

Pro-V™ Multivariable Flowmeter

Model M22 In-line Vortex



VorTek Instruments' Pro-V™ multivariable flowmeters utilize three primary sensing elements—a vortex shedding velocity sensor, an RTD temperature sensor, and a solid-state pressure transducer—to measure the mass flow rate of gases, liquids and steam.

Systems that use external process measurements to calculate mass flow may not provide adequate compensation

for the fact that process conditions can change radically between the point of velocity measurement and the point where upstream or downstream pressure and temperature measurements are being made. Because the Pro-V™ multivariable flowmeter measures all of these parameters in a single location, it delivers a more accurate process measurement.

Integrating multivariable output capability with a single line penetration also simplifies system complexity and helps reduce initial equipment cost, installation cost and maintenance costs.

The product line is available with a wide range of options and meter configurations to meet your specific application requirements.

Pro-V™ Advantage:

- Volumetric or mass flow monitoring of most liquids, gases, and steam
- Multivariable meter delivers mass flow, temperature, pressure, and density readings from a single installed device and reduces initial cost, installation cost and cost-of ownership over the lifetime of the instrument
- Mass flow equations - real gas, ideal gas, AGA 8, API 2540
- Compensated mass flow reading of liquids, gases, and steam
- Energy Monitoring—ability to compute and output energy use
- Easy to install and commission
- Reliable—no moving parts, no fluid to sensor contact
- High accuracy with rangeability up to 100:1
- Temperature up to 750°F
- Pressure up to 1500 psig
- Inline configuration for pipes from 1/2" - 12" DN15 to DN 300
- Field configurable ranges, outputs and displays
- Remote electronics option available for use in harsh environments or locations with limited access
- 4-20mA loop—powered Mass Meter design saves on energy costs
- HART protocol communications - Standard
- Modbus, BACnet communications available
- FM, FMC, ATEX, IECEx Approved

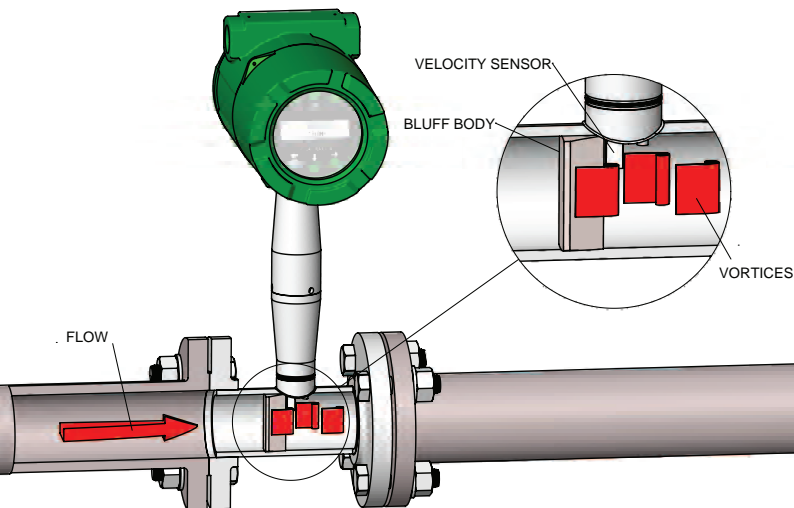


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Pro-V™ Principle of Operation

Vortex flowmeters measure flows of liquid, gas and steam by detecting the frequency at which vortices are alternately shed from a bluff body. According to proven laws of physics, the frequency at which the vortices are alternately shed is directly proportional to the flow velocity.

As flow passes a bluff body in the flow stream, the vortices create low and high pressure zones behind the bluff body, or shedder bar. The Pro-V™ M22 uses a piezoelectric crystal sensor to detect the pressure exerted by the vortices on the velocity sensor. The piezoelectric converts these “pulses” into electrical signals. The meter uses an all welded sensor design to create a robust sensor and to minimize potential leakages.



Pro-V™ Model M22-VTP

The Model M22-VTP offers you flow computer functionality in a compact field device. This multivariable 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.

Pro-V™ Model M22-VT

The Model M22-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.

Pro-V™ Model M22-V

The Model M22-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.

Pro-V™ Model M22-EM

The Model M22 Energy Monitoring option permits real-time calculation of energy consumption for a facility or process. The meter can be programmed to measure steam, hot water or chilled water. The Model M22-VTP flowmeter monitors one side of the process, either sent or returned, and uses the input from a second separate temperature sensor on the opposite leg of the process to calculate the change in energy. Selectable energy units include Btu, joules, calories, Watt-hours, Megawatt-hours and Horsepower-hours. The local or remote electronics indicate two temperatures, delta T, mass total and energy total.

Pro-V™ Model M22-VTEP, VETEP

Similar to M22-VTP but with the option for an external input (T or P) via RTD or 4-20mA or one of each.

Performance Specifications

Accuracy

Mass flow rate accuracy for gas and steam based on 50-100% of pressure range.

| Model M22 Multiparameter Inline Vortex Meter | | |
|--|---------------------|---------------------|
| Process Variables | Liquids | Gas & Steam |
| Volumetric Flow Rate | ± .7% of Rate | ± 1% of Rate |
| Mass Flow Rate | ± 1% of Rate | ± 1.5% of Rate |
| Temperature | ± 2°F (± 1°C) | ± 2°F (± 1°C) |
| Pressure | ± .3% of Full Scale | ± .3% of Full Scale |
| Density | ± .3% of Reading | ± .5% of Reading |

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

Any gas, liquid or steam compatible with 316L stainless steel, C276 hastelloy or A105 carbon steel. Not recommended for multi-phase fluids.

Process and Ambient Temperature

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)

| Pressure Transducer Ratings | | | |
|-------------------------------|------|--------------------------|------|
| Full Scale Operating Pressure | | Max. Over-Range Pressure | |
| psia | bara | psia | bara |
| 30 | 2 | 60 | 4 |
| 100 | 7 | 200 | 14 |
| 300 | 20 | 300 | 40 |
| 500 | 35 | 1000 | 70 |
| 1500 | 100 | 2750 | 175 |

Power Requirements

DCL option: 12-36 VDC, 25mA, 1W max, loop powered (single output)

DCH option: 12-36 VDC, 300mA, 9W max, (multiple outputs)

AC option: 100-240 VAC, 50/60Hz line power, 5W (multiple outputs)

Display

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

Output Signals

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 or BACnet process monitoring

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

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

| Condition | Pipe Diameters, D | |
|---|-------------------|------------|
| | Upstream | Downstream |
| One 90° elbow before meter | 10D | 5D |
| Two 90° elbows before meter | 15D | 5D |
| Two 90° elbows before meter, out of plane | 30D | 10D |
| Reduction before meter | 10D | 5D |
| Expansion before meter | 20D | 5D |
| Partially open valve | 30D | 10D |

Velocity Range

Maximum velocity, liquid: 30 feet/sec (9 meters/second)

Minimum velocity, liquid: 1 foot/sec (.3 meters/second)

Maximum velocity, gas or steam: See Table Below

Minimum velocity, gas or steam feet/sec (meters/second):

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

Pressure Drop Equations

$\Delta P = 0.00024pV^2$ English Units (ΔP in psi, p in lb/ft³, V in ft/sec)

$\Delta P = 0.000011pV^2$ Metric Units (ΔP in bar, p in kg/m³, V in m/sec)

Consult the VorTek Instruments Sizing Program @vortekinst.com for easy calculation of flow range.

Water Minimum and Maximum Flow Rates

| Rate | Nominal Pipe Size (in) | | | | | | | | | | |
|------------------------|------------------------|------|-----|-----|-----|-----|------|------|------|------|------|
| | 0.5 | 0.75 | 1 | 1.5 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| GPM min | 0.9 | 1.4 | 2.2 | 5.5 | 9.2 | 21 | 36 | 81 | 142 | 224 | 317 |
| GPM max | 22 | 40 | 67 | 166 | 276 | 618 | 1076 | 2437 | 4270 | 6715 | 9501 |
| | Nominal Pipe Size (mm) | | | | | | | | | | |
| | 15 | 20 | 25 | 40 | 50 | 80 | 100 | 150 | 200 | 250 | 300 |
| M ³ /hr min | 0.2 | 0.3 | 0.5 | 1.3 | 2.1 | 4.7 | 8.1 | 18 | 32 | 51 | 72 |
| M ³ /hr Max | 5 | 9 | 15 | 38 | 63 | 140 | 244 | 554 | 970 | 1525 | 2158 |

Gas or Steam Max Velocity

| Rate | Nominal Pipe Size (in) | | | | | | | | | | |
|------------|------------------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 0.5 | 0.75 | 1 | 1.5 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| FT/SEC Max | 175 | 250 | 250 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| | Nominal Pipe Size (mm) | | | | | | | | | | |
| | 15 | 20 | 25 | 40 | 50 | 80 | 100 | 150 | 200 | 250 | 300 |
| M/SEC Max | 53 | 76 | 76 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |

| 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 | 12 | 20 | 49 | 82 | 183 | 318 | 722 | 1264 | 1988 | 2813 |
| | 52 | 122 | 265 | 650 | 1087 | 2431 | 4231 | 9594 | 16806 | 26429 | 37395 |
| 100 psig | 15 | 27 | 46 | 112 | 187 | 419 | 728 | 1652 | 2893 | 4550 | 6438 |
| | 271 | 639 | 1386 | 3405 | 5690 | 12729 | 22156 | 50233 | 87998 | 138386 | 195803 |
| 200 psig | 20 | 37 | 62 | 151 | 253 | 565 | 983 | 2229 | 3905 | 6141 | 8689 |
| | 493 | 1163 | 2525 | 6203 | 10365 | 23184 | 40354 | 91494 | 160279 | 252055 | 356635 |
| 300 psig | 24 | 45 | 74 | 182 | 304 | 680 | 1184 | 2685 | 4704 | 7397 | 10466 |
| | 716 | 1688 | 3664 | 9000 | 15040 | 33642 | 58556 | 132763 | 232575 | 365747 | 517499 |
| 400 psig | 28 | 51 | 85 | 209 | 349 | 780 | 1358 | 3079 | 5393 | 8481 | 12000 |
| | 941 | 2220 | 4816 | 11831 | 19770 | 44222 | 76971 | 174516 | 305717 | 480771 | 680247 |
| 500 psig | 31 | 57 | 95 | 233 | 389 | 870 | 1514 | 3433 | 6014 | 9457 | 13381 |
| | 1170 | 2760 | 5988 | 14711 | 24582 | 54987 | 95710 | 217001 | 380148 | 597812 | 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 | 5 | 8 | 19 | 32 | 72 | 126 | 286 | 500 | 786 | 1113 |
| | 18 | 42 | 91 | 224 | 375 | 838 | 1459 | 3309 | 5797 | 9116 | 12898 |
| 5 barg | 6 | 11 | 18 | 45 | 75 | 167 | 290 | 658 | 1153 | 1813 | 2565 |
| | 95 | 224 | 485 | 1192 | 1992 | 4455 | 7754 | 17581 | 30799 | 48434 | 68530 |
| 10 barg | 8 | 15 | 24 | 59 | 99 | 222 | 387 | 877 | 1537 | 2417 | 3419 |
| | 168 | 397 | 862 | 2118 | 3539 | 7915 | 13777 | 31237 | 54720 | 86053 | 121758 |
| 15 barg | 9 | 17 | 29 | 71 | 119 | 266 | 463 | 1050 | 1840 | 2893 | 4094 |
| | 241 | 569 | 1236 | 3036 | 5073 | 11347 | 19750 | 44779 | 78444 | 123360 | 174543 |
| 20 barg | 11 | 20 | 33 | 81 | 136 | 304 | 529 | 1199 | 2100 | 3303 | 4673 |
| | 314 | 742 | 1610 | 3956 | 6611 | 14787 | 25738 | 58355 | 102226 | 160761 | 227463 |
| 30 barg | 13 | 24 | 40 | 99 | 165 | 369 | 642 | 1455 | 2548 | 4007 | 5669 |
| | 463 | 1092 | 2370 | 5822 | 9729 | 21763 | 37880 | 85884 | 150451 | 236599 | 334766 |

| Typical Air Minimum and Maximum Flow Rates (SCFM) Air at Standard Process Conditions 70°F, 14.6959 PSIA | | | | | | | | | | | |
|--|-----|------|------|------|-------|-------|-------|--------|--------|--------|--------|
| Nominal Pipe Size (in) | | | | | | | | | | | |
| Pressure | 0.5 | 0.75 | 1 | 1.5 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| 0 psig | 1.8 | 3 | 5 | 13 | 22 | 50 | 87 | 198 | 347 | 546 | 773 |
| | 18 | 41 | 90 | 221 | 369 | 826 | 1437 | 3258 | 5708 | 8976 | 12701 |
| 100 psig | 5 | 9 | 15 | 38 | 63 | 141 | 245 | 555 | 972 | 1529 | 2163 |
| | 138 | 325 | 704 | 1730 | 2890 | 6466 | 11254 | 25515 | 44698 | 70292 | 99456 |
| 200 psig | 7 | 13 | 21 | 52 | 86 | 193 | 335 | 761 | 1332 | 2095 | 2965 |
| | 258 | 609 | 1322 | 3248 | 5427 | 12140 | 21131 | 47911 | 83931 | 131895 | 186752 |
| 300 psig | 8 | 15 | 25 | 63 | 104 | 234 | 407 | 922 | 1615 | 2540 | 3594 |
| | 380 | 896 | 1944 | 4775 | 7978 | 17847 | 31064 | 70431 | 123375 | 194025 | 274529 |
| 400 psig | 10 | 18 | 29 | 72 | 120 | 269 | 467 | 1060 | 1857 | 2920 | 4132 |
| | 502 | 1183 | 2568 | 6309 | 10542 | 23580 | 41043 | 93057 | 163000 | 256358 | 362724 |
| 500 psig | 11 | 20 | 33 | 80 | 134 | 300 | 521 | 1182 | 2071 | 3257 | 4608 |
| | 624 | 1472 | 3195 | 7849 | 13115 | 28034 | 51063 | 115775 | 203000 | 318941 | 451272 |

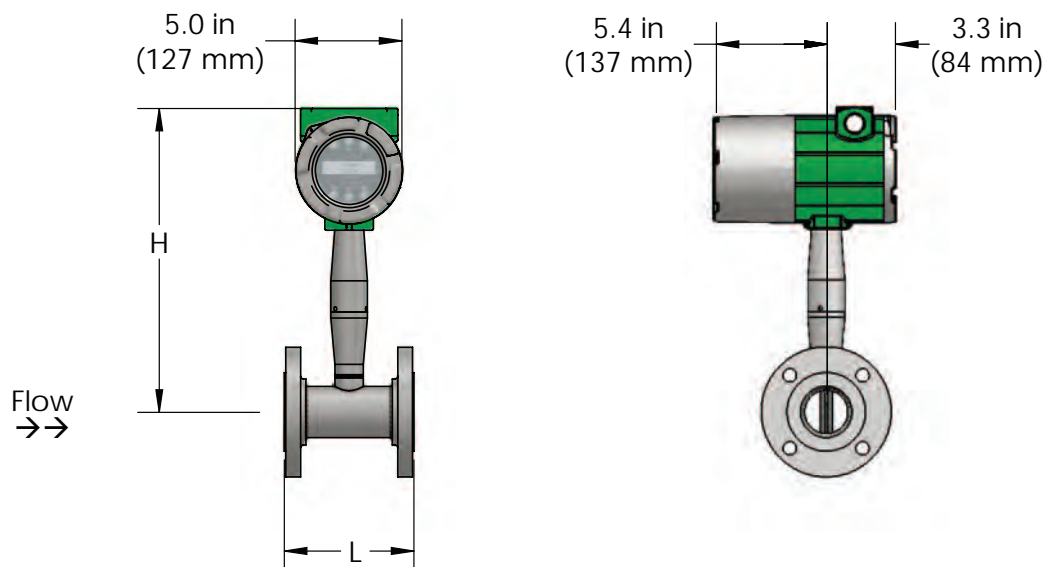
| Typical Air Minimum and Maximum Flow Rates (nm³/hr) Air at Standard conditions of 20°C, 1.0133 BARA | | | | | | | | | | | |
|--|-----|------|------|-------|-------|-------|-------|--------|--------|--------|--------|
| Nominal Pipe Size (mm) | | | | | | | | | | | |
| Pressure | 15 | 20 | 25 | 40 | 50 | 80 | 100 | 150 | 200 | 250 | 300 |
| 0 barg | 3 | 5 | 9 | 21 | 36 | 79 | 138 | 313 | 549 | 863 | 1221 |
| | 28 | 66 | 142 | 350 | 584 | 1307 | 2275 | 5157 | 9034 | 14207 | 20102 |
| 5 barg | 7 | 13 | 21 | 52 | 87 | 194 | 337 | 764 | 1339 | 2105 | 2979 |
| | 165 | 390 | 847 | 2080 | 3476 | 7775 | 13533 | 30682 | 53749 | 84525 | 119596 |
| 10 barg | 9 | 17 | 29 | 70 | 117 | 262 | 457 | 1035 | 1814 | 2853 | 4036 |
| | 304 | 716 | 1554 | 3819 | 6381 | 14273 | 24844 | 56329 | 98676 | 155178 | 219563 |
| 15 barg | 11 | 21 | 34 | 85 | 142 | 317 | 551 | 1250 | 2190 | 3444 | 4873 |
| | 442 | 1044 | 2265 | 5565 | 9299 | 20801 | 36205 | 82087 | 143801 | 297386 | 319968 |
| 20 barg | 13 | 24 | 40 | 97 | 162 | 363 | 632 | 1434 | 2511 | 3949 | 5588 |
| | 582 | 1373 | 2979 | 7318 | 12229 | 27354 | 47612 | 107949 | 189105 | 297386 | 420775 |
| 30 barg | 16 | 29 | 48 | 118 | 198 | 442 | 770 | 1745 | 3057 | 4807 | 6801 |
| | 862 | 2034 | 4414 | 10843 | 18119 | 40529 | 70544 | 159942 | 280187 | 440621 | 623439 |

Turndown

Turndown is application dependent. Consult the VorTek Instruments Sizing Program @vortekinst.com for exact values.

Turndown can exceed 100:1

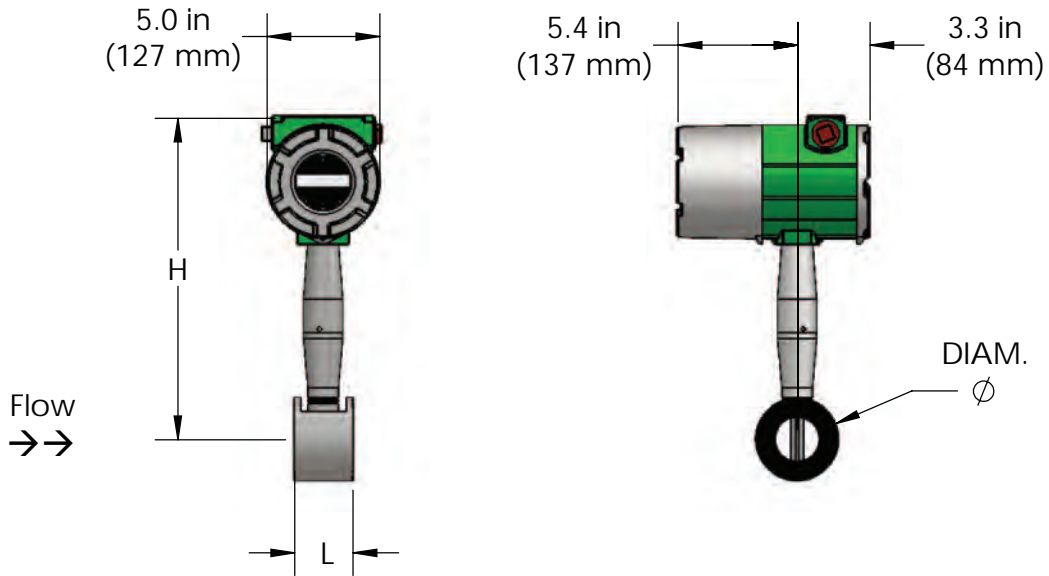
Dimensional Outline: Pro-V™ Inline Flanged Models



| Flow Meter Nominal Size | L | H | Weight | | |
|-------------------------|---------------------|---------------------|------------------------|------------------------|------------------------|
| | | | ANSI 150 (PN 16) | ANSI 300 (PN 40) | ANSI 600 (PN 64) |
| 1/2 inch (15mm) | 4.56 in (116 mm) | 13.5 in (343 mm) | 12 Lb (5.5 kg) | 12.5 Lb (5.7 kg) | 13.4 Lb (6.1 kg) |
| 3/4 inch (20 mm) | 4.8 in (122 mm) | 13.5 in (343 mm) | 13 Lb (5.9 kg) | 14.6 Lb (6.6 kg) | 15.6 Lb (7.1 kg) |
| 1 inch (25 mm) | 4.94 in (126 mm) | 13.5 in (343 mm) | 13.4 Lb (6.1 kg) | 16.3 Lb (7.4 kg) | 16.4 Lb (7.5 kg) |
| 1-1/2 inch (40 mm) | 5.5 in (140 mm) | 13.8 in (351 mm) | 16.3 Lb (7.4 kg) | 23.3 Lb (10.6 kg) | 24.6 Lb (11.2 kg) |
| 2 inch (50 mm) | 6.0 in (153 mm) | 14.0 in (356 mm) | 21.2 Lb (9.6 kg) | 26.8 Lb (12.2 kg) | 33.2 Lb (15.1 kg) |
| 3 inch (80 mm) | 6.9 in (175 mm) | 14.6 in (371 mm) | 33 Lb (15.0 kg) | 41.0 Lb (18.6 kg) | 56.1 Lb (25.5 kg) |
| 4 inch (100 mm) | 8.0 in (203 mm) | 15.1 in (384 mm) | 45.8 Lb (20.8 kg) | 66.8 Lb (30.3 kg) | 96.0 Lb (43.6 kg) |
| 6 inch (150 mm) | 9.0 in (229 mm) | 16.2 in (411 mm) | 68.3 Lb (31.0 kg) | 106.3 Lb (48.2 kg) | 194.3 Lb (88.2 kg) |
| 8 inch (200 mm) | 10.5 in (267 mm) | 17.2 in (437 mm) | 112.4 Lb (51.0 kg) | 168.4 Lb (76.5 kg) | 299.0 Lb (136 kg) |
| 10 inch (250 mm) | 15.0 in (381 mm) | 18.2 in (462 mm) | 188.3 Lb (85.5 kg) | 262.3 Lb (119.1 kg) | 462.3 Lb (209.9 kg) |
| 12 inch (300 mm) | 17.7 in (450 mm) | 19.2 in (488 mm) | 298.6 Lb (135.6 kg) | 402.6 Lb (182.8 kg) | 606.6 Lb (275.4 kg) |

Add 11 lb (5 KG) for remote electronics

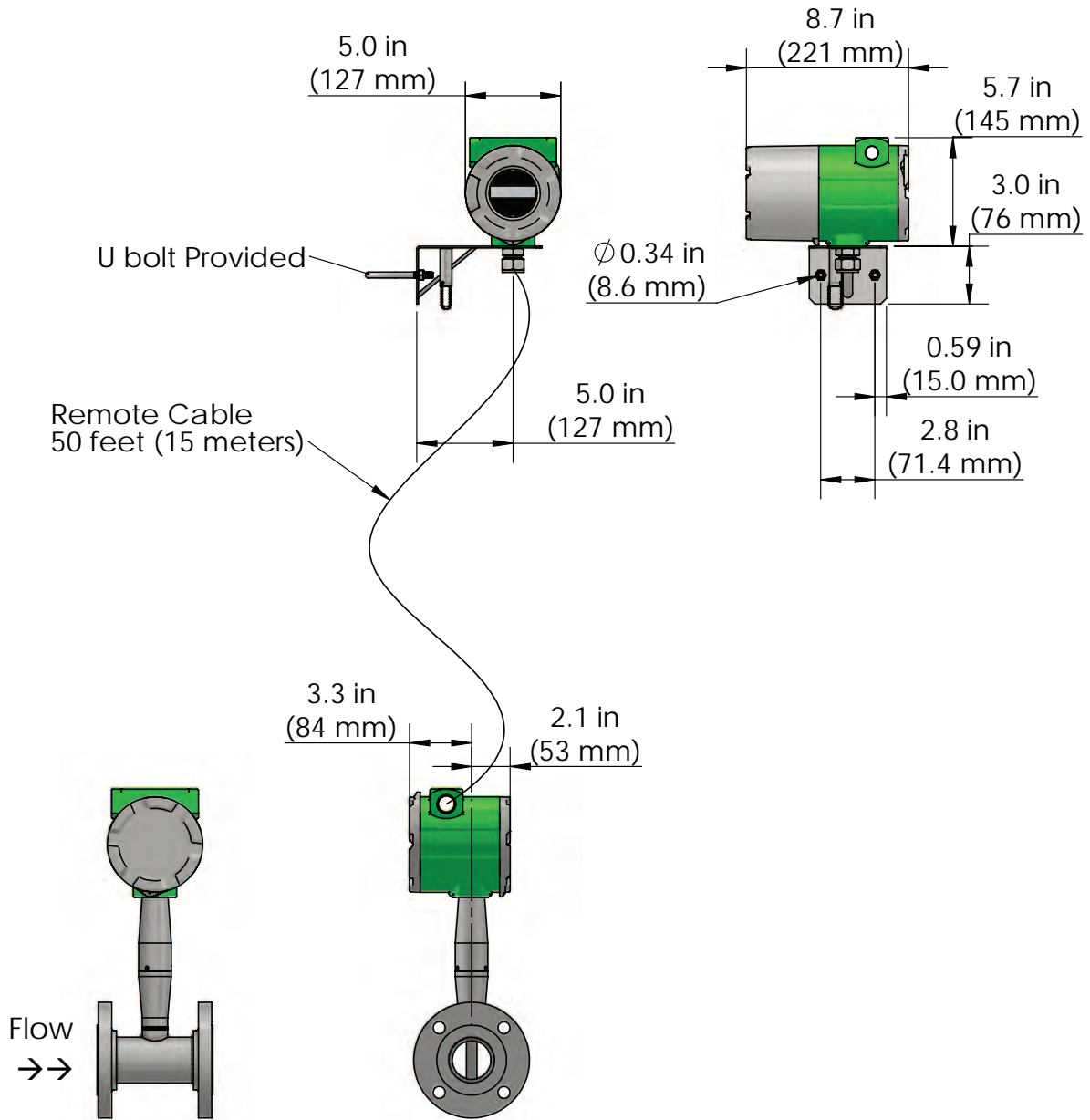
Dimensional Outline: Pro-V™ Inline Wafer Models



| Flow Meter Nominal Size | L | H | DIAM | Weight |
|-------------------------|----------------------|---------------------|---------------------|----------------------|
| | | | | Approximate Weight |
| 1/2 inch (15mm) | 4.560 in (116 mm) | 13.5 in (343 mm) | 1.38 in (35 mm) | 9.8 Lb (4.4 kg) |
| 3/4 inch (20 mm) | 4.800 in (122 mm) | 13.5 in (343 mm) | 1.69 in (43 mm) | 10.0 Lb (4.5 kg) |
| 1 inch (25 mm) | 2.756 in (70 mm) | 13.5 in (343 mm) | 2.0 in (51 mm) | 10.4 Lb (4.7 kg) |
| 1-1/2 inch (40 mm) | 2.756 in (70 mm) | 13.8 in (351 mm) | 2.88 in (73 mm) | 12.4 Lb (5.6 kg) |
| 2 inch (50 mm) | 2.956 in (75 mm) | 14.0 in (356 mm) | 3.62 in (92 mm) | 14.9 Lb (16.8 kg) |
| 3 inch (80 mm) | 3.947 in (100 mm) | 14.6 in (371 mm) | 5.00 in (127mm) | 23.9 Lb (10.9 kg) |
| 4 inch (100 mm) | 4.724 in (120 mm) | 15.1 in (384 mm) | 6.19 in (157 mm) | 35.2 Lb (16.0 kg) |

Add 11 lb (5 KG) for remote electronics

Dimensional Outline: Remote Electronics Option



Model Number Information - Pro-V™ Model M22 Inline Mass Vortex Flowmeter

