

Ultrasonic process monitoring and flow measurement of hydrocarbons

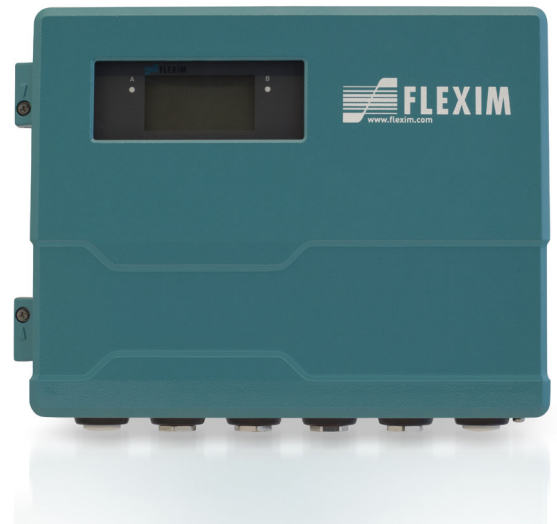
Features

- Exact and highly reliable bidirectional clamp-on flow measurement of operational and mass flow rate
- Measurement of standard volumetric flow rate according to ASTM and API determination
- Installation and start-up do not require any pipe work nor any process interruptions
- Transducers for use in hazardous areas are available
- Maintenance-free and drift-free measurement
- Transducers available for a wide range of inner pipe diameters and fluid temperatures
- Fluid data sets for all classes of hydrocarbons integrated in the transmitter
- Guided application adaptation

Applications

Applications in single and multiproduct pipelines:

- Leakage detection
- Check metering
- Fluid detection, batch/interface detection
- Fluid quality monitoring



FLUXUS H721**-*A



FLUXUS H721**-*S



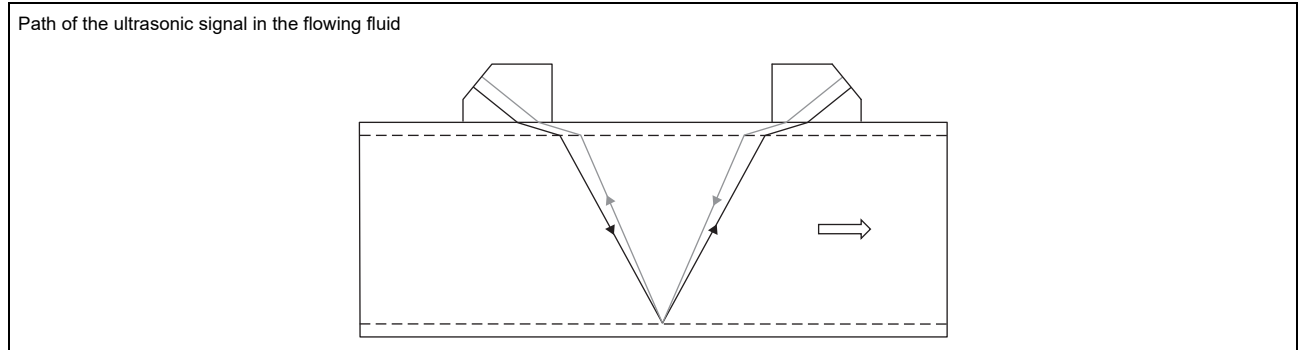
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Function

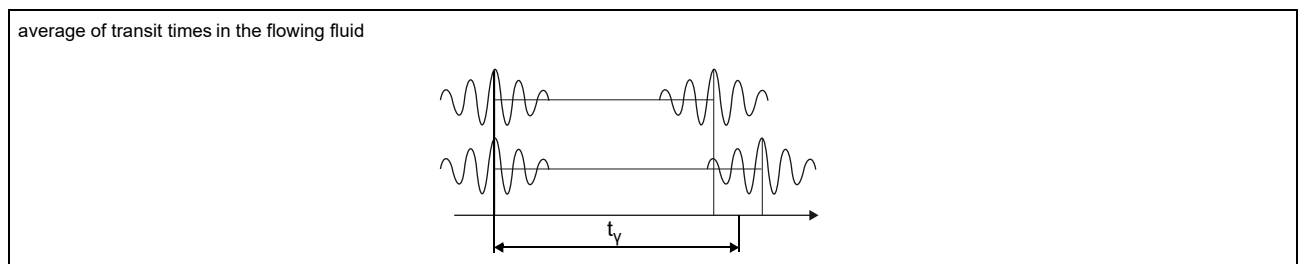
Measurement principle

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.



Transit time measurement

All HPI physical quantities are determined from the sound speed. The sound speed is calculated by using 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

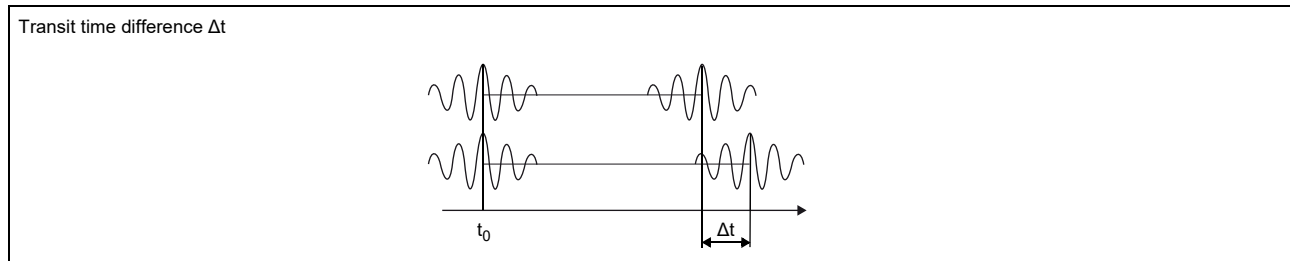
A field calibration is recommended to reduce the influence of the pipe parameters on the accuracy of the measurement.

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 standard volumetric flow rate

The standard volumetric flow rate can be selected as physical quantity. It is calculated with the following formula:

$$\dot{V}_N = \dot{V} \cdot VCF$$

where

$$VCF = CTL \cdot CPL = \frac{\rho}{\rho_N}$$

- \dot{V}_N - standard volumetric flow rate
- \dot{V} - operating volumetric flow rate
- VCF - volume correction factor
- CTL - correction for the effect of temperature on liquid
- CPL - correction for the effect of pressure on liquid
- ρ_N - normalised density
- ρ - operating density

according to ASTM D 1250-04, IP200/04

Calculation of mass flow rate

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

$$\rho = f(\text{API}, T)$$

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
- API - API gravity
- 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**

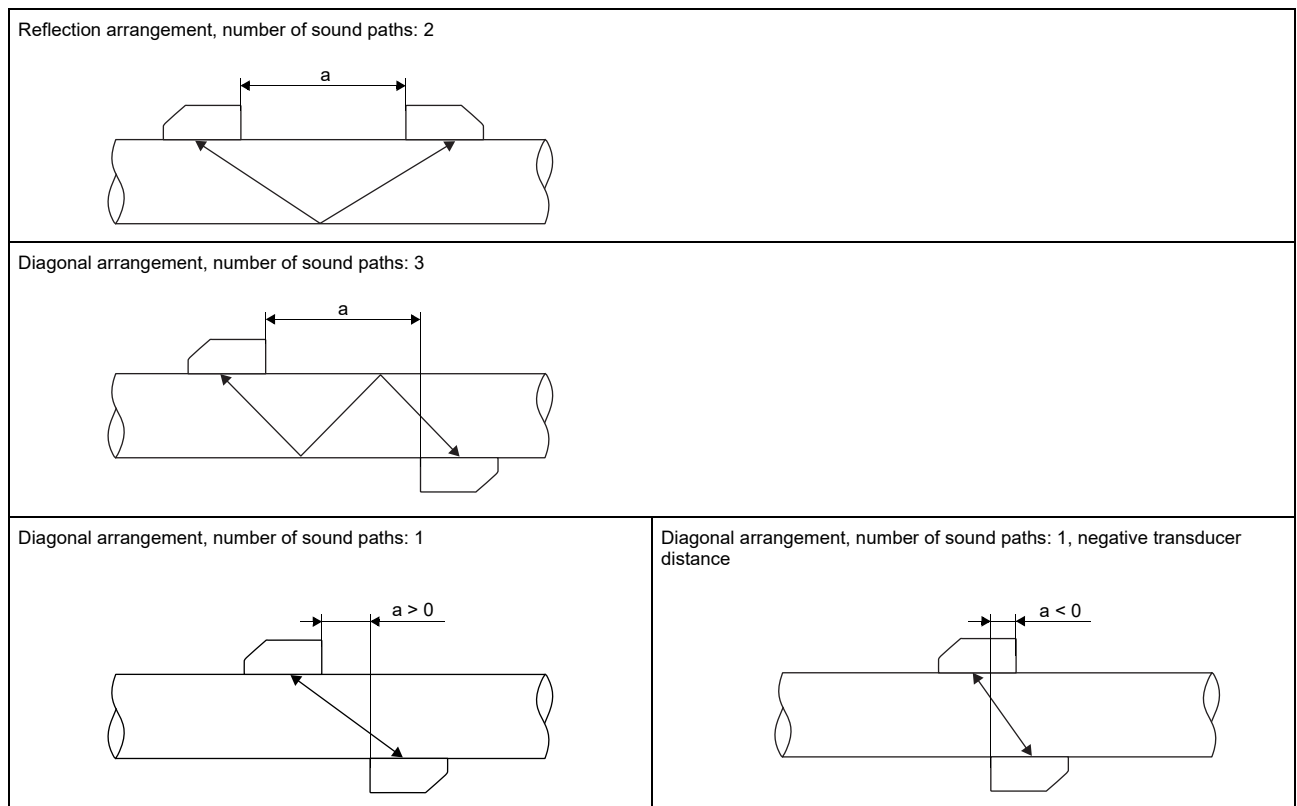
The number of sound paths is even. The transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easy.

- **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

	FLUXUS H721**-NN0*A H721**-NN0*S	FLUXUS H721**-A20*A H721**-A20*S	FLUXUS H721**-F20*A H721**-F20*S
			
design	standard field device	standard field device zone 2	standard field device FM Class I Div. 2
measurement			
• flow			
measurement principle	transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content		
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 (transit time difference principle)		
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		
• HPI			
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 $M (f_a = 1 \text{ MHz})$: repeatable: $20 \text{ ns} \pm 10^{-4} \cdot t$, absolute: $200 \text{ ns} \pm 10^{-4} \cdot t$		
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 (1 measuring point)		
damping	s 0...100 (adjustable)		
measuring cycle	Hz 100...1000 (1 channel)		
response time	s 1 (1 channel), option: 0.02		
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)

	FLUXUS H721**-NN0*A H721**-NN0*S	FLUXUS H721**-A20*A H721**-A20*S	FLUXUS H721**-F20*A H721**-F20*S
• FM			
marking	-	-	H721**-F20*S2, H721**-F20*S3:  NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 H721**-F20*S1:  NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A
measuring functions			
physical quantities	<ul style="list-style-type: none"> • flow: operating volumetric flow rate, standard volumetric flow rate according to ASTM 1250/TP25/4311, flow velocity, mass flow rate • HPI: API gravity, density, normalised density • interface detection: slope of the HPI physical quantities • fluid detection: according to fluid table 		
totaliser	volume, mass		
calculation functions	average, difference, sum (2 measuring channels necessary)		
diagnostic functions	sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times		
communication interfaces			
service interfaces	measured value transmission, parametrisation of the transmitter: <ul style="list-style-type: none"> • USB³ • LAN³ 		
process interfaces	max. 1 option: <ul style="list-style-type: none"> • Modbus RTU • HART • Profibus PA • FF H1 • Modbus TCP 		
accessories			
data transmission kit	USB cable		
software	<ul style="list-style-type: none"> • 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)

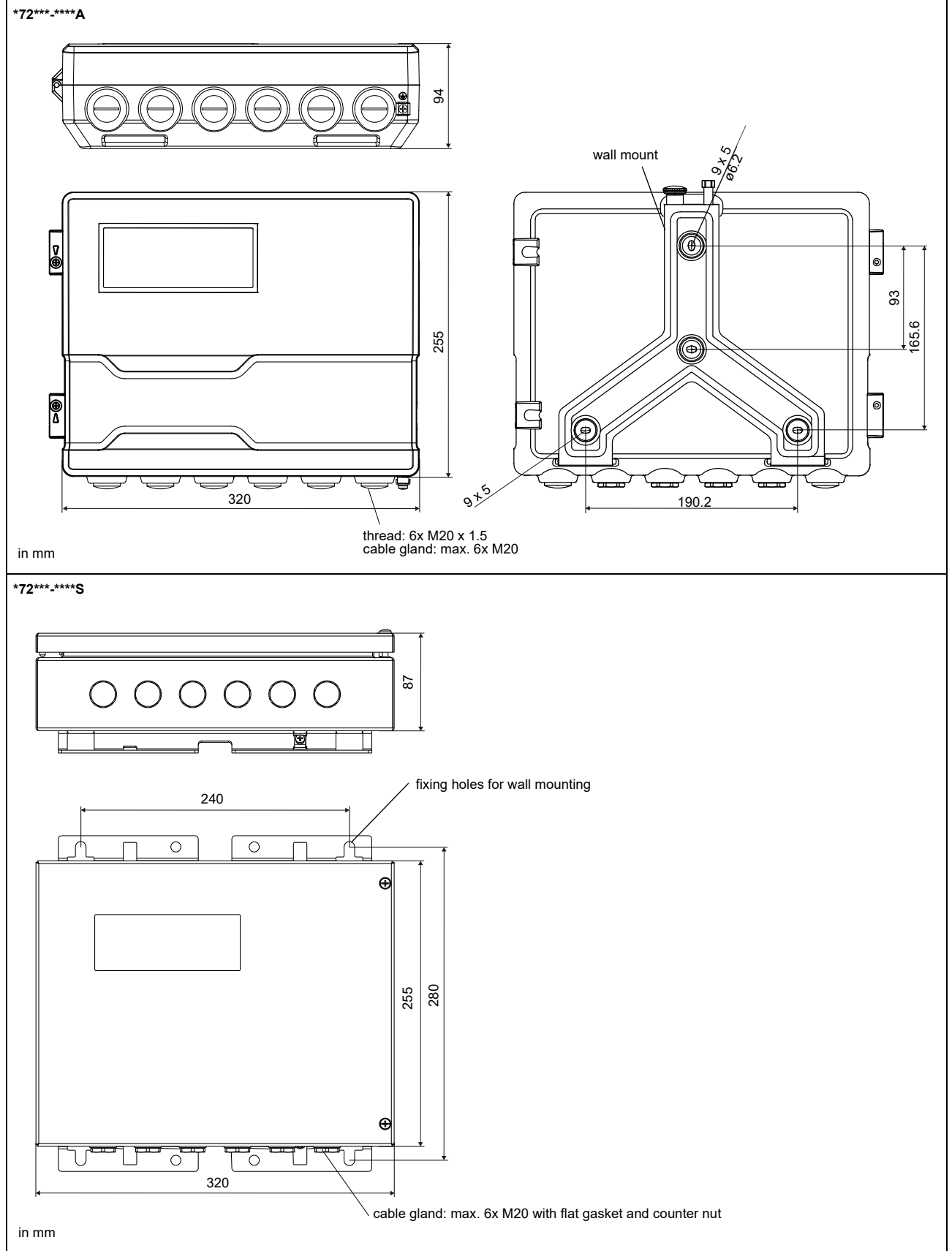
	FLUXUS H721**-NN0*A H721**-NN0*S	FLUXUS H721**-A20*A H721**-A20*S	FLUXUS H721**-F20*A H721**-F20*S
• digital output			
functions	<ul style="list-style-type: none"> • frequency output • binary output • pulse output 	-	<ul style="list-style-type: none"> • frequency output • binary output • pulse output
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		
• 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

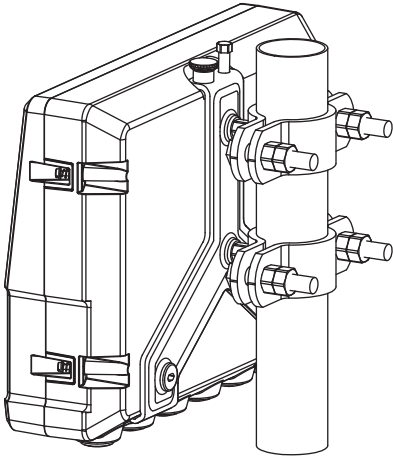
³ outside the explosive atmosphere (housing cover open)

Dimensions



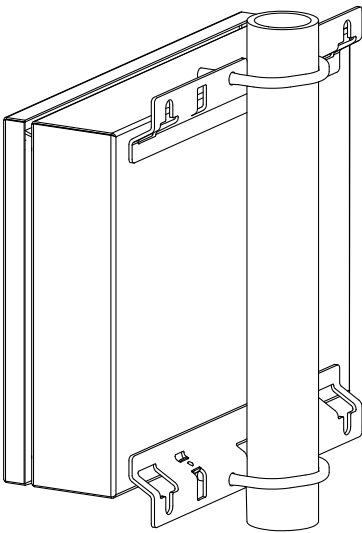
2" pipe mounting kit

*72***.****A



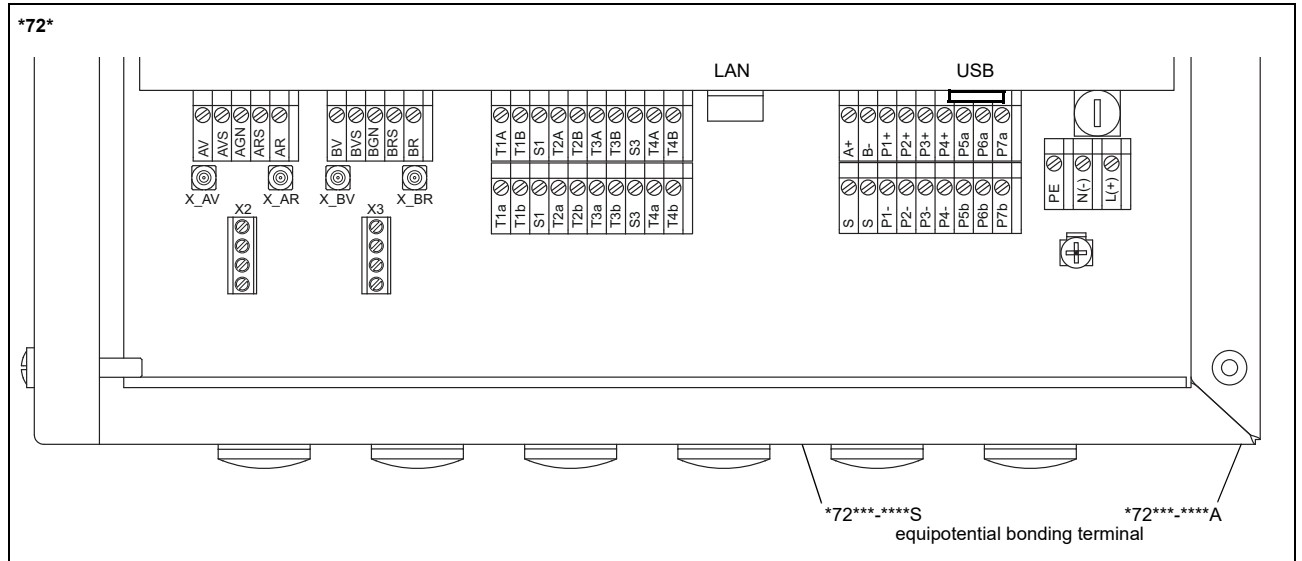
order code:
ACC-PE-*721-/PMK4

*72***.****S



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

Terminal assignment



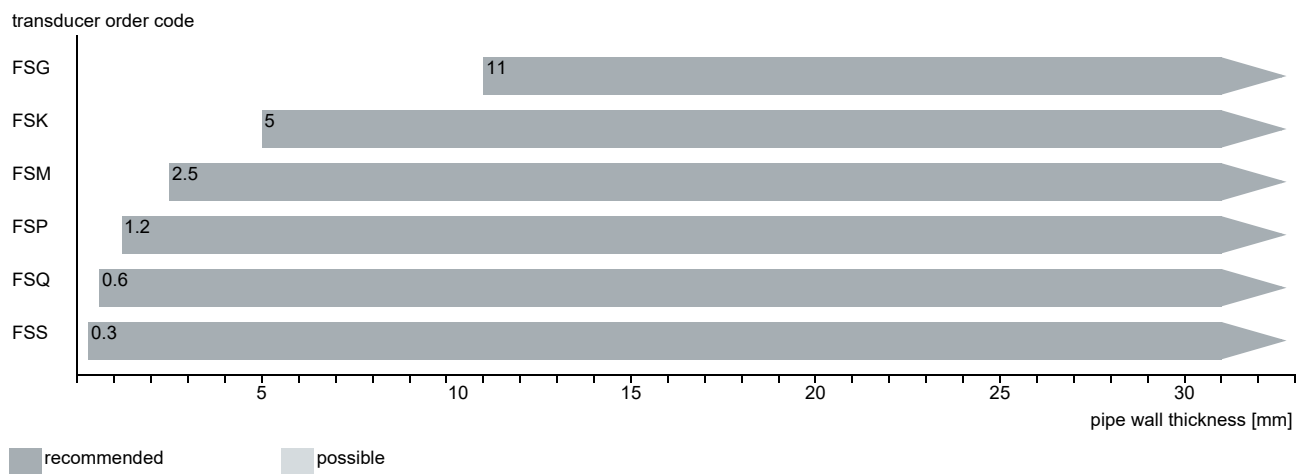
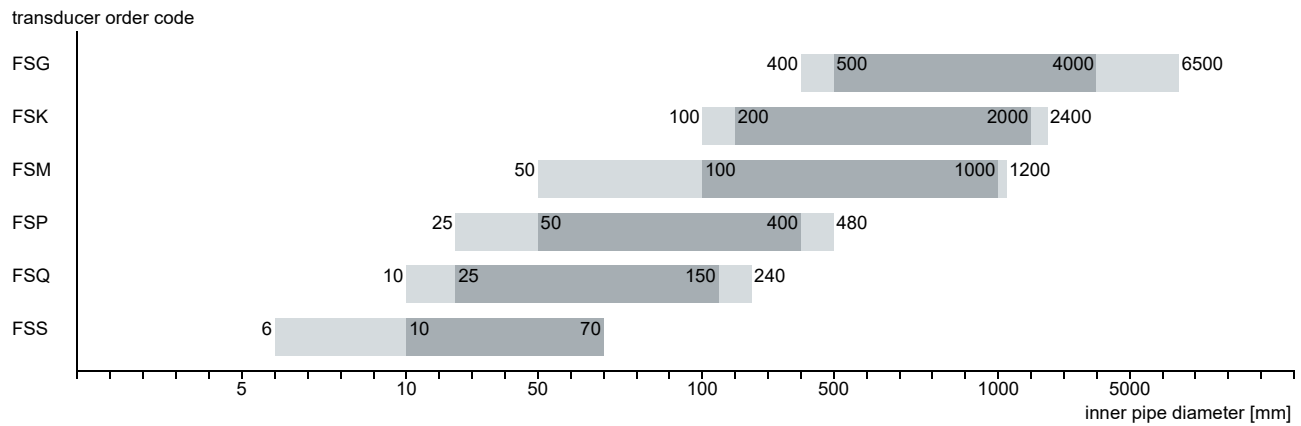
power supply ¹							
terminal		connection (AC)			connection (DC)		
PE		earth			earth		
N(-)		neutral			-		
L(+)		phase			+		
transducers							
transducer cable (transducers *****8*, ****LI*), extension cable				transducer cable (transducers *****52)			
measuring channel A		measuring channel B			measuring 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							
terminal		connection		terminal	connection		communication interface
P1+...P4+ P1-...P4-		current output, voltage output, frequency output, binary output (Reed relay), HART (P1)		A+	signal +		• Modbus RTU ¹ • Profibus PA ¹ • FF H1 ¹
				B-	signal -		
P5a...P7a P5b...P7b		binary output (optorelay), digital output		101	shield		
				USB	type B Hi-Speed USB 2.0 Device		• service (FluxDiag/FluxDiagReader)
				LAN	RJ45 10/100 Mbps Ethernet		• service (FluxDiag/FluxDiagReader) • 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

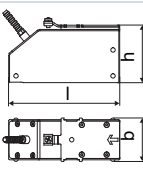
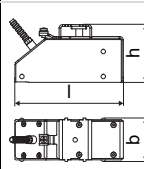
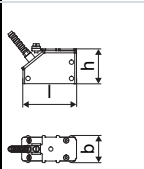

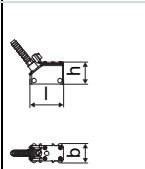
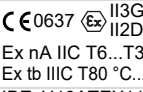



Transducer order code

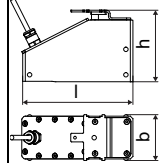
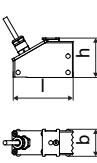
1, 2	3	4	5, 6	7, 8	9...11	no. of character	
transducer	transducer frequency	-	ambient temperature	explosion protection	connection system	-	extension cable
						/	option
							description
FS							set of ultrasonic flow transducers for liquids measurement, shear wave
	G						0.2 MHz
	K						0.5 MHz
	M						1 MHz
	P						2 MHz
	Q						4 MHz
	S						8 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)

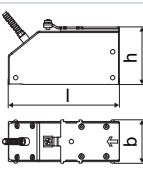
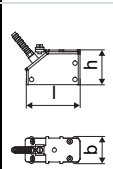
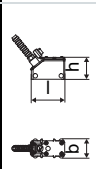


order code		FSG-N**TS/**	FSK-N**TS/**	FSM-N**TS/**	FSP-N**TS/**	FSQ-N**TS/**	FSS-N**TS/**	
technical type		C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52	CDS1N52	
transducer frequency	MHz	0.2	0.5	1	2	4	8	
inner pipe diameter d								
min. extended	mm	400	100	50	25	10	6	
min. recommended	mm	500	200	100	50	25	10	
max. recommended	mm	4000	2000	1000	400	150	70	
max. extended	mm	6500	2400	1200	480	240	70	
pipe wall thickness								
min.	mm	11	5	2.5	1.2	0.6	0.3	
material								
housing		PEEK with stainless steel cover 304 (1.4301), ***-*****/OS: 316L (1.4404)					stainless steel 304 (1.4301)	
contact surface		PEEK					PEI	
degree of protection		IP67					IP65	
transducer cable								
type		1699						
length	m	5		4	3		2	
length (**-*****/LC)	m	9						-
dimensions								
length l	mm	129.5	126.5	64	40		25	
width b	mm	51	51	32	22		13	
height h	mm	67	67.5	40.5	25.5		17	
dimensional drawing								
weight (without cable)	kg	0.47	0.36	0.066	0.016		0.004	
pipe surface temperature								
min.	°C	-40					-30	
max.	°C	+130					+130	
ambient temperature								
min.	°C	-40					-30	
max.	°C	+130					+130	
temperature compensation		x					-	
explosion protection								
• ATEX/IECEx								
order code		FSG-NA2TS/**	FSK-NA2TS/**	FSM-NA2TS/**	FSP-NA2TS/**	FSQ-NA2TS/**	-	
pipe surface temperature (Ex)								
• min.	°C	-55					-	
• max.	°C	gas: +190, dust: +180					-	
marking		 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/**	FSS-NF2TS/**	
pipe surface temperature (Ex)								
• min.	°C	-40					-	
• max.	°C	+125		+190		+125		
degree of protection		IP66						
marking		 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		CDG1LI8	CDK1LI8	CDM2LI8	CDP2LI8
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

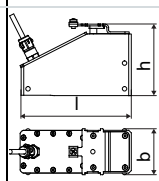
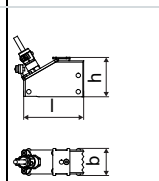

² pipe surface temperature +200...+240 °C: Variofix C without cover

³ pipe surface temperature max. +200 °C

Shear wave transducers (zone 1, T1)

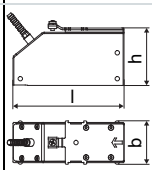
order code		FSG-N*1T1/**	FSK-N*1T1/**	FSM-N*1T1/**	FSP-N*1T1/**	FSQ-N*1T1/**
technical type		C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81
transducer frequency	MHz	0.2	0.5	1	2	4
inner pipe diameter d						
min. extended	mm	400	100	50	25	10
min. recommended	mm	500	200	100	50	25
max. recommended	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)

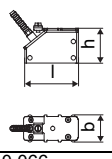
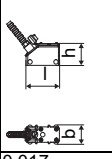

order code		FSG-N*1T1/IP68	FSK-N*1T1/IP68	FSM-N*1T1/IP68	FSP-N*1T1/IP68
technical type		CDG1L11	CDK1L11	CDM2L11	CDP2L11
transducer frequency	MHz	0.2	0.5	1	2
inner pipe diameter d					
min. extended	mm	400	100	50	25
min. recommended	mm	500	200	100	50
max. recommended	mm	4000	2000	1000	400
max. extended	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  II2G II2D Ex q IIC T6...T5 Gb Ex tb IIC 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		

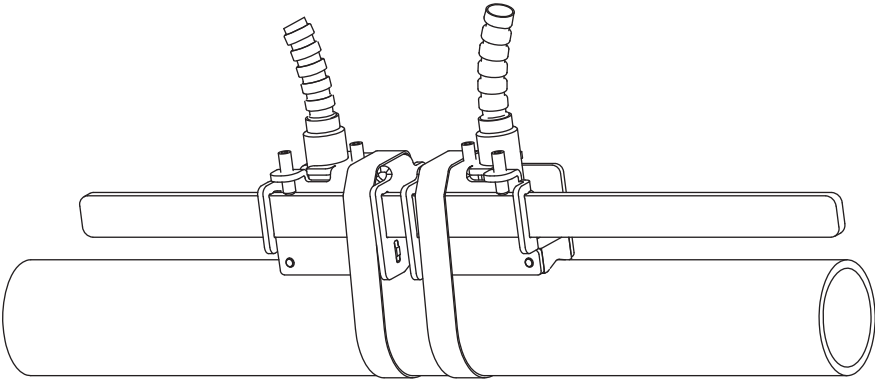
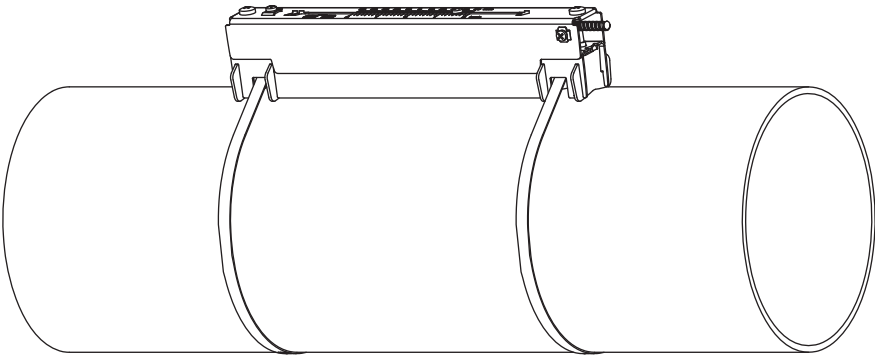
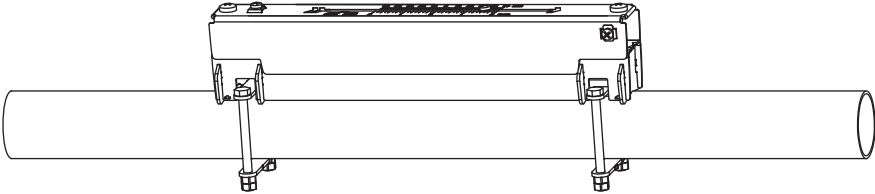
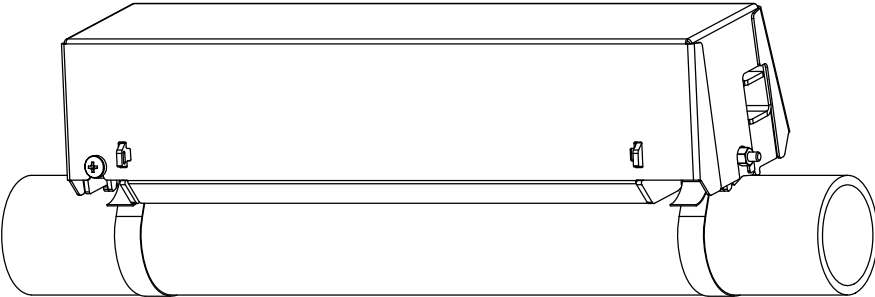
¹ > +200 °C :
 Variofix L or Variofix C
 observe the insulation instruction
 ambient temperature max. +40 °C

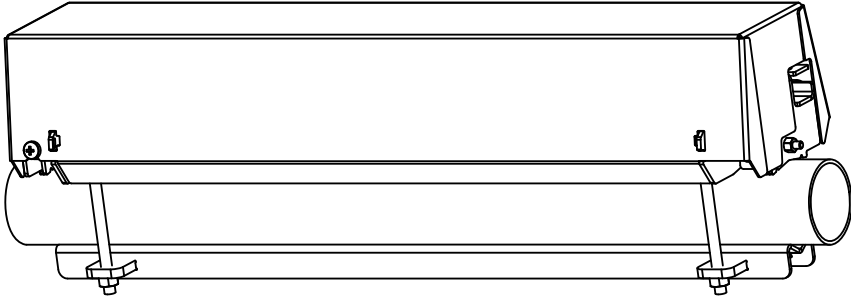
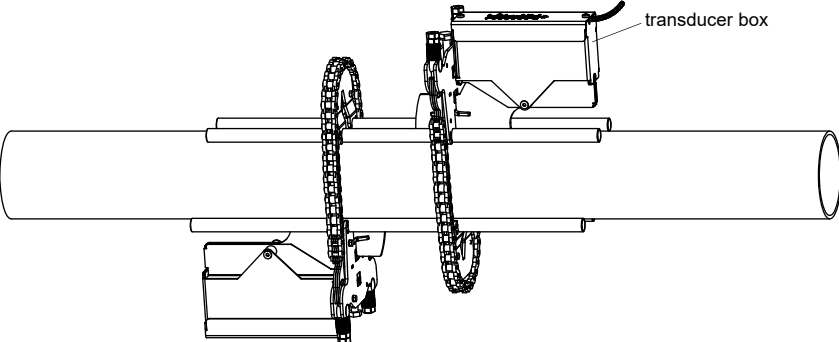
² pipe surface temperature max. +200 °C

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
	S					transducers with transducer frequency S
		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

<p>Variofix L (VLS)</p> 	<p>transducer frequency: S material: stainless steel 304 (1.4301), 303 (1.4305)</p>
<p>Variofix L (VLK, VLM, VLQ)</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: 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>
<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 VCQ: 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 VCQ: 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 VCQ: 250 mm dimensions: VCM: 460 x 96 x 82 mm VCQ: 310 x 85 x 71 mm outer pipe diameter: VCM: max. 46 mm VCQ: max. 36 mm</p>
<p>transducer box WI for WaveInjector</p> 	<p>see Technical specification TSWaveInjectorVx-x</p>

Coupling materials for transducers

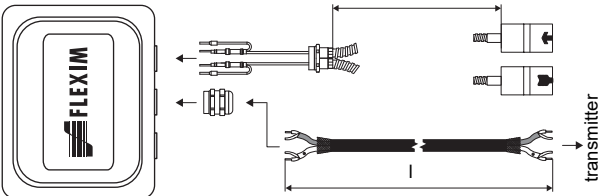
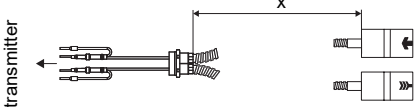
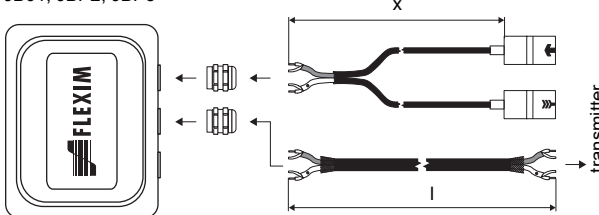
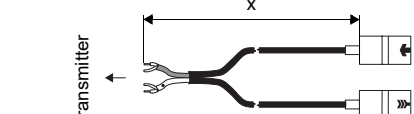
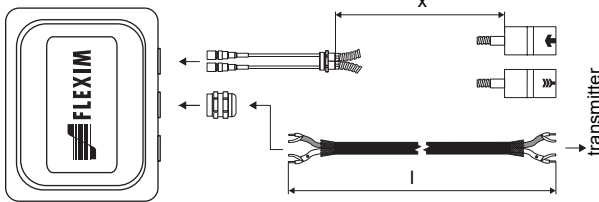
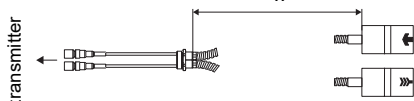
	normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)			WaveInjector WI-400	
	< 100 °C	< 170 °C	< 150 °C	< 200 °C	200...240 °C	< 280 °C	280...400 °C
< 24 h	coupling compound type N or coupling foil type VT	coupling 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>****L*</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	x	x	x
*(DR)***8*	m	5	4	3	-
option LC: *(LT)***8*	m	9	9	9	-
*(DR)***5*	m	5	4	3	2
option LC: *(LT)***5*	m	9	9	9	-
option IP68: ****L*	m	12	12	-	-

x - transducer cable length

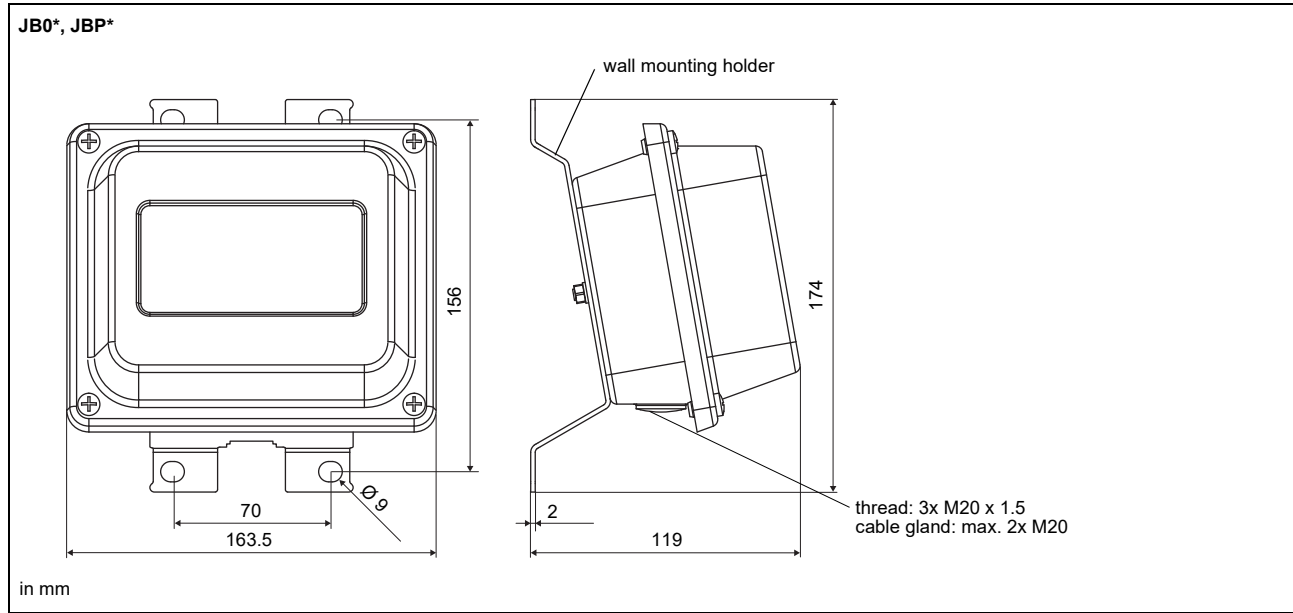
l - max. length of extension cable (depending on the application)

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		NI/CI, I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C	
Connection			
Transducers			
terminal strip	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

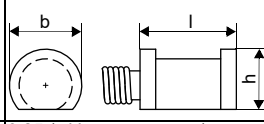
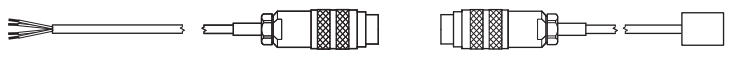
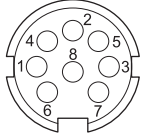


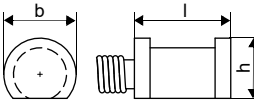
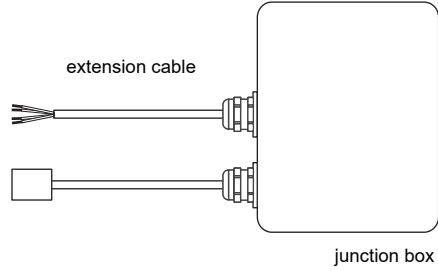
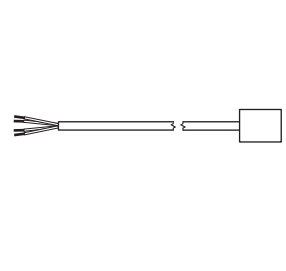




2" pipe mounting kit

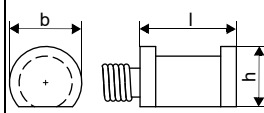

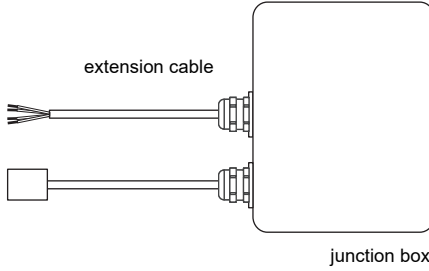
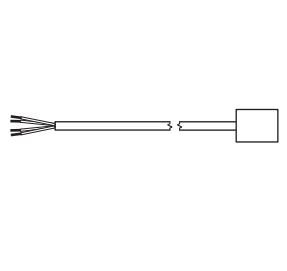
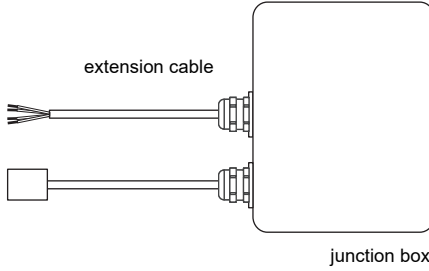
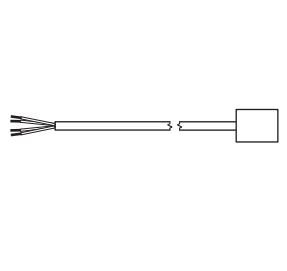
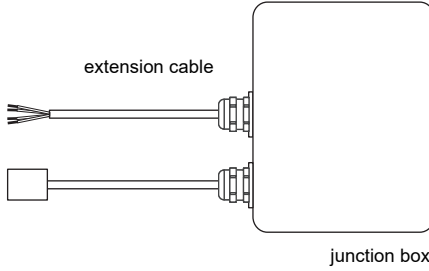
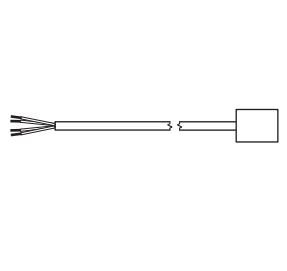














Clamp-on temperature probe (optional)

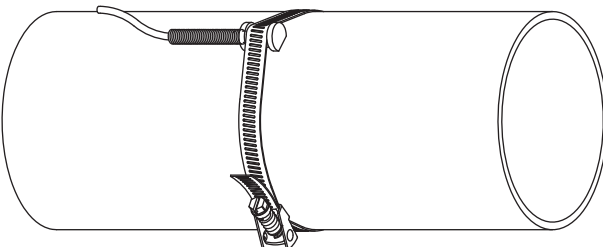
Technical data

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		$\pm(0.15 \text{ }^\circ\text{C} + 2 \cdot 10^{-3} \cdot T \text{ [}^\circ\text{C]})$ 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} , $T_1 = 25 \text{ }^\circ\text{C}$, $T_2 = 60 \text{ }^\circ\text{C}$)	
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


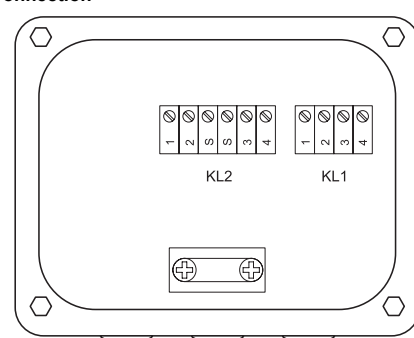
PT12N		
order code	<ul style="list-style-type: none"> ACC-PE-GNNN-/T312 ACC-PE-GNNN-/T512 (matched) 	
design	clamp-on	
type	Pt100	
connection	4-wire	
measuring range	°C -30...+250	
accuracy T	±(0.15 °C + 2 · 10 ⁻³ · T [°C]) class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)	≤ 0.1 K (3 K < ΔT < 6 K), more corresponding to EN 1434-1	
response time	s	50 (t ₅₀ , T ₁ = 25 °C, T ₂ = 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																															
<table border="1"> <thead> <tr> <th>connection with extension cable</th> <th>direct connection</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table>		connection with extension cable	direct connection																												
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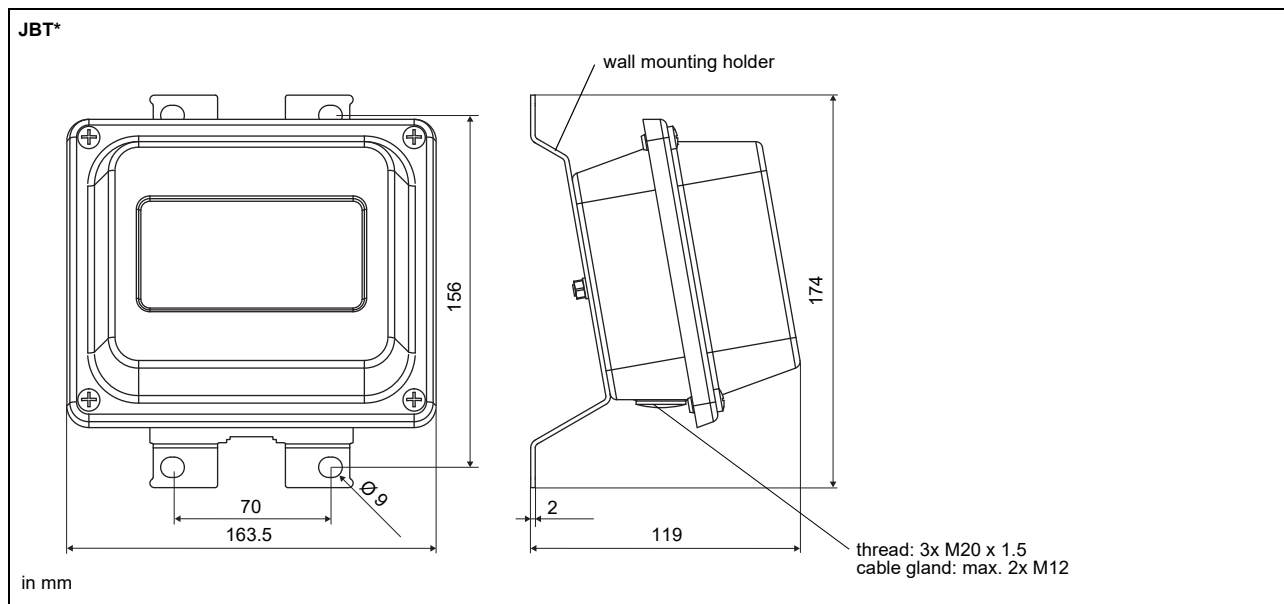
Fixation

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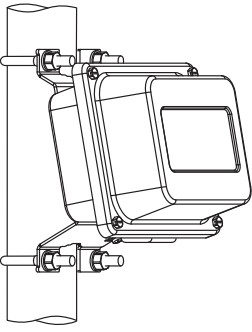
Junction box

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 IIIC 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

<p>JB**</p> 	<p>order code: ACC-PE-GNNN-JBPMK4</p>
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Errors excepted.

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