FLEXIM

Technical specification

FLUXUS F502TE

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

Precise and intelligent energy measuring system with extremely high measuring dynamic

Features

- Integrated measuring system for the determination of thermal energy in real time
- For inner pipe diameters of DN 50...DN 500
- High-precision temperature measurement using paired temperature probes (0.1 °C temperature difference)
- Extremely high measuring dynamic > 100 : 1
- Measures even the lowest flow velocities down to 0.01 m/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
- Support of standard bus systems

Applications

- District heating
  - Heating and cooling systems
  - Heat interface units
  - Distribution nets
- Building technology
  - Heating and cooling systems
  - Internal balancing
- Energy management
  - Energy efficiency
  - Energy monitoring

FLUXUS F502TE

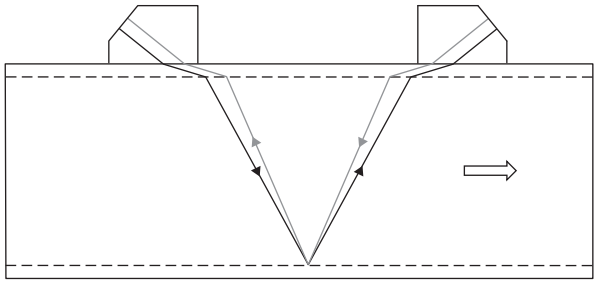
Variofix L

Function

Measurement principle

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

Path of the ultrasonic signal in the flowing fluid

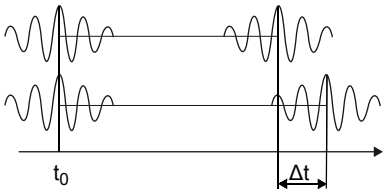


As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

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.

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.

Transit time difference Δt



Calculation of volumetric flow rate

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

where

- $\dot{V}$ - volumetric flow rate
- k_{Re} - fluid mechanics calibration factor
- A - cross-sectional pipe area
- k_a - acoustical calibration factor
- Δt - transit time difference
- t_γ - average of transit times in the fluid

Calculation of heat flow

The heat flow is internally calculated with the following formula:

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

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

where

Φ – heat flow

k_i – heat coefficient

$\dot{V}$ – volumetric flow rate

T_V – supply temperature

T_R – return temperature

The heat coefficient k_i results from several heat flow coefficients for the specific enthalpy and density of the fluid. The heat flow coefficients of some fluids are stored in the internal database of the transmitter. Further user-defined 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. It depends on Δθ and is therefore calculated according to the operational conditions at the measuring point.

$$MPE = \sqrt{E_c^2 + E_t^2 + E_f^2}$$

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

Δθ – temperature difference between supply and return line of the heat-exchange circuit

Number of sound paths

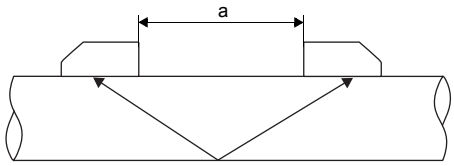
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **reflection 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. In the case of a high signal attenuation by the fluid, pipe and coatings, diagonal arrangement with 1 sound path will be used.

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.

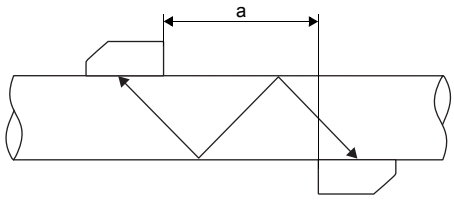
As the transducers can be mounted with the transducer mounting fixture in reflection arrangement or diagonal arrangement, the number of sound paths can be adjusted optimally for the application.

Reflection arrangement, number of sound paths: 2

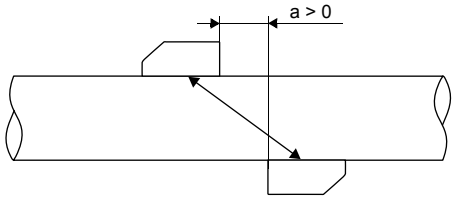


a - transducer distance

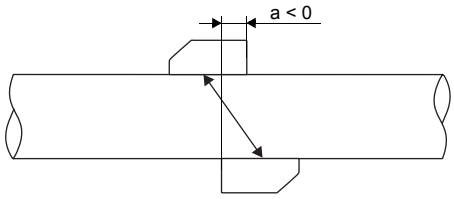
Diagonal arrangement, number of sound paths: 3



Diagonal arrangement, number of sound paths: 1

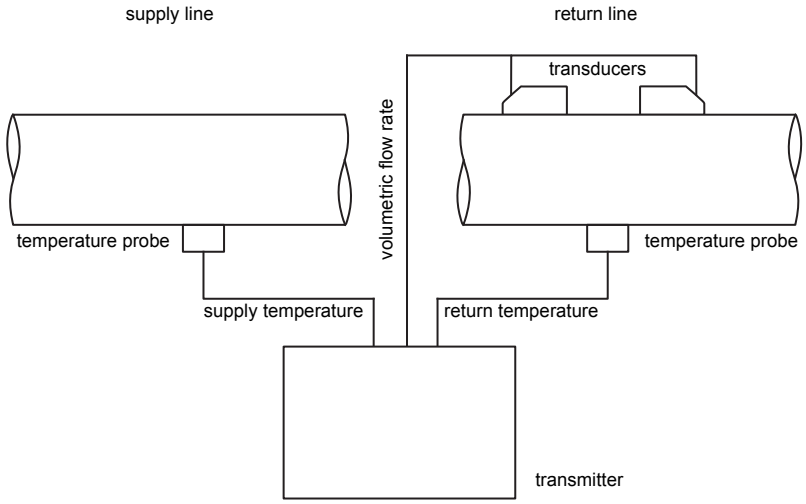


Diagonal arrangement, number of sound paths: 1, negative transducer distance



Typical measurement setup

Example of a heat flow measurement measuring the volume flow rate in the return line



Transmitter

Technical data

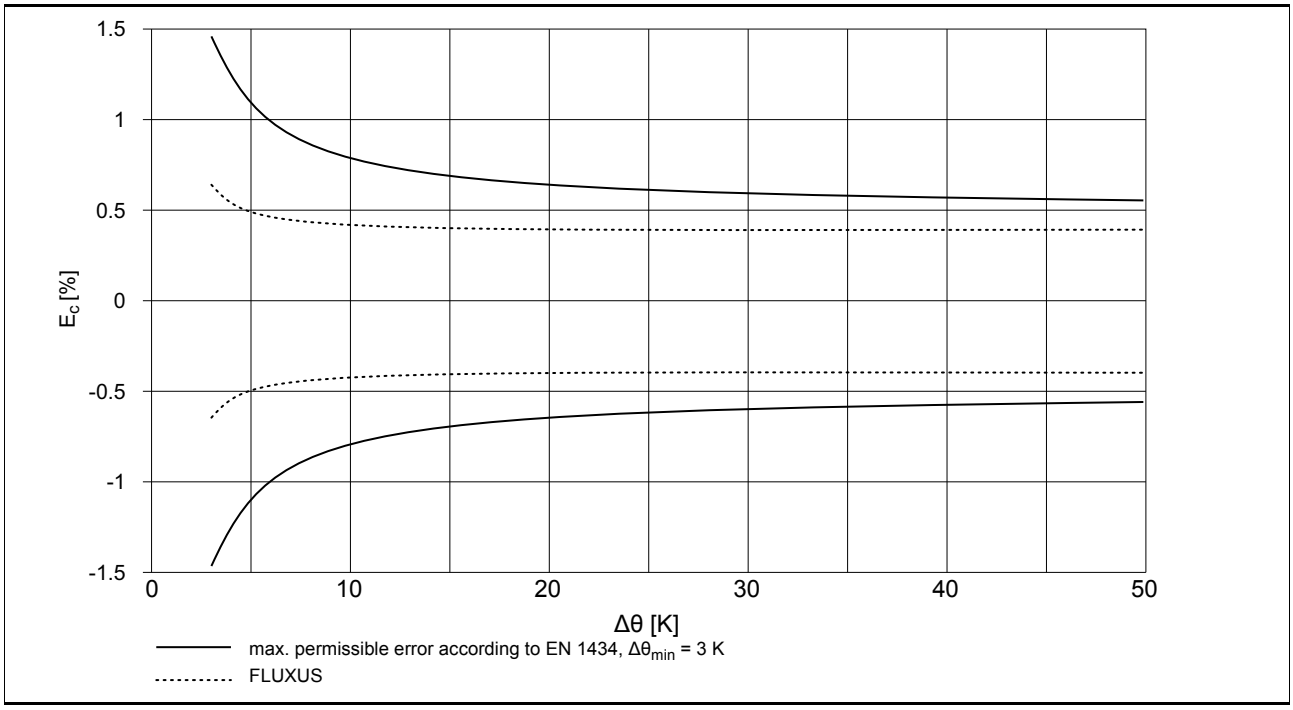
		FLUXUS F502TE-NN
		
design		field device with 1 measuring channel
application		energy meter
transducers		CDM2LZ7, CDP2LZ7, CDQ1LZ7
measurement		
• energy		
max. permissible relative error		calculator: E_c = ±(0.4 + 1 K/Δθ) %
• temperature		
temperature difference		$\Delta\theta_{min}$ = 3 K, $\Delta\theta_{max}$ = 300 K
max. permissible relative error		temperature sensor pair: E_t - depending on type, see Technical data of temperature probes
• flow		
measurement principle		transit time difference correlation principle
flow	m^3/h	Q_p = 15...6000
flow velocity	m/s	0.01...25
fluid pressure		without influence
pressure loss		-
repeatability		0.25 % of reading ±0.01 m/s
fluid		• water • glycol/H_2O: 20 %, 30 %, 40 %, 50 %
max. permissible relative error		flow sensor: E_f = ±2 % of reading ±0.01 m/s
transmitter		
power supply		• 100...230 V/50...60 Hz or • 20...32 V DC or • 11...16 V DC
power consumption	W	< 10
number of measuring channels		1
damping	s	0...100 (adjustable)
measuring cycle	Hz	10
response time	s	1
housing material		aluminum, powder coated
degree of protection		IP66
dimensions	mm	see dimensional drawing
weight	kg	1.9
fixation		wall mounting, optional: 2" pipe mounting
ambient temperature	°C	-10...+60
display		2 x 16 characters, dot matrix, backlight
menu language		English, German, French, Dutch, Spanish, Polish, Czech
measuring functions		
physical quantities		heat flow, volumetric flow rate, flow velocity
totalizer		heat quantity, volume, mass
communication interfaces		
process interfaces		max. 1 option: • RS485 (sender) • Modbus RTU, sender (switchable) • BACnet MS/TP, sender (switchable) • M-Bus
data logger		
loggable values		all physical quantities and totalized values
capacity		> 100 000 measured values
remark		with communication interface only in sender mode

[1] for reference conditions and v > 0.25 m/s

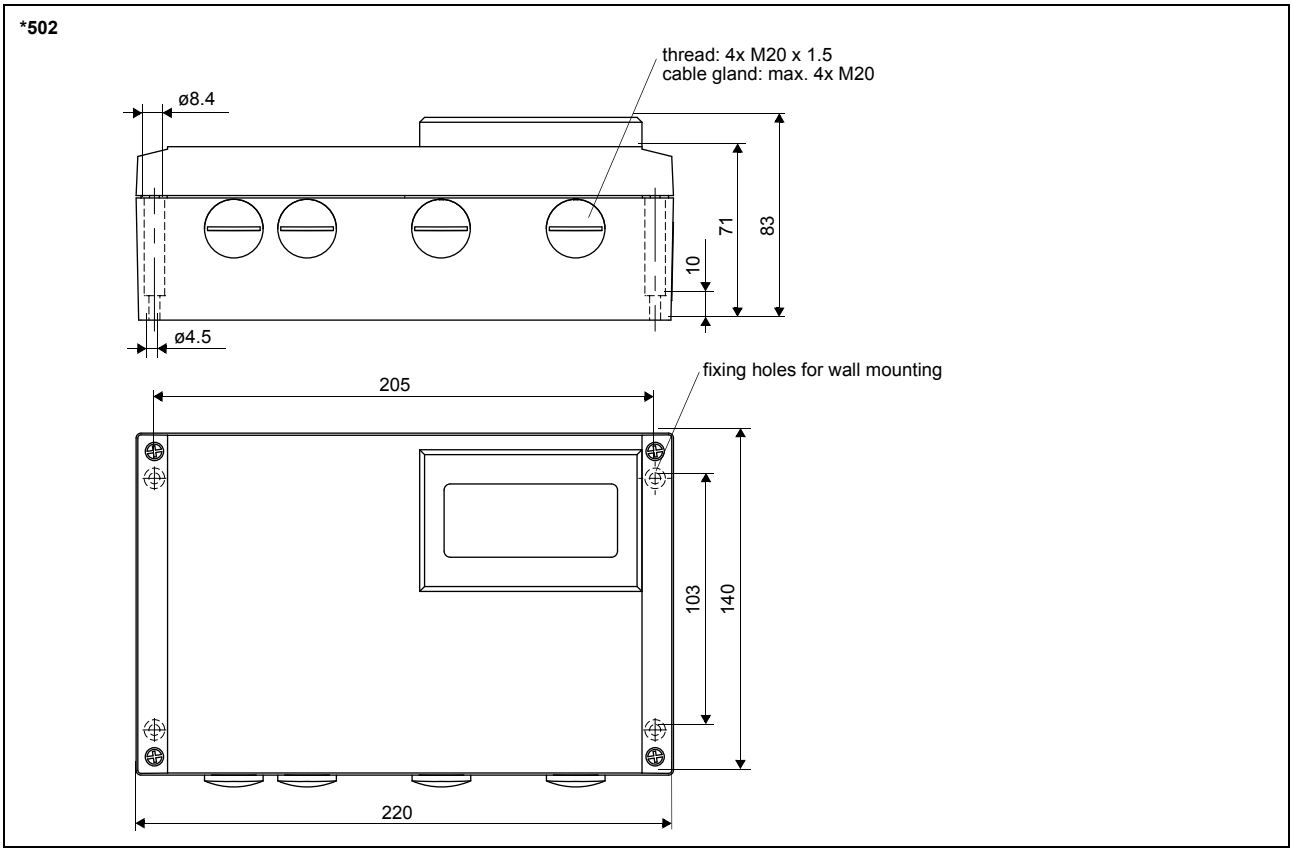
		FLUXUS F502TE-NN
outputs		
		The outputs are galvanically isolated from the transmitter.
• current output		
number		2
range	mA	0/4...20
accuracy		0.1 % of reading ±15 µA
active output		R_{ext} < 500 Ω
• binary output		
number		2
optorelay		28 V/100 mA
binary output as alarm output		
• functions		limit, change of flow direction or error
binary output as pulse output		
• functions		mainly for totalizing
• pulse value	units	0.01...1000
• pulse width	ms	80...1000
inputs		
		The inputs are galvanically isolated from the transmitter.
• temperature input		
number		2
type		Pt100/Pt1000
connection		4-wire
range	°C	-150...+560
resolution	K	0.01
accuracy		±0.01 % of reading ±0.03 K

[1] for reference conditions and v > 0.25 m/s

Max. permissible error of the calculator

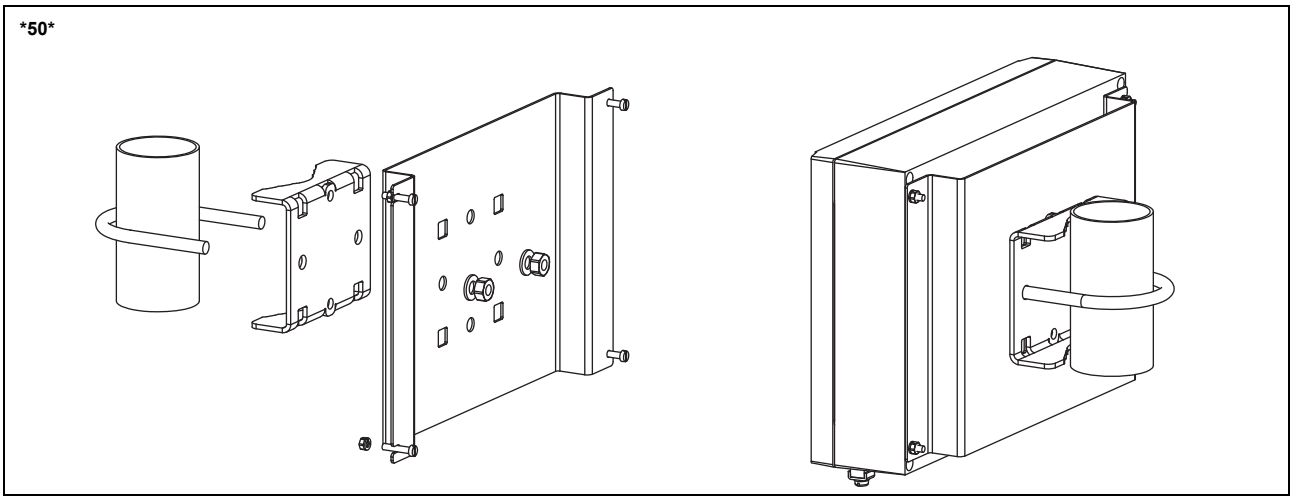


Dimensions

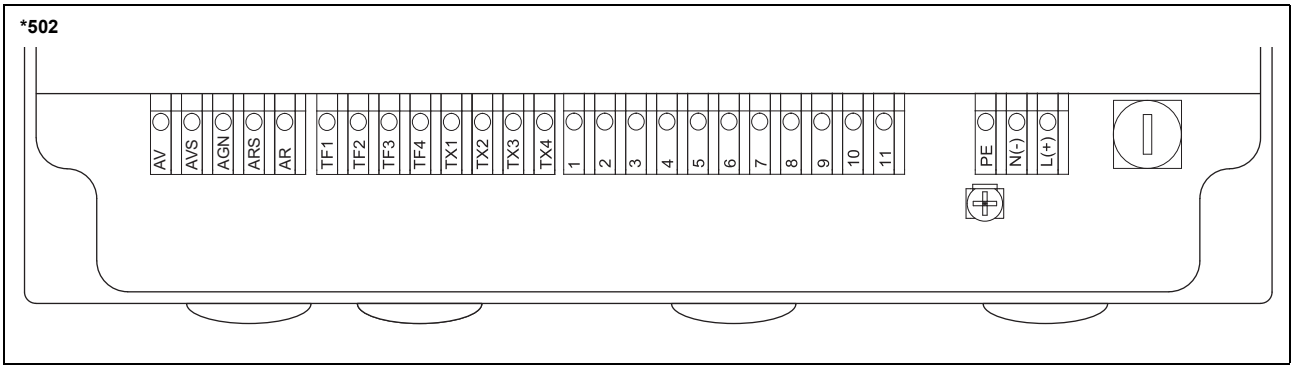


in mm

2" pipe mounting kit



Terminal assignment



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

transducers, extension cable		
terminal	**connection**	**transducer**
AV	signal	
AVS	internal shield	
ARS	internal shield	
AR	signal	
cable gland	external shield	

outputs[1]	
terminal	**connection**
1(-), 2(+)	binary output B1
3(-), 4(+)	binary output B2
5(-), 6(+)	current output I1
7(-), 8(+)	current output I2

communication interfaces[1]		
terminal	**connection**	**communication interface**
10	signal +	• RS485 • Modbus RTU • BACnet MS/TP • M-Bus
9	signal -	
11	shield	

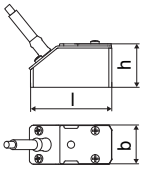
inputs[1]			
terminal	**temperature probe**		
	direct connection (clamp-on)	**connection with extension cable (clamp-on)**	**direct connection (inline)**
TF1, TX1	red	red	red
TF2, TX2	red/blue	grey	grey
TF3, TX3	white/blue	blue	blue
TF4, TX4	white	white	white

[1] cable (by customer): lead cross sectional area: 0.25...2.5 mm^2

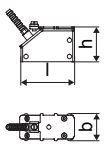
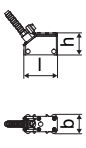
Transducers

Technical data

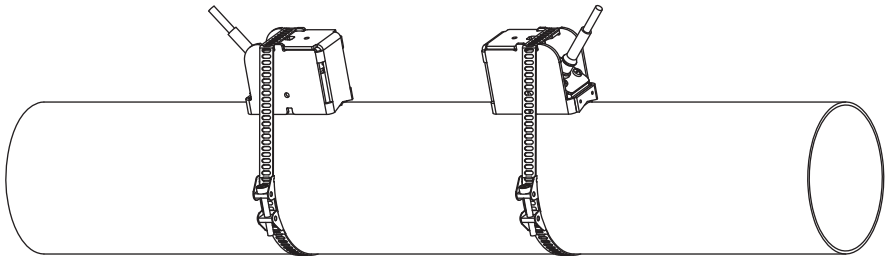
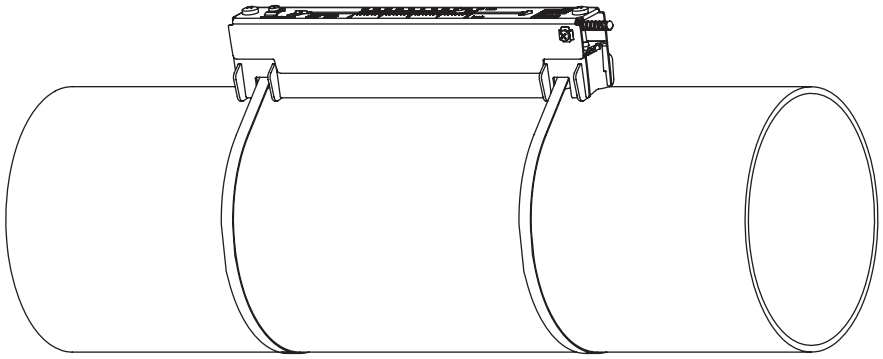
Shear wave transducers (nonEx)

technical type		CDM2LZ7	CDP2LZ7	CDQ2LZ7
transducer frequency	MHz	1	2	4
nominal size				
min.		DN 200	DN 80	DN 25
max.		DN 500	DN 250	DN 100
pipe wall thickness				
min.	mm	2	1	0.6
material				
housing		PEEK with stainless steel cap 316Ti (1.4571)		
contact surface		PEEK		
degree of protection		IP67		
transducer cable				
type		2606		
length	m	10, optional: 20		
dimensions				
length l	mm	59		36
width b	mm	28		18
height h	mm	31		21
dimensional drawing				
weight (without cable)	kg	0.066		0.024
ambient temperature				
min.	°C	-40		
max.	°C	+100		

Shear wave transducers (nonEx, extended temperature range)

technical type		C(DL)M2N53	C(DL)P2N53	C(DL)Q2N53
transducer frequency	MHz	1	2	4
nominal size				
min.		DN 200	DN 80	DN 25
max.		DN 500	DN 250	DN 100
pipe wall thickness				
min.	mm	2	1	0.6
material				
housing		PEEK with stainless steel cap 304 (1.4301		
contact surface		PEEK		
degree of protection		IP67		
transducer cable				
type		1699		
length	m	4, optional: 9		3, optional: 9
dimensions				
length l	mm	64		40
width b	mm	32		22
height h	mm	40.5		25.5
dimensional drawing				
weight (without cable)	kg	0.066		0.016
ambient temperature				
min.	°C	-40		
max.	°C	+130		

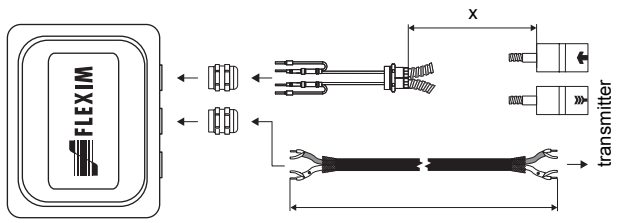
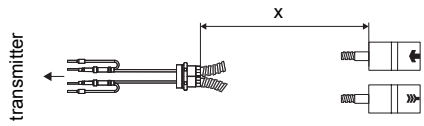
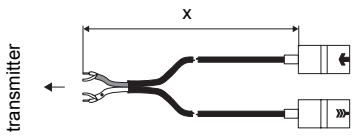
Transducer mounting fixture

tension straps, clasps and transducer shoes 	material: stainless steel 304 (1.4301), 303 (1.4305) tension strap length: 10 m transducers: CD*2LZ7
Variofix L (VLM, VLQ) 	material: stainless steel 304 (1.4301), 301 (1.4310), 410 (1.4006) inner length: **VLM**: 234 mm **VLQ**: 176 mm dimensions: **VLM**: 309 x 57 x 63 mm **VLQ**: 247 x 43 x 47 mm transducers: ***2*5*

Coupling materials for transducers

type	**ambient temperature** °C	**material**
coupling compound type N	-30...+130	mineral grease paste
coupling foil type VT	-10...+200	fluoroelastomer

Connection systems

connection with extension cable	direct connection	transducers technical type
JB05 		*****53
		****LZ7

x - transducer cable length

l - max. length of extension cable

Cable

transducer cable			
type		**2606**	**1699**
weight	kg/m	0.033	0.094
ambient temperature	°C	-40...+100	-55...+200
cable jacket			
material		PUR	PTFE
outer diameter	mm	5	2.9
thickness	mm		0.3
colour		grey	brown
shield		x	x
sheath			
material		-	stainless steel 316Ti (1.4571)
outer diameter	mm	-	8

extension cable		
type		**2615**
max. length l	m	90
weight	kg/m	0.18
ambient temperature	°C	-30...+70
properties		halogen free fire propagation test according to IEC 60332-1 combustion test according to IEC 60754-2
cable jacket		
material		PUR
outer diameter	mm	12
thickness	mm	2
colour		black
shield		x

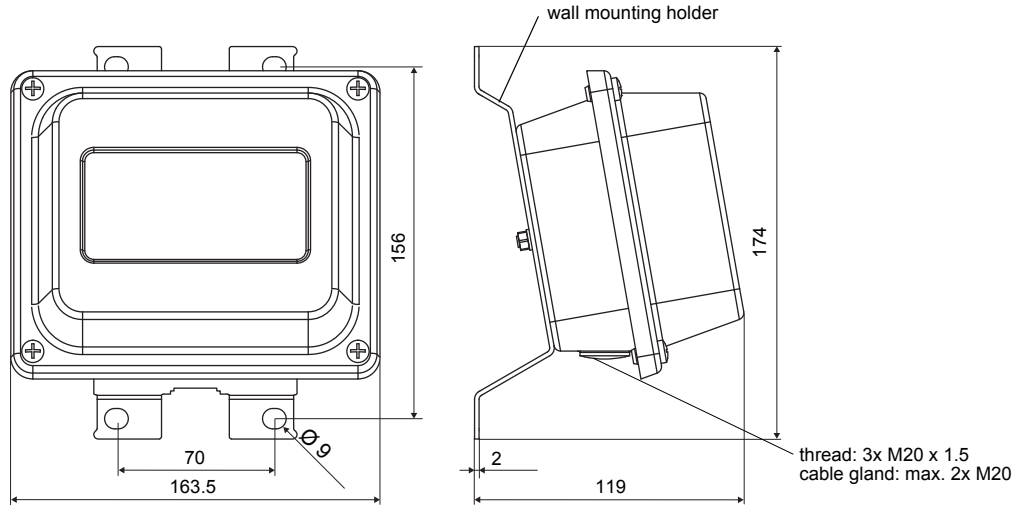
Junction box

Technical data

		JB05
weight	kg	1.2 kg
fixation		wall mounting optional: 2" pipe mounting
material		
housing		stainless steel 316L (1.4404)
gasket		silicone
degree of protection		IP67
ambient temperature		
min.	°C	-40
max.	°C	+80

Dimensions

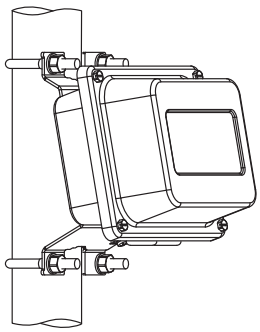
JBxx



in mm

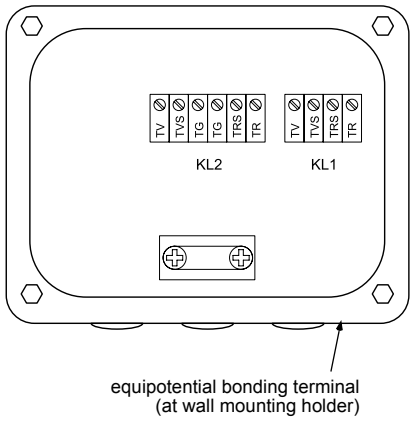
2" pipe mounting kit

JBxx



Terminal assignment

JB05

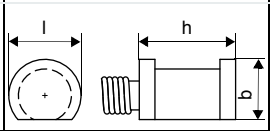


transducers			
terminal strip	**terminal**	**connection**	**transducer**
KL1	TV	signal	
	TVS	internal shield	
	TRS	internal shield	
	TR	signal	
cable gland		external shield	

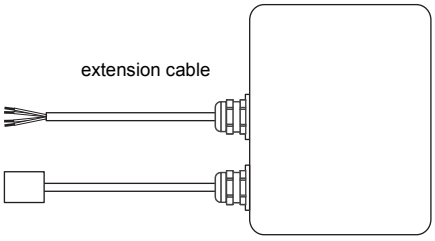
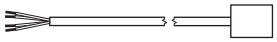
extension cable		
terminal strip	**terminal**	**connection**
KL2	TV	signal
	TVS	internal shield
	TRS	internal shield
	TR	signal
cable gland		external shield

Clamp-on temperature probe (optional)

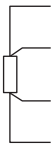
Technical data

PT12N		
type		2x Pt100 matched according to EN 1434
connection		4-wire
measuring range	°C	-30...+250
accuracy θ		±(0.15 °C + 2 · 10^{-3} · |T [°C]|) class A
max. permissible relative error		E_t = 0.1 K (3 K < Δθ ≤ 6 K) E_t = 0.2 K (6 K < Δθ ≤ 30 K) E_t = 0.3 K (30 K < Δθ ≤ 50 K)
response time	s	50
housing		aluminum
degree of protection		IP66
dimensions		
length l	mm	15
width b	mm	13
height h	mm	20
dimensional drawing		
weight	kg	0.25
accessories		
thermal conductivity foil 250 °C		x

connection system

connection with extension cable	direct connection
	

connection

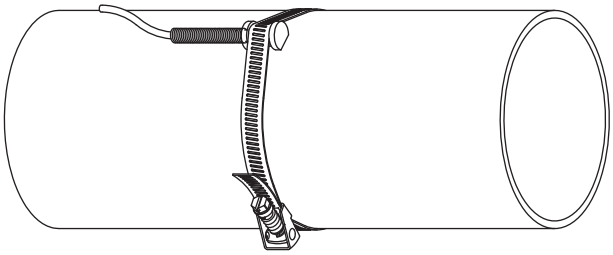
	temperature probe
	red/blue
	red
	white/blue
	white

cable

		temperature probe	extension cable
type		4 x 0.25 mm² black	LIYCY 8 x 0.14 mm² grey
standard length	m	3	5/10/25
max. length	m	-	200
cable jacket		PTFE	PVC

Fixation

tension strap PT12N



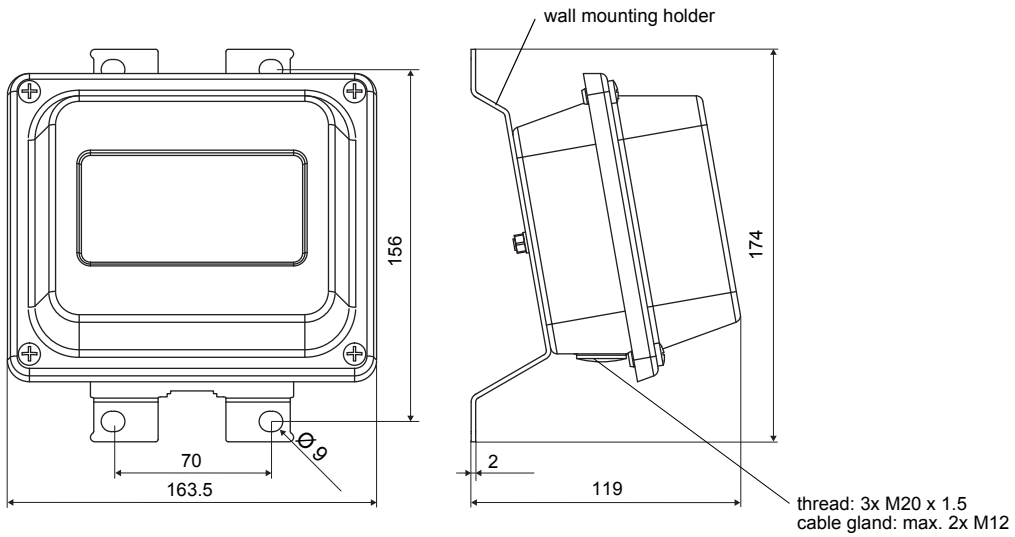
material: stainless steel 301 (1.4310), 410 (1.4006)

Junction box

		JBT3
weight	kg	1.2 kg
fixation		wall mounting optional: 2" pipe mounting
material		
housing		stainless steel 316L (1.4404)
gasket		silicone
degree of protection		IP67
ambient temperature		
min.	°C	-40
max.	°C	+80

Dimensions

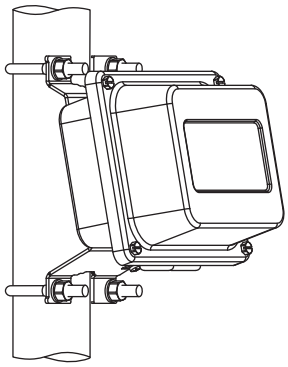
JBTx



in mm

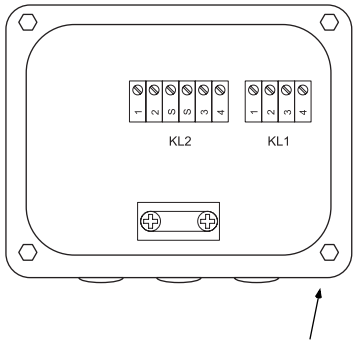
2" pipe mounting kit

JBxx



Terminal assignment

JBT3

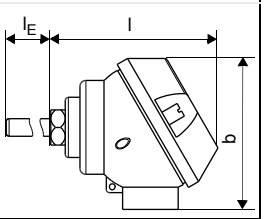


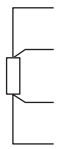
temperature probe		
terminal strip	**terminal**	**connection**
KL1	1	red
	2	red/blue
	3	white
	4	white/blue

extension cable		
terminal strip	**terminal**	**connection**
KL2	1	red
	2	grey
	3	white
	4	blue

Inline temperature probe (optional)

Technical data

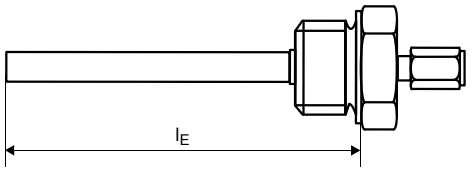
PT12N-IT-P PT12N-IU-P		
type		2x Pt100 matched according to EN 1434
connection		4-wire
measuring range	°C	-30...+200
accuracy θ		±(0.15 °C + 2 · 10^{-3} · |T [°C]|) class A
max. permissible relative error	%	$E_t = \pm 0.9 \cdot (0.5 + 3 \cdot \Delta\theta_{min}/\Delta\theta)$
response time	s	T50: 5, T90: 19
housing		316Ti (1.4571) connecting head J: aluminum
degree of protection		IP65
dimensions		
length l	mm	72 PT12N-IT-P: l_E = 140 PT12N-IU-P: l_E = 230
width b	mm	51
dimensional drawing		
weight	kg	PT12N-IT-P: 0.136 PT12N-IU-P: 0.142

connection		
	temperature probe	**cable**
	red	red
	red	grey
	white	blue
	white	white

cable		
		temperature probe
type		LIYCY 8 x 0.14 mm² grey
standard length	m	10/20
max. length	m	200
cable jacket		PVC

Fixation

threaded thermowell PT12N



		PT12N-IT-P	**PT12N-IU-P**
mounting length l_E	mm	120	210
material			
threaded thermowell		stainless steel 316L (1.4404)	
clamping nut		zinc coated steel 1.0037, PTFE	
weight	kg	0.08	0.091
outer diameter	mm	8	
process connection		G 1/2“	
fluid pressure		PN25 (water)	
max. flow velocity[1]			
water	m/s	6.93	4.37
glycol/H_2O	m/s	8.4	3.78

[1] max. permissible values for laminar flows; further influences like motors, pumps, valves which provoke turbulences, water hammers, pulsations, oscillations, etc. have to be considered by the customer

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