

Portable Ultrasonic Flow Measurement of Liquids

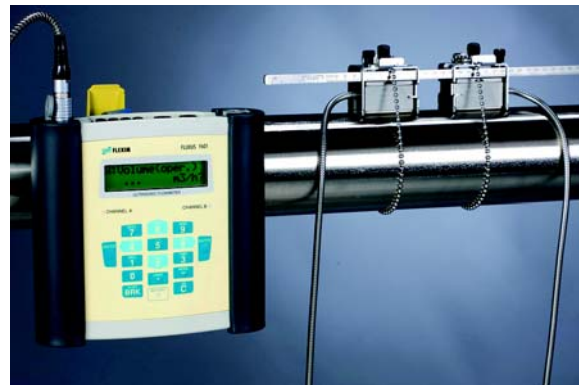
Portable instrument for non-invasive, quick ultrasonic flow measurement with clamp-on technology for all types of piping

Features

- Non-invasive measurement using the clamp-on technology for precise bi-directional, highly dynamic flow measurement
- Portable, easy-to-use flow transmitter with 2 flow channels, multiple inputs/outputs, an integrated data logger with a serial interface in the standard version
- Automatic loading of calibration data and transducer detection reduce set-up times and provide precise, long-term stable results
- Li-Ion battery provides up to 14 hours of measurement operation
- Transducers available for a wide range of inner pipe diameters (6...6500 mm) and fluid temperatures (-40...+400 °C)
- Proven clamp-on technology, transducers resistant to dust and humidity
- Probe for wall thickness measurement available
- Water and dust-tight; resistant against oil, many liquids and dirt
- Robust, water-tight (IP 67) transport case with comprehensive accessories
- HybridTrek automatically switches between transit time and NoiseTrek mode of measurement when high particulate flows are encountered
- QuickFix for fast mounting of the flow transmitter in difficult conditions



FLUXUS F601 supported by handle



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

Applications

- Designed for the following industries:
 - Chemical industry
 - Water and waste water industry
 - Cooling systems and air conditioners
 - Facility management
 - Aviation industry



Measurement equipment in transport case

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Function

Measurement Principle

Transit Time Difference Principle

In order to measure the flow of a medium in a pipe, 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 by the opposite pipe wall and received by a second transducer. These signals are emitted alternately in the flow direction and against it.

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

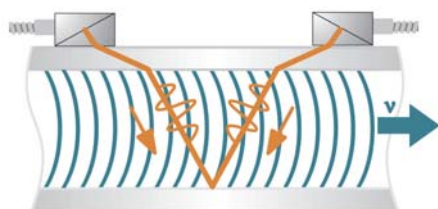
The transit time difference, Δt , is measured and allows the flowmeter to determine the average flow velocity along the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area averaged flow velocity, which is proportional to the volumetric flow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

The 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.

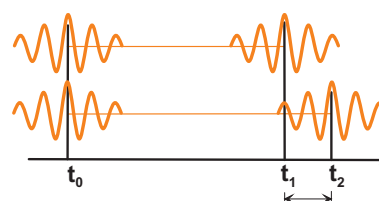
HybridTrek

If the gaseous or solid content in the medium increases occasionally during measurement, a measurement with the transit time difference principle is no longer possible. NoiseTrek mode will then be selected by the flowmeter. This measurement method allows the flowmeter to achieve a stable measurement even with high gaseous or solid content

The transmitter can switch automatically between transit time and NoiseTrek mode without any changes to the measurement setup.



Path of the ultrasonic signal



Transit time difference Δt

Calculation of Volumetric Flow Rate

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

where:

- Q - volumetric flow rate
- k_{Re} - fluid mechanics calibration factor
- A - cross-sectional area of the pipe
- k_a - acoustical calibration factor
- Δt - transit time difference
- t_{fl} - transit time in the medium

Number of Sound Paths

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

- **reflection mode**

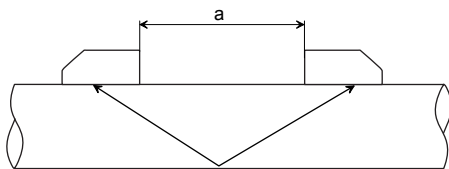
The number of sound paths is even. Both of the transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easier.

- **diagonal mode**

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 medium, pipe and coatings, diagonal mode with 1 sound path will be used.

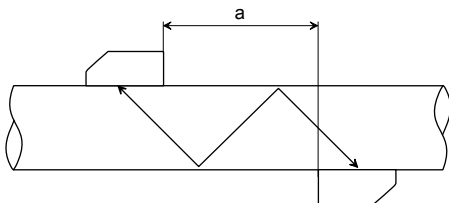
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

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

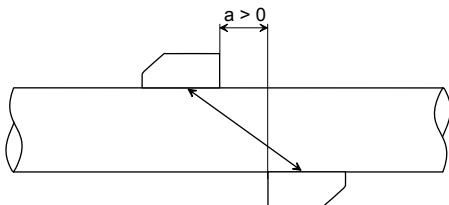


Reflection mode, number of sound paths: 2

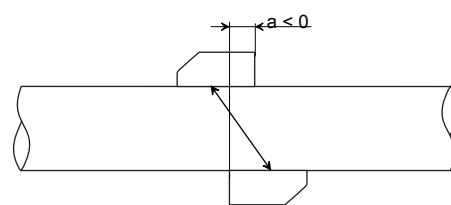
a - transducer distance



Diagonal mode, number of sound paths: 3

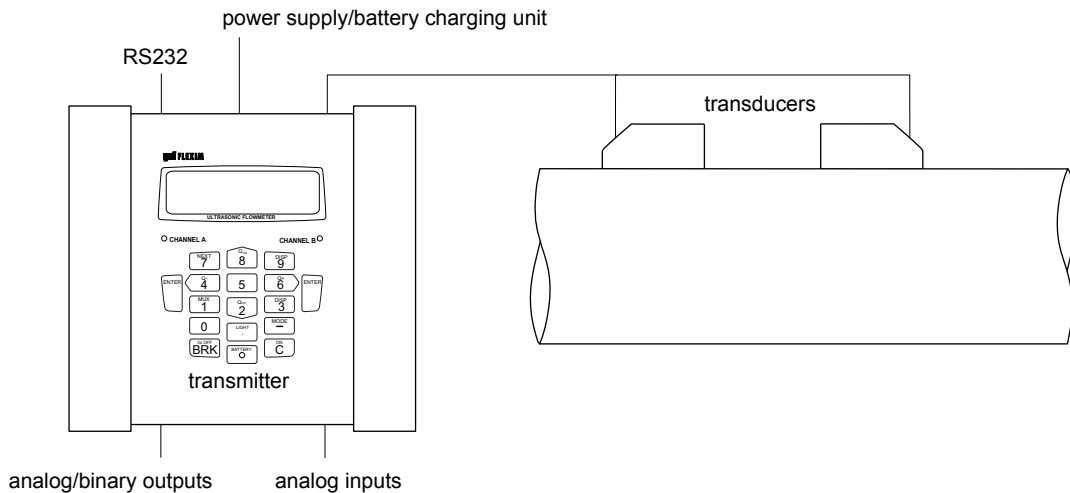


Diagonal mode , number of sound paths: 1

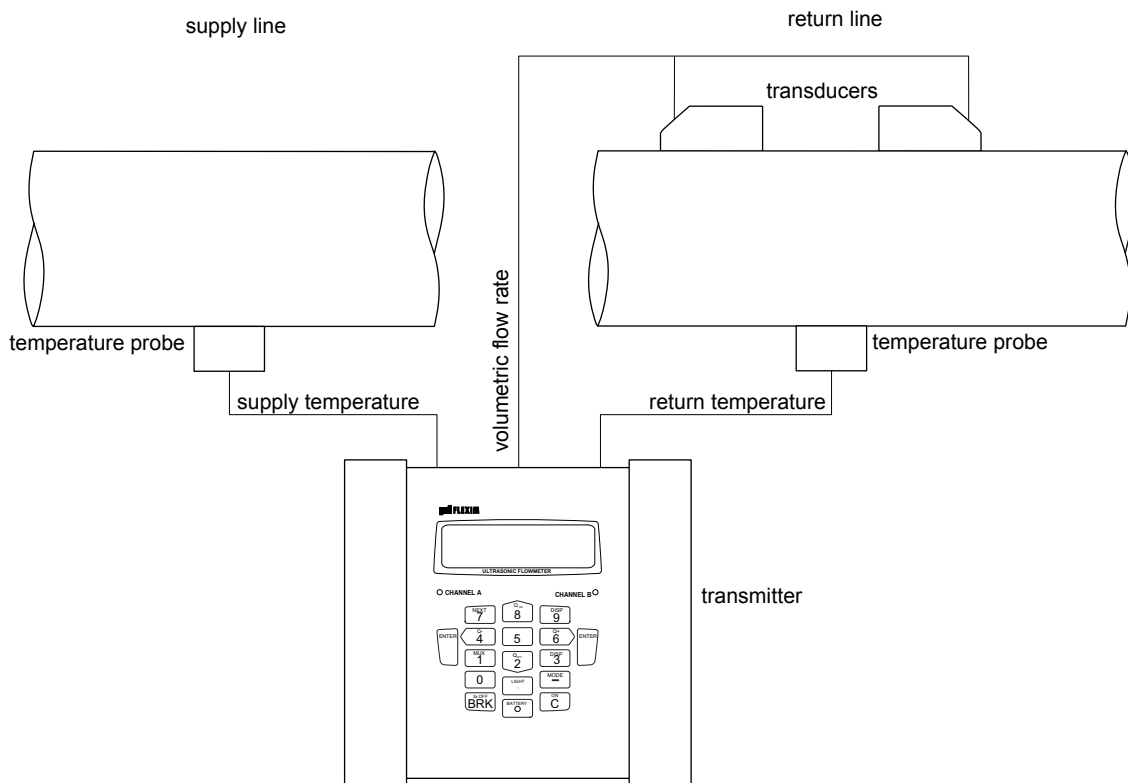


Diagonal mode , number of sound paths: 1,
negative transducer distance

Typical Measurement Setup




Example of a measurement setup in reflection mode



Example of a heat flow measurement

Flow Transmitter

Technical Data

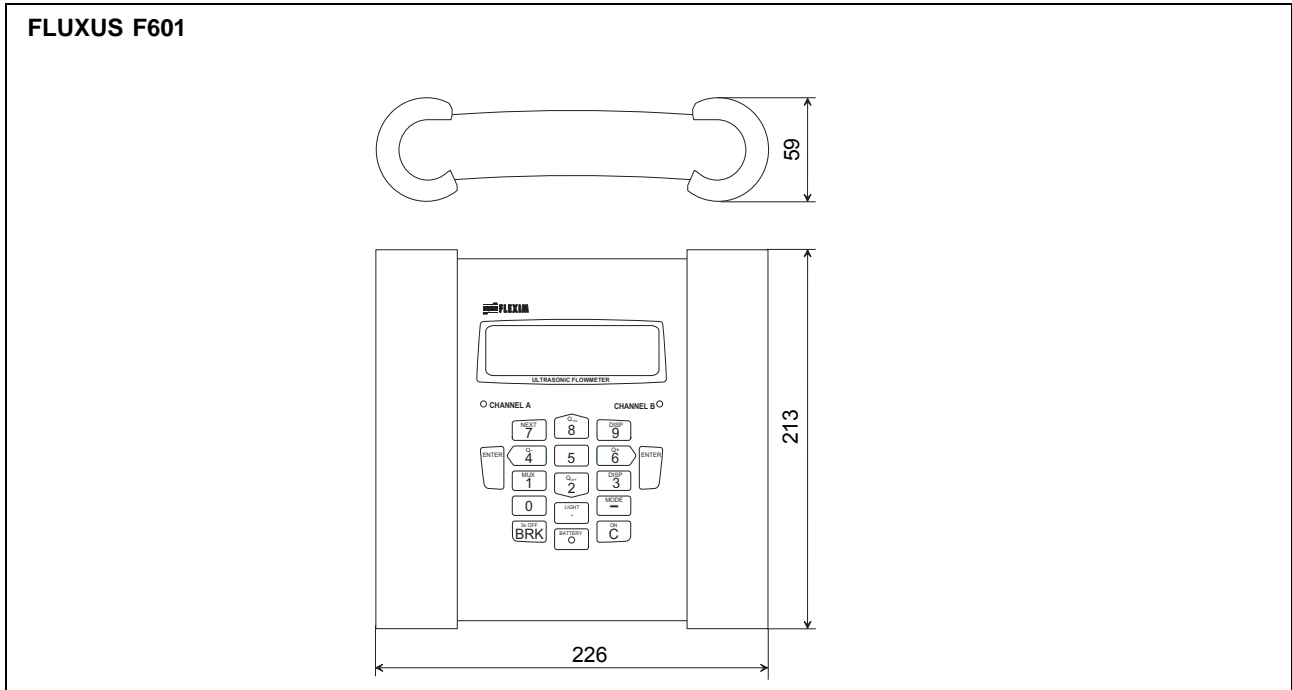
FLUXUS	F601
design	portable
	
measurement	
measuring principle	transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	0.01...25 m/s
repeatability	0.15 % of reading ±0.01 m/s
accuracy ¹	
with standard calibration	±1.6 % of reading ±0.01 m/s
with extended calibration (optional)	±1.2 % of reading ±0.01 m/s
with field calibration ²	±0.5 % of reading ±0.01 m/s
medium	all acoustically conductive liquids with < 10 % gaseous or solid content by volume (transit time difference principle)
temperature compensation	corresponding to the recommendations in ANSI/ASME MFC-5M-1985
flow transmitter	
power supply	100...240 V/50...60 Hz (power supply), 10.5...15 V DC (socket at transmitter) 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), optional: 70 ms
housing 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	volumetric flow rate, mass flow, flow velocity, heat flow (if temperature inputs are installed)
totalizers	volume, mass, optional: heat quantity
calculation functions	average, difference, sum
diagnostic functions	sound velocity, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times
data logger	
loggable values	all physical quantities, totalized values and diagnostic 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 %

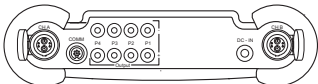
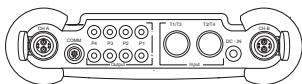
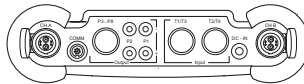
FLUXUS	F601
communication	
interface	RS232/USB
serial data kit	
software (all Windows™ versions)	- FluxData: download of measured data, graphical presentation, conversion to other formats (e.g. for Excel™) - FluxKoef: creating medium data sets
cable	RS232
adapter	RS232 - USB
transport case	
dimensions	500 x 400 x 190 mm
outputs	
	The outputs are galvanically isolated from the transmitter.
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	$R_{ext} < 200 \Omega$
passive output	$U_{ext} = 4...16 \text{ V}$, dependent on R_{ext} $R_{ext} < 500 \Omega$
frequency output	
range	0...5 kHz
open collector	24 V/4 mA
binary output	
optorelay	26 V/100 mA
binary output as alarm output - functions	limit, change of flow direction or error
binary output as pulse output - pulse value - pulse width	0.01...1 000 units 1...1 000 ms
inputs	
	The inputs are galvanically isolated from the transmitter.
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	$R_i = 50 \Omega$, $P_i < 0.3 \text{ W}$
voltage input	
range	0...1 V
accuracy	0.1 % of reading ±1 mV
internal resistance	$R_i = 1 \text{ M}\Omega$

Dimensions

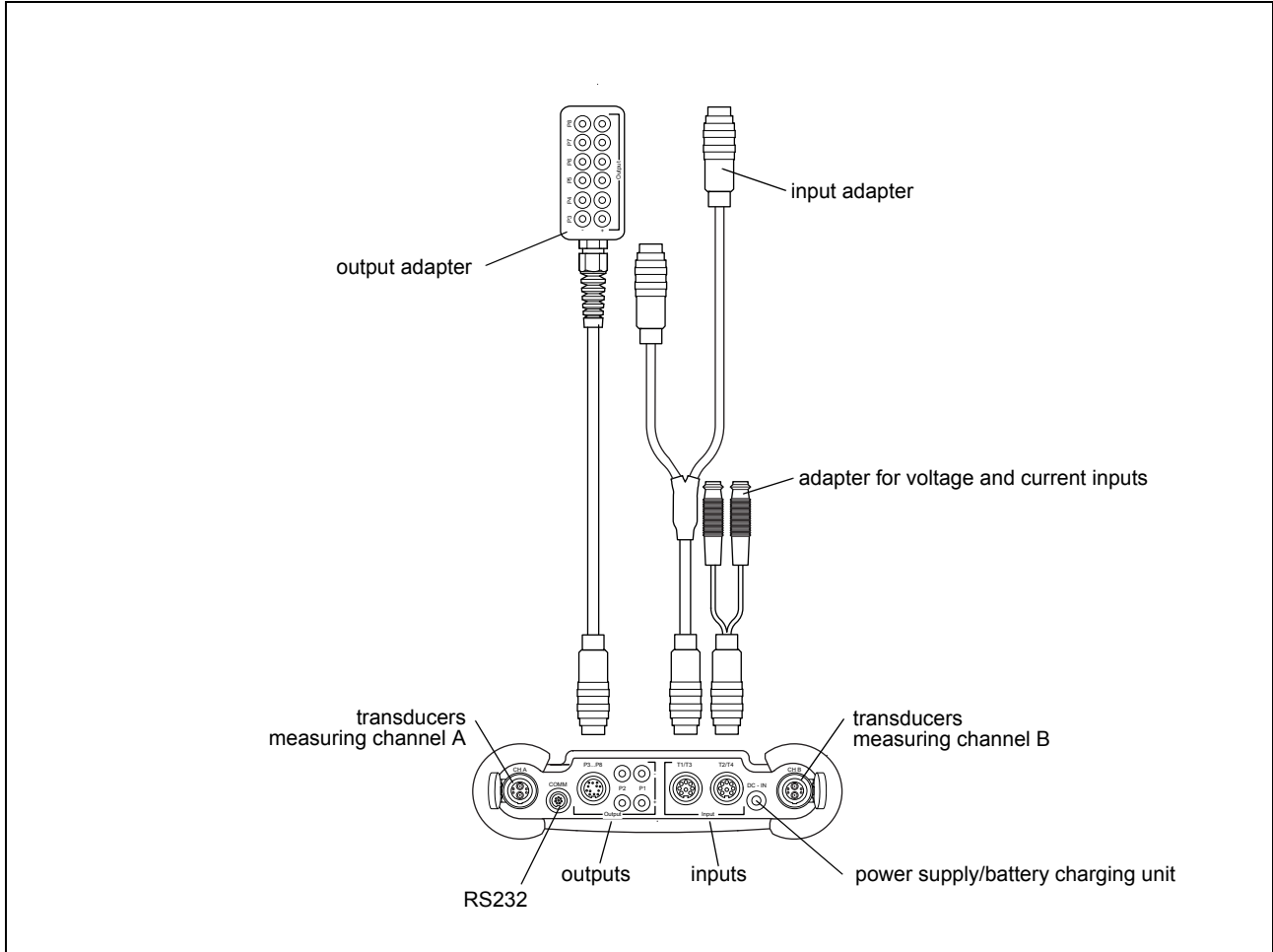


in mm

Standard Scope 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
outputs			
passive current output	2	2	4
binary output	2	2	2
inputs			
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 transmitter	x	x	x
serial data kit	x	x	x
measuring tape	x	x	x
user manual, Quick Start Guide	x	x	x
connector board at the upper side of the transmitter			

Connection of Adapters

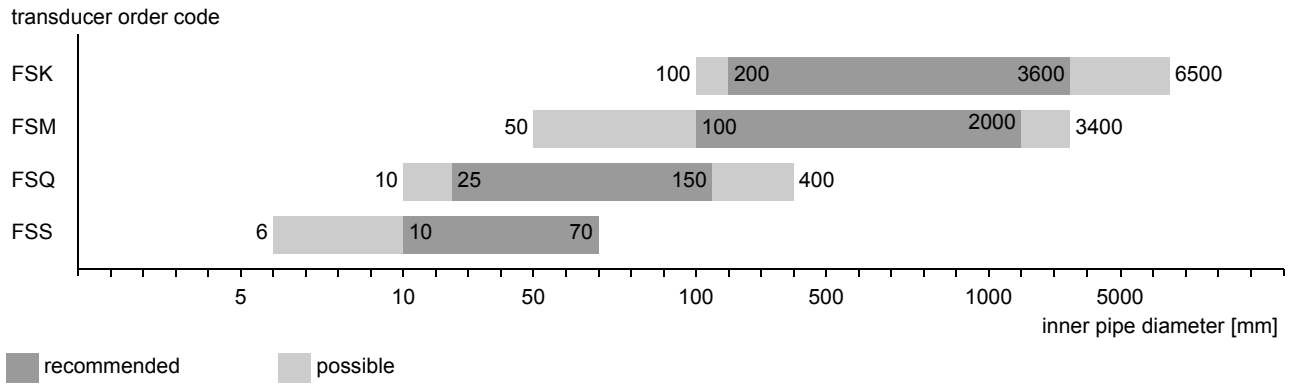


Example for the Equipment of a Transport Case



Transducers

Transducer Selection

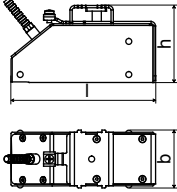
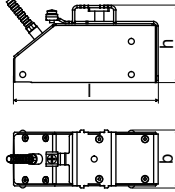
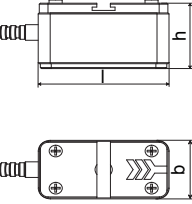


Transducer Order Codes

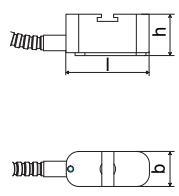
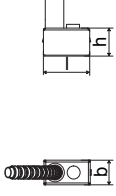
1, 2	3	4	5, 6	7, 8	9...11	12, 13	no. of character	
transducer	transducer frequency	-	temperature	explosion protection	connection system	-	extension cable	-
description								
FS								
set of ultrasonic flow transducers for liquids measurement, shear wave								
K								
0.5 MHz								
M								
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 21								
LC								
long transducer cable (only FSK)								
example								
FS	M	-	N	NN	NL	-	000	/
shear wave transducer 1 MHz, normal temperature range, connection system NL with Lemo connector								
		-				-		/

Technical Data

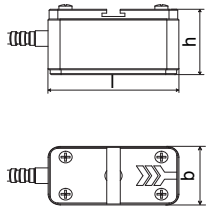
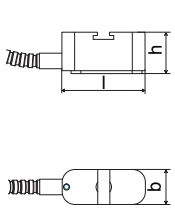
Shear Wave Transducers

technical type		CDK1NZ7	CLK1NZ7	CDM1NZ7
order code		FSK-NNNNL	FSK-NNNNL/LC	FSM-NNNNL
transducer frequency		MHz 0.5	0.5	1
inner pipe diameter d				
min. extended		mm 100	100	50
min. recommended		mm 200	200	100
max. recommended		mm 3600	3600	2000
max. extended		mm 6500	6500	3400
pipe wall thickness				
min.		mm -	-	-
max.		mm -	-	-
material				
housing		PEEK with stainless steel cap 304 (1.4301)	PEEK with stainless steel cap 304 (1.4301)	stainless steel 304 (1.4301)
contact surface		PEEK	PEEK	PEEK
degree of protection according to EN 60529		IP 67	IP 67	IP 67
transducer cable				
type		1699	1699	1699
length		m 5	9	4
dimensions				
length l		mm 126.5	126.5	60
width b		mm 51	51	30
height h		mm 67.5	67.5	33.5
dimensional drawing				
operating temperature				
min.		°C -40	-40	-40
max.		°C +130	+130	+130
temperature compensation		x	x	x

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		stainless steel 304 (1.4301)	stainless steel 304 (1.4301)
contact surface		PEEK	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
temperature compensation		x	x

Shear Wave Transducers (extended temperature range)

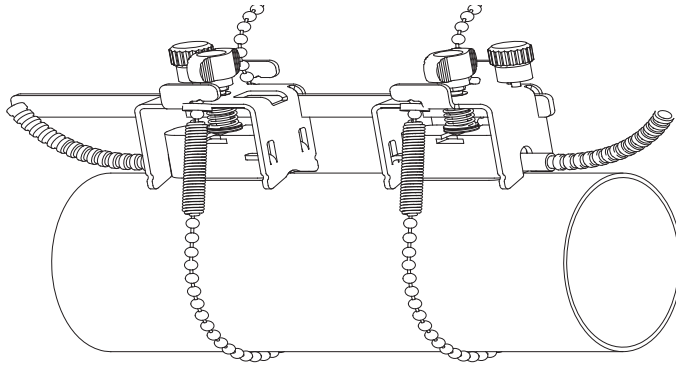
technical type		CDM1EZ7	CDQ1EZ7
order code		FSM-ENNNL	FSQ-ENNNL
transducer frequency	MHz	1	4
inner pipe diameter d			
min. extended	mm	50	10
min. recommended	mm	100	25
max. recommended	mm	2000	150
max. extended	mm	3400	400
pipe wall thickness			
min.	mm	-	-
max.	mm	-	-
material			
housing		stainless steel 304 (1.4301)	stainless steel 304 (1.4301)
contact surface		Sintimid	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
temperature compensation		x	x

Transducer Mounting Fixtures

Order Codes

1, 2	3	4	5	6	7...9	no. of character		
transducer mounting fixture	transducer	-	measuring mode	size	-	fixation	outer pipe diameter	description
FS								fastening shoes
TB								tension belts
VP								portable Variofix
WL								transducer clamping fixture of WaveInjector
	A							all transducers
	K							transducers with transducer frequency K
	M							transducers with transducer frequency M
	Q							transducers with transducer frequency Q
	S							transducers with transducer frequency S
		D						reflection mode or diagonal mode
		R						reflection mode
			S					small
			M					medium
					C			chains
					N			without fixation
						010		10...100 mm
						025		10...250 mm
						055		10...550 mm
						150		50...1500 mm
						210		50...2100 mm
example								
VP	M	-	D	M	-	C	055	portable Variofix and chains for transducers with transducer frequency M
		-			-			

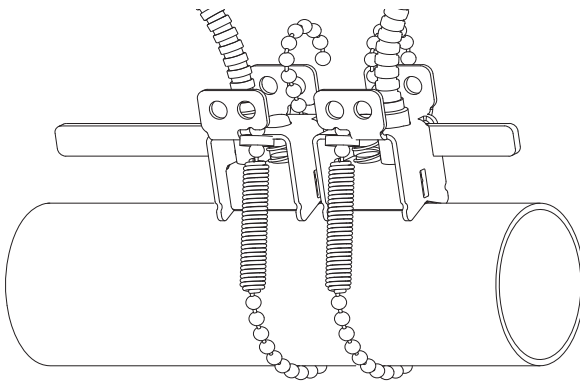
Fastening shoes FS and Chains



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

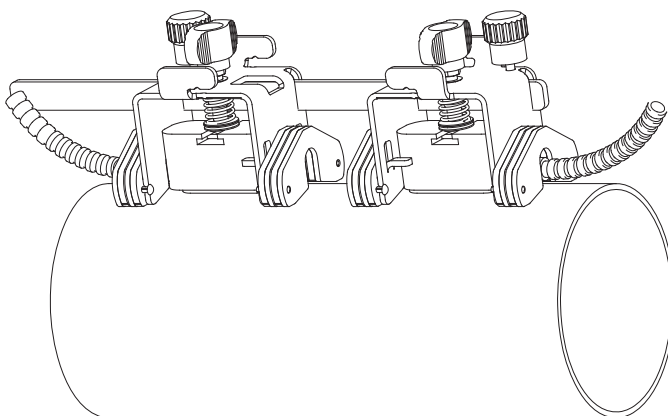


transducer frequency: S

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

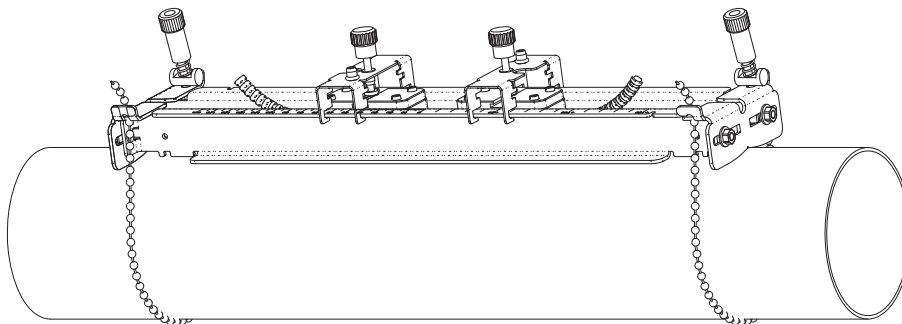
Fastening shoes FS and Magnets (optional)



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

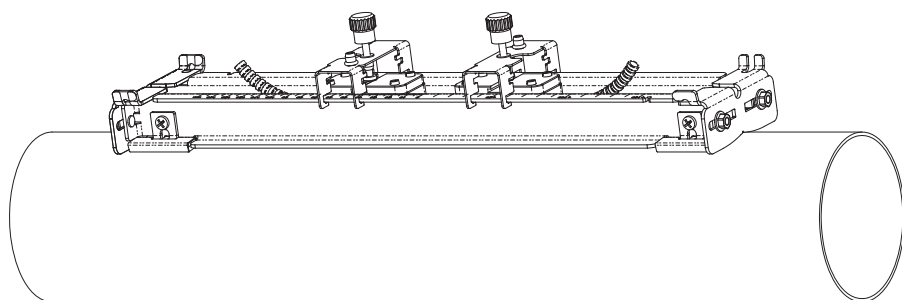
dimensions:
420 x 55 x 68 mm

Portable Variofix VP and Chains



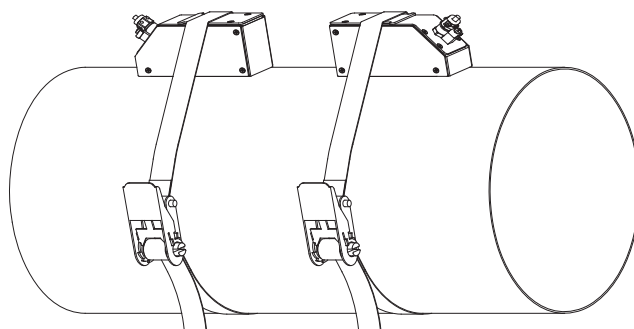
material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)
 dimensions: 414 x 84 x 50 mm
 chain length: 2 m

Portable Variofix VP and Magnets (optional)



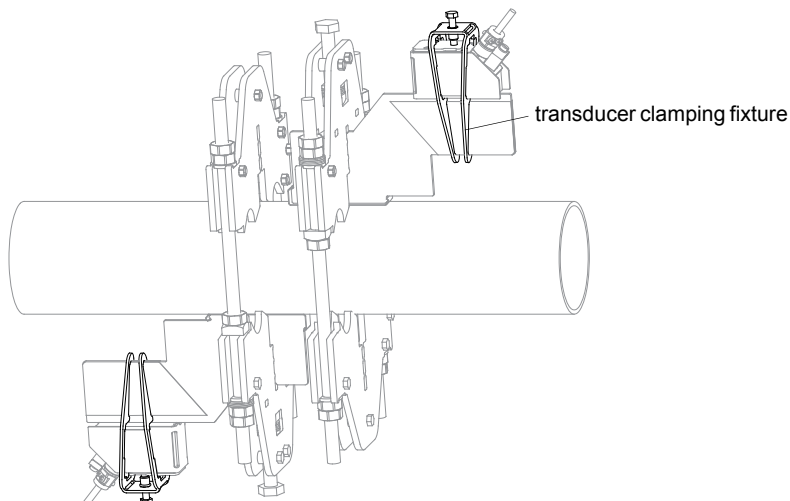
material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305)
 dimensions: 414 x 84 x 45 mm

Tension Belts TB



transducer frequency: K
 material: steel, powder coated and textile belt
 length: 5/7 m
 temperature: max. 60 °C
 outer pipe diameter: max. 1500/2100 mm

Transducer Clamping Fixture for WaveInjector WL



see Technical Specification TSWaveInjectorVx-x

Coupling Materials for Transducers

	normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)		WaveInjector WI-400	
	< 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
< 3 months	coupling compound type N	coupling compound type E	coupling foil type VT	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 shear wave transducers with transducer frequency M, P
	990739-14			for IP 68 shear wave transducers and Lambwave transducers with transducer frequency M, P
	990739-15			for shear wave transducers with transducer frequency Q
	990739-5			for Lambwave transducers with transducer frequency Q

coupling foil not to be used for transducer mounting fixture with magnets

Connection Systems

transducer frequency (3rd character of transducer order code)		G, H, K			M, P			Q			S		
cable length	m	x	y	l ¹	x	y	l ¹	x	y	l ¹	x	y	l
		2	3	≤ 25	2	2	≤ 25	2	1	≤ 25	1	1	≤ 20

¹ > 25...100 m on request

x, y - transducer cable length
l - max. length of extension cable

Transducer Cables

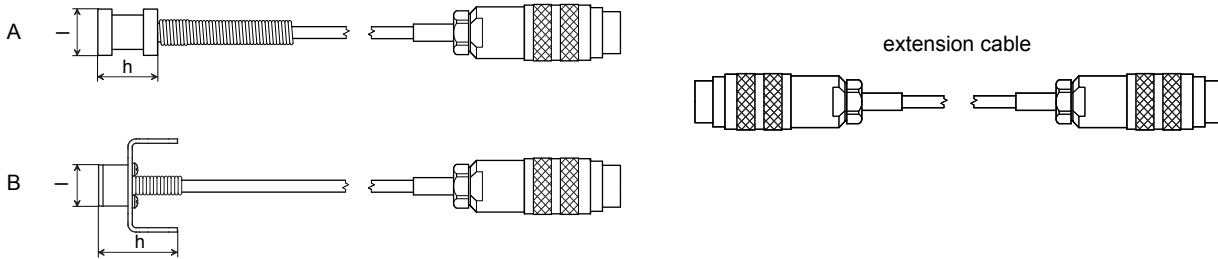
Technical Data

		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	-25...+80
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 (optional)

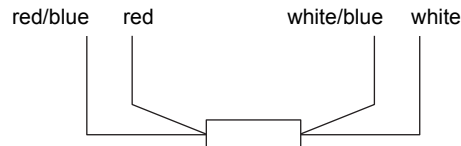
Technical Data

order code		670415-1	670414-1	670415-2	670414-2
type		Pt100	Pt100 matched according to DIN 1434-1	Pt100	Pt100 matched according to DIN 1434-1
design		4-wire		4-wire	
measuring range	°C	-30...+250		-50...+250	
accuracy T		$\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C]})$, class A		$\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C]})$, class A	
accuracy ΔT		-	$\leq 0.1 \text{ K}$ ($3\text{K} < \Delta T < 6 \text{ K}$), more corresponding to EN 1434-1	-	$\leq 0.1 \text{ K}$ ($3\text{K} < \Delta T < 6 \text{ K}$), 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	



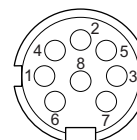
Connection

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 (optional)

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 can be connected to the flow transmitter instead of the flow transducers and the wall thickness measurement mode is activated automatically.

Acoustic coupling compound is applied to the wall thickness probe which then is placed firmly on the pipe. The wall thickness is displayed and can be stored directly in the flow transmitter.

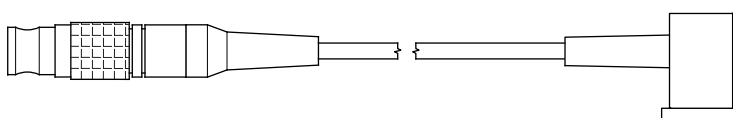


Wall thickness measurement

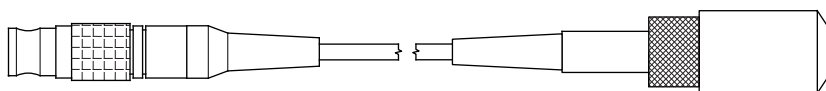
Technical Data

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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