

DigitalFlow™ CTF878

Panametrics Correlation Tag Clamp-On Gas Ultrasonic Flow Meter



Applications

The DigitalFlow CTF878 clamp-on gas flow meter is a complete ultrasonic flow metering system for the measurement of most gases, including:

- Natural gas
- Compressed air
- Fuel gases
- Corrosive gases
- Toxic gases
- High-purity gases
- Air separation gases
- Specialty gases

Features

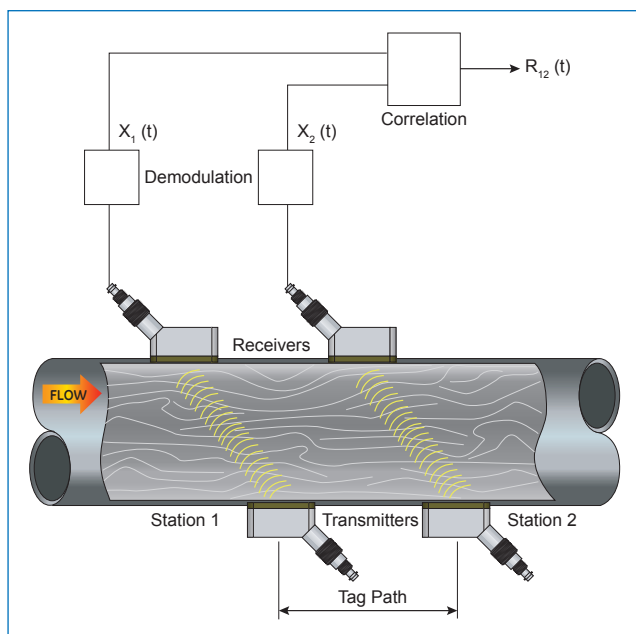
- Suitable for metal pipes with pressures as low as atmospheric pressure
- Clamp-on unobstructed installation
- No wetted parts
- No moving parts
- No pressure drop
- Simple installation
- Standard volumetric calculation (ideal gas)
- Suitable for a wide range of temperatures
- High velocity capability

Large-Pipe, High-Velocity, Clamp-On Gas Flow Meter

The DigitalFlow CTF878 clamp-on gas flow meter utilizes a new technology called correlation tag (patented) to determine gas flow rate. This technique is very different from traditional ultrasonic transit-time measurement and is well-suited for gas applications. The DigitalFlow CTF878 can measure a wide range of velocities in small to large pipes up to 200 ft/s (61 m/s), giving it broad applicability in gas flow measurement. It is used on plastic and metal pipes from 2 to 36 in. (50 to 900 mm) in diameter. Accuracy is excellent—better than ± 2 percent of reading—with repeatability of ± 0.2 to ± 0.6 percent of reading. The turndown ratio is 43-to-1.

The DigitalFlow CTF878 flow meter can be used in applications where penetrating the pipe wall is undesirable, making it ideal for erosive, corrosive, toxic, high-purity or sterile gases. Because the pipe is not tapped or cut, the cost for permanent installation is considerably lower than with other meters. There are no wetted or moving parts, there is no pressure drop, and maintenance is seldom required.

A complete system comprises the DigitalFlow CTF878 electronics, two pairs of advanced clamp-on gas ultrasonic transducers, two preamplifiers for the receiving transducers and a clamping fixture to mount the transducers on the pipe.

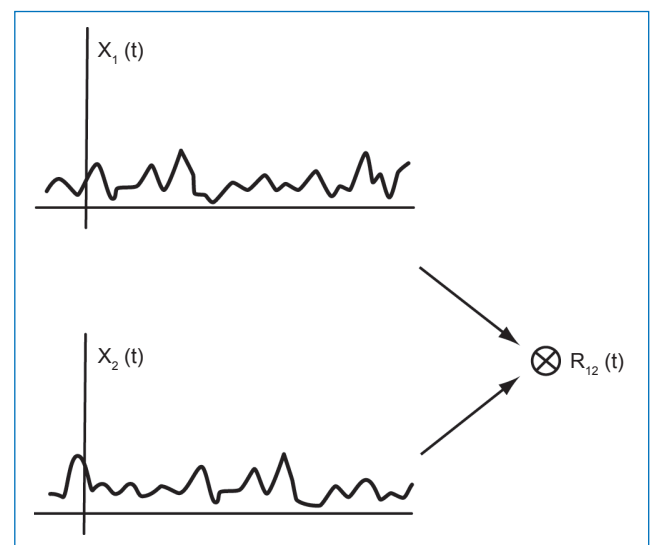


Schematic representation of a correlation tag flow meter setup

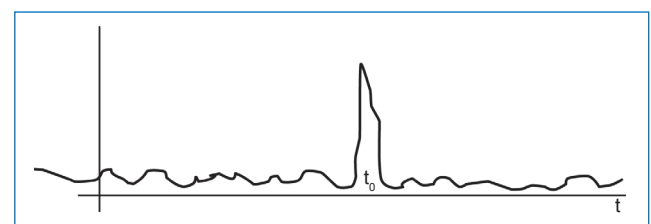
Correlation Tag Technology

The DigitalFlow CTF878 flow meter uses an ultrasonic signal pattern recognition technology, called correlation tag, for flow measurement. Correlation tag technology utilizes a total of four clamp-on transducers externally mounted on a pipe. The transducers are arranged in two pairs, one upstream and one downstream. Each pair includes one transmitter sending ultrasound in a continuous wave mode through the fluid to its receiver, forming an upstream and downstream interrogation path.

The continuous wave signal is modulated by turbulence and local density variations that are characteristic of a moving gas. Thus, both sets of the received signal contain a unique turbulence signature of the flowing gas. The received ultrasonic signals are demodulated and processed through a correlation algorithm. With turbulent flow conditions, a distinct correlation peak is recorded, which reflects the time it took for the unique turbulence signature to travel past each ultrasonic interrogation path. Since the distance between each interrogation path is defined in the transducer set-up, the flow velocity is determined by dividing distance by the time it took for the turbulence signature to pass between each interrogation path.



Two sets of data are "tagged" and cross correlated through proprietary algorithms.



A distinct correlation peak is formed for the time measurement (R_{12}).

Advanced Clamp-On Gas Ultrasonic Transducers

One of the biggest challenges in developing clamp-on ultrasonic transducers for gas applications is the difficulty in transmitting an ultrasonic signal through a metal pipe wall, through the gas, and then back through the pipe wall to the second transducer that is waiting to receive the signal. In gas systems, only 4.9×10^{-7} percent of the transmitted sound energy is actually received by traditional ultrasonic transducers. This simply isn't enough to produce reliable measurements.

New BHGE clamp-on gas transducers produce signals that are five to ten times more powerful than signals of traditional ultrasonic transducers. The new transducers produce clean, strong signals with very minimal background noise. The result is that the DigitalFlow CTF878 flow meter system performs well even in low-density gas applications.



The C-RS transducer is one of the technologically advanced clamp-on gas ultrasonic transducer available from BHGE.

Wide Range of Clamping Fixtures Available

Transducer alignment is crucial in obtaining accurate measurements in clamp-on gas installations. BHGE offers a wide range of clamping fixtures to help ensure proper alignment of transducers with minimal effort.

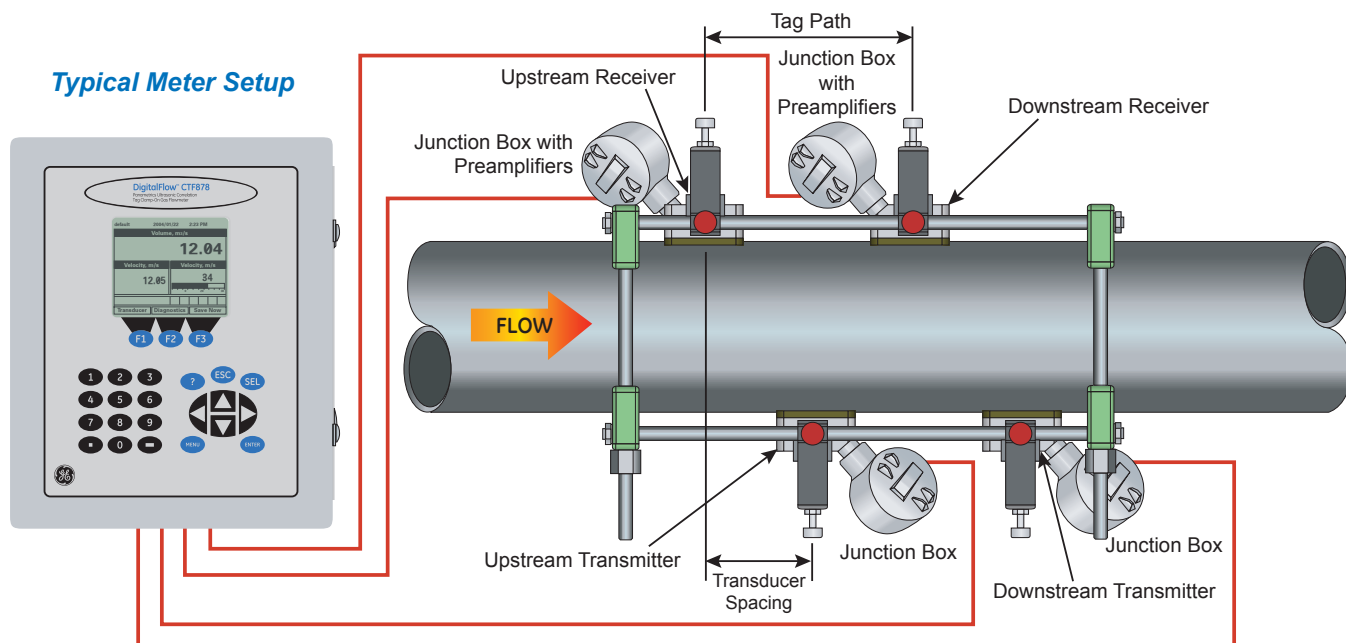
Convenient Installation

Straightforward installation is another advantage of the DigitalFlow CTF878 flow meter. The system consists of two pairs of transducers, a clamping fixture, two preamplifiers, and an electronics console. The transducers are clamped onto the outside of the existing pipe. The electronics console can be located up to 500 ft (150 m) from the transducers. Setup and output options allow the DigitalFlow CTF878 flow meter to be customized for any process.

No Pressure Drop, Low Maintenance

Because the transducers clamp onto the outside of the pipe, they do not obstruct the flow inside the pipe. This prevents the pressure drops typically caused by other types of flow meters. The DigitalFlow CTF878 has no components that will foul or collect debris, and there are no moving parts to wear out. As a result, it requires no lubrication and little or no routine maintenance.

Typical Meter Setup



CTF878 Specifications

Operation and Performance

Fluid Types

All acoustically conductive gases.

Minimum gas density: 0.074 lb/ft³ (1.2 kg/m³). Gas should not be wet or saturated with moisture.

Pipe Sizes

2 to 36 in. NB ANSI (50 to 900 mm DN)

Pipe Materials

Most metals and plastics. No lined pipes.

Flow Accuracy (Velocity)

±2% of reading

Repeatability

±0.2% to 0.6%

Range (Bi-Directional)

±10 to ±200 ft/s

(2 to 2.5 in./50 to 60 mm pipe size)

±7 to ±200 ft/s

(3 to 3.5 in./80 mm to 90 mm pipe size)

±5 to ±200 ft/s

(4 to 5 in./100 to 125 mm pipe size)

±3.5 to ±200 ft/s

(6 to 36 in. or 150 to 900 mm pipe size)

Gas Type and Minimum Pressure

Dry air, oxygen, nitrogen or argon: ≥14.5 psia (1 bara)

Sweet natural gas: ≥25 psia (1.7 bara)

Measurement Parameters

Velocity, actual and standard (ideal gas) volumetric flow, and totalized flow

Electronics

Flow Measurement

Correlation tag technique

Enclosures

- *Standard:* Epoxy-coated aluminum
- *Weatherproof:* Type 4X/IP66
- *Optional:* Stainless steel

Dimensions (h x w x d)

14.24 x 11.4 x 5.12 in. (362 x 290 x 130 mm)

Weight

11 lb (5 kg)

Channel

Single channel

Display

240 x 200 pixel backlit LCD graphic display

Keypad

24-key rubberized tactile membrane

Power Supply

85 to 264 VAC, 50/60 Hz (standard)

Operating Temperature

14 to 131°F (–10 to 55°C)

Storage Temperature

–40 to 158°F (–40 to 70°C)

Standard Inputs/Outputs

Two 0/4 to 20 mA isolated outputs, 550 Ω maximum load

Optional Inputs/Outputs

There are six expansion slots available for any combination of the following I/O boards:

- Analog Outputs: Select additional output boards, with four isolated 0/4 to 20 mA outputs, 1 k Ω maximum load
- Analog Inputs: Select one of the following:
 - *Analog Input board* with two isolated 4 to 20 mA inputs and 24 V loop power
 - *RTD Input board* with two isolated, three-wire RTD inputs; span –148 to 662°F (–100 to 350°C); 100 Ω Pt
- Totalizer/Frequency Outputs: Select output boards, with four outputs, software-selectable functioning in two modes:
 - *Totalizer Mode*: Pulse per defined unit of parameter (e.g., 1 pulse/ft³)
 - *Frequency Mode*: Pulse frequency proportional to magnitude of parameter (e.g., 10 Hz = 1 ft³/h), 10 kHz maximum
- Alarm Relays: Select one of the following:
 - *General purpose*: Relay board with three Form C relays
 - *Hermetically Sealed*: Relay board with three hermetically sealed Form C relays

Digital Interfaces

Standard: RS232

Optional: RS485 (multiuser)

Data Logging

Memory capacity (linear and/or circular type) to log over 6900 flow data points

Display Functions

- Graphic display shows flow in numerical or graphic format
- Displays logged data and diagnostics

European Compliance

- 2014/30/EU EMC Directive
- 2014/35/EU LVD Directive (Installation Category II, Pollution Degree 2)

Clamp-On Transducers

Temperature Range

–40 to 450°F (–40 to 232°C)

Area Classifications

Ex II 2 GD EEx md IIC T6

–40 to 167°F (–40 to 75°C), Kema 02ATEX2337X; C-US Class I, Division 1, Groups B, C, & D

Receiver Transducer Preamplifier

Operating and Storage Temperature:

–40 to 167°F (–40 to 75°C)

Clamping Fixture Materials

Anodized aluminum or stainless steel clamping fixture with rigid rail and strap

Clamping Fixture Size and Type

- 2 to 4 in. (50 to 100 mm) pipe: CFT-V4
- 5 to 8 in. (125 to 200 mm) pipe: CFT-V8
- 8 to 12 in. (200 to 300 mm) pipe: CFT-V12
- 14 to 36 in. (350 to 900 mm) pipe: CFT-PI

PanaView™ PC-Interface Software

BHGE's PanaView software allows the DigitalFlow CTF878 to communicate with a Windows® PC. (See the PanaView manual for details.)

Transducer Cable

Standard: Two pairs of type RG62 AU coaxial cables

Optional: Lengths up to 500 ft (150 m) maximum

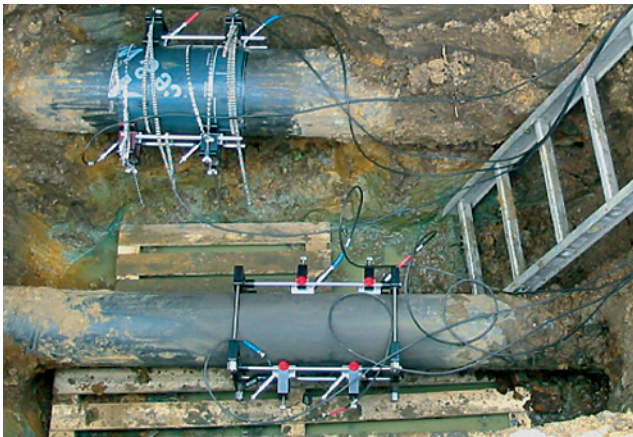
Pressure and Temperature Transmitters

Specifications available upon request

Installation Guidelines

Minimum Straight Run

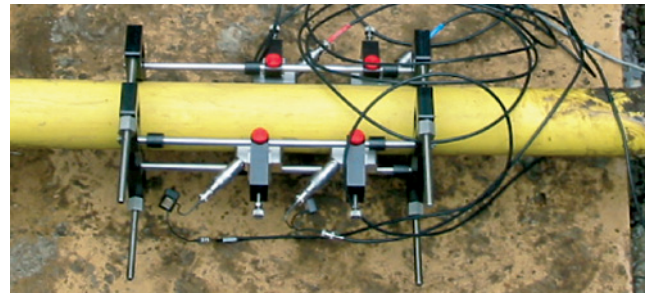
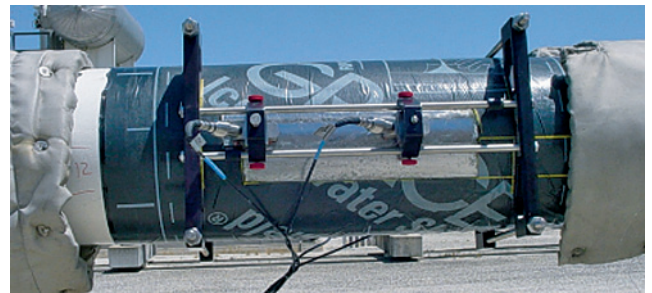
- 10 to 20 diameters (preferred) upstream
- 5 to 10 diameters (preferred) downstream
- Minimum of 20 diameters between circumferential welds



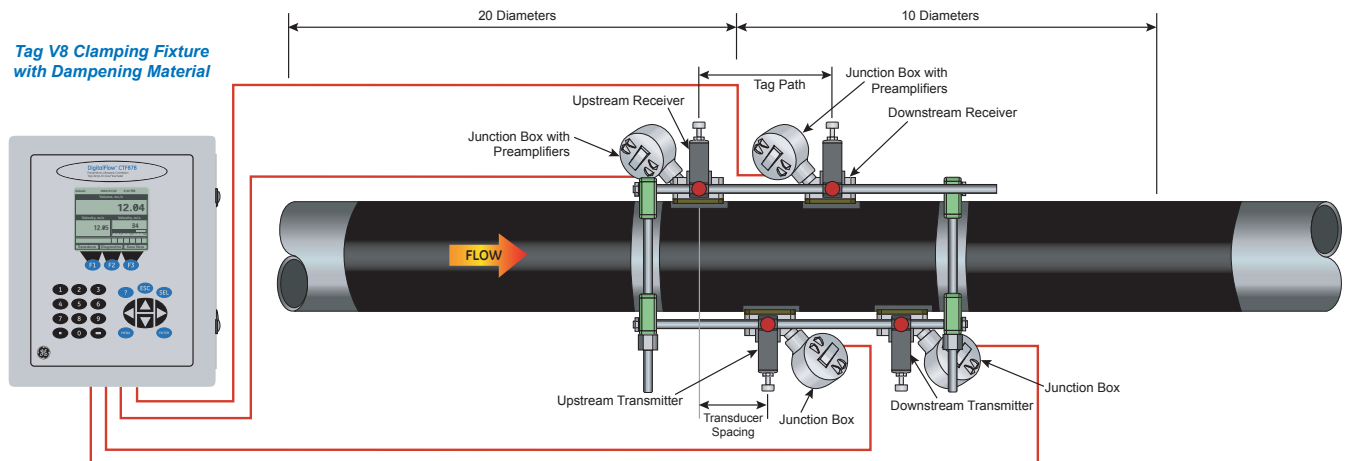
Dampening Material

May be installed inside and outside of the clamping fixture:

- For acoustic noise reduction
- Typically three sections of adhesive-backed rubber
- Not necessary for plastic pipe material (e.g. PE)



Tag V8 Clamping Fixture with Dampening Material



Independent Accuracy Test Results

pigsar™
National Standards of Germany for delivery of
high-pressure natural gas

COPY
page 3 of 5

Certificate Number: 3841/2005
Order: P-29712
Date: 2005-06-28

Applicant Name Customer Organization
Panametrics Limited

Meter under Test Type Ultrasonic meter CTF 878 Tag No: 48-FE 501
Manufacturer Panametrics
Serial number 517
Nominal Size 6"
Year of manufacture 2005

Testing Conditions p (absolute) = 20.61 bar T = 21.3 °C
p (average) = 16.510 kg/m² η = 11.55 x 10⁻⁴ Pa s

Testing medium Natural gas (analysis)
H₂ = 0.00 Vol.% CO₂ = 1.7 Vol.%
H₂ = 10.425 kWh/m³ K-ratio = 0.9629
p = 0.8426 kg/m³ at normal reference conditions (273.15 K; 101.325 kPa)

Results as found

Q / Q _{ref}	Q _i (m³/h)	velocity (m/s)	Deviation (%)	U _{rel} (%)	k-factor
0.10	263.96	4.00	-0.63	0.19	1.0063
0.25	668.77	10.12	-0.65	0.21	1.0065
0.49	1326.52	20.08	-0.74	0.24	1.0074
0.75	2029.00	30.72	-0.40	0.22	1.0040
1.00	2711.56	41.05	0.78	0.22	0.9921

Verification after adjustment (using of k-factors determined above)

Q / Q _{ref}	Q _i (m³/h)	velocity (m/s)	Deviation (%)	U _{rel} (%)
0.26	713.50	10.80	0.08	0.19
0.75	2029.57	30.63	0.02	0.33

The deviation is defined as:
$$\text{Deviation} = \frac{(\text{Indicated Volume} - \text{Reference Volume})}{(\text{Reference Volume})} \cdot 100\%$$

where the reference volume refers to the conditions at the meter under test. The reported values of this deviation are the arithmetical means of n single measurements at each flow-rate.

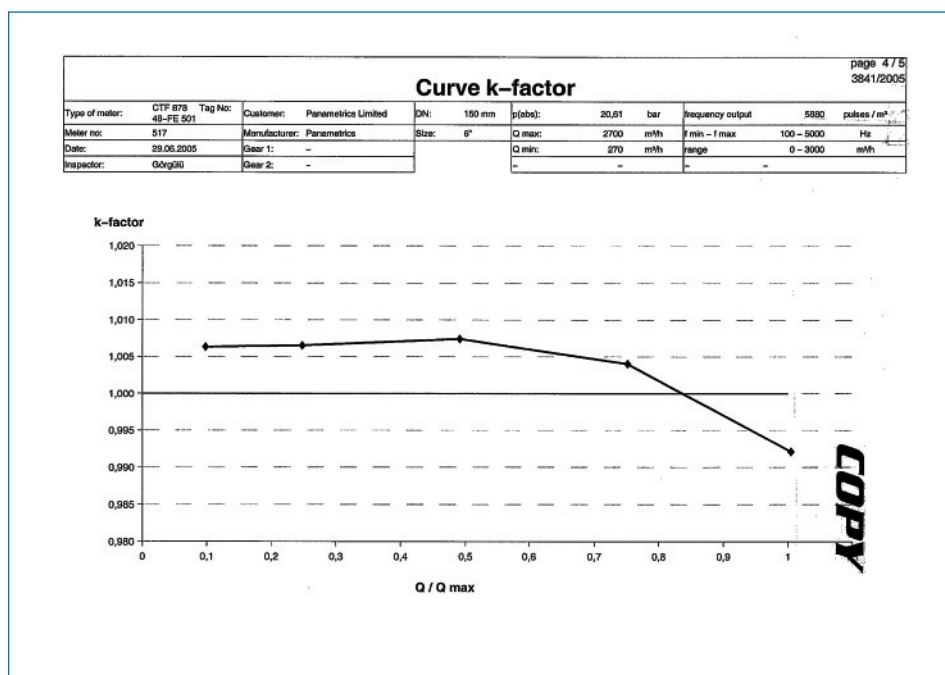
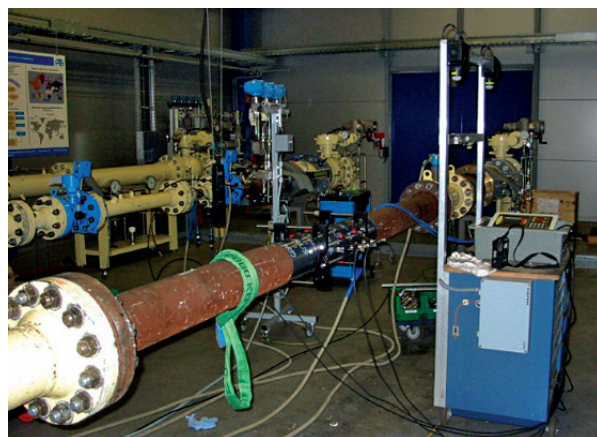
The reported total uncertainty is defined as:
$$U_{\text{tot}} = \sqrt{U_{\text{harmonized}}^2 + (k \cdot U_{\text{ref}})^2} \cdot (k+2)$$

where U_{harmonized} is the expanded uncertainty of 0.16% of the harmonized reference volume, stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, and U_{ref} is the standard uncertainty of the meter under test determined on the base of n single measurements of the meter under test at each flow-rate.

Remarks
Calibration was performed with a pulse factor of 6000 pulses/m³ according to frequency output 0 – 5000 Hz for flow range 0 – 3000 m³/h.
Values were calculated to a pulse factor of 5880 pulses/m³ according to meter settings of frequency output 100 – 5000 Hz, measured frequency was decreased by value of 100 Hz.
Straight upstream length clamp-on-system to flow straightener: 22 D (D = 6").

Tested in Dorsten at pigsar, on 2005-06-29 Görgülü

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