TEKTROL
Technology Solutions

TEK-FLO MASS 1300D

Steam Quality Meter

FLOW

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Introduction

Tek-Flo Mass 1300D Flo Meter utilize two different Flo Meter technologies in combination; vortex and differential pressure. The design has blended the two separate flow metering principles into one meter body such that the two meters do not have adverse effects on each other's performance. This combination allows for the prediction of the fluid density, volumetric flow rate and mass flow rate without any fluid density information being required from an external source.
This ability to predict fluid density allows the meter to provide several valuable measurements. With wet gas and steam applications the Flo Mass meter will provide an accurate total mass flow measurement. In steam service, the meter is able to provide a reliable steam quality (steam dryness) measurement. The Flo Mass meter is also able to calculate the density of gas mixtures.

Measuring Principle

The Flo Mass Principle of Operation With a single phase flow, a Vortex Meter measures the actual volumetric flow rate (Q). The Vortex Meter reads the vortex shedding frequency off the bluff body (f) and relates it via the meter factor (K) to the volume flow rate (Q), see equation 1. This volumetric flow rate measurement is density insensitive.

(1) $$Q = \frac{f}{K}$$

With a single phase flow, a differential pressure (DP) flow meter measures the volumetric flow rate once the density is supplied from an external source. The DP meter volume flow rate calculation is density (p) sensitive. Equation 2 shows the Cone DP Meter volumetric flow equation, where E and A_t are fixed geometry terms, C_d is the discharge coefficient, and ΔP_t is the Cone Meter DP primary signal.

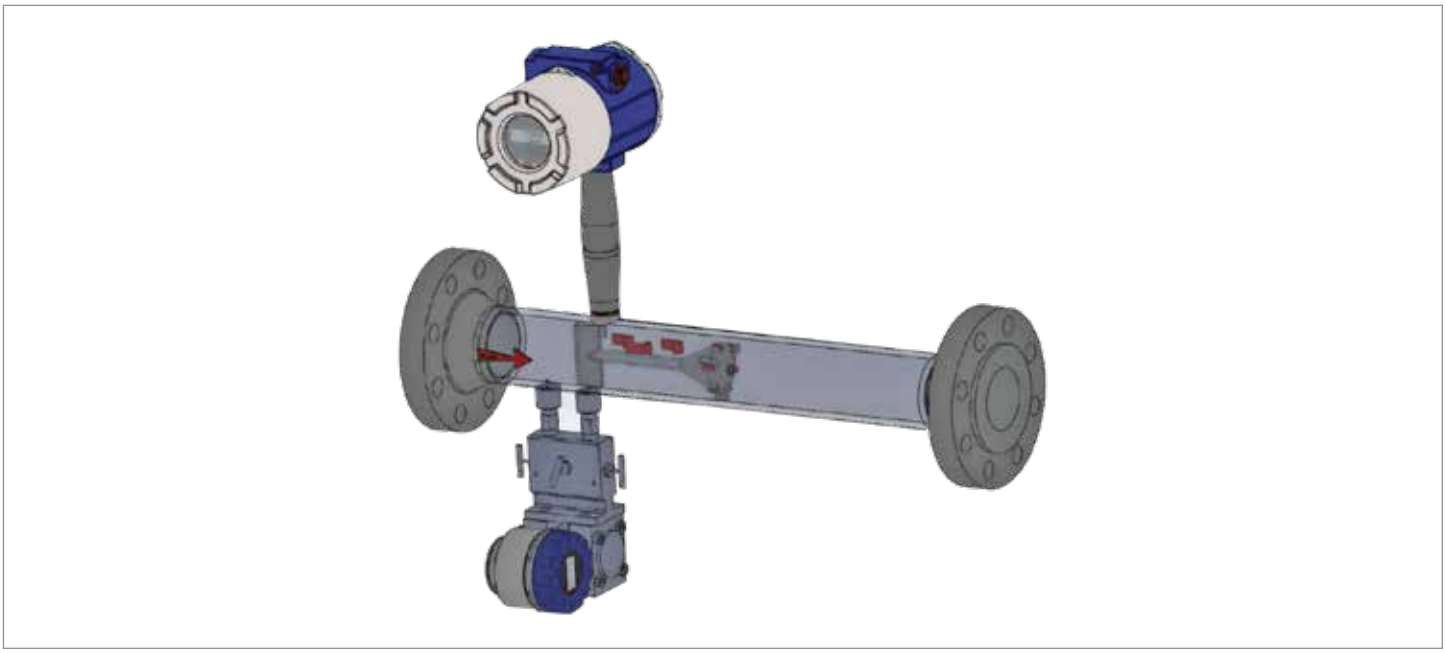
(2) $$Q = EA_tC_d \sqrt{\frac{2\Delta P_t}{P}}$$

As described by Boden's work in the 1950's, if a density sensitive meter (Cone DP Meter) is cross referenced with a density insensitive meter (Vortex Mteter) the density can be derived internally by the system, i.e. see equation 3.

(3) $$p = 2\Delta P_t \left\{ \frac{K}{f} EA_tC_d \right\}$$

The Flo Mass flow rate calculation is now calculated via equation 4, where the vortex meter volumetric flow prediction (Q) and this internal density prediction (p) are used. No external density measurement is required.

(4) $$m = pQ$$



Features

- Can provide a measurement of fluid density, volumetric flow rate and mass flow rate without any fluid infomation being required from an external source.
- In steam service, the meter is able to provide a reliable steam quality (steam dryness) measurement as well as mass flow measurement.
- Able to calculate the density of changing gas mixtures. For example, natural gas is typically a composition of many different gases which can vary over time and vary by application.
- More cost effective than current steam quality and wet gas meters on the market.
- Advanced diagnostic software is able to continually monitor and verify the meter's primary flow element health and confirm output uncertainty.
- Able to use with liquids, gases, and steam.
- Multi-variable options available for temperature and pressure measurement.
- Multiple readings from a single installed device reduces initial cost, installation cost and cost-of ownership over the lifetime of the instrument.
- Mass flow equations for additional diagnostic information and verification. - real gas, ideal gas, AGA 8, API 2540.
- Energy Monitoring–ability to compute and output energy consumption with select fluids, like Steam, water, and heat transfer fluids.
- Easy to install and commission.
- Reliable–no moving parts, no fluid to sensor contact.
- Temperature up to 750°F (400°C).
- Pressure up to 1500 psi.
- Inline configuration for pipes from 2"- 12"(DN 50 to DN 300).
- Field configurable ranges, outputs and displays.
- Remote electronics option available for use in harsh environments or locations with limited access.
- HART protocol communications - Standard.
- Modbus, BACnet, Power over Ethernet (PoE) communications available.

Vortex Meter Options

- Flo Mass Model 1300D-VTP

The Model 1300D-VTP offers you flow computer functionality in a compact field device. This multi-variable instrument incorporates temperature and pressure sensors to provide an instantaneous reading of the compensated mass flow rate of gases, liquids and steam. In addition to outputs for totalized mass and alarm settings, the field-configurable electronics deliver up to three analog 4-20 mA outputs of five process measurements, including volumetric flow rate, mass flow rate, pressure, temperature and density.

- Flo Mass Model 1300D-VT

The Model 1300D-VT integrates a precision 1000 Ohm platinum RTD temperature sensor that can be used to calculate and output a compensated mass reading. This device is typically used to measure flow rates of saturated steam.

- Flo Mass Model 1300D-V

The Model 1300D-V delivers a direct reading of volumetric flow rate generally the most cost-effective solution for liquid flow monitoring in applications ranging from general water flows to hydrocarbon fuel flow measurement.

Verification System

- Flo Mass Meter DP Cone Meter Verification System–DP Health Check™

DP Health Check is a comprehensive verification system for Differential Pressure (DP) meters. The Flo Mass meter's Cone DP Meter sub-system can operate with DP Health Check. Utilizing a third pressure port downstream of the cone and reading three DPs, DP Health Check analyses not just the traditional single DP reading, but the entire pressure field. The additional information expands the capability of the Cone Meter, offering a full diagnostic suite. DP Health Check creates a smart Cone Meter allowing for condition based maintenance operations.

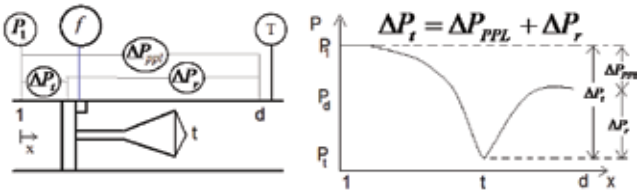


Fig 1. DP Health Check™ Ready Cone DP Meter and Associated Pressure Field

DP Health Check creates seven diagnostic checks, i.e. one DP integrity check, three separate inter-compatible flow rate predictions, and three DP ratios compatible with the baselines. The HMI (Human-Machine Interface) is designed for simplicity: the seven diagnostics are plotted as four points on a graph with a 1x1 box. All points inside the box shows the meter is functioning normally (see Fig 2). Any points out-side the box shows a potential metering issue. Figs. 3 and 4 show response to varying saturated steam quality and single phase DP reading error respectively. Pattern recognition technology allows the source of the problem to be directly identified.

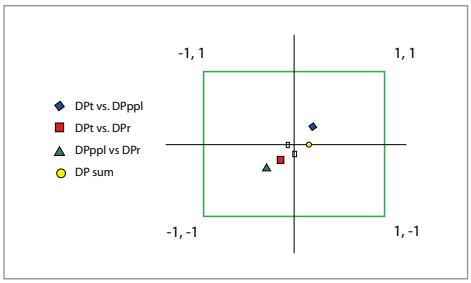


Fig 2. Display for Correctly Operating Meter

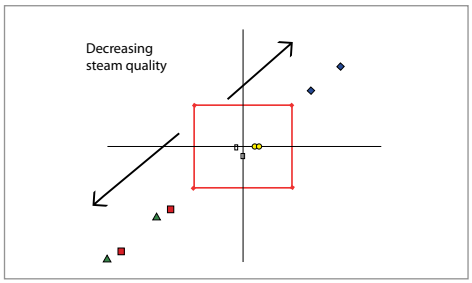


Fig 3. Display for Varying Quality Saturated Steam Flow

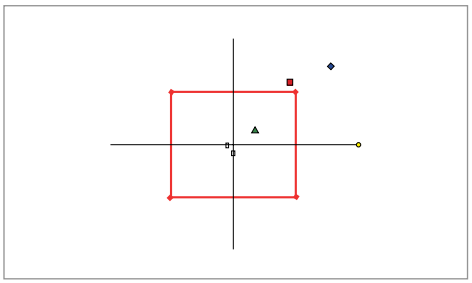


Fig 4. Display for Drifting DP Transmitter

Specifications

• Performance Specifications

Performance Specifications				
Mass Flow Rate accuracy for Dry Gas/Steam based on 50-100% of pressure range.				
Accuracy	Multi Parameter Flo Mass Meter			
	Process Variables	Liquids	Dry Gas/Steam	Wet Gas/Steam
	Volumetric Flow Rate	± .7% of Rate	± 1.5% of Rate	± 3% of Rate
	Mass Flow Rate	± 1% of Rate	± 1% of Rate	5% to 10% of Reading*
	Temperature	± 2°F (± 1°C)	± 2°F (± 1°C)	± 2°F (± 1°C)
	Pressure	± .3% of Full Scale	± .3% of Full Scale	± .3% of Full Scale
	Calculated Density**	± .3% of Reading	± .5% of Reading	N/A
	Predicted Density***	± .75% of Reading	± 1% of Reading	± 4% of Reading
	Steam Quality	N/A	± 5% of Reading	± 5% of Reading
	* Depending on percentage of liquid content & velocity ** Calculated density is performed with a known fluid temperature & pressure *** Predicted density is a function inherent to the combined technologies of vortex and differential pressure flow metering			
Repeatability	Mass Flow Rate	± .2% of rate		
	Volumetric Flow Rate	± .1% of rate		
	Temperature	± .2°F (± .1°C)		
	Pressure	± .05% of full scale		
	Density	± .1% of reading		
Stability Over 12 Months	Mass Flow Rate	± .2% of rate		
	Volumetric Flow Rate	± negligible		
	Temperature	± .9°F (± .5°C)		
	Pressure	± .1% of full scale		
	Density	± .1% of reading		
Response Time	Adjustable from 1 to 100 seconds			

• Operating Specifications

<table>
<tr><th colspan="5">Operating Specifications</th></tr>
<tr><td colspan="5">Any Gas, Liquid or Steam compatible with 316L SS, C276 Hastelloy or A105 Carbon Steel.</td></tr>
<tr><td rowspan="8">Process and Ambient Temperature</td><td colspan="4">Process Standard Temperature (code ST): -330 to 500°F (-200 to 260°C)
Process High Temperature (code HT): to 750°F (400°C)
Ambient Operating: -40 to 140°F (-40 to 60°C)
Ambient Storage: -40 to 185°F (-40 to 85°C)</td></tr>
<tr><td colspan="4">Pressure Transducer Ratings</td></tr>
<tr><td colspan="2">Full Scale Operating Pressure</td><td colspan="2">Max. Over-Range Pressure</td></tr>
<tr><td>psi</td><td>bar</td><td>psi</td><td>bar</td></tr>
<tr><td>30</td><td>2</td><td>60</td><td>4</td></tr>
<tr><td>100</td><td>7</td><td>200</td><td>14</td></tr>
<tr><td>300</td><td>20</td><td>300</td><td>40</td></tr>
<tr><td>500</td><td>35</td><td>1000</td><td>70</td></tr>
<tr><td>1500</td><td>100</td><td>2750</td><td>175</td></tr>
<tr><td>Power Requirements</td><td colspan="4">DCH option: 12-36 VDC, 300mA, 9W max, (multiple outputs)
AC option: 100-240 VAC, 50/60Hz line power, 5W (multiple outputs)</td></tr>
<tr><td>Display</td><td colspan="4">Alphanumeric 2 line x 16 character LCD digital display
Six pushbuttons for full field configuration
Pushbuttons can be operated with magnetic wand without removal of enclosure covers
Display can be mounted in 90° intervals for better viewing</td></tr>
<tr><td>Output Signals</td><td colspan="4">Analog: 4-20 mA
Alarm: Solid state relay, 40 VDC
Totalizer Pulse: 50 millisecond pulse, 40 VDC
Volumetric or Loop Powered Mass: One Analog, One Totalizer Pulse, HART
Multivariable option: Up to Three Analog Signals, Three Alarms, One Totalizer Pulse, HART
Multivariable option: Modbus, Ethernet, or BACnet process monitoring</td></tr>
</table>

• Physical Specifications

Physical Specifications	
Wetted Materials	Standard 316L Stainless Steel, plus • Optional Carbon Steel or Hastelloy C • DuPont Teflon® based thread sealant on models with pressure transducer
Approvals Pending	FM, FMC: - CLASS I, DIV. 1, GROUPS B,C,D - CLASS II/III, DIV. 1, GROUPS E,F,G - Type 4X and IP66, T6, Ta = -40 to 60°C ATEX - II 2 G Ex d IIB + H2 T6 - II 2 D EX tD A21 IP66 T85°C, Ta = -40 to 60°C IECEx - Ex d IIB + H2 T6 - Ex tD A21 IP66 T85°C, Ta = -40 to 60°C

Sizing Considerations

• Piping Conditions

- One 90° elbow before meter - upsteam diameters 10D & 5D
- Two 90° elbows before meter - upsteam diameters 15D & 5D
- Two 90° elbows before meter, out of plane - upsteam diameters 30D & 10D
- Reduction before meter - upsteam diameters 10D & 5D
- Reduction before meter - upsteam diameters 10D & 5D
- Expansion before meter - upsteam diameters 20D & 5D
- Partially open valve - upsteam diameters 30D & 10D

• Velocity Range

- Maximum velocity, liquid: 30 ft/sec (9 m/sec)
- Minimum velocity, liquid: 1 ft/sec (0.3 m/sec)
- Maximum velocity, gas or steam: See Table Below
- Minimum velocity, gas or steam ft/sec (m/sec):

$$\frac{5}{\sqrt{\text{density (Lb/ft}^3\text{)}}} \qquad \frac{6.1}{\sqrt{\text{density (Kg/m}^3\text{)}}}$$

• Pressure Drop Equation*

$\Delta P = 0.00024 p V^2$ English Units (ΔP in psi, p in lb/ft^3, Vin ft/sec)

$\Delta P = 0.000011 p V^2$ Metric Units (ΔP in bar, p in kg/m^3, Vin m/sec)

** Vortex only, does not include pressure drop created by primary element.*

• Water Minimum and Maximum Flow Rates

Rate	Size	GPM min	GPM max
Nominal Pipe Size (in)	0.5	0.9	22
	0.75	1.4	40
	1	2.2	67
	1.5	5.5	166
	2	9.2	276
	3	21	618
	4	36	1076
	6	81	2437
	8	142	4270
	10	224	6715
	12	317	9501

Rate	Size	m^3/hr min	m^3/hr Max
Nominal Pipe Size (mm)	15	0.2	5
	20	0.3	9
	25	0.5	15
	40	1.3	38
	50	2.1	63
	80	4.7	140
	100	8.1	244
	150	18	554
	200	32	970
	250	51	1525
	300	72	2158

- Gas or Steam Max Velocity

Rate	Size	FT/SEC Max
Nominal Pipe Size (in)	0.5	175
	0.75	250
	1	250
	1.5	300
	2	300
	3	300
	4	300
	6	300
	8	300
	10	300
	12	300

Rate	Size	FT/SEC Max
Nominal Pipe Size (mm)	15	53
	20	76
	25	76
	40	90
	50	90
	80	90
	100	90
	150	90
	200	90
	250	90
	300	90

Normal Pipe Sizes

- Typical Saturated Steam Minimum and Maximum, Flow Rates (lb/hr)

	Nominal Pipe Size (in)										
Pressure	0.5	0.75	1	1.5	2	3	4	6	8	10	12
5 psig	6.5 52	12 122	20 265	49 650	82 1087	183 2431	318 4231	722 9594	1264 16806	1988 26429	2813 37395
100 psig	15 271	27 639	46 1386	112 3405	187 5690	419 12729	728 22156	1652 50233	2893 87998	4550 138386	6438 195803
200 psig	20 493	37 1163	62 2525	151 6203	253 10365	565 23184	983 40354	2229 91494	3905 160279	6141 252055	8689 356635
300 psig	24 716	45 1688	74 3664	182 9000	304 15040	680 33642	1184 58556	2685 132763	4704 232575	7397 365747	10466 517499
400 psig	28 941	51 2220	85 4816	209 11831	349 19770	780 44222	1358 76971	3079 174516	5393 305717	8481 480771	12000 680247
500 psig	31 1170	57 2760	95 5988	233 14711	389 24582	870 54987	1514 95710	3433 217001	6014 380148	9457 597812	13381 845850

• Typical Saturated Steam Minimum and Maximum, Flow Rates (kg/hr)

Nominal Pipe Size (mm)											
Pressure	**15**	**20**	**25**	**40**	**50**	**80**	**100**	**150**	**200**	**250**	**300**
0 barg	3 18	5 42	8 91	19 224	32 375	72 838	126 1459	286 3309	500 5797	786 9116	1113 12898
5 barg	6 95	11 224	18 485	45 1192	75 1992	167 4455	290 7754	658 17581	1153 30799	1813 48434	2565 68530
10 barg	8 168	15 397	24 862	59 2118	99 3539	222 7915	387 13777	877 31237	1537 54720	2417 86053	3419 121758
15 barg	9 241	17 569	29 1236	71 3036	119 5073	266 11347	463 19750	1050 44779	1840 78444	2893 123360	4094 174543
20 barg	11 314	20 742	33 1610	81 3956	136 6611	304 14787	529 25738	1199 58355	2100 102226	3303 160761	4673 227463
30 barg	13 463	24 1092	40 2370	99 5822	165 9729	369 21763	642 37880	1455 85884	2548 150451	4007 236599	5669 334766

• Typical Air Minimum and Maximum Flow Rates (SCFM), Air at Standard Process Conditions 70°F, 14.6959 psi

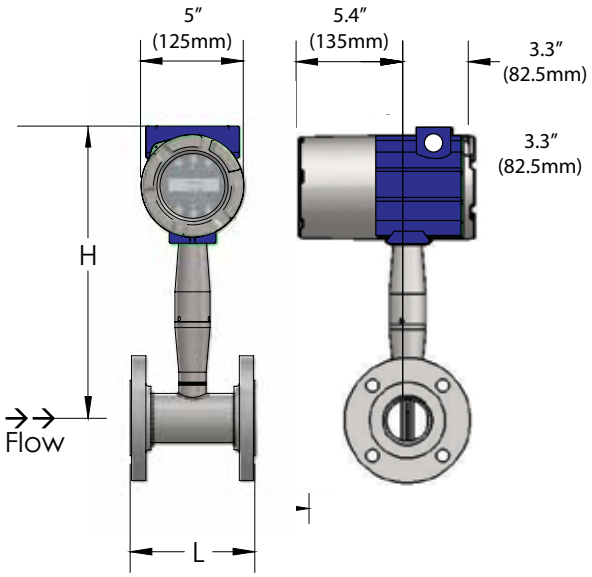
Nominal Pipe Size (in)											
Pressure	**0.5**	**0.75**	**1**	**1.5**	**2**	**3**	**4**	**6**	**8**	**10**	**12**
0 psig	1.8 18	3 41	5 90	13 221	22 369	50 826	87 1437	198 3258	347 5708	546 8976	773 12701
100 psig	5 138	9 325	15 704	38 1730	63 2890	141 6466	245 11254	555 25515	972 44698	1529 70292	2163 99456
200 psig	7 258	13 609	21 1322	52 3248	86 5427	193 12140	335 21131	761 47911	1332 83931	2095 131895	2965 186752
300 psig	8 380	15 896	25 1944	63 4775	104 7978	234 17847	407 31064	922 70431	1615 123375	2540 194025	3594 274529
400 psig	10 502	18 1183	29 2568	72 6309	120 10542	269 23580	467 41043	1060 93057	1857 163000	2920 256358	4132 362724
500 psig	11 624	20 1472	33 3195	80 7849	134 13115	300 28034	521 51063	1182 115775	2071 203000	3257 318941	4608 451272

• Typical Air Minimum and Maximum Flow Rates (nm^3/hr), Air at Standard conditions of 20°C, 1.0133 BARA

Nominal Pipe Size (mm)											
Pressure	**15**	**20**	**25**	**40**	**50**	**80**	**100**	**150**	**200**	**250**	**300**
0 barg	3 28	5 66	9 142	21 350	36 584	79 1307	138 2275	313 5157	549 9034	863 14207	1221 20102
5 barg	7 165	13 390	21 847	52 2080	87 3476	194 7775	337 13533	764 30682	1339 53749	2105 84525	2979 119596
10 barg	9 304	17 716	29 1554	70 3819	117 6381	262 14273	457 24844	1035 56329	1814 98676	2853 155178	4036 219563
15 barg	11 442	21 1044	34 2265	85 5565	142 9299	317 20801	551 36205	1250 82087	2190 143801	3444 297386	4873 319968
20 barg	13 582	24 1373	40 2979	97 7318	162 12229	363 27354	632 47612	1434 107949	2511 189105	3949 297386	5588 420775
30 barg	16 862	29 2034	48 4414	118 10843	198 18119	442 40529	770 70544	1745 159942	3057 280187	4807 440621	6801 623439

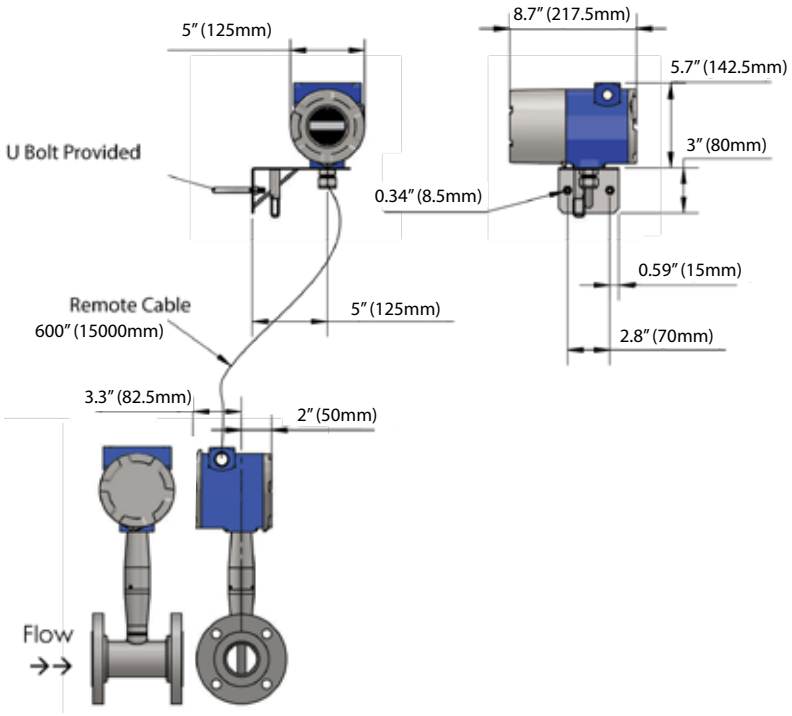
Turn-down is application dependent. Turn-down can exceed 100:1

Dimensional Drawing



- Flow Meter Nominal Size

Flow Meter Nominal Size		
	L	H
2 inch (50 mm)	10.0 in (254 mm)	14.0 in (356 mm)
3 inch (80 mm)	10.0 in (254 mm)	14.6 in (371 mm)
4 inch (100 mm)	12.9 in (327 mm)	15.1 in (384 mm)
6 inch (150 mm)	19.9 in (505 mm)	16.2 in (411 mm)
8 inch (200 mm)	19.9 in (505 mm)	17.2 in (437 mm)
10 inch (250 mm)	29.5 in (749 mm)	18.2 in (462 mm)
12 inch (300 mm)	34.9 in (886 mm)	19.2 in (488 mm)



Model Chart

Example	Tek-Flo Mass 1300D	V	16	C	150	L	DD	DCL	1AHL	ST	P1	AZ	3M	ND	Tek-Flo Mass 1300D-V-16-C-150-L-DD-DCL-1AHL-ST-P1-AZ-3M-ND
Series	Tek-Flo Mass 1300D														Flo Mass Meter
Multivariable Options	*For saturated steam quality prediction must have at least a VT model vortex meter *For wet gas liquid loading prediction must have a VTP model vortex meter	V VT VTP													Mass, Density (No P & T) Steam Qv act, W/Temperature Steam Qv act, W/Pressure
Sizes			16 24 32 48 64 80 96												2-inch Nominal Bore (50mm) 3-inch Nominal Bore (80mm) 4-inch Nominal Bore (100mm) 6-inch Nominal Bore (150mm) 8-inch Nominal Bore (200mm) 10-inch Nominal Bore (250mm) 12-inch Nominal Bore (300mm)
Meter Body Material				C S H											Carbon Steel 316 Stainless Steel Hastelloy
Process Connection					150 300 600 900										ANSI 150# Flange ANSI 300# Flange ANSI 600# Flange ANSI 900# Flange
Electronics Exclosure						L XP									NEMA 4X IP66 Enclosure Remote Electronics NEMA 4X, IP66, Specify cable length in parentheses
Display Options							DD								Digital Display and Programming Buttons
Input Power								DCH AC							12-36 VDC, 300mA, 9W max. (Able to power differential pressure transmitter if wired in series with an adequate power supply) - use with 1AH, 1AM, 3AH, 3AM32, 32R 4-inch Nominal Bore (100mm), 4-inch by 3-inch Nominal Bore Reducing Meter (80mm) 100-240 VAC, 50/60 Hz line power, 5W max. (Able to power differential pressure transmitter with DC power output) - use with 1AH, 1AM, 3AH, 3AM

Output									3AM						3 Analog Signals, 3 Alarms, 1 Totalizer Pulse, 1 Modbus
Temperature Rating										ST					Standard temperature: Process temperature -330° to 500°F (-200° to 260°C)
Process Connection											P0 P1 P2 P3 P4 P5				No Pressure Sensor Maximum 30 psia (2 bara), Proof 60 psia (4 bara) Maximum 100 psia (7 bara), Proof 200 psia (14 bara) Maximum 300 psia (20 bara), Proof 600 psia (41 bara) Maximum 500 psia (34 bara), Proof 1000 psia (64 bara) Maximum 1500 psia (100 bara), Proof 2500 psia (175 bara)
Differential Pressure Transmitter												TK CX			Factory supplied differential pressure transmitter Customer supplied differential pressure transmitter*
Differential Pressure Transmitter Manifold													3M 5W NM		3-way SST manifold. Ability to equalize high/low side pressures to set the differential pressure transmitter zero 5-way SST manifold. Ability to equalize high/low side pressures to set the differential pressure transmitter zero and the ability to check for equalizing valve leaks No manifold
Diagnostics														2AZ 2CX ND	Two additional factory supplied differential pressure transmitters with TekValSys DP No Advanced Diagnostics

Customer Service & Support

DOC # TEK/ITPS/CAT/240520/1300D/r00.2

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Tek-Trol is a fully owned subsidiary of TEKMATION LLC. We offer our customers a comprehensive range of products and solutions for process, power and oil & gas industries. Tek-Trol provides process measurement and control products for Flow, Level, Temperature & Pressure measurement, Control valves & Analyzer systems. We are present in 15 locations globally and are known for our knowledge, innovative solutions, reliable products and global presence.