USM GT400 Ultrasonic Flowmeter

Honeywell

USM GT400 Ultrasonic Flowmeter Optimized for Custody Transfer for Gas.

The GT400 ultrasonic flowmeter is a solution for the most demanding gas flow/volume measurement applications. This innovative 6-path meter replaces older, intrusive meter designs and outperforms other traditional ultrasonic multi-path meters in custody transfer applications. It is available in 4-inch to 24-inch line sizes with industry standard ±0.1% uncertainty. The GT400 is supported by Honeywell's global expertise and unmatched local support capabilities.

Proven Technology. Superior Performance.

Applications

- Fiscal metering
- Low-pressure custody/non-custody (atmospheric) transfer
- Allocation metering
- Check metering
- Gas transportation and distribution
- Underground gas storage (bi-directional)
- Gas-fired power plants
- Gas processing plants
- Refining and petrochemicals
- Industrial

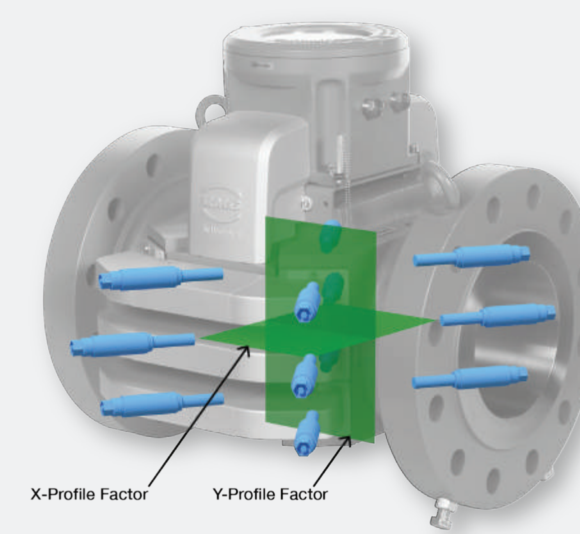
Key Features

- Field proven technology since 1999 in thousands of installations
- Intuitive RMGView^{USM} software for remote monitoring and meter diagnostics
- Key Diagnostics
  - Flow profile
  - Performance by path
  - Profile factor
  - Asymmetry
  - Turbulence
  - Automatic gain (AGC)
  - Signal to noise ratio (SNR)
  - Speed of sound (SoS) deviations
- CEESmaRT™ compliant–wireless remote Condition Based Monitoring solution
- Optimal path number and arrangement to best characterize flow profile
  - Non-reflective direct path chordal design
  - Six crossed ("X") paths on three parallel planes for "3D fidelity"
  - Truly measures in-plane cross flow
  - Detects asymmetry, single and double helix swirl
  - Insensitive to swirl and velocity profile asymmetry
  - Two paths can fail and meter still measures within fiscal limits per Measuring Instrument Directive (MID) and Measurement Canada
  - Performance exceeds AGA 9 requirements
- Measurement uncertainty of ±0.1% (flow calibrated)

Approved for fiscal metering accuracy to Measurement Canada/MID

- Measurement capability
  - Bidirectional measurement without pressure drop
  - Turndown ratio: >120:1 at line conditions
  - Gas velocity up to 130 ft/s (40 m/s) for all sizes (fiscal metering)
  - Low-to-high-pressure operation (0 psig-4351 psig, 0-300 barg)
  - Onboard AGA10 SoS calculation with direct GC input
- Insensitive to regulator noise
  - Proprietary, MID-approved firmware with advanced signal conditioning and high-power transducers handles ultrasonic noise in a wide range without additional noise reducing installations
- Insensitive to contamination
  - Since measurements are taken without ultrasound reflection, contamination on the pipe wall has no impact on the ultrasonic pulses. Furthermore, the Titanium sensor surface is contaminant-repellent.
- Patented "Live" Precision Adjustment/ Echo Measurement
  - Reduces measurement uncertainty due to in-situ auto calibration of internal system delay time (T_w) after field replacement of transducers
- Proven sensor technology
  - Fully encapsulated, high-power Titanium sensors
  - Exd design: ±200 V, 120 kHz / 200 kHz
  - Operational pressure: 0-4351 psig (0-300 barg)
  - Plug-and-play, field-replaceable design
- Compact design
  - Standardized meter body length
  - < 24" 3DN meter body length
  - ≥ 24" 2DN meter body length
- Easy installation and commissioning
  - "Honeywell User Experience" design enabling efficient operations for technicians
  - Advanced diagnostics
- Standard System and Communication Capability
  - RS485, Ethernet, analog and digital outputs, high-frequency output
  - Modbus (RTU, ASCII), TCP/IP
- Industry approvals
  - Metrological: Measurement Canada, PTB, MID
  - Hazardous area: CSA, ATEX, FM
  - Pressure: ASME, CRN, PED, TUV
- Comprehensive service and support
  - Subject Matter Experts for product and application consulting
  - Honeywell-authorized local/regional field technicians for start-up, commissioning and field service
  - Local technical support (24/7) and responsiveness
  - Spare parts support responsiveness (delivery within 48 hours)
  - Training for operators and field technicians
  - Project engineering, proposals and estimating, and project execution

RMGView^{USM} facilitates real-time performance monitoring of CBM parameters



Honeywell's advanced 6 Cross ("X") path technology.

Path Configurations

The six acoustic paths with their specific arrangement have the following significant advantages over 4-path meters:

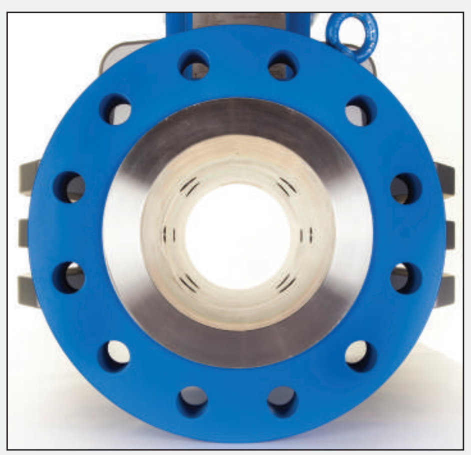
- **Insensitivity:** The path arrangement according to Gauss-Chebyshev with its crossed paths makes the gas meter largely independent of the flow profile. Thus, high-accuracy measurement is achieved without a flow straightener even in the case of flow disturbances causing swirl, asymmetry or cross flow.
- **Center Paths:** The path arrangement allows for two center paths creating a measurement at the center of the flow profile, which has been proven as a valid diagnostic path within the ultrasonic measurement industry.
- **Symmetry:** The path arrangement provides for symmetry within the X, Y, and Z-planes for "3D fidelity."
- **Redundancy:** The 6-path meter will not lose its custody transfer metering capability if any one or two of its acoustic paths fail. The failed paths will be reconstructed by means of a replacement-value function learned by the gas meter using the measuring results of all functioning paths.
- **Transferability:** The unique 6-path 3D symmetrical layout means that results achieved on a traditional test stand are more readily transferred to actual on-site, non-ideal conditions.

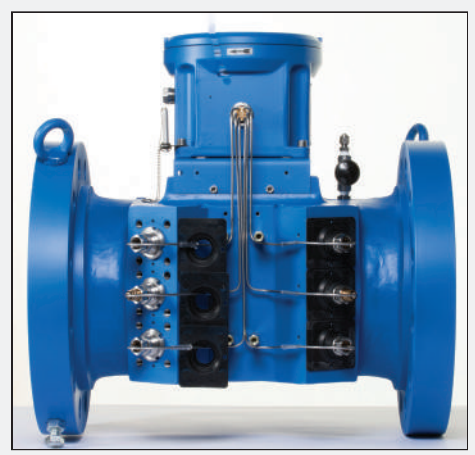
Transducer

The transducer consists of a piezoelectric crystal fully encapsulated in Titanium housing and operating with a frequency of 120 kHz to 200 kHz. Its Exd design allows high signal amplitude resulting in high signal-to-noise ratio (SNR) in comparison to traditional intrinsically safe designed transducers.

Ultrasonic noise created by gas pressure regulators and control valves at these frequencies has marginal impact on measurements.

120 kHz transducer





Precision Measurement / Echo Measurement (Patented)

The test for system delay time and adjustment described in AGA 9 (6.3) is necessary due to the fact, that beside the time-of-flight of the ultrasonic pulses, delay times may occur within the system, which are caused by the signal processing electronics, properties of the transducers and calculation algorithms. As these delay times cannot be identified directly, they must be determined at the factory by costly measurement methods.

Assuming there is no flow through the meter, the time of flight of a sound pulse is given by the following equation:

(Equation 1):

$$t = L/C_{th} + t_w \longleftrightarrow t_w = t - L/C_{th}$$

Where:

t = Transit time upstream (sec)

L = Path length (ft or m)

C_{th} = Theoretical Speed of Sound (ft/s or m/s)

To determine the system delay time "t_w" all other measured values of this equation have to be determined exactly. The ultrasonic gas meter directly measures the time of flight "t." The path length "L" can be measured exactly, at least for all meters with face-to-face arrangement of the transducers (working without reflections).

More challenging is the determination of the theoretical SoS "C_{th}." It can be calculated by the use of algorithms (AGA8/AGA10), taking into account the gas composition, as well as the actual gas temperature and pressure. To minimize the measurement uncertainty, the meter should be filled with a gas of well-known speed of sound (e.g., N2). Pressure and temperature have to be kept stable during the measurement and measured precisely. Most critical is the measurement of temperature, as levels of differing temperatures may occur inside of the meter.

Obviously, this method includes various possible sources of errors, which contribute to and increase the measurement uncertainty. Most importantly, it is not possible to verify this delay time "live" in the field, especially after a transducer exchange.

Honeywell's patented Precision Measurement/ Echo Measurement method enables the most precise adjustment of delay time and avoids all disadvantages of the classical method described above. For this adjustment, two measurements have to be done per shot:

- Time-of-flight between S_1 and S_2: t_1
- First echo on the receive sensor: t_2

The fundamental equations are:

(Equation 2):

$$C_1 = L/(t_1 - t_w)$$

(Equation 3):

$$C_2 = 3*L/(t_2 - t_w)$$

$$C_1 = C_2 = const. \text{ (for short times)}$$

Combining equation 2 and 3 and rearrange it to t_w:

(Equation 4):

$$t_w = (3*t_1 - t_2)/2$$

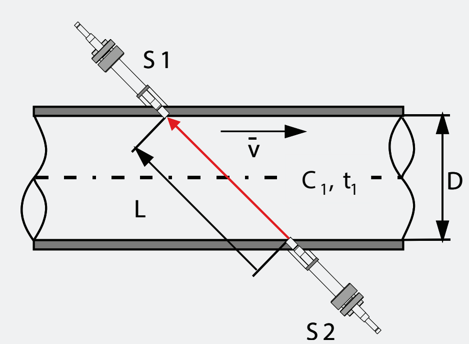
Where:

$t_{1,2}$ = Transit time (sec)

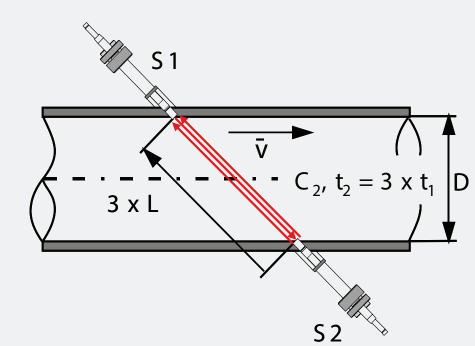
L = Path length (ft or m)

$C_{1,2}$ = Speed of Sound (ft/s or m/s)

t_w = Delay time (sec)



Direct USM measurement of signal



Echo measurement

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Instead of the time-of-flight t_1 for direct distance between sender and receiver, the time-of-flight t_2 for the first echo, reflected on receiver and sender, is measured. From Figure 5 it is evident that in this case, the path length is tripled. Both measurements provide a measured value for the speed of sound *(C_1 and C_2)*. Out of these measurements, the delay time can be determined precisely and "live" in the field.

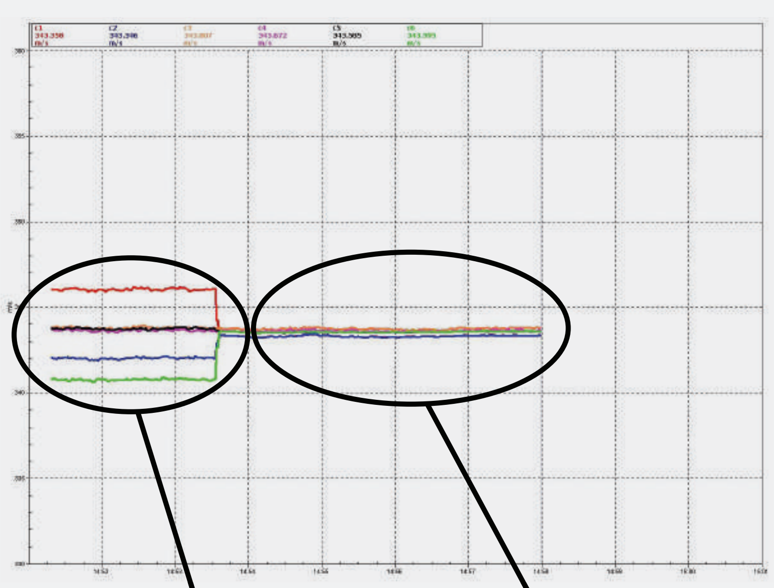
This method provides the following unique advantages:

- Composition of gas inside the meter can be unknown
- Measurement is independent of the theoretical value of the Speed of Sound
- As the absolute value of the SoS is not needed, pressure and temperature are not measured
- Adjustment can take place at any time or after a transducer exchange in the field
- Determination of the delay time is done automatically
- Higher accuracy in the determination of SoS
- Live monitoring of the transducers
- Temperature, pressure, moisture, aging of sensors and electronics have no influence on the calibration result
- Verification of the meter can be performed in the field under operating conditions

Figure 6 shows in a very notable way the influence of "live" dry calibration in comparison to the standard modus without echo measurements.

As explained, this echo measurement method allows a much more accurate determination of the speed of sound, and the transit time determination is also more accurate. This implies that the flow measurement accuracy overall is higher than conventional ultrasonic meters without echo measurements.

Standard USM operation without T_w calibration vs. USM operation after precision-adjustment mode is switched on



Standard USM Operation without t_w calibration, e.g. on the first factory start-up of the meter or after sensor change.

USM Operation after Precision-Adjustment-Mode is switched on! Real time Dry-Calibration under live conditions!

New RMGView[USM] CBM

Key Features:

Intuitive Graphical Interface:

- Flow profile
- Performance by path
- Profile factor
- Asymmetry
- Turbulence
- Automatic gain (AGC)
- Signal-to-noise ratio (SNR)
- Speed of sound deviations

First, RMGView[USM] monitors the health of the USM GT400 meter and warns if there are any pending problems (e.g., transducer failure).

Secondly, it monitors the gas process and alerts when there are any upset conditions (e.g., pipeline contamination, blockages or liquids in the gas stream).

Thirdly, monitors calculated metering uncertainties and provides alarm notification.

Technical Specifications

	High pressure > 58 psi/4 bar							
	Qmin		Qmax		Qmin		Qmax	
Measuring Range	ACFH	ft/s	ACFH	ft/s	m³/h	m/s	m³/h	m/s
DN 100/4"*	283	0.98	35315	122.82	8	0.30	1000	37.4
DN 150/6"	706	1.08	84755	129.93	20	0.33	2400	39.6
DN 200/8"	1130	0.99	148322	129.89	32	0.30	4200	39.6
DN 250/10"	1766	0.98	233077	129.91	50	0.30	6600	39.6
DN 300/12"	2472	0.97	331958	130.78	70	0.30	9400	39.9
DN 400/16"	4238	1.05	529720	131.73	120	0.32	15000	40.2
DN 500/20"	6357	1.01	829895	131.37	180	0.31	23500	40.0
DN 600/24"	9182	1.01	1200699	131.52	260	0.31	34000	40.1

			Length		Height		Width		Weight (ca.)	
Meter Dimensions	Diameter	Pressure Class	(mm)	(in)	(mm)	(in)	(mm)	(in)	(kg)	lbs)
	DN 100/4"*	ANSI 600	300	12	330	13	430	17	100	220
	DN 150/6"	ANSI 600	450	18	340	13	470	19	160	353
	DN 200/8"	ANSI 600	600	24	360	14	530	21	300	661
	DN 250/10"	ANSI 600	750	30	380	15	650	26	450	992
	DN 300/12"	ANSI 600	900	35	395	16	700	28	550	1213
	DN 400/16"	ANSI 600	1200	47	500	20	750	30	950	2094
	DN 500/20"	ANSI 600	1500	59	550	22	900	35	1500	3307
	DN 600/24"	ANSI 600	1200	47	550	22	1000	39	1550	3417

Technical Data	
Gases	Pipeline Quality Natural Gas, Air
Measurements	Volume Flow, Totalized Volume, Velocity of Gas, Speed of Sound, Swirl
Sizes	6", 8", 10", 12", 16", 20", 24" (ANSI 600); Consult Honeywell for sizes > 24".
Path Configuration	6 Direct Cross ("X") Path; 3 Planes
Measurement uncertainty (from Qt to Qmax)	
Dry calibration with Nitrogen acc. AGA 9	+/-0.5%
HP-flow calibration. Full measuring range (Qt to Qmax).	+/-0.1%
Repeatability	
Operating Pressure Range	14.5 psi (1 bar)…..4351 (300 bar)
Flanges	up to ANSI600; Consult Honeywell for higher design pressure
Ambient Temperature	-40°F (-40°C) to 131°F (+55°C)
Gas Temperature Range	-40°F (-40°C) to 176°F (+80°C)
Operating Relative Humidity	up to 95% condensing
Measuring Interval	Typically 32 measurements/sec
Power supply	24 V/DC +/- 10%
Power requirement	Typically 7 W
Hazardous Area Approvals	CSA, FM: Class I, Div 1, Groups B, C, D T6; ATEX: Ex II 2G Ex de IIB + H2 T6; IECEx: Ex de IIB + H2 T6 Gb
Metrology Approvals	Measurement Canada, MID, PTB
Conformoties	AGA9
Electrical Safety	EMV, Environmental
Analog output	0/4-20 mA (galvanically isolated, programmable, load resistor: max. 400 Ohm, Umax = 16 V)
Frequency outputs	2 HF-outputs with fmax = 5 kHz, Namur pr Open Collector
Digital I/O	2 X Programmable
Analog input for P&T	Galvanically isolated two-wire 4-20 mA p-transmitter or a 4-wire PT100
Interfaces	
RS 485-0	Service port with MODBUS-Protocol; RMGView[USM] (max. cable length: 1640 ft); Ethernet via external module
RS 485-1	Customizable for special interfacing requirements
RS 485-2	MODBUS-protocol for interfacing with Flow Computers, SCADA; Ethernet via external module
Transducer Frequency	120 kHz/200 kHz for Sizes ≥ 8" (DN 200)
	200 kHz for Sizes ≤ 6" (DN 150)
RMGView[USM] Diagnostics Software	Visualization, flow data, diagnostics, configuration, parameter changes, export/import of parameters and data
Protection	IP66
Meter Body Material	Casted Steel; CS ASME A352 gr LCC
Material Electronics Housing	Aluminum cast
Color/Finish	Metallic Silver (RAL9006, 5-9% gloss) and blue (RAL Design 260 40 40, 5-9% gloss)
Installation outside	With weather protection cover and sun roof
Remarks	Consult Honeywell for special requirements

*Consult Honeywell for 4" and Sizes > 24"

Technical data is subject to change without notice.

For More Information

To learn more about Honeywell's USM GT400, contact your Honeywell Process Solutions representative, or visit www.honeywellprocess.com.

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DS-USMGT400-US
March 2014