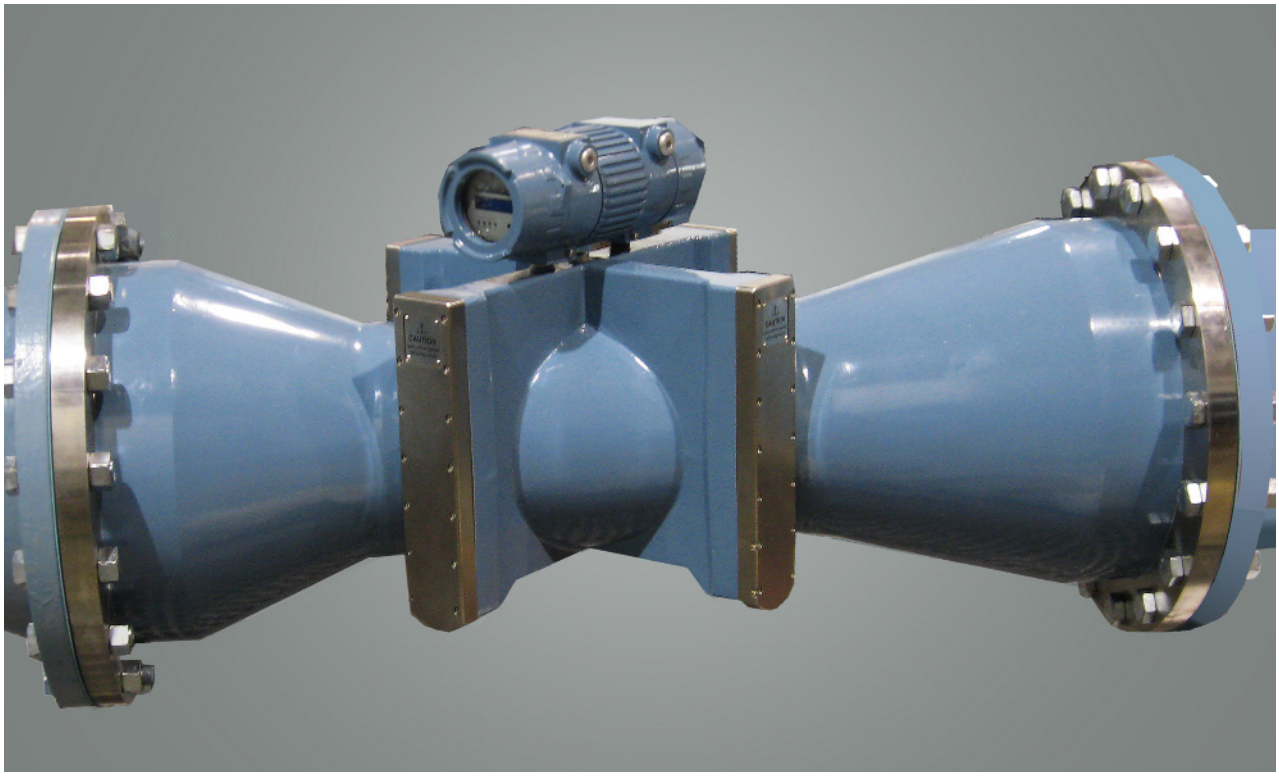
CALDON®

LEFM® 280CiRN Ultrasonic Flow Meters



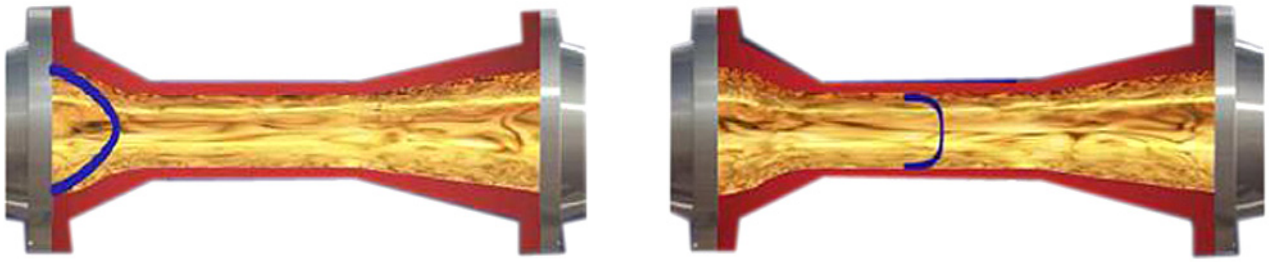
Measuring oils having high viscosity and/or low flow conditions may involve operating at Reynolds numbers below 8,000. Ultrasonic flow meter performance has traditionally been degraded for Reynolds numbers below 8,000 because the liquid velocity profile erratically switches between laminar and turbulent characteristics.

Cameron has developed a new ultrasonic flow meter design with a reduced bore, modeled after flow nozzle technology, 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 280CiRN provides the highest possible performance and has a excellent success rate of achieving a data spread of 0.05% in 5 prover runs.

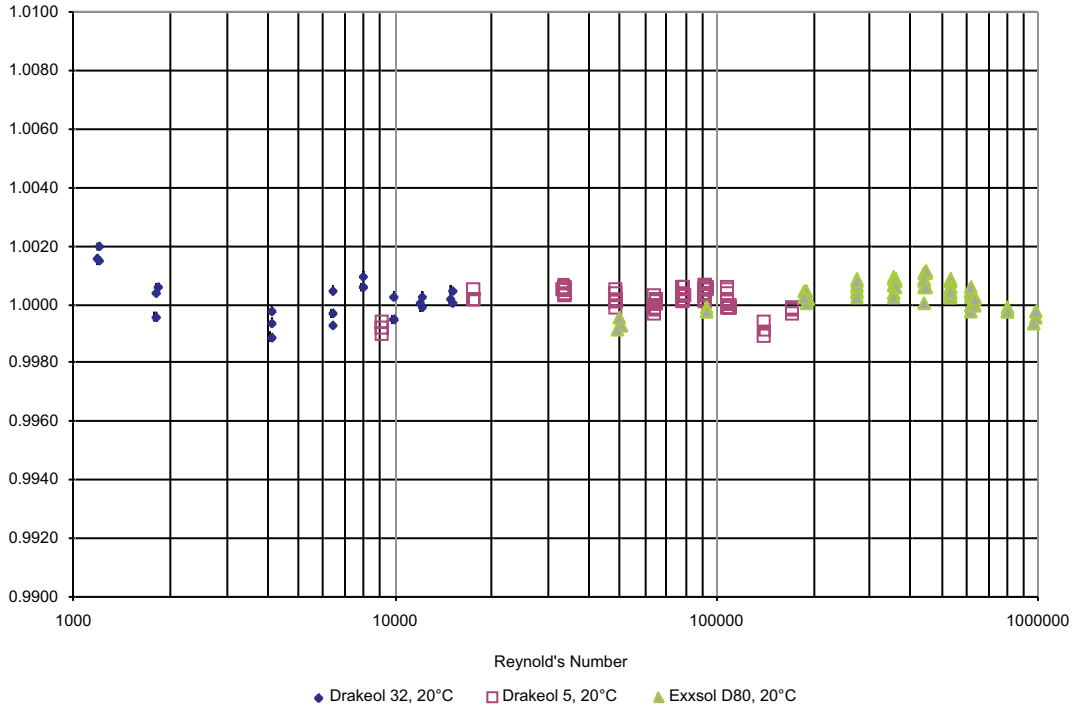
- Custody transfer performance down to Reynolds Numbers of 1000 and lower
- Ideally suited for higher viscosity oils and/or low flow rates
- High success rate for provability to 0.05% in 5 runs with standard size prover
- Minimal requirements for upstream/downstream piping

Meeting the Challenge



The above cut-away 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 flow meter 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.

General Performance

Application	High viscosity oils and or low flow rates that can create Reynolds numbers less than 8,000; any application involving in-situ calibration of the meter using a pipe prover or small volume prover (SVP).
Linearity	±0.12% over the nominal 15:1 flow range for each size meter
Reproducibility/Uncertainty	Per API MPMS Chapter 4.8 Table A-1 to achieve a meter factor uncertainty of ±0.027%
Sizes	6 inch to 36 inch (inlet diameter)
Inlet/Throat Ratio	Approximately 0.63
Nominal Max. Flow	Based on a max inlet velocity of 25 fps (7.62 mps)

Inlet Size (in.)	Nominal Maximum Flow BPH	m^3/hr	Inlet Size (in.)	Nominal Maximum Flow BPH	m^3/hr
6	3210	510	24	45230	7190
8	5660	900	26	54665	8690
10	8870	1410	28	63690	10,125
12	12710	2020	30	73540	11,690
14	15100	2400	32	83760	13,315
16	19910	3465	34	95145	15,125
18	25540	4060	36	106940	17,000
20	31075	4940	Consult Cameron for other sizes		

Flow Range	15:1 based on nominal maximum flow rate above
Custody Transfer Approval	OIML R 117 Edition 1995 (E); Accuracy Class 0.3
Pressure Loss	Approximately 5 PSI @ max flow (diffuser recovers 70% of the velocity head differential)
Water in Oil	The meter will measure the total actual volume with no change in performance for well mixed water volumes up to 10% and minimum flow corresponding to a fluid velocity above 6.5 fps (2.0 mps)
Viscosity	Maximum allowable viscosity is based on the meter size and the maximum allowable signal strength/attenuation. Consult Cameron for fluid viscosity greater than 1000 cSt

Meter Construction

The Caldon LEFM 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 eight (8) piezoelectric transducer modules (typically 1.0 MHz or 1.6 MHz) forming four (4) chordal paths. These are mounted in pressure containing housings and can be replaced while the meter body is under operating pressure.

Electrical Approvals

The meter meets the requirements of NFPA 70 for use in Class 1, Division 1, Groups C and D hazardous locations and is classified by UL/cUL. It meets the requirements for NEMA 4X and NEMA 7. It is certified by ATEX (CENELEC IIB) for use in EExd IIB (T6 direct mount) flameproof applications and has an ingress protection rating of IP66.

Compact Transmitter

CE Ex II 2 G EEx d IIB T5 c ETL us 3071314 CL I GRPS C&D

Meter Body

CE Ex II 2 G EEx d IIB T5 c SP us CLI, Div 1 GP B,C,D TYPE 4X

General Specifications

	Compact Electronics	Meter Body
Voltage	18 to 30 VDC	
Power	10 W	
Relative Humidity	0-100%	0-100%
Operating Temperature	-40°C to 60°C (ATEX) -40°C to 73.9°C (CSA)	-50°C to 93°C (ATEX) -40°C to 140°C (CSA)
	Transmitter should be remote mounted if the process temperature exceeds max. rated electronics temperature by 10°C.	**Extended Range:** -170°C to 93°C (ATEX) -200°C to 240°C (None)
Local Display	Yes; 2-line 16 characters/ line 0.22 inch high (6.0 mm)	
Remote Mounting from Meter	328 feet (100 meters)	
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)	
Serial Communication	ModBus RTU: RS-485 (2) – Up to 3,900 feet (1,200 meters)	

Standard Materials of Construction

Meter Body	Stainless Steel	Carbon Steel
Flanges	316 Forged Stainless Steel	Forged Carbon Steel – ASTM A105
Body	Cast Stainless Steel – CF8M (316)	Cast Carbon Steel – ASTM A216 Gr WCB
Manifold	304 Stainless Steel	304 Stainless Steel
Manifold Covers	316 Stainless Steel	316 Stainless Steel
Transducer Housings	316 Stainless Steel	316 Stainless Steel
Junction Boxes (optional)	Epoxy Painted Copper-Free Aluminum	Epoxy Painted Copper-Free Aluminum
Compact Transmitter		
EX – NEMA 7	Copper-Free Aluminum or optional 316 Stainless Steel	Copper-Free Aluminum or optional 316 Stainless Steel

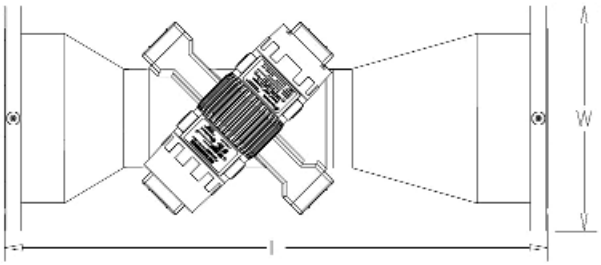
Standard End Connections & Maximum Working Pressure

Maximum Working Pressure -20°F to 100°F (-29°C to 38°C)

ANSI B16.5 Raised Face	Stainless Steel		Carbon Steel	
Class 150	275 psi	(18.96 Bars)	285 psi	(19.65 Bars)
Class 300	720 psi	(49.64 Bars)	740 psi	(51.02 Bars)
Class 600	1,440 psi	(99.29 Bars)	1,480 psi	(102.05 Bars)
Class 900	2,160 psi	(148.93 Bars)	2,220 psi	(153.07 Bars)
Class 1500	3,600 psi	(248.22 Bars)	3,705 psi	(255.46 Bars)

Dimension & Weights

Inlet/ Outlet Size (Inches)	Flange Class	Length		Width		Weight	
		Inches	(mm)	Inches	(mm)	lbs.	(kg)
6	150	27	(686)	11	(279)	201	(91)
	300	27	(686)	12.5	(318)	242	(110)
	600	27	(686)	14	(356)	319	(145)
8	150	33.5	(851)	13.5	(343)	402	(182)
	300	33.5	(851)	15	(381)	465	(211)
	600	33.5	(851)	16.5	(419)	590	(268)
10	150	39.5	(1003)	16	(406)	407	(185)
	300	39.5	(1003)	17.5	(445)	507	(230)
	600	39.5	(1003)	20	(508)	745	(338)
12	150	43.5	(1105)	19	(483)	622	(282)
	300	43.5	(1105)	20.5	(521)	748	(339)
	600	43.5	(1105)	22	(559)	1016	(461)
14	150	49	(1245)	21	(533)	725	(329)
	300	49	(1245)	23	(584)	941	(427)
	600	49	(1245)	23.75	(603)	1196	(543)
16	150	53	(1346)	23.5	(597)	1018	(462)
	300	53	(1346)	25.5	(648)	1310	(594)
	600	53	(1346)	27	(686)	1728	(784)
18	150	58.5	(1486)	25	(635)	1563	(709)
	300	58.5	(1486)	28	(711)	1985	(900)
	600	58.5	(1486)	29.25	(743)	2415	(1095)
20	150	67	(1702)	27.5	(699)	1992	(904)
	300	67	(1702)	30.5	(775)	2520	(1143)
	600	67	(1702)	32	(813)	3323	(1507)
24	150	75.25	(1911)	32	(813)	2236	(1014)
	300	75.25	(1911)	36	(914)	3227	(1464)
	600	75.25	(1911)	37	(940)	4345	(1971)
26	150	85.25	(2165)	34.25	(870)	2354	(1149)
	300	85.25	(2165)	38.25	(972)	3625	(1644)
	600	85.25	(2165)	40	(1016)	4997	(2267)
28	150	94.25	(2394)	36.5	(927	2754	(1249)
	300	94.25	(2394)	40.75	(1035)	4129	(1873)
	600	94.25	(2394)	42.5	(1080)	5771	(2618)
30	150	98.75	(2508)	38.75	(984)	3316	(1504)
	300	98.75	(2508)	43	(1092)	4905	(2225)
	600	98.75	(2508)	44.5	(1130)	6803	(3086)
32	150	108.75	(2762)	41.75	(1060)	3718	(1686)
	300	108.75	(2762)	45.25	(1149)	5519	(2503)
	600	108.75	(2762)	47	(1194)	7714	(3499)
34	150	114.5	(2908)	43.75	(1111)	4722	(2142)
	300	114.5	(2908)	47.5	(1207)	7043	(3195)
	600	114.5	(2908)	49	(1245)	9794	(4443)
36	150	116.75	(2965)	46	(1168)	4996	(2266)
	300	116.75	(2965)	50	(1270)	7510	(3407)
	600	116.75	(2965)	51.75	(1314)	10,578	(4798)



Installation Recommendations

There are basic installation requirements to follow for the LEFM 280CiRN. The meter should have upstream/downstream straight pipe sections of the same size and internal diameters as the meter inlet/outlet. Process temperature and pressure should be measured downstream of the meter. It is generally recommended that the LEFM 280CiRN be installed with at least 5 diameters of straight pipe upstream of the meter. If there is a partially open valve, or internal diameter reduction piping (such as an asymmetric reducer) upstream of the meter then 15 diameters is recommended. The LEFM 280CiRN does not require the installation of a flow conditioner. A minimum of 3 diameters of straight pipe is recommended downstream.

MEASUREMENT SYSTEMS

HOUSTON HEAD OFFICE | 281.582.9500

NORTH AMERICA | 1.800.654.3760 | ms-us@c-a-m.com

ASIA PACIFIC | +603.5569.0501 | ms-kl@c-a-m.com

EUROPE, MIDDLE EAST & AFRICA | +44.1243.826741 | ms-uk@c-a-m.com

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