

# User's Guide



FP6501/6502

FP6511/6512

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## **FP6500 SERIES** **Insertion Paddlewheel Flow Sensor**



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**Servicing North America:**

**U.S.A.:** One Omega Drive, P.O. Box 4047  
ISO 9001 Certified Stamford, CT 06907-0047  
TEL: (203) 359-1660 FAX: (203) 359-7700  
e-mail: info@omega.com

**Canada:** 976 Bergar  
Laval (Quebec) H7L 5A1, Canada  
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e-mail: sales@omegaeng.nl

**Czech Republic:** Frystatska 184, 733 01 Karviná, Czech Republic  
TEL: +420 (0)59 6311899 FAX: +420 (0)59 6311114  
Toll Free: 0800-1-66342 e-mail: info@omegashop.cz

**France:** 11, rue Jacques Cartier, 78280 Guyancourt, France  
TEL: +33 (0)1 61 37 2900 FAX: +33 (0)1 30 57 5427  
Toll Free in France: 0800 466 342  
e-mail: sales@omega.fr

**Germany/Austria:** Daimlerstrasse 26, D-75392 Deckenpfronn, Germany  
TEL: +49 (0)7056 9398-0 FAX: +49 (0)7056 9398-29  
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The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

**WARNING:** These products are not designed for use in, and should not be used for, human applications.

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## GENERAL INFORMATION

### GENERAL INFORMATION

The FP6500 Series are adjustable depth insertion paddlewheels that come in brass or 316 stainless models to fit 3" to 40" pipe. Installation fittings are standard 1-1/2" or 2" NPT. Fittings such as saddles and weldolets may be purchased either locally or from Omega.

Ruby bearings and a non-drag Hall-effect sensor give these meters the widest flow range of any of the paddlewheel types. A sensor detects the passage of miniature magnets in the six rotor blades.

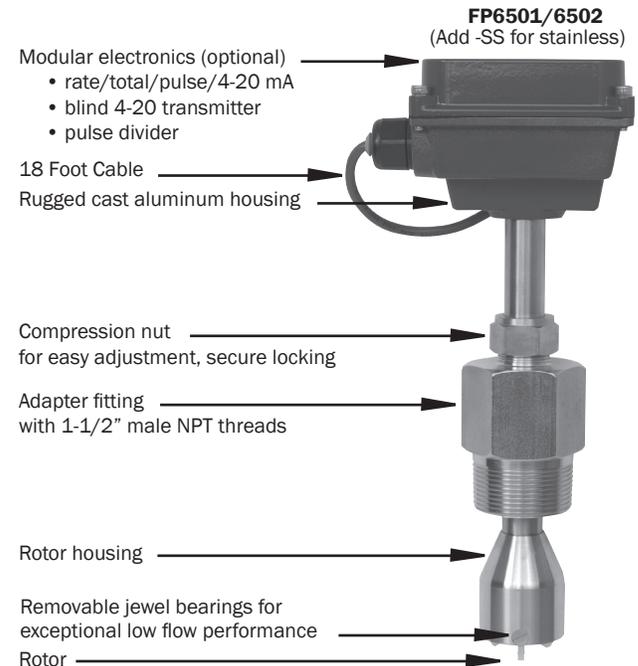
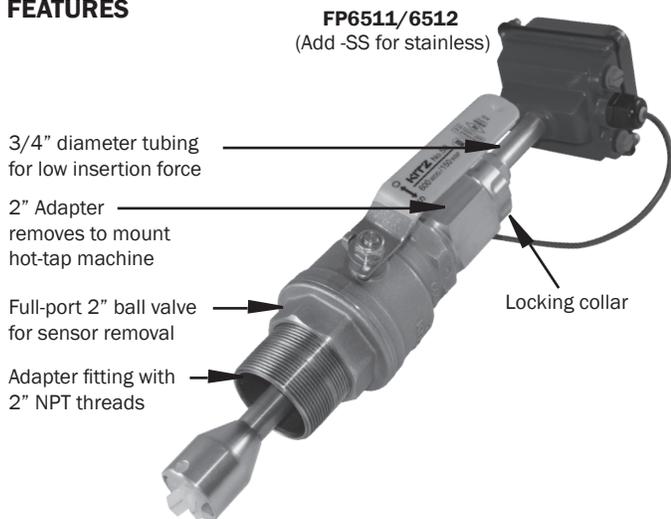
The resulting square-wave signal can be sent for hundreds of

feet over unshielded cable without a transmitter and connected directly to many PLC's and other controls without any additional electronics.

If desired, a modular system of electronics can be installed directly on the flow sensor or mounted remotely.

The "hot-tap" models (FP6511/6512) can be installed or serviced without shutting down the line by means of a 2" full-port isolation valve that comes with a nipple for installation on the pipe fitting. In most circumstances, no special tool is required.

### FEATURES



### SPECIFICATIONS\*

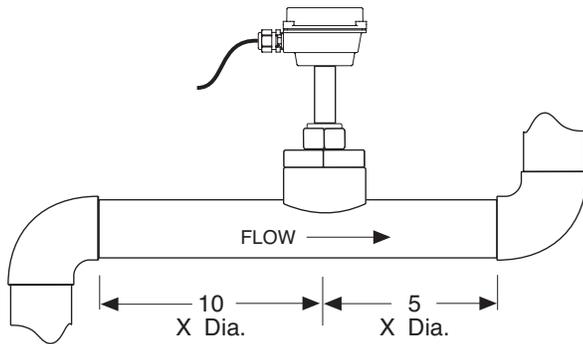
Pipe Size	FP6501/6511	FP6502/6512
	3" to 12" (50 - 300mm)	12" to 40" (300 - 1000mm) Note: For larger pipe sizes contact factory
Sensor	Hall Effect sensor, 12 Vdc current sinking pulse	
Materials	Housing	Cast aluminum
	Sensor Body	Brass or 316 SS
	Rotor	PVDF
	Shaft	Nickel-bound tungsten carbide (zirconia ceramic optional)
	Bearings	Ruby jewel
	Isolation Valve	FP6501/6502 (Add -SS for stainless)
Fitting Size	1.5" NPT	2" NPT
Flow Range	0.3 - 30 feet/sec (0.1 - 9 meter/sec)	
Accuracy	+/- 1.5% of full scale	
Maximum Temperature	200° F (93° C)	
Maximum Pressure	200 psi (14 bar)	
Insertion Force	0.44 x pressure in pipe	
Power	5-24 Vdc, 1.5 mA	
Cable	#22 AWG 3-con, 18' (6m); 2,000' (650m) maximum cable run	
Regulatory	CE Mark (Standard Power Only)	

## INSTALLATION



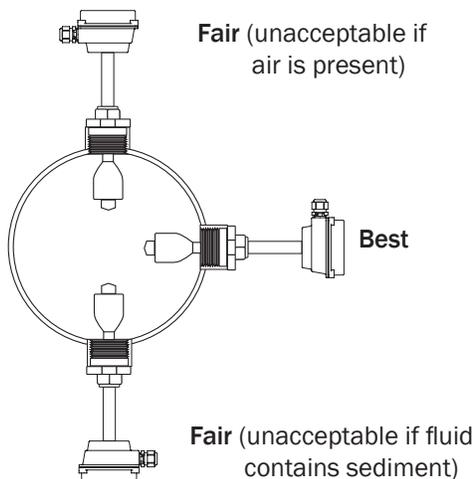
These flow sensors are not recommended for installation downstream of the boiler feedwater pump where installation fault may expose the meter to boiler pressure and temperature. Maximum recommended temperature is 200°F.

**Piping.** For best results, the FP6500 should be installed with at least ten diameters of straight pipe upstream and five downstream. Certain extreme situations such as partially-opened valves are particularly difficult and may require fifteen diameters upstream (See Straight Pipe Recommendations).



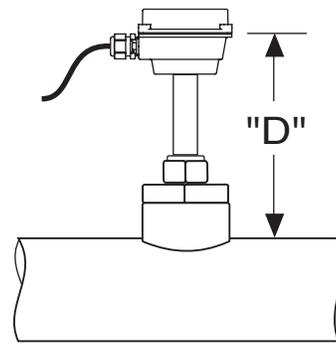
Horizontal is the preferred installation orientation, since it improves low-flow performance slightly and avoids problems with trapped air. Bottom, top, and vertical pipe installations are all acceptable if required by the piping layout. See Full Pipe Recommendations.

### POSITIONING THE METER

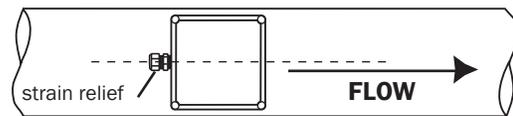


**Immersion.** The FP6500-Series standard sensors are not designed for continuous underwater operation.

**Depth Setting.** It is important for accuracy that the sensor be inserted to the correct depth into the pipe.



1. In Table 1, find Dimension C for your sensor model and pipe size.
2. Subtract wall thickness of your pipe (Table 2) to find Dimension D.
3. Measuring from the outside of the pipe to the joint in the housing, as shown in the diagram, adjust the sensor to Dimension D and hand tighten compression nut.
4. Align the conduit housing with the centerline of the pipe, as shown below. Be sure the arrow on the housing points in the direction of flow.



5. Check Dimension D one more time.
6. Tighten the compression nut fully.

### RECORD YOUR SETTINGS

Once you have the meter set up and operational, it is important to record your meter settings and save them for future reference.

K-Factor \_\_\_\_\_  
 Insertion Depth (Dim. D) \_\_\_\_\_

## INSTALLATION

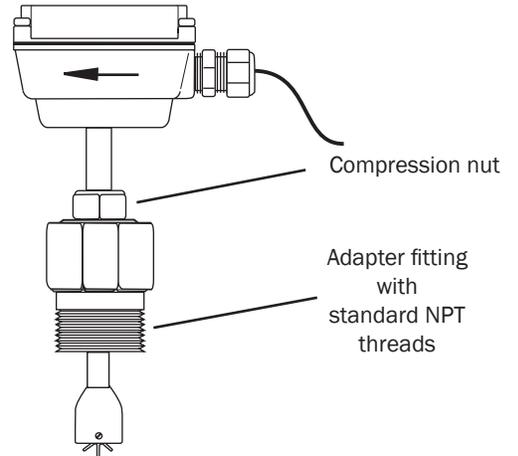
### FP6501/6502 INSTALLATION (Add -SS for stainless)

**Fitting Installation.** FP6501/6502 sensors come with a 1-1/2" male NPT pipe thread adapter fitting. Any fitting that provides the matching NPT female thread may be used. Installation procedure compensates for fitting height differences. Cut a minimum 1-3/4" hole in the pipe. If possible, measure the wall thickness and write it down for use in depth setting. Then install the threaded fitting (saddle, weldolet, etc.) on the pipe.

**Meter Installation.** Loosen the compression nut so that the adapter slides freely. Pull the meter fully upward and finger-tighten the compression nut. Using a thread sealant, install the adapter in the pipe fitting. Do not over-tighten. Now loosen the compression nut, lower the meter to the appropriate depth setting (see diagram and instructions, preceding page).

**Caution: Do not allow the meter to fall into the pipe uncontrolled, as this may damage the meter.** Be sure flow is in the direction of the arrow on the housing. Tighten compression nut fully.

FP6501/6502



### FP6511/6512 INSTALLATION (Add -SS for stainless)

'Hot tap' FP6500 Series meters are designed to be installed and serviced without depressurizing the pipe.

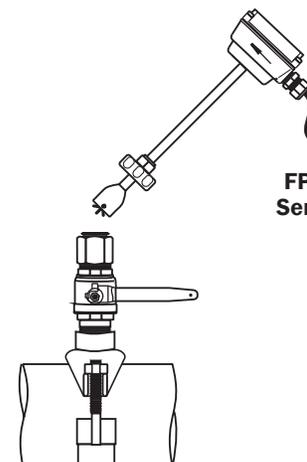
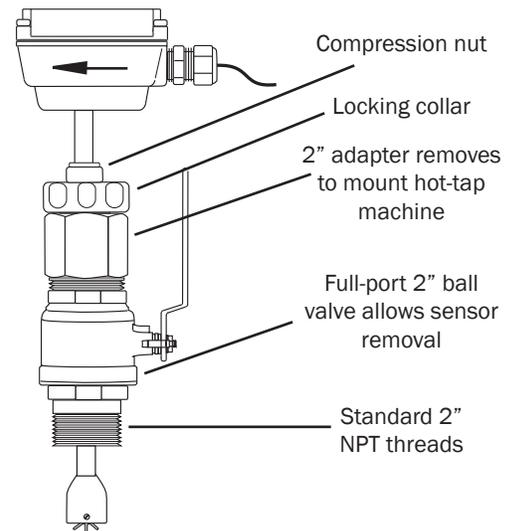
**Fitting Installation.** The sensors have a 2" NPT thread for compatibility with the 2" isolation valve. Any fitting that provides matching NPT female thread may be used. The installation procedure compensates for differences in fitting height.

If initial installation is performed on an unpressurized pipe, cut a minimum 1-3/4" hole in the pipe. If possible, measure the wall thickness and write it down for use in depth setting. Then install the threaded fitting (saddle, weldolet, etc.) on the pipe.

If it is necessary to do the initial installation under pressure, any standard hot tap drilling machine with 2" NPT adapter, such as a Transmate or a Mueller, can be used. Ordinarily, it is not necessary to use an installation tool, since the small-diameter tube can be controlled by hand at all but the highest pressures.

**Meter Installation.** Remove the sensor unit from the valve assembly. Using a thread sealant, install the valve assembly on the pipe fitting. If the initial installation is a pressure ("hot") tap, remove the 1-1/2" x 2" adapter bushing at the back of the valve. Thread the tapping machine on, open the valve, and tap using a minimum of 1-3/4" or maximum 1-7/8" cutter. After retracting the machine and closing the valve, reinstall the flow sensor. When the sensor is secure, open the valve and adjust depth setting (see diagram and instructions, preceding page). Be sure flow is in the direction of the arrow on the housing. Tighten locking collar and compression nut fully.

FP6511/6512



	Nominal Pipe Size									
	3"	4"	6"	8"	10"	12"	16"	24"	30"	36"
<b>FP6501</b>	9.20	9.03	8.69	8.35	8.01	7.67	6.99	-	-	-
<b>FP6502</b>	14.20	14.03	13.69	13.35	13.01	12.67	11.99	10.63	9.61	9.59
<b>FP6511</b>	16.21	16.01	15.71	15.31	15.01	14.7	14.01	-	-	-
<b>FP6512</b>	-	20.06	19.66	19.36	19.06	18.66	17.96	16.66	15.66	14.56

	Nominal Pipe Size									
	3"	4"	6"	8"	10"	12"	16"	24"	30"	36"
<b>PVC/Steel Sch. 40</b>	0.216	0.237	0.280	0.322	0.365	0.406	0.500	0.687	-	-
<b>PVC/Steel Sch. 80</b>	0.300	0.337	0.432	0.500	0.593	0.687	0.843	1.218	-	-
<b>Stainless Steel (10S)</b>	0.120	0.120	0.134	0.148	0.165	0.180	-	-	-	-
<b>Stainless Steel (40S)</b>	0.216	0.237	0.280	0.322	0.365	0.375	0.375	0.375	0.375	-
<b>Copper Tubing (Type L)</b>	0.090	0.100	0.140	0.200	0.250	0.280	-	-	-	-
<b>Copper Tubing (Type K)</b>	0.109	0.134	0.192	0.271	0.338	0.405	-	-	-	-
<b>Brass Pipe</b>	0.219	0.250	0.250	0.313	0.365	0.375	-	-	-	-
<b>Duct. Iron (Class 52)</b>	0.280	0.290	0.310	0.330	0.350	0.370	0.400	0.440	0.470	0.530

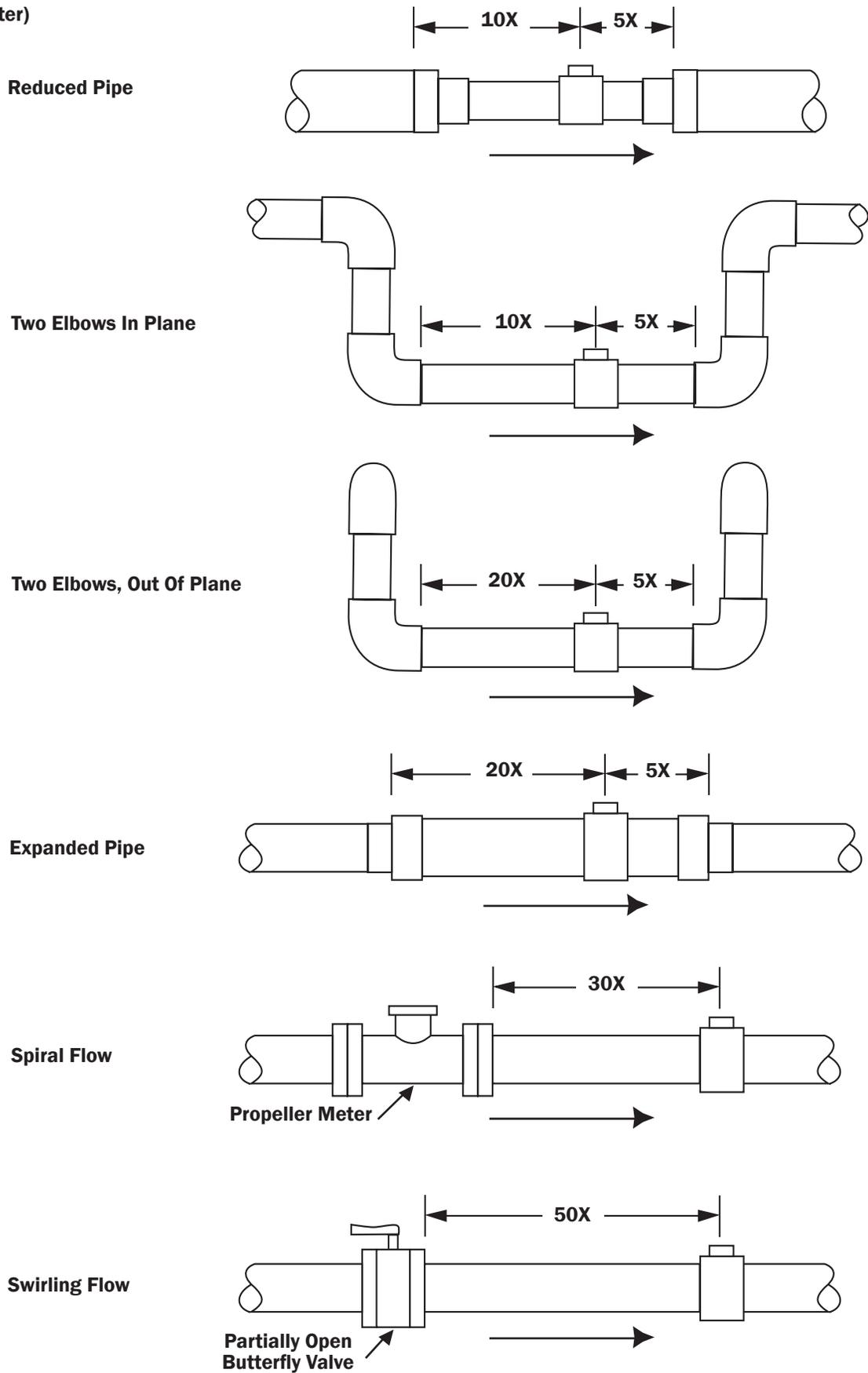
Feet / sec. ▼	Table 3: Flow (GPM) (Sched. 40 pipe)									
	Nominal pipe size									
	3"	4"	6"	8"	10"	12"	16"	24"	30"	36"
(0.3)	3.1	4.5	27	46.8	73.7	105	165	376	660	874
(0.5)	11.5	19.8	45	78	123	174	275	627	1100	1460
(1.0)	23	39.7	90	156	246	349	551	1250	2200	2910
(2.0)	46.1	79.4	180	312	492	698	1100	2510	4401	5830
(5.0)	115	198	450	780	1230	1740	2750	6270	11002	14570
(10.0)	230	397	900	1560	2460	3490	5510	12530	22005	29140
(20.0)	461	794	1800	3120	4920	6980	11020	25060	44010	58270
(30.0)	691	1190	2700	4680	7370	10470	16520	37600	66015	87410

	Table 4: FP6500 Series K-factors									
	Nominal pipe size									
	3"	4"	6"	8"	10"	12"	16"	24"	30"	36"
PVC/Steel Sch. 40	34.246	19.221	7.830	4.611	2.883	1.859	1.224	.577	-	-
PVC/Steel Sch. 80	38.329	21.844	8.779	4.980	3.213	2.097	1.304	.656	-	-
Stainless Steel (10S)	30.331	16.581	7.045	4.270	2.621	1.703	1.160	.519	.332	-
Stainless Steel (40S)	34.246	19.221	7.830	4.611	2.883	1.836	-	-	-	-
Copper Tubing (Type K)	38.145	21.420	8.846	5.027	3.302	2.126	-	-	-	-
Copper Tubing (Type L)	37.167	20.774	8.505	4.873	3.167	2.011	-	-	-	-
Brass Pipe	34.381	19.545	7.658	4.593	2.883	1.836	-	-	-	-
Duct. Iron (Class 52)	28.137	16.994	7.238	4.213	2.633	1.681	1.065	.461	.297	.207

# INSTALLATION

## STRAIGHT PIPE RECOMMENDATIONS

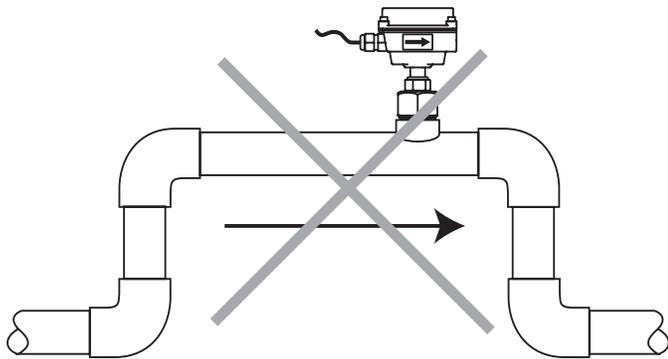
(X = diameter)



# INSTALLATION

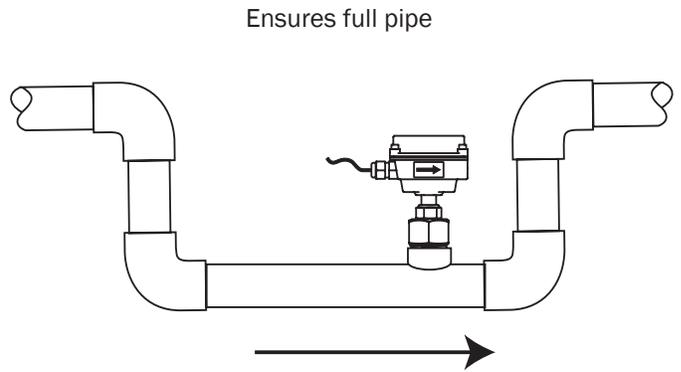
## FULL PIPE RECOMMENDATIONS

### NOT RECOMMENDED

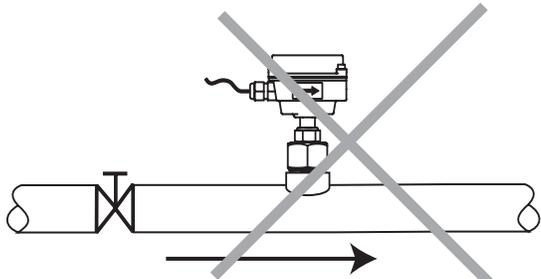


Allows air pockets to form at sensor

### RECOMMENDED

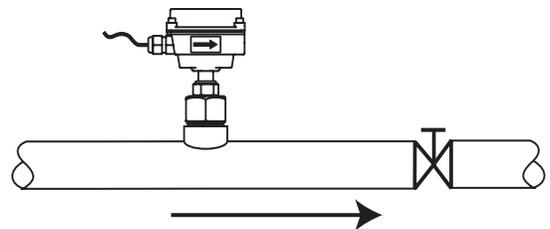


### NOT RECOMMENDED



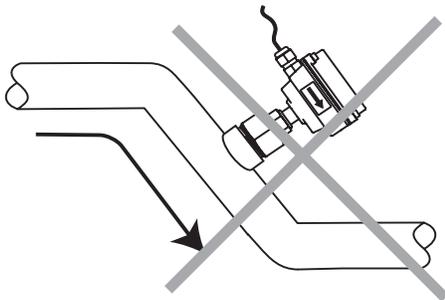
Post-valve cavitation can create air pocket

### RECOMMENDED



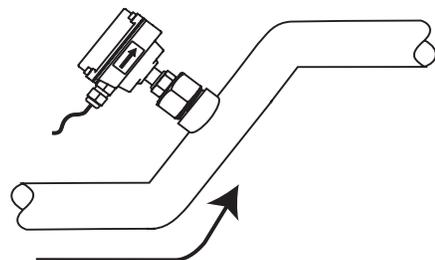
Keeps pipe full at sensor

### NOT RECOMMENDED



Air can be trapped

### RECOMMENDED



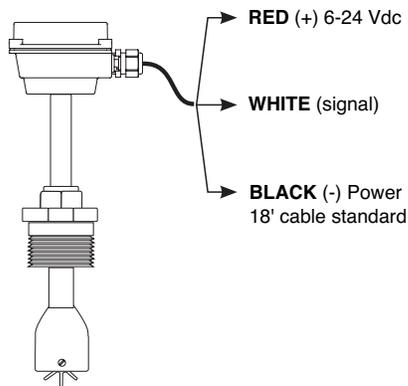
Allows air to bleed off



**Caution:** These flow sensors are not recommended for installation downstream of the boiler feedwater pump where installation fault may expose the flow sensor to boiler pressure and temperature. Maximum recommended temperature is 200°F.

### CONNECTION

Sensors are supplied with 18 ft. of cable. See diagram for color coding of connections.



**Calibration (“K-Factor”).** In order to properly process pulses from the flow sensor, a number must be entered into the control to which the sensor is connected. This number, called the K-factor, is the number of pulses the sensor puts out per unit of fluid passing through the pipe. It is provided in pulses per gallon, and is given on the chart “K-factors for Various Pipe Sizes.” These numbers are based on extensive testing, which has shown close agreement between different FP6500-Series sensors in the same installation. Typically, most K-factor error can be attributed to installation variables, such as depth setting and fitting configuration.

It is occasionally possible to field calibrate a sensor by catching the fluid in a measured container and comparing with the number of pulses recorded. (To record individual pulses, set the K-factor on the control to 1.00.) This is especially desirable if the installation has less than the recommended length of straight pipe upstream of the sensor.

### OPERATION

**Theory.** In principle, an insertion flow sensor measures the velocity of flow at one point in the pipe, and flow rate and total can be inferred from this one point. Accuracy is decreased by any factor which makes the flow at the measured point unrepresentative of the entire flow stream. This includes distorted flow patterns caused by upstream fittings too close to the sensor. The worst offenders are fittings that increase the flow on one side of the pipe, such as partially-opened gate or butterfly valves. Fluid moving in a pipe does not all flow at the same velocity. Toward the center of the pipe, fluid moves faster than at the wall, and the relationship between the two changes as overall flow rate increases. This change in the “velocity profile” can result in non-linearity, which means that the K-factor that is correct for one flow rate may be incorrect for another. The recommended depth settings have been carefully chosen to minimize this source of error, and should be followed carefully, especially in the smaller pipe sizes.

**Flow Range.** These sensors are designed to operate at flow velocities of 0.3 to 30 feet per second. (See chart for conversion to gallons per minute.) If erratic readings are encountered at low flows, check the chart to see if flow is below minimum for the pipe size. The standard shaft and bearings should have a long life at continuous high flow.

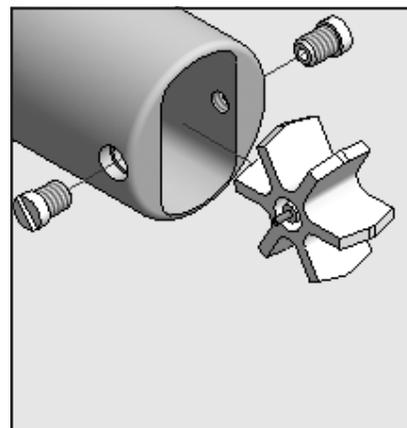
### REPAIR



**CAUTION!** Never attempt to remove a flow sensor when there is pressure in the pipe. Loosen the compression nut slowly to release any trapped pressure. If fluid sprays out when removing the sensor, stop turning and depressurize the pipe. Failure to do so could result in the sensor being thrown from the pipe, resulting in damage or serious injury.

**Rotor Replacement.** Rotors are easily field-replaced. Shaft and rotor are a single unit, and are not replaced separately. If replacement is due only to normal shaft wear, bearing replacement is probably not necessary. If the rotor has been damaged by impact, the bearings should also be replaced. Rotor and bearings can be ordered as a kit, FP15827. Follow these steps:

1. Unscrew the threaded bearing housings to expose the shaft ends. If bearings are being replaced, back them completely out.
2. Remove the rotor. Put the new rotor in its place.
3. Thread in one bearing housing part way, then the other. Take care to start the end of the shaft into the bearing hole before tightening further.
4. Screw in bearing housings until they bottom.  
**Note:** Do not use excessive force.
5. Check for free spin. Blowing lightly on the rotor should result in it spinning rapidly and coasting to a smooth stop.

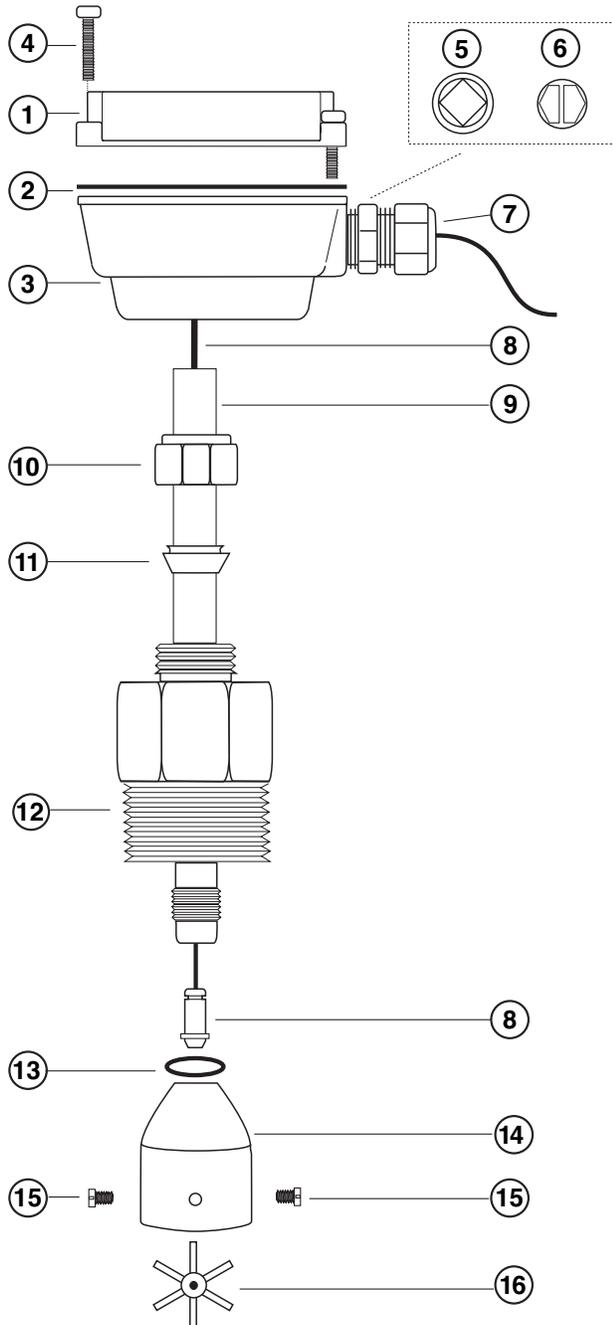


**Signal**

The flow sensor has only one moving part, the rotor. If this is turning properly and there is no signal, the Hall-effect sensor is not operating properly. To check the signal, apply 12 Vdc regulated\* power to the red (+) and black (-) leads. Set a multimeter to voltage reading. Put the positive multimeter lead on the red wire and the negative lead on the white wire. Slowly turn the rotor. Voltage reading should swing between +12 Volts and 0 Volts as the rotor turns. If it does not, the Hall effect sensor is not working properly. Checking for continuity is not a useful test of these sensors.

\*NOTE: An unregulated power supply can exceed max voltage of micro powered sensor (gray cable) and damage sensor.

**Parts Explosion**



FP6501/6502 Parts		
1	Upper housing assembly	30475
2	Gasket	26211
3	Lower housing	Not Field Replaceable
4	Housing screw (4 req'd)	26229
5	Plug, steel	26073
6	Plug, plastic	26079
7	Strain relief	07655
8	Pickup, Micropower (for FT415)	29953
	Pickup, Standard (for FT420)	26310
9	Tube	Not Field Replaceable
10	Compression nut	14199 (Brass) 15064 (S/S)
11	Compression ferrule	26065
12	Adapter fitting	30998 (Brass) 30999 (S/S)
13	Rotor housing O-ring (EPDM)	16454
14	Rotor housing	14220 (Brass) 15220 (S/S)
15	Jewel bearings (2 req)	25901
16	Rotor with shaft	11130 (PVDF/Tungsten Carbide) 11132 (PVDF/Ceramic)
17	Rotor repair kit (includes of #15 & #16)	25902 (PVDF/Tungsten Carbide) 12131 (PVDF/Ceramic)

HOT TAP: FP6511/6512 Parts (not shown)	
Adapter fitting	14180 (Brass) 15060 (S/S)
Ball valve assembly	14225 (Brass) 15225 (S/S)
Collar, locking	14190 (Brass) 15070 (S/S)
Hex nipple, 2"	14210 (Brass) 15100 (S/S)

## TROUBLESHOOTING

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<b>Problem</b>	<b>Probable Cause</b>	<b>Try...</b>
No pulse output	Below minimum flow cutoff Empty pipe No power	Check Table for velocity vs. pipe size Check plumbing Check connections
Output pulses incorrect	Incorrect depth setting Pipe not full Not enough straight pipe	Check depth setting from Dimension "C" table Refer to Installation/diagrams Refer to Installation/diagrams
Jumpy reading	Fluctuating flow rate Fluctuating around low flow cutoff Not enough straight pipe	Refer to installation diagrams Check Table for velocity vs. pipe size Refer to Installation/diagrams



## WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

**OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.**

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

## RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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