



ALTOSONIC V LNG

5-Beam ultrasonic flow meter for custody transfer of LNG

- The successor to shore tank and ship tank inventory measurement.
- Provides guaranteed 0.3% OIML-approved accuracy for true custody transfer independent of external influences such as tank geometry, strapping tables, or ambient conditions.
- Automatic LNG flow detection for accurate flow measurement of billable product
- Cryogenic design for highest available accuracy



It's time to consider a good and reliable custody transfer metering system for LNG ...

Now you can rely on an LNG metering system from the inventor of multi-beam custody transfer metering that offers the highest and consistently available accuracy that is independent of unknown and uncorrected variables such as tank geometry and ambient temperatures.

- **Accurate**

Reduces give-away through accurate and correct measurement
(10 times more accurate than existing tank inventory systems)

- **Universal multi-product**

Multi-beam means you can use one off-loading meter to discharge various ships with varying product of different calorific values from various origins. When used at loading origin and off-loading destination it can reliably measure boil off and loss in transit.

- **Reliable**

Multi-beams not only provide product differentiation, they also provide multiple built-in redundancy ensuring no drop in metering availability.

- **Cost-conscious**

The straight tube internal design causes no pressure drop and therefore lowest discharging costs. Auto detection of LNG as opposed to boil off, with automatic start of measurement for true discharge quantities.

- **Safe**

No chance of flash gasification in meter causing increased gas in receiving tanks.

No other system available provides as many advantages as
ALTOSONIC V LNG

The design ensures better accuracy

ALTOSONIC V LNG

- Custody-transfer ultrasonic flow meter

KROHNE is the company with the longest experience in multi-beam ultrasonic flow measurement. Our cryogenic measurement experience goes back many years. This led to the development of the ALTOSONIC V LNG as more accurate replacement for tank inventory measurement.

- The internal design makes the difference

Regular ultrasonic liquid flow meters can measure LNG. But our customers wanted more accuracy, more reliability, more trustability. Features they are accustomed to from KROHNE.

- Full bore measuring tube to avoid gasification or density changes
- Specially isolated transducers to prevent crosstalk and maximise signal strength
- Special transducer windows to maximize contact with product and reception of transmitted beam, again for better signal quality
- Experience-based algorithms for perfect determination of flow from signals and therefore maximum accuracy
- Redundant beams ensure permanent availability throughout the tanker discharge

Award-winning technology

At the 2009 Expogaz exhibition in Lyon, France, ALTOSONIC V LNG was awarded the First Prize in the category of technological advancement. The judges found that the unique transducer construction with its anti-crosstalk feature went further than ever before to ensuring the best possible measurement under cryogenic conditions.





Fully tested by NIST,
Germany's PTB and the
NMI in the Netherlands.

ALTOSONIC V LNG is
certified to -200°C

Translation by KACROW Altonator Original language: German
Physikalisch-Technische Bundesanstalt
 Braunschweig and Berlin

3. SUPPLEMENT
 according to Directive 89/336 Annex III B
 to EC-TYPE-EXAMINATION CERTIFICATE PTB 01 ATEX 2012 X

Equipment: Same as test type UPS 500 F-Ex, UPS 500 F-H2O-Ex, UPS 500 F-H2S-Ex,
 UPS 500 F-Ex and UPS V...-Ex

Marking: **Ex** II C Ex II MC TB...T4/T5

Manufacturer: KACROW Altonator
 Address: Harkhofweg 12, 37113 LC Dordrecht, The Netherlands

Description of assessment and modifications
 The same test type UPS 500 F-Ex, UPS 500 F-H2O-Ex, UPS 500 F-H2S-Ex, UPS 500 F-Ex and UPS V...-Ex may also be manufactured and operated in accordance with the test documents listed in the test report. The modifications concern the introduction of two new variants of type UPS V...-Ex (same type designation UPS 500 F1079-EEG) for use at very low (especially high medium) temperatures.

The type designations read as follows:
 UPS V...T-Ex Low Temperature (down to -200°C)
 UPS V...E-Ex Extra Extended Temperature (up to $+200^{\circ}\text{C}$)

Both variants have an identical construction and only differ in the application for the respective temperature range (especially suitable material ratios).
 The range of permissible ambient temperature amounts to -40°C to $+40^{\circ}\text{C}$.

The marking reads: **Ex** II C Ex II MC TB...T2

The permissible medium temperatures of the respective design in dependence of the temperature class are listed in the following table:

| Type | UPS-V...T-Ex | UPS-V...E-Ex |
|-------------------|--|-----------------------|
| Temperature class | -200°C | -40°C |
| T4 | Maximum permissible medium temperature | |
| T5 | 60°C | 80°C |
| T4 | 120°C | 120°C |
| T3 | 180°C | 180°C |
| T2 | | 200°C |

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NMI Evaluation certificate
 Number TCM85 Evaluation B
 Report number 202119
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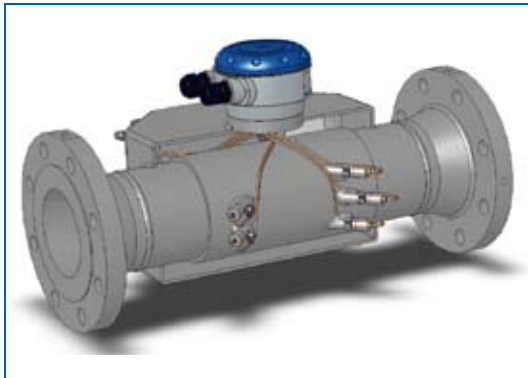
Issued by: NMI Corin B.V.
 Hoop 40 Groningen 1
 3014 GD, Groningen
 The Netherlands

In accordance with: The "Microprocessor" Risk 2006, IEC 61508 (as implementation of the Directive 2004/50/EC on measuring instruments (MIS))

Applicant: KACROW Altonator
 Harkhofweg 12
 3711 LC, Dordrecht
 The Netherlands

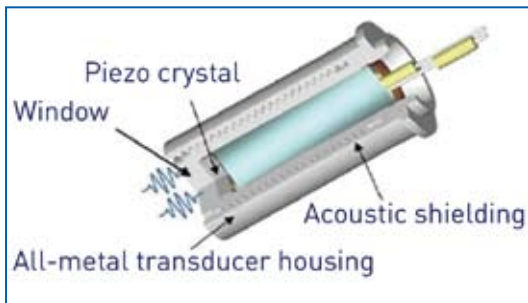
In respect of: **A Measurement sensor (Electronic measurement sensor)**
 Manufacturer: KACROW
 Designation: ALTOSONIC V UPS V (Steel)
 Order / Order no.: See paragraph 1.1 of the description
 Minimum measured quantity: See paragraph 1.2 of the description
 Accuracy: See paragraph 1.3 of the description
 Environmental class: IEC 60721 (Industrial)
 Temperature range ambient: -20°C to $+40^{\circ}\text{C}$
 Temperature range liquid: -200°C to $+100^{\circ}\text{C}$
 Intended for the measurement of: H_2 , CO , CO_2 , CH_4 , C_2H_6 , C_3H_8 , C_4H_{10} , C_5H_{12} , C_6H_{14} , C_7H_{16} , C_8H_{18} , C_9H_{20} , $\text{C}_{10}\text{H}_{22}$, $\text{C}_{11}\text{H}_{24}$, $\text{C}_{12}\text{H}_{26}$, $\text{C}_{13}\text{H}_{28}$, $\text{C}_{14}\text{H}_{30}$, $\text{C}_{15}\text{H}_{32}$, $\text{C}_{16}\text{H}_{34}$, $\text{C}_{17}\text{H}_{36}$, $\text{C}_{18}\text{H}_{38}$, $\text{C}_{19}\text{H}_{40}$, $\text{C}_{20}\text{H}_{42}$, $\text{C}_{21}\text{H}_{44}$, $\text{C}_{22}\text{H}_{46}$, $\text{C}_{23}\text{H}_{48}$, $\text{C}_{24}\text{H}_{50}$, $\text{C}_{25}\text{H}_{52}$, $\text{C}_{26}\text{H}_{54}$, $\text{C}_{27}\text{H}_{56}$, $\text{C}_{28}\text{H}_{58}$, $\text{C}_{29}\text{H}_{60}$, $\text{C}_{30}\text{H}_{62}$, $\text{C}_{31}\text{H}_{64}$, $\text{C}_{32}\text{H}_{66}$, $\text{C}_{33}\text{H}_{68}$, $\text{C}_{34}\text{H}_{70}$, $\text{C}_{35}\text{H}_{72}$, $\text{C}_{36}\text{H}_{74}$, $\text{C}_{37}\text{H}_{76}$, 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Design features for better accuracy and reliability.



Straight body - full-bore metering tube

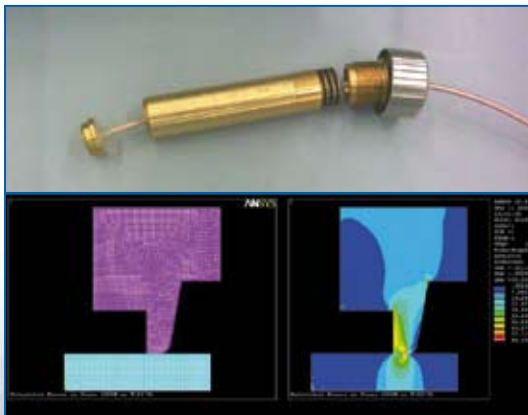
Tankers are discharged as quickly as possible, since time is money. The full-bore design of the ALTOSONIC V LNG ensures absolutely no change in flow conditions from the pipeline through the meter and beyond. There is no pressure loss nor flow rate deviations. The result is consistently accurate metering, without any risk of in-line gasification.



Anti-crosstalk transducers - higher accuracy

Under severe cryogenic conditions a normal transducer would leak the signal around the meter body to the opposite transducer. This would result in a much higher noise, and make measurement less sensitive.

ALTOSONIC V LNG overcomes this by a unique acoustic shielding that prevents acoustic leakage outside the transducer.



Ultracontact window - maximum signal

Contact between the LNG and the piezo-generated signal would fall at cryogenic temperatures if you use a normal transducer- The ALTOSONIC V LNG transducers have specially researched laminar window materials whose Young's modulus and conductivity properties are optimized for LNG at -163°C . There is no signal deterioration, no drop-outs, and no noise.

The better the signal, the better the measurement.





ALTOSONIC V LNG

From liquefaction to de-gasification

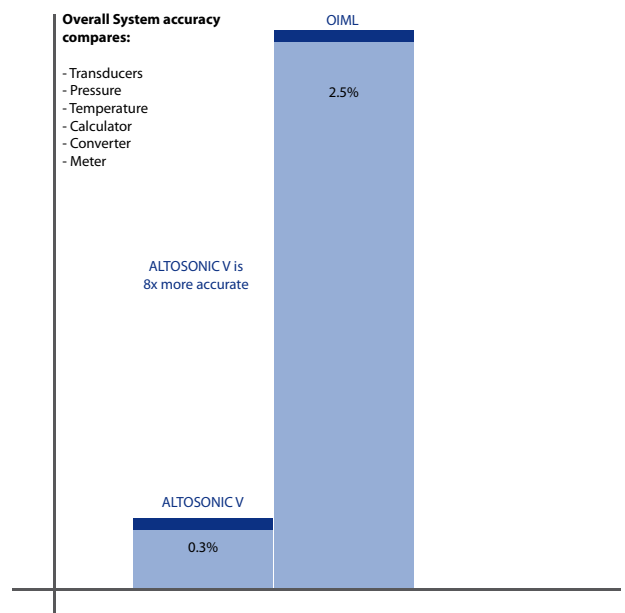
ALTOSONIC V LNG ultrasonic custody-transfer flow meter can be used along the entire chain:

- Liquefaction plant
- LNG Tanker loading
- LNG Tanker off-loading
- De-gasification
- Also as part of a Leak Detection and localisation system

Values obtained at one site are comparable 1:1 with values obtained with any ALTOSONIC V LNG anywhere in the world.

Thus you can obtain an accurate measurement of plant output, accurate boil-off figures, accurate off-loading to intermediate storage and accurate feed to the de-gasification plant - therefore maximum plant efficiency.

There is no variables such as tank geometry, strapping tables, environmental or geographic issues.



ALTOSONIC V LNG

Performance that pays off

Numerous authorities have attested the excellent accuracy of ALTOSONIC V LNG. It is more accurate than all currently available standards and a factor of min. 8 times more accurate than standard inventory procedures.

The pay-off is less give-away, more accurate billing, standardised measurement throughout the world from the liquefaction plant to de-gasification.

Years of experience confirm the quality of the ALTOSONIC V and the consistent accuracy that remains stable for decades. (Vigdis field unmanned metering station in the North Sea, data between 1998 and 2009)

| ALTOSONIC V LNG Accuracy | |
|--------------------------|--------------------------------------|
| Certificate number | TC7485 |
| MID directive | 2004/22/EC |
| Diameter range | up to 24 inch (higher on request) |
| Flow range | 1:50 |
| Minimum velocity | 0.2 m/s |
| Viscosity range | 0.1 to 400 cSt |
| Minimum temperature | -200 °C |
| Accuracy | +/- 0.2 % during initial calibration |

Tank inventory versus custody-transfer flow measurement

A typical tanker has a capacity of 125,000 m³.

A typical voyage tanker lasts 20 days.

A tanker can do around 10 round-trips per year including the time for waiting and discharge.

Each tanker transports 1.25 million m³ per year.

Flow accuracy is 8 times more accurate than inventory accuracy.

Tank inventory 2.5%

ALTOSONIC V LNG 0.3%

**The difference is 27,500 m³ per tanker per year
US \$ 3 million at current spot prices!**



Technical data

| | |
|--------------------|--|
| Approvals | |
| Custody transfer | |
| MID approval | Measuring Instrument Directive, MID 005, 2004/22/EC |
| OIML | R-117-1 Class 0.3 |
| API | Chapter 5.8 Section 8 |
| National approvals | Over 20 national approvals world wide i.e. ONML (Algeria), BEV (Austria), ANP (Brazil), INMETRO (Brazil), LNE (France), JJG 1030 (China), PTB (Germany), Legal Metrology Dept. (India), Migas (Indonesia), UTIF (Italy), SIRIM (Malaysia), CENAM (Mexico), Justervesne (Norway), DTI (United Kingdom), NMi (Netherlands), DPR (Nigeria), NOC (Libya): |
| GOST | Gosstandart approval for Russia |
| ATEX | |
| UFS-V | PTB 01 ATEX 2012 X (part of the UFS 500 approval) II 2 G EEx ib IIC T6 ...T4 |
| UFC-V | KEMA 02 ATEX 2168 II 2 G EEx [ib] IIB T5 |

| | |
|-------------------------|---|
| Performance | |
| Measurement parameters | Actual volume flow rate and totalised volume |
| Maximum measuring range | -10 m/s < velocity < +10 m/s (-66 ft/s < velocity < +66 ft/s) |
| Minimum measuring range | 0.2 m/s |
| Diameter range | 4 ... 40 inch |
| Viscosity range | 0.1 ... 400 cSt (higher viscosities on request) |
| Density range | 200 ... 1200 kg/m ³ |
| Zero stability | < 0.2 mm/s |
| Accuracy | < 0.2 % of measured value for 1 m/s to 10 m/s |
| Repeatability | OIML ± 0.06 % |
| Uncertainty | ± 0.027 % [95 % confidence level] |

| Installation requirements | |
|---------------------------|---|
| General | Process conditions are always required and must be forwarded and discussed with KROHNE specialists. |
| Position | The flow meter can be installed in a horizontal or vertical position. In a horizontal pipeline the transducers need to be installed in a horizontal plane. |
| Completely filled sensor | The UFS-V sensor needs to be installed at a location in which a completely filled pipeline is guaranteed. |
| Flow conditioning | Inlet: Minimum standard requirements are 10D straight inlet pipe section with integrated ISO pipe bundle or if no presence of swirl 20D inlet is sufficient. Outlet: On the outlet a minimum of 3D straight pipe section is required |
| Bush guides | The UFS-V sensor and inlet pipe section are provided with "bush guides" to guarantee optimum installation on site. |
| Zero checking | Zero setting is NOT required with KROHNE ultrasonic flow meters. |
| Cavitation | Sufficient back pressure is required to avoid cavitation. |
| Water in oil (well mixed) | 6 % @ > 1 m/s |
| Maximum air/gas content | Standard < 2% (Vol.), for higher content < 15% consult KROHNE |
| Maximum solid content | Standard < 5% (Vol.), for higher content consult KROHNE |
| Humidity | Maximum 95 % humidity for all components |

| Materials | |
|--|--|
| UFS | |
| Flanges | Stainless steel AISI 316 L (1.4404) |
| Measuring tube | Stainless steel AISI 316 L (1.4404) |
| Housing | Stainless steel AISI 316 L (1.4404) |
| Connection box | Stainless steel AISI 316 L (1.4404) |
| UFC | |
| Ex-d housing | Copper free aluminium, AISI 12 according to ISO 3522 – 81 (other materials on request) |
| Inlet & Outlet section | |
| Flanges/pipe | Carbon steel ASTM A105 / Carbon steel ASTM A106 (other materials on request) |
| Flow conditioner | Stainless steel |
| Finish UFS, UFC and in/outlet sections | |
| Standard | KROHNE silver |
| Optional | KROHNE offshore paint |
| Protection category | |
| UFP | IP 67 equal to NEMA 4/4X/6 to IEC 529 |
| UFC | IP 67 equal to NEMA 4/4X/6 to IEC 529 |
| Sizes | |
| UFS-V sizes | up to 40" |
| Pressure class | |
| Standard | 150 lbs, 300 lbs, 600 lbs (higher pressure ratings on request) |
| Sensor cable | |
| Connection | M20 x 1,5 or ½" NPT or PF ½ |
| Length (UFS to UFC) | 5, 10, 15, 20, 25 or 30 metres |

| Certified temperature ranges | | | | |
|------------------------------|---------|---------|---------|---------|
| | °C | | °F | |
| | minimum | maximum | minimum | maximum |
| Process | | | | |
| Standard | -40 | 150 | -40 | 302 |
| Extended | -200 | 250 | -328 | 482 |
| Ambient | | | | |
| UFS-V | -40 | 60 | -40 | 140 |
| UFC-V ATEX | -40 | 60 | -40 | 140 |
| UFC-V OIML | -40 | 70 | -40 | 158 |
| UFC-V FM | -20 | 60 | -40 | 140 |
| UFC-V LT | -55 | 60 | -67 | 140 |
| UFP-V | 5 | 40 | 41 | 104 |

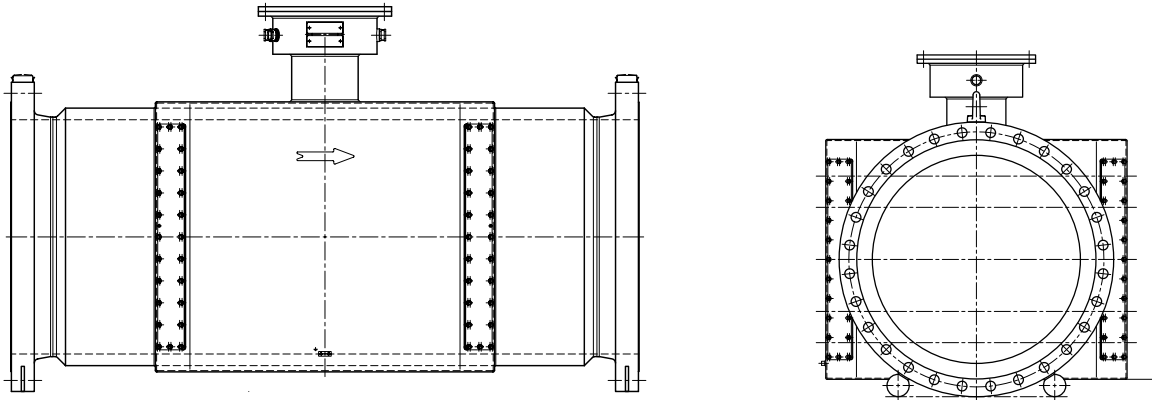
| Flow ranges | 0.2 m/s 0.7 ft/s m ³ /hr | 10 m/s 33 ft/s m ³ /hr | 0.2 m/s 0.7 ft/s GPM | 10 m/s 33 ft/s GPM | 0.2 m/s 0.7 ft/s BBL/hr | 10 m/s 33 ft/s BBL/hr |
|-------------|--|--------------------------------------|-------------------------|-----------------------|----------------------------|--------------------------|
| Size (inch) | | | | | | |
| 4 | 5.6 | 280 | 25 | 1230 | 35 | 1760 |
| 6 | 12.6 | 630 | 55 | 2770 | 80 | 3960 |
| 8 | 22.6 | 1130 | 100 | 4980 | 140 | 7120 |
| 10 | 36 | 1800 | 160 | 7900 | 225 | 11300 |
| 12 | 50 | 2500 | 220 | 11000 | 315 | 15700 |
| 14 | 70 | 3500 | 310 | 15400 | 440 | 22000 |
| 16 | 90 | 4500 | 400 | 19800 | 565 | 28280 |
| 18 | 114 | 5700 | 500 | 25100 | 715 | 35850 |
| 20 | 140 | 7000 | 616 | 30800 | 880 | 44000 |
| 24 | 200 | 10000 | 880 | 44000 | 1255 | 62850 |



ALTOSONIC V LNG skid-mounted

KROHNE Oil & Gas provide solutions to LNG measurement, from concept to completion. From metering to supervisory for both gas and liquid.

Ask for our comprehensive Corporate brochure and details on Total systems and solutions for the LNG industry.



| Dimensions [metric] | | | | | | | | |
|---------------------|--------------------------|-----------|---------------|--------------|--------------|--------------|--------------|--------------|
| ASME | ALTOSONIC V Sensor (UFS) | | | | | Spool piece | | |
| 150 lbs | | | | | | 10 D inlet | 5 D outlet | 7 D outlet |
| Size (inch) | Length (inch) | ID (inch) | Height (inch) | Width (inch) | Weight (lbs) | Weight (lbs) | Weight (lbs) | Weight (lbs) |
| 16 | 1300 | 388 | 623 | 650 | 600 | 574 | 292 | 367 |
| 18 | 1400 | 438 | 668 | 700 | 860 | 759 | 357 | 451 |
| 20 | 1500 | 483 | 729 | 750 | 960 | 1123 | 438 | 555 |
| 24 | 1800 | 575 | 813 | 813 | 1050 | 1335 | 623 | 792 |
| 300 lbs | | | | | | | | |
| Size (inch) | Length (inch) | ID (inch) | Height (inch) | Width (inch) | Weight (lbs) | Weight (lbs) | Weight (lbs) | Weight (lbs) |
| 16 | 1300 | 381 | 648 | 650 | 690 | 668 | 385 | 460 |
| 18 | 1400 | 435 | 711 | 700 | 900 | 883 | 481 | 575 |
| 20 | 1500 | 483 | 775 | 750 | 1120 | 1275 | 589 | 707 |
| 24 | 1800 | 575 | 914 | 750 | 1300 | 1612 | 901 | 1070 |

| Dimensions [imperial] | | | | | | | | |
|-----------------------|--------------------------|-----------|---------------|--------------|--------------|--------------|--------------|--------------|
| ASME | ALTOSONIC V Sensor (UFS) | | | | | Spool piece | | |
| 150 lbs | | | | | | 10 D inlet | 5 D outlet | 7 D outlet |
| Size (inch) | Length (inch) | ID (inch) | Height (inch) | Width (inch) | Weight (lbs) | Weight (lbs) | Weight (lbs) | Weight (lbs) |
| 16 | 512 | 153 | 245 | 256 | 1320 | 1263 | 642 | 807 |
| 18 | 551 | 172 | 263 | 276 | 1892 | 1670 | 785 | 992 |
| 20 | 591 | 190 | 287 | 295 | 2112 | 2471 | 964 | 1221 |
| 24 | 709 | 226 | 320 | 320 | 2310 | 2937 | 1371 | 1742 |
| 300 lbs | | | | | | | | |
| Size (inch) | Length (inch) | ID (inch) | Height (inch) | Width (inch) | Weight (lbs) | Weight (lbs) | Weight (lbs) | Weight (lbs) |
| 16 | 512 | 150 | 255 | 256 | 1518 | 1470 | 847 | 1012 |
| 18 | 551 | 171 | 280 | 276 | 1980 | 1943 | 1058 | 1265 |
| 20 | 591 | 190 | 305 | 295 | 2464 | 2805 | 1296 | 1555 |
| 24 | 709 | 226 | 360 | 295 | 2860 | 3546 | 1982 | 2354 |

Other sizes on request

Systems

- Flow Meters for Custody Transfer
- Liquid Flow Metering Systems
- Gas Flow Metering Systems
- Wet Gas Metering Systems
- Provers & Master Meters
- Flow Computing, Supervisory Software & Analyzer Management
- Calibration Systems
- Tank Inventory & Management Systems
- Analyzer Houses and Shelters
- Loading & Off-loading Systems
- Leak Detection and Localisation Systems
- Revamps & Upgrades
- Testing, Installation, Commissioning, Service
- Training

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Products

- Gas Ultrasonic Flow Meters for Custody Transfer
- Liquid Ultrasonic Flow Meters for Custody Transfer
- Mass Flow Meters for Custody Transfer
- Venturis for Wet Gas Metering
- Prover sphere detectors
- Flow Computers
- Supervisory Systems
- Meter Validation Software Packages
- Electromagnetic Flow Meters
- Level Measuring Instruments
- Variable Area Flow Meters
- Temperature Measuring Instruments
- Pressure Measuring Instruments
- Analyzers
- Vortex Flow Meters
- Flow Controllers



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