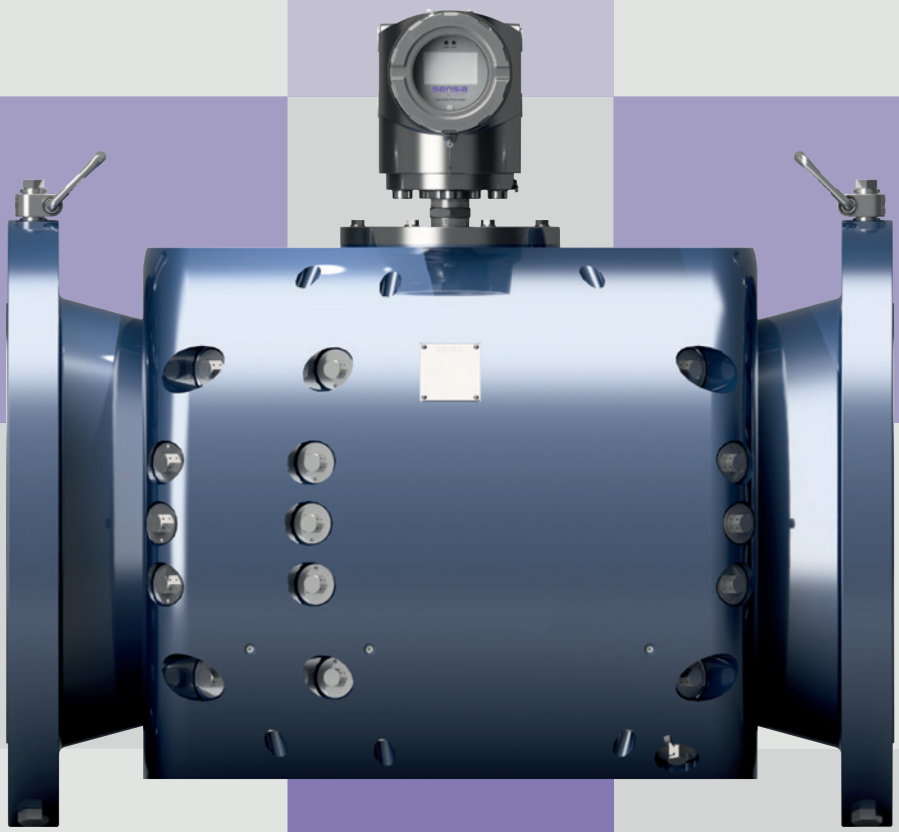
SENSIA

+ MEASUREMENT SOLUTIONS

CALDON SVM 289Ci

Self-Verifying Meter for liquids



INTELLIGENT ACTION

Building on our track record of ultrasonic metering excellence

CALDON technology has been at the forefront of high performance ultrasonic liquid metering for many decades. Significant developments over many years have reinforced our ability to deliver optimized solutions for challenging applications.

Over time, ultrasonic meters have continued to evolve with significant improvements in both accuracy and repeatability as well as the ability to monitor their long-term performance through the use of diagnostic information and Condition-Based Monitoring (CBM) software. As users move away from traditional methods such as in-situ proving due to the CAPEX and OPEX considerations, the ability to monitor the performance of the ultrasonic meter has become more important than ever before.

For installations without provers and operators who embrace a master meter or a periodic recalibration strategy, there are many factors that require consideration. Periodic removal of meters for calibration comes with safety and logistical issues associated with shutting down lines and draining and transporting meters and meter runs. Reproducibility issues owing to changes in traceability or installation at the calibration facility can introduce further concerns. Attempts to circumvent these issues through the use of master/duty or duty/check meter arrangements can be vulnerable to false alarms or undetected common-mode errors, both of which are time-consuming and costly.

In recent times, Condition-Based Monitoring (CBM) software such as CALDON USM ADVISOR has been used to continuously monitor ultrasonic meter behaviour and make essential decisions on meter health and performance. These CBM systems have evolved to become automated and intuitive platforms recognized by many operators and government regulators as means of reducing risk between calibrations and justifying reduction in the frequency of recalibration.

While the ultrasonic meter's rich diagnostic information remains a key differentiator, the use of diagnostic information is qualitative. Meaning crucial decisions are made based on supposition rather than hard evidence. Until now, diagnostic data has only given us information about meter behaviour. But that data does not have a direct relationship to the accuracy of the measurement. Whereas live uncertainty evaluation is a methodology that provides quantified information about accuracy in the same units as the measurement itself.

Self-Verifying Meter (SVM) technology is a step change in ultrasonic measurement, the first to deliver a quantitative evaluation of meter performance with a live uncertainty determination derived from first principles.

A breakthrough in in-situ verification of ultrasonic meters: Live self-evaluation of measurement uncertainty

The CALDON Self-Verifying Meter is the first high-accuracy ultrasonic metering technology to provide a quantitative evaluation of its own measurement uncertainty.

The CALDON SVM 289Ci is a 16-path meter that incorporates three significant features to produce an ultrasonic meter with unrivalled self-verification ability:

1. Axial velocity measurement verification per chord.
2. Fifth chordal measurement plane to facilitate 4-chord vs 5-chord estimation of flow profile uncertainty.
3. Vertical reflective path for detection of entrained gas or contamination.

Based on this unique configuration, the SVM 289Ci can self-verify each of the variables that contribute to the measurement result – combining these to provide a quantitative evaluation of its own uncertainty. In addition to being able to continuously output the uncertainty value in volumetric rate or percentage terms, the SVM 289Ci also incorporates uncertainty totalization in volumetric units. Allowing you to make higher-quality operational decisions based on quantitative determination of meter performance.

Higher confidence, fewer interventions

The SVM 289Ci uses the same meter body design, transducers, and electronics as the other meters in the field-proven CALDON 200 series family of meters. The measurement performance of the SVM 289Ci builds on the foundation of the well-established LEFM 280Ci, which utilizes an 8-path configuration with crossed paths in four chordal planes, all positioned and weighted according to the rules of Gaussian Integration.

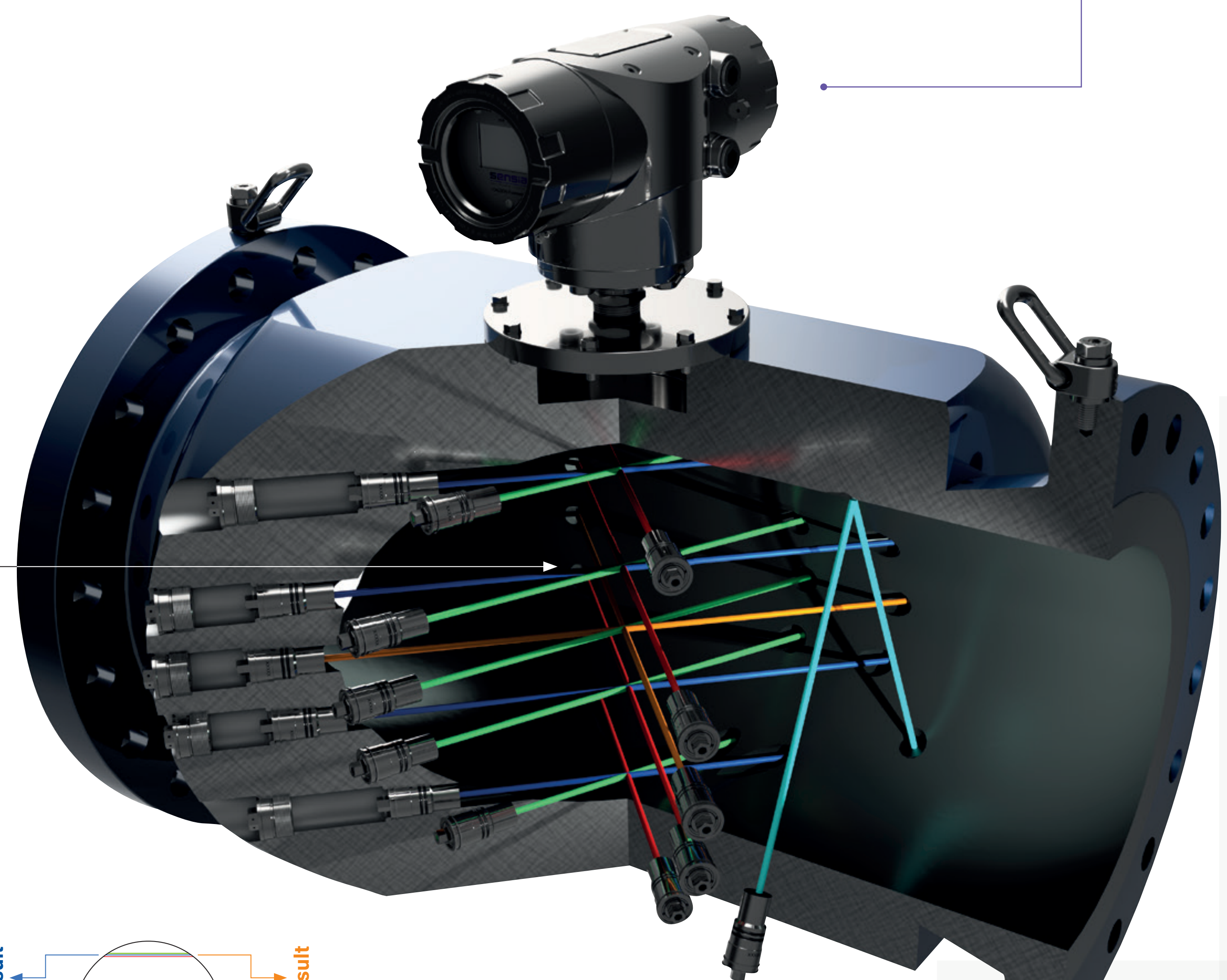
By employing the 8-path configuration for the primary measurement, the SVM 289Ci is designed to be highly accurate even in swirling flow with distorted axial velocity profiles and adds the quantitative self-verification features with no compromise in accuracy.

The CALDON SVM capabilities represent a significant breakthrough in metering technology, enabling a step-change in operational practices from intervention based on prescribed time intervals and experience to risk-based condition monitoring based on complex quantitative data. Acceptance of such a breakthrough technology and change to operational practice requires a high level of confidence in the underlying technology.

To address this – alongside the OIML R117 Class 0.3 and MID metrology certifications applicable to the whole CALDON 200 series family – the SVM technology has been subjected to an independent and robust DNV Technology Qualification in accordance with their Classification Scheme for Fiscal Metering. As a result, the CALDON SVM 289Ci liquid flow meter meets the most stringent requirements for liquid fiscal metering class L-AAA on all aspects tested.

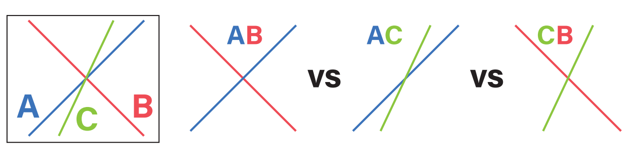
Quantitative and continuous self-verification

Ultrasonic flowmeters are well known for their advanced diagnostic capabilities, which can be used to alert a user to a change in meter behaviour or process conditions. Our CALDON SVM technology enhances and surpasses existing capabilities by enabling the meter to continuously quantify its measurement uncertainty.



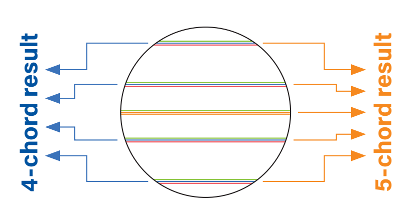
Low installation uncertainty
The CALDON SVM technology employs our proven 8-path configuration for its primary measurements. The 8-path configuration uses crossed paths in each of four chordal planes to effectively cancel the effect of non-axial velocities and accurately integrate the axial velocity profile. The meter is OIML R117 Class 0.3 certified with a minimum requirement of 5D upstream without the need for flow conditioning.

Three paths per chordal plane:
Axial velocity verification

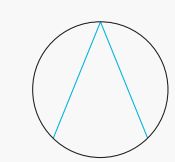


The axial velocities measured on multiple chordal planes are the primary input to an ultrasonic meter's calculation of flowrate. Use of a pair of crossed paths on each chordal plane (paths A and B as used in the 8-path meter) enables the cancellation of the unwanted components of non-axial velocity. The addition of the third (C) path enables the uncertainty of the axial velocity measurements to be determined on each chordal plane by a patented method that compares the axial velocity values from the AB, AC and BC path combinations.

4 chord versus 5 chord:
Velocity profile verification
The integration of the velocity profile in a chordal ultrasonic meter is achieved by calculating a weighted average of the chordal axial velocities. SVM technology incorporates a fifth measurement plane on the diameter. This enables the computation of a 4-chord (8-path) weighted average velocity and a 5-chord (10-path) weighted average velocity using a distinct set of weighting factors. Comparison of the four and five chord results obtained by this patented method enables quantification of the uncertainty associated with averaging the velocity profile.



Uncertainty totalization
SVM technology enables the simultaneous calculation of measurement uncertainty alongside each flow measurement calculation – updated once per second. In addition to the continuous and instantaneous output of uncertainty in terms of volumetric flowrate or a relative percentage value, SVM totalises uncertainty values internally. This powerful feature means that measured volume totals and corresponding uncertainty totals can be read at intervals – e.g. before and after a batch transaction – with the measurement uncertainty stated in volumetric terms alongside the transaction volume.



Vertical Path:
Cross-sectional area verification
The CALDON SVM 289Ci incorporates a pair of transducers that are used to form a vertical path with a reflection point at the top of the measurement cross-section. This path is not used for velocity measurement, its purpose is to enable the SVM to detect if the cross-sectional area of the pipe is not full of liquid, even if the quantity of gas is present very small. Combined with the measurements from the chordal paths, the measurement results from the vertical path are used to quantify uncertainty in the cross-sectional area of the measurement section.

Accuracy, reliability and certainty, without exception

Built upon proven ultrasonic technology
For over 50 years, CALDON ultrasonic flow meters have provided the industry with highly accurate, reliable, and low-cost-of-ownership measurement solutions. CALDON technology is well proven with installations dating back to the 1970s, utilised on a global basis across a wide range of liquid applications. The SVM 289Ci uses the same meter design elements, proven transducer, and electronics technology as all other 200 series CALDON ultrasonic meters.

CALDON USM Advisor is an intuitive, intelligent and automated Condition Based Monitoring system: For SVM models the Advisor screens, warning limits and reports include additional features using the SVM's quantitative evaluation of measurement uncertainty in % or volumetric terms.

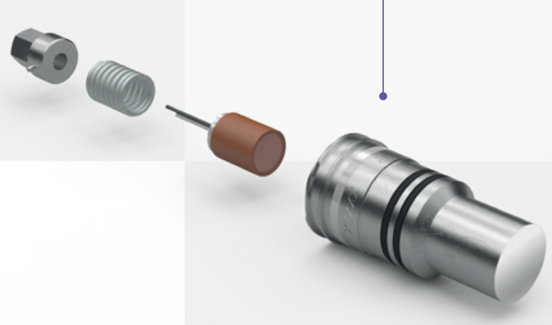
Comprehensive I/O
The CALDON SVM delivers a diverse range of I/O which can be configured to suit the needs of the operator.

Communications	RS485 (up to 3 in total) Modbus RTU
	Ethernet copper fibre
	HART (optional)
Pulse Outputs/ Alarm	Pulse direction/ outputs (4 total)
	Alarm status (4 total)
Analog Inputs	3 total
Analog outputs	2 total

Propriety corrosion and adhesion resistant coating
The largest impact on the long-term performance of an ultrasonic meter is corrosion and contamination or deposition that result in changes in cross-sectional area, path lengths or path angles. On carbon steel meters CALDON apply a field-proven and patented internal coating which significantly reduces or eliminates the risk of corrosion and contamination.

Feedback from end users who deal with pipelines impacted by contamination is that manual intervention is often required to depressurize and manually clean the internal diameter, transducer pockets and faces. This is a significant intervention, exposing personnel and the environment to hydrocarbons, increasing operational costs and downtime.

The coating has anti corrosion properties, high thermal stability, chemical inertness in aggressive environments, and superior adhesion resistance. This solution has been tested in a wide range of conditions and has been employed by CALDON for more than 10 years including challenging applications, such as crude oils with high paraffin content.

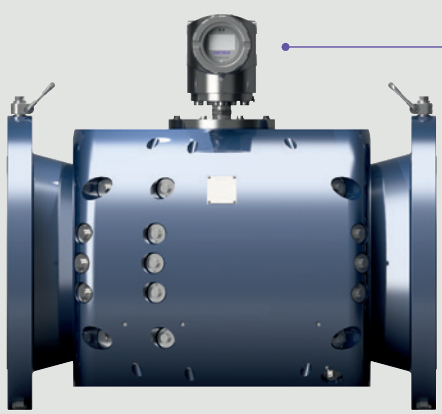


Transducer technology:
+ Transducers that are isolated from the process and outside the pressure boundary for ease of service, if required
+ No recalibration or zeroing required if a transducer is replaced
+ In-house transducer manufacturing and testing for maximum quality control

CALDON USM Advisor software

CALDON USM Advisor is an automated and intuitive Condition-Based Monitoring system which continuously monitors the health of CALDON 200 series flow meters. Multiple ultrasonic flow meters can be monitored simultaneously, locally or remotely from anywhere in the world. Diagnostic health data is transferred from the meter and stored in the CBM database and is automatically evaluated against customizable warning and alarm limits. Advisor either works with a permanent connection to the meter or can be periodically connected to access data stored within the meters integral SD card for traceability, auditability and general convenience.

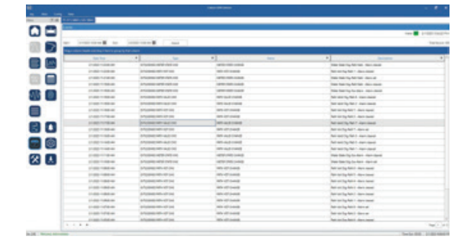
Unlike a conventional ultrasonic meter the SVM delivers a quantitative evaluation of meter performance along with a continuous and instantaneous output of uncertainty in terms of volumetric flowrate and relative percentage values. This information is reported by the CALDON USM Advisor software ensuring that the operator has a very simple insight of the meters uncertainty performance. Additionally this key information is available over Modbus to the flow computer, supervisory system and / or higher level host systems.



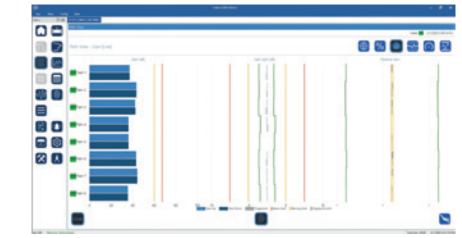
Communication (ethernet and serial)
The diagnostic software can be used with serial communication or ethernet (copper and fibre both available). Ethernet is preferred delivering additional features such as worldwide monitoring, simultaneously analyzing multiple meters and retrieving historical data from the SD card (backfill).

Easy to use, icon driven user interface
Easily monitor the active and historical health status of multiple ultrasonic flowmeters from a single overview.

You can also drill down to all available information using an icon-driven interface to get a more intelligent and detailed insight into a specific ultrasonic flowmeter in as few as three clicks.



Complete audit trail data integrity
Guaranteed coverage of historical data is provided by the meter's on-board storage of up to 10 years of key diagnostic data. Advisor software uses an SQL database that retains every minute of data that is transferred from the meter, providing long-term records limited only by the storage capacity of the host computer.



Customizable multidimensional fingerprinting
Optimize your decision-making by fingerprinting meter behaviour during normal operation under changing process conditions (flow velocity, temperature, pressure, and speed of sound).

Intuitive displays
CALDON USM Advisor provides access to intuitive displays and graphs that report the uncertainty data that is unique to SVM as well as the full complement of standard diagnostics.

Features unique to SVM
When connected to an SVM flowmeter, Advisor displays, warnings and reports include unique features based on the meter's determination of live uncertainty.

A powerful alternative to conventional in-situ verification

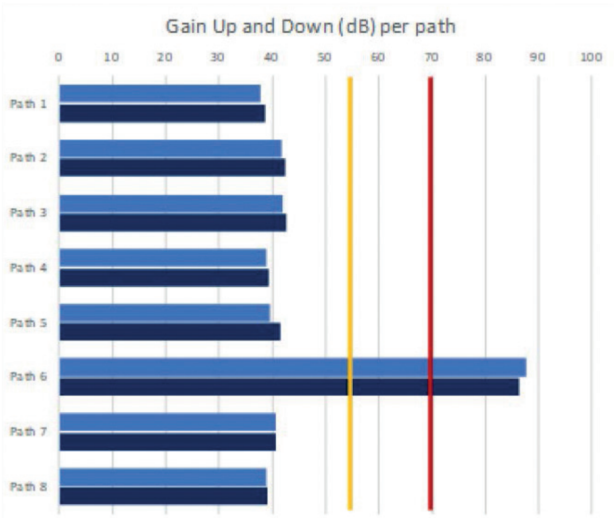
Conventional diagnostics and CBM
Conventional diagnostics can quickly and clearly alert the user of an ultrasonic meter to a problem. For example, in a meter that is having difficulty processing received ultrasonic signals (owing to a transducer problem or adverse process conditions), the meter can alert when the required gain rises above a given threshold indicating a weak signal, or when the percentage of received pulses being successfully processed falls below a certain threshold.

While detection of such problems enable a diagnosis to be performed, the next challenge is to evaluate the severity of the problem. In other words, what is the impact of the diagnosed condition on the accuracy of the measurement output?

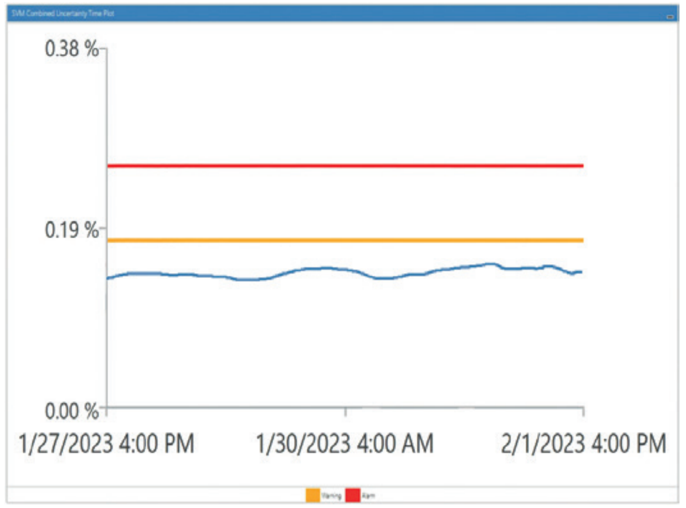
Similarly, with state-of-the-art CBM packages, changes to normal behaviors can be detected automatically and immediately. However, if, for example, a velocity profile metric such as asymmetry changes, then the question is, what is the impact on the accuracy of the measurement? These questions cannot be answered directly by analysis of conventional diagnostics.

As a clear example of the limitation of convention diagnostics it can easily be shown that in some cases, change in asymmetry can coincide with measurement errors, but in other cases the actual profile asymmetry can change without impacting the accuracy of the meter.

The SVM 289Ci is different. The quantitative uncertainty calculations in the SVM 289Ci are based on the use of additional measurement inputs that have been strategically designed to allow the measurement uncertainty to be quantified. This is what makes the SVM 289Ci so powerful: the self-verification is delivered in volumetric and % units that can be easily interpreted and actions driven accordingly.



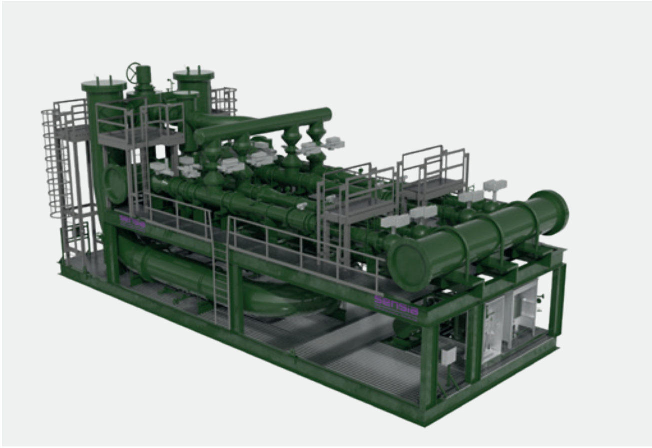
Whilst it is clear that an issue has occurred through the an alarm on signal gain the operator cannot relate this to an uncertainty value.



Unlike the qualitative information from conventional diagnostics, SVM provides direct quantitative output of the measurement uncertainty.

Volumetric provers
Volumetric provers such as ball provers and captive piston provers provide a means of determining a new meter factor and hence verifying the performance of meters in situ. In critical applications where low uncertainty is demanded the use of volumetric provers is well established. However in some applications the deployment of provers can be difficult to justify based on capital and operational costs or maintenance related challenges.

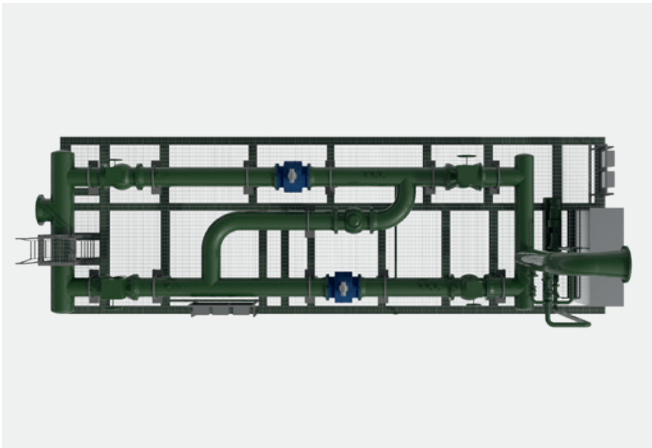
SVM provides a alternative for operators who desire continuous confidence in their measurement results without the high cost and maintenance burden of a prover. The SVM can be used in conjunction with a prover providing confidence between proves, potential for increasing the time between proves and/ or providing a back up to the prover in the event it is out of operation.



The shows a traditional ultrasonic metering system with a bi-directional prover is shown above. In the image above the prover occupies a second deck below the metering runs adding considerably to the size, weight and complexity of the system. In the event that SVM is deployed without the need for an in-situ prover the complexity, size, weight, pressure drop, CAPEX and OPEX is significantly reduced.

Two meters in series
Sometimes, two flow meters are installed in series and compared with one another as a means of in-situ verification. However, when used in this way the meters can bebe subject to 'common-mode error'. This means that both meters can be affected by a condition to the same degree and, therefore, will have errors that are very close to being equal. Sometimes differences in meter design such as transducer frequency or path configuration will be employed to try to mitigate common mode error, but these differences do not address all forms of common-mode error. Examples include axial velocity profile distortions, contamination build-up or the presence of gas reducing the cross-sectional area. For instance, the first meter could be over-reading by 1.01 % and the second meter by 0.99 %, the difference between them would be 0.02 % and could be misinterpreted as verification of low uncertainty, but in fact, the average error would be 1%.

SVM technology has been designed to detect and quantify the effects of conditions that cause common-mode error in two meters in series.

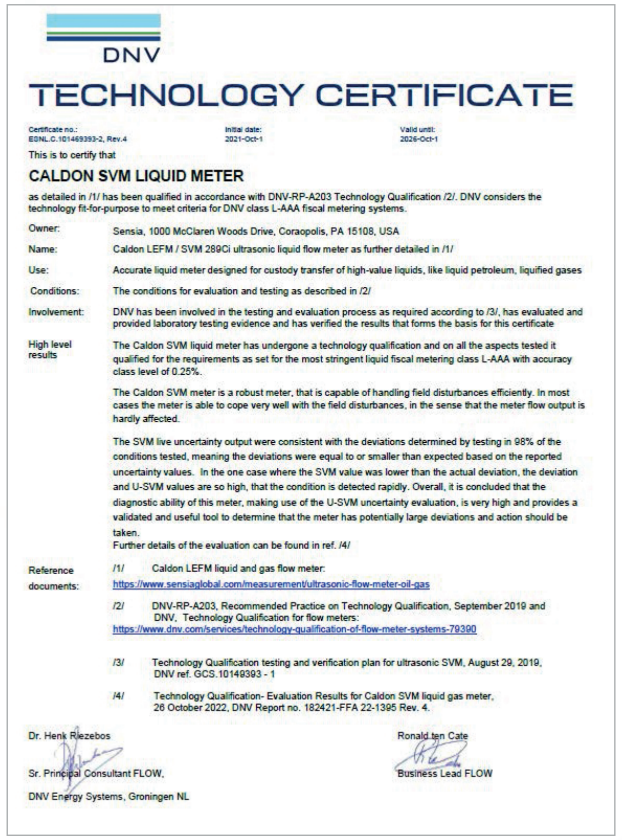


The shows a duty/ check configuration where the duty and check meters are routed in series via a cross over, otherwise referred to as a Z configuration, for comparison

Independent verification: DNV technology qualification, class L-AAA

In addition to compliance with API, MID and OIML R117, the SVM 289Ci has been subjected to a rigorous technology qualification process according to the DNV classification scheme for fiscal metering. This process evaluates the metering technology against its operational measurement uncertainty in real-world conditions, including component failures and process upset conditions. In addition to evaluating the accuracy of the meter, the CALDON SVM live uncertainty output was evaluated by DNV, with the resulting conclusions:

+ “The CALDON SVM liquid meter has undergone a technology qualification and on all aspects tested it qualified for the most stringent requirements as set for fiscal metering class L-AAA”
+ “The CALDON SVM meter is a robust meter, that is capable of handling field disturbances efficiently. In most cases the meter is able to cope very well with the field disturbances, in the sense that the meter flow output is hardly affected.”
+ “The SVM live uncertainty output were consistent with the deviations determined by testing in 98% of the conditions tested, meaning the deviations were equal to or smaller than expected based on the reported uncertainty values.”
+ “Overall, it is concluded that the overall diagnostic ability of this meter, making use of the U-SVM uncertainty evaluation, is very high and provides a validated and useful tool to determine that the meter has potentially large deviations and action should be taken.”


DNV

TECHNOLOGY CERTIFICATE

Certificate no.: ESNL.C.101469393-2, Rev.4 | Initial date: 2021-Oct-1 | Valid until: 2026-Oct-1

This is to certify that

CALDON SVM LIQUID METER

as detailed in /1/ has been qualified in accordance with DNV-RP-A203 Technology Qualification /2/. DNV considers the technology fit-for-purpose to meet criteria for DNV class L-AAA fiscal metering systems.

Owner: Sensia, 1000 McClaren Woods Drive, Coraopolis, PA 15108, USA

Name: Caldon LEFM / SVM 289Ci ultrasonic liquid flow meter as further detailed in /1/

Use: Accurate liquid meter designed for custody transfer of high-value liquids, like liquid petroleum, liquified gases

Conditions: The conditions for evaluation and testing as described in /2/

Involvement: DNV has been involved in the testing and evaluation process as required according to /3/, has evaluated and provided laboratory testing evidence and has verified the results that forms the basis for this certificate

High level results: The Caldon SVM liquid meter has undergone a technology qualification and on all the aspects tested it qualified for the requirements as set for the most stringent liquid fiscal metering class L-AAA with accuracy class level of 0.25%.

The Caldon SVM meter is a robust meter, that is capable of handling field disturbances efficiently. In most cases the meter is able to cope very well with the field disturbances, in the sense that the meter flow output is hardly affected.

The SVM live uncertainty output were consistent with the deviations determined by testing in 98% of the conditions tested, meaning the deviations were equal to or smaller than expected based on the reported uncertainty values. In the one case where the SVM value was lower than the actual deviation, the deviation and U-SVM values are so high, that the condition is detected rapidly. Overall, it is concluded that the diagnostic ability of this meter, making use of the U-SVM uncertainty evaluation, is very high and provides a validated and useful tool to determine that the meter has potentially large deviations and action should be taken.

Further details of the evaluation can be found in ref. /4/

Reference documents:

/1/ Caldon LEFM liquid and gas flow meter: https://www.sensiaglobal.com/measurement/ultrasonic-flow-meter-oil-gas

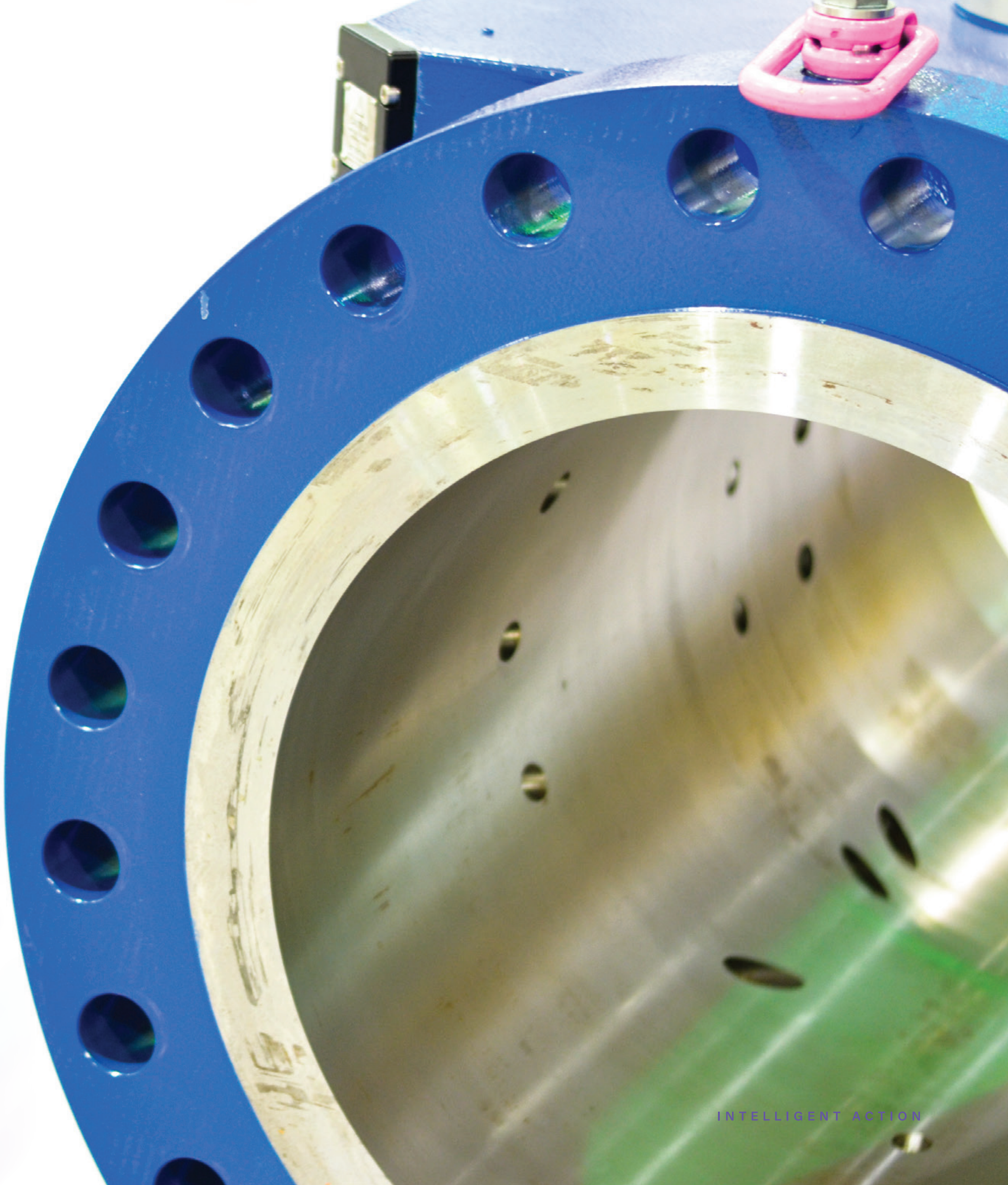
/2/ DNV-RP-A203, Recommended Practice on Technology Qualification, September 2019 and DNV, Technology Qualification for flow meters: https://www.dnv.com/services/technology-qualification-of-flow-meter-systems-79390

/3/ Technology Qualification testing and verification plan for ultrasonic SVM, August 29, 2019, DNV ref. GCS.10149393 - 1

/4/ Technology Qualification- Evaluation Results for Caldon SVM liquid gas meter, 26 October 2022, DNV Report no. 182421-FFA 22-1395 Rev. 4.

Dr. Henk Riezebos
Sr. Principal Consultant FLOW,
DNV Energy Systems, Groningen NL

Ronald ten Cate
Business Lead FLOW



Dimensions and weights

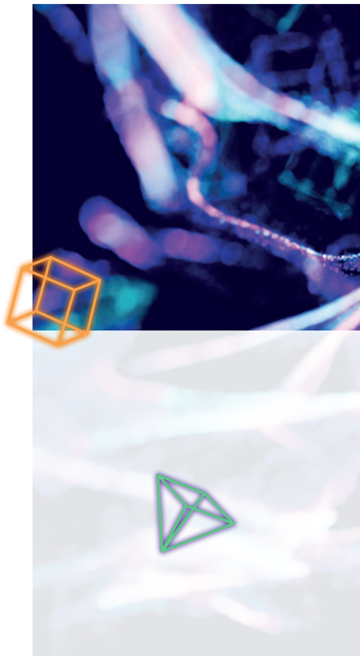
Dimensions and weights for SVM 289Ci

Nominal pipe size, in [mm]	Flange ANSI class	Width (W), in [mm]	Height (H), in [mm]	Length (L), in [mm]	Meter weight, lbm [kg]
8 [200]	150	17.0 [432]	23.9 [606]	25.8 [679]	769 [349]
	300	17.0 [432]	24.4 [619]	27.5 [699]	824 [374]
	600	17.0 [432]	25.1 [638]	29.8 [756]	919 [417]
10 [250]	150	20.0 [508]	27.4 [695]	28.8 [730]	1,193 [541]
	300	20.0 [508]	27.4 [695]	30.0 [762]	1,279 [580]
	600	20.0 [508]	28.6 [727]	33.3 [845]	1,462 [663]
12 [300]	150	22.0 [559]	30.4 [773]	31.8 [806]	1,641 [744]
	300	22.0 [559]	30.4 [773]	33.0 [838]	1,754 [795]
	600	22.0 [559]	30.9 [785]	35.5 [902]	1,927 [874]
14 [350]	150	23.8 [603]	32.3 [820]	34.0 [664]	2,011 [912]
	300	23.8 [603]	324 [822]	35.3 [895]	2,182 [990]
	600	23.8 [603]	32.7 [831]	37.5 [953]	2,328 [1,056]
16 [400]	150	27.0 [686]	35.2 [895]	35.8 [908]	2,778 [1,250]
	300	27.0 [686]	35.3 [896]	37.3 [946]	2,992 [1,357]
	600	27.0 [686]	36.0 [916]	40.3 [1,022]	3,262 [1,480]
18 [450]	150	29.3 [743]	37.2 [946]	38.8 [984]	3,309 [1,501]
	300	29.3 [743]	37.5 [954]	40.3 [1,022]	3,602 [1,634]
	600	29.3 [743]	38.2 [970]	43.3 [1,099]	3,913 [1,775]
20 [500]	150	32.0 [813]	39.6 [1,006]	41.1 [1,045]	4,118 [1,868]
	300	32.0 [813]	40.0 [1,016]	42.5 [1,080]	4,462 [2,024]
	600	32.0 [813]	40.7 [1,035]	46.3 [1,175]	4,886 [2,216]
24 [600]	150	37.0 [940]	41.9 [1,063]	45.8 [1,162]	5.555 [2.520]
	300	37.0 [940]	43.9 [1,114]	48.5 [1,232]	6,123 [2,777]
	600	37.0 [940]	44.4 [1,127]	52.3 [1,327]	6,681 [3,030]

Consult Sensia for sizes larger than 24 in.
Typical sizes shown for reference, contact our application specialists for assistance determining the proper meter sizing. Final dimensions are provided at time of order.
Please consult Sensia for higher ANSI ratings.

Installation

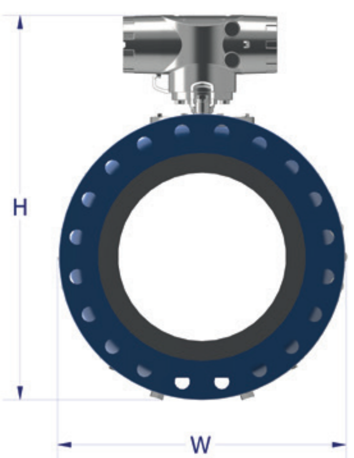
To limit uncertainty caused by hydraulic effects, we recommend installing the flowmeter in compliance with the following guidelines:

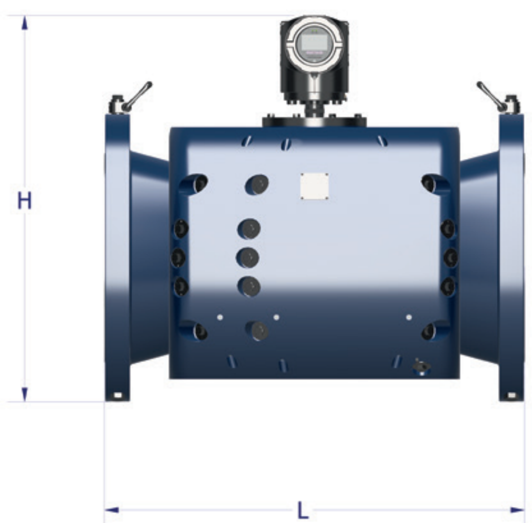


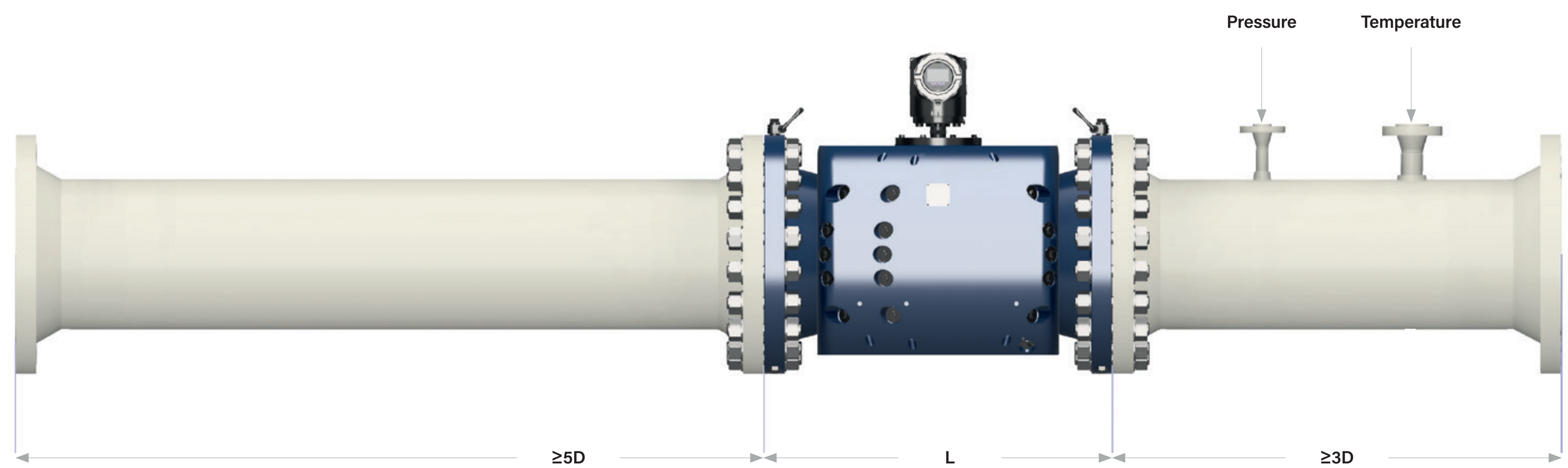
SVM 289Ci

To limit uncertainty caused by hydraulic effects, we recommend installing the flowmeter in compliance with the following guidelines. The adjoining straight pipe should be of the same schedule as the meter. Temperature elements and pressure connections should be preferably located downstream of the meter. The CALDON SVM 289Ci does not require the use of a flow conditioning element, although a conditioner may be used according to customer preference or contractual requirements.

An uninterrupted upstream pipe that is a minimum of 5 pipe diameters (D) in length is adequate in most applications. In adverse geometries where there is a constriction upstream of the meter that is smaller than the diameter of the meter run piping (such as a reduced bore valve or strainer), we recommend separating this from the meter by a pipe at least 15 pipe diameters in length. Downstream of the meter, there should be a pipe of at least 3 pipe diameters in length. For application specific recommendations or more detailed installation guidance please consult Sensia.







Specifications

Meter body with integral transmitter

Class	II 2 G, Ex db IIC Gb T6	Class I, Div. 1, Groups B,C, & D T6
SVM 289Ci models		
Temperature, degF [degC]	−58 to 158 [−50 to 70]	−58 to 158 [−50 to 70]

Standard Materials of construction (Compliance with Pressure Equipment Directive [PED])

Meter body and flanges	
SVM 289Ci model	Carbon steel (stainless and duplex optional)
Transducer housings	Stainless steel (INCONEL® material optional)
Junction boxes and transmitter enclosure	Copper-free aluminum (stainless steel optional)

Consult Sensia for other material options.

Standard end connections and maximum working pressure

ANSI B16.5 raised face	Stainless steel, psi [bar]	Carbon steel, psi [bar]
Class 150	275 [19.0]	285 [19.6]
Class 300	720 [49.6]	740 [51.1]
Class 600	1,440 [99.3]	1,480 [102.1]
Class 900	2,160 [148.2]	2,220 [153.2]
Class 1500	3,600 [248.2]	3,705 [255.3]

Consult Sensia for other material options.

Sizes and flow rates

Nominal size, in [mm]	Flow rate, bbl/h [m³/h]	
	SVM 289Ci	
	Qmin	Qmax
8 [200]	877 [139]	8,770 [1,390]
10 [250]	922 [147]	13,800 [2,200]
12 [300]	1,320 [210]	19,800 [3,150]
14 [350]	1,610 [256]	24,200 [3,840]
16 [400]	2,130 [339]	32,000 [5,090]
18 [450]	2,730 [434]	41,000 [6,510]
20 [500]	3,400 [541]	51,000 [8,110]
24 [600]	4,960 [789]	74,400 [11,800]

Note:
- This flow rate table is based on STD pipe
- Nominal maximum velocity is 12 m/s

Operation and performance

SVM 289Ci	
Linearity	±0.10% over nominal flow range
Repeatability	In accordance with the requirements of API Manual of Petroleum Measurement Standards chapter 5.8, table B.1 or OIML R 117-1 accuracy class 0.3
Flow range relative to nominal maximum†	10:1 for size 8 in [DN 200]
	≥ 15:1 for sizes 10 in and larger [≥DN 250]
Recommended minimum Reynolds number	10,000
Custody transfer certification	OIML R 117-1 Edition 2007 (E), "Dynamic measuring systems for liquids other than water"
	WELMEC Guide 8.8, "General and Administrative Aspects of the Voluntary System of Modular Evaluation of Measuring Instruments Under the MID"
Water in oil	CALDON LEFM flowmeters can operate reliably with high water contents provided that the water and oil are well mixed. Typically, the oil and water will be sufficiently well mixed for good ultrasonic meter performance at velocities above 6.5 ft/s [2 m/s]. Meter operation and performance can be affected if the water and oil are not well mixed.
Nominal pipe sizes,‡ in [mm]	8 to 24" [200 to 600mm] - Larger sizes available on request

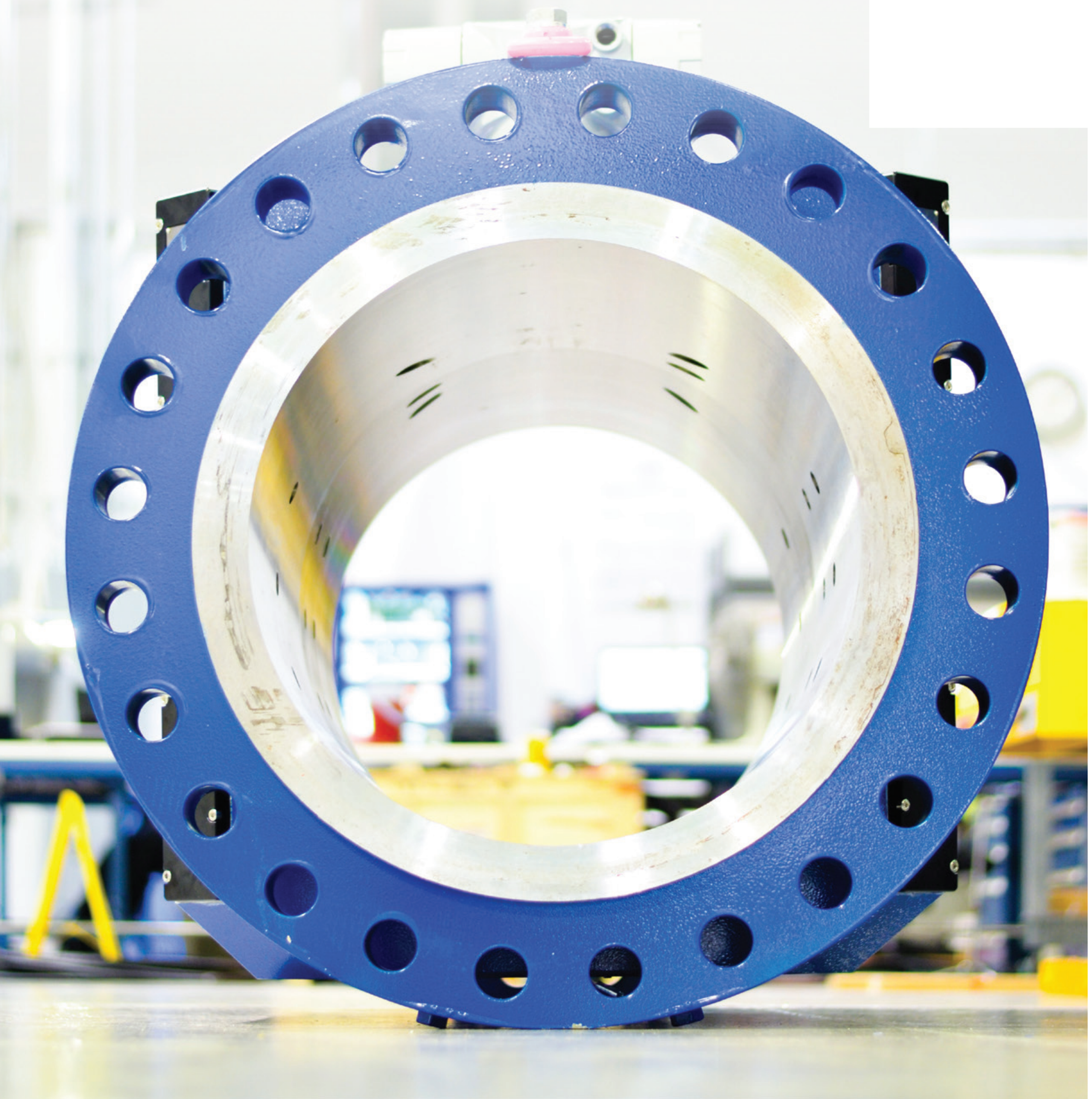
† From nominal maximum flow, range can be extended when linearity requirements are relaxed.
‡ For nominal sizes larger than 48 in [1,200 mm], contact Sensia.

General Specifications: Electronics

Power requirements—DC power	
Voltage required, V DC	24 (18 to 30)
Current draw at 24 V DC, A	0.25
Power consumption, W	6
Power requirements—AC power	
Voltage, V AC	120 (60 Hz); 230 (50 Hz)
Voltage range, V AC	108–253
Frequency range, Hz	47–63
Current draw, A	0.14
Protection	Ingress Protection (IP) 66; Association of Electrical Equipment and Medical Imaging Manufacturers (NEMA) type 4 and 4X
Relative humidity, %	0–95
Operating temperature, degF [degC]	−58 to 158 [−50 to 70]
Local display, px	400 × 240 LCD showing flow, diagnostics data, and alarms
Analog inputs (three), mA	4–20 configurable
RTD input	Meter body temperature
Analog outputs (two), mA	4–20 (configurable 650-ohm maximum load)
Digital outputs	
Flow	Four pulse output channels
	Programmable K-factor
	Programmable configuration
	1. Dual frequency set-up, 50/50 duty cycle
	Channel B lags channel A by 90° for forward flow
	Channel B leads channel A by 90° for reverse flow
	2. Frequency and direction, 0 duty cycle
	Channel B indicates flow direction
	Forward flow = 0
	Reverse flow = high (5 or 12 V DC)
	3. Alternating, forward-flow frequency on
	Channel A only reverse-flow frequency
	On channel B only 50/50 duty cycle
Alarm status	Four outputs, 0–5 or 0–12 V DC selectable (0 V = alarm)
Communication	Three serial or two serial and HART protocol
	Ethernet (copper or fiber optic) or fiber modem

OIML API American Petroleum Institute MID

Our multipath inline ultrasonic flowmeters are backed by more than 50 years of experience and a history of technological invention & innovation.



Count on CALDON

Backed by more than 50 years of experience and a history of technological firsts, the Sensia portfolio of CALDON ultrasonic flowmeters combines experience, innovation, and proven technology into the broadest offering of custody transfer, fiscal, check metering, and leak detection ultrasonic flow meters for the liquid hydrocarbon industry. Our CALDON flowmeter series accommodates the most extensive range of applications, including but not limited to refined products, high-viscosity crude oils and cryogenic fluids such as LNG.

CALDON flowmeters for liquids have become the benchmark around the world. We are proud to offer unbeatable capabilities to fit a wide range of applications and service needs by leveraging expertise from one of the most advanced liquid hydrocarbon calibration laboratories in the world.

2021
First self-verifying high-accuracy meter, the CALDON SVM 289Ci.

2020
CALDON USM Measurement Advisor; continuous, remote monitoring of multiple ultrasonic flow meters worldwide in combination with SQL database storage.

2010
First 8-path custody transfer gas ultrasonic meter with patented non-wetted transducers, OIML R137 Class 0.5 with 5D, no flow conditioner and a proprietary coating for the internal meter I.D. and transducer faces for long term performance.

2008
LEFM 280CiRN: Approval for custody transfer of heavy, viscous crude oils up to 3,000 mm²/s according to OIML R117 Class 0.3. Enhanced repeatability and provability versus conventional full bore ultrasonic meters.

2006
World class hydrocarbon flow facility opened, accredited to ISO 17025 accredited by NVLAP and CMC certified by VSL.

2005
Pioneered the use of ultrasonic technology for high accuracy cryogenic fluids with first LNG installation.

2003
First application for custody transfer of liquid hydrocarbons.

1995
First military-specification flowmeter.

1994
First measurement uncertainty recapture uprate at nuclear facilities.

1989
CALDON formed by Mr Cal Hastings. CALDON obtains Westinghouse Leading Edge Flow Meter technology in a full technology transfer acquisition.

1974
First crude oil application.

1970
First nuclear reactor coolant application.

1965
Westinghouse develop the first chordal multipath ultrasonic meters based on Gaussian integration, the predecessor to the CALDON product line.

Solving challenges from the reservoir to refinery. One challenge at a time.

We collaborate with all stakeholders to make the production, transportation and processing of oil & gas simpler, safer, more secure, more productive and better understood from end-to-end. Sensia is making the advantages of industrial-scale digitalization and seamless automation available to every oil & gas company.

Now every asset can operate more productively and more profitably.

US Patent No. 9,304,024: Acoustic Flow measurement device including a plurality of chordal planes each having a plurality of axial velocity measurements using transducer pairs.

US Patent No. 10,288,462: Acoustic Flow measurement device including a plurality of chordal planes each having a plurality of axial velocity measurements using transducer pairs.

US Patent No. 10,928,230: Acoustic Flow measurement device including a plurality of chordal planes each having a plurality of axial velocity measurements using transducer pairs.

US Patent No. 10,393,568: Ultrasonic meter employing two or more dissimilar chordal multipath integration methods in one body.

US Patent No. 11,549,841: Ultrasonic meter employing two or more dissimilar chordal multipath integration methods in one body.

US Patent No. 9,170,140: Ultrasonic Flow Meter with internal surface coating and Method.

US Patent No. 10,107,658: Ultrasonic Flow Meter with internal surface coating and Method.

Sensia LLC
Energy Tower IV, 15th floor, 11750 Katy Freeway
Houston, TX 77079

+1-866-7SENSIA (+1-866-773-6742)

hello@sensiaglobal.com
sensiaglobal.com