Portable Ultrasonic Flow Measurement of Gas

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

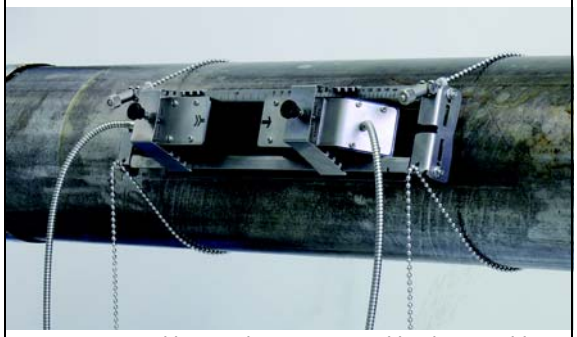
Features

- Non-invasive measurement using a clamp-on method for precise bi-directional, highly dynamic flow measurement
- New portable, easy-to-use flowmeter with 2 flow measurement channels, multiple inputs/outputs, an integrated data logger and a serial interface in the standard version
- Automatic loading of calibration data and transducer detection, reduces set-up times and provides precise, long-term stable results
- Li-Ion battery for 14 hours of measurement operation
- Proven clamp-on method; transducers are available for a wide range of rated diameters from DN 30 to DN 1600 and temperatures from -40...+170 °C; resistant to dust and humidity
- Integrated wall thickness measurement
- Water and dust-tight; resistant against oil, many liquids and dirt
- Robust, water-tight (IP 67) transport case with comprehensive accessories
- QuickFix for fast mounting of the flowmeter in difficult conditions

Applications

- Designed for industrial use in harsh environments, in gas processing and natural gas extraction, chemical industry and in the petroleum industry. Applications are possible:
  - Measurement on natural gas pipelines and in natural gas storage installations
  - Measurement for the gas supply industry
  - Supervision of permanently installed meters, service and maintenance

FLUXUS G601 supported by handle



Measurement with transducers mounted by the portable Variofix mounting fixture

Measurement equipment in transport case

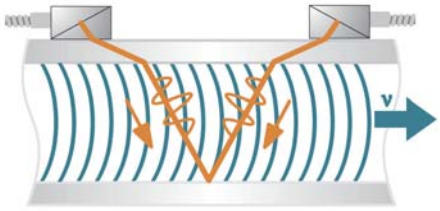
Measuring Principle

For the flow measurement of the medium, ultrasonic signals are used, employing the transit time difference principle. Ultrasonic signals are emitted by a transducer installed on one side of a pipe, reflected on the opposite side and received by a second transducer. These signals are emitted alternatively in flow direction and against it.

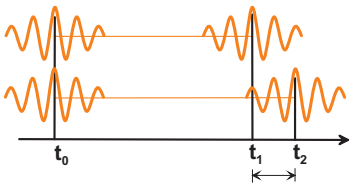
As the medium in which the signals propagate is flowing, the transit time of the ultrasonic signals in flow direction is shorter than against the flow direction.

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

The received ultrasonic signals will be checked for their usefulness for the measurement and the plausibility of the measured values will be evaluated. The complete measuring cycle is controlled by the integrated microprocessors. Disturbance signals will be eliminated by statistical signal processing.



Path of the ultrasonic signal



Transit time difference Δt

Calculation of the Flow Velocity

$v = k_\alpha \cdot \Delta t/(2 \cdot t_t)$

with:

v - flow velocity
k_α - flowmeter constant
Δt - transit time difference
t_t - transit time of the medium

Number of Sound Paths

The number of sound paths is the number of transits of the ultrasonic signals through the medium in the pipe.

reflection mode: number of sound paths = 2, the transducers are mounted on the same side of the pipe, correct positioning of the transducers easier

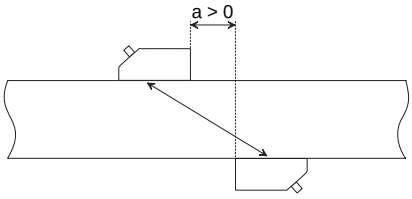
diagonal mode: number of sound paths = 1, the transducers are mounted on opposite sides of the pipe

The mode to be used depends on the application. If the number of sound paths is increased, the accuracy of the measurement will be better, but the signal attenuation is increased.

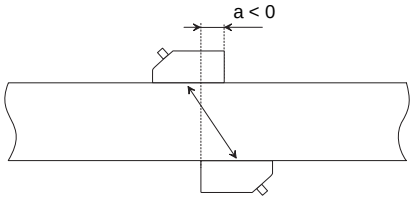
In case of a high signal attenuation by medium, pipe and coatings, diagonal mode with 1 sound path will be used.

The optimum number of sound paths for the parameters of the application will be detemined automatically by the flowmeter

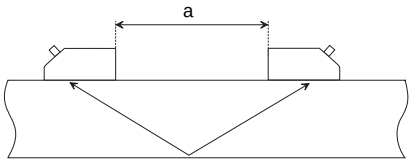
As the transducers can be mounted with the supplied transducer mounting fixture in reflection mode or diagonal mode the number of sound paths can be adjusted optimally to the application.



Diagonal mode, 1 sound path



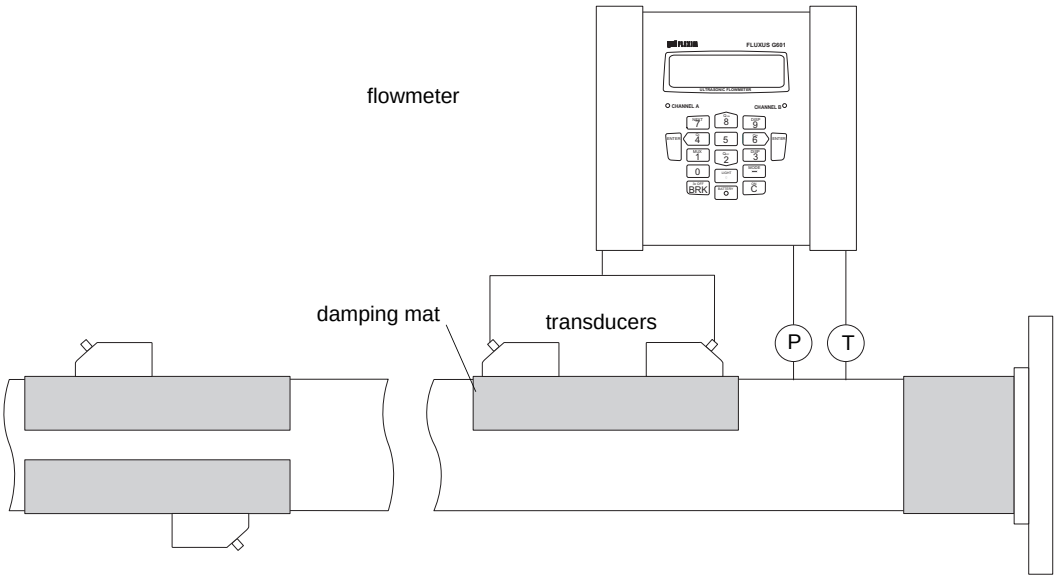
Diagonal mode, 1 sound path, negative transducer distance



Reflex mode, 2 sound paths

a - transducer distance

Typical Measurement Setup



Gas flow measurement in reflection mode with FLUXUS G601
using external process pressure and process temperature measurement
for standard volume flow calculation

Standard Volume Flow

The standard volume flow of the medium can be selected as physical quantity to be measured. It will be calculated internally by:

$V_N = V \cdot p/p_N \cdot T_N/T \cdot 1/K$

with:

V_N - standard volume flow
V - operational volume flow
p_N - standard pressure (absolute value)
p - operational pressure (absolute value)
T_N - standard temperature in K
T - operational temperature in K
K - gas compressibility factor

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

Or:

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

The gas compressibility factor K will be entered in the flowmeter:

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

Flowmeter

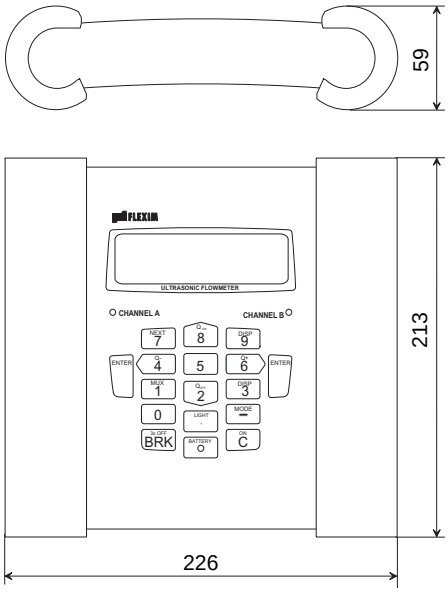
Technical Data

FLUXUS	G601
design	portable
	
measurement	
measuring principle	transit time difference correlation principle
flow velocity	0.01...35 m/s, pipe diameter dependent
repeatability	0.15 % of reading ±0.01 m/s
accuracy	
- volume flow	± 1...3 % of reading ± 0.01 m/s depending on application ± 0.5 % of reading ± 0.01 m/s with field calibration
medium	gases with a ratio of the characteristic acoustic impedances of pipe wall and gas < 3000
flowmeter	
power supply	100...230 V/50...60 Hz (power supply), 10.5...15 V DC (socket at flowmeter) or battery
battery	Li-Ion, 7.2 V/4.5 Ah operating time (without outputs, inputs and backlight): > 14 h
power consumption	< 6 W
number of flow measuring channels	2
signal damping	0...100 s, adjustable
measuring cycle (1 channel)	100...1000 Hz
response time	1 s (1 channel), option: 70 ms
material	polyamid
degree of protection according to EN 60529	IP 65
weight	1.9 kg
fixation	QuickFix pipe mounting fixture
operating temperature	-10...+60 °C
display	2 x 16 characters, dot matrix, backlit
menu language	English, German, French, Dutch, Spanish
measuring functions	
physical quantities	operational volume flow, standard volume flow, mass flow, vflow velocity
totalizers	volume, mass
calculation functions	average, difference, sum
data logger	
loggable values	all physical quantities and totalized values
capacity	> 100 000 measured values

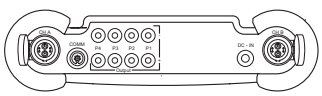
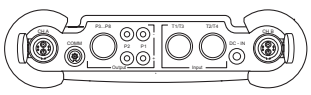
FLUXUS	G601
communication	
interface	RS232/USB
serial data kit	
software (all Windows™ versions)	- FluxData: download of measured data, graphical presentation, conversion to other formats (e.g. for Excel™) - FluxKoeff: creating medium data sets
cable	RS232
adapter	RS232 - USB
outputs	
	The outputs are galvanically isolated from the flowmeter.
number	see standard scopes of supply on page 7, max. on request
accessories	output adapter (if number of outputs > 4)
	current output
range	0/4...20 mA
accuracy	0.1 % of reading ±15 µA
active output	R_{ext} < 200 Ω
passive output	U_{ext} = 4...16 V, dependent on R_{ext} R_{ext} < 500 Ω
	frequency output
range	0...10 kHz
open collector	24 V/4 mA
	binary output
optorelay	32 V/100 mA
binary output as alarm output	
- functions	limit, change of flow direction or error
binary output as pulse output	
- pulse value	0.01...1000 units
- pulse width	1...1000 ms
inputs	
	The inputs are galvanically isolated from the flowmeter.
number	see standard scopes of supply on page 7, max. 4
accessories	input adapter (if number of inputs > 2)
	temperature input
designation	Pt100/Pt1000
connection	4-wire
range	-150...+560 °C
resolution	0.01 K
accuracy	±0.01 % of reading ±0.03 K
	current input
range	passive: -20...+20 mA
accuracy	0.1 % of reading ±10 µA
passive input	R_i = 50 Ω, P_i < 0.3 W
	voltage input
range	0...1 V
accuracy	0.1 % of reading ±1 mV
internal resistance	R_i = 1 MΩ

Dimensions (in mm)

FLUXUS G601



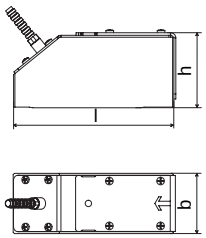
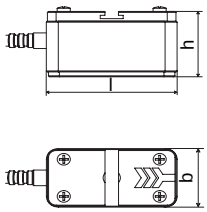
Standard Scopes of Supply

	G601 Standard	G601 Multifunctional
passive current output	2	2
binary output	2	2
frequency output	-	1
temperature input	-	1
passive current input	-	2
voltage input	-	1
application	all flow measurements on gas	for sophisticated measuring tasks, e.g. modeling of pump curves
accessories	- transport case - power supply, power cable - battery - QuickFix pipe mounting fixture for flowmeter - serial data kit - tension straps for transducer mounting - measuring tape - user manual, Quick Start Guide	- transport case - power supply, power cable - battery - output adapter - input adapter - adapter for voltage or current inputs - QuickFix pipe mounting fixture for flowmeter - serial data kit - 4 tension straps for transducer mounting - 4 portable Variofix mounting fixtures PVF and chains - measuring tape - damping mats - installation kit - wall thickness probe - user manual, Quick Start Guide
connector board at the upper side of the flow-meter		

Example for the Equipment of a Transport Case

Transducers

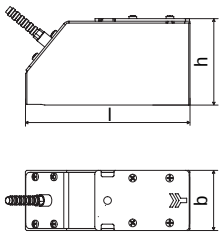
Shear Wave Transducers

technical type		GDG1NZ7	GDK1NZ7	GDM1NZ7
order code		**GSG-NNNNL**	**GSK-NNNNL**	**GSM-NNNNL**
transducer frequency	MHz	0.2	0.5	1
min. operating pressure [1]	bar	30	30	40
outer pipe diameter [2]				
min. extended	mm	250	70	30
min. recommended	mm	380	80	40
max. recommended	mm	810	500	80
max. extended	mm	1100	720	120
pipe wall thickness				
min.	mm	14	5	2.5
max.	mm	-	-	-
material				
housing		PEEK with stainless steel cap	PEEK with stainless steel cap	stainless steel
contact surface		PEEK	PEEK	PEEK
degree of protection according to EN 60529		IP 65	IP 65	IP 65
dimensions				
length l	mm	129.5	126.5	60
width b	mm	47	47	30
height h	mm	66.4	55.9	33.5
dimensional drawing				
operating temperature				
min.	°C	-40	-40	-40
max.	°C	+130	+130	+130

[1] depending on application, typical value for natural gas

[2] shear wave transducers:
typical values for natural gas, N_2, O_2, pipe diameters for other gases on request
pipe diameter min. recommended/max. recommended/max. extended: in diagonal mode and for a flow velocity of 15 m/s

Lamb Wave Transducers

technical type		GRG1NC3	GRH1NC3	GRK1NC3
order code		**GLG-NNNNL**	**GLH-NNNNL**	**GLK-NNNNL**
transducer frequency	MHz	0.2	0.3	0.5
min. operating pressure [1]	bar	30	30	30
outer pipe diameter [2]				
min. extended	mm	190	120	60
min. recommended	mm	220	140	80
max. recommended	mm	900	600	300
max. extended	mm	1600	1000	500
pipe wall thickness				
min.	mm	11	7	4
max.	mm	23	15	9
material				
housing		PPSU with stainless steel cap	PPSU with stainless steel cap	PPSU with stainless steel cap
contact surface		PPSU	PPSU	PPSU
degree of protection according to EN 60529		IP 65	IP 65	IP 65
dimensions				
length l	mm	128.5	128.5	128.5
width b	mm	47	47	47
height h	mm	69.9	69.9	69.9
dimensional drawing				
operating temperature				
min.	°C	-40	-40	-40
max.	°C	+170	+170	+170

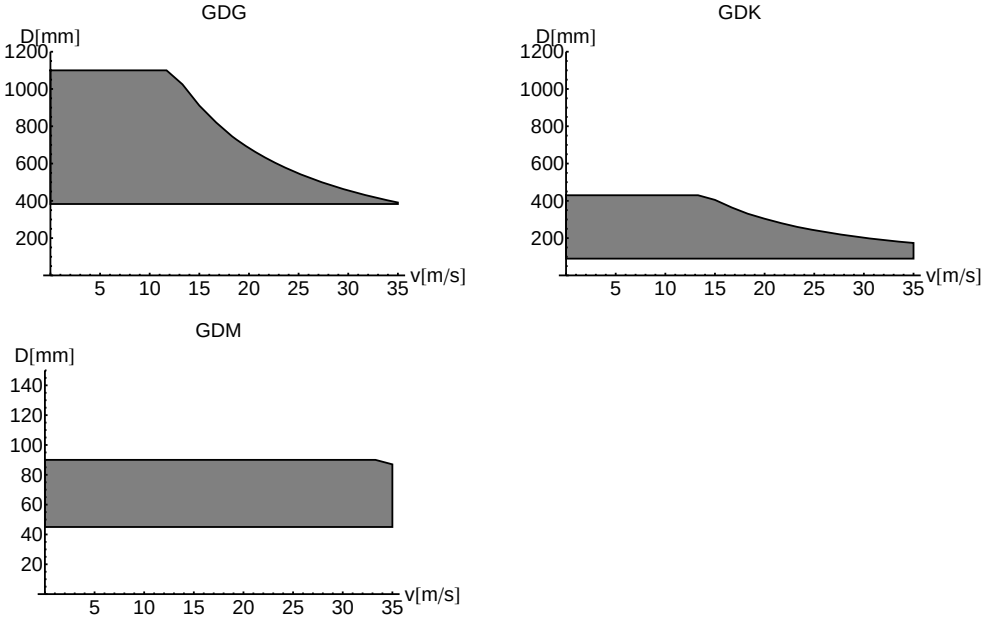
[1] depending on application, typical value for natural gas

[2] Lamb wave transducers:
typical values for natural gas, N_2, O_2, pipe diameters for other gases on request
pipe diameter min. recommended/max. recommended: in reflection mode and for a flow velocity of 15 m/s
pipe diameter max. extended: in diagonal mode and for a flow velocity of 25 m/s

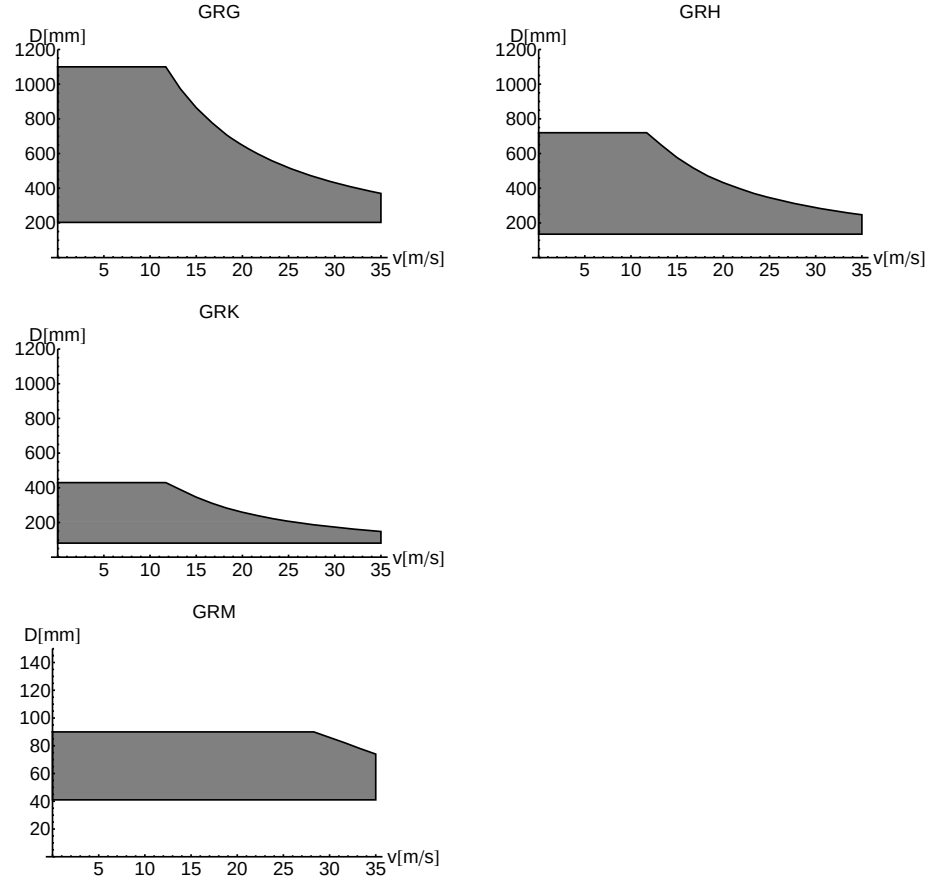
Max. Flow Velocity

for a typical application with natural gas, N_2, O_2 in reflection mode with 2 sound paths (Lamb wave transducers)/1 sound path (shear wave transducers)

Shear Wave Transducers



Lamb Wave Transducers

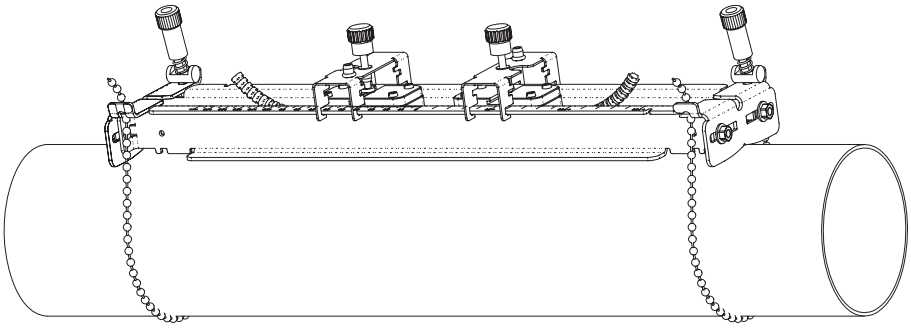


Order Code Key for Transducers

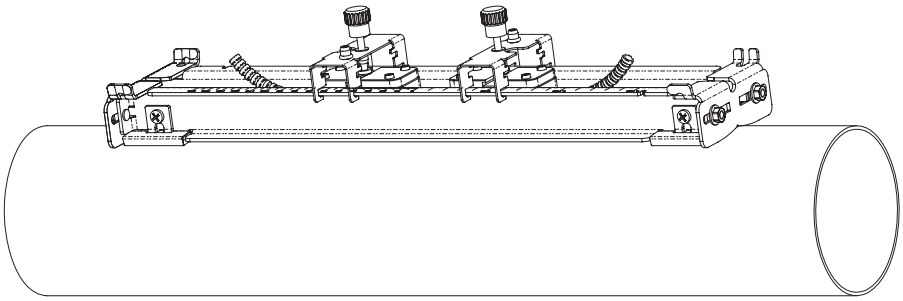
transducer model	frequency	-	temperature	explosion protection	connection system	-	extension cable	description
GL								set of ultrasonic flow transducers for gas measurement, Lamb wave
GS								set of ultrasonic flow transducers for gas measurement, shear wave
	G							0.2 MHz
	H							0.3 MHz (Lamb wave only)
	K							0.5 MHz
	M							1 MHz (shear wave only)
			N					normal temperature range
				NN				not explosion proof
					NL			with Lemo connector
							XXX	cable length in m, for max. length of extension cable see page 15
example								
GS	G	-	N	NN	NL	-	030	shear wave transducer 0.2 MHz, normal temperature range, connection system NL with 30 m extension cable and Lemo connector
		-				-		

Transducer Pipe Mounting Fixtures

Portable Variofix Mounting Fixture PVF and Chain



Portable Variofix Mounting Fixture PVF and Magnets (option)

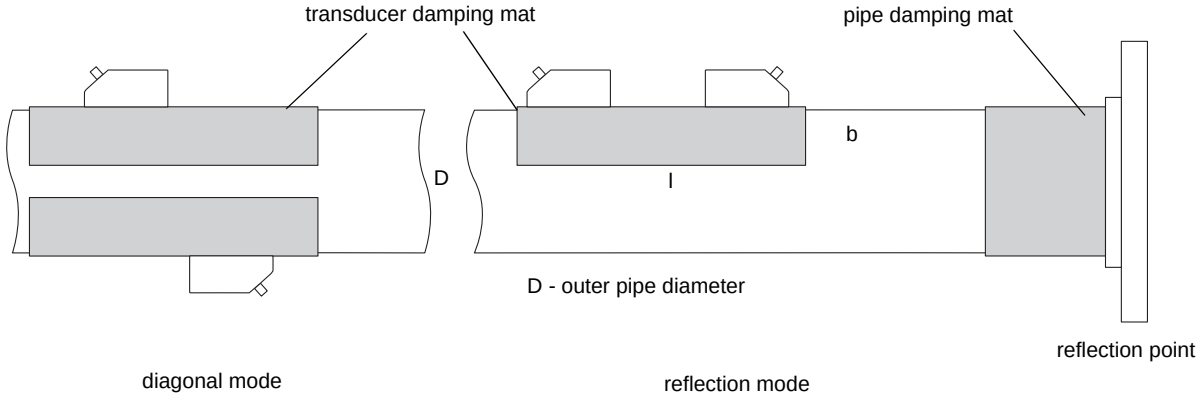


Damping Mats (Option)

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

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 G	H	K	M	P	techni-cal type	temperature °C	remark
transducer damping mat											
D	for temporary installation (multiple use), fixed with coupling compound	< 80	450 x 115 x 0.5	-	-	-	x	x	D20S3	-25...+60	
		≥ 80	900 x 230 x 0.5	-	-	x	x	-	D20S2		
			900 x 230 x 1.3	x	x	-	-	-	D50S2		
pipe damping mat											
A	for temporary installation (multiple use), fixed with coupling compound	< 300	300 x 100 x 0.5	x	x	x	x	x	A20S4	-25...+60	for number of pieces see table below
B	self-adhesive	≥ 300	l x 100 x 0.9	x	x	x	x	x	B35R2	-35...+50	l - see table below

Pipe Damping Mat Type A: Number of Pieces Depending on the Outer Pipe Diameter

outer pipe diameter D mm	number of pieces G, H	K, M, P
100	13	7
200	26	13
300	38	19
500	63	32
1000	126	63

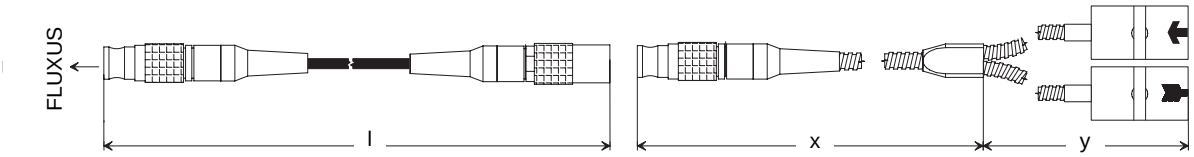
Pipe Damping Mat Type B: Length l Depending on Transducer Frequency and Outer Pipe Diameter

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

Connection Systems

Connection System NL

transducer frequency		G, H, K			M, P			Q			S		
		x	y	l	x	y	l	x	y	l	x	y	l
cable length	m	2	3	≤ 100	2	2	≤ 100	2	1	≤ 50	1	1	≤ 20



x, y - transducer cable length

l - max. length of extension cable

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9.7.2008 TSFLUXUS_G601V1-1EN