

# CALDON LFM 280CiRN

## Ultrasonic flowmeters

### APPLICATIONS

- Custody transfer
- Check or allocation metering
- Leak detection/line balance
- Heavy oil installations

### BENEFITS

- Reliable and long-term stability
- Smaller prover size

### FEATURES

- Insensitivity to swirl
- Electronics can be integrally or remote mounted
- Available in 6- to 40-in sizes
- $\pm 0.10\%$  linearity over the nominal flow range
- No limit on operating Reynolds number
- OIML R 117-1 Edition 2007 (E); Accuracy Class 0.3
- Third generation (G3) electronics

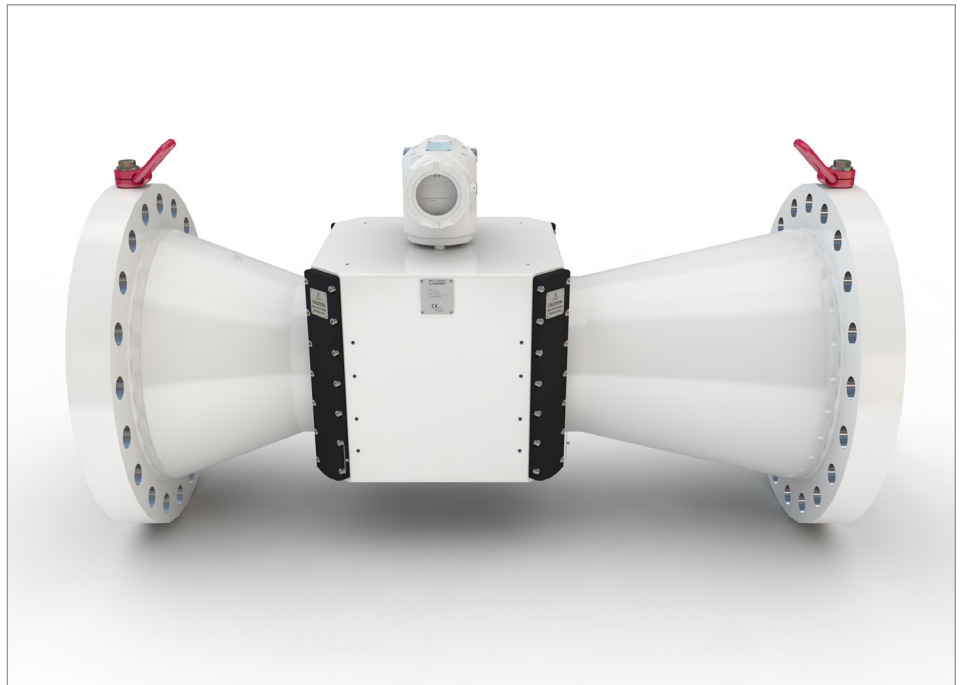
Measuring oils with high viscosity and/or in low flow conditions may involve operating at Reynolds numbers below 10,000. Ultrasonic flowmeter performance has traditionally been degraded for Reynolds numbers below 10,000 because the liquid velocity profile erratically switches between laminar and turbulent characteristics.

Cameron has developed a new ultrasonic flowmeter design with a reduced bore and a special nozzle shaped entry in which the liquid velocity profile is stabilized by forces much larger than the forces imposed by fluid viscosity. The meter design stabilizes the flow profile while preventing boundary layer separation under all operating conditions, greatly improving performance.

The CALDON\* LFM 280CiRN Series eight-path reduced nozzle liquid ultrasonic flowmeter provides the highest possible performance and has an excellent success rate of achieving a data spread of 0.05% in five prover runs.

### Meter construction

The CALDON LFM 280CiRN meter body is designed and manufactured in accordance with ASME B31.3 Process Piping Code or the Pressure Equipment Directive (PED) 97/23/EC and is suitable for handling pressurized liquid hydrocarbons. It has 16 piezoelectric transducer modules (typically 1.0 MHz or 1.6 MHz) forming four chordal paths. These are mounted in pressure containing housings and can be replaced while the meter body is under operating pressure. Ingress protection rating for transmitter and meter body is IP66 (NEMA 4/4x).



*CALDON LFM 280CiRN ultrasonic flowmeter*

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## Sizes, Maximum Flow Rates and K-factors, Based on a Maximum Inlet Velocity of 25 ft/s [7.62 m/s]

Size, in	DN	Nominal maximum flow, bbl/h [m <sup>3</sup> /h]	K-factor, P/bbl [P/m <sup>3</sup> ]
6	150	3,210 [510]	2,000 [12,600]
8	200	5,660 [900]	2,000 [12,600]
10	250	8,870 [1,410]	1,000 [6,300]
12	300	12,710 [2,020]	500 [3,150]
14	350	15,100 [2,400]	350 [2,200]
16	400	19,910 [3,165]	350 [2,200]
18	450	25,540 [4,060]	250 [1,570]
20	500	31,075 [4,940]	200 [1,000]

Size, in	DN	Nominal maximum flow, bbl/h [m <sup>3</sup> /h]	K-factor, P/bbl [P/m <sup>3</sup> ]
24	600	45,230 [7,190]	150 [940]
26	650	54,665 [8,690]	100 [630]
28	700	63,690 [10,125]	100 [630]
30	750	73,540 [11,690]	85 [530]
32	800	83,760 [13,315]	85 [530]
34	850	95,145 [15,125]	60 [380]
36	900	106,940 [17,000]	60 [380]

Consult Cameron for other sizes. K-factor is based on ~1.1 KHz output at maximum nominal rate. Other K-factors can be programmed but should be between 4 Hz and 10 KHz output at all operating flow rates. Meters are typically sized for a 15:1 flow range (from maximum flow) for sizes 4–8 in, 10:1 for sizes 10 in and larger.

## Standard Materials of Construction

Meter body	Stainless steel	Carbon steel
Flanges	Stainless steel	Carbon steel
Body	Cast or forged stainless steel	Cast or forged carbon steel
Manifold covers	Stainless steel or aluminum	Aluminum
Transducer housings	Stainless steel	316 stainless steel or Inconel
Junction boxes (remote transmitter)	Copper-free aluminum or optional cast stainless steel	

## Compact transmitter enclosure

### Standard

Copper-free aluminum

### Optional

Stainless steel

Consult Cameron for other material options.

## Standard End Connections and Maximum Working Pressure<sup>†</sup>

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

<sup>†</sup> Maximum working pressure at –20–100 degF [–29–38 degC]

# CALDON LFM 280CiRN

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## General Specifications

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### Electronics

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#### Power requirements—DC power

Voltage	24 VDC (18–30 VDC)
Current draw	0.25 A at 24 VDC
Power consumption	6 W

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#### Power requirements—AC power

Voltages	120 (60 Hz)/230 (50 Hz) VAC
Voltage range	108–253 VAC
Frequency range	47–63 Hz
Current draw	0.14A
Power consumption	7.3 W

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Relative humidity 0–95%

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Operating temperature –58–158 degF [–50–70 degC]

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Local display 400 pixel × 240 pixel LCD showing flow, diagnostics data, and alarms

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Remote mounting electronics from meter 328 ft [100 m]

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Analog inputs (three) 4–20 mA configured for pressure, temperature, or other

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RTD input Meter body temperature

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Analog outputs (two) 4–20 mA (max load 650 Ohms)

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#### 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 VDC or 12 VDC)
	3. Alternating, forward flow frequency on
	Channel A only reverse flow frequency
	On channel B only 50/50 duty cycle

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Alarm status Four outputs, 0–5 VDC or 0–12 VDC selectable  
(0 volts = alarm)

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Communication Three serial  
Ethernet or fiber modem

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### Meter Body

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Relative humidity 0–95%

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#### Operating temperature

Stainless steel	–58–284 degF [–50–140 degC]
Low-temperature carbon steel	–50–284 degF [–46–140 degC]

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See Electrical Safety Approvals for specific approval limits.

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Compliance with NACE MR0175 is available

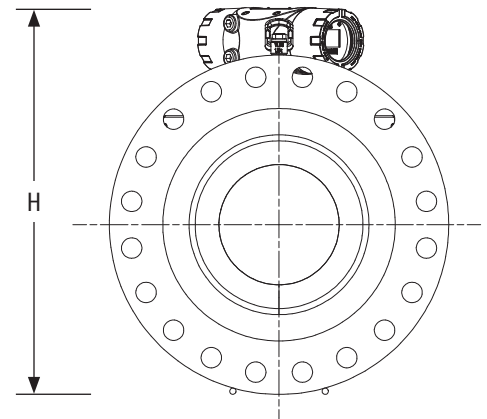
# CALDON LEFM 280CiRN

## Dimension and Weights for LEFM 280CiRN (Integral Manifold) with Compact Transmitter

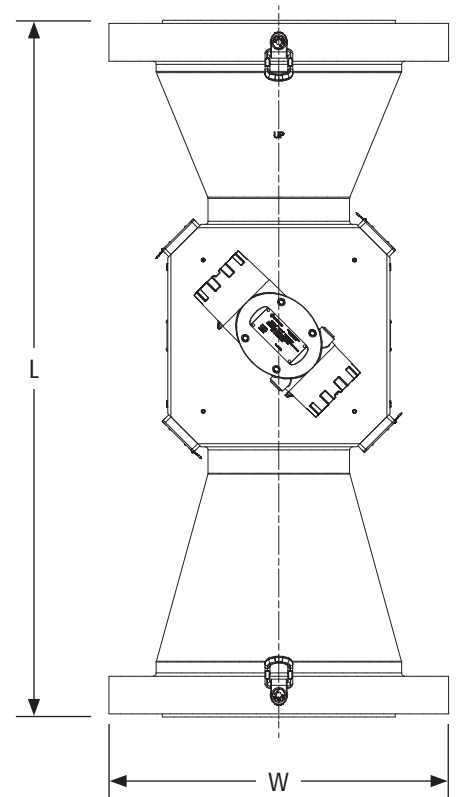
Pipe size, in [DN]	ANSI class	Length (L), in [mm]	Max width (W) <sup>†</sup> (including manifolds and sunshield), in [mm]	Height (H), in [mm]	Assembled meter weight with Xmtr <sup>‡</sup> , lbm [kg]
6 [150]	150	20.2 [513]	17.7 [450]	29.52 [749.8]	382 [173]
	300	20.9 [532]	17.7 [450]	29.52 [749.8]	433 [196]
	600	21.7 [551]	17.7 [450]	29.52 [749.8]	523 [237]
	900	22.2 [564]	17.7 [450]	30.12 [765.1]	606 [275]
	1500	22.4 [570]	17.7 [450]	29.54 [750.3]	726 [329]
8 [200]	150	22.3 [567]	17.7 [450]	35.92 [912.3]	587 [266]
	300	23.1 [586]	17.7 [450]	35.92 [912.3]	665 [302]
	600	23.8 [605]	17.7 [450]	35.92 [912.3]	813 [369]
	900	24.8 [630]	18.5 [470]	36.40 [924.7]	1,005 [456]
	1500	25.1 [637]	19.0 [483]	34.98 [888.5]	1,193 [541]
10 [250]	150	23.6 [598]	17.7 [450]	40.28 [1,023.1]	659 [299]
	300	24.3 [618]	17.7 [450]	40.28 [1,023.1]	781 [354]
	600	25.6 [649]	20.0 [508]	40.28 [1,023.1]	1,053 [478]
	900	26.3 [668]	21.5 [546]	41.19 [1,046.1]	1,290 [585]
	1500	27.1 [687]	23.0 [584]	39.87 [1,012.6]	1,713 [777]
12 [300]	150	26.3 [668]	19.0 [483]	46.11 [1,171.2]	997 [452]
	300	27.1 [687]	20.5 [521]	46.11 [1,171.2]	1,150 [522]
	600	27.8 [706]	22.0 [559]	46.11 [1,171.2]	1,488 [675]
	900	28.8 [732]	24.0 [610]	47.07 [1,195.7]	1,882 [854]
	1500	30.1 [764]	26.5 [673]	45.21 [1,148.5]	2,687 [1,219]
14 [350]	150	28.2 [716]	21.0 [533]	50.21 [1,275.4]	1,363 [618]
	300	29.2 [741]	23.0 [584]	50.21 [1,275.4]	1,628 [738]
	600	29.6 [751]	23.8 [603]	50.21 [1,275.4]	1,959 [889]
	900	30.3 [770]	25.3 [641]	51.23 [1,301.1]	2,433 [1,104]
	1500	32.4 [824]	29.5 [749]	50.59 [1,285.0]	3,724 [1,689]
16 [400]	150	29.4 [748]	23.5 [597]	55.37 [1,406.5]	1,521 [690]
	300	30.4 [773]	25.5 [648]	55.37 [1,406.5]	1,855 [841]
	600	31.2 [792]	27.0 [686]	55.37 [1,406.5]	2,388 [1,083]
	900	31.6 [802]	27.8 [705]	57.05 [1,449.1]	2,867 [1,300]
	1500	33.9 [862]	32.5 [826]	54.10 [1,374.0]	4,539 [2,059]
18 [450]	150	31.4 [799]	25.0 [635]	61.63 [1,565.4]	1,993 [904]
	300	32.9 [837]	28.0 [711]	61.63 [1,565.4]	2,451 [1,112]
	600	33.6 [852]	29.3 [743]	61.63 [1,564.4]	3,184 [1,444]
	900	34.4 [875]	31.0 [787]	62.98 [1,599.8]	4,034 [1,830]
	1500	36.9 [938]	36.0 [914]	60.12 [1,526.9]	6,145 [2,787]
20 [500]	150	33.4 [849]	27.5 [699]	65.93 [1,674.7]	2,416 [1,096]
	300	34.9 [887]	30.5 [775]	65.93 [1,674.7]	3,953 [1,793]
	600	35.7 [906]	32.0 [813]	65.93 [1,674.7]	4,018 [1,823]
	900	36.6 [929]	33.8 [857]	67.70 [1,719.5]	5,017 [2,276]
	1500	39.1 [992]	38.8 [984]	63.98 [1,625.1]	7,546 [3,423]
24 [600]	150	36.9 [938]	32.0 [813]	77.11 [1,958.6]	3,357 [1,523]
	300	38.9 [989]	36.0 [914]	77.11 [1,958.6]	4,274 [1,939]
	600	39.4 [1,002]	37.0 [940]	77.11 [1,958.6]	5,879 [2,667]
	900	41.4 [1,053]	41.0 [1,041]	78.88 [2,003.6]	8,336 [3,781]
	1500	46.0 [1,168]	46.0 [1,168]	74.42 [1,890.2]	1,1759 [5,334]

<sup>†</sup> On sizes up to 10-in Class 600 the sun shield is widest; on larger sizes the flange is the widest.

<sup>‡</sup> Consult Cameron for weights of cast or other meter construction.



16-in x 10-in LEFM 280CiRN ultrasonic flowmeter, side view.



16-in x 10-in LEFM 280CiRN ultrasonic flowmeter, top view.

# CALDON LFM 280CiRN

## General Performance

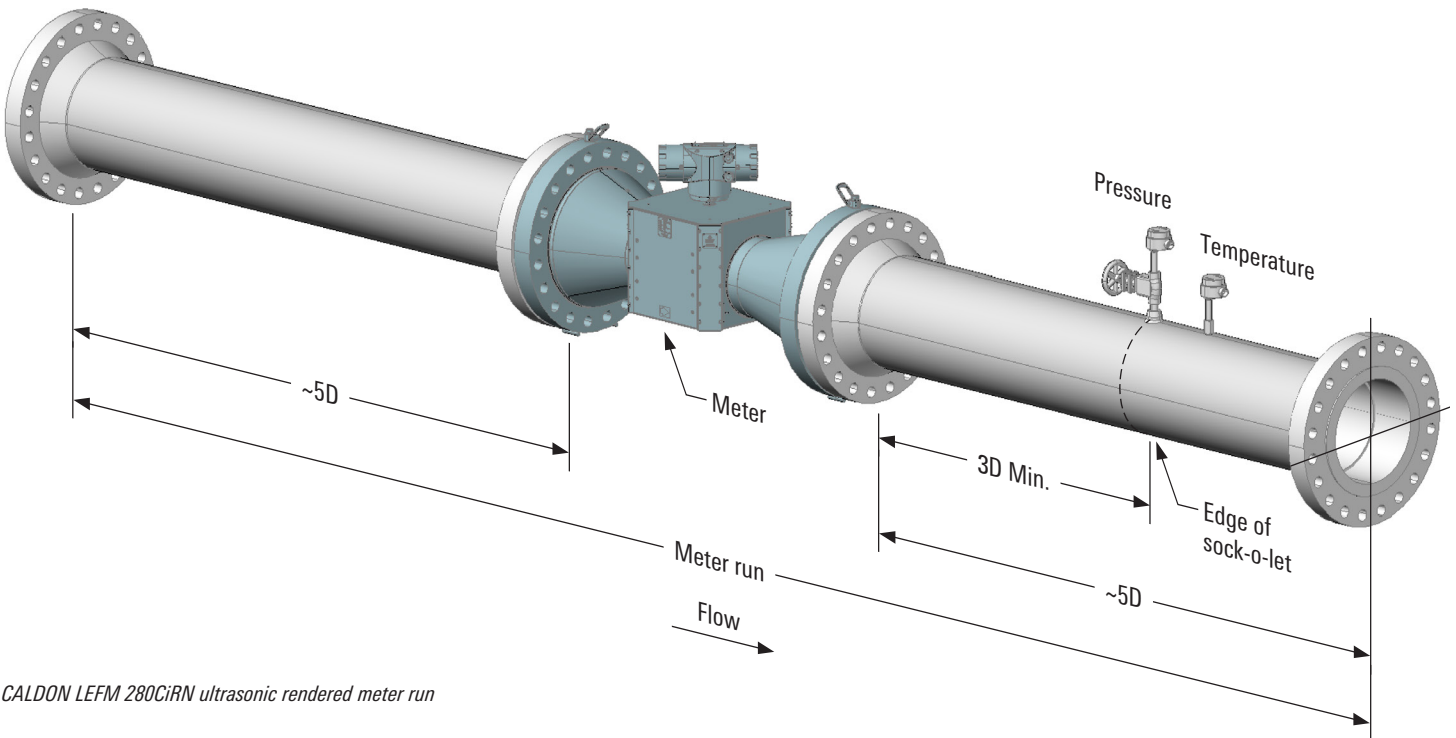
Application	High viscosity oils and or low flow rates that can create Reynolds numbers less than 10,000; any application involving in situ calibration of the meter using a pipe prover or small volume prover (SVP).
Linearity	$\pm 0.10\%$ over the nominal 15:1 flow range for each size meter.
Repeatability/uncertainty	0.02%; calibrated per API MPMS Chapter 5.8 Table B-1 to achieve a meter factor uncertainty of $\pm 0.027\%$ .
Sizes	6–36 in (nominal pipe size).
Long term stability	Meter factor is unaffected by usage.
Flow range	15:1 based on nominal maximum flow rate above.
Custody transfer approval	OIML R 117-1 Edition 2007 (E); Accuracy Class 0.3.
Pressure loss	Approximately 5 psi at maximum flow (diffuser recovers 70% of the velocity head differential).
Water in oil	The meter can operate on water in oil content as high as 50% provided the water in oil are well mixed, typically at velocities above 6.5 ft/s [2.5 m/s]. Meter operation may be affected if the water and oil phases separate or are not well mixed. Contact Cameron for further advise on high water-cut applications.
Viscosity	Maximum allowable viscosity is based on the meter size and the maximum allowable signal strength/attenuation. Consult Cameron for fluid viscosity greater than 1,000 cSt.

## Installation

**In order to limit uncertainty caused by hydraulic effects, it is recommended that the installation of the LFM 280CiRN flowmeter comply with the following guidelines. The adjoining straight pipe should be of the same schedule as the meter. Temperature elements and pressure connections should be located downstream of the meter. The LFM 280CiRN flowmeter does not normally require the use of a flow conditioning element. An uninterrupted upstream pipe five pipe diameters in length is adequate in most applications.**

In situations 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), it is recommended that this be separated from the meter by a pipe at least 10 pipe diameters in length. Downstream of the meter there

should be an uninterrupted pipe at least three pipe diameters in length. For application specific recommendations or more detailed installation guidance, please consult Cameron.



CALDON LFM 280CiRN ultrasonic rendered meter run

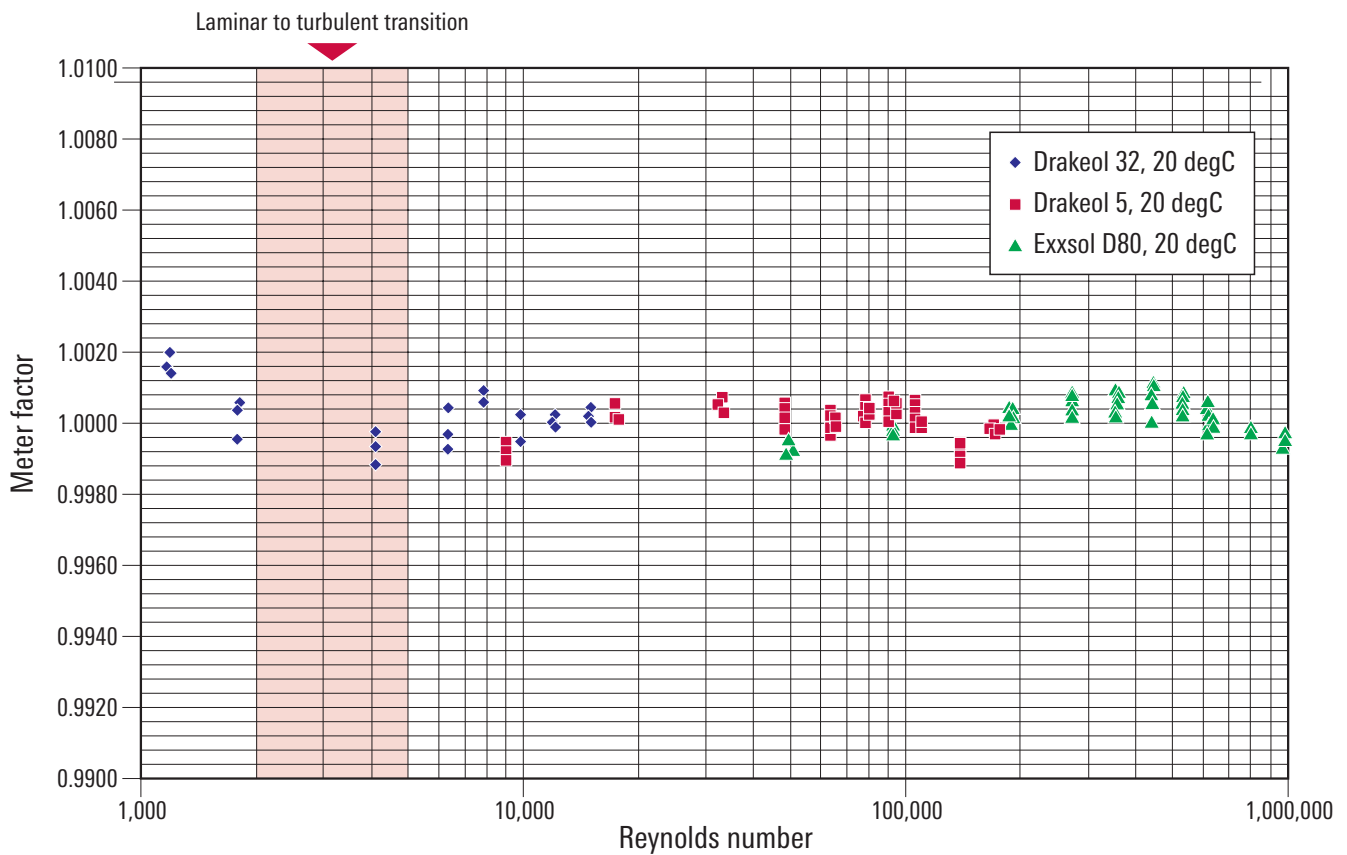
# CALDON LEFM 280CiRN

## Meeting the challenge



The above cutaway views of a reduced bore ultrasonic flow meter illustrate how transition flow velocity profiles at the inlet (left), which can change erratically between laminar and turbulent characteristics at any given flow rate, are stabilized by the forces in the throat of the meter (right). This greatly improves short term repeatability of the reduced bore design compared to a full bore design for transition flow.

## Getting the results

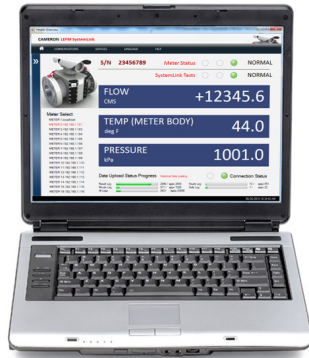


The graph above is a plot of meter factor versus Reynolds number for a 16-in LEFM 280CiRN reduced bore ultrasonic flowmeter calibrated using three oils. The reduced bore design maintains performance from turbulent flow, through the transition range, and down into laminar flow. This data was taken over a 25:1 range in flow rate which equated to a 1000:1 range in Reynolds number.

# CALDON LEFM 280CiRN

## LEFM SystemLink G3

The LEFM SystemLink G3 user interface software technology allows access to real-time diagnostic data, historical data, and event logs from a G3 ultrasonic flowmeter by using an Ethernet/fiber optic modem connection. Historical data and event logs are stored within the G3 transmitter, thus allowing for later retrieval—giving operators ability to monitor and analyze critical diagnostics, helping prevent unplanned downtime.



LEFM SystemLink G3 features:

Health overview report show the current meter status as well as meter process measurements including flow rate, temperature, and pressure

- Detailed charts and graphs present the meter diagnostic information in an easy-to-understand format with alarm limits that help identify issues
- User defined reference points are built using the meter's stored data. These reference points allow the user to graphically compare current meter performance against user defined reference points. For example, current performance can be compared against calibration or commissioning data.
- Export data as both predefined PDF reports or to customer defined Excel spreadsheets.



## Calibration lab

The Cameron Hydrocarbon Calibration Laboratory is a state-of-the-art facility located in Pittsburgh, PA. Every Caldon LEFM 200 series ultrasonic flowmeter is calibrated in this laboratory using up to three oils. The ability to use multiple oils allows calibration over a Reynolds number range that includes that of the customer's application. This ensures meter performance will be unaffected by changes in flow rate and viscosity once the meter is installed.

[cameron.slb.com/ultrasonicmeter](http://cameron.slb.com/ultrasonicmeter)