

## Liquid ultrasonic flowmeter for permanent installation

Transmitter for permanent outdoor wall or pipe mounting

### Features

- Precise bi-directional and highly dynamic flow measurement with the non-invasive clamp-on technology
- 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 (-274 to +1112 °F)
- FM Class I Div. 2 approved transducers for hazardous areas 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

- Chemical industry
- Petrochemical industry
- Oil and gas industry
- Pharmaceutical industry
- Semiconductor industry
- Mechanical engineering
- Water and wastewater industry



FLUXUS F704



FLUXUS F705



Measurement with transducers mounted with PermaRail

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## Function

### Measurement principle

#### Transit time difference principle

In order to measure the flow of a fluid in a pipe, ultrasonic signals are used, employing the transit time difference principle. Ultrasonic signals are emitted by a transducer installed on the pipe and received by a second transducer. These signals are emitted alternately in the flow direction and against it.

As the fluid in which the signals propagate is flowing, the transit time of the ultrasonic signals in the flow direction is shorter than against the flow direction.

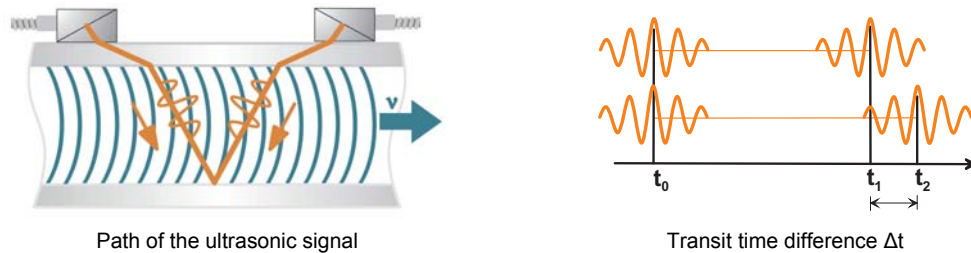
The transit time difference,  $\Delta t$ , is measured and allows the flowmeter to determine the average flow velocity along the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area averaged flow velocity, which is proportional to the volumetric flow rate.

Two integrated microprocessors control the entire measuring process. This allows the flowmeter to remove disturbance signals, and to check each received ultrasonic wave for its validity which reduces noise.

#### HybridTrek

If the gaseous or solid content in the fluid increases occasionally during measurement, a measurement with the transit time difference principle is no longer 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

$$\dot{V} = k_{Re} \cdot A \cdot k_a \cdot \Delta t / (2 \cdot t_{fl})$$

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
- $t_{fl}$  = transit time in the fluid

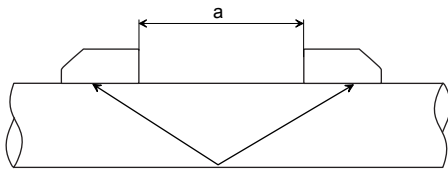
### Number of sound paths

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. Both of 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. Both of 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.

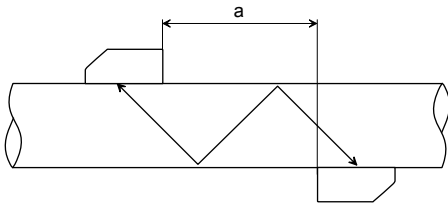
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

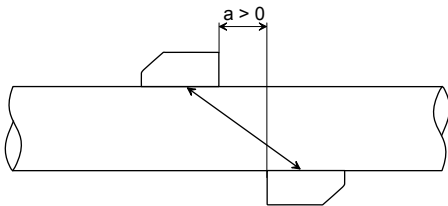


Reflect arrangement, number of sound paths: 2

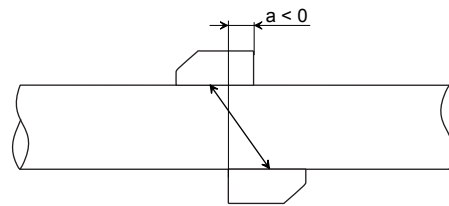
a = transducer distance



Diagonal arrangement, number of sound paths: 3

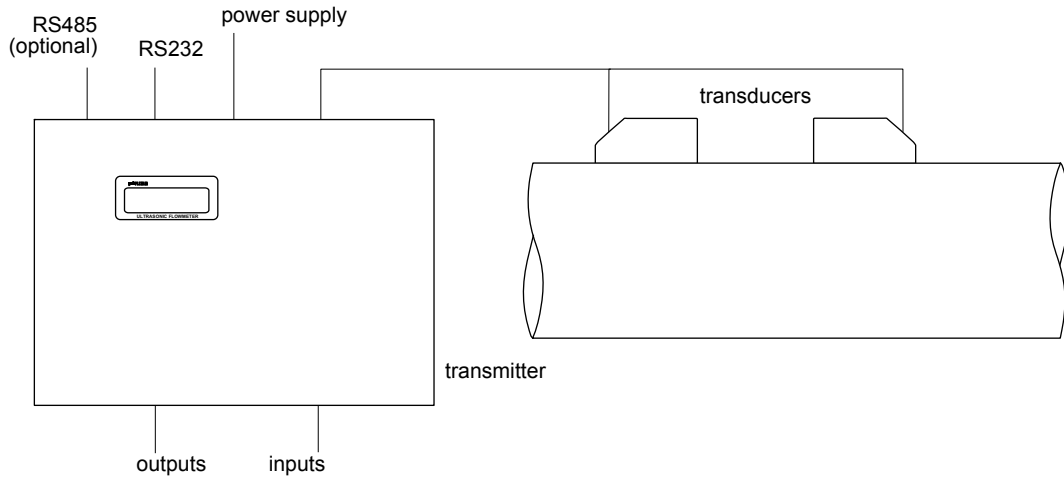


Direct mode, number of sound paths: 1

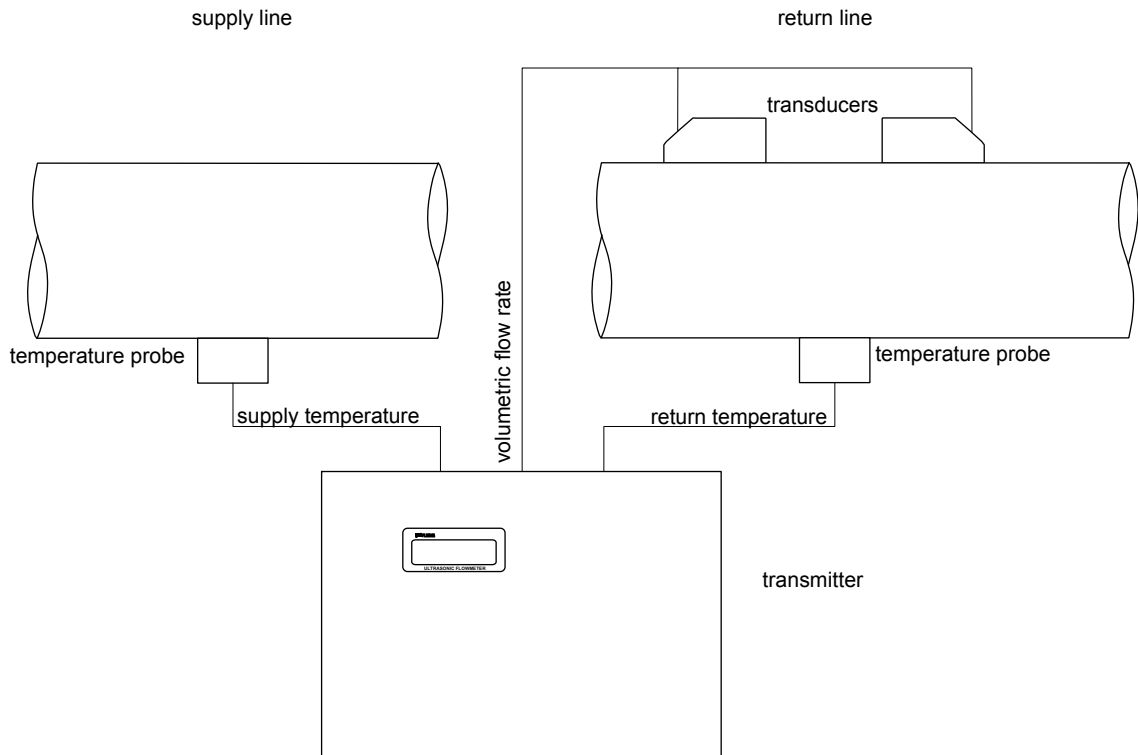


Direct mode, number of sound paths: 1,  
negative transducer distance

### Typical measurement setup









Example of a reflect arrangement



Example of a heat flow measurement

# Flow transmitter

## Technical data

FLUXUS	F704**-NN F704**-F2	F705**-NN F705**-F2 (F704.316SE)
design	standard field device	field device with 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	0.03 to 82 ft/s	
repeatability	0.15 % of reading ±0.03 ft/s	
fluid	all acoustically conductive liquids with < 10 % gaseous or solid content in volume (transit time difference principle)	
temperature compensation	corresponding to the recommendations in ANSI/ASME MFC-5.1-2011	
<b>accuracy<sup>1</sup></b>		
with standard calibration	±1.6 % of reading ±0.03 ft/s	
with advanced calibration (optional)	±1.2 % of reading ±0.03 ft/s	
with field calibration <sup>2</sup>	±0.5 % of reading ±0.03 ft/s	
<b>flow transmitter</b>		
power supply	100 to 230 V/50 to 60 Hz or 20 to 32 V DC	
power consumption	< 15 W	
number of flow measuring channels	1, optional: 2	
damping	0 to 100 s, adjustable	
measuring cycle (1 channel)	100 to 1000 Hz	
response time	1 s (1 channel), option: 70 ms	
housing material	aluminum, powder coated	stainless steel 316L
degree of protection	NEMA 4	NEMA 4X
dimensions	see dimensional drawing	
weight	6.8 lb	10.8 lb
fixation	wall mounting, optional: 2" pipe mounting	
ambient temperature	-4 to +131/140 °F	
display	2 x 16 characters, dot matrix, backlight	
menu language	English, German, French, Dutch, Spanish	
<b>explosion protection (optional)</b>		
FM	transmitter marking	F704**-F2
		F705**-F2
	F70[1 or 2]Z2**[1 or 2]:	F703Z2**[1 or 2]:
	 NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 Ta = 60 °C	 NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T5 Ta = 60 °C
	F70[1 or 2]Z2**9:	F703Z2**9:
	 NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A Ta = 55 °C	 NI/Cl. I,II,III/Div. 2/ GP. A,B,C,D,E,F,G/ T4A Ta = 55 °C

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

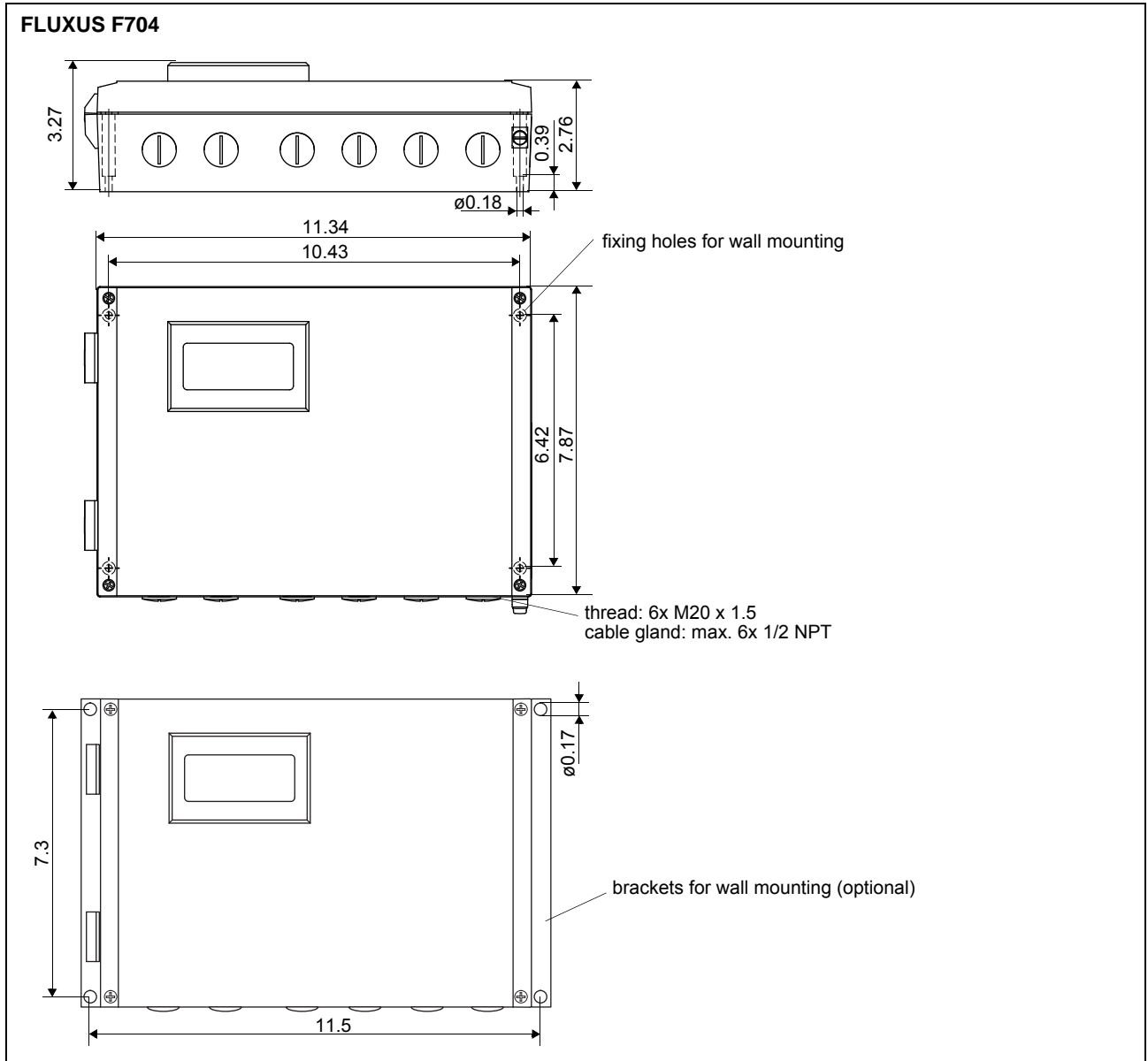
<sup>2</sup> reference uncertainty < 0.2 %

FLUXUS	F704**-NN F704**-F2	F705**-NN F705**-F2 (F704.316SE)
<b>measuring functions</b>		
physical quantities	volumetric flow rate, mass flow rate, flow velocity, heat flow (if temperature inputs are installed)	
totalizer	volume, mass, optional: heat quantity	
calculation functions	average, difference, sum (2 measuring channels necessary)	
diagnostic functions	sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times	
<b>data logger</b>		
loggable values	all physical quantities, totaled values and diagnostic values	
capacity	> 100 000 measured values	
<b>SD card, removable (nonEx, optional)</b>		
loggable values	all physical quantities and totaled values	
capacity	min. 2 GB	
<b>communication</b>		
interface	- process integration (optional): RS485 (sender) or Modbus RTU or HART or FF H1 or BACnet MS/TP (nonEx) or BACnet IP (nonEx) or SD card (nonEx) - diagnosis: RS232	
<b>serial data kit (optional)</b>		
software	- FluxDiagReader: download of measured values and parameters, graphical presentation - FluxDiag (optional): download of measurement data, graphical presentation, report generation - FluxSubstanceLoader: upload of fluid data sets	
cable	RS232	
adapter	RS232 - USB	
<b>outputs (optional)</b>		
	The outputs are galvanically isolated from the transmitter.	
number	on request	
<b>switchable current output</b>		
	All switchable current outputs are switched to active or passive mode at the same time.	
- range	4 to 20 mA (3.2 to 22 mA)	
- 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 $R_{\text{ext}}$ , $R_{\text{ext}} < 1 \text{ k}\Omega$	
<b>current output</b>		
current output		
- range	0/4 to 20 mA	
- accuracy	0.1 % of reading $\pm 15 \mu\text{A}$	
- active output	$R_{\text{ext}} < 500 \Omega$	
- passive output	$U_{\text{ext}} = 4 \text{ to } 24 \text{ V}$ , depending on $R_{\text{ext}}$ , $R_{\text{ext}} < 1 \text{ k}\Omega$	
current output I1 in HART mode		
- range	4 to 20 mA	
- passive output	$U_{\text{ext}} = 10 \text{ to } 24 \text{ V}$	
<b>voltage output</b>		
range	0 to 1 V or 0 to 10 V	
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	0 to 5 kHz	
open collector	24 V/4 mA, $R_{\text{int}} = 66.5 \Omega$	
<b>binary output</b>		
Reed relay	48 V/100 mA, P1 to P4: $R_{\text{int}} = 22 \Omega$	
open collector	24 V/4 mA, P1 to P4: $R_{\text{int}} = 22 \Omega$	
optorelay	26 V/100 mA	
binary output as alarm output		
- functions	limit, change of flow direction or error	
binary output as pulse output	mainly for totalizing	
- pulse value	0.01 to 1000 units	
- pulse width	optorelay: 1 to 1000 ms Reed relay, open collector: 80 to 1000 ms	

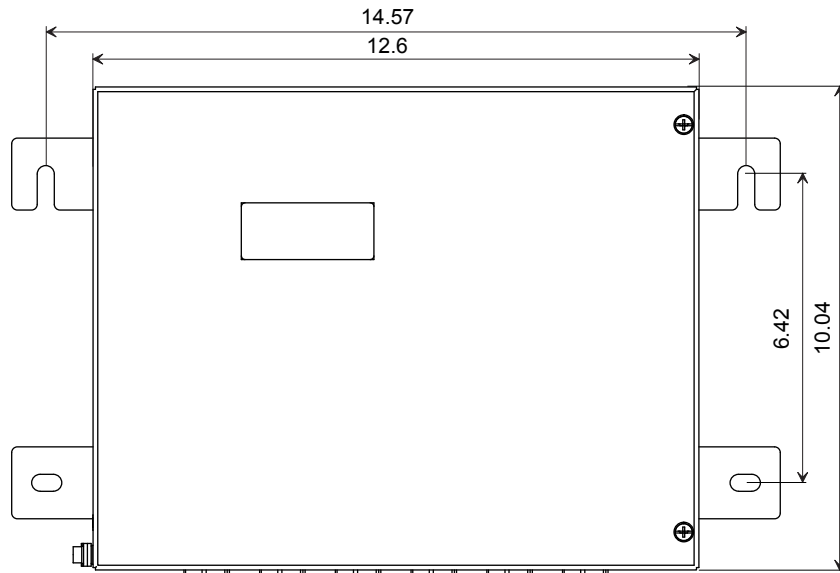
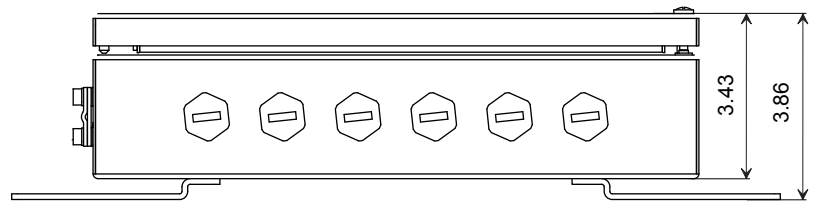
FLUXUS	F704**-NN F704**-F2	F705**-NN F705**-F2 (F704.316SE)
<b>inputs (optional)</b>		
	The inputs are galvanically isolated from the transmitter.	
number	max. 4, on request	
<b>temperature input</b>		
type	Pt100/Pt1000	
connection	4-wire	
range	-238 to +1040 °F	
resolution	0.01 K	
accuracy	±0.01 % of reading ±0.03 K	
<b>current input</b>		
accuracy	0.1 % of reading ±10 µA	
active input	U <sub>int</sub> = 24 V, R <sub>int</sub> = 50 Ω, P <sub>int</sub> < 0.5 W, not short-circuit proof	
- range	0 to 20 mA	
passive input	R <sub>int</sub> = 50 Ω, P <sub>int</sub> < 0.3 W	
- range	-20 to +20 mA	
<b>voltage input</b>		
range	0 to 1 V	
accuracy	0.1 % of reading ±1 mV	
internal resistance	R <sub>int</sub> = 1 MΩ	
<b>binary input</b>		
switching signal	5 to 30 V, 1 mA FM Class I Div. 2: 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>	



### Dimensions



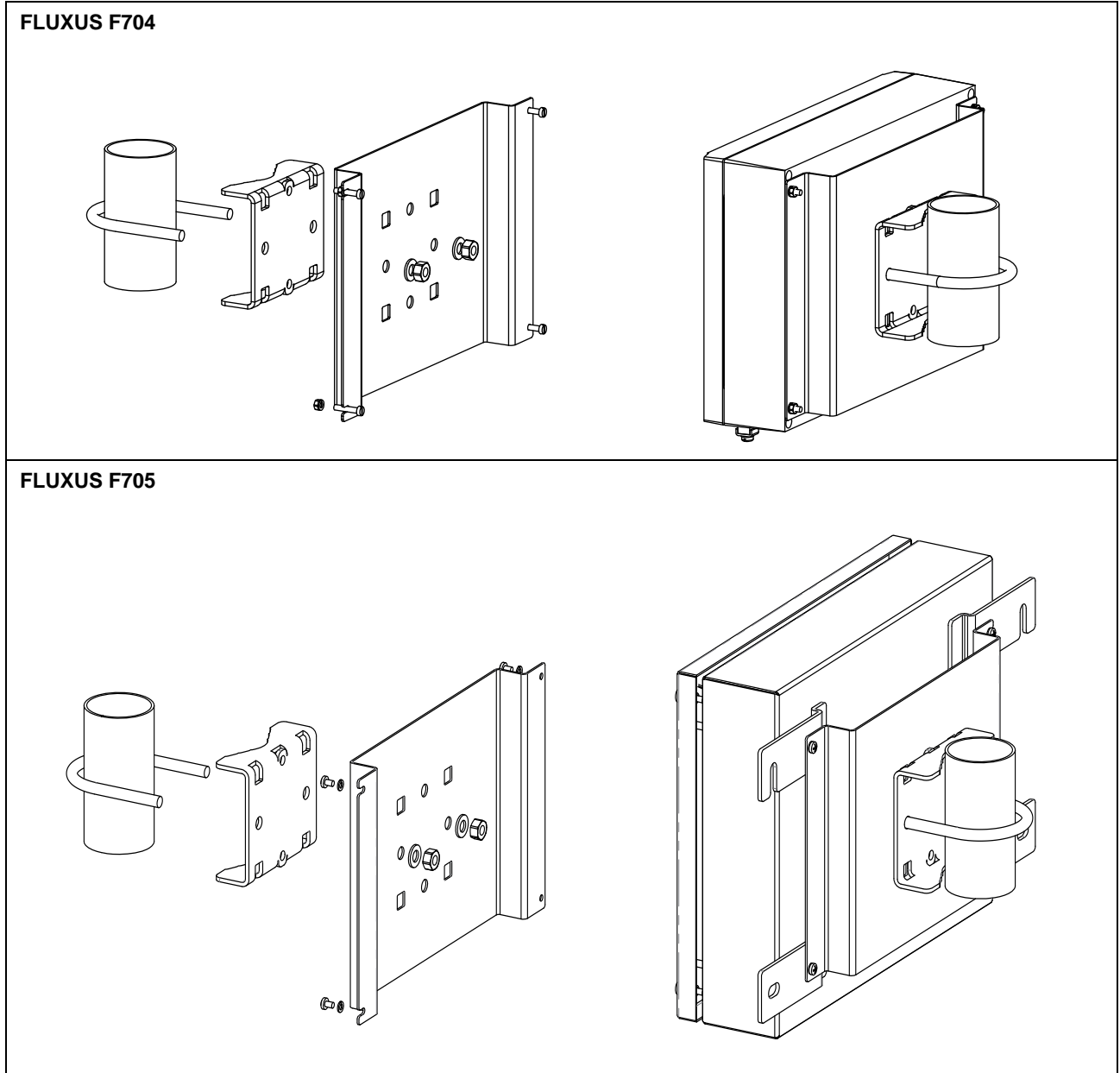
**FLUXUS F705**



cable gland: max. 6x 1/2 NPS with counter nut

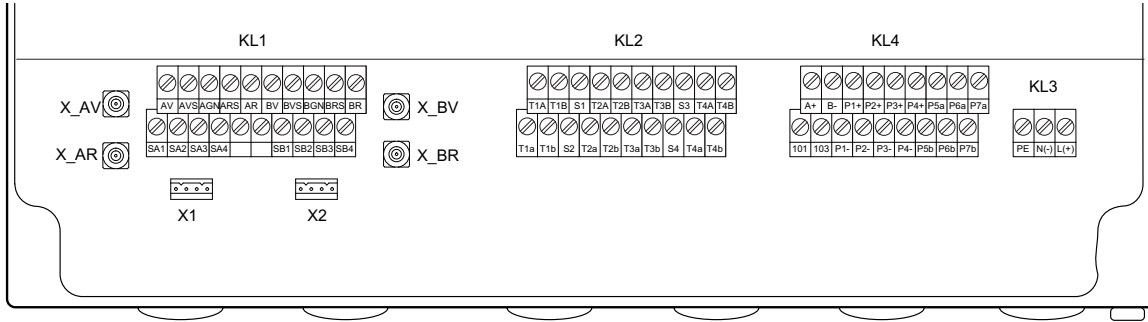
in inch

### 2" pipe mounting kit (optional)



## Terminal assignment

### FLUXUS F704, F705



### power supply

terminal strip KL3

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

### transducers

terminal strip KL1

extension cable (transducers ****LI*, *****52)			
transducer cable (transducers ****LI*)			
measuring channel A		measuring channel B	
terminal	connection	terminal	connection
AV	signal	BV	signal
AVS	shield	BVS	shield
ARS	shield	BRS	shield
AR	signal	BR	signal

transducer cable (transducers *****52)		
measuring channel A		measuring channel B
terminal		connection
X_AV	X_BV	SMB connector
X_AR	X_BR	SMB connector

### outputs<sup>2</sup>

terminal strip KL4

terminal	connection
P1+ to P4+, P1- to P4-	current output, voltage output, frequency output or binary output (Reed relay, open collector)
P5a to P7a, P5b to P7b	binary output

### communication interface

terminal strip KL4

terminal	connection
A+	signal +
B-	signal -
101	shield

### analog inputs<sup>2</sup>

terminal strip KL2

terminal	temperature probe				passive current source connection of an active input	active current source connection of a passive input
	with connector direct connection	connection with extension cable	without connector 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 to S4	shield	shield	-	-	not connected	not connected

### binary inputs<sup>2</sup>

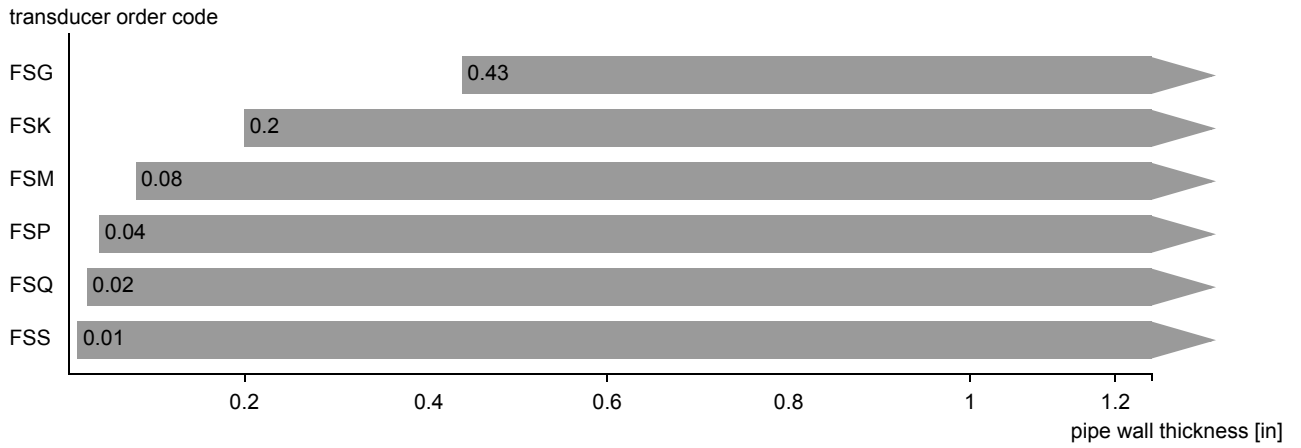
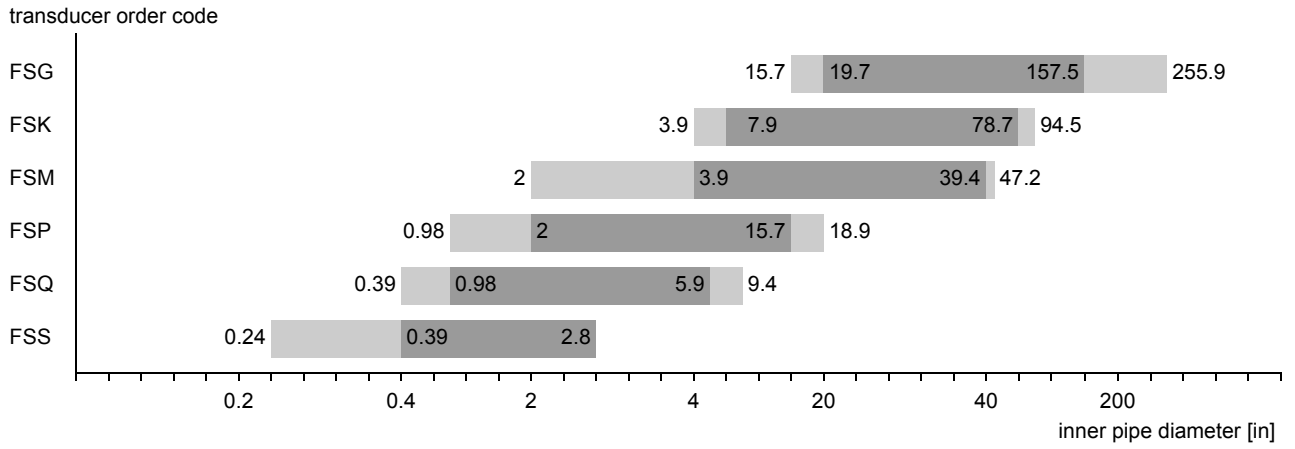
terminal strip KL4

terminal
P1+ to P2+, P1- to P2-

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

# Transducers

## Transducer selection



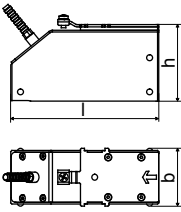
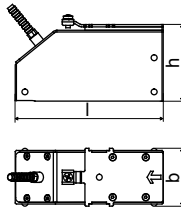
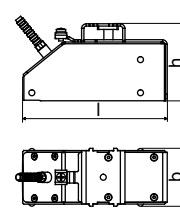
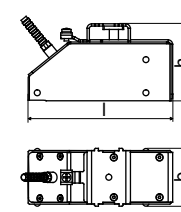




recommended
  possible

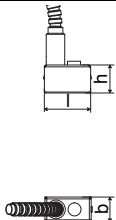

### Transducer order code

1, 2	3	4	5, 6	7, 8	9 to 11	12, 13	no. of character								
transducer	transducer frequency	-	ambient temperature	explosion protection	connection system	-	extension cable	/	option						
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 (FSM, FSP, FSQ)												
F2				FM Class I Div. 2											
NN				not explosion proof											
TS					direct connection or connection via junction box										
XXX						cable length in m, for max. length of extension cable see page 24									
						connection system TS: 0 m: without junction box > 0 m: with junction box									
LC							long transducer cable								
IP68							degree of protection NEMA6P								
OS							housing with stainless steel 316								
example															
FS	M	-	N	F2	TS	-	030			shear wave transducer 1 MHz, normal temperature range, FM Class I Div. 2, connection system TS with junction box and extension cable 30 m (98 ft)					
		-				-		/							

**Technical data**

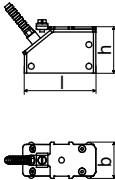
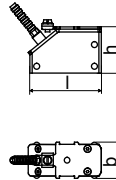
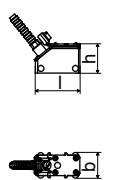



**Shear wave transducers (FM Class I Div. 2 or not explosion proof)**

technical type		CDG1N52	CLG1N52	CDK1N52	CLK1N52	
order code		FSG-NF2TS FSG-NF2TS/OS FSG-NNNTS FSG-NNNTS/OS	FSG-NF2TS/LC FSG-NF2TS/LC/OS FSG-NNNTS/LC FSG-NNNTS/LC/OS	FSK-NF2TS FSK-NF2TS/OS FSK-NNNTS FSK-NNNTS/OS	FSK-NF2TS/LC FSK-NF2TS/LC/OS FSK-NNNTS/LC FSK-NNNTS/LC/OS	
transducer frequency	MHz	0.2	0.2	0.5	0.5	
<b>inner pipe diameter d</b>						
min. extended	in	15.7	15.7	3.9	3.9	
min. recommended	in	19.7	19.7	7.9	7.9	
max. recommended	in	157.5	157.5	78.7	78.7	
max. extended	in	255.9	255.9	94.5	94.5	
<b>pipe wall thickness</b>						
min.	in	0.43	0.43	0.2	0.2	
<b>material</b>						
housing		PEEK with stainless steel cap 304, option OS: 316L	PEEK with stainless steel cap 304, option OS: 316L	PEEK with stainless steel cap 304, option OS: 316L	PEEK with stainless steel cap 304, option OS: 316L	
contact surface		PEEK	PEEK	PEEK	PEEK	
degree of protection		NEMA 6	NEMA 6	NEMA 6	NEMA 6	
<b>transducer cable</b>						
type		1699	1699	1699	1699	
length	ft	16	29	16	29	
<b>dimensions</b>						
length l	in	5.1	5.1	4.98	4.98	
width b	in	2.01	2.01	2.01	2.01	
height h	in	2.64	2.64	2.66	2.66	
dimensional drawing						
<b>ambient temperature</b>						
min.	°F	-40	-40	-40	-40	
max.	°F	+266	+266	+266	+266	
temperature compensation		x	x	x	x	
<b>explosion protection</b>						
FM	order code	FSG-NF2TS FSG-NF2TS/OS	FSG-NF2TS/LC FSG-NF2TS/LC/OS	FSK-NF2TS FSK-NF2TS/OS	FSK-NF2TS/LC FSK-NF2TS/LC/OS	
	<b>explosion protection temperature</b>					
	min.	°F	-40	-40	-40	-40
	max.	°F	+257	+257	+257	+257
	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	 NI/Cl. I,II,III/Div. 2 / GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860
type of protection		non incandive	non incandive	non incandive	non incandive	

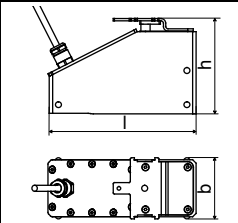
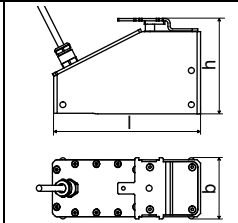
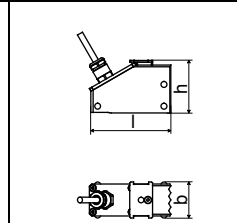
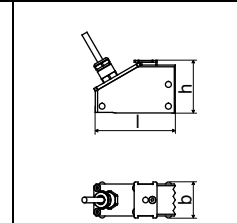
technical type		CDS1N52
order code		<b>FSS-NF2TS</b> <b>FSS-NNNTS</b>
transducer frequency	MHz	8
<b>inner pipe diameter d</b>		
min. extended	in	0.24
min. recommended	in	0.39
max. recommended	in	2.8
max. extended	in	2.8
<b>pipe wall thickness</b>		
min.	in	0.01
<b>material</b>		
housing		stainless steel 304
contact surface		PEI
degree of protection		NEMA 4
<b>transducer cable</b>		
type		1699
length	ft	6
<b>dimensions</b>		
length l	in	0.98
width b	in	0.51
height h	in	0.67
dimensional drawing		
<b>ambient temperature</b>		
min.	°F	-22
max.	°F	+266
temperature compensation		-
<b>explosion protection</b>		
order code		FSS-NF2TS
<b>explosion protection temperature</b>		
min.	°F	-40
max.	°F	+257
F M	marking	NI/Cl. I,II,III/Div. 2 /  GP A,B,C,D,E,F,G/ Temp. Codes dwg 3860
	type of protection	non incensive



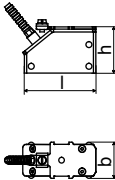
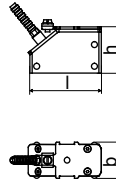
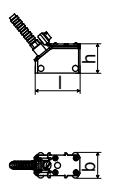



**Shear wave transducers (FM Class I Div. 2 or not explosion proof)**

technical type		CDM2N52	CDP2N52	CDQ2N52	
order code		<b>FSM-NF2TS</b> <b>FSM-NF2TS/OS</b> <b>FSM-NNNTS</b> <b>FSM-NNNTS/OS</b>	<b>FSP-NF2TS</b> <b>FSP-NF2TS/OS</b> <b>FSP-NNNTS</b> <b>FSP-NNNTS/OS</b>	<b>FSQ-NF2TS</b> <b>FSQ-NF2TS/OS</b> <b>FSQ-NNNTS</b> <b>FSQ-NNNTS/OS</b>	
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	0.08	0.04	0.02	
<b>material</b>					
housing		PEEK with stainless steel cap 304, option OS: 316L	PEEK with stainless steel cap 304, option OS: 316L	PEEK with stainless steel cap 304, option OS: 316L	
contact surface		PEEK	PEEK	PEEK	
degree of protection		NEMA 6	NEMA 6	NEMA 6	
<b>transducer cable</b>					
type		1699	1699	1699	
length	ft	13	13	9	
<b>dimensions</b>					
length l	in	2.52	2.52	1.57	
width b	in	1.26	1.26	0.87	
height h	in	1.59	1.59	1	
dimensional drawing					
<b>ambient temperature</b>					
min.	°F	-40	-40	-40	
max.	°F	+266	+266	+266	
temperature compensation		x	x	x	
<b>explosion protection</b>					
<b>FM</b>	order code		FSM-NF2TS FSM-NF2TS/OS	FSP-NF2TS FSP-NF2TS/OS	FSQ-NF2TS FSQ-NF2TS/OS
	<b>explosion protection temperature</b>				
	min.	°F	-40	-40	-40
	max.	°F	+374	+374	+374
	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
type of protection		non incandive	non incandive	non incandive	

**Shear wave transducers (not explosion proof, NEMA 6P)**

technical type		CDG1LI8	CDK1LI8	CDM2LI8	CDP2LI8
order code		<b>FSG-NNNTS/IP68</b>	<b>FSK-NNNTS/IP68</b>	<b>FSM-NNNTS/IP68</b>	<b>FSP-NNNTS/IP68</b>
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	0.08	0.04
<b>material</b>					
housing		PEEK with stainless steel cap 316Ti	PEEK with stainless steel cap 316Ti	PEEK with stainless steel cap 316Ti	PEEK with stainless steel cap 316Ti
contact surface		PEEK	PEEK	PEEK	PEEK
degree of protection		NEMA 6P	NEMA 6P	NEMA 6P	NEMA 6P
<b>transducer cable</b>					
type		2550	2550	2550	2550
length	ft	39	39	39	39
<b>dimensions</b>					
length l	in	5.12	5.12	2.76	2.76
width b	in	2.13	2.13	1.26	1.26
height h	in	3.29	3.29	1.81	1.81
dimensional drawing					
<b>ambient temperature</b>					
min.	°F	-40	-40	-40	-40
max.	°F	+212	+212	+212	+212
temperature compensation		x	x	x	x

**Shear wave transducers (extended temperature range, FM Class I Div. 2 or not explosion proof)**

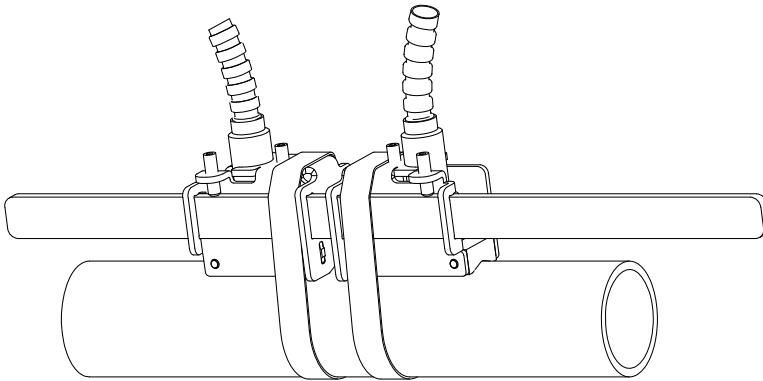
technical type		CDM2E52	CDP2E52	CDQ2E52	
order code		<b>FSM-EF2TS</b> <b>FSM-EF2TS/OS</b> <b>FSM-ENNTS</b> <b>FSM-ENNTS/OS</b>	<b>FSP-EF2TS</b> <b>FSP-EF2TS/OS</b> <b>FSP-ENNTS</b> <b>FSP-ENNTS/OS</b>	<b>FSQ-EF2TS</b> <b>FSQ-EF2TS/OS</b> <b>FSQ-ENNTS</b> <b>FSQ-ENNTS/OS</b>	
transducer frequency	MHz	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	0.08	0.04	0.02	
<b>material</b>					
housing		PI with stainless steel cap 304, option OS: 316L	PI with stainless steel cap 304, option OS: 316L	PI with stainless steel cap 304, option OS: 316L	
contact surface		PI	PI	PI	
degree of protection		NEMA 4	NEMA 4	NEMA 4	
<b>transducer cable</b>					
type		6111	6111	6111	
length	ft	13	13	9	
<b>dimensions</b>					
length l	in	2.52	2.52	1.57	
width b	in	1.26	1.26	0.87	
height h	in	1.59	1.59	1	
dimensional drawing					
<b>ambient temperature</b>					
min.	°F	-22	-22	-22	
max.	°F	+392	+392	+392	
temperature compensation		x	x	x	
<b>explosion protection</b>					
<b>F M</b>	order code	<b>FSM-EF2TS</b> <b>FSM-EF2TS/OS</b>	<b>FSP-EF2TS</b> <b>FSP-EF2TS/OS</b>	<b>FSQ-EF2TS</b> <b>FSQ-EF2TS/OS</b>	
	<b>explosion protection temperature</b>				
	min.	°F	-40	-40	-40
	max.	°F	+455	+455	+455
	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
type of protection		non incandive	non incandive	non incandive	

### Transducer mounting fixture

#### Order code

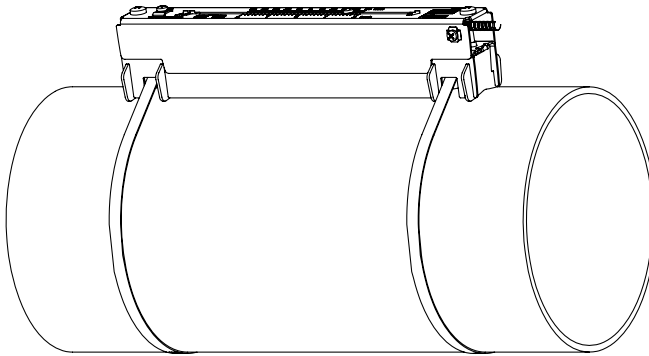
1, 2	3	4	5	6	7 to 9	10, 11	no. of character			
transducer mounting fixture	transducer	-	measurement arrangement	size	-	fixation	outer pipe diameter	/	option	description
PL										PermaLok
VL										PermaRail
WI										transducer box for WaveInjector
	K									transducers with transducer frequency G, K
	M									transducers with transducer frequency M, P
	Q									transducers with transducer frequency Q
	S									transducers with transducer frequency S
			D							reflect arrangement or diagonal arrangement/direct mode
			R							reflect arrangement
				S						small
				M						medium
				L						large
						B				bolts
						S				tension straps
						W				welding
						N				without fixation
							SK1			0.5 to 2.5 in
							SK2			3 to 6 in
							SK3			8 to 10 in
							SK4			12 to 18 in
							SK5			20 to 36 in
							SK6			42 to 100 in
							SK7			100 to 170 in
							SK8			170 to 370 in
							NDR			any
								IP68		degree of protection NEMA6P
								OS		housing with stainless steel 316
								Z		special design
example										
VL	M	-	D	S	-	S	200			PermaRail and tension straps for transducers with transducer frequency M, P
		-			-			/		

**PermaRail (VLS)**



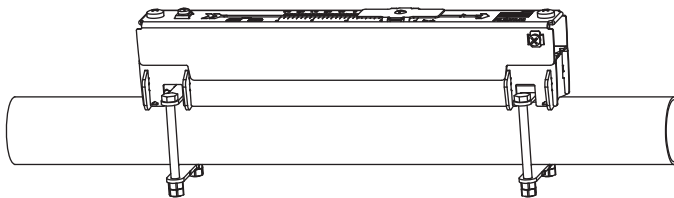
transducer frequency: S  
material: stainless steel 304, 303

**PermaRail (VLK, VLM, VLQ)**



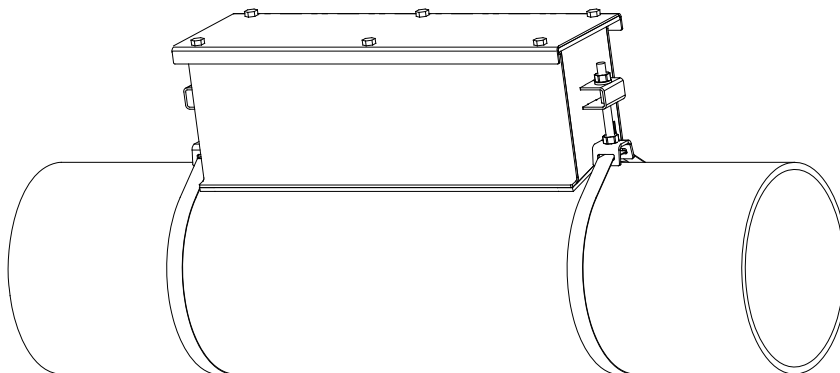
material: stainless steel 304, 301, 410  
option OS: 316, 316L, 17-7PH  
inner length:  
**VLK:** 13.7 in,  
option IP68: 14.5 in  
**VLM:** 9.2 in  
**VLQ:** 6.9 in  
dimensions:  
**VLK:** 16.65 x 3.54 x 3.66 in,  
option IP68: 17.44 x 3.7 x 4.13 in  
**VLM:** 12.17 x 2.24 x 2.48 in  
**VLQ:** 9.72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

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

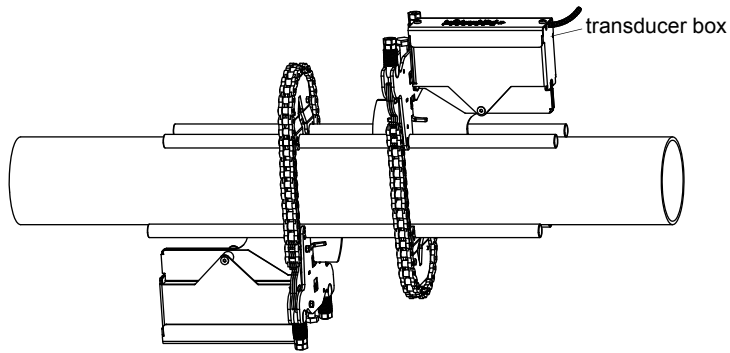


material: stainless steel 304, 301, 410  
option OS: 316, 316L, 17-7PH  
inner length:  
**VLM:** 9.2 in  
**VLQ:** 6.9 in  
dimensions:  
**VLM:** 12.17 x 2.24 x 2.48 in  
**VLQ:** 9.72 x 1.69 x 1.85 in  
outer pipe diameter:  
max. 1.9 in

**PermaLok PL**



**transducer box WI for WaveInjector**



see Technical specification  
TSWaveInjectorVx-x

## Coupling materials for transducers

	normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)		WaveInjector WI-400	
	< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 752 °F
< 24 h	coupling compound type N or coupling pad type VT	coupling compound type E or coupling pad type VT	coupling compound type E or coupling pad type VT	coupling compound type E or H or coupling pad type VT	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT
long time measurement	coupling pad type VT <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 A and coupling pad type VT	coupling pad type B and coupling pad type VT

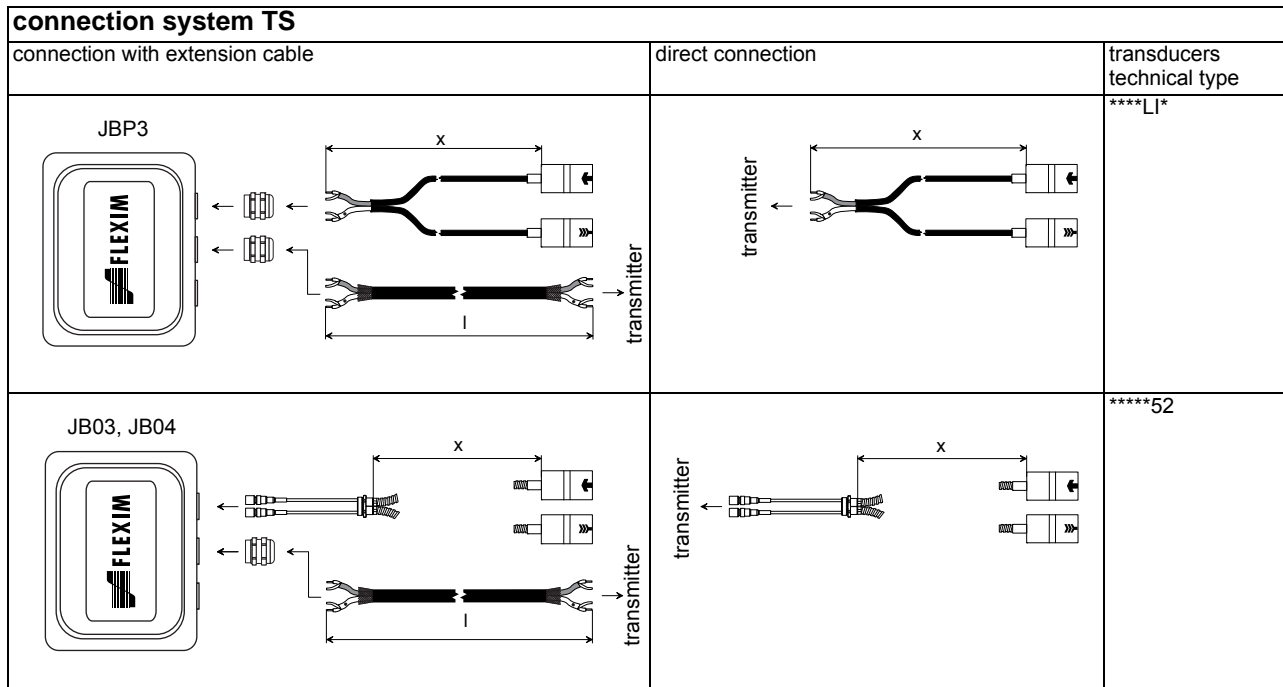
<sup>1</sup> < 5 years

<sup>2</sup> < 6 months

## Technical data

type	ambient temperature °F	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



transducer frequency (3d character of transducer order code)		F, G, H, K		M, P		Q		S		
T	S	x	l	x	l	x	l	x	l	
	cable length	ft	16	≤ 984	13	≤ 984	9	≤ 295	6	≤ 131
	cable length (option LC)	ft	29	≤ 984	-	-	-	-	-	-
	cable length (option IP68)	ft	39	≤ 984	39	≤ 984	-	-	-	-

x = transducer cable length  
l = max. length of extension cable

### Transducer cable


#### Technical data

		transducer cable			extension cable	
type		1699	2550 (option IP68)	6111	2615	5245
standard length	ft	see table above				
max. length	ft	-				
ambient temperature	°F	-67 to +392	-40 to +212	-148 to +437	-22 to +158	-22 to +158
properties			longitudinal water tight		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
<b>cable jacket</b>						
material		PTFE	PUR	PFA	PUR	PUR
outer diameter	in	0.11	0.2 ±0.01	0.11	0.47	0.47
thickness	in	0.01	0.04	0.02	0.08	0.08
color		brown	gray	white	black	black
shield		x	x	x	x	x
<b>sheath</b>						
material		stainless steel 304 option OS: 316Ti	-	stainless steel 304 option OS: 316Ti	-	steel wire braid with copolymer sheath
outer diameter	in	0.31	-	0.31	-	0.61

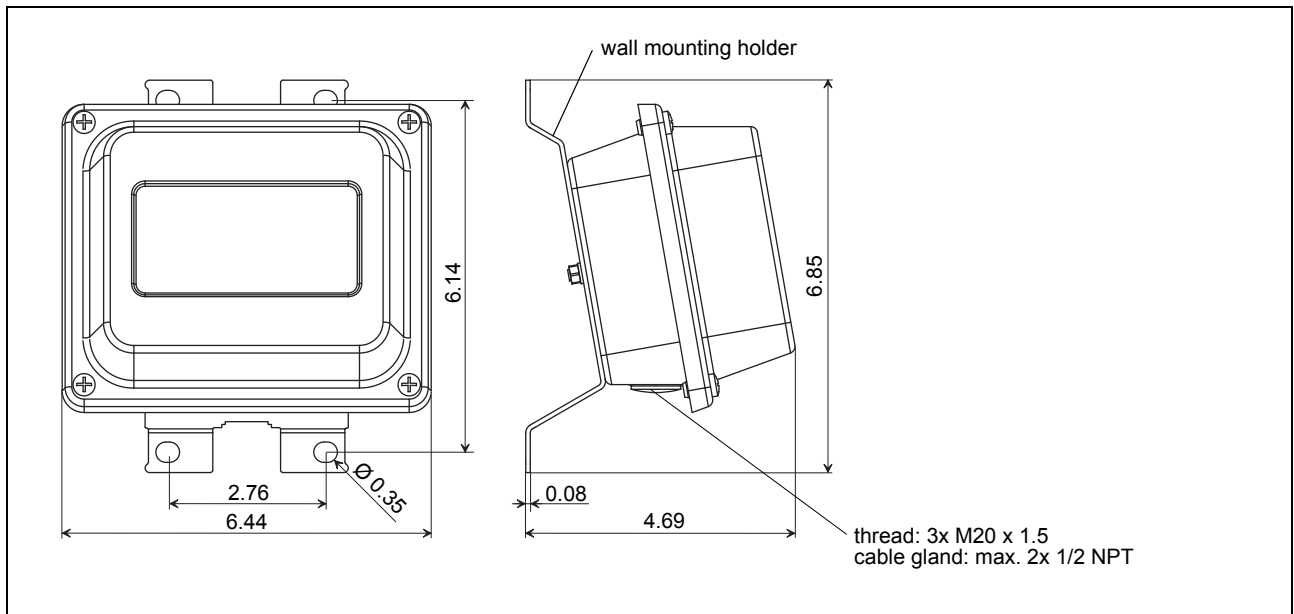


## Junction box

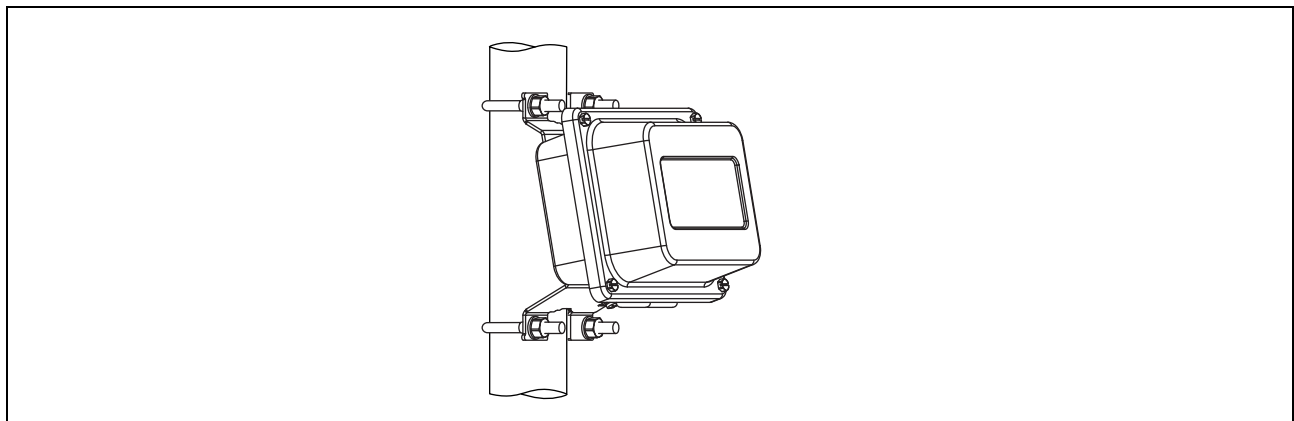
### Technical data

technical type		<b>JB03</b>	<b>JB04</b>	<b>JBP3</b>
dimensions		see dimensional drawing	see dimensional drawing	see dimensional drawing
weight	lb	2.6 lb	2.6 lb	2.6 lb
fixation		wall mounting, optional: 2 " pipe mounting	wall mounting, optional: 2 " pipe mounting	wall mounting, optional: 2 " pipe mounting
<b>material</b>				
housing		stainless steel 316L	stainless steel 316L	stainless steel 316L
gasket		silicone	silicone	silicone
degree of protection		NEMA 6	NEMA 4X	NEMA 6
<b>ambient temperature</b>				
min.	°F	-40	-40	-40
max.	°F	+176	+176	+176
<b>explosion protection</b>				
F M	marking	-	 NI/Cl. I,II,III/Div. 2 / APPROVED GP A,B,C,D,E,F,G/ T6 Ta = -40...+60 °C	-

### Dimensions

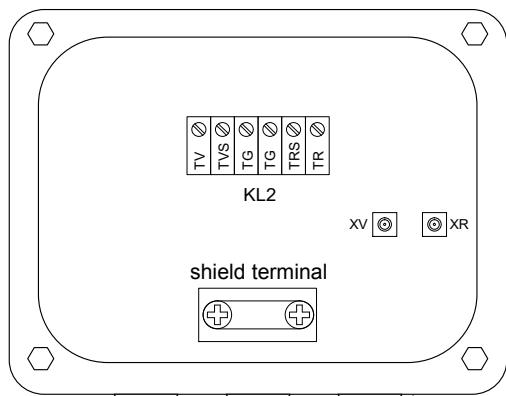


### 2 " pipe mounting kit (optional)



### Terminal assignment

#### JB03, JB04



equipotential bonding terminal  
(at wall mounting holder)

#### transducers

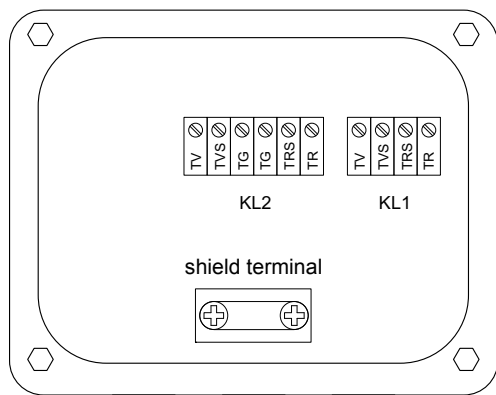
terminal	connection
XV	transducer ↗, SMB connector
XR	transducer ↘, SMB connector
cable gland	external shield

#### extension cable

terminal strip KL2

terminal	connection
TV	signal
TVS	internal shield
TRS	internal shield
TR	signal
shield terminal	external shield

#### JBP3



equipotential bonding terminal  
(at wall mounting holder)

#### transducers

terminal strip KL1

terminal	connection
TV	transducer ↗, signal
TVS	transducer ↗, internal shield
TRS	transducer ↘, internal shield
TR	transducer ↘, signal
cable gland	external shield

#### extension cable

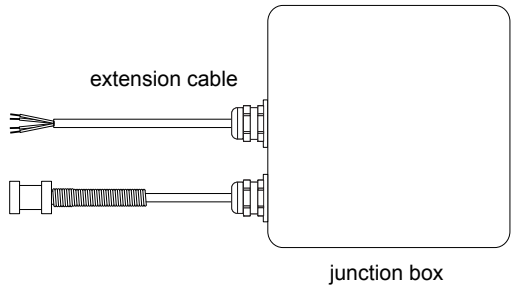
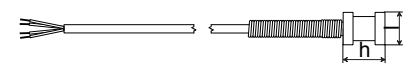
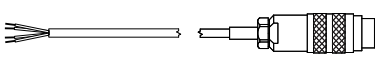
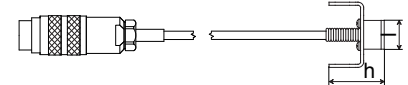
terminal strip KL2

terminal	connection
TV	signal
TVS	internal shield
TRS	internal shield
TR	signal
shield terminal	external shield

## Clamp-on temperature probe (optional)

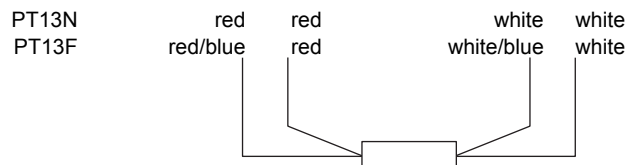
### Technical data

technical type		<b>PT13N</b>	<b>PT13F</b>
design			short response time, with connector
type		Pt1000	Pt1000
connection		4-wire	4-wire
measuring range	°F	-40 to +392	-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	$\pm(0.27 \text{ }^\circ\text{F} + 2 \cdot 10^{-3} \cdot ( T \text{ [}^\circ\text{F]}  - 32 \text{ }^\circ\text{F}))$ class A
response time	s		8
housing		360 brass alloy	PEEK, stainless steel 304, copper
degree of protection			NEMA 4
weight	lb	0.437	0.7
fixation		clamp-on	clamp-on
<b>accessories</b>			
thermal conductivity paste 392 °F		-	x
thermal conductivity foil 482 °F		x	x
plastic protection plate, insulation foam		-	x
<b>dimensions</b>			
length l	in	0.59	0.55
width b	in	0.49	1.18
height h	in	0.79	1.06

connection with extension cable	direct connection	technical type
		PT13N
		PT13F

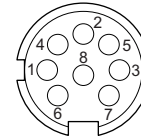
## Connection

### Temperature probe



### Connector

pin	cable of temperature probe PT13F	cable of temperature probe PT13N	extension cable
1	white/blue	white	white
2	red/blue	red	black
3, 4, 5	not connected		
6	red	red	green
7	white	white	red
8	not connected		



### Cable

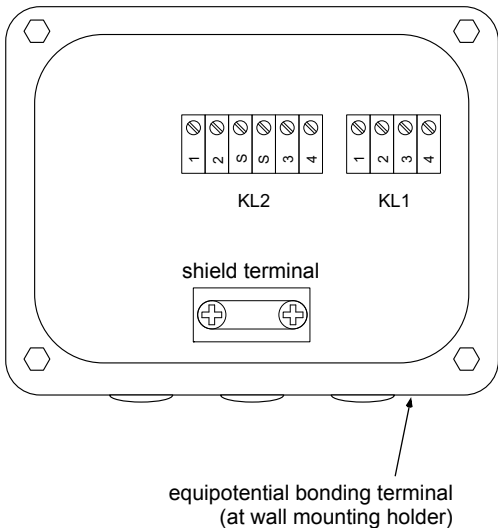
		cable of temperature probe		extension cable
temperature probe		PT13F	PT13N	
type		4 x 0.25 mm <sup>2</sup> black	4 x 24 AWG	4 x 18 AWG
standard length	ft	9	20	-
max. length	ft	-	-	656
cable jacket		PTFE	PTFE	LS PVC

### Junction box

technical type		<b>JBT3</b>
dimensions		see dimensional drawing
fixation		wall mounting optional: 2 " pipe mounting
<b>material</b>		
housing		stainless steel 316L
gasket		silicone
degree of protection		NEMA 6
cable gland		max. 2x 1/2 NPT
<b>ambient temperature</b>		
min.	°F	-40
max.	°F	+176

### Terminal assignment

**JBT3**



**temperature probe (PT13F)**  
terminal strip KL1

terminal	connection
1	red
2	red/blue
3	white
4	white/blue

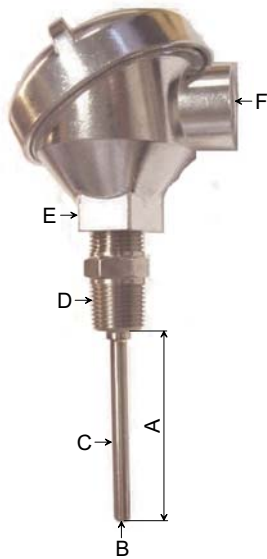
**temperature probe (PT13N)**  
terminal strip KL1

terminal	connection
1	red
2	red
3	white
4	white

**extension cable**  
terminal strip KL2

terminal	connection
1	white
2	black
3	green
4	red

### Wetted temperature probe (optional)



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



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