

VORTEX FLOWMETERS



FV-520B-F-D,
shown smaller
than actual size

- ✓ Measures Steam, Gas, and Low Viscosity Liquids
- ✓ No Moving Parts and No Sensor Contact with Process Fluid

- ✓ Accuracy Up to 0.8% of Rate
- ✓ Intelligent Amplifier Offers Many New Features
- ✓ Remote or Integral Electronics



\$1752
Basic Unit

OMEGA's FV-500B vortex flowmeter provides accurate, reliable, low-maintenance flow measurement. Vortices generated by the flowing fluid stress the shedder bar in pulses, and the shedder bar transmits the stress pulses to the encapsulated piezoelectric sensor.

The FV-500B-TBL allows access to the full power of OMEGA's new intelligent amplifier. It permits the user to display flowrate and/or total in engineering units for liquids and gases. Rate and total can be displayed in cubic feet or meters, U.S. or imperial gallons, or liters (rate and total display in the same units). If the density or enthalpy of the fluid is constant (*i.e.*, the temperature and pressure do not change), the density value can be entered into the meter to display in kilograms, pounds or metric tons; the enthalpy value can be entered to display in BTUs, kilojoules, etc. The FV-500B-TBL also provides an alphanumeric display of the units selected, and can be set to display rate only, total only, or to toggle between rate and total or rate in % full scale and rate in engineering units. Analog output span adjustment and low cutoff are also settable from the FV-500B-TBL—there is no need to adjust pots. The analog and pulse outputs can also be forced to output from 0 to 100% FS or 0 to 6,000 Hz without any flow through the meter as a test of the amplifier. Additionally, one FV-500B-TBL can be used to program multiple vortex meters.

For steam flow measurement, the FV-500B should be used with the OMEGA® FC-20 mass flow computer. The standard FV-500B is wafer-style to slip between 150# ANSI flanges, and comes supplied with extra long bolts for installation. Units with the suffix “-F” have 150# ANSI flanges.

See pages G-6 through G-10 for additional specifications and ordering information

STANDARD SPECIFICATIONS

Fluid to be measured: Liquid, gas or steam (avoid multi-phase flows and liquids with greater than 3 centipoise viscosity)

Accuracy (on linear ranges):

Liquid	±0.8% of reading
Gas and	±0.8% of reading (Velocities 114 ft/sec or less)
Steam	±1.5% of reading (Velocities 114 to 262 ft/sec)

NOTE: This table shows the accuracy of Pulse Output. In case of Analog Output, add up ±0.1% of full scale to the values given above.

Repeatability: 0.2% of reading

Process Temperature Limits:

-40 to 300°C (-40 to 572°F)

Refer to figure 1 for integral converter type. If fluid temperature goes above 300°C (572°F), OMEGA's high-temperature version ("HT") is recommended for applications up to 400°C (752°F)

Process Pressure Limits: -15 psi (-0.1 MPa) up to maximum ANSI flange ratings

Ambient Temperature Limits:

-40 to 80°C (-40 to 176°F)

With Indicator/Totalizer:

-30 to 80°C (-22 to 176°F)

Ambient Humidity Limits:

5 to 100% relative humidity

Power Supply Voltage and Load Requirements:

Analog Output: 18 to 42 Vdc

Pulse Output: 14 to 30 Vdc
(Input power supply voltage Vs)

When scaled under 1 Hz, min. low and high time are over 0.5 seconds

Maximum line capacitance: 0.22 µF
(0.1 µF if output frequency is greater than 2.5 kHz)

Maximum Lead Wire Resistance: 50 Ω

Output Signal (from converter):

Analog: 4 to 20 mA dc, 2-wire system
(delay time 0.5 seconds)

Pulse: Voltage pulse, 3-wire system
(delay time 0.5 seconds) (scaled and unscaled pulse)

Low Level: 0 to 2 V

High Level: Vs-Vd (refer to Fig. 2 on page G-9)

(Vs; Input Power Supply Voltage, Vd; Voltage Drop)

50% nominal duty cycle

Nominal pulse rates are shown in Table 2 on page G-7

Material:

Standard Body: ASTM A296 Grade

CF8M (ANSI 316 SS) Optional:

Hastelloy C (equivalent of ASTM A494CW-12WM)

Standard Shedder bar: Two-phase stainless steel (equivalent to ANSI 329

SS) Optional Hastelloy C: (equivalent of ASTM A494CW-12WM)

Gasket: ANSI SUS316 SS with polytetrafluoroethylene (Teflon®) coating

Flowmeter housing and covers: aluminum alloy

Coating Color:

Frosty white (Polyurethane resin coating)
– Converter case

Deep sea moss green (Polyurethane anticorrosion coating)—Converter cover

Mounting: Flowmeter can be installed vertically, horizontally or at any other angle. For liquid service, the flow line must be filled with the process liquid

Remote Flow Converter:

2" pipe mounting

Enclosure Classification: Designed to meet NEMA Type 4 watertight and dust-tight protection standards

Electrical Connection:

ANSI ½ NPT female

Signal Cable: used for remote detector and converter.

Outer Sheath Material: Black heat resistance polyethylene

Durable Temperature:

-40 to 150°C (-40 to 302°F)

Span Adjustment: K-factor

Constants: fluid density, temperature, pressure

Damping: 0, 2, 4, 8, 32, or 64 second time constant

Totalizer Reset

(with/TBL indicator/display option)

Display Selection:

Totalized engineering units, instantaneous flow or percent
(with/TBL indicator/display option)

Specifications: Six-digit LCD display with back-light. Totalizer value is protected by an EEPROM at the time of a power failure.

Weight: 3 kg (6.6 lb) additional.

Display Unit: %, l, t, Nm³, m³, kg scf, cf, gal, lb, /h, /m

Pressure Loss: Obtained from the following equations:

$$\Delta P = 2.33 \times 10^{-4} \times \rho f \times V^2$$

$$\text{or } \Delta P = 3.89 \times 10^{-5} \times \rho f \times [(Q_1)^2 \div D^4]$$

$$\Delta P = 6.05 \times 10^{-7} \times \rho f \times [(Q_2)^2 \div D^4]$$

where:

ΔP: Pressure loss (in psi)

ρf: Density at operating condition (in lb/ft³)

V: Flow velocity (in ft/sec)

Q₁: Actual flowrate (in U.S. gpm)

Q₂: Actual flowrate (in ACFH)

D: Internal Diameter (in inches)

Minimum Back Pressure (liquid service only):

Confirm that flow line pressure is sufficiently high that no cavitation occurs. The optimum pressure can be obtained using the following equation:

$$P = 2.7 \times \Delta P + 1.3 \times P_0$$

where:

P: Line pressure ¾ to 7/8 flow line internal diameters downstream of the vortex shedder (in psia).

ΔP: Pressure loss (in psi) see "P" above



**FV-500B-TBL-CC
Accessory**

Sizing

Fluid conditions determine the measurable range and the accuracy guaranteed range of this flowmeter. Select a suitable nominal size by taking into consideration the following conditions:

Measurable Minimum Flow Velocity:

Reynolds number must be 5000 or higher. Larger value of flow velocity obtained from Fig. 3(a) and Fig. 3(b) (relationship between the minimum flow velocity and the specific weight).

Accuracy Guaranteed Minimum Flow Velocity:

Reynolds number must be 20000 or more for ½" to 4" (40000 or more for 6 and 8 inch). Larger value of flow velocity obtained from Fig. 3 (a) and Fig. 3(b) (relationship between the minimum flow velocity and the specific weight).

Figure 4 shows the curve for Reynolds number 20,000 are ½" to 4" (40,000 at 6" and 8"), the value is four times (eight times for 6" and 8") the flow velocity obtained from Fig. 3.

The method of calculating the measurable range and the linear range are shown in Table 1(a) and Table 1(b). When the flow velocity is lower than the minimum flow velocity obtained from Table 1(a), the output (either the analog output or the pulse output) is displayed as "0".

P_o: Saturation liquid vapor pressure (psia) at operating temperature

(Example)

Water flowrate: 0 to 200 U.S. gpm

Density: 61.91 lb/ft³

Operating Pressure: 0.5 kg/cm²G (7.11 psig)

Operating temperature: 40°C (104°F)

Flowmeter size: 2 inch

Solution

$$\Delta P = 3.89 \times 10^{-5} \times 61.91 \times (200^2 \div 2.01^4)$$

$$= 5.90 \text{ psi}$$

$$P = 2.7 \times 5.90 + 1.3 \times 1.07$$

$$= 17.32 \text{ psia}$$

$$17.32 - 14.7 = 2.63 \text{ psig}$$

Since the operating pressure of 7.11 psig is higher than 2.63 psig, no cavitation will occur.

Table 1(a) Range of Measurable Flow Velocity

	Minimum Flow Velocity	Maximum Flow Velocity
Liquid	Larger of flow velocities obtained from Fig. 3 and Fig. 4	32 ft/sec
Gas or Steam	Value obtained from Fig. 3.	262 ft/sec or flow velocity obtained from Fig. 5, whichever is smaller

Table 1(b) Accuracy Guaranteed Velocity Range

	Minimum Flow Velocity	Maximum Flow Velocity
Liquid	Larger of flow velocities obtained from Fig. 3 and Fig. 4	32 ft/sec
Gas, Steam		262 ft/sec or flow velocity obtained from Fig. 5, whichever is smaller

Table 2. Nominal Pulse Rate and K-Factor

Nominal Size		Internal Diameter Inch	Cross Sectional Area ft ²	Nominal Pulse Rate Hz/ft/s	Nominal K-Factor	
mm	Inch				U.S. gal	Pulse/ft ³
15	½	0.57	0.0018	19.1	1423	10645
25	1	1.01	0.0056	10.8	259	1940
40	1½	1.56	0.0133	7.05	70.8	530
50	2	2.01	0.022	5.59	33.9	253
80	3	2.80	0.043	4.02	12.6	94.3
100	4	3.69	0.074	3.00	5.39	40.3
150	6	5.46	0.163	2.03	1.67	12.5
200	8	7.31	0.291	1.52	0.7	5.24

Table 3. Water Flow Rates

Nominal Size		Minimum and Maximum Measurable Flowrates in U.S. gpm (a)(b)
mm	in	
15	½	1.3 (4.2) and 27 (c)
25	1	2.9 (7.3) and 82
40	1½	5.9 (11.3) and 196
50	2	9.8 (14.5) and 324
80	3	20 and 628
100	4	33 and 1100
150	6	79 and 2400
200	8	150 and 4290

(a) At standard conditions of 15°C (59°F)

(b) Maximum flow rates are based on 10 m/sec (32 ft/sec)

(c) Values in parentheses show minimum linear flow rate (Re = 20,000 or 40,000) when higher than minimum measurable flowrate

Table 4. Air Flowrates at Selected Pressures

Nominal Size		Flow rate Limits	0 psig (b) (0 kg/cm ²)	Minimum and Maximum Measurable Flowrates in SCFH (a)						
mm	in			50 psig (3.52 kg/cm ²)	100 psig (7.03 kg/cm ²)	150 psig (10.5 kg/cm ²)	200 psig (14.1 kg/cm ²)	300 psig (21.1 kg/cm ²)	400 psig (28.1 kg/cm ²)	500 psig (35.2 kg/cm ²)
15	½	min. (c)	172	361	500	719	939	1379	1822	2266
		max. (d)	(429) 1700	(429) 7492	13302	19128	24967	36692	48454	60266
25	1	min.	400	839	1118	1486	1940	2851	3765	4683
		max.	(756) 5287	23215	41217	59268	77362	113692	150137	186737
40	1½	min.	792	1919	3037	4061	5026	6838	8970	11157
		max.	(1168) 1287	55397	98355	141428	184604	271296	358263	445599
50	2	min.	1313	2756	4080	5867	7558	11254	14862	18455
		max.	(1503) 20821	91779	162951	234313	305846	449474	593557	738253
80	3	min.	2534	5321	7877	11326	14784	217726	28591	35885
		max.	40195	177182	314580	452347	590443	867720	1145876	1425214
100	4	min.	4423	10710	16953	22670	28055	38174	50076	62283
		max.	70157	309249	549061	789515	1030544	1514497	1999984	2487535
150	6	min.	9886	29678	46977	64927	84749	124548	164473	204567
		max.	153618	677145	1202247	1726757	2258524	3316208	4379250	5446612
200	8	min.	20851	68121	107827	144186	178437	242799	303285	385774
		max.	274675	1210761	2149664	3091086	4034753	5929510	7830269	9739113
250	10	min.	37370	122437	193804	259153	320716	436397	545115	649056
		max.	424752	1872295	3324193	4779987	6239253	9189263	12108558	15080351
300	12	min.	53518	176343	277549	371134	459300	624968	780663	929518
		max.	608291	2681328	4760604	6845457	8935284	13131375	17340759	21588047

(a) At standard conditions of 15°C (59°F) and 1.0332 kg/cm² absolute (14.7 psia); SCFH = Standard cubic feet per hour

(b) Pressure listed is at process temperature of 15°C (59°F)

(c) Minimum values are determined from Figure 5. Values in parentheses show minimum linear flowrate (Re = 20,000 or 40,000) when higher than minimum measurable flowrate

(d) Maximum flowrates are based on fluid velocity of 80 m/s (262 ft/s)

Table 5. Saturated Steam Flowrates at Select Process Pressures

Nominal Size	Flowrate Limits	Minimum and Maximum Operating Flowrates in (lb/h)										
		1.05 kg/cm ² (15 psig)	1.76 kg/cm ² (25 psig)	3.52 kg/cm ² (50 psig)	5.27 kg/cm ² (75 psig)	7.03 kg/cm ² (100 psig)	8.79 kg/cm ² (125 psig)	10.55 kg/cm ² (150 psig)	12.30 kg/cm ² (175 psig)	14.06 kg/cm ² (200 psig)	17.58 kg/cm ² (250 psig)	21.09 kg/cm ² (300 psig)
15 ½	min. (a)	12.8 (23.5)	14.6 (23.9)	18.4 (24.9)	21.5 (25.7)	24.1 (26.0)	26.5 (26.6)	28.7	30.7	32.6	36.6	43.4
	max. (b)	122	161	254	346	437	527	616	705	796	973	1154
25 1	min.	29.7 (41.0)	34.0 (42.0)	42.8 (43.9)	49.9	56.1	61.6	66.6	71.3	75.7	83.7	91.2
	max.	379	498	788	1071	1353	1633	1910	2285	2464	3014	3575
40 1½	min.	58.7 (63.4)	87.3	84.6	98.6	118	137	156	173	191	224	257
	max.	905	1188	1879	2554	3228	3894	4557	5215	5879	7192	8530
50 2	min.	97.5	111	140	164	184	202	219	234	248	298	354
	max.	1500	1969	3113	4232	5349	6452	7550	8639	9740	11916	14133
80 3	min.	188	216	271	316	355	390	422	452	480	576	683
	max.	2895	3800	6010	8170	10326	12455	14576	16678	18804	23004	27283
100 4	min.	328	376	472	551	659	766	869	967	1085	1251	1434
	max.	5054	6633	10490	14260	18023	21739	25440	29109	32820	40150	47620
150 6	min.	719	824	1184	1516	1827	2122	2407	2681	2951	3467	3974
	max.	11065	14523	22969	31224	39483	47600	55705	63739	71864	87914	104270
200 8	min.	1549	1885	2720	3477	4193	4872	5526	6153	6773	7958	9122
	max.	19786	25968	41070	55830	705561	85111	99603	113968	128496	157194	186439
250 10	min.	2725	3387	4888	6249	7536	8756	9930	11060	12174	14304	16396
	max.	30596	40157	63509	88334	109114	131614	154024	176238	198703	243081	288305
300 12	min.	3903	4851	7000	8949	10793	12539	14220	15839	17434	20485	23481
	max.	43816	57590	90962	123640	156263	188485	220578	252392	284584	348119	412883

(a) Minimum values are determined from Figure 7. Values in parentheses show minimum linear flowrate (Re = 20,000 or 40,000) when higher than minimum measurable flowrate.
 (b) Maximum flowrates are based on fluid velocity of 80 m/s (262 ft/s).

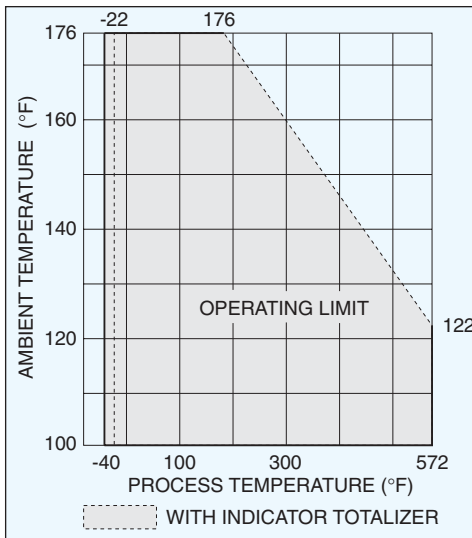


Figure 1. Operating Temperature Hi-Limit (Integral Converter Type)



FV-500B-TBL-CC Accessory



Use the FV-500B with the Model FC-20 Mass Flow/BTU Computer (See Section M)

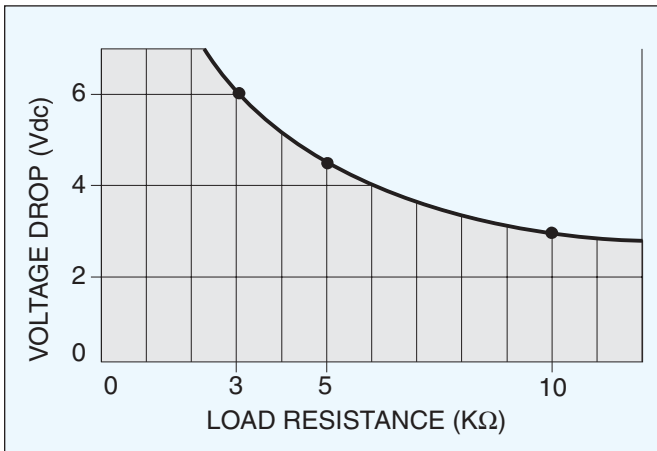


Figure 2. Load Resistance vs Voltage Drop, Pulse Output

Liquid (Minimum)

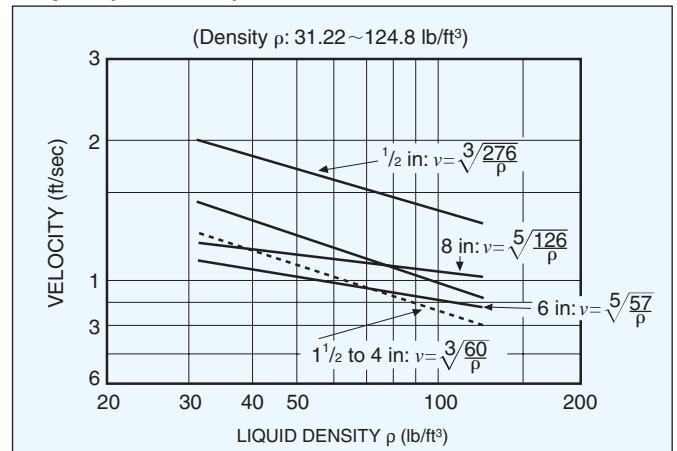


Figure 3(a). Relationship Between Minimum Velocity and Density (ρf : 31.22 lb/ft³ or more)

Gas and Steam (Minimum)

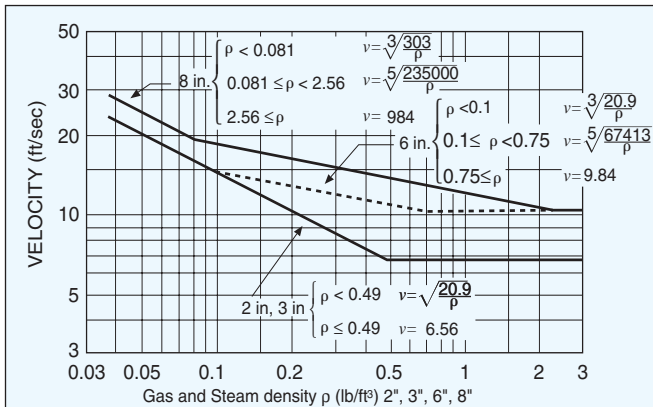
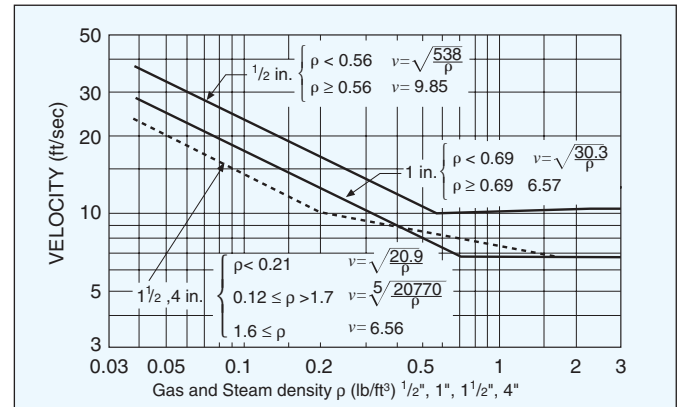
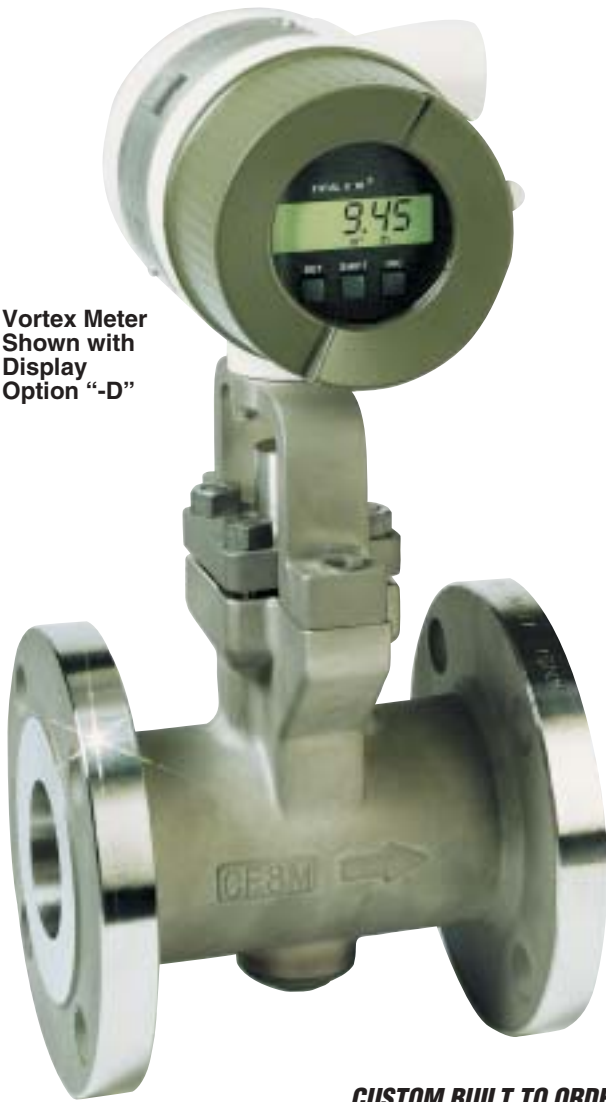


Figure 3(b). Relationship Between Minimum Velocity and Density (ρf : 0.037 lb/ft³ or more)



Vortex Meter Shown with Display Option "-D"



CUSTOM BUILT TO ORDER

To Order (Specify Model No.)[†]

Model No. (without display module)	Price	Pipe Size	Lay Length	Wt. kg (lb)*
FV-505B	\$1752	½"	2.76	3.0 (6.6)
FV-510B	1752	1"	2.76	3.9 (8.6)
FV-515B	1764	1½"	2.76	4.5 (10.0)
FV-520B	1782	2"	2.95	6.2 (13.7)
FV-520B-F	2112		6.70	11.9 (26.3)
FV-530B	1920	3"	3.94	6.9 (21.2)
FV-530B-F	2550		7.88	20.2 (44.6)
FV-540B	2160	4"	4.73	13.0 (28.7)
FV-540B-F	3096		8.67	27.6 (60.9)
FV-560B-F	3480	6"	10.63	36.6 (80.7)
FV-580B-F	5340	8"	12.21	55.6 (122.6)

† Note: When ordered, the vortex meter will be programmed at our factory for your application. Please complete and send in questionnaire from page G-3 with your order. For further details, contact Flow Dept..
 *Indicator/totalizer adds 0.4 kg (0.9 lb). Remote electronics option (ordering suffix "-R") increases all weights by 2.7 kg (6.0 lb).
 Note: Units with "-F" suffix have 150 #ANSI flanges. To order units with remote electronics, add suffix "-R" to model number and add \$290 to price. Price includes 30' interconnecting cable. For 1" through 6" units rated for 400°C (752°F), add suffix "-HT" to model number and add \$600 to price. "-HT" units are supplied only with remote electronics.

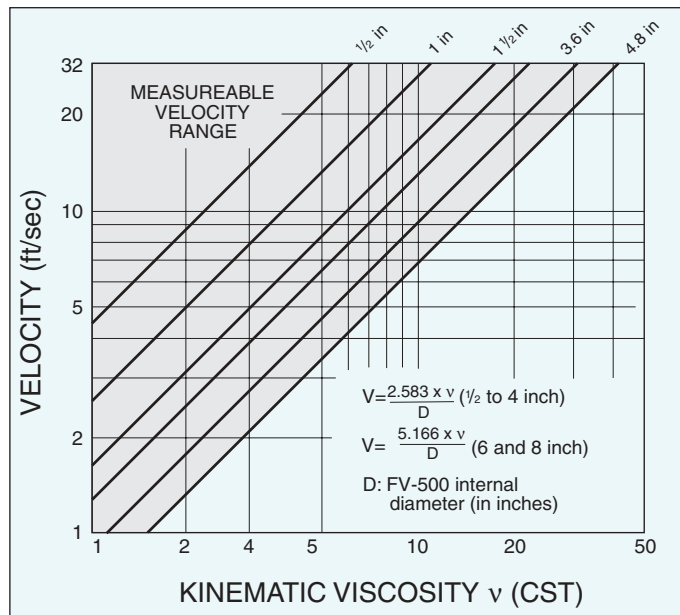


Figure 4. Relationship Between Velocity and Kinematic Viscosity (Reynolds Number of 20000 or 40000)

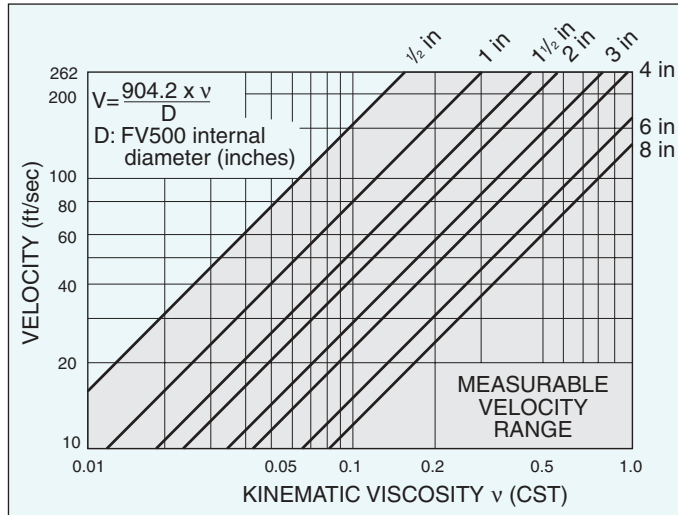


Figure 5. Relationship Between Velocity and Kinematic Viscosity (Reynolds Number of 7,000,000)

Accessories

Model No.	Price	Description
FV-500B-TBL	\$300	Display/programming module
FV-500B-TBLCC	360	FV-500B-TBL with clear cover case
FV-500B-RMK	600	Integral-to-remote electronics conversion kit

To order vortex meter with integral display/programming module (FV-500B-TBL) with clear cover, add suffix "-D" to model number and add \$270 to price.
 To order vortex meter with NIST-traceable certification, please add suffix "-NIST" to part number and add \$75 to price.
Ordering Example: Model FV-520B, Vortex Flowmeter, wafer design for use with 2" pipe with 150 #ANSI flanges. Please complete and send in questionnaire from page G-3 with your order, \$1782.



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