Technical specification

FLUXUS G532ST-LT

Non-invasive ultrasonic mass flow rate and volumetric flow rate measurement of saturated steam

Features

- Non-invasive measurement of saturated steam up to 180 °C without fluid contact – no need to open the pipe
- Temperature-compensated mass flow rate calculation via saturated steam curve possible
- Very high measuring dynamics of 0.01...60 m/s – no need to reduce pipe diameters
- Cost-efficient due to start-up during ongoing operation and without pressure/energy loss in the steam network
- Drift-free and maintenance-free, as no wear and tear
- Compact transducers that are easy to insulate – no energy loss at the measuring point
- 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

For the following measuring tasks in pharmaceutical, food and manufacturing industries, building technology and hospitals:

- Energy management and energy efficiency
- Quantity balancing and cost distribution
- Consumption metering
- Process/boiler optimization

FLEXIM GmbH
Boxberger Str. 4
12681 Berlin
Germany
Tel.: +49 (30) 93 66 76 60
Fax: +49 (30) 93 66 76 80

internet: www.flexim.com
e-mail: info@flexim.com

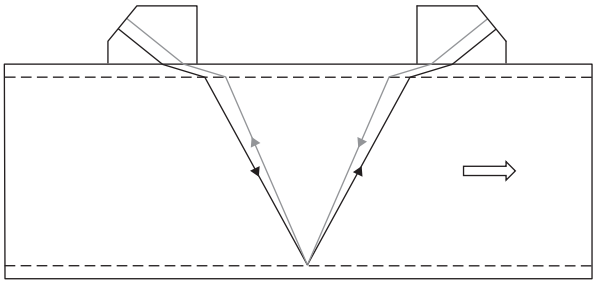
TSFLUXUS_G532ST-LTV1-0-1EN_Leu, 2023-06-12

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

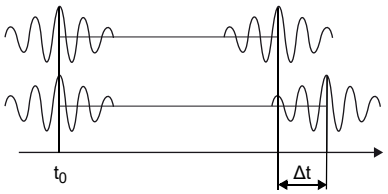


As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

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 mass flow rate

The mass flow rate is calculated from the operating density and the volumetric flow rate:

$\dot{m} = \rho \cdot \dot{V}$

The operating density of the fluid is calculated as the function of pressure and temperature of the fluid:

$\rho = f(p, T)$

where

ρ - operating density

p - fluid pressure

T - fluid temperature

$\dot{m}$ - mass flow rate

$\dot{V}$ - volumetric flow rate

Temperature-compensated mass flow rate calculation via the saturated steam curve is possible.

Number of sound paths

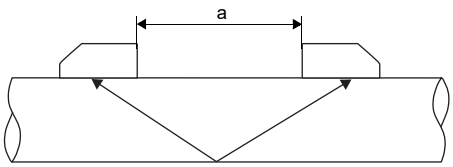
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **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.

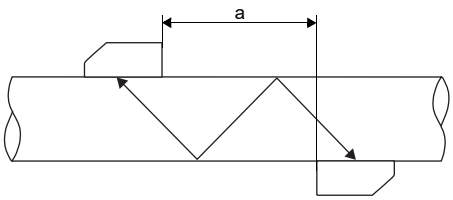
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

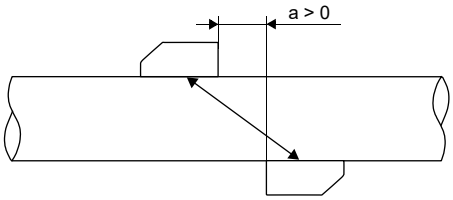
Reflection arrangement, number of sound paths: 2



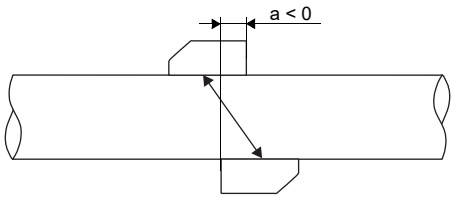
Diagonal arrangement, number of sound paths: 3



Diagonal arrangement, number of sound paths: 1



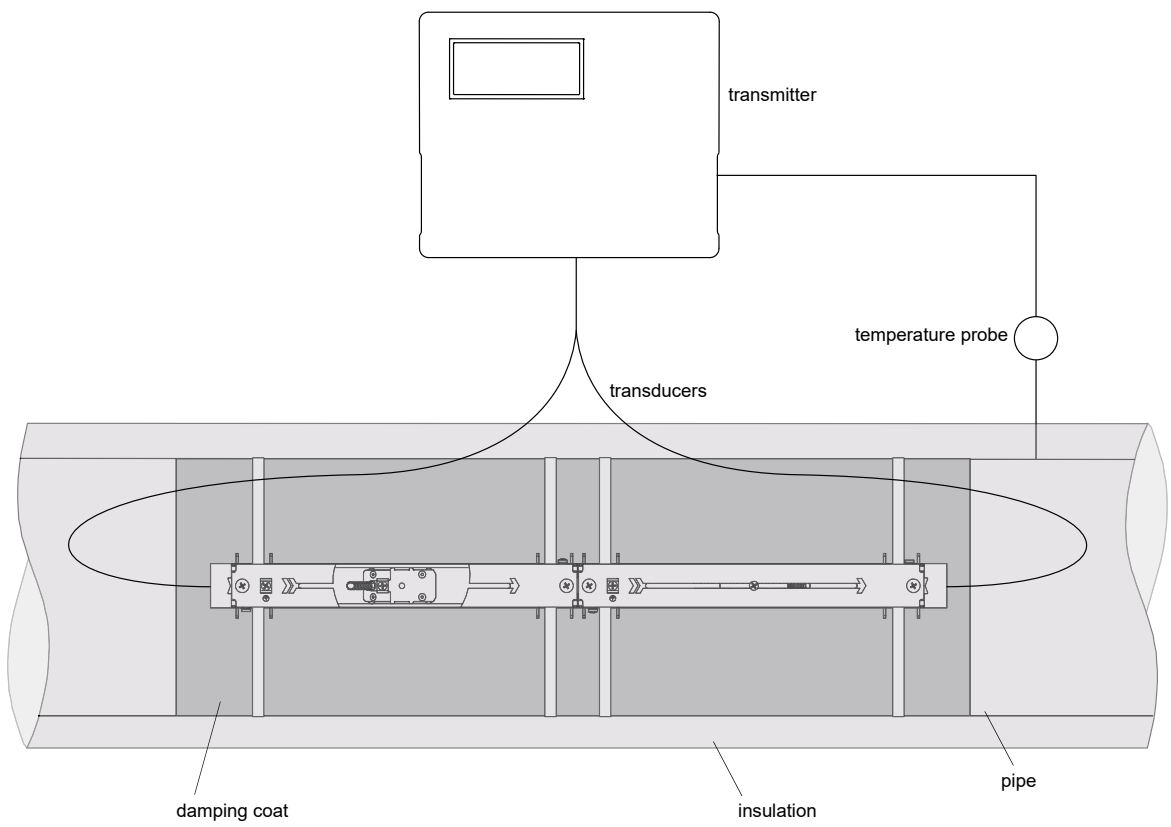
Diagonal arrangement, number of sound paths: 1, negative transducer distance



a - transducer distance

Typical measurement setup

Example of a reflection arrangement



Transmitter

Technical data

		FLUXUS G532ST-LT (analog outputs)	FLUXUS G532ST-LT (process interface)
			
design		field device with 1 measuring channel	
application		steam measurement[2]	
measurement			
measurement principle		transit time difference correlation principle	
flow velocity		depending on pipe diameter and transducer, see diagrams	
repeatability		0.15 % MV ±0.005 m/s	
fluid		saturated steam, superheated steam	
fluid pressure	bar (a)	3...10	
fluid temperature	°C	135...180	
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		±1...3 % MV ±0.005 m/s, depending on the application	
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		operating volumetric flow rate, mass flow rate, flow velocity	
totaliser		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		-	• Modbus RTU or • BACnet MS/TP or • M-Bus or • Modbus TCP or • BACnet IP
accessories			
data transmission kit		USB cable	
software		• FluxDiagReader: reading of measured values and parameters, graphical representation • FluxDiag (optional): reading of measurement data, graphical representation, report generation, parametrisation of the transmitter	
data logger			
loggable values		all physical quantities and totalised physical quantities	
capacity		max. 800 000 measured values	

[1] with aperture calibration of the transducers

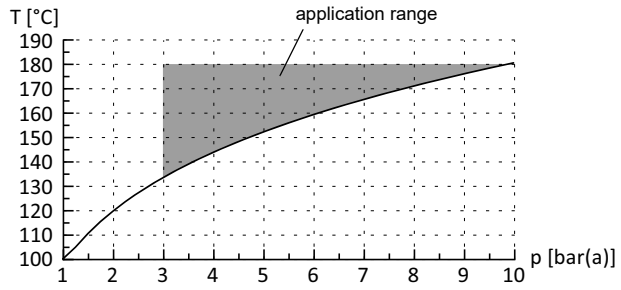
[2] test measurement to validate the application required in advance

		FLUXUS G532ST-LT (analog outputs)	FLUXUS G532ST-LT (process interface)
outputs			
		The outputs are galvanically isolated from the transmitter.	
• switchable current output			
		configurable according to NAMUR NE43 All switchable current outputs are jointly switched to active or passive.	
number		1	-
range	mA	4...20 (3.2...24)	-
accuracy		0.04 % MV ±3 µA	-
active output		R_{ext} < 530 Ω	-
passive output		U_{ext} = 9...30 V, depending on R_{ext} (R_{ext} < 458 Ω at 20 V)	-
• digital output			
number		2	-
functions		• frequency output • binary output • pulse output	-
operating parameters		U_{ext} = (8.2 ±0.1) V DC	-
frequency output			
• range	kHz	0...10	-
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	-
inputs			
		The inputs are galvanically isolated from the transmitter.	
• temperature input			
number		1	
type		Pt100/Pt1000	
connection		4-wire	
range	°C	-150...+560	
resolution	K	0.01	
accuracy		±0.01 % MV ±0.03 K	

[1] with aperture calibration of the transducers

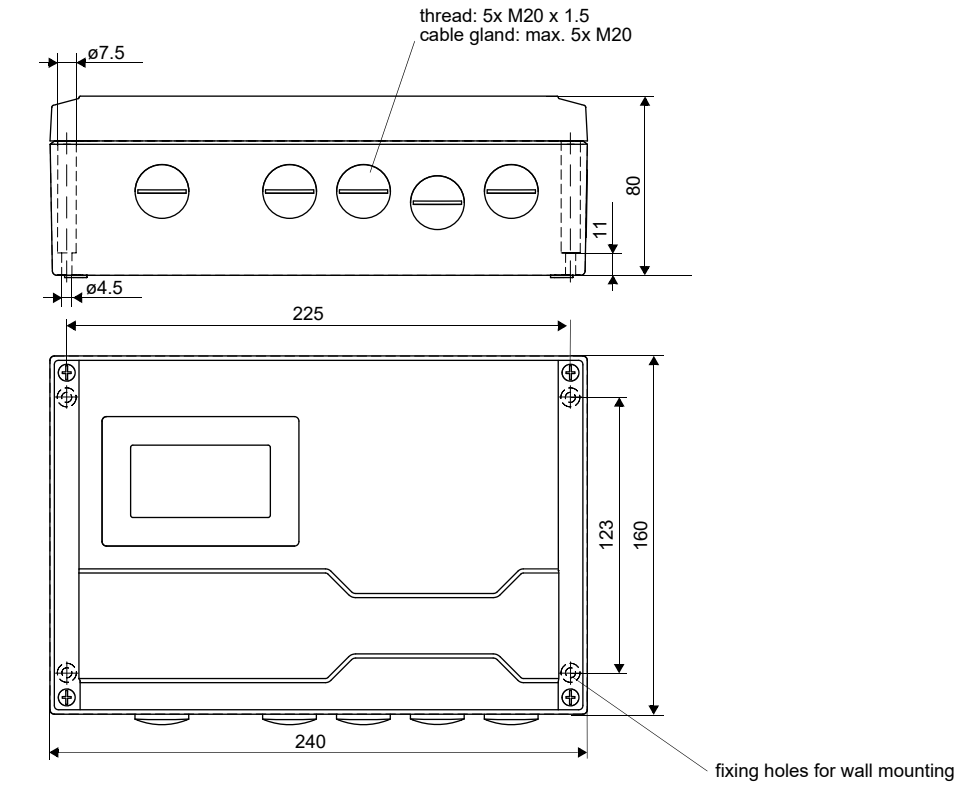
[2] test measurement to validate the application required in advance

Saturated steam pressure curve



Dimensions

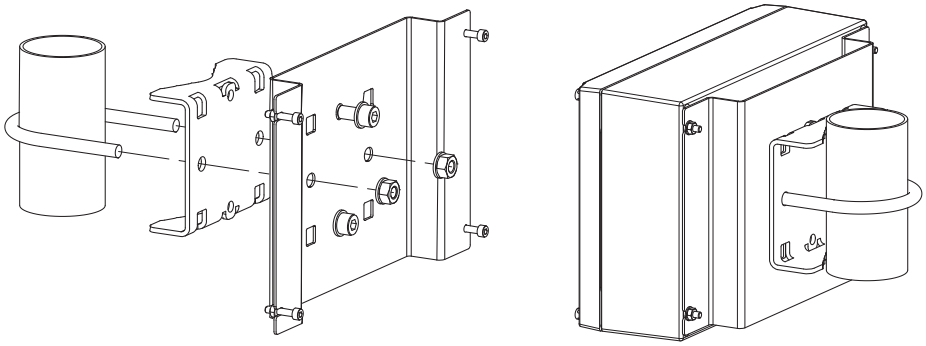
***532**



in mm

2" pipe mounting kit (optional)

***532**



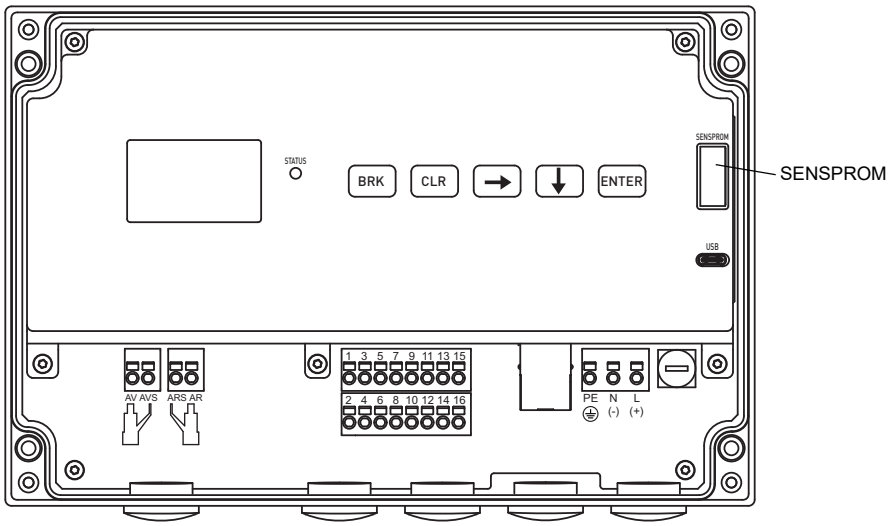
item number: 532037-1

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	earth	PE	earth
N	neutral	(-)	-
L	phase	(+)	+

transducers		
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
1, 2, 3, 4	temperature input

temperature probe		
terminal	**direct connection**	**connection with extension cable**
1	red	red
2	white	white
3	red/blue	grey
4	white/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

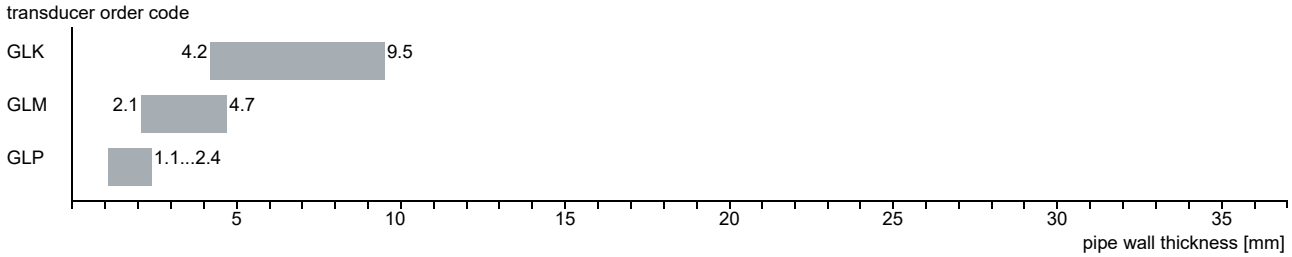
[2] The number, type and terminal assignment are customised.

Transducers

Transducer selection

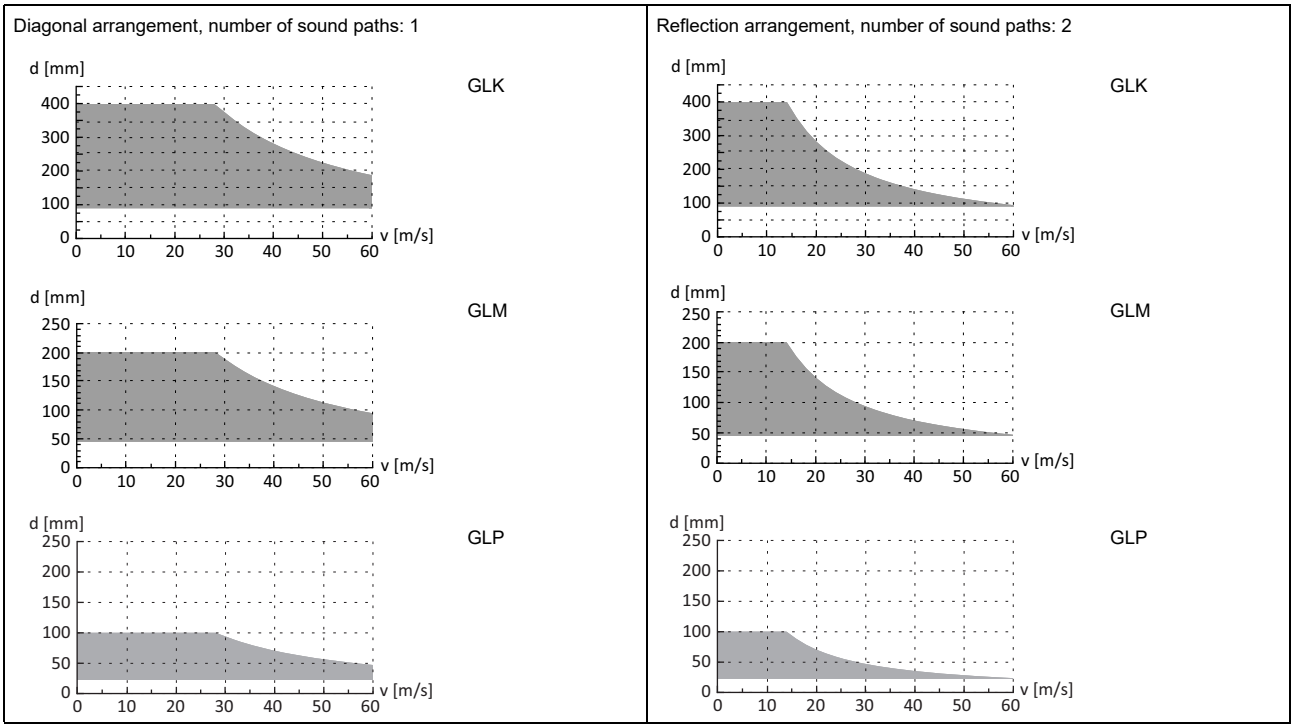
Step 1

pipe wall thickness



Step 2

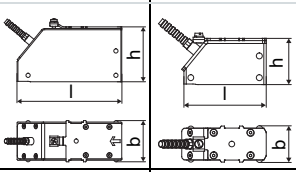
inner pipe diameter d dependent on the flow velocity v of the fluid in the pipe



inner pipe diameter and max. flow velocity for a steam application

Technical data

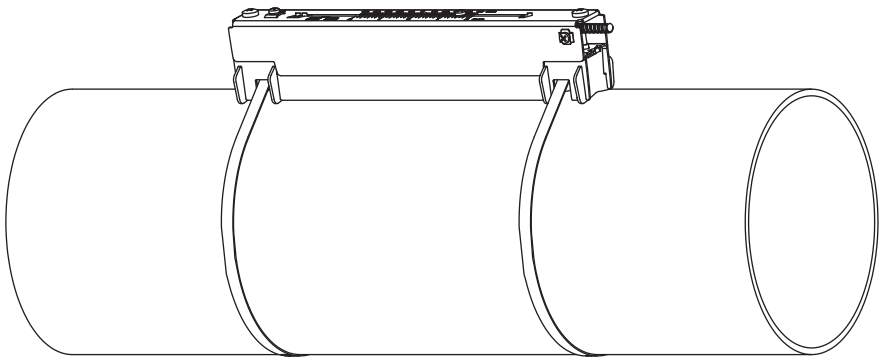
Lamb wave transducers

order code		GLK-SNNN-**T1	GLM-SNNN-**T1	GLP-SNNN-**T1
technical type		G(RT)K1S53	G(RT)M1S53	G(RT)P1S53
transducer frequency	MHz	0.5	1	2
fluid pressure		see saturated steam pressure curve		
inner pipe diameter d				
min.	mm	90	45	23
max.	mm	400	200	100
pipe wall thickness				
min.	mm	4.2	2.1	1.1
max.	mm	9.5	4.7	2.4
material				
housing		PPSU with stainless steel cover 316Ti (1.4571)		
contact surface		PPSU		
degree of protection		IP66		
transducer cable				
type		1699		
length	m	5	4	
dimensions				
length l	mm	128.5	74	
width b	mm	51	32	
height h	mm	67.5	40.5	
dimensional drawing				
weight (without cable)	kg	0.8	0.16	
storing temperature				
storing temperature	°C	-40...+180		
operating temperature	°C	100...180		
warm-up time	h	3	1	
temperature compensation		x		

completely thermically insulated transducer installation necessary

Transducer mounting fixture

Variofix L (VLK, VLM)



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

inner length:
VLK: 348 mm,
VLM: 234 mm

dimensions:
VLK: 423 x 90 x 93 mm
VLM: 309 x 57 x 63 mm

Coupling materials for transducers

type	**ambient temperature** °C
coupling foil type VT[1]	-10...+200
coupling compound type E[2]	-30...+200

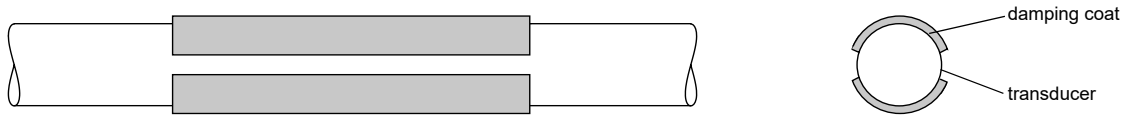
[1] fluid temperature 200 °C: min. 2 years

[2] in combination with type VT only

Damping coat

The damping coat will be used to reduce acoustic noise influences on the measurement.

Example (diagonal arrangement)



Technical data

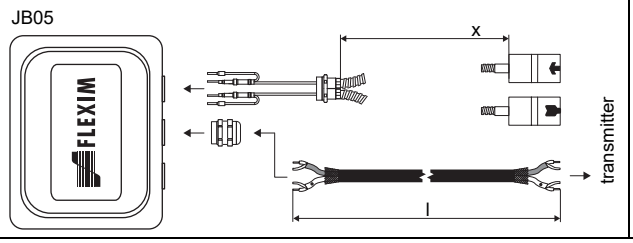
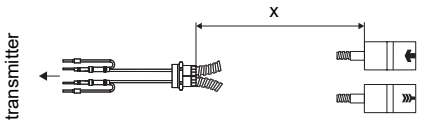
item number		992080-13
material		multipolymeric matrix/inorganic ceramic coating
packing drum	l	1
properties		heat-resistant, inert
fluid temperature when applying	°C	10...200
drying time (example)		approx. 3 h at 20 °C approx. 15 min at 150 °C
temperature resistance in dry state	°C	max. 650
durability of the packing drum (unopened)		2 years

Observe installation instructions (TI_DampingCoat).

Dimensioning

transducer frequency	**number of packing drums**	
	outer pipe diameter	
	≤300	≤500
	mm	
K	2	2
M	2	-
P	1	-

Connection systems

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

Cable

transducer cable		
type		**1699**
weight	kg/m	0.094
ambient temperature	°C	-55...+200
cable jacket		
material		PTFE
outer diameter	mm	2.9
thickness	mm	0.3
colour		brown
shield		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
cable jacket		
material		PUR
outer diameter	mm	max. 12
thickness	mm	2
colour		black
shield		x

Cable length

transducer frequency		**K**		**M, P**	
transducers technical type		x	l	x	l
*R***5*	m	5	≤ 300	4	≤ 300
*T***5*	m	9	≤ 300	9	≤ 300

x - transducer cable length

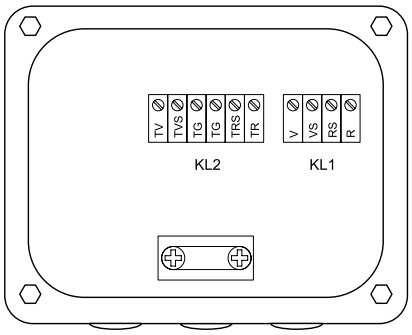
l - max. length of extension cable (depending on the application)

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

Connection



Transducers

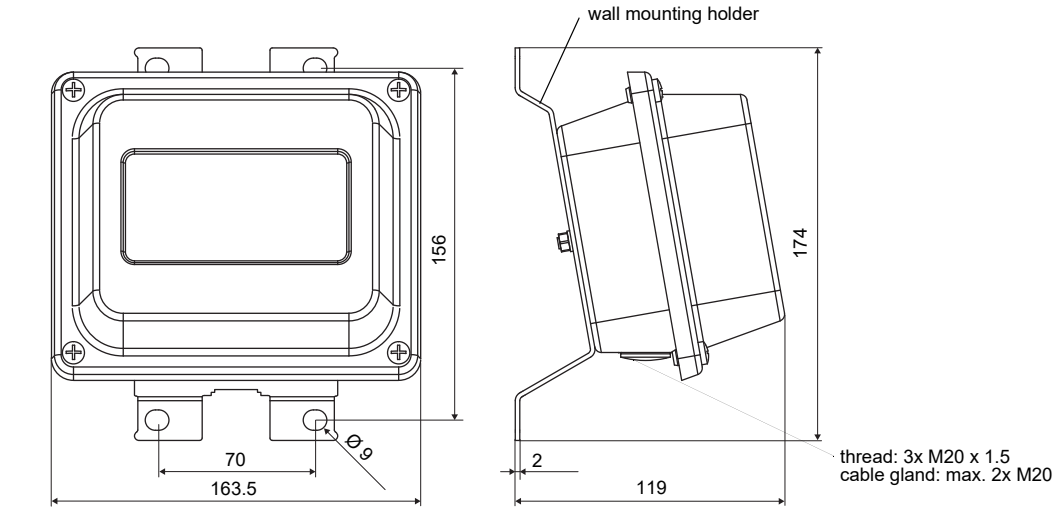
terminal strip	terminal	connection	transducer
KL1	V	signal	
	VS	internal shield	
	RS	internal shield	
	R	signal	

Extension cable

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

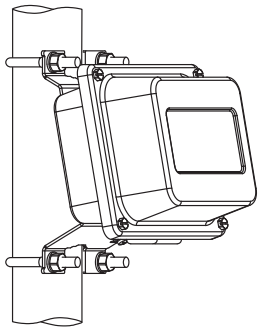
Dimensions

JB0*, JBP*



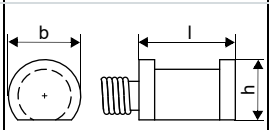
in mm

2" pipe mounting kit

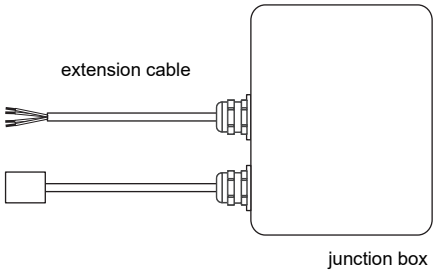
JB** 	item number: 751035-2

Clamp-on temperature probe (optional)

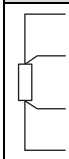
Technical data

PT12N, PT12N-LC		
item number		**PT12N:** • 770415-1 **PT12N-LC:** • 770415-4
design		clamp-on option: with long cable
type		Pt100
connection		4-wire
measuring range	°C	-30...+250
accuracy T		±(0.15 °C + 2 · 10^{-3} · |T [°C]|) class A
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

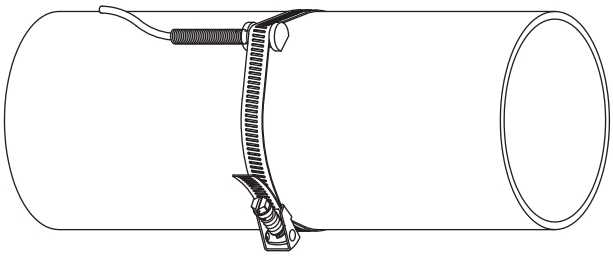
	temperature probe
	red
	red/blue
	white/blue
	white

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 ±2
colour		black		grey

Fixation

tension strap PT12N

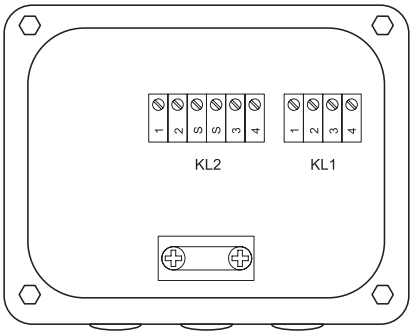


material: stainless steel 301 (1.4310), 410 (1.4006)
thermal insulation necessary

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

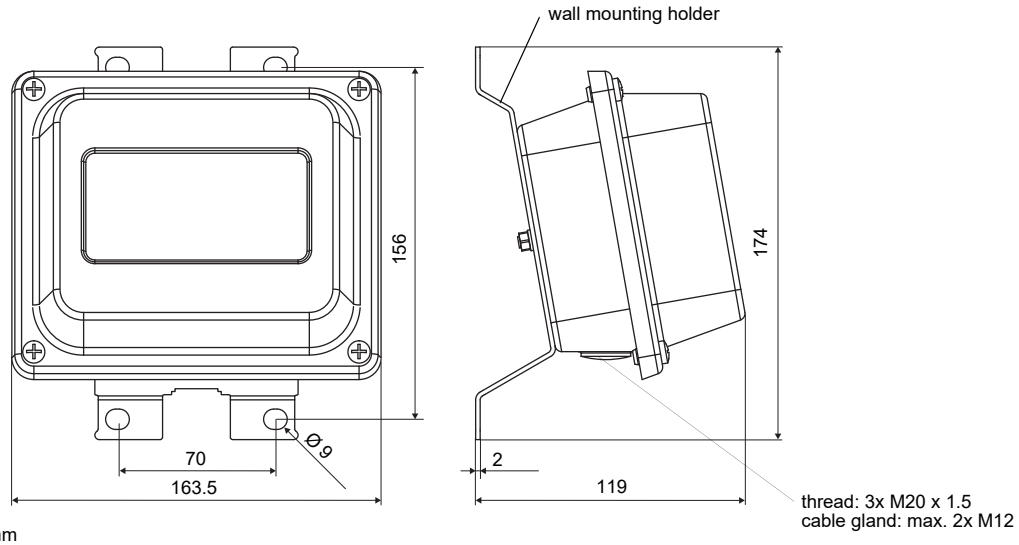
terminal strip	terminal	connection
KL1	1	red
	2	red/blue
	3	white
	4	white/blue

Extension cable

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

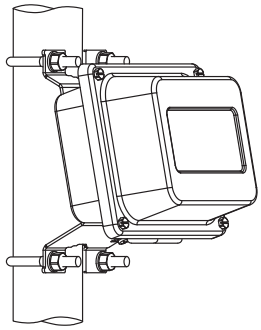
Dimensions

JBT*



in mm

2" pipe mounting kit

JB** 	item number: 751035-2