



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. 180 °C
 - Flow and thermal energy measurement of liquids
- Precise bidirectional and highly dynamic flow measurement with the non-invasive clamp-on technology
- 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 (IP65), resistant against oil, many liquids and dirt
- Robust, water-tight (IP67) 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
- Transducers available for a wide range of inner pipe diameters and fluid temperatures

Applications

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

Example applications:

- Measurement on natural gas pipelines and in natural gas storage installations
- 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



FLUXUS G601



Measurement equipment in transport case

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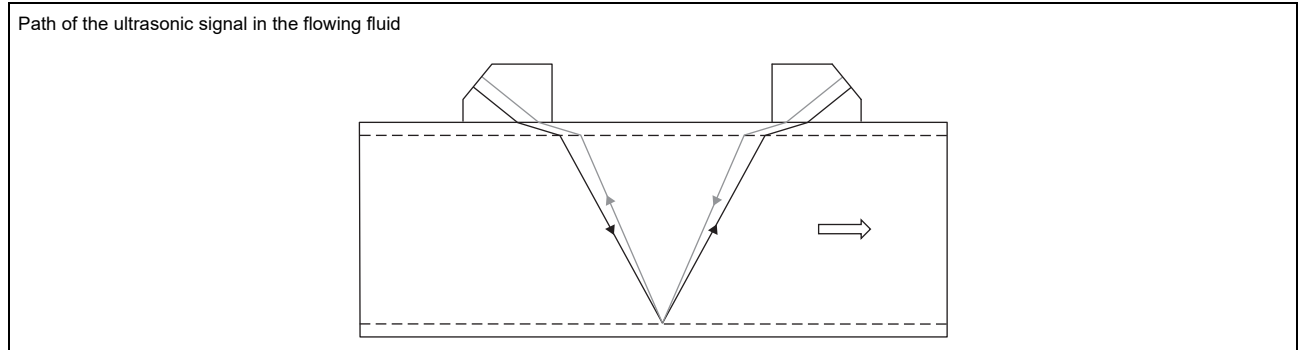
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Function

Measurement principle

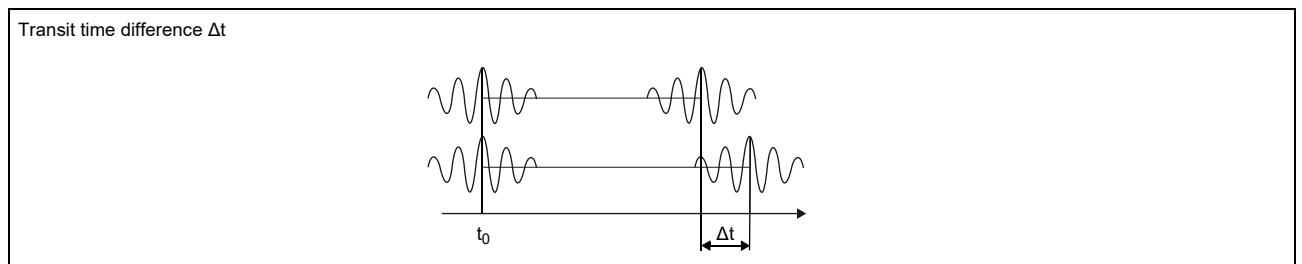
The transducers are mounted on the pipe which is completely filled with the fluid. The ultrasonic signals are emitted alternately by a transducer and received by the other. The physical quantities are determined from the transit times of the ultrasonic signals.



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.



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

Calculation of mass flow rate

The mass flow rate is calculated from the operating density and the volumetric flow rate:

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

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

$$\rho = f(p, T)$$

where

- ρ - operating density
- p - fluid pressure
- T - fluid temperature
- \dot{m} - mass flow rate
- \dot{V} - volumetric flow rate

Calculation of standard volumetric flow rate

The standard volumetric flow rate can be selected as physical quantity. It is calculated with the following formula:

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

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 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, e.g. according to AGA8 or GERG

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:

- **reflection arrangement**

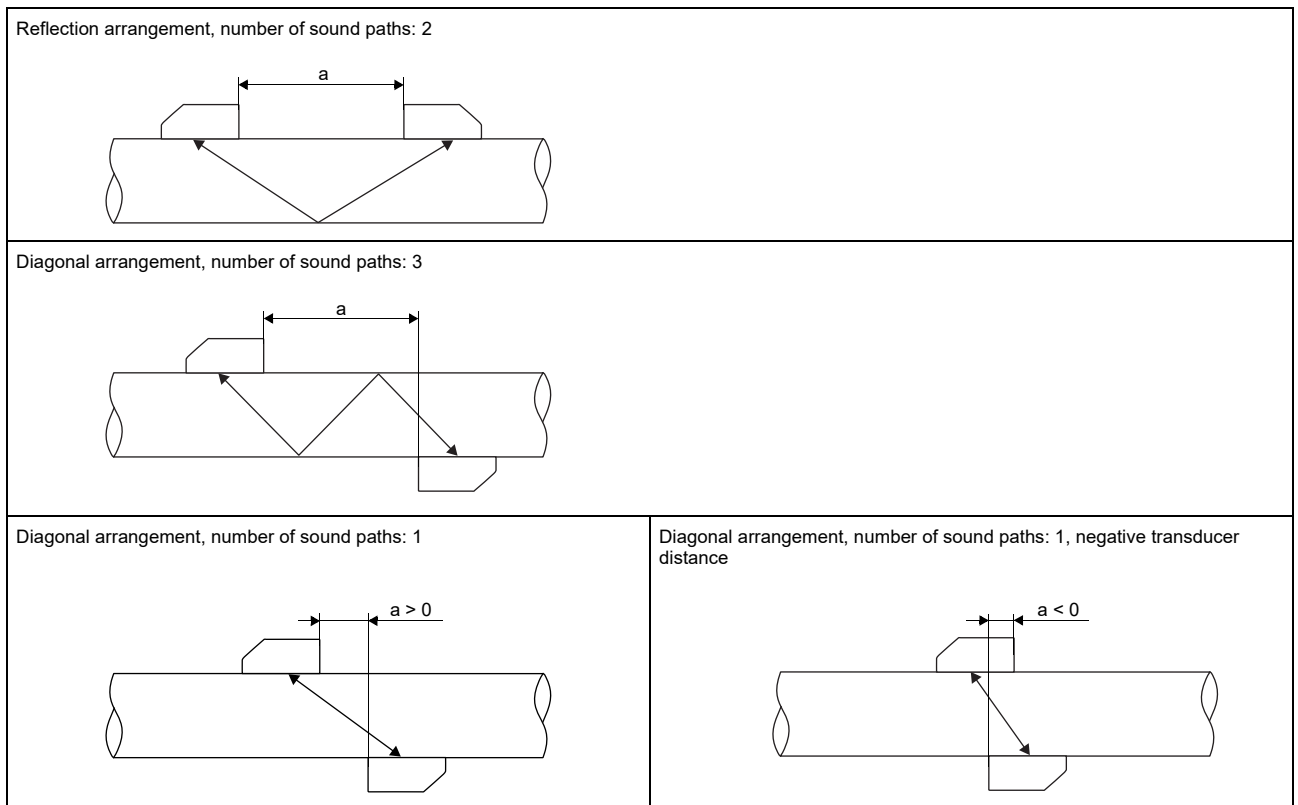
The number of sound paths is even. The transducers are mounted on the same side of the pipe. Correct positioning of the transducers is easy.

- **diagonal arrangement**

The number of sound paths is odd. The transducers are mounted on opposite sides of the pipe. In the case of a high signal attenuation by the fluid, pipe and coatings, diagonal arrangement with 1 sound path will be used.

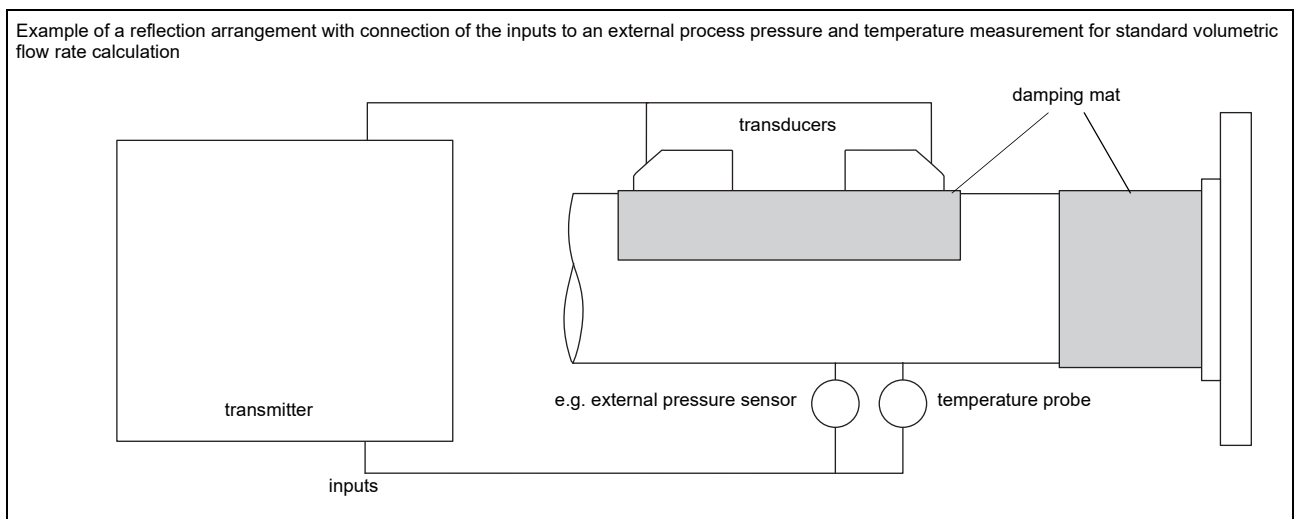
The preferred method of installation depends on the application. While increasing the number of sound paths increases the accuracy of the measurement, signal attenuation increases as well. The optimum number of sound paths for the parameters of the application will be determined automatically by the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

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




a - transducer distance

Typical measurement setup



Transmitter

Technical data

| | FLUXUS G601, G601ST | FLUXUS G601ST (steam measurement ²) |
|--|--|---|
| |  | |
| design | portable | |
| measurement | | |
| measurement principle | transit time difference correlation principle | |
| flow velocity | m/s 0.01...35, depending on pipe diameter | depending on pipe diameter and transducer, see diagrams |
| repeatability | 0.15 % MV ±0.005 m/s | |
| fluid | all acoustically conductive gases, e.g. nitrogen, air, oxygen, hydrogen, argon, helium, ethylene, propane | saturated steam, superheated steam |
| fluid pressure | bar (a) see transducers | 3...10 |
| fluid temperature | °C see transducers | 135...180 |
| temperature compensation | corresponding to the recommendations in ANSI/ASME MFC-5.1-2011 | |
| measurement uncertainty (volumetric flow rate) | | |
| measurement uncertainty of the measuring system ¹ | ±0.3 % MV ±0.005 m/s | ±0.3 % MV ±0.005 m/s |
| measurement uncertainty at the measuring point | ±1...2 % MV ±0.005 m/s, depending on the application | ±1...3 % MV ±0.005 m/s, depending on the application |
| transmitter | | |
| power supply | <ul style="list-style-type: none"> • 100...230 V/50...60 Hz (power supply unit: IP40, 0...40 °C) • 10.5...15 V DC (socket at transmitter) • integrated battery | |
| integrated battery | Li-Ion, 7.2 V/6.2 Ah | |
| operating time | <ul style="list-style-type: none"> • > 14 (without outputs, inputs and backlight)³ • > 25 (1 measuring channel, ambient temperature > 10 °C, without outputs, inputs and backlight)³ | |
| power consumption | W < 6 (with outputs, inputs and backlight), charging: 18 | |
| number of measuring channels | 2 | |
| damping | s 0...100 (adjustable) | |
| measuring cycle | Hz 100...1000 (1 channel) | |
| response time | s 1 (1 channel), option: 0.07 | |
| housing material | PA, TPE, AutoTex, stainless steel | |
| degree of protection | IP65 | |
| dimensions | mm see dimensional drawing | |
| weight | kg 2.1 | |
| fixation | QuickFix pipe mounting fixture | |
| ambient temperature | °C -10...+60 | |
| 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 |
| totaliser | 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 | <ul style="list-style-type: none"> • RS232 • USB (with adapter) | |
| process interfaces | <ul style="list-style-type: none"> • Modbus RTU (optional) | |
| accessories | | |
| data transmission kit | <ul style="list-style-type: none"> • cable RS232 • adapter RS232 - USB | |
| software | <ul style="list-style-type: none"> • FluxDiagReader: reading of measured values and parameters, graphical presentation • FluxDiag (optional): reading of measurement data, graphical presentation, report generation | |
| adapter | AO5, AO6, AO7, AO8, AI1, AI2 | |
| transport case | dimensions: 500 x 400 x 190 mm | |

¹ with aperture calibration of the transducers

² test measurement to validate the application required in advance, especially for pipe diameters < 100 mm

³ operating time extension using the power pack PP0026NN (optional, order code: ACC-PO-#601-/B6)

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

| FLUXUS G601, G601ST | | FLUXUS G601ST (steam measurement ²) |
|---|---|---|
| data logger | | |
| loggable values | all physical quantities, totalised physical quantities 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 | | |
| All switchable current outputs are jointly switched to active or passive. | | |
| range | mA | 4...20 (3.2...24) |
| accuracy | 0.04 % MV ±3 µA | |
| active output | U _{int} = 24 V, R _{ext} < 500 Ω | |
| passive output | U _{ext} = 8...30 V, depending on R _{ext} (R _{ext} < 900 Ω at 30 V) | |
| • frequency output | | |
| range | kHz | 0...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 totalising | |
| • pulse value | units | 0.01...1000 |
| • pulse width | ms | 1...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 | °C | -150...+560 |
| resolution | K | 0.01 |
| accuracy | ±0.01 % MV ±0.03 K | |
| • current input | | |
| accuracy | 0.1 % MV ±10 µA | |
| passive input | R _{int} = 50 Ω, P _{int} < 0.3 W | |
| • range | mA | -20...+20 |
| • voltage input | | |
| range | V | 0...1 |
| accuracy | 0.1 % MV ±1 mV | |
| internal resistance | R _{int} = 1 MΩ | |

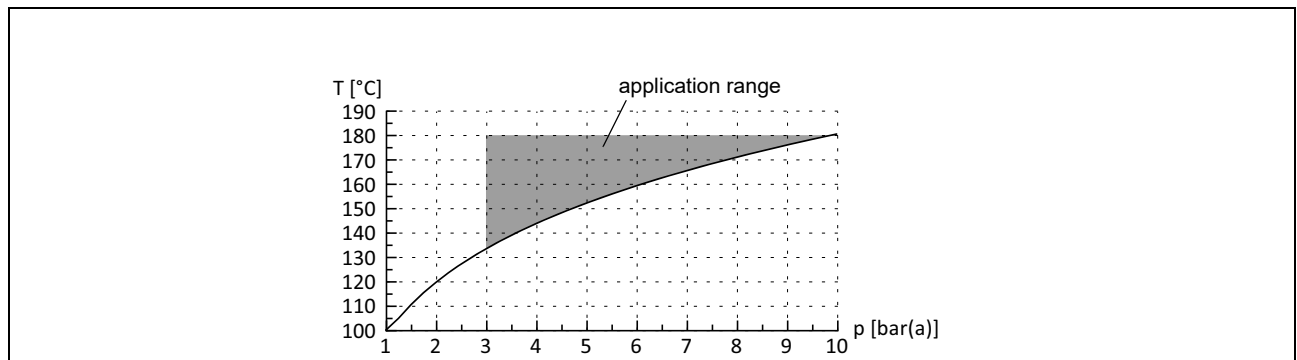
¹ with aperture calibration of the transducers

² test measurement to validate the application required in advance, especially for pipe diameters < 100 mm

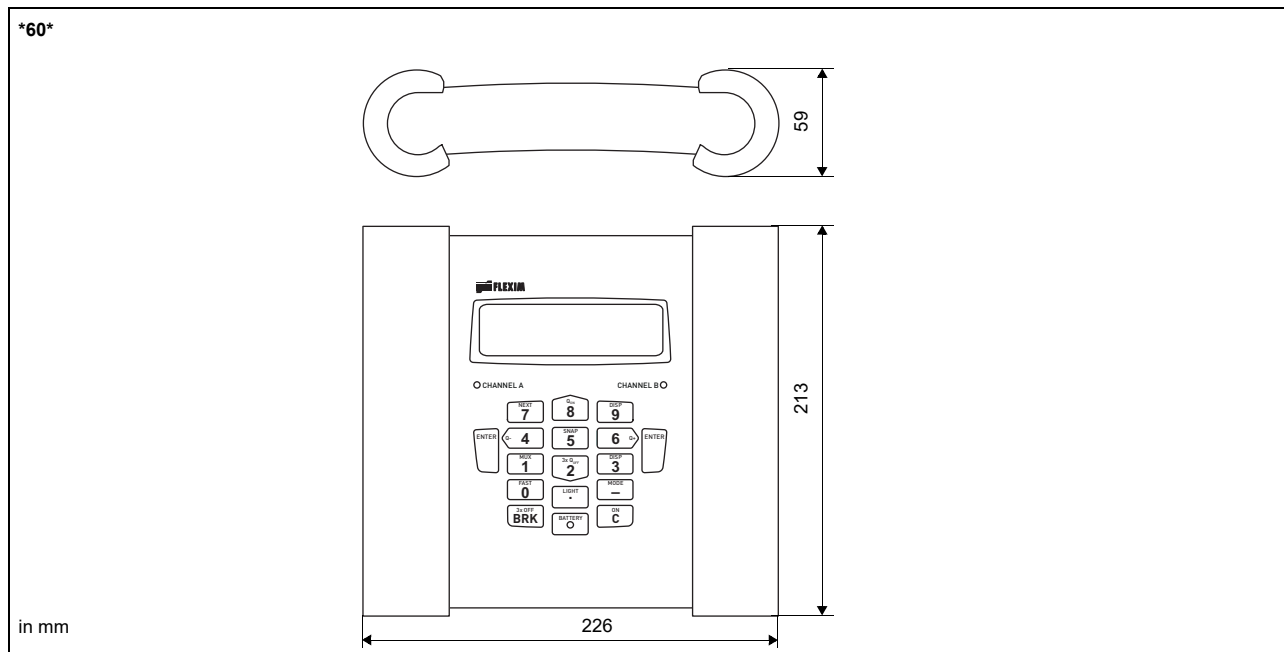
³ operating time extension using the power pack PP0026NN (optional, order code: ACC-PO-#601-/B6)

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

Saturated steam pressure curve (steam measurement)



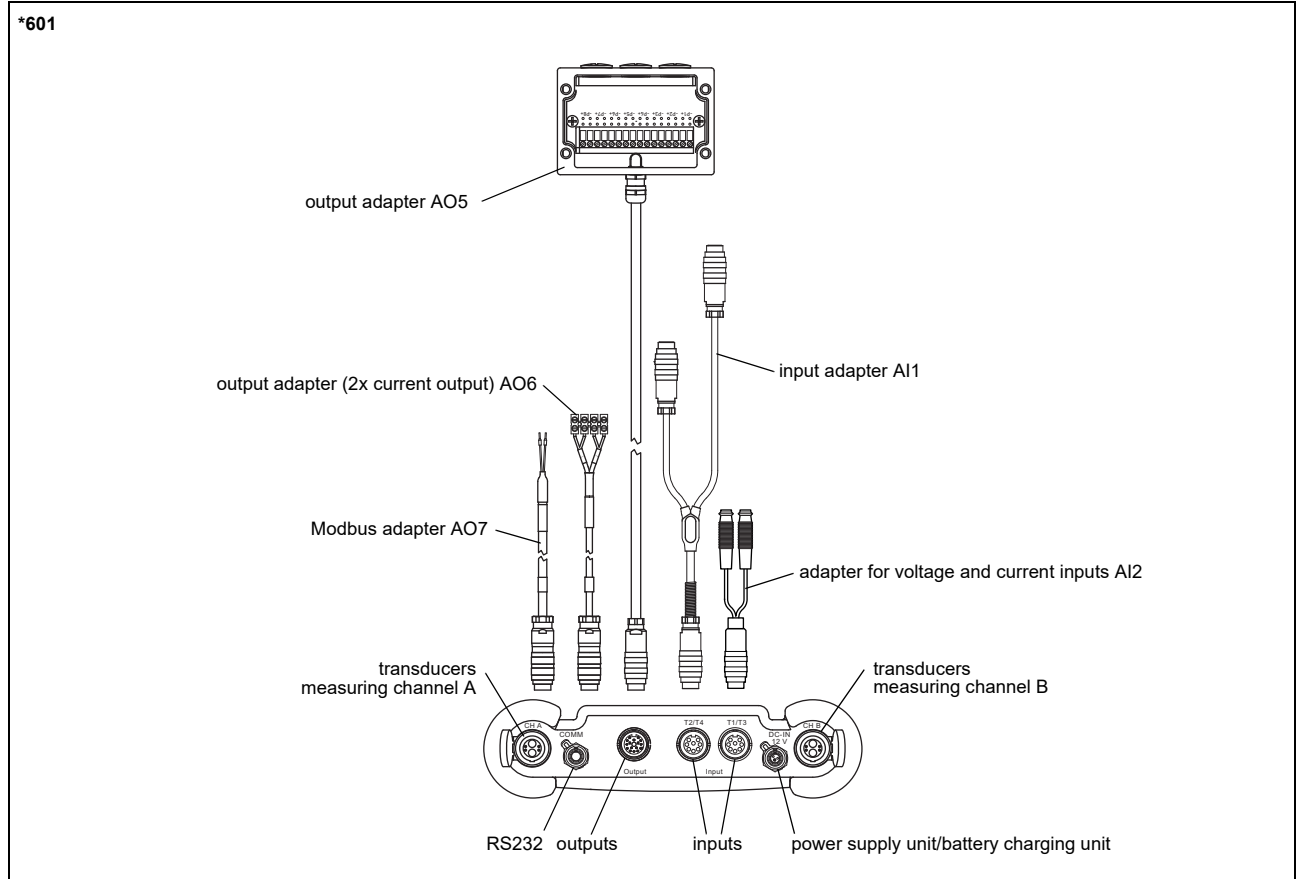
Dimensions



Standard scope of supply

| | G601 Basic | G601 CA-Energy | G601ST Steam |
|--|--|--|---|
| application | flow measurement of gas and liquids | | |
| | 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 rate according to saturated steam pressure curve |
| outputs | | | |
| switchable current 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 |
| data transmission kit | x | x | x |
| measuring tape | x | x | x |
| operating instruction, Quick start guide | x | x | x |

Adapters



Example of transport case equipment

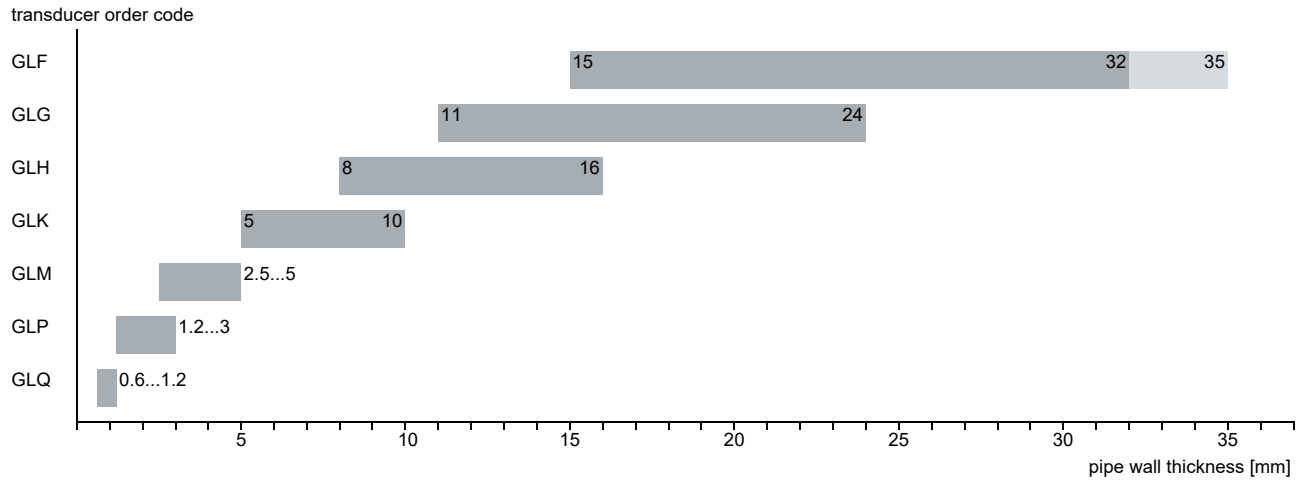


Transducers

Transducer selection (gas measurement)

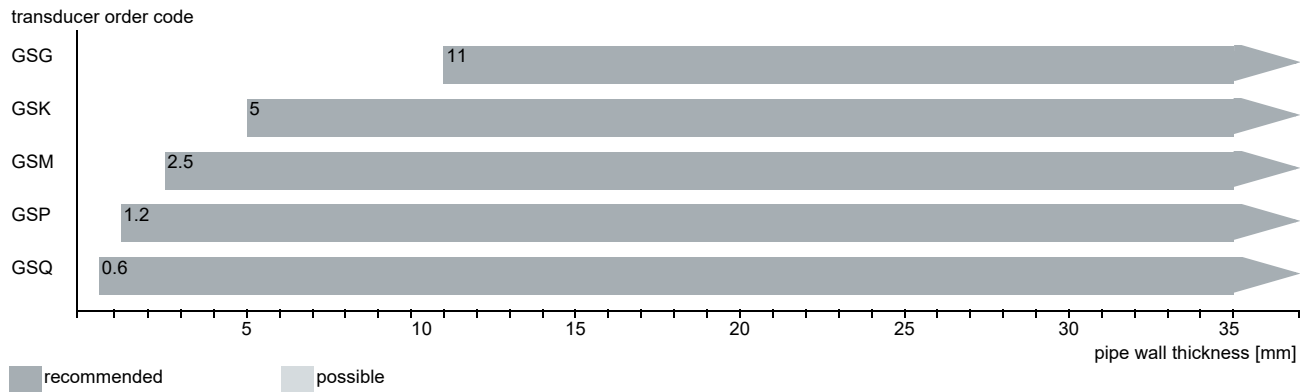
Step 1a

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:

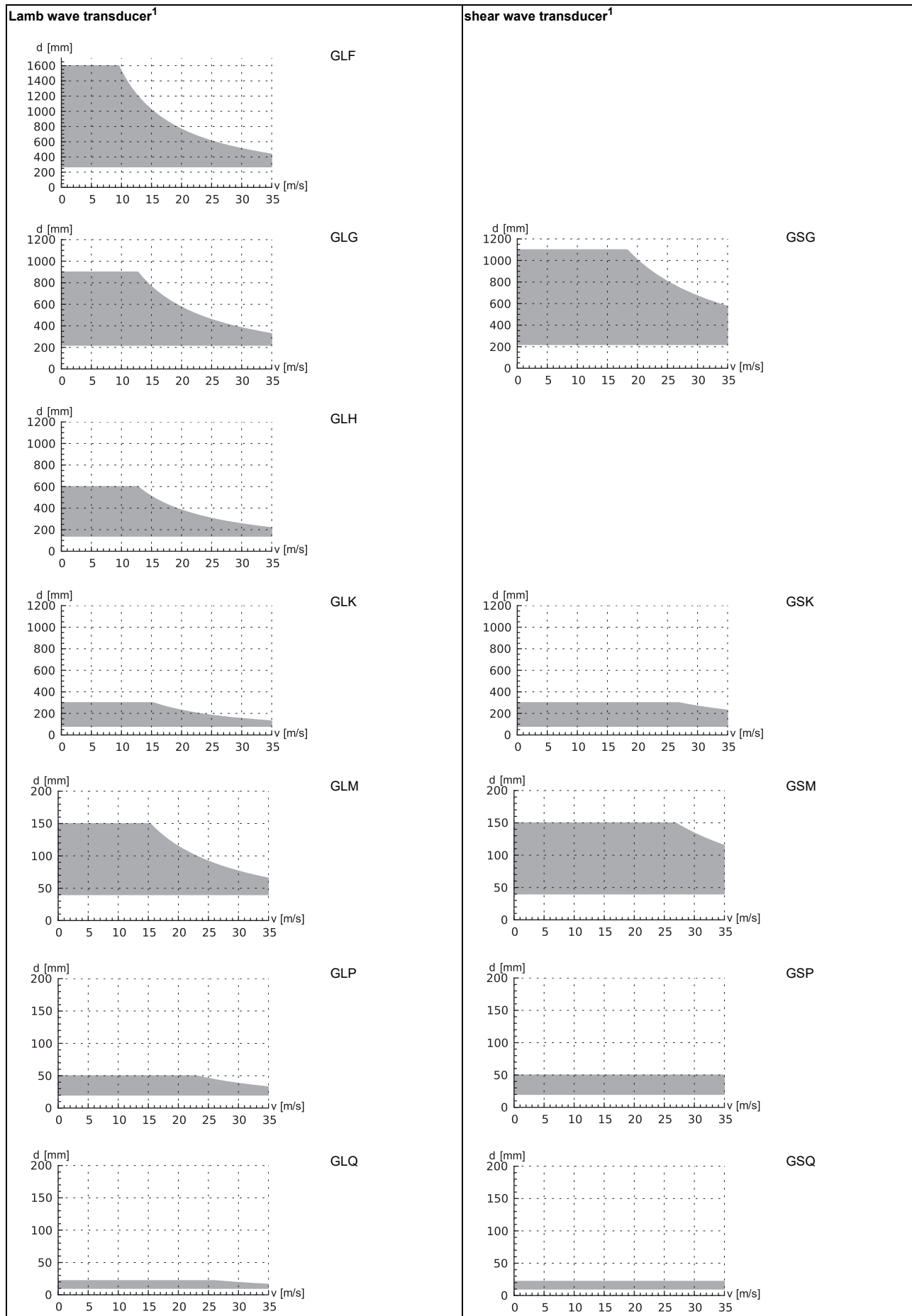


Step 2

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.



¹ inner pipe diameter and max. flow velocity for a typical application with natural gas, nitrogen, oxygen in reflection 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 [bar] | | |
| | metal pipe | | plastic pipe |
| | min. | min. extended | min. |
| GLF | 15 | 10 | 1 |
| GLG | 15 | 10 | 1 |
| GLH | 15 | 10 | 1 |
| GLK | 15 (d > 120 mm) 10 (d < 120 mm) | 10 (d > 120 mm) 3 (d < 120 mm) | 1 |
| GLM | 10 (d > 60 mm) 5 (d < 60 mm) | 3 (d < 60 mm) | 1 |
| GLP | 10 (d > 35 mm) 5 (d < 35 mm) | 3 (d < 35 mm) | 1 |
| GLQ | 10 (d > 15 mm) 5 (d < 15 mm) | 3 (d < 15 mm) | 1 |

| shear wave transducer | | | |
|-----------------------|-----------------------------------|---------------|--------------|
| transducer order code | fluid pressure ¹ [bar] | | |
| | metal pipe | | plastic pipe |
| | min. | min. extended | min. |
| GSG | 30 | 20 | 1 |
| GSK | 30 | 20 | 1 |
| GSM | 30 | 20 | 1 |
| GSP | 30 | 20 | 1 |
| GSQ | 30 | 20 | 1 |

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

d - inner pipe diameter

Example

| step | | | | | |
|------|---------------------|-----|------------|------------|-----|
| 1 | pipe wall thickness | mm | 14.3 | 8.6 | 38 |
| | selected transducer | | GLG or GLH | GLH or GLK | GS |
| 2 | inner pipe diameter | mm | 581 | 96.8 | 143 |
| | max. flow velocity | m/s | 15 | 30 | 30 |
| | selected transducer | | GLG | GLK | GSK |
| 3 | min. fluid pressure | bar | 20 | 15 | 40 |
| | selected transducer | | GLG | GLK | GSK |

Step 4

for the characters 4...11 of the transducer order code (ambient temperature, explosion protection, connection system, extension cable) see page 15

Step 5

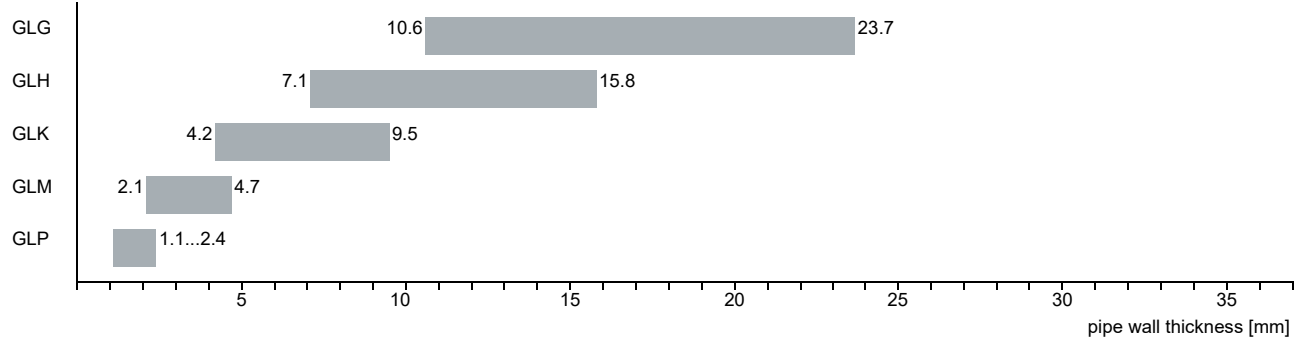
for the technical data of the selected transducer see page 16 et seqq.

Transducer selection (G**1S*3, steam measurement)

Step 1

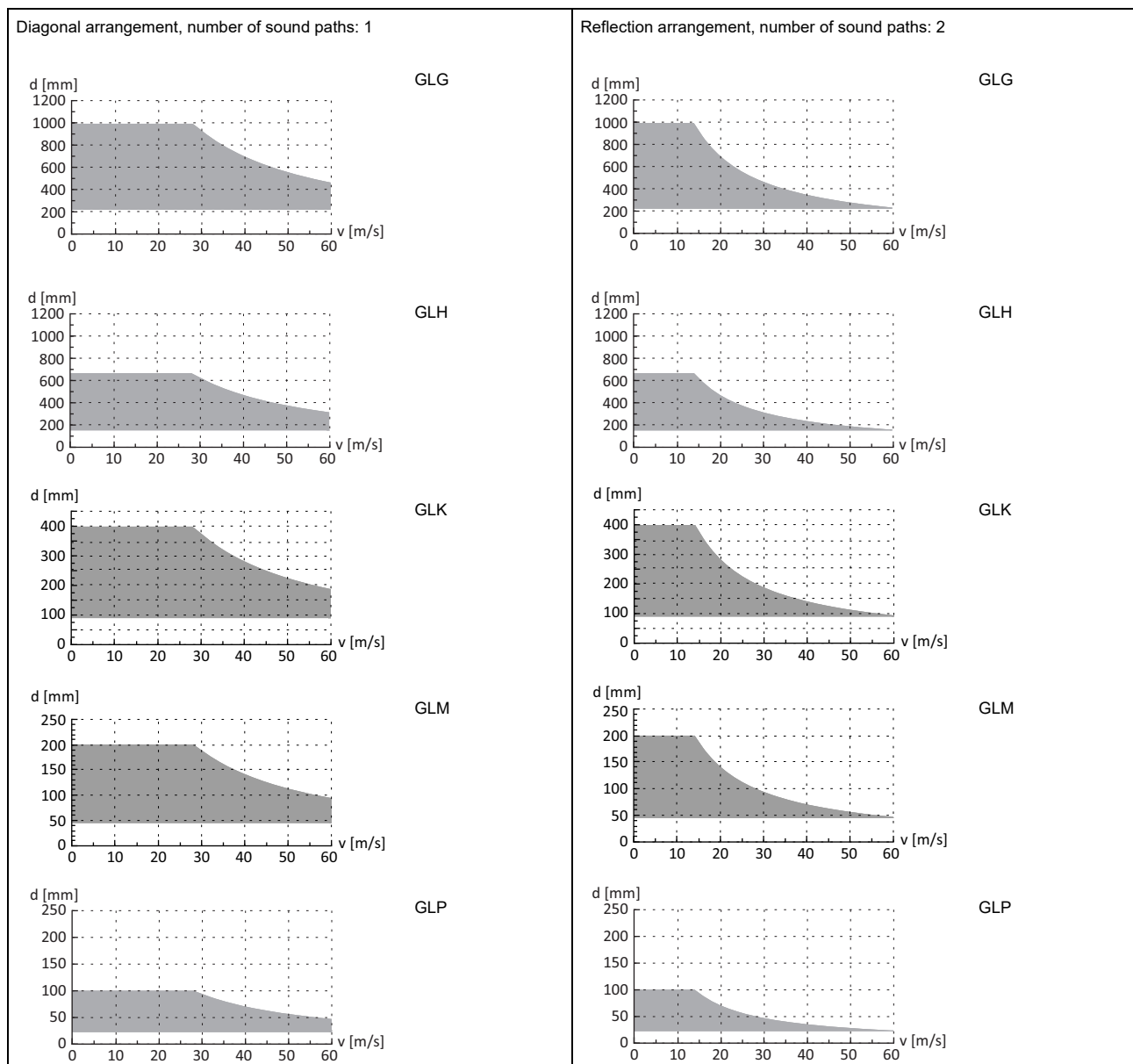
pipe wall thickness

transducer order code



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...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 > 0 m: with extension cable |
| | | | | | | | | LC | | long transducer cable |

Technical data

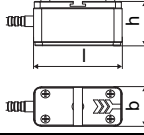
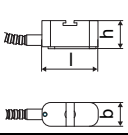
Shear wave transducers (nonEx, NL)

| | | | | | | |
|--|-----|--|--------------|------------------------------|--------------|--------------|
| 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 pressure¹ | | | | | | |
| min. extended | bar | metal pipe: 20 | | | | |
| min. | bar | metal pipe: 30, plastic pipe: 1 | | | | |
| inner pipe diameter d² | | | | | | |
| min. extended | mm | 180 | 60 | 30 | 15 | 7 |
| min. recommended | mm | 220 | 80 | 40 | 20 | 10 |
| max. recommended | mm | 900 | 300 | 150 | 50 | 22 |
| max. extended | mm | 1100 | 360 | 180 | 60 | 30 |
| pipe wall thickness | | | | | | |
| min. | mm | 11 | 5 | 2.5 | 1.2 | 0.6 |
| material | | | | | | |
| housing | | PEEK with stainless steel cover 304 (1.4301) | | stainless steel 304 (1.4301) | | |
| contact surface | | PEEK | | PEEK | | |
| degree of protection | | IP67 | | | | |
| transducer cable | | | | | | |
| type | | 1699 | | | | |
| length | m | 5 | | 4 | | 3 |
| length (***.*****/LC) | m | 9 | | | | |
| dimensions | | | | | | |
| length l | mm | 129.5 | 126.5 | 60 | 42.5 | |
| width b | mm | 51 | 51 | 30 | 18 | |
| height h | mm | 67 | 67.5 | 33.5 | 21.5 | |
| dimensional drawing | | | | | | |
| weight (without cable) | kg | 0.47 | 0.36 | 0.035 | | 0.011 |
| pipe surface temperature | | | | | | |
| min. | °C | -40 | | | | |
| max. | °C | +130 | | | | |
| ambient temperature | | | | | | |
| min. | °C | -40 | | | | |
| max. | °C | +130 | | | | |
| temperature compensation | | x | | | | |

¹ depending on the 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 reflection arrangement and for a flow velocity of 15 m/s

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

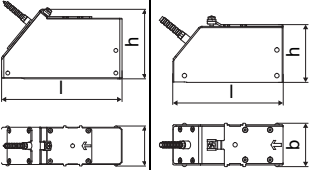
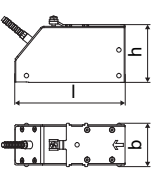
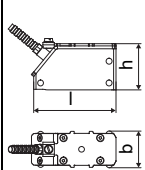
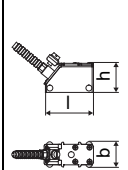
| order code | | GSM-ENNNL/** | GSP-ENNNL/** | GSQ-ENNNL/** |
|--|-----|---|--------------|---|
| technical type | | G(DL)M1EZ7 | G(DL)P1EZ7 | G(DL)Q1EZ7 |
| transducer frequency | MHz | 1 | 2 | 4 |
| fluid pressure¹ | | | | |
| min. extended | bar | metal pipe: 20 | | |
| min. | bar | metal pipe: 30, plastic pipe: 1 | | |
| inner pipe diameter d² | | | | |
| min. extended | mm | 30 | 15 | 7 |
| min. recommended | mm | 40 | 20 | 10 |
| max. recommended | mm | 150 | 50 | 22 |
| max. extended | mm | 180 | 60 | 30 |
| pipe wall thickness | | | | |
| min. | mm | 2.5 | 1.2 | 0.6 |
| material | | | | |
| housing | | stainless steel 304 (1.4301) | | |
| contact surface | | Sintimid | | |
| degree of protection | | IP65 | | |
| transducer cable | | | | |
| type | | 1699 | | |
| length | m | 4 | | 3 |
| length (***_*****/LC) | m | 9 | | |
| dimensions | | | | |
| length l | mm | 60 | | 42.5 |
| width b | mm | 30 | | 18 |
| height h | mm | 33.5 | | 21.5 |
| dimensional drawing | |  | |  |
| weight (without cable) | kg | 0.042 | | 0.011 |
| pipe surface temperature | | | | |
| min. | °C | -30 | | |
| max. | °C | +200 | | |
| ambient temperature | | | | |
| min. | °C | -30 | | |
| max. | °C | +200 | | |
| temperature compensation | | x | | |

¹ depending on the 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 reflection arrangement and for a flow velocity of 15 m/s

Lamb wave transducers

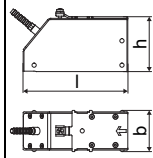
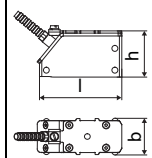
Lamb wave transducers (nonEx, NL)

| | | | | | | | | |
|--|-----|---|------------|--|---|---|--|---|
| 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 pressure¹ | | | | | | | | |
| min. extended | bar | metal pipe: 10 | | | metal pipe: 10 (d > 120 mm) 3 (d < 120 mm) | metal pipe: 3 (d < 60 mm) | metal pipe: 3 (d < 35 mm) | metal pipe: 3 (d < 15 mm) |
| min. | bar | metal pipe: 15 plastic pipe: 1 | | | metal pipe: 15 (d > 120 mm) 10 (d < 120 mm) plastic pipe: 1 | metal pipe: 10 (d > 60 mm) 5 (d < 60 mm) plastic pipe: 1 | metal pipe: 10 (d > 35 mm) 5 (d < 35 mm) plastic pipe: 1 | metal pipe: 10 (d > 15 mm) 5 (d < 15 mm) plastic pipe: 1 |
| inner pipe diameter d² | | | | | | | | |
| min. extended | mm | 220 | 180 | 110 | 60 | 30 | 15 | 7 |
| min. recommended | mm | 270 | 220 | 140 | 80 | 40 | 20 | 10 |
| max. recommended | mm | 1200 | 900 | 600 | 300 | 150 | 50 | 22 |
| max. extended | mm | 1600 | 1400 | 1000 | 360 | 180 | 60 | 30 |
| pipe wall thickness | | | | | | | | |
| min. | mm | 15 | 11 | 8 | 5 | 2.5 | 1.2 | 0.6 |
| max. | mm | 32 | 24 | 16 | 10 | 5 | 3 | 1.2 |
| max. extended | mm | 35 | - | - | - | - | - | - |
| material | | | | | | | | |
| housing | | PPSU with stainless steel cover 316Ti (1.4571) | | PPSU with stainless steel cover 304 (1.4301) | | | | |
| contact surface | | PPSU | | | | | | |
| degree of protection | | IP65 | | | | | | |
| transducer cable | | | | | | | | |
| type | | 1699 | | | | | | |
| length | m | 5 | | | 4 | | 3 | |
| length (***/****/LC) | m | 9 | | | | | | |
| dimensions | | | | | | | | |
| length l | mm | 163 | 128.5 | | | 74 | 42 | |
| width b | mm | 54 | 51 | | | 32 | 22 | |
| height h | mm | 91.3 | 67.5 | | | 40.5 | 25.5 | |
| dimensional drawing | |  | | |  | |  |  |
| weight (without cable) | kg | 0.935 | 0.471 | | | 0.077 | 0.019 | |
| pipe surface temperature | | | | | | | | |
| min. | °C | -40 | | | | | | |
| max. | °C | +130 | | | | | | |
| ambient temperature | | | | | | | | |
| min. | °C | -40 | | | | | | |
| max. | °C | +130 | | | | | | |
| temperature compensation | | x | | | | | | |

¹ depending on the 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 reflection arrangement (diagonal arrangement) and for a flow velocity of 15 m/s (30 m/s)
 inner pipe diameter max. extended: in reflection arrangement (diagonal arrangement) and for a flow velocity of 12 m/s (25 m/s)

Lamb wave transducers (nonEx, steam measurement, NL)

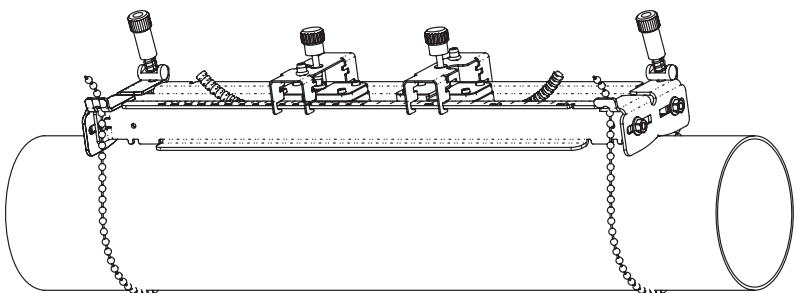
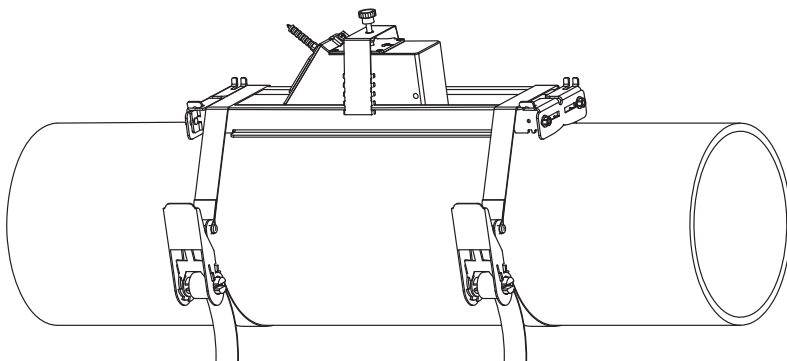
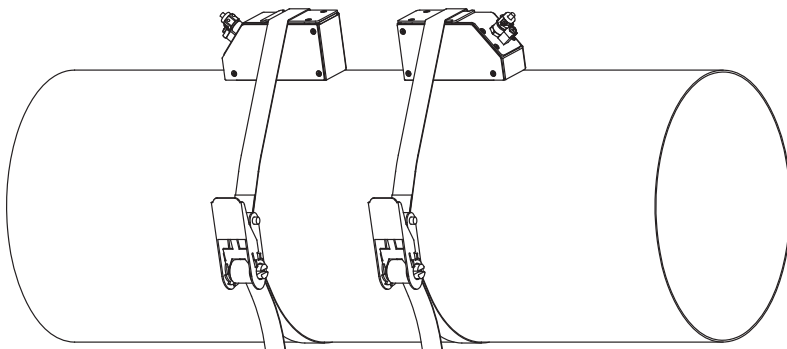
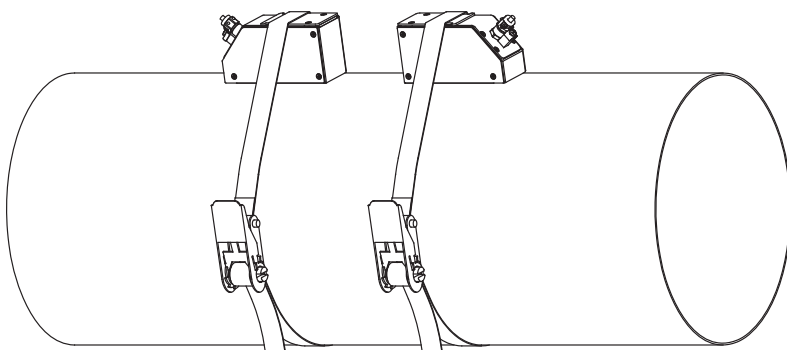
| order code | | GLG-SNNNL/** | GLH-SNNNL/** | GLK-SNNNL/** | GLM-SNNNL/** | GLP-SNNNL/** |
|--|-----|---|--------------|--------------|--|--------------|
| technical type | | G(RT)G1SC3 | G(RT)H1SC3 | G(RT)K1SC3 | G(RT)M1SC3 | G(RT)P1SC3 |
| transducer frequency | MHz | 0.2 | 0.3 | 0.5 | 1 | 2 |
| inner pipe diameter d | | | | | | |
| min. | mm | 225 | 150 | 90 | 45 | 23 |
| max. | mm | 1000 | 667 | 400 | 200 | 100 |
| pipe wall thickness | | | | | | |
| min. | mm | 10.6 | 7.1 | 4.2 | 2.1 | 1.1 |
| max. | mm | 23.7 | 15.8 | 9.5 | 4.7 | 2.4 |
| material | | | | | | |
| housing | | PPSU with stainless steel cover 316Ti (1.4571) | | | | |
| contact surface | | PPSU | | | | |
| degree of protection | | IP65 | | | | |
| transducer cable | | | | | | |
| type | | 1699 | | | | |
| length | m | 5 | | | 4 | |
| length (**_****/LC) | m | 9 | | | 9 | |
| dimensions | | | | | | |
| length l | mm | 128.5 | | | 74 | |
| width b | mm | 51 | | | 32 | |
| height h | mm | 67.5 | | | 40.5 | |
| dimensional drawing | |  | | |  | |
| weight (without cable) | kg | 0.8 | | | 0.16 | |
| storing temperature | | | | | | |
| min. | °C | -40 | | | | |
| max. | °C | +180 | | | | |
| operating temperature¹ | | | | | | |
| min. | °C | 100 | | | | |
| max. | °C | 180 | | | | |
| warm-up time | h | 3 | | | 1 | |
| temperature compensation | | x | | | | |

completely thermally insulated transducer installation necessary

Transducer mounting fixture

Order code

| 1, 2 | 3 | 4 | 5 | 6 | 7...9 | no. of character | | |
|-----------------------------|------------|---|-------------------------|------|-------|------------------|---------------------|--|
| transducer mounting fixture | transducer | - | measurement arrangement | size | - | fixation | outer pipe diameter | description |
| VP | | | | | | | | portable Variofix |
| TB | | | | | | | | tension belts |
| TH | | | | | | | | high-temperature tension belts |
| | A | | | | | | | all transducers |
| | | D | | | | | | reflection arrangement or diagonal arrangement |
| | | R | | | | | | reflection arrangement |
| | | | S | | | | | small |
| | | | M | | | | | medium |
| | | | | | C | | | chains |
| | | | | | G | | | tension belts |
| | | | | | H | | | high-temperature tension belts |
| | | | | | N | | | without fixation |
| | | | | | | 055 | | 10...550 mm |
| | | | | | | 060 | | 50...600 mm |
| | | | | | | 150 | | 50...1500 mm |
| | | | | | | 210 | | 50...2100 mm |

| | |
|--|---|
| <p>portable Variofix VP and chains</p>  <p>The diagram shows a horizontal cylindrical pipe with a Variofix VP device mounted on top. The device consists of a central frame with four adjustable clamps, each secured with a chain. The chains hang down from the clamps.</p> | <p>material: stainless steel 304 (1.4301), 301 (1.4310), 303 (1.4305) dimensions: 414 x 94 x 76 mm chain length: 2 m</p> |
| <p>portable Variofix VP and tension belts</p>  <p>The diagram shows a horizontal cylindrical pipe with a Variofix VP device mounted on top. The device has a central frame with two tension belts attached to the sides. The belts are secured with clamps and hang down from the device.</p> | |
| <p>tension belts TB</p>  <p>The diagram shows a horizontal cylindrical pipe with two tension belts (TB) attached to the top. Each belt is secured with a clasp and hangs down from the pipe.</p> | <p>material: steel, powder coated and textile tension belt length: 5/7 m</p> <p>ambient temperature: max. 60 °C outer pipe diameter: max. 1500/2100 mm</p> |
| <p>high-temperature tension belts TH</p>  <p>The diagram shows a horizontal cylindrical pipe with two high-temperature tension belts (TH) attached to the top. Each belt is secured with a clasp and hangs down from the pipe.</p> | <p>material: clasp: stainless steel 304 (1.4301) tension belt: Aramid length: 2/5 m ambient temperature: max. 260 °C outer pipe diameter: max. 600/1500 mm</p> |

Coupling materials for transducers

| normal temperature range (4th character of transducer order code = N) | | extended temperature range (4th character of transducer order code = E) | | higher temperatures (4th character of transducer order code = S) |
|--|-----------------------------|--|----------------------------------|---|
| < 100 °C | < 170 °C | < 150 °C | < 200 °C | < 180 °C |
| 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 foil type VT |

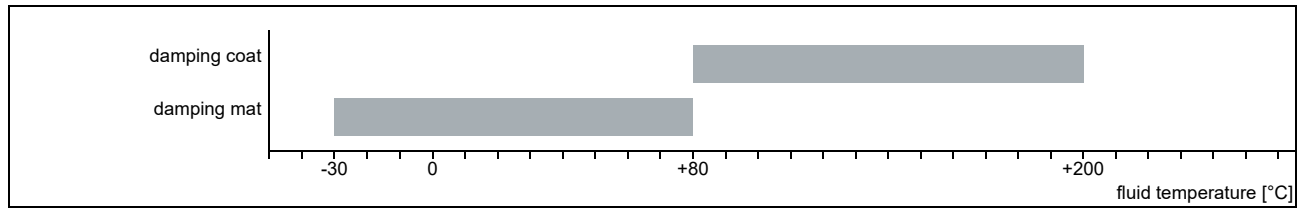
¹ in combination with type VT only

Technical data

| type | ambient temperature °C |
|--------------------------|---------------------------|
| coupling compound type N | -30...+130 |
| coupling compound type E | -30...+200 |
| coupling compound type H | -30...+250 |
| coupling foil type VT | -10...+200 |

Damping material (optional)

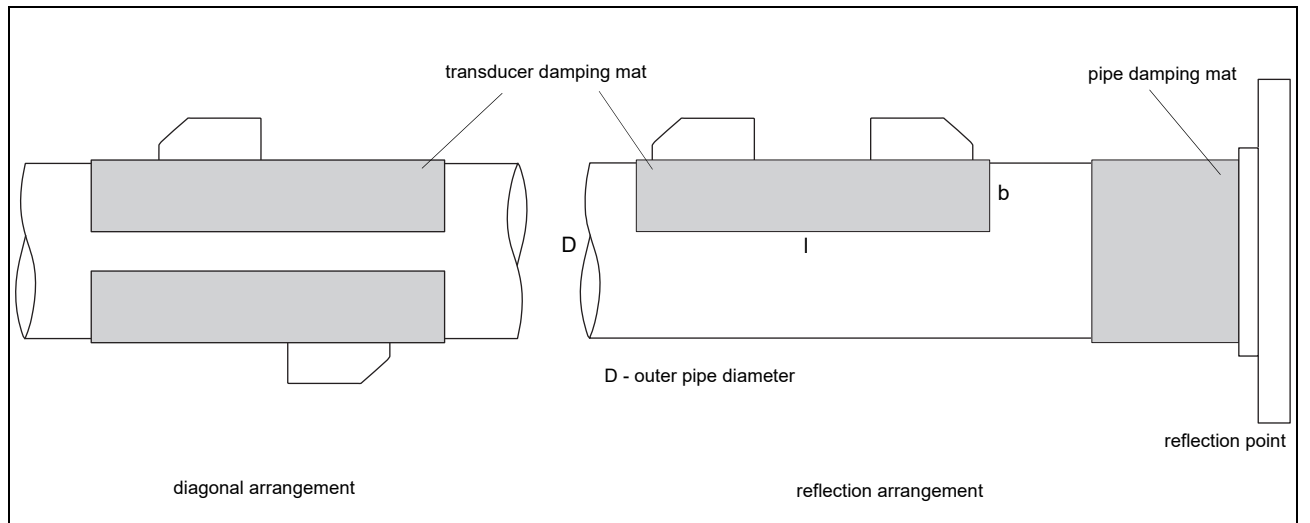
Damping material will be used for the gas measurement to reduce acoustic noise influences on the measurement.



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 mm | dimensions l x b x h mm | transducer frequency | | | | | | | | technical type | ambient temperature °C | remark |
|-------------------------------|---|---------------------------|-------------------------------|----------------------|---|---|---|---|---|-------|-------|----------------|------------------------------|--------|
| | | | | F | G | H | K | M | P | Q | | | | |
| transducer damping mat | | | | | | | | | | | | | | |
| D | for temporary installation (multiple use), fixed with coupling compound | < 80 | 450 x 115 x 0.5 | - | - | - | - | x | x | x | D20S3 | -25...+60 | | |
| | | ≥ 80 | 900 x 230 x 0.5 | - | - | - | x | x | - | - | D20S2 | | | |
| | | 900 x 230 x 1.3 | x | x | x | - | - | - | - | D50S2 | | | | |
| pipe damping mat | | | | | | | | | | | | | | |
| A | for temporary installation (multiple use), fixed with coupling compound | < 300 | 300 x 115 x 0.5 | x | x | x | x | x | x | x | A20S4 | -25...+60 | for quantity see table below | |
| B | self-adhesive | ≥ 300 | l x 100 x 0.9 | x | x | x | x | x | x | - | B35R2 | -35...+50 | l - see table below | |

Quantity for pipe damping mat - type A

(depending on outer pipe diameter)

| outer pipe diameter D mm | transducer frequency | |
|-----------------------------|----------------------|------------|
| | F, G, H | K, M, P, Q |
| 100 | 12 | 6 |
| 200 | 24 | 12 |
| 300 | 32 | 16 |

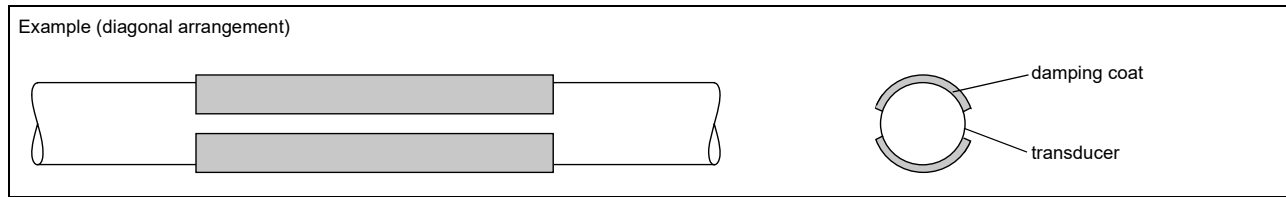
Length of pipe damping mat - type B

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

| outer pipe diameter D mm | transducer frequency | |
|-----------------------------|----------------------|--------------|
| | F, G, H m | K, M, P m |
| 300 | 12 | 6 |
| 500 | 32 | 16 |
| 1000 | 126 | 63 |

Damping coat

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



Technical data

| | |
|---|--|
| order code | ACC-PE-GNNN-/DPL1 |
| material | multipolymeric matrix/inorganic ceramic coating |
| packing drum | 1 |
| properties | heat resistant, inert |
| fluid temperature when applying | °C 10...200 |
| drying time (example) | approx. 3 h at 20 °C approx. 15 min at 150 °C |
| temperature resistance in dry state | °C max. 650 |
| durability of the packing drum (unopened) | 2 years |

Observe installation instructions (TI_DampingCoat).

Dimensioning

| transducer frequency | number of packing drums | | |
|----------------------|-------------------------|------|------|
| | outer pipe diameter | | |
| | ≤300 | ≤500 | ≤700 |
| | mm | | |
| F | 3 | 4 | 5 |
| G | 2 | 3 | 4 |
| H | 2 | 2 | 3 |
| K | 2 | 2 | - |
| M | 2 | - | - |
| P | 1 | - | - |
| Q | 1 | - | - |

Connection systems

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

Cable

| transducer cable | | |
|---------------------|------|------------------------------|
| type | | 1699 |
| weight | kg/m | 0.094 |
| ambient temperature | °C | -55...+200 |
| cable jacket | | |
| material | | PTFE |
| outer diameter | mm | 2.9 |
| thickness | mm | 0.3 |
| colour | | brown |
| shield | | x |
| sheath | | |
| material | | stainless steel 304 (1.4301) |
| outer diameter | mm | 8 |

| extension cable | | | |
|---------------------|------|------------------------------|-----------------|
| type | | 1750 | 2551 |
| standard length | m | 5 10 | - |
| max. length | m | 10 | see table below |
| weight | kg/m | 0.12 | 0.083 |
| ambient temperature | °C | < 80 | -25...+80 |
| cable jacket | | | |
| material | | PE | TPE-O |
| outer diameter | mm | 6 | 8 |
| thickness | mm | 0.5 | |
| colour | | black | black |
| shield | | x | x |
| sheath | | | |
| material | | stainless steel 304 (1.4301) | - |
| outer diameter | mm | 9 | - |
| 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 *R***C3 ¹ | m | 2 | 3 | ≤ 25 | 2 | 2 | ≤ 25 | 2 | 1 | ≤ 25 | 1 | 1 | ≤ 20 |
| option LC: *L***Z7 ¹ *T***C3 ¹ | m | 2 | 7 | ≤ 25 | 7 | 2 | ≤ 25 | 8 | 1 | ≤ 25 | - | - | - |

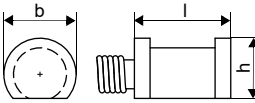
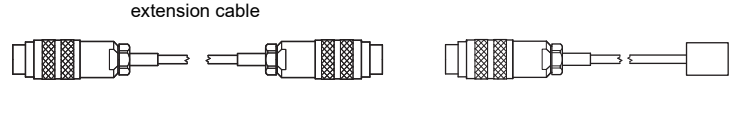
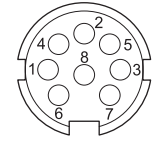
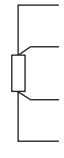
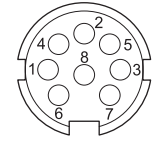
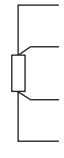
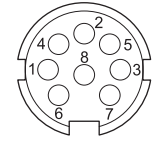
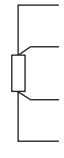
¹ l > 25...100 m on request

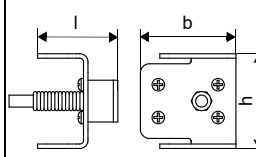
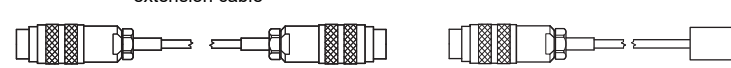
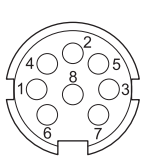
x, y - transducer cable length

l - max. length of extension cable

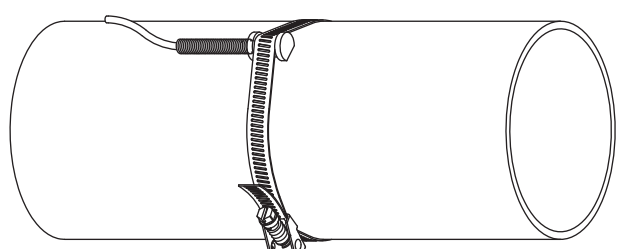
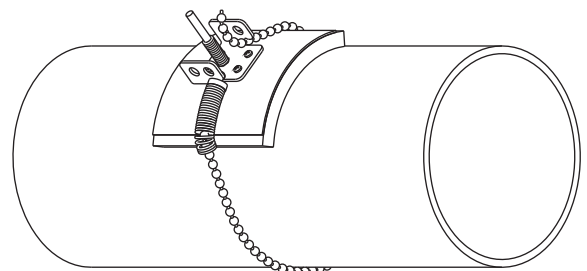
Clamp-on temperature probe (optional)

Technical data

| PT12N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|--------------------------------|-------------------|---|-----------|---|--------------------------------|-----------------|-----|---------|---|-----|------|---------------------|---------------|-----------|------------------|------------|------|---------------------|-------|-------|----------|-----|-----|----------------|--------------|--------|--------|-------|------|
| order code | <ul style="list-style-type: none"> ACC-PO-#601-/T311 ACC-PO-#601-/T511 (matched) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| design | clamp-on with connector | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| type | Pt100 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| connection | 4-wire | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| measuring range | °C -30...+250 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| accuracy T | $\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C] })$ class A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| accuracy ΔT (2x Pt matched according to EN 1434-1) | $\leq 0.1 \text{ K}$ ($3 \text{ K} < \Delta T < 6 \text{ K}$), more corresponding to EN 1434-1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| response time | s 50 (t_{50} , $T_1 = 25 \text{ °C}$, $T_2 = 60 \text{ °C}$) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| housing | aluminum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| degree of protection | IP54 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| dimensions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| length l | mm 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| width b | mm 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| height h | mm 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| dimensional drawing |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| weight | kg 0.25 (without connector) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| accessories | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| thermal conductivity paste 200 °C | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| thermal conductivity foil 250 °C | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Connection system | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| direct connection/connection with extension cable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Connection | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th></th> <th>temperature probe</th> <th>extension cable</th> <th>connector</th> <th rowspan="5">  </th> </tr> <tr> <th></th> <th></th> <th></th> <th>pin</th> </tr> </thead> <tbody> <tr> <td rowspan="4">  </td> <td>red</td> <td>grey</td> <td>2</td> </tr> <tr> <td>red/blue</td> <td>red</td> <td>6</td> </tr> <tr> <td>white/blue</td> <td>blue</td> <td>1</td> </tr> <tr> <td>white</td> <td>white</td> <td>7</td> </tr> </tbody> </table> | | temperature probe | extension cable | connector |  | | | | pin |  | red | grey | 2 | red/blue | red | 6 | white/blue | blue | 1 | white | white | 7 | | | | | | | | |
| | temperature probe | extension cable | connector |  | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | pin | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | red | grey | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | red/blue | red | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | white/blue | blue | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | white | white | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | temperature probe | extension cable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| type | 4 x 0.22 mm ² | LIYCY 8 x 0.14 mm ² | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| standard length | m 3 | 5/10/25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| max. length | m - | 200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ambient temperature | °C -30...+250 | -25...+80 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| min. bend radius | mm 27 | 68 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cable jacket | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| material | PFA | PVC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| outer diameter | mm 3.8 ±0.15 | 4.8 ±2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| colour | black | grey | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| PT12F | | | | | | | | | | | | | | | | | | | |
|--|---|--------------------------------|-------------------|-----------------|------|--------------------------|--------------------------------|-----------------|-----|---------|-------------|------|-----|---------------------|---------------|-----------|------------------|-------|----|
| order code | <ul style="list-style-type: none"> ACC-PO-#601-/T111 ACC-PO-#601-/T211 (matched) | | | | | | | | | | | | | | | | | | |
| design | clamp-on short response time, with connector | | | | | | | | | | | | | | | | | | |
| type | Pt100 | | | | | | | | | | | | | | | | | | |
| connection | 4-wire | | | | | | | | | | | | | | | | | | |
| measuring range | °C -50...+250 | | | | | | | | | | | | | | | | | | |
| accuracy T | $\pm(0.15 \text{ °C} + 2 \cdot 10^{-3} \cdot T \text{ [°C] })$ class A | | | | | | | | | | | | | | | | | | |
| accuracy ΔT (2x Pt matched according to EN 1434-1) | $\leq 0.1 \text{ K}$ ($3 \text{ K} < \Delta T < 6 \text{ K}$), more corresponding to EN 1434-1 | | | | | | | | | | | | | | | | | | |
| response time | s 8 (t50, T1 = 25 °C, T2 = 60 °C) | | | | | | | | | | | | | | | | | | |
| housing | PEEK, stainless steel 304 (1.4301), copper | | | | | | | | | | | | | | | | | | |
| degree of protection | IP54 | | | | | | | | | | | | | | | | | | |
| dimensions | | | | | | | | | | | | | | | | | | | |
| length l | mm 14 | | | | | | | | | | | | | | | | | | |
| width b | mm 30 | | | | | | | | | | | | | | | | | | |
| height h | mm 27 | | | | | | | | | | | | | | | | | | |
| dimensional drawing |  | | | | | | | | | | | | | | | | | | |
| weight | kg 0.32 (without connector) | | | | | | | | | | | | | | | | | | |
| accessories | | | | | | | | | | | | | | | | | | | |
| thermal conductivity paste 200 °C | x | | | | | | | | | | | | | | | | | | |
| thermal conductivity foil 250 °C | x | | | | | | | | | | | | | | | | | | |
| plastic protection plate, insulation foam | x | | | | | | | | | | | | | | | | | | |
| Connection system | | | | | | | | | | | | | | | | | | | |
| direct connection/connection with extension cable | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| Connection | | | | | | | | | | | | | | | | | | | |
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| temperature probe | extension cable | connector | | | | | | | | | | | | | | | | | |
| red | grey | 2 | | | | | | | | | | | | | | | | | |
| red/blue | red | 6 | | | | | | | | | | | | | | | | | |
| white/blue | blue | 1 | | | | | | | | | | | | | | | | | |
| white | white | 7 | | | | | | | | | | | | | | | | | |
| |  | | | | | | | | | | | | | | | | | | |
| Cable | | | | | | | | | | | | | | | | | | | |
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| | temperature probe | extension cable | | | | | | | | | | | | | | | | | |
| type | 4 x 0.22 mm ² | LIYCY 8 x 0.14 mm ² | | | | | | | | | | | | | | | | | |
| standard length | m 3 | 5/10/25 | | | | | | | | | | | | | | | | | |
| max. length | m - | 200 | | | | | | | | | | | | | | | | | |
| ambient temperature | °C -50...+250 | -25...+80 | | | | | | | | | | | | | | | | | |
| min. bend radius | mm 27 | 68 | | | | | | | | | | | | | | | | | |
| | cable jacket | | | | | | | | | | | | | | | | | | |
| material | PFA | PVC | | | | | | | | | | | | | | | | | |
| outer diameter | mm 3.8 ±0.15 | 4.8 ±2 | | | | | | | | | | | | | | | | | |
| colour | black | grey | | | | | | | | | | | | | | | | | |

Fixation

| | |
|---|--|
| <p>tension strap PT12N</p>  | <p>material: stainless steel 301 (1.4310), 410 (1.4006) thermal insulation necessary</p> |
| <p>ball chain PT12F</p>  | <p>material: stainless steel 316L (1.4404) length: 1 m</p> |

Wall thickness measurement (optional)

The pipe wall thickness is an important pipe parameter which has to be determined exactly for a good measurement. However, the pipe wall thickness often is unknown.

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

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

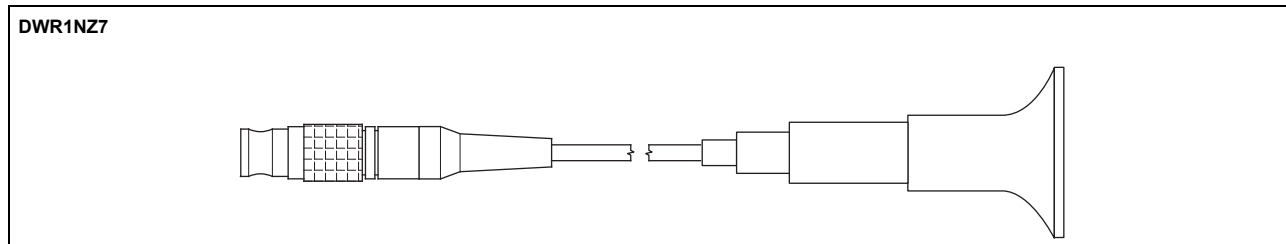
Technical data

| | | DWR1NZ7 |
|------------------------------|----|---|
| order code | | ACC-PO-G601-/W6 |
| measuring range ¹ | mm | 1...250 |
| resolution | mm | 0.01 |
| accuracy | | 1 % ±0.1 mm |
| fluid temperature | °C | -20...+200, short-time peak max. 500 |
| cable | | |
| type | | 2616 |
| length | m | 1.5 |

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 | °C | <200 |
| cable jacket | | |
| material | | FEP |
| outer diameter | mm | 5.1 |
| colour | | black |
| shield | | x |



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Errors excepted.

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