CE

User's Guide

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FL1650 / 1660 SERIES
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e-mail: nl@omega.com

Czech Republic:
Rudé armády 1868, 733 01 Karviná 8
TEL: +420 (0)69 6311899 FAX: +420 (0)69 6311114
Toll Free: 0800-1-66342 e-mail: czech@omega.com

France:
9, rue Denis Papin, 78190 Trappes
TEL: +33 (0)130 621 400 FAX: +33 (0)130 699 120
Toll Free in France: 0800-4-06342
e-mail: france@omega.com

Germany/Austria:
Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 9398-0 FAX: +49 (0)7056 9398-29
Toll Free in Germany: 0800 639 7678
e-mail: germany@omega.com

United Kingdom: ISO 9002 Certified
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Northbank, Irlam, Manchester
M44 5EX United Kingdom
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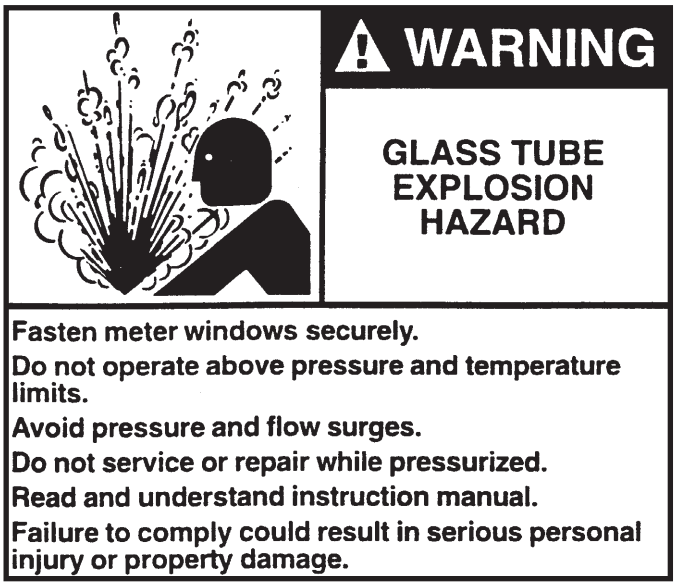
WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

TABLE OF CONTENTS
FL-1650/1660



SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® FL1650/1660 Series Rotameters provide high accuracy in a rugged, industrial housing. Standard construction has brass end fittings for mounting. The meters feature ±2% full scale accuracy, ±1/2% full scale repeatability, and are shielded for use in pressurized systems. The rotameters are supplied with arbitrary 10-100% scale, with multiplication factors for air and water.

1.2 PRINCIPLE OF OPERATION

The operating parts of the flowmeter consist of a tapered glass tube and a float which operates within the tube. The fluid enters the bottom of the tube, which has the smallest inside diameter (and smallest area), and exits from the top, which has the largest inside diameter (and largest area). Refer to Figure 1-1. The float is free to operate between the largest and smallest areas of the tube.

As the float moves up and down within the tapered tube, the annular area between the float and tube varies (area increases as the float rises). Refer to Figure 1-2. This gives the generic name of "variable area meter" for this measurement principle. The pressure differential across the float (bottom to top) is fixed by the weight of the float and the buoyant forces of the fluid. As the flow varies, the float will move within the tube until it reaches an equilibrium position, where the tube taper creates an appropriate annular area to balance the force of gravity and the fluid forces acting on the float.

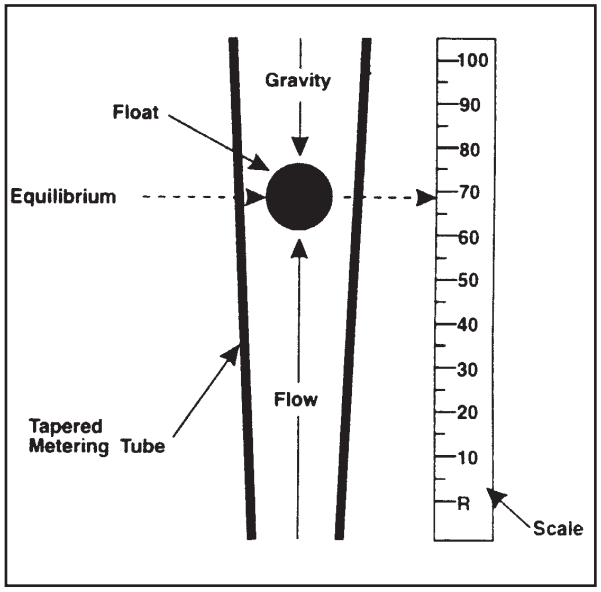


Figure 1-1 Principle of Operation

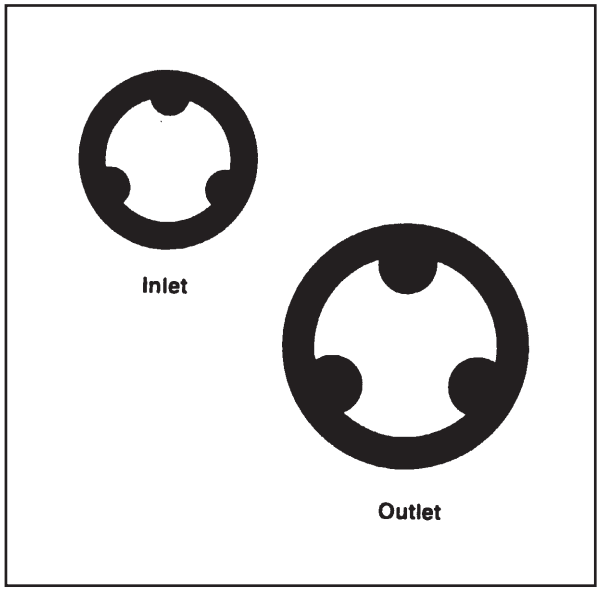


Figure 1-2 Cross-section of FL 1650/60 Flow Tubes

There are four types of floats available for the flowmeter. Refer to figure 1-3. The following description refers to floats used in the same size tube. The spherical float is the least costly, however, it has the lowest capacity and offers no viscosity immunity. The RV viscosity compensating float offers the greatest immunity form viscosity and still greater flow rate. The RS semi-compensating float gives higher capacity than the RV float, however, it is not as viscosity compensating. The LJ float offers the maximum capacity available in a given tube size however, it is less viscosity compensating than the RS float.

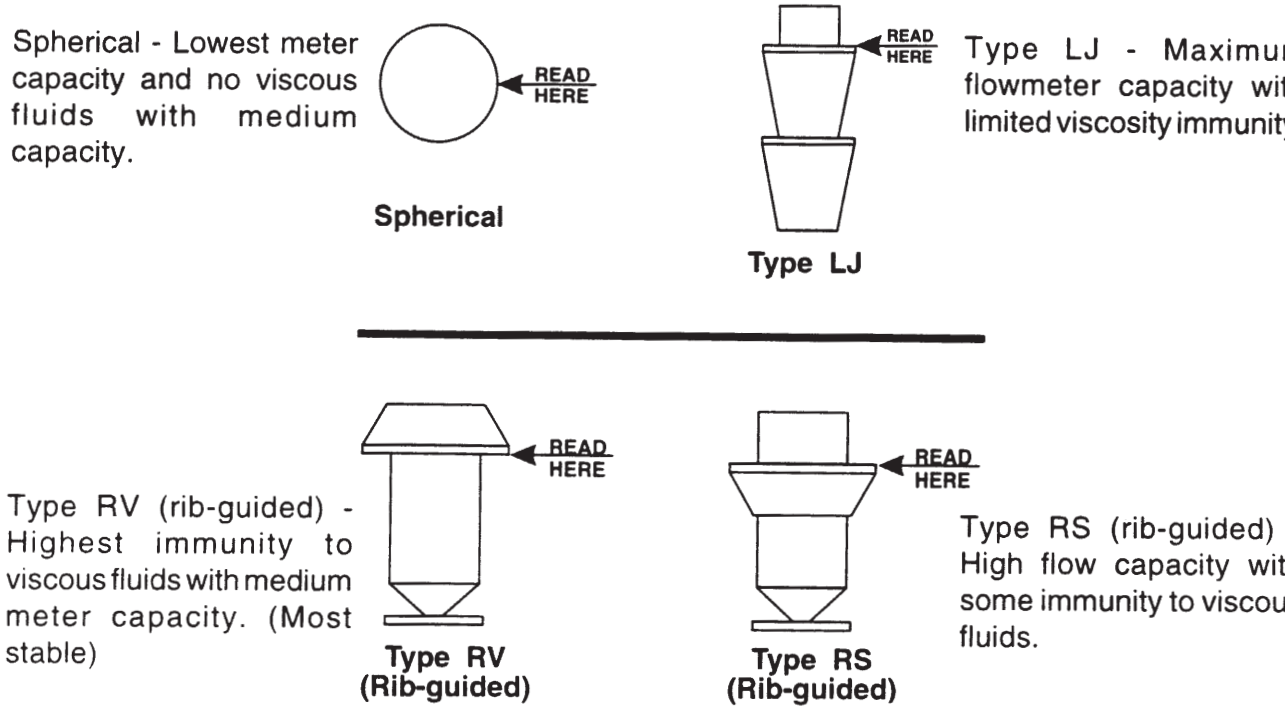


Figure 1-3. Float Types

Guide ribs are formed into the tube to keep the float operating in the center of the tube (refer to Figure 1-2). The guide ribs do not follow the taper of the tube. They are parallel to the tube centerline so that the proper operating clearance for the float is maintained for its entire range of travel. As you can see from Figure 1-2, the increasing annular area of the tube is in the area between the ribs.

A scale is mounted on the flowmeter to enable reading the height of the float above the zero reference as a percent of full scale. A factor tag is supplied which provides a constant that can be used to convert readings to actual flow rate units.

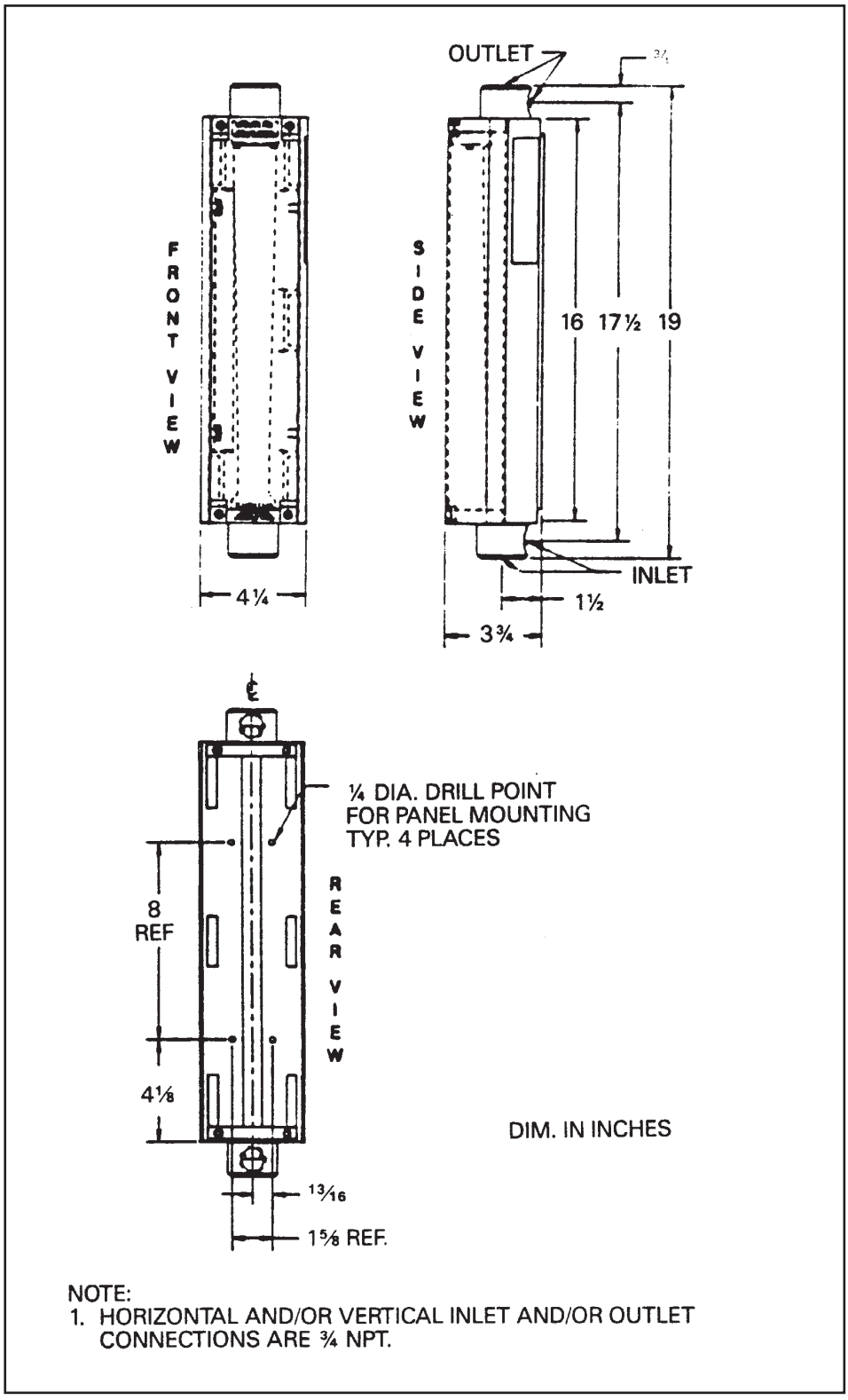


Figure 1-4. FL1650/1660 Series Dimensions

1-3 FACTORS THAT AFFECT OPERATION

Specific gravity is the ratio of the density of a given substance to that of a constant substance, usually air or water. As the specific gravity of the measured fluid increases, so does the buoyancy of the float. For this reason, the float will rise higher for fluids with a high specific gravity than in an equal flow of a fluid with lower specific gravity. The following mathematical correction can be made for changes in specific gravity.

$$Qa = Qi \frac{sgc}{sga}$$

Where:
Qa = Actual flow rate
Qi = Indicated flow rate
sgc = Specific gravity of the calibration fluid
sga = Specific gravity of the process fluid

Viscosity is a measure of fluid's resistance to flow. High viscosity means high resistance. Low viscosity means low resistance. For this reason, more energy will be required to move high viscosity fluids through the piping system. A highly viscous fluid will move the float farther up the tube than one of lower viscosity, moving at the same flow rate. This is true even when fluids have the same specific gravity.

Variable area flowmeters have a viscosity immunity ceiling (VIC) as part of their specifications. This is the highest liquid viscosity the flowmeter can handle without affecting its accuracy. If the liquid viscosity exceeds the VIC, the meter must be recalibrated at these conditions to insure accuracy. When the viscosity of the liquid rises above the VIC, the capacity of the meter will decrease.

Temperature has an indirect effect on the meter's performance, because it changes the viscosity and specific gravity of a fluid. For liquids, the viscosity and specific gravity must be known at the operating temperature. The capacity of the meter decreases as temperature increases. For gases, the following mathematical corrections can be made.

$$Qa = Qi \frac{Tc}{Ta}$$

Where:
Tc = Calibration temperature (absolute)
Ta = Actual temperature (absolute)
Qa = Actual flow rate
Qi = Indicated flow rate

Gases are easily compressed by increasing pressure, but liquids are nearly incompressible. Therefore, pressure changes have negligible effect on meters used to measure gas flow. The capacity of the meter increases as the absolute pressure increases. For gases, the following mathematical corrections can be made.

$$Qa = Qi \frac{Pa}{Pc}$$

Where:
Pa = Actual pressure (absolute)
Pc = Calibrated pressure (absolute)
Qa = Actual flow rate
Qi = Indicated flow rate

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about this shipment, please call OMEGA Customer Service Department.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

Remove the plastic float retainer which protrudes from the outlet fitting before installing the flowmeter.

2.2 INSTALLATION CONSIDERATIONS

A. LOCATION

For proper operation, the flowmeter must be mounted within 6 degrees of true vertical, with the inlet connection at the bottom of the meter, and the outlet at the top. The use of a plump-bob, level or other device to assure vertical positioning is recommended.

B. PIPING ARRANGEMENT

It is strongly recommended that the typical piping arrangement shown in Figure 2-1 be used when installing the meter. the piping arrangement permits the meter to be isolated from the flow for servicing or cleaning. The design of the flowmeter allows the horizontal inlet and outlet end fittings to rotate independently of each other simply by loosening the two clamp bolts for each end fitting at the rear of the meter. Additionally the various end fittings offer horizontal or vertical connections or a combination of both.

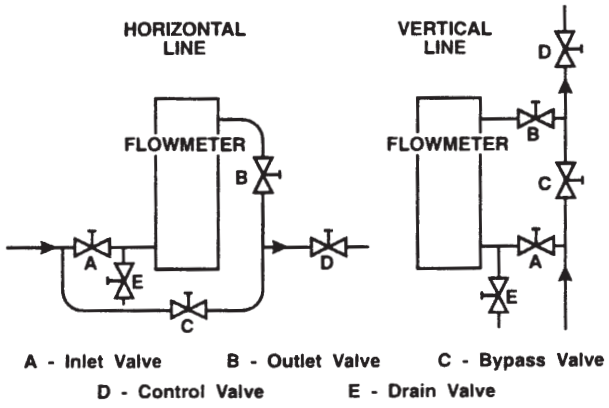


Figure 2-1 Typical Flowmeter Piping Configuration

2.3 PANEL MOUNTING

To panel mount the flowmeter, use the following procedure. Refer to Figure 2-3 for the location of the panel mounting hole pattern.

1. Remove the four screws securing the front shield to the meter, then remove the front shield.

2. Pull out on the plastic block holding the tube in position. Do not remove the two screws securing it.

When removing the metering tube from the upper end fitting in the following step, do not pull out too far or with too much force, or you may break it. Do not allow the float to fall out of the metering tube. A damaged float will affect the accuracy of the meter. Hold the inlet (lower) float stop in position with a finger when removing the tube.

3. Slide the metering tube up behind the plastic tube retainer until it clears the lower end fitting. When the tube is clear of the end fitting, pull out on it until you can remove it from the upper end fitting.

4. Remove the four socket head screws on the rear of the body casting, then remove the end fittings and their clamps.

5. Drill four 5/16 holes in the body casting at the cast-in drill marks. These holes align with the panel mounting hole pattern in Figure 2-3.

6. Install the end fitting and their clamps. Align horizontal end fittings with the piping before tightening the clamp bolts to 95 inch/pounds.

7. Bolt the meter to the panel using four 1/4-20 bolts of a proper length for the panel thickness.

8. Slide the metering tube onto the upper end fitting. Insure that the plastic tube retainer is pulled all the way out. Refer to figure 2-2 to insure that the orientation of the float is correct and that the inlet and outlet float stops are in position.

9. Push the meeting tube in and down to seat it on the lower end fitting.

10. Push the plastic tube retainer in to hold the tube in position.

Before installing the front shield, you may wish to clean the inside surface. If necessary, use a commercial glass cleaner or mild soap and water solution to clean it. DO NOT ATTEMPT TO CLEAN THE SHIELD WITH A DRY CLOTH, AS THIS MAY SCRATCH THE SURFACE.

11. Install the front shield on the meter and secure with four screws tightened to 35 inch/pounds.

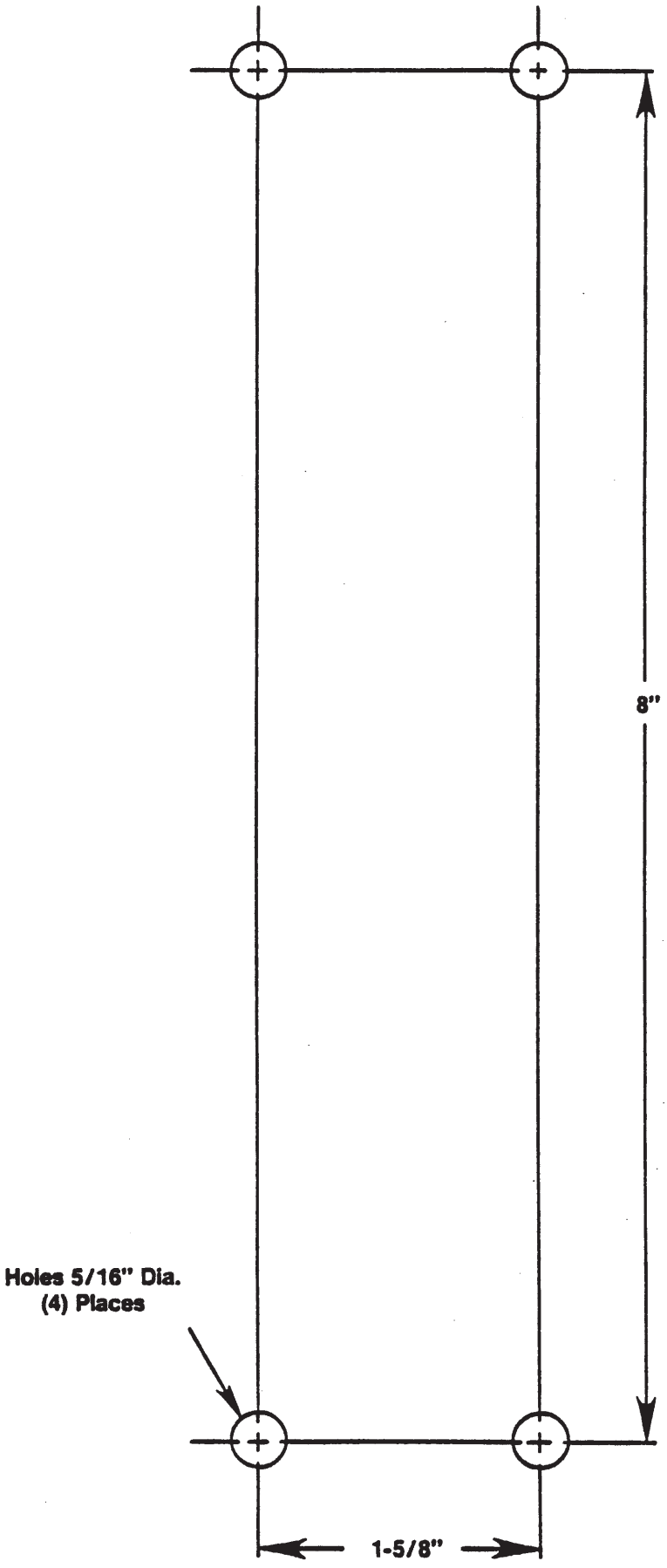


Figure 2-3. Drill Template for Front Panel Mounting (Full Scale)

WARNING

Glass metering tubes are designed for operation up to the maximum operating pressures and temperatures as specified. Due to the inherent brittle characteristics of glass, tube breakage could result below specified operating conditions. Possible glass tube breakage presents a potential hazard to operating personnel, therefore, operator protection should be supplied where operating pressures may exceed 50 psig. A customer supplied safety shield constructed of 1/2 inch acrylic plastic may be used or the glass tube meter may be replaced with an all metal (armored) meter.

3.1 PRE-OPERATIONAL CHECK

Prior to initial start-up and each time the flowmeter is reassembled, the zero alignment should be checked. If the zero line on the tube is aligned with the zero line on the scale, the flowmeter is ready for operation. If the zero lines are not aligned, loosen the screws securing the scale and move it until the marks are in alignment. Then tighten the screws.

3.2 OPERATING PROCEDURE

CAUTION

When initiating flow through the flowmeter, insure that the process flows begins slowly and evenly, without pressure surges. Surges may drive the float against the outlet float stop, resulting in damage to the tube or float.

To initiate flow through a flowmeter using bypass piping, refer to Figure 2-1

1. Close flowmeter isolation valves (A) and (B).

2. Fully open bypass valve (C) and slightly open control valve (D).

3. Initiate process flow. When flow has stabilized, fully open isolation valve (B), then slowly open isolation valve (C).

4 Close bypass valve (C).

5. Regulate process flow using control valve (D).

6. If meter is left in bypass configuration, open drain valve (E) to prevent tube damage caused by thermal expansion of the process liquid.

CAUTION

Failure to drain the flowmeter when isolated in a bypass loop may result in tube breakage caused by thermal expansion of the process liquid.

SECTION 4 MAINTENANCE

The following procedure may be used for cleaning the tube, float and end fittings.

1. Remove the four screws securing the float shield to the meter, then remove the front shield.

2. Slide out the plastic tube retainer holding the tube in position, to the limit of its trav-
e l
Do not remove the two screws securing it.

When removing the metering tube from the upper fitting in the following step, do not pull out to far or with too much force on the tube, or you may break it. Do not allow the float to fall out of the metering tube. A damaged float will affect the accuracy of the meter. Hold the inlet (lower) float stop in position with a finger when removing the tube.

3. Slide the metering tube up behind the plastic tube retainer until it clears the lower end fitting. When the tube is clear of the end fitting, pull on it until you can remove it from the upper end fitting.

4. Remove the outlet float stop, float and inlet float stop from the metering tube.

5. Clean the metering tube, float stops, float end fittings with a suitable solvent.

6. Install the inlet float stop into the metering; hold in position with a finger. Refer to Figure 2-2 for the correct orientation of the float. Slide the float into the metering tube from the outlet end. Replace the outlet float stop in the metering tube.

7. Slide the metering tube onto the upper end fitting. Insure that the plastic tube retainer is pulled all the way out.

8. Push the metering tube in and down to seat it on the lower end fitting.

9. Push the plastic tube retainer all the way in to hold the tube position

Before installing the front shield, you may wish to clean the inside surface. If necessary, use a commercial glass cleaner or mild soap and water to clean it. **DO NOT ATTEMPT TO CLEAN IT WITH A DRY CLOTH, AS THIS MAY SCRATCH THE SURFACE.**

10. Install the front shield on the meter and secure with four screws tightened to 35 inch/pounds.

SECTION 5 SPECIFICATIONS

SCALE:	Arbitrary 10 to 100%, 250 mm length
ACCURACY:	± 2% full scale
REPEATABILITY:	± 0.5% full scale
TEMP. RATING:	200°F for liquid, 250°F for gas
END FITTINGS:	Brass std; 316 SS optional
GLASS TUBE:	Borosilicate glass
FLOAT STOPS:	316 stainless steel spring wire
FLOATS:	Glass for FL1651, 316 SS all others
O-RINGS:	Viton std; Buna N optional
HOUSING:	Die cast aluminum alloy 380, not wetted
TUBE RETAINER:	ABS, not wetted
THREADED FASTENERS:	18-8 stainless steel, not wetted
SHIELD:	Polycarbonate, not wetted
CONNECTION:	3/4" FNPT, Horizontal
WEIGHT:	8.0 lbs; 3.63 kg.
DIMENSIONS:	4.25"W, 3.5"D, 19"H, 17.5" centerline port-to-port

TABLE 5-1
CAPACITIES

			Maximum Flow Rates						
			Liquid			Visc.	Gas		
Model No.	Tube Number	Float Number	gpm	lpm	Press. Drop Inches W.C.	Immunity Ceilings, Cs.**	scfm	slpm	Press. Drop Inches W.C.
FL1651	R-7M-25-1F	Glass	0.17	0.64	1	***	0.93	26.24	2
FL1652		Stainless Steel	0.37	1.40	3	***	1.64	46.54	4
FL1653	R-8M-25-4F	8-RV-3	0.78	2.95	3	2.0	3.17	89.77	3
FL1654		8-RV-8	1.09	4.13	5	3.7	4.45	126.02	5
FL1655		8-RS-14	1.83	6.93	10	1.9	7.56	214.10	11
FL1656		8-RV-31*	2.06	7.80	16	7.0	8.32	235.62	17
FL1657	R-9M-25-3F	9-RV-87*	3.92	14.84	14	17.0	16.25	460.20	16
FL1658		9-RS-87*	5.12	19.38	18	3.5	21.20	600.38	19
FL1659	R-10M-25-3F	10-RV-138*	8.84	33.46	23	23.0	36.10	1022.35	26
FL1660		10-RS-138*	10.93	41.37	30	5.5	45.90	1299.89	35
FL1661		10-LJ-238*	23.10	87.43	103	***	105.70	2993.42	135

* These floats are not recommended for gas service unless operating pressure (downstream) exceeds 30 PSI.
** Viscosity immunity ceilings listed are for stainless steel floats only and fluid Sp. Gr. 1.0. For other fluid gravities, and use this value when comparing with values in table.
*** These floats are very sensitive to viscosity changes and do not offer any immunity to viscosity changes.

NOTE: All air flows are at 14.7 PSIA and 70°F.

TABLE 5-2
RECOMMENDED WORKING PRESSURE RATINGS

Model No.	Maximum Working Pressure (PSIG) up to 200° F All Applications	Pressure Reduction Above 200° F PSI/°F	Maximum Working Pressure (PSIG) up to 250° F Gas Applications
FL1651,1652	350	0.75	312.5
FL1653-6	300	0.75	262.5
FL1657,1658	240	0.60	210.0
FL1659,60,61	200	0.45	177.5

TABLE 5-3
SIZING FORMULAS

GAS (316 SS Float)

$$\sqrt{\frac{36 \times \text{O.P.A.}}{\text{S.G. X (O.T. + 460)}}} = \text{C.F.}$$

$$\frac{\text{Cust. Flow}}{\text{C.F.}} = \text{Air @ STP}$$

Book Range x C.F. = Customer's Scale Range

Additional Correction For Floats other than 316 SS

$$\sqrt{\frac{\text{Flt. Matl. S.G.*}}{8.04}} = \text{Flt. Matl. C.F.}$$

Air @ STP
Book Range x C.F. x Flt. Matl. C.F. = Customer's Scale Range

For PPH Flow

$$\frac{\text{Cust. Flow in PPH}}{\text{4.5 x S.G. x C.F.}} = \text{Air @ STP}$$

Book Range x 4.5 x S.G. x C.F. (x Flt. Matl. C.F.) = Cust. Scale Range in PPH

For ACFM Flow

$$\frac{\text{ACFM Cust. Flow x O.P.A. x 530}}{\text{C.F. x 14.7 x (O.T. + 460)}} = \text{SCFM Air @ STP}$$

$$\frac{\text{SCFM Air @ STP Book Range x 14.7 x (O.T. + 460) x C.F.}}{\text{O.P.A. x 530}} = \text{Cust. Scale Range in ACFM}$$

LIQUID (316 SS Flt. and little or no viscosity)

$$\sqrt{\frac{8.04 - \text{Sp. Gr.}}{7.04 \times \text{Sp. Gr.}}} = \text{C.F.}$$

$$\frac{\text{Cust. Flow}}{\text{C.F.}} = \text{Water}$$

Book Range x C.F. (Water) = Customer's Scale Range

Additional Correction For Floats other than 316 SS

$$\sqrt{\frac{\text{Flt. Matl. Sp. Gr.*-Liq. Sp. Gr.}}{7.04 \times \text{Liq. Sp. Gr.}}} = \text{Flt. Matl. C.F.}$$

Water
Book Range x C.F. x Flt. Matl. C.F. = Customer's Scale Range

For PPH Flow

$$\frac{\text{Cust. Flow in PPH x C.F.}}{\text{Sp. Gr. x 8.34 x 60}} = \text{GPM Water}$$

$$\frac{\text{Bk. Range x 8.34 x Sp. Gr. x 60 (x Flt. Matl. C.F.)}}{\text{C.F.}} = \text{Cust. Scale Range in PPH}$$

GLOSSARY

O.P.A. = Operating Back Pressure in psia

Psia = psig + 14.7

C.F. = Correction Factor

O.T. = Operating Temperature in degrees Fahrenheit

S.G. = Specific Gravity (Gases) @ 70° F & 14.7 psia (STP)

Sp. Gr. = Specific Gravity (Liquids)

Book Range = Range from Table 1

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 which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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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.

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