

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

- Precise bidirectional and highly dynamic flow measurement with the non-invasive clamp-on technology
- High precision at fast and slow flow rates, high temperature and zero point stability
- Portable, easy-to-use flow transmitter with 2 flow channels, multiple inputs/outputs, an integrated data logger with a serial interface
- Water and dust-tight (NEMA 4); resistant against oil, many liquids and dirt
- Li-Ion battery provides up to 25 hours of measurement operation
- Automatic loading of calibration data and transducer detection for a fast and easy set-up (less than 5 min), providing precise and long-term stable results
- User-friendly design
- Transducers available for a wide range of inner pipe diameters and fluid temperatures (-328 to +1112 °F)
- Probe for wall thickness measurement available
- Robust, water-tight (NEMA 4) 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
- Measurement is unaffected by fluid density, viscosity and solid content (max. 10 % of volume)

Applications

Designed for the following industries:

- Chemical industry
- Water and wastewater industry
- Oil and gas industry
- Cooling systems and air conditioners
- Facility management
- Aviation industry



FLUXUS F601



Measurement with transducers mounted with mounting frames and flow transmitter fixed to the pipe with the QuickFix pipe mounting fixture



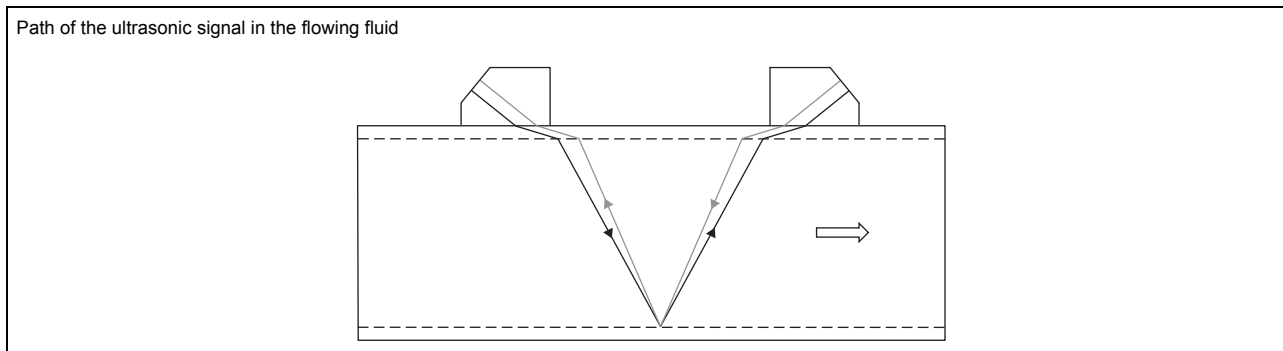
Measurement equipment in transport case

Function	3
Measurement principle	3
Calculation of volumetric flow rate	3
Number of sound paths	4
Typical measurement setup	5
Transmitter	6
Technical data	6
Dimensions	7
Standard scope of supply	8
Adapters	8
Example for the equipment of a transport case	9
Transducers	10
Transducer selection	10
Transducer order code	11
Technical data	12
Transducer mounting fixture	14
Coupling materials for transducers	17
Connection systems	18
Clamp-on temperature probe (optional)	19
Technical data	19
Fixation	20
Wall thickness measurement (optional)	21
Technical data	21

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.

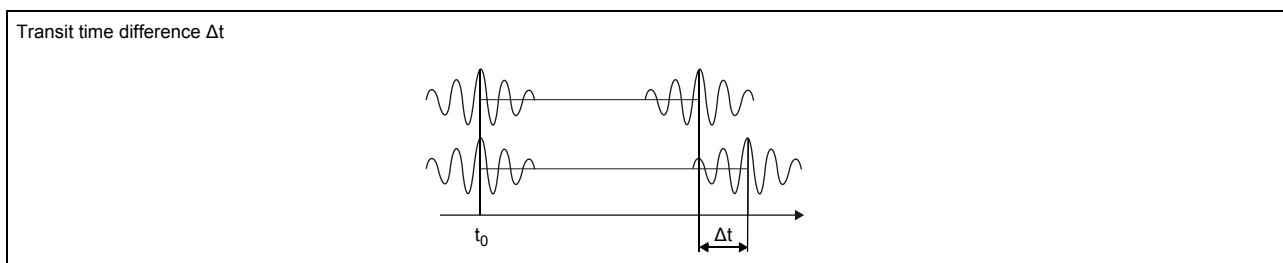


Transit time difference principle

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.



HybridTrek

If the gaseous or solid content in the fluid increases occasionally during measurement, a measurement with the transit time difference principle may no longer be 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.

Calculation of volumetric flow rate

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

where

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

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:

- **reflect 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 easier.

- **diagonal arrangement**

The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe.

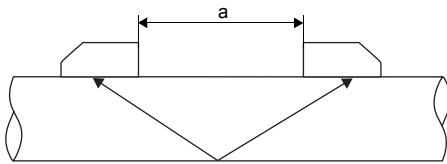
- **direct mode**

Diagonal arrangement with 1 sound path. This should be used in the case of a high signal attenuation by the fluid, pipe or coatings.

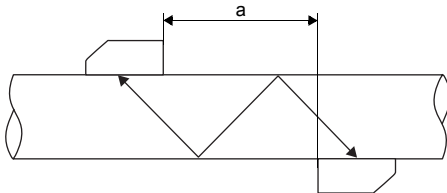
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

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

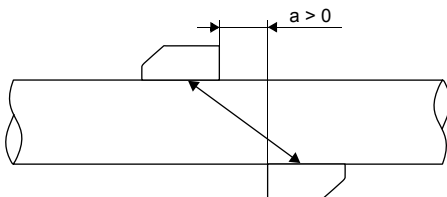
Reflect arrangement, number of sound paths: 2



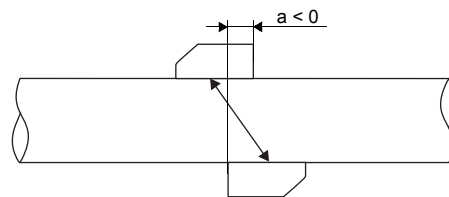
Diagonal arrangement, number of sound paths: 3



Direct mode, number of sound paths: 1



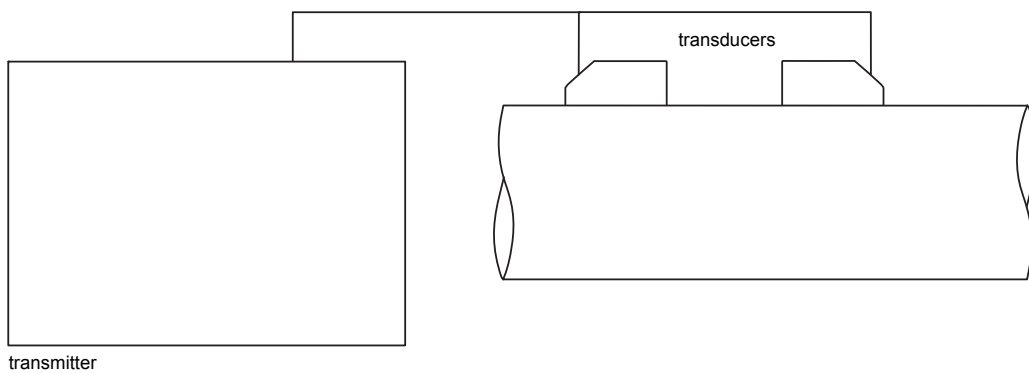
Direct mode, number of sound paths: 1, negative transducer distance



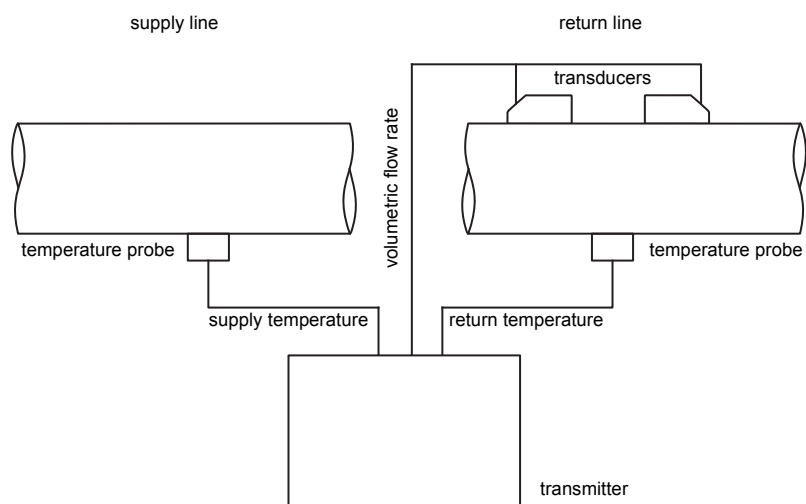
a - transducer distance

Typical measurement setup

Example of a reflect arrangement




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



Transmitter

Technical data

		FLUXUS F601
		
design		portable
measurement		
measurement principle		transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	ft/s	0.03 to 82
repeatability		0.15 % of reading ± 0.02 ft/s
fluid		all acoustically conductive liquids with < 10 % gaseous or solid content in volume (transit time difference principle)
temperature compensation		corresponding to the recommendations in ANSI/ASME MFC-5.1-2011
measurement uncertainty (volumetric flow rate)		
measurement uncertainty of measuring system ¹		± 0.3 % of reading ± 0.02 ft/s includes calibration certificate traceable to NIST calibration facility ISO 17025 accredited
measurement uncertainty at the measuring point ²		± 1 % of reading ± 0.02 ft/s
transmitter		
power supply		<ul style="list-style-type: none"> 100 to 230 V/50 to 60 Hz (power supply unit) 10.5 to 15 V DC (socket at transmitter) integrated battery
integrated battery		Li-Ion, 7.2 V/6.2 Ah
operating time	h	<ul style="list-style-type: none"> > 14 h (without outputs, inputs and backlight) > 25 h (1 measuring channel, ambient temperature > 50 °F, without outputs, inputs and backlight)
power consumption	W	< 6 (with outputs, inputs and backlight), charging: 18
number of measuring channels		2
damping	s	0 to 100 (adjustable)
measuring cycle	Hz	100 to 1000 (1 channel)
response time	s	1 (1 channel), option: 0.07
housing material		PA, TPE, AutoTex, stainless steel
degree of protection		NEMA 4
dimensions	in	see dimensional drawing
weight	lb	4.6
fixation		QuickFix pipe mounting fixture
ambient temperature	°F	14 to 140
display		2 x 16 characters, dot matrix, backlight
menu language		English, German, French, Dutch, Spanish
measuring functions		
physical quantities		volumetric flow rate, mass flow rate, flow velocity, thermal energy rate (if temperature inputs are installed)
totalizer		volume, mass, optional: thermal energy
calculation functions		average, difference, sum
diagnostic functions		sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times
communication interfaces		
service interfaces		<ul style="list-style-type: none"> RS232 USB (with adapter)
process interfaces		Modbus RTU (optional)
accessories		
serial data kit		
• cable		RS232
• adapter		RS232 - USB
software		<ul style="list-style-type: none"> FluxDiagReader: download of measured values and parameters, graphical presentation FluxDiag (optional): download of measurement data, graphical presentation, report generation FluxSubstanceLoader: upload of fluid data sets
adapter		<ul style="list-style-type: none"> output adapter (if number of outputs > 4) input adapter (if number of inputs > 2)
transport case		dimensions: 19.7 x 15.7 x 7.5 in
data logger		
loggable values		all physical quantities, totaled values and diagnostic values
capacity		> 100 000 measured values

¹ with aperture calibration of the transducers

² for transit time difference principle and reference conditions

¹ with aperture calibration of the transducers
² for transit time difference principle and reference conditions

Technical drawing of the FLEXIM 6000 device, showing front and top views with dimensions.

Front View Dimensions:

- Overall width: 8.9
- Overall height: 8.39

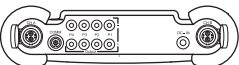
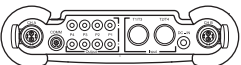
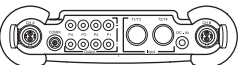
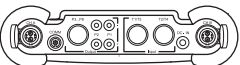
Top View Dimensions:

- Overall width: 6.0
- Overall height: 2.32

Front View Details:

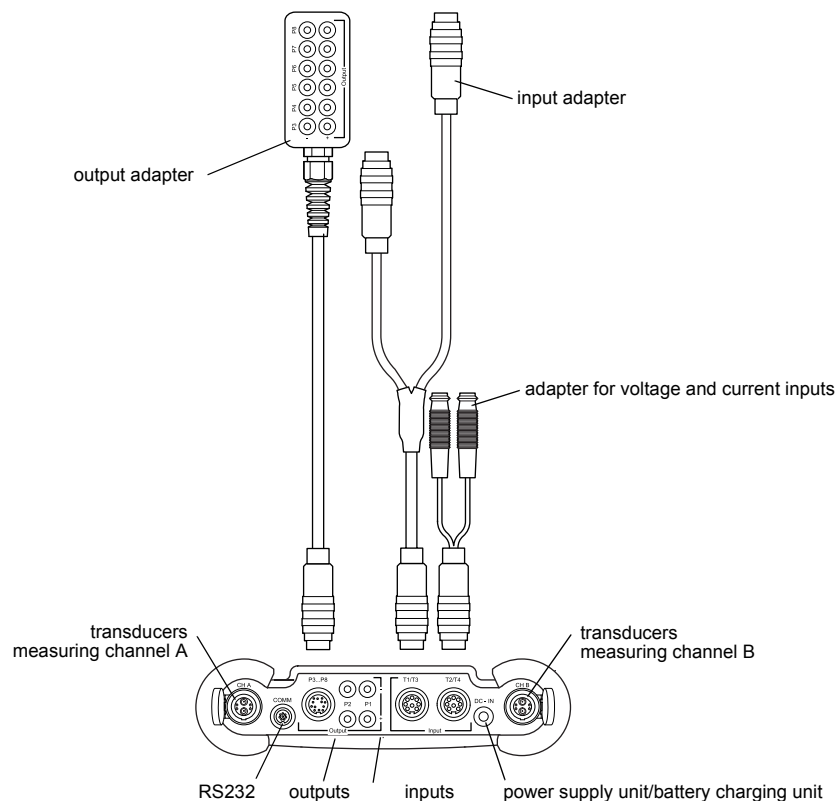
- Device name: **FLEXIM**
- Display: A rectangular LCD screen.
- Channel Selection: **CHANNEL A** and **CHANNEL B** buttons.
- Keypad: A numeric keypad (0-9) with additional function buttons: **ENTER**, **EXIT**, **MODE**, **BRK**, **PAUSE**, and **ON C**.

Standard scope of supply

	F601 Standard		F601 Energy		F601Double Energy		F601Multifunctional	
application	flow measurement of liquids							
	2 independent measuring channels							
			temperature-compensated calculation of mass flow rate					
			integrated thermal energy computer for monitoring of energy flows					
			including energy calculator for BTU and heat measurements					
simultaneous monitoring of flow and energy flow, e.g., heating systems			simultaneous monitoring of 2 energy flows, e.g., heating systems, heat exchangers)		flow measurement taking into account other process quantities, e.g., density, viscosity			
outputs								
passive current output	2	2	2	2	2	2	4	2
binary output	2	1	2	1	2	1	2	2
Modbus	-	x	-	x	-	x	-	x
inputs								
temperature input	-	-	2	2	4	4	2	2
passive current input	-	-	-	-	-	-	2	2
accessories								
transport case	x	x	x	x	x	x	x	x
power supply unit, mains cable	x	x	x	x	x	x	x	x
battery	x	x	x	x	x	x	x	x
output adapter	-	-	-	-	-	-	x	x
input adapter	-	-	-	-	2	2	2	2
adapter for voltage and current inputs	-	-	-	-	-	-	2	2
QuickFix pipe mounting fixture for transmitter	x	x	x	x	x	x	x	x
serial data kit	x	x	x	x	x	x	x	x
measuring tape	x	x	x	x	x	x	x	x
user manual, Quick start guide	x	x	x	x	x	x	x	x
connector board at the upper side of the transmitter								

Adapters

*601



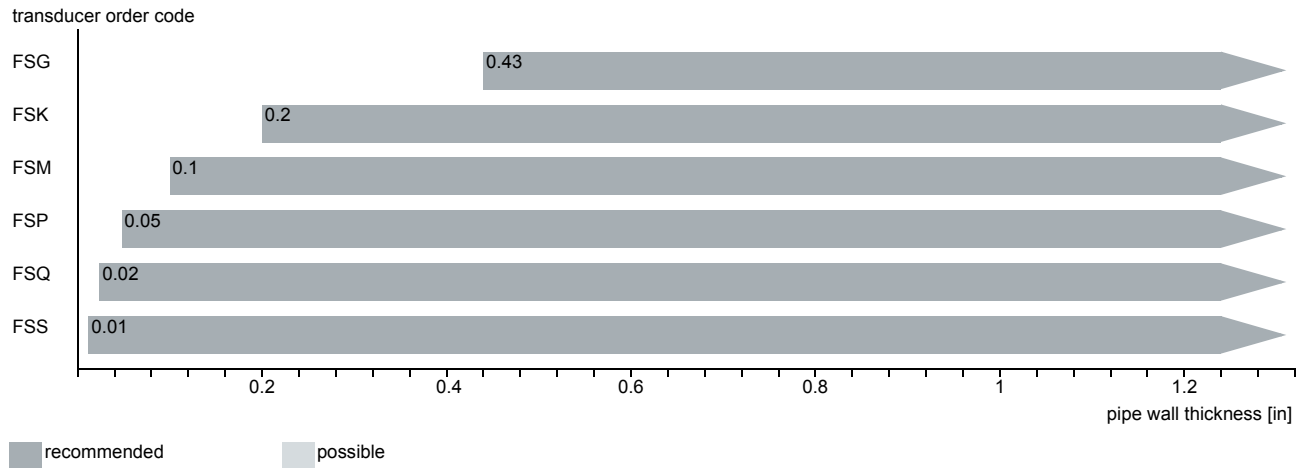
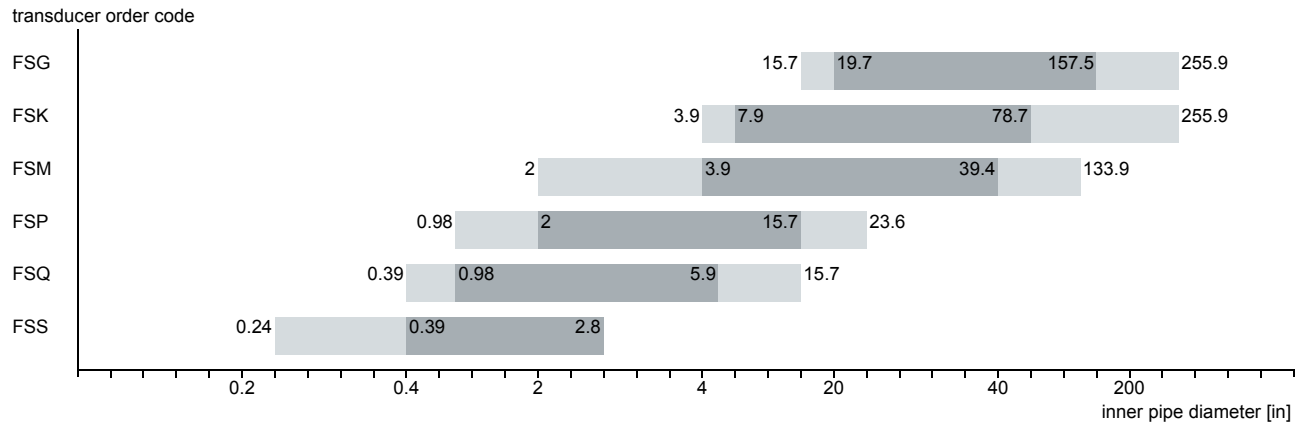
Example for the equipment of a transport case

F601



Transducers

Transducer selection

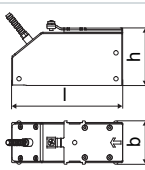
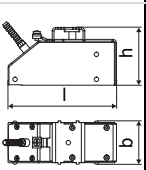
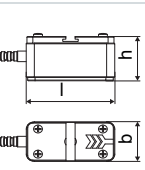
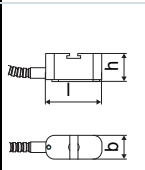
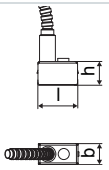


Transducer order code

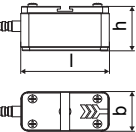
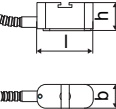
1, 2	3	4	5, 6	7, 8	9 to 11	no. of character				
transducer	transducer frequency	-	ambient temperature	explosion protection	connection system	-	extension cable	/	option	description
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	G									0.2 MHz
	K									0.5 MHz
	M									1 MHz
	P									2 MHz
	Q									4 MHz
	S									8 MHz
		N								normal temperature range
		E								extended temperature range
			NN							not explosion proof
				NL						with Lemo connector
					XXX					0 m: without extension cable
										> 0 m: with extension cable
									LC	long transducer cable

Technical data

Shear wave transducers (nonEx, NL)

order code		FSG-NNNNL/**	FSK-NNNNL/**	FSM-NNNNL/**	FSP-NNNNL/**	FSQ-NNNNL/**	FSS-NNNNL/**
technical type		C(DL)G1NZ7	C(DL)K1NZ7	C(DL)M1NZ7	C(DL)P1NZ7	C(DL)Q1NZ7	CDS1NZ7
transducer frequency	MHz	0.2	0.5	1	2	4	8
inner pipe diameter d							
min. extended	in	15.7	3.9	2	0.98	0.39	0.24
min. recommended	in	19.7	7.9	3.9	2	0.98	0.39
max. recommended	in	157.5	78.7	39.4	15.7	5.9	2.8
max. extended	in	255.9	255.9	133.9	23.6	15.7	2.8
pipe wall thickness							
min.	in	0.43	0.2	0.1	0.05	0.02	0.01
material							
housing		PEEK with stainless steel cap 304		stainless steel 304		stainless steel 304	
contact surface		PEEK		PEEK		PEI	
degree of protection		NEMA 6				NEMA 4	
transducer cable							
type		1699					
length	ft	16		13		9	6
length (***-****/LC)	ft	29					-
dimensions							
length l	in	5.1	4.98	2.36		1.67	0.98
width b	in	2.01	2.01	1.18		0.71	0.51
height h	in	2.64	2.66	1.32		0.85	0.67
dimensional drawing							
weight (without cable)	lb	1	0.79	0.08		0.03	0.01
pipe surface temperature							
min.	°F	-40					-22
max.	°F	+266					+266
ambient temperature							
min.	°F	-40					-22
max.	°F	+266					+266
temperature compensation		x					-

Shear wave transducers (nonEx, NL, extended temperature range)

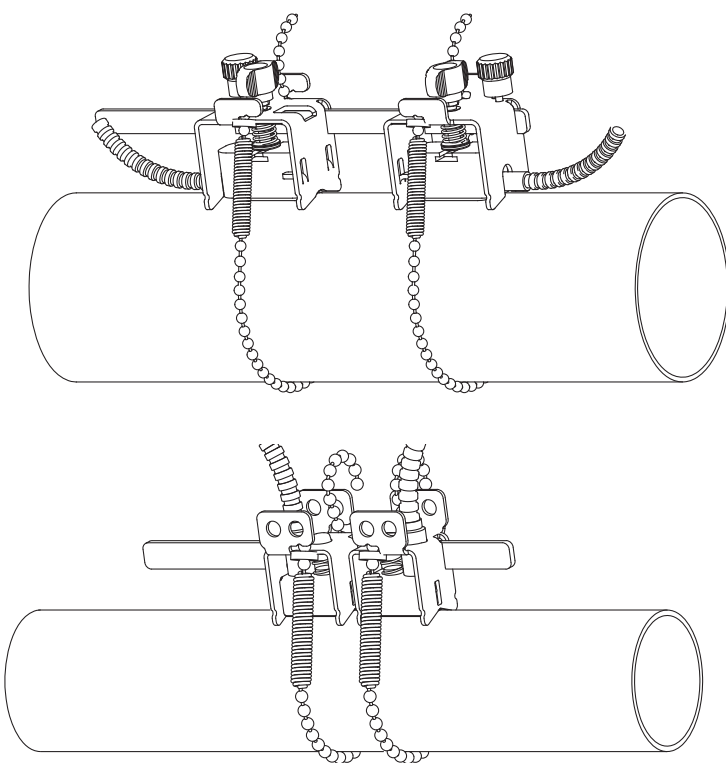
order code		FSM-ENNNL/**	FSP-ENNNL/**	FSQ-ENNNL/**
technical type		C(DL)M1EZ7	C(DL)P1EZ7	C(DL)Q1EZ7
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	133.9	23.6	15.7
pipe wall thickness				
min.	in	0.1	0.05	0.02
material				
housing		stainless steel 304		
contact surface		Sintimid		
degree of protection		NEMA 4		
transducer cable				
type		1699		
length	ft	13		9
length (***-*****/LC)	ft	29		
dimensions				
length l	in	2.36		1.67
width b	in	1.18		0.71
height h	in	1.32		0.85
dimensional drawing				
weight (without cable)	lb	0.09		0.02
pipe surface temperature				
min.	°F	-22		
max.	°F	+392		
ambient temperature				
min.	°F	-22		
max.	°F	+392		
temperature compensation		x		

Transducer mounting fixture

Order code

1, 2	3	4	5	6	7 to 9	no. of character
transducer mounting fixture	transducer	measurement arrangement	size	fixation	outer pipe diameter	description
FS						mounting frames
LM						ladder chain mounting accessory
VP						portable Variofix
TB						tension belts
WL						transducer box for WaveInjector
	A					all transducers
	K					transducers with transducer frequency G, K
	M					transducers with transducer frequency M, P
	Q					transducers with transducer frequency Q
	S					transducers with transducer frequency S
		D				reflect arrangement or diagonal arrangement/direct mode
		R				reflect arrangement
			S			small
			M			medium
				C		chains
				N		without fixation
					L08	0.5 to 8 in
					L22	0.5 to 22 in
					010	0.39 to 3.9 in
					025	0.39 to 9.8 in
					055	0.39 to 21.7 in
					150	2 to 59.1 in
					210	2 to 82.7 in

mounting frames FS and chains



transducer frequency: M, P, Q

material: stainless steel 304, 301, 303

dimensions:

M, P: 16.54 x 1.89 x 2.68 in

Q: 16.54 x 1.69 x 2.28 in

chain length: 1/3/6 ft

outer pipe diameter:

max. 5.9/12.2/23.6 in

transducer frequency: S

material: stainless steel 304, 301, 303

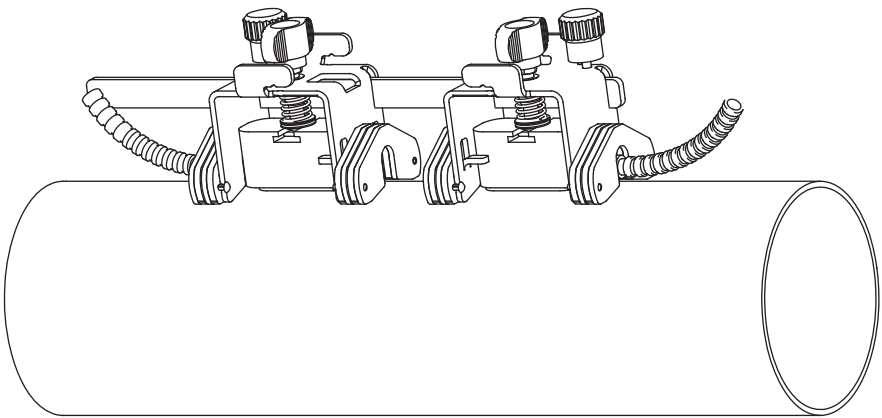
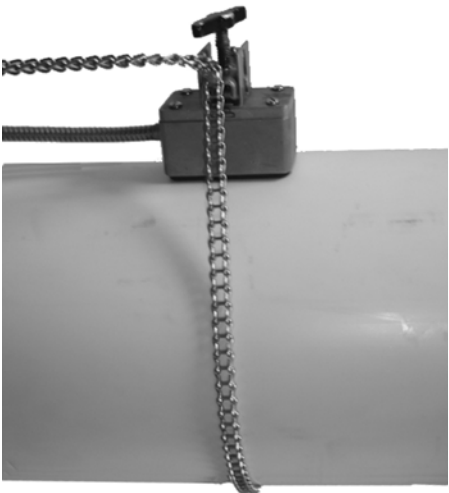
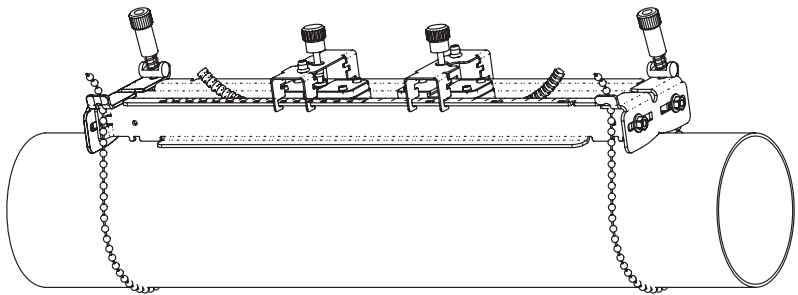
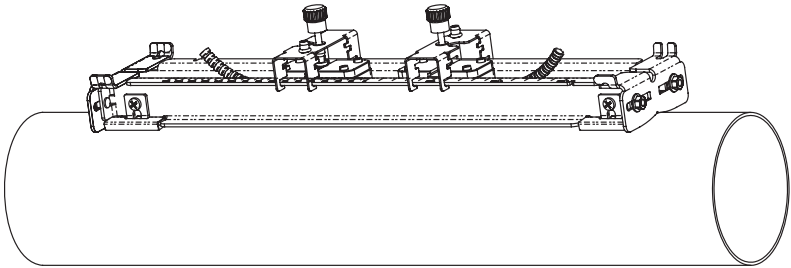
dimensions:

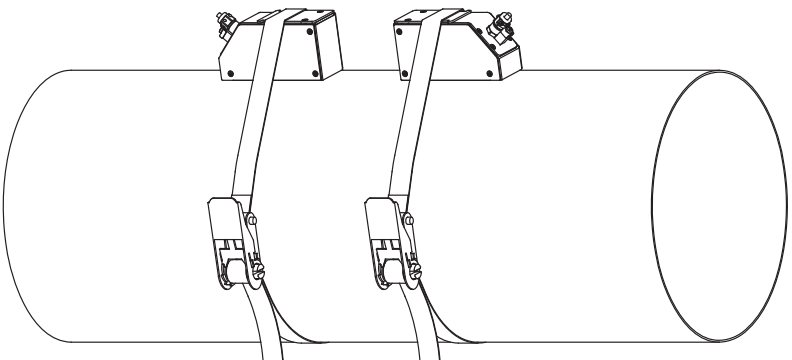
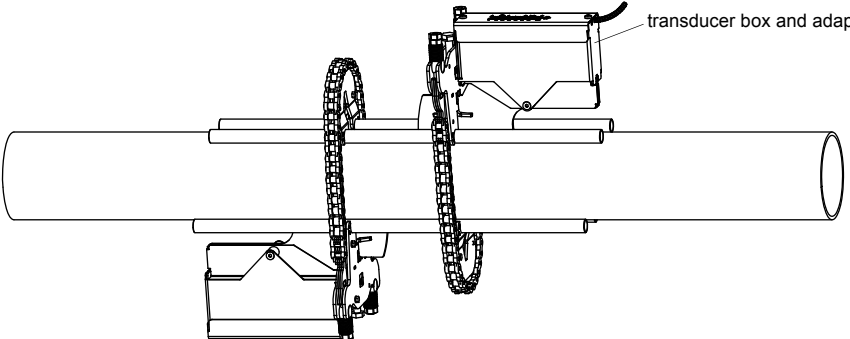
8.27 x 1.26 x 1.73 in

chain length: 1 ft

outer pipe diameter:

max. 5.9 in

<p>mounting frames FS and magnet (optional)</p> 	<p>material: stainless steel 304, 301, 303 dimensions: M, P: 16.54 x 1.89 x 2.68 in Q: 16.54 x 1.69 x 2.28 in</p>
<p>ladder chain mounting accessory LM</p> 	<p>transducer frequency: M, P, Q chain length: 30/78 in outer pipe diameter: max. 24 in</p>
<p>portable Variofix VP and chains (optional)</p> 	<p>material: stainless steel 304, 301, 303 dimensions: 16.3 x 3.7 x 2.99 in chain length: 6 ft</p>
<p>portable Variofix VP and magnet (optional)</p> 	<p>material: stainless steel 304, 301, 303 dimensions: 16.3 x 3.7 x 1.57 in</p>

<p>tension belts TB</p>  A line drawing showing a horizontal cylindrical pipe with two tension belts (TB) wrapped around it. Each belt is secured with a clasp at the top and bottom. The belts are shown in a slightly curved position, suggesting they are under tension.	<p>transducer frequency: G, K</p> <p>material: steel, powder coated and textile tension belt</p> <p>length: 16/22 ft</p> <p>ambient temperature: max. 140 °F</p> <p>outer pipe diameter: max. 59.1/82.7 in</p>
<p>transducer box WL for WaveInjector</p>  A line drawing showing a horizontal cylindrical pipe with a transducer box (WL) mounted on it. The box is connected to a chain drive system. A label points to the box with the text "transducer box and adapter". <p>transducer box and adapter</p>	<p>see Technical specification TSWaveInjectorVx-x</p>

Coupling materials for transducers

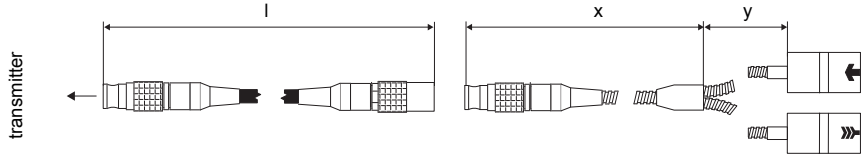
normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)		WaveInjector WI-400	
< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 752 °F
coupling compound type N	coupling compound type E	coupling compound type E	coupling compound type E or H	coupling pad type A and coupling pad type VT	coupling pad type B and coupling pad type VT

Technical data

type	ambient temperature °F
coupling compound type N	-22 to +266
coupling compound type E	-22 to +392
coupling compound type H	-22 to +482
coupling pad type A	max. 536
coupling pad type B	536 to 752
coupling pad type VT	14 to +392

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

Connection systems

connection system NL	
direct connection/connection with extension cable	transducers technical type
	*****Z7

Cable

transducer cable		
type		1699
weight	lb/ft	0.06
ambient temperature	°F	-67 to +392
cable jacket		
material		PTFE
outer diameter	in	0.11
thickness	in	0.01
color		brown
shield		x
sheath		
material		stainless steel 304
outer diameter	in	0.31

extension cable			
type		1750	2551
standard length	ft	16 32	-
max. length	ft	32	see table below
weight	lb/ft	0.08	0.06
ambient temperature	°F	< 144	-13 to +176
cable jacket			
material		PE	TPE-O
outer diameter	in	0.24	0.31
thickness	in	0.02	
color		black	black
shield		x	x
sheath			
material		stainless steel 304	-
outer diameter	in	0.35	-
remark		optional	

Cable length

transducer frequency		F, G, H, K			M, P			Q			S		
connection system NL													
transducers technical type		x	y	l	x	y	l	x	y	l	x	y	l
*D***Z7 ¹	ft	6	9	≤ 82	6	6	≤ 82	6	3	≤ 82	3	3	≤ 65
option LC: *L***Z7 ¹	ft	6	22	≤ 82	22	6	≤ 82	26	3	≤ 82	-	-	-

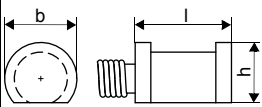

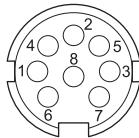
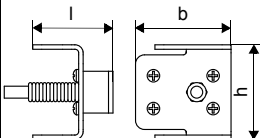

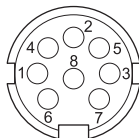
¹ l > 82 to 328 ft on request

x, y = transducer cable length

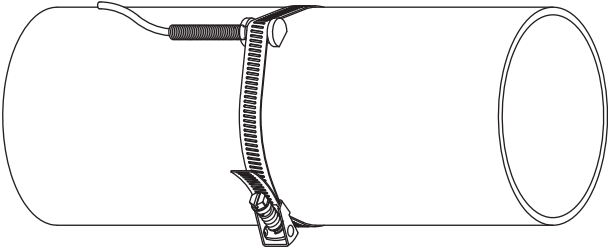
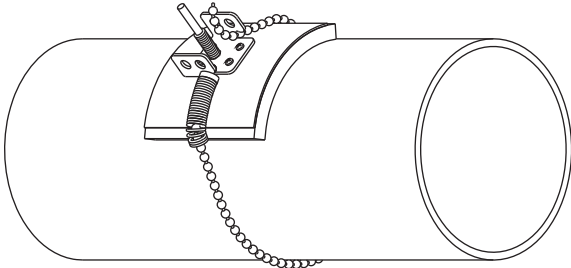
l = max. length of extension cable

Clamp-on temperature probe (optional)

Technical data

PT13N			
design		clamp-on with connector	
type		Pt1000	
connection		4-wire	
measuring range	°F	-40 to +392	
accuracy T		$\pm(0.27\text{ °F} + 2 \cdot 10^{-3} \cdot (T\text{ [°F]} - 32\text{ °F}))$ class A	
accuracy ΔT (2x Pt matched according to EN 1434-1)		$\leq 0.03\text{ °F}$ (at 50 °F)	
housing		360 brass alloy	
degree of protection		NEMA 4	
dimensions			
length l	in	0.79	
width b	in	0.59	
height h	in	0.49	
dimensional drawing			
weight	lb	0.437 (without connector)	
accessories			
thermal conductivity foil 482 °F		x	
Connection system			
direct connection/connection with extension cable			
			
Connection			
	temperature probe	extension cable	connector
			pin
	red	black	2
	red	green	6
	white	white	1
	white	red	7
			
Cable			
	temperature probe	extension cable	
type	4 x 24 AWG	4 x 18 AWG	
standard length	ft 20	-	
max. length	ft -	656	
cable jacket	PTFE	LS PVC	
PT13F			
design		clamp-on short response time, with connector	
type		Pt1000	
connection		4-wire	
measuring range	°F	-58 to +482	
accuracy T		$\pm(0.27\text{ °F} + 2 \cdot 10^{-3} \cdot (T\text{ [°F]} - 32\text{ °F}))$ class A	
accuracy ΔT (2x Pt matched according 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	8	
housing		PEEK, stainless steel 304, cop- per	
degree of protection		NEMA 4	
dimensions			
length l	in	0.55	
width b	in	1.18	
height h	in	1.06	
dimensional drawing			
weight	lb	0.7 (without connector)	
accessories			
thermal conductivity paste 392 °F		x	
thermal conductivity foil 482 °F		x	
plastic protection plate, insulation foam		x	
Connection system			
direct connection/connection with extension cable			
			
Connection			
	temperature probe	extension cable	connector
			pin
	red	black	2
	red/blue	green	6
	white/blue	white	1
	white	red	7
			
Cable			
	temperature probe	extension cable	
type	4 x 0.25 mm² black	4 x 18 AWG	
standard length	ft 9	-	
max. length	ft -	656	
cable jacket	PTFE	LS PVC	

Fixation

<p>tension strap PT13N</p>  <p>A technical line drawing showing a cylindrical object with a tension strap (PT13N) attached to its side. The strap is made of a woven material and has a metal hook at one end, which is secured to the cylinder with a bolt and nut. The other end of the strap is free.</p>	<p>material: stainless steel 301, 410</p>
<p>ball chain PT13F</p>  <p>A technical line drawing showing a cylindrical object with a ball chain (PT13F) attached to its side. The chain is made of stainless steel 316L and has a length of 3 ft. It is connected to the cylinder via a metal bracket and a bolt. The chain hangs down from the bracket.</p>	<p>material: stainless steel 316L length: 3 ft</p>

Wall thickness measurement (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 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 transmitter.

Technical data

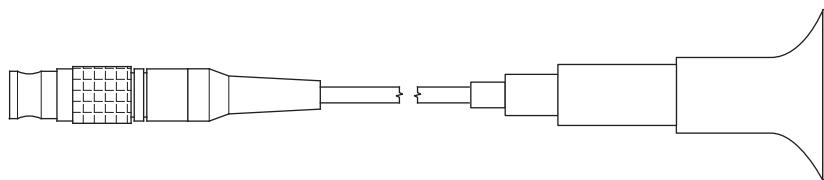
DWR1NZ7		
measuring range ¹	in	0.04 to 9.8
resolution	in	0.0004
accuracy		1 % ±0.004 in
fluid temperature	°F	-4 to +392, short-time peak max. 932
cable		
type		2616
length	ft	4

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.

Cable

2616		
ambient temperature	°F	<392
cable jacket		
material		FEP
outer diameter	in	0.2
color		black
shield		x

DWR1NZ7



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