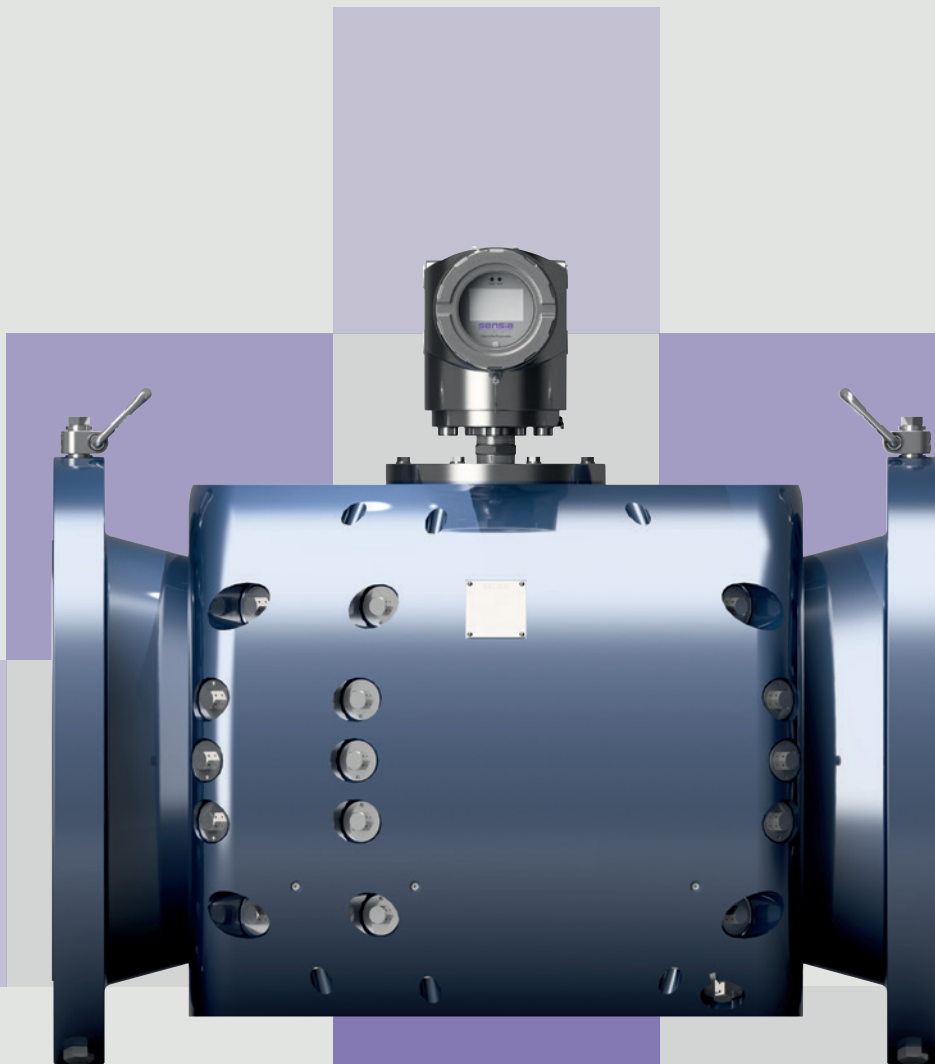


# CALDON SVM 289Ci

Self-Verifying Meter for liquids



# Building on our track record of ultrasonic metering excellence

**CALDON technology has been at the forefront of high-performance ultrasonic liquid metering for 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 behavior 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 behavior. 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.**

# Live evaluation of measurement uncertainty: an in-situ ultrasonic meter verification breakthrough

**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 unrivaled self-verification ability:

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

Based on this unique configuration, the CALDON 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 CALDON 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 CALDON 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 CALDON SVM 289Ci builds on the foundation of the well-established CALDON LEFM 280Ci, which utilizes an eight-path configuration with crossed paths in four chordal planes, all positioned and weighted according to the rules of Gaussian Integration.

By employing the eight-path configuration for the primary measurement, the CALDON 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 289Ci 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.





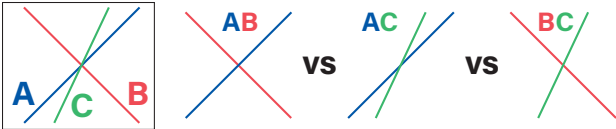
# Quantitative and continuous self-verification

Ultrasonic flow meters are well known for their advanced diagnostic capabilities, which can be used to alert a user to a change in meter behavior 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 eight-path configuration for its primary measurements. The eight-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.

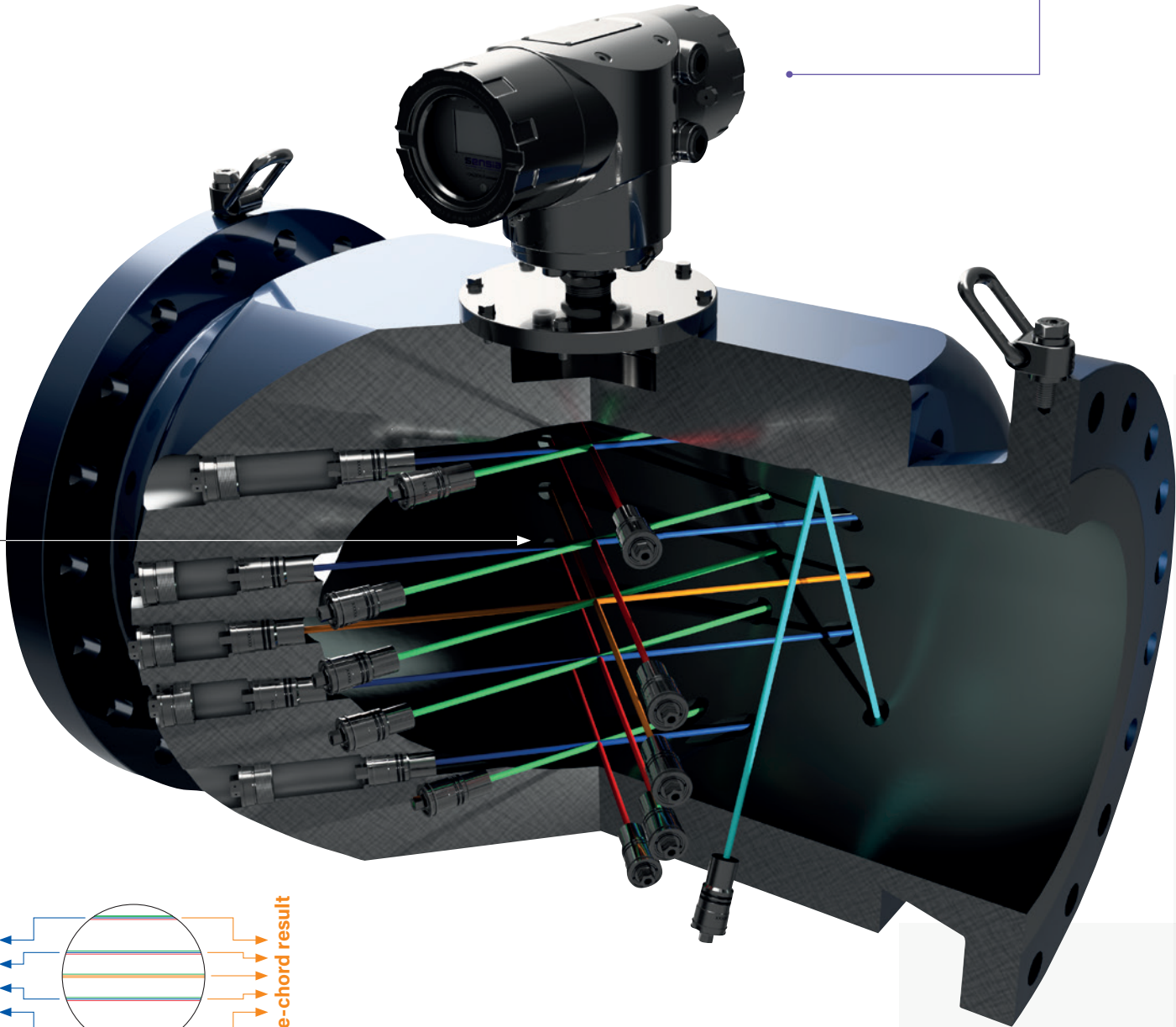
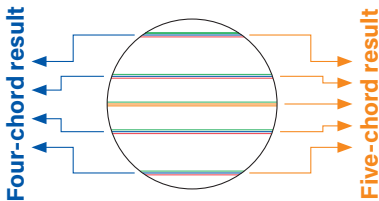
### Three paths per chordal plane: Axial velocity verification



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 eight-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.

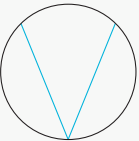
### Four-chord versus five-chord: Velocity profile verification

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 four-chord (eight-path) weighted average velocity and a five-chord (ten-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, CALDON SVM 289Ci 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 CALDON SVM 289Ci 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 utilized on a global basis across a wide range of liquid applications. The CALDON SVM 289Ci uses the same meter design elements, proven transducer, and electronics technology as all other 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 289Ci 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 fiber
	HART (optional)
Pulse Outputs/Alarm	Pulse direction/outputs (4 total)
	Alarm status (4 total)
Analog Inputs	3 total
Analog outputs	2 total

### Proprietary 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

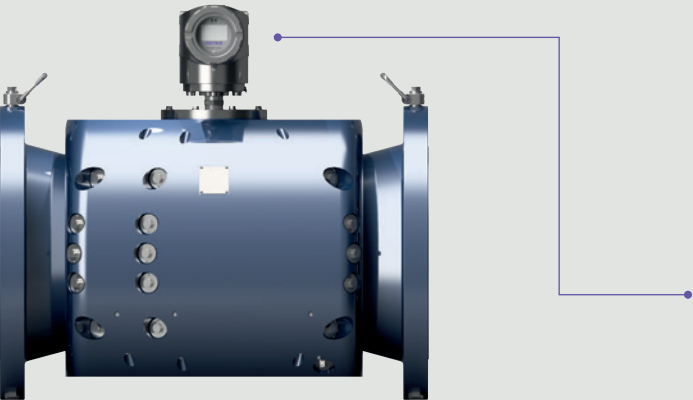


# CALDON USM Advisor software

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)

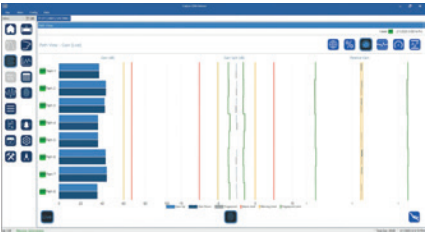
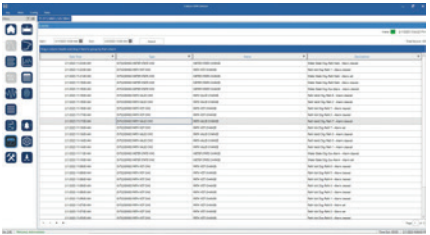
The diagnostic software can be used with serial communication or ethernet (copper and fiber both available). Ethernet is preferred delivering additional features such as worldwide monitoring, simultaneously analyzing multiple meters and retrieving historical data from the SD card (backfill).



### Easy-to-use, icon-driven user interface

Easily monitor the active and historical health status of multiple ultrasonic flow meters 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 flow meter 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 behavior 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 flow meter, 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

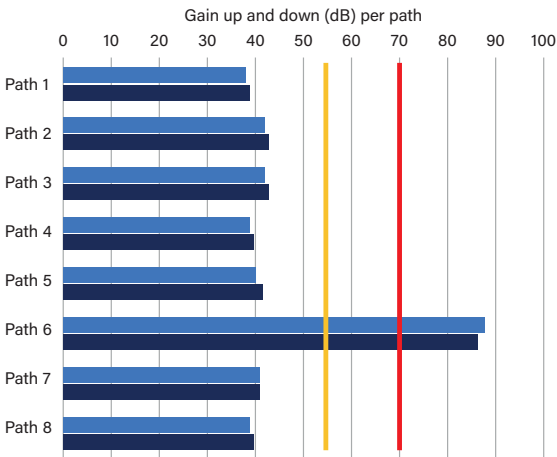
Conventional diagnostics can quickly and clearly alert the user of an ultrasonic meter to a problem. For example, a meter that is having difficulty processing received signals (owing to a transducer problem or adverse conditions), an alert can be raised when the required gain rises above a given threshold 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 and assess the impact that the diagnosed condition will have on the accuracy of the measurement output.

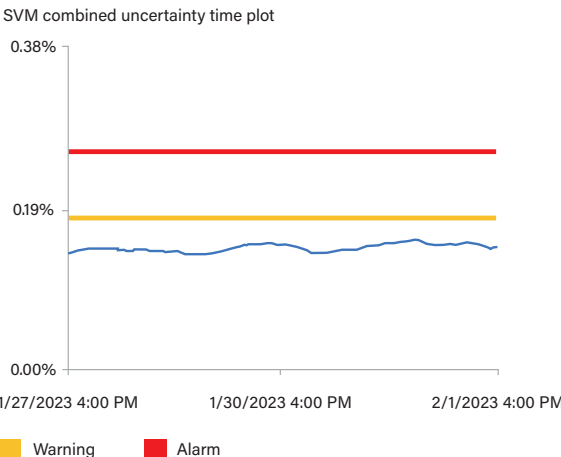
Similarly, with state-of-the-art CBM packages, changes to normal behaviors can be detected automatically and immediately. However, if, for example, a velocity profile metric such as asymmetry changes, then the question is, what is the impact on the accuracy of the measurement? These questions cannot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

As a clear example of the limitation of conventional 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 CALDON SVM 289Ci is different. The quantitative uncertainty calculations in the CALDON 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 CALDON 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.

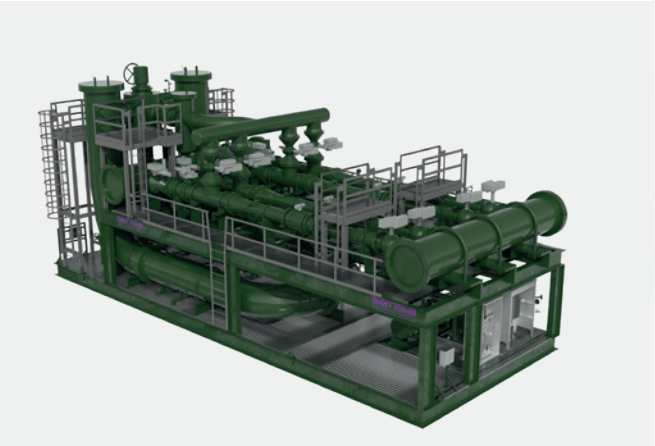


Unlike the qualitative information from conventional diagnostics, SVM provides direct quantitative output of the measurement uncertainty.

### 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.**

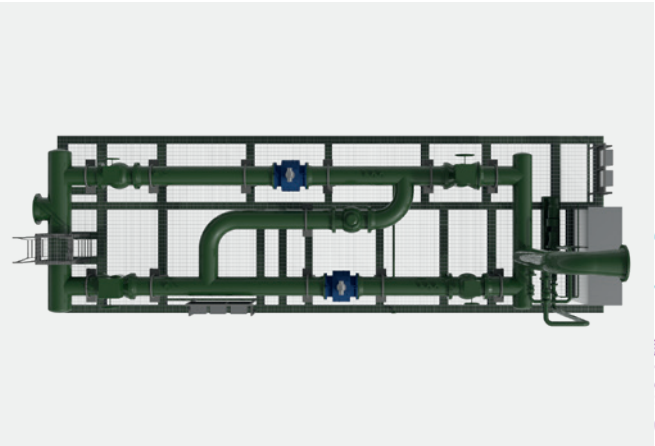


The shows a traditional ultrasonic metering system with a bi-directional prover is shown above. In the image above the prover occupies a second deck below the metering runs adding considerably to the size, weight and complexity of the system. In the event that SVM is deployed without the need for an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



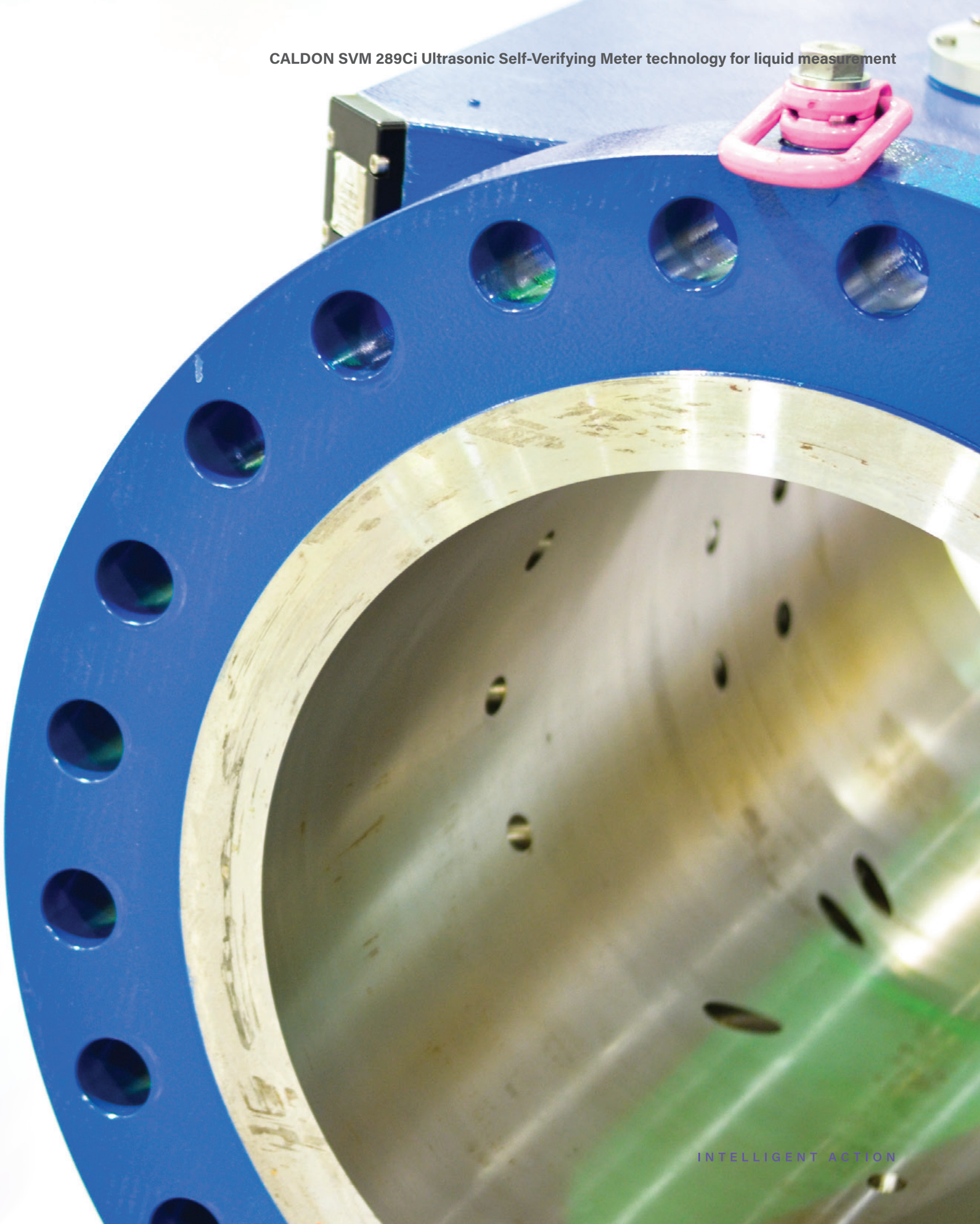
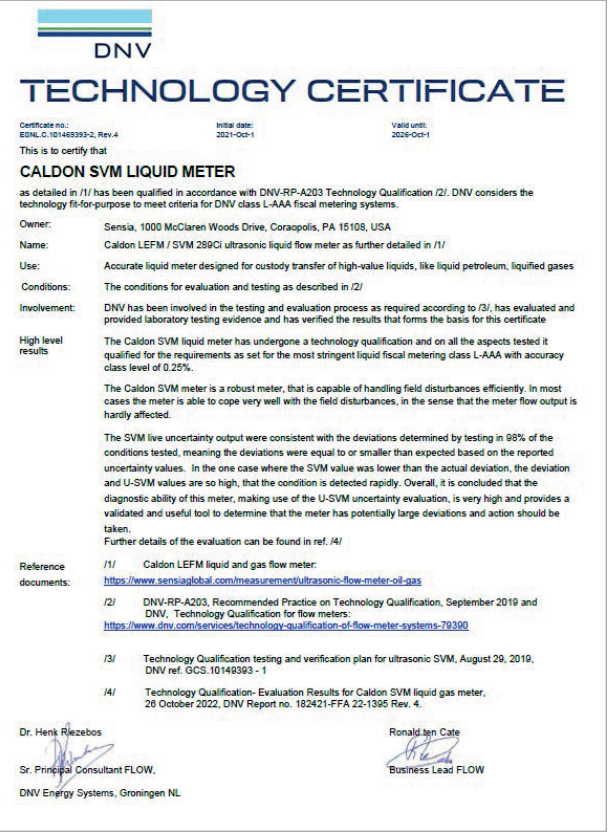
The shows a duty/check configuration where the duty and check meters are routed in series via a cross over, otherwise referred to as a Z configuration, for comparison



# Independent verification: DNV technology qualification, class L-AAA

In addition to compliance with API, MID and OIML R117, the CALDON 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 liquid 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 CALDON 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.
- + 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.

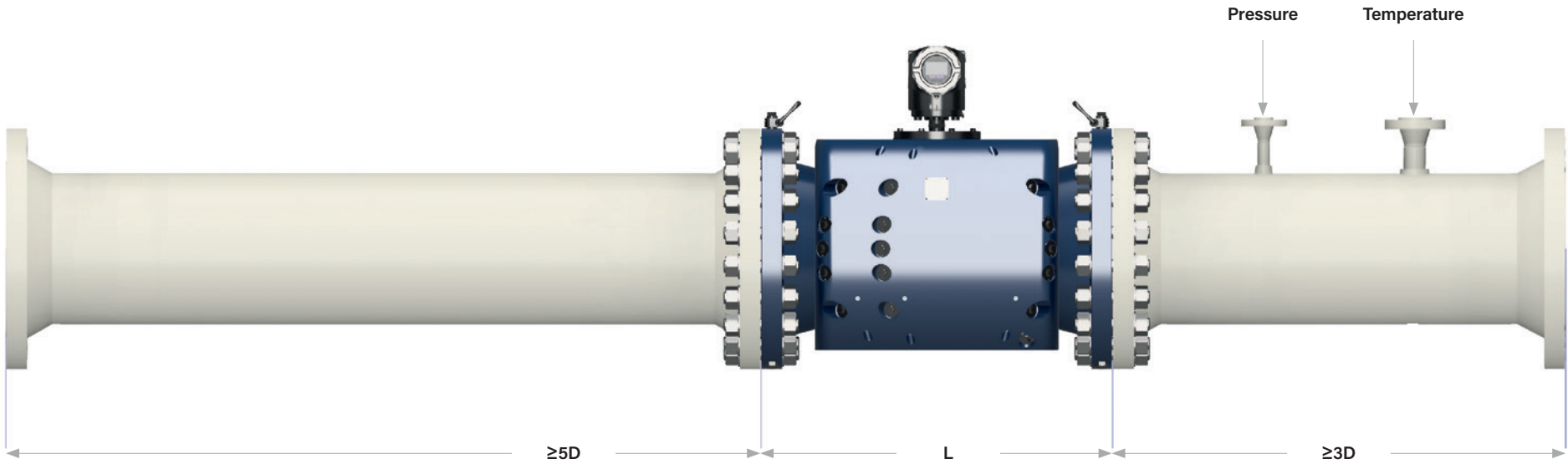
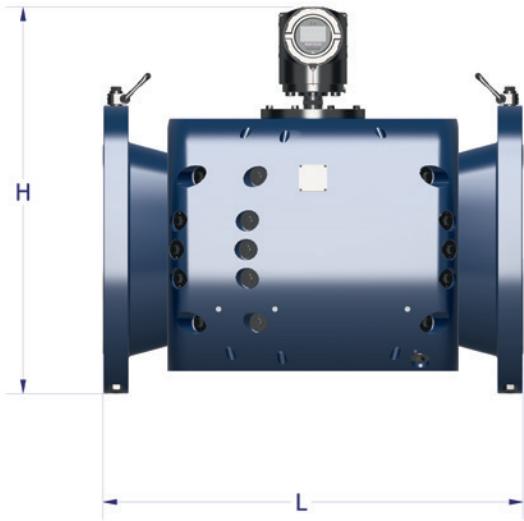
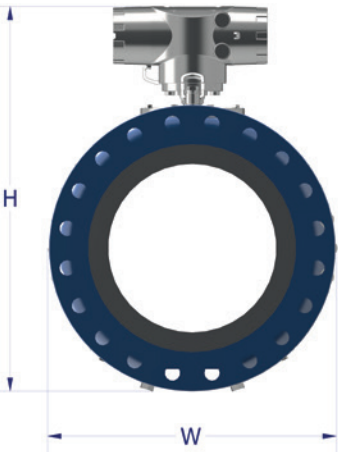




# Dimensions and weights

Dimensions and weights for CALDON 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 flow meter in compliance with the following guidelines:

**CALDON SVM 289Ci**  
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		
<div><div><div></div><div></div><div></div></div></div>		
Class	II 2 G, Ex db IIC Gb T6	Class I, Div. 1, Groups B,C, and D T6
CALDON 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]	
	CALDON 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	
CALDON 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 flow meters 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	



American  
Petroleum  
Institute







# Count on CALDON

For the last 30 years CALDON ultrasonic meters have become the benchmark around the world for high accuracy measurement of liquids. We are grateful for the opportunity to work with our valued customers to apply our unrivaled capabilities to solve their application challenges. The CALDON SVM 289Ci is another major step-change in ultrasonic metering technology.

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

2024

First Subsea ultrasonic meter for gas, liquid, Carbon Capture and Storage. Jointly developed by SLB and Sensia.

2021

First self-verifying high accuracy meter.

2016

First microbore subsea chemical injection metering valve using ultrasonic metering technology jointly developed with SLB/Cameron.

2008

LEFM 280CiRN: Approval for custody transfer of heavy, viscous crude oils up to 3,000 mm<sup>2</sup>/s according to OIML R137 Class 0.5. Enhanced repeatability and provability versus conventional full bore USMs.

2005

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

1995

First military-specification flow meter.

1989

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

1970

First nuclear reactor coolant application.

2023

First USM for dense, supercritical and liquid phase CO<sub>2</sub>, the CALDON LEFM 500 Series.

2020

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

2010

First eight-path custody transfer gas USM 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.

2007

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

2003

First application for custody transfer of Liquid hydrocarbons.

1994

First measurement uncertainty recapture uprate at nuclear facilities.

1974

First crude oil application.

1965

Westinghouse develop the LEFM product line, the first to use a chordal multipath design based on Gaussian integration, and 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](mailto:hello@sensiaglobal.com)  
[sensiaglobal.com](https://sensiaglobal.com)



Sensia LLC 2023. All rights reserved. 307A-CP-0623-BR  
\* Mark of Sensia. Other company, product, and service names  
are the properties of their respective owners