

CALDON LEFM 280Ci Ultrasonic Flow Meters

When accuracy and reliability are critical the CALDON® family of leading edge flow meters (LEFM®) provides the petroleum industry with a durable, stable and low cost-of-ownership measurement option. The LEFM 280Ci covers a broad range of measurement demands and provides users with metering horsepower – whether for custody transfer, check or allocation metering, or leak detection/line balance applications.

The LEFM 280Ci ultrasonic flow meter offers the highest level of performance of any ultrasonic flow meter on the market today. Its design makes it immune to swirl and less sensitive to other installation effects. This fact makes the LEFM 280Ci an ideal meter for the transfer of laboratory calibration to the field. It can be used with confidence in remote applications, where provers are not practical or where space and weight allowances are limited.



Meter Construction

The CALDON LEFM 280Ci 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 eight 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.

Sizes, Maximum Flow Rates and K-factors

Size (in.)	DN	Nominal Maximum Flow (BPH)	K-factor (P/Bbl)	Nominal Maximum Flow (m³/h)	K-factor (P/m³)
4	100	2050	2000	325	12,600
6	150	4650	1000	740	6300
8	200	8150	500	1290	3150
10	250	12,800	350	2030	2200
12	300	19,300	250	3070	1570
14	350	23,600	200	3750	1000
16	400	28,700	150	4560	940
18	450	41,000	100	6500	630
20	500	50,000	85	7900	530
24	600	72,000	60	11,500	380

K-factor

Size (in.)	DN	Nominal Maximum Flow (BPH)	K-factor (P/Bbl)	Nominal Maximum Flow (m³/h)	K-factor (P/m³)
26	650	87,000	45	13,900	280
28	700	100,000	40	16,200	240
30	750	115,000	35	18,700	220
32	800	130,000	30	21,300	185
34	850	150,000	25	24,200	165
36	900	165,000	25	27,200	145
40	1,000	205,000	20	32,600	125

K-factor is based on ~ 1.1 KHz output at maximum nominal rate. Other K-factors can be programmed but must be between 4 Hz and 10 KHz output at all operating flow rates. Meters are typically sized for a 5:1 flow range (from maximum flow) for sizes 4" to 8"; 10:1 for sizes 10" and larger.

Electrical Safety Approvals

Meter Body Approvals	CE Approvals	CSA Approvals
Using Integral Aluminum Transmitter	II 2 G, Ex d IIB TA Gb Ta = -40° F to 158° F (-40° C to 70° C)	Class 1, Div. 1 & 2, Grps C & D, Temp -40° F to 158° F (-40° C to 70° C)
Using Integral Stainless Steel Transmitter	II 2 G, Ex d IIC TA Gb Ta = -58° F to 158° F (-50° C to 70° C)	Class 1, Div. 1 & 2, Grps C & D, Temp -40° F to 158° F (-40° C to 70° C)
No Transmitter	II 2 G, Ex d IIC TA Gb Ta = -58° F to 257° F (-50° C to 125° C)	Class 1, Div. 1 & 2, Grps B, C & D, Temp -58° F to 257° F (-50° C to 125° C)

Transmitter Approvals	CE Approvals	CSA Approvals
Aluminum Compact Transmitter	II 2 G, Ex d IIB TA Gb Ta = -40° F to 158° F (-40° C to 70° C)	Class 1, Div. 1 & 2, Grps C & D, Temp -40° F to 158° F (-40° C to 70° C)
Stainless Steel Compact Transmitter	II 2 G, Ex d IIC TA Gb Ta = -58° F to 158° F (-50° C to 70° C)	Class 1, Div. 1 & 2, Grps C & D, Temp -40° F to 158° F (-40° C to 70° C)

Standard Materials of Construction

Meter Body	Stainless Steel	Carbon Steel
Flanges	316 Forged Stainless Steel	Forged Carbon Steel – ASTM A105 or A350 LF2
Body	Stainless Steel – (316/316L)	Cast or Forged Carbon Steel
Manifold Covers	316 Stainless Steel or Aluminum	Aluminum
Transducer Housings	316 Stainless Steel	316 Stainless Steel or Forged Carbon Steel
Junction Boxes (Remote Transmitter)	Copper-free Aluminum or Optional Cast Stainless Steel – CF8M (316)	

Compact Transmitter Enclosure

EX – NEMA 7/4	Copper-free Aluminum
EX – NEMA 7/4X	Optional Cast Stainless Steel – CF8M (316)

Consult Cameron for other material options.

Standard End Connections and Maximum Working Pressure – Maximum Working Pressure -20° F to 100° F (-29° C to 38° C)

ANSI B16.5 Raised Face	Stainless Steel		Carbon Steel	
	psi	(bar)	psi	(bar)
Class 150	275	(19.0)	285	(19.6)
Class 300	720	(49.6)	740	(51.1)
Class 600	1440	(99.3)	1480	(102.1)
Class 900	2160	(148.2)	2220	(153.2)
Class 1500	3600	(248.2)	3705	(255.3)

General Specifications

LEFM 220Ci Compact Transmitter	
Voltage	18 - 30 VDC
Power	12 W
Relative Humidity	0 - 100%
Operating Temperature	-58° F to 158° F (-50° C to 70° C) Transmitter should be remote mounted if process temperature exceeds operating temperature by more than 18° F (10° C). See Electrical Safety Approvals for specific approval limits.
Local Display	Yes (two-line 16 characters/line) 0.22" high (6.0 mm)
Remote Mounting from Meter	328 ft (100 m)
Analog Input(s)	One, 4 - 20 mA Configured for fluid temperature, pressure or density
Analog Output(s)	One, 4 - 20 mA Any process variable measured by the meter is available as an analog output
Digital Outputs	
Flow	Two pulse output channels selectable as either 0 - 5 V or 0 - 12 V; A and B continuous 50/50 duty cycle. Programmable K-factor.
Flow Direction	B-channel can be programmed as 90° out of phase with A or as a direction-indicating voltage level (high = forward flow)
Alarm Status	0 - 5 V or 0 - 12 V selectable (0 = alarm)
Communication	Modbus® RTU-485 (2) – Up to 3900 ft (1200 m) or Modbus RTU-485 (1) and Ethernet supporting Modbus/TCP and web server (1)

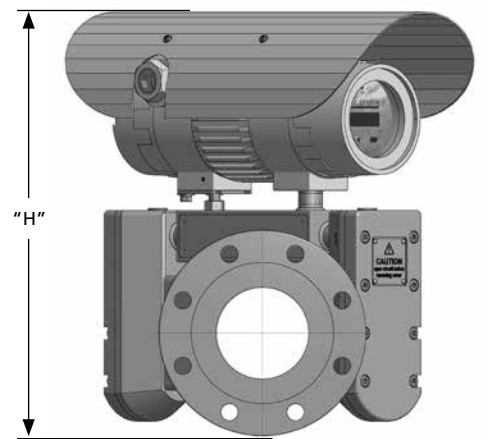
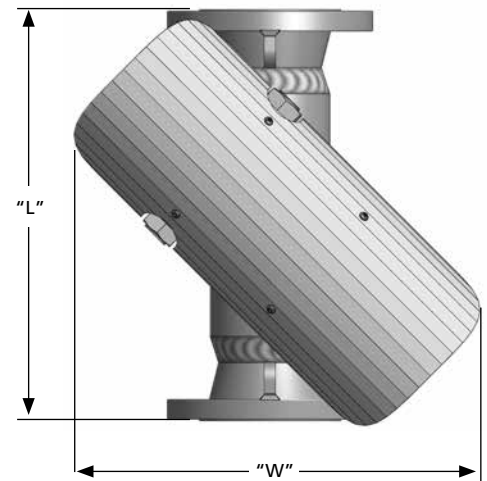
Meter Body

Relative Humidity	0 - 100%	
Operating Temperature	Stainless Steel	-58° F to 284° F (-50° C to 140° C)
	Carbon Steel	-20° F to 284° F (-29° C to 140° C)
	Low Temperature Carbon Steel	-50° F to 284° F (-46° C to 140° C)
	See Electrical Safety Approvals for specific approval limits.	

Compliance with NACE MR0175 is available.

Dimension and Weights for LFM 280Ci with Compact Transmitter

Pipe Size (in.) (DN)	ANSI Class	Length (L)		Width (W)*		Height (H)		Unpacked Weight (Cast Body)**	
		(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(lb)	(kg)
4 (100)	150	18.0	(457)	17.8	(452)	18.6	(417)	185	(84)
	300	18.8	(477)	17.8	(452)	19.1	(430)	202	(92)
	600	20.5	(521)	17.8	(452)	19.5	(440)	236	(107)
	900	21.5	(546)	17.8	(452)	19.8	(448)	254	(115)
6 (150)	1500	22.3	(565)	17.8	(452)	20.2	(458)	298	(135)
	150	20.5	(521)	17.8	(452)	20.5	(466)	279	(126)
	300	21.3	(540)	17.8	(452)	21.2	(484)	313	(142)
	600	23.2	(590)	17.8	(452)	22.0	(504)	391	(177)
8 (200)	900	25.0	(635)	17.8	(452)	22.5	(517)	449	(204)
	1500	27.5	(699)	17.8	(452)	22.7	(522)	559	(253)
	150	24.0	(610)	17.8	(452)	22.7	(522)	474	(215)
	300	24.8	(629)	17.8	(452)	23.5	(542)	530	(240)
10 (250)	600	27.0	(686)	17.8	(452)	24.2	(560)	636	(289)
	900	29.3	(743)	17.8	(452)	25.2	(585)	746	(338)
	150	26.0	(660)	17.8	(452)	25.1	(583)	714	(324)
	300	27.2	(692)	17.8	(452)	25.8	(600)	792	(359)
12 (300)	600	30.5	(775)	20.0	(508)	27.1	(633)	990	(449)
	900	33.0	(838)	21.5	(546)	27.8	(651)	1130	(513)
	150	29.5	(749)	19.0	(483)	27.6	(646)	987	(448)
	300	30.7	(781)	20.5	(521)	28.3	(664)	1107	(502)
14 (350)	600	33.2	(844)	22.0	(559)	29.1	(684)	1277	(579)
	900	36.8	(934)	24.0	(610)	30.1	(710)	1477	(670)
	150	32.0	(813)	21.0	(533)	29.3	(689)	1265	(574)
	300	33.2	(844)	23.0	(584)	30.3	(715)	1405	(637)
16 (400)	600	35.5	(902)	23.8	(603)	30.7	(725)	1605	(728)
	900	39.3	(997)	25.3	(641)	31.5	(745)	1845	(837)
	150	33.5	(851)	23.5	(597)	31.6	(748)	1467	(666)
	300	35.0	(889)	25.5	(648)	32.6	(773)	1687	(765)
18 (450)	600	38.0	(965)	27.0	(686)	33.3	(791)	1967	(892)
	900	41.5	(1054)	27.8	(705)	33.7	(801)	2177	(988)
	150	37.0	(940)	25.0	(635)	33.4	(793)	1614	(732)
	300	38.5	(978)	28.0	(711)	34.9	(832)	1954	(887)
20 (500)	600	41.0	(1041)	29.3	(743)	35.5	(847)	2264	(1027)
	900	44.5	(1130)	31.0	(787)	36.4	(870)	2674	(1213)
	150	39.4	(1000)	27.5	(699)	35.6	(849)	1640	(744)
	300	40.8	(1035)	30.5	(775)	37.1	(887)	2080	(943)
24 (600)	600	43.5	(1105)	32.0	(813)	37.9	(908)	2460	(1116)
	900	48.0	(1219)	33.8	(857)	38.7	(928)	2940	(1333)
	150	44.0	(1118)	32.0	(813)	39.9	(959)	1991	(903)
	300	45.2	(1149)	36.0	(914)	41.9	(1009)	2631	(1194)
26 (650)	600	48.5	(1232)	37.0	(940)	42.4	(1022)	3131	(1420)
	900	55.5	(1410)	41.0	(1041)	44.4	(1073)	4471	(2028)
	150	43.5	(1105)	34.3	(870)	42.0	(1012)	2204	(1000)
	300	48.5	(1232)	38.3	(972)	44.0	(1063)	2814	(1276)
28 (700)	150	45.9	(1165)	36.5	(927)	43.1	(1065)	2414	(1095)
	300	51.5	(1308)	40.8	(1035)	46.2	(1119)	3214	(1458)
30 (750)	150	48.8	(1239)	38.8	(984)	46.2	(1119)	2632	(1194)
	300	54.5	(1384)	43.0	(1092)	48.4	(1174)	3572	(1620)
32 (800)	150	51.4	(1305)	41.8	(1060)	48.7	(1182)	2949	(1338)
	300	57.5	(1461)	45.3	(1149)	50.5	(1228)	3949	(1791)
34 (850)	150	53.8	(1366)	43.8	(1111)	50.7	(1233)	3127	(1419)
	300	60.2	(1530)	47.5	(1207)	52.6	(1281)	4337	(1967)
36 (900)	150	56.4	(1432)	46.0	(1168)	52.9	(1289)	3435	(1558)
	300	63.0	(1600)	50.0	(1270)	54.9	(1340)	4705	(2134)



Meter Body with Integral Transmitter



Remote mounted compact transmitter with aluminum housing option

*On sizes up to 10" Class 300 the sun shield is widest, on larger sizes the flange is the widest.

**Consult Cameron for weights of forged or other meter construction.

General Performance

Linearity	± 0.10% over nominal flow range with recommended installation.
Reynolds Number ¹	Performance may degrade when Reynolds number falls below 10,000.
Reproducibility/Uncertainty	Per API MPMS Chapter 4.8 Table A-1 to achieve a meter factor uncertainty of ± 0.027%
Nominal Flow Range ²	10:1 for sizes 4" to 8" (DN100 – DN200) from nominal maximum flow; 15:1 or greater for sizes 10" and larger (DN250 and larger) from nominal maximum flow.
Long-term Stability	Meter factor is unaffected by usage.
Water in Oil ³	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 fps (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 recommended minimum operating Reynolds number and/or the maximum allowable signal attenuation. Contact Cameron for max. allowable viscosity for specific operating conditions.
Custody Transfer Certification	OIML R 117-1 Edition 2007 (E); Accuracy Class 0.3.

¹ Call Cameron when operating Reynolds number is expected to be below 10,000

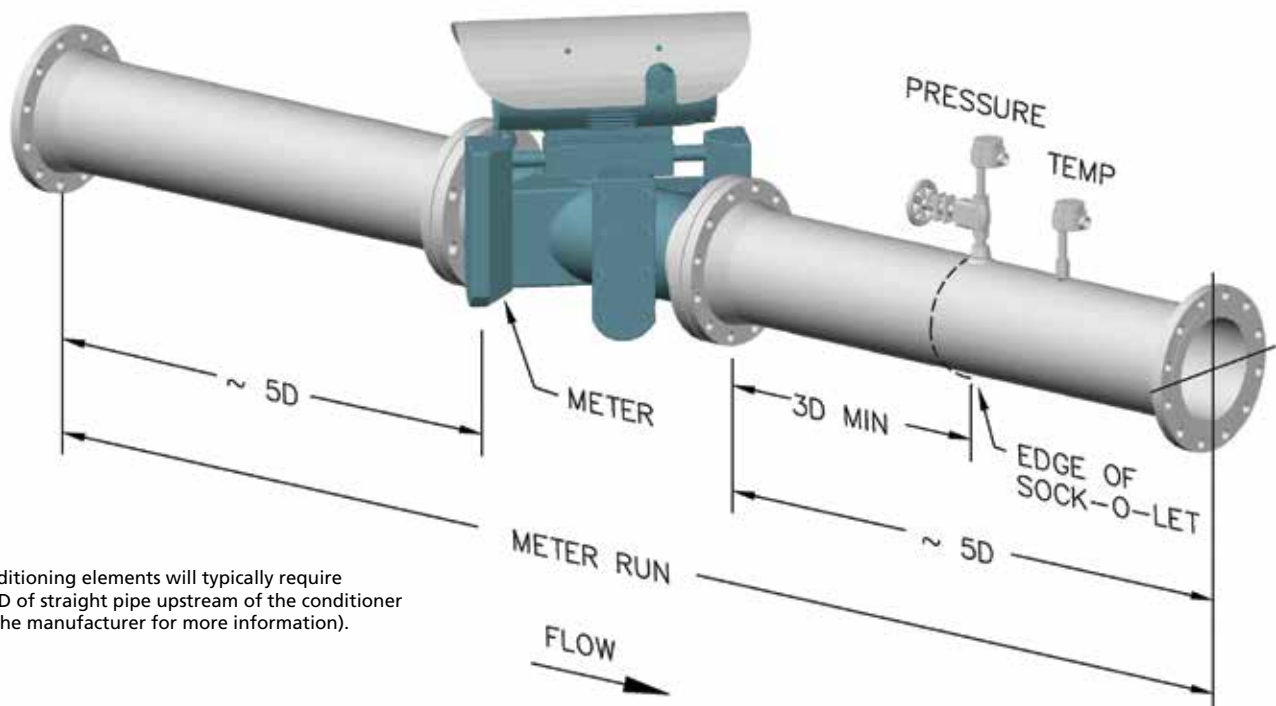
² Nominal flow range will increase for linearity greater than 0.10%

³ Call Cameron for applications outside these ranges

Installation

In order to limit uncertainty caused by hydraulic effects, it is recommended that the installation of the LEFM 280Ci 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 LEFM 280Ci 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 15 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.



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

LEFMLink 2G

LEFMLink 2G provides an interface between LEFM products and the user's PC via a serial connection.

LEFMLink 2G enables the user to view operating and diagnostic information and can also provide a continuous audit of the meter. LEFMLink 2G

software is shipped with all LEFM products and can also be downloaded from the Cameron website. LEFMLink 2G software includes a wizard that steps the user through the installation process on their PC.



- The main screen provides an overview of meter status and measurements, including flow rate, totals, temperature, pressure, viscosity, density and alarm/alert status.
- Remotely scales analog inputs/outputs and forces the pulse and analog outputs to verify values and operation.
- The diagnostic screen provides data for each ultrasonic path. The calculation diagnostics page shows velocity profile, profile factor, Reynolds number and totalizer information. Velocity profile, sound velocity and standard deviation of the transit time difference can be displayed in graphic form.
- LEFMLink 2G allows the user to store data in the PC memory. The logging capability allows the creation of a single continuous file, logging data at regular intervals. The flow profile signature can be recorded during calibration and later compared to the *in situ* flow profile to monitor for variations that could affect performance. Changes in gain or profile signature can also be tracked to identify effects of wax buildup and other conditions that could affect overall performance.

Calibration Lab



Cameron's Hydrocarbon Calibration Laboratory is a state-of-the-art facility located in Pittsburgh, PA. Every CALDON LEFM 200 Series ultrasonic flow meter 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.

- Traceable to international standards.
- Accredited to ISO 17025.
- Uncertainty certified by NMI and NVLAP (0.04% Ball Prover, 0.03% Small Volume Prover, 0.08% Master Meters, 0.04% SVP and Turbine Meter, and 0.09% Single Master Meter).
- Oil temperature controlled within a band of 60° F to 95° F (15° C to 35° C) using a chiller system.
- Oil viscosity can be controlled between 1.5 and 200 cSt.
- Maximum flow rate of 24,500 BPH/3900 m³/hr.

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US Patents: 5546813, 5597962, 5639972, 5705753; Korea Patent: 208678; Canada Patent: 2107.750;
Taiwan Patents: NI-080038, UM-119114. US and foreign patents pending.
These specifications are subject to change without notice.
Check with the factory to verify if they are currently in effect.