

CALDON LEFM 240Ci

Ultrasonic flowmeter

APPLICATIONS

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

BENEFITS

- Reliable and long-term stability

FEATURES

- Electronics can be integrally or remote mounted
- Available in 4- to 40-in sizes
- $\pm 0.15\%$ linearity over the nominal flow range
- OIML R117-1 Edition 2007 (E); Accuracy Class 0.3
- Third generation (G3) electronics

When accuracy and reliability are critical the CALDON* family of leading edge flowmeters (LEFM*) provides the petroleum industry with a durable, stable and low cost-of-ownership measurement option. The three LEFM models—the LEFM 220, LEFM 240, and LEFM 280—cover a broad range of measurement demands and allow users to choose just the right amount of metering horsepower—whether it is for custody transfer, check or allocation metering, or leak detection/line balance applications.

The CALDON* LEFM 240Ci Series four-path liquid ultrasonic flowmeter is a compact, high-performance unit designed specifically for custody transfer or fiscal metering applications. The four chordal path design ensures linearity over a wide flow range and the ability to handle a wide range of petroleum fluids including crude oils, refined products, and blends. Its versatility allows application in single or multiple product pipelines, as well as ship loading/off loading and offshore applications.

Meter construction

The CALDON LEFM 240Ci 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 eight 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 conditions. Ingress protection rating for the transmitter and meter body is IP66 (NEMA 4/4X).



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Sizes, Maximum Flow Rates and K-factors

Size, in	DN	Nominal maximum flow, bbl/h [m ³ /h]	K-factor, P/bbl [P/m ³]
4	100	2,050 [325]	2,000 [12,600]
6	150	4,650 [740]	1,000 [6,300]
8	200	8,150 [1,290]	500 [3,150]
10	250	12,800 [2,030]	350 [2,200]
12	300	19,300 [3,070]	250 [1,570]
14	350	23,600 [3,750]	200 [1,000]
16	400	28,700 [4,560]	150 [940]
18	450	41,000 [6,500]	100 [630]
20	500	50,000 [7,900]	85 [530]

Size, in	DN	Nominal maximum flow, bbl/h [m ³ /h]	K-factor, P/bbl [P/m ³]
24	600	72,000 [11,500]	60 [380]
26	650	87,000 [13,900]	45 [280]
28	700	100,000 [16,200]	40 [240]
30	750	115,000 [18,700]	35 [220]
32	800	130,000 [21,300]	30 [185]
34	850	150,000 [24,200]	25 [165]
36	900	165,000 [27,200]	25 [145]
40	1,000	205,000 [32,600]	20 [125]

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 10:1 flow range (from maximum flow) for sizes 4–8 in; 15:1 for sizes 10 in and larger.

Standard Materials of Construction

Meter body	Stainless steel	Carbon steel
Flanges	316 Stainless steel	Carbon steel
Body	Cast or forged stainless steel	Cast or forged carbon steel
Manifold covers	316 Stainless steel or aluminum	316 stainless steel or aluminum
Transducer housings	316 Stainless steel	316 stainless steel or INCONEL 625
Junction boxes (remote transmitter)	Copper-free aluminum or optional cast stainless steel — CF8M (316)	
Compact transmitter enclosure	Standard	Stainless steel
	Copper-free aluminum	Optional stainless steel

Consult Cameron for other material options.

Standard End Connections and Maximum Working Pressure[†]

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]

[†] Maximum working pressure at –20–100 degF [–29–38 degC]

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General Specifications

Electronics

Power requirements—DC power

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

Power requirements—AC power

Voltages	120 (60 Hz) / 230 (50 Hz) VAC
Voltage range	85–264 VAC
Frequency range	47–63 Hz
Current draw	0.11 A at 120 VAC
Power consumption	7.7 W

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

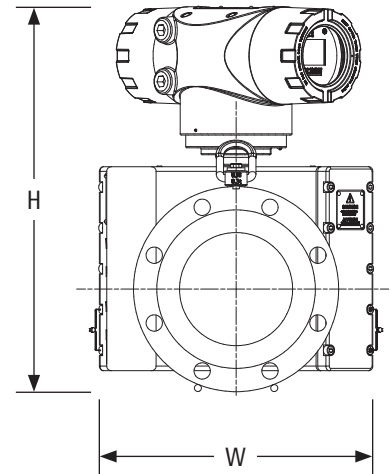
Relative humidity	0–95%
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Operating temperature	–58–257 degF [–50–125 degC]
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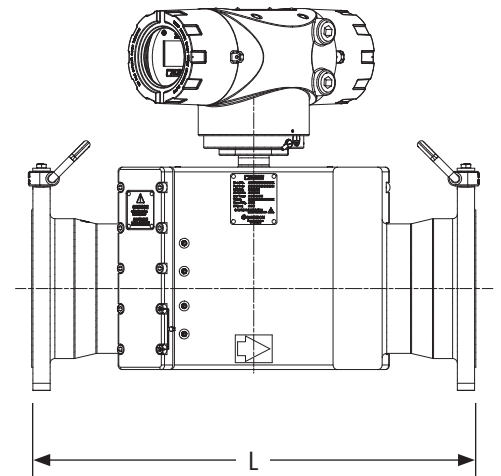
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Dimension and Weights for LEFM 240Ci (Integral Manifold) with Compact Transmitter

Pipe size, in [DN]	ANSI class	Length (L), in [mm]	Max width (W) [†] (including manifolds and sunshield), in [mm]	Height (H), in [mm]	Assembled meter weight with Xmtr [‡] , lbm [kg]
4 [100]	150	21.00 [533]	17.7 [450]	19.2 [487]	332 [151]
	300	21.75 [552]	17.7 [450]	19.7 [500]	352 [160]
	600	23.50 [597]	17.7 [450]	20.1 [510]	385 [174]
	900	24.50 [622]	17.7 [450]	20.4 [519]	419 [190]
	1500	25.25 [641]	17.7 [450]	20.8 [529]	464 [211]
6 [150]	150	24.00 [610]	17.7 [450]	21.1 [535]	494 [224]
	300	24.75 [629]	17.7 [450]	21.8 [554]	535 [243]
	600	26.75 [679]	17.7 [450]	22.6 [573]	624 [283]
	900	28.50 [724]	17.7 [450]	23.1 [586]	705 [320]
	1500	31.00 [787]	17.7 [450]	23.3 [592]	839 [381]
8 [200]	150	26.75 [679]	17.7 [450]	23.6 [598]	733 [332]
	300	27.50 [699]	17.7 [450]	24.3 [618]	793 [360]
	600	29.75 [756]	17.7 [450]	25.1 [637]	929 [421]
	900	32.00 [813]	18.5 [470]	26.1 [662]	1,112 [504]
	1500	36.00 [914]	19.0 [483]	26.3 [668]	1,334 [605]
10 [250]	150	28.75 [730]	17.7 [450]	25.7 [652]	1,010 [458]
	300	30.00 [762]	17.7 [450]	26.4 [672]	1,104 [501]
	600	33.25 [845]	20.0 [508]	27.7 [703]	1,364 [619]
	900	35.75 [908]	21.5 [546]	28.4 [722]	1,596 [724]
	1500	41.25 [1,048]	23.0 [584]	29.2 [741]	2,090 [948]
12 [300]	150	31.75 [806]	19.6 [497]	28.4 [722]	1,382 [627]
	300	33.00 [838]	20.5 [521]	29.2 [741]	1,509 [684]
	600	35.50 [920]	22.0 [559]	29.9 [760]	1,812 [822]
	900	39.00 [991]	24.0 [610]	30.9 [786]	2,194 [995]
	1500	45.50 [1,156]	26.5 [673]	32.2 [818]	3,067 [1,391]
14 [350]	150	34.00 [864]	21.0 [533]	30.2 [767]	1,669 [757]
	300	35.25 [895]	23.0 [584]	31.2 [792]	1,858 [843]
	600	37.50 [953]	23.8 [603]	31.6 [802]	2,180 [989]
	900	41.25 [1,048]	25.3 [641]	32.3 [821]	2,619 [1,188]
	1500	48.00 [1,219]	29.5 [749]	34.4 [875]	3,889 [1,764]
16 [400]	150	35.75 [908]	23.5 [597]	32.7 [830]	2,165 [982]
	300	37.25 [946]	25.5 [648]	33.7 [856]	2,400 [1,088]
	600	40.25 [1,022]	27.0 [686]	34.4 [875]	2,932 [1,330]
	900	43.25 [1,099]	27.8 [705]	34.8 [884]	3,373 [1,530]
	1500	50.75 [1,289]	32.5 [826]	37.2 [945]	5,104 [2,315]
18 [450]	150	38.75 [984]	25.0 [635]	34.4 [873]	2,659 [1,206]
	300	40.25 [1,022]	28.0 [711]	35.9 [911]	2,969 [1,347]
	600	42.75 [1,086]	29.3 [743]	36.5 [927]	3,654 [1,657]
	900	46.25 [1,175]	31.0 [787]	37.4 [949]	4,405 [1,998]
	1500	54.00 [1,372]	36.0 [914]	39.9 [1,013]	6,593 [2,990]
20 [500]	150	41.13 [1,045]	27.5 [699]	36.6 [930]	3,247 [1,473]
	300	42.50 [1,080]	30.5 [775]	38.1 [968]	3,607 [1,636]
	600	45.25 [1,149]	32.0 [813]	38.9 [987]	4,554 [2,066]
	900	49.75 [1,264]	33.8 [857]	39.8 [1,010]	5,479 [2,485]
	1500	58.25 [1,480]	38.8 [984]	42.3 [1,073]	8,208 [3,723]
24 [600]	150	45.75 [1,162]	32.0 [813]	40.8 [1,037]	4,586 [2,080]
	300	47.00 [1,194]	36.0 [914]	42.8 [1,087]	5,159 [2,340]
	600	50.25 [1,276]	37.0 [940]	43.3 [1,100]	6,617 [3,001]
	900	57.25 [1,454]	41.0 [1,041]	45.3 [1,151]	8,877 [4,027]
	1500	66.25 [1,683]	46.0 [1,168]	47.8 [1,214]	12,695 [5,758]



6-in LEFM 240Ci ultrasonic flowmeter, side view.



6-in LEFM 240Ci ultrasonic flowmeter, front view.

[†] On sizes up to 8-in Class 600 the sun shield is widest; on larger sizes the flange is the widest.

[‡] Consult Cameron for weights of cast or other meter construction.

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General Performance

Linearity	± 0.15% over nominal flow range with recommended installation.
Reynolds number [†]	Performance may degrade when Reynolds number falls below 10,000.
Repeatability/uncertainty	0.02%; Calibrated per API MPMS Chapter 5.8 Table B-1 to achieve a meter factor uncertainty of ± 0.027%.
Nominal flow range [‡]	10:1 or better for sizes 4–8 in (DN100–DN200) from nominal maximum flow; 15:1 or better for sizes 10 in and larger (DN250 and larger) from nominal maximum flow rate.
Long-term stability	Meter factor is unaffected by usage.
Water in oil [§]	The meter can operate on water in oil content as high as 50% provided the water and 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 advice on high water-cut applications.
Viscosity	The maximum allowable viscosity is based on maintaining the recommend minimum operating Reynolds number and/or the maximum allowable signal attenuation. Contact Cameron for the maximum allowable viscosity for specific operating conditions.
Custody transfer certification	OIML R 117-1 Edition 2007 (E) Accuracy Class 0.3

[†] Contact Cameron when operating Reynolds number is expected to be below 10,000

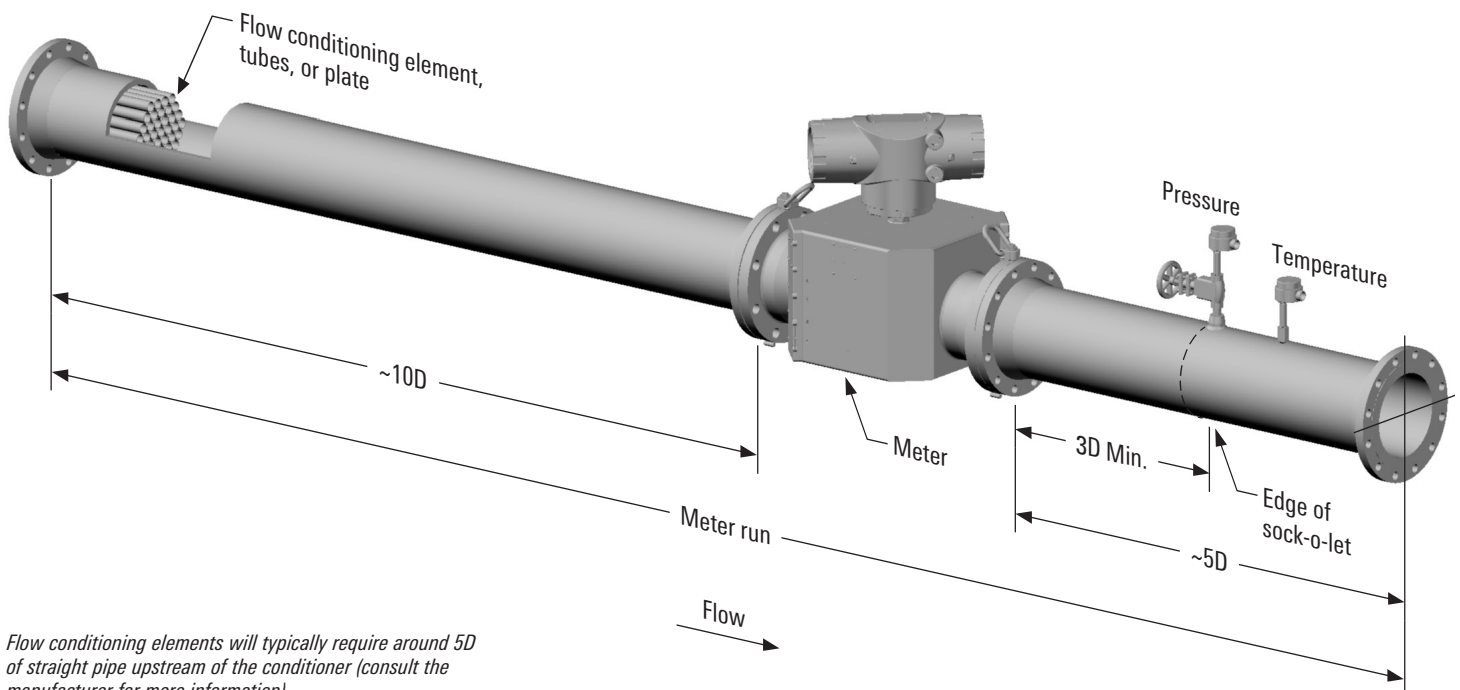
[‡] Nominal flow range will increase for values of linearity > 0.15%

[§] Call Cameron for special applications outside these ranges.

Installation

In order to limit uncertainty caused by hydraulic effects, it is recommended that the installation of a CALDON LFM 240Ci 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. It is recommended that the meter be installed downstream of a 10 diameter pipe section that includes a flow conditioning element at its inlet. For effective flow conditioning, it is generally recommended that there be an additional straight pipe of approximately five diameters in length located upstream of the flow conditioner.

Downstream of the meter there should be an uninterrupted pipe at least three pipe diameters in length. If a flow conditioning element is not used, additional uncertainty can be limited by using a straight pipe upstream at least 20 pipe diameters in length and applying strict rules to avoid the introduction of swirl upstream of that 20D length. Typically, this will dictate specific requirements for the combination of fittings that can be used for a further 30 diameters upstream. For less demanding uncertainty requirements or when the meter is calibrated in situ, the installation recommendations can be relaxed. For application specific recommendations or more detailed installation guidance, please consult Cameron.



Flow conditioning elements will typically require around 5D of straight pipe upstream of the conditioner (consult the manufacturer for more information).

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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 Series 200 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.

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