

## Permanently installed ultrasonic flowmeter for liquids

Transmitter for permanent outdoor wall or pipe mounting

### Features

- Precise bidirectional and highly dynamic flow measurement with the non-invasive clamp-on technology
- Up to 4 measuring channels to compensate highly disturbed flow profiles and to facilitate more accurate and repeatable measurements
- Best suitable for applications with limited straight runs
- High precision at fast and slow flow rates, high temperature and zero point stability
- Automatic loading of calibration data and transducer detection for a fast and easy set-up (less than 5 min), providing precise and long-term stable results
- User-friendly design
- Transducers available for a wide range of inner pipe diameters and fluid temperatures
- Transmitter and transducers for usage in hazardous areas are available
- HybridTrek automatically switches between transit time and NoiseTrek mode of measurement when high particulate flows are encountered
- Measurement is unaffected by fluid density, viscosity and solid content (max. 10 % of volume)

### Applications

- Process and control measurements in oil production, transportation and processing
- Check metering for custody transfer meter and health monitoring
- Balancing and leakage detection
- Crude oil and refined products – tank dewatering
- HPI applications for volume correction, mass flow and fluid identification
- Cryogenic and high temperature applications (-328 to +1112 °F)
- Water, waste water and sea water measurements
- For application in explosive atmospheres (ATEX, IECEx, FM Class I Div. 2)



FLUXUS F706



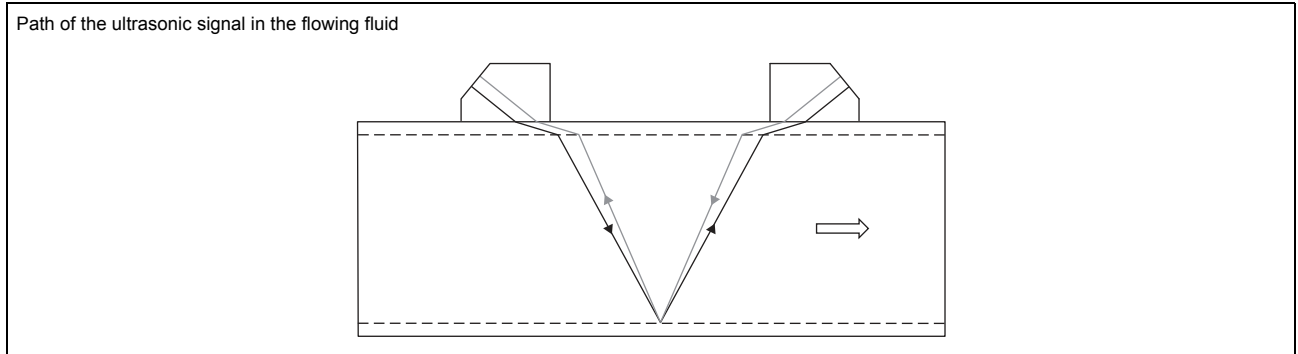
PermaRail

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## Function

### Measurement principle

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

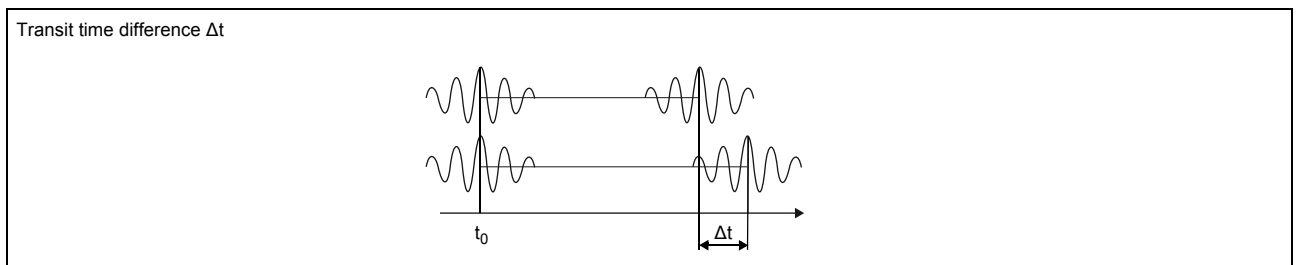


### Transit time difference principle

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  $\Delta t$  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.



### 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
- $\Delta t$  - 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**

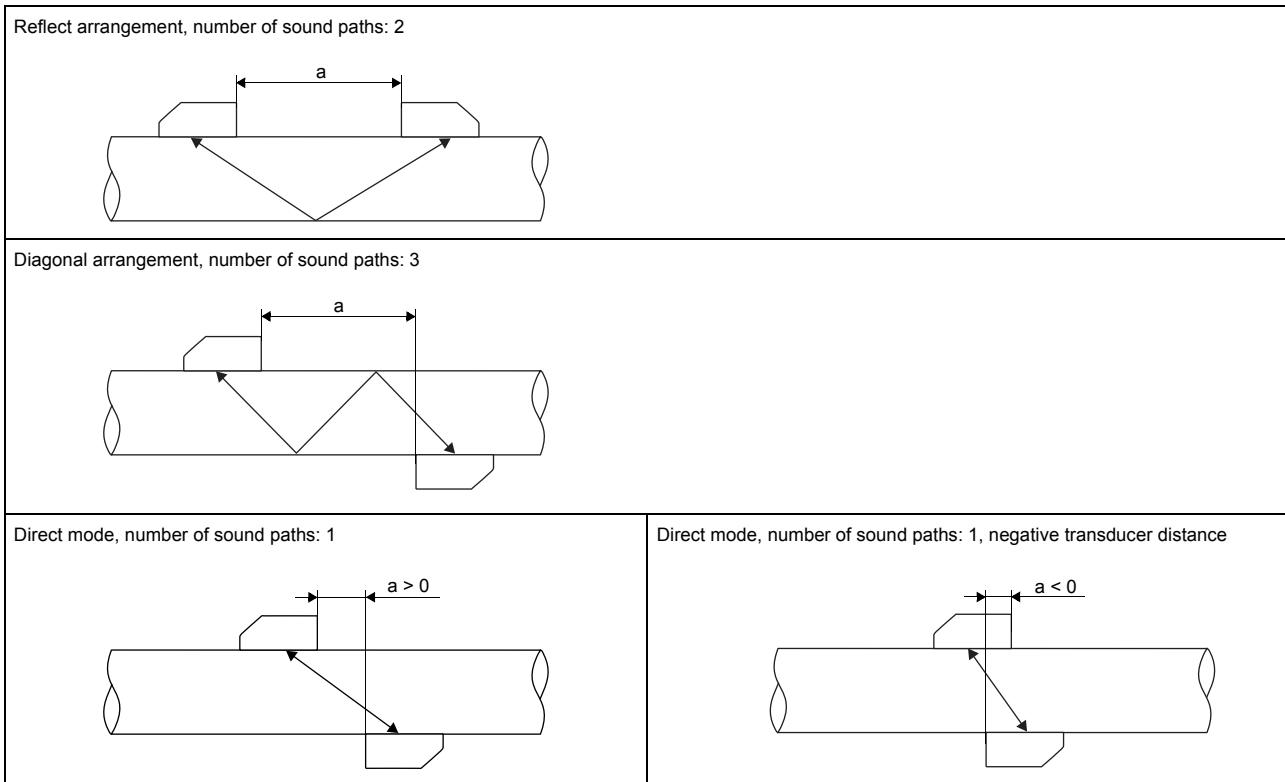
The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe.

- **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.



a - transducer distance

# Transmitter

## Technical data

	FLUXUS F706**-NN FLUXUS F706**-A2	FLUXUS F706**-F2
		
design	field device with 4 measuring channels in stainless steel housing	
<b>measurement</b>		
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 ±0.02 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	
<b>measurement uncertainty (volumetric flow rate)<sup>1</sup></b>		
measurement uncertainty of measuring system <sup>1</sup>	±0.3 % of reading ±0.02 ft/s includes calibration certificate traceable to NIST calibration facility ISO 17025 accredited	
measurement uncertainty at the measuring point <sup>2</sup>	±1 % of reading ±0.02 ft/s	
<b>transmitter</b>		
power supply	<ul style="list-style-type: none"> <li>• 100 to 230 V/50 to 60 Hz or</li> <li>• 20 to 32 V DC or</li> <li>• 11 to 16 V DC</li> </ul>	
power consumption	W	< 20
number of measuring channels	4	
damping	s	0 to 100 (adjustable)
measuring cycle	Hz	100 to 1000 (1 channel)
response time	s	1 (1 channel)
housing material	stainless steel 316L	
degree of protection	IP64	
dimensions	in	see dimensional drawing
weight	lb	15.9
fixation	wall mounting, optional: 2" pipe mounting	
ambient temperature	°F	4 to +131   -4 to +131
display	2 x 16 characters, dot matrix, backlight	
menu language	English, German, French, Dutch, Spanish	
<b>explosion protection</b>		
<b>• ATEX/IECEX</b>		
transmitter	F706**-A2	-
marking	CE 0637 Ex II3G II2D Ex nA nC ic IIC T4 Gc Ex tb IIIC T120 °C Db T <sub>a</sub> -40...+60 °C	-
certification ATEX	IBExU11ATEX1015	-
certification IECEX	IECEX IBE 11.0008	-
<b>• FM</b>		
marking	-	 NI/CI. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 -20°C≤Ta≤55°C IP64
<b>measuring functions</b>		
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	
diagnostic functions	sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times	
<b>communication interfaces</b>		
service interfaces	<ul style="list-style-type: none"> <li>• RS232<sup>3</sup></li> <li>• USB (with adapter)<sup>3</sup></li> </ul>	
process interfaces	max. 1 option: <ul style="list-style-type: none"> <li>• RS485 (ASCII sender)</li> <li>• Modbus RTU</li> <li>• HART</li> <li>• FF H1</li> <li>• SD card (nonEx)</li> </ul>	max. 1 option: <ul style="list-style-type: none"> <li>• RS485 (ASCII sender)</li> <li>• Modbus RTU</li> <li>• HART</li> <li>• FF H1</li> </ul>

<sup>1</sup> with aperture calibration of the transducers

<sup>2</sup> for transit time difference principle and reference conditions

<sup>3</sup> outside of explosive atmosphere (housing cover open)

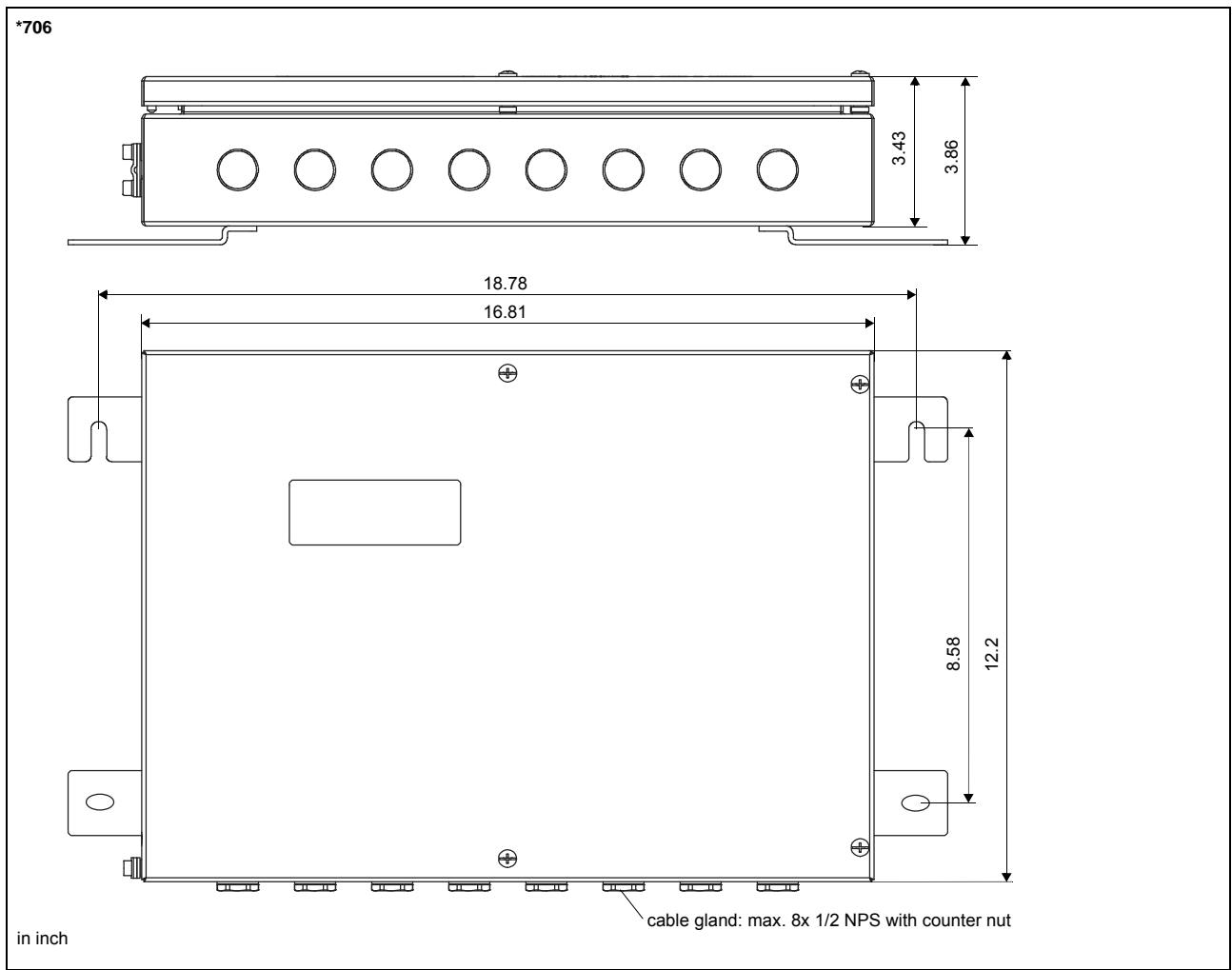
		FLUXUS F706**-NN FLUXUS F706**-A2	FLUXUS F706**-F2
<b>accessories</b>			
serial data kit		RS232 RS232 - USB	
• cable			
• adapter			
software		<ul style="list-style-type: none"> <li>FluxDiagReader: download of measured values and parameters, graphical presentation</li> <li>FluxDiag (optional): download of measurement data, graphical presentation, report generation</li> <li>FluxSubstanceLoader: upload of fluid data sets</li> </ul>	
<b>data logger</b>			
loggable values		all physical quantities, totalized values and diagnostic values	
capacity		> 100 000 measured values	
<b>SD card, removable (nonEx, optional)</b>			
loggable values		all physical quantities and totalized values	-
capacity		min. 2 GB	-
<b>outputs</b>			
		The outputs are galvanically isolated from the transmitter.	
number		on request active inputs and outputs: max. 4	
<b>• switchable current output</b>			
		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 $\pm 3 \mu\text{A}$	
active output		$R_{\text{ext}} < 350 \Omega$	
passive output		$U_{\text{ext}} = 8 \text{ to } 30 \text{ V}$ , depending on $R_{\text{ext}}$ ( $R_{\text{ext}} < 1 \text{ k}\Omega$ at 30 V)	
<b>• HART</b>			
range	mA	4 to 20	
accuracy		0.1 % of reading $\pm 15 \mu\text{A}$	
active output		$U_{\text{int}} = 24 \text{ V}$ , $R_{\text{ext}} < 500 \Omega$	
passive output		$U_{\text{ext}} = 10 \text{ to } 24 \text{ V DC}$ , depending on $R_{\text{ext}}$ ( $R_{\text{ext}} < 1 \text{ k}\Omega$ at 24 V)	
<b>• voltage output</b>			
range	V	0 to 1 or 0 to 10	
accuracy		0 to 1 V: 0.1 % of reading $\pm 1 \text{ mV}$ 0 to 10 V: 0.1 % of reading $\pm 10 \text{ mV}$	
internal resistance		$R_{\text{int}} = 500 \Omega$	
<b>• frequency output</b>			
range	kHz	0 to 5	
optorelay		24 V/4 mA, $R_{\text{int}} = 66.5 \Omega$	
<b>• binary output</b>			
optorelay		26 V/100 mA	
open collector		24 V/4 mA, P1 to P6: $R_{\text{int}} = 22 \Omega$	
Reed relay		48 V/100 mA, P1 to P6: $R_{\text{int}} = 22 \Omega$	
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, open collector: 80 to 1000	
<b>inputs</b>			
		The inputs are galvanically isolated from the transmitter.	
number		max. 4, on request active inputs and outputs: max. 4	
<b>• temperature input</b>			
type		Pt100/Pt1000	
connection		4-wire	
range	$^{\circ}\text{F}$	-238 to +1040	
resolution	K	0.01	
accuracy		$\pm 0.01 \%$ of reading $\pm 0.03 \text{ K}$	
<b>• current input</b>			
accuracy		0.1 % of reading $\pm 10 \mu$	
active input		$U_{\text{int}} = 24 \text{ V}$ , $R_{\text{int}} = 50 \Omega$ , $P_{\text{int}} < 0.5 \text{ W}$ , not short-circuit proof	
• range	mA	0 to 20	
passive input		$R_{\text{int}} = 50 \Omega$ , $P_{\text{int}} < 0.3 \text{ W}$	
• range	mA	-20 to +20	
<b>• voltage input</b>			
range	V	0 to 1	
accuracy		0.1 % of reading $\pm 1 \text{ mV}$	
internal resistance		$R_{\text{int}} = 1 \text{ M}\Omega$	
<b>• binary input</b>			
switching signal		5 to 30 V, 1 mA	5 to 26 V, 1 mA
functions		<ul style="list-style-type: none"> <li>resetting the measured values</li> <li>resetting the totalizers</li> <li>stopping the totalizers</li> <li>activation of the measuring mode for highly dynamic flows</li> </ul>	

<sup>1</sup> with aperture calibration of the transducers

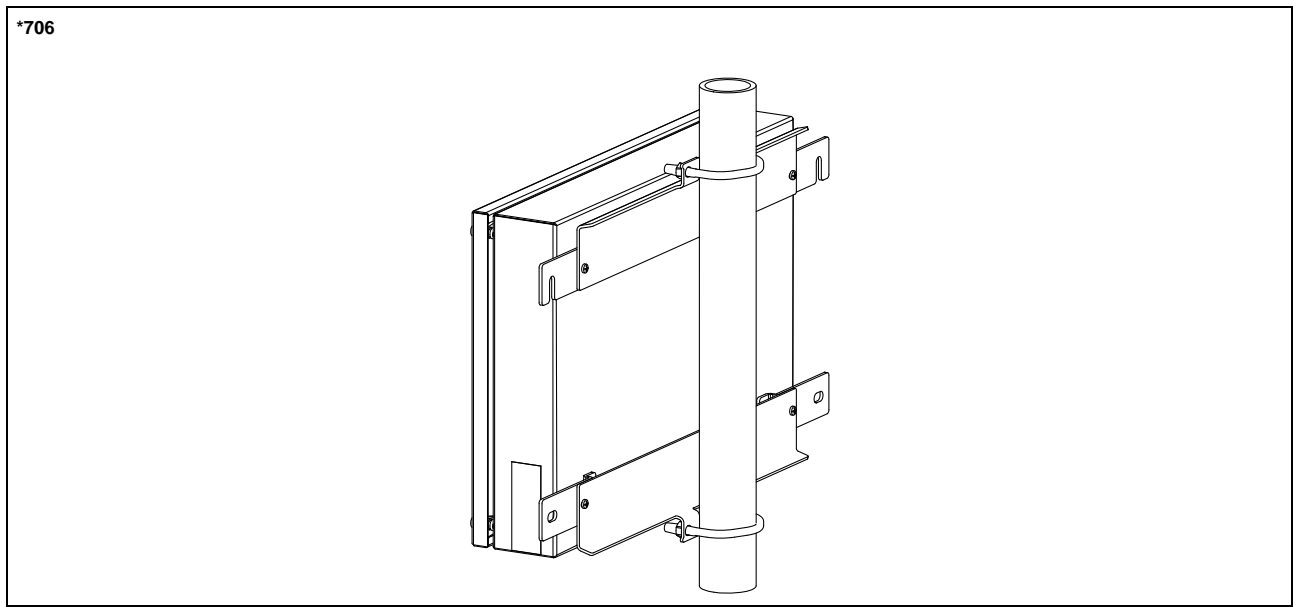
<sup>2</sup> for transit time difference principle and reference conditions

<sup>3</sup> outside of explosive atmosphere (housing cover open)

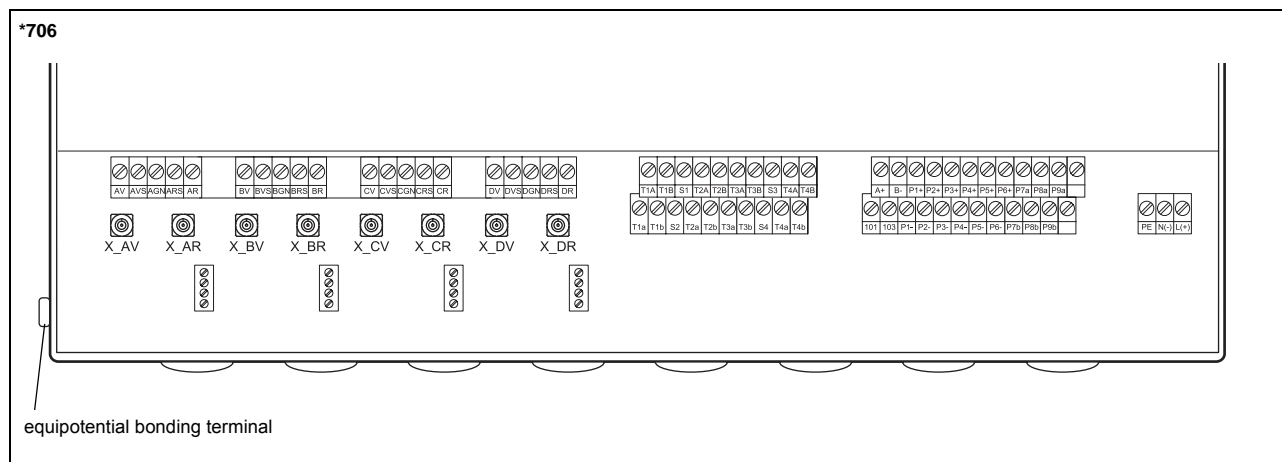
### Dimensions



### 2" pipe mounting kit



## Terminal assignment



power supply <sup>1</sup>				
terminal	connection (AC)		connection (DC)	
PE	earth		earth	
N(-)	neutral		-	
L(+)	phase		+	
transducers				
transducer cable (transducers ****L1*)			transducer cable (transducers *****52)	
extension cable (transducers ****L1*, *****52)				
measuring channel A, B, C, D			measuring channel A, B, C, D	
terminal	connection	transducer	terminal	connection
xV	signal	↑	X_xV	SMB connector
xVS	shield			
xRS	shield	⌋	X_xR	SMB connector
xR	signal			
outputs <sup>1, 2</sup>				
terminal	connection	terminal	connection	communication interface
P1+ to P6+	current output, voltage output, frequency output, binary output (Reed relay, open collector), HART (P1)	A+	signal +	<ul style="list-style-type: none"> <li>• RS485</li> <li>• Modbus RTU</li> <li>• FF</li> </ul>
P1- to P6-		B-	signal -	
P7a to P9a	binary output (Reed relay, optorelay)	101	shield	
P7b to P9b				
analog inputs <sup>1, 2</sup>				
terminal	temperature probe		passive sensor	active sensor
	direct connection	connection with extension cable	connection	connection
T1a to T4a	red	white	not connected	not connected
T1A to T4A	red	black	-	+
T1b to T4b	white	red	+	not connected
T1B to T4B	white	green	not connected	-
S1, S3	-	-	not connected	not connected
binary inputs <sup>1, 2</sup>				
terminal				
P1+ to P2+, P1- to P2-				

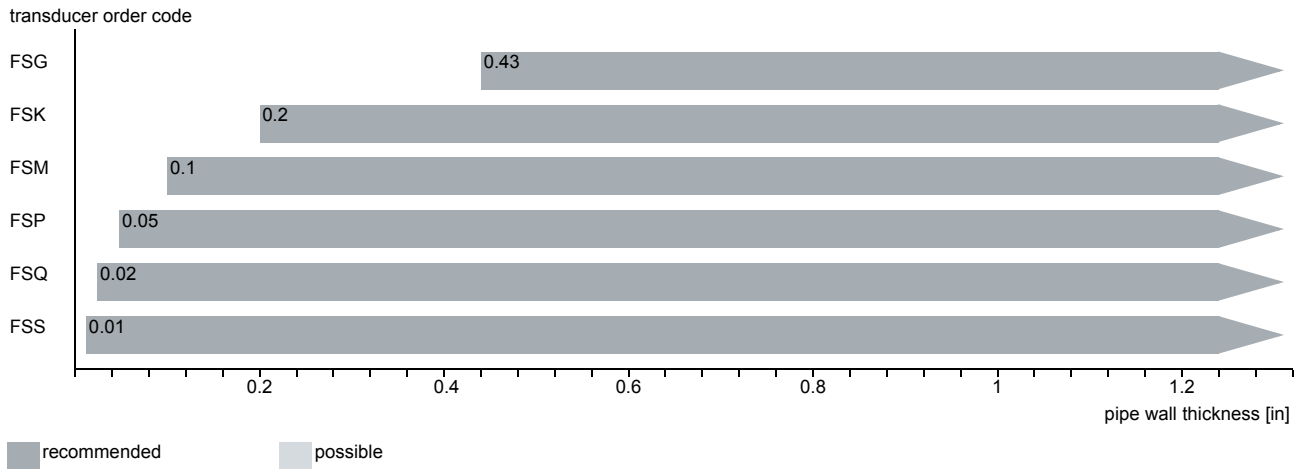
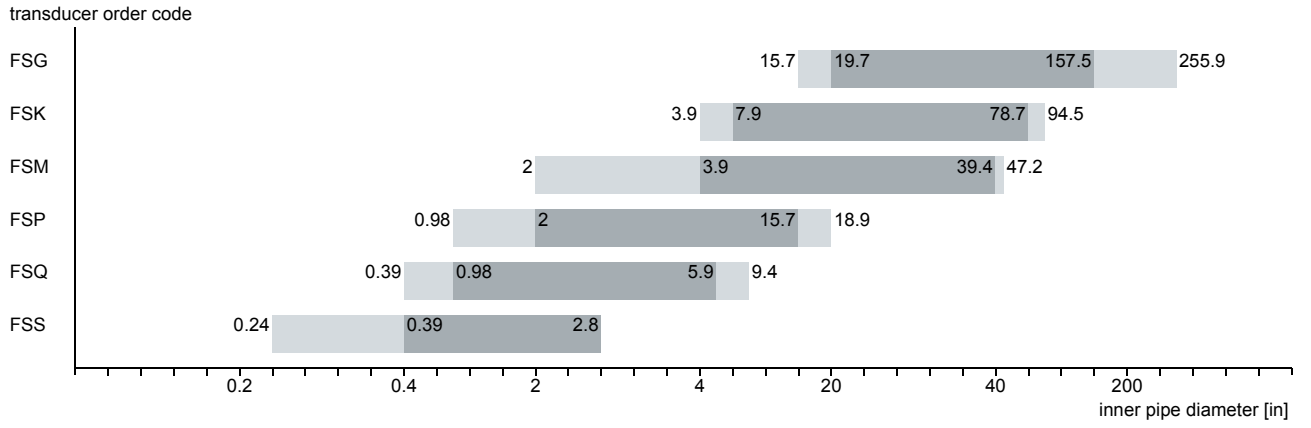
<sup>1</sup> cable (by customer):  
 - e.g., flexible leads, with insulated wire end ferrules, lead cross sectional area: AWG16 to 21  
 - with ferrite nut (nonEx): outer diameter of the cable max. 0.3 in

<sup>2</sup> The number, type and terminal assignment will be customized.



# Transducers

## Transducer selection



recommended
  possible

### Transducer order code

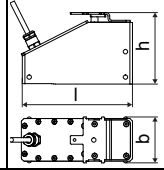
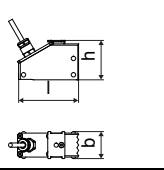
1, 2	3	4	5, 6	7, 8	9 to 11	no. of character				
transducer	transducer frequency	-	ambient temperature	explosion protection	connection system	-	extension cable	/	option	description
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	G									0.2 MHz
	K									0.5 MHz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

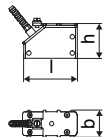
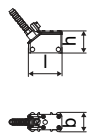

order code	FSG-N**TS/**	FSK-N**TS/**	FSM-N**TS/**	FSP-N**TS/**	FSQ-N**TS/**	FSS-N**TS/**
technical type	C(DL)G1N52	C(DL)K1N52	C(DL)M2N52	C(DL)P2N52	C(DL)Q2N52	CDS1N52
transducer frequency/MHz	0.2	0.5	1	2	4	8
<b>inner pipe diameter d</b>						
min. extended	in 15.7	3.9	2	0.98	0.39	0.24
min. recommended	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
<b>pipe wall thickness</b>						
min.	in 0.43	0.2	0.1	0.05	0.02	0.01
<b>material</b>						
housing	PEEK with stainless steel cap 304, ***-*****/OS: 316L					stainless steel 304
contact surface	PEEK					PEI
degree of protection	NEMA 6					NEMA 4
<b>transducer cable</b>						
type	1699					
length	ft 16	13			9	6
length (**-*****/LC)	ft 29					-
<b>dimensions</b>						
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
<b>pipe surface temperature</b>						
min.	°F -40					-22
max.	°F +266					+266
<b>ambient temperature</b>						
min.	°F -40					-22
max.	°F +266					+266
temperature compensation	x					-
<b>explosion protection</b>						
<b>• ATEX/IECEX</b>						
order code	FSG-NA2TS/**	FSK-NA2TS/**	FSM-NA2TS/**	FSP-NA2TS/**	FSQ-NA2TS/**	-
pipe surface temperature (Ex)						
• min.	°C -55					-
• max.	°C gas: +190, dust: +180					-
marking	CE 0637 Ex II 3G II 2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db					-
certification ATEX	IBExU10ATEX1163 X					-
certification IECEX	IECEX IBE 12.0005X					-
<b>• FM</b>						
order code	FSG-NF2TS/**	FSK-NF2TS/**	FSM-NF2TS/**	FSP-NF2TS/**	FSQ-NF2TS/**	FSS-NF2TS/**
pipe surface temperature (Ex)						
• min.	°F -40					
• max.	°F +257			+374		+257
degree of protection	IP66					
marking	NI/CI, I, II, III/Div. 2 / GP A, B, C, D, E, F, G/ Temp. Codes dwg 3860					

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

order code		FSG-N**TS/IP68	FSK-N**TS/IP68	FSM-N**TS/IP68	FSP-N**TS/IP68
technical type		CDG1L18	CDK1L18	CDM2L18	CDP2L18
transducer frequency	MHz	0.2	0.5	1	2
<b>inner pipe diameter d</b>					
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
<b>pipe wall thickness</b>					
min.	in	0.43	0.2	0.1	0.05
<b>material</b>					
housing		PEEK with stainless steel cap 316Ti			
contact surface		PEEK			
degree of protection		IP68 <sup>1</sup>			
<b>transducer cable</b>					
type		2550			
length	ft	39			
<b>dimensions</b>					
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	
<b>pipe surface temperature</b>					
min.	°F	-40			
max.	°F	+212			
<b>ambient temperature</b>					
min.	°F	-40			
max.	°F	+212			
temperature compensation		x			
<b>explosion protection</b>					
• ATEX/IECEX					
order code		FSG-NA2TS/IP68	FSK-NA2TS/IP68	FSM-NA2TS/IP68	FSP-NA2TS/IP68
pipe surface temperature (Ex)					
• min.	°C	-40			
• max.	°C	gas: +90, dust: +80			
marking		CE 0637 Ex II 3G II 2D Ex nA IIC T6...T2 Gc Ex tb IIIC TX Db			
certification ATEX		IBExU10ATEX1163 X			
certification IECEX		IECEX IBE 12.0005X			

<sup>1</sup> 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
<b>inner pipe diameter d</b>				
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
<b>pipe wall thickness</b>				
min.	in	0.1	0.05	0.02
<b>material</b>				
housing		PI with stainless steel cap 304, ***-****/OS: 316L		
contact surface		PI		
degree of protection		NEMA 4		
<b>transducer cable</b>				
type		6111		
length	ft	13		9
length (**-****/LC)	ft	29		
<b>dimensions</b>				
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
<b>pipe surface temperature</b>				
min.	°F	-22		-22
max.	°F	+450 <sup>1</sup>		+392
<b>ambient temperature</b>				
min.	°F	-22		-22
max.	°F	+104 +140 <sup>2</sup> +392 <sup>3</sup>		+392
temperature compensation		x		
<b>explosion protection</b>				
<b>• ATEX/IECEX</b>				
order code		FSM-EA2TS/**	FSP-EA2TS/**	FSQ-EA2TS/**
pipe surface temperature (Ex)		• min. °C -45 • max. °C gas: +235 <sup>1</sup> , dust: +225 <sup>1</sup>		
marking		CE 0637 Ex 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		
<b>• FM</b>				
order code		FSM-EF2TS/**	FSP-EF2TS/**	FSQ-EF2TS/**
pipe surface temperature (Ex)		• min. °F -40 • max. °F +455 <sup>1</sup>		
degree of protection		IP66		
marking		 NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860		

<sup>1</sup> > +200 °C/+392 °F:

Variofix L (nonEx, Ex) or quick release clasps and tension straps (nonEx)  
 observe the insulation instruction  
 Ex: ambient temperature max. +40 °C/+104 °F

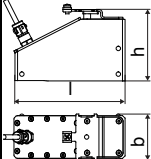
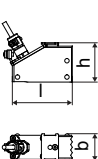
<sup>2</sup> pipe surface temperature +200 to +232 °C/+392 to +450 °F: quick release clasps and tension straps

<sup>3</sup> pipe surface temperature max. +200 °C/+392 °F

## Shear wave transducers (zone 1, TS)

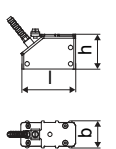
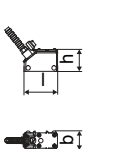
order code		FSG-N*1TS/**	FSK-N*1TS/**	FSM-N*1TS/**	FSP-N*1TS/**	FSQ-N*1TS/**
technical type		C(DL)G1N81	C(DL)K1N81	C(DL)M2N81	C(DL)P2N81	C(DL)Q2N81
transducer frequency	MHz	0.2	0.5	1	2	4
<b>inner pipe diameter d</b>						
min. extended	in	15.7	3.9	2	0.98	0.39
min. recommended	in	19.7	7.9	3.9	2	0.98
max. 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
<b>pipe wall thickness</b>						
min.	in	0.43	0.2	0.1	0.05	0.02
<b>material</b>						
housing		PEEK with stainless steel cap 304 , ***-*****/OS: 316L				
contact surface		PEEK				
degree of protection		IP65	IP66			IP65
<b>transducer cable</b>						
type		1699				
length	ft	16		13		9
length (**-*****/LC)	ft	29				
<b>dimensions</b>						
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
<b>pipe surface temperature</b>						
min.	°F	-40				
max.	°F	+266				
<b>ambient temperature</b>						
min.	°F	-40				
max.	°F	+266				
temperature compensation		x				
<b>explosion protection</b>						
• ATEX/IECEx						
order code		FSG-NA1TS/**	FSK-NA1TS/**	FSM-NA1TS/**	FSP-NA1TS/**	FSQ-NA1TS/**
pipe surface temperature (Ex)						
• min.	°C	-55				
• max.	°C	+180				
marking		CE 0637 Ex II 2G Ex q IIC T6...T3 Gb Ex tb IIC 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
<b>inner pipe diameter d</b>					
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
<b>pipe wall thickness</b>					
min.	in	0.43	0.2	0.1	0.05
<b>material</b>					
housing		PEEK with stainless steel cap 316Ti			
contact surface		PEEK			
degree of protection		IP68 <sup>1</sup>			
<b>transducer cable</b>					
type		2550			
length	ft	39			
<b>dimensions</b>					
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	
<b>pipe surface temperature</b>					
min.	°F	-40			
max.	°F	+212			
<b>ambient temperature</b>					
min.	°F	-40			
max.	°F	+212			
temperature compensation		x			
<b>explosion protection</b>					
<b>• ATEX/IECEX</b>					
order code		FSG-NA1TS/IP68	FSK-NA1TS/IP68	FSM-NA1TS/IP68	FSP-NA1TS/IP68
pipe surface temperature (Ex)					
• min.	°C	-55			
• max.	°C	+80			
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			

<sup>1</sup> 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
<b>inner pipe diameter d</b>				
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
<b>pipe wall thickness</b>				
min.	in	0.1	0.05	0.02
<b>material</b>				
housing		PI with stainless steel cap 304, ***-*****/OS: 316L		
contact surface		PI		
degree of protection		IP66		IP56
<b>transducer cable</b>				
type		6111		
length	ft	13		9
length (**-*****/LC)	ft	29		
<b>dimensions</b>				
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
<b>pipe surface temperature</b>				
min.	°F	-22		-22
max.	°F	+450 <sup>1</sup>		+392
<b>ambient temperature</b>				
min.	°F	-22		-22
max.	°F	+104 +392 <sup>2</sup>		+392
temperature compensation		x		
<b>explosion protection</b>				
• ATEX/IECEX				
order code		FSM-EA1TS/**	FSP-EA1TS/**	FSQ-EA1TS/**
pipe surface temperature (Ex)				
• min.	°C	-45		
• max.	°C	+225 <sup>1</sup>		
marking		CE 0637 Ex II 2G II 2D Ex q IIC T6...T2 Gb Ex tb IIIA TX Db		
certification ATEX		IBEXU07ATEX1168 X		
certification IECEx		IECEX IBE 08.0007X		

<sup>1</sup> > +200 °C/+392 °F:

Variofix L

observe the insulation instruction

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

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

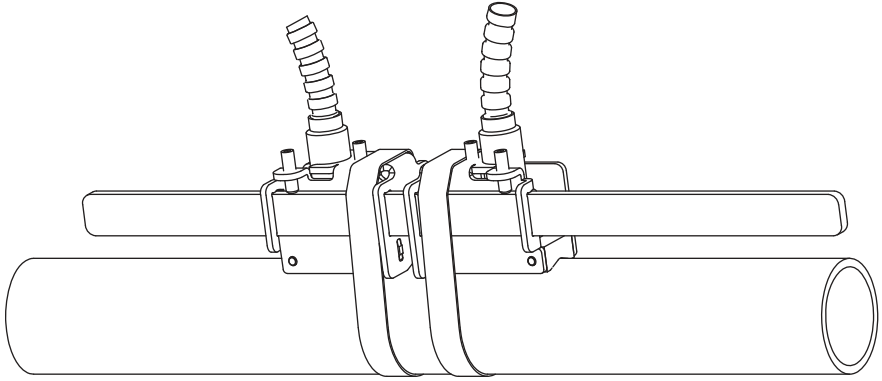


# Transducer mounting fixture

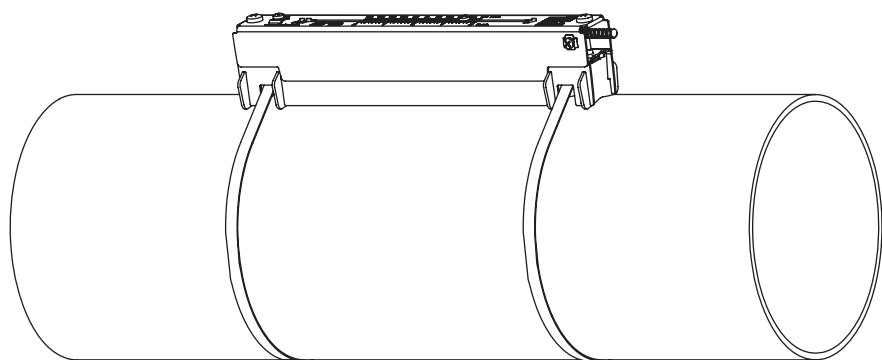
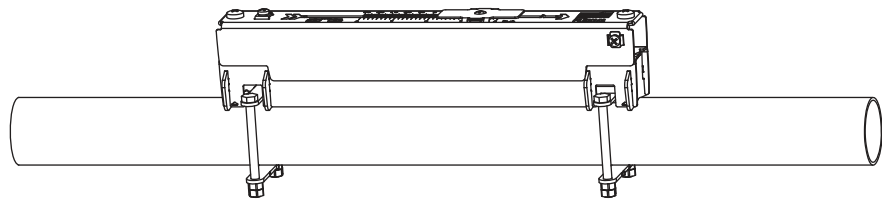
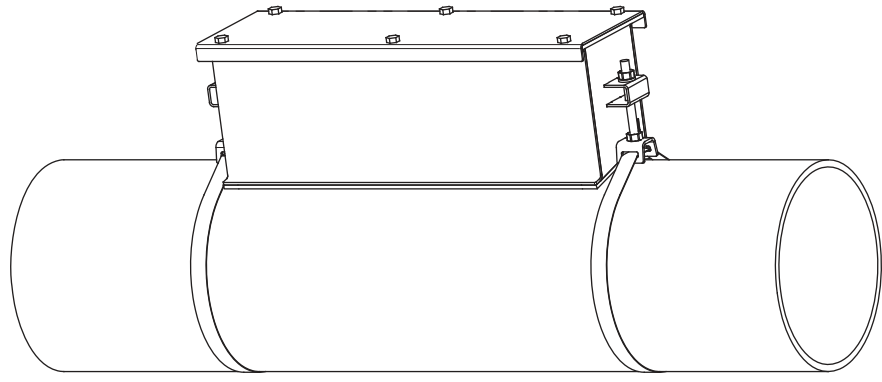
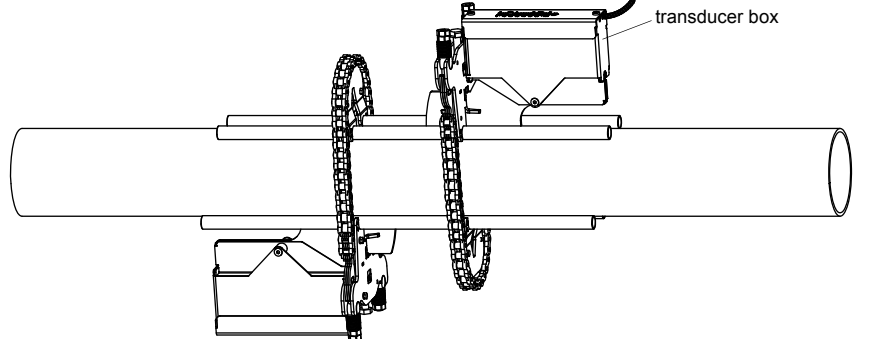
## Order code

1, 2	3	4	5	6	7 to 9	no. of character
transducer mounting fixture	transducer	measurement arrangement	size	fixation	outer pipe diameter	option
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

<p><b>PermaRail (VLK, VLM, VLQ)</b></p> 	<p>material: stainless steel 304, 301, 410  option OS: 316Ti, 316L, 17-7PH  inner length:  <b>VLK</b>: 13.7 in,  option IP68: 14.5 in  <b>VLM</b>: 9.2 in  <b>VLQ</b>: 6.9 in  dimensions:  <b>VLK</b>: 16.65 x 3.54 x 3.66 in  option IP68: 17.44 x 3.7 x 4.13 in  <b>VLM</b>: 12.17 x 2.24 x 2.48 in  <b>VLQ</b>: 9.72 x 1.69 x 1.85 in</p>
<p><b>PermaRail with bolt mounting plates (VL*-**B)</b></p> 	<p>material: stainless steel 304, 301, 410  option OS: 316Ti, 316L, 17-7PH  inner length:  <b>VLM</b>: 9.2 in  <b>VLQ</b>: 6.9 in  dimensions:  <b>VLM</b>: 12.17 x 2.24 x 2.48 in  <b>VLQ</b>: 9.72 x 1.69 x 1.85 in  outer pipe diameter:  max. 1.9 in</p>
<p><b>PermaLok PL</b></p> 	<p>material: stainless steel 316</p>
<p><b>transducer box WI for Wavelnjector</b></p> 	<p>see Technical specification  TSWavelnjectorVx-x</p>

## Coupling materials for transducers

	normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)			Waveinjector WI-400	
	< 212 °F	< 338 °F	< 302 °F	< 392 °F	392 to 464 °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 TF	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 <sup>1</sup>	coupling pad type VT <sup>2</sup>	coupling pad type VT <sup>1</sup>	coupling pad type VT <sup>2</sup>	coupling pad type TF	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT

<sup>1</sup> < 5 years

<sup>2</sup> < 6 months

### 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 752
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
<p>JB01</p>	<p>transmitter</p>	<p>****8*</p>
<p>JB01, JBP2, JBP3</p>	<p>transmitter</p>	<p>****L1*</p>
<p>JB02, JB03, JB04</p>	<p>transmitter</p>	<p>****52</p>

### Cable

transducer cable				
<b>type</b>		<b>1699</b>	<b>2550</b>	<b>6111</b>
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				
<b>type</b>		<b>2615</b>	<b>5245</b>	
connection system		TS	TS	
standard length	ft	-	-	
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	-	0.59	

### Cable length

transducer frequency		F, G, H, K		M, P		Q		S	
connection system TS									
transducers technical type		x		x		x		x	
*(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: ****L *	ft	39	≤ 984	39	≤ 984	-	-	-	-

x = transducer cable length

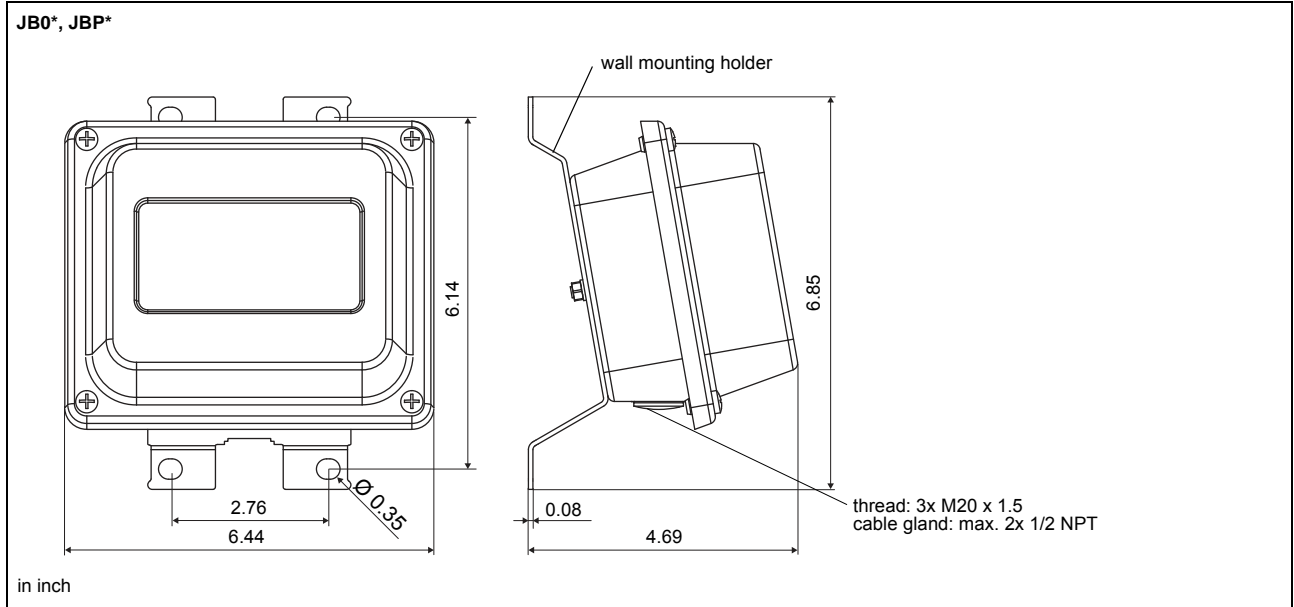
| = max. length of extension cable (depending on application)

# Junction box

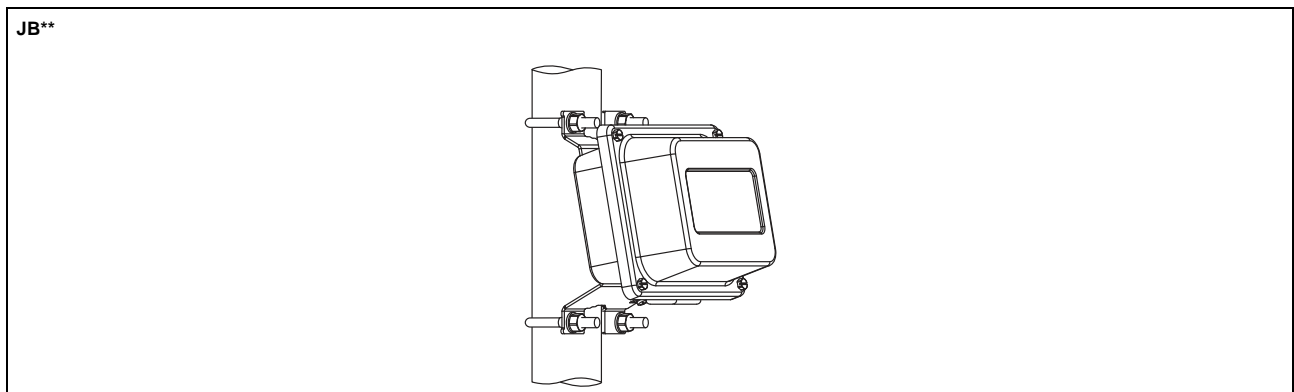
## Technical data

JB01S4E3M, JBP2, JBP3			
weight	lb	2.6 lb	
fixation		wall mounting optional: 2" pipe mounting	
<b>material</b>			
housing		stainless steel 316L	
gasket		silicone	
degree of protection		NEMA 6	
<b>ambient temperature</b>			
min.	°F	-40	
max.	°F	+176	
<b>explosion protection</b>			
• <b>ATEX/IECEx (zone 1)</b>			
junction box		JB01S4E3M	
marking		CE0637 Ex II2G II2D Ex eb mb IIC T6...T4 Gb Ex tb IIIC T100 °C Db Ta -40...+70/80 °C	
certification ATEX		IBEXU06ATEX1161	
certification IECEx		IECEx IBE 08.0006	
type of protection		gas: increased safety decoupled network: encapsulation dust: protection by enclosure	
• <b>ATEX (zone 2)</b>			
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	
<b>Connection</b>			
<b>Transducers</b>			
<b>terminal strip</b>	<b>terminal</b>	<b>connection</b>	<b>transducer</b>
KL1	V	signal	↑
	VS	internal shield	↕
	RS	internal shield	↕
	R	signal	↕
<b>Extension cable</b>			
<b>terminal strip</b>	<b>terminal</b>	<b>connection</b>	
KL2	TV	signal	
	TVS	internal shield	
	TRS	internal shield	
	TR	signal	
<b>JB02, JB03, JB04</b>			
weight	lb	2.6 lb	
fixation		wall mounting optional: 2" pipe mounting	
<b>material</b>			
housing		stainless steel 316L	
gasket		silicone	
degree of protection		IP67	
<b>ambient temperature</b>			
min.	°F	-40	
max.	°F	+176	
<b>explosion protection</b>			
• <b>ATEX</b>			
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	
• <b>FM</b>			
junction box		JB04	
marking		NI/CI. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C	
<b>Connection</b>			
<b>Transducers</b>			
	<b>terminal</b>	<b>connection</b>	<b>transducer</b>
	XV	SMB connector	↑
	XR	SMB connector	↕
<b>Extension cable</b>			
<b>terminal strip</b>	<b>terminal</b>	<b>connection</b>	
KL2	TV	signal	
	TVS	internal shield	
	TRS	internal shield	
	TR	signal	

### Dimensions

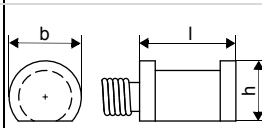
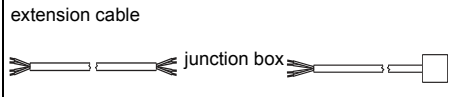
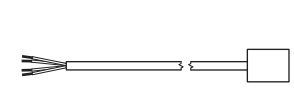
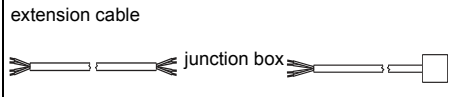
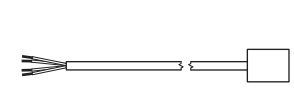
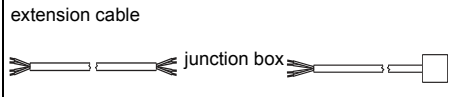
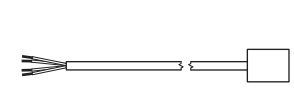
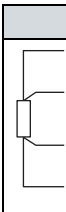
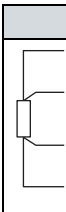
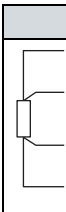
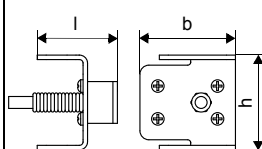
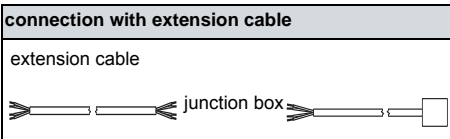
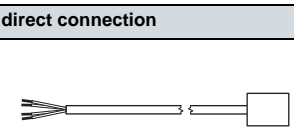
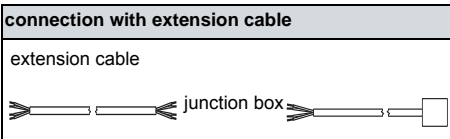
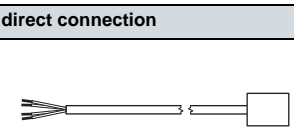
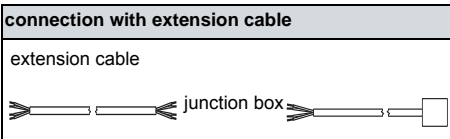
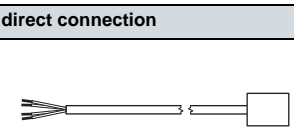
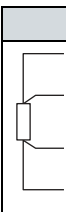
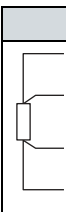
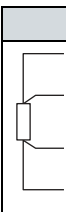


### 2" pipe mounting kit



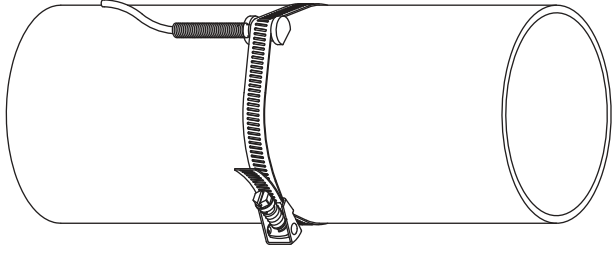
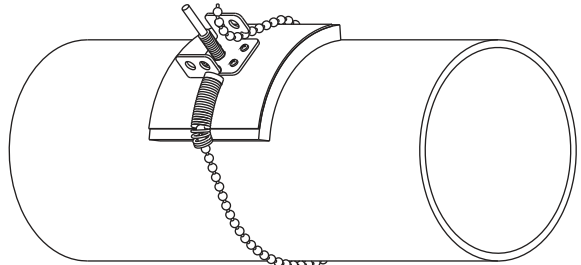
# Clamp-on temperature probe (optional)

## Technical data

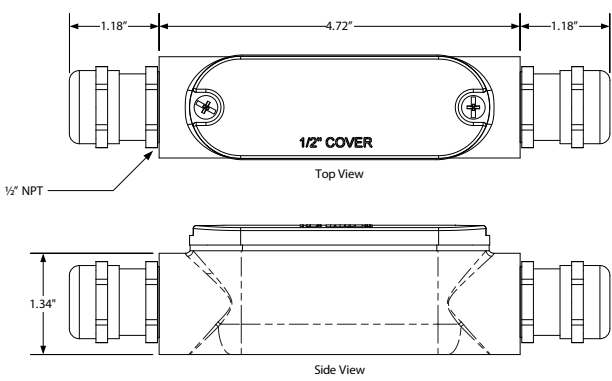
PT13N																
design	clamp-on															
type	Pt1000															
connection	4-wire															
measuring range	°F -40 to +392															
accuracy T	$\pm(0.27\text{ }^\circ\text{F} + 2 \cdot 10^{-3} \cdot ( T\text{ [}^\circ\text{F]}) - 32\text{ }^\circ\text{F})$ class A															
accuracy $\Delta T$ (2x Pt matched according to EN 1434-1)	$\leq 0.03\text{ }^\circ\text{F}$ (at 50 °F)															
housing	360 brass alloy															
degree of protection	NEMA 4															
<b>dimensions</b>																
length l	in 0.79															
width b	in 0.59															
height h	in 0.49															
dimensional drawing																
weight	lb 0.437															
<b>accessories</b>																
thermal conductivity foil 482 °F	x															
<b>Connection system</b>																
<table border="1"> <thead> <tr> <th>connection with extension cable</th> <th>direct connection</th> </tr> </thead> <tbody> <tr> <td>  </td> <td>  </td> </tr> </tbody> </table>		connection with extension cable	direct connection													
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	red															
	red															
	white															
	white															
<b>Cable</b>																
<table border="1"> <thead> <tr> <th></th> <th>temperature probe</th> <th>extension cable</th> </tr> </thead> <tbody> <tr> <td>type</td> <td>4 x 24 AWG</td> <td>4 x 18 AWG</td> </tr> <tr> <td>standard length</td> <td>ft 20</td> <td>-</td> </tr> <tr> <td>max. length</td> <td>ft -</td> <td>656</td> </tr> <tr> <td>cable jacket</td> <td>PTFE</td> <td>LS PVC</td> </tr> </tbody> </table>			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
	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														
<b>PT13F</b>																
design	clamp-on short response time															
type	Pt1000															
connection	4-wire															
measuring range	°F -58 to +482															
accuracy T	$\pm(0.27\text{ }^\circ\text{F} + 2 \cdot 10^{-3} \cdot ( T\text{ [}^\circ\text{F]}) - 32\text{ }^\circ\text{F})$ class A															
accuracy $\Delta T$ (2x Pt matched according to EN 1434-1)	$\leq 0.1\text{ K}$ ( $3\text{ K} < \Delta T < 6\text{ K}$ ), more corresponding to EN 1434															
response time	s 8															
housing	PEEK, stainless steel 304, copper															
degree of protection	NEMA 4															
<b>dimensions</b>																
length l	in 0.55															
width b	in 1.18															
height h	in 1.06															
dimensional drawing																
weight	lb 0.7															
<b>accessories</b>																
thermal conductivity paste 392 °F	x															
thermal conductivity foil 482 °F	x															
plastic protection plate, insulation foam	x															
<b>Connection system</b>																
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	temperature probe	extension cable														
type	4 x 0.25 mm <sup>2</sup> black	4 x 18 AWG														
standard length	ft 9	-														
max. length	ft -	656														
cable jacket	PTFE	PVC														



### Fixation

<p><b>tension strap PT13N</b></p> 	<p>material: stainless steel 301, 410</p>
<p><b>ball chain PT13F</b></p> 	<p>material: stainless steel 316L length: 3 ft</p>

### Junction box



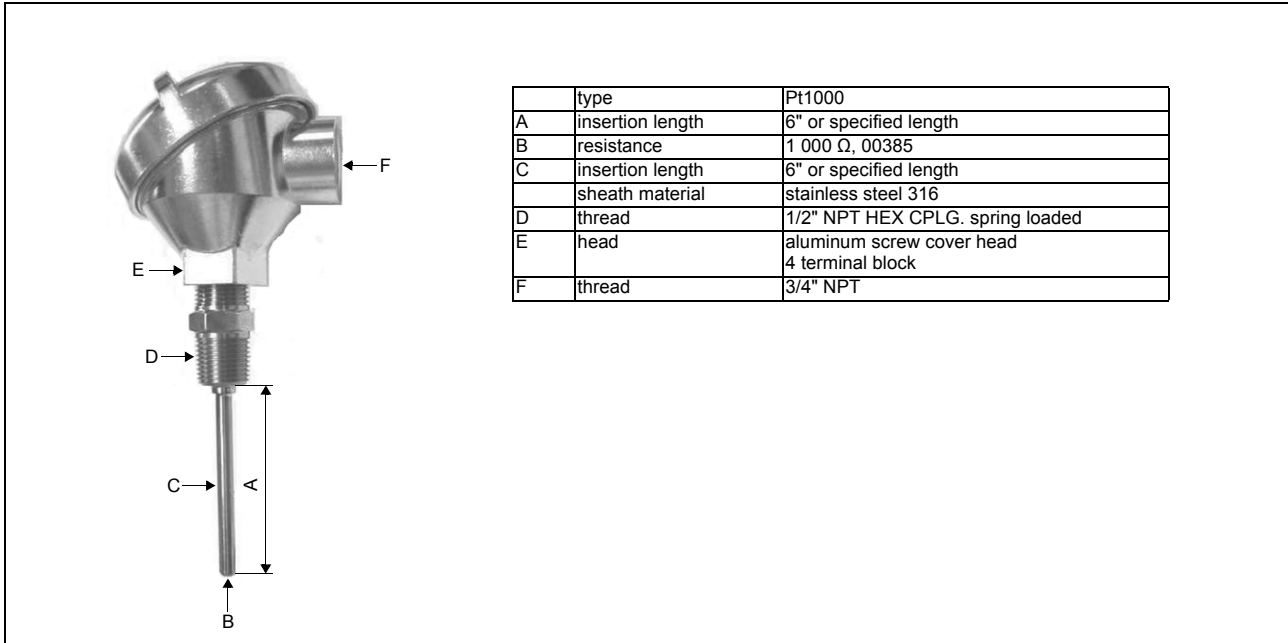
Top View dimensions: 1.18" (left offset), 4.72" (main length), 1.18" (right offset).  
Side View dimension: 1.34" (height).

Labels: 1/2" COVER, 1/2" NPT, Top View, Side View.

**Connection**

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

### Inline temperature probe (optional)



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1-888-852-7473

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