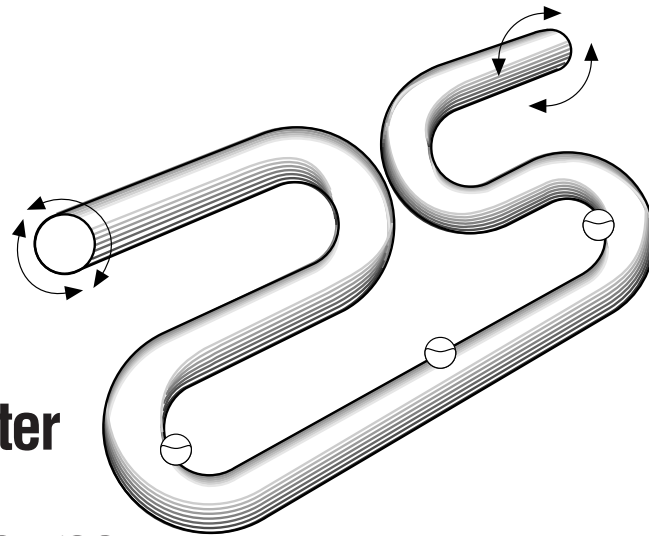


TS-613
Rev. C
Coriolis Mass Flowmeters
mXXXXXX



m mass flowmeter approved by Weights and Measures for custody transfer

ISO 9001 Certified Manufacturing Facility

DESCRIPTION

Actaris has been a leader in custody transfer of fluids for more than 100 years. Now, custody transfer by Coriolis measurement has arrived.

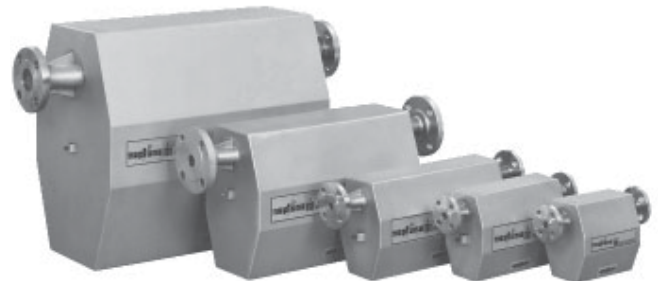
The Actaris Coriolis mass flowmeter is now Weights and Measures-approved by the National Conference on Weights and Measures and Measurement Canada, Legal Metrology Branch, for mass and volume custody transfer applications. Actaris currently offers six sizes of mass flowmeters with flow rates ranging from 6.8 to 5103 kg/min (15 to 10,000 lb/min). The Actaris mass flowmeter is custody transfer-approvable for fluids such as refined fuel products, aviation fuels, liquefied propane gases (LPG), agricultural liquids, solvents, alcohols, ammonia (NH₃) and others.

DESIGN FEATURES

Weights and Measures approval of mass flow technology is a significant step forward for custody transfer metering. Mass flow measurement is not affected by changes in viscosity, density, temperature or pressure, as are volumetric measurement systems. This results in more accurate delivery under changing climatic or process conditions.

THE LEADER IN RELIABILITY AND PRECISION

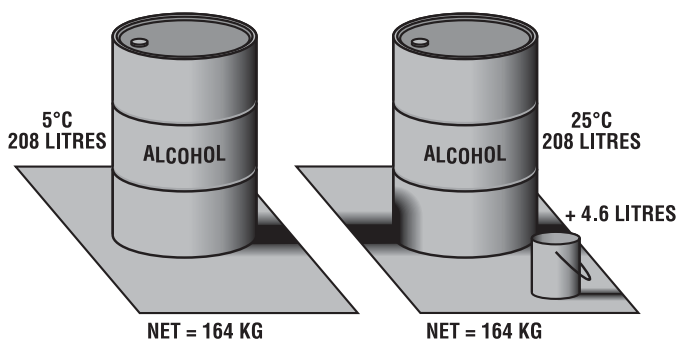
The Actaris patented, dual omega-shaped flow tube design is an unequalled combination of reliability and precision. Even if your application is not required to be certified, it is reassuring to know that the Actaris mass flowmeter manages your flow control with custody transfer precision.



- **Measurement Canada and NTEP approved for mass and volume custody transfer applications**
- **No weigh scales...immediate savings from reduced installation costs...faster vehicle on-loading and off-loading**
- **No volumetric temperature compensation... this flowmeter measures mass directly**
- **More precise delivery of costly products under varying conditions, especially with products whose viscosity or density changes with temperature**
- **Multi-compartment loading with mass measurement accuracy ($\pm 0.15\%$ of rate)**
- **Maximum filling of bulk containers**
- **Reduced maintenance...no moving parts**

THE MASS MEASUREMENT ADVANTAGE

Mass, length and time are the bases for all physical measurements. Fluid flow can be measured either by volume or mass. However, volume will vary with changes in temperature and pressure, whereas the mass of a fluid remains the same even when subjected to physical changes. This makes mass an ideal property for measuring fluid flow.



A drum filled in the yard in January would hold 4.6 litres less than the same drum filled in July, yet they would weigh exactly the same.

The Actaris mass flowmeter uses the Coriolis principle to measure mass flow of fluids.

For this reason, density, pressure, temperature, viscosity and flow profile variations have no effect on the accuracy of the mass flowmeter's mass measurement.

The mass flowmeter also directly measures density and temperature. These measurements, combined with the direct flow measurement, provide local or remote readouts of mass flow, density, temperature, % solids, solids flow and volume.

Matching the mass flowmeter with your fluid processing system has never been easier. With no straight piping runs required, the flowmeter can be installed directly in-line. Installation is further simplified because the Actaris mass flowmeter has one of the lowest pressure drops in the industry, resulting in pump horsepower conservation.

Best of all, the Actaris mass flowmeter is maintenance-free. The rugged design, with no moving parts, is certain to minimize downtime.

DATAMATE 2100™ FLOW COMPUTER

The microprocessor-based DATAMATE 2100 is the process controller transmitter for the mass flowmeter. It provides a combination of process measurements, user flexibility and optional outputs, enabling you to select the optimum parameters for your specific operation.

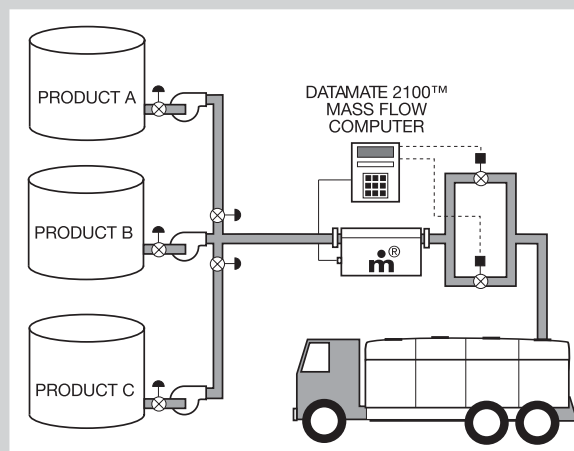
The DATAMATE 2100 is truly a versatile electronic device. Besides continuously displaying the total accumulated mass, it can be programmed to alternately display temperature, mass flow rate, volume and several other measurement variables. Based upon your input, it will display temperature in either Celsius or Fahrenheit, mass in pounds or kilograms and time in seconds, minutes or hours. A variety of display choices are offered for selection and compatibility with your operation.

The programmable operating variables are easily accessible from the keypad at the front panel. A liquid crystal display window with 40 characters on two lines is positioned above the keyboard for viewing each function.

The system is adaptable to meet specific output requirements. Plug-in modules are used to configure the basic unit for processes requiring remote outputs such as scaled pulse and/or 4–20 mA. All accumulated data are retained in memory through battery-backed RAM.

Have a mass flow custody transfer application in mind? Approval is simple...

Obtain pre-approval before purchase by submitting a flow chart such as this to Actaris with all fluids identified and characterized. Then receive final authorization following installation and proving. Contact your Actaris representative for assistance!



See Page 5 for complete specifications for the entire line of Actaris Coriolis mass flowmeters.

Additionally, the DATAMATE 2100 is completely self-diagnostic and has RS-422 interface capability for communication with an external computer or printer interface.

3A-AUTHORIZED SANITARY DESIGN

The Actaris mass flowmeter is also available in a sanitary design. The sanitary flow sensor carries the 3A Authorization, with Tri-Clamp® end connections and clean-in-place (CIP) capability. Each flow tube can be accessed individually for easy, thorough cleaning.

OPTIONS

The Actaris mass flowmeter may be specified to include various options:

- Bulk Terminal and Truck electronic registers
- A smart printer interface and a variety of ticket printers
- Vapor/air eliminators, strainers and differential control valves

PRINCIPLES OF OPERATION

The Actaris mass flowmeter precisely determines mass flow by measuring the effects of Coriolis forces on a pair of omega-shaped tubes, which are electromagnetically vibrated.

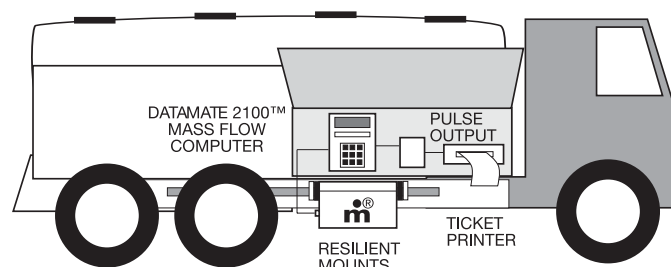
As fluid proceeds through the two parallel omega-shaped tubes, it experiences an acceleration transverse to the direction of flow, and Coriolis forces result. The Coriolis forces cause the displacement of the vibrating tubes to twist. Sensors detect this twist and transmit electrical signals reflecting the relative phase shift that is proportional to mass flow.

Since tube vibration frequency varies with fluid density, frequency measurements are used to determine the fluid density and/or the percent solids. In addition, an RTD is used to detect temperature of the tube wall. Volume measurement is determined by mass/density.

The unique omega-shaped tube design offers several key advantages. The tubes are very sensitive to the Coriolis forces at low fluid velocities. This translates into a very low pressure drop and outstanding accuracy ($\pm 0.15\%$, \pm zero stability). Since there are two tubes in parallel, the flowmeter is virtually unaffected by extraneous vibrations. In addition, the omega-shaped design distributes the stress of movement in a torsional manner to eliminate bending stress points.

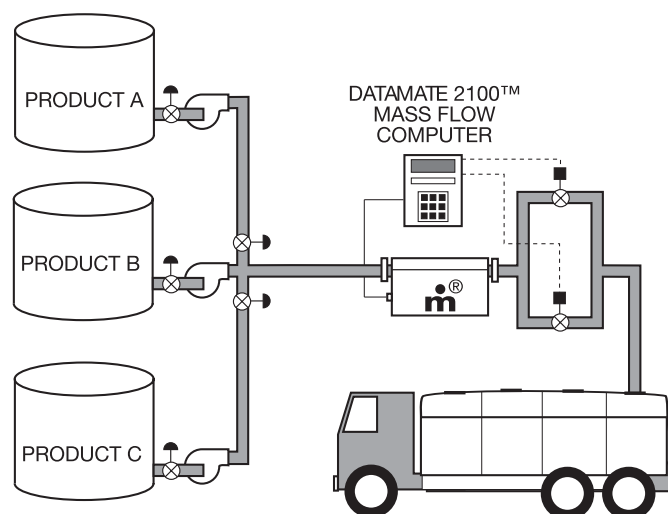
These performance advantages combine to make the Actaris mass flowmeter the market leader for low fluid velocities, highly viscous fluids and abrasive liquids.

PRECISION LOADING, FILLING AND BATCHING BY MASS



MOBILE CUSTODY TRANSFER

The Actaris mass flowmeter can be resiliently mounted to truck frames or skids for noise-free, precise mobile custody transfer of fuels or high-cost fluids such as paint.

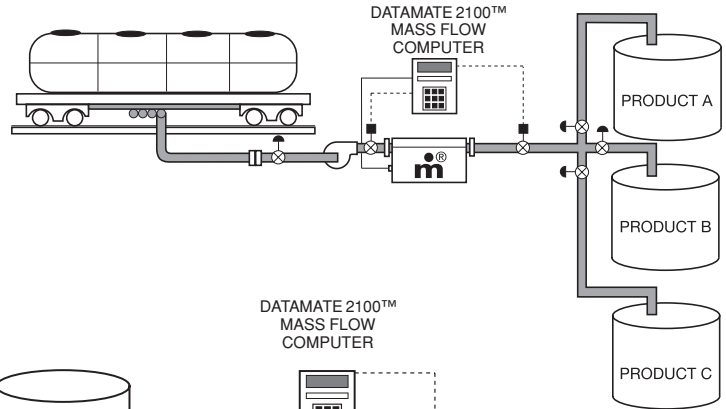


BULK LOADING

The Actaris mass flowmeter controls loading of transportation vehicles for maximum volume utilization year-round. The two-stage shut-off guards against spillage at high fill rates.

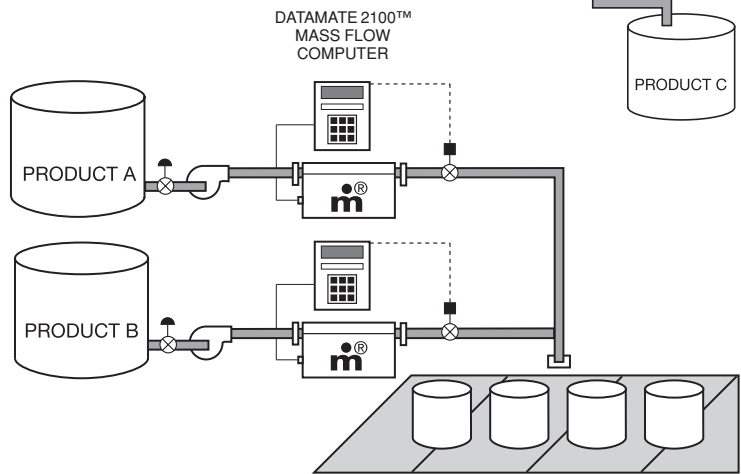
BULK OFF-LOADING

The Actaris mass flowmeter can control off-loading and inventory management of costly liquids with outstanding accuracy year-round.



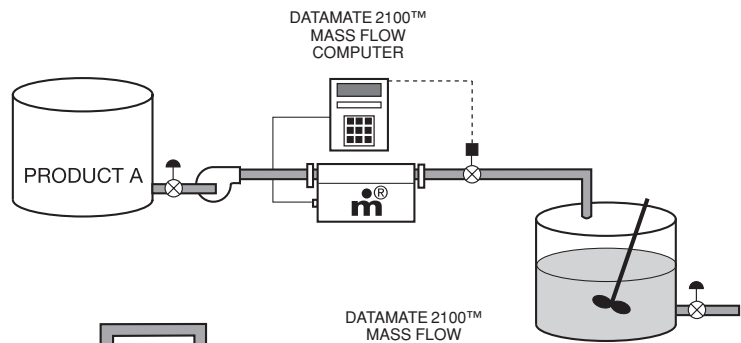
CONTAINER FILLING

Containers can be filled precisely with single or multiple fluids.



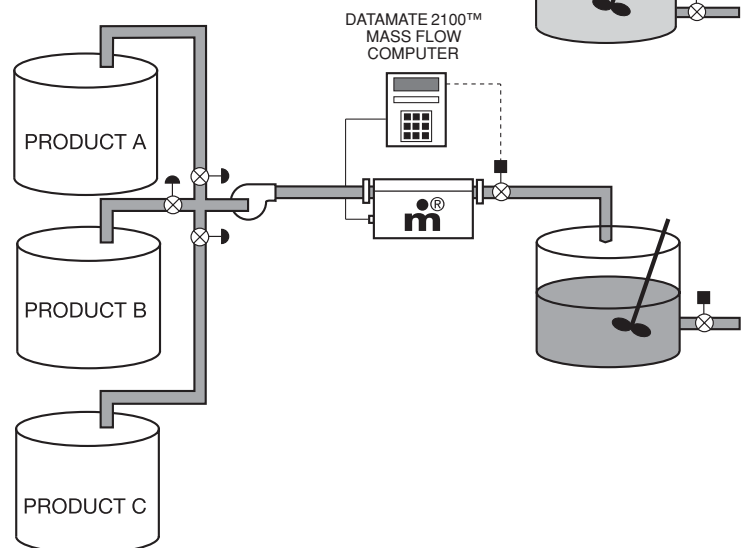
SINGLE LIQUID/SINGLE TANK

Delivery of a single costly fluid, such as a catalyst, can be metered with custody-transfer precision.



MULTI-LIQUID/MULTI-BATCH

Delivery of multiple costly or critical quantities for multiple formulations can be managed by a single mass flowmeter.



ACTARIS MASS FLOWMETER PERFORMANCE

PROPERTY	MODEL					
	m025 ¹	m050 ^{1,2}	m100 ^{1,2}	m200 ^{1,2}	m300 ^{1,2}	m400 ^{1,2}
Operating ranges						
Flow rate, kg/min (lb/min)	N/A (15–150)	6.8–1.36 (30–300)	25–500 (110–1100)	72.5–1450 (320–3200)	408–4082 (900–9000)	510–5103 (1000–10000)
Density range, g/cc	0.3 to 1.42					
Temperature ⁶ range, °C (°F)	–45 to 205 (–50 to 400)					
Max. operating pressure, bar (psi) ³	250 (3600)	250 (3600)	83 (1200)	68 (1000)	103 (1500)	103 (1500)
Accuracies/Repeatability						
Mass accuracy ±0.15% of rate ± zero stability ⁴						
Mass zero stability, kg/min (lb/min)	±0.0064 (±0.014)	±0.0168 (±0.037)	±0.0612 (±0.135)	±0.1901 (±0.419)	±.4536 (±1.0)	±0.9072 (±2.0)
Mass repeatability, % of rate	±0.10	±0.10	±0.10	±0.05	±0.05	±0.05
Density accuracy, g/cc	±0.002	±0.002	±0.001	±0.001	±0.001	±0.0008
Density repeatability, g/cc	±0.0005	±0.0005	±0.0005	±0.0005	±0.0002	±0.0002
Temperature accuracy, °C (°F)	±0.56 (±1)					
Turndown ratio	U.S. Applications: (10:1) Canada Applications:(20:1) except M300 and M400 which are (10:1)					
Physical						
Tube shape	Omega					
Wetted materials	316L SST (HASTELLOY® C-22 optional except m300)					
Nominal tube bore, mm (in.)	6.4 (1/4)	12.7 (1/2)	25.4 (1.0)	51.0 (2.0)	75.0 (3.0)	101.6 (4.0)
Housing	304L SST					
Enclosure class	Transducer is intrinsically safe when connected to an approved mass flow computer FM and CSA Class 1, Division 1, Groups C & D					
3A-authorized version	Yes	Yes	Yes	Yes	No	No
Connection type	VCO: 3/8" female ANSI: 1/2"; 150#, 300# 600# RF 3A-Authorized: Tri-Clamp® Industrial Tri-Clamp DIN: DN15; PN40, PN100	VCO: 1" female ANSI: 1/2", 3/4", 1"; 150#, 300# 600# RF 3A-Authorized: Tri-Clamp® Industrial Tri-Clamp DIN: DN15, DN25; PN40, PN100	(5) ANSI: 1", 1-1/2", 2"; 150#, 300# 600# RF 3A-Authorized: Tri-Clamp® Industrial Tri-Clamp DIN: DN25, DN50; PN40, PN100	(5) ANSI: 2", 3", 4"; 150#, 300#, 600# RF 3-Authorized: Tri-Clamp® Industrial Tri-Clamp DIN: DN50, DN80, DN100; PN40, PN100	ANSI: 3", 4", 6" 600#, 900# RF DIN: DN80 DN100, DN150; PN40, PN100	ANSI: 4", 6", 8"; 150#, 300#, 600#, 900# RF DIN: DN100, DN150, DN200; PN40, PN100

¹ Meter size approved by N.C.W.M. (Approval No: 02-049). Approved flow rates in lbs/min.

² Meter size approved by Measurement Canada (Approval No. AV-2292T). Approved flow rates in kg/min.

³ Limited by flange rating.

⁴ All calibration equipment traceable to N.C.W.M.

⁵ Special 2" flange connections to MT accessories available

⁶ Ambient temperature limits for FM & CSA approved models is –20 to 40°C (–4 to 104°F).

DATAMATE OPERATING SPECIFICATIONS

Housing ² Temperature limitations Housing LCD Display Power supply Max. length of signal cable between flowmeter transducer and DATAMATE	Fiberglass IP 66, NEMA 4X -40 to 65°C (-40 to 150°F) -20 to 65°C (-4 to 150°F) 110 or 240 VAC, 50/60 Hz 20-40 VA depending on number of analog outputs, batching relays, etc. 150 m (500') 8-core Belden 89892 shielded twisted pair
Safety approvals	FM: Class 1, Division 2, Groups A, B, C & D CSA: Class 1, Division 2, Groups C & D
Operator interface	Front panel keypad RS-422 serial communications
Configuration (via keypad or RS-422)	Display format, engineering units, system constants, scaling factors, output ranges, alarm set points, serial communication parameters, batch presets
Function commands	Display, interrogate, run, program1, zero1, calibrate1, reset totals, clear alarms, initiate measurement
Local display Flow range Data retention Fault diagnostics Serial communications	2-line, 20-character alphanumeric, variable contrast LCD: displays mass and volume flow rate and totals, density, temperature, percent solids and solids flow rate To complement the mass flowmeter By battery-backed RAM for 10 years in absence of power Four user-configured, open collector, 50 VDC, 100 mA; programmable for all variables ("Local display," above), plus batch total and diagnosis RS-422 adjustable baud rate: 1200, 2400, 4800, 9600
Performance Specifications	Mass Accuracy: $\pm 0.15\%$ of rate \pm zero stability Mass Repeatability: $\pm 0.10\%$ of rate (M400: $\pm 0.05\%$) Density Accuracy: per transducer specifications Temperature Accuracy: $\pm 0.56^\circ\text{C}$ ($\pm 1^\circ\text{F}$)
Optional outputs Up to four user-selected outputs Mass flow rate Mass flow total Density Temperature Percent solids content Volume flow rate Standard volume flow Two-stage batch control	4-20 mA: Isolated, 50 to 800 ohms load Quadrature Pulse: Scaled square wave, 0.25 to 10,000 Hz g, kg, oz, lb in time units of seconds, minutes or hours g, kg, oz, lb g/cc $^\circ\text{C}$, $^\circ\text{F}$ % Litre, U.S. gal, Imp. gal, bbl, in time units of seconds, minutes or hours Litre, U.S. gal, Imp. gal, bbl, in time units of seconds, minutes or hours Standard: Dual SPST rated 10 A at 40 VDC resistive; 7 A at 240 VAC inductive FM I.S.: Dual SPST rated 200 mA at 24 VDC resistive; 13.86 mA at 120 VAC resistive—NOT APPROVED FOR INDUCTIVE LOADS CSA I.S.: Dual SPST rated 200 mA at 24 VDC resistive; 12.6 mA at 120 VAC resistive—NOT APPROVED FOR INDUCTIVE LOADS Start/Stop: Independent momentary contact
Manufacturer Instrument model number	Actaris U.S. Liquid Measurement, Inc. DM2100 XXXXX
¹ Parameters sealed by W&M ² Ambient temperature limits for safety approved models are as shown below: FM, CSA Division 2: -20 to 65C (-4 to 149°F)	



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Specifications subject to change without prior notification.