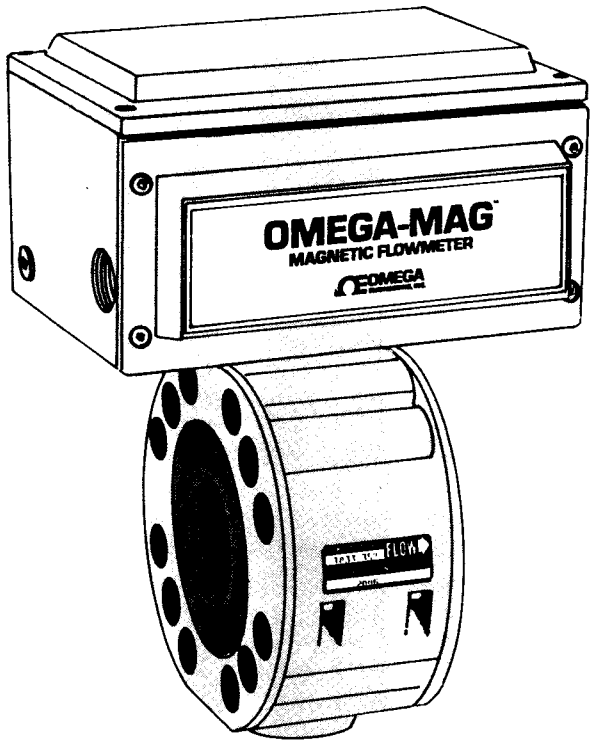
# FMG-700 Series

## Magnetic Flowmeters




OMEGA®

*An OMEGA Technologies Company*

## Operator's Manual

FMG-700 SERIES
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SECTION PAGE

CAUTION: THIS EQUIPMENT GENERATES, USES AND CAN RADIATE RADIO FREQUENCY ENERGY AND IF NOT INSTALLED AND USED IN ACCORDANCE WITH THIS INSTRUCTION MANUAL, MAY CAUSE INTERFERENCE TO RADIO COMMUNICATIONS. IT HAS BEEN TESTED AND FOUND TO COMPLY WITH THE LIMITS FOR A CLASS "A" COMPUTING DEVICE PURSUANT TO SUBPART J OF PART 15 OF THE FCC RULES, WHICH ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST SUCH INTERFERENCE WHEN OPERATED IN A COMMERCIAL ENVIRONMENT. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE INTERFERENCE IN WHICH CASE, THE USER, AT HIS OWN EXPENSE, WILL BE REQUIRED TO CORRECT THE INTERFERENCE.

Caution: MOS components such as the CMOS logic used in this unit are subject to damage by excessive levels of voltage and/or current, just as are more convential semiconductor components such as bipolar transistors and TTL logic. However, the precautions normally used to protect semiconductors are not sufficient for the protection of MOS components. Because of the very high electrical resistance of MOS components, they are susceptible to damage by electrical sources that cannot deliver enough energy to damage convential semiconductors. The energy source that most commonly destroys MOS components is the human body, that, in conjunction with nonconductive garments and floor coverings generates and retains static electricity.

These precautions must be followed specifically.

1. De-energize or disconnect all power, signal sources and loads used with the unit.
2. Place the unit on a grounded conductive work surface or make certain that it and everything that may contact it is brought to ground potential.
3. Ground the operator to the unit through a conductive wrist strap, or other device using a 1 megohm series resistor to protect the operator.
4. When a printed circuit board is not installed in a unit it should be stored in a conductive anti-static bag, do not use untreated "regular" plastic bags.

## SECTION 1 INTRODUCTION

### 1-1 Purpose

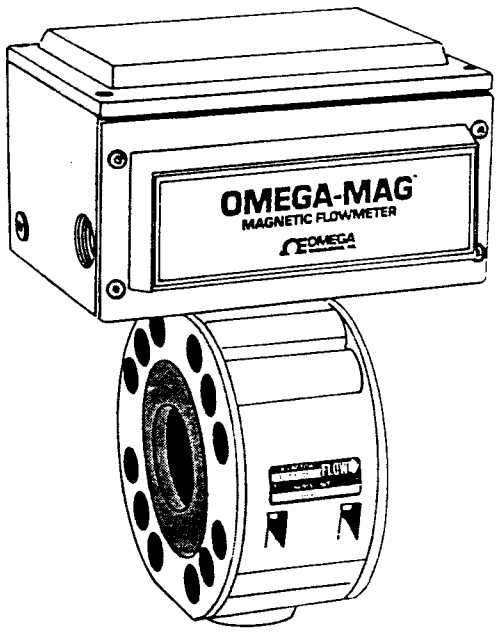
This instruction manual is intended to provide the user with all information necessary to install, operate and maintain the FMG-700 Series. The manual is organized into seven sections:

Section 1 Introduction, Specifications
Section 2 — Installation
Section 3 — Operation
Section 4 — Maintenance
Section 5 — Troubleshooting and Repair
Section 6 — Calibration including Calibrator
Section 7 — Parts List

NOTE: It is recommended that this manual be read in its entirety before attempting to install, operate or repair the flowmeter.

### 1-2 Description

The FMG-700 Series Flowmeter is a solid state, obstruction-less, flow rate measuring device, capable of measuring a wide range of clear or slurried conductive liquids. The meter is composed of two parts; a flow transmitter and a signal conditioner, called a flowhead and electronics,as shown in Figure 1-1. The integral electronics are mounted in a cast aluminum enclosure, providing weatherproof (NEMA 4X), corrosion resistant protection. The electronics mounting is suitable for locations classified as Class I, Division 2, Groups A, B, C, D; Class II, Division I, Groups E, F, G; Class III.



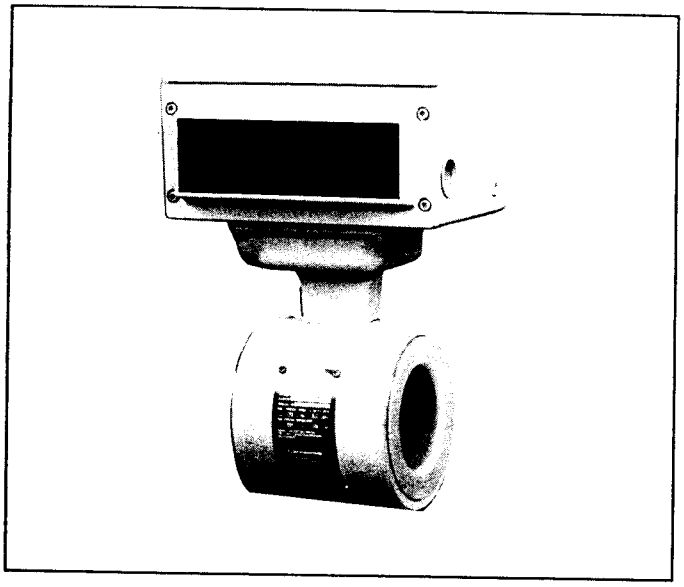


**Figure 1-1 Flow Meter and Integral Electronics**

## 1-3 Principle of Operation

Magnetic flowmeters can only be used to measure the flow of conductive liquids. Operation of a magnetic flowmeter is explained by Faraday's Law, which simply states "the voltage induced across any conductor as it moves at right angles through a magnetic field is proportional to the velocity of that conductor". In a magnetic flowmeter the measured liquid is the conductor.

Faraday's Formula:

E is proportional to V x B x D
Where:

- E = The voltage that is generated by the flow of conductive liquid through the magnetic field of the flowmeter.
- V = The average velocity of the liquid through the cross section of the flow tube in the flowhead.
- B = The strength of the magnetic field generated by the field coils.
- D = The distance between the electrodes which detect the signal voltage (E) that is generated.

As illustrated in Figure 1-2, a magnetic field is constructed throughout the entire cross section of the flow tube. If this magnetic field is considered as the measuring element of the magnetic flowmeter, it may be seen that the measuring element is exposed to the liquid to be measured throughout the entire cross section of the flowmeter.

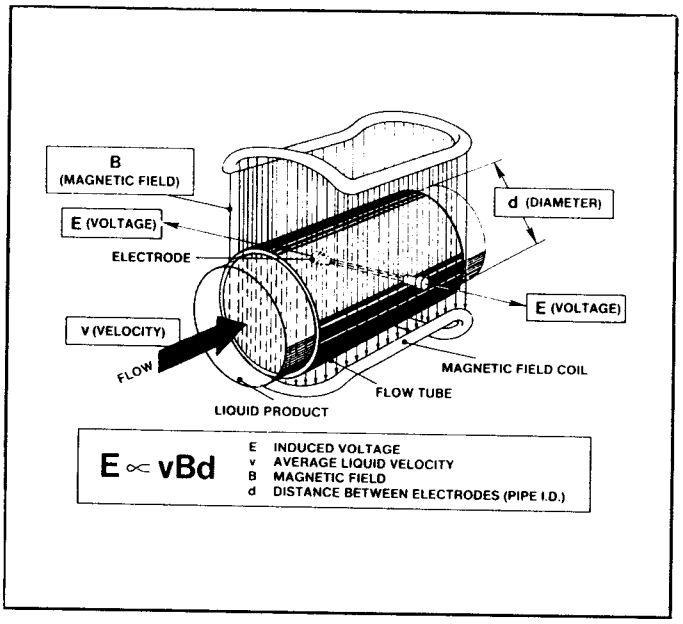



**Figure 1-2 Principle of Operation**

## 1-4 Specifications

**Caution: Do not operate this instrument in excess of specifications listed below.**

CAPACITIES
Meter Range: 1 to 10 meters/second or 1 to 10 feet/-second, jumper selectable with no special calibration required. (Refer to Table 1-1.)

ACCURACY
System ±0.5% of the rate from 1 unit per second to 10 units per second. (1 unit = 1 foot or meter.) ±0.005 units per second below 1 unit per second.

REPEATABILITY
0.25% of rate

PRESSURE LIMITS
740 PSIG @ 100°F (40°C) Tefzel & Teflon Tubes.
285 PSIG @ 100°F (40°C) Ryton Tubes.

TEMPERATURE
Ambient: 0 to 149°F (-18 to 65°C)
Process: Refer to Table 1-3.

POWER REQUIREMENTS
Selectable by jumper plug - 115 Vac or 230 Vac ±15% 47-63 Hz; 10-30 Vdc

POWER CONSUMPTION
15 watts maximum

INPUT SIGNALS
Input Signal Level to Electronics: 2.828 mV, peak to peak at 12 meters/second.

OUTPUT SIGNALS
The FMG-700 Series will supply a spannable analog output with or without the factor option board. Equipped with the factor option board, the analog output is set by four digital range switches.

As received from the factory, the meters outputs will be set as follows: frequency output of 2 kHz = 2 meters per second and an analog output of 20 mA dc = 10 meters per second.

Digital: Open collector 0.125 Amps (integral), 30 Vdc or 5 Vdc TTL compatible pulse, 0-10 kHz proportional to flow, may be factored into engineering units, jumper selected (J6 on power supply board). J6 installed = TTL output; J6 not installed = open collector.

Analog: 4-20 mA dc, 0-16 mA dc or 0-20 mA dc, potentiometer adjustable for maximum output at any flow rate between 1 ft/sec and 10m/sec.

**OUTPUT LOAD:** (load=supply Vdc - 4Vdc x 50)
0-800 OHMS for units powered by ac or 20Vdc.
0-350 OHMS at 10Vdc input
0-1000 OHMS at 24Vdc input
Reduce load by 50 OHMS per volt when dc is less than 20 volts.

**OUTPUT OVER RANGE:** 120% without fold over or latch-up.

Factor Option Board: Used to range the analog and digital outputs. The analog factor range is 1.000 to 15.000. The digital factor range is 1.000 to 150,000.

**GALVANIC ISOLATION:** Electrode inputs are isolated from power and analog/digital outputs. DC powered units are "3-wire devices". The analog/digital outputs and DC power are not galvanically isolated from each other. But are de-coupled by diodes to eliminate ground loops.

**LOW-FLO CUT-OFF:** Set to cut-off output at or below 2.3% of analog span.

PZR (Positive Zero Return): Drives the output from the electronics to 0 Hz frequency and 4 mA dc upon a dry contact closure. The dry contact closure is provided by others and can be activated by a pump or valve control switch. It should be used to prevent an erratic output whenever process control results in the flowhead becoming empty. If the flowhead does not empty during operation the use of this option should not be necessary.

MATERIALS OF CONSTRUCTION
Metering Tube
.15" and .3": Ryton
1/2"-4": Cast 303 Stainless Steel
6"-8" — A-312, Type 304 Stainless Steel
Metering Tube Liner
.15" and .3": Ryton
1/2"-8": Tefzel, Std. (Teflon optional)
Coil Housing
.15" thru 8": Steel

CONNECTIONS
Standard Mechanical — Code "W" Universal for hook-up to 150 or 300 lb. ANSI flanges.

Integral Electronics -
Two 3/4" NPT conduit connection

DIMENSIONS
Refer to Figure 1-3

**Velocity to Flow Conversion Factors**

Table 1-1 provides approximate flow conversion factors for the flowmeter. Actual values are based on the individual meter K-factor for each flow tube which will vary slightly among meters of the same size. The K-factor for a particular flow tube is stamped on a stainless steel tag permanently affixed to the outside of the flow tube coil housing. Approximate Q. max. values are listed in Table 1-1.

Maximum Flow Capacity: (Q. max) in GPM.

$$\text{Q. Max} = \frac{600{,}000}{\text{K-Factor}}$$

**Table 1-1 Capacity Table: Velocity-to-Flow Conversion Factors .15 to 8"** (All values are approximate — actual values will depend on flow tube K-factor)

| Meter Size | | Flow in GPM Units = Feet | | | | | | Flow in GPM Units = Meters | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.000 ft/sec | | 10.00 ft/sec | | Low Flow (2) Cut-off | | 1.000 m/sec | | 10.000 m/sec | | Low Flow (2) Cut-off | | Guideline Flow 6 ft/sec | |
| INCHES | MM | GPM | LPM | GMP | LPM | GPM | LPM | GPM | LPM | GPM | LPM | GPM | LPM | GPM | LPM |
| .15 (1) | 4 | .055 | .21 | .55 | 2.1 | .001 | .004 | .18 | .68 | 1.8 | 6.8 | .004 | .02 | .33 | 1.3 |
| .3 | 8 | .22 | .83 | 2.2 | 8.3 | .005 | .02 | .72 | 2.7 | 7.2 | 27 | .02 | .06 | 1.3 | 4.9 |
| 1/2" | 15 | .86 | 3.3 | 8.6 | 33 | .02 | .08 | 2.8 | 10.6 | 28 | 106 | .06 | .23 | 5 | 19 |
| 1 | 25 | 2.3 | 8.7 | 23 | 87 | .05 | .20 | 7 | 28 | 75 | 284 | .16 | .6 | 14 | 53 |
| 1-1/2" | 40 | 5.5 | 21 | 55 | 208 | .13 | .48 | 18 | 68 | 180 | 681 | .41 | 1.6 | 36 | 136 |
| 2 | 50 | 9.1 | 34 | 91 | 344 | .21 | .79 | 30 | 113 | 300 | 1136 | .69 | 2.6 | 55 | 208 |
| 3 | 80 | 21 | 80 | 213 | 806 | .48 | 1.8 | 70 | 265 | 700 | 2650 | 1.6 | 6 | 128 | 485 |
| 4 | 100 | 37 | 138 | 365 | 1382 | .85 | 3.2 | 120 | 454 | 1200 | 4542 | 2.8 | 10 | 220 | 833 |
| 6 | 150 | 83 | 314 | 830 | 3142 | 1.9 | 7.2 | 270 | 1022 | 2700 | 10220 | 6.2 | 24 | 495 | 1874 |
| 8 | 200 | 152 | 575 | 1520 | 5753 | 3.5 | 13 | 500 | 1893 | 5000 | 18925 | 11.5 | 44 | 915 | 3463 |

**(1) THESE METER SIZES ARE ONLY OFFERED WITH RYTON™ FLOW TUBES, MAXIMUM PRESSURE 285 PSIG at 100°F (40°C)**

**(2) LOW FLOW CUTOFF IS 2.3% OF THE SELECTED ANALOG SETTING ADJUSTABLE FROM 23Hz AS LISTED IN THE ABOVE TABLE THRU 230Hz at THE MAXIMUM FULL SCALE ANALOG SETTING AT 10 FT OR 10M PER SEC.**

**Table 1-2 Conversion Factors**

To Convert $Q = \frac{600{,}000}{\text{K-Factor}}$ into GPM:

| From GPM To | Multiply GPM by |
|---|---|
| CF/Sec. | $2.228 \times 10^{-3}$ |
| CF/Min | $1.337 \times 10^{-3}$ |
| CF/Hr. | 8.021 |
| CF/D | $192.5 = 1.952 \times 10^{-3}$ |
| Imp. Gal/Min. | $0.83267 = 8.3267 \times 10^{-1}$ |
| $CM^3$/Min. | $3.785 \times 10^{-3}$ |
| Liter/Sec | $6.308 \times 10^{-2}$ |
| Liter/Min | 3.785 |
| $M^3$/HR | $2.2771 \times 10^{-1}$ |
| $M^3$/D | 5.4505 |

Example — find Q. max. expressed in liters/sec:

K-Factor = 19,355 pulse/gal

$$Q = \frac{600{,}000 \text{ pulses/min}}{19{,}355 \text{ pulses/gal}} = 30.999 \text{ GPM}$$

$$\frac{30.999 \text{ gal}}{\text{min}} \times 6.308 \times 10^{-2} = 1.955 \text{ liters/sec.}$$

**Table 1-3 Maximum Working Pressures and Temperatures**

| Materials (Liner) | Characteristics (Liner) | Available in Meter Sizes | Pressure psig (kPa) 150/300 lb. Flanges | | | Maximum Allowable Liquid Temperature (1) |
|---|---|---|---|---|---|---|
| | | | 0-100°F (40°C) | 200°F(93°C) | 300°F(149°C) | |
| Tefzel | Chemical Resistant | 1/2 through 8 inch | 740 psig 5202 kPa | 675 psig 4745 kPa | 655 psig 4605 kPa | 300°F (149°C) |
| Teflon | 3A Food Services | 1/2 through 6 inch | 740 psig 5202 kPa | 675 psig 4745 kPa | 655 psig 4605 kPa | 300°F (149°C) |
| Ryton | Fractional Sizes | .15 and .30 inch | 285 psig 2004 kPa | 185 psig 1300 kPa | Not Applicable | 200°F (93°C) |

Note (1): Temperature limits may vary depending on liquid being metered.

**CAUTION: The flowhead may be installed between 300lb ANSI and DIN ND 25 and 40 flanges. The maximum allowable working pressure must be limited to 740 psig at 100°F for Tefzel and Teflon, and 285 PSIG at 100°F for Ryton.**

**Table 1-4 Dimensions (Meter Sizes .15"-8") with Integral Electronics**

| Meter Size | | Flange Size | | A | | B | | C | | D | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inch | mm | Inch | mm | Inch | mm | Inch | mm | Inch | mm | Inch | mm |
| .15 | 4 | 1/2 | 15 | 8-11/16 | 221 | 10-1/8 | 257 | 3-9/16 | 90 | 2-1/8 | 54 |
| .30 | 8 | | | | | | | | | | |
| 1/2 | 15 | | | | | | | | | | |
| 1 | 25 | 1 | 25 | 9 | 229 | 10-3/4 | 273 | 4-1/2 | 114 | 2-1/8 | 54 |
| 1-1/2 | 40 | 1-1/2 | 40 | 9 | 229 | 10-1/2 | 267 | 3-1/4 | 83 | 2-3/4 | 70 |
| 2 | 50 | 2 | 50 | 9-5/16 | 237 | 11-1/8 | 283 | 3-7/8 | 98 | 3-1/4 | 83 |
| 3 | 76 | 3 | 76 | 9-15/16 | 252 | 12-1/2 | 318 | 5-1/8 | 130 | 4-11/16 | 119 |
| 4 | 102 | 4 | 102 | 10-5/8 | 270 | 13-7/8 | 352 | 6-1/2 | 165 | 5-7/8 | 149 |
| 6 | 152 | 6 | 152 | 11-11/16 | 297 | 15-13/16 | 402 | 8-9/16 | 218 | 6-7/8 | 175 |
| 8 | 203 | 8 | 203 | 12-3/4 | 324 | 18 | 457 | 10-11/16 | 272 | 8-7/8 | 225 |

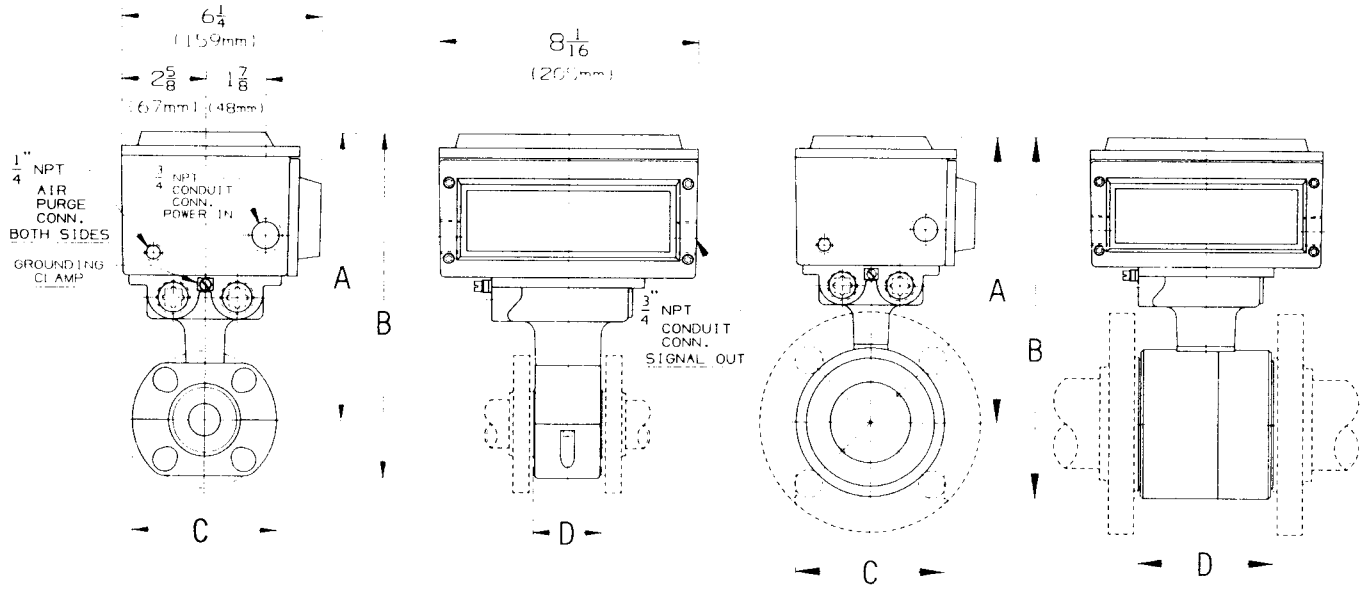



**Figure 1-3. Dimensions — Meter Sizes .15" through 8" with Integral Electronics**

## SECTION 2 INSTALLATION

### 2-1 General

This section contains the procedures for the receipt and installation of the FMG-700 Series.

### 2-2 Receipt of Equipment

When the equipment is received, the outside of the packing case should be checked for any damage incurred during shipment. If the packing case is damaged the local carrier should be notified at once regarding his liability.

Remove the envelope containing the packing list. Carefully remove the equipment from the packing case. Make sure that spare or replacement parts are not discarded with the packing material. Inspect for damaged or missing parts.

Refer to the packing list for information as to what is supplied for your particular meter. In the event that any items are missing from your shipment, contact OMEGA Customer Service Department at 1-800-622-2378.

### 2-3 Liquid Flow Characteristics

The characteristics of the fluid to be metered, and the environment of the meter are determining factors in the accuracy of a particular meter.

A. Conductivity — Electrical conductivity is simply a way of expressing the ability of a liquid to conduct electricity. Just as copper wire is a better conductor than steel wire, some liquids are better conductors than others. However, of even greater importance is the fact that, some liquids have little or no conductivity. The conductivity of the metered liquid must be at least 3 micromhos/cm (3 microsiemens/cm) for use with the flowmeter. The conductivity of the liquid can change throughout the process operation as long as it remains above the 3 micromhos/cm threshold.

B. Acids/Caustics — The chemical compositon of the product to be measured must be compatible with the meter liner and electrodes to assure maximum service life from the meter. Refer to a publication such as the Corrosion Engineers etc., to determine the correct liner material for the process liquid. Many process slurries or liquids are designated by a generic name, but may contain other substances which affect its corrosion characteristics; therefore, operating experience is often the best guide in determining the corrosive nature of the product in specific applications. In cases where there is no operating experience, it may be necessary to conduct material compatibility tests.

C. Velocity — The liquid velocity must be in the range of 1.000 to 10.000 m/sec (32.81 ft/sec) for optimum meter operation. The velocity through the meter can be controlled by properly sizing the meter. For optimum accuracy the minimum velocity should be above 1.000 unit per second. (1 foot for electronics set in the feet mode or 1 meter for electronics set in the meters mode).

D. Abrasive Slurries — Abrasive slurries may be handled with this magnetic flowmeter, provided consideration is given to the concentration of the solids in the slurry and their abrasiveness. The abrasiveness of the slurry may affect the service of the flow tube and electrodes. Velocity of the product should be limited to approximately 2 m/sec (6.5 ft/sec) maximum. An ideal slurry installation would have the meter in a vertical position with flow upward. This would ensure a uniform distribution of solids and avoid having the solids settle in the flow tube during no-flow conditions.

   Use of a protective grounding orifice is also recommended to minimize liner wear. See Section 2-8 "Grounding" for further details.

E. Sludge and Grease Bearing Liquids — Sludges and grease bearing liquids should be measured at higher velocities, above 2 m/sec (6.5 ft/sec) minimum in order to reduce the coating tendencies of the material. For a quick reference refer to Table 1-1 and the guide line number.

F. Temperature—Liquid temperature is generally not a problem provided it is within the flow tube liner limits, refer to Table 1-3.

### 2-4 General Installation Information

Prior to installing the flowmeter the following installation recommendations should be considered.

A. When installing the flowmeter, it is important to consider its location. Electromagnetic fields of high intensity may disturb the normal operation. For this reason it is desirable to locate the flowmeter away from large electric motors, transformers, communication equipment, etc. wherever possible.

B. The flowmeter should be kept in its shipping container until ready for installation. Shipping plugs should remain in conduit connectors until conduit is connected and sealed.

C. For accurate operation it is mandatory that the flowmeter be installed so the flow tube will be completely full of process liquid under all operating conditions. When the meter is only partially filled, even though the electrodes are covered, an inaccurate measurement will result. Refer to Figures 2-1 and 2-2.

**NOTE: Installation in vertical line with flow up through the meter is preferred to assure that the meter is filled with liquid under all conditions.**

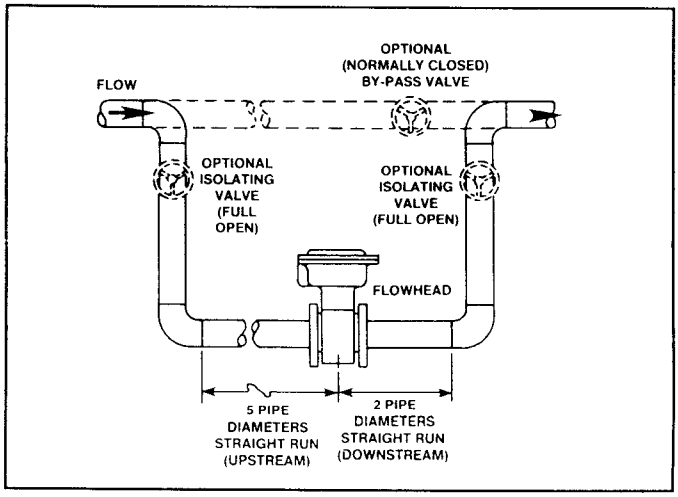



**Figure 2-1 Horizontal Installation Piping**
(Meter shown in Optional Line Drop)

It is desirable that the meter be installed in a vertical pipe run with flow upward. Refer to Figure 2-2. In slurry applications the vertical position ensures a more even distribution of solids under all flow conditions and minimizes the chances of suspended solids adhereing to the flow tube.

D. The position of the flow tube in relation to other devices in the system is also important in assuring system accuracy. Any upstream tee, elbows, valves, etc. should be placed at least 5 pipe diameters from the flowhead to minimize any obstructions or flow disturbances.

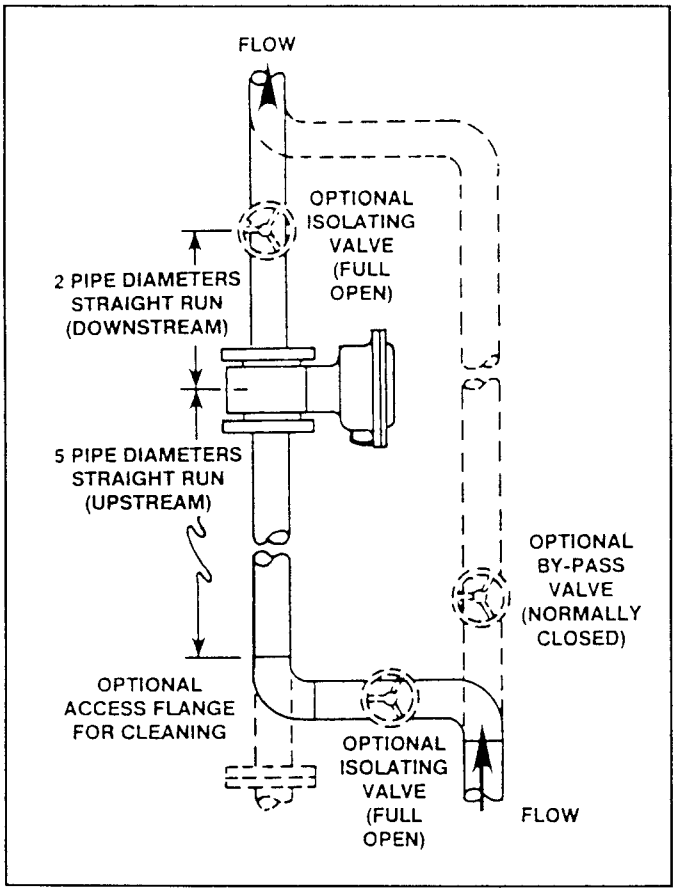



**Figure 2-2 Vertical Installation**

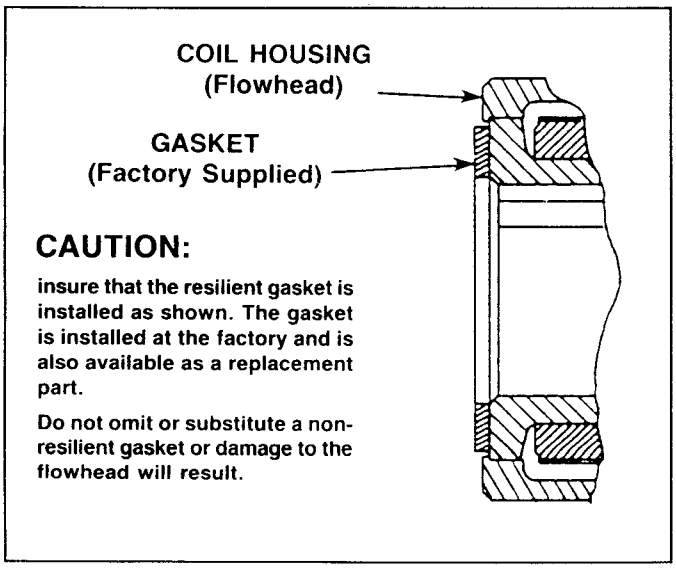



**Figure 2-3 Flowhead Gasket Installation**

## 2-5 Location

When selecting a location remember that the printed circuit boards are field replaceable. Access should be provided to the meter to permit replacement of these parts.

## 2-6 Handling

The flowhead should be lifted either by hand or by a rope sling around the outside of the flowtube.

**Caution: Never pass a cable or beam through the flow tube to lift it. This will result in damage to the flow tube liner which will render the meter unusable. Do not strain the electronics/terminal enclosure when lifting the meter.**

## 2-7 Mechanical Installation

NOTE: The flowmeter should be kept in its shipping container with its conduit opening plugged until installation.

Install the by-pass piping and valves as shown in Figures 2-1 and 2-2.

A. Flowhead Installation .15 and .3 inch Meters

1. Factory applied resilient adhesive backed gaskets are installed on the ends of the flowtube, as shown in Figure 2-3, DO NOT REMOVE THEM.

   **Caution: The factory supplied resilient adhesive backed gaskets must be in place on the ends of the flow tube. Failure to use the factory installed gaskets will result in damage to the meter.**

   NOTE: The factory supplied resilient gaskets are designed to seal the flowtube without subjecting it to the piping loads. All piping loads are to be borne by the flowhead housing.

2. Install the flowhead between the pipe flanges. Align the flowhead with the pipe flanges. Install the factory supplied studs through the pipe flanges and flowhead. Install washers and nuts.

B. Flowhead Installation 1/2" thru 8" Meters

**Caution: Flowtube liners extend over the raised fence of the flanges at each end of the flowhead. Never use spiral-wound metal gaskets as they will cause liner damage. Liner ends must never be used as gaskets. This will cause liner damage. Damage to the liner will render the meter unserviceable.**

**Table 2-1 Gasket Material Selection**

| Flowhead Liner Material | Suggested Gasket Material |
|---|---|
| Tefzel/Teflon | Neoprene or Rubber |
| Ryton | EPR |

The customer must supply gaskets for each flowhead, which should be selected to be compatible with the piping and process conditions. If specific gasket requirements have not been established, refer to Table 2-1 for the suggested gasket type to use with each liner. The gaskets, flowhead flanges, and mating pipe flanges must be thoroughly dusted with gasket talc

powder prior to installation. This is a precaution to prevent flowhead liner damage if the flowhead must be removed from the line.

C. In applications where the meter must routinely be removed from the process piping, grounding rings, protective orifices or spool pieces should be installed on each end of the flowmeter to prevent liner damage.

Install the flowhead in the piping. Forward flow direction is indicated on the coil housing by the flow direction arrow.

NOTE: The flowmeter will measure flow in either direction by changing a jumper in the electronics assembly (J12/13 on the signal conditioner board, J12 = reverse, J13 = forward).

D. Lubricate the flange bolts listed in Table 2-2 with a conductive lubricant. Torque the flange bolts to the values listed in Table 2-3, using a criss-cross pattern to ensure that the flanges are evenly tightened. If leaks occur, re-torque the flange bolts but do not exceed 10% above the values listed in Table 2-3.

E. Ground the flowmeter to a good earth safety ground as recommended by the National Electrical Code. Refer to Section 2-8 for ground suggestions.

F. Refer to Section 2-11 for instructions for electrical connections and the operation of the flowmeter.

## 2-8 Grounding

Grounding is required to eliminate stray current and voltage which may be transmitted through the piping system, the process liquid, or induced by electromagnetic fields in the same area as the flowmeter. Grounding is achieved by connecting the piping system and the flowmeter to a proper earth ground. Grounding straps from each meter flange to the piping mating flange may be used, but are not normally required.

A. In conductive piping systems, the "third wire" safety ground to the power supply and a conductive path between the flowmeter and the piping flanges is normally all that is required.

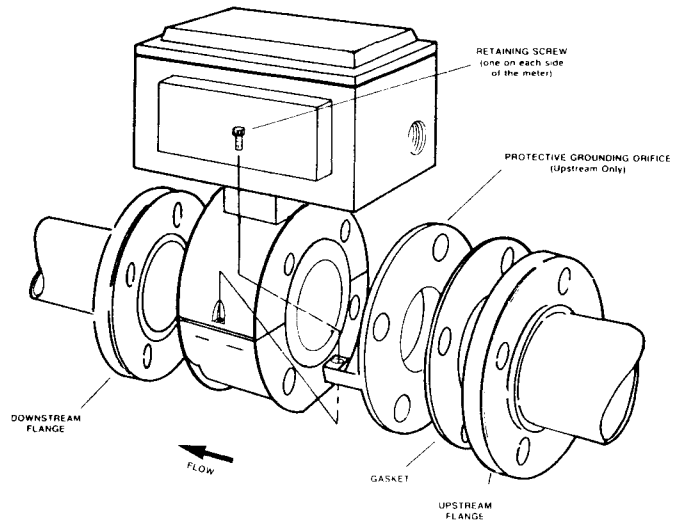
B. In non-conductive, or lined piping systems, at least one grounding ring, or grounding electrode must be supplied to provide a conductive path from the process liquid to the flowmeter.

Grounding rings are flat plate rings which serve two functions; one of which is grounding, the other is liner protection, depending on the application. They are installed as shown in Figure 2-4.

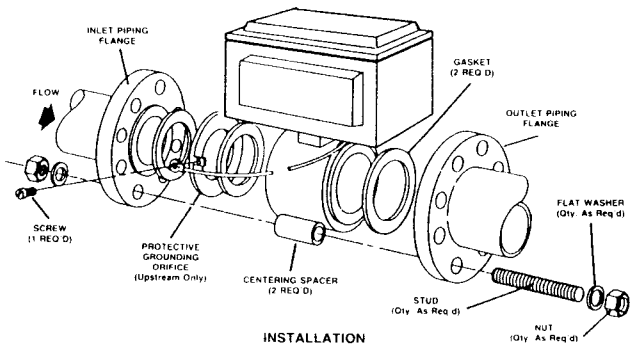
Protective orifices are used in installations where the process liquid is abrasive; the leading edge of the liner is exposed to excessive wear from the slurry impinging against it. To minimize this wear, a protective orifice is placed at the inlet end of the flowtube to cover the face and leading edge of the liner.

Grounding rings are used in installations where the pipeline is lined, or made of a non-conductive material, and it is necessary to provide a ground path to the liquid from the flowtube. This is accomplished by installing at least one grounding ring at the inlet end of the meter. A second grounding ring may also be required at the outlet end of the meter for liner protection. The grounding ring at the inlet of the meter may also function as a protective orifice.

NOTE: .15" and .3" inch Ryton flowtube have the third ground electrode as a standard feature and no additional rings are required.




INSTALLATION
PROTECTIVE GROUNDING ORIFICE
METER SIZES .15 THRU 1 INCH




INSTALLATION
PROTECTIVE GROUNDING ORIFICE
Meter Sizes 1 1/2 Through 8 Inch

INSTALLATION
PROTECTIVE GROUNDING ORIFICE
METER SIZES 1-1/2 THRU 8 INCH

**Figure 2-4 Grounding Ring and Protective Orifice**

**Table 2-2 Flange/Bolt Specifications**

| Flange Size & Rating | | OD (inches) | Bolt Circle Dia. (inches) | No. of Bolts Dia. of "Hole" (inches) | Bolt — Size Length (inches) | Part Number for Stud, Nuts, Washer & Spacer Kits |
|---|---|---|---|---|---|---|
| .15", .30", 1/2" | 150 lb. | 3-1/2 | 2-3/8 | 4 @ 5/8 | 1/2 — 13 x 5" | |
| 1/2" | 300 lb. | 3-3/4 | 2-5/8 | 4 @ 5/8 | 1/2 — 13 x 5" | 159555-033 |
| 1" | 150 lb. | 4-1/4 | 3-1/8 | 4 @ 5/8 | 1/2 — 13 x 5" | |
| 1" | 300 lb. | 4-7/8 | 3-1/2 | 4 @ 3/4 | 5/8 — 11 X 6" | -046 |
| 1-1/2" | 150 lb. | 5 | 3-7/8 | 4 @ 5/8 | 1/2 — 13 x 5-3/4 | -034 |
| 1-1/2" | 300 lb. | 6-1/8 | 4-1/2 | 4 @ 7/8 | 3/4 — 10 x 6-3/4 | -042 |
| 2" | 150 lb. | 6 | 4-3/4 | 4 @ 3/4 | 5/8 — 11 x 7-3/4 | -075 |
| 2" | 300 lb. | 6-1/2 | 5 | 8 @ 3/4 | 5/8 — 11 x 7 | -037 |
| 3" | 150 lb. | 7-1/2 | 6 | 4 @ 3/4 | 5/8 — 11 x 3-3/4 | -078 |
| 3" | 300 lb. | 8-1/4 | 6-5/8 | 8 @ 7/8 | 3/4 — 10 x 9-1/2 | -043 |
| 4" | 150 lb. | 9 | 7-1/2 | 8 @ 3/4 | 5/8 — 11 x 10 | -079 |
| 4" | 300 lb. | 10 | 7-7/8 | 8 @ 7/8 | 3/4 — 10 x 10-3/4 | -044 |
| 6" | 150 lb. | 11 | 9-1/2 | 8 @ 7/8 | 3/4 — 10 x 12 | -059 |
| 6" | 300 lb. | 12-1/2 | 10-5/8 | 12 @ 7/8 | 3/4 — 10 x 12 | -060 |
| 8" | 150 lb. | 13-1/2 | 11-3/4 | 8 @ 7/8 | 3/4 — 10 x 13-1/2 | -065 |
| 8" | 300 lb. | 15 | 13 | 12 @ 1 | 7/8 — 9 x 14-3/4 | -066 |

**Table 2-3 Flange Bolt Suggested Torque Values**

| NORMAL METER SIZE | 150 Lb. Flange Max Press 285 PSI | | 300 Lb. Flange Max Press 740 PSI | |
|---|---|---|---|---|
| | Bolt Dia. | Torque Ft. Lbs. | Bolt Dia. | Torque Ft. Lbs. |
| .15 | 1/2 | 1.5 | N/A | N/A |
| .30 | 1/2 | 1.5 | N/A | N/A |
| 1/2" | 1/2 | 1.5 | 1/2 | 4 |
| 1 | 1/2 | 3 | 5/8 | 10 |
| 1-1/2" | 1/2 | 5 | 3/4 | 20 |
| 2 | 5/8 | 10 | 5/8 | 13 |
| 3 | 5/8 | 21 | 3/4 | 35 |
| 4 | 5/8 | 20 | 3/4 | 60 |
| 6 | 3/4 | 49 | 3/4 | 85 |
| 8 | 3/4 | 83 | 7/8 | 160 |

## 2-9 Electrodes

Abrasion and corrosion must be considered in the selection of electrode material. Three (3) materials are available, Tantalum, 316 Stainless Steel and Platinum. The electrodes in the FMG-700 Series are all non-field replaceable.

Coatings with a resistance of up to $1x10^{12}$ ohms on the electrodes will not normally affect performance, so most installations will not require electrode cleaning options.

## 2-10 Electrostatic Discharge Protection

**Caution: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the installation, removal, or other handling of the internal circuit boards or devices.**

Most modern electronic designs contain electronic circuits which have proven to be highly sensitive to static electricity. These components can be damaged or destroyed by low level static charges (100 volts or less) which cannot be felt; for example, clothing can produce a significant amount of electrostatic discharge. Damaged components, though they appear to function properly at first, are often subject to early failure.

Procedures listed below must be observed during installation, removal, or other handling of printed circuit boards.

A. Printed Circuit Board Replacement

1. Power to the unit must be removed.
2. Personnel must be grounded, by means of a wrist strap or any other safe, suitable method before any printed circuit card or other internal device is installed or removed.
3. Printed circuit boards must be transported in conductive containers. DO NOT use non-conductive plastic bags. Boards must not be removed from the protective enclosure until the immediate time of installation. Any removed boards must immediately be placed in protective containers for storage or transport. Boards protected by conductive bags should be stored on a grounded conductive surface.

B. Adjustments

Should it become necessary to make adjustments, such as changing switch settings or adjusting potentiometers, ESD precautions must also be taken. A wrist strap or other suitable grounding technique must be used as described in the paragraph above.

1. Whenever possible power to the unit should be removed.
2. Since most adjustment tools have non-conductive handles, they are potential sources of static electricity. Additionally, they cannot discharge the metallic parts of the tool. To ensure complete discharge of the tool, both the handle and the metallic surfaces of the tool must be touched before using.
4. Avoid all possible contact with components or printed circuit parts.

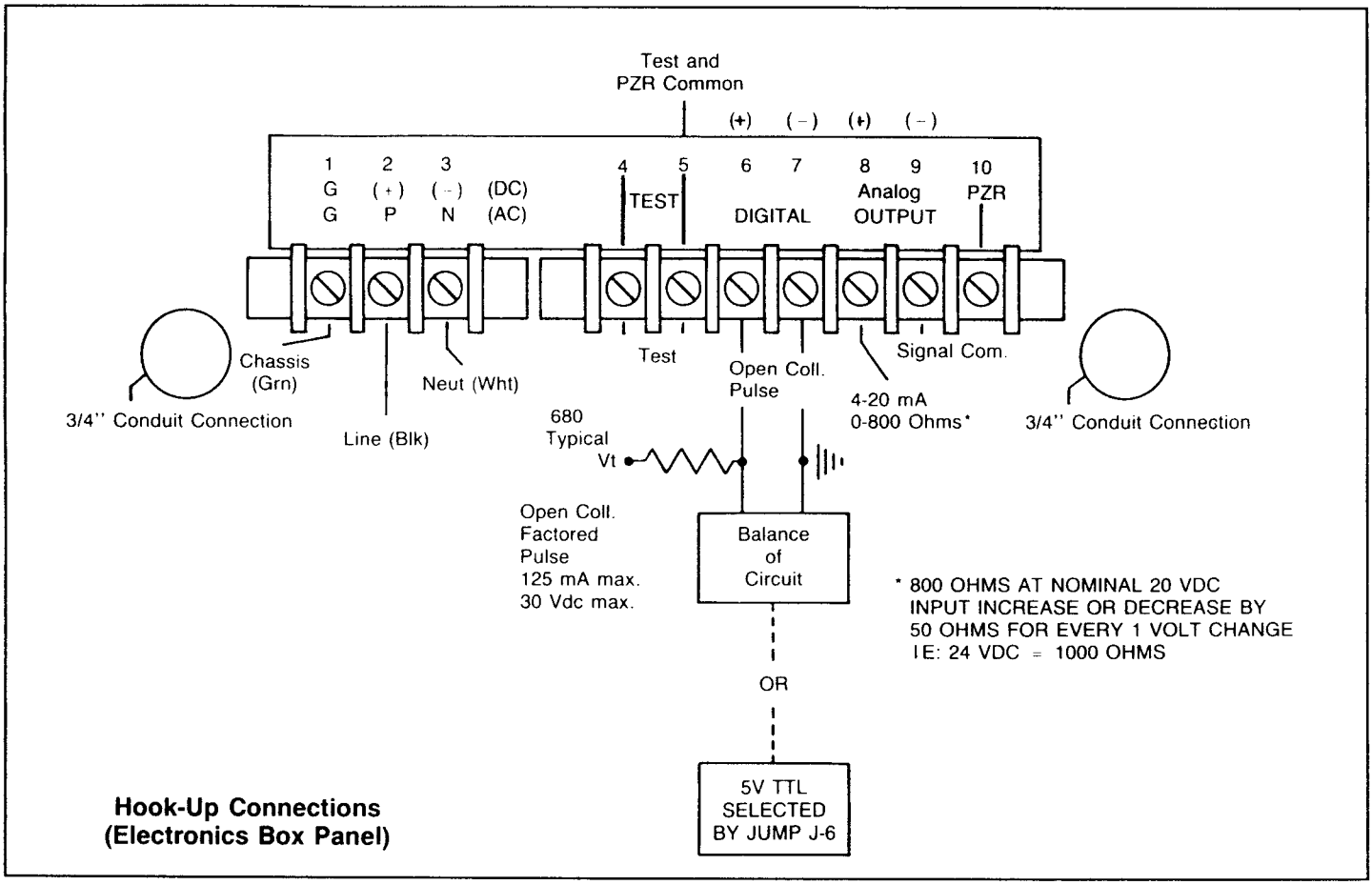



**Figure 2-5 Wiring Diagram**

### 2-11 Electronics Installation

**Caution: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the installation, removal, or other handling of internal circuit boards or devices.**

**Table 2-4 Electronics Terminal Assignment**

| Terminal | Connection | Instructions |
|---|---|---|
| #1 | Safety Ground | Tie to good earth ground. |
| #2<br>#3 | Line (P) or DC (+)<br>Line (N) or DC (-) | Check name plate for the specific line voltage required. |
| #4 | Test and PZR Common | Unpowered contact closure to operate. |
| #5 | Test | Drives meter output to 1 m/sec; 3.281 ft/sec |
| #6 | Digital (+) | +30 Vdc maximum at 0.125 amp maximum sink |
| #7 | Digital Common | ——— |
| #8 | Analog (+) | Use an external load of 0 to 1000 Ohms (see text) |
| #9 | Analog Common | ——— |
| #10 | Positve Zero Return | External contact closure drives output to 0 Hz frequency and 4 mAdc. |

A. The flowmeter should be installed in the process line.

B. The integral electronics should be wired using the wiring diagram adjacent to the terminal block, refer to Table 2-4 and Figure 2-5.

C. Conduit openings should remain plugged until conduit connections are made.

D. Check the setting of the input voltage by reading the voltage stamped on the nameplate and the voltage plug setting, Figure 2-7.

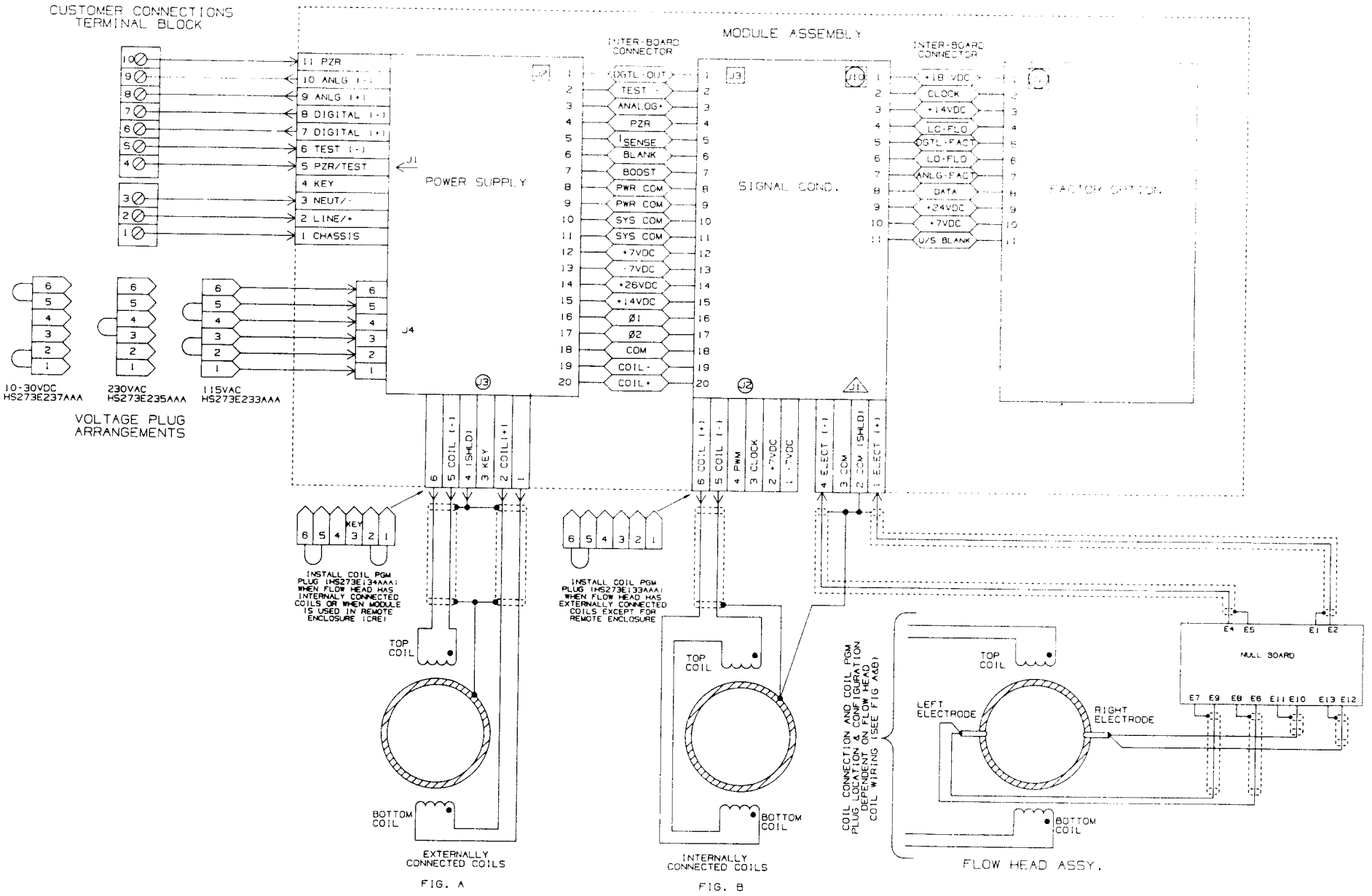



**Figure 2-6 Interconnection Diagram, Integral Electronics**

## 2-12 Start-Up (Commissioning) Adjustments

The FMG-700 magmeter outputs must be adjusted in the field for the desired span per the instructions below. In addition, confirm that the supply voltage indicated on the unit's label matches the power supply you intend to use. If it does not, change the power supply jumpers accordingly (see Fig. 2-7) and change the power supply listed on the magmeter's labels and tags.

The meter, when equipped with a factor option board, supplies both scaled frequency and spanned analog outputs.

The basic output is in two (2) selectable, 1 thru 10 unit per second ranges, selected by jumper J7 located on the signal conditioning board. With jumper J7 in the normal "IN" position, the R-factor is equal to (1 thru 10 meters per second). With jumper J7 in the "OUT" position, the R-factor is equal to 3.281 (1 thru 10 feet per second).

For flow ranges below 1 meter per second, jumper J7 must be removed ("OUT" position). The minimum full scale setting will now equal 1 foot per second. Jumper J7 is normally factory set to the meters per second range (R1).

A. Analog Output

Output terminals 8 and 9 supply a 4 to 20 mAdc output. Switches S6 thru S9 are factory set to provide 20 mAdc at a flow velocity of 2.000 units per second. This can be changed in the field to any setting between 1.000 and 10.000 units per second. To determine the new setting reference the following and Figure 2-8:

$$\text{Analog Factor} = \frac{\text{Desired GPM} \times \text{K-Factor} \times \text{R-Factor}}{60{,}000}$$

New Setting

Example:

2" Meter: K-Factor 2000
Desired analog span for 20 mAdc at 175 gpm

$$\frac{175 \text{ gpm} \times 2000 \text{ pulses/gallon} \times 1 \text{ R-Factor}}{60{,}000} = 5.834$$

New switch setting S6 through S9 = 5.834
Jumper J7 is left in the normal "IN" position

B. Factored Pulse Output

Output terminals 6 and 7 supply a frequency output. This meter is shipped from the factory with switch S1 through S4 set at 1.000 which equals 10 kHz, the maximum Q of the meter. Digital factor range 1.000 to 15.000. Set digital factor into switches S1 through S4 and select proper scaler (divide by) switch setting S5-1 through S5-5 to complete the factoring, refer to Figure 2-8.

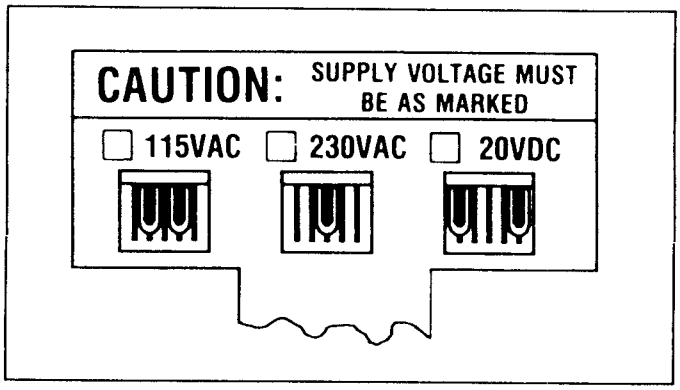



**Figure 2-7 Voltage Programming Plug Settings**

$$\text{Digital Factor} = \frac{\text{K-Factor} \times \text{R-Factor}}{\text{Desired Pulses per Gallon}}$$

Example:

2 inch Meter: K-Factor = 2000
Desired pulse output is one pulse per gallon

$$\frac{K = 2000}{1} = \frac{2000}{1000^*} = 2.000$$

Switch setting S1 thru S4 and Switch S5 set for divide by 1000* (S5-4 ON).

*The divide by 1000 must be used because S1 through S4 can only be set for values one (1) through fifteen (15). Set the digital factor into switches S1 through S4 and select the proper scaler (divide by) switch setting S5-1 through S5-5 to complete the factoring.

C. Maximum Flowhead Capacity (Q max): Varies for each flowhead and course range jumper J7 in/out.

$$Q \text{ max} = \frac{10{,}000 \text{ pulses/second} \times 60 \text{ seconds/minute}}{\text{K-Factor (from meter tag)}}$$

Example:

2 inch Meter: K-Factor = 2000

$$\frac{10{,}000 \text{ pulses/second} \times 60 \text{ seconds/minute}}{2{,}000 \text{ pulses/gallon}} = Q \text{ max}$$

Q max = 300 gallons per minute

D. Verification of Operation

By applying a jumper or simple contact closure across the output terminals 4 and 5 (Test) a test signal is generated. The frequency (digital) output equivalent to 1 m/sec or 1 ft/sec can be taken from output terminals 6 and 7 (integral electronics), terminals 10 and 11 or an equivalent current (analog) output may be taken from terminals 8 and 9 (integral).

To determine the proper current output in the test mode:

$$\left(\frac{1 \times \text{R-Factor}}{\text{Switch Setting S-6 through S-9}}\right) \times 16 + 4 = \text{Current Output}$$

Example
Switch settings S-6 through S-9 = 3.167
R-Factor = 1

$$\left(\frac{1 \times 1}{3.167}\right) \times 16 + 4 = 9.05 \text{ mAdc}$$

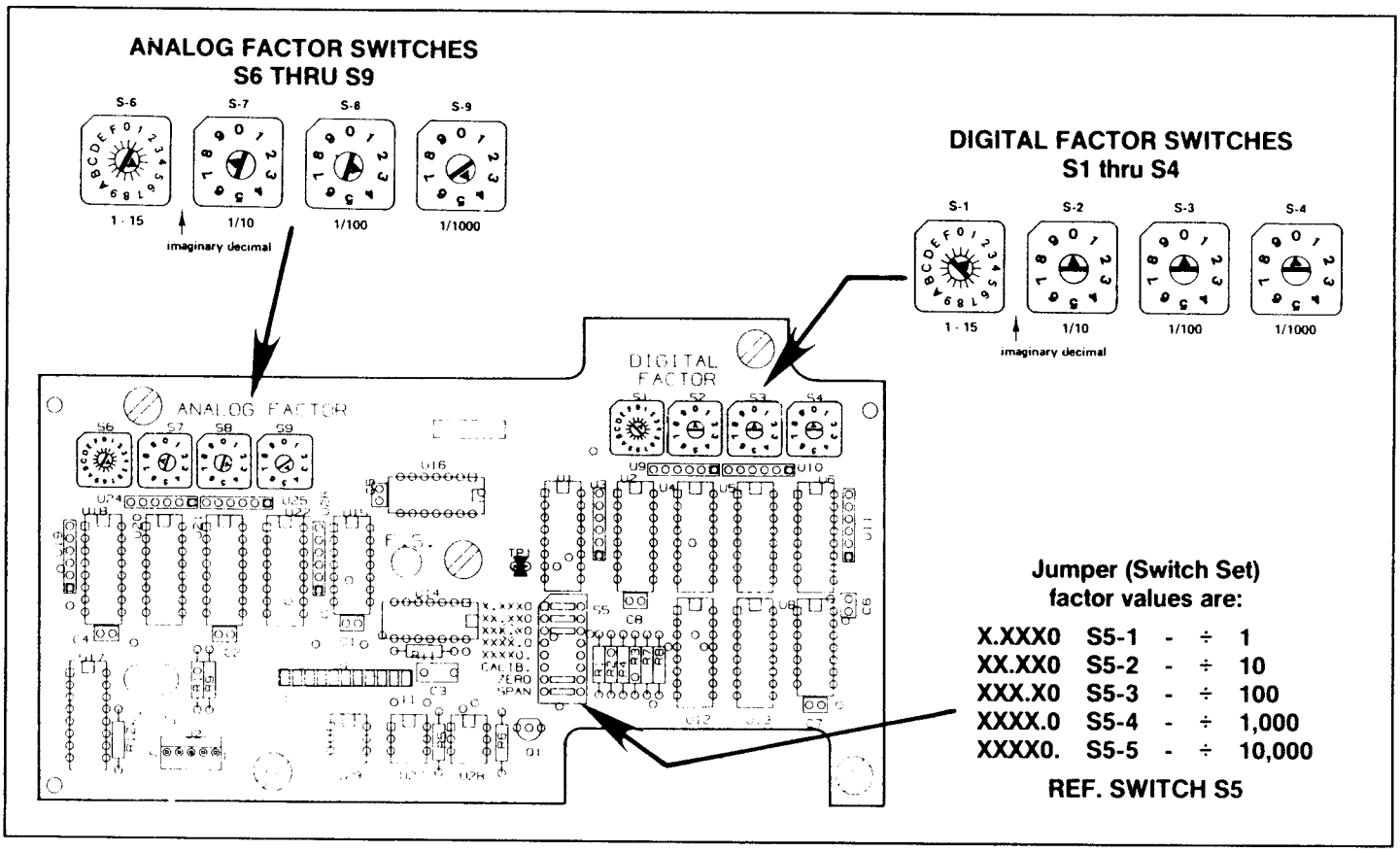



Figure 2-8. Factor Option Board Switches

## Section 3 OPERATION

### 3-1 General

A. Ensure that the meter is installed in the line following the procedures described in Section 2, Installation.

**Caution: The line power supplied to the unit must match the setting of the electronics. This should be checked before powering up the flowmeter. If the power setting of the electronics are incompatible, irreparable damage to the electronics may result.**

B. Power up the electronics and any secondary electronics.

C. Open valves to intitate flow through the meter. The output signal will commence concurrent with the flow through the meter.

## Section 4 MAINTENANCE

### 4-1 General

The flowmeter does not normally require any maintenance other than an occassional verification of its accuracy. If the flowmeter does require repair, please refer to Section 5 Troubleshooting, and Repair for these types of procedures.

## Section 5 TROUBLESHOOTING and REPAIR

**Caution:** The printed circuit boards contain components that can easily be destroyed by static electricity. Refer to Section 2-10 for the necessary handling precautions to use when working on static sensitive devices. Additionally: **POTENTIALLY LETHAL VOLTAGES ARE PRESENT IN THE FLOWMETER,** therefore, when troubleshooting, proper precautions must be taken.

### 5-1 Troubleshooting

This section is provided to facilitate troubleshooting the meter. If trouble occurs, determine the probable cause in an effort to pinpoint the source of the trouble i.e.: if no flow is present. First make sure there is flow through the meter. Troubleshooting the electronics will be limited to replacing defective printed circuit boards.

If the meter is found to be in need of repair, other than stated in this troubleshooting section, it is recommended the user contact OMEGA.

NOTE: It is important that servicing be performed only by trained and qualified service personnel.

During normal troubleshooting procedures caution should be taken to avoid power source connections.

Leakage: Presence of process liquid around the base of the meter or at the flange surface may be an indication of a leak caused by improper mounting or a damaged liner. Inspect the meter thoroughly and retorque the flange bolts to insure a proper seal. If the flowtube liner is found to be damaged in any way, consult OMEGA.

1. Remove the terminal cover of the integral electronics enclosure.
2. With no power applied, check the jumper positions for the voltage selected on the power board. (Fig. 2-7). Apply power and check for correct line voltage at terminals 2 and 3 on the customer connection terminal strip. (Fig. 2-5).
3. Check meter analog output on terminals 8 and 9 with flow through meter. If output is erratic ensure that flow tube is completely full of process liquid.
4. Refer to Table 5-1 and perform the remainder of the electronics troubleshooting.

**Table 5-1 Troubleshooting Test Points**

| Com ( - ) | Test | Digital Multi-Meter | Scope |
|---|---|---|---|
| TP8 | TP1 | OV ± 4 Vdc | ac signal proportional to flow 28 mV P-P @ 12m/sec |
| TP8 | R41 | + .45 ± .05 Vdc | See note Figure 5-1 Troubleshooting Test Points — Signal Conditioning Board |
| TP8 | TP3 | — | ac square wave signal amplitude proportional to flow 8.4 Vac P-P @ 12 m/sec signal centered about common |
| TP8 | TP4 | 0 to + 4.2 Vdc proportional to flow | A negative voltage indicates reversed wiring, swap coil leads |
| TP8 | TP5 | — | Triangle wave, rise time proportional to flow |
| TP8 | TP6 | — | ± 7 Vdc Pulsating signal synchronized with triangle wave |
| TP8 | TP7 | — | ± 7 V clock signal @ 24 KHz, 100K ohm source |
| TP8 | TP9 | Special (normally not used) | — |
| TP8 | TP10 | Special (normally not used) | — |
| TP12 | TP11 | 0.7 Vac P-P, output frequency | — |
| TP12 | TP13 | 4-20 mAdc analog output current | — |

Note: If the voltage across R41 is less than .40 Vdc it may indicate the wiring to the flowhead is open. If the voltage at TP2 is greater than .50 Vdc it may indicate a short in the flowhead wiring.

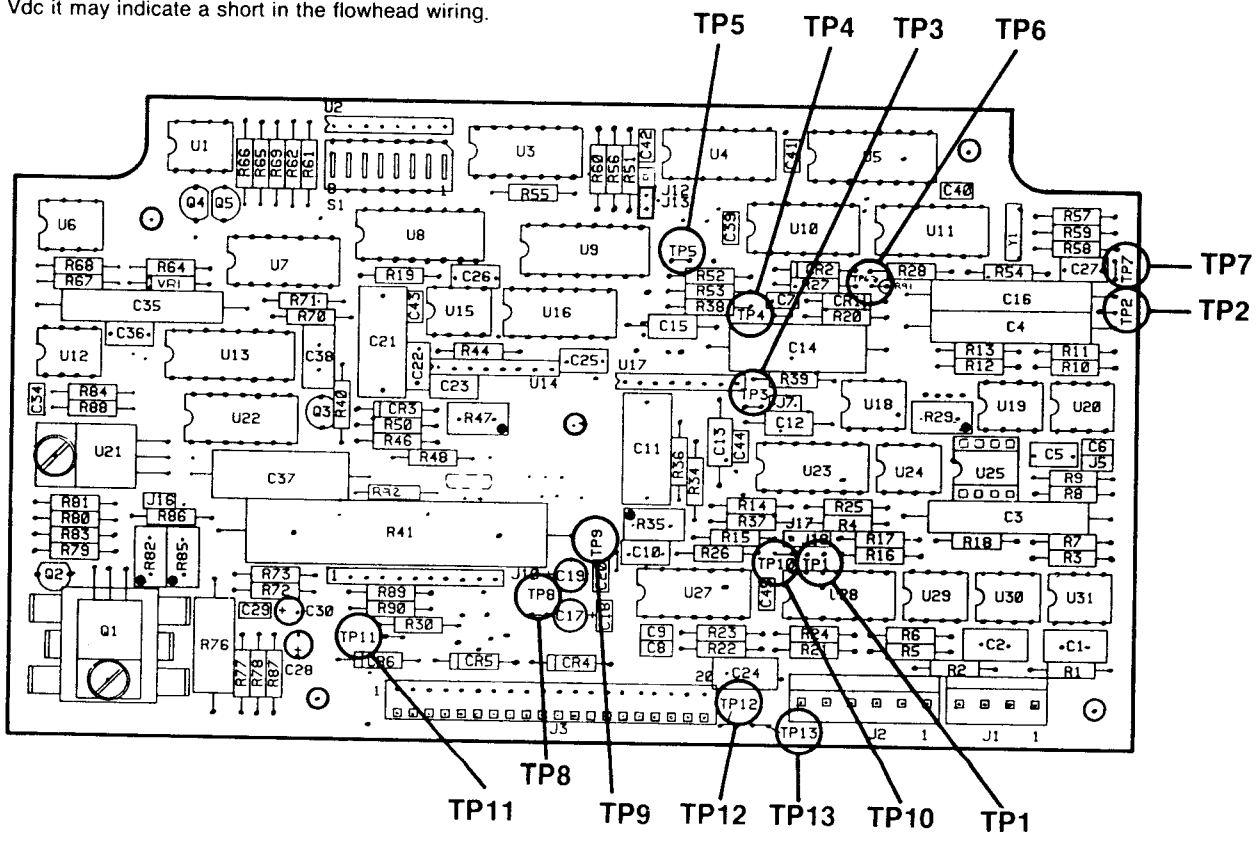



Figure 5-1 Troubleshooting Test Points — Signal Conditioning Board

**Table 6-1 Jumper Table**

| Board | Jumper | Type | Function |
|---|---|---|---|
| Power Supply Board | J1 | 11 & key | Main I/O connector |
| | J2 | 20 | Inter-board connector strip |
| | J3 | 6 & key | Coil jumper plug |
| | J4 | 6 | Power, 115/230Vac or 20 Vdc |
| | J5 | 3 | Transistor interconnect (Q1) |
| | J6 | Jumper | TTL compatible digital output |
| Signal Control Board | J1 | 4 | Electrode Input |
| | J2 | 6 | Coil w/calibrator I/O |
| | J3 | 20 | Inter-board connector strip |
| | J5 | Jumper | Damping jumper |
| | J7 | Jumper | Course span, meters/feet |
| | J12/13 | Jumper | Forward/reverse flow mode |
| | J16 | Jumper | Coarse analog span |
| | J17/18 | Jumper | Offset, flow head + and - |
| | R29 | Pot | Offset, flow head + and - |
| | R34 | Pot | Test, calibration |
| | R47 | Pot | Calibration (12 Khz pulses) |
| | R82 | Pot | ZERO, Analog zero bias (4mAdc) |
| | R85 | Pot | SPAN, Analog span adjust (20 mAdc) |
| | U25 | | Signal response time (100 kOhm std) |
| | S1-1 | sw | S1-1 thru S1-8 are used to set coil drive frequencies. The normal coil drive is 37-½ Hz. S1-4 on, Balance off. |
| | -2 | sw | |
| | -3 | sw | |
| | -4 | sw | |
| | -5 | sw | |
| | -6 | sw | |
| | -7 | sw | |
| | -8 | sw | |
| Factor Option Board | J1 | 11 | Inter-board connector strip |
| | J2 | 5 | Flow head interconnect cable |
| | S1-4 | sw | Digital factor, X.XXX units/sec |
| | S5 | 8 | Digital scaler, self calibration |
| **NOTE: For S5-1 thru S5-5 use only one position** | | | |
| | -1 | sw | X.XXX0 Divide By 1 |
| | -2 | sw | XX.XX0 Divide By 10 |
| | -3 | sw | XXX.X0 Divide By 100 |
| | -4 | sw | XXXX.0 Divide By 1000 |
| | -5 | sw | XXXX0. Divide By 10.000 |
| | -6 | sw | Analog calibration mode |
| | -7 | sw | Analog zero, calibration mode |
| | -8 | sw | Analog span, calibration mode |
| | S6-9 | 4 | Analog factor, X.XXX units/sec |

## 6-1 FMG-700 Series Range Calibration Procedure (Power is not required)

A. Disconnect power to the magmeter. Unbolt and open the electronics cover.

B. The FMG-700 Series has been provided with a jumper (J12/13) on Signal Conditioning Board which allows the meter to be reversed electrically. With the jumper in the J13 position the electronics are set for forward flow (normal), while the J12 position is used for reverse flows.

C. The FMG-700 Series is normally supplied as a three board module which includes a power supply, signal conditioning and factor board, refer to Figure 6-1. The K-factor, unless otherwise specified, is expressed in pulses per gallon in the meters/second mode. If the meter is only to be operated in the lower one third (⅓) of the specified range, an improvement in low flow performance will be realized by removing the RANGE JUMPER J7. Jumper J7 is located on the signal conditioner board, refer to Figure 6-2 and Table 6-1.

R. Factor = 1.000 for meters/second mode, (J7 installed)

R Factor = 3.281 for feet/second mode, (J7 removed)

D. The FACTOR BOARD, refer to Figure 6-3, allows you to factor the analog or digital output. Refer to the following equations for the analog and digital factors to use.

$$\text{The Analog Factor} = \frac{\text{Desired GPM x K Factor x R Factor}}{60{,}000}$$

Select Analog Factor value using switches S6, S7, S8, and S9 on the Factor Output Board (the top board in the three board module).

NOTE: The Analog Factor should fall between 1.000 and 10.000.

$$\text{The Digital Factor} = \frac{\text{K Factor x R Factor}}{\text{Desired pulses per unit volume}}$$

Select the Digital Factor value using switches S1, S2, S3 and S4 on the Factor Output Board (the top board on the three board module). Select the location of the decimal point using S5 on the Factor Board (top board of the three board module) as shown:

S5-1 = x.xxx0 ÷ 1
S5-2 = xx.xx0 ÷ 10
S5-3 = xxx.x0 ÷ 100
S5-4 = xxxx.0 ÷ 1,000
S5-5 = xxxx0. ÷ 10,000

NOTE: Use only one switch to set decimal scaling.

## 6-2 FMG-700 Series Maintenance Calibration (using built-in standards)

Calibration equipment required: Digital multi-meter

A. Analog Calibration, using built in standards: The Analog Factor circuit can be used to calibrate the Analog Output Current Generator.

B. Disconnect power to the flowmeter. Unbolt and open the electronics cover.

1. Set S5-6, S5-7, S5-8 to "ON".
2. Set the Analog Factor on switches S6, S7, S8 and S9 to C.000 (C = 12 in hexadecimal).
3. Reconnect power to the flowmeter. Read the Analog Current between TP13 (+) and TP12 (-), located on the Signal Conditioning Board (the center board of the three board module), near the electrode input connector, refer to Figure 5-1.
4. The Analog Zero/Span Potentiometers are located on the Signal Conditioning Board (center board), and are accessible through holes in the Factor Option Board, refer to Figure 6-2.
5. Adjust the "Z" potentiometer until the output at TP12 at TP13 is 4.000 mA dc.
6. Turn S5-7 "ZERO" off and adjust the "S" potentiometer until the output at TP12 and TP13 is 20.000 mAdc.
7. Remove power from the flowmeter. Turn S5-6, S5-7 and S5-8 off and re-enter the Analog Factor into the factor switches.

C. Power-up and return to normal service. This concludes the calibration procedure using the built-in standard.

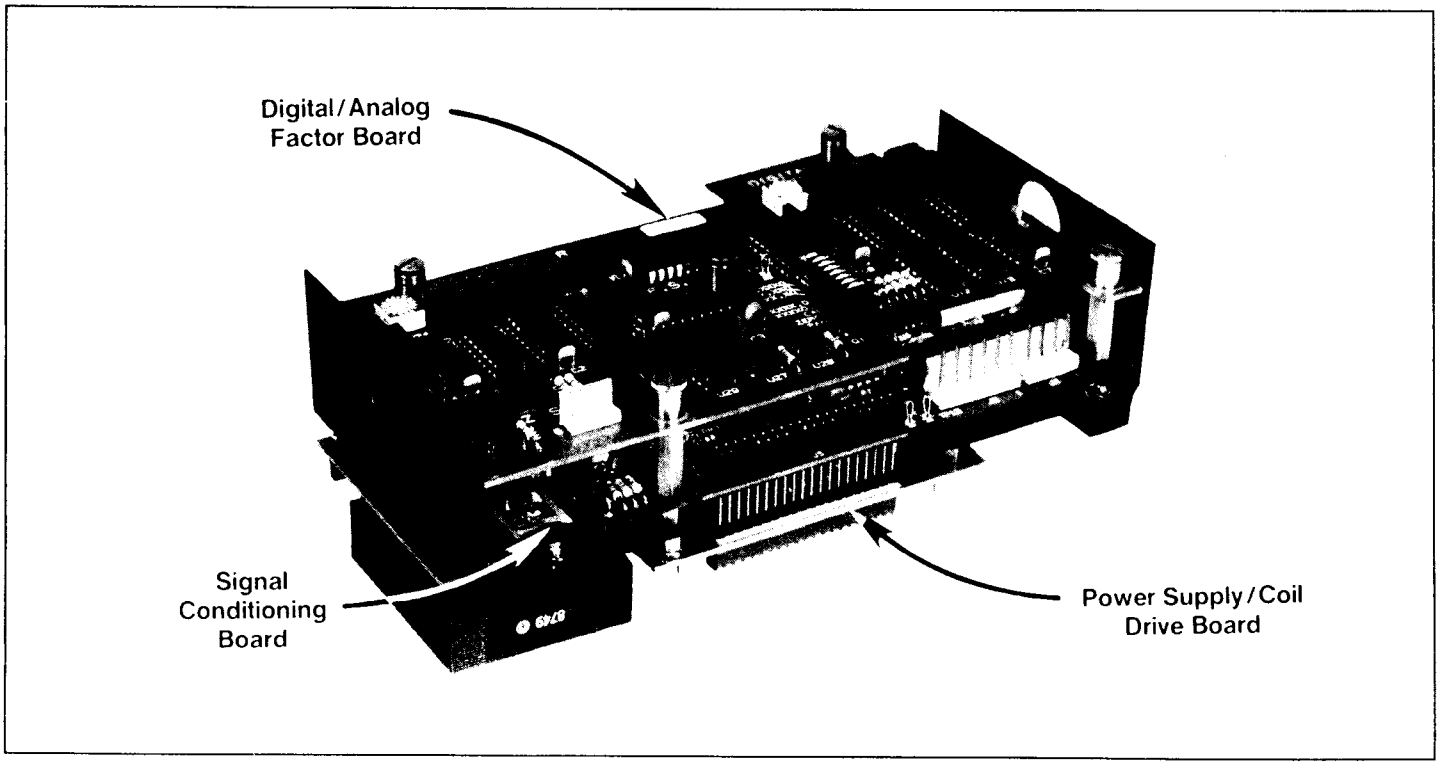



**Figure 6-1 Support Bracket and Electronic Module Assembly**

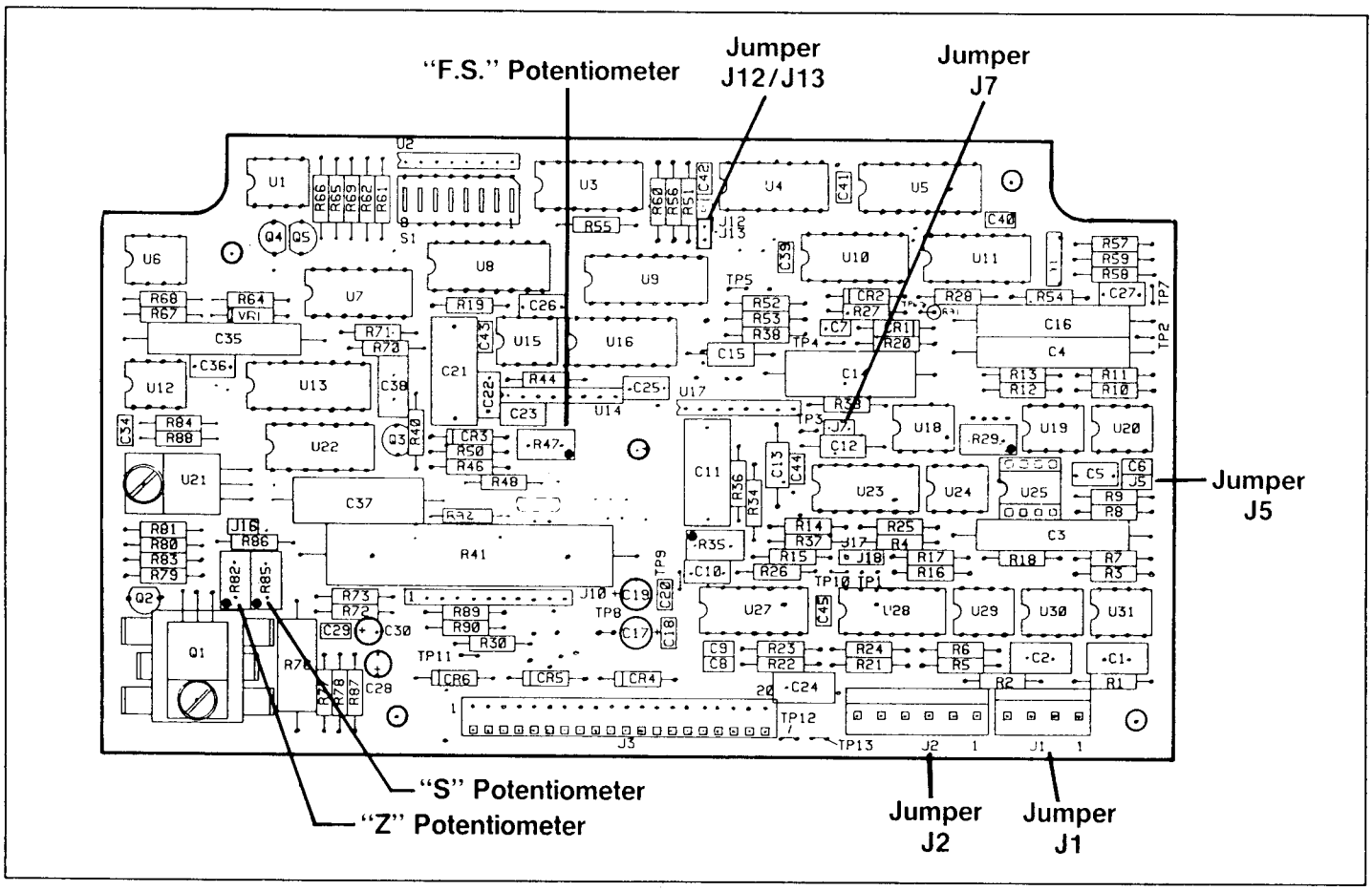



Figure 6-2 Signal Conditioner Board

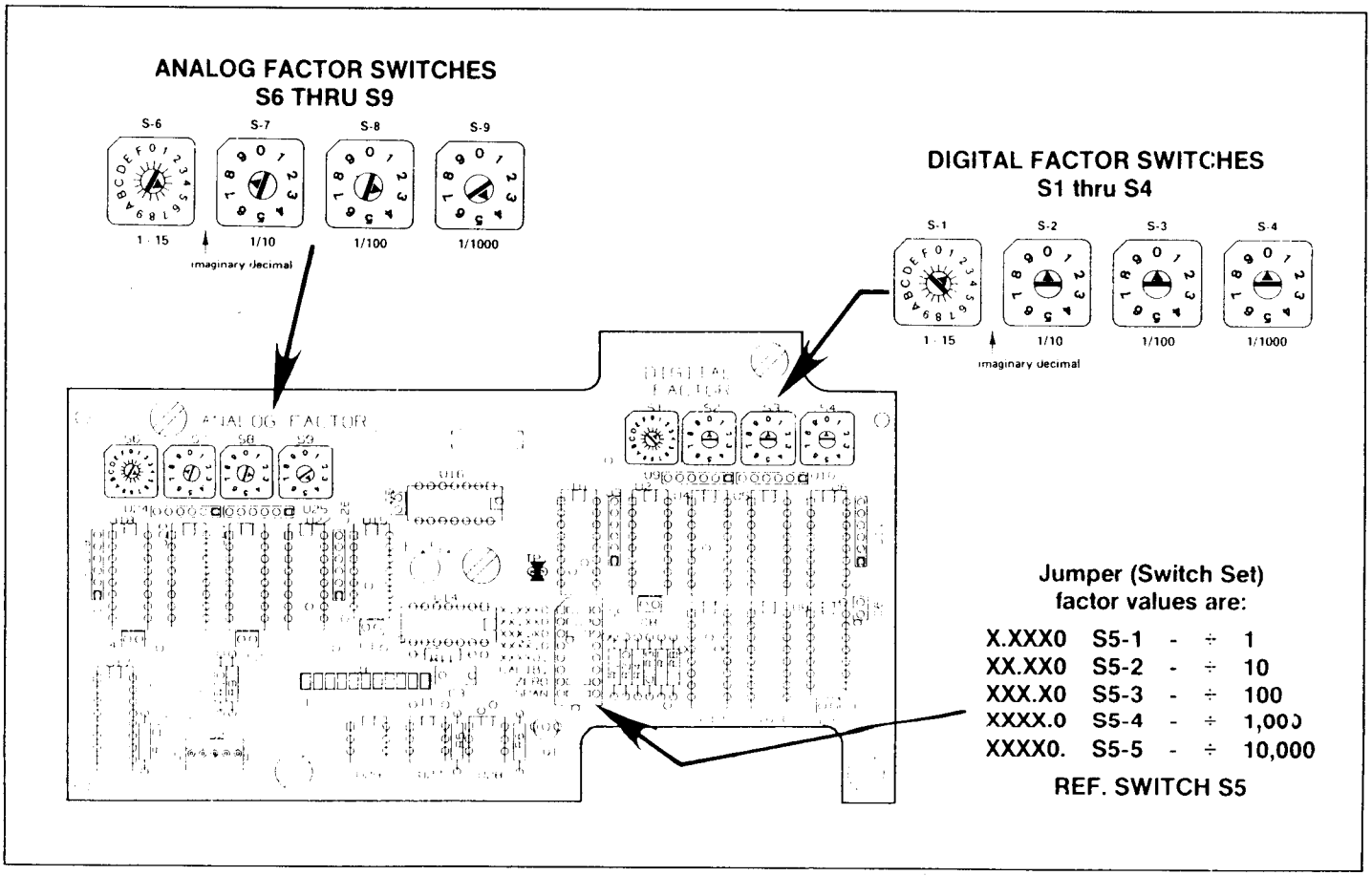



Figure 6-3 Factor Option Board Switches

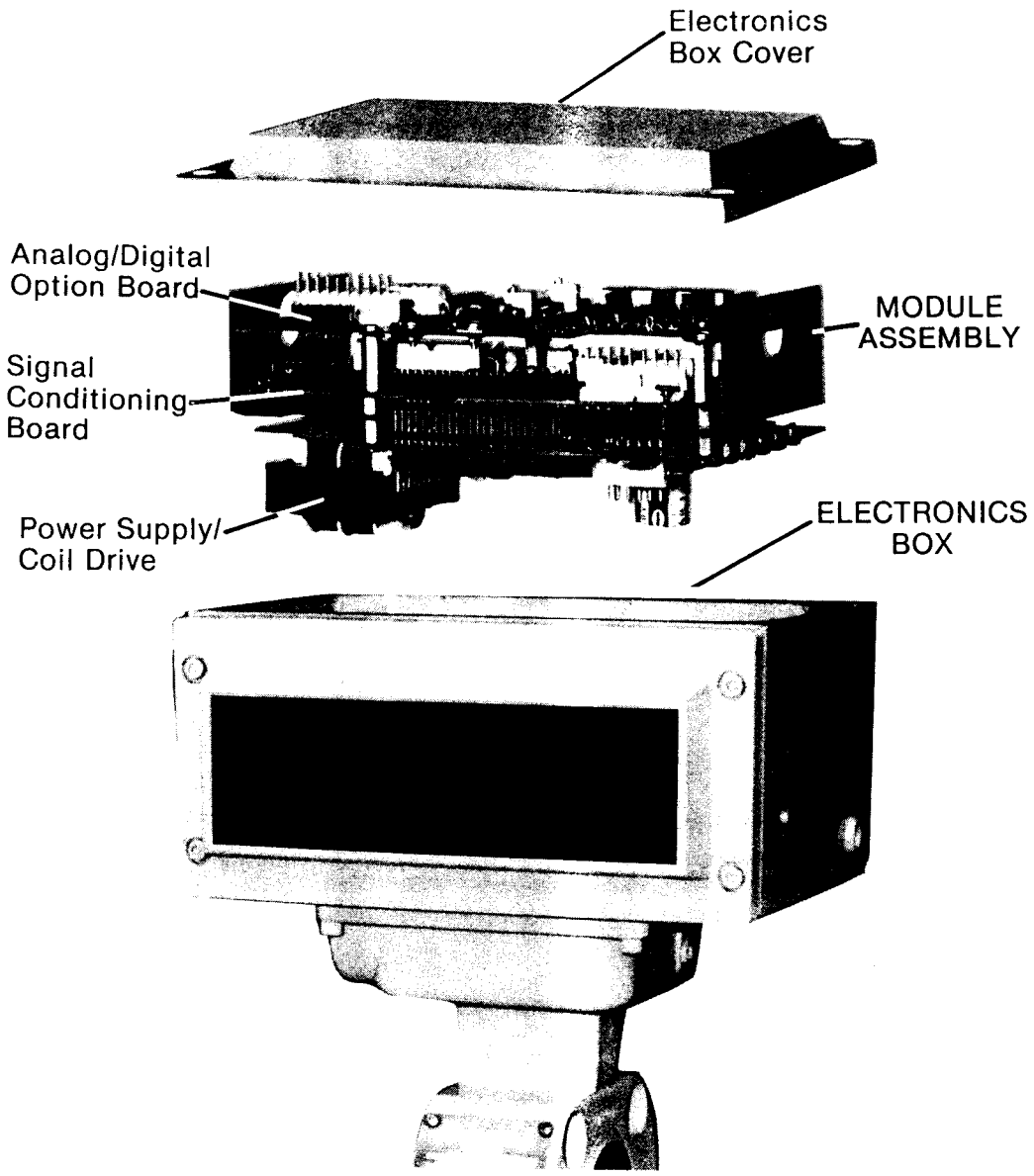



**Figure 6-4 Electronics Box Assembly**

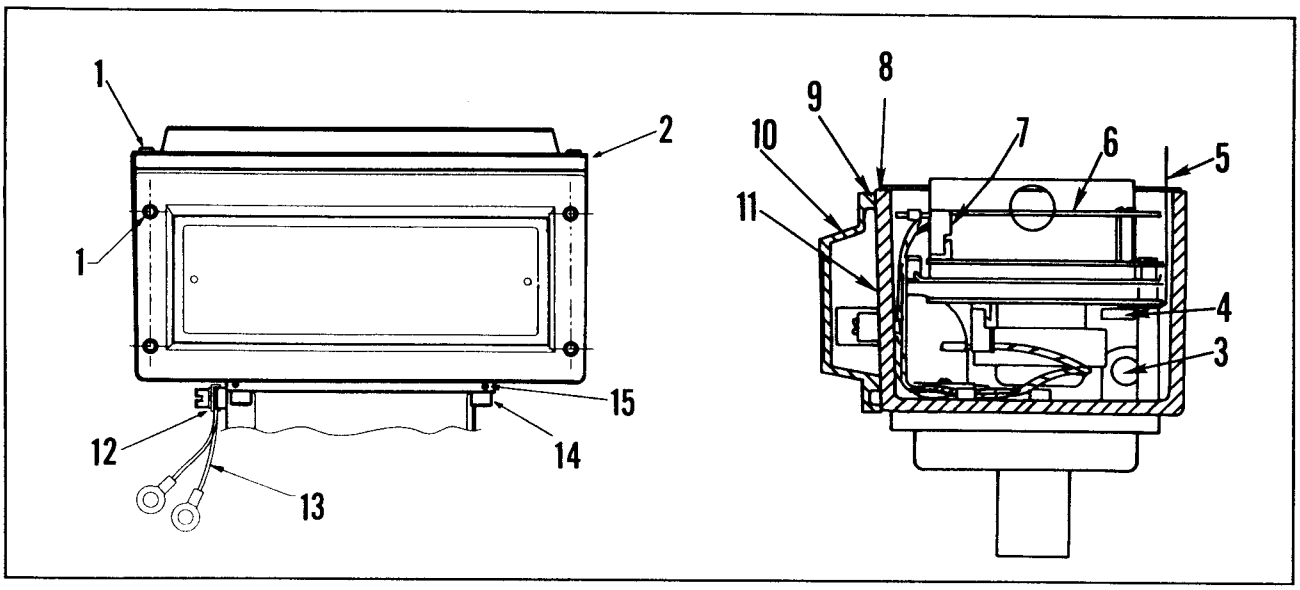



**Figure 7-2 Integral Electronics Box Assembly — All Sizes**

**Table 7-2 Parts List Electronics Box Assembly**

| Item No. | No. Req. | Description | Part Number |
|---|---|---|---|
| 1 | 8 | Screw | 151087 |
| 2 | 1 | Top Cover | HD-219Z-279-FYG |
| 3 | 2 | Pipe Plug | 157120-419 |
| 4 | 1 | Voltage Program Plug<br>115 Vac<br>230 Vac<br>20 Vdc | <br>HS-273E-233-AAA<br>HS-273E-235-AAA<br>HS-273E-237-AAA |
| 5 | 1 | Label (Voltage Program Plug) | HB-502Z-961-AAA |
| 6 | 1 | Module Assembly | HS-273E-245-AAA |
| 7 | 1 | Coil/Calibrator Jumper | HS-273E-133-AAA |
| 8 | 1 | O-ring (Top Cover) | 157380 |
| 9 | 1 | O-ring (Front Cover) | 157379 |
| 10 | 1 | Front Cover | HC-219Z-278-FYG |
| 11 | 1 | Terminal Strip Label (Integral) | HA-502Z-698-EHA |
| 12 | 1 | Grounding Clamp | B18934-004 |
| 13 | 1 | Grounding Strap | HS-969Z-709-AAA |
| 14 | 4 | Screw | 151488 |
| 15 | 4 | O-ring | 156956 |
| Ø | 2 | .15" Flowhead Gasket EFR | HA-375F-254-SYA |
| Ø | 2 | .15" Flowhead Gasket Fluorax | HA-375Z-254-AAA |
| Ø | 2 | .30" Flowhead Gasket *EPR | HA-375Z-254-SYA |

Ø Not Pictured
For Use With Ryton Flowtube Only

* EPR Ethylene Propylene Rubber

MADE IN USA

## WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA 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 should malfunction, 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. However, this WARRANTY is VOID, if the unit shows evidence of having been tampered with or shows evidence of being 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 or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

**OMEGA is glad to offer suggestions on the use of its various products. Nevertheless, OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.**

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SPECIAL CONDITION: Should this equipment be used in or with any nuclear installation or activity, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the equipment in such a manner.

## RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING 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.

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

1. P.O. 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 OR **CALIBRATION,** consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contaction OMEGA:

1. P.O. number to cover the COST of the repair/calibration,
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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# Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

## TEMPERATURE

- ☑ Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- ☑ Wire: Thermocouple, RTD & Thermistor
- ☑ Calibrators & Ice Point References
- ☑ Recorders, Controllers & Process Monitors
- ☑ Infrared Pyrometers

## PRESSURE/STRAIN FORCE

- ☑ Transducers & Strain Gages
- ☑ Load Cells & Pressure Gauges
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

## FLOW/LEVEL

- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

## pH/CONDUCTIVITY

- ☑ pH Electrodes, Testers & Accessories
- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
- ☑ Industrial pH & Conductivity Equipment

## DATA ACQUISITION

- ☑ Data Acquisition and Engineering Software
- ☑ Communications-Based Acquisition Systems
- ☑ Plug-in Cards for Apple, IBM & Compatibles
- ☑ Datalogging Systems
- ☑ Recorders, Printers & Plotters

## HEATERS

- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

## ENVIRONMENTAL MONITORING AND CONTROL

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments

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