow sensor and signal converter: OIML R117 M2
	Flow sensor: IEC 61298-3 2 g up to 1000 Hz
OIML - R117	Flow sensor: TC 8722 Environmental classes: M2 / E2
	Signal converter: TC 8548
INMETRO	P_218_22_SEI_002182_22_10
SIRIM	ATS 23/16
GOST	NL.C.29.004.A No 64100
NUPRC	E&S/SCATA/TA/521 2/98a
OTZ	02.6037

2.2 Dimensions and weights

- *Below dimensions are provided as indication. They can vary slightly with different schedule sizes.*
- *Values for larger diameters are available on request.*

Generation 1 flow sensor

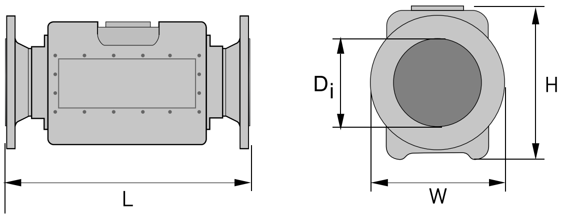


Figure 2-1: Dimensions of flow sensor

ASME 150 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	289	500	330	102.26	175	11.38	19.69	12.99	4.026	385
6" / DN150	340	600	380	154.08	310	13.39	23.62	14.96	6.066	682
8" / DN200	408	600	369	202.74	320	16.06	23.62	14.53	7.982	704
10" / DN250	510	900	450	254.46	230	20.08	35.43	17.72	10.018	506
12" / DN300	530	1000	490	304.79	310	20.87	39.37	19.29	12.000	682
14" / DN350	540	1100	540	336.54	460	21.26	43.31	21.26	13.250	1012
16" / DN400	600	1200	600	387.34	600	23.62	47.24	23.62	15.250	1320
18" / DN450	650	1350	635	437.94	860	25.59	53.15	25.00	17.242	1892
20" / DN500	700	1400	700	482.60	960	27.56	55.12	27.56	19.000	2112
24" / DN600	820	1650	820	584.60	1050	32.28	64.96	32.28	23.016	2310

ASME 300 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	289	500	330	102.26	195	11.38	19.69	12.99	4.026	429
6" / DN150	340	600	380	154.08	325	13.39	23.62	14.96	6.066	715
8" / DN200	396	600	343	202.74	335	15.59	23.62	13.50	7.982	737
10" / DN250	510	950	450	254.46	260	20.08	37.40	17.72	10.018	572
12" / DN300	530	1050	520	298,40	360	20.87	41.34	20.47	11.748	792
14" / DN350	590	1100	590	330.20	440	23.23	43.31	23.23	13.000	968
16" / DN400	650	1200	650	381.00	690	25.59	47.24	25.59	15.000	1518
18" / DN450	710	1350	710	428.46	900	27.95	53.15	27.95	16.868	1980
20" / DN500	780	1400	780	477.82	1120	30.71	55.12	30.71	18.812	2464
24" / DN600	920	1650	920	575.10	1300	36.22	64.96	36.22	22.642	2860

ASME 600 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	289	550	330	97.18	210	11.38	21,65	12.99	3.826	463
6" / DN150	340	600	380	146.36	350	13.39	23.62	14.96	5.762	770
8" / DN200	396	650	343	193.70	370	15.59	25.59	13.50	7.626	814
10" / DN250	510	1000	510	242.82	400	20.08	37.40	20.08	9.560	880
12" / DN300	560	1050	560	288.89	480	22.05	41.34	22.05	11.374	1056
14" / DN350	610	1150	610	317.50	650	24.02	45.28	24.02	12.500	1430
16" / DN400	690	1200	690	363.52	810	27.17	49.21	27.17	14.312	1782
18" / DN450	750	1300	750	409.34	960	29.53	51.18	29.53	16.116	2116
20" / DN500	820	1400	820	455.62	1250	32.28	55.12	32.28	17.938	2756
24" / DN600	940	1600	940	548.08	1910	37.01	62.99	37.01	21.578	4211

Generation 2 flow sensor

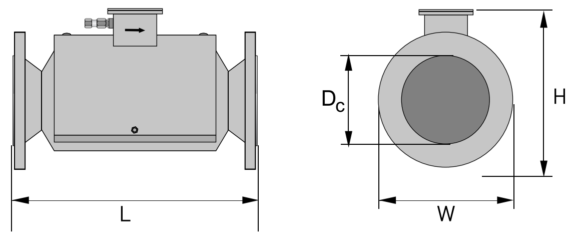


Figure 2-2: Dimensions of flow sensor

ASME 150 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	338	500	288	102.26	100	13.29	19.69	11.34	4.026	220
6" / DN150	385	510	334	154.08	135	15.16	20.08	13.15	6.066	298
8" / DN200	443	590	389	202.74	218	17.42	23.23	15.31	7.982	481
10" / DN250	503	690	444	254.46	321	19.78	27.17	17.48	10.018	708
12" / DN300	563	800	485	304.74	442	22.15	31.50	19.09	11.998	974
14" / DN350	603	880	535	336.54	541	23.72	34.65	21.06	13.250	1193
16" / DN400	658	970	595	387.34	719	25.89	38.19	23.43	15.250	1585
18" / DN450	703	1110	635	437.94	906	27.68	43.70	25.00	17.242	1997
20" / DN500	755	1240	700	482.60	1136	29.72	48.72	27.56	19.000	2504
24" / DN600	848	1470	815	584.60	1576	33.37	57.87	32.09	23.016	3474

ASME 300 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	350	520	288	102.26	105	13.78	19.69	11.34	4.026	231
6" / DN150	405	530	334	154.08	147	15.94	23.62	13.15	6.066	324
8" / DN200	460	610	389	202.74	232	18.11	23.62	15.31	7.982	511
10" / DN250	523	690	445	254.46	341	20.57	37.40	17.52	10.018	752
12" / DN300	580	800	520	298.40	461	22.83	41.34	20.47	11.748	1016
14" / DN350	628	880	585	330.20	582	24.70	43.31	23.03	13.000	1283
16" / DN400	685	970	650	381.00	773	26.97	47.24	25.59	15.000	1704
18" / DN450	740	1110	710	428.46	985	29.13	53.15	27.95	16.869	2172
20" / DN500	793	1240	775	477.82	1231	31.20	55.12	30.51	18.812	2714
24" / DN600	915	1470	915	575.04	1746	36.02	64.96	36.02	22.639	3849

ASME 600 lb

Nominal size	Metric					Imperial				
	H [mm]	L [mm]	W [mm]	D_i [mm]	Weight [kg]	H [inch]	L [inch]	W [inch]	D_i [inch]	Weight [lbs]
4" / DN100	360	550	288	97.18	116	14.17	21.65	11.34	3.826	256
6" / DN150	423	600	355	146.36	176	16.63	23.62	13.98	5.762	388
8" / DN200	480	670	420	193.70	277	18.90	26.38	16.54	7.626	611
10" / DN250	555	770	510	242.82	427	21.85	30.31	20.08	9.560	941
12" / DN300	600	830	560	288.84	541	23.62	32.68	22.05	11.372	1193
14" / DN350	638	880	605	317.50	644	25.10	34.65	23.82	12.500	1420
16" / DN400	703	970	685	363.52	879	27.67	38.19	26.97	14.312	1938
18" / DN450	758	1110	745	409.34	1119	29.84	43.70	29.33	16.116	2467
20" / DN500	815	1240	815	455.62	1413	32.09	48.82	32.09	17.938	3115
24" / DN600	940	1470	940	548.08	1979	37.01	57.87	37.01	21.578	4363

Signal converter

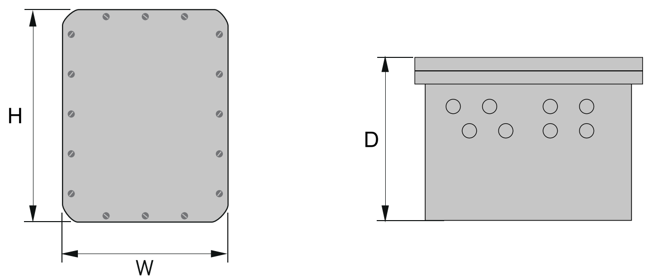


Figure 2-3: Dimensions of signal converter housing

Version	Metric				Imperial			
	H [mm]	W [mm]	D [mm]	Weight [kg]	H [inch]	W [inch]	D [inch]	Weight [lbs]
Aluminum (ATEX / IECEx)	432	332	299	25.4	17.01	13.07	11.77	56.0
Stainless steel (ATEX / IECEx)	432	382	286	75.0	17.01	15.04	11.26	165.3
Aluminum (DIV 1 / ATEX)	584	432	292	64.0	22.92	17.01	11.50	141.1

2.3 Flow table

Nominal size	Metric		Imperial	
	Q_{min} [m^3/h] 0.2 m/s	Q_{max}* [m^3/h] 10 m/s	Q_{min} [bbl/h] 0.7 ft/s	Q_{max}* [bbl/h] 33 ft/s
4" / DN100	5.6	280	35	1760
6" / DN150	12.6	630	80	3960
8" / DN200	22.6	1130	140	7120
10" / DN250	36	1800	225	11300
12" / DN300	50	2500	315	15700
14" / DN350	70	3500	440	22000
16" / DN400	90	4500	565	28280
18" / DN450	114	5700	715	33850
20" / DN500	140	7000	880	44000
24" / DN600	200	10000	1255	62850
*This table is meant for sizing purposes only, therefore Q_{max} is based on a practical maximum velocity of 10 m/s in the pipeline. However, this is not the physical limitation of the flowmeter. See for certified flowrates OIML-R117 evaluation certificate or contact KROHNE.				
Calculations are provided as indication, please ask KROHNE for detailed sizing.				

3.1 Intended use

Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The ALTOSONIC 5 is a highly accurate flowmeter, intended for custody transfer, fiscal, allocation and leak detection applications.

3.2 Installation

3.2.1 Mounting position

- *Install the flow sensor with the flow arrow indicator on the flow sensor in the direction of the positive (forward) liquid flow.*
- *Do not install the flow sensor at the highest position in the pipeline.*
- *Check the weight of the flow sensor. Typically the weight of the flow sensor will be considerably more than the same length of pipeline. To support the flow sensor, additional supports might be needed, preferably on each side of the flow sensor.*
- *If supports cannot be placed under the flow sensor flanges, supports may be placed under the mating flanges of the pipeline. If supports can only be placed under the pipeline sections upstream or downstream of the flow sensor, these supports shall be as close as possible to the flow sensor. In this case a calculation shall be made to verify that the load on the pipeline will not exceed acceptable values.*
- *The flow sensor should be installed in the pipeline with gaskets, nuts and bolts according to the type and size of the flanges of the flow sensor. The flanges of the flow sensor should match the flanges of the pipeline where the flow sensor is installed.*
- *Make sure that the gaskets do not protrude into the flow as this can reduce the accuracy of the flow sensor.*
- *The distance between the flanges should be equal to the length of the flow sensor plus gaskets. No excessive force should be necessary to tighten the gaps on either side of the flow sensor.*
- *For tightening the bolts of the flanges, apply a lubricant as required, in accordance with the materials as used and applicable standards.*
- *Tighten the bolts of the flanges with a torque according to the standards applicable to the flanges and materials used.*

3.2.2 Pipe diameters

If an inlet section is delivered for the flowmeter, then ensure that the inner diameter of the inlet section has a maximum deviation of +3% of the inner diameter of the flow sensor. Contact the manufacturer if the inner diameter deviates.
If the flowmeter is delivered without inlet section, then the flowmeter is calibrated with an inlet section that has the same inner diameter as the upstream pipe of the customer.

- *Use bush guide to ensure inlet, meter and outlet are in same level*
- *Ensure that gaskets are installed centric and do not interfere the flow*
- *The welds must be internally grinded flush to avoid flow disturbances*

3.2.3 Flow conditioners

It is preferred to install an additional flow conditioner that is installed upstream of the flow sensor to minimize the influence of upstream perturbations.

If a flow conditioner is used, then make sure that the flow conditioner, the inlet pipe and the flow sensor are calibrated together.

3.2.4 Inlet and outlet

The inlet and outlet configurations mentioned are intended as recommended guidelines.

With flow conditioner for unidirectional use

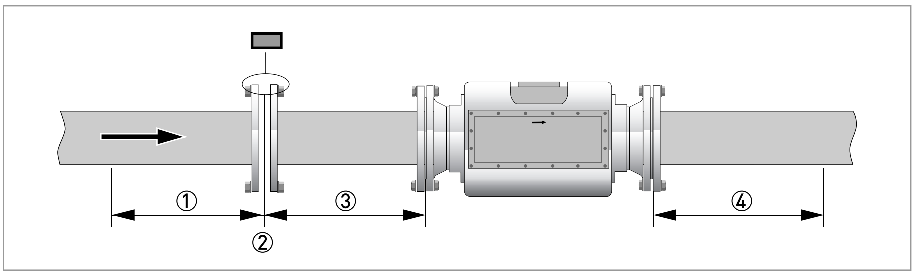


Figure 3-1: Required straight lengths for inlet and outlet

① Pipe section: minimum 5 DN
② Flow conditioner
③ Inlet section: 5 DN
④ Outlet section: 3 DN

Please note that more straight inlet length will improve overall performance.

With flow conditioner for bidirectional use

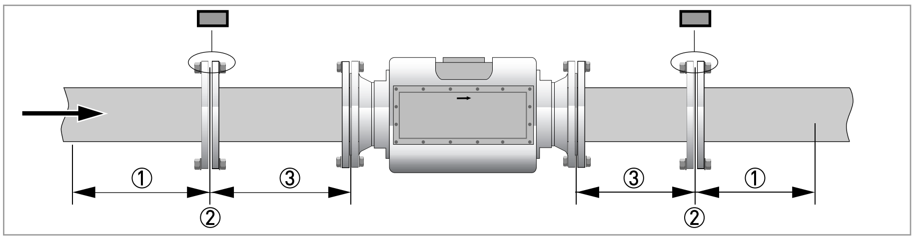


Figure 3-2: Required straight lengths for inlet and outlet

① Straight pipe section: minimum 5 DN
② Flow conditioner
③ Inlet and outlet section: 5 DN

Without flow conditioner

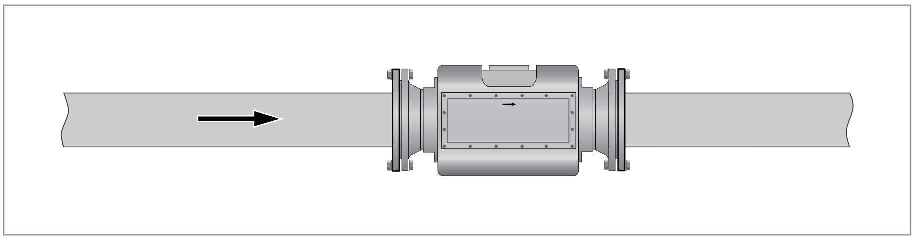


Figure 3-3: Required straight lengths for inlet and outlet

For applications without flow conditioner, the inlet and outlet lengths depend on the upstream piping arrangement and the liquid conditions (temperature, viscosity, flow rate). Please contact KROHNE for assistance.

3.2.5 Mounting position

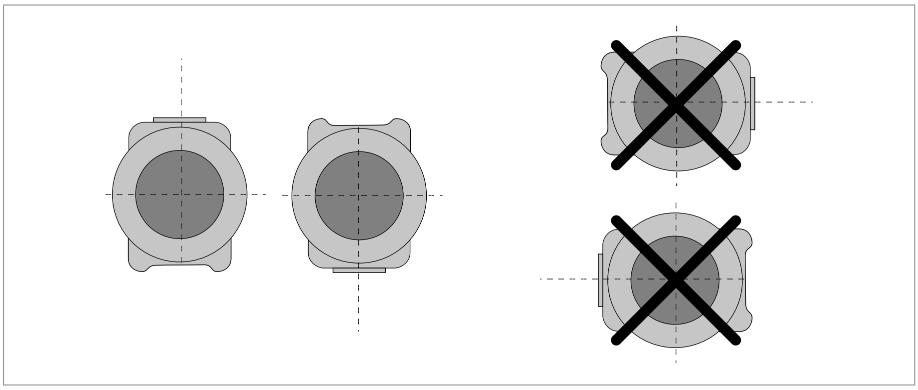


Figure 3-4: Mounting position

Install the flowmeter with the top upwards or downwards.

3.2.6 Support of the flow sensor

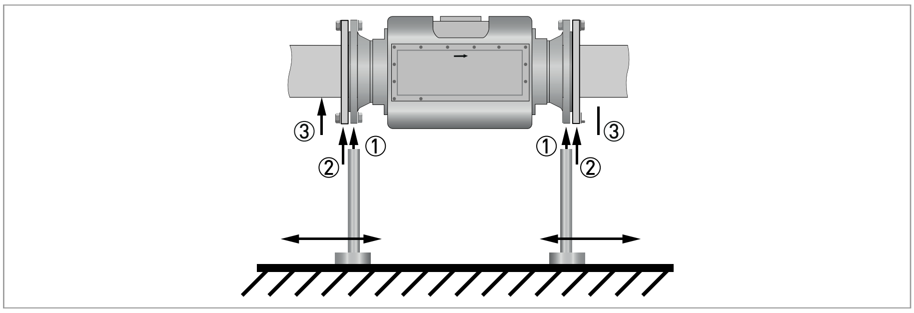


Figure 3-5: Support of flow sensor

① Preferred position of supports under flanges of flow sensor
② If preferred position is not possible, then use the mating flanges to support the flow sensor
③ If both flanges cannot be used, then put the supports under the pipeline as close to the flow sensor as possible.

3.2.7 Flange deviation

Max. permissible deviation of pipe flange faces:
$L_{max} - L_{min} \leq 0.5\ mm / 0.02"$

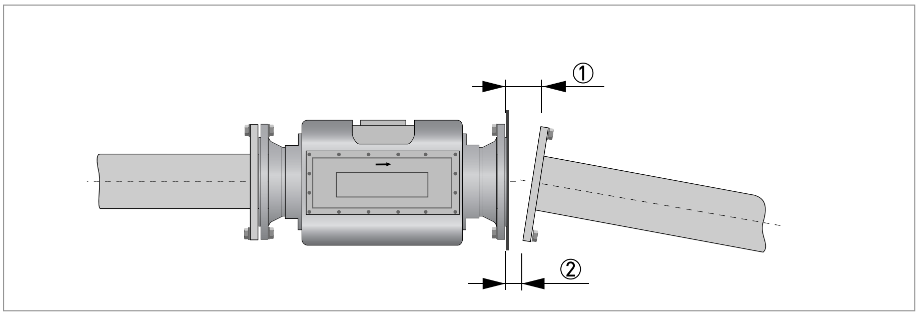


Figure 3-6: Flange deviation

① L_{max}
② L_{min}

3.2.8 Special considerations

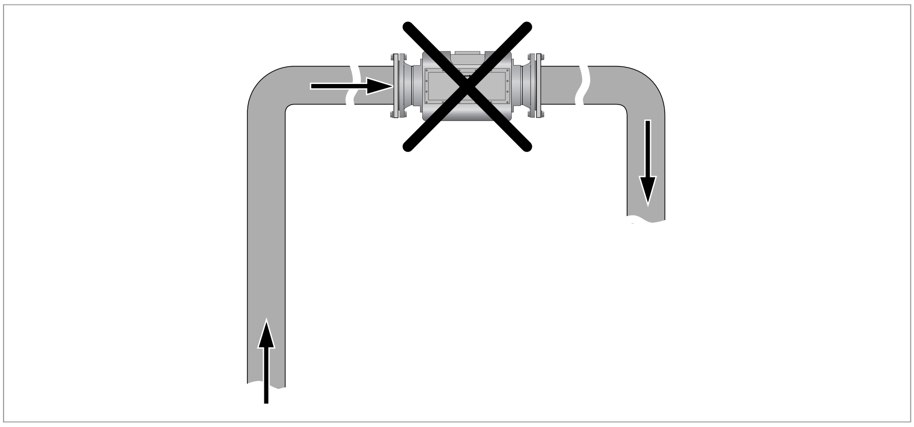


Figure 3-7: Preferrably no installation at highest point

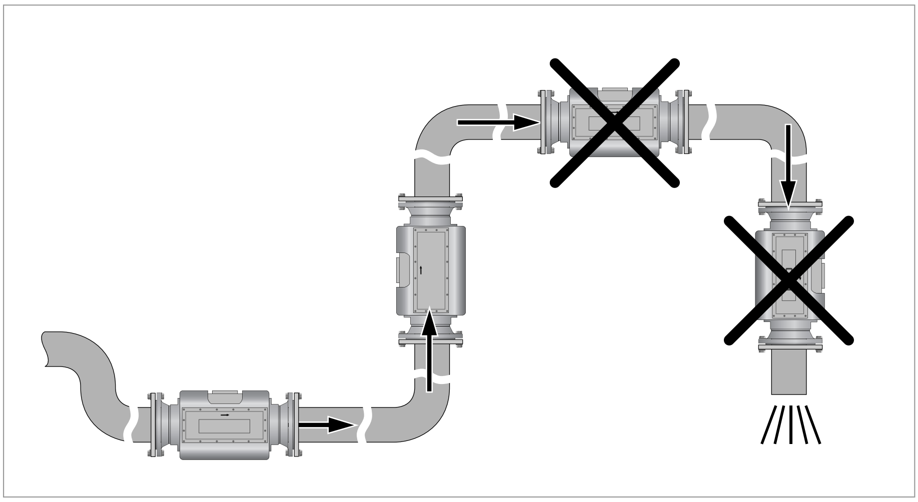


Figure 3-8: Risk of pipe being not fully filled

It is advised not to install the flow sensor at the highest point, because gas can collect there. If there is no other possible location, make sure that the pipeline is vented.

Do not install the flow sensor in a vertical line, if it is not sure that the pipe remains fully filled and / or is without gas.

The flow sensor can be installed in a vertical line, if there is no free discharge.

3.2.9 Air venting

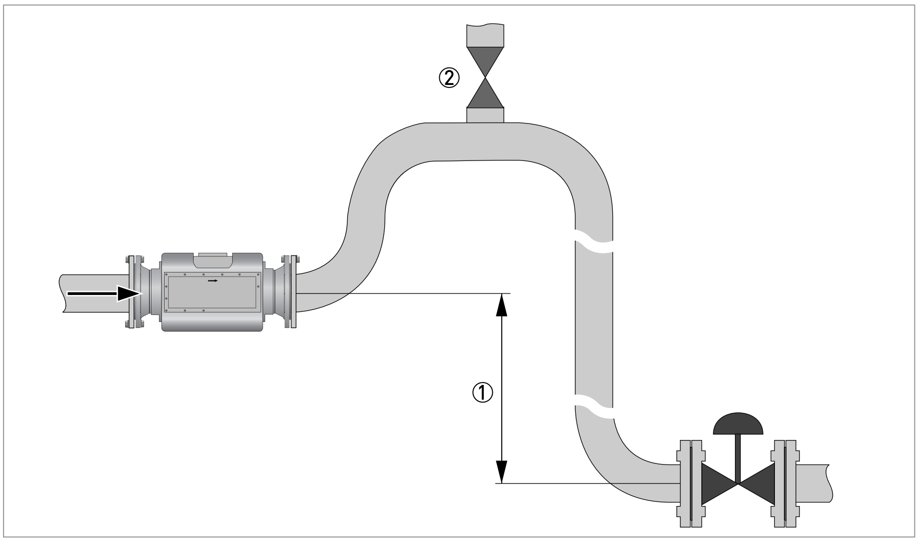


Figure 3-9: Air venting

① ≥ 5 m
② Air ventilation point

3.2.10 Pressure and temperature sensors

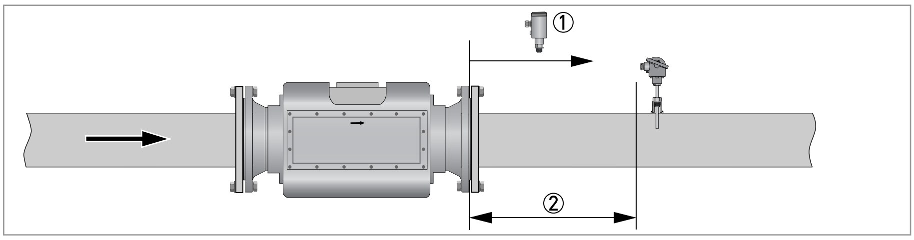


Figure 3-10: Location of pressure and temperature transmitters

① Install non perturbating devices such as pressure gauges, drains and vents downstream of the flow sensor
② Install pertubating devices such as thermowells at minimum 3 DN downstream of the flow sensor

If a bi-directional flow is used, then the thermowell must be installed during the calibration of the flow sensor to compensate for any flow distortion effects.

Shorter installation lengths for the perturbating devices is optional when specific instruments are already installed during initial flowmeter calibration. This makes the perturbating entityart of the calibrated characteristics of the flowmeter.

3.3 Backpressure

To prevent flashing / cavitation in the flow sensor, it should be installed in such a way that the flow sensor is always completely filled with liquid and has enough back pressure at the given flow velocity.

The minimum required back pressure P_b in the pipeline to avoid flashing cavitation depends on:

- The vapor pressure P_v (or P_e equilibrium) of the process liquid.
- The pressure drop dP at the given flow velocity.
  Note that a pressure drop depends on liquid density, liquid viscosity, local flow velocity, Reynolds laminar and turbulent regime and piping geometry.

The bare minimum back pressure limit is calculated as follows:
$P_{b\ limit} = P_v + dP$

The required back pressure depends on stability of the process conditions, therefore safe operating can be for example using the conservative calculation:
$P_{b\ safe} = 1.25\ P_v + 2\ dP$

Find below the pressure drop dP calculated at different flow velocities with 3 different liquid types that shows the dP dependence for the most used ALTOSONIC 5 system (8 inch) with this configuration:
Inlet 10D + FlowCon5 + Inlet 5D + ALTOSONIC 5 Reduced bore + outlet 3D

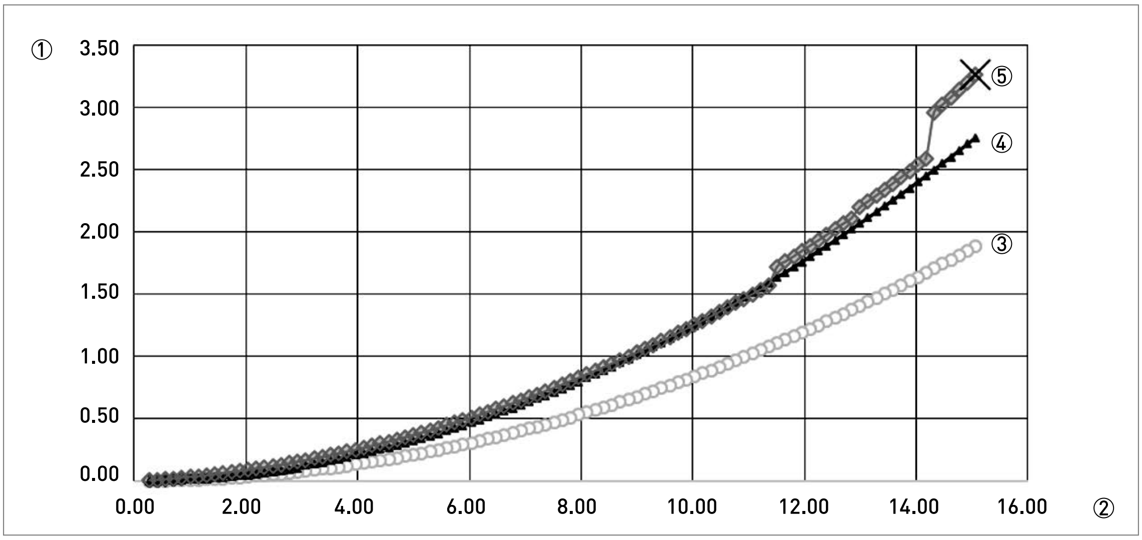


Figure 3-11: Pressure drop dP [bar] example at different pipe velocities [m/s], with 3 liquid types

① Pressure drop dP [Bar]
② Flow velocity [m/s]
③ 0.6 cSt (745 kg/m^3)
④ 150 cSt (930 kg/m^3)
⑤ 725 cSt (995 kg/m^3) with max dP = 3.268 Bar

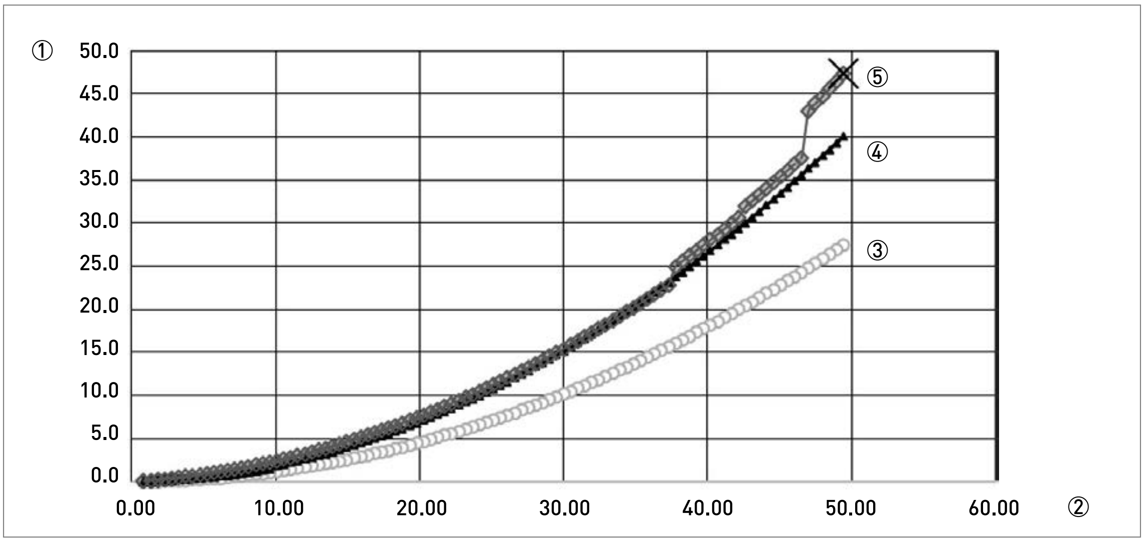


Figure 3-12: Pressure drop dP [psi] example at different pipe velocities [ft/s], with 3 liquid types

① Pressure drop dP [psi]
② Flow velocity [ft/s]
③ 0.6 cSt (745 kg/m^3)
④ 150 cSt (930 kg/m^3)
⑤ 725 cSt (995 kg/m^3) with max dP = 47.4 psi

As can be seen in the above graphs, one of the lines is not consistent and shows some dips, this is due to turbulent and laminar flow regime giving different pressure drops for different parts in the geometry at the same flow. If the graph is plotted as dP versus Reynolds, it can be seen that these dips are all in the laminar to turbulent range 3000...4000:

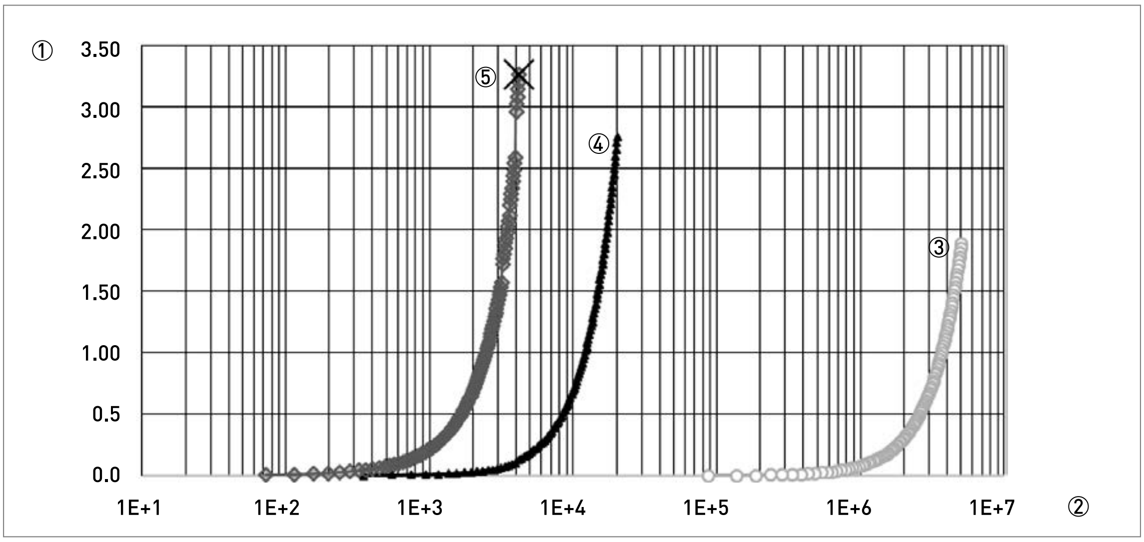


Figure 3-13: Pressure drop dP [bar] versus Reynolds [ ], with 3 liquid types

① Pressure drop dP [Bar]
② Reynolds [ ]
③ 0.6 cSt (745 kg/m^3)
④ 150 cSt (930 kg/m^3)
⑤ 725 cSt (995 kg/m^3) with max dP = 3.268 Bar

Example for crude oil, at velocity of 10 m/s:
①
② In the dP figures above, find the dP value at 10 m/s.
For example crude oil with a viscosity of approx. 150cSt the dP will be 1.33 bar
③ Calculate the minimum required pressure $P_{min} = P_v + \Delta P$. This will result in 0.7 + 1.8 = 2.5 bar as a minimum pressure for the pipe line.

1. From technical documentation or lab results, find the vapor pressure for the liquid used. For example crude oil with a vapor pressure P_v of 0.7 bar.
2. In the dP figures above, find the dP value at 10 m/s.
   For example crude oil with a viscosity of approx. 150 cSt the dP will be 1.33 bar.
3. Calculate the back pressure Pb limit minimum limit pressure:
   $P_{b\ limit} = P_v + dP$ gives: 0.7 + 1.33 = 2.03 bar
4. For example a safe operating back pressure P_b safe using a conservative calculation can be:
   $P_{b\ safe} = 1.25\ P_v + 2\ dP$ gives: 1.25 x 0.7 + 2 x 1.33 = 3.54 bar.

3.3.1 Open discharge

Make sure that with open discharge the flow meter remains completely filled. With open dicharge there is almost no back pressure, therefore this can only be used with relatively low flow velocity (maximum 3-5 m/s).

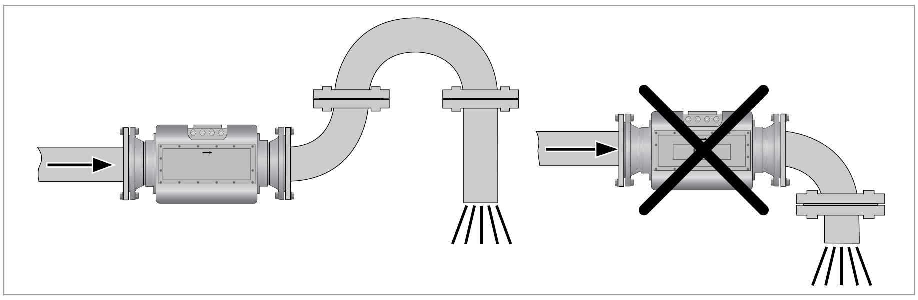


Figure 3-14: Installation in front of an open discharge

3.3.2 Control valve

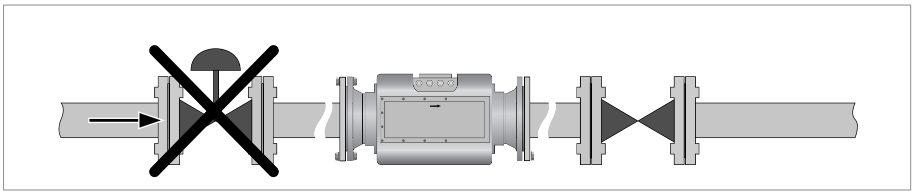


Figure 3-15: Installation in front of a control valve

Downstream of a valve there is low pressure and high flow disturbance. Therefore it is best practice to install the control valve downstream of the flow sensor.

3.3.3 Pump

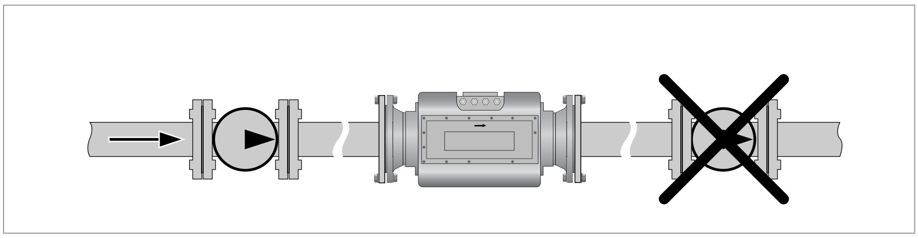


Figure 3-16: Installation behind a pump

It is recommended to install the flow sensor at least 40DN downstream of the pump to avoid perturbation influence from the pump. With the pump installed within 40DN upstream, use a flow conditioner upstream of the flow sensor.
When it can not be avoided to install the flow sensor upstream of the pump, use at least 30DN between flow sensor and pump. Note that the suction side of the pump can create low line pressure cavitation in the flow sensor in that case and therefore limit the measurement accuracy at higher flowrates.

3.4 Meteorological conditions

In case of extreme sunlight, the signal converter should be protected against direct solar radiation to avoid high temperatures and extend the lifetime of the electronics.

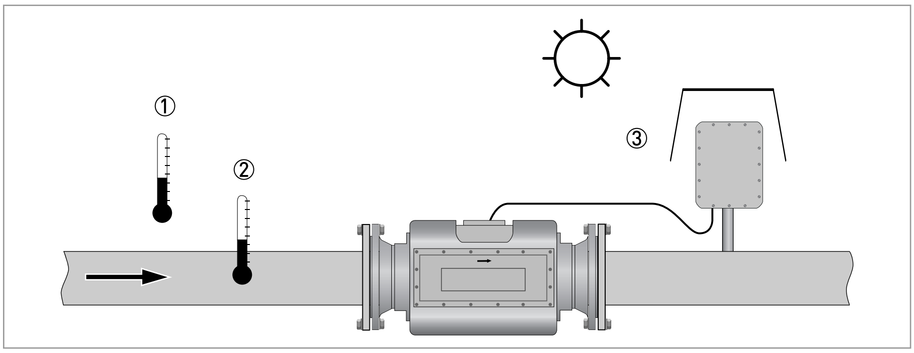


Figure 3-17: Temperatures

① Ambient temperature
② Process temperature
③ Sunshade to protect the signal converter against direct solar radiation

In case of big differences between ambient and process temperatures and especially in combination with laminar flow applications and/or extremely low flow velocities, it is beneficial for best measurement performance to insulate the upstream meter run and use light colored painting to avoid to much heat exchange.

4.1 Overview of electrical installation

An overview of a typical connection diagram is shown below.

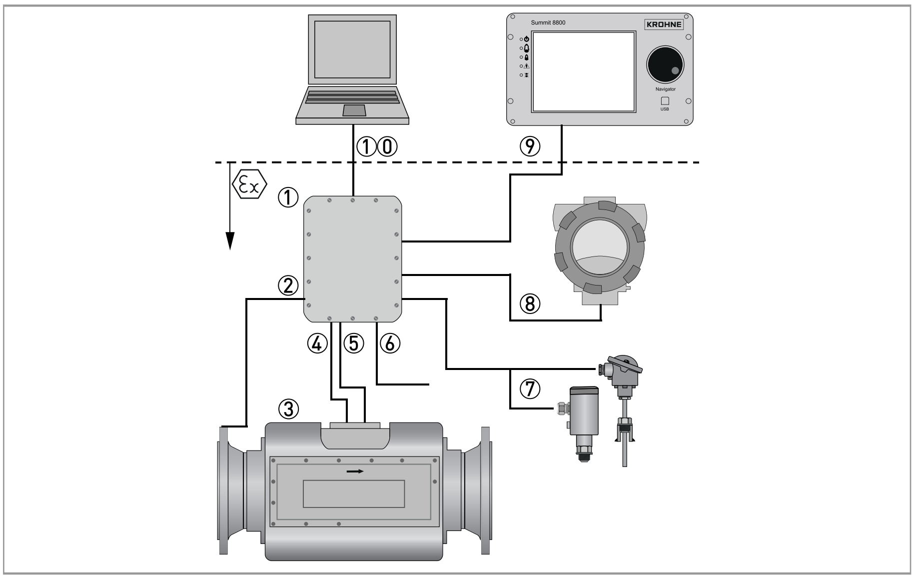


Figure 4-1: Overview electrical connections

① Signal converter
② Equipotential bonding wire (> 4 mm^2)
③ Flow sensor
④ Connection of PT100 cable for body temperature (supplied with delivery)
⑤ Connection of three signal cables of flow sensor (supplied with delivery)
⑥ Power supply
⑦ Pressure and / or temperature transmitters (optional)
⑧ Display (optional)
⑨ Flow computer (optional) via:
- MODBUS RS485, MODBUS TCP/IP
- Pulse / frequency

①⓪ MCD tool (free of charge KROHNE software tool, advised)

4.2 Flow sensor connections

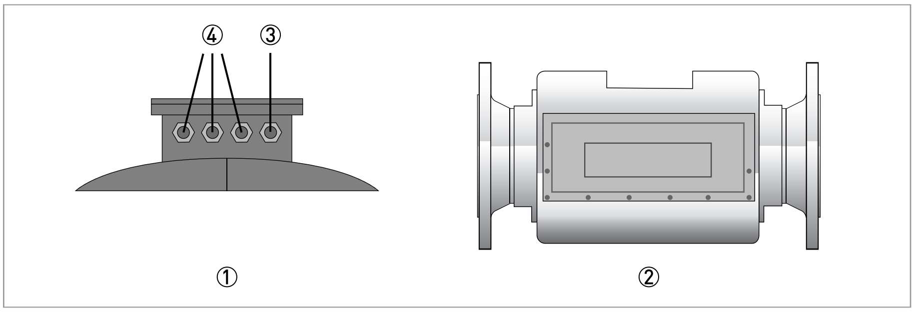


Figure 4-2: Location of cable glands

① Generation 2 flow sensor
② Generation 1 flow sensor
③ Cable entry for the PT100 cable
④ Cable entry for the signal cables

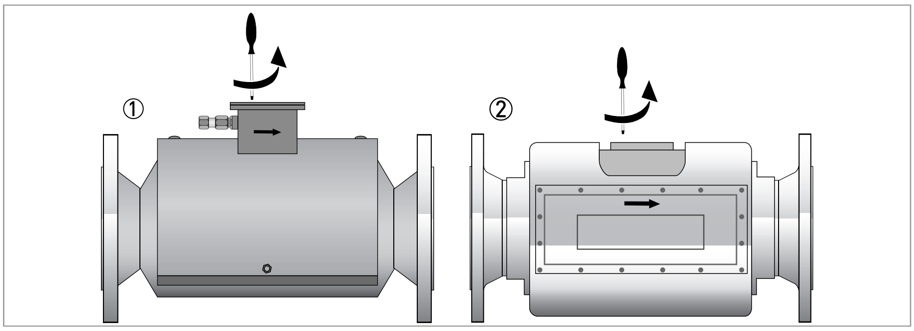


Figure 4-3: Removal of cover

① Generation 2 flow sensor
② Generation 1 flow sensor

Use the factory supplied **sensor signal cables** to make the electrical connection between the flow sensor and the signal converter.
Each cable has six coaxial cables with pre-assembled SMB connectors. Lead the cable through the cable gland and connect it to terminal strip X1 as shown. All cables are numbered in the same way as the connector. Three cables are supplied, which means that two of the pre-assembled coax cables with SMB connectors will not be used.

Use the factory supplied **PT100 cable** to make the electrical connection between the flow sensor and the signal converter. Connect the numbered wires of the cable to terminal strip X2 with the same numbers.
This cable has four wires for temperature measurement. Feed the cable through the cable entry and connect it as shown. All wires are numbered in the same way as connector X2.

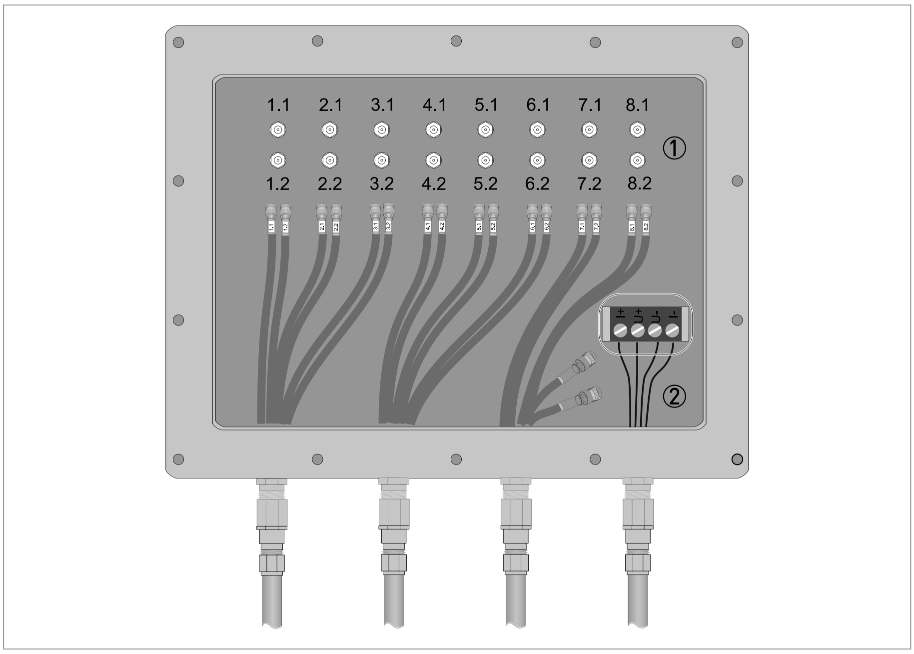


Figure 4-4: Electrical connections of flow sensor

① Terminal strip for sensor signal cables.
② Terminal strip for PT100 cable.

4.3 Signal converter connections

For the flow sensor and the signal converter that are used in a potentially explosive atmosphere, obey the following rules:

- *If the device is used in category 2G, certified cable entry devices MUST be used.*
- *Unused openings MUST be closed with certified closing elements.*
- *To avoid voltage and current addition, the intrinsically safe circuits must be separated and wired to EN 60079-14.*

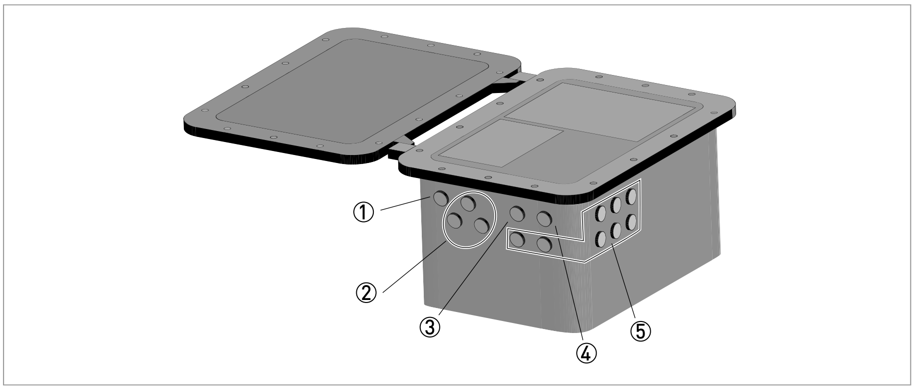


Figure 4-5: Location of cable glands

Number in Figure	Cable entry	Connection
①	PT100 cable, included in delivery	refer to *Multiplexer board (MUX) connections* on page 32
②	Sensor signal cable, included in delivery	refer to *Multiplexer board (MUX) connections* on page 32
③	Power supply cable, not included in delivery	refer to *Power Supply Unit (PSU) connections* on page 43
④	Optional power supply cable for heating	-
⑤	I/O connections	refer to *Smart IO board (SMART IO) connections* on page 34

An important safety regulation is to make sure that only certified cable glands, shielded cables and blind plugs are installed!

4.3.1 Multiplexer board (MUX) connections

The sensors and the body temperature sensor are connected to the MUX.

Use the factory supplied sensor signal cables to make the electrical connection between the flow sensor and the signal converter. Note that the cables have stripped cables on both sides, but the lengths of these stripped cables are different. Use the long side for the signal converter and the short side for the flow sensor.
Each cable has six coaxial cables with pre-assembled SMB connectors. Lead the cable through the cable gland and connect it to the card as shown. All cables are numbered in the same way as the connector.Two cables are supplied, which means that four of the pre-assembled coax cables with SMB connectors will not be used.

Use the factory supplied PT100 cable to make the electrical connection between the flow sensor and the signal converter. Connect the numbered wires of the cable to the connector with the same numbers.

Please note that the wires of the PT100 cable are numbered differently at the signal converter side and the flow sensor side.

Labels PT100 cable

flow sensor (optional)	signal converter	PT100 wire colour
5	F1	red
6	S1	red
7	S2	white
8	F2	white

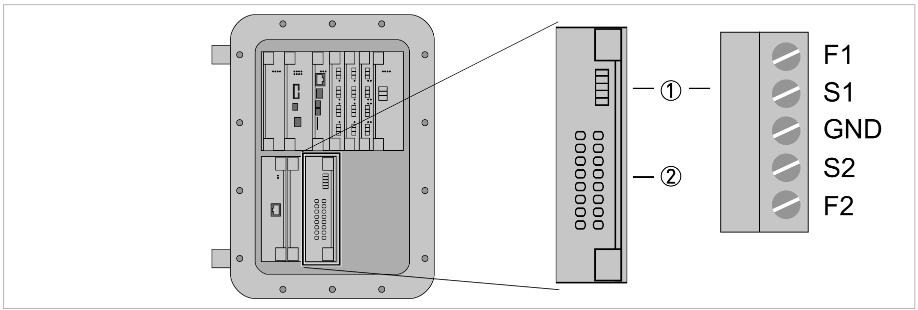


Figure 4-6: Multiplexer

① Connections for body temperature correction (body expansion correction, viscosity line correction)
② Connections of transducers of flow sensor

4.3.2 Monitoring Configuration and Diagnostics (COM 1) board connections

The COM 1 board contains the internal log files on an SD card as well as the configuration stored on an internal flash memory. TCP/IP can be used as Modbus over TCP/IP.

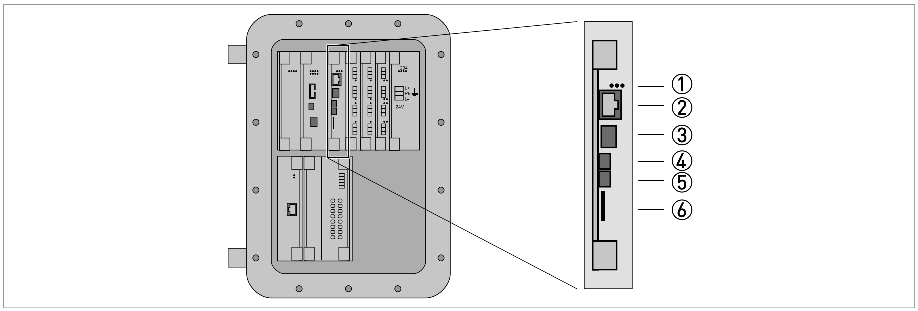


Figure 4-7: ALTOSONIC 5 COM 1 board

① - Status LEDs, see table below
② Ethernet connection 10/100 Mb
green LED: activity Rx/Tx, blinks during activity
orange LED: on if there is a connection
③ USB (only for service purposes by KROHNE service engineers)
④ mini USB (only for service purposes by KROHNE service engineers)
⑤ mini USB for configuration tool (only for short 'normal' USB usage distances)
⑥ SD card

Status LEDs

LED	Colour	Defines	Normal	Start-up (~45 s)	Service
1	Red	MCD tool connection	On	intermittent On/Off	intermittent On/Off
2	Red	Data input DSP	Blink 1 Hz	intermittent On/Off	intermittent On/Off
3	Green	Power supply	On	On	On

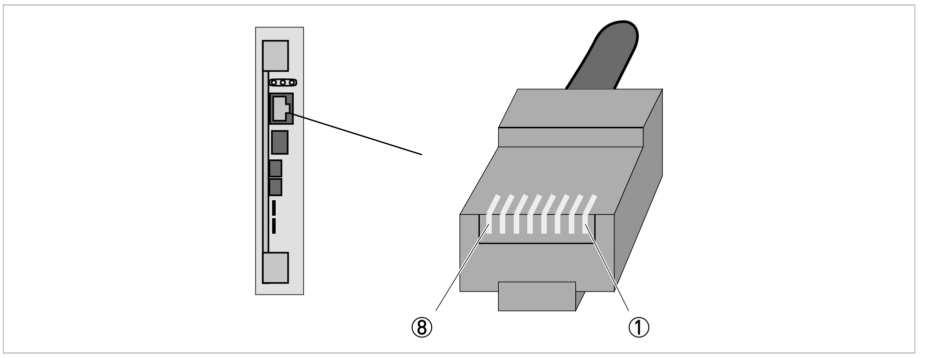


Figure 4-8: Ethernet RJ45 connector pin 1...8

RJ45 Ethernet connection pin	Wire colour (T568A)	Wire colour (T568B)	Function
1	white/green	white/orange	Transmit +
2	green	orange	Transmit -
3	white/orange	white/green	Receive +
4	blue	blue	Not used
5	white/blue	white/blue	Not used
6	orange	green	Receive -
7	white/brown	white/brown	Not used
8	brown	brown	Not used

4.3.3 Smart IO board (SMART IO) connections

The SMART IO board has multiple configurable IOs. The smart IO can be configured either as digital input/output or analog input/output. All functions use the same connections. The function is defined by the chosen configuration.

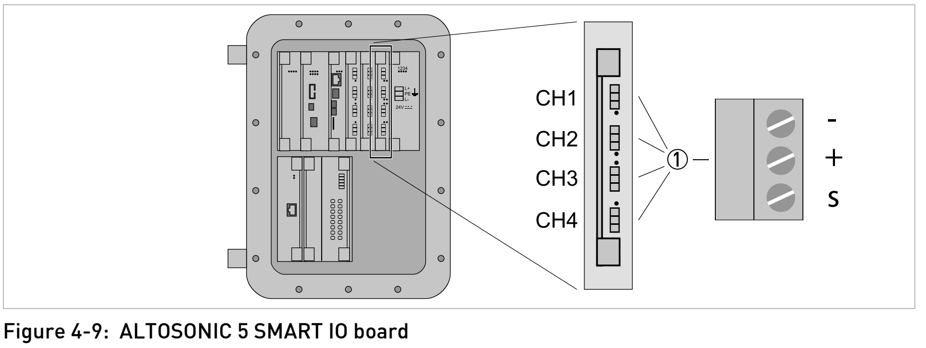


Figure 4-9: ALTOSONIC 5 SMART IO board

① 4x configurable IO connection

Status lights for each channel

Each channel has two LEDs.

- Red LED 1: configuration, will be on when the channel is set up as a functional output/input.
- Green LED 2: power, always on when signal converter is on.

- *Passive mode: If a passive external device is connected, an external power supply is necessary to operate the connected devices (U_{ext}). If an active external device is connected, it can be connected directly.*
- *Active mode: The signal converter supplies the power to operate the connected passive devices, observe max. operating data. The maximum quantity of active outputs is limited to four.*
- *Terminals that are not used should not have any conductive connection to other electrically conductive parts.*

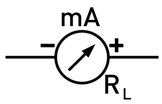
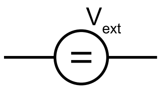
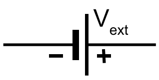
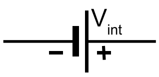
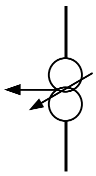
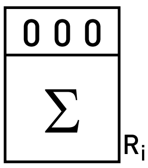
	mA meter 0...20 mA or 4...20 mA and other R_L is the internal resistance of the measuring point including the cable resistance
	DC voltage source (U_{ext}), external power supply, any connection polarity
	DC voltage source (U_{ext}), observe connection polarity according to connection diagrams
	Internal DC voltage source
	Controlled current source with current measurement
	Electronic or electromagnetic counter At frequencies above 100 Hz, shielded cables must be used to connect the counters. R_i is the internal resistance of the counter

Table 4-1: Description of symbols

Inputs and outputs

Inputs and outputs can be configured in the MCD tool as described below. The limits of currents and voltage can be configured in the MCD tool per IO. Limitation of these adjustable values are:

- U_{int} = 3...23 V
- I_{max} < 25 mA

Active frequency output

The active output can be connected to a passive external instrument.

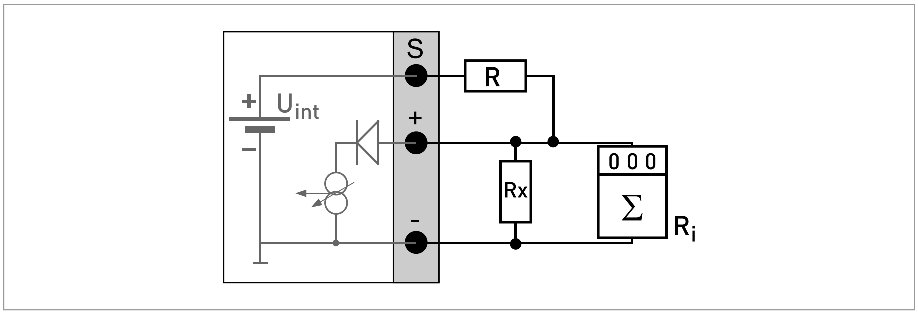


Figure 4-10: Frequency output, active

- Use terminals 'S' (Supply), '+' and '-'
- R: 1...10 kΩ (use resistor R to lower the resistance if the value is too high)
- Additional Rx (1 kΩ) is advised for cables > 200 m.

Passive frequency output

The passive output can be connected to a passive external device with an external power supply or directly to an active device.

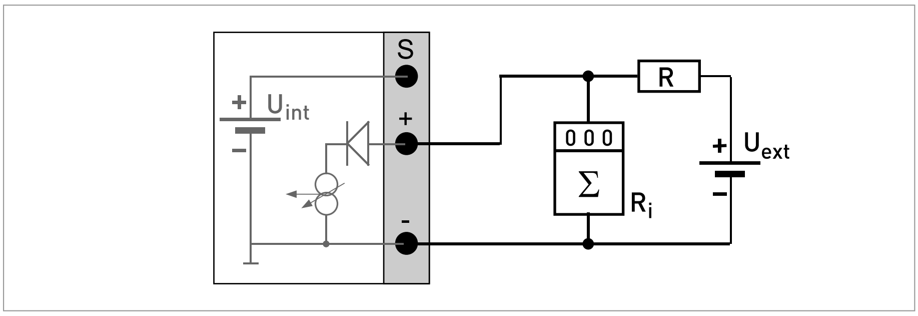


Figure 4-11: Frequency output, passive

- Use terminals '+' and '-'
- $U_{ext} \leq 27$ V

Active digital input

The active digital input can be connected to a passive external device.

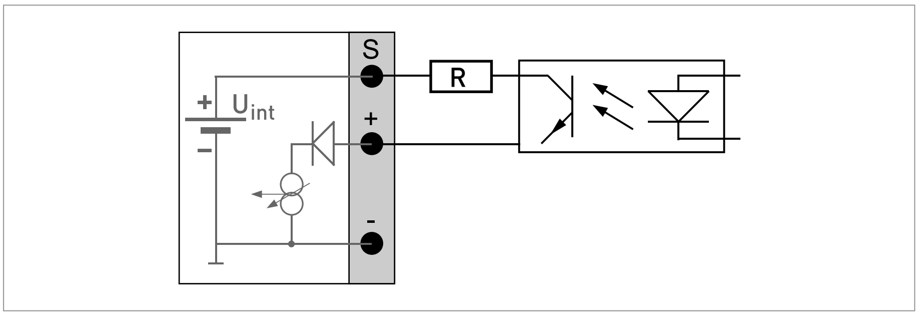


Figure 4-12: Digital input, active

- Use terminals 'S' (Supply) and '+'
- R: 1...10 kΩ

Passive digital input

The passive input can be connected to a passive external device with an external power supply or directly to an active device.

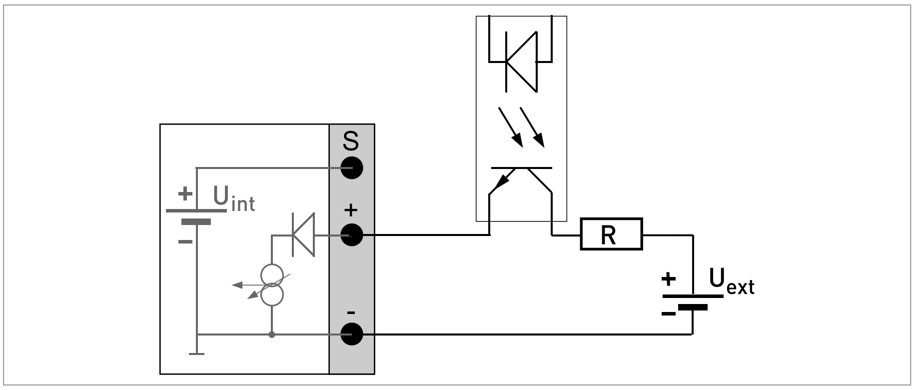


Figure 4-13: Digital input, passive, high side connection

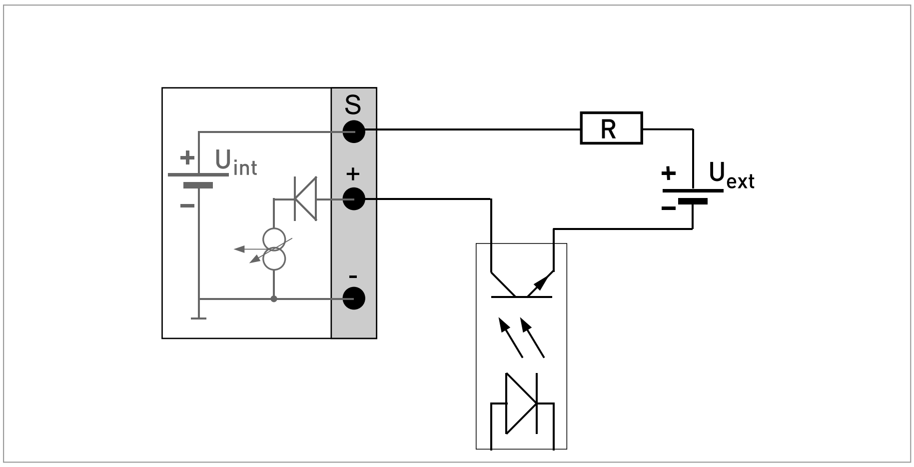


Figure 4-14: Digital input, passive, low side connection

- Use terminals '+' and '-'
- $U_{ext} \leq 27$ V

Active digital output

The active output can be connected to a passive external device.

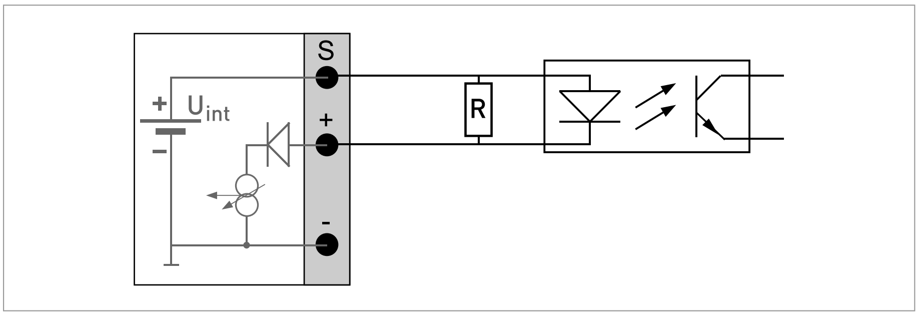


Figure 4-15: Digital output, active

- Use terminals 'S' (Supply) and '+'

Passive digital output

The passive output can be connected to a passive external device with an external power supply or directly to an active device.

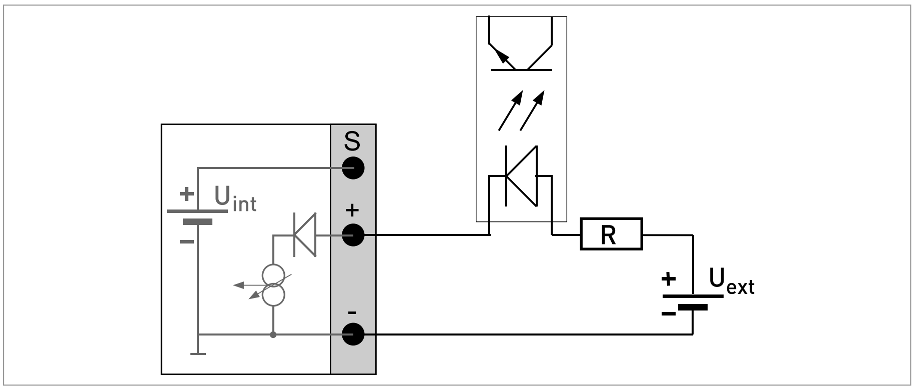


Figure 4-16: Digital output, passive, high side connection

- Use terminals '+' and '-'
- $U_{ext} \leq 27$ V

Active analog output

The active output can be connected to a passive external device.

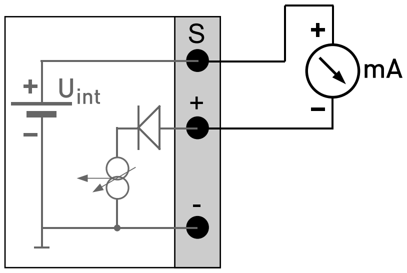


Figure 4-17: Analog output, active

- Use terminals 'S' (Supply) and '+'

Passive analog output

The passive output can be connected to a passive external device with an external power supply or directly to an active device.

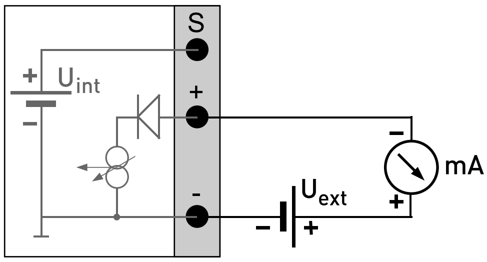


Figure 4-18: Analog output A, passive

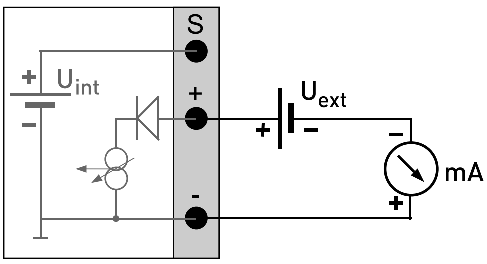


Figure 4-19: Analog output B, passive

- Use terminals '+' and '-'
- $U_{ext} \leq 27$ V

Active analog input

The active input can be connected to a passive external device.

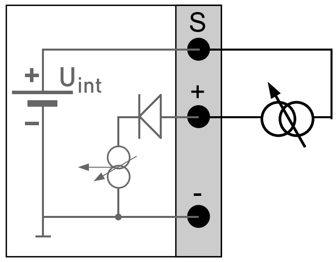


Figure 4-20: Analog input, active

- Use terminals 'S' (Supply) and '+'

Passive analog input

The passive output can be connected to a passive external device with an external power supply or directly to an active device.

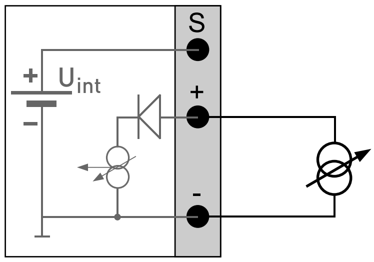


Figure 4-21: Analog input A, passive

- Use terminals '+' and '-'
- U_{max} = 27 V

4.3.4 RS485 IO board (COM 2) connections

The RS485 IO board has 4 serial communication channels.

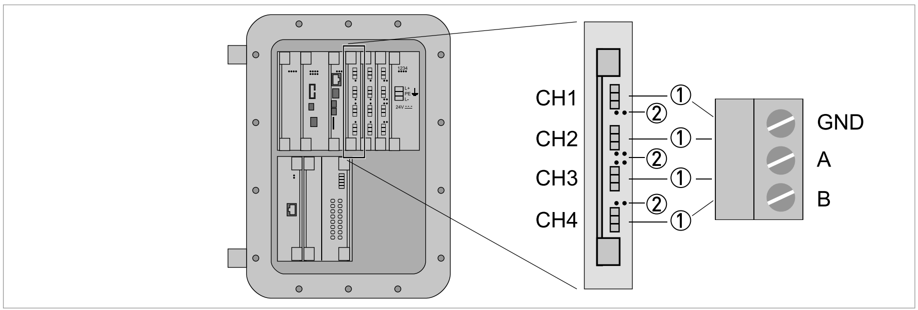


Figure 4-22: ALTOSONIC 5 RS485 IO board

① 4x RS485 connection
② 8x status LED for RS485 IO board

Status lights for each channel

Each channel has two LEDs.

- Red LED 1: configuration, only on when the channel is set up as a functional port.
- Green LED 2: power, always on when signal converter is on.

All RS485 channels are galvanically isolated. The standard configuration is as follows:

- CH1: Modbus Master
- CH2: Modbus Slave 1
- CH3: Modbus Slave 2
- CH4: Modbus Slave 3 or Backwards compatible communication between UFC V and ALTOSONIC V

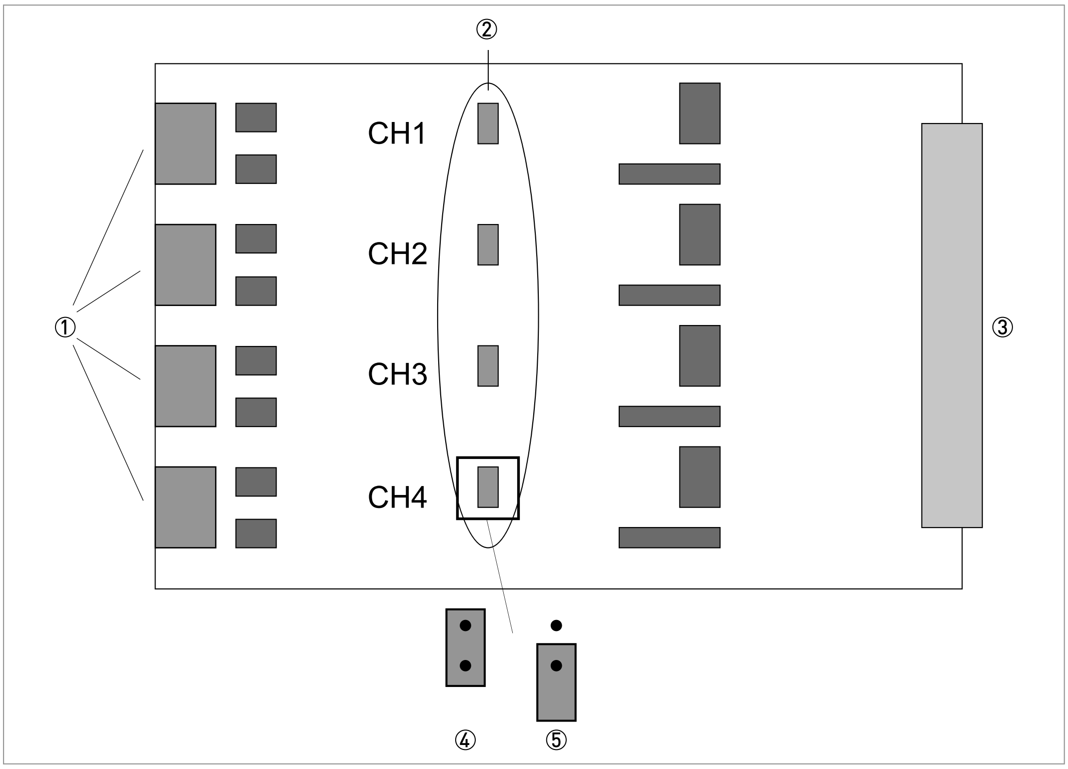


Figure 4-23: Jumpers on Communication board

① I/O connectors that are accessible on the front
② Jumpers (one for each I/O connector)
③ Multipole connector which connects the PCB to the backplane
④ Jumper is used: channel is terminated (factory default setting)
⑤ Jumper is not used: channel is not terminated

4.3.5 Power Supply Unit (PSU) connections

The PSU supplies isolated power to all cards installed in the signal converter.

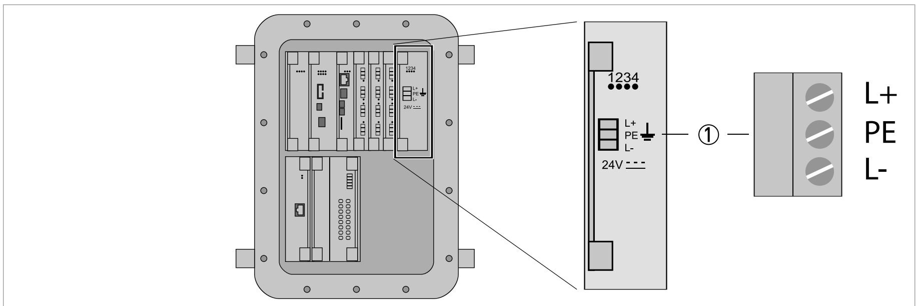


Figure 4-24: ALTOSONIC 5 PSU board

① Power Supply connections 24 V DC (+10/-15%)
green LED 1: +24 V power supply converter operational
green LED 2: +24 V system available
green LED 3: +6 V supply available
green LED 4: -6 V supply available

4.3.6 Digital Processor Board (DPB) connections

The DPB calculates the flow rate, based on the measurement of the flow sensor. All calculations, filtering and corrections are done in this card.

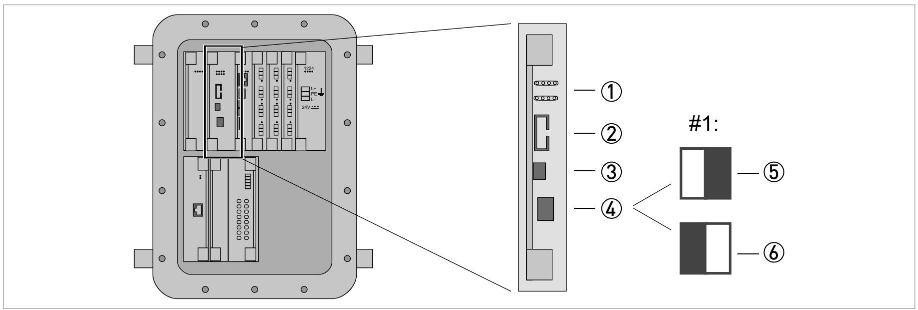


Figure 4-25: Digital Processor Board (DPB)

① Status LEDs, see table below
② Internal service connector (KROHNE purpose only)
③ Debug interface (KROHNE purpose only)
④ Dipswitches, from top to bottom:
Switch 1: Left position (⑤): CT parameters locked
Right position (⑥): CT parameters unlocked
Switch 2: Left position, do not change
Switch 3: Left position, do not change
Switch 4: Left position, do not change

LED	Colour	Defines	Normal	Start-up (~45 s)	Service
1	Green	FPGA power	On	On	On
2	Green	Internal power	On	On	On
3	Green	DPB power -6 V	On	On	On
4	Green	DPB power +6 V	On	On	On
5	Red	Internal clock	Blink - 2 Hz	Blink - 2 Hz	Blink - 2 Hz
6	Red	Flow measurement	On	On after ~10 s	Intermittently On/Off
7	Red	Data transfer	On	On after ~45 s	Intermittently On/Off
8	Red	SDRAM	Blink on access	Blink on access	Blink on access

Optionally, the dipswitch compartment can be sealed by a sticker by a notified body.

4.3.7 Power Supply Unit Intrinsically Safe (PSU Ex) connections

This board has only internal connections and serves as a certified EX(i) power supply for the intrinsically safe part of the signal converter.

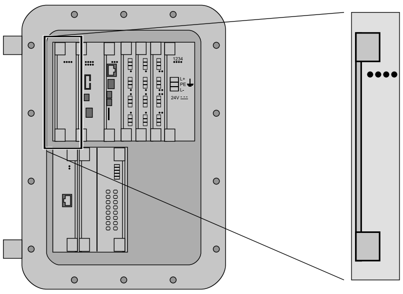


Figure 4-26: PSU Ex board

① 4x Power Supply LED
green LED 1: normally on, +DC ok
green LED 2: normally on, -DC ok
green LED 3: normally on, +Vmux ok
green LED 4: normally on, -Vmux ok

4.3.8 Analog Processor Board (APB) connections

The APB is the interface between the Multiplexer and the DPB and is installed in the intrinsically safe part of the signal converter.

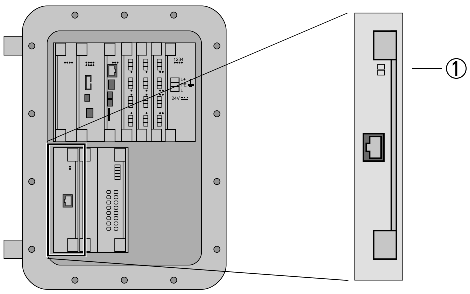


Figure 4-27: Analog Processor Board (APB)

① red LED 1, normally on, blinks in service mode and initial boot of converter
red LED 2, normally blinking, if LED does not blink, then there is a communication failure between MUX and APB

The specifications contained herein are subject to change without notice and any user of said specifications should verify from the manufacture that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications which may have been changed and are no longer in effect.

GuidantMeasurement.com

Corporate Headquarters
5825 North Sam Parkway West
Suite 120
Houston, TX 77086 USA

USA
1602 Wagner Avenue
Erie, PA 16510 USA
+1 814.898.5000

Germany
Regentstrasse 1
25474 Ellerbek, Germany
+49 4101 304.0