FLEXIM

# Technical specification

# FLUXUS G601

## Portable ultrasonic flowmeter for gas, steam and liquids

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

### Features

- Configurable as multifunctional measuring system:
  - flow measurement of gases, compressed air and saturated steam up to max. 356 °F
  - flow and thermal energy measurement of liquids
- 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
- Probe for wall thickness measurement available
- Robust, water-tight (NEMA 4) transport case with comprehensive accessories
- QuickFix for fast mounting of the flow transmitter in difficult conditions


FLUXUS G601

### Applications

Designed for industrial use in harsh environments, applicable in all areas such as maintenance, energy management, troubleshooting and verification of installed measuring systems. Practical applications

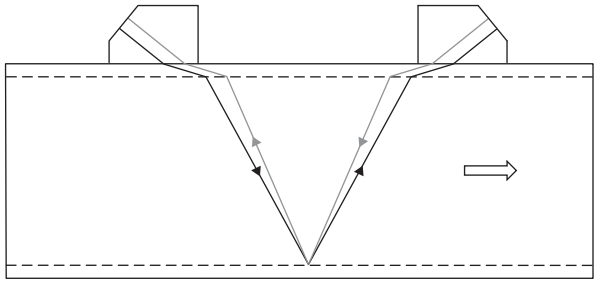
- Data gathering in energy management and certifications according to ISO 50001
- Supervision and monitoring of compressed air and steam systems
- Hydraulic balancing of cooling towers
- Measurement on natural gas pipelines and in natural gas storage installations
- Measurement of synthesized gas and injection gas
- Measurement for the gas supply industry
- 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

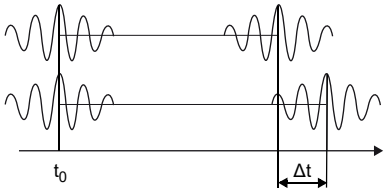


As the fluid where the ultrasound propagates is flowing, the transit time of the ultrasonic signal in flow direction is shorter than the one against the flow direction.

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




## 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

$t_\gamma$ - average of transit times in the fluid

## Calculation of mass flow

The mass flow is calculated on the base of operating density and volume flow:

$\dot{m} = \rho \cdot \dot{V}$

The operating density of the fluid is calculated as the function of concentration and temperature of the fluid:

$\rho = f(K, T)$

where

$\rho$ - operating density

K - concentration

T - temperature

$\dot{m}$ - mass flow rate

$\dot{V}$ - volumetric flow rate

## Number of sound paths

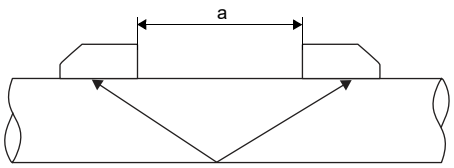
The number of sound paths is the number of transits of the ultrasonic signal through the fluid in the pipe. Depending on the number of sound paths, the following methods of installation exist:

- **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.

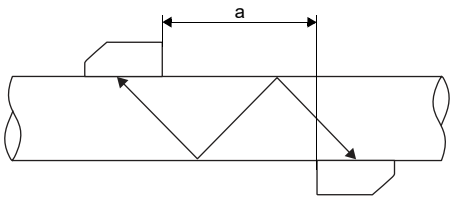
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

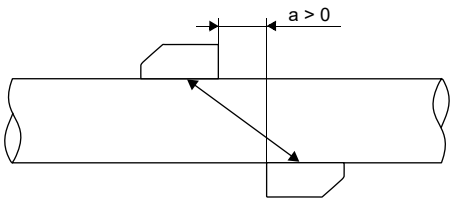
Reflect arrangement, number of sound paths: 2



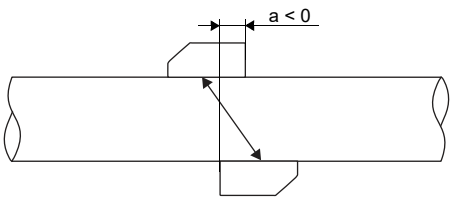

Diagonal arrangement, number of sound paths: 3




Direct mode, number of sound paths: 1



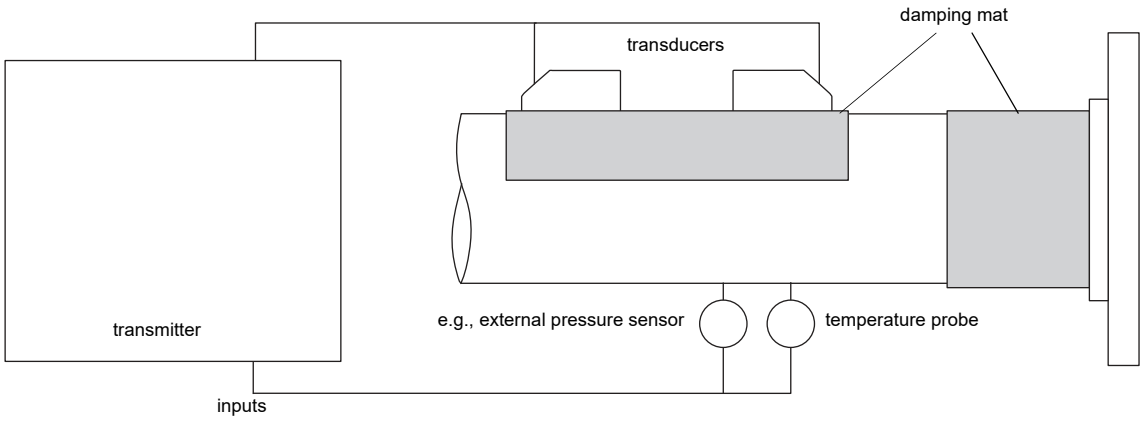

Direct mode, number of sound paths: 1, negative transducer distance




a - transducer distance

## Typical measurement setup

Example of a reflect arrangement with connection of the inputs to an external process pressure and process temperature measurement for standard volumetric flow rate calculation




## Standard volumetric flow rate

The standard volumetric flow rate can be selected as physical quantity to be measured. It will be calculated internally by:

$$\dot{V}_N = \dot{V} \cdot \frac{p}{p_N} \cdot \frac{T_N}{T} \cdot \frac{1}{K}$$

where

$\dot{V}_N$ - standard volumetric flow rate

$\dot{V}$ - operating volumetric flow rate

$p_N$ - standard pressure (absolute value)

p - operating pressure (absolute value)

$T_N$ - standard temperature in K

T - operating temperature in K

K compressibility coefficient of the gas: ratio of the compressibility factors of the gas at operating conditions and at standard conditions $Z/Z_N$

The operational pressure p and the operational temperature T of the fluid will be entered directly as fixed values into the transmitter.

or:

If inputs are installed (optional), pressure and temperature can be measured by the customer and fed in the transmitter.

The gas compressibility coefficient K of the gas is entered in the transmitter:

- as fixed value or
- as approximation according to e.g., AGA8 or GERG

# Transmitter

## Technical data

| | | FLUXUS G601** | FLUXUS G601ST (steam measurement) |
|---|---|---|---|
| | |  | |
| design | | portable | |
| **measurement** | | | |
| | | | test measurement to validate the application required in advance |
| measurement principle | | transit time difference correlation principle | |
| flow velocity | ft/s | 0.03 to 115, depending on pipe diameter | depending on pipe diameter and transducer, see diagrams |
| repeatability | | 0.15 % of reading ±0.02 ft/s | |
| fluid | | all acoustically conductive gases,<br>e.g., nitrogen, air, oxygen, hydrogen, argon, helium, ethylene, propane | saturated steam, superheated steam |
| fluid pressure | psi | see transducers | 44 to 145 |
| fluid temperature | °F | see transducers | 275 to 356 |
| 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<br>includes calibration certificate traceable to NIST calibration facility ISO 17025 accredited | ±0.3 % of reading ±0.02 ft/s<br>includes calibration certificate traceable to NIST calibration facility ISO 17025 accredited |
| measurement uncertainty at the measuring point | | ±1 to 3 % of reading ±0.02 ft/s, contact FLEXIM for an application specific uncertainty evaluation | ±1 to 3 % of reading ±0.02 ft/s, depending on application |
| **transmitter** | | | |
| power supply | | • 100 to 230 V/50 to 60 Hz (power supply unit: IP40, 32 to 104 °F)<br>• 10.5 to 15 V DC (socket at transmitter)<br>• integrated battery | |
| integrated battery<br>• operating time | h | Li-Ion, 7.2 V/6.2 Ah<br>• > 14 h (without outputs, inputs and backlight)<br>• > 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 | | operating volumetric flow rate, standard volumetric flow rate, mass flow rate, flow velocity | operating volumetric flow rate, mass flow rate, flow velocity |
| totalizer | | volume, mass | |
| 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<br>• USB (with adapter) | |
| process interfaces | | • Modbus RTU (optional) | |
| **accessories** | | | |
| serial data kit<br>• cable<br>• adapter | | <br>RS232<br>RS232 - USB | |
| software | | • FluxDiagReader: download of measured values and parameters, graphical presentation<br>• FluxDiag (optional): download of measurement data, graphical presentation, report generation<br>• FluxSubstanceLoader: upload of fluid data sets | |
| adapter | | AO5, AO6, AO7, AO8, AI1, AI2 | |
| transport case | | dimensions: 19.7 x 15.7 x 7.5 in | |

[1] with aperture calibration of the transducers

[2] for transit time difference principle and reference conditions

For the technical data in the flow measurement of liquids mode see Technical specification TSFLUXUS_F601V*-*.

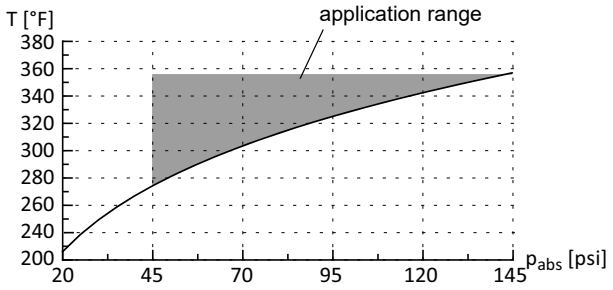
| | | FLUXUS G601** | FLUXUS G601ST (steam measurement) |
|---|---|---|---|
| **data logger** | | | |
| loggable values | | all physical quantities, totalized values and diagnostic values | |
| capacity | | > 100 000 measured values | |
| **outputs** | | | |
| | | The outputs are galvanically isolated 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<br>• range | mA | $R_{int}$ = 50 Ω, $P_{int}$ < 0.3 W<br>-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

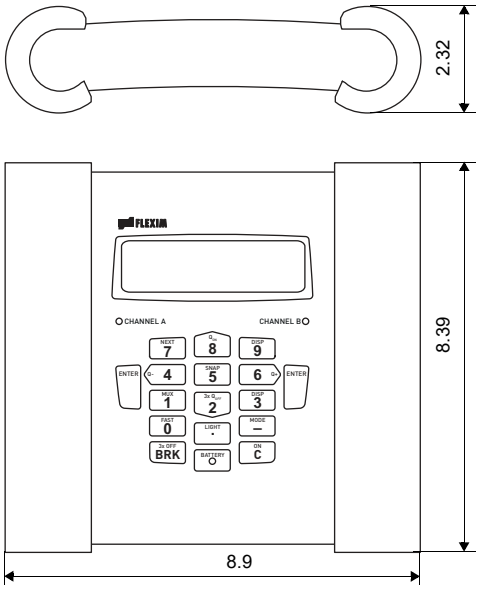
For the technical data in the flow measurement of liquids mode see Technical specification TSFLUXUS_F601V*-*.

## Saturated steam pressure curve (steam measurement)



## Dimensions

***60***



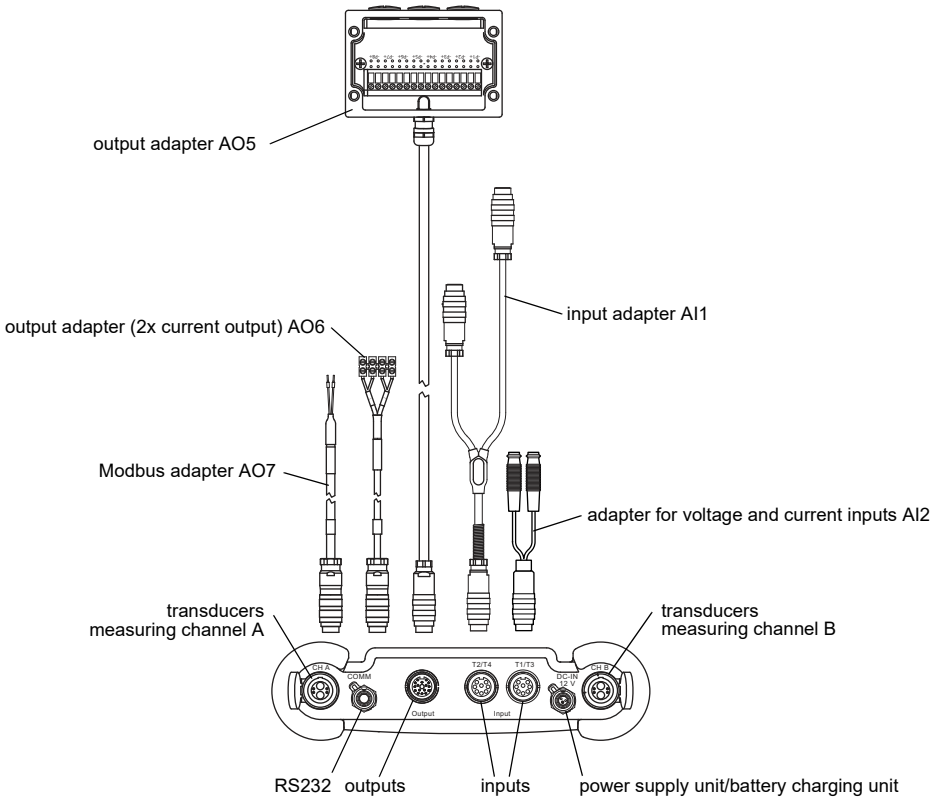

in inch

## Standard scope of supply

| | G601 Basic | G601 CA-Energy | G601ST Steam |
|---|---|---|---|
| application | flow measurement of gas | | |
| | 2 independent measuring channels | | |
| | calculation of standard volumetric flow rate | calculation of standard volumetric flow rate, with optional use of current measured pressure and temperature values | |
| | | liquids: integrated thermal energy computer for monitoring of energy flows | |
| | | | calculation of mass flow according to saturated steam pressure curve |
| **outputs** | | | |
| switchable current output | 2 | 2 | 2 |
| binary output | 2 | 2 | 2 |
| **inputs** | | | |
| temperature input | - | 2 | 2 |
| passive current input | - | 2 | 2 |
| **accessories** | | | |
| transport case | x | x | x |
| power supply unit, mains cable | x | x | x |
| battery | x | x | x |
| adapter | AO6 | AO6, AI1, AI2 | AO6, AI1, AI2 |
| 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 |

## Adapters

***601**

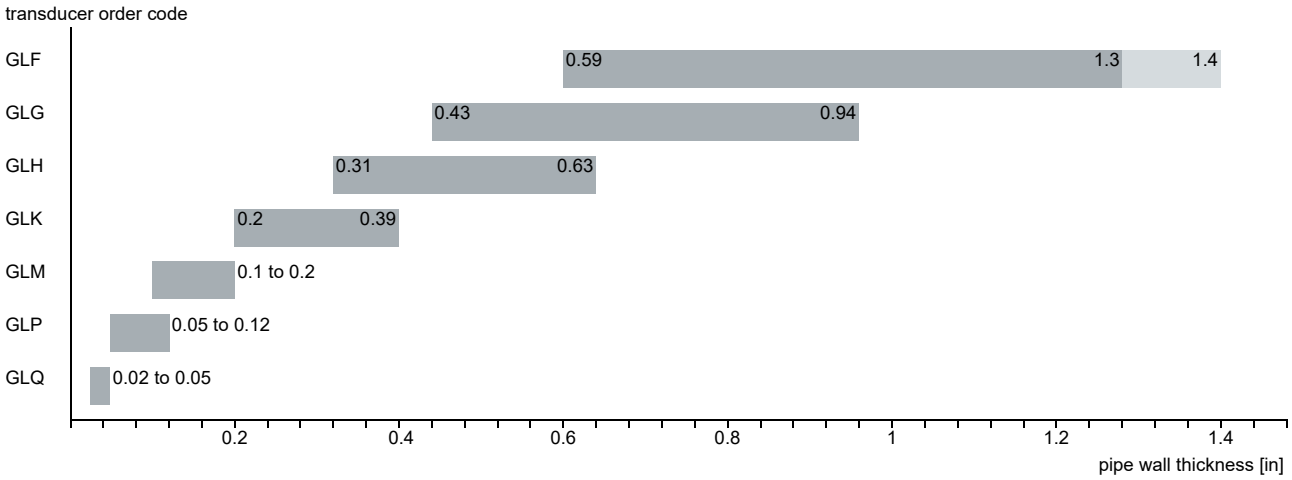


# Transducers

## Transducer selection (gas measurement)

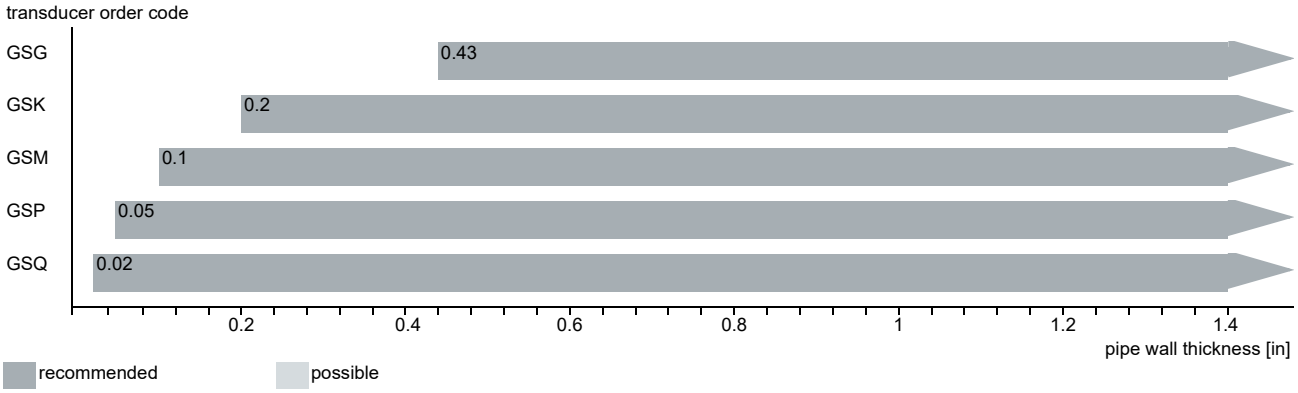
### Step 1a

Select a Lamb wave transducer:




### Step 1b

If the pipe wall thickness is not in the range of the Lamb wave transducers, select a shear wave transducer:




### Step 2

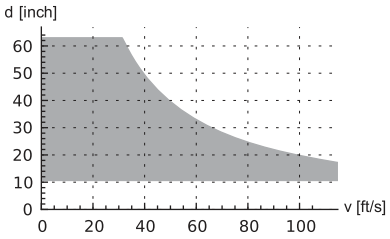
inner pipe diameter d dependent on the flow velocity v of the fluid in the pipe

The transducers are selected from the characteristics (see next page). Lamb wave transducers are selected from the left column, shear wave transducers from the right column.

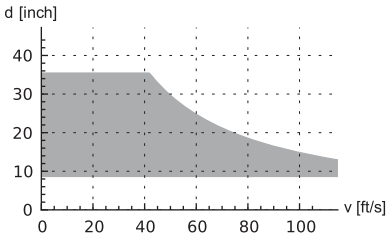
Lamb wave transducers: If the values d and v are not in the range, the diagonal arrangement with 1 sound path may be used, i.e. the same characteristics can be used with doubling the inner pipe diameter. If the values are still not in the range, shear waves transducers regarding the pipe wall thickness have to be selected in step 1b.

**Lamb wave transducer**[1]

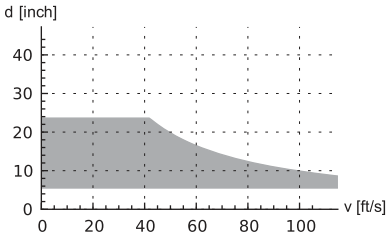
GLF



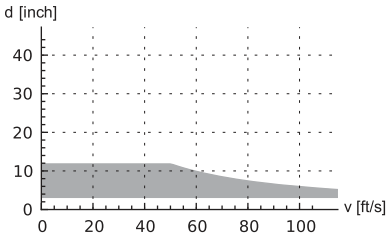

GLG



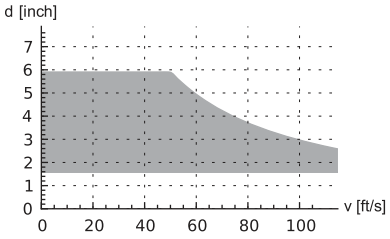

GLH



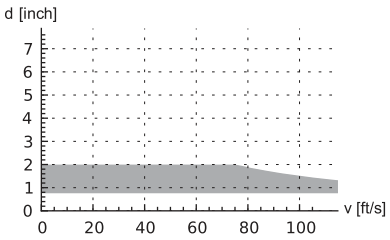

GLK



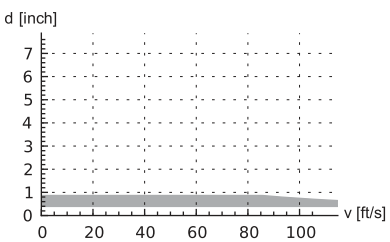

GLM




GLP

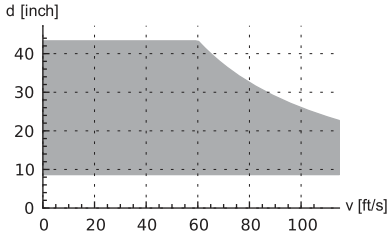



GLQ

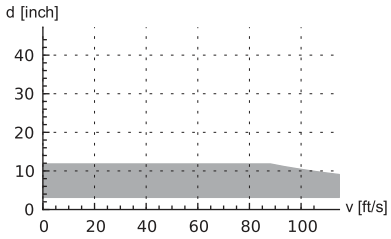



**shear wave transducer**[1]

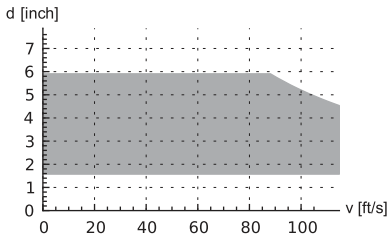
GSG



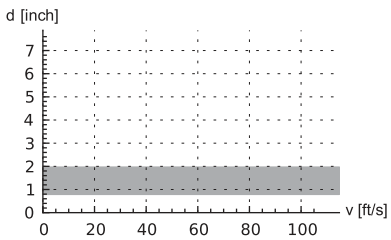

GSK



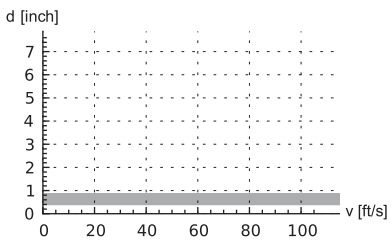

GSM




GSP




GSQ




[1] inner pipe diameter and max. flow velocity for a typical application with natural gas, nitrogen, oxygen in reflect arrangement with 2 sound paths (Lamb wave transducers)/1 sound path (shear wave transducers)

## Step 3

min. fluid pressure

| Lamb wave transducer | | | |
|---|---|---|---|
| transducer order code | fluid pressure[1] [psi] | | |
| | metal pipe | | plastic pipe |
| | min. | min. extended | min. |
| GLF | 218 | 145 | 15 |
| GLG | 218 | 145 | 15 |
| GLH | 218 | 145 | 15 |
| GLK | 218 (d > 4.7 in)<br>145 (d < 4.7 in) | 145 (d > 4.7 in)<br>44 (d < 4.7 in) | 15 |
| GLM | 145 (d > 2.4 in)<br>73 (d < 2.4 in) | 44 (d < 2.4 in) | 15 |
| GLP | 145 (d > 1.4 in)<br>73 (d < 1.4 in) | 44 (d < 1.4 in) | 15 |
| GLQ | 145 (d > 0.59 in)<br>73 (d < 0.59 in) | 44 (d < 0.59 in) | 15 |

| shear wave transducer | | | |
|---|---|---|---|
| transducer order code | fluid pressure[1] [psi] | | |
| | metal pipe | | plastic pipe |
| | min. | min. extended | min. |
| | | | |
| GSG | 435 | 290 | 15 |
| | | | |
| GSK | 435 | 290 | 15 |
| GSM | 435 | 290 | 15 |
| GSP | 435 | 290 | 15 |
| GSQ | 435 | 290 | 15 |

[1] depending on application, typical absolute value for natural gas, nitrogen, compressed air

d = inner pipe diameter

## Example

| step | | | | | |
|---|---|---|---|---|---|
| 1 | pipe wall thickness | in | 0.56 | 0.34 | 1.5 |
| | selected transducer | | GLG or GLH | GLH or GLK | GS |
| 2 | inner pipe diameter | in | 22.9 | 3.8 | 5.6 |
| | max. flow velocity | ft/s | 49 | 98 | 98 |
| | selected transducer | | GLG | GLK | GSK |
| 3 | min. fluid pressure | psi | 290 | 218 | 580 |
| | selected transducer | | GLG | GLK | GSK |

## Step 4

for the characters 4 to 11 of the transducer order code (ambient temperature, explosion protection, connection system, extension cable) see page 14

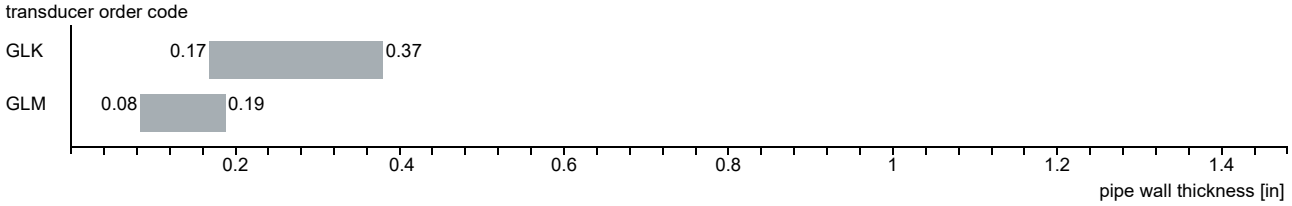
## Step 5

for the technical data of the selected transducer see page 15 et seqq.

# Transducer selection (G**1SC3)

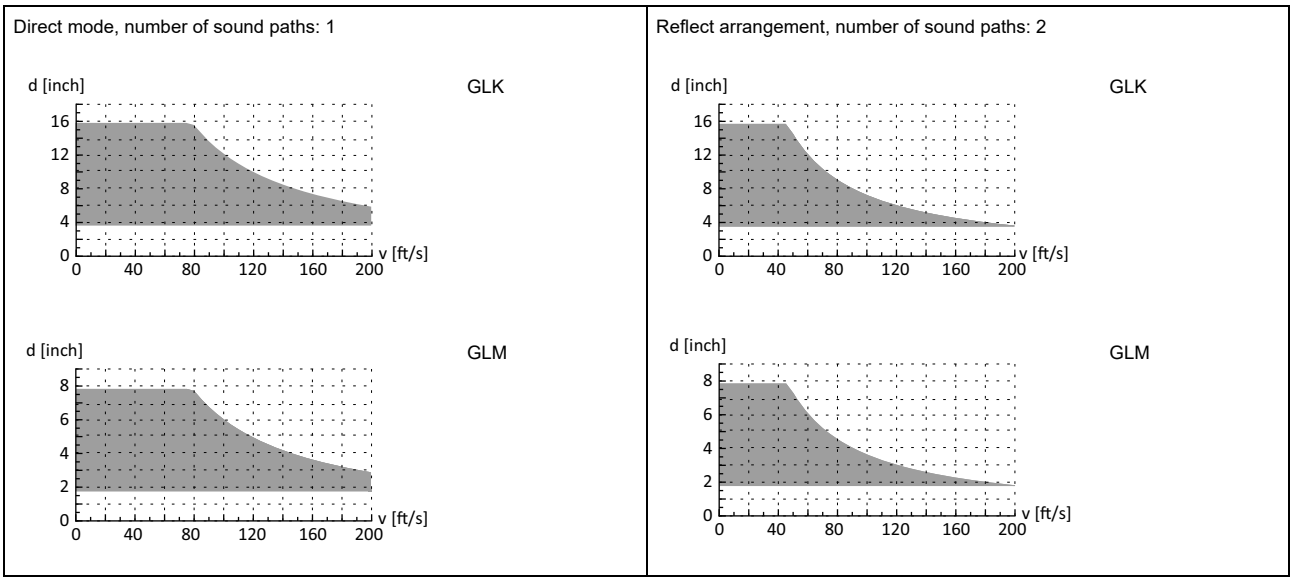
## Step 1

pipe wall thickness




## Step 2

inner pipe diameter d dependent on the flow velocity v of the fluid in the pipe



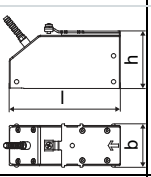
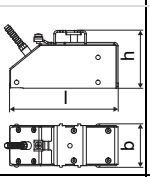
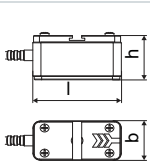
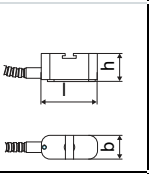

inner pipe diameter and max. flow velocity for a steam application

## 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** |
| GS | | | | | | | | | | set of ultrasonic flow transducers for gas measurement, shear wave |
| GL | | | | | | | | | | set of ultrasonic flow transducers for gas measurement, Lamb wave |
| | F | | | | | | | | | 0.15 MHz |
| | G | | | | | | | | | 0.2 MHz |
| | H | | | | | | | | | 0.3 MHz |
| | K | | | | | | | | | 0.5 MHz |
| | M | | | | | | | | | 1 MHz |
| | P | | | | | | | | | 2 MHz |
| | Q | | | | | | | | | 4 MHz |
| | | | N | | | | | | | normal temperature range |
| | | | E | | | | | | | extended temperature range |
| | | | S | | | | | | | higher temperatures |
| | | | | NN | | | | | | not explosion proof |
| | | | | | NL | | | | | with Lemo connector |
| | | | | | | | XXX | | | 0 m: without extension cable<br>> 0 m: with extension cable |
| | | | | | | | | | LC | long transducer cable |

# Technical data

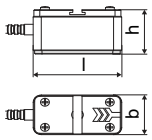
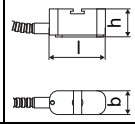
## Shear wave transducers (nonEx, NL)

| order code | | GSG-NNNNL/** | GSK-NNNNL/** | GSM-NNNNL/** | GSP-NNNNL/** | GSQ-NNNNL/** |
|---|---|---|---|---|---|---|
| technical type | | G(DL)G1NZ7 | G(DL)K1NZ7 | G(DL)M1NZ7 | G(DL)P1NZ7 | G(DL)Q1NZ7 |
| transducer frequency | MHz | 0.2 | 0.5 | 1 | 2 | 4 |
| **fluid pressure**[1] | | | | | | |
| min. extended | psi | metal pipe: 290 | | | | |
| min. | psi | metal pipe: 435, plastic pipe: 15 | | | | |
| **inner pipe diameter d**[2] | | | | | | |
| min. extended | in | 7.1 | 2.4 | 1.2 | 0.59 | 0.28 |
| min. recommended | in | 8.7 | 3.1 | 1.6 | 0.79 | 0.39 |
| max. recommended | in | 35.4 | 11.8 | 5.9 | 2 | 0.87 |
| max. extended | in | 43.3 | 14.2 | 7.1 | 2.4 | 1.2 |
| **pipe wall thickness** | | | | | | |
| min. | in | 0.43 | 0.2 | 0.1 | 0.05 | 0.02 |
| **material** | | | | | | |
| housing | | PEEK with stainless steel cap 304 | | stainless steel 304 | | |
| contact surface | | PEEK | | PEEK | | |
| degree of protection | | NEMA 6 | | | | |
| **transducer cable** | | | | | | |
| type | | 1699 | | | | |
| length | ft | 16 | | 13 | | 9 |
| length (***-*****/LC) | ft | 29 | | | | |
| **dimensions** | | | | | | |
| length l | in | 5.1 | 4.98 | 2.36 | | 1.67 |
| width b | in | 2.01 | 2.01 | 1.18 | | 0.71 |
| height h | in | 2.64 | 2.66 | 1.32 | | 0.85 |
| dimensional drawing | |  |  |  | |  |
| weight (without cable) | lb | 1 | 0.79 | 0.08 | | 0.03 |
| **pipe surface temperature** | | | | | | |
| min. | °F | -40 | | | | |
| max. | °F | +266 | | | | |
| **ambient temperature** | | | | | | |
| min. | °F | -40 | | | | |
| max. | °F | +266 | | | | |
| temperature compensation | | x | | | | |

[1] depending on application, typical absolute value for natural gas, nitrogen, compressed air

[2] shear wave transducer:
typical values for natural gas, nitrogen, oxygen, pipe diameters for other fluids on request
inner pipe diameter max. recommended/max. extended: in reflect arrangement and for a flow velocity of 49 ft/s

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

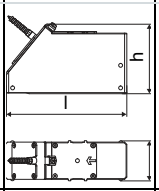
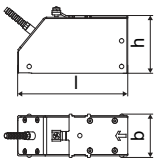
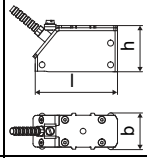
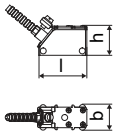
| order code | | GSM-ENNNL/** | GSP-ENNNL/** | GSQ-ENNNL/** |
|---|---|---|---|---|
| technical type | | G(DL)M1EZ7 | G(DL)P1EZ7 | G(DL)Q1EZ7 |
| transducer frequency | MHz | 1 | 2 | 4 |
| **fluid pressure**[1] | | | | |
| min. extended | psi | metal pipe: 290 | | |
| min. | psi | metal pipe: 435, plastic pipe: 15 | | |
| **inner pipe diameter d**[2] | | | | |
| min. extended | in | 1.2 | 0.59 | 0.28 |
| min. recommended | in | 1.6 | 0.79 | 0.39 |
| max. recommended | in | 5.9 | 2 | 0.87 |
| max. extended | in | 7.1 | 2.4 | 1.2 |
| **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 | | |

[1] depending on application, typical absolute value for natural gas, nitrogen, compressed air

[2] shear wave transducer:
typical values for natural gas, nitrogen, oxygen, pipe diameters for other fluids on request
inner pipe diameter max. recommended/max. extended: in reflect arrangement and for a flow velocity of 49 ft/s

# Lamb wave transducers

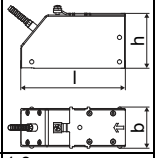
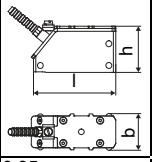
## Lamb wave transducers (nonEx, NL)

| order code | | GLF-NNNNL | GLG-NNNNL | GLH-NNNNL | GLK-NNNNL | GLM-NNNNL | GLP-NNNNL | GLQ-NNNNL |
|---|---|---|---|---|---|---|---|---|
| technical type | | G(RT)F1NC3 | G(RT)G1NC3 | G(RT)H1NC3 | G(RT)K1NC3 | G(RT)M1NC3 | G(RT)P1NC3 | G(RT)Q1NC3 |
| transducer frequency | MHz | 0.15 | 0.2 | 0.3 | 0.5 | 1 | 2 | 4 |
| **fluid pressure**[1] | | | | | | | | |
| min. extended | psi | metal pipe: 145 | | | metal pipe:<br>145 (d > 4.7 in)<br>44 (d < 4.7 in) | metal pipe:<br>44 (d < 2.4 in) | metal pipe:<br>44 (d < 1.4 in) | metal pipe:<br>44 (d < 0.59 in) |
| min. | psi | metal pipe: 218<br>plastic pipe: 15 | | | metal pipe:<br>218 (d > 4.7 in)<br>145 (d < 4.7 in)<br>plastic pipe: 15 | metal pipe:<br>145 (d > 2.4 in)<br>73 (d < 2.4 in)<br>plastic pipe: 15 | metal pipe:<br>145 (d > 1.4 in)<br>73 (d < 1.4 in)<br>plastic pipe: 15 | metal pipe:<br>145 (d > 0.59 in)<br>73 (d < 0.59 in)<br>plastic pipe: 15 |
| **inner pipe diameter d**[2] | | | | | | | | |
| min. extended | in | 8.7 | 7.1 | 4.3 | 2.4 | 1.2 | 0.59 | 0.28 |
| min. recommended | in | 10.6 | 8.7 | 5.5 | 3.1 | 1.6 | 0.79 | 0.39 |
| max. recommended | in | 47.2 | 35.4 | 23.6 | 11.8 | 5.9 | 2 | 0.87 |
| max. extended | in | 63 | 55.1 | 39.4 | 14.2 | 7.1 | 2.4 | 1.2 |
| **pipe wall thickness** | | | | | | | | |
| min. | in | 0.59 | 0.43 | 0.31 | 0.2 | 0.1 | 0.05 | 0.02 |
| max. | in | 1.3 | 0.94 | 0.63 | 0.39 | 0.2 | 0.12 | 0.05 |
| max. extended | | 1.4 | - | - | - | - | - | - |
| **material** | | | | | | | | |
| housing | | PPSU with stainless steel cap 316Ti | PPSU with stainless steel cap 304 | | | | | |
| contact surface | | PPSU | | | | | | |
| degree of protection | | NEMA 4 | | | | | | |
| **transducer cable** | | | | | | | | |
| type | | 1699 | | | | | | |
| length | ft | 16 | | | | 13 | | 9 |
| length (***-*****/LC) | ft | 29 | | | | | | |
| **dimensions** | | | | | | | | |
| length l | in | 6.42 | 5.06 | | | 2.91 | | 1.65 |
| width b | in | 2.13 | 2.01 | | | 1.26 | | 0.87 |
| height h | in | 3.59 | 2.66 | | | 1.59 | | 1 |
| dimensional drawing | |  |  | | |  | |  |
| weight (without cable) | lb | 2.1 | 1 | | | 0.17 | | 0.04 |
| **pipe surface temperature** | | | | | | | | |
| min. | °F | -40 | | | | | | |
| max. | °F | +302 | | | | +338 | | |
| **ambient temperature** | | | | | | | | |
| min. | °F | -40 | | | | | | |
| max. | °F | +302 | | | | +338 | | |
| temperature compensation | | x | | | | | | |

[1] depending on application, typical absolute value for natural gas, nitrogen, compressed air

[2] Lamb wave transducer:
typical values for natural gas, nitrogen, oxygen, pipe diameters for other fluids on request
inner pipe diameter max. recommended: in reflect arrangement (diagonal arrangement) and for a flow velocity of 49 ft/s (98 ft/s)
inner pipe diameter max. extended: in reflect arrangement (diagonal arrangement) and for a flow velocity of 39 ft/s (82 ft/s)

## Lamb wave transducers (nonEx, steam measurement, NL)

| order code | | GLK-SNNNL/** | GLM-SNNTS/** |
|---|---|---|---|
| technical type | | G(RT)K1SC3 | G(RT)M1SC3 |
| transducer frequency | MHz | 0.5 | 1 |
| **inner pipe diameter d** | | | |
| min. | in | 3.5 | 1.8 |
| max. | in | 15.7 | 7.9 |
| **pipe wall thickness** | | | |
| min. | in | 0.17 | 0.08 |
| max. | in | 0.37 | 0.19 |
| **material** | | | |
| housing | | PPSU with stainless steel cap 316Ti | PPSU with stainless steel cap 316Ti |
| contact surface | | PPSU | PPSU |
| degree of protection | | IP65 | IP65 |
| **transducer cable** | | | |
| type | | 1699 | 1699 |
| length | ft | 16 | 13 |
| length (***-*****/LC) | ft | 29 | 29 |
| **dimensions** | | | |
| length l | in | 5.06 | 2.91 |
| width b | in | 2.01 | 1.3 |
| height h | in | 2.66 | 1.59 |
| dimensional drawing | |   |   |
| weight (without cable) | lb | 1.8 | 0.35 |
| **storing temperature** | | | |
| min. | °F | -40 | -40 |
| max. | °F | +356 | +356 |
| **operating temperature**[1] | | | |
| min. | °F | 212 | 212 |
| max. | °F | 356 | 356 |
| warm-up time | h | 3 | 1 |
| temperature com-pensation | | x | x |

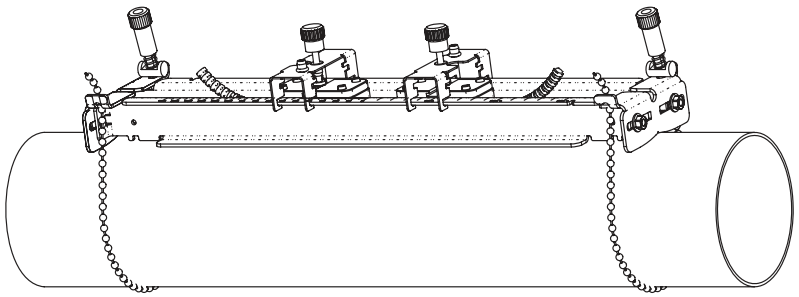
[1] completely thermically insulated transducer installation necessary

# Transducer mounting fixture

## Order code

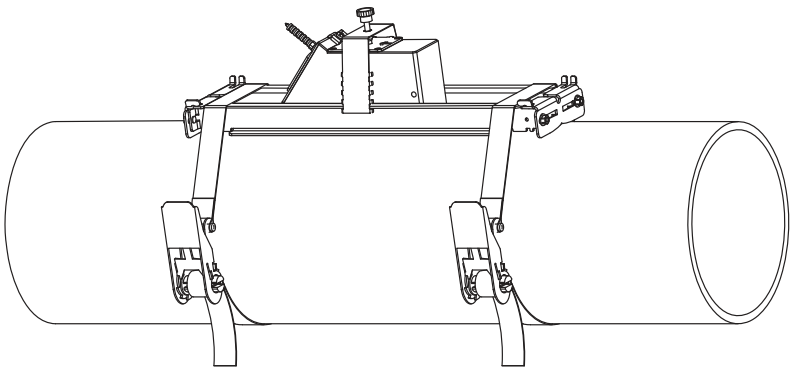
| 1, 2 | 3 | | 4 | 5 | | 6 | 7 to 9 | no. of character |
|---|---|---|---|---|---|---|---|---|
| **transducer mounting fixture** | **transducer** | **-** | **measurement arrangement** | **size** | **-** | **fixation** | **outer pipe diameter** | **description** |
| VP | | | | | | | | portable Variofix |
| TB | | | | | | | | tension belts |
| | A | | | | | | | all transducers |
| | | | D | | | | | reflect arrangement or diagonal arrangement/direct mode |
| | | | R | | | | | reflect arrangement |
| | | | | S | | | | small |
| | | | | M | | | | medium |
| | | | | | | C | | chains |
| | | | | | | G | | tension belts |
| | | | | | | N | | without fixation |
| | | | | | | | 055 | 0.39 to 21.7 in |
| | | | | | | | 150 | 2 to 59.1 in |
| | | | | | | | 210 | 2 to 82.7 in |

**portable Variofix VP and chains (optional)**

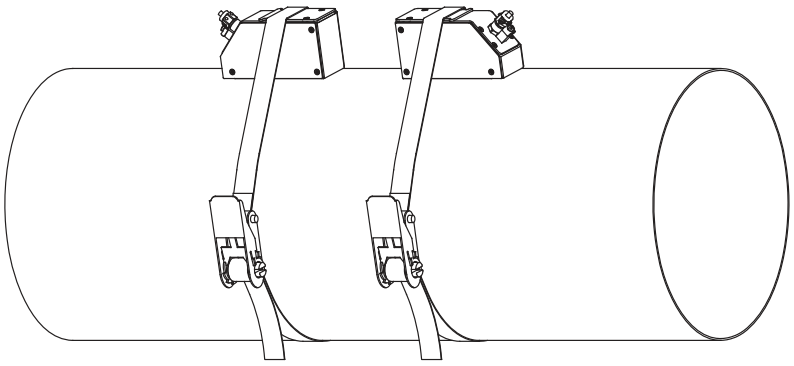


material: stainless steel 304, 301, 303
dimensions: 16.3 x 3.7 x 2.99 in
chain length: 6 ft

**portable Variofix VP and tension belts**



**tension belts TB (optional)**



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

# Coupling materials for transducers

| **normal temperature range (4th character of transducer order code = N)** | | **extended temperature range (4th character of transducer order code = E)** | | **higher temperatures (4th character of transducer order code = S)** |
|---|---|---|---|---|
| < 212 °F | < 338 °F | < 302 °F | < 392 °F | < 302 °F |
| coupling compound type N | coupling compound type E | coupling compound type E | coupling compound type E or H | coupling compound type E[1] and coupling pad type VT |

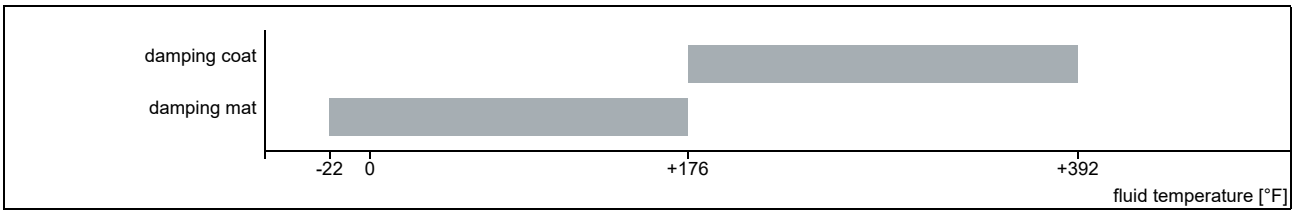
[1] in combination with type VT only

## 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 VT | 14 to +392 |

## Damping material (optional)

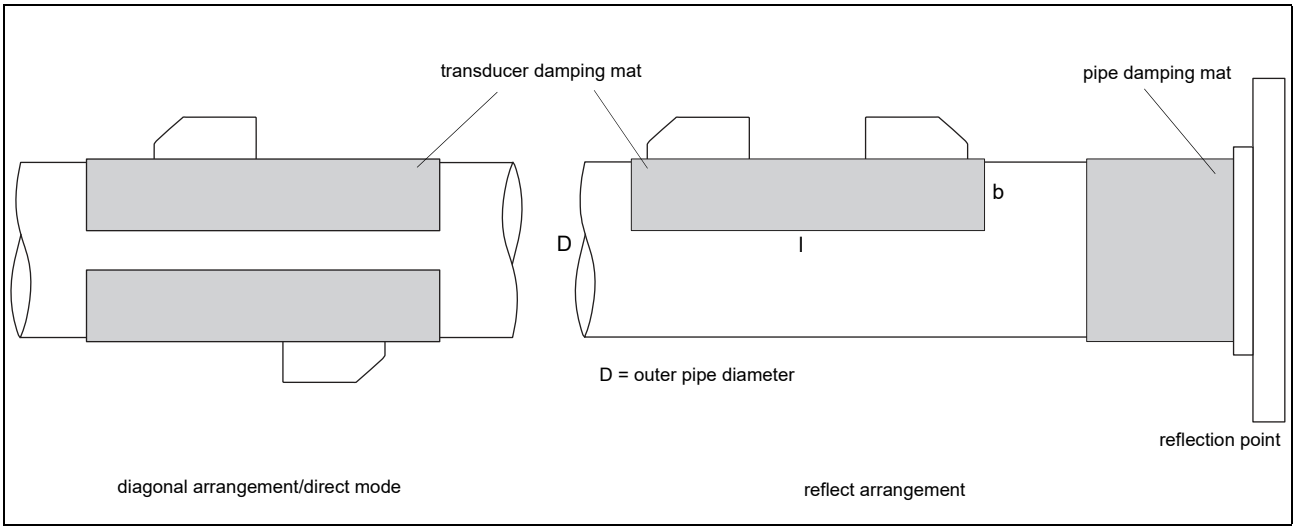
Damping material will be used for the gas measurement to reduce acoustic noise influences on the measurement.




## Damping mats

Transducer damping mats will be installed below the transducers.

Pipe damping mats will be installed at reflection points, e.g., flange, weld.




### Selection of damping mats

| type | description | outer pipe diameter<br>in | dimensions<br>l x b x h<br>in | transducer frequency<br>F | G | H | K | M | P | Q | technical type | ambient temperature<br>°F | remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **transducer damping mat** | | | | | | | | | | | | | |
| D | for temporary installation (multiple use), fixed with coupling compound | < 3.1 | 17.72 x 4.53 x 0.02 | - | - | - | - | x | x | x | D20S3 | -13 to +140 | |
| | | ≥ 3.1 | 35.43 x 9.06 x 0.02 | - | - | - | x | x | - | - | D20S2 | | |
| | | | 35.43 x 9.06 x 0.05 | x | x | x | - | - | - | - | D50S2 | | |
| **pipe damping mat** | | | | | | | | | | | | | |
| A | for temporary installation (multiple use), fixed with coupling compound | < 11.8 | 11.81 x 4.53 x 0.02 | x | x | x | x | x | x | x | A20S4 | -13 to +140 | for quantity see table below |
| B | self-adhesive | ≥ 11.8 | l x 3.94 x 0.04 | x | x | x | x | x | x | - | B35R2 | -31 to +122 | l - see table below |

### Quantity for pipe damping mat - type A

(depending on the outer pipe diameter)

| outer pipe diameter D<br>in | transducer frequency<br>F, G, H | K, M, P, Q |
|---|---|---|
| 3.9 | 12 | 6 |
| 7.9 | 24 | 12 |
| 11.8 | 32 | 16 |

### Length of pipe damping mat - type B

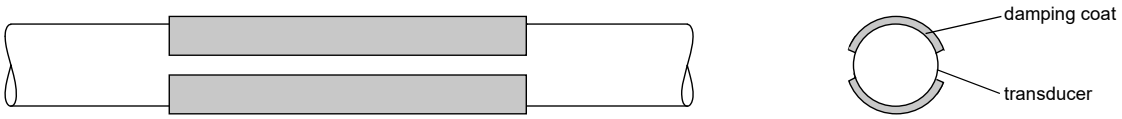
(length l depending on transducer frequency and outer pipe diameter)

| outer pipe diameter D<br>in | transducer frequency<br>F, G, H<br>ft | K, M, P<br>ft |
|---|---|---|
| 11.8 | 39 | 19 |
| 19.7 | 104 | 52 |
| 39.4 | 413 | 206 |

## Damping coat

For high temperatures it is recommended to apply the damping coat onto the pipe. In case of steam measurement it is mandatory.

Example (diagonal arrangement)




## Technical data

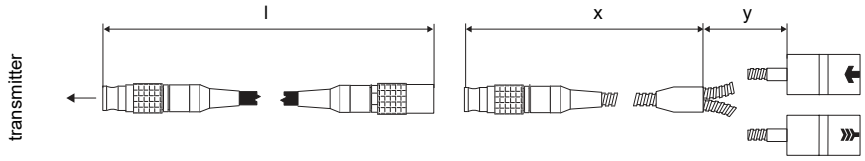
| | | |
|---|---|---|
| material | | multipolymeric matrix/inorganic ceramic coating |
| packing drum | gal | 1 |
| properties | | heat resistant, inert |
| fluid temperature when applying | °F | 50 to 392 |
| drying time (example) | | approx. 3 h at 68 °F<br>approx. 15 min at 302 °F |
| temperature resistance in dry state | °F | max. 1202 |
| durability of the packing drum (unopened) | | 2 years |

Observe installation instructions (TI_DampingCoat).

## Dimensioning

| **transducer frequency** | **number of packing drums** | | |
|---|---|---|---|
| | outer pipe diameter | | |
| | ≤11.8 | ≤19.7 | ≤27.6 |
| | in | | |
| F | 1 | 2 | 2 |
| G | 1 | 1 | 2 |
| H | 1 | 1 | 1 |
| K | 1 | 1 | - |
| M | 1 | - | - |
| P | 1 | - | - |
| Q | 1 | - | - |

# Connection systems

| connection system NL | |
|---|---|
| direct connection/connection with extension cable | transducers technical type |
|  | *****Z7<br>*****C3 |

## 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<br>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]<br>*R***C3[1] | ft | 6 | 9 | ≤ 82 | 6 | 6 | ≤ 82 | 6 | 3 | ≤ 82 | 3 | 3 | ≤ 65 |
| option LC:<br>*L***Z7[1]<br>*T***C3[1] | ft | 6 | 22 | ≤ 82 | 22 | 6 | ≤ 82 | 26 | 3 | ≤ 82 | - | - | - |

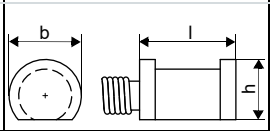
[1] l > 82 to 328 ft on request

x, y = transducer cable length

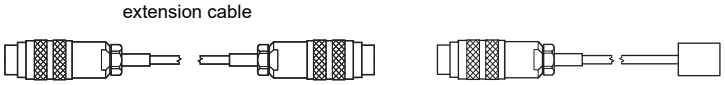
l = max. length of extension cable

# Clamp-on temperature probe (optional)

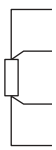
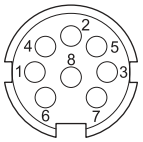
## Technical data

| PT13N | | |
|---|---|---|
| design | | clamp-on<br>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))<br>class A |
| accuracy ΔT<br>(2x Pt matched according to EN 1434-1) | | ≤ 0.03 °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**

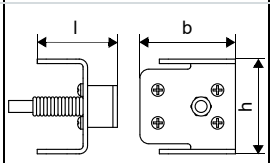
| direct connection/connection with extension cable |
|---|
|  |

**Connection**

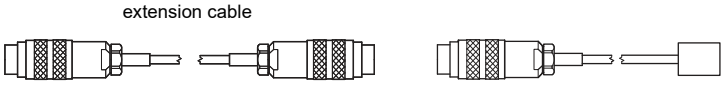
| | temperature probe | extension cable | connector<br>pin | |
|---|---|---|---|---|
|  | red | black | 2 |  |
| | red | green | 6 | |
| | white | white | 1 | |
| | white | red | 7 | |

**Cable**

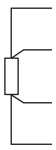
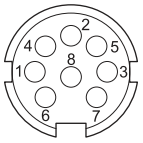
| | | temperature probe | extension cable |
|---|---|---|---|
| type | | 4 x 24 AWG | 4 x 18 AWG |
| standard length | ft | 20 | - |
| max. length | ft | - | 656 |
| cable jacket | | PTFE | LS PVC |

| PT13F | | |
|---|---|---|
| design | | clamp-on<br>short response time,<br>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))<br>class A |
| accuracy ΔT<br>(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 |
| housing | | PEEK, stainless steel 304, copper |
| 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 |
|---|
|  |

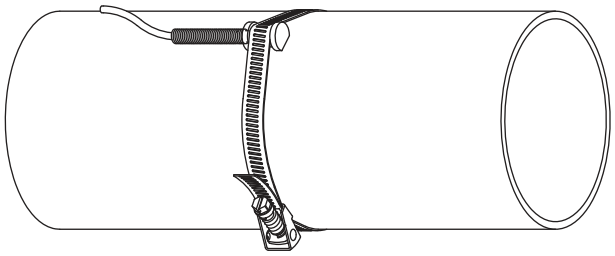
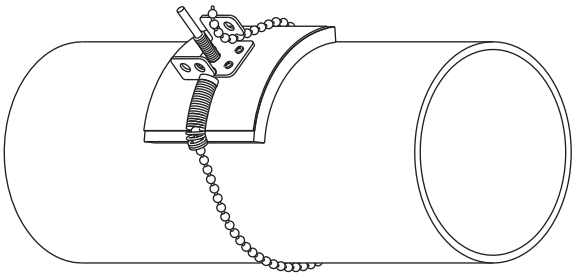
**Connection**

| | temperature probe | extension cable | connector<br>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

| | |
|---|---|
| **tension strap PT13N**<br>  | material: stainless steel 301, 410<br>thermal insulation necessary |
| **ball chain PT13F**<br>  | material: stainless steel 316L<br>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

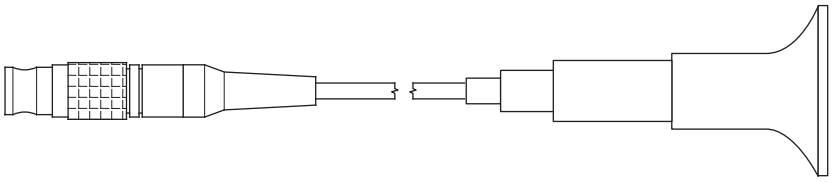
| | | **DWR1NZ7** |
|---|---|---|
| order code | | ACC-PO-G601-/W6 |
| measuring range[1] | in | 0.04 to 9.8 |
| resolution | in | 0.0004 |
| accuracy | | 1 % ±0.004 in |
| fluid temperature | °F | -4 to +392,<br>short-time peak max. 932 |
| **cable** | | |
| type | | 2616 |
| length | ft | 4 |

[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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