FLEXIM

Technical specification

FLUXUS F721

Permanently installed ultrasonic flowmeter for liquids

Transmitter for permanent outdoor wall or pipe mounting

Features

- Exact and highly reliable bidirectional clamp-on volume and mass flow measurement
- Installation and startup do not require any pipe work nor any process interruptions
- High measurement accuracy even at very low as well as very high flow rates and independent of the flow direction (bidirectional)
- Possibility to measure thermal energy quantities using clamp-on or inline temperature probes
- Automatic loading of calibration data and transducer recognition
- Bidirectional communication and support of common bus technologies (Profibus PA, Foundation Fieldbus, HART, Modbus, BACnet)
- 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 -274 to +1112 °F
- The measurement is zero point stable, drift free and independent of pipe material, process pressure, process temperature and process fluid

Applications

- Chemical industry
- Petrochemical industry
- Oil and gas industry
- Pharmaceutical industry
- Semiconductor industry
- Manufacturing industries
- Building technology/energy management
- Water and wastewater industry
- Mining industries

FLUXUS F721**-****A

FLUXUS F721**-****S

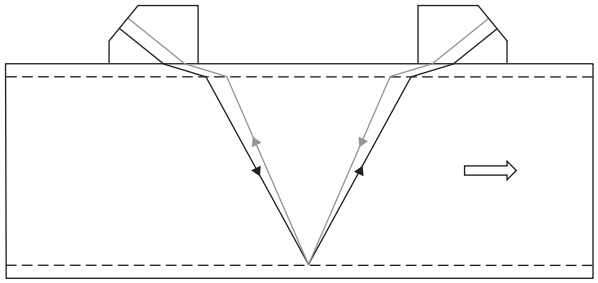
PermaRail

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.

Path of the ultrasonic signal in the flowing fluid



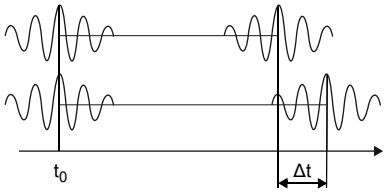
Transit time difference principle

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.

Transit time difference Δt



HybridTrek

If the gaseous or solid content in the fluid increases occasionally during measurement, a measurement with the transit time difference principle may no longer be possible. NoiseTrek mode will then be selected by the flowmeter. This measurement method allows the flowmeter to achieve a stable measurement even with high gaseous or solid content.

The transmitter can switch automatically between transit time and NoiseTrek mode without any changes to the measurement setup.

Calculation of volumetric flow rate

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

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_γ - average of transit times in the fluid

Number of sound paths

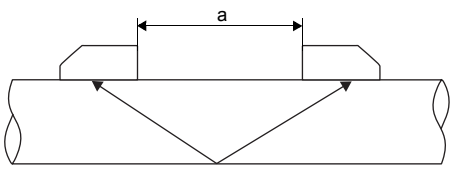
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **reflect 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 easier.
- **diagonal arrangement**
  The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe.
- **direct mode**
  Diagonal arrangement with 1 sound path. This should be used in the case of a high signal attenuation by the fluid, pipe or coatings.

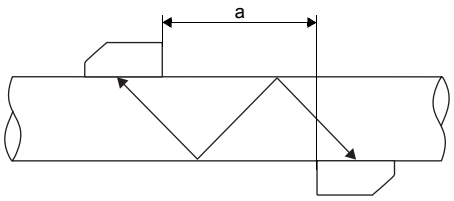
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

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

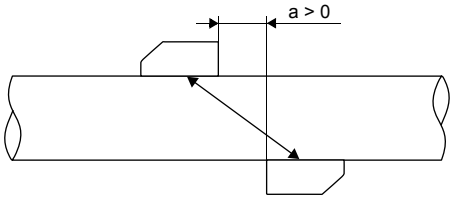
Reflect arrangement, number of sound paths: 2



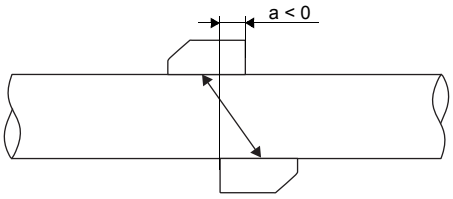
Diagonal arrangement, number of sound paths: 3



Direct mode, number of sound paths: 1



Direct mode, number of sound paths: 1, negative transducer distance



a - transducer distance

Transmitter

Technical data

		FLUXUS F721**-NN0*A	FLUXUS F721**-NN0*S	FLUXUS F721**-A20*S	FLUXUS F721**-F20*S
					
design		standard field device nonEx	field device with stainless steel housing nonEx	field device with stainless steel housing zone 2	field device with stainless steel housing FM Class I Div. 2
measurement					
measurement principle		transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content			
flow velocity	ft/s	0.03 to 82			
repeatability		0.15 % of reading ±0.03 ft/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[1]					
with calibration traceable to NIST		±1.2 % of reading ±0.03 ft/s			
with field calibration[2]		±0.5 % of reading ±0.03 ft/s			
transmitter					
power supply		• 100 to 230 V/50 to 60 Hz or • 20 to 32 V DC or • 11 to 16 V DC			
power consumption	W	< 15			
number of measuring channels		1, optional: 2			
damping	s	0 to 100 (adjustable)			
measuring cycle	Hz	100 to 1000 (1 channel)			
response time	s	1 (1 channel), option: 0.02			
housing material		aluminum, powder coated	stainless steel 316L		
degree of protection		IP65	IP65	IP66	IP65
dimensions	in	see dimensional drawing			
weight	lb	11.9	11.2		
fixation		wall mounting, optional: 2" pipe mounting			
ambient temperature	°F	-4 to +131/140 °F	-4 to +131/140 °F	-40 to +140 °F (< -4 °F without operation of the display)	-4 to +131/140 °F
display		128 x 64 dots, backlight			
menu language		English, German, French, Spanish, Dutch, Russian, Polish, Turkish			
explosion protection					
• ATEX/IECEx					
marking		-	-	CE 0637 Ex II3G II2D Ex nA nC ic IIC T4 Gc Ex tb IIIC T 120 °C Db T_a -40 to +60 °C	-
certification ATEX		-	-	IBExU11ATEX1015	-
certification IECEx		-	-	IECEx IBE 11.0008	-
• FM					
marking		-	-	-	F703Z2**1, F703Z2**2: FM APPROVED NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 Ta = 60 °C F703Z2**9: FM APPROVED NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A Ta = 55 °C

[1] for transit time difference principle, reference conditions and v > 0.49 ft/s

[2] reference uncertainty < 0.2 %

[3] outside of explosive atmosphere (housing cover open)

[4] with inputs and including parametrization of the transmitter

		FLUXUS F721**-NN0*A	FLUXUS F721**-NN0*S	FLUXUS F721**-A20*S	FLUXUS F721**-F20*S
measuring functions					
physical quantities		volumetric flow rate, mass flow rate, flow velocity, thermal energy rate (if temperature inputs are installed)			
totalizer		volume, mass, optional: thermal energy			
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, parametrization of the transmitter: • USB[3] • LAN[3]			
process interfaces		max. 1 option: • RS485 (ASCII sender) • Modbus RTU[4] • BACnet MS/TP • HART[4] • Profibus PA[4] • FF H1[4] • Modbus TCP[4] • BACnet IP	max. 1 option: • RS485 (ASCII sender) • Modbus RTU[4] • BACnet MS/TP • HART[4] • Profibus PA[4] • FF H1[4] • Modbus TCP[4] • BACnet IP	max. 1 option: • RS485 (ASCII sender) • Modbus RTU[4] • BACnet MS/TP • HART[4] • Profibus PA[4] • FF H1[4] • Modbus TCP[4] • BACnet IP	
accessories					
serial data kit		USB cable[3]			
software		• FluxDiagReader: download of measured values and parameters, graphical presentation • FluxDiag (optional): download of measurement data, graphical presentation, report generation, parametrization of the transmitter			
data logger					
loggable values		all physical quantities, totalized values and diagnostic values			
capacity		max. 800 000 measured values			
outputs					
		The outputs are galvanically isolated from the transmitter.			
number		on request			
• switchable current output					
		The switchable current outputs are menu selectable all together as passive or active.			
range	mA	4 to 20 (3.2 to 22)			
accuracy		0.04 % of reading ±3 µA			
active output		R_{ext} < 350 Ω			
passive output		U_{ext} = 8 to 30 V, depending on R_{ext} (R_{ext} < 1 kΩ at 30 V)			
• HART					
range	mA	4 to 20			
accuracy		0.1 % of reading ±15 µA			
active output		U_{int} = 24 V, R_{ext} < 500 Ω			
passive output		U_{ext} = 10 to 24 V DC, depending on R_{ext} (R_{ext} < 1 kΩ at 24 V)			
• voltage output					
range	V	0 to 1 or 0 to 10			
accuracy		0 to 1 V: 0.1 % of reading ±1 mV 0 to 10 V: 0.1 % of reading ±10 mV			
internal resistance		R_{int} = 500 Ω			
• frequency output					
range	kHz	0 to 5			
optorelay		24 V/4 mA, R_{int} = 66.5 Ω			
• binary output					
optorelay		26 V/100 mA, R_{int} = 22 Ω			
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 totalizing			
• pulse value	units	0.01 to 1000			
• pulse width	ms	optorelay: 1 to 1000 Reed relay: 80 to 1000			

[1] for transit time difference principle, reference conditions and v > 0.49 ft/s

[2] reference uncertainty < 0.2 %

[3] outside of explosive atmosphere (housing cover open)

[4] with inputs and including parametrization of the transmitter

		FLUXUS F721**-NN0*A	FLUXUS F721**-NN0*S	FLUXUS F721**-A20*S	FLUXUS F721**-F20*S
inputs					
		The inputs are galvanically isolated from the transmitter.			
number		max. 4, on request			
• temperature input					
type		Pt100/Pt1000			
connection		4-wire			
range	°F	-238 to +1040			
resolution	K	0.01			
accuracy		±0.01 % of reading ±0.03 K			
• current input					
accuracy		0.1 % of reading ±10 µA			
active input • range	 mA	U_{int} = 24 V, R_{int} = 50 Ω, P_{int} < 0.5 W, not short-circuit proof 0 to 20			
passive input • range	 mA	R_{int} = 50 Ω, P_{int} < 0.3 W -20 to +20			
• voltage input					
range	V	0 to 1			
accuracy		0.1 % of reading ±1 mV			
internal resistance		R_{int} = 1 MΩ			
• binary input					
switching signal		5 to 30 V, 1 mA	5 to 30 V, 1 mA		5 to 26 V, 1 mA
functions		• resetting the measured values • resetting the totalizers • stopping the totalizers • activation of the measuring mode for highly dynamic flows			

[1] for transit time difference principle, reference conditions and v > 0.49 ft/s

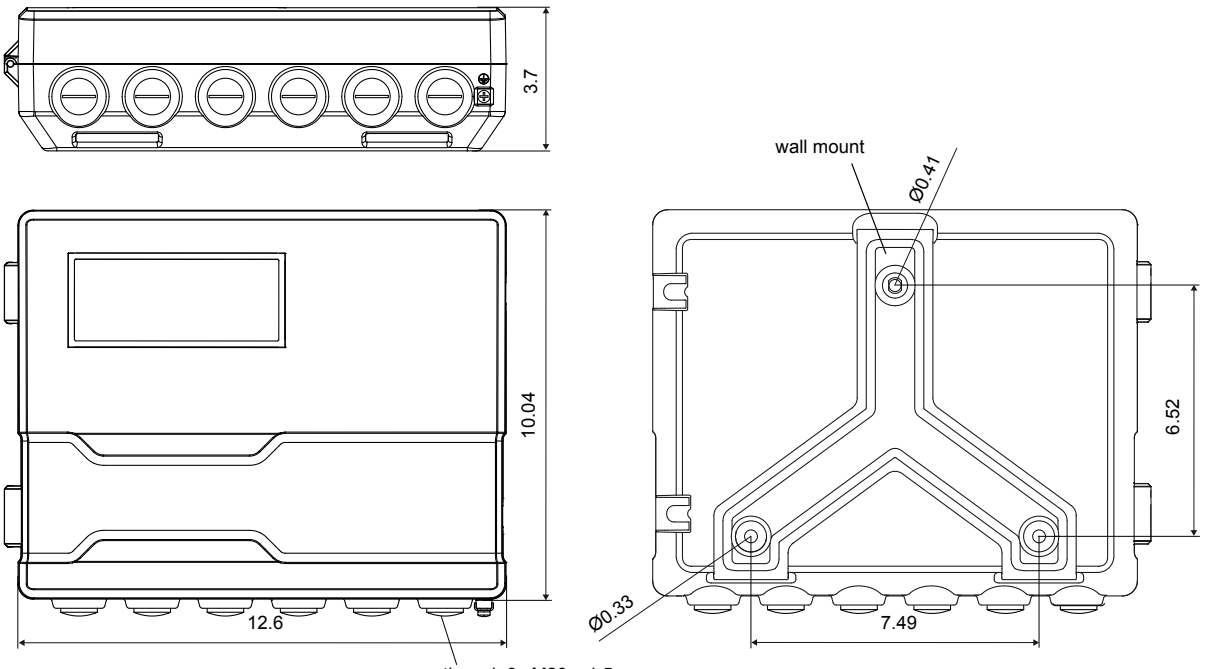
[2] reference uncertainty < 0.2 %

[3] outside of explosive atmosphere (housing cover open)

[4] with inputs and including parametrization of the transmitter

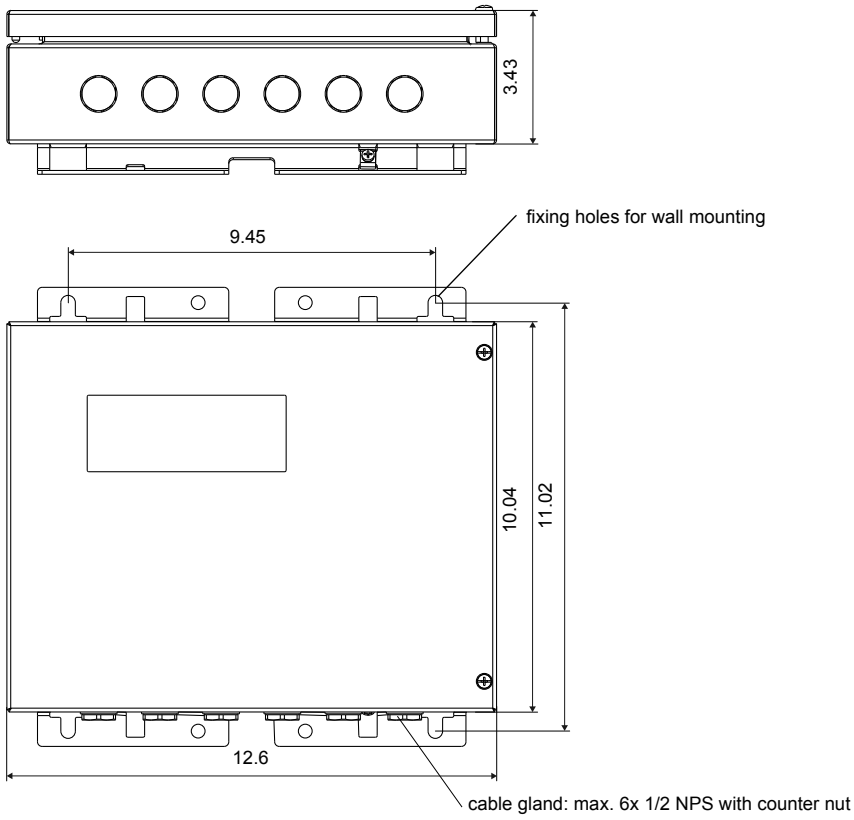
Dimensions

721**-*A**



in inch

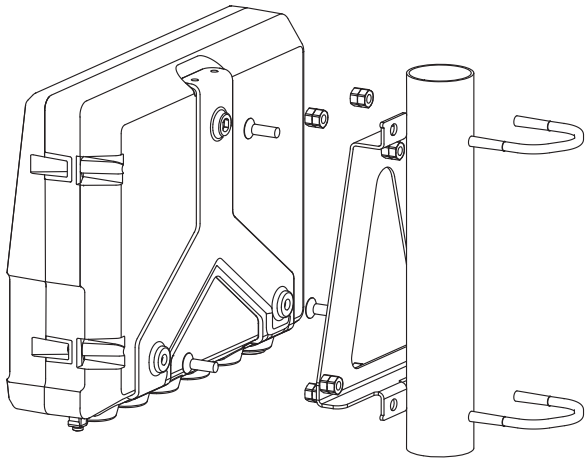
721**-*S**



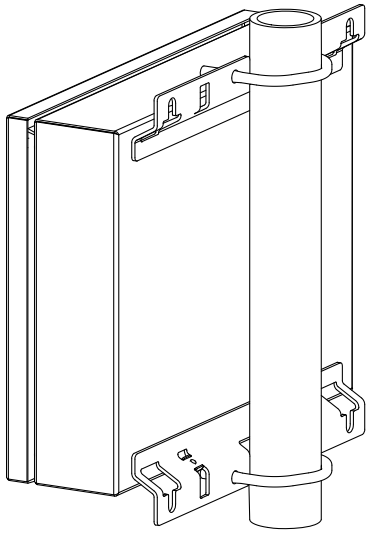
in inch

2" pipe mounting kit

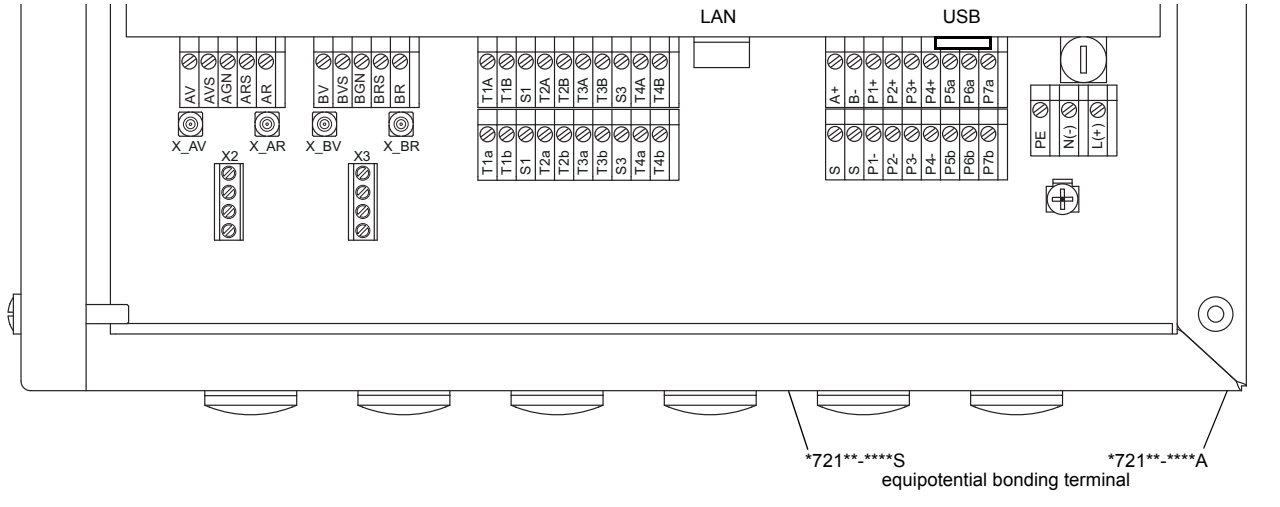
721**-*A**



721**-*S**



Terminal assignment



power supply[1]		
terminal	**connection (AC)**	**connection (DC)**
PE	earth	earth
N(-)	neutral	-
L(+)	phase	+

transducers							
transducer cable (transducers ****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**		**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+ to P4+ P1- to 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]
		B-	signal -	
P5a to P7a P5b to P7b	binary output (optorelay)	S	shield	
		USB	type B	• service (FluxDiag/ FluxDiagReader)
		LAN	RJ45	• service (FluxDiag/ FluxDiagReader) • BACnet IP • Modbus TCP

analog inputs[1, 2]						
	temperature probe				**passive sensor**	**active sensor**
terminal	**with connector**		**without connector**		**connection**	**connection**
	direct connection	**connection with extension cable**	**direct connection**	**connection with extension cable**		
T1a to T4a	red	red	red	white	not connected	not connected
T1A to T4A	red/blue	gray	red	black	-	+
T1b to T4b	white/blue	blue	white	red	+	not connected
T1B to T4B	white	white	white	green	not connected	-
S1, S3	shield	shield	-	-	not connected	not connected

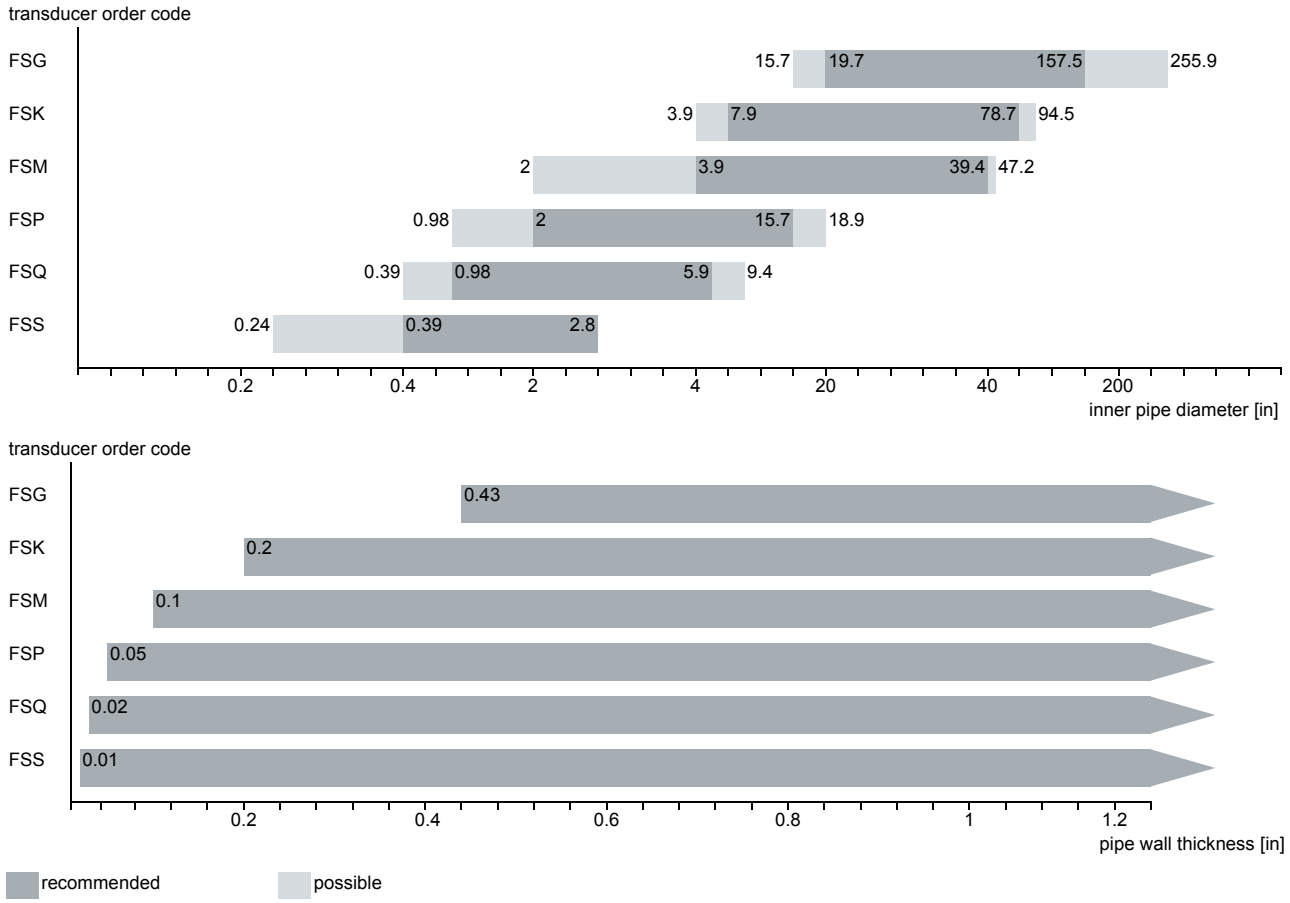
Binary inputs[1, 2]
terminal
P1+ to P2+, P1- to P2-

[1] cable (by customer):
- e.g., flexible leads, with insulated wire end ferrules, lead cross sectional area: AWG14 to 24
- outer diameter of the cable (*721**-****S with ferrite nut): max. 0.3 in

[2] The number, type and terminal assignment will be customized.

Transducers

Transducer selection

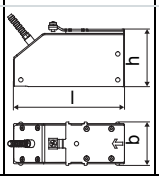
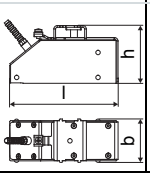
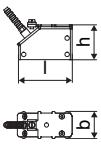
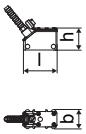
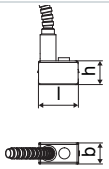


Transducer order code

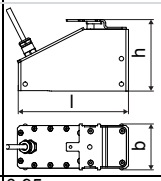
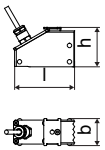
1, 2	3		4	5, 6	7, 8		9 to 11			no. of character
transducer	**transducer frequency**	**-**	**ambient temperature**	**explosion protection**	**connection system**	**-**	**extension cable**	**/**	**option**	**description**
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	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					direct connection or connection via junction box
							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)

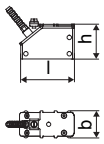
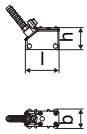
order code		FSG-N**TS/**	FSK-N**TS/**	FSM-N**TS/**	FSP-N**TS/**	FSQ-N**TS/**	FSS-N**TS/**
technical type		C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52	CDS1N52
transducer frequency	MHz	0.2	0.5	1	2	4	8
inner pipe diameter d							
min. extended	in	15.7	3.9	2	0.98	0.39	0.24
min. recommended	in	19.7	7.9	3.9	2	0.98	0.39
max. recommended	in	157.5	78.7	39.4	15.7	5.9	2.8
max. extended	in	255.9	94.5	47.2	18.9	9.4	2.8
pipe wall thickness							
min.	in	0.43	0.2	0.1	0.05	0.02	0.01
material							
housing		PEEK with stainless steel cap 304, ***-*****/OS: 316L		PEEK with stainless steel cap 304, ***-*****/OS: 316L			stainless steel 304
contact surface		PEEK		PEEK			PEI
degree of protection		NEMA 6		NEMA 6			NEMA 4
transducer cable							
type		1699		1699			1699
length	ft	16		13		9	6
length (***-*****/LC)	ft	29		29		29	-
dimensions							
length l	in	5.1	4.98	2.52		1.57	0.98
width b	in	2.01	2.01	1.26		0.87	0.51
height h	in	2.64	2.66	1.59		1	0.67
dimensional drawing							
weight (without cable)	lb	1	0.79	0.15		0.04	0.01
ambient temperature							
min.	°F	-40		-40			-22
max.	°F	+266		+266			+266
temperature compensation		x					-
explosion protection							
• ATEX/IECEx							
order code		FSG-NA2TS/**	FSK-NA2TS/**	FSM-NA2TS/**	FSP-NA2TS/**	FSQ-NA2TS/**	-
explosion protection temperature (pipe surface)							
• min.	°C	-55		-55			-
• max.	°C	gas: +190, dust: +180		gas: +190, dust: +180			-
marking		CE 0637 Ex II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db		CE 0637 Ex II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db			-
certification ATEX		IBExU10ATEX1163 X		IBExU10ATEX1163 X			-
certification IECEx		IECEx IBE 12.0005X		IECEx IBE 12.0005X			-
• FM							
order code		FSG-NF2TS/**	FSK-NF2TS/**	FSM-NF2TS/**	FSP-NF2TS/**	FSQ-NF2TS/**	FSS-NF2TS/**
explosion protection temperature							
• min.	°F	-40		-40			-40
• max.	°F	+257		+374			+257
degree of protection		IP66		IP66			IP66
marking		FM APPROVED NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		FM APPROVED NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860			FM APPROVED NI/Cl. I,II,III/ Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860

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

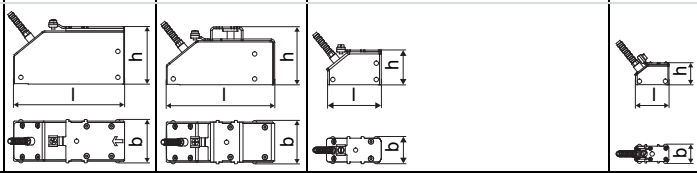
order code		FSG-N**TS/IP68	FSK-N**TS/IP68	FSM-N**TS/IP68	FSP-N**TS/IP68
technical type		CDG1LI8	CDK1LI8	CDM2LI8	CDP2LI8
transducer frequency	MHz	0.2	0.5	1	2
inner pipe diameter d					
min. extended	in	15.7	3.9	2	0.98
min. recommended	in	19.7	7.9	3.9	2
max. recommended	in	157.5	78.7	39.4	15.7
max. extended	in	255.9	94.5	47.2	18.9
pipe wall thickness					
min.	in	0.43	0.2	0.1	0.05
material					
housing		PEEK with stainless steel cap 316Ti			
contact surface		PEEK			
degree of protection		IP68[1]			
transducer cable					
type		2550			
length	ft	39			
dimensions					
length l	in	5.12		2.76	
width b	in	2.13		1.26	
height h	in	3.29		1.81	
dimensional drawing					
weight (without cable)	lb	0.95		0.19	
ambient temperature					
min.	°F	-40			
max.	°F	+212			
temperature compensation		x			
explosion protection					
• **ATEX/IECEx**					
order code		FSG-NA2TS/IP68	FSK-NA2TS/IP68	FSM-NA2TS/IP68	FSP-NA2TS/IP68
explosion protection temperature (pipe surface)					
• min.	°C	-40			
• max.	°C	gas: +90, dust: +80			
marking		CE 0637 Ex II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db			
certification ATEX		IBExU10ATEX1163 X			
certification IECEx		IECEx IBE 12.0005X			

[1] test conditions: 3 months/29 psi (65 ft)/36 °F

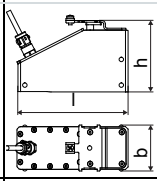
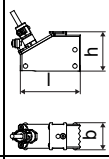
Shear wave transducers (zone 2 - FM Class I Div. 2 - nonEx, TS, extended temperature range)

order code		FSM-E**TS/**	FSP-E**TS/**	FSQ-E**TS/**
technical type		C(DL)M2E52	C(DL)P2E52	C(DL)Q2E52
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	47.2	18.9	9.4
pipe wall thickness				
min.	in	0.1	0.05	0.02
material				
housing		PI with stainless steel cap 304, ***-*****/OS: 316L		
contact surface		PI		
degree of protection		NEMA 4		
transducer cable				
type		6111		
length	ft	13		9
length (***-*****/LC)	ft	29		
dimensions				
length l	in	2.52		1.57
width b	in	1.26		0.87
height h	in	1.59		1
dimensional drawing				
weight (without cable)	lb	0.15		0.04
ambient temperature				
min.	°F	-22		
max.	°F	+392		
temperature compensation		x		
explosion protection				
• ATEX/IECEx				
order code		FSM-EA2TS/**	FSP-EA2TS/**	FSQ-EA2TS/**
explosion protection temperature (pipe surface)				
• min.	°C	-45		
• max.	°C	gas: +235, dust: +225		
marking		CE 0637 Ex II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIA TX Db		
certification ATEX		IBExU10ATEX1163 X		
certification IECEx		IECEx IBE 12.0005X		
• FM				
order code		FSM-EF2TS/**	FSP-EF2TS/**	FSQ-EF2TS/**
explosion protection temperature				
• min.	°F	-40		
• max.	°F	+455		
degree of protection		IP66		
marking		FM APPROVED NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		

Shear wave transducers (zone 1, TS)

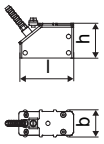
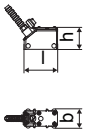
order code		FSG-N*1TS/**	FSK-N*1TS/**	FSM-N*1TS/**	FSP-N*1TS/**	FSQ-N*1TS/**
technical type		C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81
transducer frequency	MHz	0.2	0.5	1	2	4
inner pipe diameter d						
min. extended	in	15.7	3.9	2	0.98	0.39
min. recommended	in	19.7	7.9	3.9	2	0.98
max. recommended	in	157.5	78.7	39.4	15.7	5.9
max. extended	in	255.9	94.5	47.2	18.9	9.4
pipe wall thickness						
min.	in	0.43	0.2	0.1	0.05	0.02
material						
housing		PEEK with stainless steel cap 304 , ***-*****/OS: 316L				
contact surface		PEEK				
degree of protection		IP65	IP66			IP65
transducer cable						
type		1699				
length	ft	16		13		9
length (***-*****/LC)	ft	29				
dimensions						
length l	in	5.1	4.98	2.52		1.57
width b	in	2.01	2.01	1.26		0.87
height h	in	2.64	2.66	1.59		1
dimensional drawing						
weight (without cable)	lb	1	0.79	0.15		0.04
ambient temperature						
min.	°F	-40				
max.	°F	+266				
temperature compensation		x				
explosion protection						
• **ATEX/IECEx**						
order code		FSG-NA1TS/**	FSK-NA1TS/**	FSM-NA1TS/**	FSP-NA1TS/**	FSQ-NA1TS/**
explosion protection temperature (pipe surface)						
• min.	°C	-55				
• max.	°C	+180				
marking		CE 0637 Ex II2G II2D Ex q IIC T6...T3 Gb Ex tb IIIC TX Db				
certification ATEX		IBExU07ATEX1168 X				
certification IECEx		IECEx IBE 08.0007X				

Shear wave transducers (zone 1, TS, IP68)

order code		FSG-N*1TS/IP68	FSK-N*1TS/IP68	FSM-N*1TS/IP68	FSP-N*1TS/IP68
technical type		CDG1LI1	CDK1LI1	CDM2LI1	CDP2LI1
transducer frequency	MHz	0.2	0.5	1	2
inner pipe diameter d					
min. extended	in	15.7	3.9	2	0.98
min. recommended	in	19.7	7.9	3.9	2
max. recommended	in	157.5	78.7	39.4	15.7
max. extended	in	255.9	94.5	47.2	18.9
pipe wall thickness					
min.	in	0.43	0.2	0.1	0.05
material					
housing		PEEK with stainless steel cap 316Ti			
contact surface		PEEK			
degree of protection		IP68[1]			
transducer cable					
type		2550			
length	ft	39			
dimensions					
length l	in	5.12		2.76	
width b	in	2.13		1.26	
height h	in	3.29		1.81	
dimensional drawing					
weight (without cable)	lb	0.95		0.19	
ambient temperature					
min.	°F	-40			
max.	°F	+212			
temperature compensation		x			
explosion protection					
• ATEX/IECEx					
order code		FSG-NA1TS/IP68	FSK-NA1TS/IP68	FSM-NA1TS/IP68	FSP-NA1TS/IP68
explosion protection temperature (pipe surface)					
• min.	°C	-55			
• max.	°C	+180			
marking		CE 0637 Ex II2G II2D Ex q IIC T6...T3 Gb Ex tb IIIC TX Db			
certification ATEX		IBExU07ATEX1168 X			
certification IECEx		IECEx IBE 08.0007X			

[1] test conditions: 3 months/29 psi (65 ft)/36 °F

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

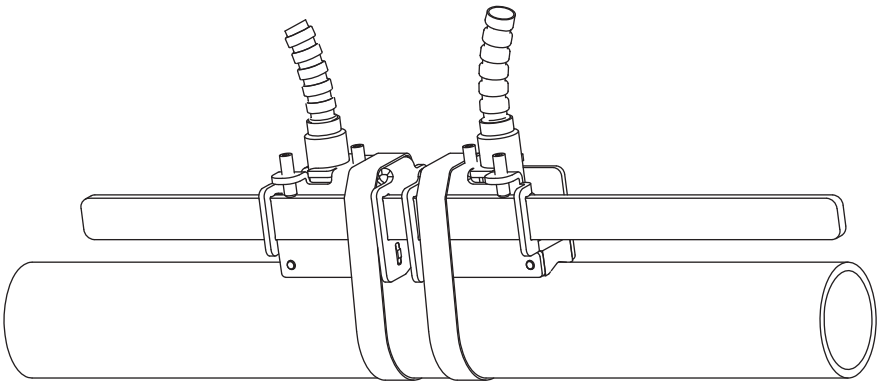
order code		FSM-E*1TS/**	FSP-E*1TS/**	FSQ-E*1TS/**
technical type		C(DL)M2E85	C(DL)P2E85	C(DL)Q2E85
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	47.2	18.9	9.4
pipe wall thickness				
min.	in	0.1	0.05	0.02
material				
housing		PI with stainless steel cap 304, ***-*****/OS: 316L		
contact surface		PI		
degree of protection		IP66		IP56
transducer cable				
type		6111		
length	ft	13		9
length (***-*****/LC)	ft	29		
dimensions				
length l	in	2.52		1.57
width b	in	1.26		0.87
height h	in	1.59		1
dimensional drawing				
weight (without cable)	lb	0.15		0.04
ambient temperature				
min.	°F	-22		
max.	°F	+392		
temperature compensation		x		
explosion protection				
• **ATEX/IECEx**				
order code		FSM-EA1TS/**	FSP-EA1TS/**	FSQ-EA1TS/**
explosion protection temperature (pipe surface)				
• min.	°C	-45		
• max.	°C	+225		
marking		CE 0637 Ex II2G II2D Ex q IIC T6...T2 Gb Ex tb IIIA TX Db		
certification ATEX		IBExU07ATEX1168 X		
certification IECEx		IECEx IBE 08.0007X		

Transducer mounting fixture

Order code

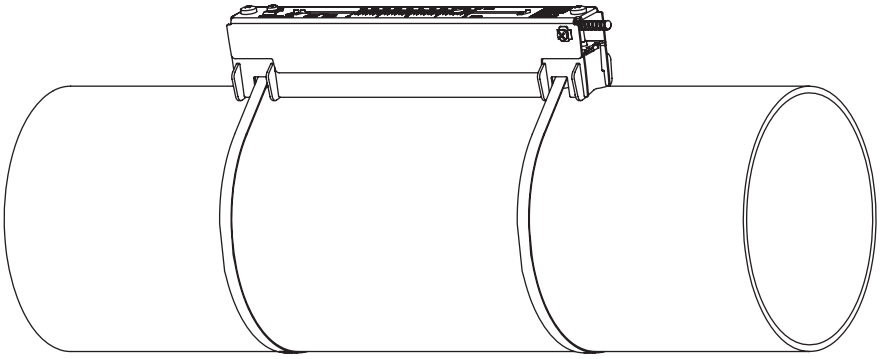
1, 2	3		4	5		6	7 to 9			no. of character
transducer mounting fixture	**transducer**	**-**	**measurement arrangement**	**size**	**-**	**fixation**	**outer pipe diameter**	**/**	**option**	**description**
PL										PermaLok
VL										PermaRail
WI										transducer box for WaveInjector
	K									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							reflect arrangement or diagonal arrangement/direct mode
			R							reflect arrangement
				S						small
				M						medium
				L						large
						B				bolts
						S				tension straps
						W				welding
						N				without fixation
							SK1			0.5 to 2.5 in
							SK2			3 to 6 in
							SK3			8 to 10 in
							SK4			12 to 18 in
							SK5			20 to 36 in
							SK6			42 to 100 in
							SK7			100 to 170 in
							SK8			170 to 370 in
							NDR			any
									IP68	for transducers with degree of protection IP68
									OS	housing with stainless steel 316
									Z	special design

PermaRail (VLS)



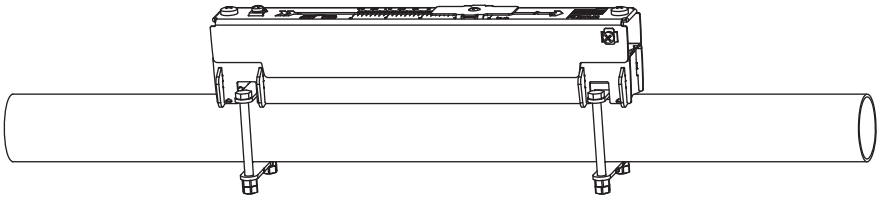
transducer frequency: S
material: stainless steel 304, 303

PermaRail (VLK, VLM, VLQ)



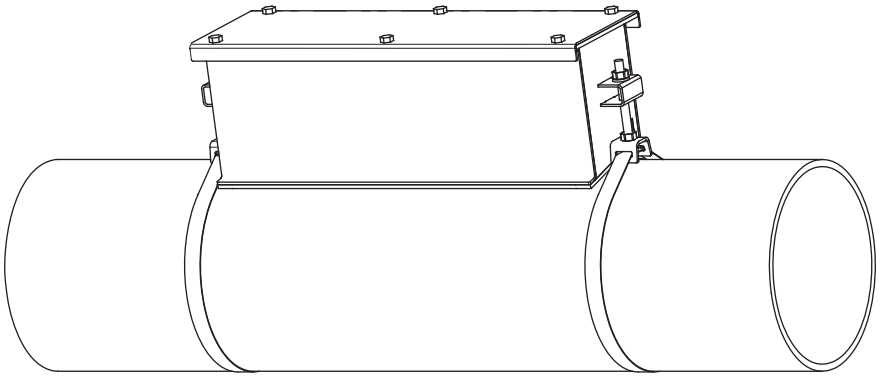
material: stainless steel 304, 301, 410
option OS: 316Ti, 316L, 17-7PH
inner length:
VLK: 13.7 in,
option IP68: 14.5 in
VLM: 9.2 in
VLQ: 6.9 in
dimensions:
VLK: 16.65 x 3.54 x 3.66 in
option IP68: 17.44 x 3.7 x 4.13 in
VLM: 12.17 x 2.24 x 2.48 in
VLQ: 9.72 x 1.69 x 1.85 in

PermaRail with bolt mounting plates (VL*--B)**

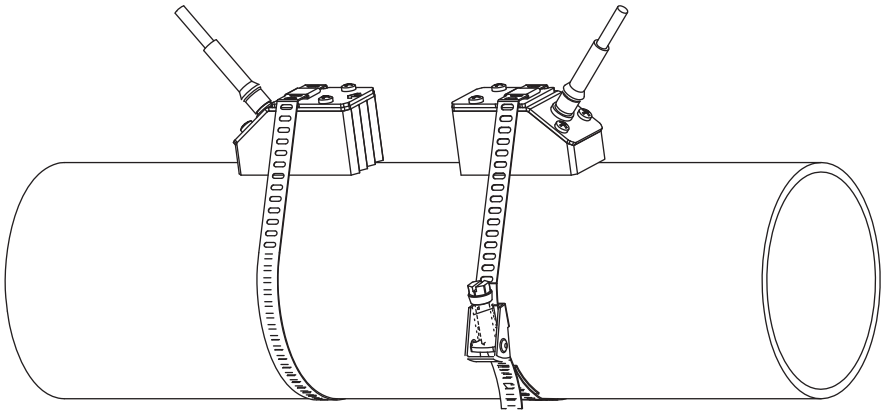
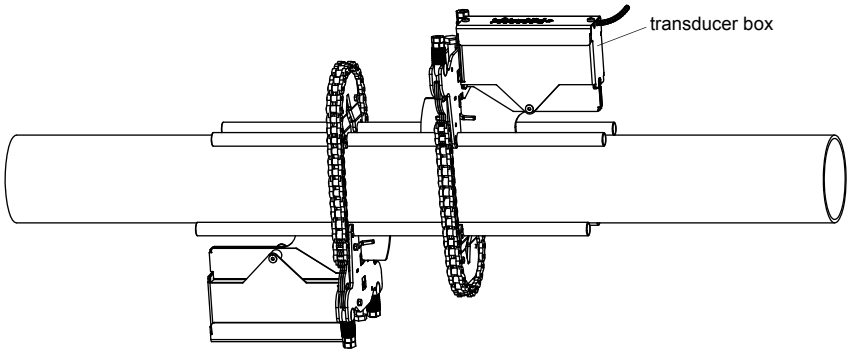


material: stainless steel 304, 301, 410
option OS: 316Ti, 316L, 17-7PH
inner length:
VLM: 9.2 in
VLQ: 6.9 in
dimensions:
VLM: 12.17 x 2.24 x 2.48 in
VLQ: 9.72 x 1.69 x 1.85 in
outer pipe diameter:
max. 1.9 in

PermaLok PL



material: stainless steel 316

quick release clasp and tension straps 	material: stainless steel 410, 200
transducer box WI for WaveInjector 	see Technical specification TSWaveInjectorVx-x

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**	
	< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 752 °F
< 24 h	coupling compound type N or coupling pad type VT	coupling compound type E or coupling pad type VT	coupling compound type E or coupling pad type VT	coupling compound type E or H or coupling pad type VT	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT
long time measurement	coupling pad type VT[1]	coupling pad type VT[2]	coupling pad type VT[1]	coupling pad type VT[2]	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT

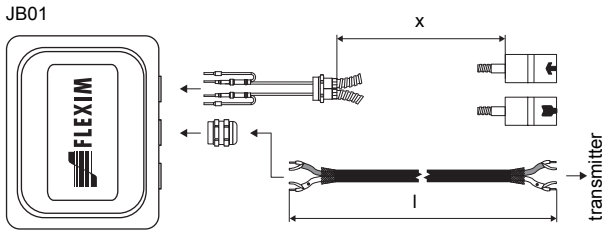
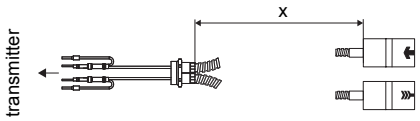
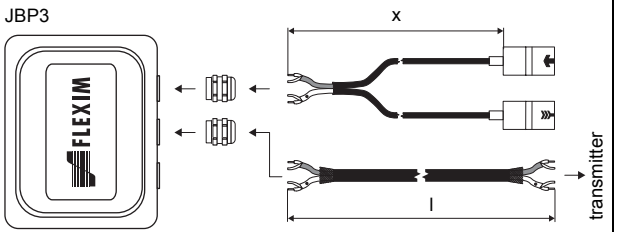
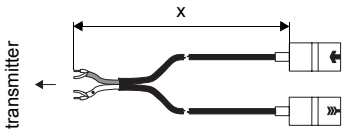
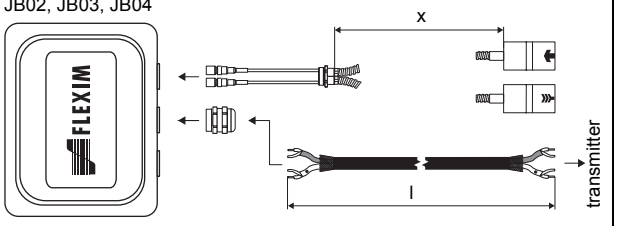
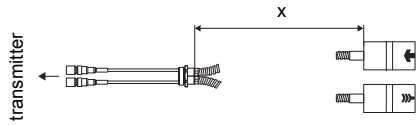
[1] < 5 years

[2] < 6 months

Technical data

type	**ambient temperature** °F	**material**
coupling compound type N	-22 to +266	mineral grease paste
coupling compound type E	-22 to +392	silicone paste
coupling compound type H	-22 to +482	fluoropolymer paste
coupling pad type A	max. 536	lead
coupling pad type B	> 536 to 752	silver
coupling pad type VT	14 to +392	fluoroelastomer

Connection systems

connection system TS		
connection with extension cable	direct connection	transducers technical type
JB01 		*****8*
JBP3 		****LI*
JB02, JB03, JB04 		*****52

Cable

transducer cable				
type		**1699**	**2550**	**6111**
weight	lb/ft	0.06	0.02	0.06
ambient temperature	°F	-67 to +392	-40 to +212	-148 to +437
properties			longitudinal watertight	
cable jacket				
material		PTFE	PUR	PFA
outer diameter	in	0.11	0.2 ±0.01	0.11
thickness	in	0.01	0.04	0.02
color		brown	gray	white
shield		x	x	x
sheath				
material		stainless steel 304 option OS: 316Ti	-	stainless steel 304 option OS: 316Ti
outer diameter	in	0.31	-	0.31

extension cable			
type		**2615**	**5245**
weight	lb/ft	0.12	0.26
ambient temperature	°F	-22 to +158	-22 to +158
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	in	0.47	0.47
thickness	in	0.08	0.08
color		black	black
shield		x	x
sheath			
material		-	steel wire braid with copolymer sheath
outer diameter	in	-	0.61

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*	ft	16	≤ 984	13	≤ 984	9	≤ 295	-	-
option LC: *(LT)***8*	ft	29	≤ 984	29	≤ 984	29	≤ 295	-	-
*(DR)***5*	ft	16	≤ 984	13	≤ 984	9	≤ 295	6	≤ 131
option LC: *(LT)***5*	ft	29	≤ 984	29	≤ 984	29	≤ 295	-	-
option IP68: ****LI*	ft	39	≤ 984	39	≤ 984	-	-	-	-

x = transducer cable length

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

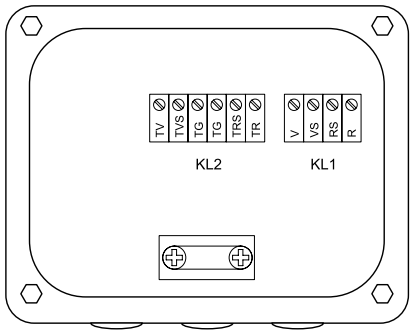
Junction box

Technical data

JB01S4E3M, JBP2, JBP3

weight	lb	2.6 lb
fixation		wall mounting optional: 2" pipe mounting
material		
housing		stainless steel 316L
gasket		silicone
degree of protection		NEMA 6
ambient temperature		
min.	°F	-40
max.	°F	+176
explosion protection		
• ATEX/IECEx (zone 1)		
junction box		JB01S4E3M
marking		CE 0637 Ex II2G II2D Ex e mb IIC (T6)...T4 Gb Ex tb IIIC T 100 °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	

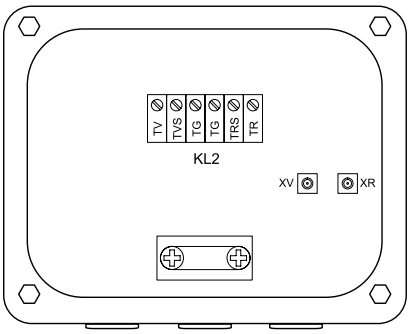
extension cable

terminal strip	terminal	connection
KL2	TV	signal
	TVS	internal shield
	TRS	internal shield
	TR	signal

JB02, JB03, JB04

weight	lb	2.6 lb
fixation		wall mounting optional: 2" pipe mounting
material		
housing		stainless steel 316L
gasket		silicone
degree of protection		IP67
ambient temperature		
min.	°F	-40
max.	°F	+176
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/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C

connection



transducers

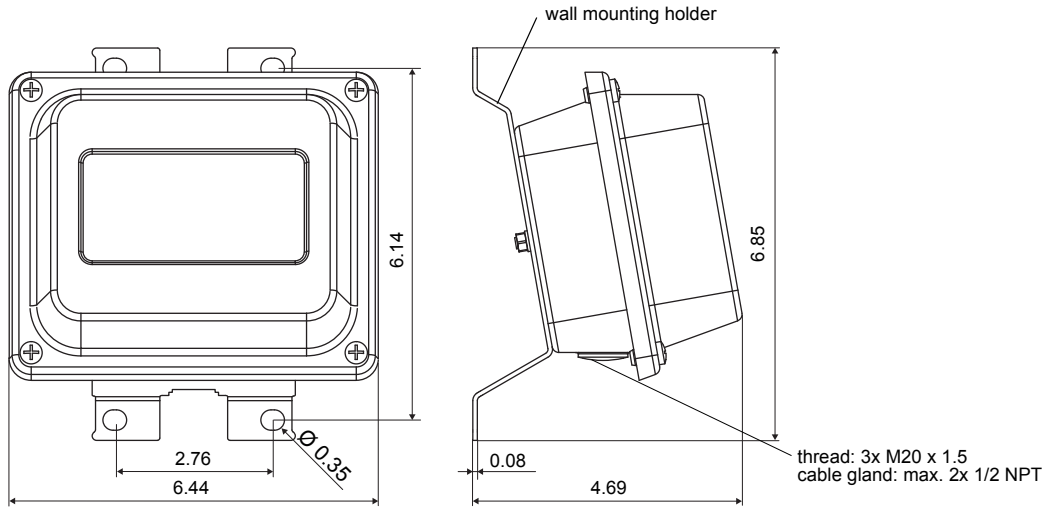
	terminal	connection	transducer
	XV	SMB connector	
	XR	SMB connector	

extension cable

terminal strip	terminal	connection
KL2	TV	signal
	TVS	internal shield
	TRS	internal shield
	TR	signal

Dimensions

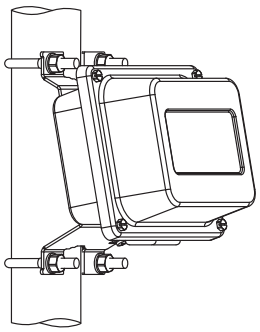
JB0*, JBP*



in inch

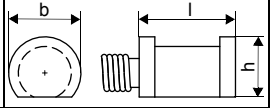
2" pipe mounting kit

JB**

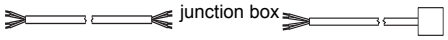
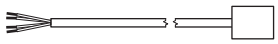


Clamp-on temperature probe (optional)

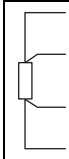
Technical data

PT13N		
design		clamp-on
type		Pt1000
connection		4-wire
measuring range	°F	-40 to +392
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		≤ 0.03 °F (at 50 °F)
housing		360 brass alloy
degree of protection		NEMA 4
dimensions		
length l	in	0.79
width b	in	0.59
height h	in	0.49
dimensional drawing		
weight	lb	0.437
accessories		
thermal conductivity foil 482 °F		x

connection system

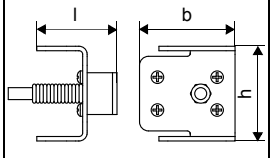
connection with extension cable	direct connection
extension cable 	

connection

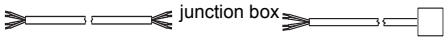
	temperature probe	extension cable
	red	red
	red	red
	white	white
	white	white

cable

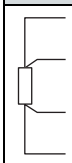
		temperature probe	extension cable
type		4 x 24 AWG	4 x 18 AWG
standard length	ft	20	-
max. length	ft	-	656
cable jacket		PTFE	LS PVC

PT13F		
design		clamp-on short response time
type		Pt1000
connection		4-wire
measuring range	°F	-58 to +482
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) 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
response time	s	8
housing		PEEK, stainless steel 304, copper
degree of protection		NEMA 4
dimensions		
length l	in	0.55
width b	in	1.18
height h	in	1.06
dimensional drawing		
weight	lb	0.7
accessories		
thermal conductivity paste 392 °F		x
thermal conductivity foil 482 °F		x
plastic protection plate, insulation foam		x

connection system

connection with extension cable	direct connection
extension cable 	

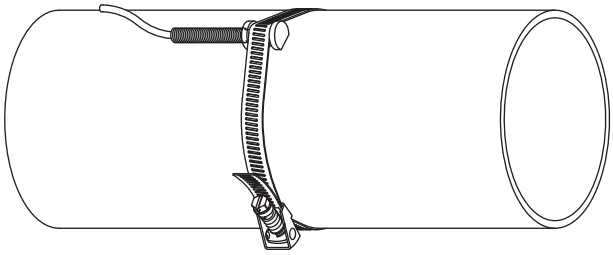
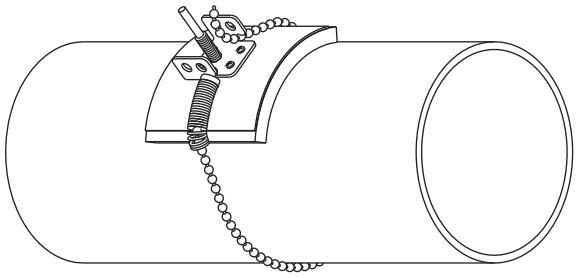
connection

	temperature probe
	red
	red/blue
	white/blue
	white

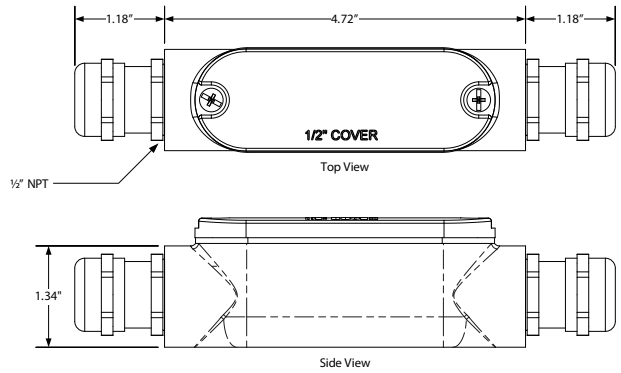
cable

		temperature probe	extension cable
type		4 x 0.25 mm² black	4 x 18 AWG
standard length	ft	9	-
max. length	ft	-	656
cable jacket		PTFE	PVC

Fixation

tension strap PT13N 	material: stainless steel 301, 410
ball chain PT13F 	material: stainless steel 316L length: 3 ft

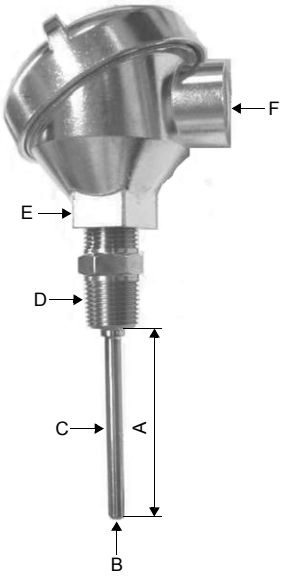
Junction box



connection

temperature probe	extension cable
red	white
red	black
white	green
white	red

Inline temperature probe (optional)



	type	Pt1000
A	insertion length	6" or specified length
B	resistance	1 000 Ω, 00385
C	insertion length	6" or specified length
	sheath material	stainless steel 316
D	thread	1/2" NPT HEX CPLG. spring loaded
E	head	aluminum screw cover head 4 terminal block
F	thread	3/4" NPT

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