

Flow Transmitters



Technical specification FLUXUS® F501SC

Ultrasonic flow measurement for the semiconductor industry

Permanently installed, completely metal-free ultrasonic clamp-on system for the flow measurement of liquids

Features

- Non-intrusive flow measurement with high measuring accuracy for stationary use
- The transducer mounting fixture and the transducers are completely metal-free
- For plastic pipes and flexible tubes with diameters of 3/8", 1/2", 3/4", 1", 1 1/4", others on request
- High measuring accuracy, even at low flow velocities
- Installation and commissioning can be carried out during operation
- No risk for potential contamination or leaks as the transducers are clamped-on to the outside of the pipe wall
- User-friendly menu navigation - the firmware is specifically adapted to the needs of the semiconductor industry

Applications

Flow measurement in the semiconductor industries for:

- Highly corrosive substances, e.g., acids or caustics
- Cleaning agents
- Solvents
- Ultrapure fluids



FLUXUS F501



Transducers CDQ2LK1 in block fastener

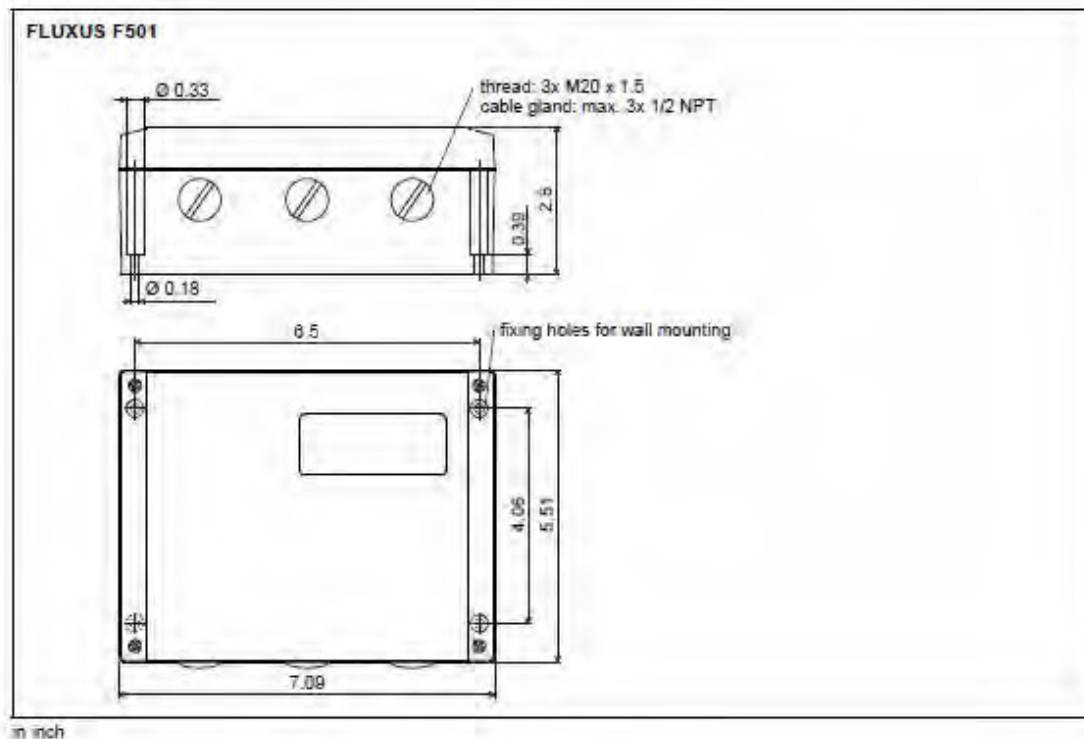
Flow transmitter

Technical data

FLUXUS	F501SC
design	field device with 1 measuring channel
application	semiconductor applications
measurement	
measurement principle	transit time difference correlation principle
flow velocity	0.03 to 82 ft/s
repeatability	0.25 % of reading ± 0.03 ft/s
fluid	water and acoustically similar liquids with < 6 % gaseous or solid content by volume
accuracy ¹ - volumetric flow rate	± 2 % of reading ± 0.03 ft/s
flow 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	< 10 W
number of flow measuring channels	1
damping	0 to 100 s, adjustable
measuring cycle (1 channel)	10 Hz
response time	1 s
housing material	aluminum, powder coated
degree of protection	NEMA 4
dimensions	see dimensional drawing
weight	3.3 lb
fixation	wall mounting
ambient temperature	14 to +140 °F
display	2 x 16 characters, dot matrix, backlight
menu language	English, German, French, Dutch, Spanish
measuring functions	
physical quantities	volumetric flow rate, mass flow rate, flow velocity
totalizer	volume, mass
data logger (optional)	
loggable values	all physical quantities and totalized values
capacity	> 100 000 measured values
communication	
interface	optional: RS485 (sender) or Modbus RTU or BACnet MS/TP
outputs (optional)	
	The outputs are galvanically isolated from the transmitter.
	current output
number	1
range	0/4 to 20 mA
accuracy	0.1 % of reading ± 15 μ A
active output	$R_{ext} < 500 \Omega$
	binary output
number	2
optorelay	28 V/100 mA
binary output as alarm output - functions	limit, change of flow direction or error
binary output as pulse output - pulse value	mainly for totalizing 0.01 to 1000 units
- pulse width	80 to 1000 ms

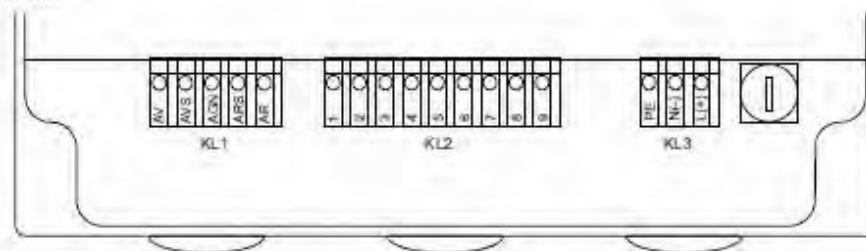
¹ for reference conditions and $v > 0.82$ ft/s

Dimensions



Terminal assignment

FLUXUS F501



power supply

terminal strip KL3

terminal	connection (AC)	connection (DC)
PE	earth	earth
N(-)	neutral	-
L(+)	phase	+

transducers

terminal strip KL1

transducer cable	
measuring channel A	
terminal	connection
AV	transducer ↗, signal
AVS	transducer ↗, internal shield
ARS	transducer ↘, internal shield
AR	transducer ↘, signal
cable gland	external shield

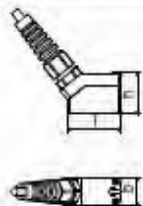
outputs

terminal strip KL2

terminal	connection
1(-), 2(+)	binary output B1
3(-), 4(+)	binary output B2
5(-), 6(+)	current output I1
7(-), 8(+), 9 (shield)	RS485 (optional)

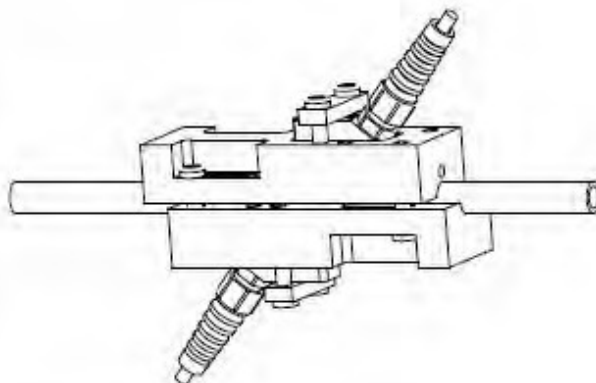
Transducers

Technical data

technical type		CDQ2LK1
transducer frequency	MHz	4
inner pipe diameter d		
min. extended	in	0.31
min. recommended	in	0.47
max. recommended	in	2
pipe wall thickness		
min.	in	0.02
material		PEEK
degree of protection		NEMA 6
transducer cable		
type		2549
length	ft	32
dimensions		
length l	in	1.57
width b	in	0.71
height h	in	1.04
dimensional drawing		
		
ambient temperature		
min.	°F	-20
max.	°F	+212

Transducer mounting fixture

block fastener



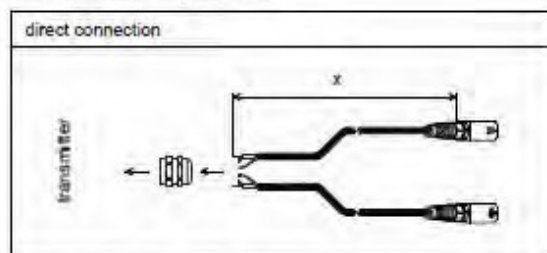
material: PP

outer pipe diameter Da:
3/8", 1/2", 3/4", 1", 1 1/4",
1 1/3", 1 1/2" (others on
request)

dimensions l x b x h:

- l: 4.72 in
- b:
3/8", 3/4", 1" ~ 1.61 in
1/2": 1.61 in
1 1/4": 2.09 in
1 1/3", 1 1/2": 2.4 in
- h: outer pipe diameter + 2x
transducer height + 0.87 in

Connection systems



x = transducer cable length

Transducer cable

Technical data

		transducer cable
type		2540
ambient temperature	°F	-148...+392
cable jacket		
material		PTFE
outer diameter	in	0.21
thickness	in	0.02
color		black
shield		x

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



PernaRail

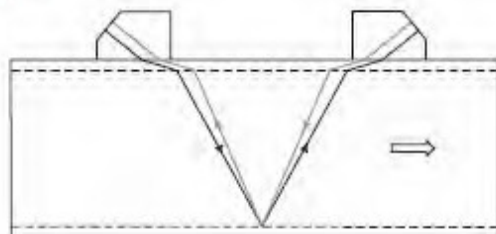
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Function

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.

Path of the ultrasonic signal in the flowing fluid



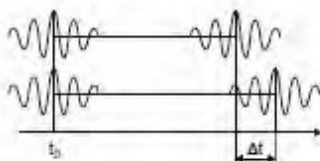
Transit time difference principle

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

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

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

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.

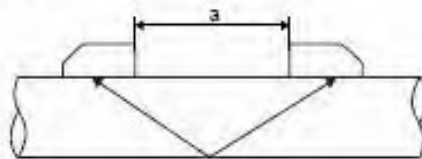
- **direct mode**

Diagonal arrangement with 1 sound path. This should be used in the case of a high signal attenuation by the fluid, pipe or coatings.

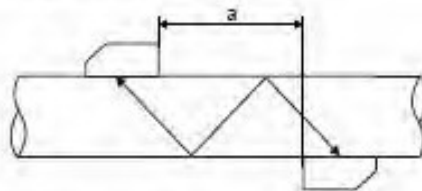
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

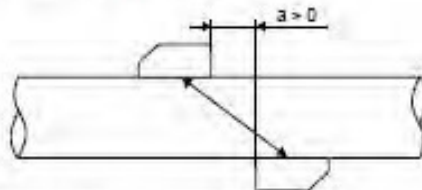
Reflect arrangement, number of sound paths: 2



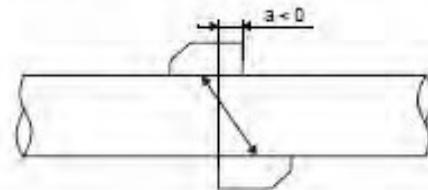
Diagonal arrangement, number of sound paths: 3



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		transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content			
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) corresponding to the recommendations in ANSI/ASME MFC-5.1-2011			
temperature compensation					
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 II 3G II 2D Ex nA nC nC IIC T4 Gc Ex tb IIC T 120 °C Db T _g -40 to +60 °C IBExU11ATEX1015	-
certification ATEX		-	-	IBExU11ATEX1015	-
certification IECEx		-	-	IECEx IBE 11.0008	-
• FM					
marking		-	-	-	F70322**1, F70322**2 N/A, I, II, III Div. 2/ GP, A, B, C, D, E, F, G/ T5 Ta = 60 °C F70322**3 N/A, I, II, III Div. 2/ GP, A, B, C, D, E, F, G/ T4A Ta = 65 °C

¹ for transit time difference principle, reference conditions and $v > 0.49$ ft/s² 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	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 ²			
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		$R_{\text{ext}} < 350 \Omega$		
passive output		$U_{\text{ext}} = 8 \text{ to } 30 \text{ V}$, depending on R_{ext} ($R_{\text{ext}} < 1 \text{ k}\Omega$ at 30 V)		
• HART				
range	mA	4 to 20		
accuracy		0.1 % of reading ±15 µA		
active output		$U_{\text{ext}} = 24 \text{ V}$, $R_{\text{ext}} < 500 \Omega$		
passive output		$U_{\text{ext}} = 10 \text{ to } 24 \text{ V DC}$, depending on R_{ext} ($R_{\text{ext}} < 1 \text{ k}\Omega$ 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		$R_{\text{int}} = 500 \Omega$		
• frequency output				
range	kHz	0 to 5		
optorelay		24 V/4 mA, $R_{\text{int}} = 66.5 \Omega$		
• binary output				
optorelay		26 V/100 mA, $R_{\text{int}} = 22 \Omega$		
Reed relay		48 V/100 mA, $R_{\text{int}} = 22 \Omega$		
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 $v > 0.49 \text{ ft/s}$ 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	$U_{int} = 24 \text{ V}$, $R_{int} = 50 \Omega$, $P_{int} < 0.5 \text{ W}$, not short-circuit proof			
• range	mA 0 to 20			
passive input	$R_{int} = 50 \Omega$, $P_{int} < 0.3 \text{ W}$			
• range	mA -20 to +20			
• voltage Input				
range	V 0 to 1			
accuracy	0.1 % of reading ±1 mV			
internal resistance	$R_{int} = 1 \text{ M}\Omega$			
• 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			

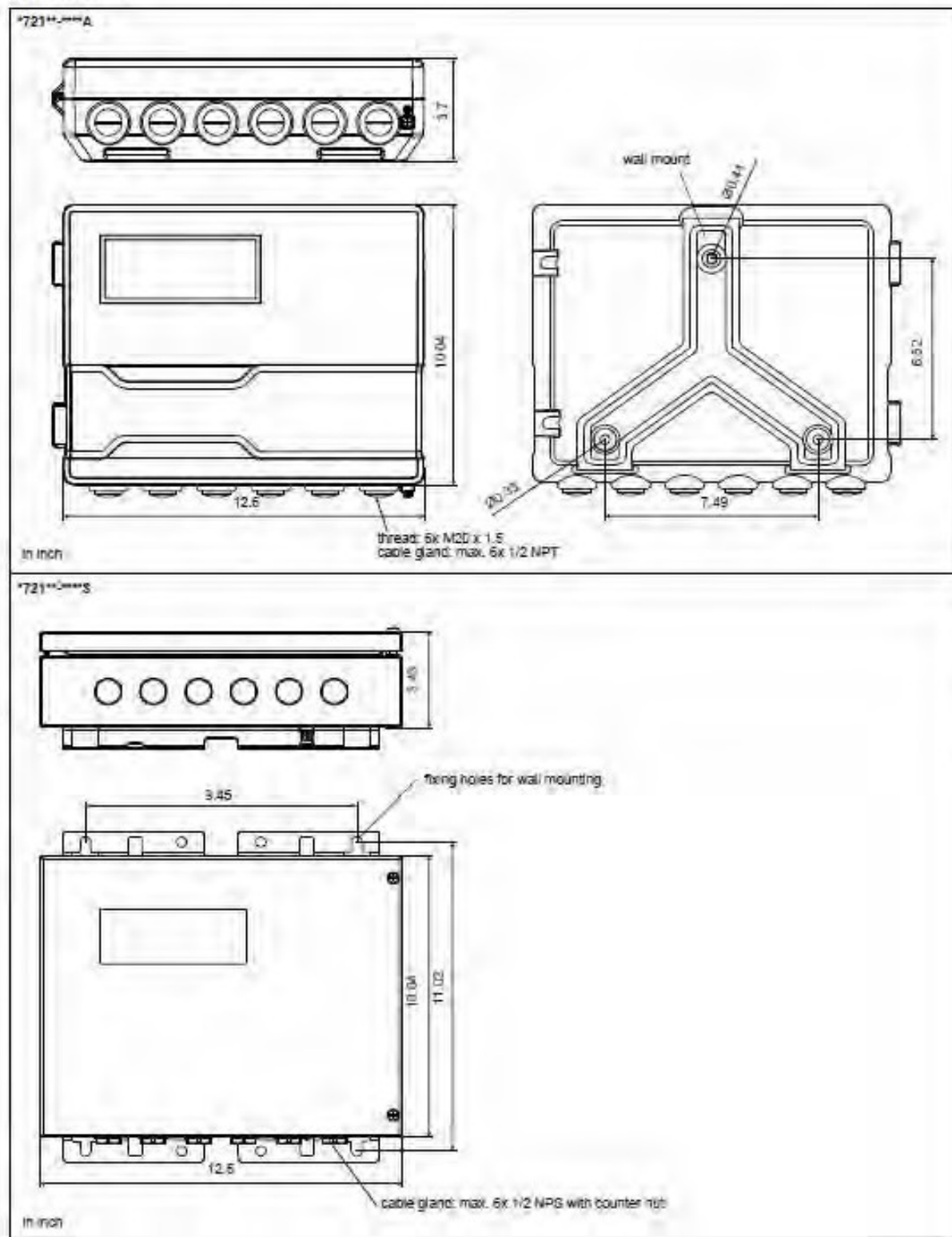
¹ for transit time difference principle, reference conditions and $v > 0.49 \text{ ft/s}$

² reference uncertainty < 0.2 %

³ outside of explosive atmosphere (housing cover open)

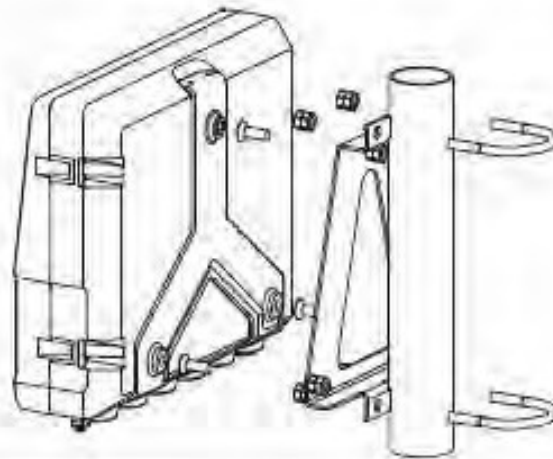
⁴ with inputs and including parametrization of the transmitter

Dimensions

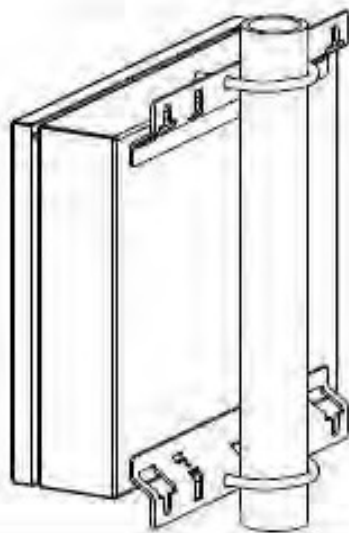


2" pipe mounting kit

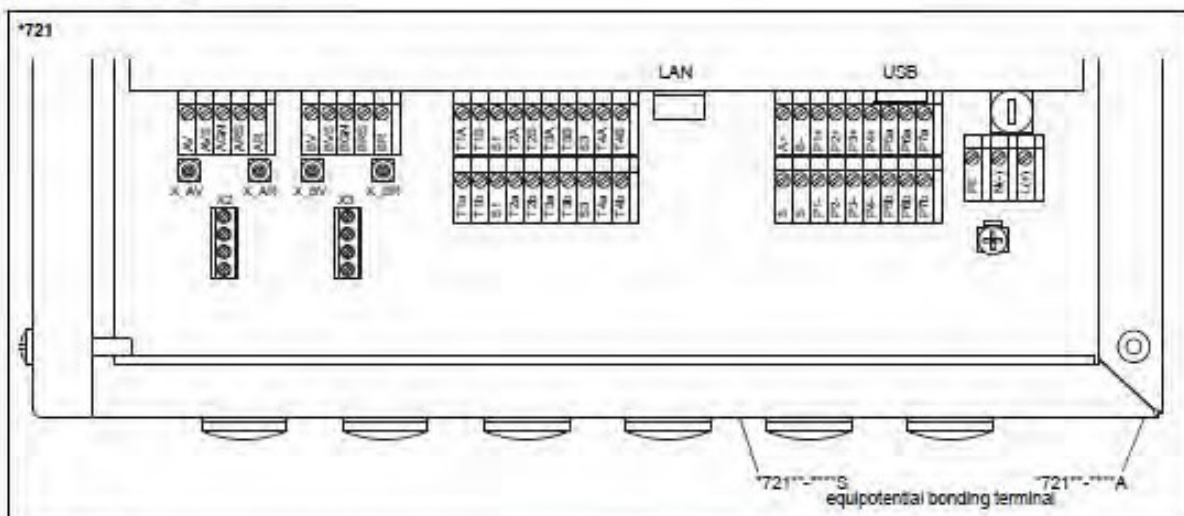
*721**...AAA



*721**...AAA



Terminal assignment



power supply ¹							
terminal		connection (AC)			connection (DC)		
PE		earth			earth		
N(-)		neutral			-		
L(+)		phase			+		
transducers							
transducer cable (transducers ****L1*), extension cable				transducer	transducer cable (transducers *****52)		
measuring channel A		measuring channel B			measuring channel A	measuring channel B	
terminal	connection	terminal	connection		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}							
terminal	temperature probe				passive sensor	active sensor	
	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):

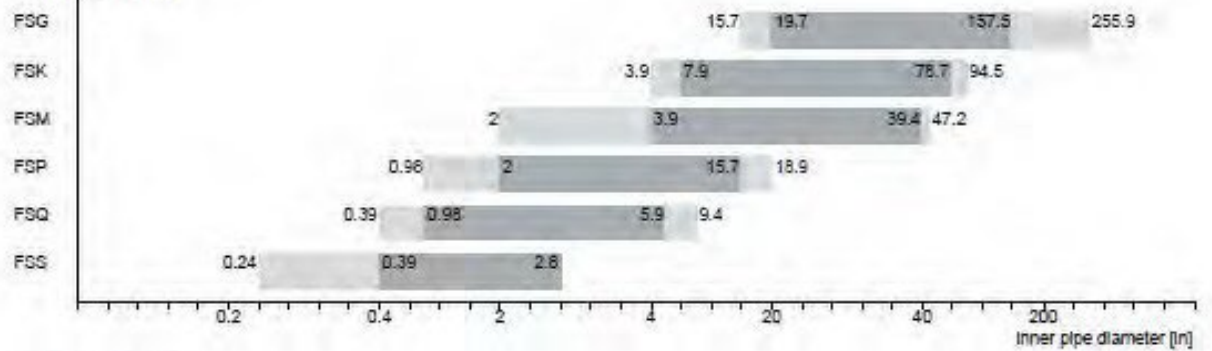
- e.g., flexible leads, with insulated wire end ferrules, lead cross sectional area: AWG14 to 24
- outer diameter of the cable (*721***-*****S with ferrite nut): max. 0.3 in

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

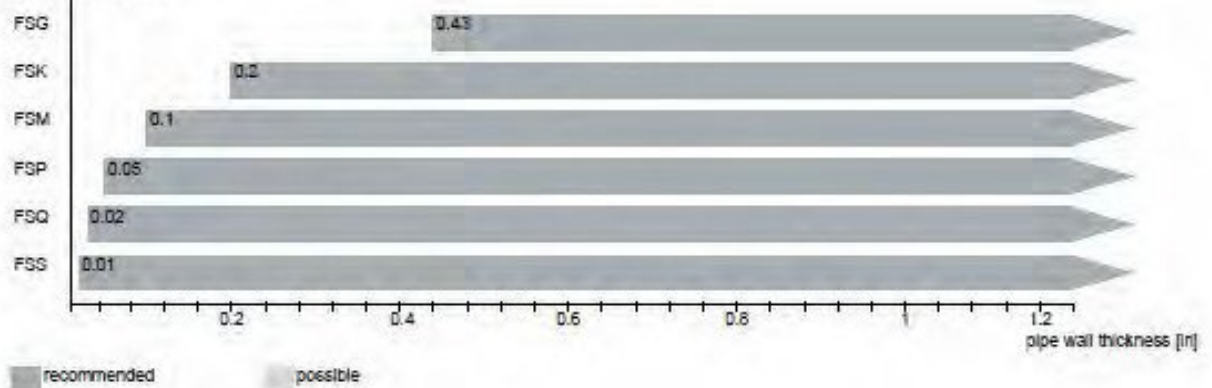
Transducers

Transducer selection

transducer order code



transducer order code

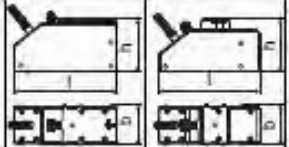
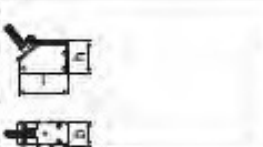
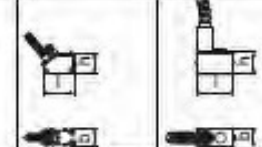


Transducer order code

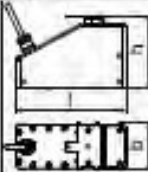
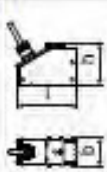
1, 2	3	4	5, 6	7, 8	9 to 11	no. of character
transducer	transducer frequency	ambient temperature	explosion protection	connection system	extension cable	option
TS						set of ultrasonic flow transducers for liquids measurement, shear wave
	G					0.2 MHz
	K					0.5 MHz
	M					1 MHz
	P					2 MHz
	Q					4 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}	FSG-N ^{TS}	FSS-N ^{TS}
technical type		C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52	CDG1N52
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	0.96	0.39
max. recommended	in	157.5	78.7	39.4	19.7	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	
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	FSG-NA2TS	-
explosion protection temperature (pipe surface)							
• min.	°C	-55		-55		-	
• max.	°C	gas: +190, dust: +180		gas: +190, dust: +180		-	
marking		CE 0637 II 3G II 2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db		CE 0637 II 3G II 2D 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	FSG-NF2TS	FSS-NF2TS
explosion protection temperature							
• min.	°F	-40		-40		-40	
• max.	°F	+257		+374		+257	
degree of protection		IP66		IP66		IP66	
marking		NI/CL I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		NI/CL I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		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 ¹ TS/IP68	FSK-N ¹ TS/IP68	FSM-N ¹ TS/IP68	FSP-N ¹ 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 II 3G Ex nA II C 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, ***-*****Q5: 316L		
contact surface		PI		
degree of protection		NEMA 4		
transducer cable				
type		5111		
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		C 0537 II 3G II 2D 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		NI/CI, I, II, III Div. 2 / GP A, B, C, D, E, F, G/ Temp. Codes dwg 3860		

Shear wave transducers (zone 1, TS)

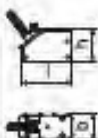
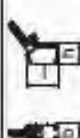
order code		FSG-N ¹ TS/''	FSK-N ¹ TS/''	FSM-N ¹ TS/''	FSP-N ¹ TS/''	FSQ-N ¹ TS/''
technical type		C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81
transducer frequency	MHz	0.2	0.5	1	2	4
inner pipe diameter d						
min. extended	in	15.7	3.9	2	0.98	0.39
min. recommended	in	19.7	7.9	3.9	2	0.98
max. 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	IP65			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 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-NA1TS/IP68	FSK-NA1TS/IP68	FSM-NA1TS/IP68	FSP-NA1TS/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	76.7	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	I 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 II2G II2D Ex q IIC T6...T3 Gb Ex tb IIC TX Db			
certification ATEX	IBExU07ATEX1168 X			
certification IECEX	IECEX IBE 06.0007X			

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

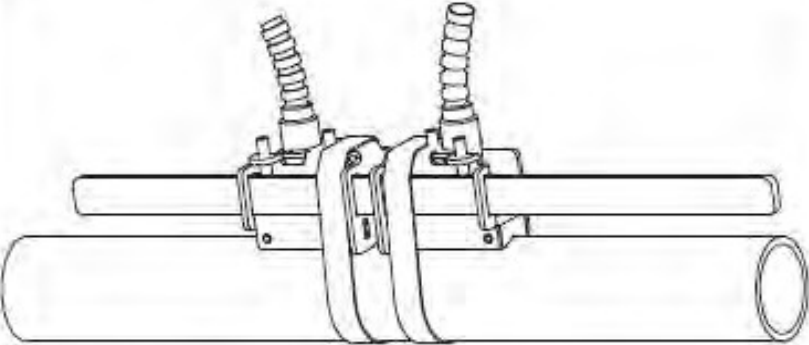
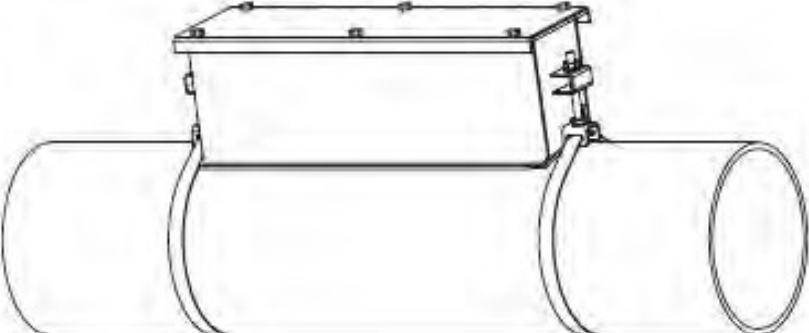
Shear wave transducers (zone 1, TS, extended temperature range)

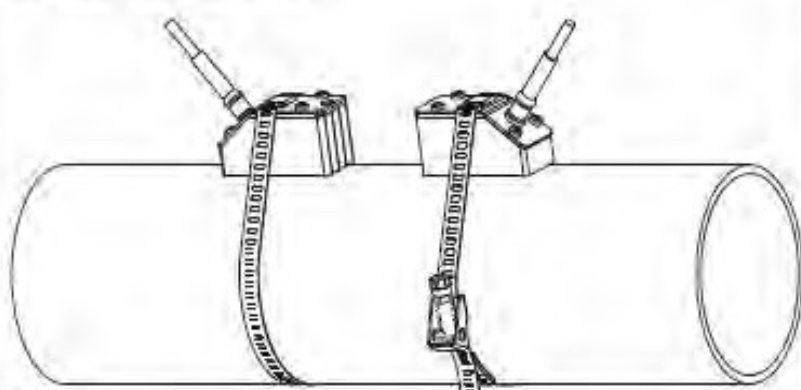
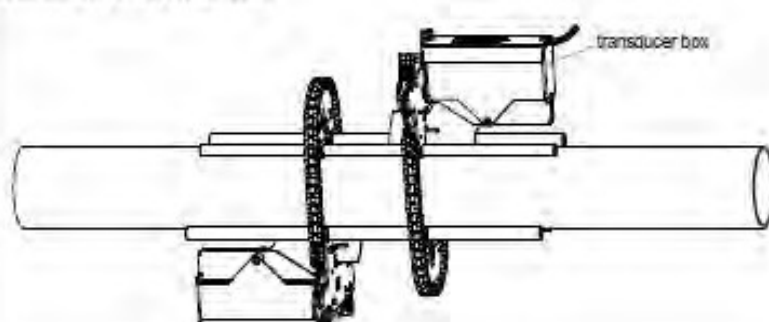
order code		FSM-E*1TS/**	FSP-E*1TS/**	FSQ-E*1TS/**
technical type		C(DL)M2E85	C(DL)P2E85	C(DL)Q2E85
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	47.2	18.9	9.4
pipe wall thickness				
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 II2G II2D Ex q IIC T6...T2 Gb Ex tb IIA 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	transducer mounting arrangement	size	fixation	outer pipe diameter	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
				IS		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  transducer box	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

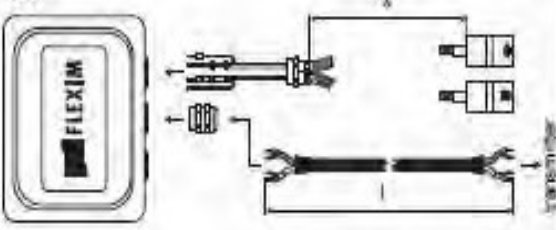
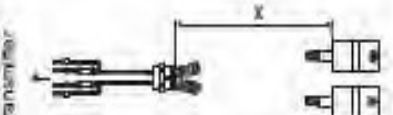
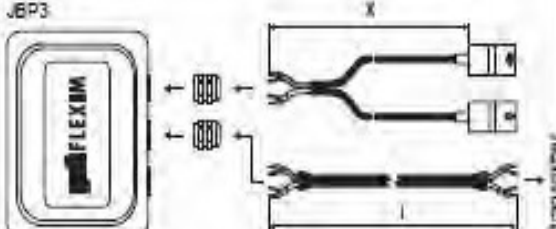
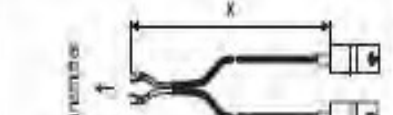
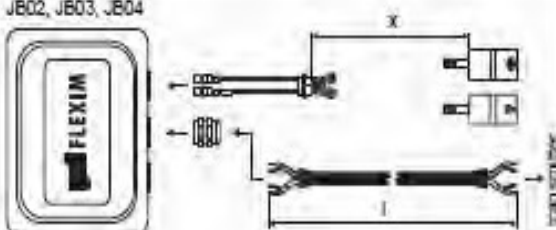
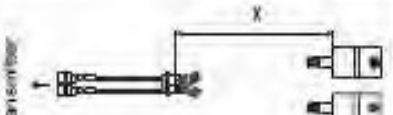
¹ < 5 years

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"
JB03 		52"
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

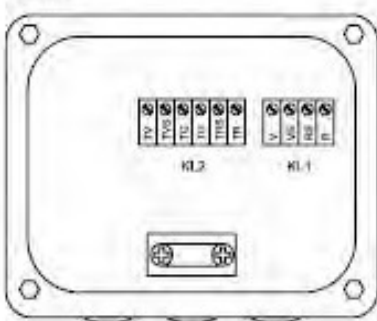
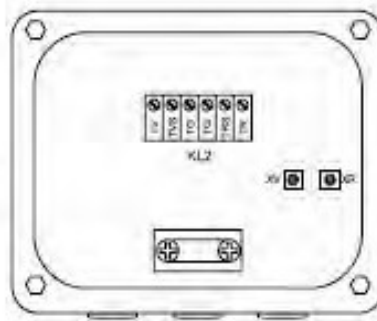
transducer frequency	F, G, H, K		M, P		Q		S	
connection system	T5							
transducer technical type	x	l	x	l	x	l	x	l
'(DR)'''8"	ft 16	± 984	13	± 984	9	± 295	-	-
option LC: '(LT)'''8"	ft 29	± 984	29	± 984	29	± 295	-	-
'(DR)'''5"	ft 16	± 984	13	± 984	9	± 295	6	± 131
option LC: '(LT)'''5"	ft 29	± 984	29	± 984	29	± 295	-	-
option IP68: '''LJ"	ft 39	± 984	39	± 984	-	-	-	-

x = transducer cable length

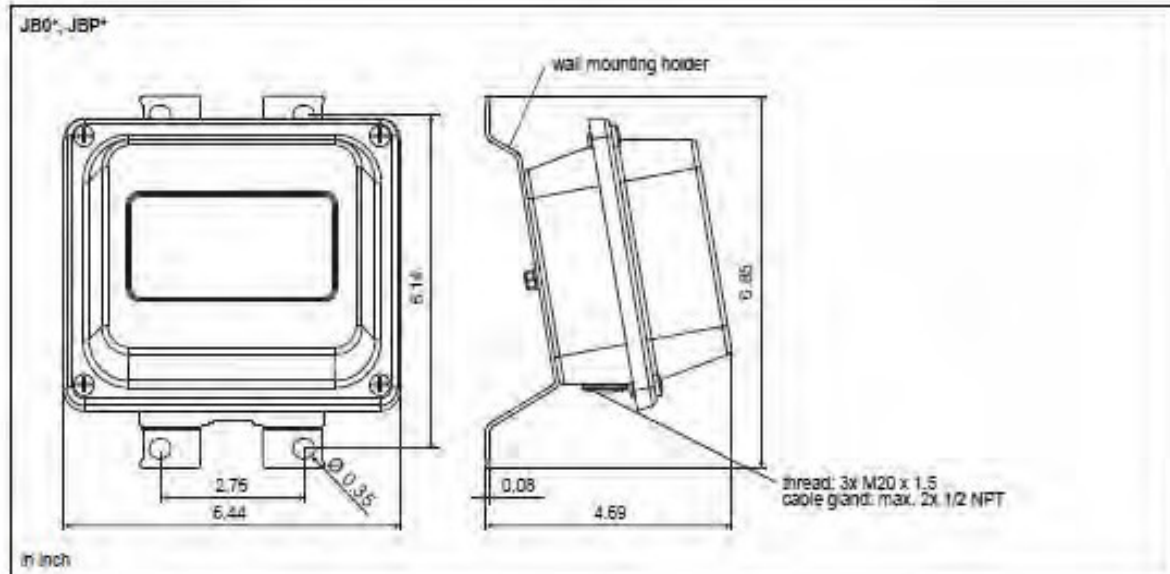
l = max. length of extension cable (depending on application)

Junction box

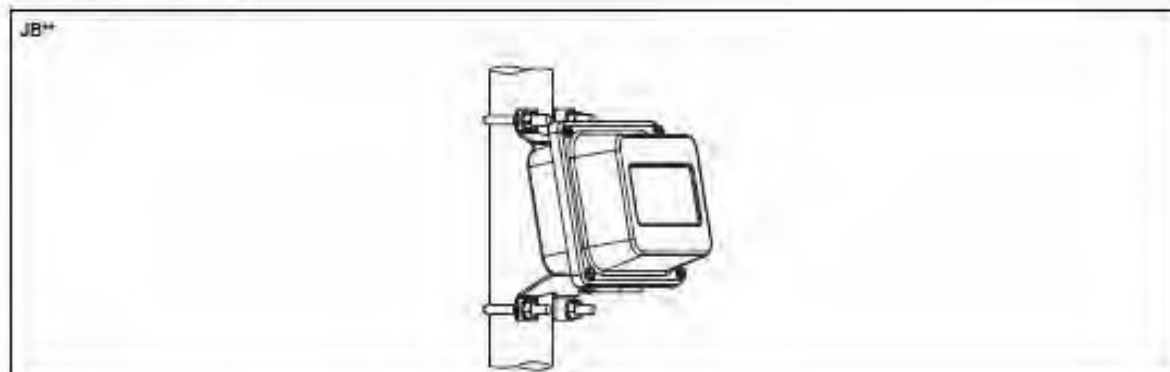
Technical data

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 5	
ambient temperature			
min.	°F	-40	
max.	°F	+176	
explosion protection			
• ATEX/IECEx (zone 1)			
junction box		JB01S4E3M	
marking		CE 0637 II2G 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 D8.0006	
type of protection		gas: increased safety decoupled network; encapsulation dust: protection by enclosure	
• ATEX (zone 2)			
junction box		JBP2	
marking		CE 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 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

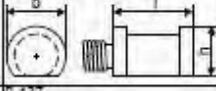


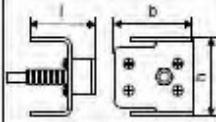
2" pipe mounting kit

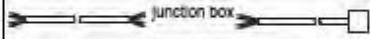


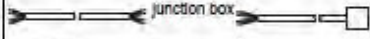
Clamp-on temperature probe (optional)

Technical data

PT13N			
design		clamp-on	
type		PT1000	
connection		4-wire	
measuring range	°F	-40 to +392	
accuracy T		$\pm(0.27^{\circ}\text{F} + 2 \cdot 10^{-5} (T [^{\circ}\text{F}] - 32^{\circ}\text{F}))$ class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)		$\pm 0.03^{\circ}\text{F}$ (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	

PT13F			
design		clamp-on short response time	
type		PT1000	
connection		4-wire	
measuring range	°F	-58 to +482	
accuracy T		$\pm(0.27^{\circ}\text{F} + 2 \cdot 10^{-5} (T [^{\circ}\text{F}] - 32^{\circ}\text{F}))$ class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)		$\pm 0.1^{\circ}\text{K}$ ($3^{\circ}\text{K} < \Delta T < 5^{\circ}\text{K}$), more corresponding to EN 1434	
response time	s	8	
housing		PEEK, stainless steel 304, cop- per	
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 pla- te, insulation foam		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 -	556
cable jacket	PTFE	LS PVC

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 -	556
cable jacket	PTFE	PVC

connection system

connection with extension cable	direct connection
	

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

connection system

connection with extension cable	direct connection
	

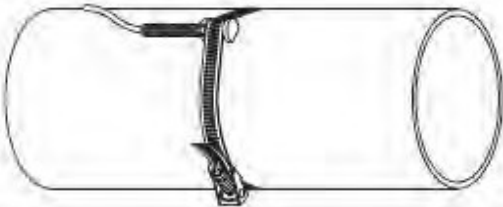
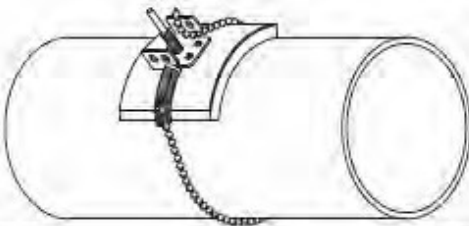
connection

	temperature probe
	red
	red/blue
	white/blue
	white

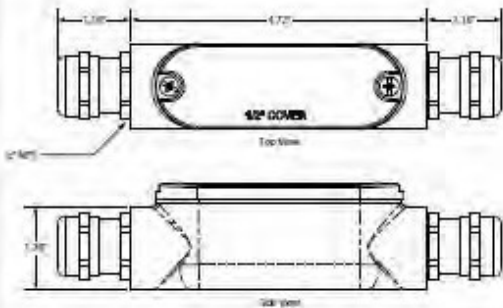
cable

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

Fixation

tension strap PT13W 	material: stainless steel 301, 410
ball chain PT13F 	material: stainless steel 316L length: 3 ft

Junction box

	connection <table><tr><th>temperature probe</th><th>extension cable</th></tr><tr><td>red</td><td>white</td></tr><tr><td>red</td><td>black</td></tr><tr><td>white</td><td>green</td></tr><tr><td>white</td><td>red</td></tr></table>	temperature probe	extension cable	red	white	red	black	white	green	white	red
temperature probe	extension cable										
red	white										
red	black										
white	green										
white	red										

Inline temperature probe (optional)

