Portable Ultrasonic Flow Measurement of Liquids

Portable instrument for non-invasive, quick ultrasonic flow measurement with clamp-on technology for all types of piping

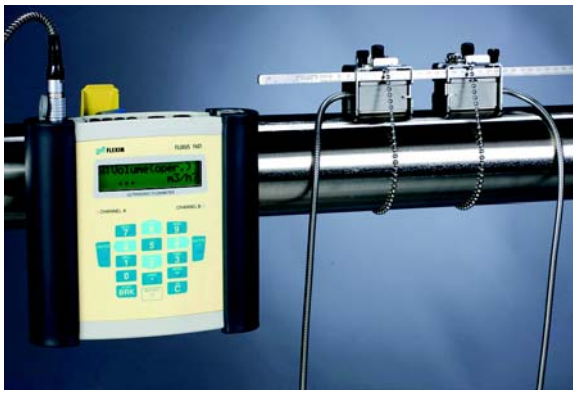
Features

- Non-invasive measurement using the clamp-on method for precise bi-directional, highly dynamic flow mesurement
- Portable, easy-to-use flowmeter with 2 flow measurement channels, multiple inputs/outputs, an integrated data logger and a serial interface in the standard version
- Automatic loading of calibration data and transducer detection, reduces set-up times and provides precise, long-term stable results
- Li-Ion battery for 14 hours of measurement operation
- Proven clamp-on method; transducers available for a wide range of inner pipe diameters (6…6500 mm) and temperatures in the range of -40...+400 °C; resistant to dust and humidity
- Integrated wall thickness measurement
- Water and dust-tight; resistant against oil, many liquids and dirt
- Robust, water-tight (IP 67) transport case with comprehensive accessories
- HybridTrek: automatic changeover between transit time difference method and NoiseTrek for media with a high proportion of solids or gases
- QuickFix for fast mounting of the flowmeter in difficult conditions

Applications

- Designed for industrial use, in particular for application in
  - Chemical industry
  - Water and waste water industry
  - Cooling systems and air conditioners
  - Facility management
  - Aviation industry

FLUXUS F601 supported by handle



Measurement with transducers mounted by fastening shoes and flowmeter fixed to the pipe by the QuickFix pipe mounting fixture

Measurement equipment in transport case

List of Contents

Function

Measuring Principle

Transit Time Difference Principle

For the flow measurement of the medium, ultrasonic signals are used, employing the transit time difference principle. Ultrasonic signals are emitted by a transducer installed on one side of a pipe, reflected on the opposite side and received by a second transducer. These signals are emitted alternatively in flow direction and against it.

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

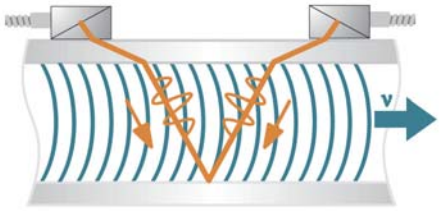
The transit time difference Δt is measured and allows to determine the average flow velocity on the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area average of the flow velocity, which is proportional to the volume flow.

The received ultrasonic signals will be checked for their usefulness for the measurement and the plausibility of the measured values will be evaluated. The complete measuring cycle is controlled by the integrated microprocessors. Disturbance signals will be eliminated.

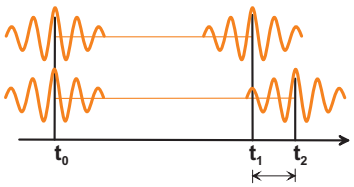
HybridTrek

If the gaseous or solid content of the medium increases occasionally during measurement, a measurement with the transit time difference principle will be no longer possible. Instead NoiseTrek will be selected, a method achieving a stable measurement even with a high gaseous or solid content.

The flowmeter switches automatically between transit time difference principle and NoiseTrek during measurement, the measurement setup does not need to be changed.



Path of the ultrasonic signal



Transit time difference Δt

Calculation of the Volume Flow

$Q = k_{Re} \cdot A \cdot k_{\alpha} \cdot \Delta t/(2 \cdot t_t)$

with:

Q - volume flow
k_{Re} - fluid mechanics correction factor
A - cross-sectional area of the pipe
k_{α} - flowmeter constant
Δt - transit time difference
t_t - transit time of the medium

Number of Sound Paths

The number of sound paths is the number of transits of the ultrasonic signals through the medium in the pipe.

reflection mode: number of sound paths = even, the transducers are mounted on the same side of the pipe, correct positioning of the transducers easier

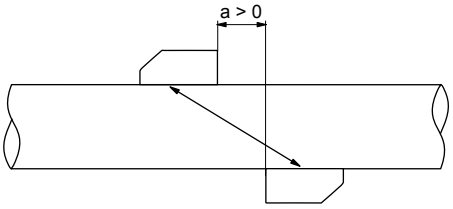
diagonal mode: number of sound paths = odd, the transducers are mounted on opposite sides of the pipe

The mode to be used depends on the application. If the number of sound paths is increased, the accuracy of the measurement will be better, but the signal attenuation is increased.

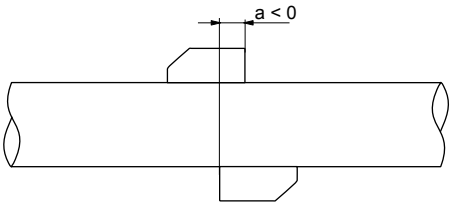
In case of a high signal attenuation by medium, pipe and coatings, diagonal mode with 1 sound path will be used.

The optimum number of sound paths for the parameters of the application will be detemined automatically by the flowmeter

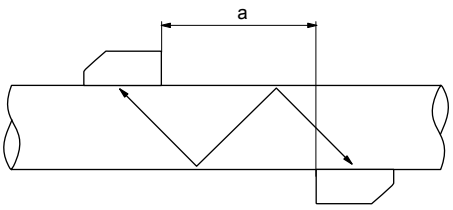
As the transducers can be mounted with the supplied transducer mounting fixture in reflection mode or diagonal mode the number of sound paths can be adjusted optimally to the application.



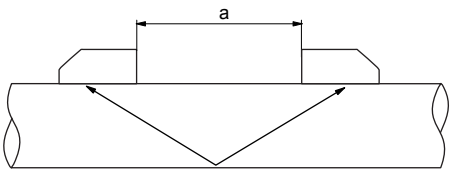
Diagonal mode, number of sound paths: 1



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



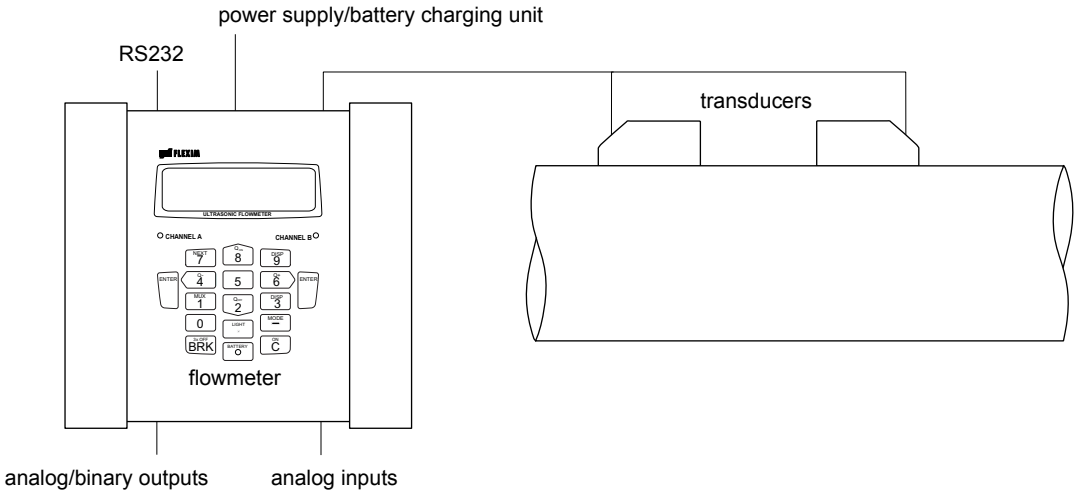
Diagonal mode, number of sound paths: 3



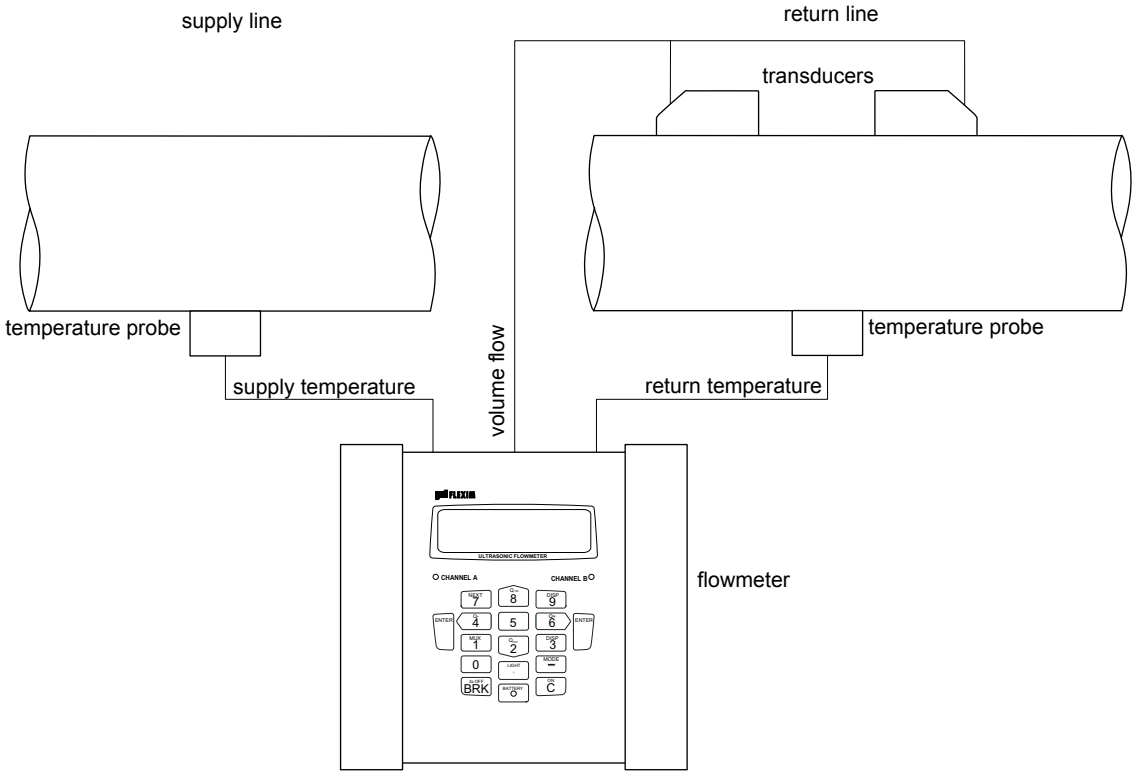
Reflex mode, number of sound paths: 2

a - transducer distance

Typical Measurement Setup



Example for a measurement setup in reflection mode



Example for heat flow measurement

Flowmeter

Technical Data

FLUXUS	F601
design	portable
	
measurement	
measuring principle	transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	0.01...25 m/s
repeatability	0.15 % of reading ±0.01 m/s
accuracy[1]	
with standard calibration with extended calibration (option) with field calibration[2]	±1.6 % of reading ±0.01 m/s ±1.2 % of reading ±0.01 m/s ±0.5 % of reading ±0.01 m/s
medium	all acoustically conductive liquids with < 10 % gaseous or solid content in volume (transit time difference principle)
flowmeter	
power supply	100...240 V/50...60 Hz (power supply), 10.5...15 V DC (socket at flowmeter) or integrated battery
battery	Li-Ion, 7.2 V/4.5 Ah operating time (without outputs, inputs and backlight): > 14 h
power consumption	< 6 W
number of flow measuring channels	2
signal damping	0...100 s, adjustable
measuring cycle (1 channel)	100...1000 Hz
response time	1 s (1 channel), option: 70 ms
material	PA, TPE, AutoTex, stainless steel
degree of protection according to EN 60529	IP 65
weight	1.9 kg
fixation	QuickFix pipe mounting fixture
operating temperature	-10...+60 °C
display	2 x 16 characters, dot matrix, backlit
menu language	English, German, French, Dutch, Spanish
measuring functions	
physical quantities	volume flow, mass flow, flow velocity, heat flow (if temperature inputs are installed)
totalizers	volume, mass, option: heat quantity
calculation functions	average, difference, sum
data logger	
loggable values	all physical quantities and totalized values
capacity	> 100 000 measured values

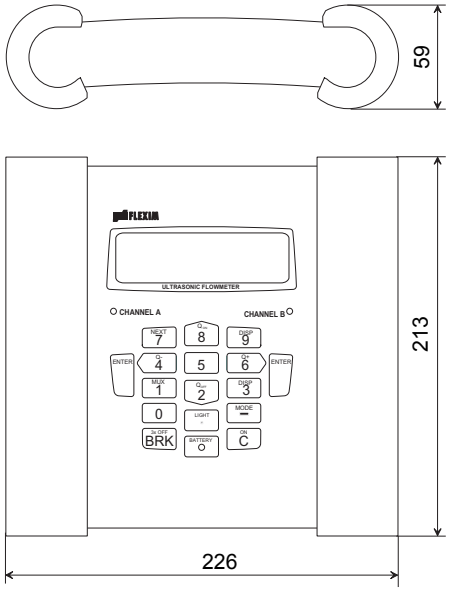
[1] for transit time difference principle, reference conditions and v > 0.15 m/s

[2] reference uncertainty < 0.2 %

FLUXUS	F601
communication	
interface	RS232/USB
serial data kit	
software (all Windows™ versions)	- FluxData: download of measured data, graphical presentation, conversion to other formats (e.g. for Excel™) - FluxKoeff: creating medium data sets
cable	RS232
adapter	RS232 - USB
transport case	
dimensions	500 x 400 x 190 mm
outputs	
	The outputs are galvanically isolated from the flowmeter.
number	see standard scopes of supply on page 9, max. on request
accessories	output adapter (if number of outputs > 4)
	current output
range	0/4...20 mA
accuracy	0.1 % of reading ±15 µA
active output	R_{ext} < 200 Ω
passive output	U_{ext} = 4...16 V, dependent on R_{ext} R_{ext} < 500 Ω
	frequency output
range	0...10 kHz
open collector	24 V/4 mA
	binary output
optorelay	32 V/100 mA
binary output as alarm output	
- functions	limit, change of flow direction or error
binary output as pulse output	
- pulse value	0.01...1000 units
- pulse width	1...1000 ms
inputs	
	The inputs are galvanically isolated from the flowmeter.
number	see standard scopes of supply on page 9, max. 4
accessories	input adapter (if number of inputs > 2)
	temperature input
designation	Pt100/Pt1000
connection	4-wire
range	-150...+560 °C
resolution	0.01 K
accuracy	±0.01 % of reading ±0.03 K
	current input
range	passive: -20...+20 mA
accuracy	0.1 % of reading ±10 µA
passive input	R_i = 50 Ω, P_i < 0.3 W
	voltage input
range	0...1 V
accuracy	0.1 % of reading ±1 mV
internal resistance	R_i = 1 MΩ

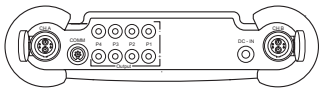
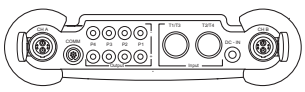
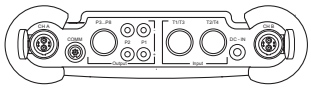
Dimensions

FLUXUS F601

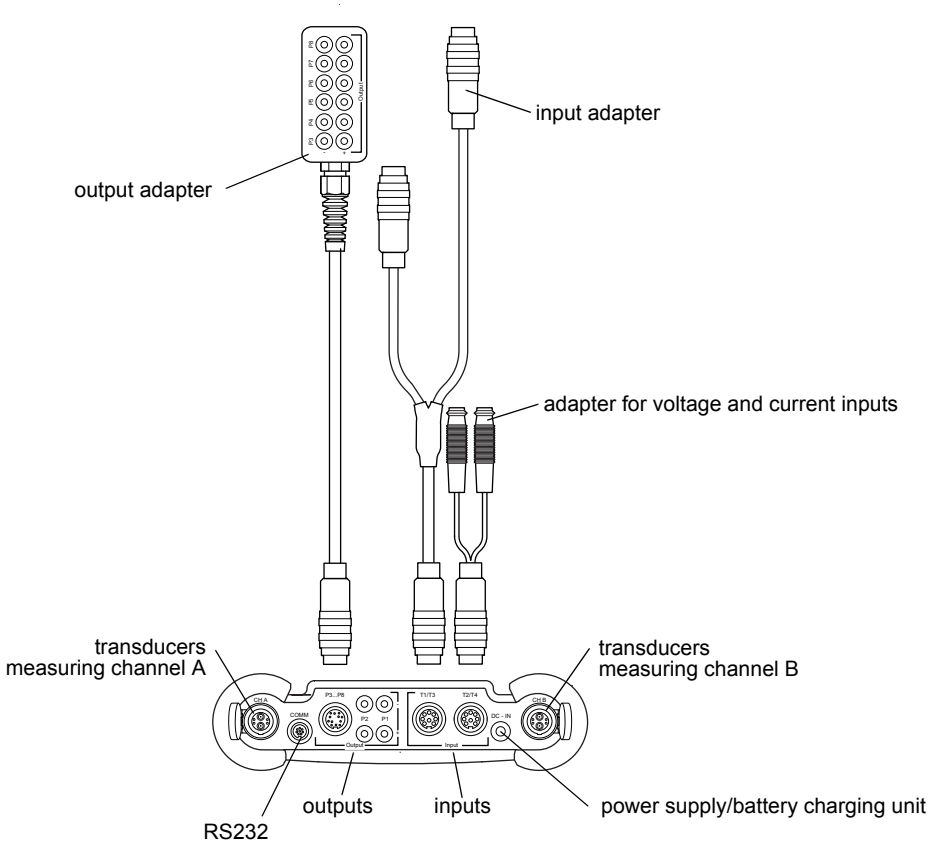


in mm

Standard Scopes of Supply

	F601 Standard	F601 Energy	F601 Multifunctional
application	all flow measurements on liquids, e.g. modeling of pump curves	including energy calculator for BTU and heat measurements	sophisticated measuring tasks, e.g. temporary substitute of other flowmeters with compensation of input quantities (e.g. density, viscosity) and simultaneous measured value output
inputs/outputs			
passive current output	2	2	4
binary output	2	2	2
temperature input	-	2	2
passive current input	-	-	2
accessories			
transport case	x	x	x
power supply, power cable	x	x	x
battery	x	x	x
output adapter	-	-	x
input adapter	-	-	2
adapter for voltage or current inputs	-	-	2
QuickFix pipe mounting fixture for flowmeter	x	x	x
serial data kit	x	x	x
fastening shoes and chains (transducer frequency M, Q)	x	x	x
measuring tape	x	x	x
user manual, Quick Start Guide	x	x	x
connector board at the upper side of the flowmeter			

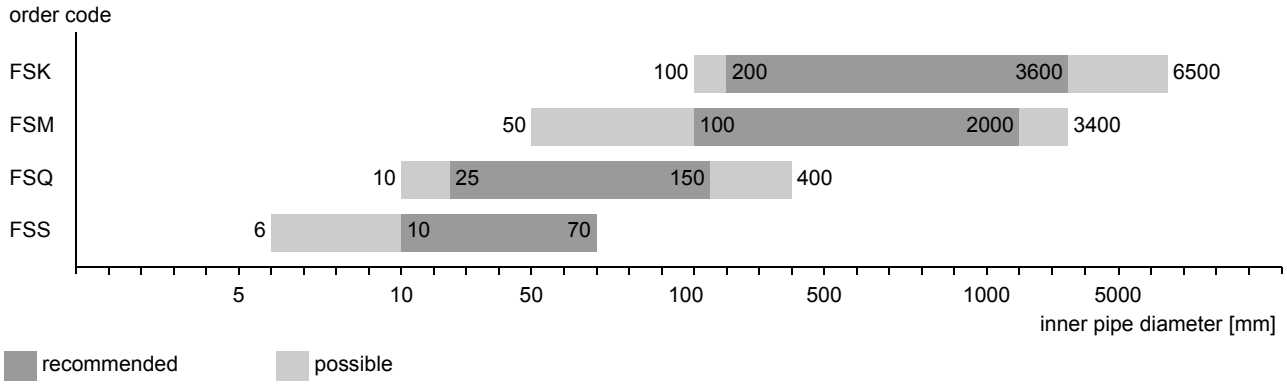
Connection of Adapters



Example for the Equipment of a Transport Case

Transducers

Transducer Selection

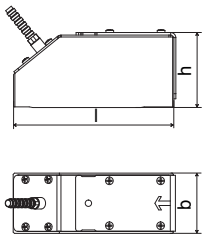
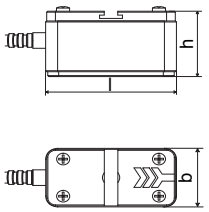


Order Code Key for Transducers

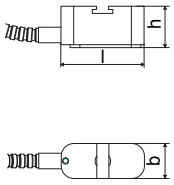
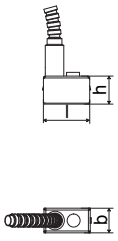
1, 2	3		4	5, 6	7, 8		9...11	no. of character
transducer	transducer frequency	-	temperature	explosion protection	connection system	-	extension cable	description
FS								set of ultrasonic flow transducers for liquids measurement, shear wave
	K							0.5 MHz
	M							1 MHz
	Q							4 MHz
	S							8 MHz
			N					normal temperature range
			E					extended temperature range (shear wave transducers with transducer frequency M, Q)
				NN				not explosion proof
					NL			with Lemo connector
							XXX	cable length in m, for max. length of extension cable see page 20
example								
FS	M	-	N	NN	NL	-	000	shear wave transducer 1 MHz, normal temperature range, connection system NL with Lemo connector
		-				-		

Technical Data

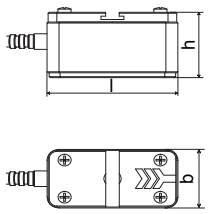
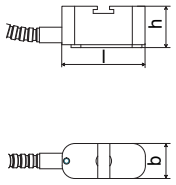
Shear Wave Transducers

technical type		CDK1NZ7	CDM1NZ7
order code		**FSK-NNNNL**	**FSM-NNNNL**
transducer frequency	MHz	0.5	1
inner pipe diameter d			
min. extended	mm	100	50
min. recommended	mm	200	100
max. recommended	mm	3600	2000
max. extended	mm	6500	3400
pipe wall thickness			
min.	mm	-	-
max.	mm	-	-
material			
housing contact surface		PEEK with stainless steel cap 304 (1.4301) PEEK	stainless steel 304 (1.4301) PEEK
degree of protection according to EN 60529		IP 67	IP 67
transducer cable			
type		1699	1699
length	m	5	4
dimensions			
length l	mm	126.5	60
width b	mm	47	30
height h	mm	55.9	33.5
dimensional drawing			
operating temperature			
min.	°C	-40	-40
max.	°C	+130	+130

Shear Wave Transducers

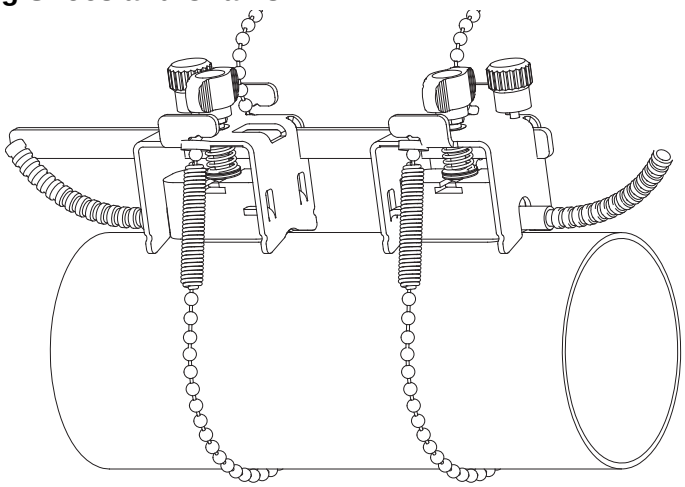
technical type		CDQ1NZ7	CDS1NZ7
order code		**FSQ-NNNNL**	**FSS-NNNNL**
transducer frequency	MHz	4	8
inner pipe diameter d			
min. extended	mm	10	6
min. recommended	mm	25	10
max. recommended	mm	150	70
max. extended	mm	400	70
pipe wall thickness			
min.	mm	-	-
max.	mm	-	-
material			
housing contact surface		stainless steel 304 (1.4301) PEEK	stainless steel 304 (1.4301) PEI
degree of protection according to EN 60529		IP 67	IP 65
transducer cable			
type		1699	1699
length	m	3	2
dimensions			
length l	mm	42.5	25
width b	mm	18	13
height h	mm	21.5	17
dimensional drawing			
operating temperature			
min.	°C	-40	-30
max.	°C	+130	+130

Shear Wave Transducers (extended temperature range)

technical type		CDM1EZ7	CDQ1EZ7
order code		**FSM-ENNNL**	**FSQ-ENNNL**
transducer frequency	MHz	1	4
inner pipe diameter d			
min. extended	mm	50	10
min. recommended	mm	100	25
max. recommended	mm	2000	150
max. extended	mm	3400	400
pipe wall thickness			
min.	mm	-	-
max.	mm	-	-
material			
housing contact surface		stainless steel 304 (1.4301) Sintimid	stainless steel 304 (1.4301) Sintimid
degree of protection according to EN 60529		IP 65	IP 65
transducer cable			
type		1699	1699
length	m	4	3
dimensions			
length l	mm	60	42.5
width b	mm	30	18
height h	mm	33.5	21.5
dimensional drawing			
operating temperature			
min.	°C	-30	-30
max.	°C	+200	+200

Transducer Mounting Fixtures

Fastening Shoes and Chains



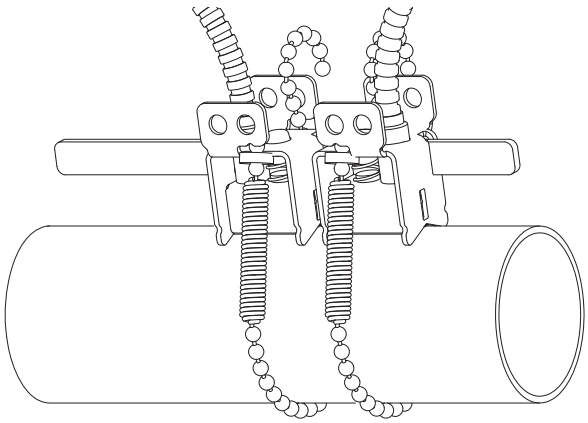
transducer frequency: M, Q

material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)

dimensions: 420 x 48 x 68 mm

chain length: 0.5/1/2 m

outer pipe diameter: max. 150/310/600 mm



transducer frequency: S

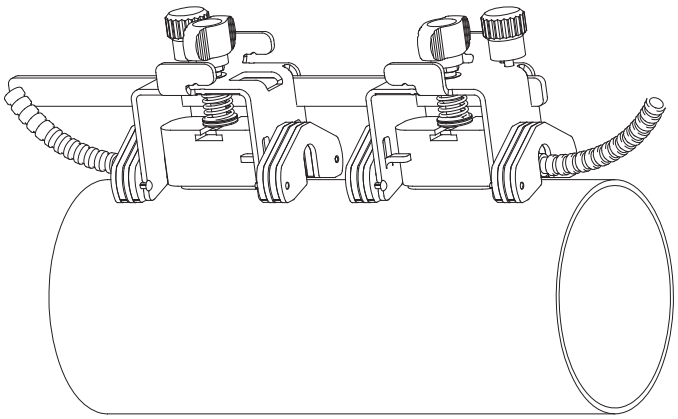
material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)

dimensions: 210 x 32 x 44 mm

chain length: 0.5 m

outer pipe diameter: max. 150 mm

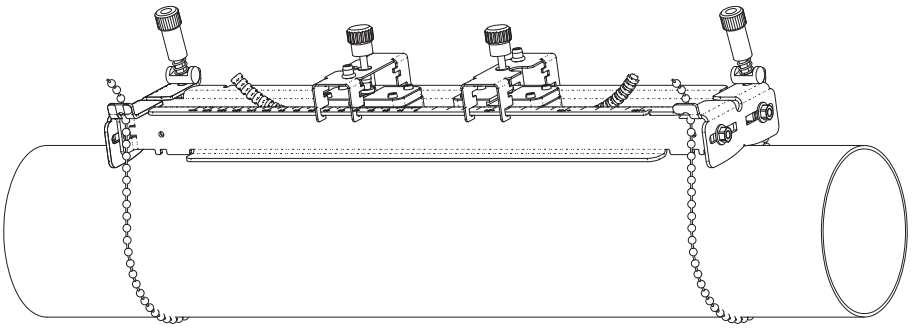
Fastening Shoes and Magnets (option)



material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)

dimensions: 420 x 55 x 68 mm

Portable Variofix Rail PVF and Chains

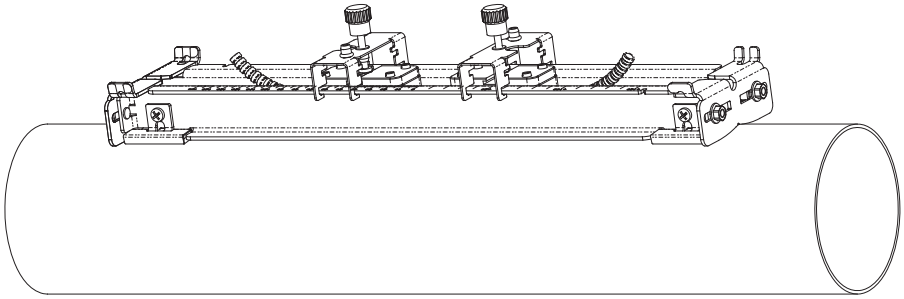


material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)

dimensions: 414 x 84 x 50 mm

chain length: 2 m

Portable Variofix Rail PVF and Magnets (option)



material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)

dimensions: 414 x 84 x 45 mm

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**	
	< 100 °C	100...170 °C	< 150 °C	150...200 °C	< 280 °C	280...400 °C
< 2 h	coupling compound type N	coupling compound type E	coupling compound type E	coupling compound type E or H	coupling foil type A	coupling foil type B
< 24 h	coupling compound type N	coupling compound type E	coupling compound type E	coupling foil type VT	coupling foil type A	coupling foil type B

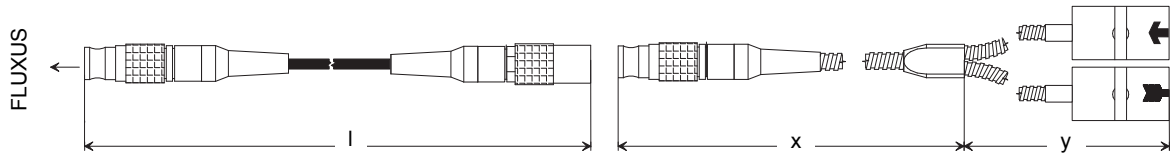
Technical Data

type	**order code**	**temperature** °C	**material**	**remark**
coupling compound type N	990739-1	-30...+130	mineral grease paste	
coupling compound type E	990739-2	-30...+200	silicone paste	
coupling compound type H	990739-3	-30...+250	fluoropolymer paste	
coupling foil type A	990739-7	max. 280	Pb	
coupling foil type B	990739-8	> 280...400	Ag	
coupling foil type VT	990739-0	-10...+150, peak max. 200	fluoroelastomer	for transducers with transducer frequency G, H, K
	990739-6			for transducers with transducer frequency M, P
	990739-5			for transducers with transducer frequency Q
	990739-10			for transducers with transducer frequency S

Connection Systems

Connection System NL

transducer frequency (3rd character of transducer order code)		G, H, K			M, P			Q			S		
		x	y	l	x	y	l	x	y	l	x	y	l
cable length	m	2	3	≤ 100	2	2	≤ 100	2	1	≤ 50	1	1	≤ 20



x, y - transducer cable length

l - max. length of extension cable

Transducer Cables

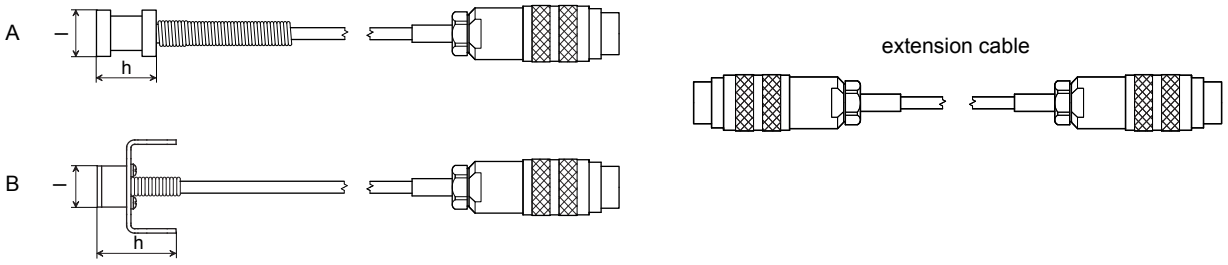
Technical Data

		transducer cable	extension cable
item number		1699	2551
standard length	m	see table above	5 10
max. length	m	-	see table above
temperature	°C	-55...+200	< 115
sheath			
material		stainless steel 304 (1.4301)	-
outer diameter	mm	8	-
cable jacket			
material		PTFE	TPE-O
outer diameter	mm	2.9	8
thickness	mm	0.3	
color		brown	black
shield		x	x

Temperature Probes (Option)

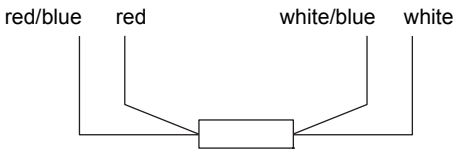
Technical Data

order code		**670415-1**	**670414-1**	**670415-2**	**670414-2**
type		Pt100	Pt100 paired according to DIN 1434-1	Pt100	Pt100 paired according to DIN 1434-1
design		4-wire		4-wire	
measuring range	°C	-30...+250		-50...+250	
accuracy T		±(0.15 °C + 2 · 10^{-3} · T), class A		±(0.15 °C + 2 · 10^{-3} · T), class A	
accuracy ΔT		-	≤ 0.1 K (3K < ΔT < 6 K), more corresponding to EN 1434-1	-	≤ 0.1 K (3K < ΔT < 6 K), more corresponding to EN 1434-1
response time	s	50		8	
housing		aluminum		PEEK, stainless steel 304 (1.4301), Cu	
degree of protection according to EN 60529		IP 66		IP 66	
weight (without connector)	kg	0.25	0.5	0.32	0.64
fixation		clamp on		clamp on	
accessories		-		plastic protection plate, isolation foam	
dimensions					
length l	mm	15		14	
width b	mm	15		30	
height h	mm	20		27	
dimensional drawing		A		B	



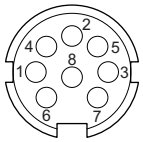
Connection

Temperature Probe



Connector

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



Cables

		cable of temperature probe	extension cable
type		4 x 0.25 mm^2 black or white	LIYCY 8 x 0.14 mm^2 gray
standard length	m	3	5/10/25
max. length	m	-	200
cable jacket		PTFE	PVC

Wall Thickness Probe (Option)

The pipe wall thickness is an important pipe parameter which has to be determined exactly for a good measurement. However, the pipe wall thickness often is unknown.

The wall thickness probe will be connected to the flowmeter instead of the flow transducers. The wall thickness measurement mode is activated automatically then.

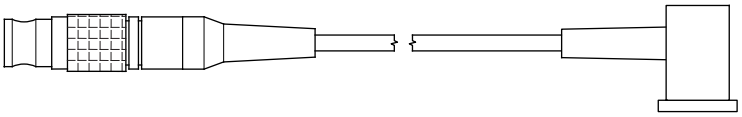
The wall thickness probe is pressed with coupling compound on the pipe. The wall thickness is displayed on the flowmeter and can be stored directly in the parameter record of the pipe.

Wall thickness measurement

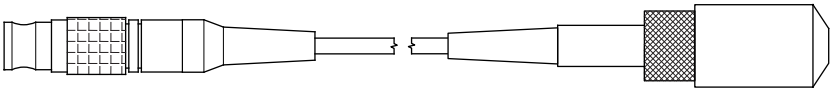
Technical Data

technical type		DWQ1xZ7	DWP1EZ7
		reverse polarity protected	
measuring range[1]	mm	1...200	
resolution	mm	0.01	
linearity	mm	0.1	
operating temperature	°C	-20...+60	-20...+200, peak max. 540
cable length	m	1.5	1.2

[1] The measuring range depends on the attenuation of the ultrasonic signal in the pipe. For strongly attenuating plastics (e.g. PFA, PTFE, PP) the measuring range is smaller.



DWQ1xZ7



DWP1EZ7

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