Flexim FLUXUS F532TE
Ultrasonic Flowmeter

Ultrasonic Measurement of Thermal Energy and Volumetric Flow Rate

Features

- Integrated flow and thermal energy calculator for the determination of the thermal power in real time
- Very high measuring dynamics and fast response time – suitable for monitoring important processes and plants
- Non-invasive measurement using ultrasonic flow transducers for inner pipe diameters 10...2400 mm and temperatures -40...+130 °C
- Temperature measurement and calculation of the thermal energy according to EN 1434
- Suitable for heating and cooling applications
- Smart meter/IoT ready via Ethernet interface with corresponding IP data protocols (e.g. Modbus TCP)
- Sophisticated support software for parameterization, remote control, recording and automatic state diagnosis FluxDiagReader, FluxDiag, Advanced Meter Verification)

Applications

Building technology, manufacturing industry, local and district heating/cooling, e.g. in the following areas:

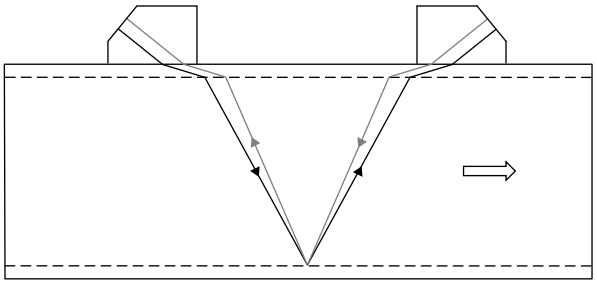
- Energy management
- Internal accounting and balancing
- Network and condition monitoring
- Process optimization
- Predictive maintenance

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

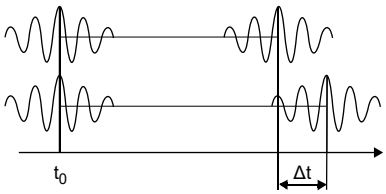


As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

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.

The integrated microprocessors control the entire measuring cycle. The received ultrasonic signals are checked for measurement usability and evaluated for their reliability. Noise signals are eliminated.

Transit time difference Δt



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

Calculation of thermal energy rate

The thermal energy rate is calculated with the following formula:

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

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

where

Φ – thermal energy rate

k_i – thermal coefficient

$\dot{V}$ – volumetric flow rate

T_V – supply temperature

T_R – return temperature

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

Max. permissible error

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

$MPE = E_c + E_t + E_f$

where

MPE – total max. permissible error

E_c – max. permissible relative error of the calculator

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

E_f – max. permissible relative error of the flow sensor

Number of sound paths

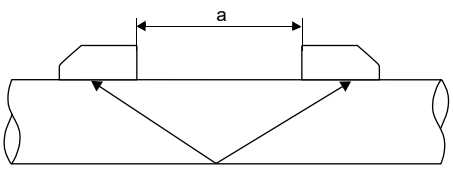
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **reflection arrangement**
  The number of sound paths is even. The transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easy.
- **diagonal arrangement**
  The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe. In case of high signal attenuation by the fluid or pipe, diagonal arrangement with 1 sound path is used.

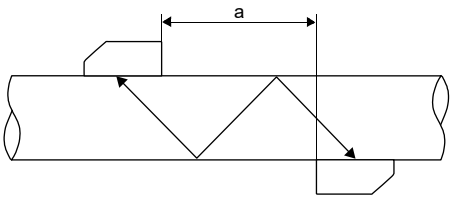
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

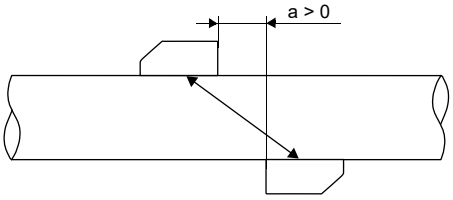
Reflection arrangement, number of sound paths: 2



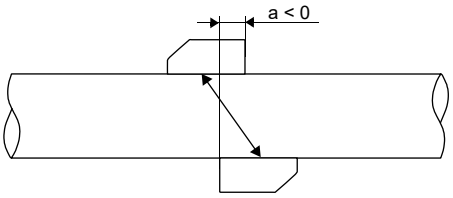
Diagonal arrangement, number of sound paths: 3



Diagonal arrangement, number of sound paths: 1



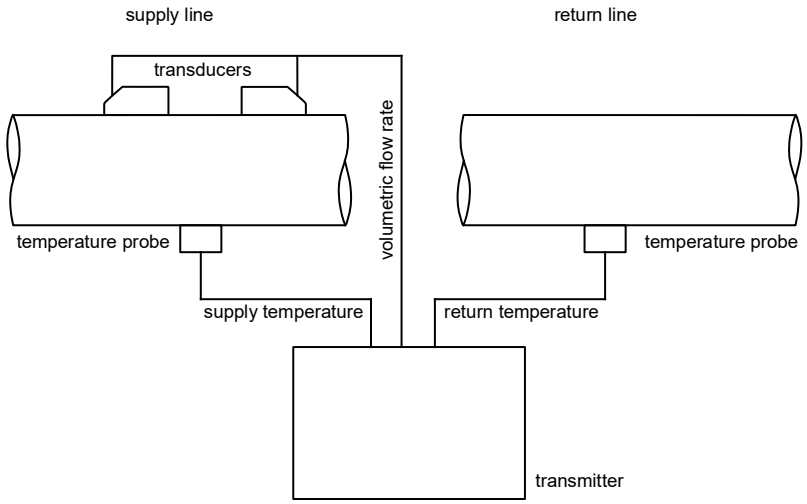
Diagonal arrangement, number of sound paths: 1, negative transducer distance



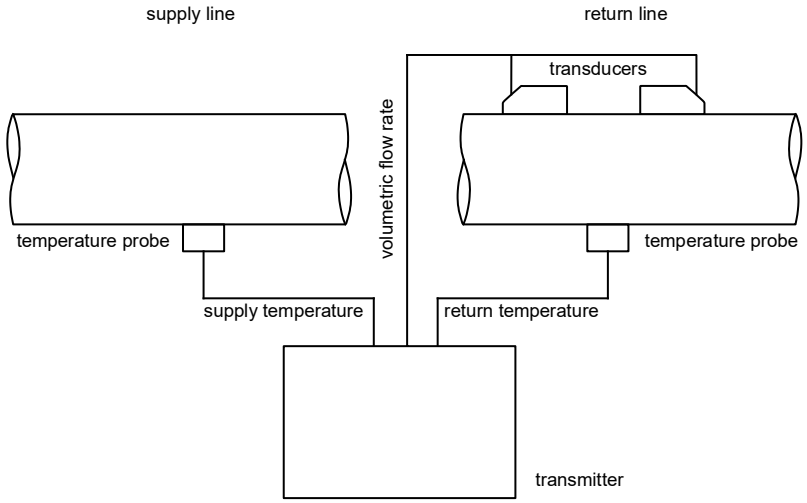
a - transducer distance

Typical measurement setup

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



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



Transmitter

Technical data

		FLUXUS F532TE (analog outputs)	FLUXUS F532TE (process interface)
			
design		field device with 1 measuring channel	
application		energy meter	
measurement			
• **energy**			
max. permissible relative error		calculator: $E_c = \pm(0.4 + 1\ K/\Delta\theta)$ %	
• **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 direction		bidirectional	
flow	m^3/h	example for 2 sound paths and factory default of the cut-off flow: • DN 50: Qp = 0.2...200 • DN 150: Qp = 1.8...900 • DN 500: Qp = 17...5000	
flow velocity	m/s	0.01...25	
repeatability		0.15 % MV ±0.005 m/s	
fluid		water, water/glycol: 0...100 %	
temperature compensation		corresponding to the recommendations in ANSI/ASME MFC-5.1-2011	
measurement uncertainty (volumetric flow rate)			
measurement uncertainty of the measuring system[1]		±0.3 % MV ±0.005 m/s	
measurement uncertainty at the measuring point[2]		±1 % MV ±0.005 m/s	
transmitter			
power supply		• 90...250 V/50...60 Hz or • 11...32 V DC	
power consumption	W	< 10	
number of measuring channels		1	
damping	s	0...100 (adjustable)	
measuring cycle	Hz	100...1000	
response time	s	1	
housing material		aluminum, powder coated	
degree of protection		IP66	
dimensions	mm	see dimensional drawing	
weight	kg	2.25	
fixation		wall mounting, optional: 2" pipe mounting	
ambient temperature	°C	-20...+60	
display		128 x 64 pixels, backlight	
menu language		English, German, French, Spanish, Dutch, Russian, Polish, Turkish, Italian, Chinese	
measuring functions			
physical quantities		thermal energy rate, volumetric flow rate, mass flow rate, flow velocity	
totaliser		thermal energy, volume, mass	
diagnostic functions		sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times	
communication interfaces			
service interfaces		measured value transmission, parametrisation of the transmitter: • USB • LAN	measured value transmission, parametrisation of the transmitter: • USB • LAN
process interfaces		-	1 option: • Modbus RTU • BACnet MS/TP • M-Bus • HART • Modbus TCP • BACnet IP

[1] with aperture calibration of the transducers

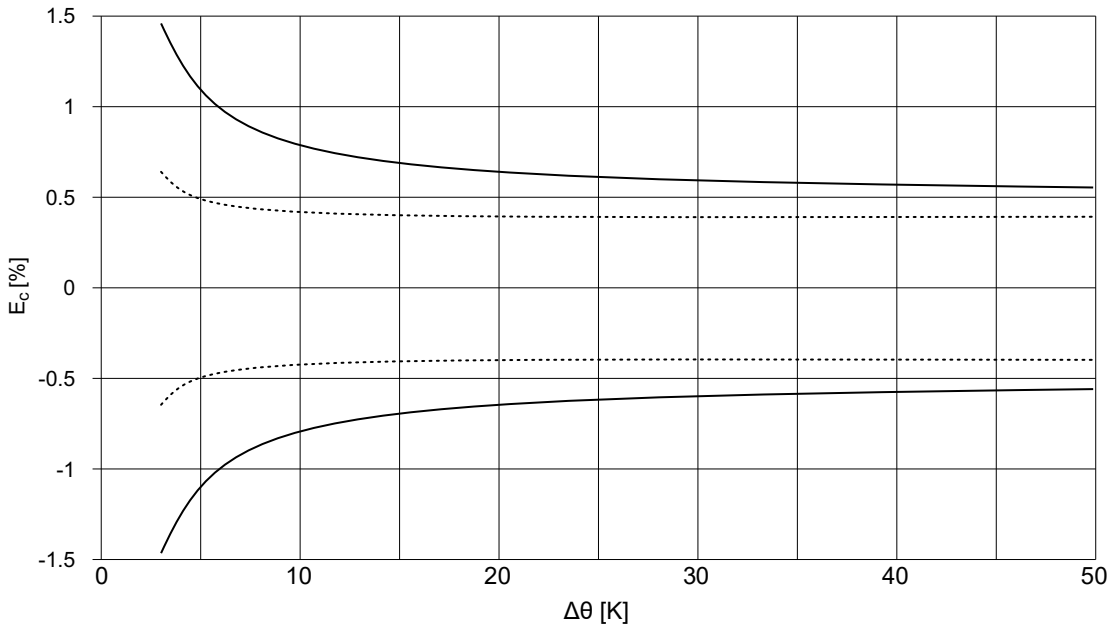
[2] for transit time difference principle and reference conditions

		FLUXUS F532TE (analog outputs)	FLUXUS F532TE (process interface)
accessories			
data transmission kit		USB cable	
software		• FluxDiagReader: reading of measured values and parameters, graphical representation • FluxDiag (optional): reading of measurement data, graphical representation, report generation, parametrisation of the transmitter	
data logger			
loggable values		all physical quantities and totalised physical quantities	
capacity		max. 800 000 measured values	
outputs			
		The outputs are galvanically isolated from the transmitter.	
• switchable current output			
		configurable according to NAMUR NE 43	
number		1	optional: 1 (HART)
range	mA	4...20 (alarm current: 3.2...3.99, 20.01...24, hardware fault current: 3.2)	4...20 (alarm current: 3.2...3.99, 20.01...24, hardware fault current: 3.2)
uncertainty		0.04 % of output value ±3 µA	0.04 % of output value ±3 µA
active output		R_{ext} = 250...530 Ω, $U_{opencircuit}$ = 28 V DC	R_{ext} = 250...530 Ω, $U_{opencircuit}$ = 28 V DC
passive output		U_{ext} = 9...30 V DC, depending on R_{ext} (R_{ext} < 458 Ω at 20 V)	U_{ext} = 9...30 V DC, depending on R_{ext} (R_{ext} < 458 Ω at 20 V)
current output in HART mode			
• range	mA	-	4...20 (alarm current: 3.5...3.99, 20.01...22, hardware fault current: 3.2)
• active output		-	R_{ext} = 250...530 Ω, $U_{opencircuit}$ = 28 V DC
• passive output		-	U_{ext} = 9...30 V DC, depending on R_{ext} (R_{ext} = 250...458 Ω at 20 V)
• digital output			
number		2	-
functions		• frequency output • binary output • pulse output	-
type		open collector (passive)	-
operating parameters		5...30 V, I_{max} = 100 mA, R_{int} = 20 Ω Low: U < 2 V at I_{loop} = 2 mA (R_{ext} = 12 kΩ at U_{ext} = 24 V) High: U > 15 V (R_{ext} = 12 kΩ at U_{ext} = 24 V)	-
frequency output			
• range	kHz	0.002...10	-
• damping	s	0...999.9 (adjustable)	-
• pulse-to-pause ratio		1:1	-
binary output			
• binary output as alarm output		limit, change of flow direction or error	-
pulse output			
• pulse value	units	0.01...1000	-
• pulse width	ms	0.05...1000	-
• pulse rate		max. 10 000 pulses	-
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 % MV ±0.03 K at 18...28 °C ±0.01 % MV ±0.03 K ±0.0005 %/K at <18 °C/>28 °C	
cable resistance	Ω	max. 1000	

[1] with aperture calibration of the transducers

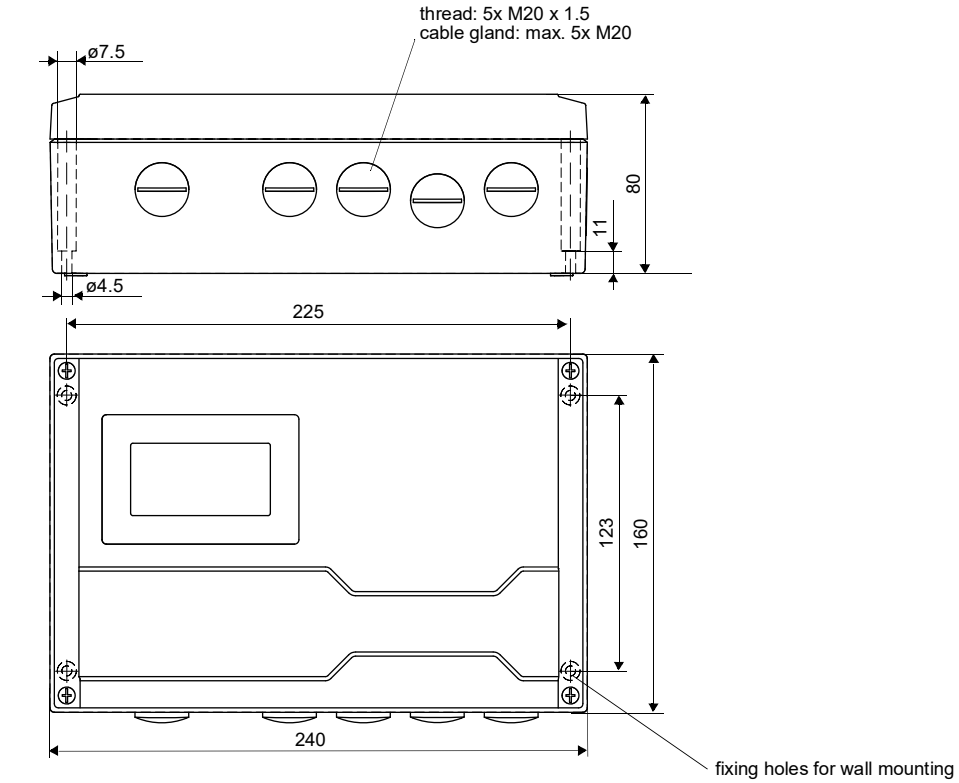
[2] for transit time difference principle and reference conditions

Max. permissible error of the calculator



Dimensions

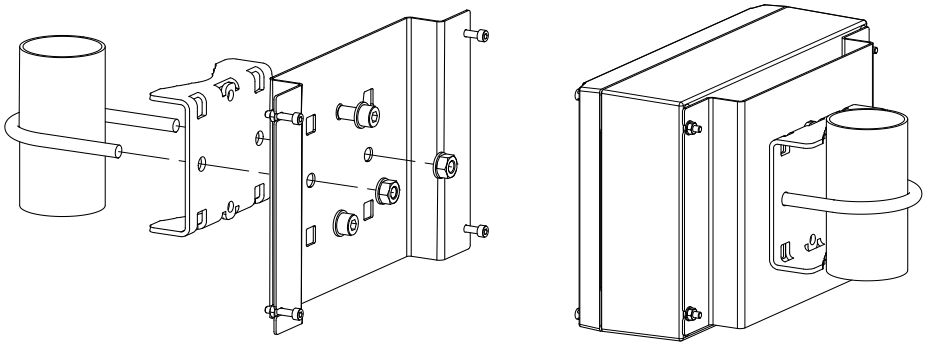
***532**



in mm

2" pipe mounting kit (optional)

***532**



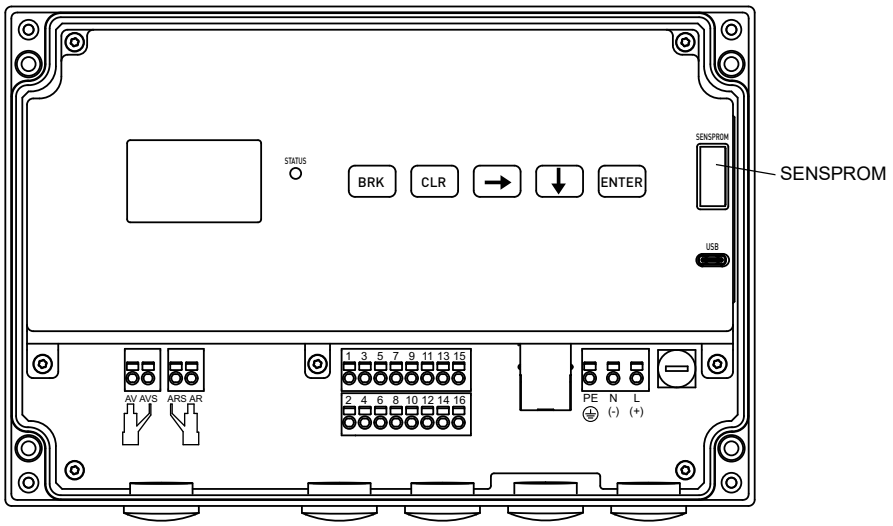
item number: 532037-1

Storage

- do not store outdoors
- store within the original package
- store in a dry and dust-free place
- protect against sunlight
- keep all openings closed
- storing temperature: -20...+60 °C

Terminal assignment

***532**



power supply[1]			
terminal	**connection (AC)**	**terminal**	**connection (DC)**
PE	protective conductor	PE	protective conductor
N	neutral conductor	(-)	-
L	line conductor	(+)	+

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

outputs, inputs[1, 2]	
terminal	**connection**
13+, 14-	passive current output
13-, 14+	active current output
9+, 10- 11+, 12-	digital output
15+, 16-	passive current output/HART
15-, 16+	active current output/HART
1, 2, 3, 4 5, 6, 7, 8	temperature input

temperature probe			
terminal	**direct connection (clamp-on)**	**connection with extension cable (clamp-on)**	**direct connection (inline)**
1, 5	red	red	red
2, 6	white	white	white
3, 7	red/blue	grey	grey
4, 8	white/blue	blue	blue

communication interfaces		
terminal	**connection**	**communication interface**
15	signal +	• Modbus RTU[1] • BACnet MS/TP[1] • M-Bus[1]
16	signal -	
USB	type C Hi-Speed USB 2.0 Device	service (FluxDiag/FluxDiagReader)
LAN	RJ45 10/100 Mbps Ethernet	• service (FluxDiag/FluxDiagReader) • Modbus TCP • BACnet IP

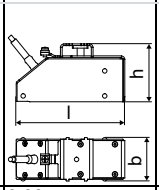
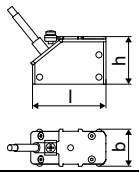
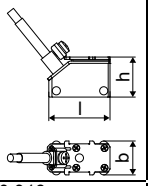
[1] cable (by customer): e.g. flexible wires, with insulated wire ferrules, wire cross-section: 0.25...2.5 mm^2

[2] The number, type and terminal assignment are customised.

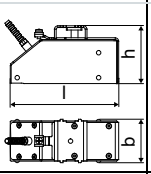
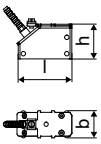
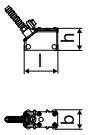
Transducers

Technical data

Shear wave transducers (max. 100 °C)

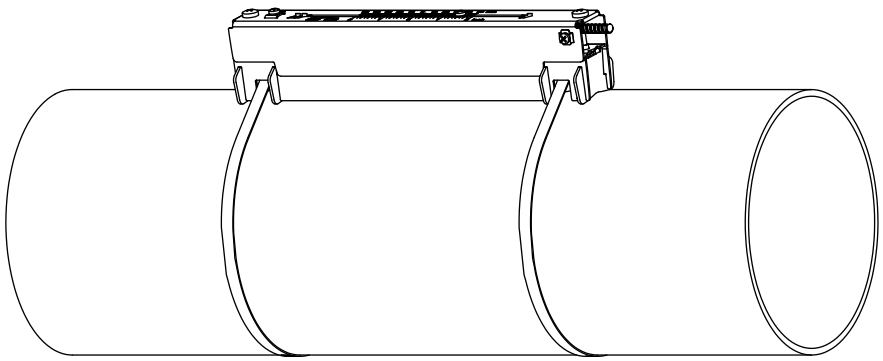
order code		FSK-LNNN-**T1	FSM-LNNN-**T1	FSP-LNNN-**T1	FSQ-LNNN-**T1
technical type		CDK1LZ7	CDM2LZ1	CDP2LZ1	CDQ2LZ1
transducer frequency	MHz	0.5	1	2	4
inner pipe diameter d					
min. extended	mm	100	50	25	10
min. recommended	mm	200	100	50	25
max. recommended	mm	2000	1000	400	150
max. extended	mm	2400	1200	480	240
pipe wall thickness					
min.	mm	5	2.5	1.2	0.6
material					
housing		PEEK with stainless steel cover 316Ti (1.4571)			
contact surface		PEEK			
degree of protection		IP66			
transducer cable					
type		2606			
length	m	10			
dimensions					
length l	mm	126.5	64		40
width b	mm	51	32		22
height h	mm	67.5	40.5		25.5
dimensional drawing					
weight (without cable)	kg	0.36	0.066		0.016
pipe surface temperature	°C	-40...+100			
ambient temperature	°C	-40...+100			

Shear wave transducers (max. 130 °C)

order code		FSK-NNNN-**T1	FSM-NNNN-**T1	FSP-NNNN-**T1	FSQ-NNNN-**T1
technical type		C(DL)K1N53	C(DL)M2N53	C(DL)P2N53	C(DL)Q2N53
transducer frequency	MHz	0.5	1	2	4
inner pipe diameter d					
min. extended	mm	100	50	25	10
min. recommended	mm	200	100	50	25
max. recommended	mm	2000	1000	400	150
max. extended	mm	2400	1200	480	240
pipe wall thickness					
min.	mm	5	2.5	1.2	0.6
material					
housing		PEEK with stainless steel cover 316L (1.4404)			
contact surface		PEEK			
degree of protection		IP66	IP66/IP67		
transducer cable					
type		1699			
length	m	5	4		3
dimensions					
length l	mm	126.5	64		40
width b	mm	51	32		22
height h	mm	67.5	40.5		25.5
dimensional drawing					
weight (without cable)	kg	0.36	0.066		0.016
pipe surface temperature	°C	-40...+130			
ambient temperature	°C	-40...+130			
temperature compensation		x			

Transducer mounting fixture

Variofix L (VL)



material: stainless steel 316Ti (1.4571), 316L (1.4404), 17-7PH (1.4568)

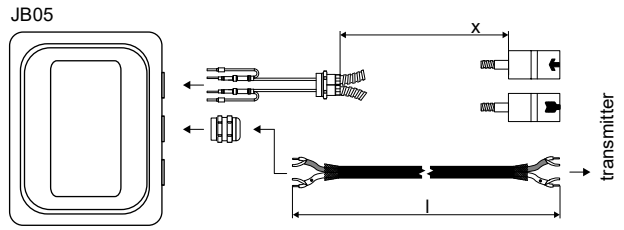
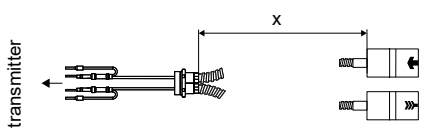
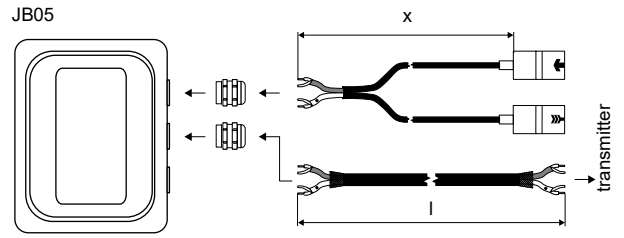
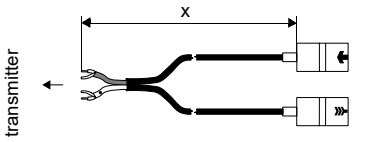
inner length:
VLK: 348 mm
VL(MP): 234 mm
VLQ: 176 mm

dimensions:
VLK: 423 x 90 x 93 mm
VL(MP): 309 x 57 x 63 mm
VLQ: 247 x 43 x 47 mm

Coupling materials for transducers

type	ambient temperature °C	remark
coupling compound type N	-30...+130	< 24 h
coupling foil type VT	-10...+200	

Connection systems

connection system T1		
connection with extension cable	direct connection	transducers technical type
		*****53
		****LZ*

Cable

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

extension cable		
type		**2615**
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

Cable length

transducer frequency		**K**		**M, P**		**Q**	
transducers technical type		x	l	x	l	x	l
CDK1LZ7	m	10	≤ 300	-	-	-	-
CD*2LZ1	m	-	-	10	≤ 300	10	≤ 90
****N53	m	5	≤ 300	4	≤ 300	3	≤ 90

x - transducer cable length

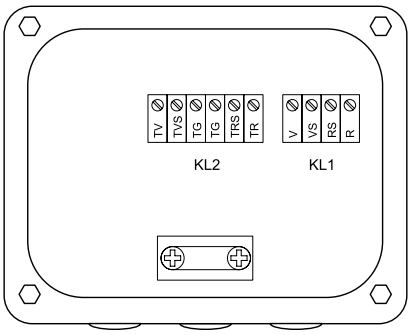
l - max. length of extension cable (depending on the application)

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		IP66/IP67
ambient temperature	°C	-40...+80

Connection



Transducers

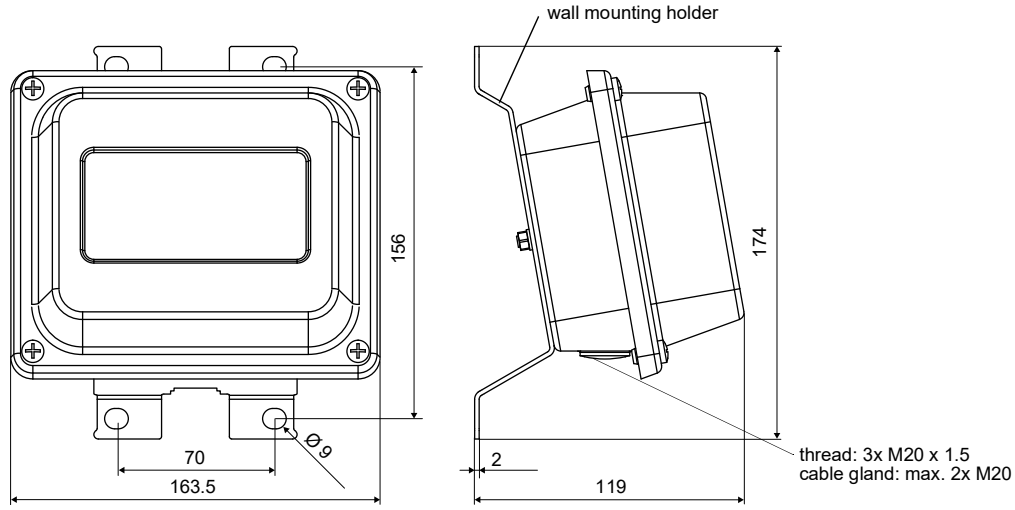
terminal strip	terminal	connection	transducer
KL1	V	signal	
	VS	internal shield	
	RS	internal shield	
	R	signal	

Extension cable

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

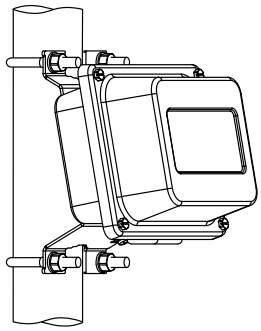
Dimensions

JB0*, JBP*



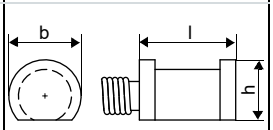
in mm

2" pipe mounting kit

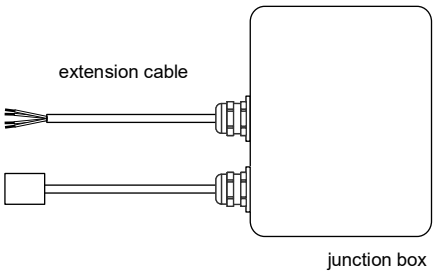
JB** 	item number: 751035-2

Clamp-on temperature probe (optional)

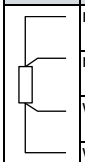
Technical data

PT12N, PT12N-LC		
order code		**PT12N:** • 770414-2 **PT12N-LC:** • 770414-4
design		clamp-on option: with long cable
type		2x Pt100, matched according to EN 1434
connection		4-wire
measuring range	°C	-30...+250
accuracy θ		±(0.15 °C + 2 · 10^{-3} · |θ [°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 material		aluminum
degree of protection		IP54
dimensions		
length l	mm	20
width b	mm	15
height h	mm	13
dimensional drawing		
weight	kg	0.25
accessories		
thermal conductivity foil 250 °C		x

Connection system

connection with extension cable	direct connection
	

Connection

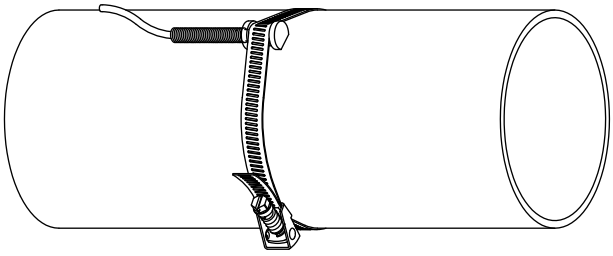
	temperature probe
	red
	red/blue
	white/blue
	white

Cable

		PT12N	PT12N-LC	extension cable
type		4 x 0.22 mm^2		LIYCY 8 x 0.14 mm^2 grey
standard length	m	3	15	5/10/25
max. length	m	-		200
ambient temperature	°C	-30...+250		-25...+80
min. bend radius	mm	27		68
cable jacket				
material		PFA		PVC
outer diameter	mm	3.8 ±0.15		4.8 ±0.2
colour		black		grey

Fixation

tension strap PT12N



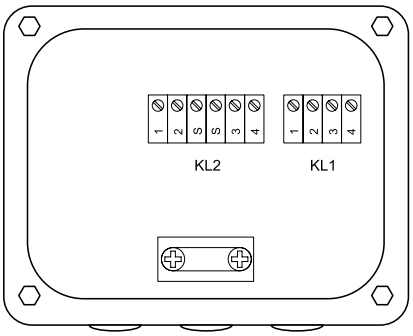
material: stainless steel 301 (1.4310), 410 (1.4006)

thermal insulation necessary

Junction box

JBT3		
item number		751040-36
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

Connection



Temperature probe

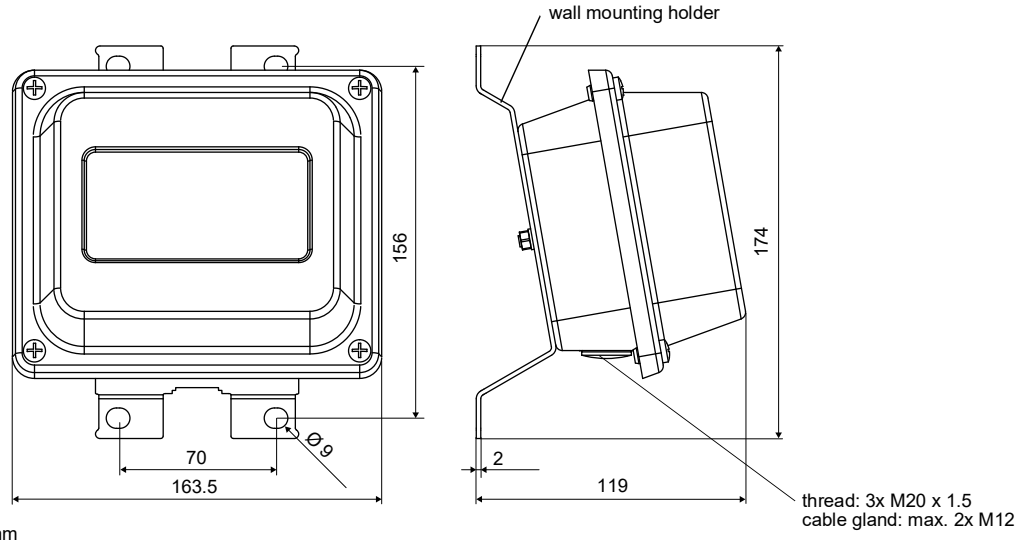
terminal strip	terminal	connection
KL1	1	red
	2	red/blue
	3	white
	4	white/blue

Extension cable

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

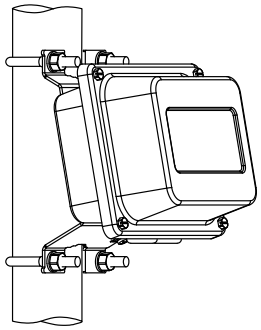
Dimensions

JBT*



in mm

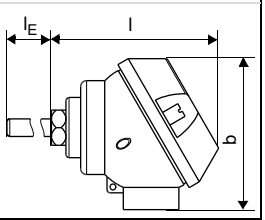
2" pipe mounting kit

JB** 	item number: 751035-2

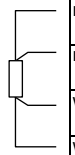
Inline temperature probe (optional)

Technical data

PT12N-IT-P
PT12N-IU-P

item number		**PT12N-IT-P**: • 770416-1 (matched, without cable) • 770416-11 (matched, 10 m) • 770416-12 (matched, 20 m) **PT12N-IU-P**: • 770416-2 (matched, without cable) • 770416-21 (matched, 10 m) • 770416-22 (matched, 20 m)
design		inline
type		Pt100
connection		4-wire
measuring range	°C	-30...+200
accuracy T		±(0.15 °C + 2 · 10^{-3} · |T [°C]|) class A
accuracy ΔT (2x Pt matched according to EN 1434)		≤ 0.1 K (3 K < ΔT < 6 K), more corresponding to EN 1434
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

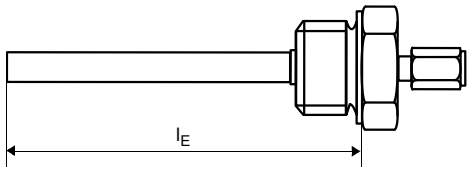
	temperature probe	cable
	red	red
	red	grey
	white	blue
	white	white

cable

		temperature probe
type		LIYCY 8 x 0.14 mm^2
standard length	m	10/20
max. length	m	200
ambient temperature	°C	-25...+80
min. bend radius	mm	68
cable jacket		
material		PVC
outer diameter	mm	4.8 ±0.2
colour		grey

Fixation

threaded thermowell PT12N-I



		PT12N-IT-P	PT12N-IU-P
mounting length l_E	mm	120	210
material			
threaded thermowell		stainless steel 316L (1.4404)	
clamping nut		galvanised 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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