

Process analysis and flow measurement with ultrasound

Non-invasive clamp-on ultrasonic measuring system for continuous monitoring of concentration, density or other process-relevant fluid properties

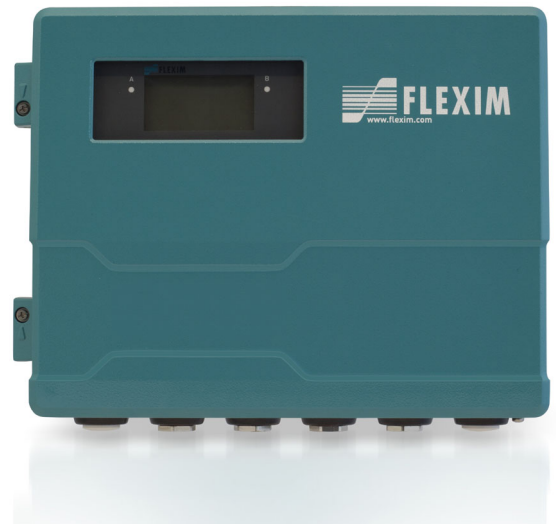
Features

- Time measurement for the accurate and repeatable determination of concentration, density and density-related physical quantities
- Reliable, maintenance-free and repeatable drift-free measurement
- High measurement accuracy even at very low as well as very high flow rates and independent of the flow direction (bidirectional)
- Installation and start-up do not require any pipe work nor any process interruptions
- Non-invasive: no fluid contact, no need of special materials, ideal for aggressive, toxic or abrasive fluids
- Bidirectional communication and support of common bus technologies (Profibus PA, Foundation Fieldbus, HART, Modbus, BACnet, M-Bus)
- Advanced self-diagnosis and possibilities for event-based triggering of data recording for the supervision and control of critical processes
- Transmitter and transducers for use in hazardous areas are available
- Transmitter and transducers are separately calibrated (traceable to national standards)
- Transducers available for a wide range of inner pipe diameters and fluid temperatures

Applications

For a wide range of fluids, e.g. H_2SO_4 , HF, HCl, HNO_3 , sugar solution (Brix), brine in:

- Chemical industry
- Petrochemical industry
- Oil and gas industry
- Pharmaceutical industry
- Semiconductor industry
- Mechanical and electrical industries
- Food industry



PIOX S721**-*44A



PIOX S721**-*44S



Variofix C

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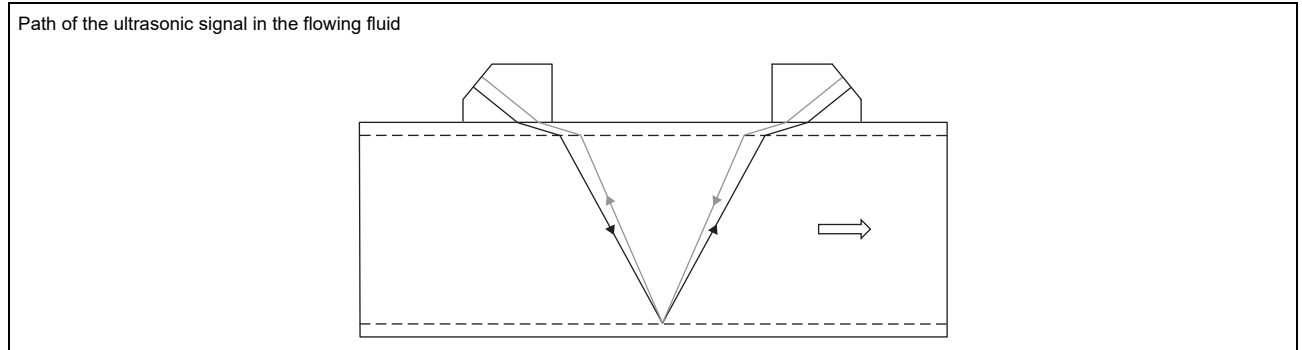
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Function

Measurement principle

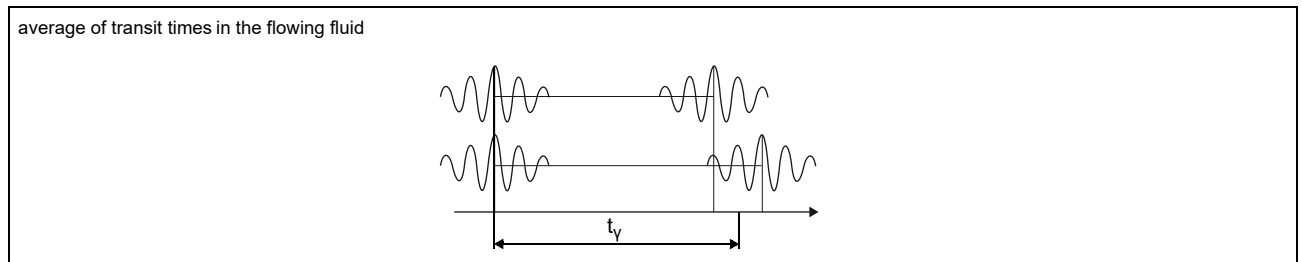
The transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are emitted alternately by a transducer and received by the other. The physical quantities are determined from the transit times of the ultrasonic signals.



The transmitter determines physical quantities for analysis by using the transit time measurement and physical quantities for flow by means of the transit time difference principle.

Transit time measurement

All physical quantities for analysis are determined from the sound speed. The sound speed is calculated from the average of both ultrasonic signals in the fluid. By using the average, the sound speed is independent of the flow velocity of the fluid.



Calculation of sound speed

The sound speed is the quotient of the path of the ultrasonic signal in the fluid and transit time. The transit time is calculated as average of the transit times of both transducer signals in the fluid, corrected by the transit time in the transducer and in the pipe wall.

$$c_v = \frac{l_v}{t_v}$$

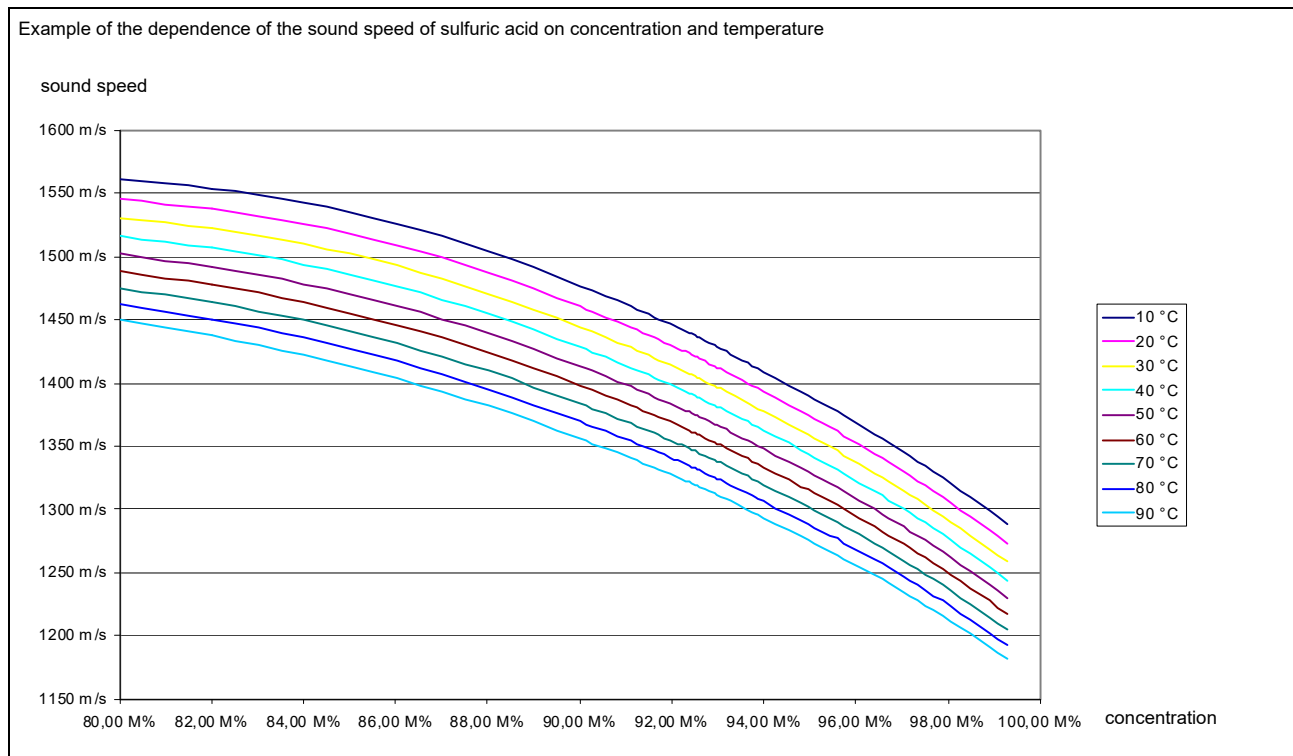
$$t_v = \frac{t_1 + t_2}{2}$$

where

- c_v - sound speed in the fluid
- l_v - sound path in the fluid
- t_v - average of transit times in the fluid
- t_1, t_2 - transit time in the fluid

A field calibration is recommended to reduce the influence of the pipe parameters on the accuracy of the measurement.

Further physical quantities, e.g. concentration, density, degree of conversion, can be calculated in dependence on the measured sound speed and fluid temperature in the transmitter. This requires a set of characteristic curves where physical quantity, sound speed and fluid temperature are correlated. The characteristic curves can be prepared by FLEXIM if required.

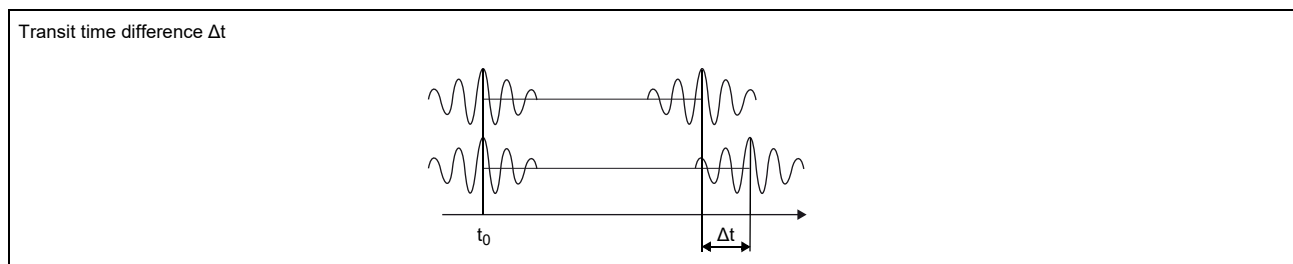


Transit time difference principle

As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

The transit time difference Δt is measured and allows the flowmeter to determine the average flow velocity along the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area averaged flow velocity, which is proportional to the volumetric flow rate.

The integrated microprocessors control the entire measuring cycle. The received ultrasonic signals are checked for measurement usability and evaluated for their reliability. Noise signals are eliminated.



Calculation of volumetric flow rate

$$\dot{V} = k_{Re} \cdot A \cdot k_a \cdot \frac{\Delta t}{2 \cdot t_y}$$

where

- \dot{V} - volumetric flow rate
- k_{Re} - fluid mechanics calibration factor
- A - cross-sectional pipe area
- k_a - acoustical calibration factor
- Δt - transit time difference
- t_y - average of transit times in the fluid

Calculation of mass flow rate

The operating density of the fluid is calculated as the function of concentration and temperature of the fluid:

$$\rho = f(K, T)$$

The mass flow rate is calculated from the operating density and the volumetric flow rate:

$$\dot{m} = \rho \cdot \dot{V}$$

where

- ρ - operating density
- K - concentration
- T - temperature
- \dot{m} - mass flow rate
- \dot{V} - volumetric flow rate

Number of sound paths

The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **reflection arrangement**

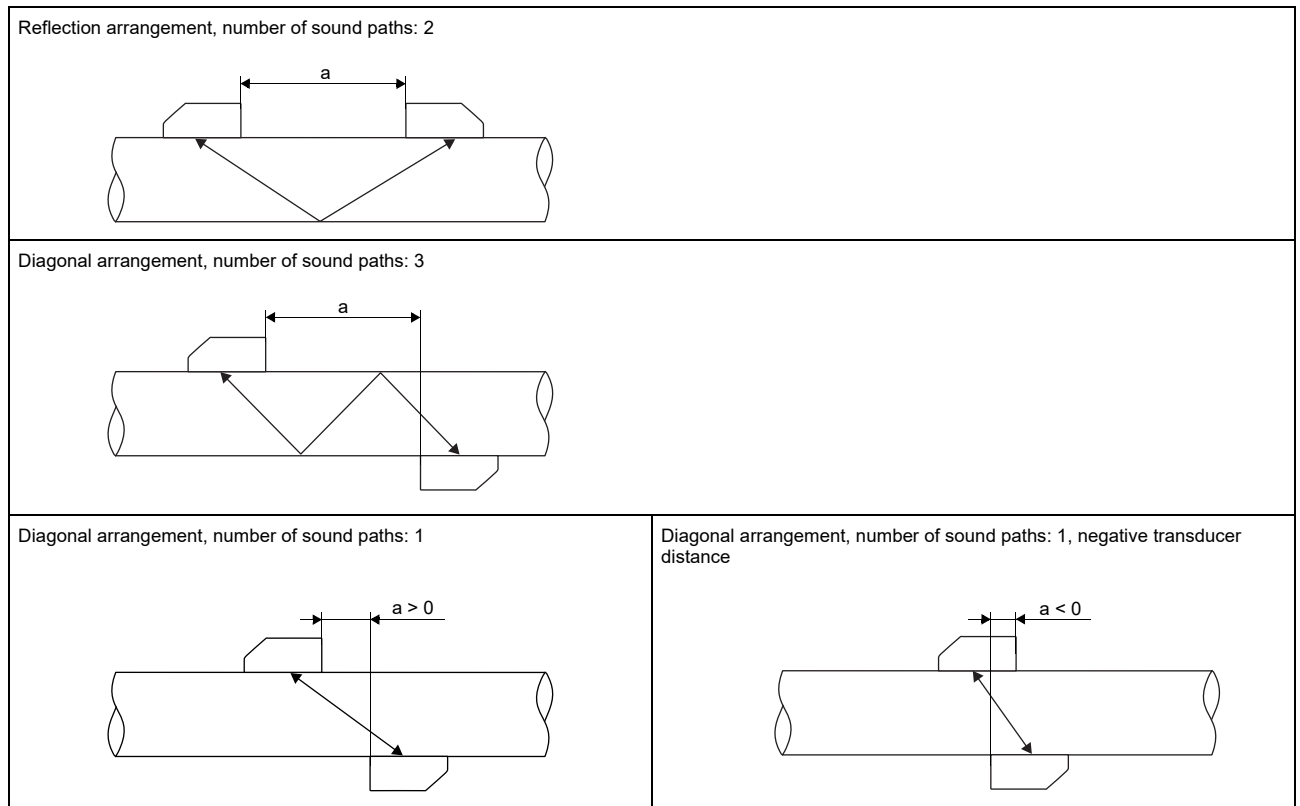
The number of sound paths is even. The transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easy.

- **diagonal arrangement**

The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe. In the case of a high signal attenuation by the fluid, pipe and coatings, diagonal arrangement with 1 sound path will be used.

The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the transmitter.

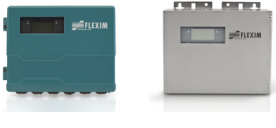

As the transducers can be mounted with the transducer mounting fixture in reflection arrangement or diagonal arrangement, the number of sound paths can be adjusted optimally for the application.



a - transducer distance

Transmitter



Technical data

	PIOX S721**-NN0*A S721**-NN0*S	PIOX S721**-A20*A S721**-A20*S	PIOX S721**-F20*A S721**-F20*S
			
design	standard field device	standard field device zone 2	standard field device FM Class I Div. 2
measurement			
• analysis			
transit time (repeatable)	$1/(50 \cdot f_a) \pm 10^{-4} \cdot t$		
transit time (absolute)	$1/(5 \cdot f_a) \pm 10^{-4} \cdot t$		
	f_a - transducer frequency, t - total transit time e.g. for transducers with transducer frequency M ($f_a = 1$ MHz): repeatable: $20 \text{ ns} \pm 10^{-4} \cdot t$, absolute: $200 \text{ ns} \pm 10^{-4} \cdot t$ The total measurement uncertainty of a physical quantity for analysis is supplied order-related as it depends on the fluid, operating range and installation. For the basis of calculation see document TIPIOX-S_uncert_analysis.		
• flow			
measurement principle	transit time difference correlation principle		
flow velocity	m/s	0.01...25	
repeatability		0.15 % MV ± 0.005 m/s	
fluid	all acoustically conductive liquids with < 10 % gaseous or solid content in volume		
temperature compensation	corresponding to the recommendations in ANSI/ASME MFC-5.1-2011		
measurement uncertainty (volumetric flow rate)			
measurement uncertainty of the measuring system ¹		± 0.3 % MV ± 0.005 m/s	
measurement uncertainty at the measuring point ²		± 1 % MV ± 0.005 m/s	
transmitter			
power supply		<ul style="list-style-type: none"> • 100...230 V/50...60 Hz or • 20...32 V DC or • 11...16 V DC 	
power consumption	W	< 15	
number of measuring channels		1, optional: 2	
damping	s	0...100 (adjustable)	
measuring cycle	Hz	100...1000 (1 channel)	
response time	s	1 (1 channel)	
housing material		aluminum, powder coated or stainless steel 316L (1.4404)	
degree of protection		IP66	aluminum housing: IP66/NEMA 4X stainless steel housing: IP65
dimensions	mm	see dimensional drawing	
weight	kg	aluminum housing: 5.4 stainless steel housing: 5.1	
fixation		wall mounting, optional: 2" pipe mounting	
ambient temperature	°C	-40...+60 (< -20 without operation of the display)	aluminum housing: -40...+55/60 (< -20 without operation of the display) stainless steel housing: -20...+55/60
display		128 x 64 pixels, backlight	
menu language		English, German, French, Spanish, Dutch, Russian, Polish, Turkish, Italian	
explosion protection			
• ATEX/IECEX			
marking	-	CE 0637  II3G II2D Ex nA nC ic IIC T4 Gc Ex tb IIIC T120 °C Db T _a -40...+60 °C	-
certification ATEX	-	IBExU11ATEX1015	-
certification IECEX	-	IECEX IBE 11.0008	-

¹ with aperture calibration of the transducers

² for transit time difference principle and reference conditions

³ outside the explosive atmosphere (housing cover open)

	PIOX S721**-NN0*A S721**-NN0*S	PIOX S721**-A20*A S721**-A20*S	PIOX S721**-F20*A S721**-F20*S
• FM			
marking	-	-	S721**-F20*S2, S721**-F20*S3:  NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 S721**-F20*S1:  NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A
measuring functions			
physical quantities	see table below		
totaliser	volume, mass		
calculation functions	average, difference, sum (2 measuring channels necessary)		
diagnostic functions	signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times		
communication interfaces			
service interfaces	measured value transmission, parametrisation of the transmitter: • USB ³ • LAN ³		
process interfaces	max. 1 option: • RS485 (ASCII sender) • Modbus RTU • BACnet MS/TP • HART • Profibus PA • FF H1 • Modbus TCP • BACnet IP		
accessories			
data transmission kit	USB cable		
software	• FluxDiagReader: reading of measured values and parameters, graphical presentation • FluxDiag (optional): reading of measurement data, graphical presentation, report generation, parametrisation of the transmitter		
data logger			
loggable values	all physical quantities, totalised physical quantities and diagnostic values		
capacity	max. 800 000 measured values		
outputs			
	The outputs are galvanically isolated from the transmitter.		
number	on request		
• switchable current output			
	All switchable current outputs are jointly switched to active or passive.		
range	mA	4...20 (3.2...22)	
accuracy		0.04 % MV ±3 µA	
active output		R _{ext} < 350 Ω	
passive output		U _{ext} = 8...30 V, depending on R _{ext} (R _{ext} < 1 kΩ at 30 V)	
• HART			
range	mA	4...20	
accuracy		0.1 % MV ±15 µA	
active output		U _{int} = 24 V, R _{ext} < 500 Ω	
passive output		U _{ext} = 10...24 V DC, depending on R _{ext} (R _{ext} < 1 kΩ at 24 V)	
• voltage output			
range	V	0...1 or 0...10	
accuracy		0...1 V: 0.1 % MV ±1 mV 0...10 V: 0.1 % MV ±10 mV	
internal resistance		R _{int} = 500 Ω	
• frequency output			
range	kHz	-	0...5
optorelay		-	24 V/4 mA, R _{int} = 66.5 Ω
• binary output			
optorelay		-	26 V/100 mA
Reed relay		-	48 V/100 mA, R _{int} = 22 Ω
binary output as alarm output			
• functions		-	limit, change of flow direction or error
binary output as pulse output			
• functions		-	mainly for totalising
• pulse value	units	-	0.01...1000
• pulse width	ms	-	optorelay: 1...1000 Reed relay: 80...1000

¹ with aperture calibration of the transducers

² for transit time difference principle and reference conditions

³ outside the explosive atmosphere (housing cover open)

	PIOX S721**-NN0*A S721**-NN0*S	PIOX S721**-A20*A S721**-A20*S	PIOX S721**-F20*A S721**-F20*S
digital output			
functions	<ul style="list-style-type: none"> frequency output binary output pulse output 	-	<ul style="list-style-type: none"> frequency output binary output pulse output
number	3	-	3
operating parameters	5...30 V/< 100 mA	-	5...30 V/< 100 mA
frequency output			
• range	kHz 0...5	-	0...5
binary output			
• binary output as alarm output	limit, change of flow direction or error	-	limit, change of flow direction or error
pulse output			
• functions	mainly for totalising	-	mainly for totalising
• pulse value	units 0.01...1000	-	0.01...1000
• pulse width	ms 0.05...1000	-	0.05...1000
inputs			
	The inputs are galvanically isolated from the transmitter.		
number	max. 4, on request min. 1 input or process interface with inputs necessary for fluid temperature		
temperature input			
type	Pt100/Pt1000		
connection	4-wire		
range	°C -150...+560		
resolution	K 0.01		
accuracy	±0.01 % MV ±0.03 K		
current input			
accuracy	0.1 % MV ±10 µA		
active input	U _{int} = 24 V, R _{int} = 50 Ω, P _{int} < 0.5 W, not short-circuit proof		
• range	mA 0...20		
passive input	R _{int} = 50 Ω, P _{int} < 0.3 W		
• range	mA -20...+20		
voltage input			
range	V 0...1		
accuracy	0.1 % MV ±1 mV		
internal resistance	R _{int} = 1 MΩ		
binary input			
switching signal	5...30 V, 1 mA		5...26 V, 1 mA
functions	<ul style="list-style-type: none"> reset of the measured values reset of the totalisers stop of the totalisers activation of the measuring mode for highly dynamic flows 		

¹ with aperture calibration of the transducers

² for transit time difference principle and reference conditions

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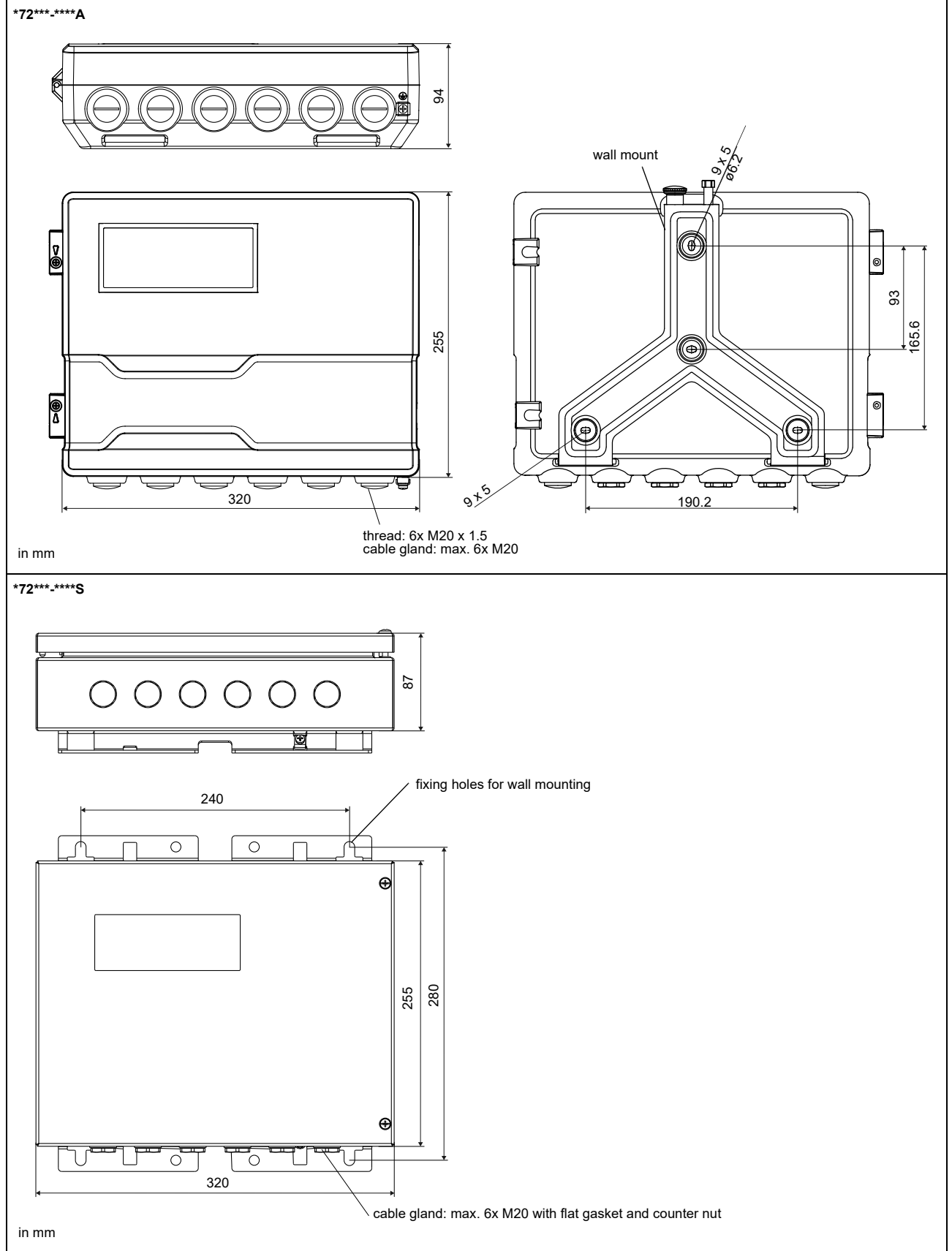
Physical quantities

The available physical quantities depend on the fluid data set in the transmitter.

fluid data set	physical quantities	remark
NN	no fluid data set	• sound speed, volumetric flow rate
MD	standard fluid data set	• analysis ¹ : concentration, mass fraction, volume fraction, density, normalised density, normalised sound speed, sound speed • flow: volumetric flow rate, flow velocity, mass flow rate
CU	customised fluid data set	• analysis ¹ : concentration, mass fraction, volume fraction, density, normalised density, normalised sound speed, sound speed • flow: volumetric flow rate, flow velocity, mass flow rate • further customised physical quantities ¹

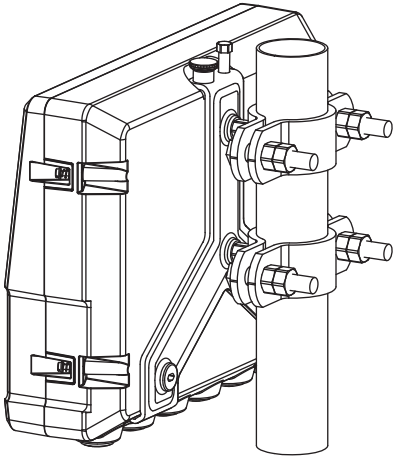
¹ min. 1 input or process interface with inputs necessary for fluid temperature

Dimensions



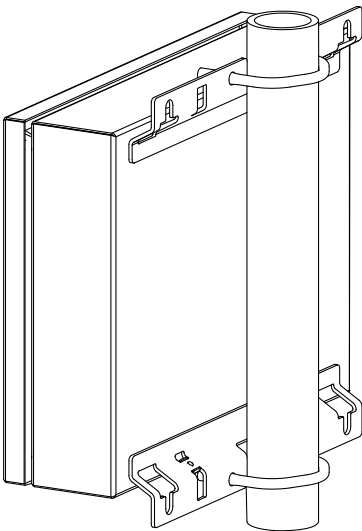
2" pipe mounting kit

*72***.****A



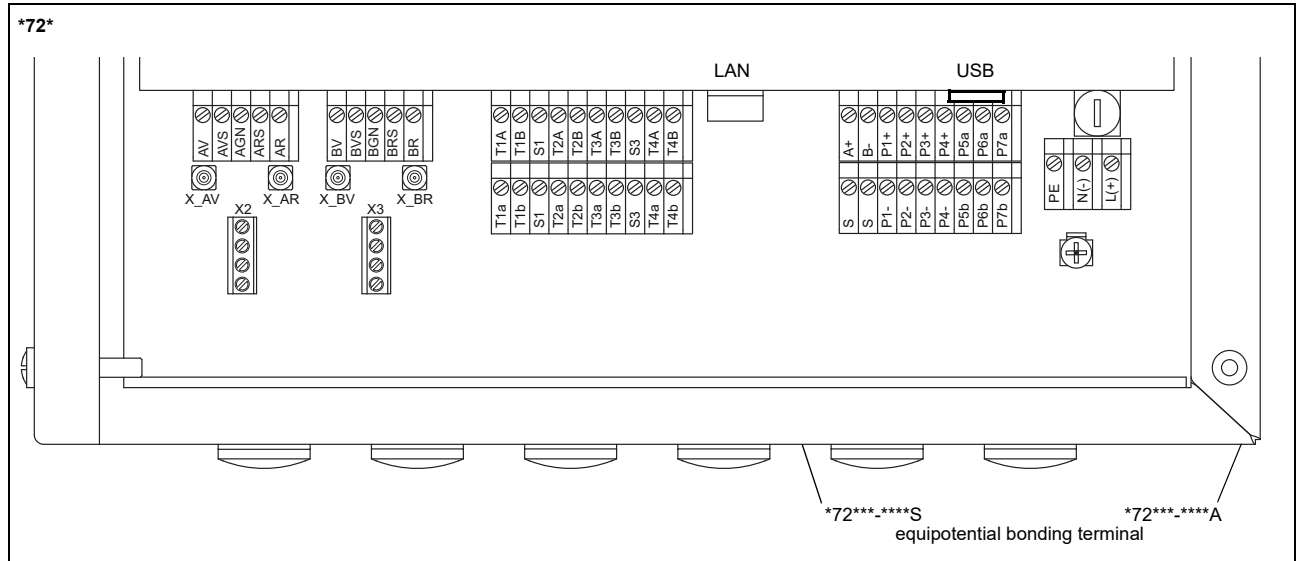
order code:
ACC-PE-*721-/PMK4

*72***.****S



order code:
ACC-PE-*721-/PMK6

Terminal assignment



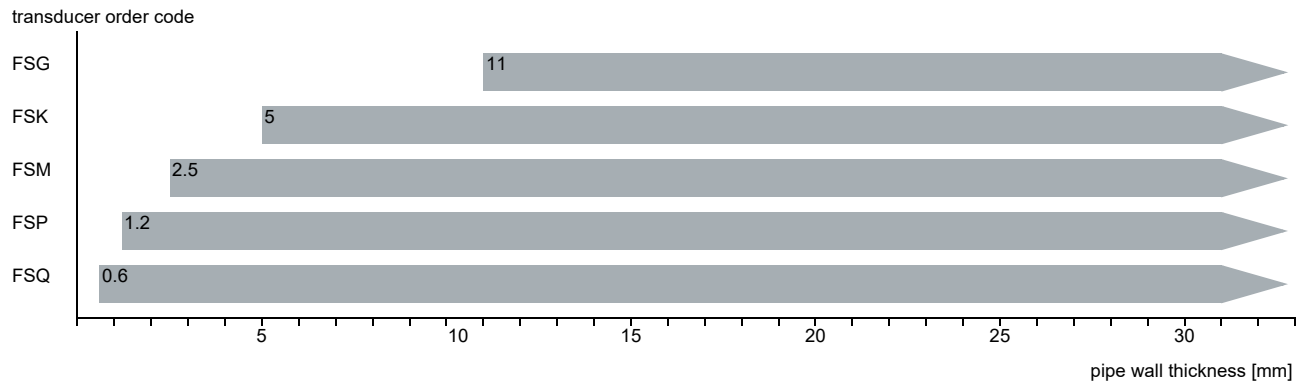
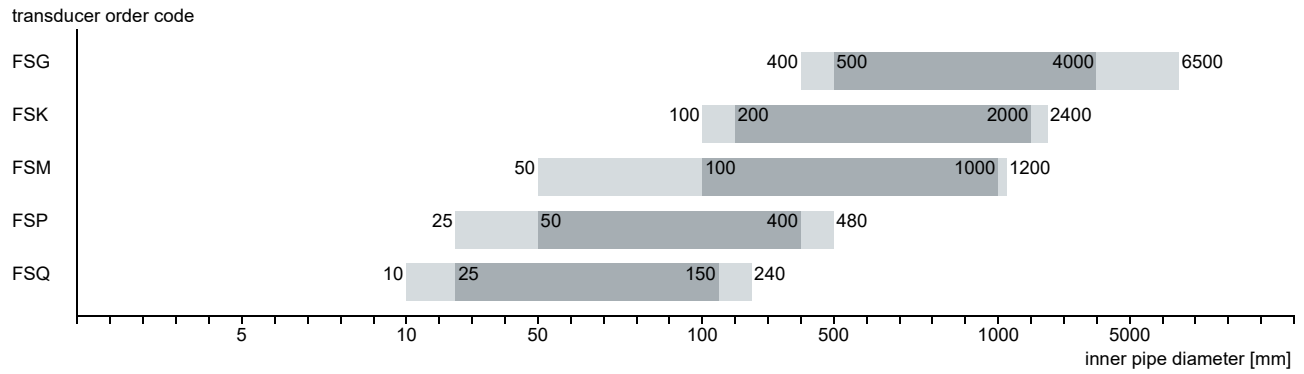
power supply ¹							
terminal		connection (AC)			connection (DC)		
PE		earth			earth		
N(-)		neutral			-		
L(+)		phase			+		
transducers							
transducer cable (transducers *****8*, ****LI*), extension cable				transducer cable (transducers *****52)			
measuring channel A		measuring channel B			measuring channel A		measuring channel B
terminal	connection	terminal	connection	transducer	terminal	terminal	connection
AV	signal	BV	signal	↑	X_AV	X_BV	SMB connector
AVS	shield	BVS	shield				
ARS	shield	BRS	shield	↗	X_AR	X_BR	SMB connector
AR	signal	BR	signal				
outputs ^{1, 2}							
terminal		connection		terminal	connection	communication interface	
P1+...P4+ P1-...P4-		current output, voltage output, frequency output, binary output (Reed relay), HART (P1)		A+	signal +	• RS485 ¹ • Modbus RTU ¹ • BACnet MS/TP ¹ • Profibus PA ¹ • FF H1 ¹	
P5a...P7a P5b...P7b		binary output (optorelay), digital output		B-	signal -		
				S	shield		
				USB	type B Hi-Speed USB 2.0 Device	• service (FluxDiag/FluxDiagReader)	
				LAN	RJ45 10/100 Mbps Ethernet	• service (FluxDiag/FluxDiagReader) • BACnet IP • Modbus TCP	
analog inputs ^{1, 2}							
		temperature probe		passive sensor		active sensor	
terminal		direct connection		connection with extension cable		connection	
T1a...T4a		red		red		not connected	
T1A...T4A		red/blue		grey		-	
T1b...T4b		white/blue		blue		+	
T1B...T4B		white		white		not connected	
S1, S3		shield		shield		not connected	
binary inputs ^{1, 2}							
terminal							
P1+...P2+, P1-...P2-							

¹ cable (by customer):
 - e.g. flexible wires, with insulated wire ferrules, wire cross-section: 0.25...2.5 mm²
 - outer diameter of the cable (*72***-****S with ferrite nut): max. 7.6 mm

² The number, type and terminal assignment are customised.

Transducers

Transducer selection



recommended
 possible

Transducer order code

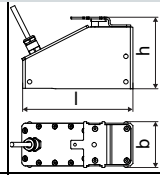
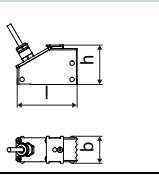
1, 2	3	4	5, 6	7, 8	9...11	no. of character				
transducer	transducer frequency	-	ambient temperature	explosion protection	connection system	-	extension cable	/	option	description
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	G									0.2 MHz
	K									0.5 MHz
	M									1 MHz
	P									2 MHz
	Q									4 MHz
			N							normal temperature range
			E							extended temperature range
				NN						not explosion-proof
				A2						ATEX zone 2/IECEX zone 2
				A1						ATEX zone 1/IECEX zone 1
				F2						FM Class I Div. 2
					TS					with SMB connector
					T1					with stripped cable ends
							XXX			0 m: without extension cable > 0 m: with extension cable
								LC		long transducer cable
								IP68		degree of protection IP68
								OS		housing with stainless steel 316

Technical data

Shear wave transducers (zone 2 - FM Class I Div. 2 - nonEx, TS)

order code	FSG-N**TS/**	FSK-N**TS/**	FSM-N**TS/**	FSP-N**TS/**	FSQ-N**TS/**
technical type	C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52
transducer frequency	MHz 0.2	0.5	1	2	4
inner pipe diameter d					
min. extended	mm 400	100	50	25	10
min. recommended	mm 500	200	100	50	25
max. recommended	mm 4000	2000	1000	400	150
max. extended	mm 6500	2400	1200	480	240
pipe wall thickness					
min.	mm 11	5	2.5	1.2	0.6
material					
housing	PEEK with stainless steel cover 304 (1.4301), ****-*****/OS: 316L (1.4404)				
contact surface	PEEK				
degree of protection	IP67				
transducer cable					
type	1699				
length	m 5	4			3
length (***,*****/LC)	m 9				
dimensions					
length l	mm 129.5	126.5	64	40	
width b	mm 51	51	32	22	
height h	mm 67	67.5	40.5	25.5	
dimensional drawing					
weight (without cable)	kg 0.47	0.36	0.066	0.016	
pipe surface temperature					
min.	°C -40				
max.	°C +130				
ambient temperature					
min.	°C -40				
max.	°C +130				
temperature compensation	x				
explosion protection					
• ATEX/IECEX					
order code	FSG-NA2TS/**	FSK-NA2TS/**	FSM-NA2TS/**	FSP-NA2TS/**	FSQ-NA2TS/**
pipe surface temperature (Ex)	°C -55 °C gas: +190, dust: +180				
marking	CE 0637 Ex II 3G II 2D Ex nA IIC T6...T3 Gc Ex tb IIIC T80 °C...T185 °C Db				
certification ATEX	IBExU10ATEX1163 X				
certification IECEx	IECEx IBE 12.0005X				
• FM					
order code	FSG-NF2TS/**	FSK-NF2TS/**	FSM-NF2TS/**	FSP-NF2TS/**	FSQ-NF2TS/**
pipe surface temperature (Ex)	°C -40 °C +125				
degree of protection	IP66			IP66	
marking	NI/CI, I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860			NI/CI, I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860	

Shear wave transducers (zone 2 - nonEx, T1, IP68)

order code		FSG-N**T1/IP68	FSK-N**T1/IP68	FSM-N**T1/IP68	FSP-N**T1/IP68
technical type		CDG1L18	CDK1L18	CDM2L18	CDP2L18
transducer frequency	MHz	0.2	0.5	1	2
inner pipe diameter d					
min. extended	mm	400	100	50	25
min. recommended	mm	500	200	100	50
max. recommended	mm	4000	2000	1000	400
max. extended	mm	6500	2400	1200	480
pipe wall thickness					
min.	mm	11	5	2.5	1.2
material					
housing		PEEK with stainless steel cover 316Ti (1.4571)			
contact surface		PEEK			
degree of protection		IP68 ¹			
transducer cable					
type		2550			
length	m	12			
dimensions					
length l	mm	130		72	
width b	mm	54		32	
height h	mm	83.5		46	
dimensional drawing					
weight (without cable)	kg	0.43		0.085	
pipe surface temperature					
min.	°C	-40			
max.	°C	+100			
ambient temperature					
min.	°C	-40			
max.	°C	+100			
temperature compensation		x			
explosion protection					
• ATEX/IECEX					
order code		FSG-NA2T1/IP68	FSK-NA2T1/IP68	FSM-NA2T1/IP68	FSP-NA2T1/IP68
pipe surface temperature (Ex)					
• min.	°C	-40			
• max.	°C	gas: +90, dust: +80			
marking		CE 0637 Ex II3G II2D Ex nA IIC T6...T5 Gc Ex tb IIIC T80 °C...T85 °C Db			
certification ATEX		IBExU10ATEX1163 X			
certification IECEX		IECEX IBE 12.0005X			

¹ test conditions: 3 months/2 bar (20 m)/20 °C

Shear wave transducers (zone 2 - FM Class I Div. 2 - nonEx, TS, extended temperature range)

order code	FSG-ENNTS/**	FSK-ENNTS/**	FSM-E**TS/**	FSP-E**TS/**	FSQ-E**TS/**
technical type	C(DL)G1E52	C(DL)K1E52	C(DL)M2E52	C(DL)P2E52	C(DL)Q2E52
transducer frequency	MHz 0.2	0.5	1	2	4
inner pipe diameter d					
min. extended	mm 400	100	50	25	10
min. recommended	mm 500	200	100	50	25
max. recommended	mm 4000	2000	1000	400	150
max. extended	mm 6500	2400	1200	480	240
pipe wall thickness					
min.	mm 11	5	2.5	1.2	0.6
material					
housing	PPSU with stainless steel cover 304 (1.4301), ***-*****/OS: 316L (1.4404)		PI with stainless steel cover 304 (1.4301), ***-*****/OS: 316L (1.4404)		
contact surface	PPSU		PI		
degree of protection	IP65		IP56		
transducer cable					
type	1699		6111		
length	m 5		4		3
length (**-*****/LC)	m 9		9		
dimensions					
length l	mm 129.5		64		40
width b	mm 51		32		22
height h	mm 67		40.5		25.5
dimensional drawing					
weight (without cable)	kg 0.82		0.066		0.017
pipe surface temperature					
min.	°C -40		-30		-30
max.	°C +180		+240 ¹		+200
ambient temperature					
min.	°C -40		-30		-30
max.	°C +180		+40 +60 ² +200 ³		+200
temperature compensation	x		x		
explosion protection					
• ATEX/IECEX					
order code	-	-	FSM-EA2TS/**	FSP-EA2TS/**	FSQ-EA2TS/**
pipe surface temperature (Ex)			-45 gas: +235 ¹ , dust: +225 ¹		
• min.	°C -	-			
• max.	°C -	-			
marking			CE 0637 II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIA T80 °C...230 °C Db		
certification ATEX			IBExU10ATEX1163 X		
certification IECEX			IECEX IBE 12.0005X		
• FM					
order code	-	-	FSM-EF2TS/**	FSP-EF2TS/**	FSQ-EF2TS/**
pipe surface temperature (Ex)			-40 +235 ¹		
• min.	°C -	-			
• max.	°C -	-			
degree of protection			IP66		
marking			NI/CI. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		

¹ > +200 °C:
Variofix C without cover or Variofix L
observe the insulation instruction
Ex: ambient temperature max. +40 °C

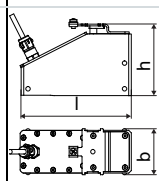
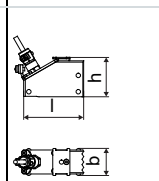
² pipe surface temperature +200...+240 °C: Variofix C without cover

³ pipe surface temperature max. +200 °C

Shear wave transducers (zone 1, T1)

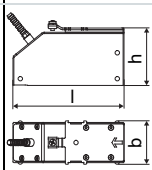
order code		FSG-N*1T1/**	FSK-N*1T1/**	FSM-N*1T1/**	FSP-N*1T1/**	FSQ-N*1T1/**
technical type		C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81
transducer frequency	MHz	0.2	0.5	1	2	4
inner pipe diameter d						
min. extended	mm	400	100	50	25	10
min. recommended	mm	500	200	100	50	25
max. recommended	mm	4000	2000	1000	400	150
max. extended	mm	6500	2400	1200	480	240
pipe wall thickness						
min.	mm	11	5	2.5	1.2	0.6
material						
housing		PEEK with stainless steel cover 304 (1.4301), ***-*****/OS: 316L (1.4404)				
contact surface		PEEK				
degree of protection		IP65	IP66			IP65
transducer cable						
type		1699				
length	m	5		4		3
length (***/*****/LC)	m	9				
dimensions						
length l	mm	129.5	126.5	64		40
width b	mm	51	51	32		22
height h	mm	67	67.5	40.5		25.5
dimensional drawing						
weight (without cable)	kg	0.47	0.36	0.066		0.016
pipe surface temperature						
min.	°C	-40				
max.	°C	+130				
ambient temperature						
min.	°C	-40				
max.	°C	+130				
temperature compensation		x				
explosion protection						
• ATEX/IECEX						
order code		FSG-NA1T1/**	FSK-NA1T1/**	FSM-NA1T1/**	FSP-NA1T1/**	FSQ-NA1T1/**
pipe surface temperature (Ex)						
• min.	°C	-55				
• max.	°C	+180				
marking		CE 0637 Ex q IIC T6...T3 Gb Ex tb IIIC T80 °C...T185 °C Db				
certification ATEX		IBExU07ATEX1168 X				
certification IECEX		IECEX IBE 08.0007X				

Shear wave transducers (zone 1, T1, IP68)

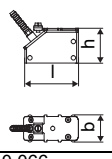
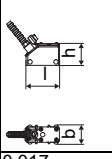

order code		FSG-N*1T1/IP68	FSK-N*1T1/IP68	FSM-N*1T1/IP68	FSP-N*1T1/IP68
technical type		CDG1L11	CDK1L11	CDM2L11	CDP2L11
transducer frequency	MHz	0.2	0.5	1	2
inner pipe diameter d					
min. extended	mm	400	100	50	25
min. recommended	mm	500	200	100	50
max. recommended	mm	4000	2000	1000	400
max. extended	mm	6500	2400	1200	480
pipe wall thickness					
min.	mm	11	5	2.5	1.2
material					
housing		PEEK with stainless steel cover 316Ti (1.4571)			
contact surface		PEEK			
degree of protection		IP68 ¹			
transducer cable					
type		2550			
length	m	12			
dimensions					
length l	mm	130		72	
width b	mm	54		32	
height h	mm	83.5		46	
dimensional drawing					
weight (without cable)	kg	0.43		0.085	
pipe surface temperature					
min.	°C	-40			
max.	°C	+100			
ambient temperature					
min.	°C	-40			
max.	°C	+100			
temperature compensation		x			
explosion protection					
• ATEX/IECEX					
order code		FSG-NA1T1/IP68	FSK-NA1T1/IP68	FSM-NA1T1/IP68	FSP-NA1T1/IP68
pipe surface temperature (Ex)					
• min.	°C	-40			
• max.	°C	+80			
marking		CE 0637 Ex II 2G II 2D Ex q IIC T6...T5 Gb Ex tb IIIC T80 °C...T85 °C Db			
certification ATEX		IBExU07ATEX1168 X			
certification IECEX		IECEX IBE 08.0007X			

¹ test conditions: 3 months/2 bar (20 m)/20 °C

Shear wave transducers (zone 1, T1, extended temperature range)

order code		FSG-EA1T1/**	FSK-EA1T1/**
technical type		C(DL)G1E83	C(DL)K1E83
transducer frequency	MHz	0.2	0.5
inner pipe diameter d			
min. extended	mm	400	100
min. recommended	mm	500	200
max. recommended	mm	4000	2000
max. extended	mm	6500	2400
pipe wall thickness			
min.	mm	11	5
material			
housing		PPSU with stainless steel cover 304 (1.4301), ***/****/OS: 316L (1.4404)	
contact surface		PPSU	
degree of protection		IP65	
transducer cable			
type		1699	
length	m	5	
length (***/****/LC)	m	9	
dimensions			
length l	mm	129.5	
width b	mm	51	
height h	mm	67	
dimensional drawing			
weight (without cable)	kg	0.82	
pipe surface temperature			
min.	°C	-40	
max.	°C	+180	
ambient temperature			
min.	°C	-40	
max.	°C	+180	
temperature compensation		x	
explosion protection			
• ATEX/IECEx			
pipe surface temperature (Ex)			
• min.	°C	-50	
• max.	°C	+155	
marking		CE 0637 Ex II2G II2D Ex q IIC T6...T3 Gb Ex tb IIIC T80 °C...T160 °C Db	
certification ATEX		IBExU07ATEX1168 X	
certification IECEx		IECEx IBE 08.0007X	

Shear wave transducers (zone 1, T1, extended temperature range)

order code		FSM-E*1T1/**	FSP-E*1T1/**	FSQ-E*1T1/**
technical type		C(DL)M2E85	C(DL)P2E85	C(DL)Q2E85
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	mm	50	25	10
min. recommended	mm	100	50	25
max. recommended	mm	1000	400	150
max. extended	mm	1200	480	240
pipe wall thickness				
min.	mm	2.5	1.2	0.6
material				
housing		PI with stainless steel cover 304 (1.4301), ***-*****/OS: 316L (1.4404)		
contact surface		PI		
degree of protection		IP66		IP56
transducer cable				
type		6111		
length	m	4		3
length (**-*****/LC)	m	9		
dimensions				
length l	mm	64		40
width b	mm	32		22
height h	mm	40.5		25.5
dimensional drawing				
weight (without cable)	kg	0.066		0.017
pipe surface temperature				
min.	°C	-30		-30
max.	°C	+240 ¹		+200
ambient temperature				
min.	°C	-30		-30
max.	°C	+40 +200 ²		+200
temperature compensation		x		
explosion protection				
• ATEX/IECEx				
order code		FSM-EA1T1/**	FSP-EA1T1/**	FSQ-EA1T1/**
pipe surface temperature (Ex)				
• min.	°C	-45		
• max.	°C	+225 ¹		
marking		CE 0637  II2G II2D Ex q IIC T6...T2 Gb Ex tb IIIA T80 °C...T230 °C Db		
certification ATEX		IBExU07ATEX1168 X		
certification IECEx		IECEx IBE 08.0007X		

¹ > +200 °C :
 Variofix L or Variofix C
 observe the insulation instruction
 ambient temperature max. +40 °C

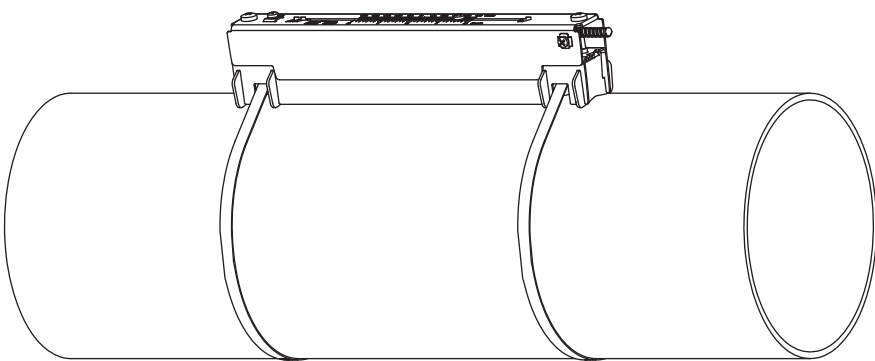
² pipe surface temperature max. +200 °C

Transducer mounting fixture

Order code

1, 2	3	4	5	6	7...9	no. of character	
transducer mounting fixture	transducer	measurement arrangement	size	fixation	outer pipe diameter	option	description
VL							Variofix L
VC							Variofix C
WI							transducer box for WaveInjector
	K						transducers with transducer frequency G, K
	M						transducers with transducer frequency M, P
	Q						transducers with transducer frequency Q
		D					reflection arrangement or diagonal arrangement
		R					reflection arrangement
			S				small
			M				medium
			L				large
				B			bolts
				S			tension straps
				W			welding
				N			without fixation
					002		10...20 mm
					004		20...40 mm
					T36		40...360 mm
					013		10...130 mm
					036		130...360 mm
					092		360...920 mm
					200		920...2000 mm
					450		2000...4500 mm
					940		4500...9400 mm
					NDR		any
						IP68	for transducers with degree of protection IP68
						OS	housing with stainless steel 316
						Z	special design

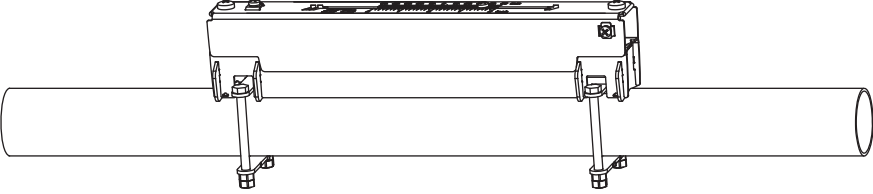
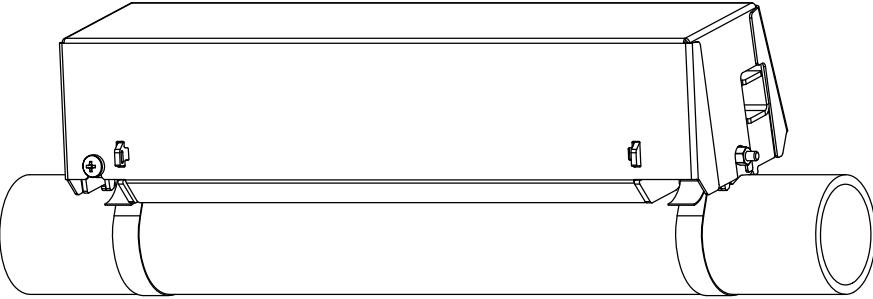
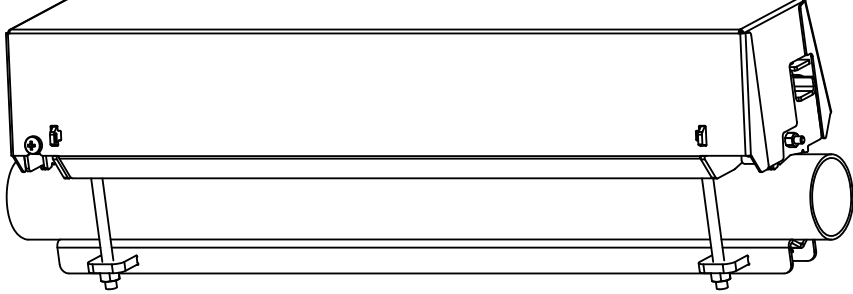
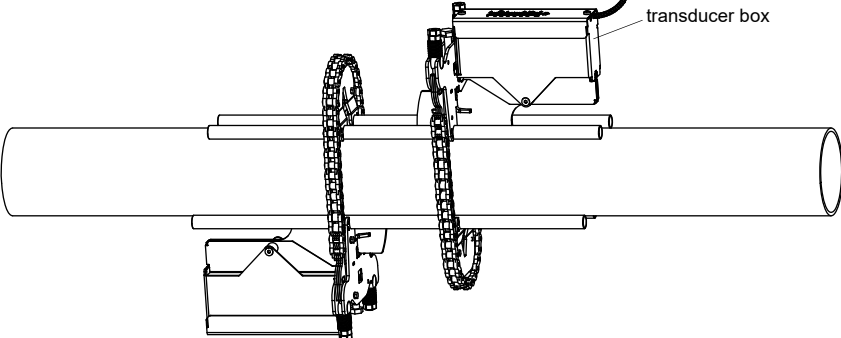
Variofix L (VLK, VLM, VLQ)



material: stainless steel 304 (1.4301), 301 (1.4310), 410 (1.4006)
 option OS: 316Ti (1.4571), 316L (1.4404), 17-7PH (1.4568)

inner length:
VLK: 348 mm,
 option IP68: 368 mm
VLM: 234 mm
VLQ: 176 mm

dimensions:
VLK: 423 x 90 x 93 mm
 option IP68: 443 x 94 x 105 mm
VLM: 309 x 57 x 63 mm
VLQ: 247 x 43 x 47 mm

<p>Variofix L with bolt mounting plates (VL*-*-B)</p> 	<p>material: stainless steel 304 (1.4301), 301 (1.4310), 410 (1.4006) option OS: 316Ti (1.4571), 316L (1.4404), 17-7PH (1.4568) inner length: VLM: 234 mm VLQ: 176 mm dimensions: VLM: 309 x 57 x 63 mm VLQ: 247 x 43 x 47 mm outer pipe diameter: max. 48 mm</p>
<p>Variofix C (VC)</p> 	<p>material: stainless steel 316Ti (1.4571) inner length: VCK-*L: 500 mm VCK-*S: 350 mm VCM: 400 mm VQC: 250 mm dimensions: VCK-*L: 560 x 126 x 125 mm VCK-*S: 410 x 126 x 125 mm VCM: 460 x 96 x 82 mm VQC: 310 x 85 x 71 mm</p>
<p>Variofix C (VC) with bolt mounting plates (VCM**-*B, VCQ**-*B)</p> 	<p>material: stainless steel 316Ti (1.4571) inner length: VCM: 400 mm VQC: 250 mm dimensions: VCM: 460 x 96 x 82 mm VQC: 310 x 85 x 71 mm outer pipe diameter: VCM: max. 46 mm VQC: max. 36 mm</p>
<p>transducer box WI for Wavelnjector</p> 	<p>see Technical specification TSWavelnjectorVx-x</p>

Coupling materials for transducers

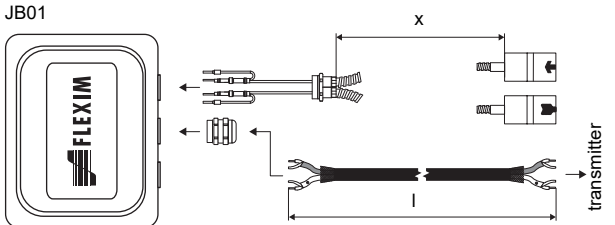
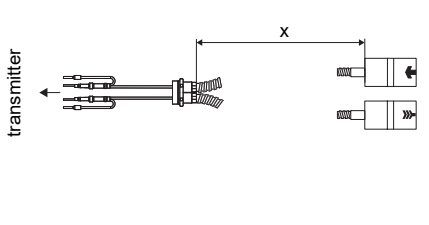
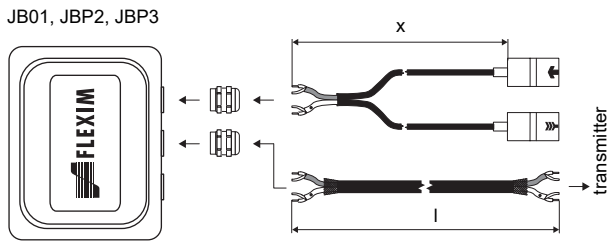
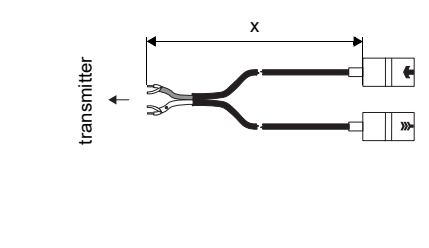
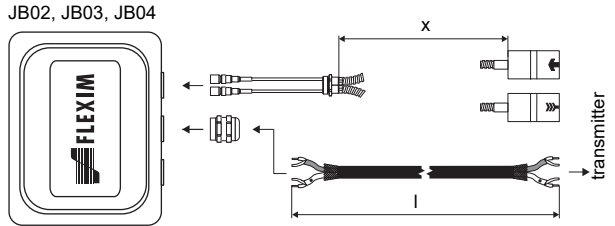
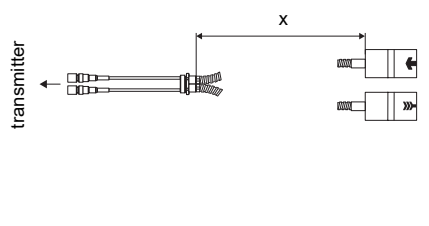
	normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)			WaveInjector WI-400	
	< 100 °C	< 170 °C	< 150 °C	< 200 °C	200...240 °C	< 280 °C	280...400 °C
< 24 h	coupling compound type N or coupling foil type VT	coupling compound type E or coupling foil type VT	coupling compound type E or coupling foil type VT	coupling compound type E or H or coupling foil type VT	coupling foil type TF	coupling foil type A and coupling foil type VT	coupling foil type B and coupling foil type VT
long time measurement	coupling foil type VT	coupling foil type VT	coupling foil type VT	coupling foil type VT	coupling foil type TF	coupling foil type A and coupling foil type VT	coupling foil type B and coupling foil type VT

type VT: fluid temperature 200 °C: min. 2 years

Technical data

type	ambient temperature °C
coupling compound type N	-30...+130
coupling compound type E	-30...+200
coupling compound type H	-30...+250
coupling foil type A	max. 280
coupling foil type B	280...400
coupling foil type VT	-10...+200
coupling foil type TF	200...240

Connection systems

connection system T1		
connection with extension cable	direct connection	transducers technical type
<p>JB01</p> 		<p>****8*</p>
<p>JB01, JBP2, JBP3</p> 		<p>****1*</p>
connection system TS		
connection with extension cable	direct connection	transducers technical type
<p>JB02, JB03, JB04</p> 		<p>****52</p>

Cable

transducer cable				
type		1699	2550	6111
weight	kg/m	0.094	0.035	0.092
ambient temperature	°C	-55...+200	-40...+100	-100...+225
properties			longitudinal watertight	
cable jacket				
material		PTFE	PUR	PFA
outer diameter	mm	2.9	5.2 ±0.2	2.7
thickness	mm	0.3	0.9	0.5
colour		brown	grey	white
shield		x	x	x
sheath				
material		stainless steel 304 (1.4301) option OS: 316Ti (1.4571)	-	stainless steel 304 (1.4301) option OS: 316Ti (1.4571)
outer diameter	mm	8	-	8

extension cable				
type		2615	5245	
order code		ACC-PE- GNNN-/EXEXXXX	ACC-PE- GNNN-/EXA1XXX	
weight	kg/m	0.18	0.38	
ambient temperature	°C	-30...+70	-30...+70	
properties		halogen free fire propagation test according to IEC 60332-1 combustion test according to IEC 60754-2	halogen free fire propagation test according to IEC 60332-1 combustion test according to IEC 60754-2	
cable jacket				
material		PUR	PUR	
outer diameter	mm	max. 12	max. 12	
thickness	mm	2	2	
colour		black	black	
shield		x	x	
sheath				
material		-	steel wire braid with copolymer sheath	
outer diameter	mm	-	max. 15.5	

XXX - cable length in m

Cable length

transducer frequency		F, G, H, K		M, P		Q		S	
connection system TS									
transducers technical type		x	l	x	l	x	l	x	l
*(DR)**8*	m	5	≤ 300	4	≤ 300	3	≤ 90	-	-
option LC: *(LT)**8*	m	9	≤ 300	9	≤ 300	9	≤ 90	-	-
*(DR)**5*	m	5	≤ 300	4	≤ 300	3	≤ 90	2	≤ 40
option LC: *(LT)**5*	m	9	≤ 300	9	≤ 300	9	≤ 90	-	-
option IP68: ****L*	m	12	≤ 300	12	≤ 300	-	-	-	-

x - transducer cable length

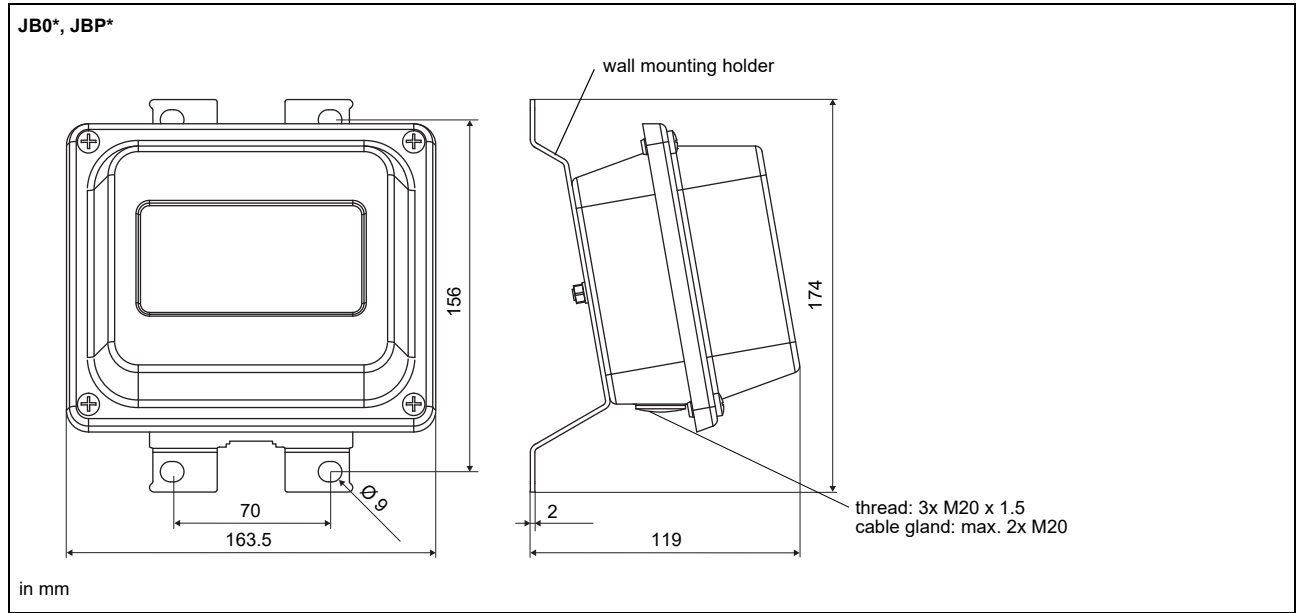
l - max. length of extension cable (depending on the application)

Junction box

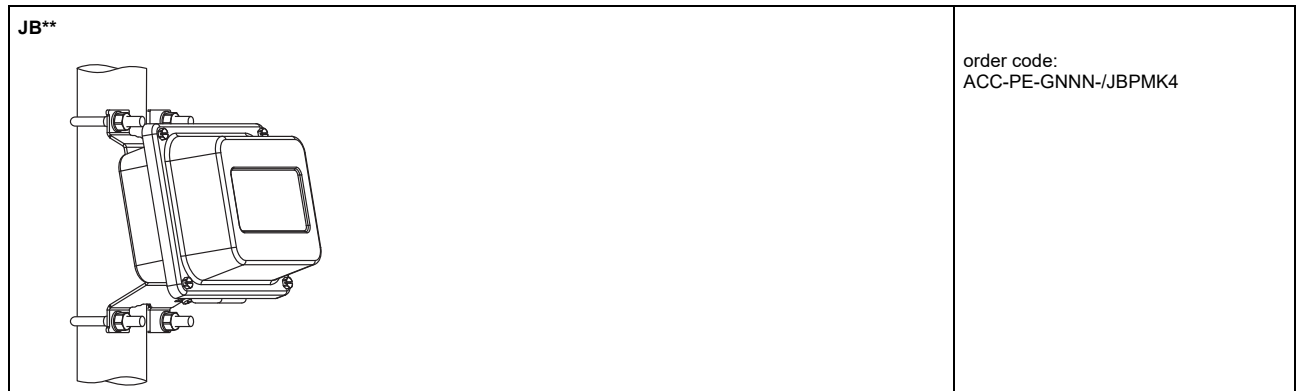
Technical data

JB01S4E3M, JBP2, JBP3			
weight	kg	1.2 kg	
fixation		wall mounting optional: 2" pipe mounting	
material			
housing		stainless steel 316L (1.4404)	
gasket		silicone	
degree of protection		IP67	
ambient temperature			
min.	°C	-40	
max.	°C	+80	
explosion protection			
• ATEX/IECEX (zone 1)			
junction box		JB01S4E3M	
marking		CE 0637 Ex II2G II2D Ex eb mb IIC T6...T4 Gb Ex tb IIIC T100 °C Db Ta -40...+70/80 °C	
certification ATEX		IBExU06ATEX1161	
certification IECEX		IECEX IBE 08.0006	
type of protection		gas: increased safety decoupled network: encapsulation dust: protection by enclosure	
• ATEX (zone 2)			
junction box		JBP2	
marking		CE Ex II3G Ex nA IIC (T6)...T4 Gc II3D Ex tc IIIC T 100 °C Dc Ta -40...+(70)80 °C	
Connection			
Transducers			
terminal strip	terminal	connection	transducer
KL1	V	signal	↑
	VS	internal shield	↕
	RS	internal shield	↕
	R	signal	↕
Extension cable			
terminal strip	terminal	connection	
KL2	TV	signal	
	TVS	internal shield	
	TRS	internal shield	
	TR	signal	
JB02, JB03, JB04			
weight	kg	1.2 kg	
fixation		wall mounting optional: 2" pipe mounting	
material			
housing		stainless steel 316L (1.4404)	
gasket		silicone	
degree of protection		IP67	
ambient temperature			
min.	°C	-40	
max.	°C	+80	
explosion protection			
• ATEX			
junction box		JB02	
marking		CE Ex II3G Ex nA IIC (T6)...T4 Gc II3D Ex tc IIIC T 100 °C Dc Ta -40...+(70)80 °C	
• FM			
junction box		JB04	
marking		FM APPROVED NI/CI. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C	
Connection			
Transducers			
	terminal	connection	transducer
	XV	SMB connector	↑
	XR	SMB connector	↕
Extension cable			
terminal strip	terminal	connection	
KL2	TV	signal	
	TVS	internal shield	
	TRS	internal shield	
	TR	signal	

Dimensions

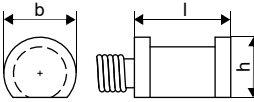
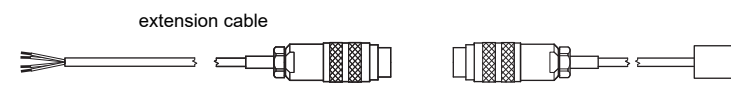
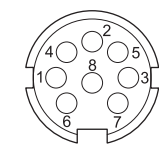






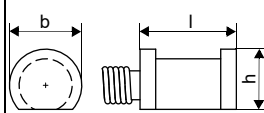
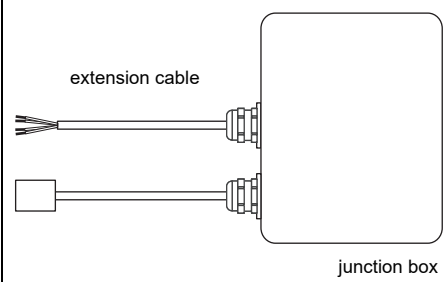
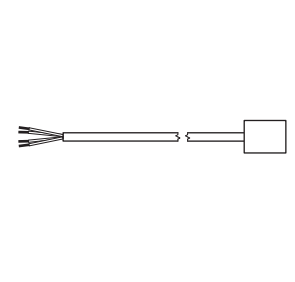
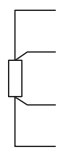
2" pipe mounting kit

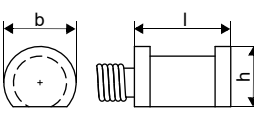

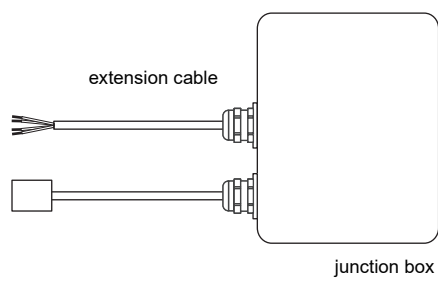
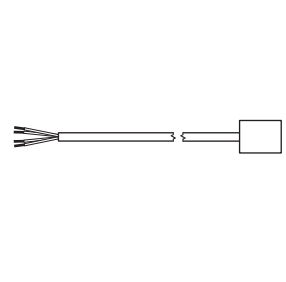
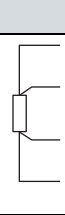


Clamp-on temperature probe (optional)

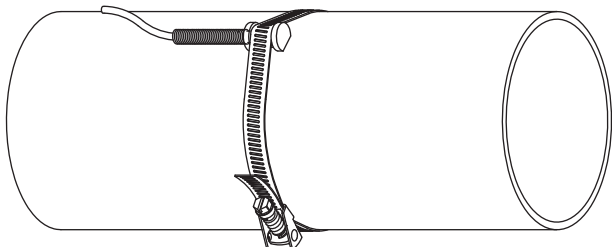
Technical data

PT12N				
order code	<ul style="list-style-type: none"> ACC-PO-#601-/T311 ACC-PO-#601-/T511 (matched) 			
design	clamp-on with connector			
type	Pt100			
connection	4-wire			
measuring range	°C -30...+250			
accuracy T	$\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C]})$ class A			
accuracy ΔT (2x Pt matched according to EN 1434-1)	$\leq 0.1 \text{ K}$ ($3 \text{ K} < \Delta T < 6 \text{ K}$), more corresponding to EN 1434-1			
response time	s 50 (t_{50} , $T_1 = 25 \text{ °C}$, $T_2 = 60 \text{ °C}$)			
housing	aluminum			
degree of protection	IP54			
dimensions				
length l	mm 20			
width b	mm 15			
height h	mm 13			
dimensional drawing				
weight	kg 0.25 (without connector)			
accessories				
thermal conductivity paste 200 °C	x			
thermal conductivity foil 250 °C	x			
Connection system				
direct connection/connection with extension cable				
				
Connection				
	temperature probe	extension cable	connector	
			pin	
	red	grey	2	
	red/blue	red	6	
	white/blue	blue	1	
	white	white	7	
Cable				
		temperature probe	extension cable	
type		4 x 0.22 mm ²	LIYCY 8 x 0.14 mm ²	
standard length	m	3	5/10/25	
max. length	m	-	200	
ambient temperature	°C	-30...+250	-25...+80	
min. bend radius	mm	27	68	
cable jacket				
material		PFA	PVC	
outer diameter	mm	3.8 ±0.15	4.8 ±2	
colour		black	grey	


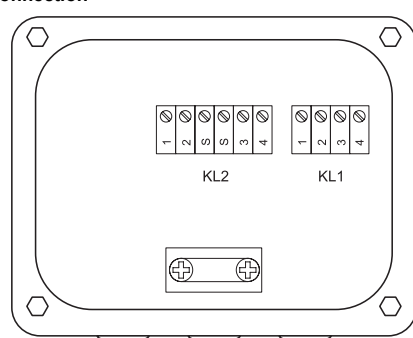
PT12N		
order code		<ul style="list-style-type: none"> ACC-PE-GNNN/T312 ACC-PE-GNNN/T512 (matched)
design		clamp-on
type		Pt100
connection		4-wire
measuring range	°C	-30...+250
accuracy T		$\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C] })$ class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		$\leq 0.1 \text{ K}$ ($3 \text{ K} < \Delta T < 6 \text{ K}$), more corresponding to EN 1434-1
response time	s	50 (t50, T1 = 25 °C, T2 = 60 °C)
housing		aluminum
degree of protection		IP54
dimensions		
length l	mm	20
width b	mm	15
height h	mm	13
dimensional drawing		
weight	kg	0.25
accessories		
thermal conductivity foil 250 °C		x
Connection system		
connection with extension cable		direct connection
		
Connection		
	temperature probe	
	red	
	red/blue	
	white/blue	
	white	
Cable		
	temperature probe	extension cable
type	4 x 0.22 mm ²	LIYCY 8 x 0.14 mm ²
standard length	m 3	5/10/25
max. length	m -	200
ambient temperature	°C -30...+250	-25...+80
min. bend radius	mm 27	68
cable jacket		
material	PFA	PVC
outer diameter	mm 3.8 ±0.15	4.8 ±2
colour	black	grey

PT12N		
order code	<ul style="list-style-type: none"> ACC-PE-GNNN-/T322 ACC-PE-GNNN-/T522 (matched) 	
design	clamp-on ATEX	
type	Pt100	
connection	4-wire	
measuring range	°C -30...+250	
accuracy T	$\pm(0.15\text{ °C} + 2 \cdot 10^{-3} \cdot T\text{ [°C] })$ class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)	$\leq 0.1\text{ K}$ ($3\text{ K} < \Delta T < 6\text{ K}$), more corresponding to EN 1434-1	
response time	s 50	
housing	aluminum	
degree of protection	IP67	
dimensions		
length l	mm 20	
width b	mm 15	
height h	mm 13	
dimensional drawing		
weight	kg 0.25	
accessories		
thermal conductivity foil 250 °C	x	
explosion protection		
• ATEX		
marking	 II3G Ex nA IIC T6...T2 Gc Ta -30...+250 °C	
Connection system		
connection with extension cable	direct connection	
		
Connection		
	temperature probe	
	red	
	red/blue	
	white	
	white/blue	
Cable		
	temperature probe	extension cable
type	4 x 0.25 mm ²	LIYCY 8 x 0.14 mm ²
standard length	m 3	5/10/25
max. length	m -	200
ambient temperature	°C -30...+250	-25...+80
min. bend radius	mm 19	68
cable jacket		
material	PTFE	PVC
outer diameter	mm 3.8	4.8 ±2
colour	black	grey

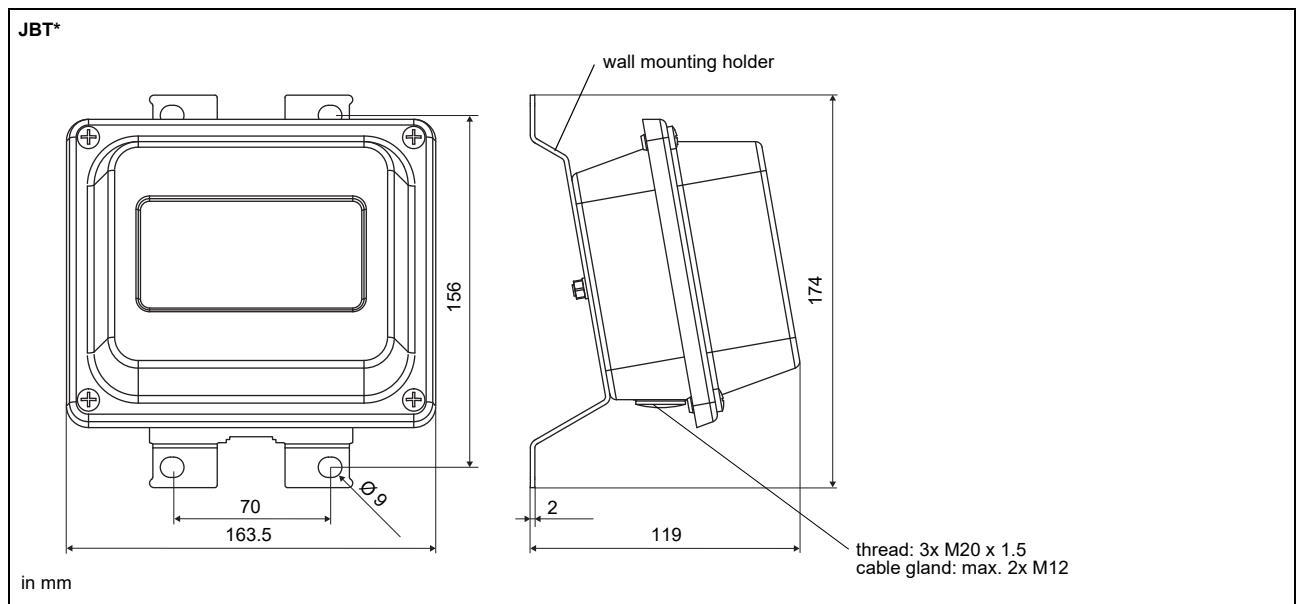
Fixation

<p>tension strap PT12N</p> 	<p>material: stainless steel 301 (1.4310), 410 (1.4006) thermal insulation necessary</p>
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Junction box

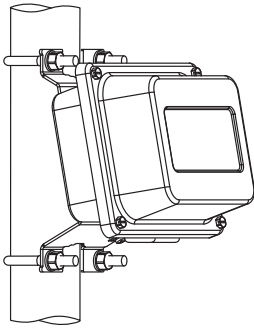
JBT2, JBT3																									
order code	<ul style="list-style-type: none"> • JBT2: ACC-PE-GNNN-/JB4 • JBT3: ACC-PE-GNNN-/JB6 																								
weight	kg 1.2 kg																								
fixation	wall mounting optional: 2" pipe mounting																								
material																									
housing	stainless steel 316L (1.4404)																								
gasket	silicone																								
degree of protection	IP67																								
ambient temperature																									
min.	°C -40																								
max.	°C +80																								
explosion protection																									
• ATEX																									
junction box marking	JBT2  II3G Ex nA IIC (T6)...T4 Gc II3D Ex tc IIC T 100 °C Dc Ta -40...+(70)80 °C																								
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Connection</p>  </div> <div style="width: 45%;"> <p>Temperature probe</p> <table border="1"> <thead> <tr> <th>terminal strip</th> <th>terminal</th> <th>connection</th> </tr> </thead> <tbody> <tr> <td rowspan="4">KL1</td> <td>1</td> <td>red</td> </tr> <tr> <td>2</td> <td>red/blue</td> </tr> <tr> <td>3</td> <td>white</td> </tr> <tr> <td>4</td> <td>white/blue</td> </tr> </tbody> </table> <p>Extension cable</p> <table border="1"> <thead> <tr> <th>terminal strip</th> <th>terminal</th> <th>connection</th> </tr> </thead> <tbody> <tr> <td rowspan="4">KL2</td> <td>1</td> <td>red</td> </tr> <tr> <td>2</td> <td>grey</td> </tr> <tr> <td>3</td> <td>white</td> </tr> <tr> <td>4</td> <td>blue</td> </tr> </tbody> </table> </div> </div>		terminal strip	terminal	connection	KL1	1	red	2	red/blue	3	white	4	white/blue	terminal strip	terminal	connection	KL2	1	red	2	grey	3	white	4	blue
terminal strip	terminal	connection																							
KL1	1	red																							
	2	red/blue																							
	3	white																							
	4	white/blue																							
terminal strip	terminal	connection																							
KL2	1	red																							
	2	grey																							
	3	white																							
	4	blue																							

Dimensions



2" pipe mounting kit

JB**



order code:
ACC-PE-GNNN-/JBPMK4

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