

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 bi-directional and highly dynamic flow measurement with the non-intrusive 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 (-274 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 supported by handle



Measurement with transducers mounted with mounting frames and flow transmitter fixed to the pipe with the Quick-Fix pipe mounting fixture



Measurement equipment in transport case

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Function

Measurement principle

Transit time difference principle

In order to measure the flow of a fluid in a pipe, ultrasonic signals are used, employing the transit time difference principle. Ultrasonic signals are emitted by a transducer installed on the pipe and received by a second transducer. These signals are emitted alternately in the flow direction and against it.

As the fluid 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.

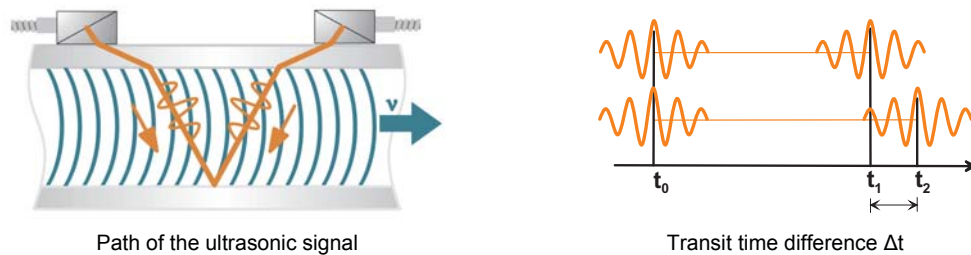
The transit time difference, Δt , is measured and allows the flowmeter to determine the average flow velocity along the propagation path of the ultrasonic signals. A flow profile correction is then performed in order to obtain the area averaged flow velocity, which is proportional to the volumetric flow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

Two integrated microprocessors control the entire measuring process. This allows the flowmeter to remove disturbance signals, and to check each received ultrasonic wave for its validity which reduces noise.

HybridTrek

If the gaseous or solid content in the fluid 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.



Calculation of volumetric flow rate

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

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_{fl} = transit time in the fluid

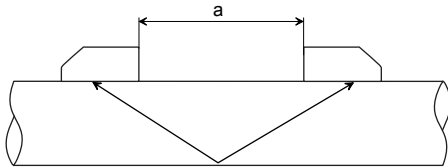
Number of sound paths

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. Both of 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. Both of 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.

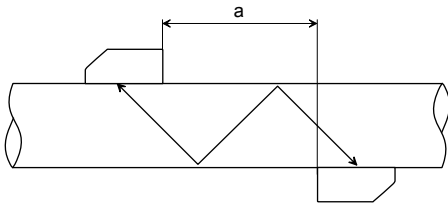
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

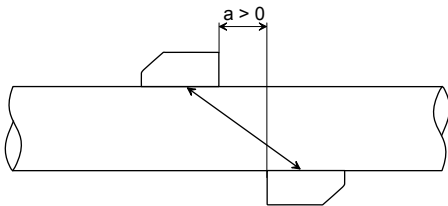


Reflect arrangement, number of sound paths: 2

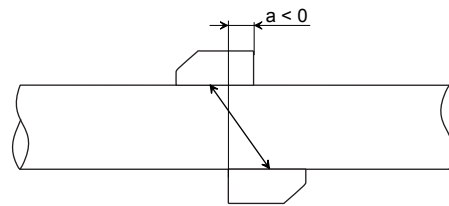
a = transducer distance



Diagonal arrangement, number of sound paths: 3

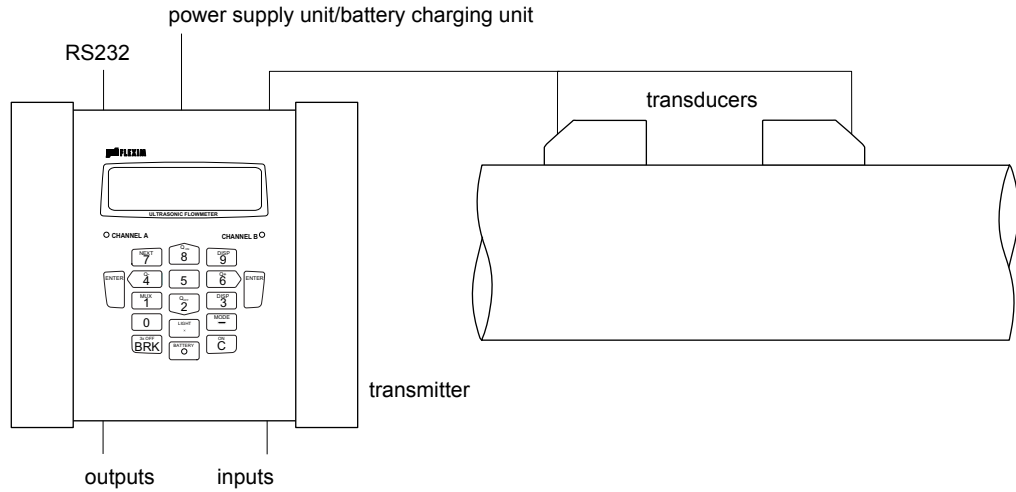


Direct mode, number of sound paths: 1

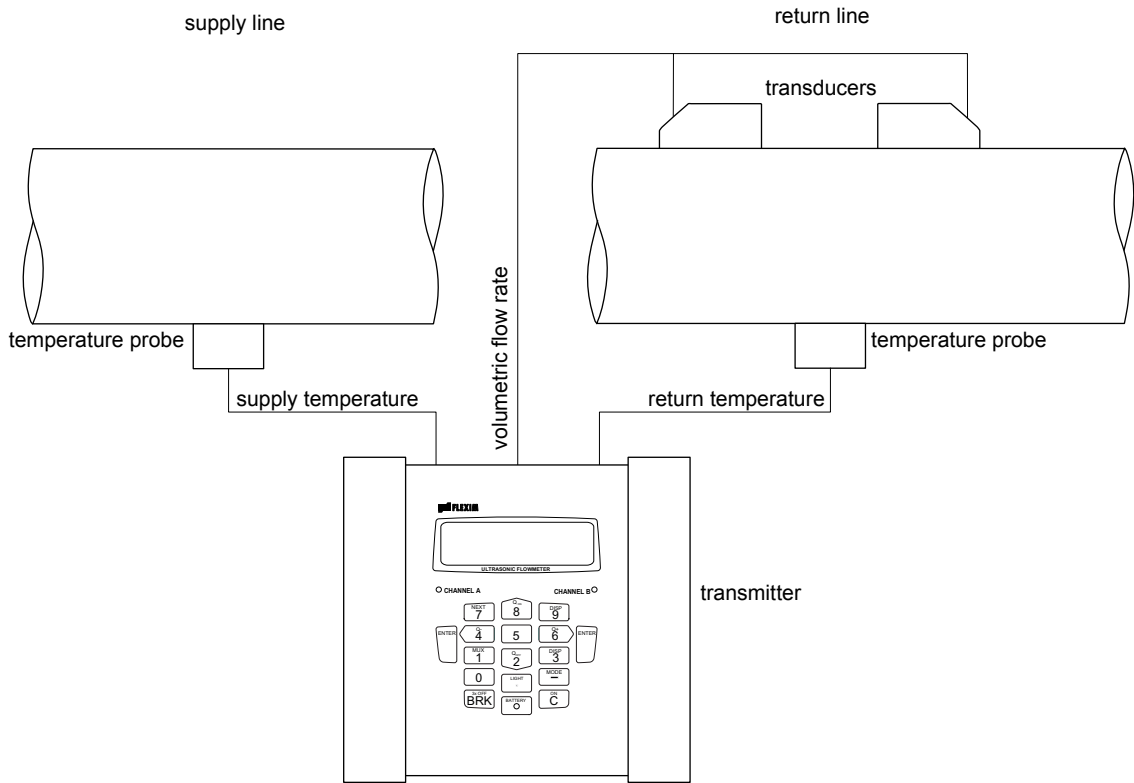


Direct mode, number of sound paths: 1,
negative transducer distance

Typical measurement setup




Example of a reflect arrangement



Example of a heat flow measurement

Flow transmitter

Technical data

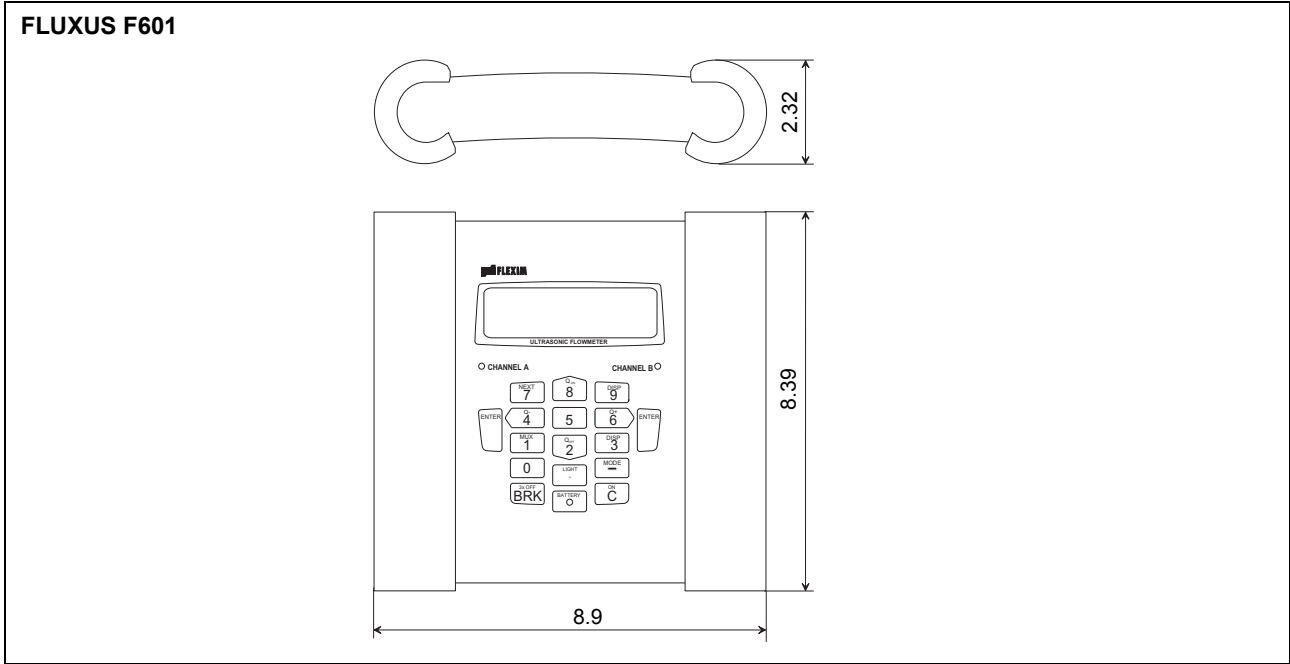
FLUXUS	F601
design	portable
	
measurement	
measurement principle	transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	0.03 to 82 ft/s
repeatability	0.15 % of reading ± 0.03 ft/s
fluid	all acoustically conductive 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
accuracy¹	
with standard calibration	± 1.6 % of reading ± 0.03 ft/s
with advanced calibration (optional)	± 1.2 % of reading ± 0.03 ft/s
with field calibration ²	± 0.5 % of reading ± 0.03 ft/s
flow transmitter	
power supply	100 to 230 V/50 to 60 Hz (power supply unit) 10.5 to 15 V DC (socket at transmitter) integrated battery
integrated battery - operating time	Li-Ion, 7.2 V/6.2 Ah > 14 h (without outputs, inputs and backlight) > 25 h (1 measuring channel, ambient temperature > 50 °F, without outputs, inputs and backlight)
power consumption	< 6 W (with outputs, inputs and backlight)
number of flow measuring channels	2
damping	0 to 100 s, adjustable
measuring cycle (1 channel)	100 to 1000 Hz
response time	1 s (1 channel), option: 70 ms
housing material	PA, TPE, AutoTex, stainless steel
degree of protection	NEMA 4
dimensions	see dimensional drawing
weight	4.6 lb
fixation	QuickFix pipe mounting fixture
ambient temperature	14 to 140 °F
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, heat flow (if temperature inputs are installed)
totalizer	volume, mass, optional: heat quantity
calculation functions	average, difference, sum
diagnostic functions	sound speed, signal amplitude, SNR, SCNR, standard deviation of amplitudes and transit times

¹ for transit time difference principle, reference conditions and $v > 0.49$ ft/s

² reference uncertainty < 0.2 %

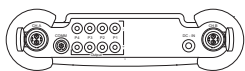
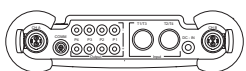
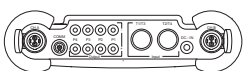
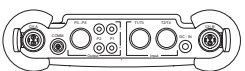
FLUXUS	F601
communication interfaces	
diagnostic interfaces	- RS232 - USB (with adapter)
process interfaces (optional)	- Modbus RTU
serial data kit	
software	- FluxDiagReader: download of measured values and parameters, graphical presentation - FluxDiag (optional): download of measurement data, graphical presentation, report generation - FluxSubstanceLoader: upload of fluid data sets
cable	RS232
adapter	RS232 - USB
data logger	
loggable values	all physical quantities, totalized values and diagnostic values
capacity	> 100 000 measured values
transport case	
dimensions	19.7 x 15.7 x 7.5 in
outputs	
	The outputs are galvanically isolated from the transmitter.
number	see standard scope of supply on page 9, max. on request
accessories	output adapter (if number of outputs > 4)
current output	
range	0/4 to 20 mA
accuracy	0.1 % of reading ±15 µA
active output	$R_{ext} < 750 \Omega$ ($U_{int} = 24 \text{ V DC}$)
passive output	$U_{ext} = 4 \text{ to } 16 \text{ V}$, depending on R_{ext} $R_{ext} < 500 \Omega$
frequency output	
range	0 to 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	mainly for totalizing 0.01 to 1000 units 1 to 1000 ms
inputs	
	The inputs are galvanically isolated from the transmitter.
number	see standard scope of supply on page 9, max. 4
accessories	input adapter (if number of inputs > 2)
temperature input	
type	Pt100/Pt1000
connection	4-wire
range	-238 to +1040 °F
resolution	0.01 K
accuracy	±0.01 % of reading ±0.03 K
current input	
accuracy	0.1 % of reading ±10 µA
passive input	$R_{int} = 50 \Omega$, $P_{int} < 0.3 \text{ W}$
- range	-20 to +20 mA
voltage input	
range	0 to 1 V
accuracy	0.1 % of reading ±1 mV
internal resistance	$R_{int} = 1 \text{ M}\Omega$

Dimensions

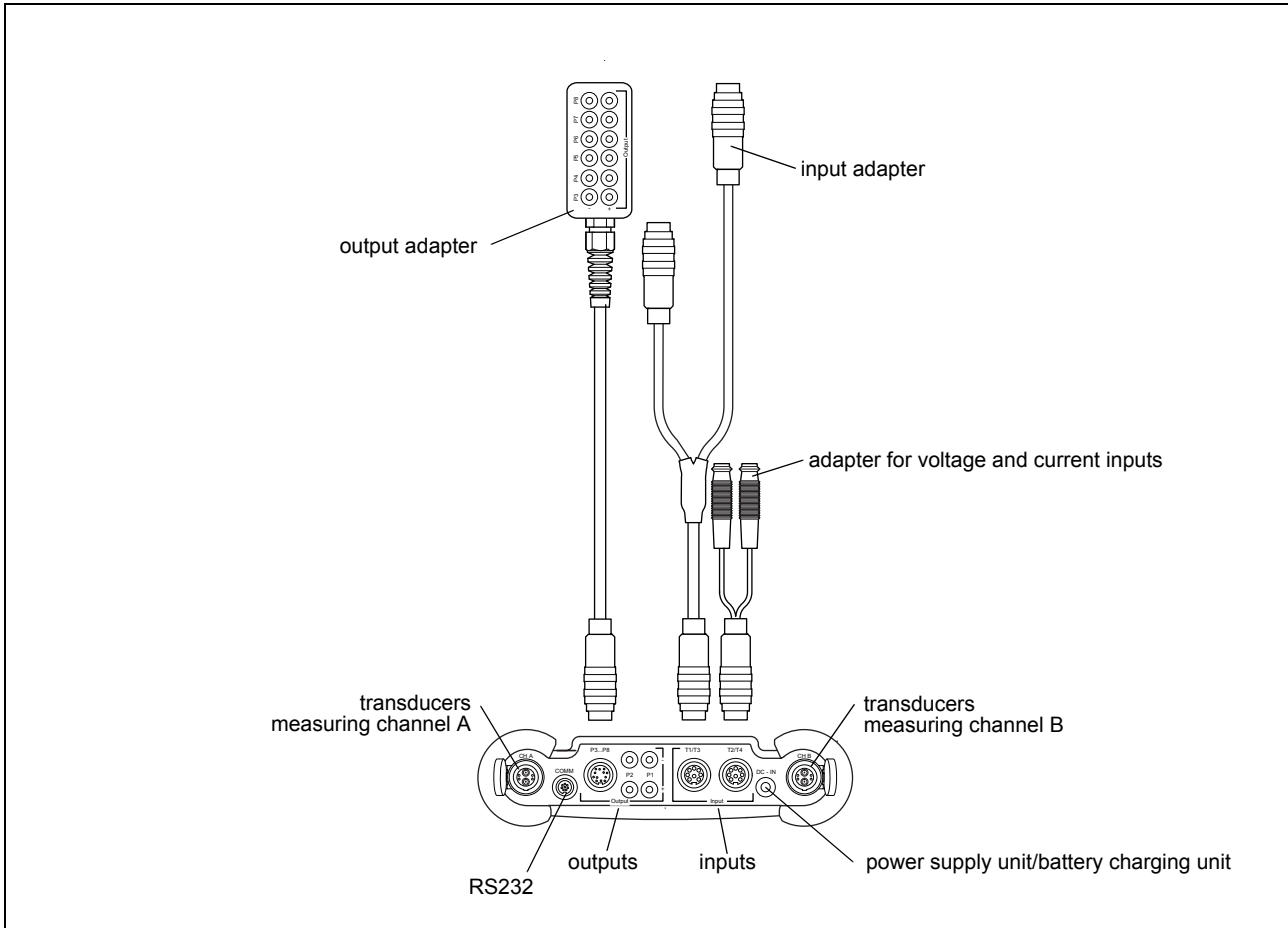


in inch

Standard scope of supply

	F601 Standard		F601 Energy		F601Double Energy		F601Multi-functional	
application	flow measurement on liquids							
	2 independent measuring channels							
			temperature-compensated calculation of mass flow rate		integrated heat flow 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								

Connection of adapters

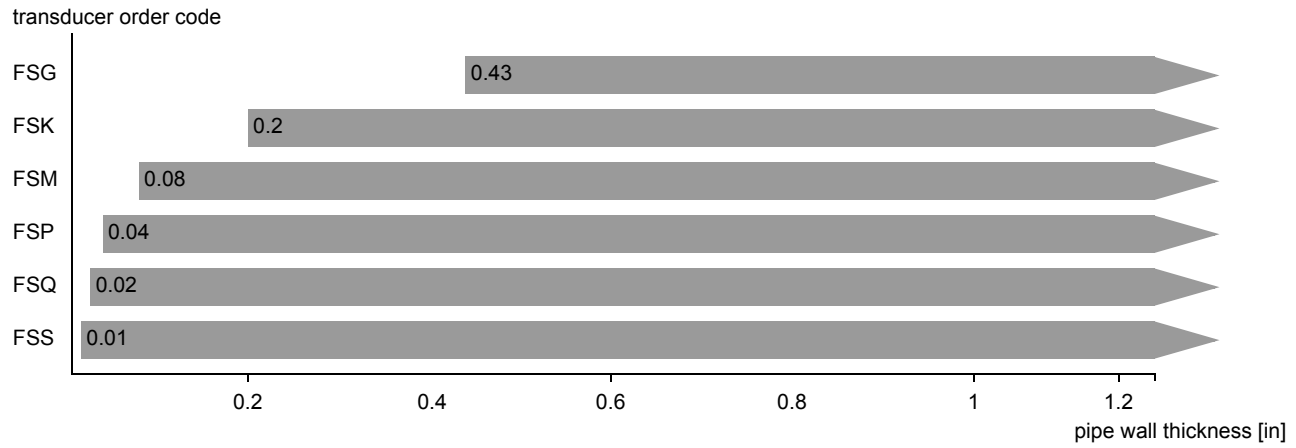
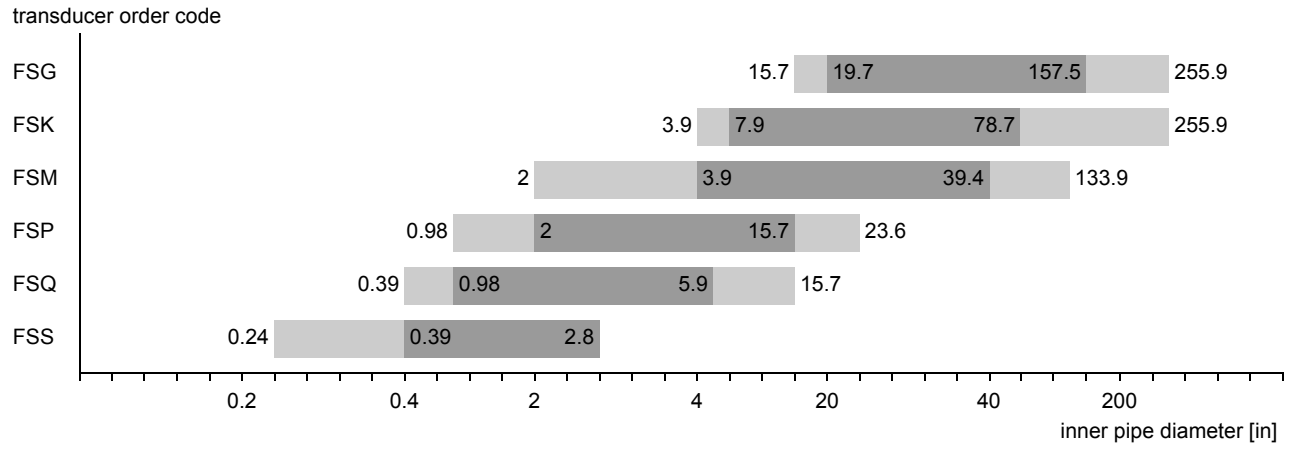


Example for the equipment of a transport case



Transducers

Transducer selection



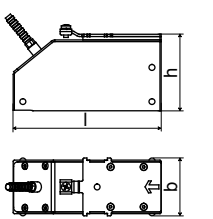
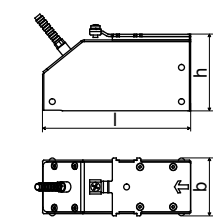
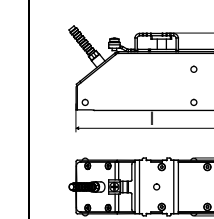
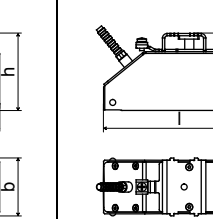
recommended
 possible

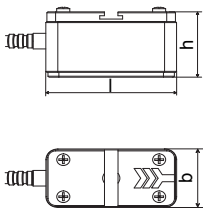
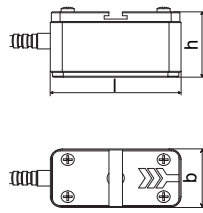
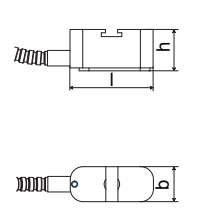
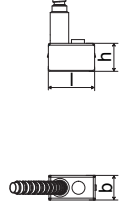
Transducer order code

1, 2	3	4	5, 6	7, 8	9 to 11	12, 13	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 (FSM, FSP, FSQ)
			NN								not explosion proof
				NL						with Lemo connector	
						XXX				cable length in m, for max. length of extension cable see page 22	
								LC	long transducer cable		
example											
FS	M	-	N	NN	NL	-	000			shear wave transducer 1 MHz, normal temperature range, connection system NL with Lemo connector	
		-				-		/			

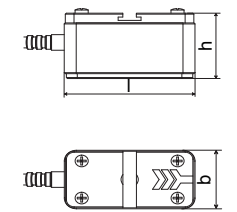
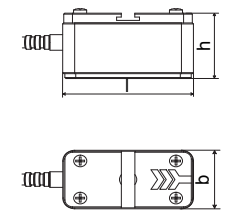
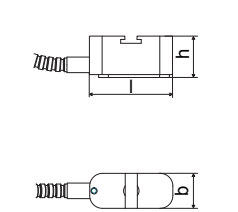
Technical data

Shear wave transducers

technical type		CDG1NZ7	CLG1NZ7	CDK1NZ7	CLK1NZ7
order code		FSG-NNNNL	FSG-NNNNL/LC	FSK-NNNNL	FSK-NNNNL/LC
transducer frequency		MHz 0.2	0.2	0.5	0.5
inner pipe diameter d					
min. extended		in 15.7	15.7	3.9	3.9
min. recommended		in 19.7	19.7	7.9	7.9
max. recommended		in 157.5	157.5	78.7	78.7
max. extended		in 255.9	255.9	255.9	255.9
pipe wall thickness					
min.		in 0.43	0.43	0.2	0.2
material					
housing		PEEK with stainless steel cap 304	PEEK with stainless steel cap 304	PEEK with stainless steel cap 304	PEEK with stainless steel cap 304
contact surface		PEEK	PEEK	PEEK	PEEK
degree of protection		NEMA 6	NEMA 6	NEMA 6	NEMA 6
transducer cable					
type		1699	1699	1699	1699
length		ft 16	29	16	29
dimensions					
length l		in 5.1	5.1	4.98	4.98
width b		in 2.01	2.01	2.01	2.01
height h		in 2.64	2.64	2.66	2.66
dimensional drawing					
ambient temperature					
min.		°F -40	-40	-40	-40
max.		°F +266	+266	+266	+266
temperature compensation		x	x	x	x

technical type		CDM1NZ7	CDP1NZ7	CDQ1NZ7	CDS1NZ7
order code		FSM-NNNNL	FSP-NNNNL	FSQ-NNNNL	FSS-NNNNL
transducer frequency	MHz	1	2	4	8
inner pipe diameter d					
min. extended	in	2	0.98	0.39	0.24
min. recommended	in	3.9	2	0.98	0.39
max. recommended	in	39.4	15.7	5.9	2.8
max. extended	in	133.9	23.6	15.7	2.8
pipe wall thickness					
min.	in	0.08	0.04	0.02	0.01
material					
housing		stainless steel 304	stainless steel 304	stainless steel 304	stainless steel 304
contact surface		PEEK	PEEK	PEEK	PEI
degree of protection		NEMA 6	NEMA 6	NEMA 6	NEMA 4
transducer cable					
type		1699	1699	1699	1699
length	ft	13	13	9	6
dimensions					
length l	in	2.36	2.36	1.67	0.98
width b	in	1.18	1.18	0.71	0.51
height h	in	1.32	1.32	0.85	0.67
dimensional drawing					
ambient temperature					
min.	°F	-40	-40	-40	-22
max.	°F	+266	+266	+266	+266
temperature compensation		x	x	x	-

Shear wave transducers (extended temperature range)

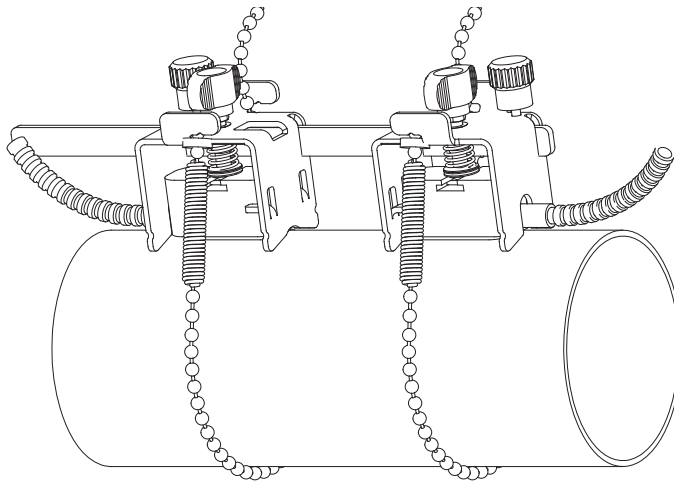
technical type		CDM1EZ7	CDP1EZ7	CDQ1EZ7
order code		FSM-ENNNL	FSP-ENNNL	FSQ-ENNNL
transducer frequency	MHz	1	2	4
inner pipe diameter d				
min. extended	in	2	0.98	0.39
min. recommended	in	3.9	2	0.98
max. recommended	in	39.4	15.7	5.9
max. extended	in	133.9	23.6	15.7
pipe wall thickness				
min.	in	0.08	0.04	0.02
material				
housing		stainless steel 304	stainless steel 304	stainless steel 304
contact surface		Sintimid	Sintimid	Sintimid
degree of protection		NEMA 4	NEMA 4	NEMA 4
transducer cable				
type		1699	1699	1699
length	ft	13	13	9
dimensions				
length l	in	2.36	2.36	1.67
width b	in	1.18	1.18	0.71
height h	in	1.32	1.32	0.85
dimensional drawing				
ambient temperature				
min.	°F	-22	-22	-22
max.	°F	+392	+392	+392
temperature compensation		x	x	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
example								
VP	A	-	D	M	-	C	055	portable Variofix and chains
		-			-			

mounting frames FS and chains



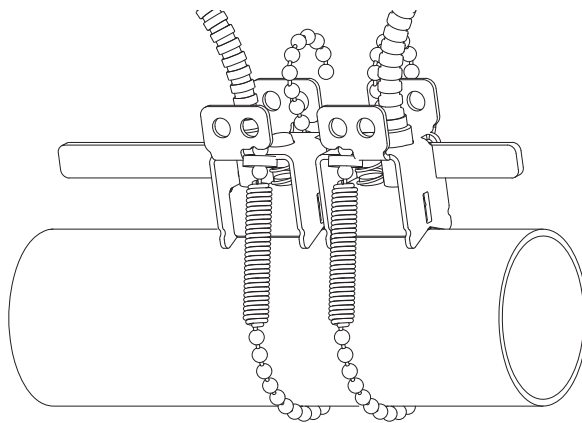
transducer frequency: M, P, Q

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

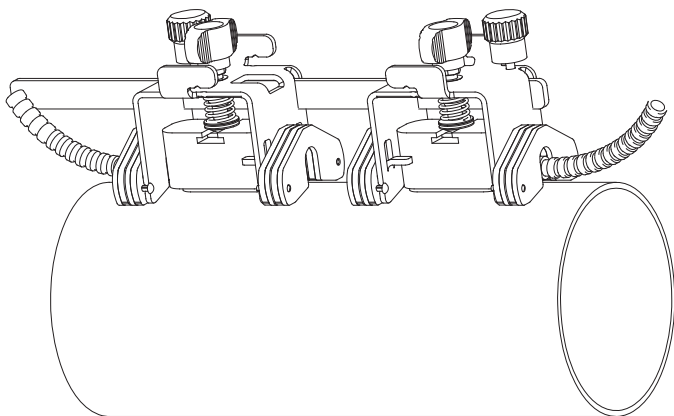
material: stainless steel 304, 301, 303

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

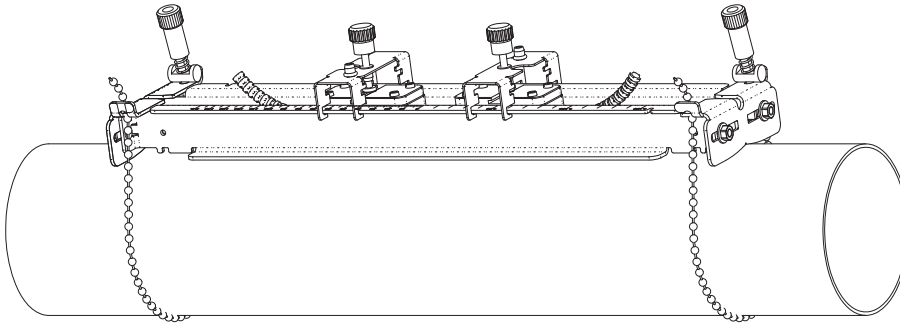
dimensions:
M, P: 16.54 x 1.89 x 2.68 in
Q: 16.54 x 1.69 x 2.28 in

ladder chain mounting accessory LM



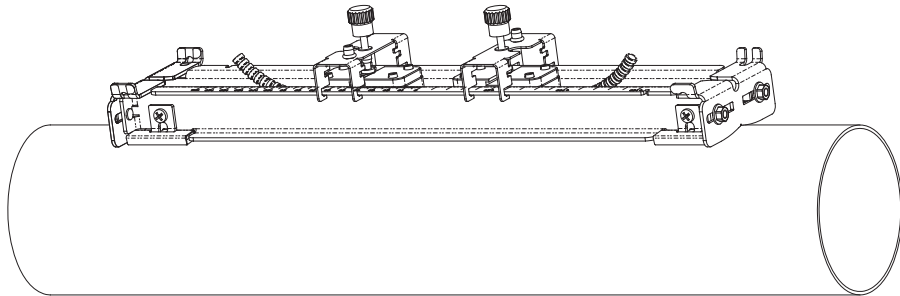
transducer frequency: M, P, Q
 chain length: 30/78 in
 outer pipe diameter:
 max. 24 in

portable Variofix VP and chains (optional)



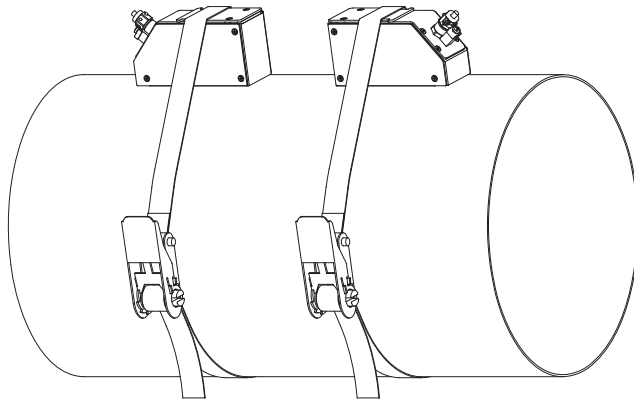
material: stainless steel 304,
 301, 303
 dimensions:
 16.3 x 3.7 x 2.99 in
 chain length: 6 ft

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 (optional)

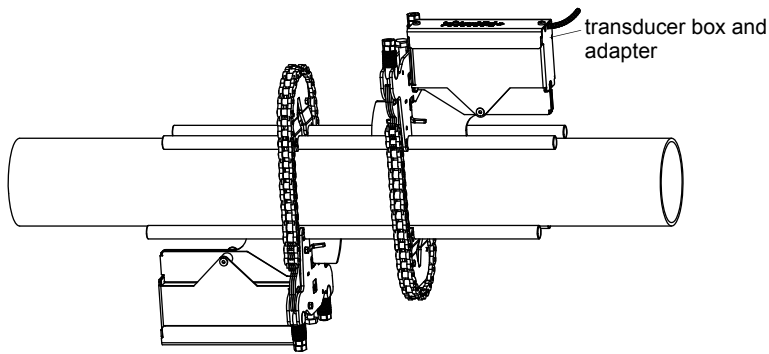


transducer frequency: G, K

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 Wavelnjector



see Technical specification
TSWavelnjectorVx-x

Coupling materials for transducers

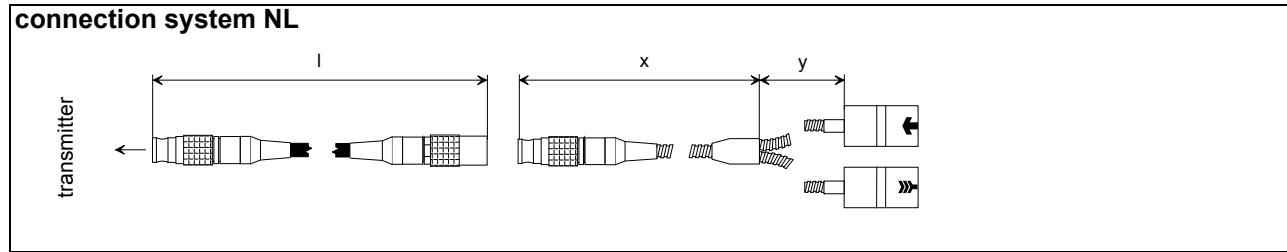
normal temperature range (4th character of transducer order code = N)		extended temperature range (4th character of transducer order code = E)		WaveInjector WI-400	
< 212 °F	< 338 °F	< 302 °F	< 392 °F	< 536 °F	536 to 752 °F
coupling compound type N	coupling compound type E	coupling compound type E	coupling 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	material
coupling compound type N	-22 to +266	mineral grease paste
coupling compound type E	-22 to +392	silicone paste
coupling compound type H	-22 to +482	fluoropolymer paste
coupling pad type A	max. 536	lead
coupling pad type B	> 536 to 752	silver
coupling pad type VT	14 to +392	fluoroelastomer

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

Connection systems



transducer frequency (3d character of transducer order code)		F, G, H, K			M, P			Q			S		
N L	cable length ft	x	y	l ¹	x	y	l ¹	x	y	l ¹	x	y	l
	cable length (option LC) ft	6	9	≤ 82	6	6	≤ 82	6	3	≤ 82	3	3	≤ 65
		6	22	≤ 82	-	-	-	-	-	-	-	-	-

¹ > 82 to 328 ft on request

x, y = transducer cable length

l = max. length of extension cable

Transducer cable

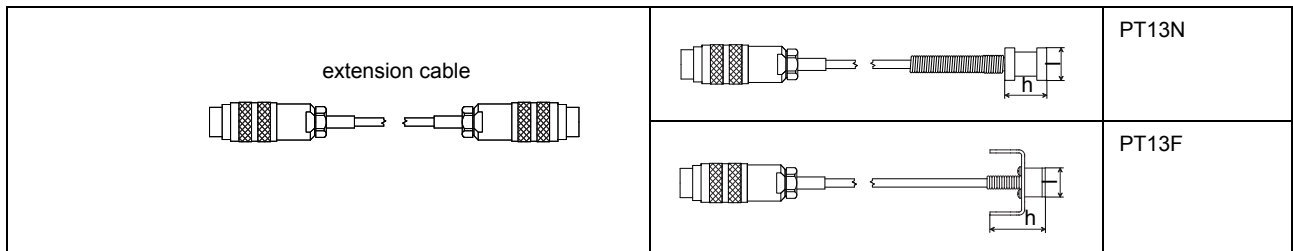
Technical data

		transducer cable		extension cable	
type		1699		2551	
standard length	ft	see table above		-	
				16 32	
max. length	ft	-		see table above	
				32	
ambient temperature	°F	-67 to +392		-13 to +176	
				< 144	
cable jacket					
material		PTFE		TPE-O	
outer diameter	in	0.11		0.31	
thickness	in	0.01		0.02	
color		brown		black	
shield		x		x	
sheath					
material		stainless steel 304		-	
outer diameter	in	0.31		-	
remark				stainless steel 304 0.35 optional	

Clamp-on temperature probe (optional)

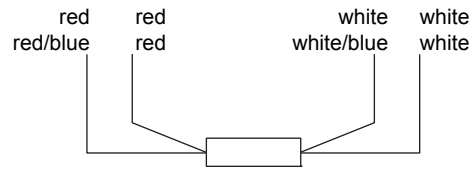
Technical data

technical type		PT13N	PT13F
design			short response time
type		Pt1000	Pt1000
connection		4-wire	4-wire
measuring range	°F	-40 to +392	-58 to +482
accuracy T		$\pm(0.27 \text{ °F} + 2 \cdot 10^{-3} \cdot (T \text{ [°F]} - 32 \text{ °F}))$ class A	$\pm(0.27 \text{ °F} + 2 \cdot 10^{-3} \cdot (T \text{ [°F]} - 32 \text{ °F}))$ class A
accuracy ΔT (2x Pt matched according to EN 1434-1)		$\leq 0.03 \text{ °F}$ (at 50 °F)	$\leq 0.1 \text{ K}$ (3 K < ΔT < 6 K), more corresponding to EN 1434-1
response time	s		8
housing		360 brass alloy	PEEK, stainless steel 304, copper
degree of protection			NEMA 4
weight	lb	0.437	0.7
fixation		clamp-on	clamp-on
accessories			
thermal conductivity paste 392 °F		-	x
thermal conductivity foil 482 °F		x	x
plastic protection plate, insulation foam		-	x
dimensions			
length l	in	0.59	0.55
width b	in	0.49	1.18
height h	in	0.79	1.06



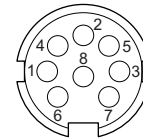
Connection

Temperature probe



Connector

pin	cable of temperature probe PT13F	cable of temperature probe PT13N	extension cable
1	white/blue	white	white
2	red/blue	red	black
3, 4, 5	not connected		
6	red	red	green
7	white	white	red
8	not connected		



Cable

		cable of temperature probe	cable of temperature probe	extension cable
		PT13F	PT13N	
temperature probe		PT13F	PT13N	
type		4 x 0.25 mm ² black	4 x 24 AWG	4 x 18 AWG
standard length	ft	9	20	-
max. length	ft	-	-	656
cable jacket		PTFE	PTFE	LS PVC

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.

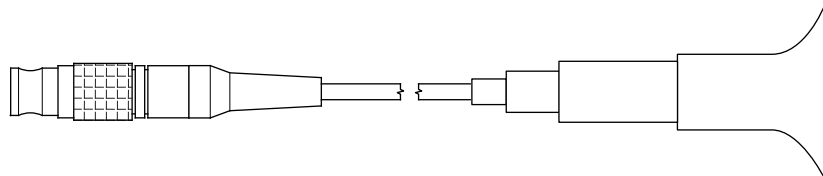
Technical data

technical type		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

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



DWR1NZ7



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