Flexim FLUXUS F601
Ultrasonic Flowmeter

Portable Ultrasonic Flow Measurement of Liquids

Portable Instrument for Non-invasive, Quick Flow and Energy Measurement with Clamp-on Technology for All Types of Piping

Features

- Transmitter configurable for flow and thermal energy measurement
  - Flow measurement for all acoustically penetrable fluids
  - Integrated thermal energy measurement for a typical heat and refrigerating agents
  - Temperature range -40 to+392 °F, with WaveInjector max. +1166 °F
- Precise bidirectional and highly dynamic flow measurement with the non-invasive clamp-on technology
- Calibrated transducers and transmitters with traceable certificates
- 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
- 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
- Integrated wall thickness measurement with connectable wall thickness probe
- The transmitter is water and dust-tight (NEMA 4), resistant against oil, many liquids and dirt
- Robust, water-tight (NEMA 4) transport case with comprehensive accessories
- Li-Ion battery provides up to 25 hours of measurement operation
- User-friendly design
- QuickFix for a simple and fast transmitter fixation, e.g., on pipes

Applications

Designed for harsh environments and applicable in all areas such as drinking water and sewerage industry, power plants, producing industry, food industry and many more

Example applications:

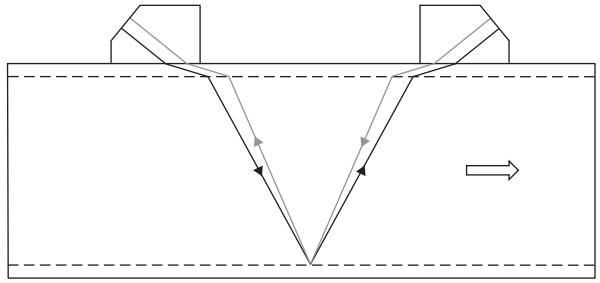
- Operation measurements
- Data gathering in energy management and certifications according to ISO 50001
- Survey of pump performances
- Hydraulic balancing
- Verification of installed measuring systems
- Supervision of permanently installed meters, service and maintenance

Function

Measurement principle

The transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are emitted alternately by a transducer and received by the other. The physical quantities are determined from the transit times of the ultrasonic signals.

Path of the ultrasonic signal in the flowing fluid



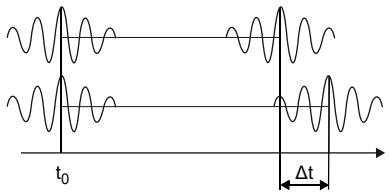
Transit time difference principle

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.

Transit time difference Δt



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

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

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_γ - average of transit times in the fluid

Number of sound paths

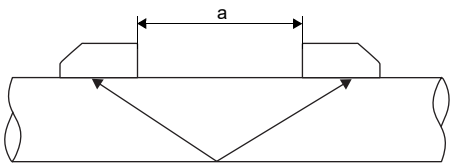
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **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.

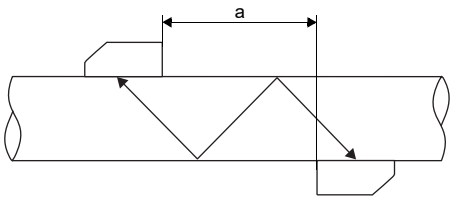
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

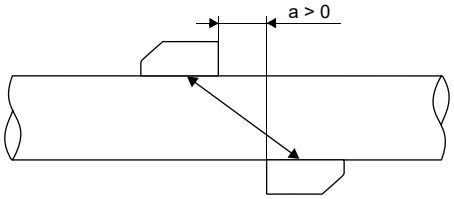
Reflect arrangement, number of sound paths: 2



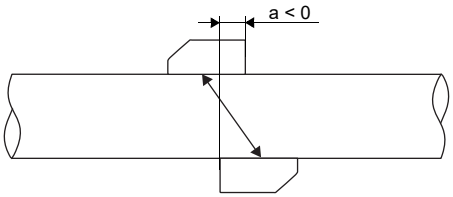
Diagonal arrangement, number of sound paths: 3



Direct mode, number of sound paths: 1



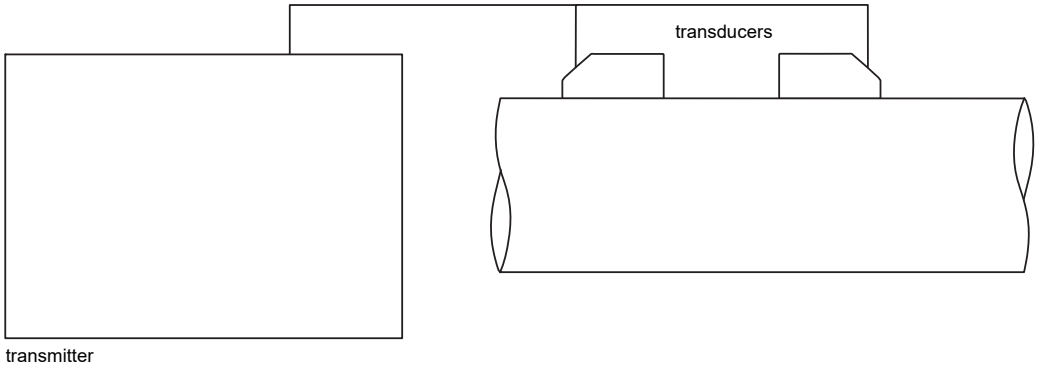
Direct mode, number of sound paths: 1, negative transducer distance



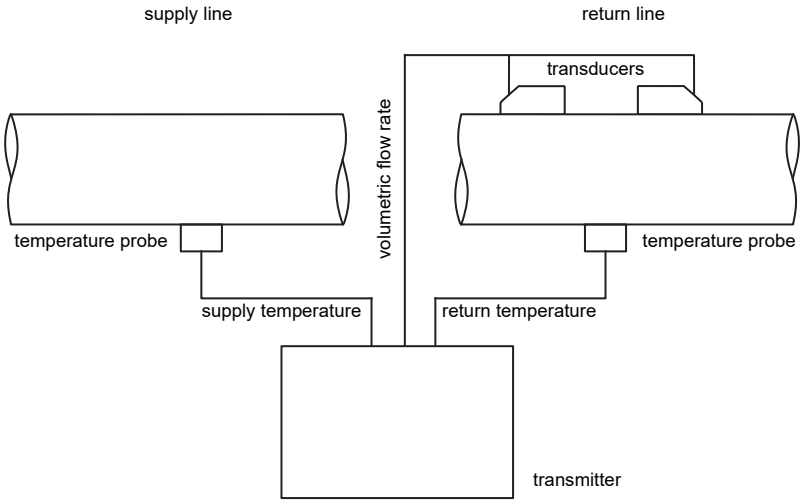
a - transducer distance

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
measurement uncertainty at the measuring point[2]		±1 % of reading ±0.02 ft/s
transmitter		
power supply		• 100 to 230 V/50 to 60 Hz (power supply unit: IP40, 32 to 104 °F) • 10.5 to 15 V DC (socket at transmitter) • integrated battery
integrated battery • operating time	 h	Li-Ion, 7.2 V/6.2 Ah • > 14 (without outputs, inputs and backlight) • > 25 (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		• RS232 • USB (with adapter)
process interfaces		• Modbus RTU (optional)
accessories		
serial data kit • cable • adapter	 	 RS232 RS232 - USB
software		• FluxDiagReader: download of measured values and parameters, graphical presentation • FluxDiag (optional): download of measurement data, graphical presentation, report generation
adapter		AO5, AO6, AO7, AO8, AI1, AI2
transport case		dimensions: 19.7 x 15.7 x 7.5 in
data logger		
loggable values		all physical quantities, totalized 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

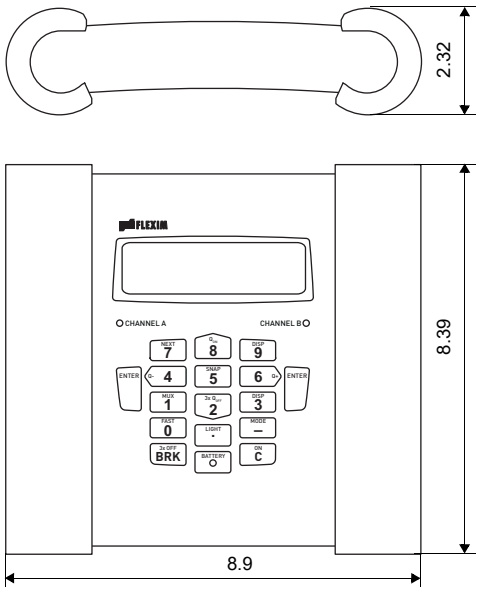
		FLUXUS F601
outputs		
		The outputs are galvanically isolated from the transmitter.
number		see standard scope of supply, max. on request
• switchable current output		
		The switchable current outputs are menu selectable all together as passive or active.
range	mA	4 to 20 (3.2 to 24)
accuracy		0.04 % of reading ±3 µA
active output		U_{int} = 24 V, R_{ext} < 500 Ω
passive output		U_{ext} = 8 to 30 V, depending on R_{ext} (R_{ext} < 900 Ω at 30 V)
• frequency output		
range	kHz	0 to 5
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		
• functions		mainly for totalizing
• pulse value	units	0.01 to 1000
• pulse width	ms	1 to 1000
inputs		
		The inputs are galvanically isolated from the transmitter.
number		see standard scope of supply, max. 4
• temperature input		
type		Pt100/Pt1000
connection		4-wire
range	°F	-238 to +1040
resolution	K	0.01
accuracy		±0.01 % of reading ±0.03 K
• current input		
accuracy		0.1 % of reading ±10 µA
passive input		R_{int} = 50 Ω, P_{int} < 0.3 W
• range	mA	-20 to +20
• voltage input		
range	V	0 to 1
accuracy		0.1 % of reading ±1 mV
internal resistance		R_{int} = 1 MΩ

[1] with aperture calibration of the transducers

[2] for transit time difference principle and reference conditions

Dimensions

60



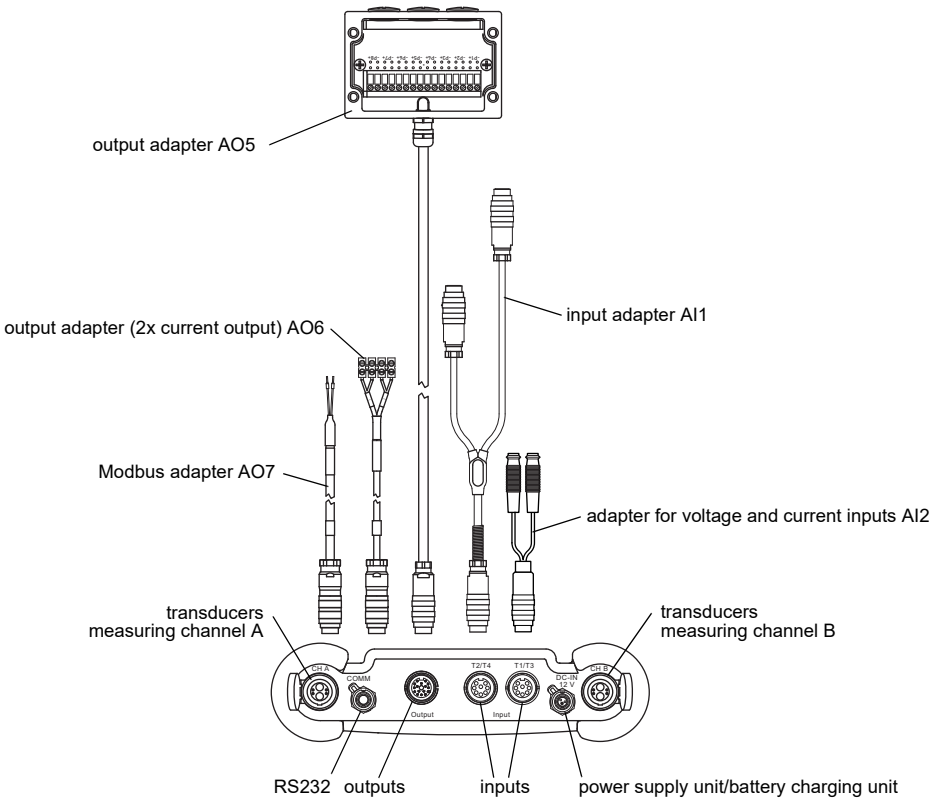
in inch

Standard scope of supply

	F601 Basic	F601 Energy
application	flow measurement of liquids	
	2 independent measuring channels, 2 calculation channels	
	wall thickness measurement (wall thickness probe to be ordered separately)	
		integrated thermal energy computer
		simultaneous monitoring of 2 energy flows
		temperature-compensated calculation of mass flow rate
outputs		
switchable current output	2	2
inputs		
temperature input	-	4
accessories		
transport case	x	x
power supply unit, mains cable	x	x
battery	x	x
adapter	AO6	AO6, AI1
QuickFix pipe mounting fixture for transmitter	x	x
serial data kit	x	x
measuring tape	x	x
user manual, Quick start guide	x	x

Adapters

***601**

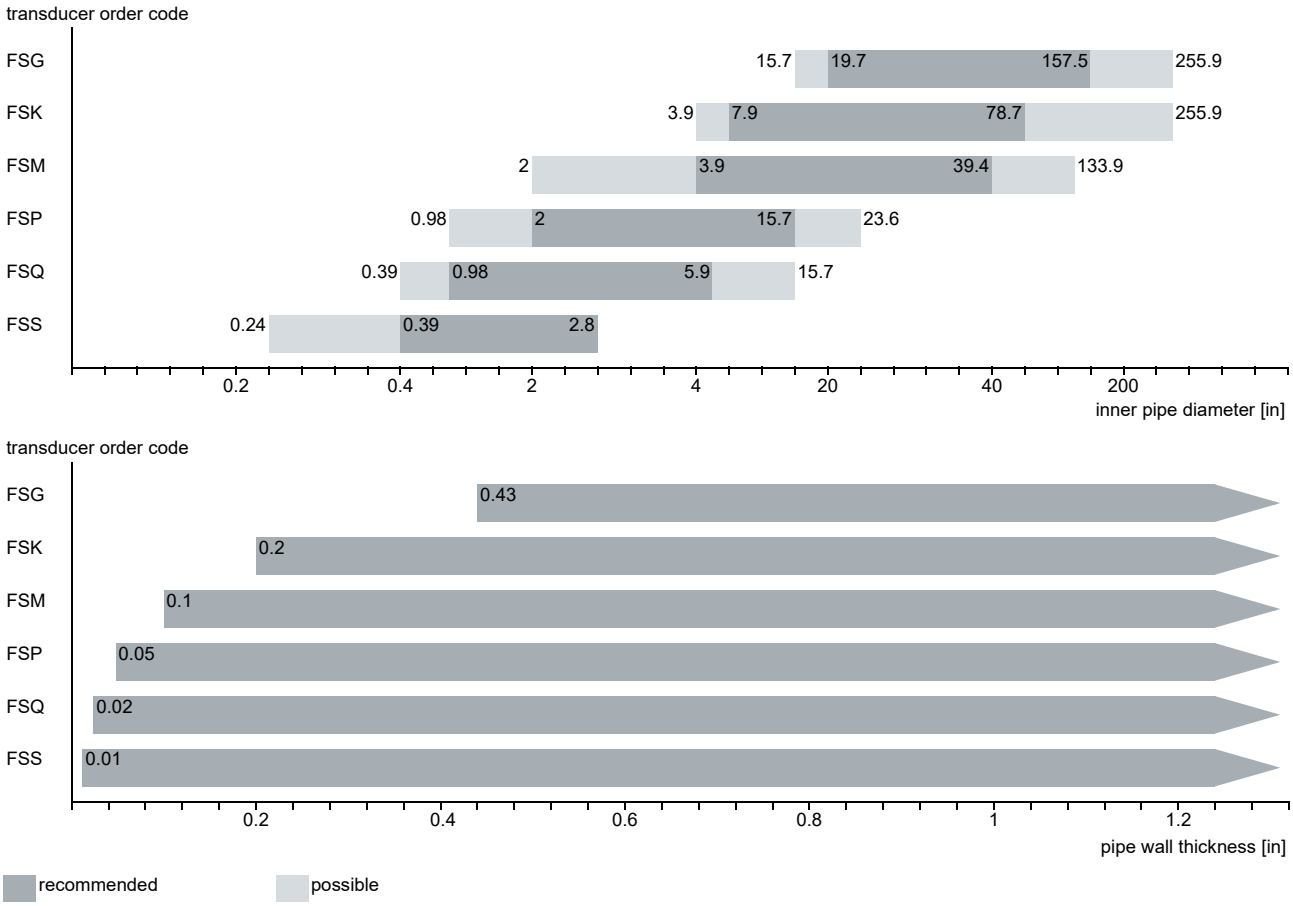


Example for the equipment of a transport case

F601

Transducers

Transducer selection

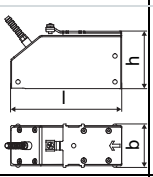
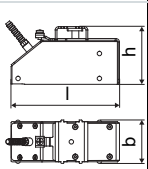
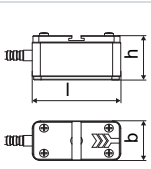
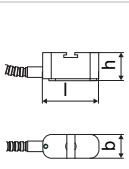
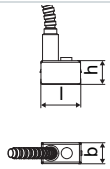


Transducer order code

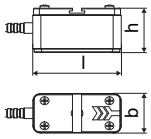
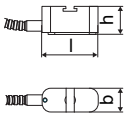
1, 2	3		4	5, 6	7, 8		9 to 11			no. of character
transducer	**transducer frequency**	**-**	**ambient temperature**	**explosion protection**	**connection system**	**-**	**extension cable**	**/**	**option**	**description**
FS										set of ultrasonic flow transducers for liquids measurement, shear wave
	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)

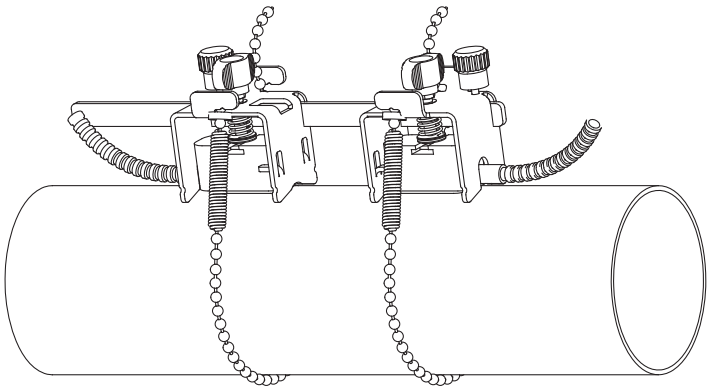
order code		FSM-ENNNL/**	FSP-ENNNL/**	FSQ-ENNNL/**
technical type		C(DL)M1EZ7	C(DL)P1EZ7	C(DL)Q1EZ7
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	133.9	23.6	15.7
pipe wall thickness				
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

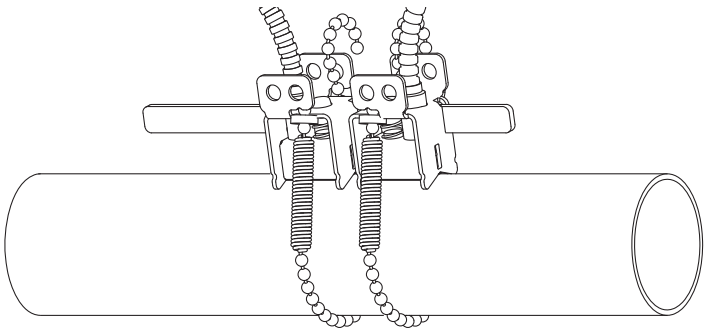
1, 2	3		4	5		6	7 to 9	no. of character
transducer mounting fixture	**transducer**	**-**	**measurement arrange-ment**	**size**	**-**	**fixation**	**outer pipe diameter**	**description**
FS								mounting frames
LM								ladder chain mounting accessory
VP								portable Variofix
TB								tension belts
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



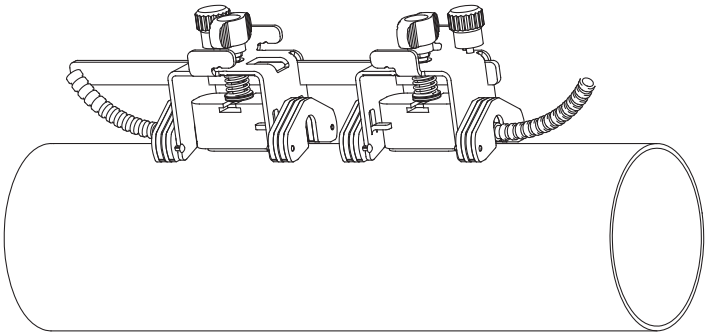
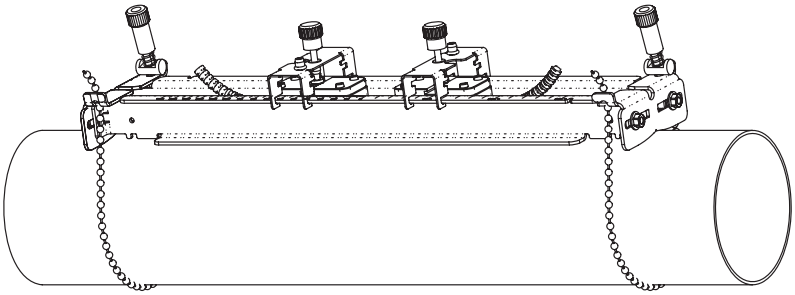
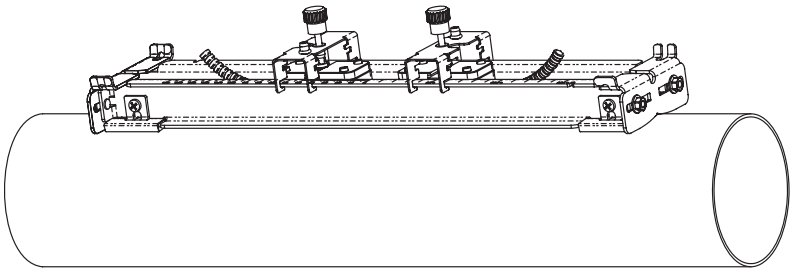
transducer frequency: M, P, Q

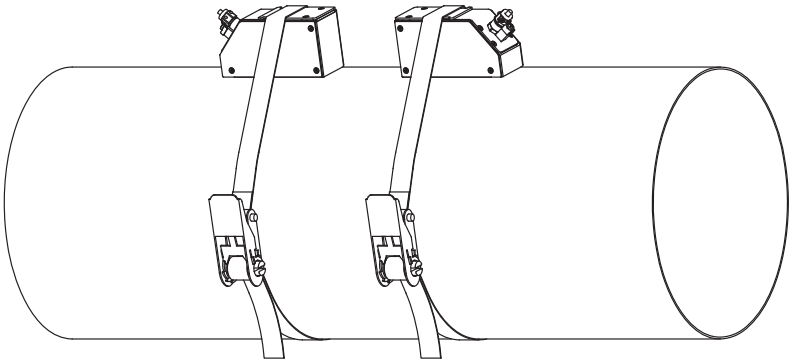
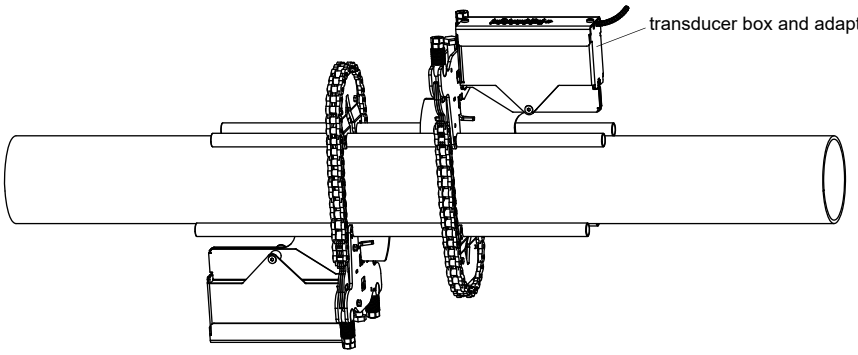
material: stainless steel 304, 301, 303
dimensions:
M, P: 16.54 x 1.89 x 2.68 in
Q: 16.54 x 1.69 x 2.28 in
chain length: 1/3/6 ft
outer pipe diameter:
max. 5.9/12.2/23.6 in



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

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

tension belts TB 	transducer frequency: G, K material: steel, powder coated and textile tension belt length: 16/22 ft ambient temperature: max. 140 °F outer pipe diameter: max. 59.1/82.7 in
transducer box WL for WaveInjector 	see Technical specification TSWaveInjectorVx-x

Coupling materials for transducers

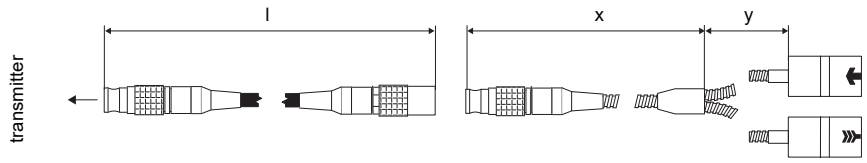
normal temperature range (4th character of transducer order code = N)		**extended temperature range (4th character of transducer order code = E)**		**WaveInjector**	
< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 1166 °F
coupling compound type N	coupling compound type E	coupling compound type E	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 1166
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

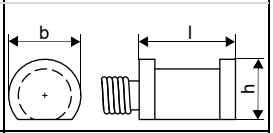
x, y = transducer cable length

l = max. length of extension cable

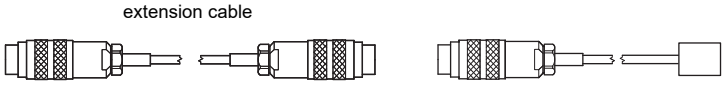
Clamp-on temperature probe (optional)

Technical data

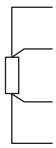
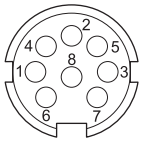
PT13N

design		clamp-on with connector
type		Pt1000
connection		4-wire
measuring range	°F	-40 to +392
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		≤ 0.03 °F (at 50 °F)
housing material		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


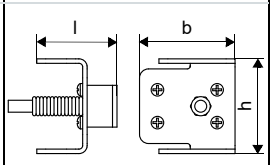
Connection

	temperature probe	extension cable	connector	
			pin	
	red	black	2	
	red	green	6	
	white	white	1	
	white	red	7	

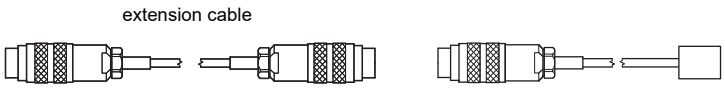
Cable

		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

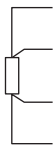
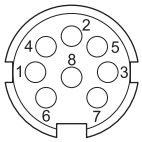
PT13F

design		clamp-on short response time, with connector
type		Pt1000
connection		4-wire
measuring range	°F	-58 to +482
accuracy T		±(0.27 °F + 2 · 10^{-3} · (|T [°F]| - 32 °F)) class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		≤ 0.1 K (3 K < ΔT < 6 K), more corresponding to EN 1434-1
response time	s	8 (t50, T1 = 25 °C, T2 = 60 °C)
housing material		PEEK, stainless steel 304, copper
degree of protection		IP54
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


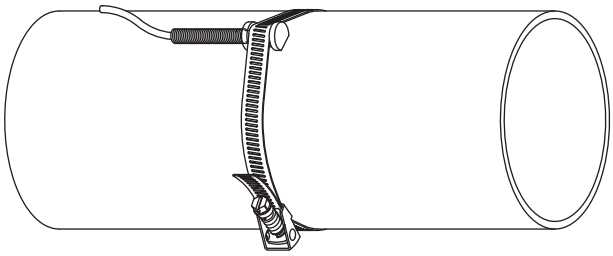
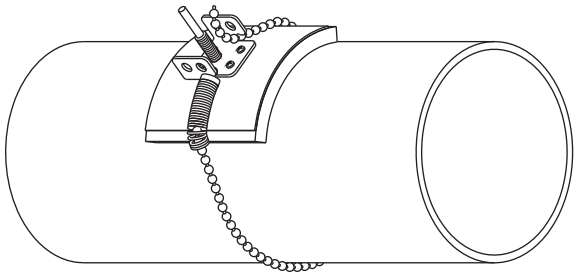
Connection

	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 0.22 mm²	4 x 18 AWG
standard length	ft	9	-
max. length	ft	-	656
ambient temperature	°F	-58 to +482	
min. bend radius	in	1.06	
cable jacket			
material		PFA	LS PVC
outer diameter	in	0.15 ±0.01	
color		black	

Fixation

tension strap PT13N 	material: stainless steel 301, 410 thermal insulation necessary
ball chain PT13F 	material: stainless steel 316L length: 3 ft

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

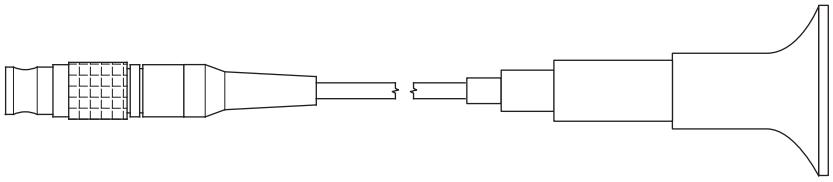
		DWR1NZ7
order code		ACC-PO-G601-/W6
measuring range[1]	in	0.04 to 9.8
resolution	in	0.0004
accuracy		1 % ±0.004 in
fluid temperature	°F	-4 to +392, short-time peak max. 932
cable		
type		2616
length	ft	4

[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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