



FLEXIM

Technical specification

FLUXUS F721TE

Permanently installed and non-invasive ultrasonic flowmeter for the measurement of thermal energy and volumetric flow rate

Stationary ultrasonic clamp-on system for thermal energy and volume flow measurement of water

Features

- Integrated measuring system for the determination of thermal energy in real time, enables smart metering
- For inner pipe diameters of 0.5 to 60"
- High-precision temperature measurement using matched pair Pt1000 temperature probes (0.03 °F temperature difference), insertion and surface mount types available
- Extremely high measuring dynamic > 1000 : 1
- Measures even the lowest flow velocities down to 0.03 ft/s – important for the measurement of low flow rates, e.g., during the night
- Permanent acoustic coupling of the ultrasonic transducers by long-lasting coupling pads; does not require further greasing and maintenance
- Bidirectional communication and support of standard bus systems
- Flowmeter can be configured for two independent heat flow measurements
- Integrated calculation functions for two measuring channels, e.g., sum or difference
- Standard configuration includes numerous heat transfer fluids; possible expansion of fluid data sets

Applications

- District heating
 - Heating and cooling systems
 - Cooling towers - condenser water
 - Steam condensate
- Building submetering
 - Heating and cooling systems
 - Internal balancing
- Energy management
 - Energy efficiency
 - Energy monitoring
- Industrial manufacturing facilities
 - Thermal processes
 - Heating and climate control
- Facilities for the generation of renewable energies
 - Solar and geothermal energy, waste heat



FLUXUS F721TE-*****-AL



FLUXUS F721TE-*****-ST



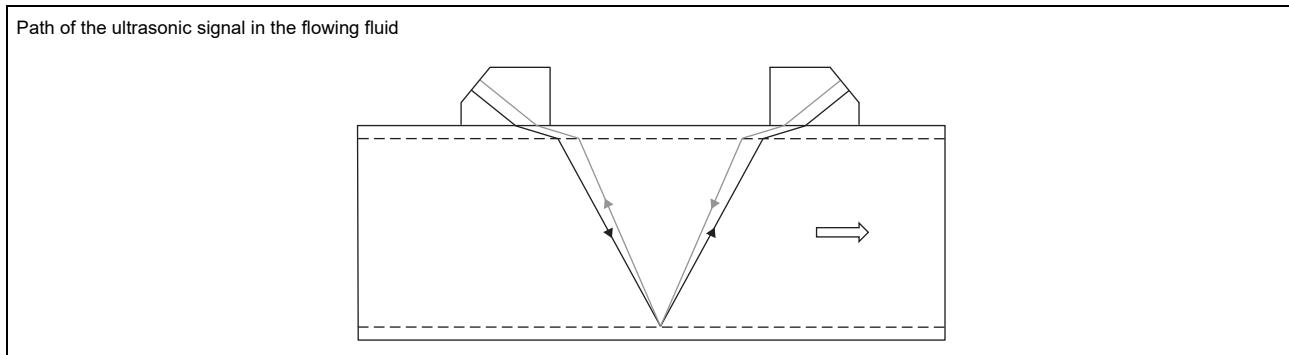
PermaRail

Function	3
Measurement principle	3
Calculation of volumetric flow rate	3
Calculation of thermal energy rate	4
Max. permissible error	4
Number of sound paths	5
Typical measurement setup	6
Transmitter	7
Technical data	7
Dimensions	11
2" pipe mounting kit	12
Storage	12
Terminal assignment	13
Transducers	14
Transducer selection	14
Transducer order code	15
Technical data	16
Transducer mounting fixture	23
Coupling materials for transducers	25
Connection systems	26
Junction box	28
Technical data	28
Dimensions	29
2" pipe mounting kit	29
Clamp-on temperature probe (optional)	30
Technical data	30
Fixation	31
Junction box	31
Inline temperature probe (optional)	32

Function

Measurement principle

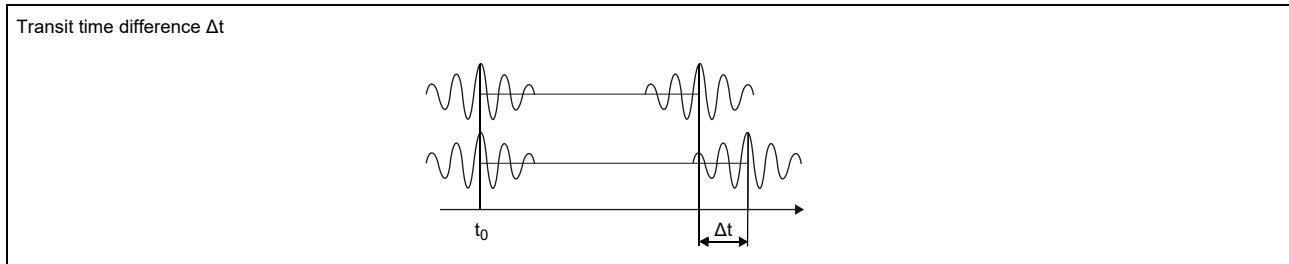
The transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are emitted alternately by a transducer and received by the other. The physical quantities are determined from the transit times of the ultrasonic signals.



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 mechanic calibration factor
- A - cross-sectional pipe area
- k_a - acoustic calibration factor
- Δt - transit time difference
- t_y - average of transit times in the fluid

Calculation of thermal energy rate

The thermal energy rate is calculated with the following formula:

$$\Phi = k_i \cdot \dot{V} \cdot (T_V - T_R) \text{ (heating application)}$$

$$\Phi = k_i \cdot \dot{V} \cdot (T_R - T_V) \text{ (cooling application)}$$

where

Φ – thermal energy rate

k_i – thermal coefficient

\dot{V} – volumetric flow rate

T_V – supply temperature

T_R – return temperature

The thermal coefficient k_i results from several thermal energy rate coefficients for the specific enthalpy and density of the fluid. The thermal energy rate coefficients of some fluids are stored in the internal database of the transmitter. Further customized fluids are possible.

Max. permissible error

The max. permissible error MPE of a complete heat meter is according to EN 1434 the arithmetic sum of the max. permissible errors of the subassemblies: calculator, temperature sensor pair and flow sensor.

$$MPE = E_c + E_t + E_f$$

where

MPE – total max. permissible error

E_c – max. permissible relative error of the calculator

E_t – max. permissible relative error of the temperature sensor pair

E_f – max. permissible relative error of the flow sensor

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 easy.

- **diagonal arrangement**

The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe.

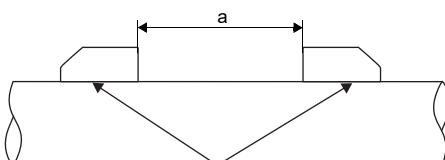
- **direct mode**

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

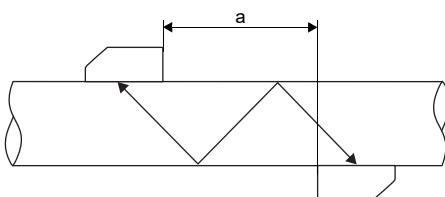
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

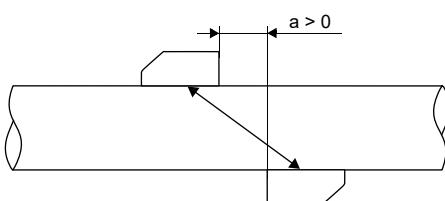
Reflect arrangement, number of sound paths: 2



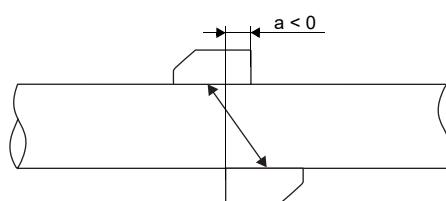
Diagonal arrangement, number of sound paths: 3



Direct mode, number of sound paths: 1



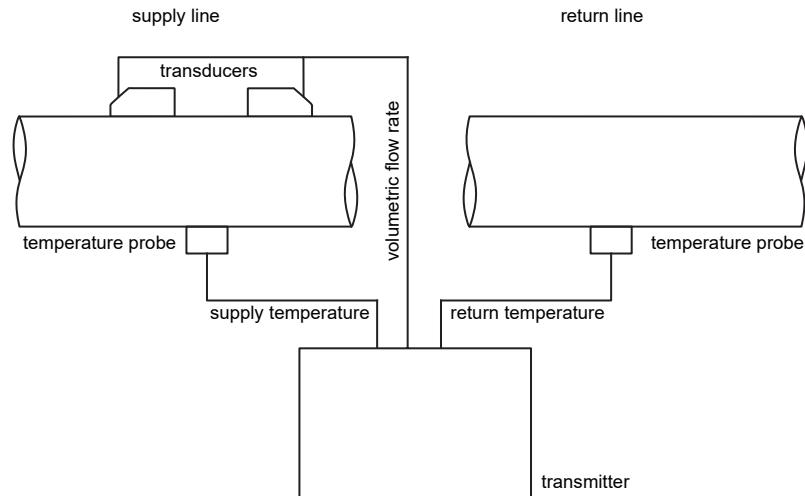
Direct mode, number of sound paths: 1, negative transducer distance



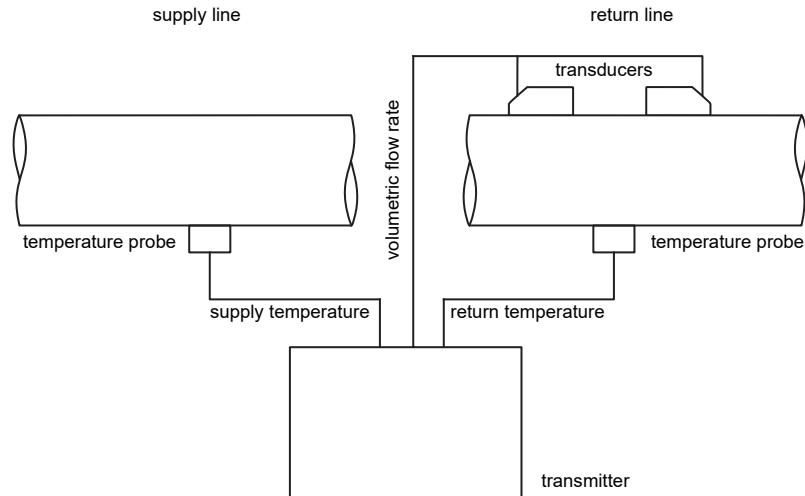
a - transducer distance

Typical measurement setup

Example of a thermal energy rate measurement measuring the volumetric flow rate in the supply line



Example of a thermal energy rate measurement measuring the volumetric flow rate in the return line



Transmitter

Technical data

	FLUXUS F721TE-NNN**-*AL F721TE-NNN**-*ST	FLUXUS F721TE-A2N**-*AL F721TE-A2N**-*ST	FLUXUS F721TE-F2N**-*AL F721TE-F2N**-*ST		
					
design	standard field device	standard field device zone 2	standard field device FM Class I Div. 2		
application	energy meter				
measurement					
• energy					
max. permissible relative error	complies to EN 1434 standard				
• temperature					
temperature difference	$\leq 0.03^{\circ}\text{F}$ (2x Pt matched)				
max. permissible relative error	complies to EN 1434 standard				
• flow					
measurement principle	transit time difference correlation principle				
flow direction	bidirectional				
flow velocity	ft/s	0.03 to 82			
repeatability	$0.15\% \text{ MV} \pm 0.02 \text{ ft/s}$				
fluid	<ul style="list-style-type: none"> • water • glycol/H₂O: 20 %, 30 %, 40 %, 50 % • thermal fluids: BP Transcal LT, BP Transcal N, R22 Freon, R134 Freon, ammonia, Shell Termina B, Mobiltherm 594, Mobiltherm 603, R407C, R410A • others on request 				
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	$\pm 0.3\% \text{ MV} \pm 0.02 \text{ ft/s}$ includes calibration certificate traceable to NIST				
measurement uncertainty at the measuring point ²	$\pm 1\% \text{ MV} \pm 0.02 \text{ ft/s}$				
transmitter					
power supply	<ul style="list-style-type: none"> • 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 or stainless steel 316L				
degree of protection	IP66				
dimensions	inch	see dimensional drawing			
weight	lb	aluminum housing: 11.9 stainless steel housing: 11.2			
fixation	wall mounting, optional: 2" pipe mounting				
ambient temperature	°F	$-40 \text{ to } +140$ (< -4 without operation of the display)			
display	128 x 64 pixels, backlight				
menu language	English, German, French, Spanish, Dutch, Russian, Polish, Turkish, Italian, Chinese				

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 F721TE-NNN**-AL F721TE-NNN**-ST	FLUXUS F721TE-A2N**-AL F721TE-A2N**-ST	FLUXUS F721TE-F2N**-AL F721TE-F2N**-ST
explosion protection			
• ATEX/IECEx			
marking	-	F721**-A20*A, F721**-A20*S: II3G II2D Ex nA nC ic IIC T4 Gc Ex tb IIIC T120 °C Db T _a -40...+60 °C	-
certification	-	IBExU11ATEX1015, IECEx IBE 11.0008	-
• FM			
marking	-	-	F721**-F20**2, F721**-F20**3: NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 F721**-F20**1: NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A
measuring functions			
physical quantities	thermal energy rate, volumetric flow rate, mass flow rate, flow velocity		
totalizer	thermal energy, 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, parametrization of the transmitter: • USB ³ • LAN ³		
process interfaces	max. 1 option: • RS485 (ASCII sender) • Modbus RTU • BACnet MS/TP • HART • Profibus PA • FF H1 • Modbus TCP • BACnet IP	max. 1 option: • RS485 (ASCII sender) • Modbus RTU • BACnet MS/TP • HART • Profibus PA • FF H1 • Modbus TCP • BACnet IP	max. 1 option: • RS485 (ASCII sender) • Modbus RTU • BACnet MS/TP • HART • Profibus PA • FF H1 • Modbus TCP • BACnet IP
accessories			
data transmission kit	USB cable		
software	• FluxDiagReader: reading of measured values and parameters, graphical representation • FluxDiag (optional): reading of measurement data, graphical representation, report generation, parametrization of the transmitter		
data logger			
loggable values	all physical quantities, totaled 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 to 20 (3.2 to 22)	
accuracy		0.04 % MV ±3 µA	
active output		R _{ext} < 250 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 % MV ±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 % MV ±1 mV 0 to 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	

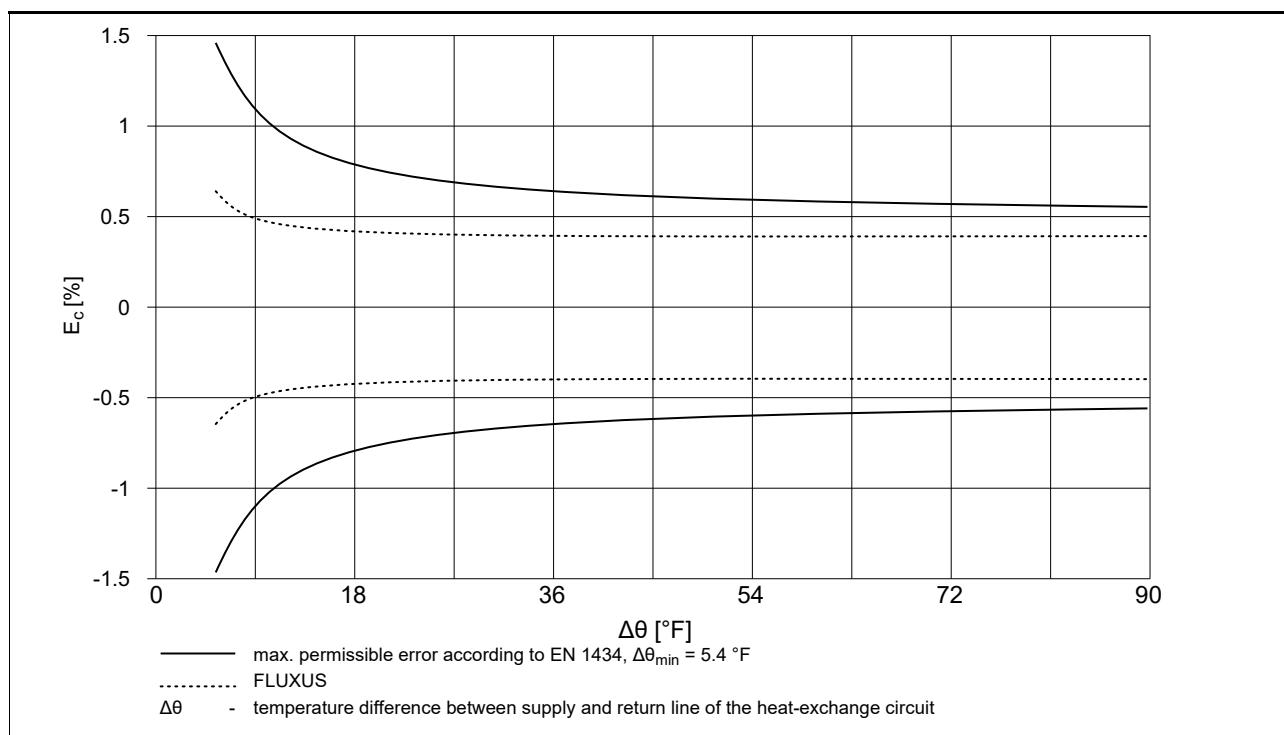
¹ with aperture calibration of the transducers² for transit time difference principle and reference conditions³ outside the explosive atmosphere (housing cover open)

	FLUXUS F721TE-NNN**-*AL F721TE-NNN**-*ST	FLUXUS F721TE-A2N**-*AL F721TE-A2N**-*ST	FLUXUS F721TE-F2N**-*AL F721TE-F2N**-*ST
• digital output			
functions		• frequency output • binary output • pulse output	
number	3		
operating parameters		5 to 30 V/< 100 mA	
frequency output			
• range	kHz	0 to 5	
binary output			
• binary output as alarm output		limit, change of flow direction or error	
pulse output			
• functions		mainly for totalizing	
• pulse value	units	0.01 to 1000	
• pulse width	ms	0.05 to 1000	
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 % MV ±0.03 K	
• current input			
accuracy		0.1 % MV ±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 % MV ±1 mV	
internal resistance		$R_{int} = 1 \text{ M}\Omega$	
• binary input			
switching signal		5 to 30 V, 1 mA	5 to 26 V, 1 mA
functions		• reset of the measured values • reset of the totalizers • stop of the totalizers • activation of the measuring mode for highly dynamic flows	

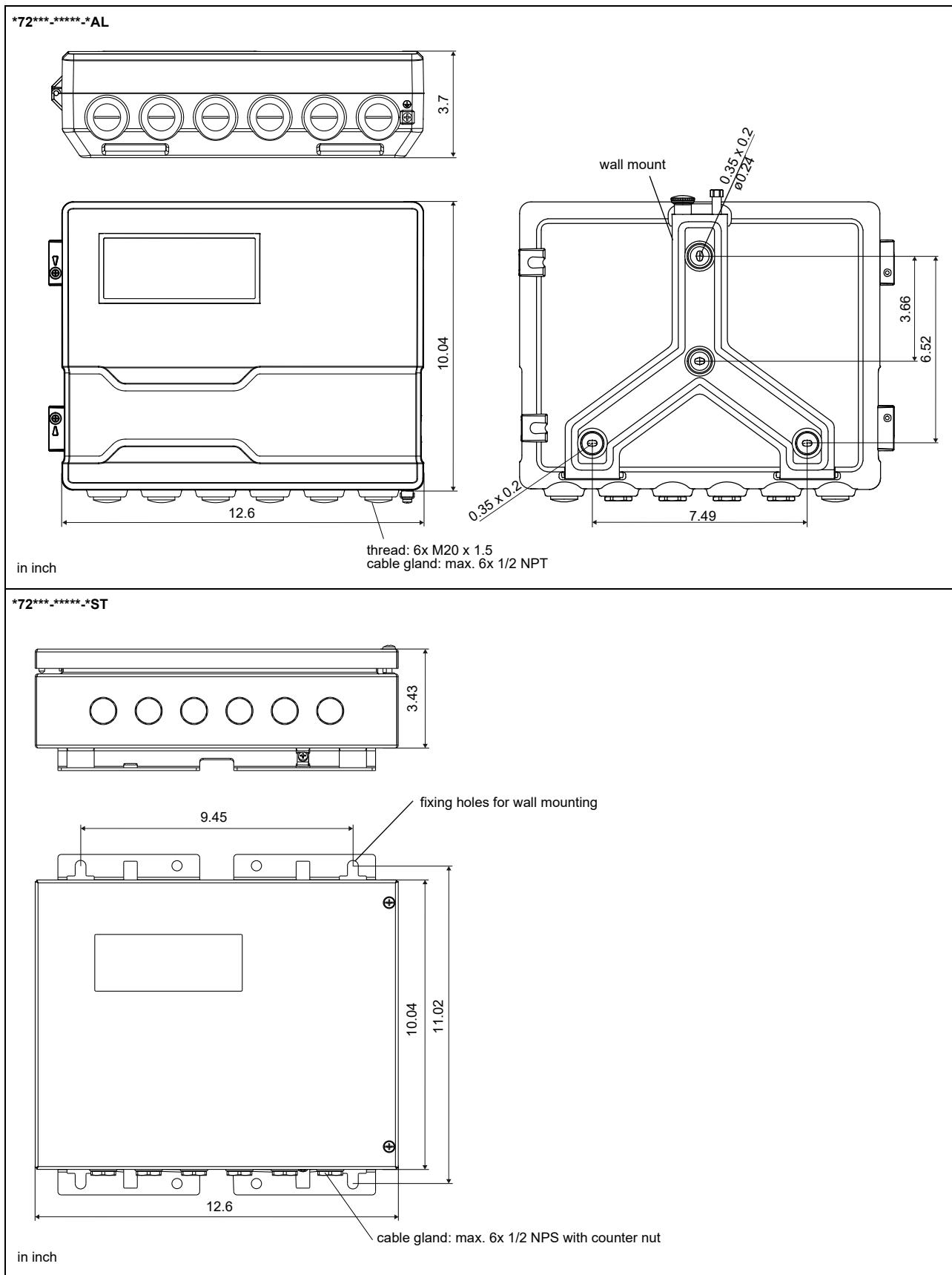
1 with aperture calibration of the transducers

2 for transit time difference principle and reference conditions

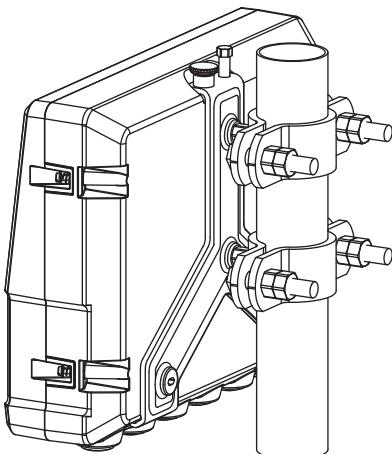
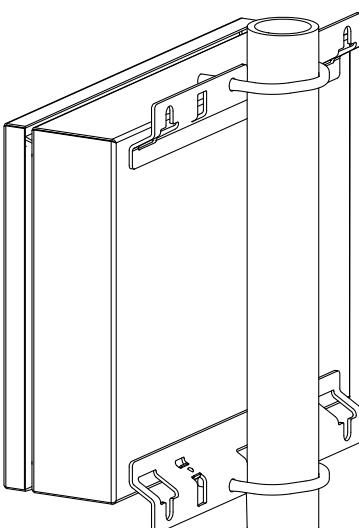
3 outside the explosive atmosphere (housing cover open)

Max. permissible error of the calculator

Dimensions



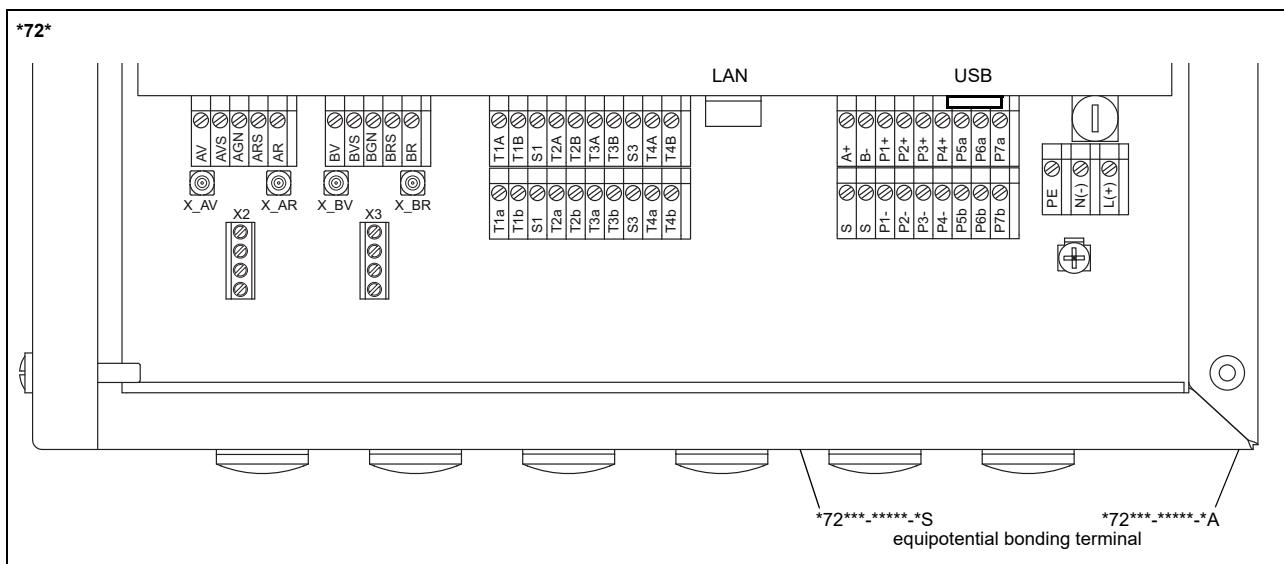
2" pipe mounting kit

*72***-****-*AL		item number: 721037-4
*72***-****-*ST		item number: 721110-4

Storage

- do not store outdoors
- store within the original package
- store in a dry and dust-free place
- protect against sunlight
- keep all openings closed
- storing temperature: -4...+140 °F

Terminal assignment



power supply ¹								
terminal	connection (AC)		connection (DC)					
PE	protective conductor			protective conductor				
N(-)	neutral conductor			-				
L(+)	outer conductor			+				
transducers								
transducer cable (transducers ****LI*), extension cable				transducer cable (transducers ****52)				
measuring channel A		measuring channel B		measuring chan-	measuring chan-			
terminal	connection	terminal	connection	channel A	channel B			
AV	signal	BV	signal	X_AV	X_BV			
AVS	shield	BVS	shield					
ARS	shield	BRS	shield	X_AR	X_BR			
AR	signal	BR	signal					
outputs ^{1, 2}								
terminal	connection		transducer	terminal	connection			
P1+ to P4+	current output, voltage output, frequency output,		↑	SMB connector				
P1- to P4-	HART (P1)			X_AV	X_BV			
P5a to P7a	digital output		↗	X_AR	X_BR			
P5b to P7b								
analog inputs ^{1, 2}								
terminal	temperature probe		passive sensor	active sensor	communication inter-			
terminal	direct connection	connection with extension cable	connection	connection	face			
T1a to T4a	red	red/white	not connected	not connected	• RS485 ¹			
T1A to T4A	red/blue	gray/black	-	+	• Modbus RTU ¹			
T1b to T4b	white/blue	blue/red	+	not connected	• BACnet MS/TP ¹			
T1B to T4B	white	white/green	not connected	-	• Profibus PA ¹			
S1, S3	shield	shield	not connected	not connected	• FF H1 ¹			
binary inputs ^{1, 2}								
terminal								
P1+ to P2+, P1- to P2-								

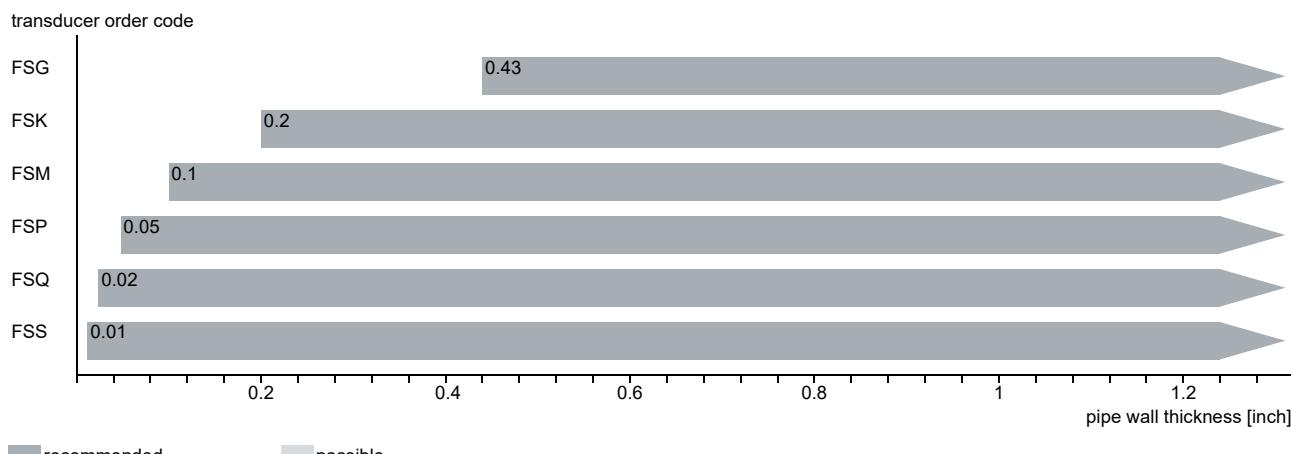
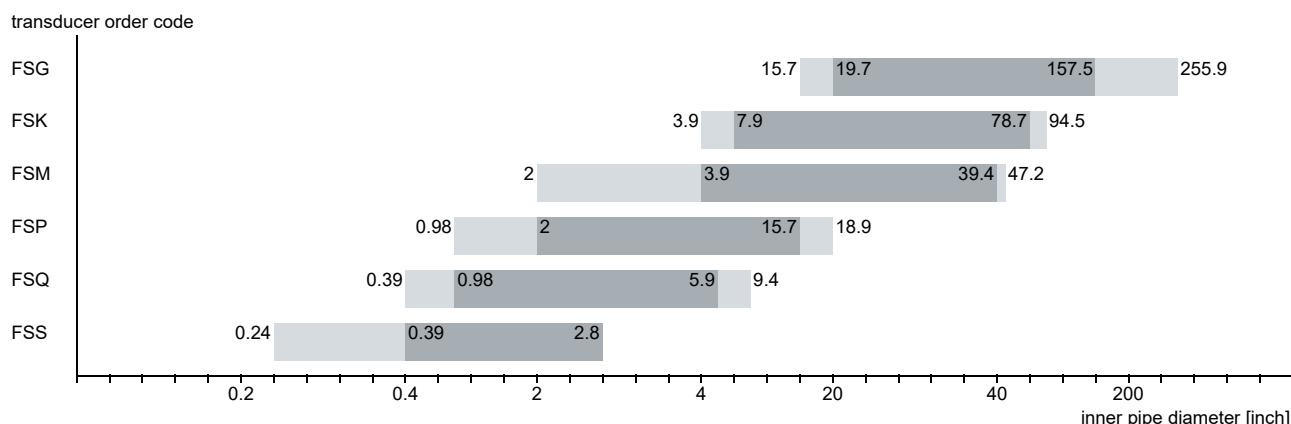
¹ cable (by customer):

- e.g., flexible wires, with insulated wire ferrules, wire cross-section: AWG14 to 24
- outer diameter of the cable (*72***-****-*S with ferrite nut): max. 0.3 inch

² The number, type and terminal assignment are customized.

Transducers

Transducer selection

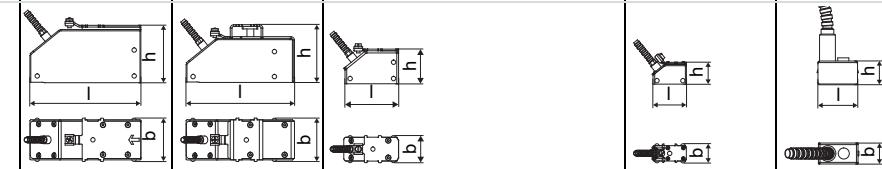


Transducer order code

1, 2	3	4	5 to 7	8, 9	10, 11	12 to 14	no. of character	
transducer	transducer frequency	-	ambient temperature	explosion protection	-	cable length	description	
FS	set of ultrasonic flow transducers for measurement of liquids, shear wave							
	G	0.2 MHz						
	K	0.5 MHz						
	M	1 MHz						
	P	2 MHz						
	Q	4 MHz						
	S	8 MHz						
	L	low temperature range						
	N	normal temperature range						
	E	extended temperature range						
	NNN	not explosion-proof						
	A2N	ATEX zone 2/IECEx zone 2						
	A1N	ATEX zone 1/IECEx zone 1						
	F2N	FM Class I Div. 2						
	**							
	TS	with SMB connector						
	T1	with stripped cable ends						
	***	in m						
	H68	degree of protection IP68						

Technical data

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

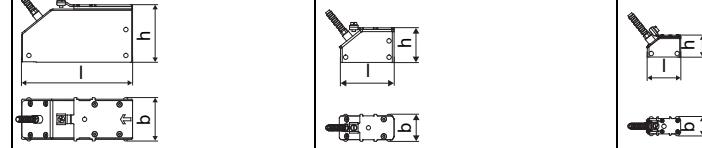
order code	FSG-N***-**TS	FSK-N***-**TS	FSM-N***-**TS	FSP-N***-**TS	FSQ-N***-**TS	FSS-N***-**TS					
technical type	C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52	CDS1N52					
transducer frequency [MHz]	0.2	0.5	1	2	4	8					
inner pipe diameter d											
min. extended	inch	15.7	3.9	2	0.98	0.39					
min. recommended	inch	19.7	7.9	3.9	2	0.98					
max. recommended	inch	157.5	78.7	39.4	15.7	5.9					
max. extended	inch	255.9	94.5	47.2	18.9	9.4					
pipe wall thickness											
min.	inch	0.43	0.2	0.1	0.05	0.02					
material											
housing		PEEK with stainless steel cover 316L				stainless steel 304					
contact surface		PEEK				PEI					
degree of protection		IP66		IP66/IP67		IP66					
transducer cable											
type		1699									
length	ft	16		13		9					
						6					
dimensions											
length l	inch	5.1	4.98	2.52	1.57	0.98					
width b	inch	2.01	2.01	1.26	0.87	0.51					
height h	inch	2.64	2.66	1.59	1	0.67					
dimensional drawing											
weight (without cable)	lb	1	0.79	0.15	0.04	0.01					
pipe surface temperature											
min.	°F	-40				-22					
max.	°F	+266				+266					
ambient temperature											
min.	°F	-40				-22					
max.	°F	+266				+266					
temperature compensation		x									
explosion protection											
• ATEX/IECEx											
order code		FSG-NA2N-**TS	FSK-NA2N-**TS	FSM-NA2N-**TS	FSP-NA2N-**TS	FSQ-NA2N-**TS					
pipe surface temperature (Ex)						-					
• min.	°C	-55				-					
• max.	°C	gas: +190, dust: +180				-					
marking		 0637 II3G II2D Ex nA IIC T6...T3 Gc Ex tb IIIC T80 °C...T185 °C Db									
certification		IBExU10ATEX1163 X, IECEEx IBE 12.0005X									
• FM											
order code		FSG-NF2N-**TS	FSK-NF2N-**TS	FSM-NF2N-**TS	FSP-NF2N-**TS	FSQ-NF2N-**TS					
pipe surface temperature (Ex)						-					
• min.	°F	-40				-					
• max.	°F	+257		+374		+257					
degree of protection		IP66									
marking		 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, T1, IP68)

order code	FSG-L***-**T1/H68	FSK-L***-**T1/H68	FSM-L***-**T1/H68	FSP-L***-**T1/H68
technical type	CDG1L18	CDK1L18	CDM2L18	CDP2L18
transducer frequency MHz	0.2	0.5	1	2
inner pipe diameter d				
min. extended	inch 15.7	3.9	2	0.98
min. recommended	inch 19.7	7.9	3.9	2
max. recommended	inch 157.5	78.7	39.4	15.7
max. extended	inch 255.9	94.5	47.2	18.9
pipe wall thickness				
min.	inch 0.43	0.2	0.1	0.05
material				
housing	PEEK with stainless steel cover 316Ti			
contact surface	PEEK			
degree of protection	IP68 ¹			
transducer cable				
type	2550			
length	ft 39			
dimensions				
length l	inch 5.12		2.76	
width b	inch 2.13		1.26	
height h	inch 3.29		1.81	
dimensional drawing				
weight (without cable)	lb 0.95		0.19	
pipe surface temperature	°F -40 to +212			
ambient temperature	°F -40 to +212			
temperature compensation	x			
explosion protection				
• ATEX/IECEx				
order code	FSG-LA2N-**T1/ H68	FSK-LA2N-**T1/ H68	FSM-LA2N-**T1/ H68	FSP-LA2N-**T1/ H68
pipe surface temperature (Ex)	°C gas: -40 to +90 dust: -40 to +80			
marking	CEx0637 Ex II3G II2D Ex nA IIC T6...T5 Gc Ex tb IIIC T80 °C...T85 °C Db			
certification	IBExU10ATEX1163 X, 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	FSG-ENNN-**TS	FSK-ENNN-**TS	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	inch 15.7	3.9	2	0.98	0.39
min. recommended	inch 19.7	7.9	3.9	2	0.98
max. recommended	inch 157.5	78.7	39.4	15.7	5.9
max. extended	inch 255.9	94.5	47.2	18.9	9.4
pipe wall thickness					
min.	inch 0.43	0.2	0.1	0.05	0.02
material					
housing	PPSU with stainless steel cover 316L	PI with stainless steel cover 316L			
contact surface	PPSU	PI			
degree of protection	IP66	IP66/IP67			
transducer cable					
type	1699	6111			
length	ft 16	13		9	
dimensions					
length l	inch 5.1	2.52		1.57	
width b	inch 2.01	1.26		0.87	
height h	inch 2.64	1.59		1	
dimensional drawing					
weight (without cable)	lb 1.8	0.15		0.04	
pipe surface temperature	°F -40...+356	-22...+450 ¹		-22...+392	
ambient temperature	°F -40...+356	-22...+104 -22...+140 ² -22...+392 ³		-22...+392	
temperature compensation	x	x			
explosion protection					
• ATEX/IECEx					
order code	-	-	FSM-EA2*-**TS	FSP-EA2*-**TS	FSQ-EA2*-**TS
pipe surface temperature (Ex)	°C -	-	gas: -45...+235 ¹ dust: -45...+225 ¹		
marking	-	-	 0637  II3G II2D Ex nA IIC T6...T2 Gc Ex tb IIIA T80 °C...T230 °C Db		
certification	-	-	IBExU10ATEX1163 X, IECEX IBE 12.0005X		
• FM					
order code	-	-	FSM-EF2*-**TS	FSP-EF2*-**TS	FSQ-EF2*-**TS
pipe surface temperature (Ex)	°F -	-	-40...+455 ¹		
degree of protection	-	-	IP66		
marking	-	-	 NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		

¹ > +200 °C/+392 °F:

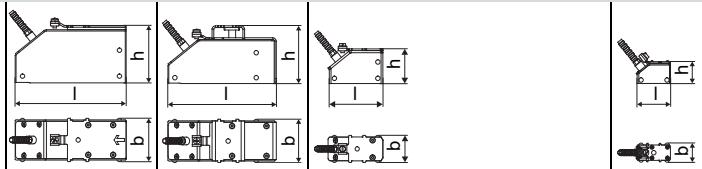
quick release clasps and tension straps (nonEx) or Variofix L (nonEx, Ex)

observe the insulation instruction

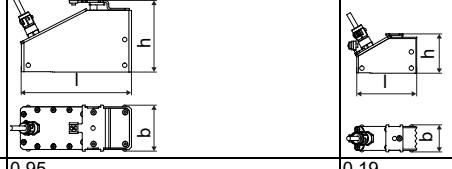
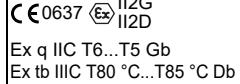
Ex: ambient temperature max. +40 °C/+104 °F

² pipe surface temperature +200...+232 °C/+392...+450 °F: quick release clasps and tension straps³ pipe surface temperature max. +200 °C/+392 °F

Shear wave transducers (zone 1, T1)

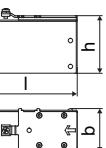
order code	FSG-N*1*-*T1	FSK-N*1*-*T1	FSM-N*1*-*T1	FSP-N*1*-*T1	FSQ-N*1*-*T1				
technical type	C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81				
transducer frequency MHz	0.2	0.5	1	2	4				
inner pipe diameter d									
min. extended	inch	15.7	3.9	2	0.98				
min. recommended	inch	19.7	7.9	3.9	2				
max. recommended	inch	157.5	78.7	39.4	15.7				
max. extended	inch	255.9	94.5	47.2	18.9				
pipe wall thickness									
min.	inch	0.43	0.2	0.1	0.05				
material									
housing	PEEK with stainless steel cover 316L								
contact surface	PEEK								
degree of protection	IP66		IP66/IP67						
transducer cable									
type	1699								
length	ft	16	13	9					
dimensions									
length l	inch	5.1	4.98	2.52	1.57				
width b	inch	2.01	2.01	1.26	0.87				
height h	inch	2.64	2.66	1.59	1				
dimensional drawing									
weight (without cable)	lb	1	0.79	0.15	0.04				
pipe surface temperature	°F	-40 to +266							
ambient temperature	°F	-40 to +266							
temperature compensation		X							
explosion protection									
• ATEX/IECEx									
order code	FSG-NA1*-*T1								
pipe surface temperature (Ex)	°C	-55 to +180							
marking	 0637  II2G Ex q IIC T6...T3 Gb Ex tb IIIC T80 °C...T185 °C Db								
certification	IBExU07ATEX1168 X, IECEx IBE 08.0007X								

Shear wave transducers (zone 1, T1, IP68)

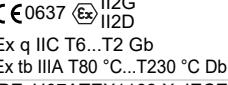
order code		FSG-L*1*-*T1/ H68	FSK-L*1*-*T1/H68	FSM-L*1*-*T1/ H68	FSP-L*1*-*T1/H68				
technical type		CDG1LI1	CDK1LI1	CDM2LI1	CDP2LI1				
transducer frequency	MHz	0.2	0.5	1	2				
inner pipe diameter d									
min. extended	inch	15.7	3.9	2	0.98				
min. recommended	inch	19.7	7.9	3.9	2				
max. recommended	inch	157.5	78.7	39.4	15.7				
max. extended	inch	255.9	94.5	47.2	18.9				
pipe wall thickness									
min.	inch	0.43	0.2	0.1	0.05				
material									
housing		PEEK with stainless steel cover 316Ti							
contact surface		PEEK							
degree of protection		IP68 ¹							
transducer cable									
type		2550							
length	ft	39							
dimensions									
length l	inch	5.12		2.76					
width b	inch	2.13		1.26					
height h	inch	3.29		1.81					
dimensional drawing									
weight (without cable)	lb	0.95		0.19					
pipe surface tempe- rature	°F	-40 to +212							
ambient temperature	°F	-40 to +212							
temperature com- pensation		x							
explosion protection									
• ATEX/IECEx									
order code		FSG-LA1*-*T1/ H68	FSK-LA1*-*T1/ H68	FSM-LA1*-*T1/ H68	FSP-LA1*-*T1/ H68				
pipe surface tempe- rature (Ex)	°C	-40 to +80							
marking		 Ex q IIC T6...T5 Gb Ex tb IIIC T80 °C...T85 °C Db							
certification		IBExU07ATEX1168 X, IECEEx IBE 08.0007X							

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

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

order code	FSG-E*1*-*T1	FSK-E*1*-*T1
technical type	CDG1E83	CDK1E83
transducer frequency MHz	0.2	0.5
inner pipe diameter d		
min. extended	inch	15.7 3.9
min. recommended	inch	19.7 7.9
max. recommended	inch	157.5 78.7
max. extended	inch	255.9 94.5
pipe wall thickness		
min.	inch	0.43 0.2
material		
housing	PPSU with stainless steel cover 316L	
contact surface	PPSU	
degree of protection	IP66	
transducer cable		
type	1699	
length	ft	16
dimensions		
length l	inch	5.1
width b	inch	2.01
height h	inch	2.64
dimensional drawing		
weight (without cable)	lb	1.8
pipe surface temperature	°F	-40 to +356
ambient temperature	°F	-40 to +356
temperature compensation		x
explosion protection		
• ATEX/IECEx		
order code	FSG-EA1*-*T1	FSK-EA1*-*T1
pipe surface temperature (Ex)	°C	-50 to +155
marking	 0637  II2G II2D Ex q IIC T6...T3 Gb Ex tb IIIC T80 °C...T160 °C Db	
certification	IBExU07ATEX1168 X, IECEx IBE 08.0007X	

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

order code	FSM-E*1*-*T1	FSP-E*1*-*T1	FSQ-E*1*-*T1
technical type	C(DL)M2E85	C(DL)P2E85	C(DL)Q2E85
transducer frequency	MHz 1	2	4
inner pipe diameter d			
min. extended	inch 2	0.98	0.39
min. recommended	inch 3.9	2	0.98
max. recommended	inch 39.4	15.7	5.9
max. extended	inch 47.2	18.9	9.4
pipe wall thickness			
min.	inch 0.1	0.05	0.02
material			
housing	PI with stainless steel cover 316L		
contact surface	PI		
degree of protection	IP66/IP67		
transducer cable			
type	6111		
length	ft 13		9
dimensions			
length l	inch 2.52		1.57
width b	inch 1.26		0.87
height h	inch 1.59		1
dimensional drawing			
weight (without cable)	lb 0.15		0.04
pipe surface temperature	°F -22 to +450 ¹		-22 to +392
ambient temperature	°F -22 to +104 -22 to +392 ²		-22 to +392
temperature compensation	x		
explosion protection			
• ATEX/IECEx			
order code	FSM-EA1*-*T1	FSP-EA1*-*T1	FSQ-EA1*-*T1
pipe surface temperature (Ex)	°C -45 to +225 ¹		
marking	 Ex q IIC T6...T2 Gb Ex tb IIIA T80 °C...T230 °C Db		
certification	IBExU07ATEX1168 X, IECEx IBE 08.0007X		

¹ > +200 °C/+392 °F:

Variofix L

observe the insulation instruction

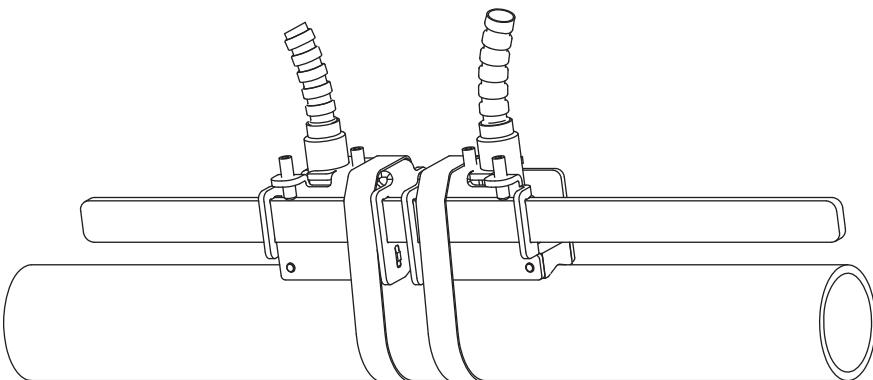
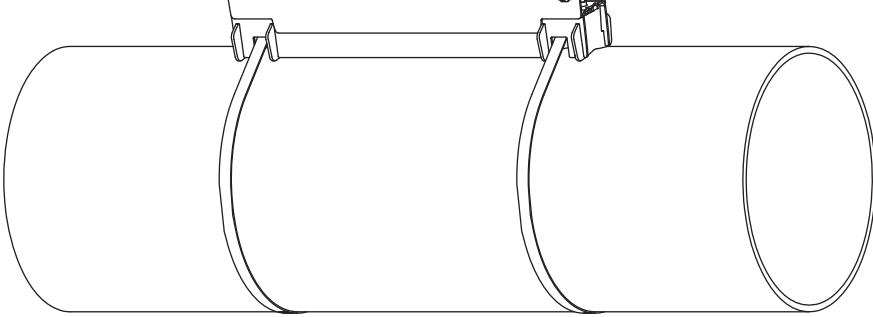
ambient temperature max. +40 °C/+104 °F

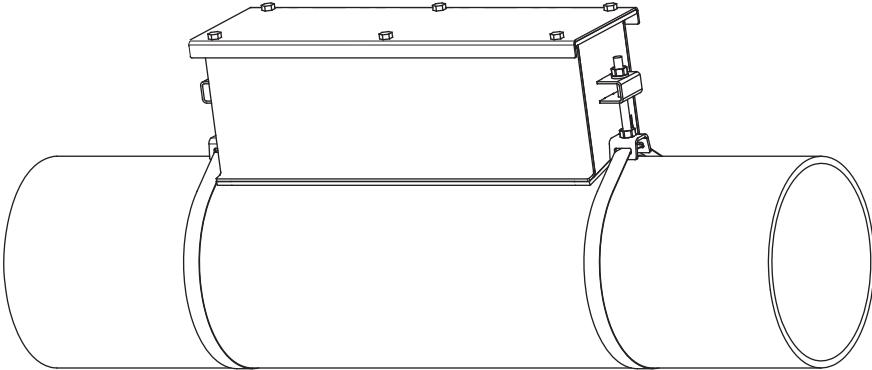
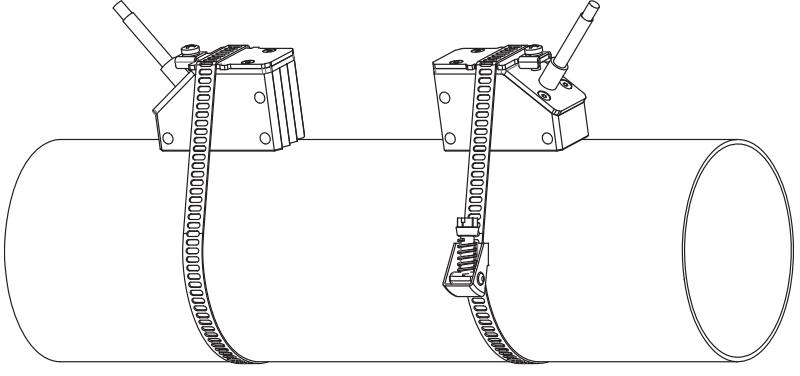
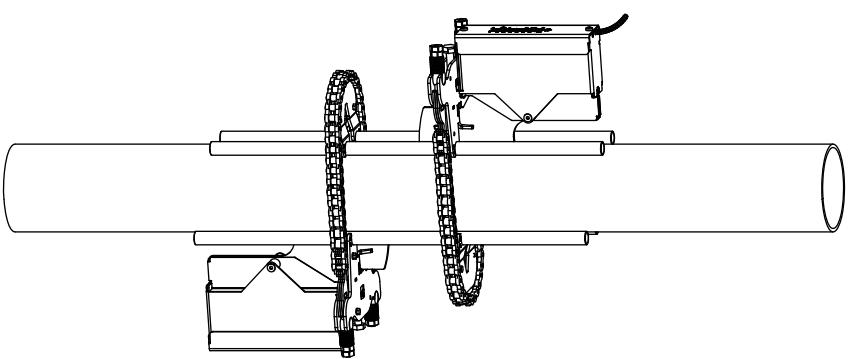
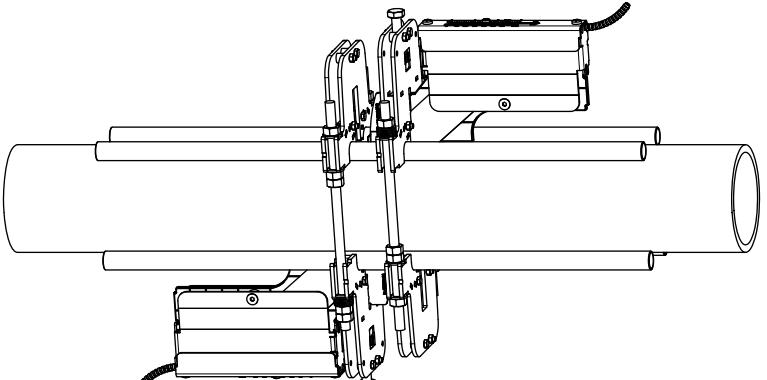
² pipe surface temperature max. +200 °C/+392 °F

Transducer mounting fixture

Order code

1, 2	3	4	5	6	7 to 10	no. of character
transducer fixture	transducer	-	measurement arrangement	size	-	fixation
PL					outer pipe diameter	/
VL						option
WN						
WH						
	G					transducers with transducer frequency G
	K					transducers with transducer frequency K
	M					transducers with transducer frequency M
	P					transducers with transducer frequency 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
	E					epoxy mount
	S					tension straps
	W					welding
		SSK1				0.5 to 2.5 inch
		SSK2				3 to 6 inch
		SSK3				8 to 10 inch
		SSK4				12 to 18 inch
		SSK5				20 to 36 inch
		NODR				any
		H68				for transducers with degree of protection IP68

PermaRail (VLS) 	transducer frequency: S material: stainless steel 304, 303
PermaRail (VL) 	material: stainless steel 316Ti, 316L, 17-7PH inner length: VL(GHK) : 13.7 inch, option H68: 14.5 inch VL(MP) : 9.2 inch VLQ : 6.9 inch dimensions: VL(GHK) : 16.65 x 3.54 x 3.66 inch option H68: 17.44 x 3.7 x 4.13 inch VL(MP) : 12.17 x 2.24 x 2.48 inch VLQ : 9.72 x 1.69 x 1.85 inch

PermaLok (PL) 	material: stainless steel 316 dimensions: PL(GHK)-RL: 19.25 x 3.9 x 3.95 inch PL(GHK)-DS: 13.25 x 3.85 x 3.95 inch PL(MP): 25.25 x 3.08 x 3.15 inch PLQ: 13.37 x 2.68 x 2.4 inch weight: PL(GHK)-RL: 6 lb PL(GHK)-DS: 4.2 lb PL(MP): 6.6 lb PLQ: 2.8 lb
quick release clasps and tension straps 	material: stainless steel 410, 200
WaveInjector with chains 	see Technical specification TSWaveInjectorVx-x
WaveInjector with threaded rods 	outer pipe diameter: 1.4 to 15 inch 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				
	< 212 °F	< 338 °F	< 302 °F	< 392 °F	392 to 464 °F	< 536 °F	536 to 1166 °F
< 24 h	coupling com- pound type N or coupling pad type VT	coupling com- pound type E or coupling pad type VT	coupling com- pound type E or H or coupling pad type VT	coupling com- pound type E or H or coupling pad type VT	coupling pad type TF	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT
long time measure- ment	coupling pad type VT	coupling pad type VT	coupling pad type VT	coupling pad type VT	coupling pad type TF	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT

type VT: fluid temperature 392 °F: min. 2 years

Technical data

type	ambient temperature °F
coupling compound type N	-22 to +266
coupling compound type E	-22 to +392
coupling compound type H	-22 to +482
coupling pad type A	max. 536
coupling pad type B	536 to 1166
coupling pad type VT	14 to +392
coupling pad type TF	392 to 464

Connection systems

connection system TS		
connection with extension cable	direct connection	transducers technical type
JB02, JB03, JB04 		*****52
connection system T1		
connection with extension cable	direct connection	transducers technical type
JB01 		*****8*
JB01, JBP2, JBP3 		****LI*

Cable

transducer cable			
type	1699	2550	6111
weight	lb/ft	0.06	0.02
ambient temperature	°F	-67 to +392	-40 to +212
properties		longitudinal watertight	
cable jacket			
material	PTFE	PUR	PFA
outer diameter	inch	0.11	0.2 ±0.01
thickness	inch	0.01	0.04
color	brown	gray	white
shield	x	x	x
sheath			
material	stainless steel 316Ti		stainless steel 316Ti
outer diameter	inch	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	inch	max. 0.47	max. 0.47
thickness	inch	0.08	0.08
color	black	black	
shield	x	x	
sheath			
material	-		steel wire braid with copolymer sheath
outer diameter	inch	-	max. 0.61

Cable length

transducer frequency		F, G, H, K		M, P		Q		S	
connection system TS									
transducers technical type		x		x		x		x	
*(DR)***5*	ft	16	≤ 984	13	≤ 984	9	≤ 295	6	≤ 131
*(LT)***5*	ft	29	≤ 984	29	≤ 984	29	≤ 295	-	-
connection system T1									
transducers technical type		x		x		x		x	
*(DR)***8*	ft	16	≤ 984	13	≤ 984	9	≤ 295	-	-
*(LT)***8*	ft	29	≤ 984	29	≤ 984	29	≤ 295	-	-
option H68: ****LI*	ft	39	≤ 984	39	≤ 984	-	-	-	-

x = transducer cable length

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

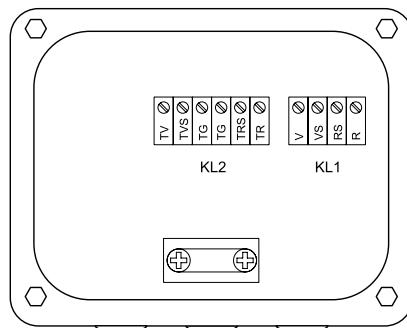
Junction box

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		IP66/IP67
ambient temperature °F	-40 to +176	
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		IBExU06ATEX1161, IECEx IBE 08.0006
type of protection		gas: increased safety decoupling network: encapsulation dust: protection by enclosure
• ATEX (zone 2)		
junction box		JPB2
marking		CE Ex UK CA II3G Ex nA IIC T6...T4 Gc II3D Ex tc IIIC T 100 °C Dc -40 ≤ Ta ≤ +70 °C/+80 °C

Connection



Transducers

terminal strip	terminal	connection	transducer
KL1	V	signal	↑
	VS	internal shield	
	RS	internal shield	⤻
	R	signal	

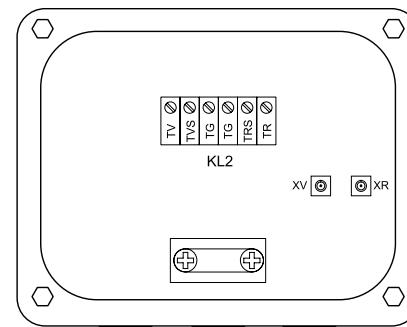
Extension cable

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		JB02, JB03: IP66/IP67 JB04: Type 4X, IP66
ambient temperature		
min.	°F	-40
max.	°F	+176
explosion protection		
• ATEX		
junction box		JB02
marking		CE Ex UK CA II3G Ex nA IIC T6...T4 Gc II3D Ex tc IIIC T 100 °C Dc -40 ≤ Ta ≤ +70 °C/+80 °C
• FM		
junction box		JB04
marking		FM APPROVED NI/CI. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C

Connection



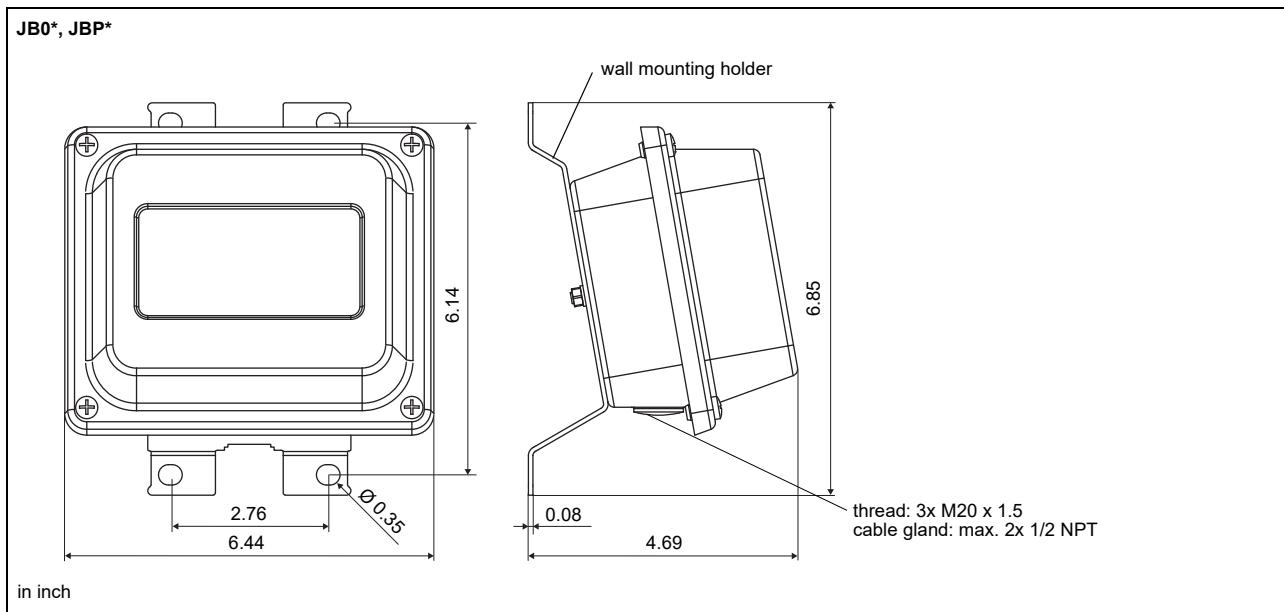
Transducers

	terminal	connection	transducer
	XV	SMB connector	↑
	XR	SMB connector	⤻

Extension cable

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

Dimensions



2" pipe mounting kit

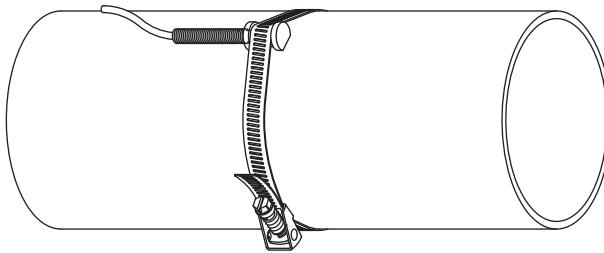
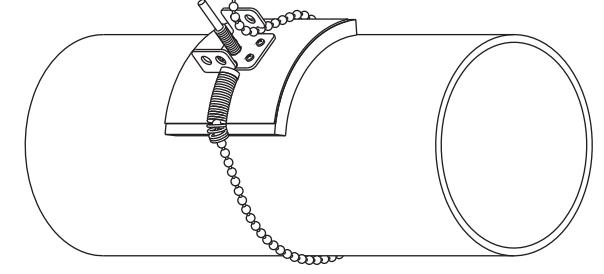


Clamp-on temperature probe (optional)

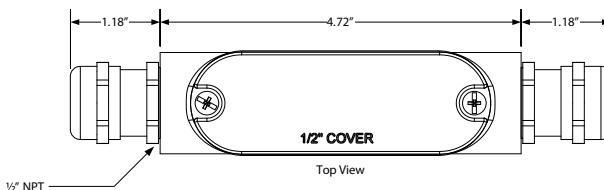
Technical data

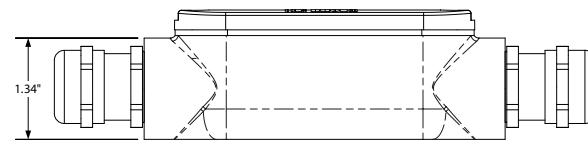
PT13N		
design	clamp-on	
type	Pt1000	
connection	4-wire	
measuring range °F	-40 to +392	
accuracy T	$\pm(0.27^\circ\text{F} + 2 \cdot 10^{-3} \cdot (T ^\circ\text{F}) - 32^\circ\text{F})$ class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)	$\leq 0.03^\circ\text{F}$ (at 50 °F)	
housing material	360 brass alloy	
degree of protection	NEMA 4	
dimensions		
length l	inch	0.79
width b	inch	0.59
height h	inch	0.49
dimensional drawing		
weight	lb	0.437
accessories		
thermal conductivity paste 392 °F	x	
PT13F		
design	clamp-on	short response time
type	Pt1000	
connection	4-wire	
measuring range °F	-58 to +482	
accuracy T	$\pm(0.27^\circ\text{F} + 2 \cdot 10^{-3} \cdot (T ^\circ\text{F}) - 32^\circ\text{F})$ class A	
response time s	8	(t50, T1 = 25 °C, T2 = 60 °C)
housing material	PEEK, stainless steel 304, copper	
degree of protection	IP54	
dimensions		
length l	inch	0.55
width b	inch	1.18
height h	inch	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		
white		
white		
Cable		
temperature probe		extension cable
type		4 x 24 AWG
standard length ft		20
max. length ft		-
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 0.22 mm²
standard length ft		9
max. length ft		-
ambient temperature °F		-58 to +482
min. bend radius inch		1.06
cable jacket		
material		PFA
outer diameter inch		0.15 ±0.01
color		black

Fixation

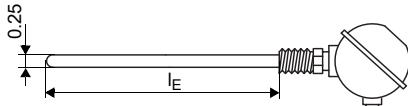
tension strap PT13N		material: stainless steel 301, 410 thermal insulation necessary
ball chain PT13F		material: stainless steel 316L length: 3 ft

Junction box

	Connection
	temperature probe
red	white
red	black
white	green
white	red



Inline temperature probe (optional)

A2179											
order code	US-TEMP.yy US-TEMP.Pyy (matched)										
design	inline										
type	Pt1000										
connection	4-wire										
measuring range °F	-58 to +500 °F										
accuracy ΔT (2x Pt matched according to EN 1434)	≤ 0.03 °F (at 32 °F)										
housing	stainless steel 316 connecting head: aluminum										
thread	1/2 NPT										
mounting length l_E inch	yy = 02.5, 04, 06, 09										
 <p>in inch</p>											
connection <table border="1"> <thead> <tr> <th></th> <th>temperature probe</th> </tr> </thead> <tbody> <tr> <td>red</td><td></td></tr> <tr> <td>red</td><td></td></tr> <tr> <td>white</td><td></td></tr> <tr> <td>white</td><td></td></tr> </tbody> </table>			temperature probe	red		red		white		white	
	temperature probe										
red											
red											
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white											
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